2019年5月30日(木)

[J] Eveningポスター発表 | セッション記号 M (領域外・複数領域)：M-IS ジョイント

17:15 ~ 18:30 | ポスター会場 幕張メッセ国際展示場 8ホール_38

[M-IS09] 最新の大気科学：ダスト

コンビーナ:石塚 正秀(香川大学)、黒崎 泰典(鳥取大学乾燥地研究センター)、関山 剛(気象庁気象研究所)、長島 佳菜(海洋研究開発機構　地球環境観測研究開発センター)

[MIS09-P01] Study on decadal influencing of the teleconnection pattern EA and SCAND on major atmospheric circulation systems of the northern China dust storms during the past 65 years (1954-2018)

*高 涛[1]、咏 梅[2] (1.中国内蒙古自治区気象科学研究所、2.中国内モンゴル師範大学)

[MIS09-P02] **Effects of freeze-thaw and land-surface processes on dust occurrence in the Mongolian desert steppe**

*Kaman kong[1]、Masato Shinoda[1]、Banzragch Nandintsetseg[1,2,3]、Yasunori Kurosaki[4] (1.Nagoya Unviserity、2.Information and Research Institute of Meteorology, Hydrology, and Environment、3.National University of Mongolia、4.Tottori University)

[MIS09-P03] 北太平洋とその縁辺海の表面水中に懸濁する鉱物粒子－海水分析から調べた風送ダストの沈着

*岩本 洋子[1]、植松 光夫[2] (1.広島大学　生物圏科学研究科、2.東京大学　大気海洋研究所)

[MIS09-P04] 石英個別粒子のカソードルミネッセンス分析に基づく，カナダ雪氷コア中のアジアダストの供給源推定とその季節変化

*長島 佳菜[1]、東 久美子[2] (1.海洋研究開発機構　地球環境観測研究開発センター、2.国立極地研究所)

[MIS09-P05] 飛砂風洞装置を用いた弱い土壌クラストが飛砂とダスト発生に与える影響の解明

*石塚 正秀[1]、中原 優祐[5]、政岡 瞳見[6]、中尾 元軌[6]、石井 智之[6]、黒崎 泰典[2]、萩野 裕章[3]、中村 公一[7]、Gantsetseg Batdelger[4]、南光 一樹[9]、西原 英治[8]、鈴木 覚[9] (1.香川大学創造工学部、2.鳥取大学乾燥地研究センター、3.森林総合研究所東北支所、4.モンゴル水文気象環境情報研究所、5.香川大学大学院工学研究科、6.香川大学工学部、7.鳥取大学工学部、8.鳥取大学農学部、9.森林総合研究所森林研究部門)

[MIS09-P06] **Effect of stone on sand saltation in Tsogt-Ovoo, Mongolia: Observation and Model simulation**

*Batjargal Buyantogtokh[1]、Yasunori Kurosaki[1]、Masahide Ishizuka[2]、Tsuyoshi Sekiyama[3] (1.Arid Land Research Center, Tottori University、2.Faculty of Engineering and Design, Kagawa University、3.Japan Meteorological Agency, Meteorological Research Institute)

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鉱物性ダストは強風により、地表面から発生し、地球内を長距離輸送する。その過程で、雲の形成や太陽放射の吸収・散乱により、気象・気候変化をもたらす。また、海洋に沈着すると、植物プランクトンに栄養塩を供給し、光合成を促進させ、雪氷に沈着すると、アルベドの変化をもたらす。日本などアジア地域では、黄砂現象として知られている。この黄砂現象を理解するためには、幅広い分野の融合が必要である。

発生過程では、乾燥域の地表面条件によってダスト発生量が大きく変化し、その条件を決めるためには、土壌や地形、植生、降水、砂漠、土壌劣化といった分野を扱う。輸送過程では、気象や大気エアロゾル、放射といった分野を扱う。沈着過程では、海洋、雪氷、人や家畜への健康といった分野を扱う。乾燥化や植生の変化は、国の政策や家畜の管理、人口増加といった社会科学的側面も有する。また、ダストや砂丘は地球だけでなく、火星・土星などの他の惑星にも共通する現象である。このように、一つ分野だけでは、ダスト現象を理解することはできず、本セッションを通して、多くの分野の研究者が議論し、情報共有を行うことが重要であり、研究者の交流を進める。

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Study on decadal influencing of the teleconnection pattern EA and SCAND on major atmospheric circulation systems of the northern China dust storms during the past 65 years (1954-2018)

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Frequent cold-air attacks with less precipitation and aired surface conditions are mainly direct causes of more dust storm occurrences over the dust-source-areas during winter-spring season. In this study, the observation records of the horizontal visibility at 65 stations dotted in northern China (35˚-45˚N, 94˚-120˚E) for 65 years (1954-2018) were collected and used to investigate the frequencies of dust storm (DS) and severe dust storm (SDS) events during the term of February-June. As a whole, declining trends were appeared for both DS and SDS during the past several decades. A dust storm frequently occurrence term is confirmed from 1950s to 1970s, with decadal means of 7.1 and 2.5 events for both DS and SDS. From 1980s to 2010s, the DS and SDS decreased significantly with decadal means of 3.8 and 1.1 events, separately. The 1970s is the most frequent dust storm decade, during which 81 DS events have been recorded. Oppositely, the 1990s is the most infrequent decade with totally 25 DS events. Comparing spring precipitation and snow events of the previous winter, the precipitation anomaly of the 1970s is -13.3% and for 1990s, it is 15.9%. Decadal mean of the prior winter snow events are 3.6 and 4.8 respectively for 1970s and 1990s. That means 1970s has less than normal precipitation during winter-spring. The climate was dry. In turn, it had more precipitation during the 1990s, the climate was wet and the dust storm decreased.

By comparing the major atmospheric circulation systems relating to frequent and infrequent dust storm springs, it has been identified that a weak West Pacific subtropical high (WPSH), a strong North Polar vortex (NPV) and a strong and western position East Asian trough (EAT), in general, corresponding to less precipitation and dry climate, and then, a frequent dust storm spring. Contrarily, it is opposite.

Indices of the atmospheric teleconnection pattern EA and SCAND (also named EU1) were issued on the website of the Climate Prediction Center of USA. Influence of these two teleconnection patterns on the major atmospheric circulation systems and dust storms was studied in this work. Analyzed outcomes indicate that the EA has a closely positive connection with the WPSH and the westerly for winter-spring season. A strong WPSH is benefit to the sea vapor transportation for the dust source regions where located in northern China, bring more rainfalls to there. Additionally, a strong westerly over Eurasia confines the extension of the NPV, and the cold air from the Polar decreases, corresponding to an infrequent DS spring. It is opposite when the EA is weak. The SCAND displays a significantly negative relationship with the westerly and a converse variation trend with the DS frequency. The westerly not only has an impact on the NPV, but also affects the EAT as well. The westerly may become weak when the SCAND is strong, at the same term, the meridionality varied big and the polar cold air attacks may increase, lead to more DS weathers. The EAT may becomes strong and moves to more western position while the westerly is weak. This EAT condition is unfavorable to the vapor transferred to the focused area from the East Sea, results in less precipitation and dry climate, DS may increase during the springtime. Conversely, the westerly may become strong when the SCAND is in weak phases. The NPV, in general, is

weak and the cold air attacks decrease. The EAT varies weak and move to eastern than normal position, favoring to the vapor transportation and more rainfall moistening the surface soil, the DS may decrease.

キーワード：ダスト、テレコネクションパターン、大気循環、中国北部
Keywords: Dust storm, Teleconnection pattern, Atmospheric circulation, Northern China

Effects of freeze-thaw and land-surface processes on dust occurrence in the Mongolian desert steppe

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Dust storms not only cause serious environmental problems, but also influence social and economic activities. They depend on the relationships between erosivity (wind speed) and erodibility (e.g., soil moisture, freeze-thaw cycle, and vegetation). However, in the Mongolian desert steppe (MDS), these relationships have not fully been investigated, particularly the effect of freeze-thaw cycles on dust events. Here, we investigated the impacts of freeze-thaw and land surface processes on dust occurrence at Tsogt-Ovoo in the MDS during 2012–2017. This study uses the saltation number and dust concentration measurements, and modelled land-surface variables by an ecosystem (DAYCENT) model, which was validated with field measurements. Results showed that interannual variations in wind speed and dust concentration were not significantly different within springs (April–June) of 2012–2017. However, large interannual variability of saltation events observed at the same time. Saltation events were high in springs of 2012 and 2015 because small threshold wind speed that was related to dry soil and less vegetation, which were, in turn, the result of less precipitation in the preceding summer. Additionally, saltation events tended to occur after near-surface soil temperature rose above the freezing point. This freeze-thaw process likely plays an important role in increasing the susceptibility of soil to erosion.

Keywords: Mongolian desert steppe, freeze-thaw cycles, land-surface processes, dust occurrence, DAYCENT model

北太平洋とその縁辺海の表面水中に懸濁する鉱物粒子ー海水分析から調べた風送ダストの沈着

Mineral particles suspending in the surface waters of the North Pacific and its marginal seas –atmospheric dust deposition as investigated from seawater analysis

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Suspended particulate matter (SPM) in the ocean consists of a variety of components from both biogenic and crustal sources. The mineral particles from crustal sources are brought to the oceans mainly via river run-off and atmospheric deposition. The atmospheric pathway becomes important especially in the open ocean far from the continents. In addition, atmospheric dust contains iron which can be used as nutrients for marine phytoplankton. Therefore, it is important to understand the size and chemical characteristics of the mineral particles that deposit to the ocean in understanding the linkage between atmosphere and marine ecosystem.

This study presents the properties of mineral particles in the SPM collected in the North Pacific and its marginal seas (the Sea of Okhotsk, the Bering Sea and the Chukchi Sea) based on bulk and individual particle analyses.

The mineral particles were distributed ubiquitously in the North Pacific even during summer when the influence of atmospheric Asian dust transport is small. Their relative abundances in the total SPM was 5 to15% by number and about 2 to 7% by volume. The size distribution of the suspended mineral particles in the SPM was similar to that of the atmospheric dust aerosols, indicating that mineral dust of background level occurs in the marine boundary layer even in summer.

The shipboard observation during a Kosa (Asian dust) season showed that atmoepheric dust settled onto the ocean surface, and resulted in increase in the mineral particles' concentration four to five times in surface water of the western subarctic North Pacific. The deposition flux of atmospheric dust into the ocean surface by a Kosa-event was calculated to be 270 mg m^{-2} $event^{-1}$. The dissolve iron flux at the Kosa-event was also estimated at 130-230 μg m^{-2} $event^{-1}$, and is found to have a potential to supply enough iron to lead the phytoplankton bloom in HNLC waters. This result confirms that a sporadic supply of dissolved iron that leading to phytoplankton bloom can naturally occur in the western subarctic North Pacific.

キーワード：北太平洋、縁辺海、海水懸濁粒子、黄砂、鉄、地理的分布
Keywords: the North Pacific, Marginal seas, Suspended particulate matters in seawater, Kosa, Iron, Geographical distribution

石英個別粒子のカソードルミネッセンス分析に基づく，カナダ雪氷コア中のアジアダストの供給源推定とその季節変化

Seasonal change of the Asian dust provenance within the Canadian ice core estimated from cathodoluminescence spectra of single quartz grains

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Mineral dust is considered to have a great effect on the natural environment of the Earth by altering the global radiative balance, cloud properties (Intergovernmental Panel on Climate Change (IPCC) AR5, 2014) and ocean primary productivity (Maher et al., 2010). At present, a large amount of aeolian dust is emitted from the huge dry areas of East Asia, typically the Taklimakan Desert in western China and Gobi in southern Mongolia and northern China (Sun et al., 2001). The dust particles derived from such deserts are transported to China, Korea, Japan, and the northwestern North Pacific by the westerlies and is sometimes transported more than one full circuit around the globe through the westerly jet (Uno et al., 2009). Hence, the Asian dust affects climate/environments throughout the northern hemisphere. For the further investigation and evaluation of Asian dust impacts on global environment, it is critical to determine the amount and main sources of Asian dust transported over long distances.
Ice cores from Mt. Logan (60N, 141E), Canada, are the ideal recorder of seasonal to decadal-scale changes in dust transport over a long distance (Zdanowicz et al., 2006). Hence here we examine the past seasonal change of dust provenance using an ice core from King col (4135m above sea level) at Mt. Logan by utilizing a new provenance-tracing method, cathodoluminescence (CL) spectral analysis of “single” quartz grains (Nagashima et al., 2017). CL spectroscopy can detect crystal-chemical features in quartz such as impurities and intrinsic imperfections that depend on the conditions affecting quartz from its formation onward, which are useful to identify the quartz from two major Asian deserts, the Taklimakan Desert and Mongolian Gobi. The CL analysis was performed on quartz grains within ice core samples corresponding to 1941, 1951, 1967, 1983, and 1986 A.D. (6–7 samples/year). We found most quartz grains from ice core samples show two CL emission bands in red and blue regions, which were deconvolved to at most five emission components, each of which represents a specific defect due to an impurity or imperfection. The statistical analysis using the ratios of emission components exhibits ratios of clusters of each sample, which are mostly between those of quartz from Taklimakan Desert and Mongolian Gobi, suggesting the mixing of quartz from the two deserts. Furthermore, the cluster compositions of ice core samples suggest seasonal and possible decadal-scale changes of the dust provenance transported over a long distance, of which detail will discuss in the presentation.

キーワード：黄砂、供給源、雪氷コア
Keywords: Asian dust, provenance, ice core

飛砂風洞装置を用いた弱い土壌クラストが飛砂とダスト発生に与える影響の解明

Wind tunnel experiments for saltation and dust emission under weak crusted Mongolian soil

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Dryland area is enlarging and its environment is changing in the globe. Mineral dust is generated from such dry area and causes various problems such as health damage which is caused by well-known air pollutants such as $PM_{2.5}$, traffics stoppage due to low visibility, and a reduction of agricultural productivity due to loss of nitrogen and phosphorus contained in surface soil. The nutrients and soil minerals make algal blooms in ocean and its photosynthesis makes CO_2 absorption from atmosphere. Mineral dust itself acts as an ice nuclei primarily and effects cloud formation, and absorbs and/or diffuses solar and infrared radiations secondary. In addition, it transports biological gene of microorganism and bacteria attached to the soil surfaces. Like this, mineral dust gives large influences for various fields and is important to understand the natural and social changes.

This study focuses on the emission process of dust, especially, soil crust effect on the saltation and dust emission. Soil crust is one of the ground surface conditions, which affects dust generation largely due to strong soil aggregation. But it is well not understood how much soil crust effects saltation and dust emission amount yet. To clarify this, wind tunnel experiment was conducted in a laboratory of Forestry and Forest Products Research Institute, Tsukaba, Japan. Toyoura sand is used as saltating grains and Mongol soil which has both finer and larger particles (Loam) sampled at Tsogt-Ovoo in the northern Gobi Desert is used as a target soil. The water ratio is set 0-15 % for making artificial soil crust.

PTV (Particle Tracking Velocimetry) analysis by using a high-speed camera (30000 fps) shows the reduction of kinetic energy of saltation particle after it hits the ground surface. The crusted surface soil was not much erodible under the higher water ratio. Dust concentration decreases under the crusted condition. These findings are fundamental for elucidating the process of dust emission and will link to improve dust forecasting accuracy by atmospheric models.

キーワード：黄砂、アジアンダスト、乾燥地、含水比、PM2.5

Keywords: KOSA, Asian dust, dryland, water ratio, PM2.5

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Non-erodible elements (i.e., pebble, stone, bedrock, vegetation, dead leaf) are key factors to control wind erosion. The non-erodible elements can protect the underlining surface by absorbing the wind momentum, thus increasing the threshold velocity for sand movement on the intervening surface (Tan et al., 2013). According to Haustein et al. (2015), however, all results of box models, which are 0-dimensional dust emission models installing schemes of Marticorena and Bergametti (1995), Shao (2004), and Alfero and Gomes (2001), overestimate the horizontal sand flux due to lack of consideration in the surface coverage by the non-erodible elements. This suggests current global and regional dust models don’ t consider the effects of them well. We will show observation and box models result of sand saltation at different land surface characteristics at Tsogt-Ovoo located in a northern part of the Gobi Desert, Mongolia.

An analysis of meteorological observatory data showed that the frequency of dust storms was the highest at Tsogt-Ovoo in East Asia (Kurosaki and Mikami, 2007). There is a topographic depression, whose sizes are about 10 km and 20 km in NE-SW and NW-SE directions, respectively. Such topography makes spatially different soil and land surface characteristics such as bedrock coverage, stone coverage, parent soil particle size and vegetation coverage. We made a measurement of sand saltation and wind speed at 7 sites during 31 April –5 May 2018. We installed ud-101 (Udo 2009; Sherman 2011) at 0.1 m height for sand saltation and anemometer (S-WSA-M003, Onset Company) at 1.7 m height at each site.

Our observation shows the sand saltation counts and threshold wind speed differs very much site-by-site due to differences in non-erodible elements like stone, dead leaf and soil crust. Even though wind speed is high, small counts of sand saltation were observed at Sub18A and Sub18C sites which are highly covered by bedrock and stone, whose coverages (hereafter, BSC) are 76.9% and 50.6%, respectively. Our sand saltation box model, which is based on Shao's dust emission scheme, also showed small sand flux under such high BSC like those sites. Big sand saltation counts were observed at Main and Sub14B sites, those stone coverages are 18.2 % and 17.6 %, respectively. The threshold wind speeds of sand flux with stone effect are similar with observation in the result of model. The observation and model simulations showed that BSC effect is a major controlling factor for sand saltation counts and flux for Sub18A, Sub18C, Main and Sub14B sites.
At Sub14A and Sub18D sites, even though stone coverages are small (2.1% and 6.4%, respectively), our observations show very small sand saltation counts even under strong wind conditions. These results suggest a hypothesis that other non-erodible elements such as standing dead leaves and soil crusts majorly suppress sand saltation, though we could find them by our eyes but we don't have their quantitative data. Our simulations show sand saltation fluxes increase with wind speed. One reason of it is the BSC effect doesn't work very much due to small stone coverages at sites. Another possible reason is effects of other non-erodible elements such as standing dead leaves and soil crusts are not installed in our model but they work very much in reality.

Keywords: Non-erodible elements, sand saltation, stone effect, box model

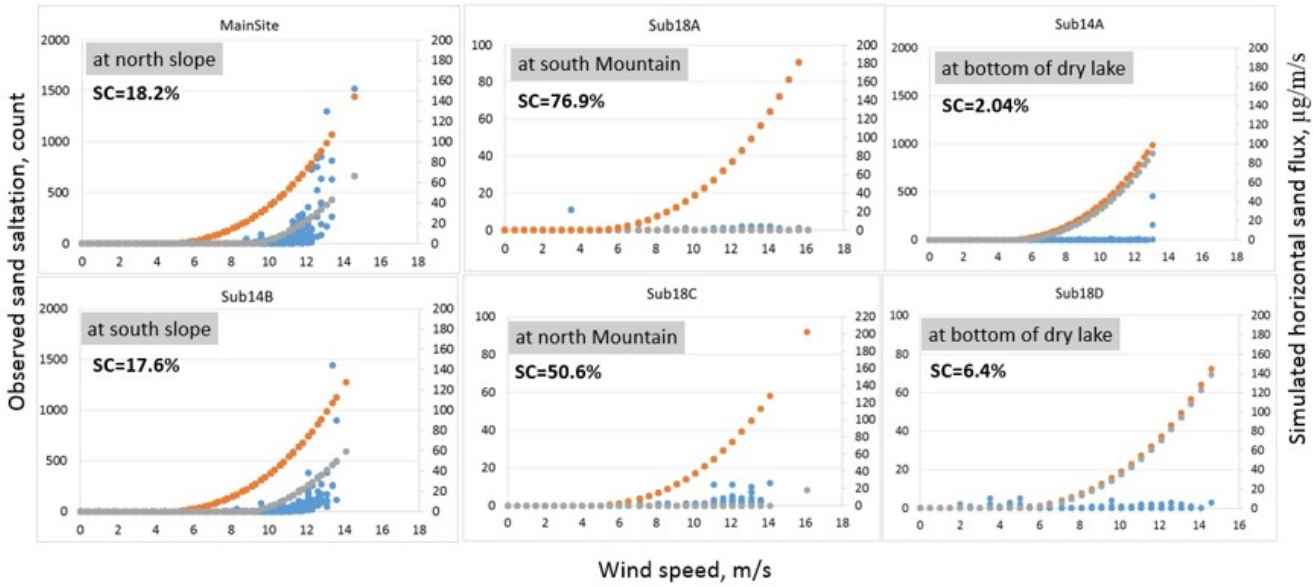

Fig. 1 Observed wind speed (x-axis) and observed sand saltation counts (left axis) (shown by blue dots) at sites which different stone coverage (SC) during the period of May 1-5, 2018 at Tsogt-Ovoo, Mongolia. Simulated wind speed (x-axis) and simulated sand fluxes (right axis) without BSC effect (BSC=0%) (orange dots) and same for with BSC effect (observed BSC value) (gray dots) for same sites and for same period.

