Sat. Jun 5, 2021

[E] Poster | U (Union)：Union

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.01_1

[U-13] Advanced understanding of Quaternary and Anthropocene hydroclimate changes in East Asia:

convener:Li Lo(Department of Geosciences, National Taiwan University), Kaoru Kubota(Graduate School of Human Development and Environment, Kobe University), Chuan-Chou Shen(National Taiwan University), Yusuke Yokoyama(Atmosphere and Ocean Research Institute, University of Tokyo)

[U13-P01] Sclerochronology and geochemistry of *Mercenaria stimpsoni* collected from the western North Pacific

*Kaoru Kubota[1], Kotaro Shirai[2], Naoko Sugihara[2], Koji Seike[3], Kazushige Tanabe[4], Masayo Minami[5], Toshio Nakamura[5] (1.Graduate School of Human Development and Environment, Kobe University, 2.Atmosphere and Ocean Research Institute, The University of Tokyo, 3.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, 4.The University Museum, The University of Tokyo, 5.Institute for Space-Earth Environmental Research, Nagoya University)

[U13-P02] **Radiocarbon Variability Recorded in Coral from Kikai Island to Understand Oceanography in the North Pacific Region**

★Invited Papers

*Yuning Zeng[1], Yusuke Yokoyama[1], Yosuke Miyairi[1], Shoko Hirabayashi[2], Atsushi Suzuki[3] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Faculty of Geo-Environmental Science, Rissho University, 3.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST))

[U13-P03] Anthropocene signals recorded as Plutonium isotopes and Cesium-137 in Beppu Bay marine sediments, Eastern Kyushu, Japan.

*Yusuke Yokoyama[1,2,3,4,5], Stephen Tims[5], Michaela Froehlich[5], Takahiro AZE[1], Keith Fifield[5], Shoko Hirabayashi[6], Dominik Knoll[5], Michinobu Kuwae[7], Yosuke Miyairi[1], Stefan Pavetich[5] (1.Atmosphere and Ocean Research Institute, University of Tokyo, 2.Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, 3.Graduate Program on Environmental Sciences, Graduate School of Arts and Sciences, The University of Tokyo, 4.Biogeochemistry Program, Japan Agency for Marine-Earth Science and Technology, 5.Research School of Physics, The Australian National University, 6.Faculty Geo-Environmental Science, Rissho University, 7.Center for Marine Environmental Studies, Ehime University)

[U13-P04] High-resolution marine surface $\Delta^{14}C$ reconstructions using marine organisms produced carbonate attached to tetrapod ashored by high-wave in northern Pacific Coast of Japan.

*Kai Leggett[1], Yusuke Yokoyama[1], Yosuke Miyairi[1], Ota Kosuke[1], Yoshiki Shirahama[2] (1.Atmosphere and Ocean Research Institute, University of Tokyo, 2.Advanced Industrial Science and Technology, Geological Survey of Japan, Research Institute of Earthquake and Volcano Geology, Active Fault Research Group)

[U13-P05] Bronze age megadrought and Trans-Eurasian culture exchange

★Invited Papers

*Liangcheng Tan[1,2,3,4], Guanghui Dong[5], Zhisheng An[1,2,4], Lawrence R. Edwards[6,7], Haiming li[8], Dong Li[9], Robert Spengler[10], Yanjun Cai[3], Hai Cheng[3,1], Jianghu Lan[1,2], Rustam Orozbaev[11,12], Ruiliang Liu[13], Jianhui Chen[5], Hai Xu[14], Fahu Chen[15] (1. Institute of Earth Environment, Chinese Academy of Sciences, 2. Center for Excellence in Quaternary Science and Global Change, Chinese Academy of Sciences, 3.Institute of Global Environmental Change, Xi'an Jiaotong University, 4.Open Studio for Oceanic-Continental Climate and Environment Changes, Pilot National Laboratory for Marine Science and Technology (Qingdao), 5. College of Earth and Environmental Sciences, Lanzhou University, 6.Department of Earth and Environmental Sciences, University of Minnesota, 7. School of Geography, Nanjing Normal University, 8.Institution of Chinese Agricultural Civilization, Nanjing Agricultural University, 9.Library of Chang'an University, 10. Max Planck Institute for the Science of Human History, 11.Research Center for Ecology and Environment of Central Asia (Bishkek), Chinese Academy of Sciences, 12. Institute of Geology, National Academy of Sciences of Kyrgyz Republic, 13. School of Archaeology, University of Oxford, 14.Institute of Surface-Earth System Science, Tianjin University, 15.Key Laboratory of Alpine Ecology and Biodiversity, Institute of Tibetan Plateau Research, Chinese Academy of Sciences)

[U13-P06] **A gradual transition into Greenland Interstadial 14 in southeastern China based on a sub-decadally-resolved stalagmite record**

★Invited Papers

*Xin Zhang[1], Xiuyang Jiang[1,2], Haiyan Xiao[2], Binggui Cai[1,2], Tsai-Luen Yu[3,4], Chuan-Chou Shen[3,4,5] (1.Key Laboratory of Humid Subtropical Eco-geographical Processes, Ministry of Education, College of Geography Science, Fujian Normal University, 2.Institute of Geography, Fujian Normal University, 3.High-Precision Mass Spectrometry and Environment Change Laboratory (HISPEC), Department of Geosciences, National Taiwan University, 4.Research Center for Future Earth, National Taiwan University, 5.Global Change Research Center, National Taiwan University)

[U13-P07] Beppu Bay stratigraphy records the timing of human-induced planetary-scale biological and environmental shift at the beginning of the Anthropocene

★Invited Papers

*Michinobu Kuwae[1], Narumi Tsugeki[2], Atsuko Amano[3], Testuro Agusa[4], Yoshiaki Suzuki[3], Jun Tsutsumi[7], Peter R. Leavitt[5], Kotaro Hirose[6] (1.Center for Marine Environmental Studies, 2. The Faculty of Law, Matsuyama Univesity, Matsuyama, 3.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, 4.Faculty of Environmental & Symbiotic Sciences, Prefectural University of Kumamoto, 5.Department of Biology,University of Regina, 6.Faculty of Science & Engineering, Waseda University, 7.School of Life and Environmental Science, University of Tsukuba)

[U13-P08] The series of precious coral samples collected from off the southwest coast of Kochi Prefecture: one potential thousand-scale proxy for understanding subsurface ocean conditions.

★Invited Papers

*Tomoyo Okumura[1], Fujio Kumon[1], Tokuyama Hidekazu[1] (1.Center for Advanced Marine Core Research, Kochi University)

[U13-P09] Impact of human activities and natural hazards recorded in a subtropical mountain lake, northeastern Taiwan

★Invited Papers

*Tsai-wen Lin[1], Stefanie Kaboth-Bahr[2], Kweku Afrifa Yamoah[3], André Bahr[4], George Burr[1], Chih-Chieh Su[5], Liang-Chi Wang[6], Ludvig A Lowemark[1] (1.Dept. of Geosciences, NTU, 2.Institute for Geosciences, Univ. of Potsdam, 3.School of Geography, Earth & Environmental Sciences, Univ. of Birmingham, 4.Institute of Earth Sciences., Heidelberg Univ., 5.Institute of Oceanography, NTU, 6.Dept. of Earth and Environmental Sciences, NCCU)

[U13-P10] Reconstruction of ventilation ages of the Indian Ocean sector of the Southern Ocean using ^{14}C and U-Th ages of deep-sea isidid octocorals

★Invited Papers

*Yukiko Kozaka[1], Chuan-Chou (River) Shen[2], Hiroshi Sato[3], Masayo Minami[1], Yuki Tokuda[4], Minoru Ikehara[5] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Department of Geosciences, National Taiwan University, 3.School of Business Administration, Senshu University, 4.Faculty of Environmental Studies, Tottori University of Environmental Studies, 5.Center for Advanced Marine Core Research, Kochi University)

[U13-P11] **North Atlantic cooling desiccated western India during Early Holocene: Evidence-based on clumped and stable oxygen isotope analysis of Gastropod**

*THAMIZHARASAN SAKTHIVEL[1,2], PROSENJIT GHOSH[1,2], YOGARAJ BANERJEE[1] (1.Centre for Earth Sciences, Indian Institute of Science, Bangalore, India -560012, 2.Divecha Centre for Climate Change, Indian Institute of Science, Bangalore, India -560012)

[E] Poster | P (Space and Planetary Sciences)：P-PS Planetary Sciences

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.02_1

[P-PS03] Regolith Science

convener:Koji Wada(Planetary Exploration Research Center, Chiba Institute of Technology), Akiko Nakamura(Graduate School of Science, Kobe University), Patrick Michel(Universite Cote D Azur Observatoire De La Cote D Azur CNRS Laboratoire Lagrange), John Kevin Walsh(Southwest Research Institute Boulder)

[PPS03-P01] Disk-resolved photometric properties of local regions on asteroid 25143 Itokawa

*Naru Hirata[1,2], Kohei Kitazato[1,2], Eri Tatsumi[3], Shota Katahira[1], Takuma Furudate[1], Hiroshi Kikuchi[4], Hiroyuki Sato[4] (1.Dep. of Computer Science and Engineering, Univ. of Aizu, 2.ARC-Space, Univ of Aizu, 3.Instituto de Astrofisica de Canarias, 4.Japan Aerospace Exploration Agency)

[PPS03-P02] Experimental study on impact ejecta velocity scaling law for regolith layer composed of weak boulders

*Yuya Yamamoto[1], Masahiko Arakawa[1], Minami Yasui[1], Sunao Hasegawa[2], Yusaku Yokota[1], Hatsune Okawa[1], Ryo Sugimura[1] (1.Graduate School of Science, Kobe University, 2.institute of Space and Astronautical Science, JAXA)

[PPS03-P03] Particle size of Ryugu's subsurface layer inferred from observation of SCI crater's ejecta curtain.

*Koji Wada[1], Ko Ishibashi[1], Hiroshi Kimura[1], Masahiko Arakawa[2], Hirotaka Sawada[3], Kazunori Ogawa[4,2], Kei Shirai[2], Rie Honda[5], Yuichi Iijima[3], Toshihiko Kadono[6], Naoya Sakatani[7], Yuya Mimasu[3], Tomoaki Toda[3], Yuri Shimaki[3], Satoru Nakazawa[3], Hajime Hayakawa[3], Takanao Saiki[3], Yasuhiko Takagi[8], Hiroshi Imamura[3], Chisato Okamoto[2], Masahiko Hayakawa[3], Naru Hirata[9], Hajime Yano[3] (1.Planetary Exploration Research Center, Chiba Institute of Technology, 2.Department of Planetology, Kobe University, 3.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 4.JAXA Space Exploration Center, Japan Aerospace Exploration Agency, 5.Department of Science and Technology, Kochi University, 6.Department of Basic Sciences, University of Occupational and Environmental Health, 7.Department of Physics, Rikkyo University, 8.Aichi Toho University, 9.School of Computer Science and Engineering, The University of Aizu)

[PPS03-P04] Ryugu's surface change formed by SCI forward debris

*Yuri Shimaki[1], Yasuhiro Yokota[1], Rie Honda[2], Masahiko Arakawa[3], Koji Wada[4], Toshihiko Kadono[5], Kei Shirai[3], Kazunori Ogawa[6], Naoya Sakatani[7], Ko Ishibashi[4], Takanao saiki[1], Hiroshi Imamura[1], Satoru Nakazawa[1], Masahiko Hayakawa[1], Hajime Yano[1], Yasuhiko Takagi[8], Naru Hirata[9], Hirotaka Sawada[1], Seiji Sugita[10], Tomokatsu Morota[10], Shingo Kameda[7], Eri Tatsumi[11], Manabu Yamada[4], Toru Kouyama[12], Yuichiro Cho[10], Moe Matsuoka[1], Kazuo Yoshioka[10], Hidehiko Suzuki[13], Chikatoshi Honda[9] (1.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 2.Kochi University, 3.Kobe University, 4.Planetary Exploration Research Center, Chiba Institute of Technology, 5.University of Occupational and Environmental Health, 6.JAXA Space Exploration Center, Japan Aerospace Exploration Agency, 7.Rikkyo University, 8.Aichi Toho University, 9.The University of Aizu, 10.The University of Tokyo, 11.Instituto de Astrofisica de Canarias, University of La Laguna, 12.National Institute of Advanced Industrial Science and Technology, 13.Meiji University)

[PPS03-P05] Static and impact strength of brittle regolith analogs

*Akiko Nakamura[1], Sae Shigaki[1] (1.Graduate School of Science, Kobe University)

[E] Poster | P (Space and Planetary Sciences)：P-EM Solar-Terrestrial Sciences, Space Electromagnetism & Space Environment

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.03_1

[P-EM08] Space Weather and Space Climate

convener:Ryuho Kataoka(National Institute of Polar Research), A Antti Pulkkinen(NASA Goddard Space Flight Center), Kanya Kusano(Institute for Space-Earth Environmental Research, Nagoya University), Kaori Sakaguchi(National Institute of Information and Communications Technology)

[PEM08-P01] NASA Goddard Space Flight Center Space Weather Activities

*Antti A Pulkkinen[1] (1.NASA Goddard Space Flight Center)

[PEM08-P02] Relationship between X-ray and EUV solar flare emissions and the Dellinger phenomenon

*Kyoko Watanabe[1], Munechika Arao[1], Shohei Nishimoto[1], Chihiro Tao[2], Michi Nishioka[2] (1.National Defense Academy of Japan, 2.National Institute of Information and Communications Technology)

[PEM08-P03] A comparative study of the empirical and physics-based methods for solar flare predictions

*Kaho Kondo[1], Kanya Kusano[1] (1.Institute for Space-Earth Environmental Research, Nagoya University)

[PEM08-P04] Data-driven MHD Simulation of Solar Active Region NOAA 11283

*Yeongmin Kang[1], Takafumi Kaneko[1], Kanya Kusano[1] (1.Institute for Space-Earth Environmental Research)

[PEM08-P05] Unusual enhancement of ~30 MeV proton flux in an ICME sheath region

*Takahiro Obara[1], Mitsuo Oka[2], Nariaki V Nitta[3], Seiji Yashiro[4], Daikou Shiota[5], Kiyoshi Ichimoto[6] (1.Planetary Plasma and Atmospheric Research Center,Tohoku University, 2.University of California Berkeley, 3.Lockheed Martin Solar and Astrophysics Laboratory, 4.The Catholic University of America, 5.National Institute of Information and Communications Technology, 6.Kyoto University)

[PEM08-P06] Development of spectral riometer for observation of energetic electron precipitation at Syowa Station, Antarctica

*Yoshimasa Tanaka[1,2,3], Masayuki Yamamoto[4], Koji Nishimura[1,2,3], Hisao Yamagishi[1], Antti Kero[5], Akira Kadokura[1,2,3], Akira Mizuno[6], Akira Sessai Yukimatu[1,3], Herbert Akihito Uchida[3], Ryuho Kataoka[1,3], Yasunobu Ogawa[1,2,3], Takanori Nishiyama[1,3], Masaki Tsutsumi[1,3], Mitsunori Ozaki[7], Yoshizumi Miyoshi[6], Shin-ichiro Oyama[6], Fuminori Tsuchiya[8] (1.National Institute of Polar Research, 2.Polar Environment Data Science Center, Joint Support-Center for Data Science Research, Research Organization of Information and Systems, 3.The Graduate University for Advanced Studies, SOKENDAI, 4.National Institute of Information and Communications Technology, 5.Sodankyla Geophysical Observatory, 6.Institute for Space-Earth Environmental Research, Nagoya University, 7.Faculty of Electrical and Computer Engineering, Institute of Science and Engineering, Kanazawa University, 8.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University)

[PEM08-P07] Auroral oval in the last 3000 years and future

*Ryuho Kataoka[1], Shin ya Nakano[2] (1.National Institute of Polar Research, 2.The Institute of Statistical Mathmatics)

[PEM08-P08] Solar cycles around the onset of the Maunder Minimum

*Hiroko Miyahara[1], Fuyuki Tokanai[2], Toru Moriya[2], Mirei Takeyama[2], Hirohisa Sakurai[2], Kazuho Horiuchi[3], Hideyuki Hotta[4] (1.College of Art and Design, Musashino Art University, 2.Faculty of Science, Yamagata University, 3.Graduate School of Science and Technology, Hirosaki University, 4.Graduate School of Science, Chiba University)

[PEM08-P09] Simultaneous observation of cosmic rays with muon detector and neutron monitor at the Syowa station in the Antarctic

*Chihiro Kato[1], Kazuoki Munakata[1], Akira Kadokura[2], Ryuho Kataoka[2], Shoko Miyake[3], Paul Evenson[4], Shunta Asano[1] (1.Shinshu University, 2.National Institute of Polar Research, 3.National Institute of Technology, Ibaraki College, 4.University of Delaware)

[PEM08-P10] Measurement of cosmogenic 10Be in endogenic travertine deposits at Baishuitai

*Hiroko Miyahara[1], Hongyang Xu[2], Limin Zhou[2], Kazuho Horiuchi[3], Hiroyuki Matsuzaki[4] (1.College of Art and Design, Musashino Art University, 2.East China Normal University, 3.Hirosaki University, 4.The University Museum, The Univ. of Tokyo)

[PEM08-P11] Be-7 in Japan, Iceland and Thailand during solar cycle 24 descent phase

*Hirohisa Sakurai[1], Youmei Kawamura[1], Souichiro Suzuki[1], Fuyuki Tokanai[1], Emiko Inui[1], Mirei Takeyama[1], Toru Moriya[1], Satosi Kikuchi[1], Fusa Miyake[2], Akira Kadokura[3], Natsuo Sato[3], Naoko Sugihara[6], Bjornsson Gunnlaugur[4], David Ruffolo[5], Warit Mitthumsiri[5], Ronald Macatangay[7] (1.Yamagata University, 2.ISEE, Nagoya University, 3.National Institute of Polar Research, 4.Science Institute, Iceland University, 5.Department of Physics, Mahidol University, 6.Department of Chemical Oceanography Atmosphere and Ocean Research Institute,The University of Tokyo, 7.National Astronomical Research Institute of Thailand)

[PEM08-P12] Forecast of energetic electron flux variations of the outer belt using the machine learning

*Satoshi Fukuoka[1], Yoshizumi Miyoshi[1], Daikou Shiota[2], Shinji Saito[4], Takefumi Mitani[3], Tomoaki Hori[1], Nana Higashio[3], Shun Imajo[1], Iku Shinohara[3] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.National Institute of Information and Communications Technology (NICT), 3.Japan Aerospace Exploration Agency, Institute of Space and Astronautical Science, 4.National Institute of Information and Communications Technology)

[PEM08-P13] Spacecraft surface charging environment in the medium earth orbit

*Masao Nakamura[1], Kosei Nagasawa[1] (1.Osaka Prefecture University)

[PEM08-P14] Active Region Detection in the HMI magnetograms using the Mask R-CNN technique

*Akito Komatsu[1], Yusuke Iida[1] (1.Niigata University)

[PEM08-P15] Operations of Solar Flare Prediction Model Using Deep Neural Networks

*Naoto Nishizuka[1], Yuki Kubo[1], Komei Sugiura[2], Mitsue Den[1], Mamoru Ishii[1] (1.National Institute of Information and Communications Technology, 2.Keio University)

[PEM08-P16] Empirical/physical-based modeling of three-dimensional outer radiation belt for real-time operation

*Shinji Saito[1], Kaori Sakaguchi[1], Yuki kubo[1] (1.National Institute of Information and Communications Technology)

[PEM08-P17] **Mid-term Research Plan of NICT Space Weather Monitoring and Forecast**

*Mamoru Ishii[1] (1.National Institute of Information and Communications Technology)

[PEM08-P18] Development of a prediction system of the sporadic E layer occurrence: Current status and future prospects

*Hiroyuki Shinagawa[1], Chihiro Tao[1], Hidekatsu Jin[1], Yasunobu Miyoshi[2], Hitoshi Fujiwara[3] (1.National Institute of Information and Communications Technology, 2.Kyushu University, 3.Seikei University)

[PEM08-P19] Economic impacts of atmospheric radiation storm on aircraft operations and potential use of space weather information

*Susumu Saito[1], Navinda Kithmal Wickramasinghe[1], Tatsuhiko Sato[2], Daikou Shiota[3] (1.Electronic Navigation Research Institute, National Institute of Maritime, Port, and Aviation Technology, 2.Japan Atomic Energy Agency, 3.National Institute of Information and Communications Technology)

[PEM08-P20] Status of the GEO-X (Geospace X-ray imager) mission

*Yuichiro Ezoe[1], Ryu Funase[2,6], Harunori Nagata[3], Yoshizumi Miyoshi[4], Hiroshi Nakajima[5], Ikuyuki Mitsuishi[4], Kumi Ishikawa[1], Munetaka UENO[6], Atsushi Yamazaki[6], Hiroshi Hasegawa[6], Makoto Mita[6], Masaki Fujimoto[6], Yasuhiro Kawakatsu[6], Takahiro Iwata[6], Kazuhisa Mitsuda[7], Junko Hiraga[8], Satoshi Kasahara[6], Hironori Sahara[1], Yoshiaki Kanamori[9], Kohei Morishita[10], Takefumi Mitani[6], Masaki Numazawa[11] (1.Tokyo Metropolitan University, 2.University of Tokyo, 3.Hokkaido University, 4.Nagoya University, 5.Kanto Gakuin University, 6.ISAS/JAXA, 7.NAOJ, 8.Kwansei Gakuin University, 9.Tohoku University, 10.Kyushu University, 11.RIKEN)

[PEM08-P21] Soft-X ray emissions from Geospace: Possible science objectives of GEO-X

*Yoshizumi Miyoshi[1], Yosuke Matsumoto[2], Yuichiro Ezoe[3] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Chiba University, 3.Tokyo Metropolitan University)

[PEM08-P22] Effects of Solar Proton Event on Global Lightning Activity

*Mitsuteru Sato[1], Ryuho Kataoka[2] (1.Department of Cosmoscience, Hokkaido University, 2.National Institute of Polar Research)

[PEM08-P23] Atmospheric electric field measurement for the study of space and atmospheric climate changes

*Masashi Kamogawa[1], Yasuhiro Minamoto[2], Akira Kadokura[3], Mitsuteru Sato[4] (1.Global Center for Asian and Regional Research, University of Shizuoka, 2.Laboratory for Environmental Research at Mount Fuji, 3.National Institute of Polar Research, 4.Hokkaido University)

[PEM08-P24] Current status of the new multi-frequency millimeter-wave spectrometer installed at Showa Station and initial results of multi-line observations

*Akira Mizuno[1], Daichi Tsutsumi[1], Takahiko Kosegaki[1], Hiroyuki Iwata[1], Kouki Satani[1], Taku Nakajima[1], Kohei Haratani[1], Tomoo Nagahama[1], Syoki Iriyama[1], Genma Mizoguchi[1], Shixun Fan[1], Naoto Sekiya[2], Takuma Hayashi[2], Masaki Tsutsumi[3], Yoshihiro Tomikawa[3], Mitsumu K. Ejiri[3], Kaoru Sato[4] (1.ISEE, Nagoya University, 2.University of Yamanashi, 3.National Institute of Polar Research, 4.University of Tokyo)

[PEM08-P25] Antarctica-based future space weather research project since 2022

*Ryuho Kataoka[1] (1.National Institute of Polar Research)

[PEM08-P26] Development of real-time prediction system of CME arrival and magnetic field with ensemble SUSANOO-CME simulation 2

*Daikou Shiota[1,4], Seiji Yashiro[2], Ryuho Kataoka[3], Kazumasa Iwai[4], Yusuke Ebihara[5], Kaori Sakaguchi[1], Yuki Kubo[1] (1.National Institute of Information and Communications Technology (NICT), 2.Catholic University of America, 3.National Institute of Polar Research, 4.Institute for Space-Earth Environmental Research, Nagoya University, 5.Research Institute for Sustainable Humanosphere, Kyoto University)

[PEM08-P27] Ionospheric storms in GAIA under lower atmospheric and magnetospheric inputs

*Chihiro Tao[1], Hidekatsu Jin[1], Hiroyuki Shinagawa[1], Yasunobu Miyoshi[2], Hitoshi Fujiwara[3] (1.National Institute of Information and Communications Technology, 2.Kyushu University, 3.Seikei University)

[PEM08-P28] The relevance between cosmic ray and ozone depletion

*Kazuyoshi Yamashita[1] (1.The Open University of Japan)

[PEM08-P29] Geomagnetically induced currents observed around solar minimum of Cycle 24

*Shinichi Watari[1], Satoko Nakamura[2], Yusuke Ebihara[3], Aoi Nakamizo[1] (1.National Institute of Information and Communications Technology, 2.Institute for Space-Earth Environmental Research, Nagoya University, 3.Research Institute for Sustainable Humanosphere, Kyoto University)

[E] Poster | P (Space and Planetary Sciences)：P-EM Solar-Terrestrial Sciences, Space Electromagnetism & Space Environment

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.04_1

[P-EM12] Dynamics of the Inner Magnetospheric System

convener:Kunihiro Keika(Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo), Yoshizumi Miyoshi(Institute for Space-Earth Environmental Research, Nagoya University), W Lauren Blum(University of Colorado Boulder), Yuri Shprits(Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences)

[PEM12-P01] Modulation of chorus intensity and UHR frequency in the off equatorial regions observed by the Arase satellite.

*Yuri Ampuku[1], Fuminori Tsuchiya[1], Yasumasa Kasaba[1], Satoshi Kurita[2], Yoshiya Kasahara[3], Shoya Matsuda[4], Atsushi Kumamoto[5], Ayako Matsuoka[6] (1.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 2.Research Institute for Sustainable Humanosphere, Kyoto University, 3.Graduate School of Natural Science and Technology, Kanazawa University, 4.Institute of Space and Astronautical Science, JAXA, 5.Graduate School of Science, Tohoku University, 6.Graduate School of Science, Kyoto University)

[PEM12-P02] Spatio-temporal characteristics of the precipitating electron energy of pulsating aurora and comparison with the numerical simulation

*Kohei Toyama[1], Satoshi Kurita[2], Yoshizumi Miyoshi[1], Keisuke Hosokawa[3], Yasunobu Ogawa[4], Shin-ichiro Oyama[1], Satonori Nozawa[1], Tetsuya Kawabata[1], Shinji Saito[5], Yoshiki Ito[1] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Research Institute for Sustainable Humanosphere, 3.University of Electro-Communications, 4.National Institute of Polar Research, 5.National Institute of Information and Communications Technology)

[PEM12-P03] An error estimation for energetic electron flux measured by the high-energy electron experiments (HEP) onboard the Arase satellite.

*Tomoaki Hori[1], Takefumi Mitani[2], Takeshi Takashima[2], Yoshizumi Miyoshi[1], Iku Shinohara[2] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Japan Aerospace Exploration Agency)

[PEM12-P04] **Relationship between polar cap potential and MLT distribution of ground delta H during geomagnetic storms using observations and RAM-SCB simulations**

*Sandeep Kumar[1], Yoshizumi Miyoshi[1], Vania Jordanova[2] (1.Institute for Space Earth Environmental Research, Nagoya University, 2.Los Alamos National Laboratory, US)

[PEM12-P05] Global characteristics of cold protons in the near-Earth magnetotail: MMS/HPCA observations

*Kunihiro Keika[1], Masahiro Hoshino[1], Ryuta Asami[1] (1.Graduate School of Science, The University of Tokyo)

[PEM12-P06] Interaction between whistler waves and electrons at Earth's magnetotail: Test particle simulation and THEMIS observation

*Fumiko Otsuka[1], Kaiti Wang[2], Kirolosse Mina GIRGIS[1], Tohru Hada[1] (1.Earth System Science and Technology, 2.Tamkang University)

[PEM12-P07] Case analysis of SAPS wave structure events observed by ERG, DMSP, and SuperDARN

*Takehiro Fukami[1], Atsushi Kumamoto[1], Yuto Katoh[1], Nozomu Nishitani[2], Tomoaki Hori[2], Yasumasa Kasaba[3], Fuminori Tsuchiya[3], Mariko Teramoto[4], Tomoki Kimura[5], Yoshiya Kasahara[6], Masafumi Shoji[2], Satoko Nakamura[2], Masahiro Kitahara[2], Ayako Matsuoka[7], Shun Imajo[2], Satoshi Kasahara[8], Shoichiro Yokota[9], Kunihiro Keika[8], Yoichi Kazama[10], Shiang-Yu Wang Wang[10], Jun Chae-Woo[2], Kazushi Asamura[11], Yoshizumi Miyoshi[2], Iku Shinohara[11], Simon G. Shepherd[12] (1.Department of Geophysics, Graduate School of Science, Tohoku University, 2.Institute for Space-Earth Environmental Research, Nagoya University, 3.Planetary Plasma and Atmospheric Research Center, Tohoku University, 4.Kyushu Institute of Technology, 5.The Frontier Research Institute for Interdisciplinary Sciences, 6.Information Media Center, Kanazawa University, 7.Data analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University, 8.The university of Tokyo, 9.Graduate School of Science, Osaka University, 10.Academia Sinica Institute of Astronomy & Astrophysics, 11.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 12.Dartmouth College)

[PEM12-P08] Energetic electron precipitations showing ULF modulation observed by VLF/LF transmitter signals

*Tanaka Kentaro[1], Hiroyo Ohya[1], Fuminori Tsuchiya[2], Kazuo Shiokawa[3], Yoshizumi Miyoshi[3], Nozomu Nishitani[3], Tomoaki Hori[3], Mariko Teramoto[4], Martin G Connors[5], Simon G Shepherd[6], Hiroyuki Nakata[1] (1.Graduate School of Engineering, Chiba University, 2.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 3.Institute for Space-Earth Environmental Research, Nagoya University, 4.Kyushu Institute of Technology, 5.Athabasca University, 6.Dartmouth College)

[PEM12-P09] A statistical study on the detachment of arc from the main auroral oval using all-sky imaging observations at Athabasca, Canada

*Sneha Yadav[1], Kazuo Shiokawa[1], Yuichi Otsuka[1], Martin G Connors[2,3] (1.Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan, 2.Athabasca University Observatories, Athabasca University, Athabasca, Alberta, Canada, 3.Department of Physics and Astronomy, University of Calgary, Calgary, Alberta, Canada)

[PEM12-P10] SAPS electric field and particle observations by the Arase satellite and SuperDARN

*Tomoya Takada[1], Nozomu Nishitani[1], Tomoaki Hori[1], Yasumasa Kasaba[2], Atsushi Kumamoto[2], Yuto Katoh[2], Yoshiya Kasahara[3], Masafumi Shoji[1], Satoko Nakamura[1], Masahiro Kitahara[1], Fuminori Tsuchiya[2], Kazushi Asamura[4], Yoshizumi Miyoshi[1], Yoichi Kazama[5], S Y Wang[5], Shoichiro Yokota[6], Satoshi Kasahara[7], Kunihiro Keika[7], Ayako Matsuoka[8], Shun Imajo[1], Iku Shinohara[4], Chae-Woo Jun[1], Simon G Shepherd[9] (1.Institute for Space-Earth Environmental Research, 2.Tohoku University, 3.Kanazawa University, 4.JAXA, 5.Academia Sinica, 6.Osaka University, 7.The University of Tokyo, 8.Kyoto University, 9.Thayer School of Engineering)

[PEM12-P11] Properties of EMIC waves observed by Van Allen Probes and ground-based magnetometers during relativistic electron precipitation

*Asuka Hirai[1], Fuminori Tsuchiya[1], Takahiro Obara[1], Yasumasa Kasaba[1], Yuto Katoh[2], Hiroaki Misawa[1], Kazuo Shiokawa[3], Yoshizumi Miyoshi[3], Chae-Woo Jun[3], Satoshi Kurita[4], Martin G Connors[5], Aaron Hendry[6] (1.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku Univ. , 2.Department of Geophysics, Graduate School of Science, Tohoku University, 3.Institute for Space-Earth Environmental Research, Nagoya University, 4.Research Institute for Sustainable Humanosphere, Kyoto University, 5.Athabasca University, 6.Otago University)

[PEM12-P12] A Study on the Effect of the Number of Snapshots for Averaging and the Noise Level on the Estimation Accuracy in Direction Finding

*Yuji Tanaka[1], Yoshiya Kasahara[1] (1.Division of Electrical Engineering and Computer Science, Graduate School of Natural Science and Technology, Kanazawa University)

[PEM12-P13] Relative Contribution of ULF Waves and Whistler-mode Chorus to the Radiation Belt Variation during the May 2017 Storm

*Naoko Takahashi[1], Kanako Seki[1], Mei-Ching Fok[2], Yihua Zheng[2], Yoshizumi Miyoshi[3], Satoshi Kasahara[1], Kunihiro Keika[1], David Hartley[4], Yoshiya Kasahara[5], Yasumasa Kasaba[6], Nana Higashio[1,7], Ayako Matsuoka[8], Shoichiro Yokota[9], Tomoaki Hori[3], Masafumi Shoji[3], Satoko Nakamura[3], Shun Imajo[3], Iku Shinohara[10] (1.Graduate School of Science, The University of Tokyo, 2.NASA Goddard Space Flight Center, 3.Institute for Space-Earth Environmental Research, Nagoya University, 4.Department of Physics and Astronomy, University of Iowa, 5.Graduate School of Natural Science and Technology, Kanazawa University, 6.Graduate School of Science, Tohoku University, 7.Japan Aerospace Exploration Agency, 8. Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University, 9.Graduate School of Science, Osaka University, 10.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency)

[PEM12-P14] Initial results on multi event analysis of the simultaneous observation of isolated proton auroras at subauroral latitudes by a highly sensitive all-sky camera and the Van Allen Probes satellites

*Kohki Nakamura[1], Kazuo Shiokawa[1], Masahito Nose[1], Tsutomu Nagatsuma[2], Kaori Sakaguchi[2], Harlan Spence[3], Geoff Reeves[4], Herbert Funsten[4], Craig Kletzing[5], Robert MacDowall[6], Charles Smith[3], John Wygant[7], John Bonnell[7] (1.Nagoya Univ., 2.National Institute of Information and Communications Technology, 3.New Hampshire Univ., 4.Los Alamos National Laboratory, 5.Iowa Univ., 6.Goddard Space Flight Center, 7.Minnesota Univ.)

[PEM12-P15] Study of the excitation mechanism of internally driven ULF waves by the drift-bounce resonance with ring current ions based on the Magnetosphere-Ionosphere coupled model

*Tomotsugu Yamakawa[1], Kanako Seki[1], Takanobu Amano[1], Naoko Takahashi[1], Yoshizumi Miyoshi[2], Aoi Nakamizo[3] (1.Department of Earth and Planetary Science, School of Science, The University of Tokyo, 2.Institute for Space-Earth Environmental Research, Nagoya University, 3.National Institute of Information and Communications Technology)

[PEM12-P16] Statistical Analysis of Latitudinal Electron Density Distribution in the Plasmasphere

*Ayano Hambara[1], Yuki Obana[2], Yukinaga Miyashita[3,4], Atsuki Shinbori[5], Yuichi Otsuka[5], Atsushi Kumamoto[6], Fuminori Tsuchiya[7], Shoya Matsuda[8], Ayako Matsuoka[9], Yoshiya Kasahara[10], Yoshizumi Miyoshi[5], Iku Shinohara[8], William S. Kurth[11], Craig A. Kletzing[11], Charles W. Smith[12], Robert J. MacDowall[13] (1.Advanced Science and Engineering Course, Graduate School of Engineering, Osaka Electro-Communication University, 2.Department of Engineering Science, Faculty of Engineering, Osaka Electro-Communication University, 3.Korea Astronomy and Space Science Institute, 4.Korea University of Science and Technology, 5.Institute for Space-Earth Environmental Research, Nagoya University, 6.Department of Geophysics, Graduate School of Science, Tohoku University, 7.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 8.Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency, 9.Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University, 10.Information Media Center, Kanazawa University, 11.Department of Physics and Astronomy, University of Iowa, 12.Institute for the Study of Earth, Oceans, and Space, University of New Hampshire, 13. Solar System Exploration Division, Goddard Space Flight Center)

[PEM12-P17] A statistical study of longitudinal extent of Pc1 pulsations using seven PWING ground stations at subauroral latitudes

*Jie Liu[1], Kazuo Shiokawa[1], Shin-ichiro Oyama[1], Yuichi Otsuka[1], Chae-Woo Jun[1], Masahito Nose[1], Tsutomu Nagatsuma[2], Kaori Sakaguchi[2], Akira Kadokura[3], Mitsunori Ozaki[4], Martin G Connors[5], Dmitry Baishev[6], Nozomu Nishitani[1], Alexey Oinats[7], Vladimir Kurkin[7], Tero Reita[8] (1.Institude for Space-Earth Environmental Research, Nagoya University, 2.National Institute of Information and Communications Technology, Japan, 3.National Institute of Polar Research, Tokyo, Japan, 4.Kanazawa University, Kanazawa, Japan, 5.Athabasca University, Athabasca, Canada, 6.Yu.G.Shafer Institute of Cosmophysical Research and Aeronomy of Siberian Branch of the Russian Academy of Sciences, Yakutsk, Russia, 7.Institute of Solar-Terrestrial Physics, Siberian Branch of the Russian Academy of Sciences, Irkutsk, Russia, 8.Sodankyla Geophysical Observatory, University of Oulu, Oulu, Finland)

[PEM12-P18] Altitude profile of isolated proton aurora as estimated from digital camera observations from International Space Station

*Kazuteru Takahashi[1], Sota Nanjo[2], Yuta Hozumi[2], Keisuke Hosokawa[2], Yoshizumi Miyoshi[1] (1.Institute for Space–Earth Environmental Research, 2.The University of Electro-Communications)

[PEM12-P19] Development of ISEE_Wave; Interactive Plasma Wave Analysis Tool

*Shoya Matsuda[1], Yoshizumi Miyoshi[2], Satoko Nakamura[2], Masahiro Kitahara[2], Masafumi Shoji[2], Tomoaki Hori[2], Shun Imajo[2], Chae-Woo Jun[2], Satoshi Kurita[3], Yoshiya Kasahara[4], Ayako Matsuoka[5], Iku Shinohara[1] (1.Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency, 2.Institute for Space-Earth Environmental Laboratory, Nagoya University, 3.Research Institute for Sustainable Humanosphere, Kyoto University, 4.Kanazawa University, 5.kyoto University)

[PEM12-P20] Radiation characteristics of upper-band and lower-band chorus emissions in the generation region deduced from the Arase observation

*Seigo Hayashi[1], Satoshi Kurita[2], Hirotsugu Kojima[2], Yoshiya Kasahara[3], Shoya Matsuda[4], Ayako Matsuoka[5], Iku Shinohara[4], Yoshizumi Miyoshi[6] (1.Undergraduate School of Electrical and Electronic Engineering, Kyoto University, 2.Research Institute for Sustainable Humanosphere, Kyoto University, 3.Graduate School of Natural Science and Technology, Kanazawa University, 4.ISAS/JAXA, 5.Graduate School of Science, Kyoto University, 6.Institute for Space-Earth Environmental Research, Nagoya University)

[PEM12-P21] Isolated Electrostatic Potentials Observed by the Arase Satellite

*Tomoe Taki[1], Satoshi Kurita[1], Hirotsugu Kojima[1], Yoshiya Kasahara[2], Yoshizumi Miyoshi[3], Ayako Matsuoka[4], Shoya Matsuda[5] (1.Research Institute for Sustainable Humanosphere, Kyoto University, 2.Information Media Center, Kanazawa University, 3.Institute Space-Earth Environmental Research, Nagoya University, 4.Data Analysis Center for Geomagnetism and Space Magnetism Graduate School of Science, Kyoto University, 5.Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency)

[PEM12-P22] Statistical study of drifting electron holes associated with substorms observed by the Arase satellite

*Taku Namekawa[1,2], Iku Shinohara[1], Takefumi Mitani[1], Kazushi Asamura[1], Nagai Tsugunobu[1], Satoshi Kasahara[2], Shoichiro Yokota[3], Tomoaki Hori[4], Ayako Matsuoka[5], Yoshizumi Miyoshi[4] (1.ISAS / JAXA, 2.The University of Tokyo, 3.Osaka University, 4.Nagoya University, 5.Kyoto University)

[PEM12-P23] **The influence of EMIC (ElectroMagnetic Ion Cyclotron) wave-interaction on energetic protons in the magnetosphere using Arase observations**

*Chae-Woo Jun[1], Yoshizumi Miyoshi[1], Satoko Nakamura[1], Shun Imajo[1], Masafumi Shoji[1], Chao Yue[2], Jacob Bortnik[3], Larry Lyons[3], Yoshiya Kasahara[4], Yasumasa Kasaba[5], Fuminori Tsuchiya[5], Atsushi Kumamoto[5], Shoya Matsuda[6], Kazushi Asamura[6], Iku Shinohara[6], Ayako Matsuoka[7] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Peking University, Beijing, China , 3.Atmospheric and Oceanic Sciences, University of California Los Angeles, Los Angeles, USA, 4.Kanazawa University, Kanazawa, Japan, 5.Tohoku University, Sendai, Japan, 6.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Japan, 7.Kyoto University, Kyoto, Japan)

[PEM12-P24] A statistical study on high-energy electron injection events observed by Arase (ERG)

*JINGXUAN YANG[1], Iku Shinohara[2], Taku Namekawa[1], Takefumi Mitani[2], Kazushi Asamura[2], Satoshi Kasahara[3], Nana Higashio[4], Ayako Matsuoka[5] (1.Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, 2.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 3.The University of Tokyo, 4.Japan Aerospace Exploration Agency, 5.Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University)

[PEM12-P25] Development of a high-energy electron analyzer onboard CubeSats

*Iku Shinohara[1], Takefumi Mitani[1], Mariko Teramoto[2], Kazushi Asamura[1], Ryota Onogi[1], Takeshi Takashima[1] (1.Japan Aerospace Exploration Agency/Institute of Space and Astronautical Science, 2.Kyushu Institute of Technology)

[PEM12-P26] **An observational study on possible excitation of storm-time Pc5 waves**

*Kento Otani[1], Iku Shinohara[2], Mariko Teramoto[3], Tomotsugu Yamakawa[1], Kanako Seki[4], Satoshi Kasahara[4], Shoichiro Yokota[5], Kunihiro Keika[1], Naoko Takahashi[4], Takefumi Mitani[2], Nana Higashio[2], Ayako Matsuoka[6], Kazuhiro Yamamoto[4] (1.Tokyo University/Graduate School of Science, 2.JAXA, 3.Kyushu Institute of Technology, 4.Tokyo University, 5.Graduate school of Science, Osaka University, 6.Graduate school of Science, Kyoto University)

[PEM12-P27] A Novel Calibration Method of Short Time Waveform Signals and its Approcation for the PWE/WFC Data

*Masahiro Kitahara[1], Shoya Matsuda[2], Yuto Katoh[3], Yoshiya Kasahara[4], Hirotsugu Kojima[5], Yoshizumi Miyoshi[1], Mitsuru Hikishima[2] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency, 3.Department of Geophysics, Graduate School of Science, Tohoku University, 4.Information Media Center, Kanazawa University, 5.Research Institute for Sustainable Humanosphere, Kyoto University)

[PEM12-P28] Nitrogen and oxygen ions from the Earth's ionosphere observed by the Arase satellite

*Shoichiro Yokota[1], Koichiro Tsuda[1], Satoshi Kasahara[2], Tomoaki Hori[3], Kunihiro Keika[2], Yoshizumi Miyoshi[3], Iku Shinohara[4] (1.Osaka University, 2.University of Tokyo, 3.ISEE, Nagoya University, 4.ISAS/JAXA)

[PEM12-P29] Electron Energization during Dipolarization Events: Test Particle Simulations

*Kirolosse Mina Girgis[1], Tohru Hada[1], Fumiko Otsuka[1], Kaiti Wang[2] (1.Department of Earth System Science and Technology, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Japan , 2.Department of Aerospace Engineering, University of Tamkang, Taiwan)

[PEM12-P30] Computer simulations of electron scatterings through chorus-wave particle interactions

Yoshiki Ito[1], *Yoshizumi Miyoshi[1], Shinji Saito[2] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.NICT)

[PEM12-P31] Statistical analyses of low energy ion heating by electromagnetic ion cyclotron waves via wave-particle interaction analyses: Arase observations

*Masafumi Shoji[1], Yoshizumi Miyoshi[1], Lynn M Kistler[1,2], Kazushi Asamura[3], Yasumasa Kasaba[4], Ayako Matsuoka[5], Yoshiya Kasahara[6], Shoya Matsuda[3], Fuminori Tsuchiya[4], Atsushi Kumamoto[4], Satoko Nakamura[1], Masahiro Kitahara[1], Shun Imajo[1], Chae-Woo Jun[1], Iku Shinohara[3] (1.Institute for Space-Earth Environmental Research, Nagoya Univ., 2.University of New Hampshire, 3.ISAS/JAXA, 4.Tohoku Univ., 5.Kyoto Univ., 6.Kanazawa Univ.)

[PEM12-P32] Plasma waves causing 20 Hz intensity modulation of pulsating aurora: High-speed Tjörnes-Arase-Syowa conjugate observation

*Herbert Akihito Uchida[1], Ryuho Kataoka[2,1], Kiyoka Murase[1], Shoya Matsuda[3], Yoshiya Kasahara[4], Masafumi Shoji[5], Yoshizumi Miyoshi[5], Iku Shinohara[3], Ayako Matsuoka[6], Satoshi Kurita[7], Keisuke Hosokawa[8], Shun Imajo[5] (1.The Graduate University for Advanced Studies, 2.National Institute of Polar Research, 3.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 4.Kanazawa University, 5.Institute for Space–Earth

Environmental Research, Nagoya University, 6.Kyoto University, 7.Research Institute for Sustainable Humanosphere, Kyoto University, 8.University of Electro-Communications)

[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-OS Ocean Sciences & Ocean Environment

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.05_1

[A-OS11] Ocean Mixing Frontiers

convener:Toshiyuki Hibiya(Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo)

[AOS11-P01] Sensitivity of the ocean state estimation to the vertical distribution of tidally induced far-field mixing

*Satoshi Osafune[1], Shinya Kouketsu[1], Toshimasa Doi[1], Nozomi Sugiura[1], Shuhei Masuda[1] (1.Japan Agency for Marine-Earth Science and Technology)

[AOS11-P02] Tracer distribution produced by an optimized physical field with an improved vertical mixing

*Toshimasa Doi[1], Shinya Kouketsu[1], Satoshi Osafune[1], Shuhei Masuda[1], Nozomi Sugiura[1] (1.Japan Agency for Marine-Earth Science and Technology)

[AOS11-P03] **Lagrangian Dispersion and Mixing in the Open-ocean convection**

*Ankit Bhadouriya[1,2], Bishakhdatta Gayen[1,3] (1.The University of Melbourne, Australia, 2.Indian Institute of Technology Kanpur, India, 3.Indian Institute of Science, India)

[AOS11-P04] Assessing the role of deep ocean mixing on carbon and nutrients cycles using an Earth System Model

*Michio Watanabe[1], Akitomo Yamamoto[1], Tomohiro Hajima[1], Hiroaki Tatebe[1] (1.Research Center for Environmental Modeling and Application, Japan Agency for Marine-Earth Science and Technology (JAMSTEC))

[AOS11-P05] Performance of microstructure measurements using a deep float with a fast-response thermistor

*Shuo Zhai[1], Ichiro Yasuda[1] (1.Atmosphere and Ocean Research Institute, The University of Tokyo)

[AOS11-P06] Seasonal variations in salinity of the North Pacific Intermediate Water and vertical mixing intensity over the Okinawa Trough

*Hirohiko Nakamura[1], Ryuichiro Inoue[2], Ayako Nishina[1], Toshiya NAKANO[3] (1.Kagoshima University, Faculy of Fisheries, 2.Japan Agency for Marine-Earth Science and Technology, 3.Nagasaki Meteorological Office)

[AOS11-P07] **Elevated nutrient supply caused by the approaching Kuroshio to the southern coast of Japan**

*Gloria Silvana Duran Gomez[1], Takeyoshi Nagai[2] (1.Graduate School of Tokyo University of Marine Science and Technology, 2.Tokyo University of Marine Science and Technology)

[AOS11-P08] Direct estimates of turbulent mixing in the Indonesian Archipelago and its role in the transformation of the ITF waters

*Taira Nagai[1], Toshiyuki Hibiya[1] (1.Graduate School of Science, The University of Tokyo)

[AOS11-P09] **Double diffusion in the Arabian Sea during winter and spring**

*Ashin Kuriakose[1,2], Girishkumar M S -[1], Jofia Joseph -[1], Eric D'Asaro -[3], Sureshkumar N -[1], Sherin V R -[1], Murali B -[1], Thangaprakash V P -[1], E Pattabhi Ram Rao[1], S. S. C. Shenoi (1.Indian National Centre for Ocean Information Services, 2.School of Ocean Science and Technology, Kerala University of Fisheries and Ocean Studies, 3.Applied Physics Laboratory and School of Oceanography, University of Washington, Seattle, Washington, USA)

[AOS11-P10] On widespread intensified thermocline turbulence in the seasonally stratified Yellow Sea

*Wei Yang[1] (1.Tianjin University)

[AOS11-P11] Observation of energy transfer from traveling typhoons to turbulent mixing in the ocean

*Aiqi Zhang[1], Ichiro Yasuda[1], Daigo Yanagimoto[1], Shinzou Fujio[1], Yusuke Sasaki[1] (1.the University of Tokyo)

[AOS11-P12] Can tidal forcing alone generate a GM-like internal wave spectrum?

*Zhiwu Chen[1], Shaomin Chen[1], Zhiyu Liu[2], Jiexin Xu[1], Jieshuo Xie[1], Yinghui He[1], Shuqun Cai[1] (1.South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2.Department of Physical Oceanography, College of Ocean and Earth Sciences, Xiamen University)

[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-OS Ocean Sciences & Ocean Environment

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.05_2

[A-OS12] Physical, biogeochemical, and ecological processes and variability in the Indian Ocean

convener:Yukio Masumoto(Graduate School of Science, The University of Tokyo), Hiroaki Saito(Atmosphere and Ocean Research Institute, The University of Tokyo)

[AOS12-P01] **Nitrogen cycling in the primary nitrite maximum of the Indian Ocean**

*Shigenobu Takeda[1], Kunioki Hirata[1], Takuhei Shiozaki[2] (1.Nagasaki University, 2.The University of Tokyo)

[AOS12-P02] Coastal ecosystem study in the Indian Ocean and adjacent seas under international collaboration

*Hiroaki Saito[1], Yukio Masumoto[2], Zainal Arifin[3] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Graduate School of Science, The University of Tokyo, 3.Research Centre for Oceanograph, Indonesian Institute of Sciences)

[AOS12-P03] Issues and future directions of the Indian Ocean researches

*Yukio Masumoto[1] (1.Graduate School of Science, The University of Tokyo)

[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-OS Ocean Sciences & Ocean Environment

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.05_3

[A-OS13] Marine ecosystems and biogeochemical cycles: theory, observation and modeling

convener:Takafumi Hirata(Arctic Research Center, Hokkaido University), Shin-ichi Ito(Atmosphere and Ocean Research Institute, The University of Tokyo), E Eileen Hofmann(Old Dominion University), N Enrique Curchitser(Rutgers University New Brunswick)

[AOS13-P01] Marine fish distribution in the Kuroshio Extension area observed by OceanDNA

*ZESHU YU[1], Shin-ichi Ito[2], Marty Wong[2], Susumu Yoshizawa[2], Jun Inoue[2], Sachihiko Itoh[2], Susumu Hyodo[2] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, 2. Atmosphere and Ocean Research Institute, The University of Tokyo)

[AOS13-P02] Introducing phytoplankton size structure in an ocean biogeochemical model OECO2

*Wenhui Sun[1], Ryota Shibano[1], Michio Watanabe[2], Sachihiko Itoh[1] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Japan Agency for Marine-Earth Science and Technology)

[AOS13-P03] Origin of dissolved inorganic nitrogen in the Tsushima Strait and its seasonal and interannual variation

*Ryota Shibano[1], Akihiko Morimoto[2], Katsumi Takayama[3], Tetsutaro Takikawa[4], Joji Ishizaka[5], Xinyu Guo[2] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Center for Marine Environmental Studies, Ehime University, 3.Research Institute for Applied Mechanics, Kyushu University, 4.Graduate School of Fisheries and Environmental Sciences, Nagasaki University, 5.Institute for Space-Earth Environmental Research, Nagoya University)

[AOS13-P04] Comparative study on respiration of Japanese anchovy (*Engraulis japonicus*) around Japan II.

*Shin-ichi Ito[1], Chenying Guo[1], Megumi Enomoto[1], Tomoya Aono[1], Michio Yoneda[2], Michiya Matsuyama[3], Takashi Kitagawa[1], Motomitsu Takahashi[2], Taketo Hashioka[4] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Japan Fisheries Research and Education Agency, 3.Kyushu University, 4.Japan Agency for Marine-Earth Science and Technology)

[AOS13-P05] A state-space production model to analyze the impact of stock enhancement on population dynamics: a case study of Japanese flounder in the Seto Inland Sea

*LIN ZHEN[1], Toshihide Kitakado[2], Naoki Suzuki[2], Shin-ichi Ito[1] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Tokyo University of Marine Science and Technology)

[AOS13-P06] Variability in phytoplankton Chlorophyll-a in the Kuroshio western boundary current: a result from 14-year observation by satellite remote sensing

*Takafumi Hirata[1], Keiko Sato[1], Satoshi Kitaoka (1.Arctic Research Center, Hokkaido University)

[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-HW Hydrology & Water Environment

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.07_1

[A-HW20] Hydrology & Water Environment

convener:Takeshi Hayashi(Faculty of Education and Human Studies, Akita University), Keisuke Fukushi(Institute of Nature & Environmental Technology, Kanazawa University), Koichi Sakakibara(Department of Environmental Sciences, Faculty of Science, Shinshu University), Dai Yamazaki(Institute of Industrial Sciences, The University of Tokyo)

[AHW20-P01] Contribution of understory vegetation to evapotranspiration in a tropical dry forest, Cambodia

*Shin'ichi Iida[1], Takanori Shimizu[1], Koji Tamai[1], Naoki Kabeya[1], Akira Shimizu[1], Eriko Ito[1], Yasuhiro Ohnuki[1], Sophal Chann[2], Delphis F. Levia[3] (1.Forestry and Forest Products Research Institute, Japan, 2.Institute of Forest and Wildlife Research and Development, Cambodia, 3.University of Delaware, USA)

[AHW20-P02] Rainfall partitioning in two Japanese cedar stands with high stand densities as evidence of splash droplet evaporation hypothesis

*Shigeki Murakami[1], Kenzo Kitamura[1] (1.Kyushu Research Center, Forestry and Forest Products Research Institute)

[AHW20-P03] Vegetation response to soil moisture and groundwater in west-central Africa revealed by satellite observations

*Ryotaro Suzuki[1], Atsushi Higuchi[2] (1.Graduate School of Science and Engineering, Chiba University, Japan, 2.Center for Environmental Remote Sensing, Chiba University, Japan)

[AHW20-P04] An Efficient Surrogate Model for Extreme Hydrologic Predictions using Polynomial Chaos-Kriging

Vinh Ngoc Tran[1], *Jongho Kim[1] (1.University of Ulsan)

[AHW20-P05] **Hydrological Hindcasts and Parameterizations for Flash Floods Real-Time Forecasting in the Chugoku Region of Japan**

*Josko Troselj[1], Han Soo Lee[1] (1.Graduate School of Advanced Science and Engineering, Hiroshima University)

[AHW20-P06] Geochemical signature of trace elements in lake water at Lake Tazawa

*Arata Katamura[1], Daizo Ishiyama[1], Takeshi Hayashi[2], Yasumasa Ogawa[1] (1.Graduate School of International Resource Science, Akita University, 2.Faculty of Education and Human Studies, Akita University)

[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-HW Hydrology & Water Environment

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.07_2

[A-HW21] Interdisciplinary approach to support climate change adaptation measures in regional scale

convener:TEBAKARI TAICHI(Toyama Prefectural University), Sompratana Ritphring(Kasetsart University), Masashi Kiguchi(University of Tokyo), weerakaset Suanpaga(Associate professor in Civil Engineering,Kasetsart University)

[AHW21-P01] Attempt to separate factors to reduce locality of precipitation-elevation dependence in Japan

*Mayu Otsuki[1], Atsushi Higuchi[2], Hitoshi Hirose[3] (1.Chiba University, 2.Center for Environmental Remote Sensing Chiba University, 3.Japan Aerospace Exploration Agency)

[AHW21-P02] Prediction process in the seasonal forecast model of monthly precipitation by global climate data using deep learning

*Shingo Zenkoji[1], TEBAKARI TAICHI[1], SAKAKIBARA KAZUTOSHI[1] (1.Toyama Prefecural University)

[AHW21-P03] Regional climate change impacts on groundwater level in the Kurobe River alluvial fan, Japan

*Takuya Matsuura[1], TEBAKARI TAICHI[1] (1.Toyama prefectural University)

[AHW21-P04] Atmosphericfronts of the rainy season in kyushu region using an objective method

*Maki Miyamoto[1], Tomohito Yamada[1] (1.Hokkaido University)

[AHW21-P05] Climate Change Impact on Salt Affected Soil in Northeast Thailand

*KOSHI YOSHIDA[1], Supranee SRITUMBOON[2], Mallika SRISUTHAM[3], KOKI HOMMA[4], MASAYASU MAKI[5], KAZUO OKI[6] (1.The University of Tokyo, 2.Land Development Department, Thailand, 3.Khon Kaen University, Thailand, 4.Tohoku University, 5.Fukushima University, 6.Kyoto University of Advanced Science)

[AHW21-P06] Development of a numerical model to simulate the salinity distribution in the tidal area of the lower Chao Phraya Basin, Thailand

*Ryota Tsuji[1], TAICHI TEBAKARI[1], Keisuke Nakayama[2] (1.Toyama Prefectural University, 2.Kobe University)

[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-CG Complex & General

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.08_1

[A-CG30] Multi-scale ocean-atmosphere interaction in the tropics

convener:Hiroki Tokinaga(Research Institute for Applied Mechanics, Kyushu University), Yu Kosaka(Research Center for Advanced Science and Technology, University of Tokyo), Ayako Seiki(Japan Agency for Marine-Earth Science and Technology), Tomoki Tozuka(Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo)

[ACG30-P01] Evaluation of externally forced component on interannual-scale SST anomalies over the tropical Indo-Pacific Ocean

*Takuya Hasegawa[1,2], Yuma Miyaji[1], Youichi Tanimoto[1,3] (1.Hokkaido University, 2.Tohoku University, 3.JAMSTEC)

[ACG30-P02] Potential predictability of regional extreme events associated with large-scale teleconnection from the tropical ocean

*Yukiko Imada[1], Hiroaki Kawase[1] (1.Meteorological Research Institute, Japan Meteorological Agency)

[ACG30-P03] **External and Internal forcings of the Indian Ocean Dipole**

*Lianyi Zhang[1,2], Yan Du[1,2], Tomoki Tozuka[3] (1.South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2.Southern Marine Science and Engineering Guangdong Laboratory, 3.Dept. of Earth and Planetary Science Graduate School of Science, Univ. of Tokyo)

[ACG30-P04] Variations of sea surface temperature and salinity using coral Sr/Ca and $\delta^{18}O$ in the Java Sea and the Lombok Strait.

*Ai Genda[1], Ali Arman[2], Minoru Ikehara[3], Atsushi Suzuki[4], Mayuri Inoue[1] (1.Graduate School of National Science and Technology, Okayama University, 2.National Nuclear Energy Agency of Indonesia (BATAN), 3.Center of Advanced Marine Core Research, Kochi University, 4.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology)

[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-CG Complex & General

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.08_2

[A-CG34] Global Carbon Cycle Observation and Analysis

convener:Kazuhito Ichii(Chiba University), Prabir Patra(Research Institute for Global Change, JAMSTEC), Akihiko Ito(National Institute for Environmental Studies)

[ACG34-P01] Asian methane outflow captured by the CONTRAIL flask air samplings

*Yosuke Niwa[1,2], Toshinobu Machida[1], Taku Umezawa[1], Kazuhiro Tsuboi[2], Kentaro Ishijima[2], Ryo Fujita[2], Hidekazu Matsueda[3], Takuya Saito[1] (1.National Institute for Environmental Studies, 2.Meteorological Research Institute, 3.Dokkyo University)

[ACG34-P02] High-resolution mapping of anthropogenic CO_2 emissions in Japan

*Makoto Saito[1], Hiroko Yamada[1] (1.National Institute for Environmental Studies)

[ACG34-P03] Estimating solar-induced chlorophyll fluorescence using process-based ecosystem model VISIT-SIF

*Tatsuya Miyauchi[1], Makoto Saito[1], Hibiki M. Noda[1], Yukio Yoshida[1], Haruki Oshio[1], Akihiko Ito[1], Tsuneo Matsunaga[1] (1.National Institute for Environmental Studies)

[ACG34-P04] **Estimation of Aerosol Optical Characteristics of Wildfires in 2018 - 2020 with GCOM-C/SGLI**

*Kazuhisa Tanada[1], Hiroshi Murakami[1] (1.Earth Observation Research Center, Japan Aerospace Exploration Agency)

[ACG34-P05] **Satellite-data based monitoring of changes in the terrestrial carbon cycle in Mongolia: Synthesis analysis**

*ZAYA MART[1], Ichii Kazuhito [1], Tsolmon Renchin[2] (1.Chiba University , 2.National University of Mongolia)

[ACG34-P06] **Changes in terrestrial vegetation activities observed by satellite-based products across Eurasia**

*Da WANG[1], Kazuhito Ichii[1] (1.Chiba University)

[E] Poster | H (Human Geosciences)：H-DS Disaster geosciences

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.10_1

[H-DS06] Natural hazard impacts on human society, economics, and technological systems

convener:ELENA PETROVA(Lomonosov Moscow State University, Faculty of Geography), Hajime Matsushima(Research Faculty of Agriculture, Hokkaido University)

[HDS06-P01] Introduction

[HDS06-P02] Effects of abandoned paddy field use for the conservation of threatened hydrophyte after the 2011 Tohoku-oki tsunami

★Invited Papers

*Korehisa Kaneko[1], Hiroshi Jinguji[2] (1.Hokuso Creature Association, 2.Fukushima University)

[HDS06-P03] Citizens' Awareness of Transmitting Information about Earthquake Experiences in the Areas Affected by the Great East Japan Earthquake: A Focus on the Use of Earthquake Ruins

*Ryo Nishisaka[1], Katsunori Furuya[1] (1.Chiba University)

[HDS06-P04] Location of the Visitor Centers of National Parks of Japan and their Adapt to Climate Change

*Satoshi Sasaki[1], Kiyotatsu Yamamoto[1], Kazuhiko W. Nakamura[1] (1.The University of Tokyo)

[HDS06-P05] **The Activity of Kamchatka Volcanoes and theirs Danger to Human Society**

*Olga Girina[1], Evgenii Loupian[2], Alexei Ozerov[1], Dmitry Melnikov[1], Alexander Manevich[1], Elena Petrova[3] (1.Institute of Volcanology and Seismology, Far East Division, Russian Academy of Sciences, Russia, 2.Space Research Institute, Russian Academy of Sciences, Russia, 3.Lomonosov Moscow State University, Geography Faculty, Russia)

[HDS06-P06] The impact of the reduction of beach width by seawall construction on the distribution of ground prowling insects

*Hinata Okoshi[1], Hajime Matsushima[1], Junjiro Negishi[2], Masahiro Ohara[3] (1.Graduate School of Agriculture, Hokkaido University, 2.Faculty of Environmental Earth Science, Hokkaido University, 3.The Hokkaido University Museum, Hokkaido University)

[HDS06-P07] Discussion

[E] Poster | H (Human Geosciences)：H-TT Technology & Techniques

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.11_1

[H-TT13] Environmental Remote Sensing

convener:Wei Yang(Chiba University), Akihiko Kondoh(Center for Environmental Remote Sensing, Chiba University)

[HTT13-P01] A study on the long-term dynamics and phenology of mangrove forests based on the narratives of inhabitants in western India using Landsat

*Kai Yamamoto[1], Nobuhito Ohte[1], Ranit Chatterjee[1], Kenlo Nasahara[2], Pankaj Joshi Sahjeevan[4], Lyla Mehta[3] (1.Graduate School of Informatics Kyoto University, 2.Faculty of Life and Environmental Sciences University of Tsukuba, 3. Institute of Development Studies, Brighton, United Kingdom, 4.Sahjeevan(NGO))

[HTT13-P02] **Mapping Paddy Rice Planting Areas on the Cloud: Is Spatio-Temporal Fusion Helpful or Not**

*Ziping Yang[1], Wei Yang[2], Akihiko Kondoh[2] (1.Graduate School of Science and Engineering, Chiba University, 2.Center of Environmental Remote Sensing, Chiba University)

[HTT13-P03] Removal of residual reflected skylight for accurate measurement of water-leaving reflectance

*Wei Yang[1], Bunkei Matsushita[2], Dalin Jiang[2] (1.Chiba University, 2.University of Tsukuba)

[HTT13-P04] Yield Estimation of Paddy Rice using High Spatial and Temporal Satellite Data in Indonesia

*Yuki Sofue[1], Chiharu Hongo[1], Naohiro Manago[1], Koki Homma[2], Gunardi Sigit[3], Budi Utoyo[4] (1.Chiba University, 2.Tohoku University, 3.West Java Food Crops and Horticultural Agency, 4.Bogor Agricultural University)

[HTT13-P05] **Random Forest for Estimating Soil Moisture Based on Remote Sensing Test**

*Jyun-Lin Chen[1], Hong-Ru Lin[1], Jet-Chau Wen[1] (1.National Yunlin University of Science and Technology)

[E] Poster | H (Human Geosciences)：H-TT Technology & Techniques

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.11_2

[H-TT15] Non-destructive techniques applied to stone cultural heritage

convener:Celine Thomachot-Schneider(University of Reims-Champagne-Ardenne), Chiaki T. Oguchi(Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University), Patricia vazquez(University of Reims Champagne Ardenne)

[HTT15-P01] Ultrasonic velocity attempted to the various rocks - laboratory experiment and field measurement -

*Chiaki T. Oguchi[1], Keishin Takahashi[2], Sota Noshiro[2], Yukina Ikeda[1] (1.Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University, 2.Faculty of civil Engineering, Saitama University)

[HTT15-P02] **Magnetic susceptibility of obsidian from Shirataki, Hokkaido, Japan, to identify the source of obsidian tools**

*Kyohei Sano[1] (1.Graduate School of Regional Resource Management, University of Hyogo)

[HTT15-P03] **Estimation of uniaxial compressive strength and water permeability from elastic waves measurements in sedimentary stones**

*David Benavente[1], Juan Jose Galiana-Merino [2], Concepcion Pla[3], Marli De Jongh[4], Noe Garcia-Martinez[1], Javier Martinez-Martinez[5] (1.Department of Earth and Environmental Sciences, University of Alicante, 2.Department of Physics, Systems Engineering and Signal Theory, University of Alicante, 3.Department of Civil Engineering, University of Alicante, 4.University of Glasgow, School of Geographical & Earth Sciences, 5.Spanish Geological Survey)

[HTT15-P04] **INFLUENCE OF POROSITY AND MINERALOGY ON INFRARED THERMOGRAPHY MEASUREMENTS**

*Patricia vazquez[1], Thomas Junique[1], Sesil Can[1], Lena Ageorges[1], Dania Benkara[1] (1.University of Reims Champagne Ardenne)

[E] Poster | H (Human Geosciences)：H-CG Complex & General

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.12_1

[H-CG22] Nuclear Geoscience in Developing Countries

convener:Mohammad Rajib(Bangladesh Atomic Energy Commission)

[HCG22-P01] Radioactive waste disposal in Japan, especially focused on geological disposal of high-level radioactive waste

★Invited Papers

*Eiji Sasao[1] (1.Tono Geoscience Center, Japan Atomic Energy Agency)

[HCG22-P02] Effect of external radioactivity on the mineral grains from placer deposits of Bangladesh

*Mohammad Rajib[1,2,3], Mahmudul Hossain[1,4], Md. Fahad Hossain[1,5], Tumpa Saha[1,5] (1.Bangladesh Atomic Energy Commission, 2.Atomic Energy Research Establishment, 3.Institute of Nuclear Minerals, 4.Sterile Insect Technique Unit and INMAS, Cox's Bazar, 5.Beach Sand Minerals Exploitation Centre, Cox's Bazar)

[E] Poster | S (Solid Earth Sciences)：S-SS Seismology

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.13_1

[S-SS03] New insights in Earthquake predictability: modelling and forecasting

convener:Hiroshi Tsuruoka(Earthquake Research Institute, Tokyo Univ.), Jiancang Zhuang(Institute of Statistical Mathematics), Danijel Schorlemmer(GFZ German Research Centre for Geosciences), Naoshi Hirata(National Research Institute for Earth Science and Disaster Resilience)

[SSS03-P01] A spherical version of the space-time ETAS model

*Jiancang Zhuang[1], Ziyao Xiong[1], Yosihiko Ogata[1] (1.Institute of Statistical Mathematics)

[SSS03-P02] Nonstationary Renewal Model for Forecasting Repeating Earthquakes under Aftershock-Triggering Effects

*Shunichi Nomura[1], Masayuki Tanaka[2] (1.The Institute of Statistical Mathematics, 2.Meteorological Research Institute)

[SSS03-P03] Machine Learning Models for Earthquake Number Forecasting in the Kanto Region

*Hanyuan Huang[1], Hiroe Miyake[1], Hiroshi Tsuruoka[1] (1.Earthquake Research Institute, University of Tokyo)

[E] Poster | S (Solid Earth Sciences)：S-IT Science of the Earth's Interior & Techtonophysics

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.14_1

[S-IT17] Property and role of liquids inside terrestrial planets

convener:Tatsuya Sakamaki(Department of Earth Science, Tohoku University), Yoichi Nakajima(Kumamoto University, Priority Organization for Innovation and Excellence)

[SIT17-P01] Viscosity of silicate melts under high pressures

*Tatsuya Sakamaki[1] (1.Department of Earth Science, Tohoku University)

[SIT17-P02] Elastic wave velocity of silicate glasses at high pressure

*Tatsuya Sakamaki[1] (1.Department of Earth Science, Tohoku University)

[SIT17-P03] Density of Fe_2O_3–bearing magma under high pressure

*Rintaro Ban[1], Akio Suzuki[1], Tatsuya Sakamaki[1] (1.Department of Earth Science, Graduate School of Science, Tohoku University)

[SIT17-P04] **Melting phase equilibrium relations in the $MgSiO_3$-SiO_2 system at 13.5 GPa**

*Takuya Moriguti[1], Yusuke Yachi[1], Akira Yoneda[1], Eiji Ito[1] (1.Institute for Planetary Materials, Okayama University)

[E] Poster | S (Solid Earth Sciences)：S-IT Science of the Earth's Interior & Techtonophysics

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.14_2

[S-IT20] MAGMA, FLUID TRANSPORT, AND SEISMICITY IN THE EARTH'S INTERIOR

convener:Eiji Ohtani(Department of Earth and Planetary Materials Science, Graduate School of Science, Tohoku University), Saeko Kita(International Institute of Seismology and Earthquake Engineering, BRI), Michihiko Nakamura(Division of Earth and Planetary Materials Science, Department of Earth Science, Graduate School of Science, Tohoku University), Bjorn Mysen(Geophysical Laboratory, Carnegie Inst. Washington)

[SIT20-P01] **Electrical conductivity in texturally equilibrated fluid-bearing forsterite aggregates at 800°C and 1 GPa: implications for the high electrical conductivity anomalies in mantle wedges**

*Yongsheng HUANG[1], Haihao Guo[2], Takayuki Nakatani[1,4], Kentaro Uesugi[3], Michihiko Nakamura[1], Hans Keppler[2] (1.Graduate School of Science, Tohoku University, 2.Bayerisches Geoinstitut, University of Bayreuth, 3.Spring-8, Japan Synchrotron Radiation Research Institute (JASRI), 4.Geological Survey of Japan)

[SIT20-P02] Role of water in subducting slabs: dry phase transformation kinetics in wet slabs

*Eiji Ohtani[1], Takayuki Ishii[2,3] (1.Department of Earth and Planetary Materials Science, Graduate School of Science, Tohoku University, 2.Bayeriches Geoinstitut, University of Bayreuth, 3.Center for High Pressure Science and Technology Advanced Research)

[SIT20-P03] Melting phase relation of hydrous peridotite at the top of the lower mantle

*Kayan Lau[1], Takashi Yoshino[1], Hideharu Kuwahara[1] (1.Institute for Planetary Materials, Okayama University)

[SIT20-P04] Completeness magnitude of earthquakes and spatial variations of b-VALUE in Myanmar

Ngun Za Iang[1], *Saeko Kita[2] (1.Department of Meteorology and Hydrology (DMH), Ministry of Transport and Communications, Naypyitaw, Myanmar, 2.Building Research Institute)

[E] Poster | S (Solid Earth Sciences)：S-MP Mineralogy & Petrology

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.15_2

[S-MP24] Supercontinents and Crustal Evolution

convener:Tomokazu Hokada(National Institute of Polar Research), Tetsuo Kawakami(Graduate School of Science, Kyoto University), Krishnan Sajeev(Centre for Earth Sciences, Indian Institute of Science), Madhusoodhan Satish-Kumar(Department of Geology, Faculty of Science, Niigata University)

[SMP24-P01] Geochronology of the metamorphic rocks at the Oyayubi ridge of Brattnipene, Sør Rondane Mountains, East Antarctica.

*Tatsuro ADACHI[1], Tetsuo Kawakami[2], Masaoki Uno[3], Fumiko Higashino[4] (1.Kyushu University, 2.Kyoto University, 3.Tohoku University, 4.Okayama University of Science)

[SMP24-P02] **Evidence of Paleoproterozoic rift-to-drift transition in eastern margin of Singhbhum Craton, India from U-Pb zircon, Sr-Nd isotopic and geochemical study of dismembered gabbro-wehrlite of Bangriposi**

*Tushar Mouli Chakraborti[1,2], Kosuke Kimura[1,2], Arijit Ray[3], Ramananda Chakrabarti[4], Gautam Kumar Deb[3] (1.Earth and Planetary System Science program, Graduate School of Advanced Science and Engineering, Hiroshima University, Japan, 2.Hiroshima Institute of Plate Convergence Region Research (HiPeR), Hiroshima University, Japan, 3.Department of Geology, Presidency University, Kolkata, India, 4.Centre for Earth Sciences, Indian Institute of Science, Bangalore, India)

[SMP24-P03] Sulfur isotope study of high-grade metamorphic rocks in Highland Complex, Sri Lanka

*Tokuya Mitsubori[1], Madhusoodhan Satish-Kumar[2], Sanjeewa P.K. Malaviarachchi[3] (1.Graduate School of Science and Technology, Niigata University, 2.Department of Geology, Faculty of Science, Niigata University, 3.Department of Geology, Faculty of Science, University of Peradeniya)

[SMP24-P04] **Sulfur isotope study of metacarbonate rocks from Highland Complex, Sri Lanka**

*Aoi Yoshioka[1], Madhusoodhan Satish-Kumar[1] (1.Department of Geology, Faculty of Science, Niigata University)

[SMP24-P05] Preliminary reports of U-Pb zircon age of charnockites in Aker Peaks of the Napier Complex, East Antarctica

*Kenji Horie[1,2], Mami Takehara[1], Tomokazu Hokada[1,2], Allen Nutman[3] (1.National Institute of Polar Research, 2.The Graduate University for Advanced Studies, SOKENDAI, 3.University of Wollongong)

[SMP24-P06] **Microtextural, fluid inclusion and C-O stable isotope studies of sparry magnesite of Deoban group of Kumaun Lesser Himalayas**

*Prakash Chandra Arya[1], Sajeev Krishnan[1], Kiran S[2,3], Satish Kumar[2], Claude Nambaje[1] (1.Centre for Earth Science, Indian Institute of Science, Bangalore, India, 2.Department of Geology, Faculty of Science, Niigata University, Niigata, Japan, 3.Graduate School of Science and Technology, Niigata University, Niigata, Japan)

[SMP24-P07] **Petrography and progressive metamorphism of Chitradurga Schist Belt, Dharwar Craton, southern India**

*Tomokazu Hokada[1,2], Madhusoodhan Satish-Kumar[3], Yuichiro Ueno[4], Tsuyoshi Toyoshima[3], Kaoru Mishima[4], Abdulla Nasheeth[4,5], Chiaki Ikawa[2] (1.National Institute of Polar Research, 2.The Graduate University for Advanced Studies (SOKENDAI), 3.Niigata University, 4.Tokyo Institute of Technology, 5.Osaka City University)

[E] Poster | S (Solid Earth Sciences)：S-GC Geochemistry

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.17_1

[S-GC32] Volatiles in the Earth - from Surface to Deep Mantle

convener:Takeshi Hanyu(Japan Agency for Marine-Earth Science and Technology, Research Institute for Marine Geodynamics), E Gray Bebout(Lehigh University), Yuji Sano(Division of Ocean and Earth Systems, Atmosphere and Ocean Research Institute, University of Tokyo), Hirochika Sumino(Department of General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo)

[SGC32-P01] Secular variation of helium isotope ratios in Izu Oshima: What will be observed in the next eruption?

*Hirochika Sumino[1], Kei Ikehata[2], Aya Shimizu[3], Kotaro Toyama[4], Tomoya Obase[1], Kenji Notsu[5] (1.Department of General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo, 2.Faculty of Life and Environmental Sciences, University of Tsukuba, 3.Tokyo Metropolitan Industrial Technology Research Institute, 4.Atmosphere and Ocean Research Institute, The University of Tokyo, 5.Geochemical Research Center, Graduate School of Science, University of Tokyo)

[SGC32-P02] Noble gas analysis and microstructure observation of the Finero phlogopite peridotite in Northern Italy to constrain the origin of deformation process of mantle wedge peridotite

*Nanae Fukushima[1], Hirochika Sumino[1], Jun-ichi Ando[2], DAS KAUSHIK[2], Masahiro Kobayashi[3], Hiroyuki Kagi[4], Takafumi Yamamoto[2] (1.Graduate School of Arts and Sciences, the University of Tokyo, 2.Graduate School of Advanced Science and Engineering, Hiroshima University, 3.Metropolitan Industrial Technology Research Institute, 4.Graduate School of Science, the University of Tokyo)

[SGC32-P03] Noble gas isotopic composition of directly ascending petit-spot from the northwest Pacific Ocean

*Kaishi Nakao[1], Naoto Hirano[2], Hirochika Sumino[3] (1.Department of Earth Science, Graduate School of Science, Tohoku University, 2.Center for Northeast Asian Studies, Tohoku University, 3.Graduate School of Arts and Sciences, The University of Tokyo)

[SGC32-P04] Fate of Subducting Organic Carbon: Evidence from HP/UHP Metasedimentary Suites and Implications for Isotopic Compositions of Arc Volcanic Gases

*Gray E Bebout[1], Kaylee H. Kraft[1], Jennie Pinho[2], Gabe S. Epstein[1] (1.Lehigh University, Dept. Earth and Environmental Sciences, Bethlehem, Pennsylvania, USA, 2.Lafayette College, Dept. Chemistry, Easton, Pennsylvania, USA)

[SGC32-P05] **Monitoring the magmatic activity and volatile fluxes of Wakamiko caldera in southern Japan**

*Ma. Teresa Escobar[1], Naoto Takahata[1], Kotaro Shirai[1], Takanori Kagoshima[1,2], Kentaro Tanaka[1], Hajime Obata[1], Yuji Sano[1] (1.Atmosphere and Ocean Research Institute University of Tokyo, 2.University of Toyama)

[SGC32-P06] Heterogeneous accretion of Earth's volatiles as constrained by nitrogen isotopes

*Lanlan Shi[2,1,3], Takanori Kagoshima[2], Yuji Sano[2] (1.State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of 7 Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China, 2.Division of Ocean-Earth System Science, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba 277-8564, Japan, 3.University of Chinese Academy of Sciences, Beijing 100049, China)

[SGC32-P07] **Hydrogen isotope of the mantle source in Pitcairn Island**

*Takahiro Ozawa[1], Akira Ishikawa[1], Takeshi Hanyu[2], Kenji Shimizu[3], Takayuki Ushikubo[3], Morihisa Hamada[2], Hikaru Iwamori[4] (1.Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 2.Japan Agency for Marine-Earth Science and Technology, 3.Kochi Core Center, Japan Agency for Marine-Earth Science and Technology, 4.Earthquake Research Institute, the University of Tokyo)

[SGC32-P08] Helium isotope heterogeneity recorded in different phenocrysts in Samoan lavas

*Takeshi Hanyu[1] (1.Japan Agency for Marine-Earth Science and Technology, Research Institute for Marine Geodynamics)

[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-IS Intersection

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.20_1

[M-IS06] Human-environment Nexus from Pre-Historic to Modern Times

convener:F Harry Lee(The Chinese University of Hong Kong)

[MIS06-P01] The socio-hydrological interactions in modern China: a case study based on flood events in Yangtze River Basin

*CHANG LIU[1], Akiyuki Kawasaki[1], Tomoko Shiroyama[2] (1.Department of Civil Engineering, the University of Tokyo, 2.Graduate School of Economics, the University of Tokyo)

[MIS06-P02] Historical climate-war nexus in the eyes of geographers

*Harry F Lee[1] (1.The Chinese University of Hong Kong)

[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-IS Intersection

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.21_1

[M-IS07] Effects of lightning, severe weather and tropical storms

convener:Mitsuteru Sato(Department of Cosmoscience, Hokkaido University), Hisayuki Kubota(Hokkaido University), C. Glenn Vincent Lopez(- - -), Purwadi Purwadi(Department of Cosmosciences, Hokkaido University, Sapporo 0600810, Japan)

[MIS07-P01] Lightning bursts observed during the tropical cyclone genesis over the Philippine Sea

*Hisayuki Kubota[1], Yukihiro Takahashi[1], Mitsuteru Sato[1] (1.Hokkaido University)

[MIS07-P02] Spatial and temporal variations of heavy rainfall in the Metro Manila, Philippines in the dry-wet transitional season based on a dense surface meteorological observation network

*Jun-Ichi Hamada[1], Jun Matsumoto[1], Hisayuki Kubota[2], Mitsuteru Sato[2], Yukihiro Takahashi[2], Glenn Vincent[3] (1.Tokyo Metropolitan University, 2.Hokkaido University, 3.Advanced Science and Technology Institute, Philippines)

[MIS07-P03] Estimation of the relation between electrical properties of lightning and tropical cyclone intensity in the western north Pacific.

*Shunsuke Niwa[1], Mitsuteru Sato[1], Yukihiro Takahashi[1], Hisayuki Kubota[1] (1.Department of Cosmoscience, Hokkaido University)

[MIS07-P04] Lightning Activity in Western North Pacific Measured by the V-POTEKA Network and Its Relation to Typhoon Intensity

*Mitsuteru Sato[1], Yukihiro Takahashi[1], Hisayuki Kubota[1], Glenn Vincent C. Lopez[2] (1.Faculty of Science, Hokkaido University, 2.ASTI, DOST)

[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-IS Intersection

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.20_2

[M-IS09] Weathering and conservation of cultural heritage and geosites

convener:Luigi Germinario(University of Padova, Italy), Chiaki T. Oguchi(Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University), Akos Torok(Budapest University of Technology and Economics), Tetsuya Waragai(Graduate School of Science and Engineering, Nihon University)

[MIS09-P01] Mineralogical and microclimatic control on the salt weathering of Oya stone

*Luigi Germinario[1,2], Chiaki T. Oguchi[2] (1.University of Padova, Italy, 2.Saitama University, Japan)

[MIS09-P02] Relationship between carbon dioxide concentration and temperature in the Taya cave

*Chiaki T. Oguchi[1], Rina Matsumoto[2], Yasuhiko TAMURA[3] (1.Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University, 2.Faculty of civil Engineering, Saitama University, 3.Executive Committee for the Preservation of TAYA CAVERN)

[MIS09-P03] Material properties and durability of stone in a medieval fortress; lessons to learn: an example from Hungary

*Akos Torok[1], Benedek Lógó[1] (1.Budapest University of Technology and Economics)

[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-IS Intersection

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.21_2

[M-IS10] Exploring Origin of Space, Galaxies, Earth, Moon, Solar System, Plate Tectonics, and Life

convener:Akira Taneko(SEED SCIENCE Lab.)

[MIS10-P01] **Investigating Origin and how to verify it-** Verification goes back to the past -make Hypothesis and explain of Evolution Resules ***in a unified manner,*** MIH as a sanple

★Invited Papers

*Akira Taneko[1] (1.SEED SCIENCE Lab.)

[MIS10-P02] Most Scientists **do not deny the existence of Plate Tectonics**, but ***cannot explain why Plate Tectonics happened.*** **"Multi-Impact Hypothesis"** ***can explain Origin of Plate Tectonics*** and also ***verify Origin of Moon and Solar System.***

★Invited Papers

*Akira Taneko[1] (1.SEED SCIENCE Lab.)

[MIS10-P03] Liquid Crystal Peptide/DNA Coacervates in the Context of Prebiotic Molecular Evolution

★Invited Papers

*Tony Z Jia[1,2], Tommaso P Fraccia[3] (1.Earth-Life Science Institute, Tokyo Institute of Technology, 2.Blue Marble Space Institute of Technology, 3.Institut Pierre-Gilles de Gennes, CBI, ESPCI Paris, Université PSL, CNRS)

[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-GI General Geosciences, Information Geosciences & Simulations

5:15 PM - 6:30 PM JST | 8:15 AM - 9:30 AM UTC | Ch.20_4

[M-GI32] Integration of Earth Observations and Multiple use for Earth Science and Benefits to Societies - GEO

convener:Kentaro Ando(Japan Agency for Marine and Earth Science and Technology), Hiroyuki Muraoka(River Basin Research Center), Osamu Ochiai(Japan Aerospace Exploration Agency), Shinichi Sobue(Japan Aerospace Exploration Agency)

[MGI32-P01] Developments of a new ocean data networking system for coastal ocean data sharing, and satellite data management system for Integrated Priority Study in AOGEO

*Kentaro Ando[1], Fumihiko Akazawa[1] (1.Japan Agency for Marine and Earth Science and Technology)

[MGI32-P02] Asia Pacific Biodiversity Observation Network (APBON) Strategic Plan 2030

*Hiroyuki Muraoka[1], Yayoi Takeuchi[2], Takehisa Yamakita[3], Yuichi Kano[4], Shin Nagai[3], Masahiro Nakaoka[5], Yongyut Trisurat[6], Runi Sylvester Pungga[7] (1.Gifu University, 2.National Institute for Environmental Studies, 3.Japan Agency for Marin-Earth Science and Technology, 4.Kyusyu University, 5.Hokkaido University, 6.Kasetsart University, 7.Forest Department Sarawak)

[MGI32-P03] Status of Global Forest Observation Initiative (GFOI) and its contribution to climate change monitoring

*Osamu Ochiai[1] (1.Japan Aerospace Exploration Agency)

[E] Poster | U (Union) : Union

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.01_1

[U-13] Advanced understanding of Quaternary and Anthropocene hydroclimate changes in East Asia:

convener:Li Lo(Department of Geosciences, National Taiwan University), Kaoru Kubota(Graduate School of Human Development and Environment, Kobe University), Chuan-Chou Shen(National Taiwan University), Yusuke Yokoyama(Atmosphere and Ocean Research Institute, University of Tokyo)



For the sustainability of biosphere and human society, it is crucial to in-depth understand Earth's climate system changes on different timescales. Anthropogenic forcing is also strongly affecting different aspects of human living environments, natural ecological through physical and chemical climatic perturbations, especially in East Asia with swift economic takeoff in the recent decades. We welcome climate and environmental reconstructions based on natural archives, proxy data, numerical simulations on the topics of monsoon, precipitation beef shifting, typhoon, and drought histories in Quaternary and Anthropocene. atmospheric and oceanic interactions, greenhouse gases radiative forcing and anthropogenic forcing impact from regional to global are also welcomed.

[U13-P01] Sclerochronology and geochemistry of *Mercenaria stimpsoni* collected from the western North Pacific

*Kaoru Kubota[1], Kotaro Shirai[2], Naoko Sugihara[2], Koji Seike[3], Kazushige Tanabe[4], Masayo Minami[5], Toshio Nakamura[5] (1.Graduate School of Human Development and Environment, Kobe University, 2.Atmosphere and Ocean Research Institute, The University of Tokyo, 3.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, 4.The University Museum, The University of Tokyo, 5.Institute for Space-Earth Environmental Research, Nagoya University)

[U13-P02] Radiocarbon Variability Recorded in Coral from Kikai Island to Understand Oceanography in the North Pacific Region

★Invited Papers

*Yuning Zeng[1], Yusuke Yokoyama[1], Yosuke Miyairi[1], Shoko Hirabayashi[2], Atsushi Suzuki[3] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Faculty of Geo-Environmental Science, Rissho University, 3.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST))

[U13-P03] Anthropocene signals recorded as Plutonium isotopes and Cesium-137 in Beppu Bay marine sediments, Eastern Kyushu, Japan.

*Yusuke Yokoyama[1,2,3,4,5], Stephen Tims[5], Michaela Froehlich[5], Takahiro AZE[1], Keith Fifield[5], Shoko Hirabayashi[6], Dominik Knoll[5], Michinobu Kuwae[7], Yosuke Miyairi[1], Stefan Pavetich[5] (1.Atmosphere and Ocean Research Institute, University of Tokyo, 2.Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, 3.Graduate Program on Environmental Sciences, Graduate School of Arts and Sciences, The University of Tokyo, 4.Biogeochemistry Program, Japan Agency for Marine-Earth Science and Technology, 5.Research School of Physics, The Australian National University, 6.Faculty Geo-Environmental Science, Rissho University, 7.Center for Marine Environmental Studies, Ehime University)

[U13-P04] High-resolution marine surface $\Delta^{14}C$ reconstructions using marine organisms produced carbonate attached to tetrapod ashored by high-wave in northern Pacific Coast of Japan.

*Kai Leggett[1], Yusuke Yokoyama[1], Yosuke Miyairi[1], Ota Kosuke[1], Yoshiki Shirahama[2] (1.Atmosphere and Ocean Research Institute, University of Tokyo, 2.Advanced Industrial Science and Technology, Geological Survey of Japan, Research Institute of Earthquake and Volcano Geology, Active Fault Research Group)

[U13-P05] Bronze age megadrought and Trans-Eurasian culture exchange
★Invited Papers

*Liangcheng Tan[1,2,3,4], Guanghui Dong[5], Zhisheng An[1,2,4], Lawrence R. Edwards[6,7], Haiming li[8], Dong Li[9], Robert Spengler[10], Yanjun Cai[3], Hai Cheng[3,1], Jianghu Lan[1,2], Rustam Orozbaev[11,12], Ruiliang Liu[13], Jianhui Chen[5], Hai Xu[14], Fahu Chen[15] (1. Institute of Earth Environment, Chinese Academy of Sciences, 2. Center for Excellence in Quaternary Science and Global Change, Chinese Academy of Sciences, 3.Institute of Global Environmental Change, Xi'an Jiaotong University, 4.Open Studio for Oceanic-Continental Climate and Environment Changes, Pilot National Laboratory for Marine Science and Technology (Qingdao), 5. College of Earth and Environmental Sciences, Lanzhou University, 6.Department of Earth and Environmental Sciences, University of Minnesota, 7. School of Geography, Nanjing Normal University, 8.Institution of Chinese Agricultural Civilization, Nanjing Agricultural University, 9.Library of Chang'an University, 10. Max Planck Institute for the Science of Human History, 11.Research Center for Ecology and Environment of Central Asia (Bishkek), Chinese Academy of Sciences, 12. Institute of Geology, National Academy of Sciences of Kyrgyz Republic, 13. School of Archaeology, University of Oxford, 14.Institute of Surface-Earth System Science, Tianjin University, 15.Key Laboratory of Alpine Ecology and Biodiversity, Institute of Tibetan Plateau Research, Chinese Academy of Sciences)

[U13-P06] **A gradual transition into Greenland Interstadial 14 in southeastern China based on a sub-decadally-resolved stalagmite record**
★Invited Papers

*Xin Zhang[1], Xiuyang Jiang[1,2], Haiyan Xiao[2], Binggui Cai[1,2], Tsai-Luen Yu[3,4], Chuan-Chou Shen[3,4,5] (1.Key Laboratory of Humid Subtropical Eco-geographical Processes, Ministry of Education, College of Geography Science, Fujian Normal University, 2.Institute of Geography, Fujian Normal University, 3.High-Precision Mass Spectrometry and Environment Change Laboratory (HISPEC), Department of Geosciences, National Taiwan University, 4.Research Center for Future Earth, National Taiwan University, 5.Global Change Research Center, National Taiwan University)

[U13-P07] Beppu Bay stratigraphy records the timing of human-induced planetary-scale biological and environmental shift at the beginning of the Anthropocene
★Invited Papers

*Michinobu Kuwae[1], Narumi Tsugeki[2], Atsuko Amano[3], Testuro Agusa[4], Yoshiaki Suzuki[3], Jun Tsutsumi[7], Peter R. Leavitt[5], Kotaro Hirose[6] (1.Center for Marine Environmental Studies, 2. The Faculty of Law, Matsuyama Univesity, Matsuyama, 3.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, 4.Faculty of Environmental & Symbiotic Sciences, Prefectural University of Kumamoto, 5.Department of Biology,University of Regina, 6.Faculty of Science & Engineering, Waseda University, 7.School of Life and Environmental Science, University of Tsukuba)

[U13-P08] The series of precious coral samples collected from off the southwest coast of Kochi Prefecture: one potential thousand-scale proxy for understanding subsurface ocean conditions.
★Invited Papers

*Tomoyo Okumura[1], Fujio Kumon[1], Tokuyama Hidekazu[1] (1.Center for Advanced Marine Core Research, Kochi University)

[U13-P09] Impact of human activities and natural hazards recorded in a subtropical mountain lake, northeastern Taiwan
★Invited Papers

*Tsai-wen Lin[1], Stefanie Kaboth-Bahr[2], Kweku Afrifa Yamoah[3], André Bahr[4], George Burr[1], Chih-Chieh Su[5], Liang-Chi Wang[6], Ludvig A Lowemark[1] (1.Dept. of Geosciences, NTU, 2.Institute for Geosciences, Univ. of Potsdam, 3.School of Geography, Earth & Environmental Sciences, Univ. of Birmingham, 4.Institute of Earth Sciences., Heidelberg Univ., 5.Institute of Oceanography, NTU, 6.Dept. of Earth and Environmental Sciences, NCCU)

[U13-P10] Reconstruction of ventilation ages of the Indian Ocean sector of the Southern Ocean using ^{14}C and U-Th ages of deep-sea isidid octocorals

★Invited Papers

*Yukiko Kozaka[1], Chuan-Chou (River) Shen[2], Hiroshi Sato[3], Masayo Minami[1], Yuki Tokuda[4], Minoru Ikehara[5] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Department of Geosciences, National Taiwan University, 3.School of Business Administration, Senshu University, 4.Faculty of Environmental Studies, Tottori University of Environmental Studies, 5.Center for Advanced Marine Core Research, Kochi University)

[U13-P11] **North Atlantic cooling desiccated western India during Early Holocene: Evidence-based on clumped and stable oxygen isotope analysis of Gastropod**

*THAMIZHARASAN SAKTHIVEL[1,2], PROSENJIT GHOSH[1,2], YOGARAJ BANERJEE[1] (1.Centre for Earth Sciences, Indian Institute of Science, Bangalore, India -560012, 2.Divecha Centre for Climate Change, Indian Institute of Science, Bangalore, India -560012)

Sclerochronology and geochemistry of *Mercenaria stimpsoni* collected from the western North Pacific

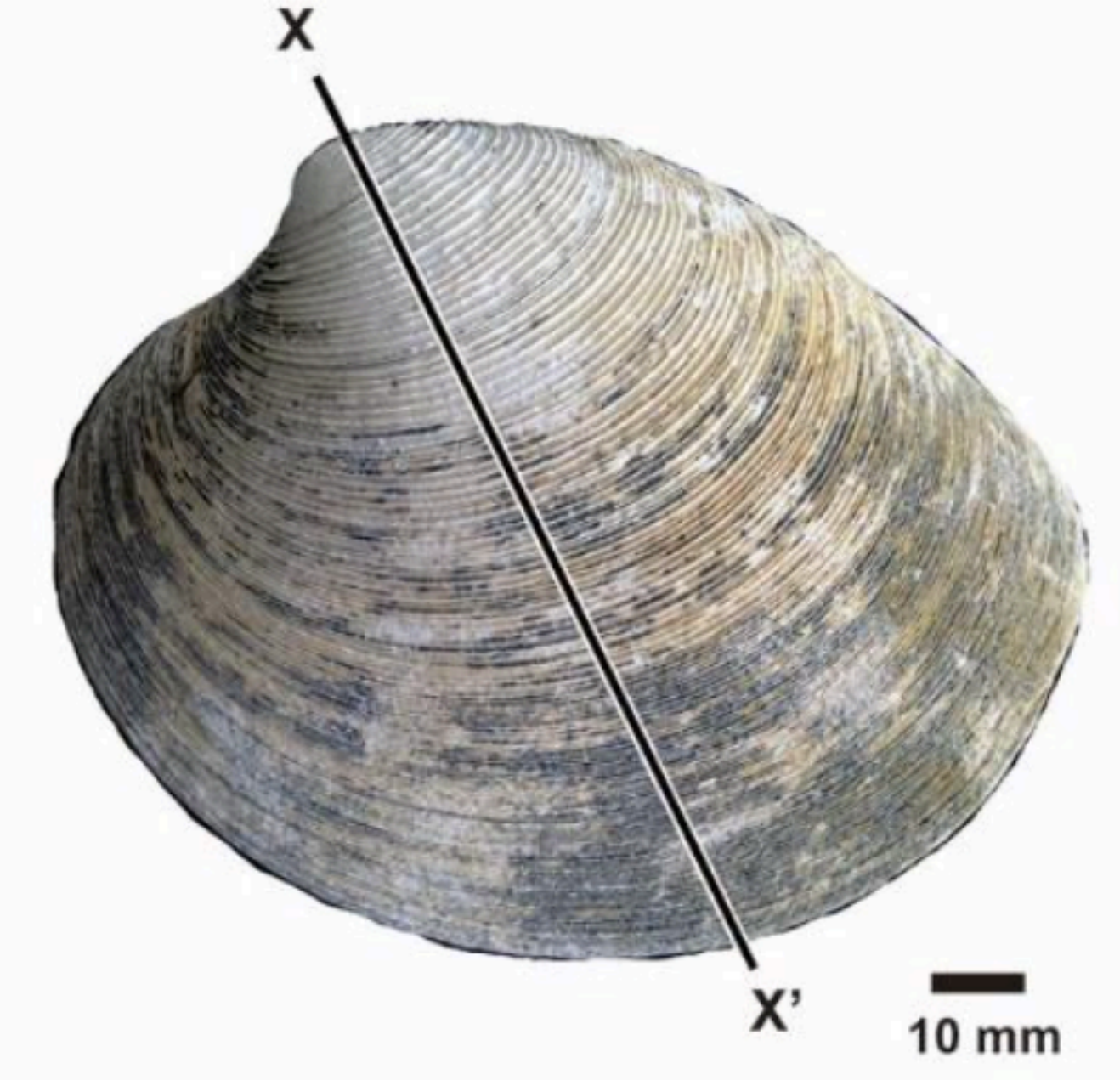
*Kaoru Kubota[1], Kotaro Shirai[2], Naoko Sugihara[2], Koji Seike[3], Kazushige Tanabe[4], Masayo Minami[5], Toshio Nakamura[5]

1. Graduate School of Human Development and Environment, Kobe University, 2. Atmosphere and Ocean Research Institute, The University of Tokyo, 3. Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, 4. The University Museum, The University of Tokyo, 5. Institute for Space-Earth Environmental Research, Nagoya University

Bivalve shell is one of the most important archives of past environmental changes because some species can live more than several decades and distribute broadly (e.g., from high to low latitude, fresh/brackish/sea water). We have investigated potential of long-lived cold water bivalve, *Mercenaria stimpsoni* (Stimpson's hard clam) living in the western North Pacific (especially, coastal area of North East Japan). In this presentation we will show sclerochlonological and geochemical records (e.g., oxygen isotopes and radiocarbon) of both live-caught and dead specimens collected from the seafloor of NE Japan (5–20 m). From both sclerochlonology and nuclear bomb-derived radiocarbon (bomb-^{14}C), it was found that this animal can live for more than 100 years, thus very useful for paleoeanograpic studies. It was also found that a lot of *M. stimpsoni* were killed by huge tsunami that hit NE Japan in March 2011, which is likely caused by disturbance of marine sediment, including seabed liquefaction.

Keywords: bivalve, radiocarbon, sclerochronology, oxygen isotope, tsunami, paleoeanography

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Radiocarbon Variability Recorded in Coral from Kikai Island to Understand Oceanography in the North Pacific Region

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Atmospheric radiocarbon (^{14}C) rapidly increased after 1955 because of the nuclear test. This artificial ^{14}C called bomb-^{14}C is diffused into the surface ocean and taken up by coral skeletons from ambient seawater. However, the deep ocean is isolated from direct CO_2 exchange from the atmosphere. Therefore, bomb-^{14}C in coral can be used as a very sensitive indicator of vertical and horizontal advection of water masses, which contributes to the understanding of ocean circulation [1].

In this study, a challenge has made with a high vacuum gas treatment line that specially designed for small quantity of samples (ca.100 μg C). This experiment is aiming at obtaining seasonal-resolution ^{14}C data between 1940 and 1990 using the coral obtained from Kikai Island and revealing physical oceanographic information around Kuroshio region. The age model was based on high resolution Sr/Ca data determined by Kawakubo et al. (2017) [2].

At present, the contamination level during experimental steps of our method has been confirmed to be relatively low and constant by several repeated tests using standard samples distributed from International Atomic Energy Agency (IAEA). Besides, samples from the top part of coral corresponding to summer and winter shown by peaks of Sr/Ca data after 1975 has been measured. The trend and value of current bomb curve are similar to previous studies in Kikai Island and at other sampling sites in the Pacific, which proves the reliability of our data in high confidence. In this presentation, we will show the ^{14}C results and discuss the oceanographic implications inferred from the data.

[1] Hirabayashi, S., Yokoyama, Y., Suzuki, A., Miyairi, Y., Aze, T., Siringan, F., & Maeda, Y. (2019). Insight into Western Pacific Circulation from South China Sea Coral Skeletal Radiocarbon. *Radiocarbon*, 61(6), 1923-1937.

[2] Kawakubo, Y., Alibert, C., & Yokoyama, Y. (2017). A reconstruction of subtropical western North Pacific SST variability back to 1578, based on a Porites Coral Sr/Ca record from the northern Ryukyus, Japan. *Paleoceanography*, 32, 1352– 1370.

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Anthropocene signals recorded as Plutonium isotopes and Cesium-137 in Beppu Bay marine sediments, Eastern Kyushu, Japan.

*Yusuke Yokoyama[1,2,3,4,5], Stephen Tims[5], Michaela Froehlich[5], Takahiro AZE[1], Keith Fifield[5], Shoko Hirabayashi[6], Dominik Knoll[5], Michinobu Kuwae[7], Yosuke Miyairi[1], Stefan Pavetich[5]

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Above ground nuclear weapon tests conducted between 1945 and 1980, have lead to the distribution of various anthropogenic radionuclides in the environment including Plutonium (Pu). It has been used as a time-marker of mid twentieth century in various geological archives similar to the ^{137}Cs fall out signature. Further, advancement of analytical techniques allows us to measure ^{239}Pu and ^{240}Pu accurately that can fingerprint the Pacific Pu signal that originated from the former Pacific Proving Grounds (PPG) in the Marshall Islands. Here we report the record of Pu isotopes between 1950 to 1990 for the sediments obtained from Beppu Bay, in Eastern Kyushu, Japan. Approximately 8m length of core was taken from 70m water depth and radiocarbon dates suggested the high sedimentation rate (2-3mm/yr) throughout (Kuwae et al., 2013). The record shows a clear Pu increase in 1950, which peaked during the1960s, followed by sharp decline in the section corresponding to the 1970s. A minor increase in the 1980s is also observed in the sediment, namely the sediment follows global fallout trends. However, a constantly higher isotope ratio between ^{239}Pu and ^{240}Pu suggest an additional contribution other than global fallout via ocean current. Further, distinguished higher points provided supportive evidence of close-in-fallout that are previously reported in open ocean environments.

Keywords: Anthropocene, Beppu Bay, Pu

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High-resolution marine surface $\Delta^{14}C$ reconstructions using marine organisms produced carbonate attached to tetrapod ashored by high-wave in northern Pacific Coast of Japan.

*Kai Leggett[1], Yusuke Yokoyama[1], Yosuke Miyairi[1], Ota Kosuke[1], Yoshiki Shirahama[2]

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Radiocarbon is produced in the upper atmosphere and distributed on the surface of the Earth via carbon cycles and has been used for radiometric dating and as a tracer of Earth surface processes including ocean current. Due to global ocean circulation, apparent radiocarbon ages ranging from ca. 400 to 2,000 years (eg., Servettaz et al., 2019), known as marine reservoir ages. Thus, continuous monitoring of radiocarbon concentrations, $\Delta^{14}C$, has been conducted commonly using annual bands of coral skeletons to reconstruct local oceanography (eg., Hirabayashi et al., 2019). Though, it has mainly been restricted in low latitude since warmer water (higher than 18 degrees C) is required to live for corals. One of the few studies that reconstruct the $\Delta^{14}C$ values in higher latitude, such as the Tohoku region, in Japan, Kubota et al. (2018) reported the $\Delta^{14}C$ values in the inner bay of the Otsuchi area using *M.stimposoni* shells. Yet the records could not cover recent $\Delta^{14}C$ variations. Additionally, the *M.stimposoni* samples used in this study are mostly collected from 20 m deep from the sea surface, only one sample collected from shallow water at around 5 m water depth thus more information at shallow water is needed. Ota et al. (2019) also reported high-resolution $\Delta^{14}C$ records using abalone shells. However, habitat differences for individual tests could not provide the reference of local marine water $\Delta^{14}C$. In this study, we reconstruct the $\Delta^{14}C$ of the sea surface by analyzing the calcium carbonate calcareous tubes of *Hydroides elegans*, which lives at ambient sea level. The samples were obtained from Iwate Prefecture and the carbonate tubes are found on tetrapods at an elevation of 7~8 m and were 30 m away from the nearest group of wave-dissipating blocks. According to the aerial photographs, we identified the exact timing when the tetrapods were dislodged. Eighteen samples of carbonate tubes of *Hydroides elegans* have filled the gap of the dataset previously published by Kubota et al. (2018). The oceanographic condition also seems to be overprinted to the signal and we will discuss it during the presentation.

Keywords: ΔC-14, Radiocarbon analysis, Hydroides Elegans, Aerial photographs, Accelerator Mass Spectrometer, Sanriku

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Bronze age megadrought and Trans-Eurasian culture exchange

*Liangcheng Tan[1,2,3,4], Guanghui Dong[5], Zhisheng An[1,2,4], Lawrence R. Edwards[6,7], Haiming li[8], Dong Li[9], Robert Spengler[10], Yanjun Cai[3], Hai Cheng[3,1], Jianghu Lan[1,2], Rustam Orozbaev[11,12], Ruiliang Liu[13], Jianhui Chen[5], Hai Xu[14], Fahu Chen[15]

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Arid Central Asia (ACA), with its diverse landscapes of high mountains, oases, and deserts, hosted the central routes of the Silk Roads that linked trade centers from East Asia to the eastern Mediterranean. Ecological pockets and ecoclines in ACA are largely determined by local precipitation. However, little research has gone into the effects of hydroclimatic changes on trans-Eurasian cultural exchange. Here, we reconstruct precipitation changes in ACA, covering the mid-late Holocene with a U-Th dated, ~3 a resolution, multi-proxy time series of replicated stalagmites from the southeastern Fergana Valley, Kyrgyzstan. Our data reveal a 640-a megadrought between 5820 and 5180 a BP, which likely impacted cultural development in ACA and impeded the expansion of cultural traits along oasis routes. Instead, it may have diverted the earliest transcontinental exchange along the Eurasian steppe during the 5th millennium BP. With gradually increasing precipitation after the megadrought, settlement of peoples in the oases and river valleys may have facilitated the opening of the oasis routes, ‘ ‘prehistoric Silk Roads”, of trans-Eurasian exchange. By the 4th millennium BP, this process may have reshaped cultures across the two continents, laying the foundation for the organized Silk Roads.

Keywords: Megadrought, Trans-Eurasian exchange, Silk Roads, Arid Central Asia, Mid-Holocene

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A gradual transition into Greenland Interstadial 14 in southeastern China based on a sub-decadally-resolved stalagmite record

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Greenland stadials and interstadials (GS and GIS) are prominent features in ice core records of the last glacial period and are characterized by millennial-scale climate oscillations with sub-decadal- to decadal-scale hydroclimatic shifts. Over the past two decades, studies of Chinese stalagmite records have revealed corresponding Chinese stadials/interstadials (CS/CIS). However, the CS/CIS shifts and their corresponding forcings across the Asian monsoon region are still not fully understood. In this study, we present a ^{230}Th-based sub-decadally-resolved stalagmite δ^{18}O record from Xianyun Cave in southeastern China covering the period 58.2–50.8 kyr BP (before 1950 AD) and including GIS (and CIS) 16–14. We used GIS (CIS) 15.1 (peak point) and 15.2 (first point) to chronologically link the high and low-latitude records. We found that the onset of GIS 14 in our record occurred earlier than in an ice core record from Greenland and stalagmite records from northern China. This finding implies that low-latitude tropical climate likely played a key role in triggering abrupt millennial-scale event. Moreover, the transition into GIS 14 lasted 1.49 kyr in our record, which is in contrast to the abrupt temperature rise observed in NGRIP (the North Greenland Ice Core Project, 0.02 kyr). Compared with previous stalagmite records, we identified two transitional patterns into GIS 14 in monsoonal China: 1) a rapid transition in northern China and 2) a gradual transition in southeastern China. The gradual transition in our Xianyun record is analogous to a sea surface temperature (SST) record in the western tropical Pacific, highlighting a possible inherent connection between the changes in western tropical Pacific SSTs and East Asian summer monsoon variability in southeastern China. Paleoclimate records in southeastern China are therefore critical for understanding the mechanisms of abrupt millennial-scale climate events, as they can act as a bridge between the high- and low-latitude records.

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Beppu Bay stratigraphy records the timing of human-induced planetary-scale biological and environmental shift at the beginning of the Anthropocene

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1. Center for Marine Environmental Studies, 2. The Faculty of Law, Matsuyama Univesity, Matsuyama, 3. Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, 4. Faculty of Environmental & Symbiotic Sciences, Prefectural University of Kumamoto, 5. Department of Biology,University of Regina, 6. Faculty of Science & Engineering, Waseda University, 7. School of Life and Environmental Science, University of Tsukuba

The definition of the lower boundary of Anthropocene requires a global stratotype section showing a human-induced planetary-scale biological and environmental shift. However, such stratotype remains unclear. Here we present multiproxy records showing biological and environmental changes for the last multi-century or millennia using the sediment core samples from anoxic coastal marine basin, Beppu Bay, Japan. Biotic marker records showed an abrupt biological change as seen in algal communities due to eutrophication in 1960s, early Great Acceleration, which was unprecedented over the last 670 years. The remarkable biological changes reconstructed from Asian oceanic sediment imply that intensified coastal marine ecosystem degradation which started in Europe in 18th century extended over the northern hemisphere at the early Great Acceleration. Our results provide a geological evidence of the human-induced planetary-scale biological and environmental shift at the lower boundary of Anthropocene.

Keywords: GSSP, biostratigraphy, Beppu Bay

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The series of precious coral samples collected from off the southwest coast of Kochi Prefecture: one potential thousand-scale proxy for understanding subsurface ocean conditions.

*Tomoyo Okumura[1], Fujio Kumon[1], Tokuyama Hidekazu[1]

1. Center for Advanced Marine Core Research, Kochi University

Radiocarbon dating was performed for various types of precious coral colony fragments collected from the Ashizuri fishing field, around 100 to 200 m deep, off the southwest coast of Kochi Prefecture as a first step for understanding the historical background of one of the largest precious coral fishing fields in Japan. The ^{14}C ages of the 55 specimens range from cal BC 5617–5411 to the modern and are broadly distributed over the past ~7500 years [1]. Most of the measured samples were older than 1871, when fishing activities of precious corals began in Kochi Prefecture. These results suggest that most of the deaths of the precious coral colonies were due to natural causes, such as natural mortality, predation, or various forms of environmental degradation, and not strictly related to destructive fishing practices. Additionally, precious corals started inhabiting the study area at least ~7500 years ago, when the marine condition became similar to that of today after the Last Glacial Period. The series of the measured samples have the potential to provide thousand-scale records of environmental conditions at deep waters. Preliminary measurements of Mg, Sr, S, Ba, $\delta^{13}C$, and $\delta^{18}O$ are underway by following previous studies [2, 3, 4, 5].

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Keywords: precious corals, Octocorallia

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Impact of human activities and natural hazards recorded in a subtropical mountain lake, northeastern Taiwan

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Alpine and subalpine lakes are sensitive to hydroclimate change in the catchment, making sediments from those lakes an ideal material to reconstruct terrestrial paleoclimate and paleoenvironment alteration. In addition to long-term climate change, natural hazards (e.g. forest fire and landslide) and human activities (e.g. logging, cultivation, and construction) also cause environmental changes recorded in the lake sediment. It is therefore important to differentiate between sediment geochemical signals induced by climate change, natural hazards, and human activity. Here we compare signals from a sediment core with historical records to understand how natural and artificial events affect the mountain environment and are recorded in the lake sediment. We used the most recent 300 years of record from a sediment core taken in Cueifong Lake, a mountain lake in northeastern Taiwan. The age model based on ^{210}Pb and ^{137}Cs indicates that the sediment environment in Cueifong Lake remained stable during the past 300 years. We use different parameters to make a multi-proxy reconstruction of environmental conditions in the sediment core, including TOC, C/N, δ^{13}C, charcoal, and element abundancy reconstructed from XRF core scanning. Historical documents and aerial photos were reviewed to assess forestry, constructions, and events in the catchment. Variations of organic matter and element abundancy indicate the sediment source changes before and after deforestation. Aerial photos can be used to capture the time and degree of deforestation surrounding the lake catchment. Our result could help to understand how human development might affect a mountainous closed-lake environment.

Keywords: deforestation, forest fire, aerial photo, XRF core scanning, mountain lake

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Reconstruction of ventilation ages of the Indian Ocean sector of the Southern Ocean using ^{14}C and U-Th ages of deep-sea isidid octocorals

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Carbonaceous skeletons of the deep-sea corals are generally dated by uranium-series systematics. By combining the absolute ages obtained with radiocarbon, the past ocean ventilation rate has been estimated. This approach is particularly effective in the Southern Ocean, where carbonate compensation depths are shallow and carbonate rocks are not likely to remain. Previous studies performed on the Southern Ocean have mainly focused on corals from the Drake Passage and off Tasmania. In this study, we focused on deep-sea isidid octocorals (Bamboo coral) collected from the Conrad Rise, Indian sector of the Southern Ocean, and report the results of ^{14}C and U-Th ages in the presentation. The skeleton of deep-sea isidid octocorals is formed of very dense calcite material, which makes it difficult to dissolve even after the death of the coral polyp that cover it.

A characteristic of deep-sea isidid octocorals is that new skeletons may form to encapsulate the old coral skeleton. We performed both of uranium-series and radiocarbon measurements on two samples of old coral inclusions. The U-Th dating provided insight into the age distribution of coral skeletons collected by dredge from Conrad Rise. Periods of relatively high coral production frequency may indicate that the environment was conducive to coral growth.

Keywords: Deep-sea coral, Bamboo coral, U-Th dating, radiocarbon dating, Southern Ocean, Conrad Rise

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North Atlantic cooling desiccated western India during Early Holocene: Evidence-based on clumped and stable oxygen isotope analysis of Gastropod

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Last Glacial Period witnessed modulation of Indian Summer Monsoon (ISM) intensity due to its teleconnection with the North Atlantic climatology (Schulz et al.,1998). We investigated here the millennium scale record of Sea Surface Temperature (SST) and δ18O of seawater at coastal location during Early Holocene (12 to 7 kyr BP) based on clumped and stable oxygen isotope composition of well-preserved fossil specimen of Cerithium sp. These shells grow in the tidal environment and has potential to record upwelling process which controls the variation in water and air temperature (Yekta al., 2019). The raised paleo-gulf sedimentary sequence exposed adjoining the region of present-day Arabian Sea i.e., Great Rann of Kutch provided opportunity to study the coastal climate during the time interval when solar variability was minimal. The record of solar variability from the region was earlier studied from the offshore sedimentary archives from the Arabian Sea (Gupta et al., 2003). Our observation revealed variation of coastal apparent Sea Surface Temperature (SST) from 30 to 36˚C, which is negatively correlated with upwelling proxy G.bulloides abundance from the adjoining region of Eastern Arabian Sea (Naik et al., 2016). This suggests vertical entrainment of deep water due to wind strength variability drove the upwelling process and regional SST . The estimated equilibrium δ18O of water is consistent with the shift observed in the available record from the Indian Subcontinent (Dixit et al., 2014). We provided here fist evidence of intense monsoonal wind strength assessment at 12.2, 9.47, and 7.9 kyr BP. In contrast, our observation revealed weakening of ISM wind intensity at 9.86, 8.51, and 7.65 kyr BP, which is coherent sea ice variability in the North Atlantic (Bond et al., 2001). Therefore, we showed that North Atlantic climate has strong impact on ISM even during past as seen in the historical data and present day (Borah et al., 2020).

Keywords: Early Holocene , Clumped and Stable isotope of Gastropod, Indian Summer Monsoon, North Atlantic Teleconnection

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[E] Poster | P (Space and Planetary Sciences)：P-PS Planetary Sciences

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[P-PS03] Regolith Science

convener:Koji Wada(Planetary Exploration Research Center, Chiba Institute of Technology), Akiko Nakamura(Graduate School of Science, Kobe University), Patrick Michel(Universite Cote D Azur Observatoire De La Cote D Azur CNRS Laboratoire Lagrange), John Kevin Walsh(Southwest Research Institute Boulder)

Recent planetary explorations have revealed that almost all solid bodies in the solar system are covered with small particles, called regolith. The surface geology, especially regolith behavior on the surfaces of solid bodies, becomes increasingly more important as represented by Hayabusa mission and other on-going and planned sample-return missions such as Hayabusa2, OSIRIS-REx, and MMX.
For fully understanding the regolith science, it is required to know and compare the regolith conditions on various celestial bodies, from asteroids to planets, with various methods.
Therefore, this session welcomes broad topics related to regolith on various celestial bodies, such as asteroids, comets, the Moon, the martian moons, Mars, etc. Papers on the formation, evolution, and alteration processes of regolith particles and regolith systems on the surface of planetary bodies, remote and in-situ observational results and techniques, analyses and results of returned samples, and laboratory, numerical, and theoretical studies on the fundamental physical and chemical processes are all welcome.
Note that what we call regolith is not just fine grains: all kinds of materials (more or less loose) that lie on the surface, from cobbles to finer grains, are our targets.

[PPS03-P01] Disk-resolved photometric properties of local regions on asteroid 25143 Itokawa

*Naru Hirata[1,2], Kohei Kitazato[1,2], Eri Tatsumi[3], Shota Katahira[1], Takuma Furudate[1], Hiroshi Kikuchi[4], Hiroyuki Sato[4] (1.Dep. of Computer Science and Engineering, Univ. of Aizu, 2.ARC-Space, Univ of Aizu, 3.Instituto de Astrofisica de Canarias, 4.Japan Aerospace Exploration Agency)

[PPS03-P02] Experimental study on impact ejecta velocity scaling law for regolith layer composed of weak boulders

*Yuya Yamamoto[1], Masahiko Arakawa[1], Minami Yasui[1], Sunao Hasegawa[2], Yusaku Yokota[1], Hatsune Okawa[1], Ryo Sugimura[1] (1.Graduate School of Science, Kobe University, 2.institute of Space and Astronautical Science, JAXA)

[PPS03-P03] Particle size of Ryugu's subsurface layer inferred from observation of SCI crater's ejecta curtain.

*Koji Wada[1], Ko Ishibashi[1], Hiroshi Kimura[1], Masahiko Arakawa[2], Hirotaka Sawada[3], Kazunori Ogawa[4,2], Kei Shirai[2], Rie Honda[5], Yuichi Iijima[3], Toshihiko Kadono[6], Naoya Sakatani[7], Yuya Mimasu[3], Tomoaki Toda[3], Yuri Shimaki[3], Satoru Nakazawa[3], Hajime Hayakawa[3], Takanao Saiki[3], Yasuhiko Takagi[8], Hiroshi Imamura[3], Chisato Okamoto[2], Masahiko Hayakawa[3], Naru Hirata[9], Hajime Yano[3] (1.Planetary Exploration Research Center, Chiba Institute of Technology, 2.Department of Planetology, Kobe University, 3.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 4.JAXA Space Exploration Center, Japan Aerospace Exploration Agency, 5.Department of Science and Technology, Kochi University, 6.Department of Basic Sciences, University of Occupational and Environmental Health, 7.Department of Physics, Rikkyo University, 8.Aichi Toho University, 9.School of Computer Science and Engineering, The University of Aizu)

[PPS03-P04] Ryugu's surface change formed by SCI forward debris

*Yuri Shimaki[1], Yasuhiro Yokota[1], Rie Honda[2], Masahiko Arakawa[3], Koji Wada[4], Toshihiko Kadono[5], Kei Shirai[3], Kazunori Ogawa[6], Naoya Sakatani[7], Ko Ishibashi[4], Takanao saiki[1], Hiroshi Imamura[1], Satoru

Nakazawa[1], Masahiko Hayakawa[1], Hajime Yano[1], Yasuhiko Takagi[8], Naru Hirata[9], Hirotaka Sawada[1], Seiji Sugita[10], Tomokatsu Morota[10], Shingo Kameda[7], Eri Tatsumi[11], Manabu Yamada[4], Toru Kouyama[12], Yuichiro Cho[10], Moe Matsuoka[1], Kazuo Yoshioka[10], Hidehiko Suzuki[13], Chikatoshi Honda[9] (1.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 2.Kochi University, 3.Kobe University, 4.Planetary Exploration Research Center, Chiba Institute of Technology, 5.University of Occupational and Environmental Health, 6.JAXA Space Exploration Center, Japan Aerospace Exploration Agency, 7.Rikkyo University, 8.Aichi Toho University, 9.The University of Aizu, 10.The University of Tokyo, 11.Instituto de Astrofisica de Canarias, University of La Laguna, 12.National Institute of Advanced Industrial Science and Technology, 13.Meiji University)

[PPS03-P05] Static and impact strength of brittle regolith analogs

*Akiko Nakamura[1], Sae Shigaki[1] (1.Graduate School of Science, Kobe University)

Disk-resolved photometric properties of local regions on asteroid 25143 Itokawa

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The photometric properties of asteroids reflect their surface compositions and conditions. Disk-integrated photometry of asteroid 25143 Itokawa was studied based on observations by AMICA on Hayabusa spacecraft (Tatsumi et al., 2018) and gave a global averaged surface properties. However, the surface of Itokawa shows a wide variety of terrains. Rough terrains are covered with numerous boulders of various sizes, while smooth terrains are covered with well-sorted pebbles. The degree of space weathering is also quite diverse over the surface. Disk-resolved photometry gives an opportunity to investigate local photometric properties of these interesting sites, but it requires considering the incidence angles and emission angles of observations at every pixel in observations. Our pixel database system stores individual pixel values with observation conditions such as incidence, emission, and phase angles extracted from observations, and enable us to make analysis using pixel values throughout all available images. We present results of disk-resolved photometric modeling at selected local regions on Itokawa using the pixel DB of AMICA images.

Keywords: Haybusa, Itokawa, light scattering property, asteroid

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Experimental study on impact ejecta velocity scaling law for regolith layer composed of weak boulders

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Impact cratering on solid bodies is one of the most important geological processes in our solar system. The excavation and ejection processes of sub-surface materials during the crater formation process are keys to understand the regolith formation and the escape of meteorite precursors from asteroids. Thus, it is essential to understand the ejecta velocity distribution regarding the crater formation process. Previous studies showed that both the size ratio of an impactor to surface boulders and the fracture strength of boulders would affect the final crater size, and they would also affect the ejecta velocity distribution. Then, in this study, we conducted impact experiments on granular targets composed of coarse-grains with low strength in order to study the effects of size and strength of target grains on the ejecta velocity distribution.

Cratering experiments were conducted by using a gas gun set at Kobe University and ISAS. Granular targets were prepared by using weathered tuff granules with the size of 1 to 4mm (small particle) and the size of 1 to 4cm (large particle). The crush strength of these tuff particles was measured to be about 60 kPa for small particles and 30 kPa for large particles. A spherical projectile with the size of 3mm (stainless steel, zirconia, alumina, glass, and nylon) was lunched at the impact velocity from 40 to 200m/s, and a spherical projectile with the size of 2mm (tungsten carbide, copper, stainless steel, zirconia, titan, aluminum, and nylon) was lunched at the impact velocity (U) from 1.2 to 4.5 km/s, and these two types of the projectile were impacted on the target surface at the normal direction. Impact cratering process was observed by a high-speed camera at 10^3-10^5 fps. We tracked positions of individual particles in the recorded high-speed images and tracked back initial positions of these tracked particles. Then, the ejection velocity and the ejection angle of these particles were calculated according to the ballistic trajectories.

As a result of the analysis for the high-speed images, we found that the large particles near the impact point were disrupted and the fractured particles were then ejected as a dust cloud immediately after the collision. After that, the intact large particles were ejected out of the crater slowly. The ejection velocity of the particles (v_e) decreased with the increase of the initial position (x), and we obtained the relationship between the normalized ejection velocity (v_e/U) and the normalized initial position (x/a), where a is a projectile radius. The slopes of these distributions were found to be dependent on the projectile density, so the conventional ejecta velocity scaling law was applied to these results. Then, we examined how the size and the strength of these particles affected the ejecta velocity distribution. All the data were clearly separated into two regions: One had large ejection velocities ($v_e/U > 10^{-3}$) and the other had small ejection velocities ($v_e/U < 10^{-3}$). The large normalized ejection velocities would represent those of disrupted particles around the impact point, thus we speculate that the ejection velocity could be scaled by the crushed strength scaled velocity of a particle. On the other hand, the small ejection velocities would show those of the intact particles, so the ejection velocities would be scaled by the gravity scaled velocity. Furthermore, the ejecta velocities at the crater wall were two to three times larger than those in the previous study, and the slope of the velocity distribution was gentler than those in previous studies. We obtained the relationship between the ejection angle and the normalized initial position (x/R), where

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R is a crater radius, and the ejection angle was found to scatter from 20˚to 80˚depending on x/R, irrespective of the projectile density.

Keywords: ejecta velocity distribution, regolith, low-strength coarse grain, ejecta velocity scaling laws

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Particle size of Ryugu's subsurface layer inferred from observation of SCI crater’ s ejecta curtain.

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The particle size of subsurface layers of asteroids would result from the formation and the surface evolution processes of the asteroids. It is difficult, however, to reveal the properties of subsurface particles with remote sensing observations from spacecraft and telescopes. Hayabusa2, the second asteroid explorer mission led by Japan Aerospace Exploration Agency (JAXA), succeeded in forming an artificial crater on the asteroid Ryugu with Small Carry-on Impactor (SCI). In the course of the crater formation process, an ejecta curtain was observed by Deployable Camera 3 (DCAM3) that was separated from the spacecraft to take time-lapse optical images of the ejecta curtain. Since particles that compose the ejecta curtain emerged from a certain depth of the subsurface layer (~ 1 m deep), we are able to extract physical properties of the subsurface particles from the analysis of the ejecta curtain images.

We constructed a theoretical model of the ejecta curtain based on the crater scaling laws and compared it with the images in terms of optical depth. We found that the typical size of the ejecta particles lies in the range from several centimeters to decimeters, indicating a deficit of particles smaller than ~ 1 mm in the subsurface layer. The lack of minute particles suggests that Ryugu might have experienced some kind of surface flow process such as mass wasting to sink small particles into a deeper region or that small particles would have been eliminated by solar radiation pressure during the formation of a rubble pile asteroid Ryugu. We expect laboratory analysis of the size distribution and the interparticle adhesion of Ryugu returned samples to help elucidate the possibility of these processes.

Keywords: Hayabusa2, Small Carry-on Impctor, Impact crater, Subsurface particle size, Ryugu, Deployable Camera 3

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Ryugu's surface change formed by SCI forward debris

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The small carry-on impactor (SCI) on the Hayabusa2 spacecraft is designed to create an artificial crater on an asteroid surface for the collection of sub-surface materials and validation of crater scaling laws [1]. The SCI launches a hollow hemisphere copper liner with a diameter of 13 cm at a velocity of 2 km/s, accompanied by numerous debris [2]. In the ground tests, the SCI forward debris generated concentric damage on the target surface. The SCI successfully created an artificial crater on the surface of Ryugu in 2019 [3]. Besides the artificial crater, surface changes around the crater, such as rim formation, boulder movement, and the emergence of new boulders were observed by the optical navigation camera telescope (ONC-T) [4]. Additionally, concentric surface changes were observed ~70 m distance from the artificial crater, created by the SCI forward debris. Here we report the distribution of the surface changes formed by the SCI forward debris both in the ground test and Ryugu. Based on the SCI detonation position [5], we found that the polar angle of the forward debris in the ground tests is ~11˚, whereas that in Ryugu is ~15˚, probably due to the absence of ambient pressure.

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Keywords: Hayabusa2, Crater formation, Asteroid Ryugu

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Static and impact strength of brittle regolith analogs

*Akiko Nakamura[1], Sae Shigaki[1]

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Thermal observations showed that the surface rocks of the asteroid Ryugu have large porosity. Comparison of the porosity and strength of the returned samples with those of meteorites and terrestrial rocks is of interest in understanding the evolution of asteroid materials. Generally, a structure having a large porosity has a lower static strength than a structure having a dense structure even if the structure has the same composition. However, the relationship between static strength and porosity is not one-to-one. In addition, the relationship between impact strength and static strength also varies depending on the structure and material composition.

We have investigated static strength and impact strength of some natural brittle materials [1-4]. Samples were basalt, chondrules disassembled from meteorite specimens, dunite, pyrophyllite, pumice, and sandstones. Crushing strength was determined from compression test of spherical specimens and tensile strength was determined from compression test of disc specimens (Brazilian disc test). We obtained the Weibull parameter from the static strength measurement results of the samples, and the value range was 1.5 to 24. Two types of impact disruption experiments were conducted. One is the usual one using brittle targets and study the disruption threshold of the targets, and the other is the case of a small specimen using a brittle sample as a projectile. These results are discussed in comparison with the literature data of chondrites [5, 6].

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Keywords: regolith, strength

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[E] Poster | P (Space and Planetary Sciences)：P-EM Solar-Terrestrial Sciences, Space Electromagnetism & Space Environment

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.03_1

[P-EM08] Space Weather and Space Climate

convener:Ryuho Kataoka(National Institute of Polar Research), A Antti Pulkkinen(NASA Goddard Space Flight Center), Kanya Kusano(Institute for Space-Earth Environmental Research, Nagoya University), Kaori Sakaguchi(National Institute of Information and Communications Technology)

We share the latest scientific papers to understand how the space environment changes in various time scales, and to discuss how we will react via international and interdisciplinary collaborations. More specifically, welcomed papers include space climate studies to reconstruct the long-term variations from radio isotopes; cutting-edge observational and modeling studies of the ionosphere, geospace, heliosphere and the sun; simulation and statistical studies to predict the future space weather and space climate; applied science such as operational space weather forecast and mitigation of the social impact due to extreme space hazards. Focused topics in 2021 include extreme events, theoretical maxima and benchmarks for hazard assessments, and space weather and deep space human spaceflight activities at Moon and at Mars.

[PEM08-P01] NASA Goddard Space Flight Center Space Weather Activities

*Antti A Pulkkinen[1] (1.NASA Goddard Space Flight Center)

[PEM08-P02] Relationship between X-ray and EUV solar flare emissions and the Dellinger phenomenon

*Kyoko Watanabe[1], Munechika Arao[1], Shohei Nishimoto[1], Chihiro Tao[2], Michi Nishioka[2] (1.National Defense Academy of Japan, 2.National Institute of Information and Communications Technology)

[PEM08-P03] A comparative study of the empirical and physics-based methods for solar flare predictions

*Kaho Kondo[1], Kanya Kusano[1] (1.Institute for Space-Earth Environmental Research, Nagoya University)

[PEM08-P04] Data-driven MHD Simulation of Solar Active Region NOAA 11283

*Yeongmin Kang[1], Takafumi Kaneko[1], Kanya Kusano[1] (1.Institute for Space-Earth Environmental Research)

[PEM08-P05] Unusual enhancement of ~30 MeV proton flux in an ICME sheath region

*Takahiro Obara[1], Mitsuo Oka[2], Nariaki V Nitta[3], Seiji Yashiro[4], Daikou Shiota[5], Kiyoshi Ichimoto[6] (1.Planetary Plasma and Atmospheric Research Center,Tohoku University, 2.University of California Berkeley, 3.Lockheed Martin Solar and Astrophysics Laboratory, 4.The Catholic University of America, 5.National Institute of Information and Communications Technology, 6.Kyoto University)

[PEM08-P06] Development of spectral riometer for observation of energetic electron precipitation at Syowa Station, Antarctica

*Yoshimasa Tanaka[1,2,3], Masayuki Yamamoto[4], Koji Nishimura[1,2,3], Hisao Yamagishi[1], Antti Kero[5], Akira Kadokura[1,2,3], Akira Mizuno[6], Akira Sessai Yukimatu[1,3], Herbert Akihito Uchida[3], Ryuho Kataoka[1,3], Yasunobu Ogawa[1,2,3], Takanori Nishiyama[1,3], Masaki Tsutsumi[1,3], Mitsunori Ozaki[7], Yoshizumi Miyoshi[6], Shin-ichiro Oyama[6], Fuminori Tsuchiya[8] (1.National Institute of Polar Research, 2.Polar Environment Data Science Center, Joint Support-Center for Data Science Research, Research Organization of Information and Systems, 3.The Graduate University for Advanced Studies, SOKENDAI, 4.National Institute of Information and Communications Technology, 5.Sodankyla Geophysical Observatory, 6.Institute for Space-Earth Environmental Research, Nagoya University, 7.Faculty of Electrical and Computer Engineering, Institute of Science and Engineering, Kanazawa University, 8.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University)

[PEM08-P07] Auroral oval in the last 3000 years and future

*Ryuho Kataoka[1], Shin ya Nakano[2] (1.National Institute of Polar Research, 2.The Institute of Statistical Mathmatics)

[PEM08-P08] Solar cycles around the onset of the Maunder Minimum

*Hiroko Miyahara[1], Fuyuki Tokanai[2], Toru Moriya[2], Mirei Takeyama[2], Hirohisa Sakurai[2], Kazuho Horiuchi[3], Hideyuki Hotta[4] (1.College of Art and Design, Musashino Art University, 2.Faculty of Science, Yamagata University, 3.Graduate School of Science and Technology, Hirosaki University, 4.Graduate School of Science, Chiba University)

[PEM08-P09] Simultaneous observation of cosmic rays with muon detector and neutron monitor at the Syowa station in the Antarctic

*Chihiro Kato[1], Kazuoki Munakata[1], Akira Kadokura[2], Ryuho Kataoka[2], Shoko Miyake[3], Paul Evenson[4], Shunta Asano[1] (1.Shinshu University, 2.National Institute of Polar Research, 3.National Institute of Technology, Ibaraki College, 4.University of Delaware)

[PEM08-P10] Measurement of cosmogenic 10Be in endogenic travertine deposits at Baishuitai

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[PEM08-P11] **Be-7 in Japan, Iceland and Thailand during solar cycle 24 descent phase**

*Hirohisa Sakurai[1], Youmei Kawamura[1], Souichiro Suzuki[1], Fuyuki Tokanai[1], Emiko Inui[1], Mirei Takeyama[1], Toru Moriya[1], Satosi Kikuchi[1], Fusa Miyake[2], Akira Kadokura[3], Natsuo Sato[3], Naoko Sugihara[6], Bjornsson Gunnlaugur[4], David Ruffolo[5], Warit Mitthumsiri[5], Ronald Macatangay[7] (1.Yamagata University, 2.ISEE, Nagoya University, 3.National Institute of Polar Research, 4.Science Institute, Iceland University, 5.Department of Physics, Mahidol University, 6.Department of Chemical Oceanography Atmosphere and Ocean Research Institute,The University of Tokyo, 7.National Astronomical Research Institute of Thailand)

[PEM08-P12] Forecast of energetic electron flux variations of the outer belt using the machine learning

*Satoshi Fukuoka[1], Yoshizumi Miyoshi[1], Daikou Shiota[2], Shinji Saito[4], Takefumi Mitani[3], Tomoaki Hori[1], Nana Higashio[3], Shun Imajo[1], Iku Shinohara[3] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.National Institute of Information and Communications Technology (NICT), 3.Japan Aerospace Exploration Agency, Institute of Space and Astronautical Science, 4.National Institute of Information and Communications Technology)

[PEM08-P13] Spacecraft surface charging environment in the medium earth orbit

*Masao Nakamura[1], Kosei Nagasawa[1] (1.Osaka Prefecture University)

[PEM08-P14] Active Region Detection in the HMI magnetograms using the Mask R-CNN technique

*Akito Komatsu[1], Yusuke Iida[1] (1.Niigata University)

[PEM08-P15] Operations of Solar Flare Prediction Model Using Deep Neural Networks

*Naoto Nishizuka[1], Yuki Kubo[1], Komei Sugiura[2], Mitsue Den[1], Mamoru Ishii[1] (1.National Institute of Information and Communications Technology, 2.Keio University)

[PEM08-P16] Empirical/physical-based modeling of three-dimensional outer radiation belt for real-time operation

*Shinji Saito[1], Kaori Sakaguchi[1], Yuki kubo[1] (1.National Institute of Information and Communications Technology)

[PEM08-P17] **Mid-term Research Plan of NICT Space Weather Monitoring and Forecast**

*Mamoru Ishii[1] (1.National Institute of Information and Communications Technology)

[PEM08-P18] Development of a prediction system of the sporadic E layer occurrence: Current status and future prospects

*Hiroyuki Shinagawa[1], Chihiro Tao[1], Hidekatsu Jin[1], Yasunobu Miyoshi[2], Hitoshi Fujiwara[3] (1.National Institute of Information and Communications Technology, 2.Kyushu University, 3.Seikei University)

[PEM08-P19] Economic impacts of atmospheric radiation storm on aircraft operations and potential use of space weather information

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[PEM08-P20] Status of the GEO-X (Geospace X-ray imager) mission

*Yuichiro Ezoe[1], Ryu Funase[2,6], Harunori Nagata[3], Yoshizumi Miyoshi[4], Hiroshi Nakajima[5], Ikuyuki Mitsuishi[4], Kumi Ishikawa[1], Munetaka UENO[6], Atsushi Yamazaki[6], Hiroshi Hasegawa[6], Makoto Mita[6], Masaki Fujimoto[6], Yasuhiro Kawakatsu[6], Takahiro Iwata[6], Kazuhisa Mitsuda[7], Junko Hiraga[8], Satoshi Kasahara[6], Hironori Sahara[1], Yoshiaki Kanamori[9], Kohei Morishita[10], Takefumi Mitani[6], Masaki Numazawa[11] (1.Tokyo Metropolitan University, 2.University of Tokyo, 3.Hokkaido University, 4.Nagoya University, 5.Kanto Gakuin University, 6.ISAS/JAXA, 7.NAOJ, 8.Kwansei Gakuin University, 9.Tohoku University, 10.Kyushu University, 11.RIKEN)

[PEM08-P21] Soft-X ray emissions from Geospace: Possible science objectives of GEO-X

*Yoshizumi Miyoshi[1], Yosuke Matsumoto[2], Yuichiro Ezoe[3] (1.Institute for Space-Earth Environmental Research, Nagoya University, 2.Chiba University, 3.Tokyo Metropolitan University)

[PEM08-P22] Effects of Solar Proton Event on Global Lightning Activity

*Mitsuteru Sato[1], Ryuho Kataoka[2] (1.Department of Cosmoscience, Hokkaido University, 2.National Institute of Polar Research)

[PEM08-P23] Atmospheric electric field measurement for the study of space and atmospheric climate changes

*Masashi Kamogawa[1], Yasuhiro Minamoto[2], Akira Kadokura[3], Mitsuteru Sato[4] (1.Global Center for Asian and Regional Research, University of Shizuoka, 2.Laboratory for Environmental Research at Mount Fuji, 3.National Institute of Polar Research, 4.Hokkaido University)

[PEM08-P24] Current status of the new multi-frequency millimeter-wave spectrometer installed at Showa Station and initial results of multi-line observations

*Akira Mizuno[1], Daichi Tsutsumi[1], Takahiko Kosegaki[1], Hiroyuki Iwata[1], Kouki Satani[1], Taku Nakajima[1], Kohei Haratani[1], Tomoo Nagahama[1], Syoki Iriyama[1], Genma Mizoguchi[1], Shixun Fan[1], Naoto Sekiya[2], Takuma Hayashi[2], Masaki Tsutsumi[3], Yoshihiro Tomikawa[3], Mitsumu K. Ejiri[3], Kaoru Sato[4] (1.ISEE, Nagoya University, 2.University of Yamanashi, 3.National Institute of Polar Research, 4.University of Tokyo)

[PEM08-P25] Antarctica-based future space weather research project since 2022

*Ryuho Kataoka[1] (1.National Institute of Polar Research)

[PEM08-P26] Development of real-time prediction system of CME arrival and magnetic field with ensemble SUSANOO-CME simulation 2

*Daikou Shiota[1,4], Seiji Yashiro[2], Ryuho Kataoka[3], Kazumasa Iwai[4], Yusuke Ebihara[5], Kaori Sakaguchi[1], Yuki Kubo[1] (1.National Institute of Information and Communications Technology (NICT), 2.Catholic

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[PEM08-P27] Ionospheric storms in GAIA under lower atmospheric and magnetospheric inputs

*Chihiro Tao[1], Hidekatsu Jin[1], Hiroyuki Shinagawa[1], Yasunobu Miyoshi[2], Hitoshi Fujiwara[3] (1.National Institute of Information and Communications Technology, 2.Kyushu University, 3.Seikei University)

[PEM08-P28] The relevance between cosmic ray and ozone depletion

*Kazuyoshi Yamashita[1] (1.The Open University of Japan)

[PEM08-P29] Geomagnetically induced currents observed around solar minimum of Cycle 24

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NASA Goddard Space Flight Center Space Weather Activities

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The NASA Goddard Space Flight Center’ s Heliophysics Science Division (HSD) conducts research on the Sun, its extended solar-system environment (the heliosphere), and interactions of Earth, other planets, small bodies, and interstellar gas with the heliosphere. Division research also encompasses geospace -- Earth's uppermost atmosphere, the ionosphere, and the magnetosphere -- and the changing environmental conditions throughout the coupled heliosphere. Scientists in the HSD develop models, spacecraft missions and instruments, and systems to manage and disseminate heliophysical data. They interpret and evaluate data gathered from instruments, draw comparisons with computer simulations and theoretical models, and publish the results. The Division also conducts education and public outreach programs to communicate the excitement and social value of NASA heliophysics.

Space weather is a major part of HSD activities and the Division is the home for entities such as Community Coordinated Modeling Center and Space Physics Data Facility. HSD scientists work in close collaboration with federal partner organizations such as NOAA, USGS and Air Force to help transition the latest scientific information into space weather operations. HSD scientists are also supporting many of the National Space Weather Action Plan goals and play significant role in a variety of international space weather efforts. In this talk, we will provide a general introduction to HSD and its many activities that pertain to space weather. We also discuss our views for future directions of space weather and opportunities for enhanced collaborations.

Keywords: Space weather, Heliophysics

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Relationship between X-ray and EUV solar flare emissions and the Dellinger phenomenon

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The radiation from the sun is the most important ionization and heating energy source for the Earth’s upper atmosphere. When solar flares occur, the intensity of multi-wavelength electromagnetic emissions suddenly increases. Among these, the intensification of X-rays to extreme ultraviolet (EUV) emissions accelerates the ionization and molecular dissociation of atmospheric components in the ionosphere and thermosphere, and it may cause a sharp increase in electron density. It is generally considered that ultraviolet (UV) emissions with a long wavelength of 100 nm or more affect the lower atmosphere, whereas short-wavelength EUVs and X-rays may also affect the mesosphere (e.g. Woods et al., 2000). These short-wavelength UV radiation reaches the ionosphere D region at 60–90 km, thereby causing an increase in electron density in this region. The communication failure caused by the absorption of the short-wave due to the variations in electron density in the ionosphere D region is known as the Dellinger phenomenon (Dellinger 1937). Generally, the Dellinger phenomenon is considered to be caused by the occurrence of M-class or higher solar flares and predicted by using the magnitude of the solar flares. However, reportedly, the Dellinger phenomenon sometimes occurred even in during C-class flares; however, it did not occur even in during X-class flares (e.g. Tao et al., 2020). From these results, it is considered that the flare emissions contributing to the occurrence of the Dellinger phenomenon may also be affected by emissions that are not proportional to the X-ray intensity.

The occurrence of the Dellinger phenomenon can be known by using the minimum reflection frequency (fmin) from vertical incident ionograms. When a strong Dellinger phenomenon occurs, the reflected wave from ionosonde becomes invisible due to ionospheric absorption, and the fmin cannot be measured. However, in the case of the Dellinger phenomenon, which is not too strong, increases of fmin values are observed. Therefore, we checked the fmin observed in the ionosonde held by the National Institute of Information and Communications Technology (NICT) at Kokubunji. And then, we statistically compared with the solar flare emission (X-rays and EUVs). When the fluctuation of fmin (about 4,000 events) between 1996 and 2018 was compared with the GOES X-ray intensity, a relationship was seen that was almost in agreement with the results of previous studies (Sato, 1975; Tao et al., 2020).

In this paper, we will report the results of statistical comparison of the Dellinger phenomenon (fmin fluctuation) that occurred from 1996 to 2018 with X-ray data. We also report on the results of comparisons between fmin and EUV data which are observed by the Solar and Heliospheric Observatory (SOHO)/Solar EUV Monitor (SEM) and Project for On-Board Autonomy (PROBA)-2/LYman-alpha RAdiometer (LYRA), and discuss the effects of EUV emission on the Dellinger phenomenon.

Keywords: Dellinger phenomenon, Solar flare, EUV

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A comparative study of the empirical and physics-based methods for solar flare predictions

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Solar flares suddenly emit electromagnetic waves, plasma, and energetic particles into the interplanetary space, and cause space weather disturbances. Therefore, the prediction of solar flares is important to mitigate the space weather impact. For predicting solar flares, various types of empirical methods have been developed so far, and very recently the physics-based prediction of large solar flares, called the kappa-scheme, has been developed by Kusano et al. (2020). In this study, we conduct a comparative study of empirical and physics-based predictions of solar flares with the aim of developing a new type of solar flare prediction by combining empirical methods and the physics-based method. As the preliminary study, we focus on Schrijver’ s R-parameter (Schrijver 2007), which is given by the unsigned magnetic flux near the polarity inversion line (PIL) of the high magnetic gradient, as a typical empirical method. First, we use the vector magnetic field data of the active region NOAA 12673 observed by the Solar Dynamics Observatory before the onset time of the largest solar flare in the solar cycle 24 (11:48 UT on September 6, 2017), and calculated the unsigned magnetic flux (local magnetic flux) within a circle of radius 2 Mm centered at each point on the PILs. As a result, we found the following features. (1) The local magnetic flux correlates well with the magnetic gradient on PIL. (2) The local magnetic flux was also high at the flaring point predicted accurately by the kappa-scheme. (3) However, there were places where the local magnetic flux was high although flare did not occur. The results suggest that the local magnetic flux near PIL is only partially related to the predictors of the kappa-scheme. Second, we calculated the total unsigned magnetic flux within 2 Mm from all points on PILs for the two groups of active regions. Group 1 is seven active regions that produced flare larger than the GOES X2-class and group 2 is 199 active regions that did not produce any X-class flare for 20 hours after the observation. The comparison between the analyses of the unsigned total flux and the kappa-scheme suggests that the kappa-scheme can better discriminate the two groups than the unsigned total flux while the unsigned total flux has a moderate power to discriminate the flaring active regions. We consider a new scheme using these results.

Keywords: solar flare, prediction, space whether

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Data-driven MHD Simulation of Solar Active Region NOAA 11283

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Solar eruptive events such as flares or prominence eruptions are caused by the release of magnetic energy accumulated in the solar atmosphere. They occur in the solar active regions (ARs) where the strong magnetic fields are present. Focusing on flare events, not all of the energy accumulated in AR is released with a single flare. It is still difficult to predict the exact value of released energy. Moreover, the physical mechanism to determine the ratio between the released energy and the stored magnetic energy is unclear because the coronal magnetic field cannot be observed directly. MHD simulation is a powerful method to investigate and understand the evolution of the coronal magnetic fields. In this study, we conducted an MHD simulation on AR11283 where multiple M and X class flares have occurred. The objective of this study is to know about the energy release rate of these two flares and the physical mechanism to determine the rate. We applied a newly developed data-driven simulation method in which the time series observational photospheric magnetic field data are introduced as the bottom boundary condition to the MHD simulation. The SDO/HMI vector magnetic data of AR11283 were used. As a result, the dynamic evolution of the coronal magnetic fields was reproduced. We investigated the energy build-up and evolution of trigger magnetic fields leading to the sudden energy releases.

Keywords: Sun, AR11283, MHD Simulation, Solar Flare

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Unusual enhancement of ~30 MeV proton flux in an ICME sheath region

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In gradual Solar Energetic Particle (SEP) events, shock waves driven by coronal mass ejections (CMEs) play a major role in accelerating particles, and the energetic particle flux enhances substantially when the shock front passes by the observer. Such enhancements are historically referred to as Energetic Storm Particle (ESP) events, but it remains unclear why ESP time profiles vary significantly from event to event. In some cases, energetic protons are not even clearly associated with shocks. Here we report an unusual, short-duration proton event detected on 5 June 2011 in the compressed sheath region bounded by an interplanetary shock and the leading-edge of the interplanetary CME (or ICME) that was driving the shock. While <10 MeV protons were detected already at the shock front, the higher-energy (>30 MeV) protons were detected about four hours after the shock arrival, apparently correlated with a turbulent magnetic cavity embedded in the ICME sheath region.

Keywords: SEP, shock, acceleration

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Development of spectral riometer for observation of energetic electron precipitation at Syowa Station, Antarctica

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Recently, from the viewpoint of the space weather research, much interest has been focused on the effect of energetic electron precipitation (EEP) from the magnetosphere on the atmosphere. The precipitation of the electrons with energies greater than several tens of keV can be detected by riometers from the ground. The riometer is an instrument that measures the ionospheric absorption of cosmic radio noise (CRN), which is caused by the electron density enhancement mainly in the ionospheric D region due to the auroral electron precipitation. However, the existing riometer which observes the CRN at a single frequency can detect the appearance of EEP only, but it cannot estimate the flux of the precipitating electrons quantitatively. In order to investigate the flux of precipitating electrons quantitatively, a wide-band riometer, so-called spectral riometer has recently been developed by the Sodankyla Geophysical Observatory (SGO) (Kero et al., 2014). We have developed the spectral riometer to conduct the wide-band-frequency riometer observation at Syowa Station, Antarctica, during the 63rd Japanese Antarctic Research Expedition (JARE-63, 2022-2023). The spectral riometer measures cosmic noise absorption (CNA) in the frequency range from 20 to 60 MHz and enables us to estimate the height profile of the electron density between about 50 and 120 km and the electron energy spectra in the energy range from several keV to about 1 MeV.

There is a problem to be solved in the spectral riometer observation at Syowa Station. At Syowa, a high-power atmosphere radar, PANSY, is being regularly operated at a frequency of 47 MHz, which is inside the frequency range of the spectral riometer. To solve this problem, we collect only the CRN signals when the PANSY radar is not transmitting pulses by using the software-defined radio (SDR) technique. The CRN signals and the transmission timing pulses from the radar are sampled by a sampler for SDR, and then the signals are transferred to the personal computer (PC). Using the transmission timing pulse, PC extracts CRN signals when the PANSY radar is not transmitting. The extracted CRN signals are then fast Fourier transformed and decimated in real-time, and the obtained power spectra are recorded every second. In the presentation, we will show the scientific goal of the spectral riometer observation, the observation system, and results of test observation.

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Kero, A., J. Vierinen, D. McKay-Bukowski, C.-F. Enell, M. Sinor, L. Roininen, and Y. Ogawa, Ionospheric electron density profiles inverted from a spectral riometer measurement, Geophys. Res. Lett., doi:10.1002/2014GL060986, 2014.

Keywords: aurora, energetic electron precipitation, riometer, Syowa Station, cosmic noise absorption, software-defined radio

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Auroral oval in the last 3000 years and future

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We investigate the global shape of auroral oval based on the paleomagnetism models for the last 3000 years. Recent IGRF models are also used for future extraporation. Similar method as proposed by Oguti (1993, JGR) is adopted to draw the auroral oval. The method as well as the dependence on the geomagnetic activity etc. are examined by the >30 year data from DMSP satellites and the >70 year data from ground-based magnetometers located at high latitudes. It is confirmed that there is only a weak effect of the dipole moment to change the shape of the auroral oval, as theoretically expected.

Keywords: aurora, paleogeomagnetism

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Solar cycles around the onset of the Maunder Minimum

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The Sun indicates long-term activity variations at the time scales of a few hundred years to a few millenia, and sometimes experience grand minima when number of sunspots significantly decreases for more than several decades. In order to understand the physical mechanism of such grand minima, we conducted high-precision measurements of carbon-14 in tree rings with annal resolution and reconstructed the solar cycles around the onset of the Maunder Minimum (1645-1715 CE). In this presentation, we report the transition of cycle lengths indicated by the high-precision data.

Keywords: Solar cycle, Grand solar minimum, The Maunder Minimum, Carbon-14

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Simultaneous observation of cosmic rays with muon detector and neutron monitor at the Syowa station in the Antarctic

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Since 2018.2, simultaneous observation of cosmic ray muon and neutron is continued. The operation is quite stable and its duty cycle is higher than 94%. These detectors are showing their usefulness by responding to, for example, a peculiar CME event in August 2018. There is another interesting event in September 2019. A Sudden Stratospheric Warming (SSW) was observed and muon counts responded to the SSW. This response is caused by that muon counts on the ground are affected by high altitude temperature. Temperature effect on CR muon now can be corrected with high altitude temperature data. There is, however, some matter of research about how the method works. This event seems to be valuable to improve correction method. We describe a character of muon and neutron data accumulated during the last three years and discuss potential use in studying atmospheric effect on CR muon and neutron count rates.

Keywords: Cosmic Ray, Atmospheric Effect

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Measurement of cosmogenic 10Be in endogenic travertine deposits at Baishuitai

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Past solar and cosmic ray variations are often reconstructed using the carbon-14 in tree rings and the beryllium-10 in ice cores. Previous studies have suggested that beryllium-10 in travertine deposits may also reflect the temporal variation of cosmic rays and thus can be used to trace the past solar activity variations. In this paper, we report our preliminary results obtained from the measurement of beryllium-10 in annual layers of travertine from Baishutai, China.

Keywords: Cosmogenic nuclide, solar activity, cosmic ray variations

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Be-7 in Japan, Iceland and Thailand during solar cycle 24 descent phase

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Be-7 concentrations (BEC) in surface air should be correlated to cosmic rays, because Be-7 is produced by interactions between cosmic rays and nitrogen and/or oxygen in the atmosphere, and then it falls down with aerosols. Since cosmic rays which reach the earth are modulated by the solar activities when travelling the heliosphere, the variation in BEC involve some modulation profiles such as 27-day variation and 11-year solar cycle. Daily Be-7 concentrations in surface air have been continuously observed at Yamagata (38˚ N), Japan since 2000. To investigate the latitude effect of 11-year solar cycle, we set up a daily observation system of Be-7 concentration at Husafell in Iceland located (64˚ N) and have been continuously observed BEC since September 2003 as well as in Japan. Furthermore, we set up a daily observation system of Be-7 concentration at Bangkok in Thailand located (13.7˚ N) and have been continuously observed BEC since June 2014.

The BEC at Iceland, Japan, and Thailand were 2.0 mBq/m^3, 5.5 mBq/m^3, and 2.0 mBq/m^3 on average during 2015 and 2019, respectively, representing a kind of latitude effect. The increasing rates of BEC from 2019 to 2015 were 29.8%, 19.6%, and 43.5% at Iceland, Japan, and Thailand, respectively, while that of Oulu neutron monitor data was 8.8%. The larger increasing rates of BEC than the neutron monitor data is due to the much lower production threshold of Be-7 which is approximately 10MeV. Also, the latitude effects of BEC would indicate a response of cosmic ray spectral variation at lower energy band caused by solar modulation. However, as the increasing rates include a factor of air-mass advection in the atmosphere, the rates do not merely appear the solar modulation of cosmic rays. We describe the observed data of Be-7 concentrations taking account of latitudes effects of Be-7 production rates in the stratosphere and troposphere.

Keywords: Be-7, cosmogenic nuclide, solar modulation

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Forecast of energetic electron flux variations of the outer belt using the machine learning

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The relativistic/sub-relativistic electron flux variations of the outer radiation belt often cause serious damage on the satellite operations through the dielectric charging. In order to forecast flux variations of these electrons, various forecast methods based on the physics-based simulation and empirical modeling have been developed. For the physics-based simulation, we have operated the SUSANOO system that is simulating a code-coupling simulation of heliosphere and radiation belt provides MeV electron flux variations for the next couple of days. For the empirical modeling, the linear prediction filter and the auto-regressive moving average are popular methods, which have been used for the forecast of MeV electrons. Recently, the machine learning techniques have widely been used for the space weather forecast, for example, ionospheric variations, the flare prediction, etc. In this study, we have developed the forecast system of relativistic/sub-relativistic electron flux variations based on long short-term memory recurrent neural network (LSTM-RNN). As the training data, we use the solar wind data and energetic electron data observed by Arase/HEP, XEP instruments at different L-shells of the outer belt. Our developed network provides time variations of the energetic electron flux around L=4,5,6 using the solar wind data as an input parameter. In this presentation, we will report the forecast performance, focusing on how forecast skills depend on the lead-time and energy ranges.

Keywords: Forecast of energetic electron flux

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Spacecraft surface charging environment in the medium earth orbit

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Analysis of spacecraft surface charging in the medium earth orbit (MEO) is important for spacecraft designs and operations, because the significant charging sometimes cause spacecraft anomalies due to discharging arcs. We study the surface charging environment using the Electric Field and Wave instruments (EFW) and the Helium Oxygen Proton Electron (HOPE) data of the Van Allen Probes. The charging events (< -50 V) are located about 25000 km further away from the center of the Earth and in the mid-night to dawn region. Among them, the significant charging (< -1 kV) events are only observed in eclipse. By using a charging analysis tool for the Van Allen Probes, we analyze the electron and ion energy flux spectrum observed in eclipse. The electrons usually have multi-temperature spectrum. For the onset of negative charging, the incoming hot electron (~ keV) current overcomes the outgoing secondary electron current emitted by warm electron (~hundreds eV) impacts. The analysis shows that the combination of critical temperature and threshold density of the hot electrons give the criterion for the onset of negative charging in the MEO eclipse. We will discuss the charging events in sunlight and the relationship between the charging events and space weather conditions.

Keywords: Spacecraft surface charging, Medium earth orbit, Space weather

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Active Region Detection in the HMI magnetograms using the Mask R-CNN technique

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For predicting solar flares, it is necessary and important to detect active regions accurately. Conventionally, active regions is detected using rule-based methods with the defined thresholds. In this study, we aimed to establish a noval prediction method that goes beyond the rule-based flare prediction method by using the Mask R-CNN technique.
We used the full-disk line-of-sight magnetograms taken by SDO/HMI from May 2010 to July 2011 for the inpbackground image, the SHARP dataset for annotation, and the SWAN dataset for labeling. We reduced the data cadence to 1 hour and used 80% for training and 20% for testing. Training is performed using Mask R-CNN, which is one of the methods of Instance Segmentation. Mask R-CNN takes the background image and the annotation for the object position in the image as input, and learns the features of the region representing the object in the image. The network can detect the bounding box and mask that indicate the location of the object in the image. The network of the Mask R-CNN is divided into a Region Proposal network (RPN), which detects the location of the object, and a recognition network that detects which object the detected region represents. Based on the feature map obtained from the Resnet51 pre-trained model, network reduce the loss functions of Class, BoundingBox, and Mask.
As a result of training, we achieved Average Precision[IoU=0.50] =0.940 with the constructed model. Since the maximum accuracy of training and detection in natural images using Mask R-CNN is about Average Precision[IoU=0.50] =0.600, we have shown that the Mask R-CNN is the very effective method even for solar magnetic images. In the future, we would like to construct a model that can predict whether the detected region actually causes a flare or not.

Keywords: Space weather, Deep learning, Image recognition, Big data

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Operations of Solar Flare Prediction Model Using Deep Neural Networks

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Solar flares are an origin of space weather phenomena, and it is important to predict solar flares more accurately. Especially, an automated prediction model in real-time operations, which can be used by even non-scientists and can give a better feedback from previous prediction experience, is expected. In our previous works, we developed an operational solar flare prediction model using deep neural networks, named Deep Flare Net (DeFN). DeFN can issue probabilistic forecasts of solar flares in two categories, such as >=M-class and <M-class events or >=C-class and <C-class events, occurring in the next 24 h after observations and the maximum class of flares occurring in the next 24 h. DeFN is set to run every 6 h and has been operated since January 2019.

The input database of solar observation images taken by the Solar Dynamic Observatory (SDO) is downloaded from the data archive operated by the Joint Science Operations Center (JSOC) of Stanford University. Active regions are automatically detected from magnetograms, and 79 features are extracted from each region nearly in real-time using multiwavelength observation data. Flare labels are attached to the feature database, then the database is standardized and input into DeFN for prediction. DeFN was pretrained using the datasets obtained from 2010 to 2015. The model was evaluated with the skill score of the true skill statistics (TSS) and achieved predictions with TSS = 0.80 for >=M-class flares and TSS = 0.63 for >=C-class flares.

For comparison, we evaluated the operationally forecast results from January 2019 to June 2020. We found that operational DeFN forecasts achieved TSS = 0.70 (0.84) for >=C-class flares with the probability threshold of 50 (40) %, although there were very few M-class flares during this period and we should continue monitoring the results for a longer time. Here, we adopted a chronological split to divide the database into two for training and testing. The chronological split appears suitable for evaluating operational models. Furthermore, we proposed the use of time-series cross-validation.

In this talk, we would like to introduce our solar flare prediction model, Deep Flare Net, and the operational prediction results. We also would like to discuss the standard evaluation methods for operational forecasting models, such as the preparation of observation, training, and testing datasets, and the selection of verification metrics.

Keywords: solar flares, space weather forecasting, operational model, deep neural networks, verification

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Empirical/physical-based modeling of three-dimensional outer radiation belt for real-time operation

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1. National Institute of Information and Communications Technology

Radiation belt electrons are controlled by various processes occurring in the earth's magnetosphere. Time and spatial scales of the processes are very broad, so it is difficult to demonstrate dynamics of electron radiation belts by only one physics-based model. Coupling of several models would be necessary to demonstrate radiation belt dynamics.
There are various empirical models to estimate the conditions of the earth's magnetosphere. If we can appropriately couple these empirical models, we might be able to reproduce the temporal variation of the geospace condition, and apply it to solve dynamics of radiation belt electrons using physics-based model. Based on this idea, we are developing the three dimensional radiation belt model coupling both empirical models for global dynamics, and physics-based models for electron kinetic dynamics, in order to forecast energetic electron environment at any location in magnetosphere.
In this talk we will introduce a provisional version of the three-dimensional (global) radiation belt model. This model couples two empirical models and one physics-based model to form the global radiation belt model. Empirical models used here calculate three-dimensional magnetic field configulation (Tsyganenko model TS04) and an energetic electron distribution j(L,E), where L is a L-value, E is an electron kinetic energy. Both models can be driven by real-time solar wind data set. As a physics-based model, we use a guiding-centered test-particle model, which calculates trajectories of energetic test-electrons in the three-dimensional magnetic field. The global radiation belt model imports real-time solar wind data, and calculates the magnetic field configuration and energetic electron flux distribution in L and E using empirical models. The test-particle model, which is the physics-based model, expands the electron flux distribution in L coordinate into that in the three dimensional GSM coordinate in earth's magnetosphere, by tracing adiabatic trajectories of test-electrons with energy E.
By tracing all of test-electrons distributed in outer radiation belt region, the model enables us to calculate phase space density in three-dimensional outer radiation belt. The model with higher-versions is expected to incorporate particle scattering processes corresponding to radial diffusion, pitch angle scattering, and nonlinear acceleration. The goal of this model is to demonstrate the temporal variation of three dimensional electron radiation belt governed by many kinds of electron scattering processes for real-time operation.

Keywords: electron radiation belt, numerical modeling, test-particle simulation

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Mid-term Research Plan of NICT Space Weather Monitoring and Forecast

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National Institute of Information and Communications Technology, Japan (NICT) starts the fifth mid-term research plan since April 2021. Space Environment Laboratory, NICT is in charge of operational space weather monitoring and forecast in Japan, and the new research and development plan for space weather monitoring and forecast starts at the same time.

NICT has a long history to observe space weather phenomena with ground-based sensors, e.g., ionosondes, solar radio telescope, and GNSS receivers. In addition to the domestic observation, we have an international cooperative project for monitoring ionospheric disturbance in the equatorial region e.g., equatorial plasma bubbles (EPBs) in South-east Asia. We will try to extend the network under the cooperation. In addition, we will seek the opportunity of development of satellite-based sensors.

Prediction models are important to have precise space weather forecast. We have been developing numerical code for predicting the response of solar wind, magnetosphere and ionosphere with the solar activities. We will start operational forecast using data assimilation with these numerical codes.

For the dissemination of space weather information, we have been providing space weather forecast since 1988. We keep the communication with information users by establishing space weather users' committee for seeking the requirement of users. We will continue the activity and provide the necessary information for users.

We expect some specific targets of our activity is, high-precision satellite positioning with QZSS, support of deep space exploration for providing space weather information, and mitigation of space weather disaster by providing benchmark.

Keywords: space weather, ionosphere, magnetosphere, sun/solar wind

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Development of a prediction system of the sporadic E layer occurrence: Current status and future prospects

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Prediction of sporadic E (Es) layers is one of the most important issues in the space weather forecast. In our space weather forecasting, one-day prediction of the Es layer occurrence has been done, based on current observations of Es layers obtained by our ionosondes. However, Es layers occasionally show significant day-to-day variations, and present conditions may not last until one day later. In order to study a method of the Es layer occurrence prediction, we analyzed the simulation data of the whole atmosphere-ionosphere coupled model GAIA, and compared the data with foEs data. We found that the ion convergence at 120 km altitude agrees fairly well with the variation in the observed foEs. Based on this result, we have been investigating a prediction scheme of the Es layer occurrence. Our group has recently developed a real-time GAIA simulation system, which is capable of predicting ionospheric conditions for a few days ahead. Using data obtained from the real-time GAIA, we are developing a prediction system of the Es layer occurrence. We will report the status of development of the prediction system, preliminary results, problems, and future prospects.

Keywords: Sporadic E layer, Model, Prediction, Vertical ion convergence

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Economic impacts of atmospheric radiation storm on aircraft operations and potential use of space weather information

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Secondary particles generated by a solar energetic particle (SEP) event cause an atmospheric radiation storm (ARS) at aircraft cruising altitudes. Radiation storm is one of the advisories in the space weather information service for aircraft operations provided by the International Civil Aviation Organization (ICAO). However, it has not been defined well how aircraft operators shoud react when such advisories are issued.

In order to contribute to establishing effective reactions to space weather information, we estimate the economic impact which would be induced when certain means are taken to mitigate the radiation hazard. This would be an important information to establish effective reactions to space weather radiation advisories.
We used the Warning System for AVIation Exposure to Solar energetic particle (WASAVIES) to estimate the effective dose rate (EDR) along the aircraft trajectory. Flight path length, flight time, and fuel consumption for realistic flight routes are calculated by using a flight trajectory generation algorithm and the aircraft performance parameters from the Base of Aircraft Data (BADA) model developed by EUROCONTROL.

We used the conditions of the GLE-69 event as a reference. Two routes from Japan which go through high latitude regions, from New York JFK airport (JFK) to Tokyo Narita airport (NRT) and from NRT to London Heathrow airport (LHR), are chosen as examples. We set up flight scenarios based on several strategies of mitigation where constraints on the flight altitude and the latitude are imposed. For each scenarios, flight path length, flight time, and fuel consumption were estimated.

Our results show that the fuel consumption could be increased by 33-58% for JFK-NRT, if very conservative mitigation strategies are taken. Similar analysis has been performed for NRT-LHR.

This economic impact may be reduced, if the space weather nowcast for the ARS associated with the SEP and an optimal flight trajectory generation algorithm are used together. Setting more flexible constraints in the flight route and generating optimal flight trajectories with minimal economic impacts by fully utilizing the global EDR distribution would be effective, which is our next step. Furthermore, prediction of the progress of ARS associated with SEP events would be effective in reducing the economic impacts by adaptively modifying the flight path during the flight.

Keywords: Solar energetic particle event, Economic impact in aircraft operation, Radiation

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Status of the GEO-X (Geospace X-ray imager) mission

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Understanding of geospace environment, especially response of the Earth's magnetosphere to solar wind, is crucial for planetary and space science, astrophysics and space weather. GEO-X (GEOspace X-ray imager) is a small satellite mission aiming global imaging of the Earth's magnetosphere in X-rays. It is proposed to be launched in 2023-25, around which solar cycle 25 is expected to peak. In this paper, we present its science objectives and development of spacecraft, proplusion system, and payload based on cutting edge technologies.

Keywords: Earth's magnetosphere, Global imaging, X-ray

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Soft-X ray emissions from Geospace: Possible science objectives of GEO-X

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Recent studies have indicated that charge-exchange between geocorona and On+ ions of the solar wind causes the soft-X ray emission. The soft-X ray emission can be used as a tool to measure global topology of Geospace. In order to investigate how we can observe the soft-X ray emissions, we conduct a computer simulation by a code coupling of the global magnetospheric MHD simulation model (Matsumoto+, 2010) and empirical geocorona model. The simulation shows clear emissions from the dayside sheath region as well as the cusp region. The new satellite project GEO-X has been proposed to measure the soft-X ray emission through solar wind charge exchange (SWCX) from the dayside magnetosphere. In this presentation, we show the possible soft-X ray images by the computer simulation, by considering the GEO-X satellite orbit.

Keywords: solar wind-magnetosphere coupling, soft-Xray emissions

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Effects of Solar Proton Event on Global Lightning Activity

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Lightning discharges tend to occur at active thunderclouds generated by the strong upward wind, which transports the moist air mass from the ground surface to the upper troposphere. In the global scale, lightning discharges mainly occur in tropical and subtropical land areas because the land surface can be easily heated by the solar radiation, which finally establishes the strong upward wind. Thus, it is the conventional theory that the lightning activities are purely determined by the tropospheric dynamics. However, recent studies show the observational evidences that the lightning activity and lightning-excited radio wave activity are modulated by the energetic solar event, such as solar-X-ray burst and solar proton event. For example, it was shown that the resonance frequency and amplitude of Schumann resonance waves radiated by lightning discharges are rapidly increased during the e energetic solar proton precipitation. It was also shown that the lightning occurrence number and thunder days over Europe were increased after the arrival of the high speed solar wind stream to the Earth and increase of the solar energetic proton flux. Despite these observational facts, it is still not clear whether these modulation was simply created by the rapid change of the Earth-ionosphere waveguide structure or by lightning activity. Even though these modulation was created by the change of lightning activity itself, it is not clear that such change occurs locally or globally. In order to clarify the relation between the energetic solar events and global lightning activity and to identify the effects of solar proton events on the global lightning occurrence number, we have analyzed lighting data derived from the global lightning detection network (WWLLN) and ELF magnetic field waveform data obtained at Syowa station, Antarctica in 2013-2015. We have conducted the superposed epoch analysis for the WWLLN lightning data and have calculated the time variation of the Schumann resonance amplitude and resonance frequency using Syowa ELF data. At the presentation, we will show the detailed results derived from these analysis and will report the effects of the energetic solar events on the global lighting activity.

Keywords: Lightning activity, Solar proton event

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Atmospheric electric field measurement for the study of space and atmospheric climate changes

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The atmospheric electric field is an electric field perpendicular to the ground and has an average value of about 100 V/m in fair weather. This value varies daily, peaking around 2000 UTC, with a range of variation within tens of percent of the average. This diurnal variation is known to be similar throughout the globe in fair weather. This diurnal variation is called Carnegie Curve after the Carnegie research vessel that contributed to the discovery.

It has been pointed out since around the 1920s that the reason for understanding that the same diurnal variation globally occurs regardless of local time is that the entire earth consists of an electric circuit, called global electrical circuit. The electric circuit consists of a capacitor in which the ionosphere/mesosphere (Approximately 60 km altitude) and the conductive ground (including sea areas), both of which have high atmospheric conductivity, become spherical shell electrodes, and sandwich the atmosphere with low atmospheric conductivity. Although the conductivity of the atmosphere between these electrodes is low, it is slightly conductive due to the ionization of the atmosphere by cosmic rays and natural radionuclides. This yields electric current flows from the ionosphere to the earth in fair weather region due to the atmospheric electric field caused by the potential difference between the two electrodes. This means a discharge process. The atmosphere, therefore, plays a role of resistance in the global electrical circuit. On the other hand, since cloud-to-ground lightning and charged rainfall transport electric charges into the ionosphere and the ground during the thunderstorm activity which continuously and globally. Therefore, the capacitance is always charged in the thunderstorm region, and simultaneously discharged in the fair weather region. The ionospheric potential in the global electric circuit can be understood to some extent by observing the atmospheric electric field in the fair weather region.

Because the atmospheric electric field during fair weather varies greatly due to the presence of radioactive materials and transport of air pollution, many researchers point out that it is affected by global changes in radioactive materials (nuclear bomb tests, nuclear power plant accidents,) as well as climate change. In addition, the ionosphere/magnetosphere and the global electrical circuit are considered to be electrically coupled and not unrelated to space weather.

From the above history, it is considered that the measurement of atmospheric electric field on the ground surface can greatly contribute to the study of space weather and atmospheric climate change. We have conducted the measurement of the atmospheric electric field in Antarctica, where there is no air pollution. Although there is no air pollution in the polar regions, drifting snow is known to be a noise source for measurement. Therefore, we examined the atmospheric electric field generated by these drifting snow and developed a methodology to easily distinguish between drifting snow and fair weather. This made it possible to establish an environment for investigating the relationship between global electrical circuits and climate change and space weather.

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Current status of the new multi-frequency millimeter-wave spectrometer installed at Showa Station and initial results of multi-line observations

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It is well-known that energetic particle precipitation (EPP) triggered by solar activity produces nitrogen oxides, which catalytically destroy ozone in the polar regions. We have been conducting steady measurements of millimeter-wave spectra of nitric oxide and ozone to monitor the temporal variation in the mesosphere and lower thermosphere above the Showa Station since 2012, in order to study the influences of the energetic particles on the atmospheric composition change. Simultaneous observations of several molecular species which are chemically and dynamically related with can provide useful information to understand the factors that cause temporal changes of atmospheric composition. However, due to the limitation of the instantaneous frequency bandwidth of the backend spectrometer, it is not possible to cover the line spectra of both molecules at the same time, so we had to switch the receiving frequency and observe nitric oxide and ozone alternately. To overcome this situation, we developed a new observing system for multi-frequency observations using a waveguide-type frequency multiplexer (Nakajima et al. 2020).

The new multi-frequency millimeter-wave spectrometer was installed at Showa Station by the 61st Antarctic Research Expedition, and the steady observation was started in November 2020. The new spectrometer enables simultaneous observations of NO, O_3, CO, and HO_2 spectral lines between 230 GHz and 250 GHz. In this spectrometer system, the radio waves are focused by a newly designed frequency-independent optical system using the quasi-optical approximation method (Gonzalez, 2016), and the signals in two frequency bands are extracted by two superconducting mixers cooled by a small power-saving refrigerator (Ulvac UR4K03) with a cooling power of 0.3W. Then, the signals of two frequency bands are recombined through the IF circuit into the 2 GHz band width of the final stage FFT processor to obtain the spectral signals of the multiple molecular species simultaneously.

In the presentation, we will explain the configuration of the new observation system in detail, and summarize the characteristics, problems, and issues of the actual system, and report the initial analysis results of the observation data acquired after November.

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Keywords: Millimeter-wave spectroscopy, Polar science, Energetic Particle Precipitation, Atmospheric minor constituents

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Antarctica-based future space weather research project since 2022

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We are planning a new Antarctic-based space weather research project, for coming 6 years from April 2022, which covers the solar-maximum active period of solar cycle 25. We will arrange the international collaboration to investigate the high-latitude polar cap, by multiple ground-based all-sky imagers. The low-cost and maintainance-free all-sky cameras with a new housing system are under development. Both polar cap auroral electronss and the direct impact of solar protons are of interest in the open magnetic field region, and possible wavelengths to be observed would be 630.0 nm and 391.4 nm, respectively. We discuss the science goals, and share the latest situation of the preparation to enhance international collaborations.

Keywords: polar cap, aurora, solar proton

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Development of real-time prediction system of CME arrival and magnetic field with ensemble SUSANOO-CME simulation 2

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The predictions of CME arrival to the Earth and the southward magnetic field brought by the CME flux ropes are one of crucial tasks for space weather forecast. We have developed an MHD simulation of the interplanetary propagation of multiple CMEs with their internal magnetic flux ropes, called as SUSANOO-CME (Shiota & Kataoka 2016). The simulation solves propagation of solar wind and CMEs in the inner heliosphere from 25 solar radii where all the balk flow exceeds fast mode speed. The information of solar wind and CME is specified at the inner boundary with empirical and analytical models using real-time observations of the Sun and the corona.
Recently, we have been constructing a prediction system of CME impacts (CME arrival and magnetic field) utilizing SUSANOO-CME with the real-time solar observations for the purpose of use in space weather forecast in NICT. The system is designed to be controlled through web-browser interfaces in all steps of the simulation: measuring CME speed, editing input parameters, submitting the ensemble jobs into supercomputer, seeing the ensemble results, and seeing aggregated results summarizing all or some of ensemble cases.
In this presentation, showing a demonstration prediction result on a CME occurred on December 7, 2020 associate with a C7.4 flare, we will report the current status of the development and discuss the remaining issues and the future development.

Keywords: CME, solar wind , space weather forecast

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Ionospheric storms in GAIA under lower atmospheric and magnetospheric inputs

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Upper atmosphere shows variations reflecting complex interactions under inputs from lower and upper regions. These interactions have been an important target of the upper atmosphere physics and space weather purpose. GAIA, Ground-to-Topside Model of Atmosphere and Ionosphere for Aeronomy, is the whole atmosphere model including interaction with ionized plasma under solar EUV variation and a various waves input using a meteorological reanalysis data. We input magnetospheric variation into GAIA via electric field deposition at polar region and auroral electron precipitation using empirical models. We input polar electric potential map based on Weimer model driven by solar wind and interplanetary magnetic field with saturation effect of cross-polar-cap potential for large potential case. Variable auroral precipitation driven by Kp index is considered. Enhancement of total electron content (TEC) up to mid-to-low latitude during the magnetospheric storm event is produced due to the consideration of penetration electric field.
Ionospheric storms, i.e., significant variations of ionospheric plasma, are detected using a scale called “I-scale”, which represents the relative levels of the ionospheric plasma deviations from their 27-day median among their statistical distribution over long-time. As a result, GAIA simulation over January 2019—March 2020 showed increased detection ability of ionospheric storms compared to the high latitude constant case.
We will discuss the effect of high latitude setting on the penetration of electric field and plasma distributions in this presentation.

Keywords: ionospheric storm, GAIA, simulation

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The relevance between cosmic ray and ozone depletion

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In the upper atmosphere, ozone is thought to be destroyed by NOx produced by galactic cosmic rays and solar cosmic rays.In order to clarify the decrease in total ozone with increasing NOx, a correlation map between AEindex and total ozone was created. The results showed that total ozone increased with increasing AEindex at low latitudes in the Northern Hemisphere.This suggests that the decrease in total ozone due to the increase in NOx is due more to galactic cosmic rays than to solar cosmic rays.

Keywords: AEindex, cosmic ray, ozone

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Geomagnetically induced currents observed around solar minimum of Cycle 24

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We started to install our equipment to substations around Kanto area and to measure geomagnetic induced currents (GICs) by the KAKENHI project (PSTEP) since the end of February 2017. Geomagnetic storms with Dst less than -100 nT occurred only three times during this periods because of solar minimum of Cycle 24. GICs were relatively often observed associated with bay disturbances, which were caused by aurora activities at high latitudes although GICs associated with SSCs or SIs were also observed. A GIC was observed associated with a geomagnetic disturbance by M4.4 flare on 1 April 2017. The geomagnetic disturbance caused by a solar flare is called Solar Flare Effect (SFE). This SFE was not an intense event. Kakioka magnetic observatory reported a SFE with a maximum variation of geomagnetic horizontal component of -67 nT on 15 November 1960. The maximum value of time derivative of this event was approximately -20 nT/min. We will report the analysis of these events using GIC observations of neighboring substations.

After solar minimum in December 2019, solar activities gradually increases and large flares and intense geomagnetic storms are expected. We will continue the GIC measurements and have a plan to utilize the result of the simulation of the Earth’s magnetosphere for the estimation of GICs.

Keywords: Geomagnetically Induced Current (GIC), geomagnetic storm, Sudden Storm Commencement (SSC), Sudden Impulse (SI), bay disturbance, Solar Flare Effect (SFE)

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[E] Poster | P (Space and Planetary Sciences)：P-EM Solar-Terrestrial Sciences, Space Electromagnetism & Space Environment

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.04_1

[P-EM12] Dynamics of the Inner Magnetospheric System

convener:Kunihiro Keika(Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo), Yoshizumi Miyoshi(Institute for Space-Earth Environmental Research, Nagoya University), W Lauren Blum(University of Colorado Boulder), Yuri Shprits(Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences)

The inner magnetosphere is highly variable because dynamical variations of incoming energy from the solar wind, magnetospheric tail, and the ionosphere. Cross-regional, cross-scale, and cross-energy couplings are the key processes for understanding this dynamical system. Coordinated observations by multi-satellites and ground-based observations are very essential to revealing these processes. In the 24th and 25th solar cycles, a number of satellites such as Van Allen Probes, MMS, THEMIS, DSX and Arase; coordinated ground-based observations (THEMIS-GBO, SuperDARN, EISCAT, magnetometers, riometer, etc); and numerical simulations (global kinetic model, MHD model, micro PIC, hybrid simulations) have successfully investigated the inner magnetosphere system. We invite papers on recent results of the inner magnetosphere and/or its coupling with the other regions including the ionosphere and the outer magnetosphere. Presentations on new projects such as sounding rocket experiments and data assimilation/machine learning are also welcome.

[PEM12-P01] Modulation of chorus intensity and UHR frequency in the off equatorial regions observed by the Arase satellite.

*Yuri Ampuku[1], Fuminori Tsuchiya[1], Yasumasa Kasaba[1], Satoshi Kurita[2], Yoshiya Kasahara[3], Shoya Matsuda[4], Atsushi Kumamoto[5], Ayako Matsuoka[6] (1.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 2.Research Institute for Sustainable Humanosphere, Kyoto University, 3.Graduate School of Natural Science and Technology, Kanazawa University, 4.Institute of Space and Astronautical Science, JAXA, 5.Graduate School of Science, Tohoku University, 6.Graduate School of Science, Kyoto University)

[PEM12-P02] Spatio-temporal characteristics of the precipitating electron energy of pulsating aurora and comparison with the numerical simulation

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[PEM12-P03] An error estimation for energetic electron flux measured by the high-energy electron experiments (HEP) onboard the Arase satellite.

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[PEM12-P04] Relationship between polar cap potential and MLT distribution of ground delta H during geomagnetic storms using observations and RAM-SCB simulations

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[PEM12-P05] Global characteristics of cold protons in the near-Earth magnetotail: MMS/HPCA observations

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[PEM12-P06] Interaction between whistler waves and electrons at Earth's magnetotail: Test particle simulation and THEMIS observation

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[PEM12-P07] Case analysis of SAPS wave structure events observed by ERG, DMSP, and SuperDARN

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[PEM12-P08] Energetic electron precipitations showing ULF modulation observed by VLF/LF transmitter signals

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[PEM12-P09] A statistical study on the detachment of arc from the main auroral oval using all-sky imaging observations at Athabasca, Canada

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[PEM12-P10] SAPS electric field and particle observations by the Arase satellite and SuperDARN

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[PEM12-P11] Properties of EMIC waves observed by Van Allen Probes and ground-based magnetometers during relativistic electron precipitation

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[PEM12-P12] A Study on the Effect of the Number of Snapshots for Averaging and the Noise Level on the Estimation Accuracy in Direction Finding

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[PEM12-P13] Relative Contribution of ULF Waves and Whistler-mode Chorus to the Radiation Belt Variation during the May 2017 Storm

*Naoko Takahashi[1], Kanako Seki[1], Mei-Ching Fok[2], Yihua Zheng[2], Yoshizumi Miyoshi[3], Satoshi Kasahara[1], Kunihiro Keika[1], David Hartley[4], Yoshiya Kasahara[5], Yasumasa Kasaba[6], Nana Higashio[1,7], Ayako Matsuoka[8], Shoichiro Yokota[9], Tomoaki Hori[3], Masafumi Shoji[3], Satoko Nakamura[3], Shun Imajo[3], Iku Shinohara[10] (1.Graduate School of Science, The University of Tokyo, 2.NASA Goddard Space Flight Center, 3.Institute for Space-Earth Environmental Research, Nagoya University, 4.Department of Physics and Astronomy, University of Iowa, 5.Graduate School of Natural Science and Technology, Kanazawa University, 6.Graduate School of Science, Tohoku University, 7.Japan Aerospace Exploration Agency, 8. Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University, 9.Graduate School of Science, Osaka University, 10.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency)

[PEM12-P14] Initial results on multi event analysis of the simultaneous observation of isolated proton auroras at subauroral latitudes by a highly sensitive all-sky camera and the Van Allen Probes satellites

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[PEM12-P15] Study of the excitation mechanism of internally driven ULF waves by the drift-bounce resonance with ring current ions based on the Magnetosphere-Ionosphere coupled model

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[PEM12-P16] Statistical Analysis of Latitudinal Electron Density Distribution in the Plasmasphere

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[PEM12-P17] A statistical study of longitudinal extent of Pc1 pulsations using seven PWING ground stations at subauroral latitudes

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[PEM12-P18] Altitude profile of isolated proton aurora as estimated from digital camera observations from International Space Station

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[PEM12-P19] Development of ISEE_Wave; Interactive Plasma Wave Analysis Tool

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[PEM12-P20] Radiation characteristics of upper-band and lower-band chorus emissions in the generation region deduced from the Arase observation

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[PEM12-P21] Isolated Electrostatic Potentials Observed by the Arase Satellite

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[PEM12-P22] Statistical study of drifting electron holes associated with substorms observed by the Arase satellite

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[PEM12-P23] **The influence of EMIC (ElectroMagnetic Ion Cyclotron) wave-interaction on energetic protons in the magnetosphere using Arase observations**

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[PEM12-P24] A statistical study on high-energy electron injection events observed by Arase (ERG)

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[PEM12-P25] Development of a high-energy electron analyzer onboard CubeSats

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[PEM12-P26] **An observational study on possible excitation of storm-time Pc5 waves**

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[PEM12-P27] A Novel Calibration Method of Short Time Waveform Signals and its Approcation for the PWE/WFC Data

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[PEM12-P28] Nitrogen and oxygen ions from the Earth's ionosphere observed by the Arase satellite

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[PEM12-P29] Electron Energization during Dipolarization Events: Test Particle Simulations

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[PEM12-P30] Computer simulations of electron scatterings through chorus-wave particle interactions

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[PEM12-P31] Statistical analyses of low energy ion heating by electromagnetic ion cyclotron waves via wave-particle interaction analyses: Arase observations

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[PEM12-P32] Plasma waves causing 20 Hz intensity modulation of pulsating aurora: High-speed Tjörnes-Arase-Syowa conjugate observation

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Modulation of chorus intensity and UHR frequency in the off equatorial regions observed by the Arase satellite.

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The whistler mode chorus is a type of plasma wave generated near the geomagnetic equator by the wave-particle interactions. The chorus waves scatter the pitch angle of electrons by the wave-particle interactions, and the scattered electrons precipitate into the polar region and cause diffuse aurora. In particular, chorus waves which propagate to high latitudes could scatter the relativistic electrons, thus its propagation is of great importance for loss of radiation belt electrons and impact on the middle atmosphere. The mechanism of the chorus propagation from the source region at the equator to higher latitudes has not been clarified. However, the leading theory is chorus propagation along the duct (a field-aligned increase of the plasma density).

Plasma wave experiment (PWE) / Onboard frequency analyzer (OFA) on board Arase satellite observed modulations of chorus intensity which were correlated with variations in the UHR frequency with a period of a dozen seconds at geomagnetic latitude ~17° and Mallwain parameter L~6.0 at 00:06-00:10 UT, March 29, 2017. Interpretations of the phenomenon are as follows: (1) chorus propagating along the duct structure, (2)overlapping of another wave whose frequency is close to the UHR frequency, (3)electron density modulation caused by chorus. The simulation study reported (1) chorus propagation with duct structure (Hanzelka and Santolik, 2019). However, there is no report on observation of duct structure and the chorus propagating along the duct at off-equator. The case of (3) electron density modulation caused by chorus was reported by Nishimura et al. (2015).

In this study, we analyzed this plasma wave data at off-equator to consider whether the corresponding modulation of chorus intensity and UHR frequency could be explained by duct propagation. We assumed that Arase satellite crossed through ducts. We estimated the duct structure (width and relative density increase) from changes in UHR frequency and orbit data of Arase satellite. We identified UHR frequency by fitting the Gaussian function in the frequency direction to narrow band continuous emission observed by OFA with 1 s time resolution and calculated electron density by using magnetic field intensity observed by Magnetic Field Experiment (MGF). We obtain 20 examples of the presumed duct structure which correlated with chorus intensity modulation. Full width at half maximum of the duct structures and relative density increase in the center of the ducts are 5.9 km and 1.3 % (minimum), 17 km and 1.8 % (maximum), 10 km and 1.4 % (average), respectively. Hanzelka and Santolik (2019) simulated ducting chorus with various scales of duct and reported limits of the spatial scale and the relative density increase which were needed for ducting. Comparing our result with their simulation, the scale of density changes observed by Arase satellite was that the chorus could propagate up to geomagnetic latitude 45° or more at their propagation angle 15 degrees or loss.

We will investigate another possibility of (2) overlapping of other waves by using polarization information of the waves and look for similar events from the observation of the Arase satellite.

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Reference:
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Keywords: whistler mode chorus, electron density, Arase satellite

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Spatio-temporal characteristics of the precipitating electron energy of pulsating aurora and comparison with the numerical simulation

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Pulsating aurora (PsA) is characterized by quasi-periodic intensity modulations with a period of 2-20 s which is known as the main modulation. Electrostatic Cyclotron Harmonic waves and whistler-mode waves are known to cause the pitch angle scattering of energetic electrons in the magnetosphere. In particular, whistler-mode chorus waves play a crucial role in the pitch angle scattering of the electrons. The lower-band chorus causes precipitation of electrons whose energy is greater than several keV [Miyoshi et al., 2015]. The energy of precipitating electrons causing PsA has been estimated from ground-based optical observations. Ono [1993] observed the emission intensities of PsAs at wavelengths of 427.8 and 844.6 nm using a multi-channel photometer at Syowa Station in Antarctica, and estimated the energy of the precipitating electrons by combining the ratio of the two emission intensities and the model calculation. However, Ono [1993] conducted observations using the instrument with a narrow field-of-view, and the energy estimation using all-sky imagers has not yet been performed. In Tromsoe, Norway, several highly-sensitive EMCCD cameras have been operated, which have simultaneously observed all-sky images of the emission intensity at the two wavelengths (427.8 and 844.6 nm) with a sampling frequency of 10 Hz. In this study, we investigate the spatio-temporal variations of precipitating electron energy using these EMCCD cameras. We estimated the precipitating electron energy of PsA by comparing the intensity ratio of the two emission lines using the all-sky images and the emission intensity calculation results obtained by the GLOW model. We will compare the emission intensity ratio obtained from a code coupling simulation of GEMSIS-RBW that calculates wave-particle interactions and resultant precipitations and the GLOW model to estimate the optical emissions at different wavelength. In this presentation, we show the spatio-temporal characteristics of the precipitating electron energy of PsA and discuss energy spectrum of precipitating electrons by comparing with the code-coupling simulation.

Keywords: Pulsating aurora, wave-particle interactions, optical obserbation

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An error estimation for energetic electron flux measured by the high-energy electron experiments (HEP) onboard the Arase satellite.

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We have developed an error estimation method for energetic electron flux data obtained by the high-energy electron experiments (HEP) onboard the Arase satellite. The error estimation is based on the assumption of counting statistics in which the error of raw electron counts measured by the HEP instrument is provided as a square root of the counts. The error propagation from the count error to a differential electron flux value, however, is not as simple as other types of particle instruments, such as electrostatic analyzers. This is because observed electron counts in each energy channel are contributed by not only incident electrons of the designated energy range but also those with energies higher than it, being a convolution of all such electrons. For this reason, we derive differential electron fluxes by applying “deconvolution” matrices, which have been developed with a set of Geant4 simulations best reproducing the response characteristics of the instrument. Accordingly, the same deconvolution needs to be applied also to the error of raw electron counts in order to correctly process the error propagation. The derived flux errors show a rough proportionality to the square root of the corresponding flux values, as expected from the above method. In addition, we confirm that a given flux value can have a range of flux error depending on the power law index of the energy spectrum of electron flux; the harder an energy spectrum is, the relatively larger the resultant flux error is. After initial check and brief validation studies, the preprocessed flux error values are going to be stored in an updated version of level-2 data files and then delivered to data users.

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Relationship between polar cap potential and MLT distribution of ground delta H during geomagnetic storms using observations and RAM-SCB simulations

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The hourly Dst index and the equivalent 1-min SYM-H index values derived from low-latitude magnetic observations are considered to represent the intensity of the magnetospheric ring current. However, due to limited number of stations used in the calculation, these indices are not enough to capture the spatial/longitudinal variation of ring current. Therefore 30 low to mid latitude (9-45º CGM lat) magnetic stations are used to calculate **Delta** H_m. In addition to building the ring currents, the incoming solar wind energy is also used to influence further disturbance processes such as polar and auroral magnetic substorm activity. Polar Cap (PC) indices is a good proxy of the polar cap potential. Therefore, it is expected that ring current intensities have close relationship with polar cap indices. Some studies have shown relationship between Sym/Asym H with PC indices. However, the MLT distribution of ground Delta H_{asy} (Delta H_{asy} = Delta H - Delta H_m) that represent ring current asymmetry and its relation to the polar cap potential is not explored. In this study, we will examine the relationship between ground Delta H_{asy} and polar cap potential during selected geomagnetic storms. In order to see the magnetospheric origin, RAM-SCB simulations will be used to compare the ring current pressure distribution during these events.

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Global characteristics of cold protons in the near-Earth magnetotail: MMS/HPCA observations

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We conduct a statistical study of cold protons in the near-Earth magnetotail under quiet magnetotail conditions. Performing two-component Maxwellian fits to velocity distributions, we extract densities and temperatures of cold protons. Cold protons are separated into three distinct populations in the density-plasma b space. We interpret that Population I, characterized by a positive correlation of density to b, is solar-wind origin plasma transported over the polar regions. Population II, seen only in the high-b (>0.1) and tailward region (r > 20 Re) particularly on the dusk side, is solar-wind origin plasma entering through the flank magnetopauses and remains cold. Population III, clearly identified in the near-Earth region (r < 10 Re), is of ionospheric origin. The results also suggest that plasma supply to the plasma sheet is dominated by Population I and that cold plasma in the near-Earth magnetotail is mostly of ionospheric origin.

Keywords: plasma transport in the magnetosphere, origin of plasma sheet populations, two-component plasma

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Interaction between whistler waves and electrons at Earth's magnetotail: Test particle simulation and THEMIS observation

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Whistler waves play important roles in electron scattering in a collisionless plasma. We have analyzed a dipolarization event detected by THEMIS satellite on 19 February 2008. The event shows emission of whistler waves that lasted for a few seconds at the dipolarization site near the nightside equator at ~10 Re. Two types of waves were observed: one type has a frequency below ~0.1 f_{ce} (electron gyrofrequency) with the wave propagation angle relative to the background magnetic field around 120 degrees. The other type has a higher frequency from ~0.25 to ~0.5 f_{ce} with the propagation angles at ~20 and 160 degrees. Simultaneous observation of the electron pitch-angle distribution (PAD) reveals that associated with these waves, electron flux for energies below 4 keV is decreased while that with higher energies remains almost constant. These observations may indicate that the whistler waves are excited by the lower energetic electrons, whereas the higher energetic electrons may be treated as test particles in the given electromagnetic field.

In this presentation, we discuss electron scattering by obliquely propagating whistler waves performing test particle simulations and apply the results to the dipolarization event. The whistler waves are given as a superposition of sinusoidal waves obeying a cold plasma dispersion relation, using parameters consistent with the observation. Stretched dipole magnetic field is used as the background field model, assuming a Harris-type current sheet. Variation of the electron PAD is evaluated as a function of the electron energy and is compared with the THEMIS data. We discuss how the pitch-angle scattering by the whistler waves affects the variation of the PADs.

Keywords: whistler waves, electron scattering, earth's magnetotail

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Case analysis of SAPS wave structure events observed by ERG, DMSP, and SuperDARN

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Subauroral Polarization Stream (SAPS) and Subauroral Ion Drift (SAID) are ionospheric high-speed westward flows found in the subauroral region mainly on the dusk side, and are considered to be driven by a strong poleward electric field [Spiro et al., 1979; Anderson et al., 1993; Foster and Burke, 2002]. Ericson et al. (2002) reported that irregular substructures with a scale size of the order of tens of km presented within SAPS. These structures are called “SAPS wave Structure (SAPSWS)”. Based on CRESS satellite observation, Mishin and Burke (2005) showed that high-temperature ions were transported into the inner magnetosphere, and showed a spatial distribution with characteristic energy dispersion (ion nose structure) when the electromagnetic field fluctuations of SAPSWS were observed. Ebihara et al. (2009) performed a simulation of coupling processes between the inner magnetosphere and the subauroral ionosphere, and reported that hot plasma with complex pressure distribution was transported into the inner magnetosphere, and contributed to the temporal and spatial variations of SAPS. Further detailed comparisons among electromagnetic field fluctuations and hot ions in the magnetosphere and plasma flows in the ionosphere are important for understanding the mechanism of SAPSWS.

In this study, we used data from the ERG satellite [Miyoshi et al., 2018], which measures the electromagnetic fields and the flux of ring current particles in the magnetosphere. For 15 events of ion nose structures found from the observations of particle instruments (MEP-i, LEP-I, LEP-e), we examined electric field variations in the radial direction and hot ion isotropic pressure derived from the particle flux in an energy range of 10-180 keV (measured by MEP-i). In several of the 15 events, we also analyzed data measured at the ionospheric conjugated positions by DMSP satellites and SuperDARN radar. DMSP satellites measure the drift velocity of ions and magnetic field in the ionosphere. SuperDARN radar [Greenwald et al., 1995] observes two-dimensional distribution of ionospheric plasma flow velocity in the direction of the line of sight.

In 7 of the 15 ion nose structure events, the amplitude of the electric field was more than twice as large as 1 mV/m. In 6 of the 7 events, the hot ion pressure variations were more than twice as large as those of the rest 8 events with electric field variation smaller than 1 mV/m. In a conjugated event between ERG and SuperDARN Christmas Valley East (CVE) in a period from 2:30 to 3:00 UT on July 9, 2017, a small-scale structure with a flow velocity fluctuation of 200 m/s or larger was observed by CVE radar. In a conjugate event between ERG and DMSP F18 satellite in a period from 8:40 to 9:10 UT on August 31, 2017, small

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substructures with 200 m/s ionospheric flow were observed. In both events, variations of the ionospheric poleward electric field derived from ionospheric flow observations are about 10 mV/m. The electric field measured by ERG can be mapped to the ionosphere by assuming a dipole magnetic field. ERG observed a strong electric field with an amplitude of 2 mV/m or more near 17-19 MLT and L = 4-5. From the electric field measured in the magnetosphere, the electric field in the ionosphere was estimated to be 30-40 mV /m. The Electric field in the ionosphere based on SuperDARN and DMSP is comparable but a little smaller than that based on ERG. For further detailed comparison, we should take it into consideration that SuperDARN and DMSP measured a flow speed in a little different direction from westward, and the actual magnetic field could be different from the dipole field model. In the conjugate event between ERG and SuperDARN, the scale of the structure in the magnetosphere was estimated to be 4,000 km from the SuperDARN observation in the ionosphere and 3,000-3,600 km from the ERG observation in the magnetosphere. Based on ERG observation, we also confirmed the correspondence between variations of hot ion pressure and magnetic field, which indicated the existence of the field-aligned currents in the magnetosphere.

From the observations of plasma flows in the ionosphere, electric field, and hot ions pressure variations in the magnetosphere presented in this study, it is suggested that hot ions moving toward the earth with small-scale pressure inhomogeneities in the inner magnetosphere generate field-aligned currents and thereby cause SAPSWS in the ionosphere.

Keywords: SAPS, ERG / Arase, SuperDARN

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Energetic electron precipitations showing ULF modulation observed by VLF/LF transmitter signals

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Energetic electron precipitation (EEP; >100 keV) from radiation belts to the D-region ionosphere during substorms has been studied since the 1960s using very low frequency (VLF; 3 kHz to 30 kHz)/low-frequency (LF;30 kHz to 300 kHz) radio transmitter signals and riometers (Thorne and Larsen, 1976). The VLF/LF technique is most sensitive to the ionization of the D-region ionosphere, which is caused by energetic electron precipitation with energies typically >100 keV (Rodger et al., 2012). The low-latitude limit of particle precipitation is $L \sim 4.0$ (Berkey et al., 1974). Several studies have reported ionospheric modulations due to ultra low frequency (ULF) Pc5 and Pi2 modulations (Asnes et al., 2004). Modulation of D-region due to ULF waves during a substorm was reported (Miyashita et al., 2020). However, there was only one report for the EEP associated with ULF modulation using VLF/LF transmitter signals. In this study, we investigate the energetic electron precipitations associated with the ULF modulation that occurred on May 5, 2011, using the VLF/LF transmitter signals observed in North America. The three transmitters were NDK (frequency: 25.2 kHz, 46.37°N, 261.47°E, L=3.0); WWVB (60.0 kHz, 40.67°N, 254.95°E, L=2.3); and NLK (24.8 kHz, 48.20°N, 238.08°E, L=2.9). One receiver at Athabasca (ATHA), Canada (54.6°N, 246.7°E, L=4.3) was used. During 05:00-05:30 UT on May 5, 2011(magnetically quiet time), oscillations in amplitude and phase of VLF/LF waves with a period of 4-6 minutes were observed on the NDK-ATHA and WWVB-ATHA paths. This suggests that the EEP occurred over the two paths. The ground-based H-component magnetic field variations and Doppler velocity observed by the SuperDARN HF radars showed the there were small regions where the Doppler velocity was large near the WWVB-ATHA and NDK-ATHA paths during the VLF-LF oscillations. It is possible that the EEP occurred over the two paths. Based on ground-based magnetic field data, the propagation direction of the ULF wave was eastward (83.5 km/s) from the pre-midnight sector. In this presentation, we will discuss the cause of these VLF/LF oscillations.

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A statistical study on the detachment of arc from the main auroral oval using all-sky imaging observations at Athabasca, Canada

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The phenomenon of ‘detached arcs’ was first reported by Anger et al. (1978) to describe the arc-like auroral emissions equatorward of the auroral particle precipitation region. Recently, a common feature of detachment of arc from the main auroral oval has been brought to the attention for SAR (Stable Auroral Red) arcs (e.g., Shiokawa et al., AIP, 2009; EPS, 2017; Takagi et al., GRL, 2018) and STEVE (strong thermal emission velocity enhancement) (e.g., Gallardo-Lacourt et al., JGR, 2018; Yadav et al., JGR, 2021). Although the occurrence characteristics and geomagnetic conditions under which these arcs occur are known, studies comparing the occurrence characteristics and specific geomagnetic under which these detached arcs culminate as pure-red (SAR) arc, STEVE, and red+green arc (arc consisting of both red and green line emissions) are lacking. Based on 15-years (2006-2020) of all-sky imaging observations at Athabasca (magnetic latitude = 61.5˚N), Canada, here we present a comparative statistical analysis on the occurrence characteristics and geomagnetic conditions of detached SAR arcs, STEVE, and red+green arcs. Results show that the occurrence of pure red arcs peaks during low geomagnetic activity, which is in contrast to the occurrence of red+green arcs that peaks during active geomagnetic conditions. In order to access the substorm activity in the longitude zone of the Athabasca ASI, we have analysed the X-component magnetogram at Fort Smith (FSMI; magnetic latitude: 67.28˚N) which is located ~6˚ magnetic latitude poleward of Athabasca. In general, STEVE and SAR arcs tend to occur at the beginning of recovery phase, whereas red+green arcs occur towards the end of expansion phase of a substorm. The geomagnetic activity levels were found to be highest for STEVE and lowest for the SAR arcs. Prior to the STEVE event, the ASY-H index shows gradual increase and STEVE occurred when the ASY-H values maximized, indicating the magnetospheric linkage of STEVE. STEVE is associated with substorms that have abrupt expansion and recovery, whereas substorms exhibit gradual expansion and recovery phase for the SAR arcs. Further, STEVE is found to be associated with the sharp increase in the X-component of the geomagnetic field at FSMI.

Anger et al. (JGR, 1978) https://doi.org/10.1029/JA083iA06p02683

Shiokawa et al. (AIP Conf. Proc., 2009) https://doi.org/10.1063/1.3169292

Shiokawa et al. (EPS, 2017) https://doi.org/10.1186/s40623-017-0745-9

Takagi et al. (GRL, 2018) https://doi.org/10.1029/2018GL079615

Gallardo-Lacourt et al. (JGR, 2018) https://doi.org/10.1029/2018JA025368

Yadav et al. (JGR, 2021) https://doi.org/10.1029/2020JA028622

Keywords: Arc detachment, Auroral oval, Imaging observations

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SAPS electric field and particle observations by the Arase satellite and SuperDARN

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The comparison between the ionospheric convection and magnetospheric electric field is important for understanding the magnetosphere-ionosphere coupling. However, there have been few studies making comparison between the SuperDARN convection and satellite electric field related to the Sub-Auroral Polarization Streams (SAPS). In this study, simultaneous observation of the SAPS electric field were carried out by SuperDARN radar and the Arase satellite. In 52 simultaneous observation events identified during the analyzed period from June 2017 to Dec. 2019, SAPS were observed by the SuperDARN radar near the calculated footprint of the Arase satellite and almost concurrently the satellite detected electric field enhancements. In association with the SAPS electric field, the satellite observed the plasmapause crossing and increase of low energy (< 1 keV) ions fluxes in most of the events. We performed a statistical analysis of these low energy ion enhancement events. The result is that the low energy ion enhancement appears mainly in the field-aligned directions and the intensity of flux enhancement has a weak positive correlation with the flow velocity of SAPS. On the other hand, the gap in timing of SAPS encounter often seen between the satellite and the ground also suggests that the actual ionospheric footprint of the Arase satellite would deviate from the foot-print calculated using the empirical magnetic field model. Details of the relationship between these low-energy ion characteristics and the electric field distribution, as well as the deviation of the ionospheric footprint of the satellite, will be discussed.

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Properties of EMIC waves observed by Van Allen Probes and ground-based magnetometers during relativistic electron precipitation

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Electromagnetic ion cyclotron (EMIC) waves are observed as Pc1-2 pulsations in the Earth’s magnetosphere. They are excited due to the temperature anisotropy of ring current ions, and scatter the pitch angle of relativistic electrons through cyclotron resonance. This process is considered as one of the mechanisms to cause the loss of the outer radiation belt. There still remain questions about the amount of the contribution from the EMIC waves to the overall loss of radiation belt electrons. In order to estimate quantitatively the electron loss from the outer radiation belt, we need to estimate the spatial extent and temporal evolution of the source region of EMIC waves. We investigated EMIC waves observed by Van Allen Probes and ground magnetometers in North America in 02:30-06:05UT on 19 April 2017. This event occurred in a substorm during main and early recovery phase of small geomagnetic storm. Van Allen Probe A observed EMIC waves in hot proton populations inside plasmapause. The footprint of Van Allen Probe A was located in North America during the wave activity observed by Van Allen probes. Simultaneously, Pc1 pulsations were observed at some stations of induction magnetometers from “Study of dynamical variation of Particles and Waves in the Inner magnetosphere using Ground-based network observations (PWING)” project and the Canadian Array for Realtime Investigations of Magnetic Activity (CARISMA). Energetic electron precipitation was detected by subionospheric VLF radio waves received at Athabasca, Canada and POES satellites. The VLF radio waves propagate near the footprint of Van Allen Probe A and ground-based magnetometers during EMIC wave activity. This suggests that detected electron precipitation was driven by EMIC waves. From satellite and ground-based magnetometer data, we estimated the local time extent of source region of ~6.8 hour and L shell extent of ~2.2. Pc1 pulsations started to be observed by east side stations on the ground. The time lag and difference of longitude between stations suggest that the source region of EMIC waves move westward and to low latitude.

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A Study on the Effect of the Number of Snapshots for Averaging and the Noise Level on the Estimation Accuracy in Direction Finding

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The analysis of plasma waves obtained from in-situ observations by scientific satellites is an effective method to investigate the plasma environment in the inner magnetosphere. Direction finding of plasma waves provides important information for understanding not only local plasma environment but also the global features of the inner magnetosphere.

In the direction finding, information on the amplitude and phase difference of the electromagnetic field extracted from the correlation matrix called spectral matrix is used. The quality of the information from the spectral matrix depends on the number of snapshots for averaging, the noise level on the electromagnetic sensor, and so on. What is more, the accuracy and the robustness of the estimated result about direction finding depends on the a priori information such as the number of waves, propagation mode, plasma density and geomagnetic field intensity.

In this study, the effect of the number of snapshots for averaging and the level of noise on the electromagnetic field sensors on the estimation accuracy of the direction finding is verified.

Keywords: Direction Finding, Spectral Matrix

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Relative Contribution of ULF Waves and Whistler-mode Chorus to the Radiation Belt Variation during the May 2017 Storm

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The Earth's radiation belt exhibits a dramatic variation during the active condition of the magnetosphere such as magnetic storms. The dynamic variation of the radiation belt is, in part, contributed by various wave-particle interactions, including: (1) the radial diffusion of electrons driven by ultra-low-frequency (ULF) waves in the Pc5 frequency range (2-7 mHz), and (2) the local acceleration caused by wave-particle interactions between whistler-mode chorus and radiation belt particles. Over the past decade, multi-point observations and numerical simulations have separately demonstrated evidence for the contribution of ULF waves and whistler-mode chorus to the relativistic electron flux enhancement. However, comparison of the contribution of ULF waves and whistler-mode chorus has not been extensively made yet. To the best of our knowledge, only few papers have demonstrated the global picture of the relative contribution of waves to the total radiation belt content.

In this study, we investigate when and where ultra-low-frequency (ULF) waves and whistler-mode chorus contribute to the net flux enhancement of relativistic electrons during the May 2017 storm. During the early recovery phase, ULF waves mainly contribute to the global enhancement of relativistic electron flux in the dusk sector. On the nightside, both waves are related to the flux variation. During the late recovery phase, both Van Allen Probe (RBSP)-B and Arase show that whistler-mode chorus contributes to the flux enhancement confined in L-value. The Comprehensive Ring Current Model (CRCM) coupled with Block-Adaptive-Tree Solar-Wind Roe-Type Upwind Scheme (BATS-R-US) simulation qualitatively reproduces the global evolution of ULF waves. Although the electron flux is underestimated by the simulation, we find the large anisotropy of hot electrons in the region where whistler-mode chorus waves were actually observed by satellites. In addition, the estimated magnetic field curvature on the dayside is small during the recovery phase.

We also investigate what controls the wave evolution. Both observations and simulation suggest that observed ULF waves in a frequency range of ~2-4 mHz are excited by the enhancement of the solar wind dynamic pressure. Observations also indicate that whistler-mode chorus on the nightside is predominantly excited by hot electrons with temperature anisotropy, whereas dayside chorus is enhanced by the change of the magnetic field line configuration. Estimated spatial distributions of electron anisotropy and magnetic field curvature give an explanation for observational results that enhanced whistler-mode chorus exists in the dusk sector, which is far from the ordinary location of wave generation.

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Initial results on multi event analysis of the simultaneous observation of isolated proton auroras at subauroral latitudes by a highly sensitive all-sky camera and the Van Allen Probes satellites

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Isolated proton aurora (IPA) appears at subauroral latitudes with Pc1 geomagnetic pulsations. This aurora has a spot-like feature extending in the east-west direction. Proton aurora is caused by energetic proton precipitating from the magnetosphere through charge-exchange collisions with atmospheric particles in the ionosphere. Previous studies suggested that IPA is caused by electromagnetic ion cyclotron (EMIC) waves which scatter pitch angle of energetic protons into the loss cone in the magnetosphere and making their precipitation into the ionosphere. EMIC waves are considered to make rapid loss of the radiation belt electrons into the atmosphere through wave-particle interaction. The IPA is the projection of the wave-particle interaction region into the ionosphere. Thus, simultaneous observation of magnetospheric EMIC waves and IPA is important to understand the scale sizes of the wave-particle interaction region. There have been few observation of IPA and its magnetospheric source region except for Nishimura et al. [JGR, 2014; doi: 10.1002/2014JA020029] and Nakamura et al. [submitted to JGR, 2021]. In this study, we detected three events of simultaneous observation of IPAs and plasma and electromagnetic variations in the magnetospheric source region of IPAs by using an all-sky camera at Kapuskasing, Canada, and the Van Allen Probes satellites. As a result, when the footprints of the Van Allen Probes satellites passed over IPAs, isolated EMIC waves were observed by the satellites (March 22, April 22, and September 7, 2018). All events were observed during geomagnetically quiet times. The equatorward boundaries of the EMIC waves correspond to the increase of the proton flux at energies of ~10 keV, and the flux was predominantly perpendicular to the magnetic field lines. On the other hand, the poleward boundaries of the EMIC waves correspond to the region where the local plasma density began to decrease rapidly. These characteristics were common to all events. Based on these results, we will discuss possible cause of localization of IPA and EMIC waves in the magnetosphere.

Keywords: isolated proton aurora, EMIC wave

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Study of the excitation mechanism of internally driven ULF waves by the drift-bounce resonance with ring current ions based on the Magnetosphere-Ionosphere coupled model

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Internally driven ULF waves can be generated by ring current ions associated with the injection from the magnetotail during substorms. The excitation mechanism and global distribution of ULF waves are keys to understand dynamic variation of the outer radiation belt, since Pc5 ULF waves (1.67-6.67 mHz) can drive radial diffusion of radiation belt electrons [e.g. Elkington et al., 2003]. The drift-bounce resonance [Southwood, 1976] has been considered to be a candidate excitation mechanism. Previous spacecraft observations suggest both drift resonance and drift-bounce resonance excitation of ULF waves [e.g. Dai et al., 2013; Oimatsu et al., 2018]. Recently, Yamakawa et al. [2019] confirmed the drift resonance excitation of Pc5 waves by an isotropic Maxwellian PSD ion injection based on the drift-kinetic model. We also found the drift-bounce resonance excitation of Pc3 waves under asymmetric butterfly type injection [Yamakawa et al., 2020]. However the amplitude of the excited ULF waves is too small compared to spacecraft observations. One possible reason is the damping of field fluctuations at the ionospheric boundary in the model.

In order to improve the ionospheric boundary condition, we have made Magnetosphere-Ionosphere coupling between GEMSIS-RC [Amano et al., 2011] and GEMSIS-POT model [Nakamizo et al., 2012]. We use GEMSIS-RC model in the inner magnetosphere, in which 5D drift-kinetic equation for the PSD of ions and Maxwell equations are solved self-consistently. GEMSIS-POT is an ionospheric model, which solves 2-D electric potential. We use FAC from GEMSIS-RC as an input to GEMSIS-POT for the Region 2 current. The resultant electric field potential is then used as inner boundary condition of GEMSIS-RC. The coupled model enables us to simulate the ion injection from the plasma sheet into the inner magnetosphere. Simulation results have shown the excitation of Pc5 waves in the dayside (drift resonance) and Pc4 waves in the duskside (drift-bounce resonance). We have found that the amplitude of the excited ULF waves are enhanced by improving the ionospheric boundary condition. We will also report on the details of the effects of the boundary condition and R2FAC related electric field on the excitation of ULF waves.

Keywords: ring current, ULF wave, substorm, drift-kinetic model, drift-bounce resonance

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Statistical Analysis of Latitudinal Electron Density Distribution in the Plasmasphere

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Plasma density distributions along magnetic field lines give important information on plasma supply mechanisms from the ionosphere.However, most observations so far are biased near the equatorial plane; there have been few observations which give information on the density along field lines.The geospace exploration satellites Arase and Van Allen Probes(RBSP) have orbital inclinations of about 31 and 10 degrees, respectively.These satellites sometimes fly at different latitudes on the same field line, simultaneously.Using such conjunction data, the field aligned profile of the electron density can be estimated.

The electron densities were calculated from the Upper Hybrid Resonance frequencies obtained by HFA / PWE onboard Arase or the EMFISIS Waves instrument onboard RBSP.In this study, we assumed a power-law density model in which the density decreases with the m_{th}-power of the geocentric distance by comparing electron densities at Arase and RBSP-A or B.

At this moment, the conjunction events on April 5, 2017 were analyzed, and the following results were obtained.For flux tubes of 3.20 The expected power-law index m depends on the plasma supply model. In the collisionless models, m is close to 4.On the other hand, in the diffusive equilibrium model, close to 0.5~1.So our results suggest that the plasmasphere is in diffusive equilibrium.

In this presentation, we will introduce further results and discuss the plasma supply mechanism.

Keywords: plasmasphere, magnetosphere-ionosphere coupling

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A statistical study of longitudinal extent of Pc1 pulsations using seven PWING ground stations at subauroral latitudes

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Ultra-low-frequency (ULF) Pc1 geomagnetic pulsations correspond to the electromagnetic ion cyclotron (EMIC) waves in the magnetosphere, and are excited sporadically in the magnetospheric equatorial plane with a frequency range of 0.2-5 Hz. Pc1/EMIC waves occur as a result of the ion-cyclotron instability. These waves may contribute to loss of the radiation belt electrons in the inner magnetosphere through wave-particle interactions. Previous researches on the spatial extent of EMIC waves mainly used only a specific ground station or a few ground stations. There are also some researches on the global distribution of EMIC waves using statistical study of data obtained by single satellite rather than through ground stations. However, the instantaneous longitudinal extent of Pc1 waves has not been fully understood yet. In order to investigate this instantaneous longitudinal extent of Pc1 waves, in this study, we analyze the magnetic field data obtained at the seven ground stations at Athabasca (54.6N, 246.36E), Kapuskasing (49.39N, 277.81E), Gakona (62.39N, 214.78E), Husafell (64.67N, 338.97E), Zhigansk (66.78N, 123.37E), Istok (70.03N, 88.01E), and Oulu (65.08N, 25.90E) for one year from July 2018 to June 2019. The magnetometers at the 6 stations have been deployed and operated by “study of dynamical variation of Particles and Waves in the INner magnetosphere using Ground-based network observations (PWING)” project, while the magnetometer at Oulu has been operated by Sodankylä Geophysical Observatory. We will report local time variations of the occurrence rates and average frequencies of the Pc1/EMIC waves at these stations and discuss the characteristics of the wave appearance including their instantaneous longitudinal extent. We also make some model calculation about the possible longitudinal extent to explain the observed instantaneous occurrence rate distributions. The above analysis reveals that the average instantaneous longitudinal extent of the Pc1 waves is about 80 degrees in longitudes at subauroral latitudes. There was no clear difference in the longitudinal extent of Pc1 waves between two different geomagnetic activity levels defined by the Dst index less/more than -15 nT.

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Altitude profile of isolated proton aurora as estimated from digital camera observations from International Space Station

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Proton aurora, that appears as an isolated spot at sub-auroral latitudes well away from the electron auroral oval, is called as the “Isolated Proton Aurora” (IPA). It has been believed that proton precipitation responsible for IPA is caused by scattering of protons through interaction with Electromagnetic Ion Cyclotron (EMIC) waves in the magnetosphere. It is well known that IPA appears in a horizontally (i.e., latitudinal and longitudinal directions) localized region. However, its spatial structure in the vertical direction has not been well understood. Therefore, we employ the full-color aurora images captured by the digital camera onboard the “International Space Station” (ISS) for deriving the altitude profile of emission of IPA. The digital camera onboard ISS is able to carry out limb viewing observations of the upper atmosphere of the Earth which allows us to capture the vertical structure of aurora, especially IPA. Nanjo et al. (2020) showed that it is possible to map the horizontal structure of aurora with high spatial/temporal resolutions. Thus far, however, The vertical structure of auroras has not been derived with the photographs captured from the ISS; thus, the details of the height structure of IPA are still unknown. In this study, we developed a method for mapping the vertical profile of the emission of IPA using limb-viewing digital camera images from ISS. In this presentation, we will discuss how the altitude profiles of the red and green emissions of IPA are distributed based on the mapping results of the altitude structure of the IPA observed in the southern hemisphere on April 20, 2018.

Keywords: Isolated proton aurora, International Space Station

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Development of ISEE_Wave; Interactive Plasma Wave Analysis Tool

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In this study, we developed ISEE_Wave, which is an interactive plasma wave analysis tool for electric and magnetic field waveforms observed by the plasma wave experiment aboard the Arase satellite. ISEE_Wave provides an end-to-end wave analysis environment on a graphical user interface, where users can visualize advanced wave properties, such as the electric and magnetic field wave power spectra, wave normal polar angle, polarization ellipse, planarity of polarization, and Poynting vector angle. Users can simply select a time interval, and ISEE_Wave automatically downloads the waveform data, ambient magnetic field data, and spacecraft attitude data from the ERG Science Center, and performs coordinate transformation and spectral matrix calculation. Singular value decomposition is used as the core technique for the wave property analysis of ISEE_Wave. Users can freely specify the parameters of the wave property analysis and as well as the plot styles using the graphical user interface of ISEE_Wave. The results can be saved as image files and/or a tplot save file. The proposed tool aids in the identification of fine-structures of observed plasma waves, wave mode identification, and wave propagation analysis. These properties can be used to understand plasma wave generation, propagation, and wave-particle interaction in the inner magnetosphere. ISEE_Wave can also be applied to waveform data observed by other spacecrafts by replacing the data loading procedures.

Keywords: Plasma waves, Direction finding, Arase satellite

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Radiation characteristics of upper-band and lower-band chorus emissions in the generation region deduced from the Arase observation

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Chorus waves are plasma waves that propagate along the geomagnetic field line. The waves are observed at frequencies below the electron cyclotron frequency (fce), and they often have a minimum in wave power at 0.5fce. Those observed above 0.5fce are called upper-band chorus (UBC), while those observed below 0.5fce are called low-band chorus (LBC). Chorus waves are excited near the magnetic equator and propagate to the polar region. Previous studies show that LBC frequently change their radiation direction within the generation region. However, the radiation characteristics of UBC in the generation region and the differences between UBC and LBC have not yet been clarified. The purpose of this study is to clarify the radiation characteristics of UBC and LBC in the generation region by analyzing the data obtained by the Arase satellite.
The Arase satellite has nine instruments on board. In this study, we use the background magnetic field data acquired by the MGF(Magnetic field experiment) and the electromagnetic waveform data acquired by the WFC (Waveform capture) of the PWE (Plasma wave experiment). Using the data acquired by the Arase satellite, we focused on the power spectrum of the electric and magnetic fields and the Poynting vector along the direction of the background magnetic field. Our results show that the Poynting flux ratio of northward to southward waves of UBC and LBC varies with the distance between the magnetic equator and the Arase satellite. Comparing the radiation direction of UBC with that of LBC, in many cases, we find that the generation region of these waves is located at the different directions relative to the satellite location. The results revealed by this study suggest that the radiation timing and generation region of UBC and LBC are different. We propose that the collection of localized UBC and LBC generation points forms the entire generation region of Chorus waves.

Keywords: Arase satellite, whistler mode, chorus, inner magnetosphere

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Isolated Electrostatic Potentials Observed by the Arase Satellite

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The present paper discuss the estimation of the spatial structure of the isolated electrostatic potentials observed by the Arase satellite in the Earth’ s inner magnetosphere applying the interferometry technique.

Isolated electrostatic potentials in the Earth's magnetosphere have been observed as Electrostatic Solitary Waves (ESWs) by many satellites such as GEOTAIL, RBSP, Polar, and FAST. It has been suggested that the isolated potentials contribute to electron acceleration in the magnetosphere because they may lead to spatial steps in the potential. Therefore, the spatial scale and structure of the isolated potentials and their electric energy are important. In the magnetotail region, a sheet-like structure represented by one-dimensional Gaussian was proposed, based on the ESW features observed by the GEOTAIL satellite. On the other hand, no specific spatial structure has been proposed for the isolated potential observed in the Earth's inner magnetosphere.

The purpose of this study is to propose a spatial structure of the isolated potentials observed by the Arase satellite. For this purpose, we calculate the spatial scale and polarity of the ESW observed by the Arase satellite, and propose a spatial structure model of the isolated potential that can reproduce the ESWs.

Using the monopole observation of the Arase satellite, it is possible to determine the direction of passage of the isolated potential relative to the satellite and the time difference between the two observation points. This provides the spatial scale of the potential. It is also possible to determine the polarity of the isolated potentials by considering the direction of its passage and the antenna polarity. In addition, the structure of the isolated potentials is discussed. Assuming a two-dimensional model of the electrostatic potential, numerical experiments are conducted to reproduce the waveform observed by Arase.

The ESWs observed by the Arase satellite have two characteristics: pulse waveforms are observed not only parallel but also perpendicular to the background magnetic field, and various types of waveforms such as bipolar and asymmetric waveforms are irregularly observed. We analyzed the waveforms of the monopole observations, focusing on the bipolar waveforms. The spatial scales are estimated to be between 380m and 3 km. The potentials with both positive and negative polarities are present. A model with a small scale structure in the perpendicular direction to the background magnetic field was proposed, and the above features could be reproduced in two-dimensional Gaussian by numerical experiments.

By using the monopole observations of the Arase satellite, we have succeeded in calculating the spatial scale of the isolated potential and determining their polarity. It is suggested that the isolated potentials observed by the Arase satellite has a different structure from the previously proposed model.
It is also suggested that the proposed structure does not have potential step and does not contribute to the acceleration of electrons.

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Keywords: Electrostatic Solitary Waves, Isolated Potentials, Interferometry observation, Arase satellite, Time domain structures

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Statistical study of drifting electron holes associated with substorms observed by the Arase satellite

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Drifting electron hole (DEH) is a dropout in the electron flux frequently observed in an energy range similar to that of electron injections in the Earth's magnetosphere [Sergeev et al., 1992]. The flux dropout is thought to be caused by the deformation of the electron drift shell due to a large-scale reconfiguration of the magnetic field associated with substorm onset.
Most of these substorm-related DEHs were observed near and outside the geosynchronous orbit [Cohen et al., 2019, Liu et al., 2019, Shukhtina et al., 1996]. DEHs were also observed in the region of L > 5 inside the geosynchronous orbit by the Arase satellite [Miyoshi et al., 2018]. However, there has been very limited discussion of these DEHs since the statistics cover only quiet conditions and a small number of events, and this electron dropout is not yet fully understood.
To investigate the characteristics of DEH, we conducted a statistical study by analyzing data obtained by the HEP and MEP-e instruments onboard the Arase satellite. We selected the DEH events that were observed simultaneously with the injection by inspecting the data during the periods when Arase observed the night side to the dawn side of the magnetosphere from 2017 to 2019. The resultant DEH events were mainly observed in the pre-midnight sector to the dawn side. We estimated the drift trajectories of electrons corresponding to energy-dispersed DEHs to identify their source region. The source region of DEHs extends over 3-4 hours around local magnetic midnight, which distribution is similar to that of the injections simultaneously observed. This result is consistent with the model presented by Sergeev et al. [1992].
On the other hand, there are some events in which the source sectors of DEH and injection are different, even though they were observed simultaneously. The existence of such events suggests that DEHs may not be explained by a simple model assuming a single source region.

Keywords: Drifting electron hole, Particle injection, Substorm, Arase satellite

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The influence of EMIC (ElectroMagnetic Ion Cyclotron) wave-interaction on energetic protons in the magnetosphere using Arase observations

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Electromagnetic ion cyclotron (EMIC) waves have been driven by temperature anisotropy of energetic ions near the magnetic equator. These waves constitute a significant loss process of energetic protons and sub-relativistic electrons through pitch-angle scattering by wave-particle interactions. In our previous study, we found that EMIC waves show significantly different characteristics at the different peak occurrence regions depending on geomagnetic environments. In this study, we performed a statistical study to demonstrate the influence of EMIC wave-particle interaction on energetic protons in the magnetosphere using in-situ observations by Exploration of energization and Radiation in Geospace (Arase) satellite. For this study, we identified EMIC waves by visual inspection and separated them into two wave-bands (H+ and He+ bands) in 2017-2020. We also measured energetic proton pitch angle distributions with an energy range of 30 eV to 25 keV. In this presentation, we show spatial distributions of EMIC waves in the magnetosphere and comparisons of energetic proton pitch angle distributions between with and without EMIC wave activities, discuss possible free energy sources causing EMIC waves at different regions. We will demonstrate the influence of different generation processes of EMIC waves on energetic proton distributions using in-situ satellite observations and theoretical model calculations.

Keywords: Electromagnetic ion cyclotron (EMIC) waves, Exploration of energization and Radiation in Geospace (Arase) satellite mission, EMIC wave-particle interaction

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A statistical study on high-energy electron injection events observed by Arase (ERG)

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The substorm injection is a critical phenomenon for supplying the free-energy necessary to generate relativistic electrons in the radiation belts. Numbers of studies on substorm injections have been demonstrated. However, how the injected electrons penetrate the inner magnetosphere and get their energy remains unclear. The energization of the particle injection is thought to be resulting from the transient enhancement of the electric field associated with the dipolarization, although there is no observational evidence such large electric fields accelerate injection particles.
Arase (ERG) often observes electron injections whose maximum energies reach hundreds of keV, while the typical maximum energy of injected electrons is about 100 keV or less. In this study, we would like to address how injected electrons are accelerated to such high energies. Collecting injection events during the period when the apogee of Arase is located in the nightside, we are examining the statistical properties of the high-energy injection events, e.g., the distribution of their estimated source regions, characteristics of energy spectra, pitch angle anisotropy, and other parameters in detail. We expect that finding dependence on the maximum energy is a key to limit the acceleration mechanisms of electron injections.
In the presentation, we will present preliminary results.

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Development of a high-energy electron analyzer onboard CubeSats

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Nowadays, the use of CubeSats for space science researches is no longer unusual in the world. We expect that CubeSats become a more powerful platform for space environment observations, enabling ultra-multi-point 'in-situ' measurements. More chances to install scientific instruments onboard CubeSats are desired to realize future observations and test new technologies in space. Thanks to the JSPS KAKENHI support and the collaboration with Kyushu Institute of Technology, we have an opportunity to install a new high-energy electron analyzer onboard the BIRDS-5 satellite, which is the fifth satellite in Joint Global Multi-Nation Birds Satellite (BIRDS) Program of Kyushu Institute of Technology. BIRDS-5 will be released from the international space station (ISS) in Spring 2022, and its orbit is almost the same as ISS.
Our high-energy electron analyzer for BIRDS-5 is nicknamed "Particle Instrument for NanO-satellite (PINO)." The mission objectives of PINO are followings. 1) To demonstrate a compact high-energy electron detector onboard a CubeSat using the Si/CdTe semiconductor, and 2) To measure the high-energy electron flux precipitating along the geomagnetic fields from the radiation belts. The CdTe semiconductor is commonly used for recent gamma-ray detectors in high-energy astrophysics, but the application of the CdTe semiconductor to the high-energy electron sensor is the first trial. We expect that the CdTe sensor can efficiently measure higher energy electrons because of the higher stopping power of CdTe than that of Si. This characteristic of the CdTe sensor is the advantage of developing a more compact analyzer. We will turn on PINO for continuous 5 minutes in an orbital revolution since electric power resource limits the operation. PINO can observe the precipitating high-energy electron fluxes above 60 degrees of the geomagnetic latitude in the northern hemisphere under this operational condition. With the collaboration between BIRDS-5 and Arase (ERG), we will be able to conduct simultaneous observations of precipitating high-energy electrons from the outer radiation belt at both low and high altitudes.
In this presentation, we will present the outline of science and the PINO development's latest status.

Keywords: high energy electron, radiation belt, cubesat

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An observational study on possible excitation of storm-time Pc5 waves

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The adiabatic acceleration associated with the radial diffusion by the ULF wave is an important mechanism that generates relativistic electrons in the radiation belts. Among various ULF waves observed in the geospace, the storm-time Pc5 wave is a possible candidate to drive the radial diffusion during magnetic storms, although its excitation process and the relation between the observed waves and the radial diffusion have not been confirmed. Storm-time Pc5 wave is thought to be excited by injected ions from magnetotail to the ring current. Recently, Yamakawa et al. (2019) demonstrate that Pc5 waves can be excited by the injected ions via the drift resonance by a numerical simulation study.

This paper would like to address the Pc5 excitation process based on recent multi-satellite observation datasets obtained in the inner magnetosphere. According to the results of Yamakawa et al. (2019), Pc5 waves excited by the drift resonance have a characteristic of the frequency evolution. Using the magnetic field observation of Arase (ERG), we have collected Pc5 wave events that show the same frequency evolution as that observed in the numerical simulation. As a result, the occurrence probability of the Pc5 wave events depends on the geomagnetic activity, and the spatial distribution of the selected events is consistent with the simulation results.

Further, we pick up the examples of Pc5 events where the ion injections are observed just before and investigate if the observed injected ions can excite Pc5 waves through drift resonance. This presentation will discuss the relationship between ion injection events and Pc5 observations in the drift resonance context.

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A Novel Calibration Method of Short Time Waveform Signals and its Approcation for the PWE/WFC Data

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The Waveform Capture (WFC) is a receiver of the Plasma Wave Experiment (PWE) on board the Arase satellite. The WFC measures the electric and magnetic field waveform in the frequency range from a few Hz to 20 kHz and aims to detect plasma waves related to the electron acceleration, such as whistler mode chorus emissions. A new-type instrument named Software-type Wave-Particle Interaction Analyzer (S-WPIA) is also installed in the Arase satellite to measure energy and momentum exchange between plasma waves and particles directly and quantitatively. The S-WPIA requires the high-accuracy calibration of both amplitude and phase of waveform data detected by the WFC with a reasonable processing load so as to realize the onboard calibration. In a typical calibration process, raw data passed through a system comprising of antennas, amplifiers, and filters should be (1) tapered by a window function to reduce the side lobe effect, (2) Fourier-transformed into a spectrum, (3) divided by a transfer function of the system in the frequency domain, (4) inverse-transformed into a waveform, and (5) divided by the window function in the time domain. However, the calibrated waveform data are distorted in the time domain in the case of using a short-time window consisting of several hundred of data points.
In this study, we reveal that the main lobe expansion caused by a window function yields the phase shift of the window function in the process (3) and the process (5) dividing by an un-shifted window function results in the distortion of waveforms in the time domain. To perform accurate calibration with a short-time window, we suggest a novel calibration method to estimate the phase shifts of a window function from the gradient of a transfer function and remove the distortion by dividing the shifted window functions at each frequency in the time domain. We applied the proposed method to simple sinusoidal signals and evaluated the frequency response of the accuracy of the calibrated data. As a result, we conclude that the proposed method can reduce errors to less than one percent of the signals even in the short-time window cases of using several hundred of data points. The accuracy tends to decrease at the low frequency range close to the frequency of a window function and at the high frequency range close to the Nyquist frequency. We also applied the methods to actual electric field data of chorus emissions observed by the PWE/WFC. In consequence, although the proposed method requires longer calculation time as compared to other conventional methods, the proposed method can reproduce the seamless waveforms of chorus emissions with errors of one percent of the wave amplitude or less in the case of using a band pass filter at the frequency range of the typical chorus emissions. We need to take account of the relation between the frequency range of the electromagnetic waveform and the window function in interpreting observation results.

Keywords: the Arase satellite, Plasma waves, waveform calibration

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Nitrogen and oxygen ions from the Earth's ionosphere observed by the Arase satellite

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Various ion species originating from the Earth's upper ionosphere have been observed by the ERG (Exploration of energization and Radiation in Geospace)/Arase satellite. Among them, heavy ions such as O+ are used as markers to monitor ionospheric ion outflow, and their correlation with solar activity and magnetic activity has been investigated. The Arase satellite has successfully observed not only O+ but also molecular ions (N2+, NO+, and O2+). However, there have been a few reports of observations of N+ due to its close mass number to that of O+. In this presentation, we report on the extraction of N+ from the Arase observation data, which has been rarely observed due to its close mass number.
We used the TOF (Time-of-flight) mode data obtained by the MEP-i onboard the Arase satellite. The two types of ions were separated from the TOF spectra at each energy by fitting the TOF profiles of N+ and O+. On the other hand, calibration curves of the TOF profile were also prepared from the data obtained in the pre-launch calibration experiments. This calibration curves were calculated from a comprehensive model calculation by incorporating the TOF dispersion caused by the passage of ultra-thin carbon in the TOF mass spectrometer and the energy resolution of the energy analyzer. It was confirmed that the TOF profiles used in the fitting of the observation data analysis and the calibration curves obtained from the calibration data were in good agreement. From the Arase MEP-i data, the counts necessary for the separation of N+ and O+ were obtained from about 30 minutes of data.
The N+/O+ ratio obtained from the Arase data is expected to provide information on the ionospheric region where the outflow originates and its mechanism. Here we report the details of the N+ extraction method and the results.

Keywords: Nitrogen, Arase, ERG, Geospace, Inner Magnetosphere

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Electron Energization during Dipolarization Events: Test Particle Simulations

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In this research, we have developed a test particle simulation code to examine the electron energization during multiple dipolarization events. The Tao-Chan-Brizard guiding center model was implemented to evaluate the trajectories of 0.1, 1, 10 keV electrons with different initial pitch angles and *L*-shells. The time-varying magnetic field model was evaluated by the Tsyganenko model TS05 with the corresponding inductive electric field. Dipolarization events are characterized by an enhancement in particle energy in the nighttime magnetosphere. The increase in the magnetic field and the corresponding induced electric field can energize and transport the particles earthward, which can explain the mechanism of the particle flux enhancement in the inner magnetosphere. Numerical results will be compared with THEMIS measurements.

Keywords: Dipolarization, Electron Energization, Test Particle Simulations, Tsyganenko Model, Inductive Electric Field

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Computer simulations of electron scatterings through chorus-wave particle interactions

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Whistler mode chorus waves cause scattering and acceleration of energetic electrons in the inner magnetosphere, and recent studies identified that chorus waves cause the pulsating aurora. The interaction processes have been modeled as diffusions in the velocity space, and the scattering rate increases with increasing the wave amplitude. However, actual wave-particle interactions with chorus waves are non-linear process, so that it is expected that the scattering rate does not have a simple correlation with wave amplitude. In this study, we conduct a computer simulation to investigate electron scattering process through chorus-wave particle interactions with the GEMSIS-RBW code. The GEMSIS-RBW simulation calculates variations of local pitch angle and energy of each test particle by the imposed chorus wavesby calculating the Max well equations.

We calculate the trajectory of a number of electrons with various energy and pitch angles. We analyzed the electron motion in the phase space and try to discriminate the motion with the parameter ρ [Bortnick et al., 2008] that is a proxy of the ratio of the wave-induced and the background inhomogeneity effects for the momentum change of the resonant electron. We identified that the phase trapping effect decreases the precipitating flux and contribute to generation of the butterfly type pitch angle distributions. Moreover, we identified diffusion and dislocation contribute to the precipitations into the atmosphere. Multiple resonance changes the ρ of electrons from the phase trapping to dislocation, which causes rapid precipitations of electrons.

Keywords: wave-particle interactions, Computer simulation

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Statistical analyses of low energy ion heating by electromagnetic ion cyclotron waves via wave-particle interaction analyses: Arase observations

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Electromagnetic ion cyclotron (EMIC) waves are generated through the cyclotron wave-particle interaction, affecting the plasma environment in the magnetosphere. Heating of ions by EMIC waves in the inner magnetosphere has been investigated using spacecraft observations by comparing the pitch angle distribution of the ions and the wave emissions. We can directly detect the energy transfer between the plasma waves and the ions via the wave-particle interaction analysis (WPIA) method which calculates the inner product between the wave electric fields and the ion velocities. We adapt the WPIA method to the Arase spacecraft data and investigate the spatial distribution of the positive region in the inner magnetosphere. From March 21st 2017 to September 27th 2019, we select 60 EMIC wave events with associated proton flux enhancement between 10 eV to 100 eV which are a suitable dataset for the WPIA method observed by PWE/EFD, MGF, and LEP-i onboard the Arase satellite. The peak of the proton heating occurrence appears in the dayside and post noon regions. Typical EMIC waves inside the plasma plume contribute to the peak in the afternoon sector in both geomagnetically quiet and active times. On the other hand, in the dayside region, the proton heating takes place predominantly during quiet times. It suggests that the protons in the region are energized by the EMIC waves generated through compression of the ambient magnetic field. We also discuss the species dependence of the ion heating.

Keywords: Wave-particle interaction, Ion heating

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Plasma waves causing 20 Hz intensity modulation of pulsating aurora: High-speed Tjörnes-Arase-Syowa conjugate observation

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We show the evidence of the simultaneously observed ~20 Hz intensity modulation of the auroral luminosity and the chorus wave intensity, and the evolution of pulsating aurora in terms of the transition of on and off of the pulsating patch, patch size, and pulsating period in different timescales. Pulsating auroras were observed by ground-based high-speed imagers after an auroral breakup at Tjörnes in Iceland and at its magnetic conjugate station, Syowa Station in Antarctica simultaneously on 22 September 2018. Two identical all-sky imagers at both stations and a narrow field-of-view imager at Syowa station were used to elucidate the hierarchical structure of the modulation in the auroral luminosity and the evolution of pulsating patches at different time scales. A few minutes before the main pulsation start, a fast intensity modulation of ~20 Hz was identified by the narrow field-of-view imager with ~3 Hz modulation in a small aurora patch. The foot-print of the Arase satellite was located within the all-sky field of view at that time, and the Plasma Wave Experiment onboard the Arase satellite observed chorus emissions whose intensity was modulated at the same period of the auroral fast intensity modulation. The patch size and the pulsation period evolved in time at both hemispheres and the period settled in the period of main pulsation. The pulsating patches differ in its shape and period between both hemispheres although several synchronized patches were also observed when the pulsating aurora drifted away from the all-sky field-of-view.

Keywords: Pulsating aurora, Chorus waves, High-speed observation

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[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-OS Ocean Sciences & Ocean Environment

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.05_1

[A-OS11] Ocean Mixing Frontiers

convener:Toshiyuki Hibiya(Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo)

Ocean mixing plays crucial roles both in the open and coastal ocean, affecting key physical, biological and chemical processes. Mixing in the upper ocean influences the sea surface temperature and hence air-sea interactions which impact global climate change, while mixing in the deep ocean maintains abyssal stratification of the world's oceans and impacts the global overturning circulation. In coastal oceans, mixing modulates the transport and dispersal of dissolved and suspended materials including pollutants and nutrients. Planktonic ecosystems are controlled by nutrient pumping associated with ocean mixing.

In this session, we encourage contributors to present recent findings of ocean mixing obtained through field observations as well as theoretical, numerical, and laboratory studies. Through the related detailed discussions, we would like to confirm how far has our understanding of the ocean mixing processes advanced, defining the new frontier of ocean mixing research to be tackled in the next decade. The session encompasses a wide variety of aspects of coastal and open ocean mixing processes; within the water column from the surface through the interior to the near boundary benthic mixing, including the roles of mixing in the biological processes and productivity of the ocean. Observational, theoretical, and numerical modeling studies are all encouraged.

[AOS11-P01] Sensitivity of the ocean state estimation to the vertical distribution of tidally induced far-field mixing

*Satoshi Osafune[1], Shinya Kouketsu[1], Toshimasa Doi[1], Nozomi Sugiura[1], Shuhei Masuda[1] (1.Japan Agency for Marine-Earth Science and Technology)

[AOS11-P02] Tracer distribution produced by an optimized physical field with an improved vertical mixing

*Toshimasa Doi[1], Shinya Kouketsu[1], Satoshi Osafune[1], Shuhei Masuda[1], Nozomi Sugiura[1] (1.Japan Agency for Marine-Earth Science and Technology)

[AOS11-P03] Lagrangian Dispersion and Mixing in the Open-ocean convection

*Ankit Bhadouriya[1,2], Bishakhdatta Gayen[1,3] (1.The University of Melbourne, Australia, 2.Indian Institute of Technology Kanpur, India, 3.Indian Institute of Science, India)

[AOS11-P04] Assessing the role of deep ocean mixing on carbon and nutrients cycles using an Earth System Model

*Michio Watanabe[1], Akitomo Yamamoto[1], Tomohiro Hajima[1], Hiroaki Tatebe[1] (1.Research Center for Environmental Modeling and Application, Japan Agency for Marine-Earth Science and Technology (JAMSTEC))

[AOS11-P05] Performance of microstructure measurements using a deep float with a fast-response thermistor

*Shuo Zhai[1], Ichiro Yasuda[1] (1.Atmosphere and Ocean Research Institute, The University of Tokyo)

[AOS11-P06] Seasonal variations in salinity of the North Pacific Intermediate Water and vertical mixing intensity over the Okinawa Trough

*Hirohiko Nakamura[1], Ryuichiro Inoue[2], Ayako Nishina[1], Toshiya NAKANO[3] (1.Kagoshima University, Faculy of Fisheries, 2.Japan Agency for Marine-Earth Science and Technology, 3.Nagasaki Meteorological Office)

[AOS11-P07] **Elevated nutrient supply caused by the approaching Kuroshio to the southern coast of Japan**

*Gloria Silvana Duran Gomez[1], Takeyoshi Nagai[2] (1.Graduate School of Tokyo University of Marine Science and Technology, 2.Tokyo University of Marine Science and Technology)

[AOS11-P08] Direct estimates of turbulent mixing in the Indonesian Archipelago and its role in the transformation of the ITF waters

*Taira Nagai[1], Toshiyuki Hibiya[1] (1.Graduate School of Science, The University of Tokyo)

[AOS11-P09] **Double diffusion in the Arabian Sea during winter and spring**

*Ashin Kuriakose[1,2], Girishkumar M S -[1], Jofia Joseph -[1], Eric D'Asaro -[3], Sureshkumar N -[1], Sherin V R -[1], Murali B -[1], Thangaprakash V P -[1], E Pattabhi Ram Rao[1], S. S. C. Shenoi (1.Indian National Centre for Ocean Information Services, 2.School of Ocean Science and Technology, Kerala University of Fisheries and Ocean Studies, 3.Applied Physics Laboratory and School of Oceanography, University of Washington, Seattle, Washington, USA)

[AOS11-P10] On widespread intensified thermocline turbulence in the seasonally stratified Yellow Sea

*Wei Yang[1] (1.Tianjin University)

[AOS11-P11] Observation of energy transfer from traveling typhoons to turbulent mixing in the ocean

*Aiqi Zhang[1], Ichiro Yasuda[1], Daigo Yanagimoto[1], Shinzou Fujio[1], Yusuke Sasaki[1] (1.the University of Tokyo)

[AOS11-P12] Can tidal forcing alone generate a GM-like internal wave spectrum?

*Zhiwu Chen[1], Shaomin Chen[1], Zhiyu Liu[2], Jiexin Xu[1], Jieshuo Xie[1], Yinghui He[1], Shuqun Cai[1] (1.South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2.Department of Physical Oceanography, College of Ocean and Earth Sciences, Xiamen University)

Sensitivity of the ocean state estimation to the vertical distribution of tidally induced far-field mixing

*Satoshi Osafune[1], Shinya Kouketsu[1], Toshimasa Doi[1], Nozomi Sugiura[1], Shuhei Masuda[1]

1. Japan Agency for Marine-Earth Science and Technology

Vertical mixing plays an important role in determining the large-scale ocean circulation including the meridional overturning and the distribution of water properties. The breaking of internal tide is a major source of interior vertical mixing below the surface mixed layer. Recent numerical studies have shown the importance of incorporating tidally induced far-field mixing in addition to the near-field mixing. In our previous study under the OMIX project, we conducted a linear optimization experiment to reproduce the climatological distribution of water properties with an ocean general circulation model using tidally induced near- and far-field mixing schemes with an assumption that diffusivity is vertically constant for far-field mixing. The optimized model performed reasonably well in reproducing the deep-water properties of the Pacific Ocean. However, the reproducibility of water mass distribution is degraded in some places, especially in the sub-surface-intermediate layers, when compared with the optimized state in the earlier version of our model using semi-empirical interior mixing schemes. This shortcoming may be overcome by improving model interior mixing. Our new model uses the far-field mixing scheme only related to the wave-wave interactions, but the far-field mixing is caused through various mechanisms, on which the vertical structure of diffusivity depends. In this study, we conducted numerical experiments using our new model but with different vertical distribution function for the far-field mixing on the basis of a previous semi-empirical scheme. We show the incorporation of a vertical structure into the far-field mixing representation can possibly resolve the upper layer issues in our state estimation. It can be a clue to uncover nature of vertical mixing in the real ocean. We will discuss the effectiveness of the proposed implementation in our experiments, referring the recent vertical mixing schemes suggested in the theoretical studies.

Keywords: tide, vertical mixing, thermohaline circulation

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Tracer distribution produced by an optimized physical field with an improved vertical mixing

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1. Japan Agency for Marine-Earth Science and Technology

Revealing the global oceanic tracer distribution is vital for climate research. To investigate how the circulation reproduced with the spatial changes in vertical mixing affects the biogeochemical cycles, in this study, the numerical experiment of advection/diffusion for chlorofluorocarbon (CFC) was conducted. An effect of spatial changes in vertical mixing was considered to an ocean general circulation model with near- and far-field vertical mixing schemes. The improved model was optimized with a four-dimensional variational data assimilation system, so that the temperature and salinity fields were consistent to a certain extent with the observations. It is known that the CFC is one of the anthropogenic substances, has no sink in the interior of the ocean, and the diffusion strongly influence on the transient behavior of CFC after being absorbed from the sea surface into the ocean. The time series of atmospheric CFCs concentration were given as the boundary condition of the model, and we show that transports by advection and diffusion of the absorbed CFCs in the ocean were calculated on the reanalysis circulation. Furthermore, we will discuss the effects of the spatial changes in the vertical field by comparing the result with the one with different vertical mixing schemes.

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Lagrangian Dispersion and Mixing in the Open-ocean convection

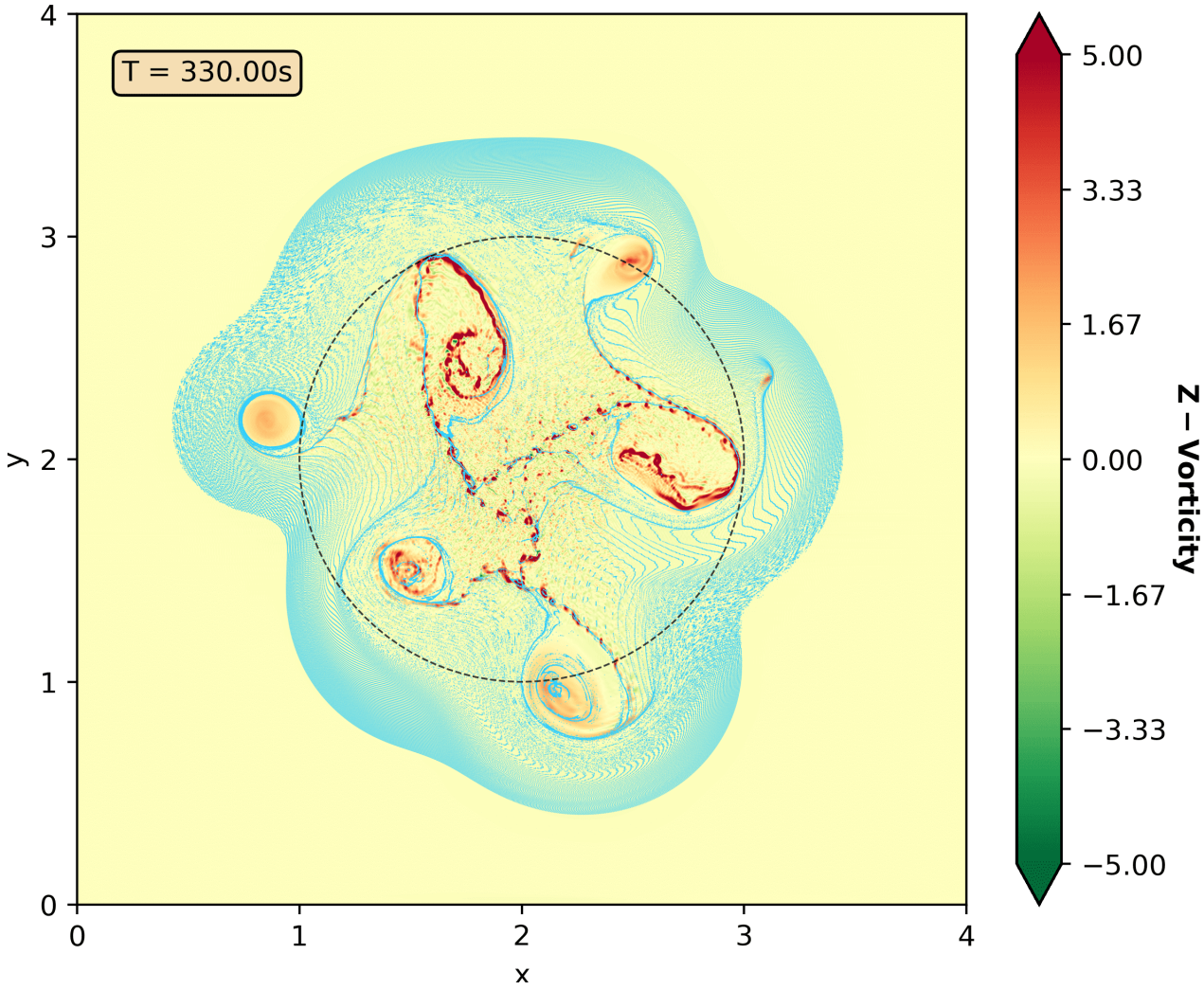
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1. The University of Melbourne, Australia, 2. Indian Institute of Technology Kanpur, India, 3. Indian Institute of Science, India

Open ocean convection (OOC) connects the surface ocean to the abyssal in high latitude regions, regulating heat, global marine biological activity, and carbon uptake. It creates destabilizing stratification by intense heat loss to the atmosphere, which results in turbulent convection and the mixing of surface water to greater depths. Large amounts of organic matter, including particulate and dissolved carbon, are often injected into the deep ocean by sinking dense water through convection. Therefore, convection has a significant pathway for the export of organic matter and fields of passive chemical tracers. However, the importance of the deep convection phenomenon on biogenic particle transport remains uncertain. Ocean climate models are limited to resolve all the spatial and temporal scales generated within the mixed layer during the development of convective plumes, which necessitated a study of OOC through turbulence resolving simulations. The dispersion and mixing of particles during convection events is thus required to assess the accumulation, mixing, redistribution of it and, in general, to understand better particulate or biogeological cycling. A three-dimensional velocity field computed from well-resolved DNS is used to make trajectory analysis of Lagrangian particles. This work aims to evaluate the dispersion and mixing of tracer and dynamic properties associated with Lagrangian particles to assess the transport and mixing mechanism.

Keywords: Deep convection, Lagrangian particles, Dispersion, Mixed layer

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Assessing the role of deep ocean mixing on carbon and nutrients cycles using an Earth System Model

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Earth System Models (ESMs) that incorporate biogeochemical processes into General Circulation Models (GCMs) have been developed to project future climate. In the Earth system, the ocean redistributes heat, anthropogenic carbon dioxide absorbed from the atmosphere, and nutrients that control primary production, and the meridional circulation in the ocean plays a major role in this redistribution. The pattern and strength of this circulation is strongly controlled by microscale turbulent mixing due to tide-induced internal wave breaking in the deep ocean. However, the distribution of the intensity of deep-ocean mixing is not clear, and the effects of deep-ocean mixing on the global carbon and nutrient cycles have not been well discussed. In this study, two implementations of deep ocean mixing were used to execute an ESM under pre-industrial forcing and under increasing atmospheric CO2 concentration by 1% per year. The results will be discussed in terms of how the distribution of the intensity of deep ocean mixing affects the distribution of carbon and nutrients in the ocean.

Keywords: Deep ocean mixing, Earth System Model, Carbon cycle, Nutrient cycle

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Performance of microstructure measurements using a deep float with a fast-response thermistor

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Turbulence measurements are required to quantify diapycnal flux of heat and substances which controls general ocean circulation, nutrients supply and marine ecosystem. Whereas, since turbulence measurements are still scarce especially in the deep ocean or near the bottom, autonomous microstructure observations are strongly desired. In the present study, as a step to realize autonomous microstructure observations using profiling deep floats, vibration impacts by active motors to adjust buoyancy on the fast-response thermistor (FP07) measurements were examined by using field data obtained in the western North Pacific in the vicinity of Japan. Although the FP07 measurements are much less sensitive to instrument vibration than velocity shear measurements, overestimations were evident when the float ascending speed was small and the motor vibration was active for acceleration, and those were proportional to and to the magnitude of the instrument acceleration. These are explained by the vibrational noise generated by high-frequency motion of the instrument, and the noise was amplified in the slow speed as a function of . By subtracting the vibrational noise estimated from the measured acceleration, corrected turbulence data in abyssal ocean or near ocean bottom can be obtained. The present study is the first study which discusses the impact of vibration on the turbulence estimation using FP07, and contributes to improving deep ocean turbulence measurements by proposing the effective methods which can be applied to Argo floats, gliders, CTDs and moorings.

Keywords: turbulence, deep float

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Seasonal variations in salinity of the North Pacific Intermediate Water and vertical mixing intensity over the Okinawa Trough

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Seasonal variations in vertical mixing intensity in the intermediate layer of the northern Okinawa Trough were deduced using the seasonal variations in salinity in the North Pacific Intermediate Water (NPIW) using two distinct datasets: the World Ocean Atlas 2013 and historical conductivity, temperature, and depth data in the Okinawa Trough. Water mass analysis of the NPIW with a simple advection model showed that the vertical mixing intensity in the intermediate layer is enhanced in the winter at a rate of 20%–50% of the annual mean amplitude value. To determine the driving force behind the seasonal variations in vertical mixing, we examined moored current-meter data in the northern Okinawa Trough during 2004–2011 and showed that the near-inertial internal wave energy in the intermediate layer was enhanced around January beneath the Kuroshio on the continental slope; this was due to strong southwestward flows associated with deep cyclonic eddies developing in the winter. We used density and velocity data from a realistic high-resolution ocean general circulation model simulation to hypothesize that the large-amplitude Kuroshio meander and associated deep cyclonic eddies in the winter generate near-inertial internal waves through centrifugal/inertial instability in the area of negative potential vorticity that appears not only beneath the Kuroshio near the western slope but also near the eastern slope of the trough. In addition, the symmetric instability along the offshore Kuroshio front and the wind energy input in the winter are suggested as possible sources of winter-enhanced near-inertial internal wave energy in the intermediate layer.

Keywords: Seasonal variation, Vertical mixing, North Pacific Intermediate Water, Kuroshio, Near-inertial internal wave

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Elevated nutrient supply caused by the approaching Kuroshio to the southern coast of Japan

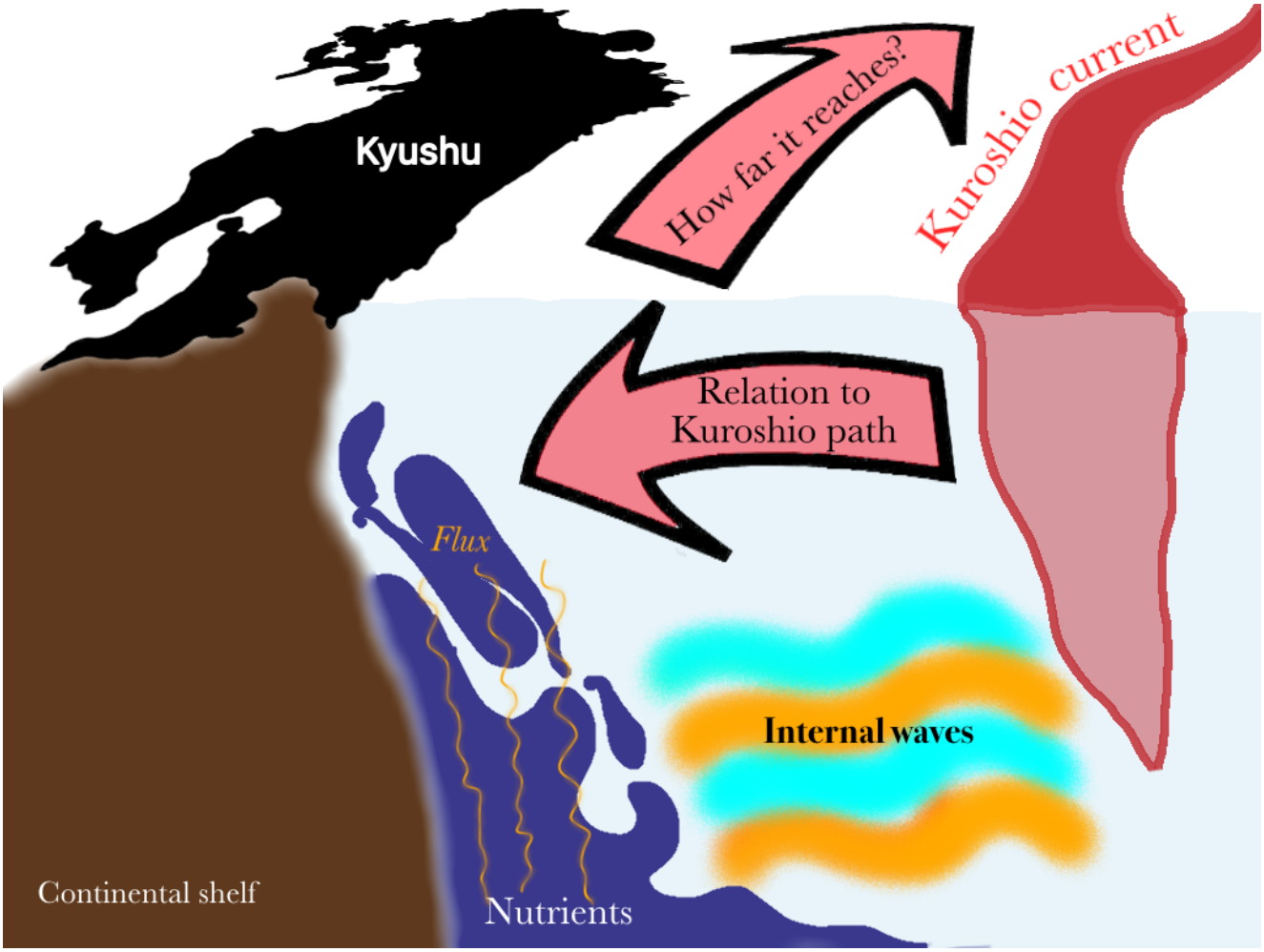
*Gloria Silvana Duran Gomez[1], Takeyoshi Nagai[2]

1. Graduate School of Tokyo University of Marine Science and Technology, 2. Tokyo University of Marine Science and Technology

Although the Kuroshio Current has been known for being nutrient poor in its upper layers, it supports a great fishery industry in Japan due to the great biodiversity it presents. Previous studies reported that the Kuroshio carries a large amount of nutrients in dark subsurface layers, but the mechanisms of how these nutrients from dark subsurface layers are brought to the sunlit layers are still unclear. In a previous observational study by the authors, it is showed that the Kuroshio flowing on the continental shelf can induce very strong turbulent dissipation rates O(10^{-7} W kg^{-1}) associated with trapped near-inertial internal waves in this region, leading to the generation of a large diffusive nitrate flux of >O(1 mmol N m^{-2} day^{-1}). Nevertheless, since this previous study was conducted for just one transect survey, questions remain of how long this enhanced turbulent diffusive nitrate flux extends further to the downstream and how the Kuroshio path modulations can influence on this nutrient injection.
In this study, using a high-resolution nested simulation coupled with a N_2PZD_2 ecosystem model, observed features were reproduced, showing that when the model Kuroshio flows closer to the coast, it hits the small bump in the upstream region of the Hyuganada Sea producing negative potential vorticity. At the same time, it is observed that near-inertial internal waves are trapped in the streak of lowered lowest internal wave frequencies, producing the strong turbulence and vertical mixing. As a result, the elevated mixing diffuses up the nitrate from dark subsurface layers to sunlit shallow layers. The results of this study can improve our understanding of the role of the Kuroshio in providing nutrients and enhancing biological productions including fish abundances, providing a better predicting of the ecosystem responses to the Kuroshio path modulations.

Keywords: Nutrient injection, Hyuganada Sea

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Direct estimates of turbulent mixing in the Indonesian Archipelago and its role in the transformation of the ITF waters

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Turbulent mixing enhanced in the Indonesian Archipelago (IA) is thought to influence the coupled ocean-climate system through sea surface temperature cooling and water-mass transformation. The present study describes the first extensive microstructure measurements conducted in the IA in 2019. A total of 120 profiles of turbulent energy dissipation rates showed that strong turbulent mixing was extremely localized in a few narrow tidal straits, where large density overturns and high vertical diffusivity associated with downslope jets were found. Far away from mixing hotspots, in contrast, observed vertical diffusivities were similar to typical open ocean values. Microstructure measurements together with a high-resolution numerical simulation suggest that significant water-mass transformation occurred within very short distances, O(10 km), in these narrow tidal straits through not only vertical mixing but also horizontal mixing enhanced by submesoscale topographic eddies.

Keywords: Direct microstructure measurements, Indonesian Archipelago, Water-mass transformation

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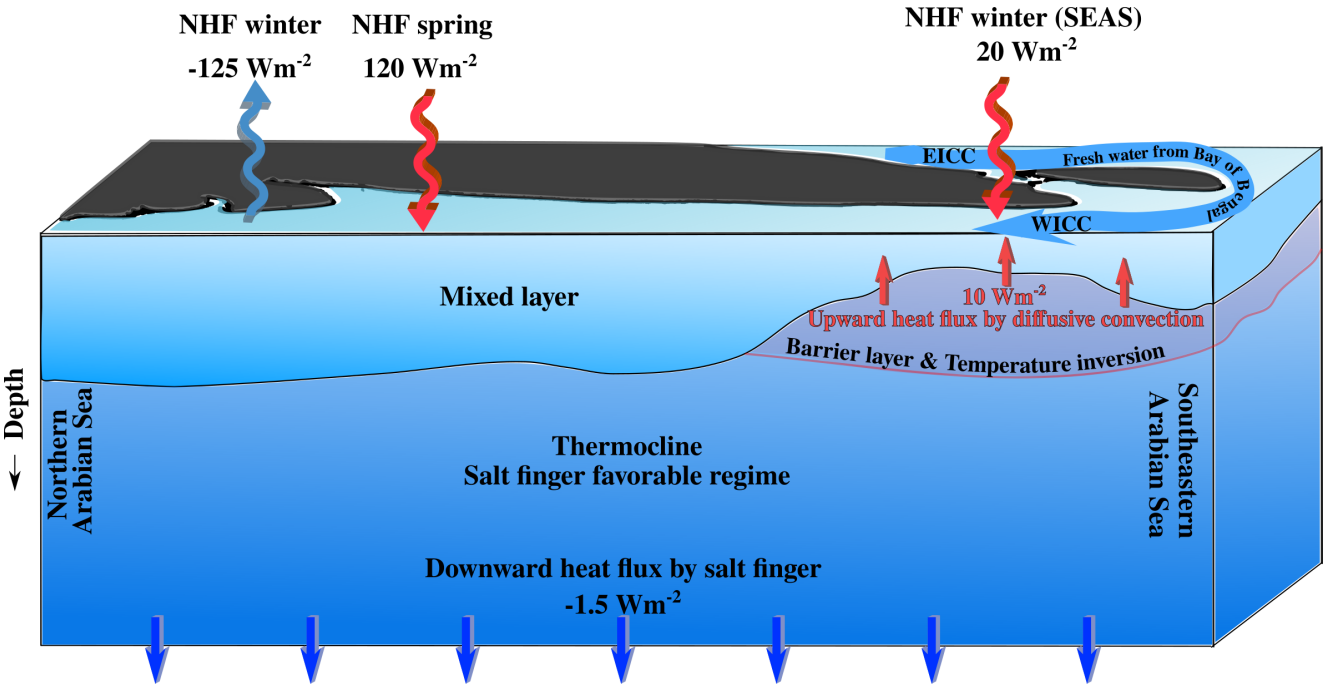
Double diffusion in the Arabian Sea during winter and spring

*Ashin Kuriakose[1,2], Girishkumar M S -[1], Jofia Joseph -[1], Eric D'Asaro -[3], Sureshkumar N -[1], Sherin V R -[1], Murali B -[1], Thangaprakash V P -[1], E Pattabhi Ram Rao[1], S. S. C. Shenoi

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Microstructure measurements from two cruises during winter and spring 2019 documented the importance of double diffusion processes for small-scale mixing in the upper 400 m of the open ocean region of the eastern Arabian Sea (EAS). The data indicated that shear-driven mixing rates are weak, contributing diapycnal diffusivity (K_ρ) of not more than 5.2×10^{-6} m^2 s^{-1} in the EAS. Instead, signatures of double diffusion were strong, with the stratification favorable for salt fingers in 70% of the region and favorable for diffusive convection in 2-3% of the region. Well-defined thermohaline staircases were present in all the profiles in these regions that occupied 20% of the water column. Stratification favorable for strong diffusive convection occurred in ~ 45% of data in the barrier layer region of the south EAS (SEAS). The mean dissipation ratio ($\gamma_{\chi\varepsilon}$) in the salt fingering (0.8) and diffusive convection (19-39) regimes were much higher than the expected turbulence mixing efficiency (γ_{Rf}=0.2), again suggesting the importance of double-diffusive processes here. Validation of different parameterizations of double diffusion with the measurements of vertical heat diffusivity (K_T) found that the Radko and Smith (2012) salt fingering scheme and the Kelley (1984) diffusive convection scheme showed the best agreement with observations. The downward heat flux associated with salt fingering in the thermocline region of the EAS of approximately -1.5 Wm^{-2} and upward heat flux due to diffusive convection in the barrier layer region of the SEAS of ~10 Wm^{-2} combine to cool the thermocline.

Keywords: Double Diffusion in the Arabian Sea, Heat flux due to Double diffusion



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On widespread intensified thermocline turbulence in the seasonally stratified Yellow Sea

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Thermocline turbulent mixing lies at the heart of shelf sea systems, regulating the vertical exchange of momentum, mass, and biogeochemical constituents. Based on microstructure measurements conducted in the summer of 2013 and 2017, here we show for the first time that there is widespread intensified thermocline turbulence in the summer stratified Yellow Sea. Shipboard velocity measurements demonstrate that the wind-induced near-inertial waves have driven prevailing strong velocity shear across the thermocline. However, analysis shows that the shear is not always large enough to excite shear instability according to the Richardson number criterion (Ri < 1/4). Strikingly, we show that the elevated thermocline turbulent kinetic energy dissipation rates ε O(10^{-7} Wkg^{-1}) and microscale thermal dissipation rates χ O(10^{-6} K^2s^{-1}) are more related to the presence of low-salinity water layers (5 –15 m thick) adjacent to the main thermocline at isopycnals 24 –25 kgm^{-3}. Turner angle (Tu) analysis demonstrates the presence of salt-finger favorable conditions (Tu > 45˚) at the upper boundary of the intrusion. High values of ε and χ tend to occur in the salt-finger favorable layers suggesting the occurrence of double-diffusive convective instability. These results have important implications for nutrients cycling and the maintenance of primary productivity in seasonally stratified shelf seas.

Keywords: Thermocline turbulence, Salt fingers, Low-salinity water intrusion, Near-inertial waves, The Yellow Sea

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Observation of energy transfer from traveling typhoons to turbulent mixing in the ocean

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1. the University of Tokyo

Double-inertial internal waves are supposed to play an important role in transferring wind-induced energy from the surface layer to the deep ocean, thus sustaining the Meridional Overturning Circulation (MOC). However, the influence of double-inertial internal waves on the MOC is not fully understood due to the scarcity of observational data.

During the R/V Shinsei-maru cruise (KS-20-11) from August 4 through August 13, 2020, two typhoons passed the observation areas (in the Oyashio region) coincidentally, and the measurement of the oceanic response was carried out. Both near-inertial and double-inertial internal waves were detected with the moored ADCP. The vertical distribution of kinetic energy indicates that the internal waves at the surface are strengthened by the typhoons, and gradually propagate downward. The frequency spectra of kinetic energy suggests that double-inertial energy is enhanced down to ~600 m within the depth limitation of ADCP. Furthermore, we analyze wind energy input to each mode of internal waves, in order to examine the energy transfer process. Among them, much energy is fed into high-vertical-mode near-inertial waves below the mixed layer. The result suggests that traveling typhoons may contribute to turbulent mixing in the ocean interior through a nonlinear wave-wave interaction.

Keywords: near-inertial internal wave, double-inertial internal wave, typhoon, turbulent mixing

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Can tidal forcing alone generate a GM-like internal wave spectrum?

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1. South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2. Department of Physical Oceanography, College of Ocean and Earth Sciences, Xiamen University

An idealized two-dimensional numerical model is utilized to study internal wave generation by tide-topography interaction and wind forcing. Previous studies suggest that the quasi-universal Garrett-Munk (GM) internal wave spectrum can be generated and maintained only when energy is supplied from both the wind and the tides, while the present study shows that M_2 tidal forcing alone is sufficient to generate a GM-like spectrum in a latitude band roughly between 17° and 29°, with the steepness parameter $\varepsilon > 1$, $N_0 h_0 / u_0 > 1$ (N_0 is buoyancy frequency, h_0 topographic height, and u_0 tidal amplitude), and a finite excursion parameter. The key lies in the generation of near-inertial waves (NIWs) by breaking internal tides and triadic resonant interactions around supercritical topography. Remarkably, in the northern South China Sea, tidal forcing can contribute a comparable amount of near-inertial energy as that contributed by the summer wind and thus is an important NIW generation mechanism.

Keywords: Internal waves, Garrett-Munk spectrum, Near-inertial waves, Parametruc Subharmonic Instability

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[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-OS Ocean Sciences & Ocean Environment

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.05_2

[A-OS12] Physical, biogeochemical, and ecological processes and variability in the Indian Ocean

convener:Yukio Masumoto(Graduate School of Science, The University of Tokyo), Hiroaki Saito(Atmosphere and Ocean Research Institute, The University of Tokyo)

The Indian Ocean has been recognized to play important roles in regional and global climate systems, material circulations, ecosystems, and their variability, with linked biophysical phenomena that span a wide range of spatial and temporal scales. These phenomena include, for example, diurnal cycling, intraseasonal disturbances, seasonal variations, Indian Ocean dipole events, and decadal to multi-decadal variations as well as secular trends under the global warming stress. In situ and remotely-sensed physical and biogeochemical observations using the Indian Ocean Observing System (IndOOS) and other means are now accumulating high quality data, and research efforts with numerical models and analyses of comprehensive datasets are also being conducted under International Indian Ocean Expedition-2 (IIOE-2) and the Eastern/Western Indian Ocean Upwelling Research Initiative (EIOURI/WIOURI). To advance our understanding of such Indian Ocean phenomena, disciplinary studies are essential, as are interdisciplinary investigations that elucidate the linkages between the physical and biogeochemical/ecological researches realms.
The objective of this session is to share our knowledge on, and to advance our understanding of, all facets of Indian Ocean variability. We invite papers on physical, biogeochemical and ecological aspects of the variability, as well as those related to atmosphere-ocean interactions, over the full spectrum of temporal and spatial scales. Discussions to facilitate mutual interactions among different research communities would also be expected and encouraged.

[AOS12-P01] **Nitrogen cycling in the primary nitrite maximum of the Indian Ocean**

*Shigenobu Takeda[1], Kunioki Hirata[1], Takuhei Shiozaki[2] (1.Nagasaki University, 2.The University of Tokyo)

[AOS12-P02] Coastal ecosystem study in the Indian Ocean and adjacent seas under international collaboration

*Hiroaki Saito[1], Yukio Masumoto[2], Zainal Arifin[3] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Graduate School of Science, The University of Tokyo, 3.Research Centre for Oceanograph, Indonesian Institute of Sciences)

[AOS12-P03] Issues and future directions of the Indian Ocean researches

*Yukio Masumoto[1] (1.Graduate School of Science, The University of Tokyo)

Nitrogen cycling in the primary nitrite maximum of the Indian Ocean

*Shigenobu Takeda[1], Kunioki Hirata[1], Takuhei Shiozaki[2]

1. Nagasaki University, 2. The University of Tokyo

The mechanisms that maintains a peak in nitrite concentrations at the bottom of the euphotic zone (primary nitrite maximum, PNM) remains unclear, despite data supporting either microbial nitrification or phytoplankton release of nitrite. In this study, based on field observations and on board incubation experiments conducted at three stations in the Bay of Bengal (BB), Equatorial Region (ER), and Subtropical South Indian Ocean (SI) along 88 degree E in the Indian Ocean, we tested the hypothesis that iron limitation stimulates the release of nitrite from phytoplankton cells into ambient water near the subsurface chlorophyll maximum (SCM) by inhibiting the nitrite metabolic pathway.
In BB, the PNM layer was shallower than 1% light depth and appeared near the bottom of the subsurface chlorophyll maximum. In contrast, in ER and SI, the PNM layer was deeper than 1% light depth and was formed between the subsurface chlorophyll maximum and the upper part of the nitracline. Ammonia oxidation rates measured under dark conditions increased with depth within the euphotic layer in BB. However, in ER and SI, it was not detected within the euphotic layer and increased from layers deeper than 1% light depth. Among the ammonia-oxidizing archaea, Shallow Marine Clade (SMC) appeared in all subsurface layers and showed a tendency to increase in abundance with depth, while Deep Marine Clade (DMC) was detected only in layers deeper than around 1% light depth. The SMC accounted for more than 95% of the ammonia-oxidizing archaeal community detected near the PNM layer, suggesting a relationship with nitrite accumulation. The effects of Fe and light on the plankton community near the PNM suggested that a lack of light or iron in BB, a lack of light in ER, and a lack of both Fe and light in SI may be responsible for the release of nitrite. The changes in nitrite concentration during the incubation experiments indicated that the regulation of ammonia oxidation by light and nitrite oxidation by iron in ER. Based on these results, it is clear that the effects of light intensity and Fe availability on microbial nitrification and phytoplankton nitrogen metabolism near the PNM are different in the northern and southern Indian Ocean.

Keywords: Trace metal, Nitrogen cycle, Indian Ocean, Nitrite, Iron

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Coastal ecosystem study in the Indian Ocean and adjacent seas under international collaboration

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Coastal ecosystems in the eastern Indian Ocean and its adjacent seas are in the center of coral triangle, the hot spot of marine diversity. The society in this region receives various ecosystem services, such as food supply, water quality regulation, cultural and spiritual services. The region is also the center of changing ocean influenced by anthropogenic activities. With development of industry and increase in population, demands on ecosystem services are increasing. The users of marine ecosystem, or stakeholders, are increasing which makes it difficult to build consensus for wise and sustainable use of marine ecosystems. Since scientific knowledge forms the basis for consensus building between different stakeholders, scientists are expected from society to prepare the best scientific knowledge on the structure and dynamics of marine ecosystems in appropriate timing. The scientific issues are, however, too big to solve by one country, and need international collaboration with exchanging scientists and transfer of marine science technology. Recognizing the situation, the United Nation declared the Decade of Ocean Science for Sustainable Development (2021-2030). It is also pointed out that the importance of international collaboration since the marine ecosystems are connected each other and counter measures to prevent the destruction of marine ecosystems is to be driven under international collaboration scheme even each EEZ is under the control of national jurisdiction. In the presentation, we will discuss what issues are emerged in the coastal ecosystems in the eastern Indian Oceans and its adjacent seas and the direction of international collaboration as well as remaining issue to realize the collaboration.

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Issues and future directions of the Indian Ocean researches

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Based on presentations during the session, current issues and future directions of the Indian Ocean researches will be discussed.

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[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-OS Ocean Sciences & Ocean Environment

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.05_3

[A-OS13] Marine ecosystems and biogeochemical cycles: theory, observation and modeling

convener:Takafumi Hirata(Arctic Research Center, Hokkaido University), Shin-ichi Ito(Atmosphere and Ocean Research Institute, The University of Tokyo), E Eileen Hofmann(Old Dominion University), N Enrique Curchitser(Rutgers University New Brunswick)



The ocean accounts for about 50% of global net primary production. This production is significant for carbon cycling and ecosystem functioning, and is related directly or indirectly to a variety of climatic and ecological phenomena. The responses to natural and anthropogenic environmental stressors that influence marine production and diversity can cause perturbations to marine ecosystems that alter trophic dependencies and interactions among organisms at a range of space and time scales. Quantification of the principal mechanisms driving spatio-temporal variability of marine ecosystem remains to be done, especially in terms of evaluation of uncertainty in responses. As a result, evaluating vulnerability of marine ecosystems to environmental change requires systematic and holistic approaches that integrate physics to ecology and are based in observations and modelling. In addition, expectations to deliver these science to public society is raising. This session aims to provide a venue for not only discussing recent advances in understanding marine biogeochemical cycles, ecosystems and their interactions, but also networking with a variety of people to seed new ideas in marine ecological research. Observational, modeling and conceptual studies, including technological development and operational applications, that consider linkages among biogeochemical and ecosystem processes, biodiversity, and the effects of multiple stressors from molecular to planetary scales are encouraged.

[AOS13-P01] Marine fish distribution in the Kuroshio Extension area observed by OceanDNA

*ZESHU YU[1], Shin-ichi Ito[2], Marty Wong[2], Susumu Yoshizawa[2], Jun Inoue[2], Sachihiko Itoh[2], Susumu Hyodo[2] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, 2. Atmosphere and Ocean Research Institute, The University of Tokyo)

[AOS13-P02] Introducing phytoplankton size structure in an ocean biogeochemical model OECO2

*Wenhui Sun[1], Ryota Shibano[1], Michio Watanabe[2], Sachihiko Itoh[1] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Japan Agency for Marine-Earth Science and Technology)

[AOS13-P03] Origin of dissolved inorganic nitrogen in the Tsushima Strait and its seasonal and interannual variation

*Ryota Shibano[1], Akihiko Morimoto[2], Katsumi Takayama[3], Tetsutaro Takikawa[4], Joji Ishizaka[5], Xinyu Guo[2] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Center for Marine Environmental Studies, Ehime University, 3.Research Institute for Applied Mechanics, Kyushu University, 4.Graduate School of Fisheries and Environmental Sciences, Nagasaki University, 5.Institute for Space-Earth Environmental Research, Nagoya University)

[AOS13-P04] Comparative study on respiration of Japanese anchovy (*Engraulis japonicus*) around Japan II.

*Shin-ichi Ito[1], Chenying Guo[1], Megumi Enomoto[1], Tomoya Aono[1], Michio Yoneda[2], Michiya Matsuyama[3], Takashi Kitagawa[1], Motomitsu Takahashi[2], Taketo Hashioka[4] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Japan Fisheries Research and Education Agency, 3.Kyushu University, 4.Japan Agency for Marine-Earth Science and Technology)

[AOS13-P05] A state-space production model to analyze the impact of stock enhancement on population dynamics: a case study of Japanese flounder in the Seto Inland Sea

*LIN ZHEN[1], Toshihide Kitakado[2], Naoki Suzuki[2], Shin-ichi Ito[1] (1.Atmosphere and Ocean Research Institute, The University of Tokyo, 2.Tokyo University of Marine Science and Technology)

[AOS13-P06] Variability in phytoplankton Chlorophyll-a in the Kuroshio western boundary current: a result from 14-year observation by satellite remote sensing

*Takafumi Hirata[1], Keiko Sato[1], Satoshi Kitaoka (1.Arctic Research Center, Hokkaido University)

Marine fish distribution in the Kuroshio Extension area observed by OceanDNA

*ZESHU YU[1], Shin-ichi Ito[2], Marty Wong[2], Susumu Yoshizawa[2], Jun Inoue[2], Sachihiko Itoh[2], Susumu Hyodo[2]

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Due to huge volume of the ocean and the difficulty of observing in stormy weather, distribution patterns of marine fish species are still underdetermined. In recent years, a new survey technique using environmental DNA (eDNA) in water has been developed and actively conducted. However, the lower density of fish in the open ocean leaves questions about the effectiveness of ‘eDNA survey in the open ocean’ (hereafter OceanDNA). We have three purposes in this research: 1. comparing the fish distribution found by OceanDNA with the net-sampling result, 2. analyzing the difference between OceanDNA data from MiFish and from qPCR method, 3. comparing the OceanDNA data from Niskin bottle and from ship-bottom-intake seawater. During the KS-18-5 cruise by Shinsei-Maru, seawater samples were collected at several stations in the Kuroshio Extension area from different depth using two methods. One is water sampling by Niskin bottles from 5 to 300 m combined with Conductivity Temperature Depth (CTD) instrument, which measured water mass distribution, and by a bucket for 0 m (130 samples). The other is water sampling from intake seawater from the bottom of the ship (15 samples). Water samples were filtered by Sterivex DNA filter (0.45 μm) and the filters were stored at -20 ˚C, then DNA was extracted from filter after the cruise. To analyze the OceanDNA samples, we used the DNA metabarcoding method with universal MiFish primers targeting a hyper-variable region of fish mitochondrial 12S rRNA gene. The PCR results were compared to DNA library to identify the species. 60 marine fish species were identified and in terms of number of species, Myctophidae is the most dominating family that contains 15 species of all 60. The results showed spatial segregating distribution of 15 Myctophidae species, in which 4 groups were segregated by depth and 2 groups were segregated by sampling stations. On the other hand, two potential predator species of Myctophidae were found out from all 60 species, and both showed depth-segregating distribution with Myctophidae. The fish distribution pattern found here, especially the depth-segregating distribution in Myctophidae and in two prey/predator groups were consist with previous studies. We also used qPCR method to analyze the OceanDNA samples to detect 6 small pelagic fish species (*Sardinops melanostictus, Engraulis japonicus, Scomber japonicus, Scomber australasicus, Trachurus japonicus,* and *Cololabis saira*). We first compared the absence/presence of the 6 small pelagic species between MiFish and qPCR methods. When DNA of one species was found by either method, we admitted its existence. Two *Scomber* species and *Sardinops melanostictus* got high existence rate (higher than 40%) while *Engraulis japonicus* and *Cololabis saira* were found in less than 15% samples (*Trachurus japonicus* was found in only one sample). From the Niskin water samples, the positive significant correlations were found between data of qPCR and MiFish analyzing for the existence of two *Scomber* species and *Sardinops melanostictus*, but qPCR got more than three times discover rate compared with MiFish method. Same correlations were not found in data from ship-bottom-intake seawater. However, if pooling data of six species together, the positive significant correlation was found between data of qPCR and MiFish analyzing although qPCR got more discover rate than MiFish method in both two kinds of water. The result suggests that qPCR method we developed is a proper method to observe distribution of the small pelagic species. On the other hand, when looking at qPCR method data, discover rate from Niskin-bottles seawater and from ship-bottom-intake seawater were always similar in highly existed species. But for sparse distributed species *Engraulis japonicus*, it was discovered more from

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ship-bottom-intake seawater rather than from Niskin-bottles seawater. When using MiFish data, the discover rates were often higher from ship-bottom-intake seawater than from Niskin-bottles seawater. The data was limited and the reason why the discover rates differ between the water sampling methods is still unclear. Further comparison is essential to clarify the mechanism in future.

Keywords: environmental DNA, fish distribution, Kuroshio Extension, small pelagics

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Introducing phytoplankton size structure in an ocean biogeochemical model OECO2

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The biodiversity ecosystem functioning (BEF) caused by biodiversity affects the ecosystem services that humans receive, through the enhancement of productivity, stability, resistivity against invasive species, nutrient dynamics, etc. Many previous studies for marine ecosystems suggested that biodiversity generally has positive impacts on the ecosystem functioning. For instance, increasing biodiversity enhances the productivity through selection effects and niche complementarity. The underlying mechanism, however, has yet to be revealed. Recently, trait-based marine ecosystem models are gaining increasing attention due to their ability to explore the ecological and biochemical mechanism of biodiversity, which can take the environmental variability into account and complement spatiotemporal sparseness of field observation. However, development of a trait-based model has mostly been separated from the achievements of classical non-trait-based plankton functional type models, which is widely used in the global scale modeling. Therefore, this study aim at introducing trait factors in the existing non-trait-based marine ecosystem model, and exploring the relationship between phytoplankton diversity and ecosystem functions. The biogeochemical component OECO-v2a for an earth system model MIROC-ES2L is used to do this extension, which is run with the physical environmental field driven by the average external forces during 1981–2000. To represent phytoplankton biodiversity and reduce the number of parameters in the model, we introduce the concept of relative volume and determine physiological parameters, such as the rate of nutrient uptake, using size-based power laws. Based on this BEF model, we will discuss the relationship between phytoplankton diversity and BEF such as primary production and export production in the North Pacific under changing environments.

Keywords: trait-based ecosystem modeling , size scaling, biodiversity ecosystem functioning

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Origin of dissolved inorganic nitrogen in the Tsushima Strait and its seasonal and interannual variation

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Tsushima Strait is shallow and narrow straits connecting the East China Sea and the Japan Sea. Along the coast of Japan in the Japan Sea, a warm and saline water mass is supplied from the East China Sea (ECS) and the Pacific Ocean by the Tsushima Warm Current (TWC). This current transports water, heat, and nutrients from the southern regions to the Japan Sea. TWC is originated the transports from the six sources, the Pacific through the Kuroshio, the Taiwan Strait, the Changjiang and Yellow Rivers, the dust from the atmosphere, and the bottom layer in the East China and Yellow Seas. The transports by TWC have the large variations in the seasons and/or years according to the observations in the Tsushima Strait. To investigate the dynamics in the Tsushima Strait, the estimations on the nutrient cycles in ECS and the Yellow Sea.

We developed a physical and ecosystem coupled model for the East China, Yellow, and Japan Seas to investigate the origin of dissolved inorganic nitrogen (DIN) in the Tsushima Strait. Assuming the potential six sources of DIN in the Tsushima Strait, we calculated the contribution ratio of each source of DIN in the Tsushima Strait using the numerical model. The most dominant source of DIN in the strait was DIN from the Pacific Ocean, with a contribution ratio of 40–50%. The second most dominant source was that from the Taiwan Strait, with 10%. The contribution from the rivers was less than 5%. Although more than 70% of the freshwater discharged from the Changjiang River enters the Japan Sea through the Tsushima Strait, most of the DIN input from the river sinks to the bottom of the ECS. A small portion that is decomposed at the bottom of the sea is transported in subsurface and lower layers to the Tsushima Strait. Interannual variation in DIN concentration was caused by variation in the DIN flux across the continental shelf in the ECS, and the influence of DIN originating from the Changjiang River was small. However, a drastic increase in DIN concentration could possibly occur if the N/P ratio in the Changjiang River were to become much higher than the current ratio.

Keywords: East China Sea, nutrient cycle, river discharge

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Comparative study on respiration of Japanese anchovy (*Engraulis japonicus*) around Japan II.

*Shin-ichi Ito[1], Chenying Guo[1], Megumi Enomoto[1], Tomoya Aono[1], Michio Yoneda[2], Michiya Matsuyama[3], Takashi Kitagawa[1], Motomitsu Takahashi[2], Taketo Hashioka[4]

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Japanese anchovy (*Engraulis japonicus*) is an important species not only as an exploited species but also as prey for variety of predators including marine mammals, tunas, mackerels, flounders, etc. However, the biomass of Japanese anchovy has shown large fluctuation and is one of the main actors of the fish species alternation responding to basin scale climate variabilities. From the stock management views, three sub-populations are defined in Japan: Pacific stock, Tsushima stock (also called the East China Sea stock), and Seto-inland Sea stock. The three sub-population shows difference in weights-at-age and longevity. While the three sub-populations of anchovy share their spawning grounds, the migration route and nursery grounds are divided. In addition, while Seto-inland Sea sub-populations do not show a large migration, Pacific and Tsushima sub-populations make long distance ontogenetic migrations.

All anchovy sub-populations are plankton feeders and mainly conduct filter feeding. Therefore, we hypothesized that different respiration characteristics induce different behaviors and hence growth and migration routes between the anchovy sub-populations. To test the hypothesis, we conducted laboratory respiration experiments using a 5L swimming tunnel. Since anchovy is sensitive and difficult to stabilize by individual, two anchovies were putted in the sealed tank and were measured oxygen consumption rate with various temperatures and velocities. Based on the experiment data, oxygen consumption rate dependencies on temperature, swimming speed, and body weight were determined. In addition, basic oxygen consumption rate at 0 degC temperature without swimming was estimated. Those derived oxygen consumption characteristics showed similar dependency on swimming speed. However, the Pacific-stock showed lower dependency on temperature but higher dependency on body weight compared with those of the Seto-inland Sea stock. The oxygen consumption characteristics of the Pacific-stock were similar to those of Peruvian anchoveta (*Engraulis ringens*) and South African anchovy (*Engraulis capensis*).

Keywords: respiration, migration, Japanese anchovy

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A state-space production model to analyze the impact of stock enhancement on population dynamics: a case study of Japanese flounder in the Seto Inland Sea

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More than 26 billion juveniles of 180 marine species have been released annually into the wild in over 20 countries. Because it is not easy to separate the wild fish and hatchery fish in the natural condition and clarify how released fish influence the biomass of the wild stock, the usefulness of stock enhancement remains unclear (Kitada, 2020). Recapture rate has been adopted as an important index to measure the success of the stock enhancement, and the corresponding cohort models were used to analyze the biomass of the hatchery stock separated by the recapture ratio. Lorenzen (2005) added the density-dependent parameters and depicted the growth of the hatchery cohort more rationally. However, those models require a huge amount of information, and generally, the dimensions and quality of data are not enough in the fishery. Thus, new models should be developed to cope with those situations. We developed state-space production models to answer the question about “Do hatcheries produce extra fish?”, and applied it in the fishery of Japanese flounder *Paralichthys olivaceus* in the Seto Inland Sea to shed some light on the effect of stock enhancement.

First, we developed the state-space production model (SSPM) to elucidate the fishery with stock enhancement. Considering the data with the large process and observation errors in the real fishery might vague the hidden information, maximum likelihood augmented with prior information (Maximum a posterior or MAP) was used in the parameter estimation. Time-trajectories of biomass and catch per unit effort (CPUE) data were simulated to test the reliability of MAP. Then, we used the SSPM to evaluate key parameter values that influence the biomass variation. The biomass increment by the stock enhancement can be extracted from the difference between the estimated current biomass and the hypothesized biomass trajectories without hatchery releasement. Furthermore, we used the Monte Calo Markov chain to calculate the distribution of process error, and projected future biomass under the different fishing pressures.

As a result, although the whole biomass resulting from the stock enhancement in the Seto Inland Sea has been increased until 2005, the extra biomass showed more moderate growth. It suggested the hatchery stock did not contribute to increasing much extra biomass, instead, it tended to “replace” the niche of the wild fish. In the future projections, the biomass increment by the stock enhancement was increased under higher fishing pressure, but the total biomass was reduced simultaneously. Therefore, the balance between the stock enhancement and the exploitation is important.

Keywords: Stock enhancement evaluation, State-space model, Japanese flounder

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Variability in phytoplankton Chlorophyll-a in the Kuroshio western boundary current: a result from 14-year observation by satellite remote sensing

*Takafumi Hirata[1], Keiko Sato[1], Satoshi Kitaoka

1. Arctic Research Center, Hokkaido University

The Kuroshio western boundary current transports thermal energy and water mass from low latitudes to mid-latitudes in the Western Pacific and its water is characterized relatively oligotrophic by low Chlorophyll-a concentration (Chla). In spite of the oligotrophy, spawning and feeding grounds of fish are located along the Kuroshio, resulting in a higher fisheries production in the region. How the oligotrophic environment can support the high fishery production is unclear. To better understand the Kuroshio ecosystem, how a standing stock of primary producer varies and how higher trophic organisms follow it, spatio-temporal variability of Chla in and around the Kuroshio current between 125-140˚E is investigated using 14 years (2006-2020) of monthly satellite remote sensing data. The surface water in the region was classified according to seasonality of Chla, to find out that a dominant mode of seasonality on the Kuroshio is characterized by both spring bloom and winter increase. The spring and winter increases in Chla were approximately 8-month away from each other within a specific year. They showed no correlation with each other, implying that there is no “biological memory” kept from one to the other. Anomalously-High Seasonal Amplitudes (AHSA, defined as a peak Chla value exceeds 2 or 3 times its standard deviation at an observation point of interest) were also found in the Kuroshio, most evidently between Year 2010 and 2012. One-by-one seasonal peak analysis using satellite images showed that the AHSA were found either when the Kuroshio passes through a very high Chla water or when turbulent water patches with high Chla horizontally intrudes into the Kuroshio. The latter implies a possibility of intermittent supply of high Chla into the Kuroshio by local turbulences even at smaller temporal scales not resolved by our satellite data. Time series analysis showed that there is seemingly a periodic interannual variability. We suspect that the seemingly periodic inter-annual oscillation of Chla may result from random turbulences of water mass in local scale in and along the Kuroshio, which implied that the variability may merely reflect a seasonal modulation of Chla rather than an existence of interannual variability caused by a mechanism independent of the seasonal modulation. The estimation of a 14-year trend using two low-pass filtered Chla time series (> 1.5 years variability included, and >7 years variability included) and a regression analysis did not show a statistically significant difference. Thus, there was no significant effect of the interannual variability on the 14-year trend.

Keywords: phytoplankton, chlorophyll, Kuroshio, Remote Sensing

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[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-HW Hydrology & Water Environment

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[A-HW20] Hydrology & Water Environment

convener:Takeshi Hayashi(Faculty of Education and Human Studies, Akita University), Keisuke Fukushi(Institute of Nature & Environmental Technology, Kanazawa University), Koichi Sakakibara(Department of Environmental Sciences, Faculty of Science, Shinshu University), Dai Yamazaki(Institute of Industrial Sciences, The University of Tokyo)

We focus on various issues of water cycle and environment and aim to answer questions of hydrological and earth system sciences; 1) surface, subsurface and their boundary hydrological processes of water cycle, 2) natural and anthropogenic hydrothermal systems, 3) environments issues and studies on a watershed or global scale, 4) water-related issues with ecological, environmental, and geochemical aspects, and 5) other issues in hydrological sciences. We welcome presentations regarding various kinds of approaches and techniques such as field survey, remote sensing, chemical and isotope tracers, numerical simulation, and theoretical analysis. This session is jointly hosted by societies of water-related geoscience (Geochemical Society of Japan, Japanese Association of Groundwater Hydrology, Japanese Association of Hydrological Sciences, and Japan Society of Hydrology and Water Resources), and accepts wide-range research topics related to water cycle and environment described above.

[AHW20-P01] Contribution of understory vegetation to evapotranspiration in a tropical dry forest, Cambodia

*Shin'ichi Iida[1], Takanori Shimizu[1], Koji Tamai[1], Naoki Kabeya[1], Akira Shimizu[1], Eriko Ito[1], Yasuhiro Ohnuki[1], Sophal Chann[2], Delphis F. Levia[3] (1.Forestry and Forest Products Research Institute, Japan, 2.Institute of Forest and Wildlife Research and Development, Cambodia, 3.University of Delaware, USA)

[AHW20-P02] Rainfall partitioning in two Japanese cedar stands with high stand densities as evidence of splash droplet evaporation hypothesis

*Shigeki Murakami[1], Kenzo Kitamura[1] (1.Kyushu Research Center, Forestry and Forest Products Research Institute)

[AHW20-P03] Vegetation response to soil moisture and groundwater in west-central Africa revealed by satellite observations

*Ryotaro Suzuki[1], Atsushi Higuchi[2] (1.Graduate School of Science and Engineering, Chiba University, Japan, 2.Center for Environmental Remote Sensing, Chiba University, Japan)

[AHW20-P04] An Efficient Surrogate Model for Extreme Hydrologic Predictions using Polynomial Chaos-Kriging

Vinh Ngoc Tran[1], *Jongho Kim[1] (1.University of Ulsan)

[AHW20-P05] Hydrological Hindcasts and Parameterizations for Flash Floods Real-Time Forecasting in the Chugoku Region of Japan

*Josko Troselj[1], Han Soo Lee[1] (1.Graduate School of Advanced Science and Engineering, Hiroshima University)

[AHW20-P06] Geochemical signature of trace elements in lake water at Lake Tazawa

*Arata Katamura[1], Daizo Ishiyama[1], Takeshi Hayashi[2], Yasumasa Ogawa[1] (1.Graduate School of International Resource Science, Akita University, 2.Faculty of Education and Human Studies, Akita University)

Contribution of understory vegetation to evapotranspiration in a tropical dry forest, Cambodia

*Shin'ichi Iida[1], Takanori Shimizu[1], Koji Tamai[1], Naoki Kabeya[1], Akira Shimizu[1], Eriko Ito[1], Yasuhiro Ohnuki[1], Sophal Chann[2], Delphis F. Levia[3]

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Tropical dry forests cover about 20% of the global forested area, and their annual amounts of evapotranspiration are equivalent to more than 70% of annual rainfall, suggesting significant enhancements of water-vapor circulation between the land surface and the atmosphere over this land cover type. For example, Kanae et al. (2001) reported a decrease of rainfall around the Indochina peninsula engendered by forest decline. Although previous studies investigated evapotranspirational processes on the Indochina peninsula, Tanaka et al. (2008) pointed out the lack of research on dry deciduous forests. A dense understory vegetation generally covers the ground of dry deciduous forests, however, its contribution to evapotranspirational processes has not been comprehensively estimated. Here, we measured whole ecosystem evapotranspiration (ET_W) and evapotranspiration from the understory vegetation (ET_U) separately, and analyzed the factors controlling the understory contribution to evapotranspiration (ET_U/ET_W).

We measured evapotranspiration components at the dry deciduous forest located in Kratie province, Cambodia. The forest consists of deciduous trees, comprised of *Dipterocarpus tuberculatus*, *Terminalia alata*, *Shorea obtusa* and *Xylia xylocarpa*, and understory vegetation (*Vietnamosasa pusilla*). Both ET_W and ET_U were estimated by the band-pass eddy covariance method, applying the instruments installed above the sparse overstory canopy (leaf area index, LAI = 1.05) and understory vegetation, respectively. The overstory transpiration (TR) was estimated by sap flow technique (Granier, 1985) for all trees within the measurement plot (n=12). Canopy interception loss was calculated as the difference between gross rainfall and the sum of throughfall and stemflow. The period of analysis was from June 2010 to June 2011 (total available days was 354).

The total amount of ET_W was 1064 mm corresponding to 74% of the annual rainfall. This percentage was typically similar with previous reports (e.g., Farrick and Branfireun, 2013). The dry season ET_W (424 mm) was larger than rainfall (353 mm) indicating that this ecosystem uses water resources recharged during the wet season. The understory contribution to evapotranspiration (ET_U/ET_W) was 35%, and we concluded that understory vegetation is one of the most important components of evapotranspiration in this ecosystem. Seasonal changes of ET_U/ET_W were negatively correlated with LAI. We reviewed annual ET_U/ET_W values among the tropics, temperate, subhumid and boreal forests. We found that the annual ET_U/ET_W showed a negative correlation with LAI when LAI < 4. Thus, it is concluded that both seasonality and magnitude of ET_U/ET_W were controlled by LAI. On the other hand, overstory transpiration (TR) estimated by the original calibration coefficient showed high and positive correlation with the difference between ET_W and the sum of ET_U and interception loss, but we found clear underestimations of TR. When we applied recently published sets of calibration coefficients (Fuchs et al., 2017; Ouyang et al., 2018), the

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underestimation was improved. Applications of the coefficients of Ouyang et al. (2018) corrected almost all underestimations. We highly recommend the establishment of new calibration coefficients to evaluate TR precisely at dry deciduous forests in future studies.

This presentation is based on the following open access article: Iida, S., Shimizu, T., Tamai, K., Kabeya, N., Shimizu, A., Ito, E., Ohnuki, Y., Chann, S., Levia, D.F. (2020): Evapotranspiration from the understory of a tropical dry deciduous forest in Cambodia. Agricultural and Forest Meteorology, 295, 108170.

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Keywords: Tropical dry forest, Understory vegetation, Evapotranspiration, Leaf area index

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Rainfall partitioning in two Japanese cedar stands with high stand densities as evidence of splash droplet evaporation hypothesis

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1. Introduction

Rainfall partitioning in two Japanese cedar stands with the stand densities of 5700 trees/ha (the stand A) and 9700 trees/ha (the stand B) was measured, which were the highest densities in measurements of rainfall partitioning in Japanese coniferous plantations (Jeong et al. 2019). Gross rainfall GR, throughfall TF, stemflow SF and canopy interception CI were analyzed. The results were discussed from the viewpoint of splash droplet evaporation hypothesis that claims splash droplets generated by raindrops impacting on the canopy surface evaporate that is a major mechanism of CI (Murakami, 2006).

2. Site and methods

Both stands were 7 years old and located at Kyushu Research Center, Forestry and Forest Products Research Institute, Kumamoto, Japan. Four tipping bucket type flowmeters were used to measure TF and SF of each stand for some 6 months. Data were recorded with an interval of 10 minutes, and analysis was conducted on a rain event basis. Hourly analysis was also made and the results will be shown at the time of the presentation.

3. Results

Total GR during the period was 1405.0 mm. The percentage of CI/GR, TF/GR and SF/GR in the stand A (B) was 18.2% (13.1%), 38.6% (24.7%) and 43.2% (62.2%), respectively. TF/GR and SF/GR in the stand B were, respectively, the smallest and the largest record in Japanese coniferous stands referring to Jeong et al. (2019).

As shown in Fig. 1 CI, TF and SF increase with GR in both stands on a rain event basis. However, in each stand data do not fit with a single linear regression line except for SF of the stand B in Fig. 1c. Instead, there are threshold values, over which data are not placed on the regression line. In Fig. 1a the increment in CI with respect to GR abruptly becomes large for GR > 107.0 mm (162.5 mm) in the stand A (B). Inversely, in Fig. 1b the increment in TF reduces for GR>107.0 mm (37.0 mm) in the stand A (B). In Fig. 1c SF has a single linear relationship with GR in the stand B, but the increment in SF declines for GR>139.5 mm in the stand A.

4. Discussion

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High stand density restricts wider extension of branches because of limited canopy area per tree that forces the tree to grow branches upward with steeper angle. The branches collect rainwater effectively and produce much SF.

There exists a possible mechanism to reduce TF and SF for large rain events that are often accompanied by high rainfall intensity. Bassette and Bussière (2008) pointed out that the steeper the leaf angle was the smaller the production of splash became and that the proportion of splash increased with drop kinetic energy. Similar mechanism can work for branches. Upward branches collect rainwater efficiently like a funnel and generate SF without producing much splash for rainfall with low intensity. TF is also large for low-intensity rainfall because raindrops generate less splash with less splash droplet evaporation on upward branches. Nonetheless, when rainfall intensity becomes high the production rate of splash is boosted that reduces TF (Fig. 1b) and SF (Fig. 1c, the stand A) because of active splash droplet evaporation. As a consequence CI is augmented for heavy rainfall, though we have no idea why the threshold values exist.

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Keywords: Canopy interception, Throughfall, Stemflow, Splash droplet evaporation

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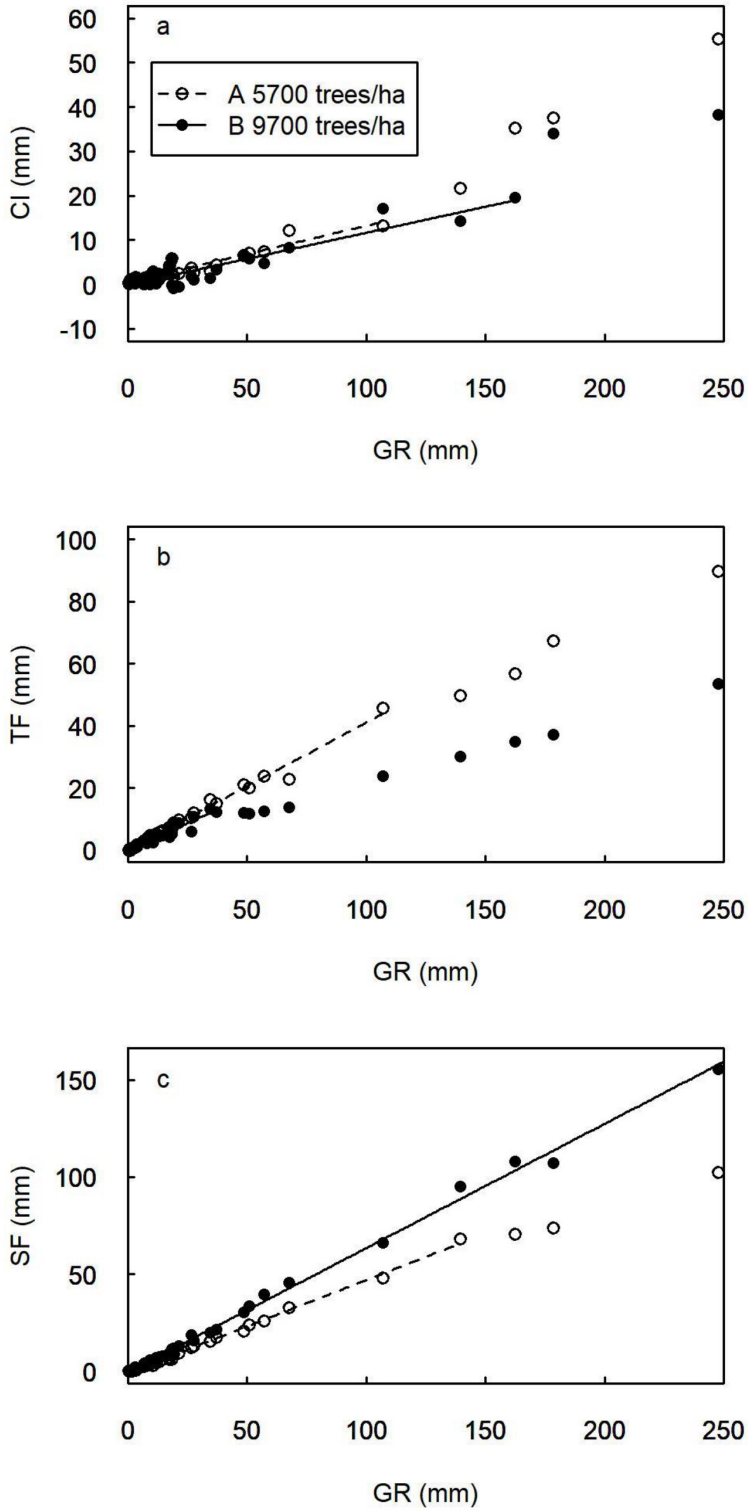


Fig. 1 Relationship between gross rainfall *GR* and (a) canopy interception *CI*, (b) throughfall *TF* and (c) stemflow *SF* on a rain event basis.

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Vegetation response to soil moisture and groundwater in west-central Africa revealed by satellite observations

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Vegetation is always exposed to environmental changes, and vegetation green-up is mainly affected by water in arid lands. Root systems primarily carry out water intake by terrestrial plants. Therefore, it is vital to grasp soil water for the investigation of vegetation responses to water. However, in-situ data are generally limited and spatially sparse. We investigated the relationship between water availability and vegetation growth in west-central Africa, which contains dry regions south of the Sahara Desert and wet regions in the Equatorial region. Used satellite observation data including Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E) Soil Moisture Content (SMC), i.e., reflecting soil moisture in the near-surface layer, and Gravity Recovery and Climate Experiment (GRACE) Terrestrial Water Storage (TWS), i.e., reflecting terrestrial water change.
We performed multiple regression analysis using Leaf Area Index (LAI) as the response variable and considering SMC and TWS as explanatory variables. The relationship between the SMC and LAI is vital in the region covered by annual plants, utilizing only near-surface soil water because of the shallow rooting system. The region’s relationship covered by perennial plants is relatively weak, caused by a more in-depth rooting system. TWS contains soil water that cannot be used by plants because of too deep. Therefore, the relationship between LAI and TWS is weak.
We found that TWS decline during the primary dry season becomes more pronounced toward the equatorial region. Thus, we assessed the relationship between TWS fluctuation and LAI in the preceding dry season. We confirmed the strong negative relationship between LAI and the inclination of TWS change in areas that receive very little rainfall during the considered period, which may be caused by clarifying vegetation activities’ difference by a scant supply of water.
The above findings suggest that it can be possible to investigate the relationship between soil water and vegetation using microwave signatures in the regions covered by annual plants and those in the regions covered by perennial plants by focusing on TWS decline.Following this, it is necessary to consider the water availability and investigate the relationship in the equatorial region and other regions during the rainy season to grasp vegetation’s water stress due to the effects of cloud cover.

Keywords: GRACE, Africa, AMSR-E, satellite observations, LAI

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An Efficient Surrogate Model for Extreme Hydrologic Predictions using Polynomial Chaos-Kriging

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Due to their versatility and high-performance, surrogate models have become an attractive approach that yields the potency to break down the computational barrier of the expensive hydrological models that are often confronted with parameter uncertainties. However, the surrogate models are not qualified for accurately diagnosing extreme events that are not designed in the training data space. This study presents a state-of-the-art surrogate model, i.e., polynomial chaos-kriging (PCK), that enables us to fill the gap above effectively. The effectiveness of PCK was evidenced by comparing it with two well-known surrogate models of polynomial chaos expansion (PCE) and ordinary kriging (OK). Comprehensive analyses demonstrate that: (1) PCK outperforms others in mimicking the original model more precisely with a smaller number of design sites; (2) the extraordinary predictability of PCK is manifest by accurate predictions for extreme flood events with the flood peak about three times higher than those used to train itself, while PCE and OK failed; (3) results of sensitivity analysis verify that characteristics and behaviors of uncertain parameters in PCK are closer to those in the original model compared to PCE and OK; (4) based on a new efficient index that depicts for the robustness of the surrogate models in providing accurate predictions, PCK has shown superiority to both PCE and OK due to its accurate prognosis for extreme events, although all three surrogates speed up to about 500 times than the original model. Overall, our study reinforces a knowledge basis to perform a robust, efficient surrogate model for ensemble predictions of extreme flood events.

Acknowledgment:
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Keywords: Surrogate model, Hydrologic predictions, Extreme floods, Polynomial chaos-kriging, Uncertainty quantification

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Hydrological Hindcasts and Parameterizations for Flash Floods Real-Time Forecasting in the Chugoku Region of Japan

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As a result of climate change, unprecedented heavy rainfall disasters are increasingly occurring worldwide. It is therefore important to develop Early Warning Systems for real-time forecasting of extreme river water levels and discharges. This study applies the Cell Distributed Runoff Model version 3.1.1 (CDRM) hydrological model calibrated by the Shuffled Complex Evolution optimization method developed at the University of Arizona (SCE-UA) for seven first-class river basins in the Chugoku region of Japan, to obtain hydrological parameterizations and hindcasts of river mouth discharge hydrographs during the Heavy Rainfall Event of in July 2018. This study evaluates hypothesis that calibrated river basin parameters from historical extreme rainfall-induced extreme river discharge events can be used to accurately forecast extreme river discharge hydrographs from future events of similar scales by introducing an innovative historical extreme rainfall event classification methodology based on similarities between the events on the way that the classification criterion is meaningful for future real-time forecasting application. Using this approach, this study produced cumulative ensemble mean validation results with very high reproducibility metrics for the two evaluated methods, using 5 and 7 calibrated parameters. This methodology can therefore be used for accurate real-time forecasting of future flash floods caused by extreme rainfall in the region and similarly also worldwide.

Keywords: extreme river discharge, 2018 Japanese flash floods, CDRM hydrological model, SCE-UA optimization method, real-time flood forecasting

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Geochemical signature of trace elements in lake water at Lake Tazawa

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Lake Tazawa is located at the eastern part of Akita Prefecture in Japan. The lake has the maximum depth of 423.4 m and is known as the deepest lake in Japan. Various kinds of fishes including endemic species had lived in the lake. However, an acidic river water of Tama River has been introduced to the lake for electricity and agriculture developments. As a result, numerous kinds of fishes and endemic species were died out because the lake water quality changed to acidic dramatically. The pH of the lake water decreased from 6.7 in 1920s to 4.6 in 1970s (Kato, 1989). Since 1991, a neutralization treatment of the acidic river water was started and the neutralized river water has been introduced to the lake. The pH of the lake surface water was 5.6 in August, 2020 (this study).

To investigate how the lake water quality be able to improve, understanding of details of the lake water quality and mechanism of lake water circulation are essential. Previous studies have pointed out that the lake water quality is homogeneous from shallow to deep parts and the circulation of the lake water occurs in a limited period (Boehrer et al., 2008; Ishiyama et al., 2013). In addition, Chikita et al. (2019) suggested that there are turnovers of the lake water in cold seasons around March. This study aims to clarify the geochemical signature of the lake water in Lake Tazawa from June to November.

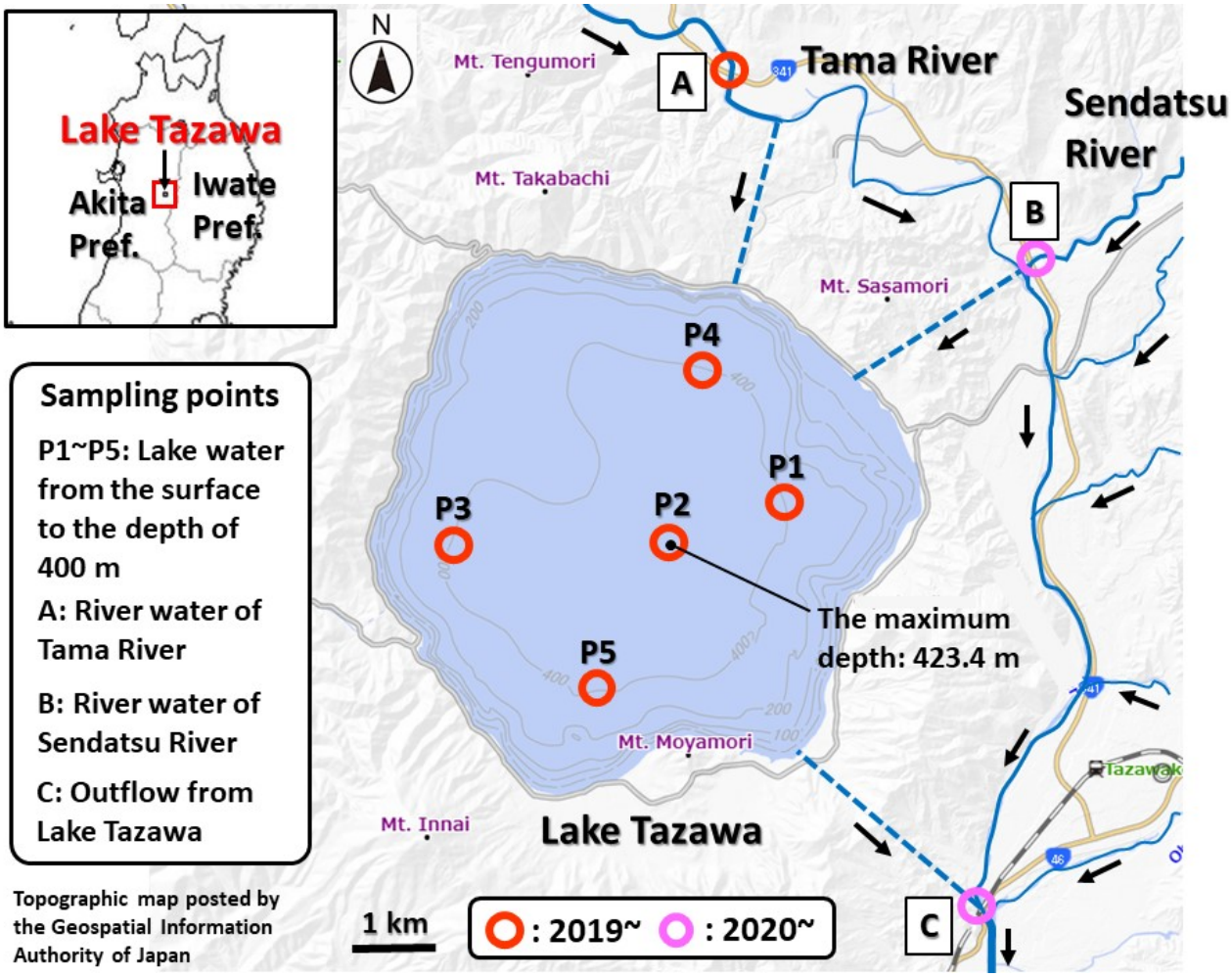
The samplings of the lake water were carried out from June to October in 2019 and from August to November in 2020. The lake water samples were collected from the depths of 400 m to the lake surface at five locations in the lake (P1 to P5 in the map). In addition, the river waters of Tama Rriver (A) and Sendatsu Rriver (B) that inflow into the lake and an outflow of the lake water to Tama River (C) were also collected. Water temperature, pH, Eh, EC, major dissolved ions and trace elements were measured. Trace elements were analyzed separately in dissolved and particulate fractions.

Concentrations of Na, Cl and Al in the lake water increase from the lake surface to the depth of 400 m in August, 2019 (Na: 4.7 ppm (0 m), 4.9 ppm (50 m), 5.1 ppm (400 m); Cl: 17.3 ppm (0 m), 18.8 ppm (50 m), 19.3 ppm (400 m); Total Al: 269 ppb (0 m), 437 ppb (50 m), 522 ppb (400 m)). On the other hand, the concentration of total Fe (T-Fe) in the lake water decreases from 14.5 ppb (0 m) to 8.5 ppb (100 m), then gradually increases to 25.8 ppb (400 m). The ratio of the amount of Al particulate fraction in the total amount of Al is 0.04. While, the ratio of the amount of Fe particulate fraction in the total amount of Fe is 0.42. Therefore, approximately half of Fe is present as particulate fraction in the lake water. There is a possibility that the Fe particulate fraction scavenges other metals by adsorption. Boron-normalized values (N_B), which defined as $N_B=(M/B)_{X(total)} / (M/B)_{Base\ point(total)}$, where $(M/B)_{X(total)}$ and $(M/B)_{Base\ point(total)}$ denote the ratio of total mobile amounts (the sum of dissolved and particulate fractions) of the target elements *M* and B at the certain point (X) and the base point, respectively. The base point is acidic river water of Tama River at the Kawasaki bridge immediately before inflow of the river water to Lake Tazawa (Point A in the map). The N_B of Al of the surface water is 0.6 and the value increases around 0.7 toward the depth of 400 m. While, the N_B of Fe of the surface water is around 0.5 and the value decrease to around 0.2 at the depth of 50 m. Then, the value increases to 0.5 towards at the depth of 400 m. These facts that the surface water has low N_B of Al and Fe between 0.5 and 0.6 suggests that there is a process of dilution of acidic river water of Tama River by the lake water having low Al/B and Fe/B ratios in the lake. In addition,

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N_B of Al and Fe in the lake water from the depth of 50 m to 400 m range from 0.2 to 0.7. This fact suggests that Al and Fe in the lake water from the depth of 50 m to 400 m are precipitated on the lake bed. According to the profiles of chemical compositions of lake sediments (Ishiguro et al., 2017), the concentrations of Al and Fe in the sediments of Lake Tazawa increase from prior to posterior to the introduction of the acidic river water of Tama River. The estimation on Al and Fe based on the N_B is consistent with variations of Al and Fe contents in the sediments of the lake.

Keywords: Lake Tazawa, Water quality, Trace elements, Dilution, Precipitation



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[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-HW Hydrology & Water Environment

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.07_2

[A-HW21] Interdisciplinary approach to support climate change adaptation measures in regional scale

convener:TEBAKARI TAICHI(Toyama Prefectural University), Sompratana Ritphring(Kasetsart University), Masashi Kiguchi(University of Tokyo), weerakaset Suanpaga(Associate professor in Civil Engineering,Kasetsart University)

In Japan, the impact of climate change has already become apparent and may become even more serious in the future. For example, there are the following specific damages; crop damage such as mandarin orange edema and white immature grains of rice, health hazards such as the northward distribution of Aedes albopictus and heat stroke patients, meteorological disasters such as increased torrential rain and increased number of strong typhoons, and coral bleaching Ecosystem.
The climate change adaptation law, which was enacted in 2018, clarified the legal position of adaptation measures in Japan, and is a legal for the national, local governments, businesses and citizens to cooperate and cooperate to promote adaptation measures. Based on this law, the Climate Change Adaptation Information Platform (A-PLAT) was established to develop and provide tools to support information provision and adaptation actions, and to collect, organize and provide best practices. AP-PLAT and T -Overseas development such as -PLAT is also progressing. Overseas expansion such as AP-PLAT and T-PLAT are also progressing.
In each research field, it is necessary to promote effective adaptation measures based on reliable and detailed information, and measures based on scientific knowledge of future impacts and strengthening of adaptation in the region are urgently needed.
This proposed session would like to invite presentations on the latest achievements in interdisciplinary fields such as hydrology, agriculture, forestry, weather, and climate that support specific climate change adaptation measures, as well as on the development of new research.

[AHW21-P01] Attempt to separate factors to reduce locality of precipitation-elevation dependence in Japan

*Mayu Otsuki[1], Atsushi Higuchi[2], Hitoshi Hirose[3] (1.Chiba University, 2.Center for Environmental Remote Sensing Chiba University, 3.Japan Aerospace Exploration Agency)

[AHW21-P02] Prediction process in the seasonal forecast model of monthly precipitation by global climate data using deep learning

*Shingo Zenkoji[1], TEBAKARI TAICHI[1], SAKAKIBARA KAZUTOSHI[1] (1.Toyama Prefecural University)

[AHW21-P03] Regional climate change impacts on groundwater level in the Kurobe River alluvial fan, Japan

*Takuya Matsuura[1], TEBAKARI TAICHI[1] (1.Toyama prefectural University)

[AHW21-P04] Atmosphericfronts of the rainy season in kyushu region using an objective method

*Maki Miyamoto[1], Tomohito Yamada[1] (1.Hokkaido University)

[AHW21-P05] Climate Change Impact on Salt Affected Soil in Northeast Thailand

*KOSHI YOSHIDA[1], Supranee SRITUMBOON[2], Mallika SRISUTHAM[3], KOKI HOMMA[4], MASAYASU MAKI[5], KAZUO OKI[6] (1.The University of Tokyo, 2.Land Development Department, Thailand, 3.Khon Kaen University, Thailand, 4.Tohoku University, 5.Fukushima University, 6.Kyoto University of Advanced Science)

[AHW21-P06] Development of a numerical model to simulate the salinity distribution in the tidal area of the lower Chao Phraya Basin, Thailand

*Ryota Tsuji[1], TAICHI TEBAKARI[1], Keisuke Nakayama[2] (1.Toyama Prefectural University, 2.Kobe University)

Attempt to separate factors to reduce locality of precipitation-elevation dependence in Japan

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1. Chiba University, 2. Center for Environmental Remote Sensing Chiba University, 3. Japan Aerospace Exploration Agency

Japan is located in the northwest of the Pacific Ocean. There is the Sea of Japan between Japan and the Eurasian continent. Japan, which has such geographical characteristics, has a climate different from other regions in the mid-latitude. For example, the annual precipitation amount in the mid-latitude is approximately 800 mm, while 1700 mm in Japan. The orographic effect attributes such regional differences in annual precipitation in precipitation. Forced rise aloft the airmass by the mountain enhances the condensation; thus, the mass of precipitation varies with the elevation. It is well-known as elevation dependence. Previous studies have been conducted on the elevation dependence over various regions, but not many analyze Japan. Therefore, this study analyzed the elevation dependence of precipitation in Japan from 2016 to 2018 using radar AMeDAS analysis rainfall. Hokkaido and Nansei Islands are excluded due to different climatic zone with Japan's mainland. In addition, the areas over 1000 m in elevation are masked to take into account radar-beam shielding. Since the elevation dependence dramatically depends on the precipitation and topographical characteristics of the region, this study aimed to separate the factors that bring regionality to the elevation dependence and evaluate Japan's elevation dependence more universally. At this time, we hypothesized that the factors that cause regional differences in precipitation are "frontal precipitation," "typhoons," and "cold outbreak precipitation in winter." Not only do these precipitation systems bring large amounts of precipitation to some areas, but they also have different elevation dependence. Therefore we separated these factors. After removing these three factors, the regional difference in annual precipitation amount becomes more homogeneous. Its amount is approximately 800 mm, which close to the mid-latitude's value. Seasonal variability in separated precipitation was analyzed. There was a clear regionality in the season when precipitation was brought about.

Keywords: Elevation dependence, Orographic precipitation, Radar AMeDAS, Precipitation, Topography

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Prediction process in the seasonal forecast model of monthly precipitation by global climate data using deep learning

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1. Toyama Prefecural University

Thailand, a country in Southeast Asia, has a clear distinction between the dry season (November-April) and the rainy season (May-October). As a result, many natural disasters such as droughts occur during the dry season and tropical storms and floods occur during the rainy season, and their frequency and intensity are increasing. The GCM model using physical equations is often used as a long-term prediction method for precipitation. However, the prediction by the GCM model is highly uncertain and cannot be quantitatively predicted. The purpose of this study is to develop a lunar precipitation prediction model after 2 months in the upper Chao Phraya River basin, Thailand, from global climate value data using deep learning.

The used data were five types of global monthly average climate values (surface temperature, atmospheric pressure, specific humidity, soil moisture content, precipitation), latitude, longitude, and land mask obtained from JRA55. The study period was 1958 / 1-1988 / 12, the verification period was 1989 / 1-2009 / 12, and the examination period was 2010 / 1-2020 / 9.

In this study, we developed a model for predicting monthly precipitation two months later using the Deep Convolutional Neural Network (DCNN), which is one of the deep learning algorithms. The input data is a total of 4 types of global climate data (surface temperature, pressure, specific humidity, soil moisture) and 3 types of geographic data (Lat, Lon, Land mask) 2 to 9 months before the forecast month. Output data is monthly precipitation after 2 months. For the purpose of reducing the calculation cost and suppressing overfitting, the input data was average pooled using a 3 ×3 window. The DCNN model consists of one convolutional layer and two fully connected layers. In the convolution layer, the global data at each point is compressed into one feature (neuron) by the filter. The hyperparameters of the deep learning method were optimized using Bayesian optimization.

Next, as a result of predicting the monthly precipitation after 2 months under the above-mentioned conditions, the MAE was 41 mm and the RMSE was 53 mm during the test period. When the amount of precipitation by JRA55 was large, the predicted precipitation was underestimated, and when the amount of precipitation by JRA55 was small, the predicted amount of precipitation was overestimated (threshold value of about 300 mm). However, from 2011 to 2016, the fluctuations in the predicted monthly precipitation in June and July showed the same behavior as the fluctuations in the monthly precipitation by JRA55. Therefore, it was suggested that this prediction model has prediction skills. We visualized the first fully connected layer of the developed monthly precipitation prediction model. The positive and negative values of neurons in this layer are related to the occurrence and suppression of precipitation phenomena. Looking at the distribution of the neuron values at each point output from the first fully connected layer of the DCNN model during the test period, the maximum neuron values in the continental regions are a large positive value was confirmed, and a large negative value was confirmed for the minimum neuron value in the waters.

Finally, as a result of developing a monthly precipitation prediction model in the upper reaches of the Chao Phraya River in Thailand from global climate value data using deep learning, the monthly

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precipitation prediction model is difficult to predict quantitatively. It was confirmed that he had predictive skills. By visualizing this precipitation prediction model, it was found that this prediction model has the characteristic that the precipitation phenomenon is caused by the meteorological conditions of the continental area and the precipitation phenomenon is suppressed by the meteorological conditions of the sea area.

Keywords: Seasonal forecast, Deep learning, Monthly precipitation, Climate factor, Thailand

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Regional climate change impacts on groundwater level in the Kurobe River alluvial fan, Japan

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The purpose of this study is to clarify the impact of climate change on the groundwater level in the Kurobe River Alluvial Fan. It has been pointed out that the temperature is on the rise due to climate change, and that the form of precipitation in the future will change from snowfall to rainfall. As a result, water supply from snow cover will decrease and the peak period of river flow will be earlier. Groundwater is also predicted to change its peak groundwater level in the same way as river flow. Increased rainfall is predicted to increase winter recharge and raise the groundwater level. This study evaluates the effects of climate change on the water balance and fan groundwater level in the Kurobe River basin using the RCP8.5 scenario.

The meteorological data used were precipitation, temperature, and solar radiation which used was the NIES statistical downscaled 1 km mesh data provided by the National Institute for Agro-Environmental Sciences. The analysis was conducted for the historical climate (1981-2000) and the end of the 21st century (2081-2100). This study was developing a model that combines a distributed water balance model and a groundwater analysis model (Dtransu), and conducted numerical experiments. The snowfall rate was calculated as 100% for temperatures below 0 ℃ and 0% for temperatures above 4.5 ℃. The snowfall rate between 0 and 4.5 ℃ was approximated by a linear line, and the amount of snowfall and rainfall was calculated by multiplying the amount of precipitation by the snowfall rate. The validity of the model was evaluated based on the river flow rate at the observation points where no water engineering facilities exist in the upstream area, 18 groundwater level stations located in the alluvial fan area, and the groundwater residence time calculated from the tritium analysis results. As a result, the flow rate of the river and the residence time of the groundwater were generally the same and could be reproduced. On the other hand, the groundwater level could not be reproduced at all stations, but the contour map of the groundwater level in the whole alluvial fan area could be reproduced.

As a result of the increase in temperature, it was found that at the end of the 21st century, the amount of snow water equivalent would decrease by 23 % (260 mm) compared to the historical climate, and the snow disappearance period would end one month earlier than the historical. As a result, the water balance of the Kurobe River basin showed that the peak of surface runoff and infiltration in the late 21st century was projected to be one month earlier than historical, and the surface runoff and infiltration increased from November to February. The groundwater level in the alluvial fan area increased during January to March and decreased during May to July. The results suggest that the current water system may not be able to provide sufficient water supply during the cultivation period, because climate change causes a decrease in surface runoff and groundwater level during the cultivation period from May to June.

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Atmosphericfronts of the rainy season in kyushu region using an objective method

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Torrential rainfall disasters induced by baiu fronts, which are stationary fronts appearing from May to July in Japan, occur frequently in kyushu region, western Japan. It is significant for society to examine variation of frontal rainfall associated with climate change. Atmospheric fronts depicted on a surface weather map published from Japan Meteorology Agency are estimated by forecasters[1]. We need to use an objective method for the detection of fronts in order to quantitative analysis.

Weather elements which defines atmospheric fronts are thermodynamical and dynamical variables[2]. The former is primary and used in TFP(Thermal Frontal Paramater)[2], which is common for an objective analysis[1][3]. The latter is secondary variables such as change of wind direction and employed for detection of fronts[4]. Another method using dimensionless number made of both variables is also proposed[5]. No method can detect all atmospheric fronts. We should investigate the feature of objective methods for frontal analysis and adopt an appropriate method.

In this research, we apply the method using thermodynamical and dynamical variables for analysis of atmospheric fronts, F diagnostic, subject to the rainy season in Japan. It is presented that fronts on surface weather chart exist succesively around the kyushu resion for many days in heavy rainfall events. In such a case, there are fronts detected by the objective method more frequently than usual.

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Keywords: atmospheric fronts, surface weather chart, objective analysis

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Climate Change Impact on Salt Affected Soil in Northeast Thailand

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In North East Thailand, annual rainfall is about 1200mm and average rice yield is only 2.1 t/ha (rain-fed). In addition, 50% of total agricultural land in this region are classified as salt affected area. Improvement of salt-affected soils in NE Thailand is a major concern of responsible agency Land Development Department(LDD) and other relevant institutions. Currently, numerous efforts have been carried out for this purpose, but existing knowledge is still insufficient. In future, climate change may cause negative impact on salt-affected soil problems. Therefore, in this study, we conducted the field survey to evaluate the seasonal changes of salt affected soil indicator such as ECe and SAR. Then, Hydrus1D was applied to predict how change the salinity level under climate change condition.
The study area was located in the salt-affected area in Ban Phai District, Khon Kaen Province, Northeast of Thailand. According to the LDD salt affected soil classification, agricultural land was classified into 4 classes including class 1 “very severely” (salt crust >50 %, ECe >16 dS/m), class 2 “severely” (salt crust 10-50%,ECe 8-16 dS/m), class 3 “moderately” (salt crust 1-10%,ECe 4-8 dS/m), and class 4 “slightly” (salt crust < 1%, ECe 2-4 dS/m). In this study, class 2 field was selected and 15 soil samples were collected in every 2 weeks from October 2016 to December 2018. Because farmers still can continue rice cultivation in class 2 field, although any crop can not grow in class 1 fields. To protect the class 2 fields is major concern for sustainable agriculture in this area. The electrical conductivity (ECe), Sodium Adsorption Ratio (SAR), soil moisture content SMC(%w/w), and soil textures were analyzed at Land Development Department Regional Office 5’s laboratory.
To predict the climate change impact, Hydrus1D model was employed in this study. Hydrus-1D is a one-dimensional finite element model for simulating the movement of water, heat, and multiple solutes in variably saturated media. The model is supported by an interactive graphics-based interface for data-preprocessing, discretization of the soil profile, and graphic presentation of the results. The soil parameters were calibrated. Calculated SMC, ECe were good agreement with observed data and SAR also simulated in sufficient. By using this Hydrus1D, future ECe and SAR were calculated by using the global circulation model (MIROC5) outputs of RCP8.5 scenario. Due to the temperature increase of 3 degree Celsius from 2006 to 2100, annual evapotranspiration increased 154 mm in 2100. And both ECe and SAR increased in the rate of 0.02dS/m/year and 0.04/year respectively. For the countermeasure, 20cm reduction of ground water level had significant effect to mitigate the salt accumulation.

Keywords: Soil Environment, Climate Change, Thailand

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Development of a numerical model to simulate the salinity distribution in the tidal area of the lower Chao Phraya Basin, Thailand

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The purpose of this study is to clarify the actual situation of saltwater intrusion in the lower Chao Phraya River in Thailand. In coastal flatlands, sea level rise due to climate change causes an increase in the extent of saltwater intrusion. As a result, there is a risk of tap water intake failure in areas where brackish area in river is used as water intake source.
Thailand has large seasonal variations in river flows due to its tropical monsoon climate. 75% of BMA tap water is taken from Chao Phraya River. The intake plant is located in a brackish area 95.1 km upstream from the river mouth, and is affected by water intake failure when the river flow is low. In this study, a numerical model was developed to estimate the salinity distribution in the lower Chao Phraya River in Thailand.
This study used a three-dimensional environmental hydrodynamic model, Fantom, which is based on a k-ε turbulence model. The structure of the longitudinal section was the riverbed elevation surveyed by the ultrasonic sounding (DT-X). The structure in the cross section was a constant upstream river width. The used data were the flow velocity observed by the acoustic Doppler current profiler(ADCP), the periodical water quality analysis data and the monitoring data of water quality observed by MWA. The boundary condition at the upstream end was the discharge (m^3/s) of Chao Phraya dam, 287.4 km upstream from the river mouth, and the boundary condition for water quality was 0.1 (‰) of the lowest observed salinity. The boundary condition at the downstream end was the water level (m MSL.) at the river mouth and the boundary condition for water quality was 30 (‰) of the average salinity of the Thailand Bay. The meteorological conditions were the hourly wind speed (m/s), temperature (˚C), relative humidity (‰), pressure (Pa), and rainfall (mm) at Bang Na, where a station of the Meteorological Department of Thailand is located.
As the result of the simulation, the peak salinity at the intake plant in the dry season and the fluid mixing near the bottom layer could be modeled. However, the study has not been able to simulate the peak salinity timing and quantitatively.
The numerical model in this study was able to model the qualitative seasonal variation of salinity. In the future, it is necessary to analyze the risk of water intake using the experimental results of climate change.

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[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-CG Complex & General

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.08_1

[A-CG30] Multi-scale ocean-atmosphere interaction in the tropics

convener:Hiroki Tokinaga(Research Institute for Applied Mechanics, Kyushu University), Yu Kosaka(Research Center for Advanced Science and Technology, University of Tokyo), Ayako Seiki(Japan Agency for Marine-Earth Science and Technology), Tomoki Tozuka(Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo)

Tropical ocean-atmosphere interactions exert a significant impact on regional and global climate on a broad range of spatio-temporal scales. Since the 1980s, in-situ and satellite observations, reanalysis products, and advancements in climate modeling have led to depicting various aspects of intraseasonal (e.g., MJO), interannual (e.g., ENSO, IOD, and Atlantic Nino) and decadal (e.g., IPO) variability in the tropical ocean basins and their linkages with tropical (e.g., monsoons) and extratropical (e.g., storm track) climate. Newer studies find an active role of salinity in tropical ocean-atmosphere interaction, including tropical cyclone intensification. Other recent studies highlight the tropical inter-basin coupling among the Pacific, Indian Ocean, and Atlantic in seasonal prediction of the Asian summer monsoon and decadal redistribution of ocean heat content associated with the so-called "hiatus" of global warming. Long term change in the Pacific Walker circulation has been recapturing attention in terms of the pattern effect of warming on climate feedback and sensitivity against radiative forcing as well as ENSO modulations under a warmer climate. A variety of processes are mutually interrelated and shape the climate, its variability, and change. To examine these challenging issues from various perspectives and foster understanding of the role of tropical ocean-atmosphere interaction in the climate system, this session offers a forum to discuss recent progress in observational, modeling and theoretical studies of multi-scale ocean-atmosphere interaction in the tropics.

[ACG30-P01] Evaluation of externally forced component on interannual-scale SST anomalies over the tropical Indo-Pacific Ocean

*Takuya Hasegawa[1,2], Yuma Miyaji[1], Youichi Tanimoto[1,3] (1.Hokkaido University, 2.Tohoku University, 3.JAMSTEC)

[ACG30-P02] Potential predictability of regional extreme events associated with large-scale teleconnection from the tropical ocean

*Yukiko Imada[1], Hiroaki Kawase[1] (1.Meteorological Research Institute, Japan Meteorological Agency)

[ACG30-P03] External and Internal forcings of the Indian Ocean Dipole

*Lianyi Zhang[1,2], Yan Du[1,2], Tomoki Tozuka[3] (1.South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2.Southern Marine Science and Engineering Guangdong Laboratory, 3.Dept. of Earth and Planetary Science Graduate School of Science, Univ. of Tokyo)

[ACG30-P04] Variations of sea surface temperature and salinity using coral Sr/Ca and $\delta^{18}O$ in the Java Sea and the Lombok Strait.

*Ai Genda[1], Ali Arman[2], Minoru Ikehara[3], Atsushi Suzuki[4], Mayuri Inoue[1] (1.Graduate School of National Science and Technology, Okayama University, 2.National Nuclear Energy Agency of Indonesia (BATAN), 3.Center of Advanced Marine Core Research, Kochi University, 4.Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology)

Evaluation of externally forced component on interannual-scale SST anomalies over the tropical Indo-Pacific Ocean

*Takuya Hasegawa[1,2], Yuma Miyaji[1], Youichi Tanimoto[1,3]

1. Hokkaido University, 2. Tohoku University, 3. JAMSTEC

In order to investigate internal variability phenomena in the atmosphere-ocean climate system, it is necessary to remove the components generated by the external forcing such as anthropogenic global warming and volcanic eruptions (hereinafter referred to as externally forced component) from analyzed time series. In past studies, a method removing a linear trend at each grid point of the data has been widely used (hereinafter, LT method). On the other hand, in recent studies (e.g., Steinman et al. 2015; Dai et al. 2015), the new method of evaluating the externally forced component using the multi-model ensemble mean (MME) of the global mean surface temperature (GMST) anomaly using a large number of simulations in the Coupled Model Intercomparison Project Phase 5 (CMIP5) (hereinafter, GMST method) was applied to surface air temperature anomalies and sea surface temperature anomalies at each grid point by using the MME of GMST (GMSTmme). The purpose of this study is an inter-comparison between the LT and GMST methods when applying to interannual SST anomalies in the tropical Pacific and Indian Oceans.

In this study, we use the historical simulations with three ensemble members on a basis of the 12 CMIP5 models including MIROC5 (i.e., totally 36 historical experiments) to calculate the GMSTmme. After the linear regression coefficient (α) of the SST anomalies at each grid point onto the GMSTmme is calculated, the product of α and GMSTmme at each grid point is removed from the original SST anomalies. The remaining SST anomalies will be treated as the component of the natural internal variability.

We examined the different characteristics in the component of the natural internal variability in the Nino-3 index between the LT and the GMST methods on a basis of the observed SST of the COBE SST 2 (analysis period: 1850-2017). The monthly values of the Nino-3 index for the period 1960-1999 (2000-2017) tend to be 0.2℃ lower (higher) by the GMST method than by the LT method.

To quantify the different characteristics in the Nino-3 index between GMST and LT methods, the ratio of the root mean square deviation of externally forced components between the GMST and LT methods (RMSD) and the standard deviation of the internal variability component estimated by the GMST method (SD) was defined as R (R = RMSD/SD x 100). R of the Nino-3 index for a period of 1960-2017 is approximately 10%.

For the Indian Ocean Basin-wide warming (IOBW) index, the difference in amplitude between the GMST and LT methods was approximately 0.3˚C, i.e., approximately 50% lager than that of Nino-3 index. The amplitude of the internal variability of the IOBW index was a fraction of that of the Nino-3 index. Therefore, R of the IOBW (approximately 50%) was much larger than that of Nino-3 index (10%). On the other hand, Indian Ocean dipole mode index (DMI) shows little difference between the two methods. Because the externally forced component are mostly equal in the western and eastern tropical Indian Ocean, it is mostly canceled out by definition of the DMI.

To investigate the different characteristics in natural internal SST variability between the two methods, R is calculated in the whole ocean basin in two analysis periods such as a long term during 1850-2017 and

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a short term during 1958-2017, respectively. R is 10 to 20% larger in the long-term analysis than in the short-term analysis for the whole ocean basin. When the GMSTmme by MIROC5 is employed for a longer period using the historical simulation and the RCP4.5 scenario simulation (1850-2100), R becomes much larger in all ocean basins. The results of this study indicate that the conventional LT method induces large estimation errors of the externally forced component by changing the calculation periods, suggesting usefulness of the GMST method.

Keywords: global warming, externally forced component, sea surface temperature, ENSO/IOD/IOBW, tropical Indo-Paicifc Ocean

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Potential predictability of regional extreme events associated with large-scale teleconnection from the tropical ocean

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Compared to the high predictability of seasonal forecasts in the tropics, predictability in the mid- and high- latitudes is low due to the high atmospheric noise and low signal-to-noise ratio. Large ensemble prediction is one solution to reduce noise by taking the ensemble average. Despite the enormous computational cost issues, a large ensemble is also a powerful tool for capturing rare extreme weather and climate events.
Here, I will present our recent studies using high-resolution large ensemble simulations, focusing on the potential predictability of extreme event probability. The large ensemble simulations were carried out by the global atmospheric general circulation model with a horizontal resolution of 60 km and the regional climate model around Japan with a horizontal resolution of 20 km, which were prescribed by the observed SST. The dataset covers more than 6000 years (100 members from 1951 to the present). Using this dataset, we confirmed that a large ensemble improves temporal anomaly correlation skills over land at the mid-latitudes. Furthermore, the high-resolution 20-km runs can reproduce local heavy rainfall affected by fine topography and mesoscale rainfall systems. By combining global and regional simulations, we found that large-scale slow tropical ocean variability affects the frequency of local heavy rainfall, and local terrain sometimes helps to reduce atmospheric noises, resulting in higher potential predictability of rainfall in some areas of Japan.

Keywords: Potential Predictability, heavy rain events, large-ensemble simulation, teleconnection from the tropics

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External and Internal forcings of the Indian Ocean Dipole

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The Indian Ocean Dipole (IOD) is a climatic phenomenon occurring in the tropical Indian Ocean, which can cause anomalous weather and climate over the surrounding rims even the globe. This study investigates the remote impacts of the El Nino-Southern Oscillation (ENSO), and the internal forcing from the southern Indian Ocean on the IOD. The ENSO impacts on the IOD are revisited by a new statistical method namely the Combine Linear Regression (CLR). When the ENSO impacts are isolated, the IOD survives with same phase-locking to boreal fall season, while it weakens and peaks earlier by 1 month. After removing the ENSO impacts by the CLR, we propose a new triggering mechanism of IOD originating from the Southern Hemisphere, namely the Southern Hemisphere Mechanism (SHM). The SHM is independent from ENSO and cooperate with ENSO to affect the IOD in fall, leading to the IOD diversity such as the unseasonable IOD. The subtropical high in the southern Indian Ocean and high-latitude climate activities play important roles in the SHM. To consider these forcings would help to improve the IOD predictability.

Keywords: Indian Ocean Dipole , ENSO , Tropical-Extratropical Interaction

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Variations of sea surface temperature and salinity using coral Sr/Ca and $\delta^{18}O$ in the Java Sea and the Lombok Strait.

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The Indonesian Throughflow (ITF) runs from the Pacific into the Indian Ocean through the Indonesian archipelago. The ITF modulate heats and water budget between the Pacific and the Indian Ocean, and therefore the ITF plays an important role in climate change. In addition, during northwest monsoon, sea surface currents drive low salinity and buoyant water from the Java Sea to the southern Makassar Strait. This water caps surface flow through the Makassar Strait and called "freshwater plug". In contrast, during southeast monsoon, sea surface currents remove freshwater plug from the southern Makassar Strait. Thus, it is suggested that behavior of freshwater plug would affect variation of Asia monsoon and climate change. However, instrumental records have accumulated only for decades in the Indonesian Seas partially due to the complex topography. In this study, we reconstructed sea surface environments using Sr/Ca and oxygen isotopic ratios ($\delta^{18}O$) in coral skeleton collected from Seribu Islands and Bali Island. While both coral Sr/Ca and $\delta^{18}O$ depend on sea surface temperature (SST), coral $\delta^{18}O$ also depend on seawater $\delta^{18}O$ which mostly correspond to salinity. Therefore, both SST and salinity can be reconstructed from based on coral Sr/Ca and $\delta^{18}O$.
Coral samples used in this study were collected from two sites: one is the Seribu Islands located in the Java Sea where freshwater plug appears and the other is the southeast of Bali Island in the Lombok Strait, which is one of outlet of ITF connecting to the Indian Ocean. Seribu's and Bali's records covered about 70-year from 1931-2002 and 50-year from 1962-2012, respectively. In 1997 when positive Indian Ocean Dipole mode and El Niño occurred, Bali's record show large anomaly (cool SST and drought), whereas Seribu's record shows only a slightly change. Furthermore, it seems that a relatively big change of marine environments like a regime shift has occurred in the Lombok Strait around late 1990s with no clear change in the Java Sea. We will show and discuss the temporal and spatial change of the variation of SST and salinity based on coral Sr/Ca and $\delta^{18}O$ in both sites over the past decades.

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[E] Poster | A (Atmospheric and Hydrospheric Sciences)：A-CG Complex & General

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[A-CG34] Global Carbon Cycle Observation and Analysis

convener:Kazuhito Ichii(Chiba University), Prabir Patra(Research Institute for Global Change, JAMSTEC), Akihiko Ito(National Institute for Environmental Studies)

The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) is a landmark agreement, which aims at reduction of greenhouse gases (GHGs) emission to keep the global warming below 2 deg C. The national commitments and progresses should be carefully monitored and verified by international bodies using different but complementary methodologies.

Many observation and technique to monitor GHGs budget have been improved in recent years. The improvements include observational platforms for monitoring atmospheric GHGs, national or regional emission inventories, top-down estimations (e.g. atmospheric inverse analysis), and bottom-up estimations (e.g. process-based models). However, due to uncertainties in sparse observation network and integration methods, large uncertainty remains in GHGs sources/sinks estimations at global and regional scales.

The purpose of the session is to discuss state-of-the-art techniques for estimations of GHGs (e.g. CO2, CH4, N2O) budget at global and regional scales. The topic includes natural and anthropogenic processes, various methodologies (e.g. in-situ observation, aircraft monitoring, remote sensing, modeling), and various targets (e.g. atmosphere, terrestrial, and ocean), various spatial and temporal coverage (e.g. regional to global scales and past-present-future). Improved estimates of emissions from land use change, forest fires, and other anthropogenic sources (urban developments and thermal power station etc.) are also of interest. We also welcome discussions for designs and plans for future studies targeting city and country scale emission estimations using sophisticated modeling tools and inventories.

[ACG34-P01] Asian methane outflow captured by the CONTRAIL flask air samplings

*Yosuke Niwa[1,2], Toshinobu Machida[1], Taku Umezawa[1], Kazuhiro Tsuboi[2], Kentaro Ishijima[2], Ryo Fujita[2], Hidekazu Matsueda[3], Takuya Saito[1] (1.National Institute for Environmental Studies, 2.Meteorological Research Institute, 3.Dokkyo University)

[ACG34-P02] High-resolution mapping of anthropogenic CO_2 emissions in Japan

*Makoto Saito[1], Hiroko Yamada[1] (1.National Institute for Environmental Studies)

[ACG34-P03] Estimating solar-induced chlorophyll fluorescence using process-based ecosystem model VISIT-SIF

*Tatsuya Miyauchi[1], Makoto Saito[1], Hibiki M. Noda[1], Yukio Yoshida[1], Haruki Oshio[1], Akihiko Ito[1], Tsuneo Matsunaga[1] (1.National Institute for Environmental Studies)

[ACG34-P04] Estimation of Aerosol Optical Characteristics of Wildfires in 2018 - 2020 with GCOM-C/SGLI

*Kazuhisa Tanada[1], Hiroshi Murakami[1] (1.Earth Observation Research Center, Japan Aerospace Exploration Agency)

[ACG34-P05] Satellite-data based monitoring of changes in the terrestrial carbon cycle in Mongolia: Synthesis analysis

*ZAYA MART[1], Ichii Kazuhito [1], Tsolmon Renchin[2] (1.Chiba University , 2.National University of Mongolia)

[ACG34-P06] Changes in terrestrial vegetation activities observed by satellite-based products across Eurasia

*Da WANG[1], Kazuhito Ichii[1] (1.Chiba University)

Asian methane outflow captured by the CONTRAIL flask air samplings

*Yosuke Niwa[1,2], Toshinobu Machida[1], Taku Umezawa[1], Kazuhiro Tsuboi[2], Kentaro Ishijima[2], Ryo Fujita[2], Hidekazu Matsueda[3], Takuya Saito[1]

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Methane (CH_4) is one of important greenhouse gases. A large part of the global CH_4 emission exists in Asia with various kinds of sources such as fossil fuel exploitation, wetland, rice cultivation and biomass burning. Estimating and monitoring those Asian CH_4 emissions are imperative for better understanding of the growth of the atmospheric CH_4 and for developing a strategy to mitigate CH_4 emissions. Atmospheric observations over the western North Pacific, at the downwind side of Asia, have frequently captured CH_4 -rich outflows from the Asian continent. From those elevated CH_4 concentrations, we could obtain useful information of CH_4 emissions in Asia. Especially, sporadic high CH_4 concentrations observed in the upper troposphere during the summer monsoon season are noteworthy because they are largely contributed by biogenic sources that are increased in the summer. Biogenic CH_4 emissions have distinct seasonal variations in response to variations of temperatures and precipitations, and also have a significant role in interannual variations of the atmospheric CH_4. In fact, the commercial aircraft observation project named CONTRAIL has observed notably elevated CH_4 concentrations in the upper troposphere during summer by flask air sampling measurements along Japan-East/Southeast Asia routes. However, the transport mechanism of such a CH_4 outflow is still unclear. Furthermore, the fossil fuel exploitation and other sources that constantly emit CH_4 through a whole year could also contribute the summer CH_4 elevations, which complicates quantitative estimation of the biogenic sources. In this study, the atmospheric transport model NICAM-TM is used to elucidate transport pathways and origins of CH_4 outflows that reach the upper troposphere over the western North Pacific. Furthermore, using simultaneous observations of other chemical species such as ethane (C_2H_6) are used to separate contributions of biogenic sources of CH_4.

Keywords: methane, Asia, aircraft, atmospheric transport model

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High-resolution mapping of anthropogenic CO_2 emissions in Japan

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Fossil fuel combustion is a main contributor of increasing atmospheric carbon dioxide (CO_2) concentration. Fossil fuel CO_2 ($FFCO_2$) emission inventories have been usually compiled for global and national scales. However, evaluation of local climate action for global warming necessitates quantifying the $FFCO_2$ emissions from cities, which are responsible for more than 70% of the global $FFCO_2$, with more detailed information on temporospatial distribution of the emission at sub-city levels. This study proposes a new $FFCO_2$ emission inventory using a bottom-up approach for whole area in Japan. The emission inventory consists of the emissions from 3 sources: point (electricity generation, waste incineration, civil aviation, and waterborne navigation sectors); line (road transport sector); and area (industrial and commercial, residential, and agricultural machinery sectors) sources with 1 km spatial resolution and monthly temporal resolution. The emissions for each sector were calculated based on the census data and the national statistical data. We will present the calculation methodology for our emission inventory and the results with comparison with other emission estimates.

Keywords: Anthropogenic CO2 emissions, Fossil fuel, Inventory

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Estimating solar-induced chlorophyll fluorescence using process-based ecosystem model VISIT-SIF

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1. National Institute for Environmental Studies

Photosynthesis is a fundamental process of carbon fixation in terrestrial ecosystem and monitoring changes of photosynthetic activity is necessary to probe global carbon cycle. Solar-induced chlorophyll fluorescence (SIF) is known as a good index to monitor photosynthetic activity, and satellite-observed SIF is useful to improve global carbon cycle simulations by terrestrial ecosystem models. The forward model which can calculate SIF based on ecophysiological process is required for utilization of SIF for model parameter adjustment. Moreover model-simulated SIF needs to calculate the satellite observing proportion of total canopy SIF to compare satellite-observed SIF. We developed the process-based ecosystem model to estimate SIF based on VISIT model (VISIT-SIF). We incorporated biochemical process of SIF and geometric effect of observing direction to the model and assessed the reproducibility of SIF by comparing SIF simulated by VISIT-SIF with SIF observed by Greenhouse gases Observating SATellite (GOSAT). The annual mean global SIF by VISIT-SIF showed good agreement with one observed by GOSAT. The seasonal change of SIF in several regions by VISIT-SIF also showed good agreement with one by GOSAT. However, some region showed deference of phenological term. In our presentation, we will explain the model processes and results of comparing SIF by VISIT-SIF and GOSAT.

Keywords: Solar-induced chlorophyll fluorescence, Process based ecosystem model, Global carbon cycle, Satellite observation

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Estimation of Aerosol Optical Characteristics of Wildfires in 2018 - 2020 with GCOM-C/SGLI

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It is known that wildfires not only damage land ecosystems, but also have a great impact on the atmospheric environment due to the release of large amounts of CO2, aerosols and so on. Greenhouse gases such as CO2 are well known to have positive radiative forcing, however, aerosols from wildfires have both positive and negative radiation forcing potentials, which can perturb the global radiation balance. Therefore, it is important to investigate the aerosol optical characteristics of wildfires and estimate their radiative forcing in order to predict the future climatic impacts by wildfires.

GCOM-C (Global Change Observation Mission - Climate) called “SHIKISAI”, which is JAXA polar-orbit satellite, has been launched on 23 December 2017. In this work, we analyze the world’s wildfires that occurred after 2018 with the GCOM-C products. By comparing the characteristics of aerosols such as aerosol optical thickness (AOT), aerosol angstrom exponent (AE), and aerosol single scattering albedo (SSA), we visualize the difference between wildfire events. According to the results, we can suggest that the values of AE seem to depend on the latitude of the fire location. In addition, the values of SSA also slightly different for each event, which might be caused by the differences of the land cover and/or human activity and the like. In the future, we plan to estimate the radiative forcing for each event in order to understand the direct and indirect effects of wildfire aerosols.

Keywords: GCOM-C, SHIKISAI, SGLI, wildfire, aerosol, radiative forcing

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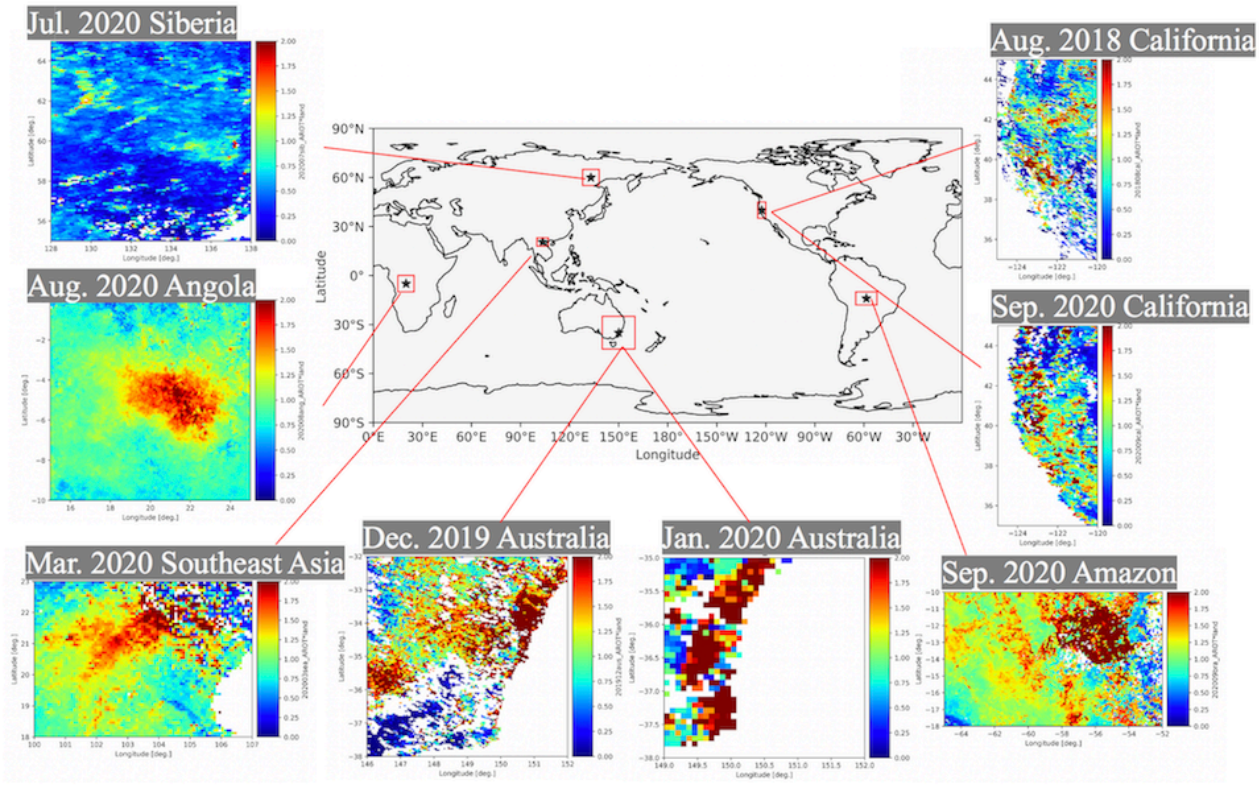


Fig. Estimated Aerosol Optical Thickness (AOT) over land for the world's wildfire events occurred after 2018. We use GCOM-C/SGLI's AOT products provided by JAXA.

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Satellite-data based monitoring of changes in the terrestrial carbon cycle in Mongolia: Synthesis analysis

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The terrestrial biosphere plays an important role in the global carbon cycle link with climate change, the main cause of global warming. Mongolian ecosystems are particularly vulnerable due to the relatively high altitude of the country and the continental semi-arid climate. Therefore, it is important to monitor environmental changes. So far, many studies have analyzed terrestrial vegetation changes in Mongolia using a single satellite-based vegetation index, datasets, such as MODIS and GIMMS datasets. However, synthesis analysis using ground observation, remote sensing, and ecosystem modeling is missing.

The purpose of this study is to show robust vegetation and terrestrial carbon cycle changes using multiple available datasets of climate, vegetation, and carbon cycles, covering ground observation, remote sensing datasets, and model outputs. This study covers periods from the 1980s to 2020.

Keywords: Carbon cycle, Remote sensing, Climate change

Satellite-data based monitoring of changes in terrestrial carbon cycle in Mongolia: Synthesis analysis

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The terrestrial biosphere plays an important role in the global carbon cycle link with climate change, the main cause of global warming. Mongolian ecosystems are particularly vulnerable due to the relatively high altitude of the country and the continental semi-arid climate. Therefore, it is important to monitor environmental changes. So far, many studies have analyzed terrestrial vegetation changes in Mongolia using a single satellite-based vegetation index, datasets, such as MODIS and GIMMS datasets. However, synthesis analysis using ground observation, remote sensing, and ecosystem modeling is missing.
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Changes in terrestrial vegetation activities observed by satellite-based products across Eurasia

*Da WANG[1], Kazuhito Ichii[1]

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Eurasia experienced significant temperature and precipitation changes, and these changes can affect terrestrial vegetation environments. So far, many studies analyzed satellite-based vegetation datasets using NOAA AVHRR and Terra and Aqua MODIS. Most studies focused on the years by 2015. Therefore, more updated analysis is required since more clear warning has been occurred. Therefore, in this study, we used multiple satellite datasets from 2000 to 2019 to understand the long-term trends of vegetation changes across Eurasia. We used multiple Terra and Aqua MODIS products and multiple climate datasets to understand changes in vegetation and potential causes of these vegetation changes.

Regions with increased NDVI are widely distributed in Eurasia. There is an increasing trend in 45.6% of the regions and a decreasing trend in 2.5% of the regions. NDVI increased significantly in Siberia, China, India, Turkey and western Russia. On the other hand, NDVI decreased in some parts of Central Asia such as the northwestern part of Kazakhstan. As a result of analyzing the rank correlation between NDVI and climate variables, the correlation between NDVI and temperature was high in Siberia, northeastern China and western Russia (NDVI-temperature: r = 0.66 (Siberia), r = 0.51 (northeast China), r = 0.55 (Western Russia)). On the other hand, there was a high correlation between NDVI and precipitation in southern China, India, Turkey and northwestern Kazakhstan (NDVI-precipitation: r = 0.35 (southern China), r = 0.48 (India), r = 0.52 (Turkey), r = 0.75 (northwestern Kazakhstan)). Thus, we clarified vegetation change trends and its potential mechanisms. As future plans, we will analyze the factors by adding parameters such as the amount of solar radiation, soil moisture, and human activities.

Keywords: remote sensing, NDVI, Eurasia

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[E] Poster | H (Human Geosciences)：H-DS Disaster geosciences

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.10_1

[H-DS06] Natural hazard impacts on human society, economics, and technological systems

convener:ELENA PETROVA(Lomonosov Moscow State University, Faculty of Geography), Hajime Matsushima(Research Faculty of Agriculture, Hokkaido University)

The last decade set a record for the number and scale of natural disasters and demonstrates high vulnerability of human society, economics, and ecosystems to their impacts. The most serious consequences have the so-called natural-technological disasters in which natural hazards trigger accidents at technology and infrastructure such as nuclear power and chemical plants, oil refineries and pipelines, power supply systems, buildings, roads, and railways. A distinctive feature of natural-technological events, such as of the 2011 Tohoku earthquake, is their multi-hazard and synergistic nature, which creates cascading impacts, resulting in simultaneous occurrences of myriad catastrophes. The main goal of this multidisciplinary session is to summarize case studies of relationships between natural hazards and technological disasters, their social and economic consequences; and to encourage a discussion about tools and methods to prevent disasters and to minimize their consequences, disaster reconstruction, and tourism for reconstruction, Eco-DRR, and green infrastructure.

[HDS06-P01] Introduction

[HDS06-P02] Effects of abandoned paddy field use for the conservation of threatened hydrophyte after the 2011 Tohoku-oki tsunami

★Invited Papers

*Korehisa Kaneko[1], Hiroshi Jinguji[2] (1.Hokuso Creature Association, 2.Fukushima University)

[HDS06-P03] Citizens' Awareness of Transmitting Information about Earthquake Experiences in the Areas Affected by the Great East Japan Earthquake: A Focus on the Use of Earthquake Ruins

*Ryo Nishisaka[1], Katsunori Furuya[1] (1.Chiba University)

[HDS06-P04] Location of the Visitor Centers of National Parks of Japan and their Adapt to Climate Change

*Satoshi Sasaki[1], Kiyotatsu Yamamoto[1], Kazuhiko W. Nakamura[1] (1.The University of Tokyo)

[HDS06-P05] **The Activity of Kamchatka Volcanoes and theirs Danger to Human Society**

*Olga Girina[1], Evgenii Loupian[2], Alexei Ozerov[1], Dmitry Melnikov[1], Alexander Manevich[1], Elena Petrova[3] (1.Institute of Volcanology and Seismology, Far East Division, Russian Academy of Sciences, Russia, 2.Space Research Institute, Russian Academy of Sciences, Russia, 3.Lomonosov Moscow State University, Geography Faculty, Russia)

[HDS06-P06] The impact of the reduction of beach width by seawall construction on the distribution of ground prowling insects

*Hinata Okoshi[1], Hajime Matsushima[1], Junjiro Negishi[2], Masahiro Ohara[3] (1.Graduate School of Agriculture, Hokkaido University, 2.Faculty of Environmental Earth Science, Hokkaido University, 3.The Hokkaido University Museum, Hokkaido University)

[HDS06-P07] Discussion

[E] Poster | H (Human Geosciences) | H-DS Disaster geosciences

[H-DS06] Natural hazard impacts on human society, economics, and technological systems

convener:ELENA PETROVA(Lomonosov Moscow State University, Faculty of Geography), Hajime Matsushima(Research Faculty of Agriculture, Hokkaido University)

Sat. Jun 5, 2021 5:15 PM - 6:30 PM Ch.10

The last decade set a record for the number and scale of natural disasters and demonstrates high vulnerability of human society, economics, and ecosystems to their impacts. The most serious consequences have the so-called natural-technological disasters in which natural hazards trigger accidents at technology and infrastructure such as nuclear power and chemical plants, oil refineries and pipelines, power supply systems, buildings, roads, and railways. A distinctive feature of natural-technological events, such as of the 2011 Tohoku earthquake, is their multi-hazard and synergistic nature, which creates cascading impacts, resulting in simultaneous occurrences of myriad catastrophes. The main goal of this multidisciplinary session is to summarize case studies of relationships between natural hazards and technological disasters, their social and economic consequences; and to encourage a discussion about tools and methods to prevent disasters and to minimize their consequences, disaster reconstruction, and tourism for reconstruction, Eco-DRR, and green infrastructure.

5:15 PM - 6:30 PM

[HDS06-P01]Introduction

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Effects of abandoned paddy field use for the conservation of threatened hydrophyte after the 2011 Tohoku-oki tsunami

*Korehisa Kaneko[1], Hiroshi Jinguji[2]

1. Hokuso Creature Association, 2. Fukushima University

1. Introduction

Threatened plant species, *Ottelia alismoides*, *Monochoria korsakowii*, *Najas graminea*, *Najas minor,* and *Chara braunii* were found in swampy paddy field after the 2011 Tohoku-oki tsunami Japan. These hydrophyte are classified as near-threatened or vulnerable species in the Red Data book of Ministry of environment, Japan. Hygrophyte communities were vanishing rapidly as reconstruction of road and agriculture proceeds. Therefore, surface soil of hygrophytes community was transplanted to abandoned paddy field 5km away from the original hygrophyte community.

In the present study, we transplanted soil seed to examine whether abandoned paddy field is effective for the hygrophytes species conservation. We investigated 1) whether hygrophytes including threatened species emerge and grow in the abandoned paddy field and 2) management methods of abandoned paddy field to conserve hygrophytes species.

2. Method

The sturdy site was located at Hadenya district in Miyagi prefecture Japan (lat.38°38¢37.9’’ N. and long.141°28¢10.5’’ E). The vegetation survey conducted on July and September during 2014-2016 in accordance with the methodology of Braun-Blanquet (1964). The surface soil of paddy field was puddled by human power on April 2014 and 2015, and was strongly puddled by agricultural tractor on April 2016. The water temperature was recorded using a thermo-logger (Tidbit, Onset, USA) at the center of each quadrate frame in transplantation sites and donor seed bank. The water temperature was measured from May to September during 2014-2016 in transplantation site. The water depth was measured with ruler in the center of each quadrate frame.

3. Results

Monochoria korsakowii were recoveried in transplantation site from 2014 to 2016. In particular, *Monochoria korsakowii* formed large community in 2016, and the volume of plant increased singnificantly hihger than that in 2014 and 2015. *Ottelia alismoides* and *Chara braunii* were found in 2014 and 2016. The intensity disturbance with a agricultural tractor suppressed the flourishing of the herbaceous plants of *Phragmites australis* and *Typhaceae* spp. in 2016. Consequently, *Ottelia alismoides* and *Chara braunii* regenerated again in taransplantation site. *Najas graminea* and *Najas minor* were not found during vegetation survey. *Salvinia natans* and *Alisma plantago-aquatica* were newly appeared in transplantion site. Our findings suggest that transplantation of surface soil including seed bank to abandoned paddy field is effective for the conservation of hygrophyte, *Monochoria korsakowii, Ottelia alismoides* and *Chara braunii*. The intensity disturbance for suppression of herbaceous perennial plant is needed to maitain the habitat of threatened plant species.

4. Conclusion

For the future, keeping the intensity disturbance with tractor is desirable on April. In addition, weeding of *Echinochloa spp* by human work is needed to conserve threatened plant species. Furthermore, we must develop the field at water depth 25 cm for the habitat of *Najas graminea* and *Najas minor* and re-transplantation. Long-term field monitoring is needed to elucidate frequency, intensity and period of

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suitable disturbance and water depth to maintain threatened hygrophytes.

Keywords: Threatened plant, Seed bank, Soil disturbance, Abandoned paddy field, Tunami

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Citizens' Awareness of Transmitting Information about Earthquake Experiences in the Areas Affected by the Great East Japan Earthquake: A Focus on the Use of Earthquake Ruins

*Ryo Nishisaka[1], Katsunori Furuya[1]

1. Chiba University

1. Background
Ten years have passed since the Great East Japan Earthquake. One of the important projects for recovery after the earthquake is to transmit the lessons learned from the experience.Buildings and structures damaged by the earthquake and tsunami are being preserved by municipalities as earthquake ruins. The municipalities have preserved these as public facilities in anticipation of their use in transmitting lessons learned from the disaster and as a means of disaster prevention education. Some people have opposed the ruins' preservation because it reminds people of the horror of the earthquake, or on account of preservation efforts' costs. However, after much consideration, it has been decided more than 30 locations will be preserved in the Iwate, Miyagi, and Fukushima prefectures.

2. Purpose
To transmit the lessons learned from the earthquake, affected citizens' participation is important. Therefore, this study first aims to grasp citizens' awareness of the importance of transmitting the lessons from the earthquakes and what messages they want to transmit. In addition, the earthquake ruins are expected to play a role in communicating about the disaster. This is one of the desirable methods for using them to transmit citizens' experiences of the earthquake. Therefore, the second purpose is to clarify how close the citizens feel to the earthquake ruins and citizens' awareness of their use.

3. Method
A web survey was conducted from March 10–22, 2020 for citizens living in the nine municipalities where the earthquake ruins are preserved. Participants were asked about the importance of communicating the experience of the disaster to others, about their awareness of the earthquake ruins, and so on.

4. Results
4-1. Respondents
Responses were received from a total of 1,080 people from the nine target municipalities. The genders of the respondents were 566 males (52.4%) and 514 females (47.6%), with an average age of 49.4.
4-2. Awareness of and participation in the transmission of the earthquake experience
In all, 89.2% of respondents said, "It is important to transmit information about the disaster," 62.0% said, "I have told other people about the disaster," and 8.8% answered, "I have participated in activities to transmit information about the disaster."
4-3. Contents of knowledge transmission
Of those surveyed, 39.3% responded, "I want to tell how our homes and towns were destroyed by the disaster," and 47.9% responded, "I want to tell about what was lost in the disaster (human life, daily life, and culture)." More than half (54.5%) responded, "I want to tell about our efforts to recover from the disaster."
4-4. Recognition of the earthquake ruins
Almost half (42.3%) of the respondents answered, "I knew whether earthquake ruins would be preserved

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in my city," and 39.2% said, "I often see and talk about the earthquake ruins."
4-5. Willingness to use the earthquake ruins
About one quarter (24.6%) of respondents said, "I want to participate if there is a ceremony or event," while 23.7% answered, "I want to visit on a daily basis," and 18.9% replied, "I want to be involved in the ruins' management and use."
4-6. Awareness of earthquake ruins
Most respondents (61.9%) said the ruins were "a symbol of the disaster," and 49.9% answered, "They are a symbol of recovery." Although the earthquake ruins are comprised of buildings and structures damaged by the disaster, they also have a positive image as symbols of recovery.

5. Discussion
Citizens in the disaster areas are very conscious of the importance of transmitting their experiences, but it seems difficult to engage them in actual activities related to the ruins. The high level of awareness of the need to transmit information about lessons learned is noteworthy, but in the future, it may be necessary to take measures to support the shift of awareness from transmission to action.
We found that the earthquake ruins are recognized as symbols both of the disaster and the recovery, and they have a positive image. By contrast, about 40% knew that ruins would be preserved in their town, and about 40% see and talk about them on a daily basis, but only 20% intend to use them, so the ruins, by and large, are not familiar facilities. Before supporting the use of the earthquake ruins by the citizens, it is first necessary to inform them of their existence.
Future studies should examine how earthquake ruins can be devoted to the activities of transmitting information about the citizens' experiences of the earthquake.

Keywords: earthquake ruins, Great East Japan Earthquake, transmitting earthquake experiences

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Location of the Visitor Centers of National Parks of Japan and their Adapt to Climate Change

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1. The University of Tokyo

1. Introduction

Global warming is not only increasing the number of climate-related disasters, but also triggering complex disasters that affect many people around the world (Mora et al. , 2018), and this has led to calls for action on climate change. The VCs of national parks, which serve as refuge shelter in times of disaster, are also required to adapt to climate change. When the Ministry of the Environment and prefectural governments select sites for VCs, they focus on whether the sites are in location that is not subject to natural disasters. However, there is no existing knowledge that clarifies the potential of location of VCs to fulfill the aforementioned function in the aftermath of disasters. In this study, we focused on the potential of VCs to serve as refuge shelter in a disaster, with the following two objectives: 1) to clarify the differences between each type by classifying VCs of national parks of Japan according to their location, 2) to examine the potential of VCs as refuge shelter.

2. Methods

A total of 101 VCs in national parks of Japan were adopted as case study facilities and the following indicators were selected for analysis: (1) shortest distance from the VCs (highway interchanges, restaurants, stores), (2) land use within a radius of 500 m around the VCs (rice fields, agricultural land other than rice fields, forests, river lands and lakes, sea areas, building sites). Then, in order to prevent the effect of outliers, the distance scale in indicator (1) was replaced by an ordinal one. Finally, The cluster analysis (Ward's method, squared Euclidean distance) using indicator (1) and (2), and the multiple comparison tests (Bonferroni method, $P<.05$) were employed.

3. Results and Discussion

VCs were classified into four types through cluster analysis. Type I (N=48) is close to restaurants and stores, and has many forests and building sites in its vicinity, suggesting that this type is located at densely built-up area in mountainous national park. Type II (N=13) is close to restaurants and stores, and has many sea areas and building sites in its vicinity, suggesting that this is located at densely built-up area in coastal national park. Type III (N=28) is far from highway interchanges, restaurants and stores, and has many forests in the vicinity, suggesting that this is located near core area of mountains national park. Type IV (N=12) is located far from the highway interchange and is surrounded by rivers, lakes and marshes, and agricultural land, suggesting that this is located in a national park of lakes and marshes.

Type I is assumed that people can procure food, beverages and fuel because restaurants, stores, many buildings, forests are located near VCs. Similar to Type I, Type II, is inferred that food and beverages can be secured since there are restaurants, stores and many buildings. This type has also seawater areas and the countermeasures is necessary in order that facilities should not be isolated from surrounding areas in the event of a tsunami disaster. Compared to Type I, II, Type III is far away from restaurants and stores, and the surrounding area is mostly forest. Although fuel can be secured, it is difficult to secure supplies such as food and beverages, so it is important to stockpile supplies in preparation for disasters. Type IV is easy to secure drinking water because there are many rivers and lakes. Taken into consideration that the distance from restaurants and stores, and the small number of building in the area, it is necessary to stockpile food in particular.

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In Conclusion, more than half of the VCs were located within walking distance (500m) from restaurants and stores, suggesting that they have the potential to serve as refuge shelter in a disaster. The results indicated that the resilience and vulnerability of VC differs depending on the location type and the planning and management should be proposed by referring the potential of VCs as refuge shelter.

Keywords: climate change, national parks, visitor center, location



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The Activity of Kamchatka Volcanoes and theirs Danger to Human Society

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1. Institute of Volcanology and Seismology, Far East Division, Russian Academy of Sciences, Russia, 2. Space Research Institute, Russian Academy of Sciences, Russia, 3. Lomonosov Moscow State University, Geography Faculty, Russia

There are 30 active volcanoes in the Kamchatka, and several of them are continuously active. In the XX-XXI centuries 17 volcanoes of Kamchatka erupted. During this time, 183 volcanic eruptions occurred, including three catastrophic eruptions (Ksudach, 1907; Bezymianny, 1956; Sheveluch, 1964). Strong explosive eruptions of volcanoes were the most dangerous for human society because they produce in a few hours or days to the atmosphere till 2-3 cubic kilometers of volcanic products. Ash plumes and the clouds, depending on the power of the eruptions, the strength and wind speed, to traveled thousands of kilometers from the volcanoes for several days. Any territory of the Kamchatka Peninsula has repeatedly been exposed to ash falls, the thickness of ash in settlements was from less than 1 mm to 4-5 cm. Strong explosive eruptions of volcanoes Sheveluch, Klyuchevskoy, Bezymianny, Kizimen, Karymsky, Zhupanovsky, Avachinsky, Kambalny were the most dangerous for air travel not only over Kamchatka, but also hundreds of kilometers away from the peninsula.

The strong explosive and effusive eruptions of Sheveluch, Klyuchevskoy, Bezymianny, Kizimen and the other were often accompanied by the formation of hot mud flows (lahars), which sometimes disrupted transport communications (roads, bridges) of nearby settlements.

Scientists of KVERT monitor Kamchatkan volcanoes since 1993. Thanks to satellite monitoring of volcanoes carried out by KVERT, several explosive eruptions were predicted in the XXI century, and early warnings were made to the population about possible ashfalls in settlements and about hazard to aviation.

Keywords: volcano, eruption, Kamchatka, danger, population

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The impact of the reduction of beach width by seawall construction on the distribution of ground prowling insects

*Hinata Okoshi[1], Hajime Matsushima[1], Junjiro Negishi[2], Masahiro Ohara[3]

1. Graduate School of Agriculture, Hokkaido University, 2. Faculty of Environmental Earth Science, Hokkaido University, 3. The Hokkaido University Museum, Hokkaido University

Seawalls were constructed on sandy beaches in the Sendai coast, Miyagi prefecture after the Great East Japan Earthquake occurred on 11 March 2011. These structures narrowed the beaches and it is concerned that the coastal ecosystems are degraded due to the direct impacts of habitat loss and indirect impacts of the increased environmental pressures from the sea such as waves, sand transportations, salt sprays, etc. It has been suggested that such anthropogenic impacts on ecosystems may also affect the nutrient cycle in the ecotone between sea and land, and it is required to clarify the impacts quantitatively. The purpose of this study was investigated whether the distribution of ground prowling insects living on the beach is affected by the reduction of the beach width caused by seawall constructions.
The survey was conducted in the coastline of Miyagi prefecture at five sites: Arahama A and B (Sendai City), Ido (Sendai City), Yuriage (Natori City), Kitagama (Natori City). These sites were selected considering the width of the beach and the state of the vegetation. Ground prowling insects were sampled by pitfall traps. The traps were set from the seawall to the shoreline in a direction vertical to the seawall at 20 m intervals for approximately 40 hours. These samplings were undertaken from 26 to 28 August 2020.
The results suggested that the loss of vegetation caused by the reduction of beach width affects the distribution of ground prowling insects. The narrower beaches received more environmental impacts from the sea, and it also lead to the loss of habitat of them and vegetation. In addition, Gonocephalum (Gonocephalum) recticolle and Meristhus (Sulcimerus) niponensis were found only in the vicinity of the seawalls in Yuriage, the widest beach (about 200 m width) of all five sites. At other sites, their habitat may have been lost due to the construction of seawalls.

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[E] Poster | H (Human Geosciences) | H-DS Disaster geosciences

[H-DS06] Natural hazard impacts on human society, economics, and technological systems

convener:ELENA PETROVA(Lomonosov Moscow State University, Faculty of Geography), Hajime Matsushima(Research Faculty of Agriculture, Hokkaido University)

Sat. Jun 5, 2021 5:15 PM - 6:30 PM Ch.10

The last decade set a record for the number and scale of natural disasters and demonstrates high vulnerability of human society, economics, and ecosystems to their impacts. The most serious consequences have the so-called natural-technological disasters in which natural hazards trigger accidents at technology and infrastructure such as nuclear power and chemical plants, oil refineries and pipelines, power supply systems, buildings, roads, and railways. A distinctive feature of natural-technological events, such as of the 2011 Tohoku earthquake, is their multi-hazard and synergistic nature, which creates cascading impacts, resulting in simultaneous occurrences of myriad catastrophes. The main goal of this multidisciplinary session is to summarize case studies of relationships between natural hazards and technological disasters, their social and economic consequences; and to encourage a discussion about tools and methods to prevent disasters and to minimize their consequences, disaster reconstruction, and tourism for reconstruction, Eco-DRR, and green infrastructure.

5:15 PM - 6:30 PM

[HDS06-P07]Discussion

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[H-TT13] Environmental Remote Sensing

convener:Wei Yang(Chiba University), Akihiko Kondoh(Center for Environmental Remote Sensing, Chiba University)

Our planet Earth is encountering extensive environmental issues caused either by climate change or human activities. It is our urgent task to find out solutions for these issues based on all kinds of techniques, sciences, as well as transdisciplinary cooperation. Remote sensing is currently the only feasible technique to observe the Earth environment at regional/continental /global scales over long periods, and consequently detects the environmental changes occurred all over the world. Although remote sensing has been extensively applied to a number of environmental studies, there are still many challenges for data analysis and applications. Consequently, this session provides a communication platform on theory, science, technology, and applications of remote sensing to study the Earth environment from local, regional to global scales. Both oral and poster presentations are sincerely welcome.

[HTT13-P01] A study on the long-term dynamics and phenology of mangrove forests based on the narratives of inhabitants in western India using Landsat

*Kai Yamamoto[1], Nobuhito Ohte[1], Ranit Chatterjee[1], Kenlo Nasahara[2], Pankaj Joshi Sahjeevan[4], Lyla Mehta[3] (1.Graduate School of Informatics Kyoto University, 2.Faculty of Life and Environmental Sciences University of Tsukuba, 3. Institute of Development Studies, Brighton, United Kingdom, 4.Sahjeevan(NGO))

[HTT13-P02] **Mapping Paddy Rice Planting Areas on the Cloud: Is Spatio-Temporal Fusion Helpful or Not**

*Ziping Yang[1], Wei Yang[2], Akihiko Kondoh[2] (1.Graduate School of Science and Engineering, Chiba University, 2.Center of Environmental Remote Sensing, Chiba University)

[HTT13-P03] Removal of residual reflected skylight for accurate measurement of water-leaving reflectance

*Wei Yang[1], Bunkei Matsushita[2], Dalin Jiang[2] (1.Chiba University, 2.University of Tsukuba)

[HTT13-P04] Yield Estimation of Paddy Rice using High Spatial and Temporal Satellite Data in Indonesia

*Yuki Sofue[1], Chiharu Hongo[1], Naohiro Manago[1], Koki Homma[2], Gunardi Sigit[3], Budi Utoyo[4] (1.Chiba University, 2.Tohoku University, 3.West Java Food Crops and Horticultural Agency, 4.Bogor Agricultural University)

[HTT13-P05] **Random Forest for Estimating Soil Moisture Based on Remote Sensing Test**

*Jyun-Lin Chen[1], Hong-Ru Lin[1], Jet-Chau Wen[1] (1.National Yunlin University of Science and Technology)

A study on the long-term dynamics and phenology of mangrove forests based on the narratives of inhabitants in western India using Landsat

*Kai Yamamoto[1], Nobuhito Ohte[1], Ranit Chatterjee[1], Kenlo Nasahara[2], Pankaj Joshi Sahjeevan[4], Lyla Mehta[3]

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Kutch, Gujarat, Western India (Kutch), is under an arid and semi-arid environment, and the terrestrial ecosystem is dominated by drought and salinity tolerant plants. Mangroves grow in the coastal areas of Kutch and have been continuously used by the local communities for timber, livestock feed, and as fishery resources. However, the ecosystem services of these mangrove forests have partly been lost due to the development of salt pans in coastal areas and disturbed by natural disasters such as cyclones and earthquakes. In order to use mangrove forests with maintaining the sustainability of ecosystem services, it is necessary to accumulate knowledge on the dynamics of these mangrove forests and their response to environmental changes.

In this study, the following three aspects were analyzed by using satellite images in order to understand the long-term and the phenology over the past 30 years. 1) The long-term changes in biomass of mangrove forests in the area. 2) How arid environment or droughts affects the biomass. 3) In the meantime, where have the mangrove forests expanded or shrunk due to development and other environmental alteration?

For 1), we used Landsat-5, 7&8 images, medium spatial resolution data, to investigate the long-term dynamics of mangrove forests by calculating NDVI, one of the vegetation indices that is considered to indicate the plant activity or biomass. For 2), the Standardized Precipitation Index (SPI), which is an index of the drought and dryness, was calculated from the precipitation data in the study area. For 3), the changes in mangrove coverage in the area were evaluated by pixel-based landcover maps for two years, 1988 and 2019.

The NDVI of mangrove forests in the area has basically increased from 1988 to the present, suggesting an increase in biomass. However, it decreased from the late 1990s to the early 2000s. The most possible reason was the increase in water stress due to the continuous occurrence of low precipitation period from the late 1990s to the early 2000s. The lack of significant changes in NDVI by single-year drought suggests that mangrove forests had the resilience against dryness and/or drought, and that continuous dryness affected mangrove vegetation. Several factors, such as relatively high precipitation from 2003, were considered to be responsible for the long-term increase in NDVI in mangrove forests over a 30-year period.

NDVI of mangrove forests in the area was found to be monotonically decreasing since the middle of the dry season (January) and started increasing with the onset of the rainy season. This was due to the leaf growth of mangroves was enhanced by the relief of water stress-related to salinity due to precipitation during the rainy season. On the other hand, during the dry season, the leaf area decreased by the leaf longevity and photosynthesis suppression caused by the increase in water stress.

The relief of water conditions for mangroves was due to the direct supply of freshwater to the soil by

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rainfall and groundwater from inland. Considering the long-term relationship between NDVI changes, mangrove seasonality, and precipitation, it was possible that the amount of available water resources significantly affects mangrove leaf growth in these arid and semi-arid regions. It is important to evaluate the availability of water resources accurately in the future.

The comparison of the landcover maps of 1988 and 2019 showed that the main reasons for the decrease of mangrove forests were the erosion of sandy soil by tides and land-use conversion associated with the development of coastal areas. On the other hand, some mangrove forests expanded their area in areas that were not significantly affected by tides.

The information from this study will be provided to local communities, the government, and NGOs for use in formulating policies for the continuous usage of mangrove forests toward the future.

Keywords: remote sensing, NDVI, mangrove, phenology, landcover

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Mapping Paddy Rice Planting Areas on the Cloud: Is Spatio-Temporal Fusion Helpful or Not

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Mapping paddy rice planting area has great significance for calculating the paddy rice planting area, monitoring rice yield, monitoring global freshwater usage and monitoring methane emissions. If remote sensing satellite images can be used instead of manual visits to map paddy rice planting areas, it will greatly reduce the money and time. The basic principle of using remote sensing images to map paddy rice is to capture the characteristics of rice, that is, they are all transplanted in water. Different vegetation indices calculated from remote sensing images respond differently to water, so this characteristic of paddy rice can be used to distinguish it from other surface types. However, because Japan’ s farming modes mostly are family farming, the area of a single paddy field is small, and due to the existence of fallow or crop rotation, there are often multiple uses of land in a piece of farmland. Coarse spatial resolution remote sensing satellite images will not achieve good results. At the same time, due to the influence of climate and other factors, the transplantation period of rice generally occurs in the rainy season in Japan. Images with low temporal resolution will be affected by clouds and rain, and it is difficult for them to provide effective data. Unfortunately, due to technical limitations, no sensor can obtain images with high temporal resolution and high spatial resolution at the same time. One processing method is to use a fusion algorithm to fuse images with high temporal resolution and low spatial resolution (e.g. MODIS, MERIS) and images with high spatial resolution and low temporal resolution (e.g. Sentinel, Landsat) to obtain images have both high temporal resolution and high spatial resolution. However, the existing Spatio-temporal fusion algorithm does not have high accuracy for heterogeneous areas or areas where the type of landcover will change in one year (e.g. agricultural land). Therefore, this study will use Spatio-temporal fusion algorithm based on similar pixels (e.g. ESTARFM) and filtering based fusion algorithm (e.g. GF-SG) to fuse MODIS, Landsat and Sentinel images in different latitudes and regions. The vegetation index time series obtained after the fusion is used for searching for the flooding signal that can represent the rice transplantation period (that is, the time when the vegetation index LSWI is less than the NDVI before the start of the green up stage of paddy rice), and compare it with the real data published by the Ministry of Agriculture, Forestry and Fisheries. It is found that the fusion algorithm based on similar pixels retains the details of the time series better than the filtering-based fusion algorithm, and the time series fused by the filtering-based algorithm cannot reflect the mutation of LSWI or NDVI. But fusion algorithms based on similar pixels are more susceptible to cloud influence.

Keywords: mapping paddy rice, family farming, flooding signal, Spatio-temporal fusion

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Removal of residual reflected skylight for accurate measurement of water-leaving reflectance

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Water-leaving reflectance (Rrs) is crucial for remote estimation of water quality parameters. However, Rrs measured using the above-water approach usually suffers from residual reflected skylight, and thus its applicability is limited. In this study, we proposed a simple method, which only required the in situ Rrs spectrum itself as input, to further remove this effect in the in situ Rrs spectrum. The performance of the proposed method was evaluated using both simulation data and in situ Rrs spectra measured using a radiance sensor with a black tube. The results showed that the proposed method outperformed other existing methods and can be applied to various types of waters. From a comparison analysis using skylight-free in situ Rrs data, the proposed method showed the best performance with the smallest MAPE of 45% (MAPE ranged from 52% to 260% for other existing methods). In addition, the proposed method can improve the quality of Rrs spectra collected under various sky conditions (clear, scattered clouds and overcast), with an increased proportion of higher quality assurance scores. Two showcases indicate that the skylight corrections should be carried out for all above water approach-measured Rrs spectra before they are applied to develop water quality estimation algorithms or to evaluate the performances of atmospheric correction algorithms.

Keywords: remote sensing, inland lakes, above-water method, water-leaving reflectance

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Yield Estimation of Paddy Rice using High Spatial and Temporal Satellite Data in Indonesia

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Although Indonesia is one of the world's leading rice producers, it suffers from weather conditions such as precipitation, pest and disease. Therefore, it is important to conduct a quantitative damage assessment and utilize the agricultural insurance system. In quantitative damage assessment, it is essential to understand rice yield per field, however, the work to take yield data per field consume time and intensive labor. To solve this problem, we aim to reduce the time, labor, and cost in the field by estimating rice yield using remote sensing data.
In West Java, Indonesia, scale of paddy fields is small and paddy rice per field with different growth stages are mixed because transplanting date varies from field to field. Therefore, to better understand and estimate yield per field, time series data with high spatial and temporal resolution is required. In this study, an enhanced spatial and temporal adaptive reflectance fusion model (ESTARFM) was employed to combine 250-m Moderate Resolution Imaging Spectroradiometer (MODIS) and Sentinetl-2 data to generate a synthetic Sentinel-2 time series data for estimation of rice yield. The blue, green, red, near infrared and short wave infrared were chosen for this processing.
Normalized Different Vegetation Index (NDVI) was calculated, and defined heading stage at maximum NDVI of NDVI curve. It is clarified that the rice yield has a high relationship with some vegetation indices and reflectance at heading stage and after the stage in previous studies. These differences are considered to be due to environmental factors in the study area and differences in rice varieties. Based on these conclusions of previous studies, this analysis included the period from the heading period estimated by time-series NDVI to 40 days. For this period, synthetic Sentinel-2 time series data was used with original Sentinel-2 data to create time-series data of reflectance, NDVI, Green Normalized Difference Vegetation Index (GNDVI) and Normalized Different Water Index (NDWI). Then, yield estimation model was created based on these data every 5 days. Finally, the model which has GNDVI and NDWI as parameters was chosen based on AIC and RMSE.
The results showed that ESTARFM could be used to combine time series MODIS and Sentinel-2 data with a correlation coefficient from 0.77 to 0.92. The model could estimate yield per field with correlation coefficient of 0.6 and RMSE was about 1.30 t/ha. Therefore, it is considered that this methodology can be used for this study area to estimate rice yield.

Keywords: Data fusion, Sentinel-2, MODIS, Time-series

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Random Forest for Estimating Soil Moisture Based on Remote Sensing Test

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This study used a remote sensing method to estimate surface soil moisture (SM) using images from the visible spectrum in the laboratory darkroom. The uniformity was analyzed in the ring light source from a hemispherical darkroom with a ring light source. The soil sample images were then taken and recorded with weight in a laboratory darkroom using a remote sensing test (RST) for five narrow-range soil particle sizes. Next, a comparison of the validation results for the five different narrow-range soil particle sizes using a Random Forest (RF) regression.

Results showed a uniformity test using the ring source set in the darkroom, and results have illumination uniformity without a hot spot existing. The best parameters for film speed, aperture, and shutter use Color Calibration Matrix (CCM) to reduce error for the digital image. SM analysis results showed that the mean value (red line) of SM versus time for five different narrow-range soil particle sizes is reproducible. Fine sand (0.149–0.250 mm) has the best regression and validation results, proving the feasibility and reference value of the previous regression models. The results of this research prove the feasibility of using the RF model for narrow-range soil particle size.

Keywords: Remote sensing, Soil moisture, Random Forest, Visible spectrum

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[E] Poster | H (Human Geosciences)：H-TT Technology & Techniques

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.11_2

[H-TT15] Non-destructive techniques applied to stone cultural heritage

convener:Celine Thomachot-Schneider(University of Reims-Champagne-Ardenne), Chiaki T. Oguchi(Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University), Patricia vazquez(University of Reims Champagne Ardenne)

Non destructive and non invasive techniques applying to cultural heritage made of stones, soils and earthen materials have been significantly developed over past years, and thus, the interest in such techniques has greatly increased. Here, we focus the session on new devices, new protocols and new data treatments that allow better understanding of weathering mechanisms, decay states and response to treatments. A few topics would be listed as follows: 1) The development of new techniques and devices in cultural heritage and new protocols using non-destructive techniques; 2) The application of these techniques and protocols on indoor and outdoor case studies and laboratory studies; 3) The assessment of weathering mechanisms, weathering kinetics, decay state, and response to treatments and 4) The modeling and simulation of decay processes.

[HTT15-P01] Ultrasonic velocity attempted to the various rocks - laboratory experiment and field measurement -

*Chiaki T. Oguchi[1], Keishin Takahashi[2], Sota Noshiro[2], Yukina Ikeda[1] (1.Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University, 2.Faculty of civil Engineering, Saitama University)

[HTT15-P02] Magnetic susceptibility of obsidian from Shirataki, Hokkaido, Japan, to identify the source of obsidian tools

*Kyohei Sano[1] (1.Graduate School of Regional Resource Management, University of Hyogo)

[HTT15-P03] Estimation of uniaxial compressive strength and water permeability from elastic waves measurements in sedimentary stones

*David Benavente[1], Juan Jose Galiana-Merino [2], Concepcion Pla[3], Marli De Jongh[4], Noe Garcia-Martinez[1], Javier Martinez-Martinez[5] (1.Department of Earth and Environmental Sciences, University of Alicante, 2.Department of Physics, Systems Engineering and Signal Theory, University of Alicante, 3.Department of Civil Engineering, University of Alicante, 4.University of Glasgow, School of Geographical & Earth Sciences, 5.Spanish Geological Survey)

[HTT15-P04] INFLUENCE OF POROSITY AND MINERALOGY ON INFRARED THERMOGRAPHY MEASUREMENTS

*Patricia vazquez[1], Thomas Junique[1], Sesil Can[1], Lena Ageorges[1], Dania Benkara[1] (1.University of Reims Champagne Ardenne)

Ultrasonic velocity attempted to the various rocks - laboratory experiment and field measurement -

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The ultrasonic velocity test is one of the non-destructive and easy handling devices that allows the physical and mechanical properties of rocks to be investigated. Despite many research reports, there are still unclear in applying performed in the laboratory and the field as well. In this study, the correlation among porosity, hardness and the ultrasonic velocity was investigated by using soft rocks. First, for various tuffs (Oya tuff, Ashino tuff, Towada tuff, and Tatsuno tuff), the ultrasonic velocity of the rock sample in the air-dried state and the wet state was measured in the laboratory. As a result, the speed in the wet state was higher than the speed in the air-dried state in all cases except Towada tuff. On-site measurements were also performed at the Taya Cave (Sakae-Ku, Yokohama). The Taya Cave is composed of early to mid-Pleistocene deposits and is extremely low in strength. In the field, measurements were taken by the surface method at intervals of 20 cm. Although the sensitivity was low, the measured values converged and reproducible values were obtained.

Keywords: Ultrasonic velocity , Tuff, Taya Cave, Porosity

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Magnetic susceptibility of obsidian from Shirataki, Hokkaido, Japan, to identify the source of obsidian tools

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Magnetic susceptibility is often used to identify the source of tools and tombstones that are made from igneous rocks, such as obsidian and granite. This study reports on how the relationship between magnetic susceptibility and sample thickness of obsidian contributes to identifying the source of obsidian tools. Obsidian samples from Shirataki, Hokkaido, Japan, were analyzed, focusing on those from the lava flows of Tokachi-Ishizawa (TI), Akaishiyama (AK), and Horoka-Yubetsu (HY). The sample thickness ranges from 2.74 to 20.84 mm and the magnetic susceptibility ranges from 6.1 $\times 10^{-5}$ to 4.2 $\times 10^{-4}$ SI for the TI lava, from 2.52 to 13.78 mm and 3.3 $\times 10^{-5}$ to 2.1 $\times 10^{-4}$ SI for the AK lava, and from 2.05 to 23.28 mm and from 1.9 $\times 10^{-4}$ to 7.3 $\times 10^{-4}$ SI for the HY lava, depending on the thickness of the sample wafer. The results revealed that obsidian from the HY lava demonstrated the highest value of magnetic susceptibility among the analyzed samples; thus, obsidian from the HY lava could be identified by this characteristic. Concurrently, heterogeneity in the magnetic susceptibility within a single lava flow was observed in the AK lava. These results could contribute to the identification of the source of obsidian tools and development of nondestructive techniques for measurement of magnetic susceptibility.

Keywords: magnetic susceptibility, obsidian, nondestructive analysis, rock texture

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Estimation of uniaxial compressive strength and water permeability from elastic waves measurements in sedimentary stones

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Uniaxial compressive strength (UCS) and water permeability (WP) are two of the most critical petrophysical parameters used in many fields of engineering and geosciences. Particularly, in stone conservation studies, these parameters are closely related to stone stability and durability in monuments. Although stone conservation studies can require large data sets, many have limited access to samples, and so require non-destructive on-site characterisation of UCS and WP.

Non-destructive methods (NDT) based on elastic wave measurements are commonly used in stone conservation studies and can be performed in both laboratory and field experiments. Experimentally, P-waves are easy to generate and acquire, whereas the generation and acquisition of pure S-waves in rocks can be difficult. Moreover, other ultrasonic parameters from the analysis of the recorded output waveform (mostly of the P-waves) can be extracted. These additional parameters provide complementary information from the same measurement performed for the calculation of P-wave velocity.

In this paper, we estimate USC and WP by combining connected porosity and ultrasonic parameters recorded from P- and S- waves for a wide range of carbonate sedimentary rock types. Fifteen rock samples were measured including calcarenites, sandstones, dolostones and travertines. These rock types are building stones quarried in Spain and were selected based on their different petrophysical and petrographic characteristics.

The ultrasonic measurements were carried out using the transmission method, which consists of two piezoelectric sensors (1 MHz Panametric transducers) coupled to the sample at constant pressure. We determine the onset of P- and S-waves considering signal pre-processing and the analysis of the recorded signals. We calculated P- and S-wave velocities, and the spatial attenuation and the wavelength of the first pulse of P-waves. Statistical analysis was applied to establish the structure of the variable dependence and their interrelationship using the code SPSS 22.0. Statistical analysis includes scattering diagrams and Pearson’s correlation coefficients, a principal component analysis, and a stepwise multiple regression analysis.

Mineralogical composition, porosity and particle size affect the wave velocity, attenuation, wavelength and waveform, which can be used as a selection criterion of parameters in the predictive functions. Results reveal that mineralogical composition significantly affects P-wave velocity values, especially for quartz-bearing rocks. Grain size is also reflected in the waveform. Thus, coarse-grained rocks have the highest wavelength and spatial attenuation. Spatial attenuation is a parameter sensitive to occasional rock defects such as the vuggy porosity observed in travertines. UCS and WP strongly depends on this type of vuggy porosity and how the vuggy porosity is connected.

Several simple and multiple predictive expressions for UCS and WP are fitted, which are quantified

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through the Pearson correlation coefficient (R). Curve fitting improves as the number of petrophysical parameters increases in the multiple linear regressions. The best correlation is found when the predictive equation incorporates all the elastic wave parameters obtained non-destructively and connected porosity for UCS (R=0.921) and WP (R=0.903). Spatial attenuation is the most significant variable of the elastic wave parameters of the fitted regressions, and its addition into multiple linear equations causes an increase of goodness of fit. Connected porosity also improves R whereas wavelength and P-wave velocity have a lower statistical weight in the predictive expressions. The UCS and WC estimation from all NDT, without considering connected porosity, shows a good correlation (R=0.852 and 0.864, respectively). This study shows that UCS and WC can be obtained non-destructively using portable equipment and can provide large data sets at a relatively low cost.

Keywords: Ultrasounds, Hydraulic conductivity, Stone conservation, Petrophysics, Limestone

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INFLUENCE OF POROSITY AND MINERALOGY ON INFRARED THERMOGRAPHY MEASUREMENTS

*Patricia vazquez[1], Thomas Junique[1], Sesil Can[1], Lena Ageorges[1], Dania Benkara[1]

1. University of Reims Champagne Ardenne

Infrared thermography (IRT) is a new tool in development in the field of cultural heritage, due mainly to the fact of being a non-destructive and non-invasive technique. Infrared thermography gives information about the apparent temperature of an object, related to its composition, shape, isolated defects and also decay state. However, within a building, sometimes the images show different values for the same material. Thus, a deep study on the consistency, the repeatability, and the establishment of key values is needed to better understand the reliability of this technique and to improve the accuracy in the stone characterization.

Three kinds of studies were carried out to determine the reliability and the influence of heterogeneity in the infrared thermographic signal:

- Detection threshold of small variations in porosity. For this study, ten cubes of 4 cm size of Fontainebleau sandstone were selected, with pure quartzitic composition, homogeneous grain size and sample color. Differents degrees of grain compaction were observed, which gave enough porosity and variability of physical properties for this study. Porosity was obtained following the standard EN-1936 and capillary water absorption as stated in EN-1925. Ultrasound measurements were measured with a Pundit-PL200 with transducers of 250KhZ. After this characterization, the cooling rate index (CRI) for each sample was obtained by infrared thermography as follows. The samples were dried at a temperature of 70˚C and then extracted at room temperature. The cooling from the time= 30 seconds up to 15 minutes and 30 seconds was monitored with an infrared thermographic camera FLIR A645 at a speed rate of 1 frame every 10 seconds. The data were analyzed with a software researchIR and the CRI calculated as:

T_f-T_o / t_f - t_o

Where To is the average temperature of the measured face at the beginning of the monitoring (to=30 sec after extraction of the oven), Tf is the average temperature of the measured face at a time tf.

A relationship between CRI and the porosity of each stone was studied, as well as the thermal response of each face with its vectorial properties (capillary coefficient and ultrasounds velocity).

-Influence of induced thermal fissuration on the thermosignal. Four granitoids with differences in mineralogy and grain size were tested. The samples were slabs of 7 x 3,5 x 2 cm. One sample of each type was submitted to one high- temperature heating, that is 200˚C, 400˚C, 600˚C, and 800˚C and compared to the intact rock. The heating rate was 6˚C/min to force the fissuration and the samples were kept at the set temperature for four hours, enough to get uniform temperature through the sample. The cooling down was carried out freely with a rate <1˚C/min, to ensure that the damage was only produced by the fast heating. Porosity, capillary water uptake and ultrasounds velocity was determined as in the previous study, as well as CRI calculation by IRT monitoring.

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-Influence of mineralogy on the thermosignal. Each mineral has its own thermal properties. Thus, a rock behaves differently against temperature variations depending on its mineralogy and texture. Ten granitoids with differences in mineralogy and crystal size were heated at 70˚C and the CRI was measured by infrared thermography similarly to the other studies. A relationship between the mineral proportion, grain size and thermal properties of each stone were related to CRI results.

The results showed that only great variations of porosity are related to CRI values as occurred between the intact stone and the rocks heated at 600˚C or 800˚C. Lower temperatures as 200˚C or 400˚C produced a variation of the microstructural system, although the infrared thermography did not permit to differentiate it accurately. Mineralogy plays an important role in CRI values, although the grain size resulted more decisive than the mineral proportion.

Keywords: infrared thermography, porosity, mineralogy, cooling rate index

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[E] Poster | H (Human Geosciences)：H-CG Complex & General

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.12_1

[H-CG22] Nuclear Geoscience in Developing Countries

convener:Mohammad Rajib(Bangladesh Atomic Energy Commission)

Application of nuclear techniques are being utilized in various fields of geoscience for many years. We would like to hear about the research outcomes of those studies, specially which are being conducted in developing countries. Peaceful application of nuclear energy is a very potential way of advanced researches and with the development of such techniques, many problems have been successfully solved in different countries. This session would like to accumulate the findings of such success stories and to gather various types of nuclear geoscience research at one place. Researches conducted in developed countries which can be implemented in any low or middle income countries with limited resources are also welcomed. Therefore, main objective of the session is to know various types of nuclear geoscientific researches which can be helpful in obtaining sustainable development.

[HCG22-P01] Radioactive waste disposal in Japan, especially focused on geological disposal of high-level radioactive waste

★Invited Papers

*Eiji Sasao[1] (1.Tono Geoscience Center, Japan Atomic Energy Agency)

[HCG22-P02] Effect of external radioactivity on the mineral grains from placer deposits of Bangladesh

*Mohammad Rajib[1,2,3], Mahmudul Hossain[1,4], Md. Fahad Hossain[1,5], Tumpa Saha[1,5] (1.Bangladesh Atomic Energy Commission, 2.Atomic Energy Research Establishment, 3.Institute of Nuclear Minerals, 4.Sterile Insect Technique Unit and INMAS, Cox's Bazar, 5.Beach Sand Minerals Exploitation Centre, Cox's Bazar)

Radioactive waste disposal in Japan, especially focused on geological disposal of high-level radioactive waste

*Eiji Sasao[1]

1. Tono Geoscience Center, Japan Atomic Energy Agency

Disposal of radioactive waste is one of the important issues for peaceful utilization of nuclear power. Trench and pit disposals have been performed for low- and intermediate-level radioactive waste in many countries: however, progress on geological disposal program varies from country to country.

In Japan, there are four principles of the treatment and disposal of radioactive waste: 1) the liability of generators, 2) minimization of radioactive waste, 3) rational treatment and disposal, and 4) implementation based on mutual understanding with the people. Under these principles, it is important to make appropriate classifications of the wastes and treat and dispose of them safely for each classification based on the recognition that the wastes may include materials with characteristics that take an extraordinary long time for the radioactivity to drop to insignificant levels (Japan Atomic Energy Commission, 2015).

Radioactive wastes generated by nuclear power are generally classified into low-level waste (LLW) and high-level waste (HLW), based on its origin and level of radioactivity in Japan. HLW is produced through the reprocessing spent fuel, and the others are classified as LLW. Disposal method is selected from the following four methods according to waste properties and radioactivity levels etc.; sub-surface trench, sub-surface pit, mid-depth underground and deep geological disposals.

A disposal business has already been established for most of the LLW generated at nuclear power plants. While the selection of a high-level waste repository site will be undertaken via a three-stage process based on the “Final Disposal Act”. The site selection procedure specified in the Final Disposal Act consists of three steps; literature survey, preliminary investigations and detailed investigations. Literature survey has actually been initiated in two municipalities of the northern part of Japan.

Geoscientifically, Japan is located on plate-boundary and affected by intense geological phenomena such as volcanic and fault activities, and erosion. A LLW disposal facility is regulated to locate in an area without influence of earthquake, tsunami and volcano (Sema, 2020). As for the mid-depth disposal, a repository should be located in an area without influence of volcanic activity, faulting and erosion for at least 100,000 years.

Since HLW will last higher radioactivity than natural uranium ore in the order of 100,000 years, it is necessary to consider longer time safety. In Japan, the Nationwide Map of “Scientific Features” relevant for Geological Disposal” was published. The map shows nation-wide distribution of unfavorable and preferable geoscientific features.

In this presentation, the speaker will introduce outline of radioactive waste disposal in Japan and geoscientific features preferable for HLW disposal.

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Reference

Japan Atomic Energy Commission (2015) Framework for Nuclear Energy Policy

http://www.aec.go.jp/jicst/NC/tyoki/taikou/kettei/eng_ver.pdf

Sema (2020) Journal of Nuclear Fuel Cycle and Environment, vol.27, pp.40-42.

Keywords: Radioactive waste, Geological Disposal

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Effect of external radioactivity on the mineral grains from placer deposits of Bangladesh

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1. Bangladesh Atomic Energy Commission, 2. Atomic Energy Research Establishment, 3. Institute of Nuclear Minerals, 4. Sterile Insect Technique Unit and INMAS, Cox's Bazar, 5. Beach Sand Minerals Exploitation Centre, Cox's Bazar

Major beach placers of Bangladesh, such as ilmenite, magnetite, rutile, zircon, garnet along with potential monazite concentrated and silica were undergone irradiation. Co-60 gamma irradiator was utilized to irradiate the separated minerals. Objective of this research was to observe any effect of gamma irradiation to the morphology and composition and thereby obtaining information of possibility of synthesizing any mineral. The mentioned heavy minerals have variety of industrial uses. Among them, ilmenite has the largest quantity in beach placer deposits of Bangladesh. However, the chemical grade of Bangladesh ilmenite has lagging behind the international grade, with TiO_2 content of approximately 35% and Fe of 55%. Therefore, potential utilization of these ilmenites for Ti are still not possible. Moreover, zircon and monazite contains radioactive materials needs to be studied in details for the presence of radioactive and rare earth element. Placer garnet and silica could be a potential industrial mineral if characterized properly. As nuclear geoscientific research activity, the present study reports the characterization of those minerals with the artificially induced radiation.

Individual minerals were separated from beach sand and upgraded to best possible physical grade by density, magnetic and electric separators. Gamma dose of 0.01, 0.1 million Grey (mGy) was provided by the Co-60 source of initial activity of 12 KiloCurie, KCi (with present source activity of 9.511 KCi) and with 100% source efficiency. The samples were again irradiated at 1.0 mGy with similar source of approximate present activity of 90 KCi (from initial source activity of 350 KCi). Microscopic observation, X-ray diffraction analysis and elemental composition was attempted before and after irradiation, and radiation induced effects was analyzed. The study would provide the characterization of those minerals for various application. Besides, it would also contribute to the study of the minerals' property in the case of any radiation effect of geological materials in any potential host rock of geological repository for radioactive waste.

Keywords: Gamma irradiator, Radioactivity, Placer Mineral, Bangladesh

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[E] Poster | S (Solid Earth Sciences)：S-SS Seismology

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.13_1

[S-SS03] New insights in Earthquake predictability: modelling and forecasting

convener:Hiroshi Tsuruoka(Earthquake Research Institute, Tokyo Univ.), Jiancang Zhuang(Institute of Statistical Mathematics), Danijel Schorlemmer(GFZ German Research Centre for Geosciences), Naoshi Hirata(National Research Institute for Earth Science and Disaster Resilience)

Probabilistic models have been developed for describing, analyzing, and forecasting seismicity, including recurrence and stress-release models for long-term earthquake hazard assessment, and short-term models describing earthquake clustering, e.g. the ETAS model. Some models have become standard tools in seismic hazard assessment. The Collaboratory for the Study of Earthquake Predictability and its Japan branch has provided the testing capabilities for rigorous and unbiased evaluation of forecasting models. This session invites contributions of model developments based on the increased understanding of the physical process of earthquakes, such as the preparation and rupture processes of the earthquake source and the interaction between earthquakes and tectonic environments. We also welcome development and implementation of improved statistical methods for forecasting seismicity

[SSS03-P01] A spherical version of the space-time ETAS model

*Jiancang Zhuang[1], Ziyao Xiong[1], Yosihiko Ogata[1] (1.Institute of Statistical Mathematics)

[SSS03-P02] Nonstationary Renewal Model for Forecasting Repeating Earthquakes under Aftershock-Triggering Effects

*Shunichi Nomura[1], Masayuki Tanaka[2] (1.The Institute of Statistical Mathematics, 2.Meteorological Research Institute)

[SSS03-P03] Machine Learning Models for Earthquake Number Forecasting in the Kanto Region

*Hanyuan Huang[1], Hiroe Miyake[1], Hiroshi Tsuruoka[1] (1.Earthquake Research Institute, University of Tokyo)

A spherical version of the space-time ETAS model

*Jiancang Zhuang[1], Ziyao Xiong[1], Yosihiko Ogata[1]

1. Institute of Statistical Mathematics

In this study, by modifying the spatial response function in the triggering term, we propose and implement a spherical version of the space-time ETAS model. At the small local scale, the new model is equivalent to the original 2D planar ETAS model. We analyze and forecast global seismicity with this new model, and test some interesting hypotheses related to global seismicity, such as antipolar triggering phenomena.

Keywords: ETAS model, Spherical, earthquake clustering, earthquake forecast

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Nonstationary Renewal Model for Forecasting Repeating Earthquakes under Aftershock-Triggering Effects

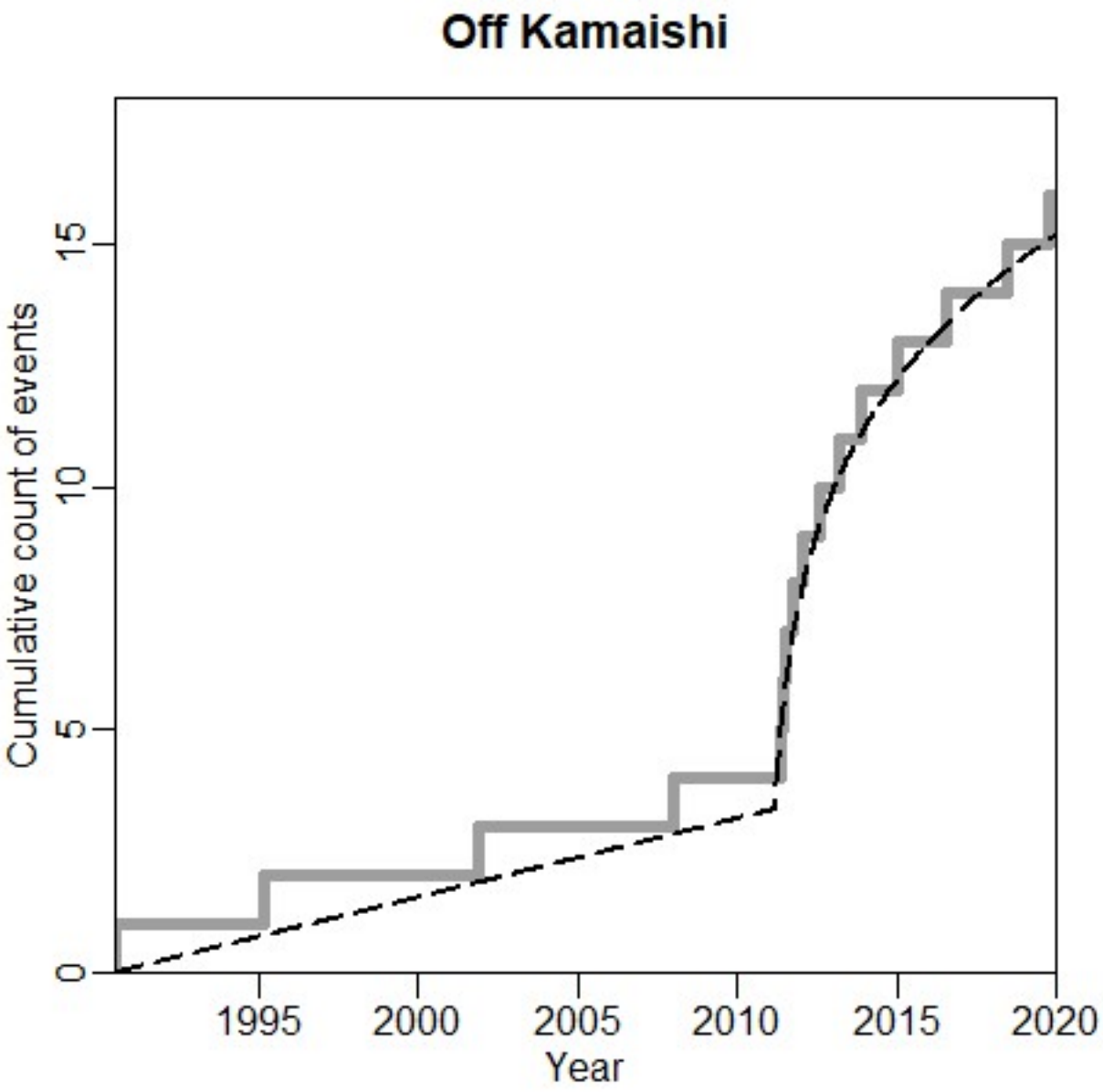
*Shunichi Nomura[1], Masayuki Tanaka[2]

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The point process models to predict earthquake occurrences are roughly classified into two types except for the simplest Poisson process; one is the renewal process for repeating earthquakes and the other is the ETAS (Epidemic-type aftershock sequence) model taking the aftershock-triggering effect of every earthquake into account. However, relatively small repeating earthquakes have the characteristics of both models such that they usually recur periodically but their recurrence intervals get much shorter after nearby large earthquakes. We propose a nonstationary renewal process model for such repeating earthquakes that incorporates the aftershock-triggering effect of nearby large earthquakes as a relative change in the loading rate. We apply the proposed model to the repeating earthquake catalog on Pacific Plate subduction zone in the northeastern Japan and evaluate probabilistic forecasts of the next repeating events considering the aftershock-triggering effect of the 2011 Tohoku earthquake.

Keywords: Recurrent earthquakes, Renewal processes, ETAS model

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Machine Learning Models for Earthquake Number Forecasting in the Kanto Region

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Machine learning techniques are developing in seismology contributed by the increasing amount of observable information. Some researchers suggest the earthquake cannot be predicted while many others think it is a predictable phenomenon. Through years of research, some regularities and patterns are found in the spatial and temporal distribution of seismicity. This research focuses to forecast the earthquake number on a certain day by using machine learning techniques to analyze past earthquake catalog, which could be considered as a reference for future earthquake hazard evaluation. We obtained the earthquake catalog of the Kanto region (longitude from 34.5 to 37.0, latitude from 138.5 to 141.5) from the Japanese Meteorological Agency (JMA), from 1 January 1999 to 31 December 2019. And the earthquake catalog is converted to statistical data in the patterns of the summation, mean, median, and max value of earthquake magnitude and number in different time windows (1 day, 3 days, 5 days, 7 days, 1 month, 2 months, 3 months, and one year) before the targeted day. As the machine learning models, multiple linear regression (MLR), and a 9 layers recurrent neural network (RNN) containing full connected layers, convolution layers, and long short-term memory (LSTM) layers are applied. Considering that the different patterns may exist in different depth and magnitude, we built different datasets containing earthquakes whose JMA magnitude (M_J) are greater or equal to 2.0 (M_J 2.0 sets), 3.0 (M_J 3.0 sets), and 4.0 (M_J 4.0 sets), with depths in the range of 0–30 km, 0–100 km, and 30–100 km respectively. The ratio of training, validation, and test sets is 6:2:2, and each model is trained separately. In the sector of results, because the recorded catalog with magnitudes of 2.0 or larger in 0–100 km set is abundant almost linearly related to the time except at around December 2016 when a shallow M_J 6.3 earthquake occurred, both MLR and RNN models perform pretty well, but in 0–30 km set, the MLR model almost totally fail to fit the trending while the RNN model still yields good forecasting. Among all the test tests, the results yielded from the MLR model are unstable while the performance of the RNN model is always satisfactory. Compared the results from machine learning models with the epidemic type aftershock sequence (ETAS) model, in all tested sets (M_J 3.0 sets and M_J 4.0 sets), the RNN model yielded the best results in cumulative number forecasting ranging from 1 January 2016 to 31 December 2019 while each the ETAS model and the MLR model reaches the second tier at times. For instance, the observed number of earthquakes with magnitudes of M_J 3.0 or larger with depth 0–100 km is 1519, and the forecasted value from RNN, MLR, and ETAS model is 1408, 1166, 1967. Yet the RNN model’s performance right after a relatively large earthquake is worse than others, and the MLR model lacks stability prominently. To conclude, we applied a recurrent neural network to forecast the number of earthquakes in the Kanto region. Even though the large magnitude earthquake number forecasting in a short term time-window (one day) seems impossible, the RNN model can output more accurate results in a long term time-windows cumulative number forecasting compared with the ETAS model, and this result may indicate that the earthquake temporal distribution can be better described by deep layer machine learning models.

Keywords: earthquake number forecasting, machine learning, long short-term memory

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[E] Poster | S (Solid Earth Sciences)：S-IT Science of the Earth's Interior & Techtonophysics

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[S-IT17] Property and role of liquids inside terrestrial planets

convener:Tatsuya Sakamaki(Department of Earth Science, Tohoku University), Yoichi Nakajima(Kumamoto University, Priority Organization for Innovation and Excellence)

Liquids of silicates and metals inside terrestrial planets play important role in the physical, chemical, and thermal evolutions of planets. This session aims at understanding the physical and chemical properties of liquids from shallow to deep parts of terrestrial planets, which are strongly related to the long history of those planets from the planetary accretion to the present-day dynamics. In addition, we call for presentations by researchers from various backgrounds of geochemical, experimental, theoretical/computational, and seismic/geodynamical ones, who investigate the physical and chemical properties of liquids and the behaviors and roles inside of terrestrial planets. Relevant topics include, but are not limited to, partial melting and melt extraction, liquid-solid partitioning, high pressure experiments on melts, and seismic detections of mantle melts and outer core anomaly.

[SIT17-P01] Viscosity of silicate melts under high pressures

*Tatsuya Sakamaki[1] (1.Department of Earth Science, Tohoku University)

[SIT17-P02] Elastic wave velocity of silicate glasses at high pressure

*Tatsuya Sakamaki[1] (1.Department of Earth Science, Tohoku University)

[SIT17-P03] Density of Fe_2O_3–bearing magma under high pressure

*Rintaro Ban[1], Akio Suzuki[1], Tatsuya Sakamaki[1] (1.Department of Earth Science, Graduate School of Science, Tohoku University)

[SIT17-P04] **Melting phase equilibrium relations in the $MgSiO_3$-SiO_2 system at 13.5 GPa**

*Takuya Moriguti[1], Yusuke Yachi[1], Akira Yoneda[1], Eiji Ito[1] (1.Institute for Planetary Materials, Okayama University)

Viscosity of silicate melts under high pressures

*Tatsuya Sakamaki[1]

1. Department of Earth Science, Tohoku University

I would like to review the viscosity measurements of silicate melts at high pressure. The viscosity of silicate melts controls their mobility, and gives us important knowledge about the timescale of volcanic activities and eruption styles in the present Earth. In addition, viscosity plays a central role in the dynamics of a terrestrial magma ocean, core formation, and chemical differentiation of the mantle in the Earth’s early history. For silicate melts, viscosity measurements at high pressure have been performed by a falling sphere method using a large volume press. The falling sphere method has been significantly advanced by combination with synchrotron-based X-ray radiography, which enables us to determine the melt viscosity more accurately. Because the viscosity of silicate melts is considered to be closely related to the network structure, simultaneous measurements of viscosity and structure at high pressure and high temperature significantly have enhanced our understanding of the relationship between viscosity and structure.
The ratio between the number of non-bridging oxygen anions (NBO) and that of tetrahedrally coordinated cations (T), NBO/T, is widely used as an indicator of the network structure of silicate melts. The degree of polymerization, which increases with decreasing NBO/T, has long been recognized as a fundamental structural factor influencing physical properties. Also, the viscosity of silicate melts is characterized by the degree of polymerization. Polymerized melts show higher viscosity at ambient pressure due to their strong three-dimensional network featuring oxygen bridges between tetrahedral cations. Depolymerized melts have lower tetrahedral connectivity and lower viscosity. The contrasting behavior between polymerized and depolymerized melts is also shown in the pressure dependence of viscosity. Although free-volume theory predicts that viscosity increases with pressure, isothermal viscosity of polymerized melts decreases with pressure up to 3-5 GPa, above which it turns over to positive pressure dependence.

Keywords: Viscosity, Silicate melt, High pressure

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Elastic wave velocity of silicate glasses at high pressure

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I would like to review the elastic wave velocity measurements of silicate glasses under high pressures. Knowledge of the elastic properties of silicate melts/glasses enables us to infer the magma behavior at high pressure. Elastic wave velocities have been reported for several silicate glasses. Sakamaki et al. (2014) have investigated sound velocities of polymerized (jadeite and albite composition: NBO/T=0 at 1 atm) and depolymerized (diopside composition: NBO/T=2 at 1 atm) glasses at pressures up to 10 GPa using an ultrasonic technique and synchrotron radiation in a Paris-Edinburgh press, and demonstrated the dichotomous trend of elastic wave velocity of silicate glasses. The pressure dependence of velocities also clearly falls into two groups, one for polymerized (jadeite, albite, and silica) glasses, and the other for depolymerized (diopside and enstatite) glasses. These results indicate that the degree of polymerization fundamentally affects the behavior of silicate glasses under compression. For fully polymerized glasses, sound velocities first decrease with pressure before increasing above a certain pressure, similarly to silica glass. The velocity softening is much more pronounced for V_S than V_P. In contrast, for partially depolymerized glasses such as diopside and enstatite glasses, both V_P and V_S change only slightly with increasing pressure, a behavior different from that of polymerized glasses. The cation substitution of Fe and Al into the enstatite composition glass reduces the velocities at ambient pressure. Glasses with higher SiO_2 content have lower sound velocities, while the higher MgO content promotes increases in velocities. Basaltic glasses, which have the most complex composition among all glasses and an NBO/T around 0.7, have an intermediate pressure dependence: V_P and V_S decrease slightly with increasing pressure.

Keywords: Elastic wave velocity, Silicate glass, High pressure

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Density of Fe_2O_3–bearing magma under high pressure

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1. Department of Earth Science, Graduate School of Science, Tohoku University

Previous studies indicate the high concentration of Fe_2O_3 in the lower mantle. Even though the partial molar volume of Fe_2O_3 has become essential for discussing the magma in the deep mantle, there is no data of partial molar volume of Fe_2O_3 at high pressure and temperature. This study is aimed to obtain partial molar volume of Fe_2O_3 in silicate melts under high pressure. Fe_2O_3 -bearing starting material was compressed by a Kawai-type multi-anvil apparatus. We determined the density of silicate melts using sink-float method. By combining the density and the equation of state of silicate melts proposed in Wakabayashi and Funamori (2013), partial molar volumes were yielded.

Keywords: magma, lower mantle, sink-float method, partial molar volume

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Melting phase equilibrium relations in the $MgSiO_3$-SiO_2 system at 13.5 GPa

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Melting relations in the system $MgSiO_3$-SiO_2 were investigated at 13.5 GPa and up to 2900 ºC using the Kawai-type of multi anvil apparatus (KMAA) in this study. The melting relations of the system MgO-SiO_2 as a representative of the mantle have been extensively studied since a pioneering work by Bowen and Anderson (1914). However, almost all of these works have been carried out on the compositions ranging from MgO to $MgSiO_3$ because the bulk mantle composition has been assumed to be peridotitic or close to that derived from CI chondrite. On the other hand, enstatite chondrite (E-chondrite) has been recommended as the source material of bulk Earth (e.g., Javoy et al., 2010) because the isotope compositions of the Earth, Moon and E-chondrite are indistinguishable over O, N, Mo, Ru, Os, Cr, and Ti. In order to understand the mantle differentiation in the E-chondrite model, it is indispensable to clarify the melting relations in the system $MgSiO_3$-SiO_2 at high pressures. Nevertheless, there have been limited works on the melting behavior of the system $MgSiO_3$-SiO_2 under high pressures. In this study, we aimed to determine the melting relations in the system $MgSiO_3$-SiO_2 at 13.5 GPa as precisely as possible using the KMAA. We found that the X_{Si} value (SiO_2/(SiO_2+MgO) (mol)) of the eutectic composition increases from 0.556 to 0.61 at a range from 1 to 13.5 GPa (down to ~400 km depth in mantle) (Hudon et al., 2005; Dalton and Presnall, 1997; Moriguti et al., under review), which are close to those of E-chondrites (0.533 - 0.577). This implies that if bulk Earth composition corresponds to E-chondrites, the upper mantle composition resulting from fractional crystallization of a terrestrial magma ocean would be around 0.6 in X_{Si}, significantly enriched in SiO_2 compared with estimates of the current upper mantle composition, 0.47. In addition, melting relations in the $MgSiO_3$ - SiO_2 system up to 13.5 GPa show that the liquidus phase is enstatite if E-chondrites melted in the magma ocean. Consequently, it is impossible to produce the present upper mantle composition through simple fractional crystallization processes without efficient Si partitioning out from a silicate mantle to molten iron (the core).

In the present study, the sample heating was conducted up to 2900 ˚C. In this presentation, the special endeavor to pressure calibration at such extreme temperature are also shown. In the multi anvil apparatus, the generated pressure is substantially altered on heating the specimen due to the increases of the thermal expansion and the fluidity of the pressure medium as shown in previous works conducted at high temperatures, > 1000 ˚C (e.g., Gasparik, 1989; Ito and Takahashi, 1989). However, the high temperature effect to the generated pressure under > 2000 ˚C has not been known well. Therefore, the temperature effect was also evaluated at 2500 and 2850 ˚C on the basis of phase transition between coesite and stishovite in SiO_2 determined by Zhang et al. (1996). Compared with the generated pressure at room temperature (10.5 GPa), the pressure increases by 2.1 and 3.0 GPa were recognized at 2500 ˚C against the press load of 2.25 MN and at 2850 ˚C against that of 2.4 MN, respectively.

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Keywords: MgSiO3-SiO2 system, Enstatite chondrite model, Mantle, Multi anvil, High pressure and high temperature, Pressure calibration

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[S-IT20] MAGMA, FLUID TRANSPORT, AND SEISMICITY IN THE EARTH'S INTERIOR

convener:Eiji Ohtani(Department of Earth and Planetary Materials Science, Graduate School of Science, Tohoku University), Saeko Kita(International Institute of Seismology and Earthquake Engineering, BRI), Michihiko Nakamura(Division of Earth and Planetary Materials Science, Department of Earth Science, Graduate School of Science, Tohoku University), Bjorn Mysen(Geophysical Laboratory, Carnegie Inst. Washington)

The mass transfer depends on properties of the Earth's materials and geodynamic processes including cold slab subduction and magmatism due to hot plume activity. The mass transfer processes are imaged by geophysical observations such as seismic tomography and electrical conductivity profiles. One of the most important processes to transport volatiles is the slab subduction. The degree of hydration and dehydration in the slab is essential to evaluate amounts of volatiles transported into the deep mantle. Hydration and dehydration in the slab directly related to slab earthquakes, deformation of the slabs, and the arc magmatism. The fate of the fluid dehydrated in the deep slab is also a debated issue since permeability at the depth may be small, and the fluid might be trapped in the slabs and transported in the deep earth's interior at that depths without escaping to the mantle wedge. Recent seismic tomographic studies of the slab revealed direct observations of hydration and dehydration sites in the slabs. There exists growing evidence for alteration and hydration of the old lithosphere due to fracturing and Putit spot volcanisms which affect the volatile transport into the deep mantle due to slab subduction. The mass transfer to the surface can also be observed as the volcanic eruption in which phase separation of magma and fluid, and crystallization during the magma ascent controls the type of eruptions. The proposed session will focus on those phenomena including laboratory experiments, numerical modeling, and geophysical and geochemical observations including physical and chemical properties of magma and fluid, and geophysical imaging of various scales including seismic tomography of the descending slabs, and monitoring of near surface processes of volcanic eruptions. Contributions to any of these subjects are encouraged. We also encourage papers stimulating an interdisciplinary collaboration relating to establishment of the SEDI-Japan community.

[SIT20-P01] Electrical conductivity in texturally equilibrated fluid-bearing forsterite aggregates at 800°C and 1 GPa: implications for the high electrical conductivity anomalies in mantle wedges

*Yongsheng HUANG[1], Haihao Guo[2], Takayuki Nakatani[1,4], Kentaro Uesugi[3], Michihiko Nakamura[1], Hans Keppler[2] (1.Graduate School of Science, Tohoku University, 2.Bayerisches Geoinstitut, University of Bayreuth, 3.Spring-8, Japan Synchrotron Radiation Research Institute (JASRI), 4.Geological Survey of Japan)

[SIT20-P02] Role of water in subducting slabs: dry phase transformation kinetics in wet slabs

*Eiji Ohtani[1], Takayuki Ishii[2,3] (1.Department of Earth and Planetary Materials Science, Graduate School of Science, Tohoku University, 2.Bayeriches Geoinstitut, University of Bayreuth, 3.Center for High Pressure Science and Technology Advanced Research)

[SIT20-P03] Melting phase relation of hydrous peridotite at the top of the lower mantle

*Kayan Lau[1], Takashi Yoshino[1], Hideharu Kuwahara[1] (1.Institute for Planetary Materials, Okayama University)

[SIT20-P04] Completeness magnitude of earthquakes and spatial variations of b-VALUE in Myanmar

Ngun Za Iang[1], *Saeko Kita[2] (1.Department of Meteorology and Hydrology (DMH), Ministry of Transport and Communications, Naypyitaw, Myanmar, 2.Building Research Institute)

Electrical conductivity in texturally equilibrated fluid-bearing forsterite aggregates at 800ºC and 1 GPa: implications for the high electrical conductivity anomalies in mantle wedges

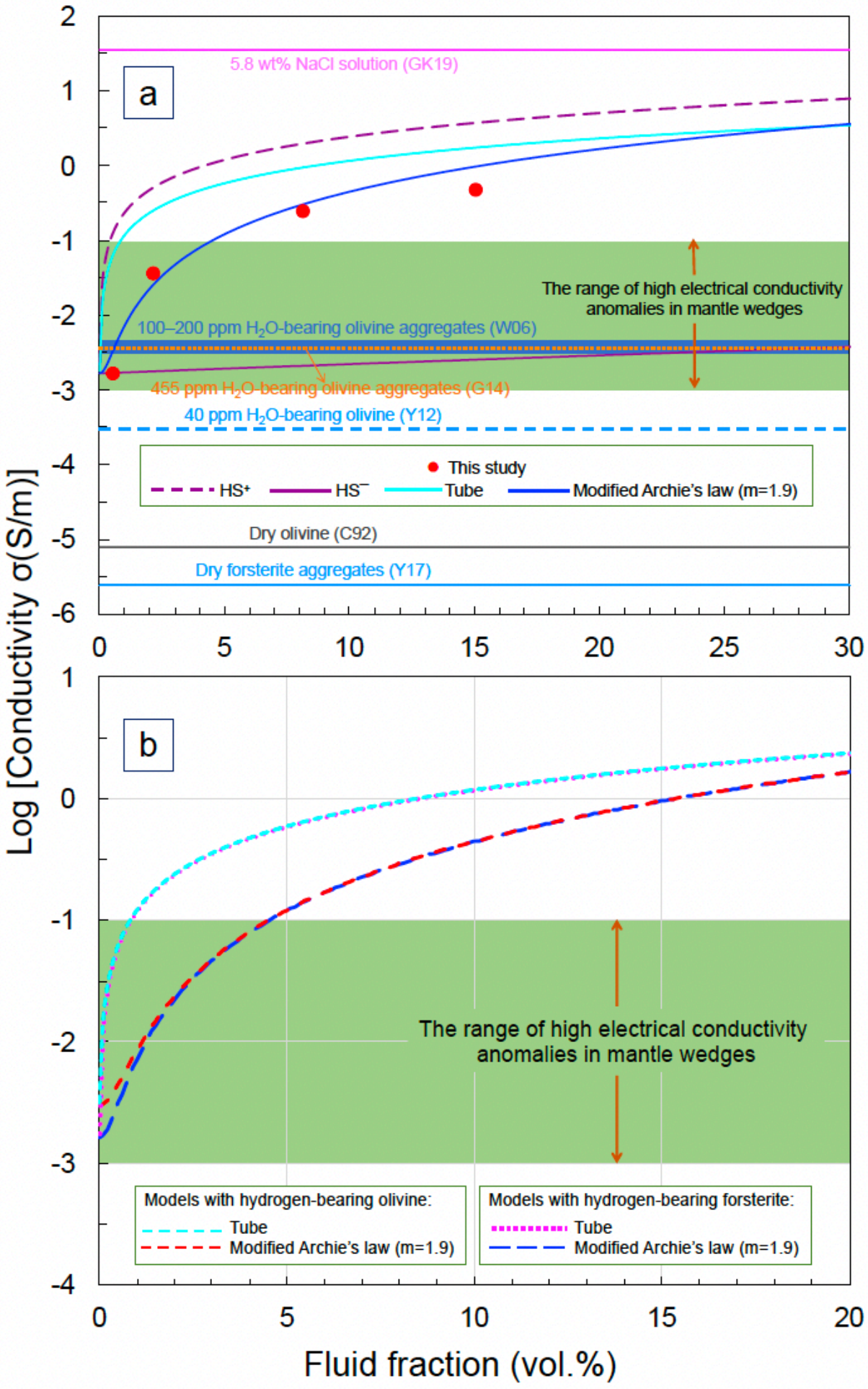
*Yongsheng HUANG[1], Haihao Guo[2], Takayuki Nakatani[1,4], Kentaro Uesugi[3], Michihiko Nakamura[1], Hans Keppler[2]

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In subduction zones, aqueous fluids released from the subducting slab percolate through the mantle wedge, controlling arc magma genesis and element recycling. Because the presence of fluid significantly enhances the bulk electrical conductivity of rocks, the distribution of fluids in subduction zones may be imaged by magnetotelluric (MT) observations. Recently, a growing number of MT observations have revealed high electrical conductivity anomalies (0.001–1 S/m) in the deep fore-arc crust and mantle wedge in some subduction zones. The precise determination of fluid fraction is essential to understand bulk physical-properties such as rheology and permeability, and the geophysical-state of the mantle. Laboratory-based electrical conductivity measurements are an effective method to estimate the fluid distribution and fraction in a fluid-bearing rock. In this study, the electrical conductivity of texturally equilibrated fluid-bearing forsterite aggregates was for the first time measured for various fluid fractions at a constant salinity of 5.0 wt.% NaCl at 1 GPa and 800 ˚C. We found that the electrical conductivity nonlinearly increases with increasing fluid fraction, and the data can be well reproduced by the modified Archie’s law model. Three-dimensional (3-D) microstructure of interstitial-pores visualized by the high-resolution synchrotron X-ray computed micro-tomography shows a change in fluid distribution from isolated pockets at fluid fraction of 0.51 vol.% to interconnected networks at fluid fractions of 2.14 vol.% and above due to grain anisotropy and grain size differences, accounting for the nonlinear-increase in the electrical conductivity. The rapid-enhancement of conductivity indicated that there is a threshold fluid fraction between 0.51 and 2.14 vol.% for forming interconnected fluid networks, which is consistent with the 3-D images. Our results provide direct evidence that > 1.0 vol.% aqueous fluid with 5.0 wt.% NaCl is required to explain the high conductivity anomalies above 0.01 S/m detected in deep fore-arc mantle wedges. This work was supported by JSPS Japanese–German Graduate Externship, International Joint Graduate Program in Earth and Environmental Sciences, Tohoku University (GP-EES).

Keywords: Electrical conductivity, Brine-bearing forsterite aggregates, Textural equilibrium, X-ray CT, Mantle wedge, Subduction zones

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Role of water in subducting slabs: dry phase transformation kinetics in wet slabs

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We have investigated the water partitioning between nominally hydrous minerals and hydrous minerals under the water-undersaturated conditions. Our experiments on partitioning of water between olivine and hydrous phase A, wasleyite and hydrous phase A, bridgmanite and phase D/phase d revealed that water is strongly preferred to hydrous phases resulting in formation of nearly dry nominally anhydrous minerals such as olivine (<1 ppm), wadsleyite (<300ppm), and bridgmanite (<1ppm) under the water-undersaturated conditions.

Oceanic lithosphere generated at the ridge originally contains very small amount of water about 100-200 ppm [1]. However, after formation of the oceanic plates, various processes provided hydration of the oceanic plates such as ascending plumes across the lithosphere [2], Putit spot volcanisms recently discovered in the back-arc regions [3], fracturing of the plate bending at the shallow depths of the slab subduction estimated from the seismicity near the trenches [4, 5]. Seismic tomography studies in subducting slabs [6, 7] and distributions of the intermediate earthquakes such as double seismic zones reveal that wet regions in the slabs extend into exceeding 50 km inward from the slab surface [8, 9]. We estimated the average water contents in the slabs based on the analyses of geophysical observations and mineral physics data on hydrous and nominally hydrous minerals by Hacker et al. [10] to be in the range from 1600-3500 ppm. These water contents in the slabs together with our experiments reveal that water in the slabs is stored in hydrous minerals, i.e., the subducting slabs are under the wet conditions, whereas coexisting nominally anhydrous minerals contain very small amount of water, resulting in dry conditions.

Rheology and deformation of dry olivine and its phase transformation kinetics have been applied for the large deformation of subducting slabs in the mantle transition zone [11] and origin of the deep seismicity [12, 13]. Geophysical and mineral physics data together with our experiments revealed that subducting slabs are under the wet conditions, and water in the slabs is stored only in hydrous minerals, and coexisting nominally anhydrous minerals are essentially dry. Therefore, the dry transformation kinetics of olivine and its high-pressure polymorphs can be applied even for the wet slabs under water-undersaturated conditions. Our results also revealed that hydrous minerals with dry anhydrous minerals could exist in wet slabs at the top of the lower mantle. Therefore, some of the deep earthquakes occurred at the depths exceeding 660 km may be caused by dehydration of hydrous minerals such as superhydrous phase B or phase D which is stable at the top of the lower mantle [14].

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Keywords: Hydrous mineral, Nominally hydrous mineral, Subducting slab, Water content, Seismicity, Phase transforamation kinetics

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Melting phase relation of hydrous peridotite at the top of the lower mantle

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Previous seismic observations on the Earth’ s mantle have found the low-velocity anomaly around 750 km depth and proposed the existence of partial melting layer atop the lower mantle (e.g., Schmandt et al., 2014; Liu et al., 2018). This layer could be formed by dehydration melting upon the decomposition of hydrous ringwoodite to bridgmanite and ferropericlasein downward flow from the mantle transition zone into the lower mantle.According to the melting relation of hydrous KLB1 peridotite in this depth reported by Kawamoto (2004), at lower temperatures less than 1300C, dense hydrous Mg silicate (DHMS) phases should appear rather than dehydration of ringwoodite. In addition,the observed seismic low-velocity region is approximately 100 km deeper than the ringwoodite-bridgmanite phase transition depth (i.e., 660 km), suggesting that the major cause of partial melting at the top of the lower mantle has been poorly understood.
In order to constrain the melting phase relation of hydrous peridotite at the top of the lower mantle, we conducted high-pressure experiments using a Kawai-type multi-anvil apparatus. The starting material was a powder mixture of natural KLB1 peridotite and brucite + talc as a water source. High-pressure experiments were performed at various pressures from 22 GPa to 28GPa and temperatures from 1200C to 1400C. The recovered samples were observed by scanning electron microscope, and phases were identified by micro-focused X-ray diffractometer, and infrared spectroscopy. In the presentation, we will discuss the origin of the low velocity anomalyfrom the view point ofdehydration melting at the top of the lower mantlebased on the melting phase relation of hydrous peridotite.

Keywords: hydrous phase, melting, lower mantle, low-velocity anomaly

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Completeness magnitude of earthquakes and spatial variations of b-VALUE in Myanmar

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In order to estimate completeness magnitude of earthquakes and b-value of events in Myanmar and surrounding areas, we examined 1,350 hypocenters in the NEDC (National Earthquake Data Center, Myanmar) hypocenter catalog from 2014 to 2018, which determined by a hypocenter determination code SEISAN (Havskov and Ottemoller, 2010) and 21 seismic stations. The completeness magnitude (Mc) was estimated as 2.8 with a b-value of 0.68±0.02 in the whole study area, and the b-values regionally varied from 0.52 to 1.0. The values of completeness magnitude became improved with increase of time. The tendency relation between b-value and faulting styles was found along the Sagaing Fault. The southern part with a smaller b-value indicates thrust type focal mechanism, whereas the northern part with a larger b-value shows strike-slip type focal mechanism. The b-value generally increases with the increase of depth in the whole study area. In the active fault region, the b-value decrease with the increase of depth at depths of less than 15 km. At a depth of more than 15 km, the b-value then increases with the increase of depth. In contrast, a significant decrease of b-value with depth was observed at depths of 75-85 km in the subduction zone of the study region, which could be related with the dehydration process in the subducting oceanic plate. The information of spatial variation of b-value could help to understand the seismotectonics beneath Myanmar and the methodology of this study might be fruitful for the evaluation of ability of detectivity of seismicity there.

Keywords: b-value, Myanmar, intraslab earthquake, the Sagaing Fault, seismicity

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[S-MP24] Supercontinents and Crustal Evolution

convener:Tomokazu Hokada(National Institute of Polar Research), Tetsuo Kawakami(Graduate School of Science, Kyoto University), Krishnan Sajeev(Centre for Earth Sciences, Indian Institute of Science), Madhusoodhan Satish-Kumar(Department of Geology, Faculty of Science, Niigata University)

Supercontinent formation and dispersion has been enigmatic in the Earth's history. Eurasia is one such current supercontinent and incredible progress in the understanding of its geological evolution has been achieved in the past decade. Earlier supercontinents in the Earth's history such as Gondwana (0.5 Ga), Rodinia (1.0 Ga), Columbia/Nuna (2.0 Ga), Kenorland (2.5 Ga) and Vaalbara (3.1 Ga), have been the focus of several studies, however limited information on older supercontinents has restricted an understanding their tectonic evolution. Several important unsolved issues remain, such as how, when and where these supercontinents formed and how long they remained as such before breaking apart. Additional questions arise on the processes that triggered the fragmentation and unification of continents. In this session, we invite authors around the world to present original new data as well as review results on the continental scale crustal processes and tectonic evolution that are associated with supercontinent formation events in Earth's history. The well-studied Eurasia and Gondwana supercontinents are of particular focus. Topics of interest include, but not restricted to, extremes in metamorphism, P-T-d-t evolution, magmatism, and the role of fluids. We hope to provide a platform for scientific discussions that will enlighten our understanding of the physical and chemical processes in the continental crust that records episodes of orogenesis that contributed to the formation and evolution of supercontinents.

[SMP24-P01] Geochronology of the metamorphic rocks at the Oyayubi ridge of Brattnipene, Sør Rondane Mountains, East Antarctica.

*Tatsuro ADACHI[1], Tetsuo Kawakami[2], Masaoki Uno[3], Fumiko Higashino[4] (1.Kyushu University, 2.Kyoto University, 3.Tohoku University, 4.Okayama University of Science)

[SMP24-P02] **Evidence of Paleoproterozoic rift-to-drift transition in eastern margin of Singhbhum Craton, India from U-Pb zircon, Sr-Nd isotopic and geochemical study of dismembered gabbro-wehrlite of Bangriposi**

*Tushar Mouli Chakraborti[1,2], Kosuke Kimura[1,2], Arijit Ray[3], Ramananda Chakrabarti[4], Gautam Kumar Deb[3] (1.Earth and Planetary System Science program, Graduate School of Advanced Science and Engineering, Hiroshima University, Japan, 2.Hiroshima Institute of Plate Convergence Region Research (HiPeR), Hiroshima University, Japan, 3.Department of Geology, Presidency University, Kolkata, India, 4.Centre for Earth Sciences, Indian Institute of Science, Bangalore, India)

[SMP24-P03] Sulfur isotope study of high-grade metamorphic rocks in Highland Complex, Sri Lanka

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[SMP24-P04] **Sulfur isotope study of metacarbonate rocks from Highland Complex, Sri Lanka**

*Aoi Yoshioka[1], Madhusoodhan Satish-Kumar[1] (1.Department of Geology, Faculty of Science, Niigata University)

[SMP24-P05] Preliminary reports of U-Pb zircon age of charnockites in Aker Peaks of the Napier Complex, East Antarctica

*Kenji Horie[1,2], Mami Takehara[1], Tomokazu Hokada[1,2], Allen Nutman[3] (1.National Institute of Polar Research, 2.The Graduate University for Advanced Studies, SOKENDAI, 3.University of Wollongong)

[SMP24-P06] **Microtextural, fluid inclusion and C-O stable isotope studies of sparry magnesite of Deoban group of Kumaun Lesser Himalayas**

*Prakash Chandra Arya[1], Sajeev Krishnan[1], Kiran S[2,3], Satish Kumar[2], Claude Nambaje[1] (1.Centre for Earth Science, Indian Institute of Science, Bangalore, India, 2.Department of Geology, Faculty of Science, Niigata University, Niigata, Japan, 3.Graduate School of Science and Technology, Niigata University, Niigata, Japan)

[SMP24-P07] **Petrography and progressive metamorphism of Chitradurga Schist Belt, Dharwar Craton, southern India**

*Tomokazu Hokada[1,2], Madhusoodhan Satish-Kumar[3], Yuichiro Ueno[4], Tsuyoshi Toyoshima[3], Kaoru Mishima[4], Abdulla Nasheeth[4,5], Chiaki Ikawa[2] (1.National Institute of Polar Research, 2.The Graduate University for Advanced Studies (SOKENDAI), 3.Niigata University, 4.Tokyo Institute of Technology, 5.Osaka City University)

Geochronology of the metamorphic rocks at the Oyayubi ridge of Brattnipene, Sør Rondane Mountains, East Antarctica.

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The Sør Rondane Mountains (SRM) comprise medium to high-grade metamorphic rocks with granitic, syenitic and minor mafic dikes (e.g. Shiraishi et al., 1997, *Antarctic Geological Map Series, Sheet 35*). The SRM is divided into the NE terrane and the SW terrane by the Main Tectonic Boundary (MTB), and each terrane is defined by shape of *P-T* path and age distribution of detrital zircon (Osanai et al., 2013, *Precambrian Research, 234*)). The SRM is considered to be formed by collision of both terranes at 600-650Ma during which the NE terrane have thrusted up over the SW terrane (Osanai et al., 2013). This model also suggests that whole of the SW terrane behaved as a single geological body during and after the 650-600 Ma collision event. However, this model is not sufficiently correlated with the *P-T* conditions and ages, so it requires to be tested by conducting more detailed analyses widely in the SRM. This study reports geochronological result (LA-ICP-MS zircon U-Pb dating and EPMA monazite U-Th-Pb dating) of rocks from Brattnipene area in the SW terrane.

At the eastern slope of the Oyayubi ridge of Brattnipene, pelitic gneisses (garnet-sillimanite-biotite gneiss and garnet-biotite gneiss) and felsic gneisses (hornblende-biotite gneiss and garnet-clinopyroxene gneiss) are in contact with each other by the low angle ductile shear zone. The pelitic gneisses are distributed structurally upper than the felsic gneisses. The *P-T* conditions of these gneisses examined in this study were reported by Adachi et al. (2020, *NIPR symposium abstract*).

The garnet-sillimanite-biotite gneiss (sample No. TA19120703C) shows several textures indicating retrograde hydration. The texture replacing garnet by kyanite, sillimanite and biotite is interpreted as retrograde products which are reported from several localities in the Brattnipene area (e.g. Adachi et al., 2013a, *Geological Society Special Publication,* 383). Peak-*T* condition is estimated as ca. 800 ˚C. The garnet in garnet-biotite gneiss (TA19120703F) is extensively replaced by biotite and plagioclase, suggesting intense retrograde hydration. These pelitic rocks are located a few tens of cm away from each other.

Zircon grains in TA19120703C shows oscillatory- or planer-zoned cores truncated by vaguely zoned rims. The grains were dated using LA-ICP-MS U-Pb method and the results from the inherited core are grouped at 1100-900 Ma and 800-700 Ma (Th/U: 1.00-0.02), and those from the rim range from 600 to 540 Ma (Th/U: 0.31-0.02), Similar date distribution is also obtained from monazite EPMA dating. Monazite grains in TA19120703F yield date distribution with a large peak centered at ca. 550 Ma and without older date than 700 Ma. These data suggest that these pelitic gneisses reached peak condition at ca. 600 Ma and suffered retrograde hydration at ca. 550 Ma, which is consistent with the result reported from the central SRM in the previous studies (e.g. Adachi et al., 2013b, *Precambrian Research, 234*).

In contrast, the hornblende-biotite gneiss (TA19120703A) and garnet-clinopyroxene gneiss (TA19120701B) preserve information acquired under the peak metamorphic conditions in the matrix minerals. Especially plagioclase in hornblende-biotite gneiss shows increase in calcium concentration rimward, suggesting prograde process. No clear hydration texture can be recognized in these rocks. Peak *P-T* condition is estmated as 700-750 ˚C and 5-9 kbar. Zircons are present in the matrix whereas

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monazites are absent in these samples.

Zircon grains in TA19120701B shows oscillatory-zoned cores truncated by bright-CL mantles which are surrounded by dark-CL rims. Each domain yields different date cluster: the core at ca. 600 Ma (Th/U: 0.56-0.21, Ave. 0.43), the mantle at ca. 570 Ma (Th/U: 0.32-0.17, Ave. 0.23) and the rim at ca. 550 Ma (Th/U: 0.54-0.06, Ave. 0.16). Zircon grains in TA19120703A preserve oscillatory-zoned cores which are truncated and partially replaced by unzoned domains. The core dates cluster at ca. 600 Ma (Th/U: 0.75-0.12, Ave. 0.25), and the rim dates at ca. 550 Ma (Th/U: 0.20-0.06, Ave. 0.14). These data from the felsic gneisses indicate that igneous activity which formed the protolith of the felsic gneisses at ca. 600 Ma and the subsequent metamorphism which reached peak condition at ca. 550 Ma.

In summary, the pelitic gneisses experienced peak and subsequent retrograde metamorphism at around 600-540 Ma, whereas the felsic gneisses record prograde metamorphism after 600 Ma. This suggests that two distinct metamorphisms are recognized at the Oyayubi ridge of the Brattnipene in the SW terrane. If such a relationship can be observed widely in the SRM, the tectonic model for the SRM needs to be reconsidered.

Keywords: Sør Rondane Mountains, East Antarctica, metamorphic rocks, geochronology, zircon, monazite

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Evidence of Paleoproterozoic rift-to-drift transition in eastern margin of Singhbhum Craton, India from U-Pb zircon, Sr-Nd isotopic and geochemical study of dismembered gabbro-wehrlite of Bangriposi

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Dismembered modally layered gabbro and serpentinized wehrlite are found emplaced within multiply deformed metapelites of the North Singhbhum Mobile Belt assemblage, Singhbhum Craton, India. Zircon grains from the gabbro unit analyzed by LA-ICP MS yields an average U-Pb crystallization age of 1881.1 ± 8.4 Ma. The undeformed, cumulate gabbroic body exhibits excellent modal and cryptic layering, generated by the interplay of ad cumulate and textural coarsening growth process. It is moderately evolved with Mg number (100Mg/Mg+Fe) 48-63, low Alkali and TiO_2, high Al_2O_3; enrichment of Pb, Ba, Rb with depletion of U, Th, Zr and unfractionated rare earth patterns with positive Eu anomaly. The serpentinized wehrlite shows evidence of cumulate nature of the protolith and extensive post-crystallization metasomatism. Mineral chemistry, whole-rock geochemistry and clinopyroxene trace elements reveals progressive fluid-rock interaction from very high-temperature to low-temperature regimes. Calculated melts in equilibrium with the gabbroic rocks display enrichment in lighter elements similar to EMORBs and resembles the estimated average composition of the metasomatic fluid of the wehrlite rocks. The gabbros have initial $^{87}Sr/^{86}Sr$ 0.70600-0.71099, initial $^{143}Nd/^{144}Nd$ 0.510130-0.510294, and E_{Nd} (t) 1.8 to -1.4. The serpentinized wehrlite displays extreme enrichment with initial $^{87}Sr/^{86}Sr$ 0.71045- 0.72640, initial $^{143}Nd/^{144}Nd$ 0.509120- 0.509706, and almost crust-like E_{Nd} (t) of -9.7 to -21.2. The cumulate nature of the mafic-ultramafic rocks with other petrographical evidences imply formation in a static magma chamber. Dismembered nature, occurrence within an orogenic belt assemblage and temporal considerations suggest emplacement by obduction and affinity towards oceanic magma chambers. This is also reflected in mineralogy, whole-rock geochemistry and trace element compositions of modeled equilibrium melts which resemble rift volcanics and are similar to mafic dykes of continental margin ophiolites. The isotopic character of the gabbros can be explained by 30%-40% mixing between a depleted and a subduction-influenced enriched domain in the Sub-Continental Lithospheric Mantle beneath Singhbhum Craton. The isotopic signature of the wehrlite has been perturbed by the metasomatic event and reflects the enriched nature of the fluid phase. The occurrence of the mafic-ultramafic rocks within the shallow-deep marine, intra-continental rift basinal assemblage of Chaibasa formation, shows that rift-to-drift transition took place during Paleoproterozoic and incipient oceanic crust was formed. A 1.86 Ga orogenic event marked by intrusion of anorogenic granites caused closure of this basin and obduction of these fragments onto the orogenic belt assemblage. This result represents the first such discovery in Singhbhum Craton and can be correlated Paleoproterozoic ophiolites of south India. The formation and emplacement of these oceanic crustal rocks fits with the rift-dominated tectonics of that era and the widespread continental amalgamation and ophiolite emplacement which took place in Columbia supercontinent during Paleoproterozoic.

Keywords: Layered gabbro, Wehrlite, Cumulate dunite, Rift-to-drift, Ophioplite, Columbia supercontinent

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Sulfur isotope study of high-grade metamorphic rocks in Highland Complex, Sri Lanka

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Large deviations from mass independent fractionation in sulfur isotopes, termed as MIF-S, are characteristic of Archean sediments[1]. Although there are reports of Archean detrital zircon ages from 2400 to 3200 Ma in the Highland Complex (HC), Sri Lanka, it is not clear whether the sediments itself have detrital components other than zircon grains. Multiple sulfur isotope studies may provide some information in this aspect. Furthermore, the behavior of sulfur during high-grade metamorphism is not well understood, although sulfur isotope studies have been conducted in low-grade metamorphic rocks, previously[2]. In this study, we measured sulfur isotopes ratios for bulk rock samples from the HC, Sri Lanka, to verify whether the Archean MIF-S is preserved and try to discuss the behavior of sulfur during high-grade metamorphism.

Sulfide minerals in the metapelitic Grt-Sil gneiss are composed of pyrrhotite, chalcopyrite and pentlandite, that has a wide range of $\delta^{34}S_{V\text{-}CDT}$ from -1.7 ‰to 14.2 ‰. Charnockite contain various sulfide minerals such as pyrrhotite, chalcopyrite, pyrite, pentlandite and molybdenite, and their $\delta^{34}S_{V\text{-}CDT}$ values range between -1.0 ‰to 5.9 ‰. These values are consistent with an igneous origin for charnockites in the HC. However, there was no clear signature of MIF-S, although minor positive trend is observed in metapelitic rocks.

The with positive $\delta^{34}S_{V\text{-}CDT}$ values Grt-Sil gneiss are assumed to be sedimentary pyrite that are close to the sulfur isotopic composition of seawater sulfate, considering that the sulfate concentration in seawater was low at that time. When pyrite breakdown to pyrrhotite during metamorphism, $\delta^{34}S$ values increases at most 2-3 ‰[3]. Considering that the $\delta^{34}S_{V\text{-}CDT}$ values represent near seawater sulfate values, the bulk sulfur isotopic composition is preserved even after high grade metamorphism. Considering the minor spikes in MIF-S in metapelitic rocks, further detailed studies are in progress.

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3. Bucholz et al., 2020 Earth and Planetary Science Letters 549, 116494

Keywords: Sulfur isotopes, Archean, High-grade metamorphism, Highland Complex, Sri Lanka

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Sulfur isotope study of metacarbonate rocks from Highland Complex, Sri Lanka

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Sulfur isotopes in carbonate rocks record variations in seawater sulfate reservoirs associated with global oxygenation as well as depositional environments. During the Proterozoic, several evolutionary and biogeochemical events have occurred, with particular attention being paid to the rise in oxygen (GOE and NOE) in the Earth's atmosphere and oceans. These events appear to be closely linked to global sulfur geochemistry by both the production of weathered sulphates on land and the oxidation of sulfides and the evolution of disproportionated bacteria in the marine environment (Bottrell and Newton, 2006). Here, we report sulfur isotopic compositions of pyrite in metacarbonate rocks in order to estimate the depositional environment and gain insight into the effects of metamorphism. Metamorphic carbonate rocks containing pyrite from the Highland Complex in Sri Lanka was investigated in this study, which is believed to have been deposited in the Precambrian period. The $\delta^{34}S_{V\text{-}CDT}$ values of pyrite ranges from +6 to +26‰, and $\Delta^{33}S$ was slightly negative, most of which falls in the same quadrant in a $\Delta^{33}S$ vs. $\delta^{34}S$ diagram. This reflects a closed system sulfur isotope behavior caused by microbial sulfate reduction (MSR) and high sulfate demand, among other factors. In addition, while comparing the results of this study with un-metamorphic carbonate rocks in Proterozoic, the $\Delta^{33}S/\delta^{34}S$ and $\Delta^{33}S/\Delta^{36}S$ tendency of sulfur isotopes were similar. Therefore, it is considered that the change of sulfur isotopes due to metamorphism is negligible and the carbonate rocks act as perfect time capsule for preserving Precambrian ocean signatures. In addition, comparison with sulfur isotopic composition of pyrite in carbonate rocks of various ages indicate that the sulfur isotopic composition in the metacarbonate rocks in the Highland Complex were higher than in Archean, and similar to those in other Proterozoic eras. Therefore, we believe that the carbonate rocks provide key information in support of the hypothesized global ocean.

Reference

Bottrell, S. H., and Newton, R. J., 2006. Reconstructionofchangesin global sulfur cycling from marine sulfate isotopes. *Earth science Reviews.*, 75, 59-83.

Keywords: sulfur isotopes, metamorphism, microbial sulfate reduction, Highland Complex Sri Lanka, metacarbonate rocks

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Preliminary reports of U-Pb zircon age of charnockites in Aker Peaks of the Napier Complex, East Antarctica

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The Napier Complex in East Antarctica has attracted considerable interest on account of its long Archaean crustal history from 3800 Ma to 2500Ma as well as position in Precambrian supercontinents as well as its extremely high peak metamorphic temperature (UHT: ultra-high temperature), which exceeds 1100 ˚C. The discovery of extremely ancient crustal material of ca. 4000Ma obtained by Pb-Pb isochron in the Fyfe Hills (Sobotovich et al., 1976) generated intense interest in the Napier Complex. Similar evidences of ancient crustal materials were reported for the Mt. Sones and Gage Ridge region (Black et al., 1986; Harley and Black, 1997). Belyatsky et al. (2011) reported Eoarchean U-Pb zircon age of 3981 ± 8 Ma from charnockites in Aker Peaks. In this study, we report preliminary geochronological and geochemical data of zircons collected from two charnockite samples of Aker Peaks.

The sample #22a is phlogopite-bearing orthopyroxene-mesoperthite-charnockite and contains zircon, monazite and rutile as accessory mineral. Phlogopite replaces orthopyroxene forming symplectites with quartz. The sample #36a is phlogopite-bearing orthopyroxene-mesoperthite-cataclastic charnockite and contains zircon as accessory mineral. Plagioclase is replaced by mesoperthite which is corroded by quartz. The zircon garains separated from both samples were analyzed using a sensitive high-resolution ion microprobe (SHRIMP) at National Institute of Polar Research.

Both samples show Paleoarchean to Eoarchean evidence. The sample #22a yielded two age peaks centered at ca. 3600 Ma and ca. 3500 Ma. The former is the protolith age and the latter indicates the timing of recrystallization. On the other hand, some zircon grains in the sample #36a shows core-rim structure. The age data are scattered from >3700 Ma to 3300 Ma and major age peak is ca. 3630 Ma. The Pb-Pb age of rim is ca. 2500 Ma, whith corresponds to the timing of UHT metamorphism. The results are consistent with previous report that early high-temperature metamorphic event accompanied by the emplacement of granodiorite intrusions occurred in the vicinity of Aker Peaks at 3620-3630 Ma. Further geochemical information such as trace element concentrations including rare earth elements will be demonstrated.

Keywords: Napier Complex, U-Pb zircon, Antarctica, SHRIMP

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Microtextural, fluid inclusion and C-O stable isotope studies of sparry magnesite of Deoban group of Kumaun Lesser Himalayas

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Carbonate-hosted voluminous sparry magnesite (Pinolite) occurrence are known from Deoban group of Kumaun Lesser Himalayas. The origin of the sparry magnesite is still not fully understood and is still a matter of debate. Several models have been proposed for their origin such as evaporative, diagenetic, hydrothermal, metamorphic, metasomatic, and biogenic. In the Kumaun region, the field evidence suggests a close association of stromatolites with the magnesite-bearing beds (10-120 mts). The sparry magnesite's microtextural and fluid inclusion studies are investigated to understand the magnesite formation and trapping temperatures of fluids during magnesite crystallization. The color of the sparry magnesite of Kumaun Himalayas varies from yellow to white-off white, grey, and muck colored. The grain size of magnesite crystal varies from few millimeters to 2 to 3 cm, with deformed rhombohedral cleavage. Fluid inclusion results suggest, presence of low density bi-phase primary and bi-phase pseudo secondary fluids. Three fluids populations were classified based on the homogenization temperature (T_h) and final ice melting (T_f). The first category (T_f ~ -18 to -23 °C with T_h ~160 to 200 °C), the second (T_f ~ -7 to -12 °C with T_h ~150 to 320 °C), and the third (T_f ~ 0 to -5 °C with T_h ~160 to 280 °C). The maximum homogenization temperature of fluids ~320 °C. These observations suggest that the magnesites hosting in the Deoban group were subjected to a minimum temperature of 320 °C. Preliminary carbon and oxygen stable isotope results indicate that magnesite have a relatively constant carbon isotopic composition comparable to marine carbonates, however with large variations in oxygen isotopic composition. Further studies are ongoing and we present a comprehensive discussion on the origin of sparry magnesite.

Keywords: Microtexture, Fluid Inclusion, Sparry magnesite (Pinolite), Stable isotopes

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Petrography and progressive metamorphism of Chitradurga Schist Belt, Dharwar Craton, southern India

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Dharwar Crton in southern India is typical Archaean granite-greenstone belt, and underwent regional metamorphism at about 2.5 Ga. The progressive change of the regional metamorphic conditions has been summarized by Raase et al. (1986), and they concluded the metamorphic grade increasing from greenschist-facies in the north to granulite-facies in the south. This is based on the change of the metamorphic minerals in mafic rocks either associated with felsic orthogneiss (granite-zone) or metasedimentary sequences (greenstone-zone).

We have investigated metamorphic mineral assemblages of pelitic and psammitic rocks within the greenstone belt of the Chitradurga Schist Belt that is one of well-studied area and located middle of the Dharwar Craton. The sedimentary sequences of this greenstone belt consist of four groups (Sargur, Bababudan, Chitradurga, Hiriyuru Groups from lower to upper structure; e.g., Sreehari and Toyoshima, 2020). Pelitic and psammitic rocks are charactreized by biotite-muscovite asssemblage with minor muscovite/muscovite-chlorite assemblages. Wihtin the schist belt, progressive change of the metamorphic grade is not clear, but muscovite-chlorite assemblage is observed sporadically in central to eastern part (relatively lower structural layer). These observation are not always consistent with the previously summarized south-north metamorphic variation (Raase et al., 1986) estimated from mafic rocks.

We will discuss in this presentation on the petrography and progressive metamorphism of this part of Dharwar Craton and implications on the regional metamorphism of the Archaean greenstone belt.

Keywords: Archaean, Dharwar Craton, India, Metamorphism

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[E] Poster | S (Solid Earth Sciences)：S-GC Geochemistry

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.17_1

[S-GC32] Volatiles in the Earth - from Surface to Deep Mantle

convener:Takeshi Hanyu(Japan Agency for Marine-Earth Science and Technology, Research Institute for Marine Geodynamics), E Gray Bebout(Lehigh University), Yuji Sano(Division of Ocean and Earth Systems, Atmosphere and Ocean Research Institute, University of Tokyo), Hirochika Sumino(Department of General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo)

Volatiles play an important role in the dynamical and chemical processes in the Earth. The presence of volatiles drastically changes mineral stability and rheological behavior of the rocks. Chemical fractionation, such as partial melting, hydration, and dehydration are controlled by volatiles in the rocks. Volatiles enhance the production of magmas and drive their ascent and volcanic eruption. The atmosphere and hydrosphere have been generated by variety of degassing events from the mantle through volcanism. Some volatiles in the Earth's surface have been suggested to be recycled back into the mantle beyond subduction zones. Although the significance of volatiles in the Earth's evolution has been recognized, each of these processes is poorly constrained. We therefore welcome contributions from experimental, observational, and modeling studies that help shed light on the behavior, chemical/physical characteristic, and flux/budget of volatiles, such as hydrogen, carbon, nitrogen, noble gases, halogens, and sulfur. We encourage studies linking the behavior of multiple volatile elements and their isotopic compositions. Studies investigating the linkage between volatile and solid geochemical tracers, the phase equilibria of volatile-bearing mantle assemblages, and the effect of volatiles on the physical properties of the mantle are also welcome.

[SGC32-P01] Secular variation of helium isotope ratios in Izu Oshima: What will be observed in the next eruption?

*Hirochika Sumino[1], Kei Ikehata[2], Aya Shimizu[3], Kotaro Toyama[4], Tomoya Obase[1], Kenji Notsu[5] (1.Department of General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo, 2.Faculty of Life and Environmental Sciences, University of Tsukuba, 3.Tokyo Metropolitan Industrial Technology Research Institute, 4.Atmosphere and Ocean Research Institute, The University of Tokyo, 5.Geochemical Research Center, Graduate School of Science, University of Tokyo)

[SGC32-P02] Noble gas analysis and microstructure observation of the Finero phlogopite peridotite in Northern Italy to constrain the origin of deformation process of mantle wedge peridotite

*Nanae Fukushima[1], Hirochika Sumino[1], Jun-ichi Ando[2], DAS KAUSHIK[2], Masahiro Kobayashi[3], Hiroyuki Kagi[4], Takafumi Yamamoto[2] (1.Graduate School of Arts and Sciences, the University of Tokyo, 2.Graduate School of Advanced Science and Engineering, Hiroshima University, 3.Metropolitan Industrial Technology Research Institute, 4.Graduate School of Science, the University of Tokyo)

[SGC32-P03] Noble gas isotopic composition of directly ascending petit-spot from the northwest Pacific Ocean

*Kaishi Nakao[1], Naoto Hirano[2], Hirochika Sumino[3] (1.Department of Earth Science, Graduate School of Science, Tohoku University, 2.Center for Northeast Asian Studies, Tohoku University, 3.Graduate School of Arts and Sciences, The University of Tokyo)

[SGC32-P04] Fate of Subducting Organic Carbon: Evidence from HP/UHP Metasedimentary Suites and Implications for Isotopic Compositions of Arc Volcanic Gases

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[SGC32-P05] Monitoring the magmatic activity and volatile fluxes of Wakamiko caldera in southern Japan

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[SGC32-P06] Heterogeneous accretion of Earth's volatiles as constrained by nitrogen isotopes

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[SGC32-P07] **Hydrogen isotope of the mantle source in Pitcairn Island**

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[SGC32-P08] Helium isotope heterogeneity recorded in different phenocrysts in Samoan lavas

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Secular variation of helium isotope ratios in Izu Oshima: What will be observed in the next eruption?

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The helium isotope ratio ($^3He/^4He$ ratio) differs significantly in geochemical reservoirs ($^3He/^4He$ in air and meteoric water: 1 Ra = 1.4×10^{-6}, crust: 0.02 Ra, MORB source mantle: 8±1 Ra), and because helium is chemically inert, the $^3He/^4He$ ratio does not change by degassing from magma or by dissolution/degassing in water. Therefore, helium in volcanic gases, hot spring water, and hot spring gases can be used as a sensitive tracer of magma activity, and in fact, it has been reported that the $^3He/^4He$ ratio increased or decreased before and after eruptions at several volcanoes (Padrón et al., Geology 2013; Sano et al., Sci. Rep. 2015; Paonita et al., Geology 2016). Izu-Oshima volcano, an active volcanic island located around 100 km SSW of Tokyo, regularly erupted with 30 to 40 years intervals, but no eruption has occurred since the last activity in 1986-1990. In this presentation, we report the $^3He/^4He$ ratios of volcanic gases and olivines in pyroclastic materials collected in Izu Oshima, and discuss the long-term secular variation of $^3He/^4He$ ratios combining the reports of previous studies (Sano et al., EPSL 1991; Shimoike and Notsu, JVGR 2000).

The $^3He/^4He$ ratio of the observation steam well located in the north of the caldera in the center of Izu Oshima increased sharply immediately after the 1986 eruption from a low value of 1.7 Ra, peaked in 1988 at 5.5 Ra, and has been decreasing until now. The present $^3He/^4He$ ratio is around 1.5 Ra, which is lower than that before the last eruptive activity. The $^3He/^4He$ ratio corrected for atmospheric contamination using $^4He/^{20}Ne$ ratio was about 6.2 Ra throughout the last active period from 1986 to 1990. On the other hand, air-corrected $^3He/^4He$ ratios of hot spring gas collected from a well 500 m away from the steam well have been constant at 6.2 Ra since 2001. These results suggest that the mixing ratio of magma-derived and atmospheric helium in the steam well has changed in response to the decrease of supply of magma-derived helium, and the magmatic contribution has now almost completely decayed, while the $^3He/^4He$ ratio of magmatic gas itself has been constant over the past 30 years.

The observation that the helium released from the present magma is significantly lower than the value of 8 Ra, which is considered to be the value of the mantle wedge in subduction zone, suggests the significant contribution crustal helium in the magma reservoir. On the other hand, the $^3He/^4He$ ratio of olivines separated from lava flows of the Senzu Group, which erupted 20,000-40,000 years ago, and that from scoria in the lowest part (O95) of pyroclastic layers of the Older Oshima group, which was active after 20,000 years ago, are 7.4±0.4 Ra and 7.1±0.7 Ra, respectively, suggesting that $^3He/^4He$ ratios of the magma at these stages were almost equal to that of the mantle. However, the $^3He/^4He$ ratio of olivines in the N4 scoria erupted about 1300 years ago is 4.6±0.2 Ra, indicating that crustal helium was significantly contaminated into the magma.

Based on these results, two possible changes in the $^3He/^4He$ ratios of the steam and hot-spring wells can be expected: first, if the magma reservoir erupted in 1986 is reactivated, the $^3He/^4He$ ratio of hot spring gas will remain unchanged at about 6 Ra, and only the contribution of magma-derived helium observed in

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the steam well will increase. This means that the change in the $^{3}He/^{4}He$ ratio observed during the previous activity in 1986-1990 will be reproduced. The second scenario, in which the reactivation of the magma reservoir is caused by the supply of primitive magma with a high $^{3}He/^{4}He$ ratio derived from the mantle, is that not only the contribution of magmatic helium in the steam well increases, but also the air-corrected $^{3}He/^{4}He$ ratio of the steam and hot-spring wells themselves become higher than 6 Ra. In other words, it is expected that the $^{3}He/^{4}He$ ratio can be used to clarify whether the next eruption results from new magma supply from greater depths or just reactivation of the old magma.

Keywords: helium isotopes, Izu-Oshima volcano, eruption

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Noble gas analysis and microstructure observation of the Finero phlogopite peridotite in Northern Italy to constrain the origin of deformation process of mantle wedge peridotite

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Since the rheology of mantle control the behavior of deep earthquakes and orogenic activity, it is important to understand the elementary processes of deformation of the mantle rocks. Alpine-type peridotites are rock bodies formed by the solid penetration of upper mantle fragments along large faults at convergent plate boundaries, and are likely to preserve deformation structures in the brittle-ductile regime during the ascending process. We focus on the effect of water in mantle region on the deformation characteristics preserved in Finero phlogopite peridotite in Northern Italy, which is an alpine-type peridotite and had been metasomatized by slab dehydration in the mantle wedge during the Paleozoic and Mesozoic (Selverstone & Sharp, EPSL 2011; Hartmann & Wedepohl, GCA 1993; [3] Zanetti et al., Contrib. Mineral. Petrol. 1999).

In order to clarify the water-rock interaction and deformation history of the peridotite, we performed: (1) microstructural observations using a scanning electron microscope and a transmission electron microscope, and (2) noble gases analysis of the fluid/melt inclusions in mineral grains, which provide information of the origin of fluids/melts. In the noble gas analysis, the crushing method was adopted to selectively extract noble gases from fluid/melt inclusions.

In the field survey, we found a strain localization zone about 80 m wide in the peridotite, and collected rocks in the strain localization zone and 750 m away from the strain localization zone, respectively. A comparison of the two rocks by thin-section observation shows that the rock of the strain localization zone may have been deformed with forming microcracks under hydrous condition and subsequently may have trapped the fluid/melt inclusions. On the other hand, no such characteristic was observed in the samples away from the strain localization zone. The results of the olivine slip system observation suggest that fluid may have penetrated the rock of the strain localization zone during brittle-ductile deformation.

Noble gas analyses of fluid/melt inclusions show that the He, Ne, and Ar isotope ratios of all samples can be accounted for by three-component mixing of atmosphere/seawater, radiogenic/nucleogenic and mantle components. Similar mixing relation has been observed in very fine-grained apatite and orthopyroxene separated from the Finero peridotite (Matsumoto et al., EPSL 2005). On the other hand, the Ne-Ar-Xe elemental ratios of the samples show that a seawater-derived component is dominant. In addition, while the $^{3}He/^{4}He$ ratios are uniform, the $^{40}Ar/^{36}Ar$ ratios become lower with increasing deformation of the sample rock. This suggests that the seawater-derived component may have added to the mantle + radiogenic/nucleogenic component, and that the metasomatism by slab-derived, water-rich fluids may have promoted plastic deformation of peridotite in the mantle region. The observation that the mantle + radiogenic/nucleogenic end members behave as a single component cannot be explained by an addition of fluid released from surrounding metamorphic rocks, in which abundant

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radiogenic/nucleogenic noble gases had accumulated, during exhumation of the Finero peridotite body. Alternatively, the radiogenic/nucleogenic component would result from accumulation of radiogenic/nucleogenic noble gases in the mantle wedge previously metasomatized by slab-derived fluids enriched in U, Th, and K.

Keywords: peridotite, mantle, noble gas, metasomatism

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Noble gas isotopic composition of directly ascending petit-spot from the northwest Pacific Ocean

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The petit-spot magmatism provides us with information about the mantle beneath old part of oceanic lithosphere prior to subduction where we have never seen besides the underlying mantle below hotspot volcanoes and mid-ocean ridges. The asthenospheric $^{3}He/^{4}He$ ratios are recognized only using the mid-ocean ridge basalts (MORBs) as shown by uniform values of 8.75 ±2.14 Ra in the world MORBs (Graham, 2002). The petit-spot volcanoes on the northwestern Pacific Plate are classified into two types based on magmatic compositions and the difference in stress fields associated with plate flexure. One is erupted at the eastern slope of the outer rise (regular petit-spot). In this case, the differentiated melt without phenocrystic olivine does not ascend rectilinearly due to the compressional stress field of upper lithosphere, which may cause the metasomatic interaction with lithospheric mantle. The other is the directly ascending petit-spot (DAP) erupted at the top of outer rise where the tectonic stress-field is totally tensile in lithosphere. The DAP melt directly ascends to the surface without magma-stagnations in lithospheric mantle, uniquely including phenocrystic olivines. Therefore, DAPs likely have more primordial composition than regular petit-spots.

In this study, we measured the noble gas isotopic compositions of quenched glasses and phenocrystic olivines separated from DAP lavas using stepwise heating methods. The samples were both regular petit-spot and DAP, located at the Japan Trench axis and at the top of the outer-rise, respectively.

The $^{3}He/^{4}He$ ratios of phenocrystic olivines of DAPs, relatively young in eruption age, are similar to those of MORB (7.5- 9.7 Ra), and the $^{40}Ar/^{36}Ar$ ratios are 337- 3284 at 600℃ and 1800℃. The $^{3}He/^{4}He$ ratio of the quenched glasses of regular petit-spot is 3.1 Ra, and the $^{40}Ar/^{36}Ar$ ratio is as high as 7000 at 1500℃. The Ne isotope ratios of all the samples are similar to the MORB trend although the values are close to atmosphere. The data of regular petit-spots are explained by the three components of MORB source, crust or sediment (radiogenic) and atmospheric components. Most of DAPs, on the other hand, simply show the mixing of atmospheric components and MORB sources, designating more primary composition than those of regular petit-spots. An exceptional data of high $^{3}He/^{4}He$ ratio (13.5 Ra) of the DAP quenched glasses is enigmatic. As the phenocrystic olivines of same sample, initially crystallized from primary melts, show MORB value, it might be due to the influence of shallower lithosphere or marine sediments, in which cosmic dusts with high $^{3}He/^{4}He$ ratios and high He concentrations are contained.

Keywords: petit-spot, noble gas, olivine, quenched glass

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Fate of Subducting Organic Carbon: Evidence from HP/UHP Metasedimentary Suites and Implications for Isotopic Compositions of Arc Volcanic Gases

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Western Alps high-pressure and ultrahigh-pressure (HP/UHP) metasedimentary rocks record transit of organic (reduced) C through forearcs (40-70 km) to depths approaching those beneath volcanic fronts. The Schistes Lustrés, exposed in the Italian and French Alps, represents subduction of sediment to depths of up to ~70km, where they were underplated, along an extremely low-P/T trajectory of 7-8ºC/km. Across the range of grade in this suite (peak temperatures of ~350-550ºC), reduced C shows little evidence of loss (based on normalization to concentrations of Al_2O_3, TiO_2, and Zr) but considerable increase in $\delta^{13}C_{VPDB}$ to near mantle values of -6‰ related to isotopic exchange with coexisting carbonate. In Schistes Lustrés metashales lacking carbonate, reduced C preserves protolith $\delta^{13}C$ of -24 to -21‰ independent of grade and degrees of devolatilization. Reduced C occurs as amorphous carbonaceous matter at low grades and its transformation to graphite at higher grades presumably enhances isotopic exchange with carbonate. For comparison, in carbonate-poor lower-grade units of the Catalina Schist (in California), and Franciscan Complex (California) and Western Baja Terrane (Mexico) blueschist-facies rocks, together representing subduction to 10-40 km depths, reduced C concentrations and $\delta^{13}C$, C/N, and $\delta^{15}N$ are similar to those of sediment protoliths (see Sadofsky and Bebout, 2003; G-cubed), as in the lowest-grade unit of the Schistes Lustrés (regardless of carbonate content; for the N isotope data see Bebout et al., 2013; Chem. Geol.). In Catalina Schist units that experienced warmer prograde P-T paths, reduced C is shifted in $\delta^{13}C$ from -25 to -19‰ related to minor loss of C as CH_4 during devolatilization.

Our work implies that much of the reduced C reservoir is retained in rocks subducting to depths approaching those beneath volcanic fronts and could be available for transfer into the sub-arc mantle wedge, perhaps via partial melting. Yet unknown is whether reduced and oxidized C reservoirs, and their isotopic compositions, are fractionated during sub-arc mobilization and delivery into the mantle wedge. Such fractionation, and any isotopic exchange between the two reservoirs (in addition to accretion and underplating; see House et al., 2019, Geology), could have implications for application of the $CO_2/^3He$-$\delta^{13}C$ approach used in studies of arc volcanic gases to calculate contributions from mantle and disparate sediment sources.

Keywords: carbon cycling, subduction, metamorphism

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Monitoring the magmatic activity and volatile fluxes of Wakamiko caldera in southern Japan

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Volatiles from subduction zones, submerged calderas in particular, are poorly quantified. Unlike subaerial volcanoes, underwater volcanic activity is difficult to observe. Wakamiko, a submerged caldera in southern Japan shares a magma source with the active subaerial volcano, Mt. Sakurajima . Following years of inactivity, the volcanic eruptions in Mt. Sakurajima became more frequent in 2009; however, it is undetermined how the neighboring Wakamiko caldera has behaved in relation to this upsurge in activity. In this study, we assess the state of hydrothermal venting inside Wakamiko following recent disturbances in Mt. Sakurajima. Based on gas bubbles, seawater and sediment pore water measurements of samples obtained in 2015, it appears that acidic fluids enriched in ^{3}He continue to be discharged to the seafloor. Excess ^{3}He in the water column shows no apparent change since 2010; however, the helium isotopic ratio of the magmatic source continues to be elevated at ~7.2 Ra. This ratio for the magmatic component is higher than previously observed in 1986 (~6 Ra). The difference could be related to changes in the degassing activity as well as the mantle composition of the magmatic source. Using the new data from sediment pore water, we estimate the diffusive fluxes of ^{3}He and ^{4}He through the seafloor at 16.05 atoms $cm^{-2}s^{-1}$ and 1.52 x 10^{6} atoms $cm^{-2}s^{-1}$, respectively. We also calculated the vent ^{3}He flux at 3.38 x10^{4} atoms $cm^{-2}s^{-1}$. With the use of the ^{3}He flux, we calculated the diffusive CO_2 flux from Wakamiko at 1.41 x 10^{6} mol yr^{-1} and the vent flux at 3.72 x 10^{8} mol yr^{-1}. The available data that we have are still limited and a more frequent and longer observation is necessary to deduce the temporal changes in Wakamiko and its relation to the volcanic activity of Mt. Sakurajima.

Keywords: submarine caldera, helium isotopes, magmatic volatiles

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Heterogeneous accretion of Earth’s volatiles as constrained by nitrogen isotopes

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The origin of planetary volatiles such as nitrogen is critical for understanding planetary accretion, differentiation, and habitability. However, the detailed processes for the origin of Earth’s volatiles remain unresolved. Nitrogen shows large isotopic fractionations among geochemical and cosmochemical reservoirs, which places tight constraints on Earth’s volatile accretion process. Here we experimentally determine N-partitioning and -isotopic fractionations between planetary cores and silicate mantles at 1–8 GPa and 1700–2200 ˚C. We show that the core/mantle N-isotopic fractionations increase from −4‰ to +10‰, as oxygen fugacity decreases from 0.3 to 4.7 log units below the iron-wüstite buffer. The core/mantle nitrogen partition coefficients, ranging from 0.03 to 80, are a multifunction of oxygen fugacity, temperature, pressure, and the compositions of core and mantle. We apply N partition coefficients and isotopic fractionations in in a state-of-the-art model of planetary accretion and core-mantle differentiation. We find that the N-budget and -isotopic composition of Earth’s atmosphere plus crust, silicate mantle, and the source region of oceanic island basalts are best explained by Earth’s early accretions of enstatite chondrite-like reduced impactors, followed by late accretions of increasingly oxidized impactors and minimal CI chondrite-like material shortly before and during the Moon-forming giant impact. Earth may thus have acquired its nitrogen and other major volatiles heterogeneously, and its volatile budget may have been established during the main accretion stages.

Keywords: nitrogen, isotope fractionation, core formation, oxygen fugacity, volatiles

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Hydrogen isotope of the mantle source in Pitcairn Island

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The origin of Earth’s water has long been debated based on the hydrogen isotope [deuterium/hydrogen (D/H)] ratio of the Earth. However, the D/H ratio of the bulk Earth estimate remains controversial since substantial amounts of water could be present inside the Earth. The relatively uniform D/H ratio for the upper mantle (δ D of -60 ±5 ‰relative to VSMOW) is established by the analysis of submarine glass from mid-oceanic ridge basalts (Clog et al., 2013). Recently, Hallis et al. (2015) reported much lower D/H ratios from olivine-hosted melt inclusions in Baffin Island and Icelandic lavas, and suggested that the Earth’s deep mantle has much lower D/H ratio (δ D < -218 ‰). They attributed such low- δ D signature to a protosolar nebula origin which is derived from an isolated reservoir resided in the Earth’s deep interior. However, another possibility that such low- δ D signature was created via dehydration of subducting slab (Shaw et al., 2008) needs to be evaluated.

The oceanic island basalt (OIB) of Pitcairn Island is typical of containing recycled material such as subducted slab (Eisele et al., 2002; Garapic et al., 2015). We found rapidly-quenched hyaloclastite containing abundant automorphic fresh olivine crystals and volcanic glass shards. Since the olivine crystals contain many crystal-free glassy inclusions, we analyzed concentration of volatiles (CO_2, H_2O, F, S and Cl) and P_2O_5, and hydrogen isotope ratio (δ D) with SIMS, and major elements with EPMA for melt inclusions and glass shards, and compared them with the aim to evaluate the D/H fractionation during magma evolution and to constrain the D/H ratio of recycled components stored in the deep mantle.

Our results demonstrate that olivine-hosted melt inclusions have much higher H_2O and CO_2 contents than matrix-derived glass shards, consistent with that magma degassing is responsible for their volatile element abundances. Their δ D values positively correlate with H_2O contents, also indicative of vapor-melt D/H fractionation during final stage of degassing. Since most measured melt inclusions were high in CO_2, such degassing of H_2O and D/H fractionation could be minor. With the exception of some inclusions depleted in volatiles, we obtained an average water content of 1.06 ±0.16 wt.% and an average δ D value of -89 ± 12‰ (2 SD) as the composition of primitive melt, which is significantly lower than the upper mantle value. This suggests that Pitcairn mantle plume tapped the material with a low D/H ratio, which could be derived from recycled slab components.

Keywords: hydrogen isotope ratio, hotspot, Pitcairn Island

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Helium isotope heterogeneity recorded in different phenocrysts in Samoan lavas

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Ocean island basalts (OIBs) are generally considered to be fed by upwelling mantle plumes sourced from deep mantle domain. Geochemical variation observed in OIBs should reflect heterogeneous deep mantle materials including subducted slabs. Isotopically enriched signature of Samoan OIBs have been recognized to be the manifestation of subducted sedimentary materials. Samoan OIBs also show depleted and primordial isotopic signature, suggesting that variety of source materials are involved in the magma sources as demonstrated by geochemical heterogeneity in the inter-island scale to phenocryst scale. For example, lavas on Ofu Island show large $^{3}He/^{4}He$ range (19-34 Ra) despite limited Sr and Nd isotopic variation. Lavas with very high $^{87}Sr/^{86}Sr$ show Sr isotopic difference between clinopyroxene and whole rock. Moreover, variation in $^{87}Sr/^{86}Sr$ has been found in melt inclusions in olivine. In this study, we show $^{3}He/^{4}He$ isotopic difference between olivine and clinopyroxene in a single lava from Tutuila Island. Radiogenic isotope data from the literatures and this study indicate the presence of at least four mixing components; EM2 (enriched mantle-2), HIMU (high-mu), FOZO (focal zone mantle), and depleted mantle. Olivine and clinopyroxene in lavas with FOZO-like compositions show similar $^{3}He/^{4}He$. In contrast, olivine show higher $^{3}He/^{4}He$ than clinopyroxene in lavas with radiogenic $^{87}Sr/^{86}Sr$. Some lavas with radiogenic $^{87}Sr/^{86}Sr$ also have $^{87}Sr/^{86}Sr$ that is different from clinopyroxene hosted in them. The 3-D isotopic plot (e.g., Sr-Pb-He) of Samoan OIBs displays a cone-shape distribution with the FOZO component at the top (high $^{3}He/^{4}He$) and EM2, HIMU and depleted component at the bottom (low $^{3}He/^{4}He$). Tutuila lavas plot on a steep slope of the cone. I suggest that small difference in mixing proportion of the components is responsible for relatively large isotopic difference. Such isotopic difference may not be caused by the coupled effect of temporal change in magma composition and mineral crystallization, as Mg# of olivine and clinopyroxene overlaps with each other. I infer that compositional variation existed in a magma chamber where olivine and clinopyroxene crystallized, and thereby geochemical heterogeneity in a deep-rooted mantle plume was preserved to the shallow depth.

Keywords: Helium, Ocean island basalt, Samoa

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[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-IS Intersection

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.20_1

[M-IS06] Human-environment Nexus from Pre-Historic to Modern Times

convener:F Harry Lee(The Chinese University of Hong Kong)

We sincerely invite researchers to present their works pertaining to the socio-economic and demographic impacts of climate change in pre-historic, historical, and modern times, which is a topic focusing on human-environment interactions. The related knowledge may have important implications for global and regional sustainability. This session is going to serve as an interdisciplinary platform for collecting different views and facilitating a constructive debate about the ways in which human-environment interactions can be generalized, contextualized, or even denied - - - a philosophical issue pertinent to the theoretical underpinnings of environmental humanities. To further facilitate the debate about global and regional sustainability from different perspectives, scholars who agree on the significant impact of climate change on human societies, or who are skeptical about this relationship, are welcome to present their related works in this session. Topics of interest include, but are not limited to, the following:

A. How and to what extent human societies are (or are not) affected by climate change or climatic extremes;

B. The use of empirical archaeological/historical data in investigating human-environment interactions;

C. Case studies in illustrating human-environment interactions;

D. The influence of spatio-temporal scale, study period, and study area on human-environment interactions; and

E. Philosophical discussion about human-environment interactions.

[MIS06-P01] The socio-hydrological interactions in modern China: a case study based on flood events in Yangtze River Basin

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[MIS06-P02] Historical climate-war nexus in the eyes of geographers

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The socio-hydrological interactions in modern China: a case study based on flood events in Yangtze River Basin

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As the longest river in Asia, the Yangtze River has shown its impact on human societies with floods recorded since 12th century. In 1931, the Yangtze River has manifested its force again with one of the deadliest floods ever recorded in Chinese history, causing 422,499 deaths, damages to more than 25.2 million people and 58.7 billion m^2 farmland. Similar flood occurred again in 1954, resulting in 31,762 deaths, damages to 18.9 million people and 31.7 billion m^2 farmland. Researches have shown 1954 flood being larger and higher compared to 1931 flood. However, it is still unclear for what reason that a more severe flood leading to fewer casualties, especially when there being no significant progress in the countermeasure technique. To answer this question, here we propose a conceptual socio-hydrological framework within which the mutual influence between society and water system is analyzed. We found that before and after 1931 flood, a change of social structure of villages aggravated the vulnerability of agricultural production towards natural hazards, and hydrological extremes speeded-up such structure change afterwards. As for 1954 flood, remolding of village structure strengthened the resilient ability to a certain degree, while the damage was controlled at the cost of rural settlements. Our results demonstrate how the conceptual framework is likely to help comprehend the inner correlation of a pre-industrial society like the early 20th century of China. We anticipate our study to be a starting point for more sophisticated socio-hydrological models, which will likely to be applicable to many other regions and times.

Keywords: socio-hydrology, Yangtze River Basin, flood

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Historical climate-war nexus in the eyes of geographers

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Did climate change cause wars in history? While a growing number of quantitative studies (particularly in the field of geography) illustrate the climate-war nexus in pre-industrial societies, there are opposing opinions on the subject. Such conflicting views invite us to reconsider whether the climate-war nexus can be conceptualized as a yes/no dichotomy. This paper seeks to address this issue. I will first recapitulate the key findings of those quantitative studies of geographers that substantiate the significant role of climate deterioration in causing wars. Then I will pinpoint those issues that complicate the conceptualization of the climate-war nexus, indicating that the nexus cannot be taken as a simple yes/no question. Finally, I will propose a research approach that may facilitate a productive interdisciplinary collaboration, perhaps between geographers and historians, to conduct research on the interconnection between climate change and wars in history. I hope that the interpretation of the climate-war nexus can move away from a dichotomy of yes/no, and the multiple dimensions of wars and social resilience to climate change will be thoroughly considered. Also, the advantages of geography and history could be integrated to enrich understanding of the climate-war nexus in history.

Keywords: Climate change, War, Geography, History, Preindustrial era

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[E] Poster | M (Multidisciplinary and Interdisciplinary) : M-IS Intersection

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.21_1

[M-IS07] Effects of lightning, severe weather and tropical storms

convener:Mitsuteru Sato(Department of Cosmoscience, Hokkaido University), Hisayuki Kubota(Hokkaido University), C. Glenn Vincent Lopez(- - -), Purwadi Purwadi(Department of Cosmosciences, Hokkaido University, Sapporo 0600810, Japan)

Thunderstorms are markers of deep convection and severe weather, producing heavy precipitation, hail and strong winds that lead to significant natural hazards, especially in coastal and urban areas. Huge economic damages and loss of human lives often result from such events. As the intensity and frequency of thunderstorms is projected to increase in the future - when the atmosphere and oceans become warmer - the need for detecting and nowcasting thunderstorms and lightning on local and regional scales becomes crucial.
We invite contributions dealing with thunderstorms and lightning and their atmospheric effects. We seek contributions focusing on convective storm evolution, forecasting of thunderstorms and lightning using local, regional and global detection networks as well as other sensors. Also, works on global lightning patterns in an era of climate change, satellite-based studies of thunderstorms and other remote-sensing technologies, as well as urban effects on lightning and public safety from lightning danger.

[MIS07-P01] Lightning bursts observed during the tropical cyclone genesis over the Philippine Sea

*Hisayuki Kubota[1], Yukihiro Takahashi[1], Mitsuteru Sato[1] (1.Hokkaido University)

[MIS07-P02] Spatial and temporal variations of heavy rainfall in the Metro Manila, Philippines in the dry-wet transitional season based on a dense surface meteorological observation network

*Jun-Ichi Hamada[1], Jun Matsumoto[1], Hisayuki Kubota[2], Mitsuteru Sato[2], Yukihiro Takahashi[2], Glenn Vincent[3] (1.Tokyo Metropolitan University, 2.Hokkaido University, 3.Advanced Science and Technology Institute, Philippines)

[MIS07-P03] Estimation of the relation between electrical properties of lightning and tropical cyclone intensity in the western north Pacific.

*Shunsuke Niwa[1], Mitsuteru Sato[1], Yukihiro Takahashi[1], Hisayuki Kubota[1] (1.Department of Cosmoscience, Hokkaido University)

[MIS07-P04] Lightning Activity in Western North Pacific Measured by the V-POTEKA Network and Its Relation to Typhoon Intensity

*Mitsuteru Sato[1], Yukihiro Takahashi[1], Hisayuki Kubota[1], Glenn Vincent C. Lopez[2] (1.Faculty of Science, Hokkaido University, 2.ASTI, DOST)

Lightning bursts observed during the tropical cyclone genesis over the Philippine Sea

*Hisayuki Kubota[1], Yukihiro Takahashi[1], Mitsuteru Sato[1]

1. Hokkaido University

The accuracy of tropical cyclone (TC) track forecast has been improved year by years, on the other hand, the forecast of tropical cyclone intensity still has a difficulty of improvement. Recently the relationship between lightning activity and tropical cyclone intensity has been investigated. Lightning tends to increase during the rapid intensification of the TC. Therefore, monitoring the lightning activity becomes important for a TC intensity forecast. Lightning observation network are deployed over the western north Pacific by five very long frequency events trigger measurements called V-POTEKA at Palau, Guam, Manila Philippines, Okinawa Japan and Serpong Indonesia under the ULAT (Understanding Lightning and Thunderstorm) of SATREPS (Science and Technology Research Partnership for Sustainable Development) in the Philippines.

Lightning activity was drastically increased around the TC during the TC genesis stage of tropical storm Maysak on 28 August 2020. Numbers of lightning reached the maximum during the life cycle of the TC. Location of lightnings were concentrated near the center of TC in about 100 to 200 km radius. Convective clouds reached less than 190K of blackbody temperature near the center of the TC. We called this phenomenon as “lightning burst”. It seems that lightning burst is associated with the convective burst which tends to occur during the TC genesis stage. About half of TCs observed lightning bursts during the TC genesis stage over the Philippine Sea in 2020. We will investigate further what kind of structure occurred during the lightning burst and what kind of mechanism responsible for the lightning burst.

Keywords: Tropical cyclone, Lightning, Philippine Sea

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Spatial and temporal variations of heavy rainfall in the Metro Manila, Philippines in the dry-wet transitional season based on a dense surface meteorological observation network

*Jun-Ichi Hamada[1], Jun Matsumoto[1], Hisayuki Kubota[2], Mitsuteru Sato[2], Yukihiro Takahashi[2], Glenn Vincent[3]

1. Tokyo Metropolitan University, 2. Hokkaido University, 3. Advanced Science and Technology Institute, Philippines

To monitor heavy rainfall and thunder cloud in the Metro Manila, Philippines, an observational network of the automatic weather station with lightning detection sensors (P-POTEKA) has been established since 2018. As of June 2020, 35 P-POTEKA stations were installed in the area. In this study, we aimed to investigate spatial and temporal distributions of heavy rainfall in the Metro Manila during the dry-wet transitional season (May-June) of 2019 and 2020 using the P-POTEKA observational data.

The wet season (westerly monsoon season) started in the middle of June in the both of 2019 and 2020. Two tropical cyclones landed in the Philippines in the transitional season of 2020, whereas no tropical cyclone approached in the 2019. The area average total rainfall amounts were larger in 2019 (484.5 mm) than 2020 (309.5 mm). Total numbers (hours) of heavy rainfall events (equal or more than 20.0 mm/h) for all the P-POTEKA stations were also larger in 2019 (131 hours) than 2020 (82 hours). These obtained results may imply that local convection was predominant in 2019. We will introduce the spatial distributions of the heavy rainfall events in the Metro Manila and their diurnal variations at the meeting.

This work was supported by Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA) under the Science and Technology Research Partnership for Sustainable Development (SATREPS) Project.

Keywords: Heavy rainfall, Monsoon, Local convection, Metro Manila

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Estimation of the relation between electrical properties of lightning and tropical cyclone intensity in the western north Pacific.

*Shunsuke Niwa[1], Mitsuteru Sato[1], Yukihiro Takahashi[1], Hisayuki Kubota[1]

1. Department of Cosmoscience, Hokkaido University

Although the track prediction of tropical cyclones (TC) is improved year by year, the prediction of the TC intensities such as the minimum sea level pressure and the maximum wind speed is getting worse year by year and is an big issue to be solved. Previous studies indicate that the lightning activities in TCs can be a good proxy of the TC intensity development. In the previous studies, the relation between the lightning occurrence number and the TC intensity development were investigated. However, the relation of the electrical properties (EPs) of lightning discharges with the TC intensity development is poorly investigated. As there are some reports showing close relation between the lightning EPs and the thunderstorm activities causing severe weather, it’ s important to clarify the relation between the lightning occurrence number, lightning EPs and the TC intensity development.
The purpose of this study is to clarify the relation between the lightning EPs and the TC intensity development and to verify whether the lightning EPs or the lightning occurrence number is a better proxy to predict the TC intensity development. For this purpose, we have (1) estimated the lightning occurrence number in the inner core and the rainband of TCs using the ground-based lightning detection network data, (2) identified the transient ELF waves detected by the ground-based ELF observation network and related to lightning discharge in the TC region, and (3) estimated the lightning EPs and analyzed relation between the lightning EPs and the TC intensity development. We used the best track data of TCs provided by Joint Typhoon Warning Center (JTWC), lightning data containing both time and location data provided by World Wide Lightning Location Network (WWLLN) and ELF magnetic field waveform data obtained at Syowa station in Antarctica and Kuju station in Japan, that are the two stations of Global ELF Observation Network (GEON). As the collection window of lightning discharges in TCs, we defined (i) the inner core as the region within the 100 km (200 km) distance from the TC center for normal (large) TCs, (ii) the rainband as the region of 100-500 km (200-1000 km) from the center for normal (large) TCs. Using ELF waveform data, we estimated the peak current (Ip), charge moment change (Qdl), and charge amount (Q) as the lightning EPs. Ip and Qdl were estimated from ELF data obtained at Syowa, while Q was estimated from ELF data obtained at Kuju. Using above methods and the estimated parameters, we conducted the cross-correlation analyses between the TC intensity development and the lightning EPs for 40 TCs occurred in the western north Pacific in 2013 and 2014.
First, we found that the median value of the lightning EPs in positive cloud-to-ground (+CG) discharges peaked at the generation stage in the 29 TCs. When multiple cumulonimbus are merged in the TC region, the cloud top of these cumulonimbus reaches near the tropopause, and the upper clouds will horizontally spread. Then +CG with long discharge length occur from the upper positive charge region overhanging or the developing stratiform region. Second, we found that total value and median value of the EPs of -CGs peaked during the development stage in the 11 super TCs (very strong typhoons and violent typhoons) out of the 12 super TCs analyzed. This is probably caused by the updraft intensification in the eyewall which tends to reduce the electrical breakdown voltage and transfer the negative charge to upper layer. As the EPs of -CG discharges during the development stage in the super TCs peaked 1-2 days before the TC intensity maximum, the EPs of -CG discharges as well as lightning occurrence number can be a good predictor of the TC intensity development.

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Keywords: lightning , typhoon, ELF, charge moment change

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Lightning Activity in Western North Pacific Measured by the V-POTEKA Network and Its Relation to Typhoon Intensity

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Lightning activity is the good proxy representing precipitations and the updraft intensities in thunderclouds. Recent studies revealed that the lightning occurrence number in tropical cyclones (TCs) shows clear relation to the intensity development of TCs, whereas the prediction of the typhoon intensity development is very hard even though the recent meteorological model is used. Many countries in the western north Pacific suffer from the attack of TCs (typhoons) and have a strong demand to predict the intensity development of typhoons by a cost-effective methods. Thus, we have developed a new automatic weather and lightning observation system (V-POTEKA) and installed this system in the Philippines, Guam, Palau, Jakarta, Okinawa since September 2017. Using the V-POTEKA data, lightning locations are estimated by using the time-of-arrival geolocation algorithm. We have compared the relation between the lightning activities measured by the V-POTEKA network and the intensity change of the western north Pacific typhoons in the period of 2018-2020. In this 3 years, a total of 81 typhoons occurred. As for the 2018 typhoons, we selected 11 of 29 typhoons and conducted cross-correlation analysis between lightning activities and typhoon intensity development. We confirmed that the time variations of the detected lightning event numbers and typhoon intensities (maximum wind speed and center pressure) are highly correlated. Especially, there is clear time lag (~1.5 days) between lightning activities and typhoon intensities in the category 1-3 typhoons, that is, the peak of lightning activity comes first, then the peak of the typhoon intensity comes next. However, as for the super typhoons (category 5 typhoons), this relation is not always clear. At the presentation, we will also show the detailed results derived from this cross-correlation analysis between lightning activities and intensity development of the 2019, 2020 typhoons.

Keywords: Lightning activity, Typhoon, Intensity prediction

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[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-IS Intersection

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[M-IS09] Weathering and conservation of cultural heritage and geosites

convener:Luigi Germinario(University of Padova, Italy), Chiaki T. Oguchi(Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University), Akos Torok(Budapest University of Technology and Economics), Tetsuya Waragai(Graduate School of Science and Engineering, Nihon University)



Cultural heritage (World Heritage Sites, historical structures, archaeological artifacts, etc.) and geoheritage (geosites, geoparks, etc.) are exposed to weathering in the geological and human time scale. The resulting deterioration of the rocks and other geological materials in cultural and natural contexts can be often severe and demands the prompt adoption of conservation measures. The relevant research involves a range of disciplines: mineralogy, geomorphology, geoarchaeology, environmental science, engineering geology, materials science, analytical chemistry, etc. However, our knowledge on many aspects is still limited. This session welcomes contributions presenting original research, case studies, and discussions on damage assessment, experimental techniques, monitoring, predictive models, conservation procedures, documentation, etc. related to geological materials in cultural heritage and geosites.

[MIS09-P01] Mineralogical and microclimatic control on the salt weathering of Oya stone

*Luigi Germinario[1,2], Chiaki T. Oguchi[2] (1.University of Padova, Italy, 2.Saitama University, Japan)

[MIS09-P02] Relationship between carbon dioxide concentration and temperature in the Taya cave

*Chiaki T. Oguchi[1], Rina Matsumoto[2], Yasuhiko TAMURA[3] (1.Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University, 2.Faculty of civil Engineering, Saitama University, 3.Executive Committee for the Preservation of TAYA CAVERN)

[MIS09-P03] Material properties and durability of stone in a medieval fortress; lessons to learn: an example from Hungary

*Akos Torok[1], Benedek Lógó[1] (1.Budapest University of Technology and Economics)

Mineralogical and microclimatic control on the salt weathering of Oya stone

*Luigi Germinario[1,2], Chiaki T. Oguchi[2]

1. University of Padova, Italy, 2. Saitama University, Japan

Oya tuff is one of the most renowned building stones in Japan. It has been used historically in vernacular architecture, construction, rock-cut and relief sculpture, but its extensive exploitation began only in the Edo period (17th century). The extraction has been conducted mostly underground in over 200 quarries in Tochigi prefecture, with few being still active, many others abandoned or transformed into sites of geoheritage and touristic value. This study deals with the salt weathering of Oya stone, one of the most common decay patterns in underground cultural heritage and geosites, following a mineralogical and environmental approach. The experimental outline included field explorations, mineralogical and geochemical analyses of the rock and its efflorescences, a microclimate monitoring, and the chemical analysis of groundwater and rainwater. The efflorescences turn out to be composed of mixed sulfates, including gypsum, mirabilite, and thenardite. Their formation and stability is strictly dependent on the weathering of accessory phases, in particular pyrite and zeolites, reflected on the groundwater composition; and the subterranean microclimate, especially the variations of relative humidity in time and space, controlling the seasonality and principal composition of the salt mixtures and the occurrence of crystallization/dissolution cycles.

Keywords: Tuff, Underground geoheritage, Efflorescences, Sulfates

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Relationship between carbon dioxide concentration and temperature in the Taya cave

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The Taya Caves, an artificial hand-dug cave in the Josenji Temple in Yokohama City, originated in the Kamakura period as one of the worship places of Shingon Esoteric Buddhism. Many people are still visiting the cave. There remains still questions about how 800m of tunnels were manually dug in the dark and narrow spaces of the ground when there were no large tools. A torch should have been lit in the dark, however, there must be a ventilation pit to prevent oxygen deficiency. No such pit is found. Further, it is known that CO2 concentration also increases due to bacterial activities in the underground environment.In this study, we will examine the causes of the increase in CO2 concentration due to the continuation of temperature and humidity monitoring inside and outside the cave, daily changes in the number of visitors, and changes in CO2 concentration. From the correlation between the daily maximum temperature and the CO2 concentration, and the correlation between the temperature at each site and the CO2 concentration, it is expected that the increase in temperature may cause the increase in the CO2 concentration.

Keywords: Taya Cave, CO2 concentration, Temperature

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Material properties and durability of stone in a medieval fortress; lessons to learn: an example from Hungary

*Akos Torok[1], Benedek Lógó[1]

1. Budapest University of Technology and Economics

The material use of Medieval structures justifies the local knowledge and experience of the builders. Studying material properties and construction technology helps to understand medieval skills and expertise. In this study, the stone and renders of a 14th to the 15th-century fortress is presented. The fortress is located at Balaton Highland at Nagyvázsony (Hungary). It has an emblematic 25 m high tower, which was used as a living quarter. The fortress is surrounded by a system of external walls, while the tower is in the courtyard. The structure was mostly built from stone but rammed earth was also used for the interior parts of the wall. Stone, render were studied on-site using various non-destructive techniques. Surface strength of materials was tested by Schmidt hammer and Duroskop while moisture content was measured on-site with a portable device. Petrology of lithotypes was identified on site using a portable microscope. Samples were also taken for laboratory testing. Physical and mechanical properties such as density, ultrasonic pulse wave propagation, uniaxial compressive strength (UCS) and indirect tensile strength (Brasilian) test were measured in laboratory conditions according to EN and ASTM standards. Samples were measured in dry and water-saturated conditions. According to lithological description and laboratory tests, the prevailing lithotypes are basaltic tuffs, well-cemented limestone and travertine. A few ashlars of Miocene porous limestone, travertine and sandstone were also identified. The condition assessment of stone elements and laboratory tests suggest that basaltic tuffs suffered the most for weathering while other stone types seem to be more durable. This current study provides new hints to understand the medieval construction techniques and the material selection of medieval fortresses of Central Europe.

Keywords: basaltic tuff, physical properties, condition assessment, medieval

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[M-IS10] Exploring Origin of Space, Galaxies, Earth, Moon, Solar System, Plate Tectonics, and Life

convener:Akira Taneko(SEED SCIENCE Lab.)

The purpose of SCIENCE is to explain the mystery of the universe.
Traditional methods include analytical inquiry followed by integration, and qualitative and quantitative inquiry. In nature, there are periodic phenomena and one-way evolution and differentiation phenomena. Periodic phenomena are easy to reproduce, the laws of physics are elucidated, and elucidation is easy, but the mystery of evolution is difficult to elucidate because the time axis is particularly long and the mechanism is unknown.
Is there anyone who challenges the origin of the solar system or the origin of the galaxy or the universe?
Creative reasoning (hypothesis reasoning) that verifies using the results of evolution can be verified that a hypothesis that can uniformly explain the results (characteristics) of evolution that has occurred only once and surely is correct.
Please challenge the search for the origin as well.

[MIS10-P01] **Investigating Origin and how to verify it-** Verification goes back to the past -make Hypothesis and explain of Evolution Resules ***in a unified manner***,MIH as a sanple

★Invited Papers

*Akira Taneko[1] (1.SEED SCIENCE Lab.)

[MIS10-P02] Most Scientists **do not deny the existence of Plate Tectonics**, but ***cannot explain why Plate Tectonics happened.*** **"Multi-Impact Hypothesis"** ***can explain Origin of Plate Tectonics*** and also ***verify Origin of Moon and Solar System.***

★Invited Papers

*Akira Taneko[1] (1.SEED SCIENCE Lab.)

[MIS10-P03] Liquid Crystal Peptide/DNA Coacervates in the Context of Prebiotic Molecular Evolution

★Invited Papers

*Tony Z Jia[1,2], Tommaso P Fraccia[3] (1.Earth-Life Science Institute, Tokyo Institute of Technology, 2.Blue Marble Space Institute of Technology, 3.Institut Pierre-Gilles de Gennes, CBI, ESPCI Paris, Université PSL, CNRS)

Investigating Origin and how to verify it- Verification goes back to the past -make Hypothesis and explain of Evolution Resules *in a unified manner* ,MIH as a sanple

*Akira Taneko[1]

1. SEED SCIENCE Lab.

When I learned of ***Simulation Paper*** called **Giant Impact Theory**,it was correct(?) because ***a Mars-Sized Model collided with*** **Earth Model**, and Moon with only Mantle was created, was Reasoning.It is unclear whether or not it will **hit Earth**, but even if Luna finally arrives to **Potential Energy as *1/20*** by ***Specifying Speed-Angle***, **so it is *strange* Lunar not to accelerate.**

Search for Origin is *more True as there are more Items* that *can make Hypotheses* and ***explain*** **Evolutionary Results (Characteristics and Current Situation)** ***in a unified manner.***
If even one Item cannot be explained, it is False.It is the Mistake of Hhypothetical Model that even one Item of the Feature cannot be completely explained by the Simulation. If Hypothetical Model is correct, **it can be verified by Creative Reasoning (Abduction with Evolution)**, and even unexpected Results can be verified at Same Time.

Comparing with **Lunar Origin Hypothesis**.
Multi-Impact Hypothesis / Giant-Impact Hypothesis,
with Model of Collision body.
Only Moon-Sized Mantle / Differentiated Mars-Sized Mantle with Core,
with Verification Methods.
Inevitable Collision of Creative Reasoning /Selection by Calculation Comparison of Collision Conditions in Simulation.

Comparing with Conclusion of Lunar origin hypothesis

In M-IH,
> M1. As an explanation of **Origin of Moon** M1-1.**Inevitable Collision**,M1-2.Origin of **Mantle Impactor**, M1-3.Collision **Velocity12.4km/s and Angle36˚**, M1-4.**Orbital Energy** of Ejected Moon, 1-5.**Eccentricity** of Moon and Cause of always **facing Earth**, M1-6.Origin of **Moon's Sea**, M1-7.**Backside Legoris** of Moon,
>M2. As an explanation of **Origin of Earth**, M2-1.Origin of **Deep Ocean Floor of Earth**, M2-2.Origin of **Plate Tectonics**, M2-3.Origin of Plate Bundary, M2-4. Origin of **Driving Force**, M2-5.Ocean Reasons for No Wrinkles or Buckling of Plates, M2-6.Mechanism of Transform Faults, M2-7.Origin of Arc-shaped archipelago, dorsal arc concave basin and seafloor, M2-8.Mechanism of **Plate Overlap**, M2 -9.Mechanism of **Sudden Change in Plate Movement Direction**, M2-10.Source of geomagnetic reversal, M2-11.Cause of van allen zone eccentricity, M2-12.Cause of **Non-Movement of Antarctic continent**,M2-13.Himalayan mountains Causes of arcs, M2-14.Origin of Titis Sea, M2-15.Origin of **Kimberlite pipes**, M2-16.Origin of Tilt of Earth's axis,
>M3. Explanation of **Origin of Solar system** M3-1.Origin of **Jupiter's Great Red Spot**, M3-2.Origin of Pluto(first flyby), M3-3.Cause of **Mercury core rich**, M3-4.Origin of **asteroid belt**, M3-5.Causes of Earth meteorite **differentiation**, M3-6.Causes of **asteroids as mantle aggregates.**

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In G-IH. As an explanation of **Origin of Moon**,
>G1-1.Prediction of results **for Each Initial Condition** by Simulation, G1-2.×Prediction and Comparative Evaluation with Current Situation, G1-3.Evaluation of **Core Ratio of Lunar** Component, G1-4.×Assuming Collision **at Time of Magma Ocean**, G1-5. Visualization of Collision,
>G2.As Explanation of **Origin of Earth**, G2-1.**×No Origin of Earth's Ocean**, G2-2.**×No Origin of Plate Tectonics,**
>G3. As Explanation of **Origin of Solar System**, G3-1. Completely Ignored, G3-2.**×Ignoring** Planet **Formation Mechanism assuming Accidental Collision,** G3-3. **Same Orbit or Planetary Migration Hypothesis,** *Need for proof.*

Hypothetical Model is Moon Size of MIH **Mantle only** and Size of Mars of GIH **Differentiated Core** + **Mantle**, which are Different Collision Models. **Evaluation Method** is *different* from **Creative Reasoning** and ***Simulation***, and ***MIH****Evaluation is 7 + 16 + 6 = 29*, and Selection of lunar of Collision Condition of **Moon only in Mantle** and Explanation of Visualization 1 ***question Truth?****, and Difference is like this.* **It will come out.**

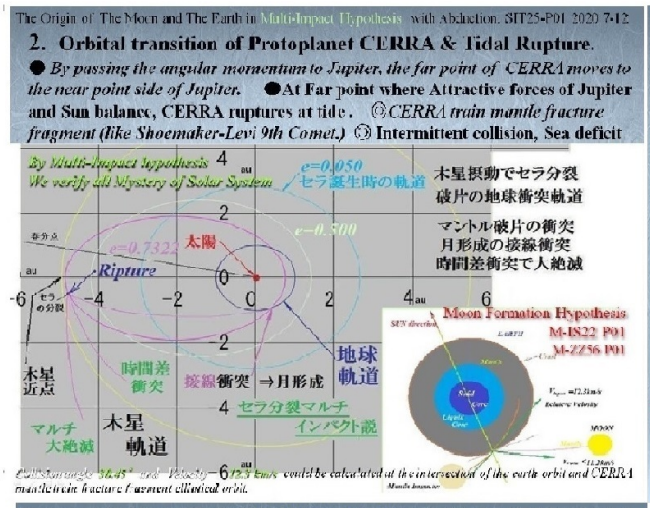
It is **Important** to ***select*** **First Model** and **Evaluation Method.**

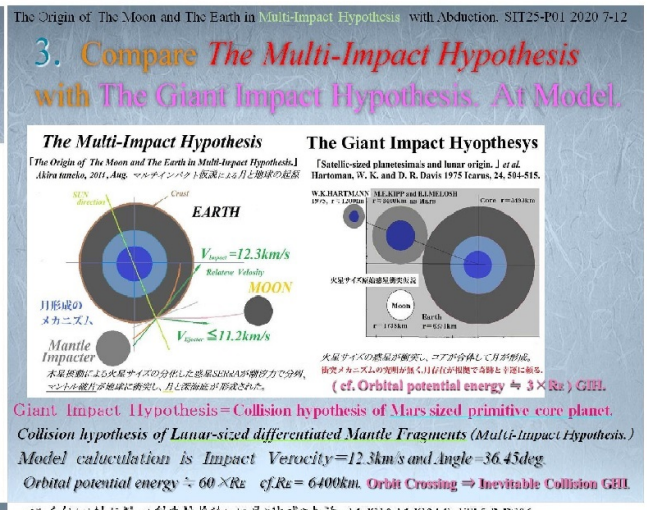
So, let's Discuss here Tips on **how to make Model** *for Creative Reasoning.*
>First, **Don't be overconfident.**
>Considering **all Possibilities**, **Natural Nature** is used as Evaluation Standard.
>Listen to **Laws of Universe**. believe. There is, but Ephemeral. **Listen to Truth**.
>Discover Law, not make it,**thank Nature.**
>Models that violate Law are free from **Nature.**
>**Do not explain with Result, explain Result.** How to research**, why to explore.**
>Path to **Truth is Narrow**, but I believe to be always One.
Life is born in Galaxy in Corner of Vast Universe, **we explore Origin of Life, Earth, Solar System, and Galaxy, is Miracle.**

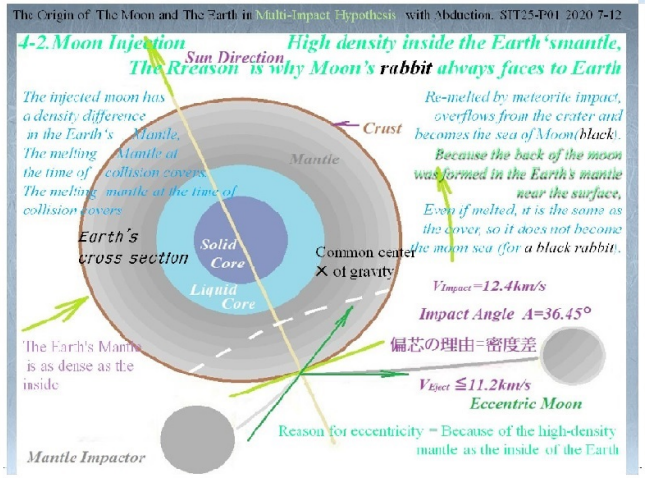
Assuming Collision Body **with only Mantle**, and **considering Inevitable** Collision **Mechanism**, Orbits of Moon matched and Mysteries of Solar system and Earth could be explained together, and Simple Unified Story was created. Excel was sufficient for Calculation, and *Collision* ***Speed and Angle*** *could be derived from Model.*

Keywords: Search for Origin and Verification Method, verification that goes back to Past-Make Hypothesis and explain All Results (Characteristics) of Evolution in a Unified Manner, Multi-Impact Hypothesis verifies Origin of Moon, Plate Tectonics, and Mercury, Multi-Impact Hypothesis verifies Origin of Asteroid Belt, Great Red Spot of Jupiter, Origin of Pluto, Multi-Impact Hypothesis verifies Origin of Deep Ocean Floor, Pacific Rim Arc Archipelago and Back-Arc Basin, Multi-Impact Hypothesis explains Origin of Plate Boundaries, Plate Driving Forces, and Sudden Changes in Direction of Movement, Explain Orbit of Moon, Origin of Lunar Mare, and Mystery that Moon always faces Earth with Multi-Impact Hypothesis

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Most Scientists **do not deny the existence of Plate Tectonics**, but ***cannot explain why Plate Tectonics happened.*** **"Multi-Impact Hypothesis"** ***can explain Origin of Plate Tectonics*** and also ***verify Origin of Moon and Solar System.***

*Akira Taneko[1]

1. SEED SCIENCE Lab.

Most Scientists do not deny Existence of **Plate Tectonics**, but cannot explain *why Plate Tectonics happened.*
It has been 100 years since Wegener proposed **Theory of Continental Drift**, but No one could explore Mechanism that forms Plate Tectonics and *why Plate moves*.
Wegener's **Theory of Continental Drift** was denied that Driving Force could not be explained, but Name was changed to ***Plate Tectonics***, and although Driving Force could not be explained, it behaved as if **Most Scientists** had discovere ***the Pate Tectonics.*** Therefore, Scientists leave "Why Plate moves?" to **Thermal Convection Hypothesis** and work only on "how it moves".

1. Planetary accumulation mechanism (Bode's law and supply range, coalescence law)
(1).As Law of coalescence in Solar System, all but Sun draw an Elliptical Orbit with Central Star as **one Unifocal Focus.**
(2).As a Coalescence Condition, when **Speed Difference is small and a Collision occ**urs, Potential Energy decreases b**y Amount of Thermal Energy** and becomes **an Inner Orbit.**
(3). When passing near Central Star, it is captured by Central Star.
(4). Circular Orbits and Elliptical Orbits **with Same Orbital Energy** have **Same Period and Semimajor Axis**.
(5). Bode's Law was **an Empirical Law** between Planetary Orbits in Solar System. <**Feeding zone**>
[My discovery] **Law of orbital degeneracy.**
An EllipticalOrbit that has Same Orbital Energy as **Earth's Orbit** and tangent to **Forbidden Band** is inscribed in Orbit of Mars. Similarly, ***an Elliptical Orbit*** that has Same Orbital Energy as Venus Orbit and is tangent to **Forbidden Band** is approximately inscribed in Earth's Orbit.
This means that Planetesimals with a Substantially Elliptical Orbit that **accumulate on Earth** have **an Accumulation Range** of Earth's Orbit Range inside Mars orbit (according to 1-(3)).

2. "Multi-impact hypothesis" and moon formation cf. MIS10-1,PPS06-xx.
He explained Origin of Moon, Mechanism of moon formation only in Mantle, Feature that Sea of Moon always faces Earth due to Eccentricity, and Feature only in regolith on Back side in Earth collision of Mantle impactor. (By Abduction using the result of evolution)

3.Origin of deep ocean floor, Formation of Plate Boundary Cracks and Origin of **Plate Tectonics**, Driving Force.
Intermittent Collisions of **Multiple Train Mantle Fragments** with Earth showed Formation Mechanism of Deep Seafloors spreading with an Average Depth of 4 km and Origin of Species Extinction, due to Detachment of Earth's Mantle and Uplift caused by Isostasy. Origin of Land Plate due to Formation Mantle Crack of Sea, which Occupies 70% of Earth's Surface Area by Connecting Multiple Seas, was also shown.
In Collision of Mantle Impactor with Earth,Mantle was craked and an Eccentric Moon was formed like a Newton cradle. Furthermore, Semi-molten Structure of Asthenosphere gave Plate Fluidity, and it was

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driven until Plate was balanced by a Couple that minimized an Eccentric Moment of Inertia due to Earth's Rotation and Plate Imbalance.

4. Origin of **Pacific Rim arc arch archipelago and back-arc basin**, reason for Plate overlap, origin of obliquity, origin of sudden change in plate movement direction, origin of Van Allen belt eccentricity, Origin of geomagnetic reversal, Origin of kimberlite pipe

Considering Van Allen Belt Eccentricity in Cross-Sectional View of Earth passing through Pacific Ocean and Rio, Core Eccentricity of about 500 km is about 10% (500/6400), so it is a Mantle Defect due to **Lunar Ejection** and a Darwin Uplift due to **Isostasy**. Pacific Rim Arc Basin are Back-Arc Basin are **surrounding Depressions** due to Uplift of Darwin, and Japanese Archipelago and Sea of Japan are Result.

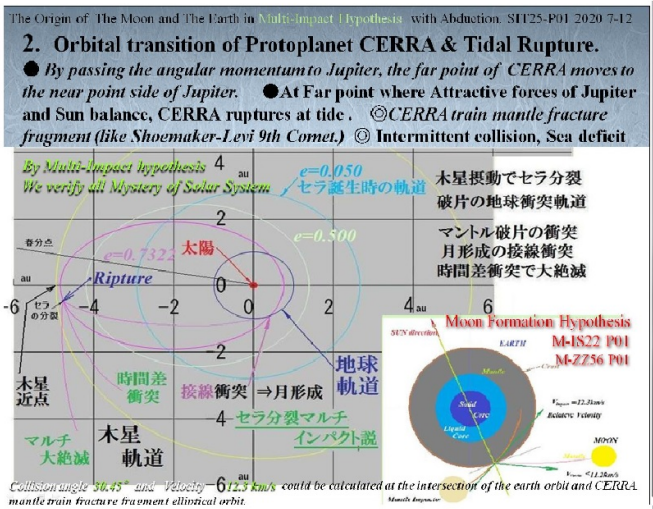
5. Explain Origin of about **30 Items of Universe**, such as Origin of Great Red Spot of Jupiter, Origin of Asteroid belt, Origin of Pluto, Origin of Mercury Corerich, Origin of Differentiated Rocks of Ryugu and Itokawa, and Origin of Planet. I think MIH has been completely Verified.

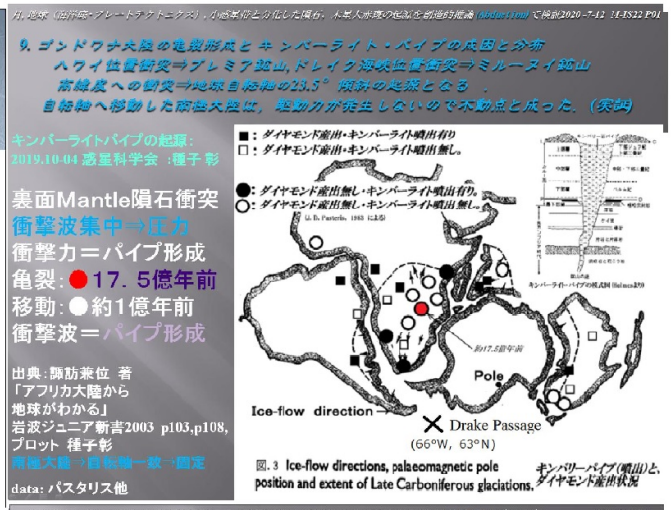
"Multi-Impact Hypothesis" can explain **Origin of Plate Tectonics** and also verify **Origin of Moon and Solar System.**

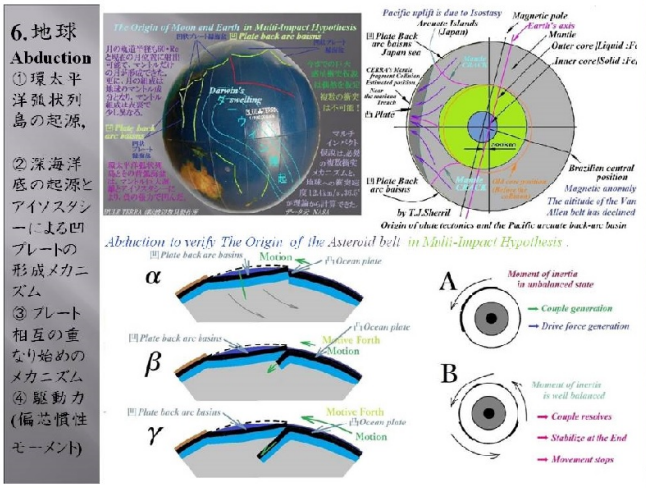
This time, it was announced on P-PS06 (3 Thu J). S-IT16 (4 Fri E), M-IS10 (5 Sat E), M-IS24 (6 Sun J). General and high school students can also participate on Sundays.WHY?

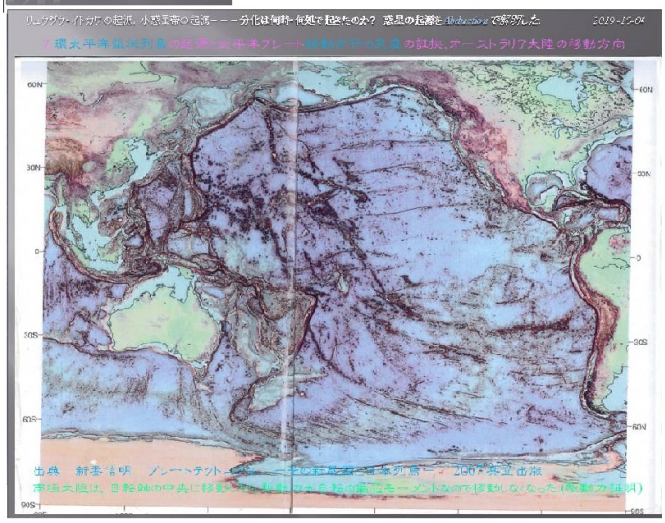
Keywords: Plate Tectonics Origin, Multi-Impact Hypothesis Evolution , Moon Earth Solar System Origin Space Life, Diamond mine kimber lite pipe collision , Jupiter Great Red Spot Pluto Mercury Origin , Lunar mare front side, always facing the earth, eccentric Pacific Rim arc-shaped archipelago

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Liquid Crystal Peptide/DNA Coacervates in the Context of Prebiotic Molecular Evolution

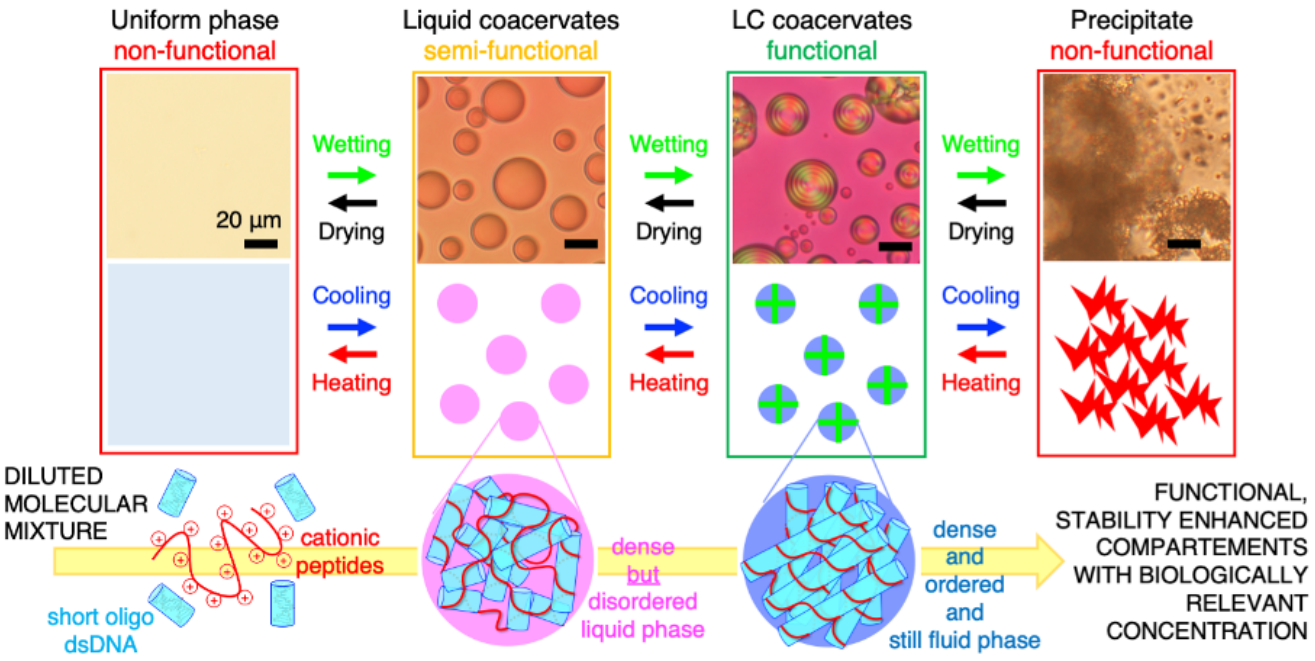
*Tony Z Jia[1,2], Tommaso P Fraccia[3]

1. Earth-Life Science Institute, Tokyo Institute of Technology, 2. Blue Marble Space Institute of Technology, 3. Institut Pierre-Gilles de Gennes, CBI, ESPCI Paris, Université PSL, CNRS

Liquid–liquid phase separation (LLPS) phenomena are ubiquitous in biological systems, as various cellular LLPS structures control important biological processes. Due to their ease of in vitro assembly into membraneless compartments and their presence within modern cells, LLPS systems have been postulated to be one potential form that the first cells on Earth took on. Recently, liquid crystal (LC)-coacervate droplets assembled from aqueous solutions of short double-stranded DNA (s-dsDNA) and poly-L-lysine (PLL) have been reported. Such LC-coacervates conjugate the advantages of an associative LLPS with the relevant long-range ordering and fluidity properties typical of LC, which reflect and propagate the physico-chemical properties of their molecular constituents. Here, we investigate the structure, assembly, and function of DNA LC-coacervates in the context of prebiotic molecular evolution and the emergence of functional protocells on early Earth. We observe through polarization microscopy that LC-coacervate systems can be dynamically assembled and disassembled based on prebiotically available environmental factors including temperature, salinity, and dehydration/rehydration cycles. Based on these observations, we discuss how LC-coacervates can in principle provide selective pressures effecting and sustaining chemical evolution within partially ordered compartments. Finally, we speculate about the potential for LC-coacervates to perform various biologically relevant properties, such as segregation and concentration of biomolecules, catalysis, and scaffolding, potentially providing additional structural complexity, such as linearization of nucleic acids and peptides within the LC ordered matrix, that could have promoted more efficient polymerization. While there are still a number of remaining open questions regarding coacervates, as protocell models, including how modern biologies acquired such membraneless organelles, further elucidation of the structure and function of different LLPS systems in the context of origins of life and prebiotic chemistry could provide new insights for understanding new pathways of molecular evolution possibly leading to the emergence of the first cells on Earth.

Keywords: Origin of Life, Origin of the Cell, Protocell, Prebiotic Chemistry, Astrobiology

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[E] Poster | M (Multidisciplinary and Interdisciplinary)：M-GI General Geosciences, Information Geosciences & Simulations

Sat. Jun 5, 2021 5:15 PM - 6:30 PM JST | Sat. Jun 5, 2021 8:15 AM - 9:30 AM UTC | Ch.20_4

[M-GI32] Integration of Earth Observations and Multiple use for Earth Science and Benefits to Societies - GEO

convener:Kentaro Ando(Japan Agency for Marine and Earth Science and Technology), Hiroyuki Muraoka(River Basin Research Center), Osamu Ochiai(Japan Aerospace Exploration Agency), Shinichi Sobue(Japan Aerospace Exploration Agency)

Floods and drought, environment deterioration and pollution, global warming and island losing, and ecosystem degradation endanger the security of water, food, energy, health and ecosystem services. To confront these challenges, there is a demand to foster its application capacity and to develop an integrated, sharable, and sustained observation systems. Group on Earth Observations (GEO) as an intergovernmental body is a partnership of more than 100 national governments including Japan and in excess of 100 Participating Organizations that envisions a future where decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations. To promote a regional cooperation on earth observation with broad engagement of various communities of earth observations, earth system modeling, environmental assessment and society, AOGEO as one of regional initiatives is established to foster regional application activities focusing on the emerging issues in the region.

The purpose of this session is 1) to exchange the current status of data integration efforts in global GEO and regional AOGEO, 2) to welcome any contributions of similar activities from outside of GEO and AOGEO, and 3) to foster GEO and AOGEO activities and its related activities via any submissions and contributions of analysis of earth observations both from integrated data and single unique data on the earth science and societal applications. Therefore, we seek submissions which include a) scientific researches by use of earth observation data both from various platforms including satellite and in-situ, b) development of new data sets for national, regional and global analyses, and c) development of data integration and management platforms and its broad application to our society including a concept of knowledge hubs.

[MGI32-P01] Developments of a new ocean data networking system for coastal ocean data sharing, and satellite data management system for Integrated Priority Study in AOGEO

*Kentaro Ando[1], Fumihiko Akazawa[1] (1.Japan Agency for Marine and Earth Science and Technology)

[MGI32-P02] Asia Pacific Biodiversity Observation Network (APBON) Strategic Plan 2030

*Hiroyuki Muraoka[1], Yayoi Takeuchi[2], Takehisa Yamakita[3], Yuichi Kano[4], Shin Nagai[3], Masahiro Nakaoka[5], Yongyut Trisurat[6], Runi Sylvester Pungga[7] (1.Gifu University, 2.National Institute for Environmental Studies, 3.Japan Agency for Marin-Earth Science and Technology, 4.Kyusyu University, 5.Hokkaido University, 6.Kasetsart University, 7.Forest Department Sarawak)

[MGI32-P03] Status of Global Forest Observation Initiative (GFOI) and its contribution to climate change monitoring

*Osamu Ochiai[1] (1.Japan Aerospace Exploration Agency)

Developments of a new ocean data networking system for coastal ocean data sharing, and satellite data management system for Integrated Priority Study in AOGEO

*Kentaro Ando[1], Fumihiko Akazawa[1]

1. Japan Agency for Marine and Earth Science and Technology

For contributing to the Asia-Oceania Group on Earth Observation (AOGEO) activities from the Ocean, Coasts and Islands (OCI) Task, new ocean data networking system for coastal ocean data sharing has been developing by using Geonetworks (open source, https://geonetwork-opensource.org/). This system allows all users visiting one site to jump to other sites by using the data-portal based on Geonetworks. The demonstration system was developed in 2019 by JAMSTEC and CSIRO, and it has been expanding to few Asian countries after the technology exchange session of OCI Task in February 2021. This new approach will bring us a new opportunity to use coastal data, which are not well accessed from a third party.

For contributing the Integrated Priority Study (IPS) of the AOGEO regional activity, we also have developed the demonstration system of Open Data Cube (ODC) to manage the satellite data (ALOS and ALOS-2) and satellite-based products. In the framework of IPS, Japan as well as Australia, China and Korea will develop own ODC system to be able to distribute each own satellite and satellite-based products. As the ODC will be able to provide Python Notebook/Hub for users to run demonstration codes and to develop own codes of python by using datasets from products provided by each country. We will report the update of preparations of ODC system in Japan and will show the preliminary plots and demonstration.

From the two presentations, any comments on these developments are welcomed.

Keywords: GEO, AOGEO, data utilization

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Asia Pacific Biodiversity Observation Network (APBON) Strategic Plan 2030

*Hiroyuki Muraoka[1], Yayoi Takeuchi[2], Takehisa Yamakita[3], Yuichi Kano[4], Shin Nagai[3], Masahiro Nakaoka[5], Yongyut Trisurat[6], Runi Sylvester Pungga[7]

1. Gifu University, 2. National Institute for Environmental Studies, 3. Japan Agency for Marin-Earth Science and Technology, 4. Kyusyu University, 5. Hokkaido University, 6. Kasetsart University, 7. Forest Department Sarawak

Asia Pacific Biodiversity Observation Network (APBON) was established in 2009 and it is contributing to Asia Oceania Group on Earth Observations (AOGEO) as well as GEO Biodiversity Observation Network (GEO BON). We are now moving to the next steps to address challenges in biodiversity observations and assessments in our region, based on our 10-year achievements (Takeuchi et al. 2021, Ecological Research DOI: 10.1111/1440-1703.12212).

The societal demands for the Earth observation have been increasing because of emerging environmental issues such as climate change and species extinction in both global and local scale. Our ecosystem and biodiversity monitoring activities as “Earth observation” and subsequent scientific analyses provide an essential data to understand the status, trends, and projection of the future earth system including under climate and societal change. Through the high-quality observation of biodiversity change, APBON will strive to provide scientific evidence to develop sound assessments and facilitate policy-making.

Regional networks, such as APBON, play an essential role in taking an initiative to gather, explore, and prioritize local issues and practices and link these over regions, scientific communities, and stakeholders. We cherish the bottom-up approaches and/or landscape-level approaches, which our members have used, as it matches with the scale of the biodiversity-issues and the goal setting to maximize the benefits to local people, regional ecosystems, and biodiversity. It also offers more opportunities to work with scientists and local stakeholders and facilitate problem-solving corporation using the available knowledge. Another target is to promote data sharing and data accessibility through and by strengthening the networking of the observation networks in local to AP regional scale and deliver our information and knowledge to global platform. APBON plays a role as a “hub” to link the local, national, regional, and global needs of biodiversity observations, customizing observation designs and tools, and matching science-policy interface.
In this presentation we are willing to share our implementation plans with the Earth observation communities to respond to the following new needs to the biodiversity observations: (1) Developing national BONs and networking them in the region to contribute to CBD Aichi Biodiversity Targets and post 2020 Global Biodiversity Framework, (2) Filling observational and knowledge gaps for biodiversity status and trends to contribute to IPBES assessments, (3) Producing data and knowledge to address the issues particularly related to biodiversity and ecosystem sustainability by coordinated activities with GEO and AOGEO, (4) Contributing to achievements of SDGs by providing adequate and defensible biodiversity data that help developing policy for conservation and sustainable use of biodiversity, and (5) Learning the challenges of biodiversity issues under COVID-19 pandemic and on-going climate change.

Keywords: biodiversity, ecosystems, ecosystem services, forest, freshwater, marine

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Status of Global Forest Observation Initiative (GFOI) and its contribution to climate change monitoring

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Group on Earth Observation (GEO) coordinates multiple Earth observation activities around the world. The coordination is essential towards converging similar activities in many countries and making synegy for achievement various global challenges. As one of GEO Flagships, Global Forest Observation Initiative (GFOI) has been initiated in 2011. GFOI provides international coordination machanism in order to support implementing National Forest Monitoring System by using Earth observation data. GFOI provides method and guidance to use Earth observation data, research and development of new science and technologies, data and information provision support and capacity development for those who are not familiar to use Earth observation data. Recently, GFOI has initiated discussion on how to contribute GFOI activities to Paris agreement. It would be expected significant contributions by GFOI to the stakeholders in the Climate Change agenda.

Keywords: Earth obaservation, GFOI, data

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