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2019年5月29日(水) 15:30 ~ 17:00 | A03 東京ベイ幕張ホール

[P-EM09] Vertical coupling in the atmosphere and Ionosphere

コンビーナ:Liu Huixin(九州大学理学研究院地球惑星科学専攻 九州大学宙空環境研究センター)、Chang Loren(Institute of Space Science, National Central University)、大塚 雄一(名古屋大学宇宙地球環境研究所)、座長:大塚 雄一、Yosuke Yosuke Yamazaki(GFZ Potsdam, Germany)

Vertical coupling mechanisms throughout the whole atmosphere are critical to understanding the near Earth space environment, as well as its sensitivity to the solar, geomagnetic, and atmospheric drivers. This international session focuses on physical/chemical processes occurring in the mesosphere, thermosphere, and ionosphere (MTI). Both quiet and disturbed states in response to lower atmospheric forcing or solar forcing are important for understanding the MTI system and its coupling to other regions. We invite presentations of observations and observational concepts with ground-based and/or space-borne instruments, theoretical studies, numerical simulations, and development of data analysis systems for various kinds of temporal and spatial variations in atmosphere-ionosphere coupled system.

15:30 ~ 15:50

[PEM09-06] Results of FORMOSAT-3/COSMIC to the most recent developments on FORMOSAT-7/COSMIC-2

★Invited Papers

*JANN-YENQ Liu[1] (1.Center for Astronautical Physics and Engineering; Graduate Institute of Space Science, National Central University, Taiwan)

15:50 ~ 16:05

[PEM09-07] A morphological study on the relationship between electron density fluctuations and magnetic fluctuations observed by low altitude satellites in low and middle latitudes

*家森 俊彦[1]、青山 忠司[1]、横山 佳弘[1] (1.京都大学)

16:05 ~ 16:25

[PEM09-08] Observations of the Thermosphere and Ionosphere by the NASA GOLD Mission

★Invited Papers

*Stanley C Solomon[1]、Alan G. Burns[1]、Richard W. Eastes[2]、William E. McClintock[2] (1.National Center for Atmospheric Research、2.University of Colorado)

16:25 ~ 16:40

[PEM09-09] 全球TECに見られる磁気嵐時の中低緯度域における電子密度増大の時間・空間発展

*新堀 淳樹[1]、惣宇利 卓也[1]、大塚 雄一[1]、津川 卓也[2]、西岡 未知[2] (1.名古屋大学宇宙地球環境研究所、2.情報通信研究機構)

16:40 ~ 16:55

[PEM09-10] **Tidal Forcing Effects on the Zonal Variation of Solstice Equatorial Plasma Bubbles**

*Loren Chang[1]、Jude Salinas[1]、Yi-Chung Chiu[1]、Pei-yun Chiu[1]、Charles Lin[2] (1.Institute of Space Science and Engineering, Center for Astronautical Physics and Engineering, National Central University, Taiwan、2.Department of Earth Science, National Cheng Kung University, Taiwan)

16:55 ~ 17:00

Discussion

Results of FORMOSAT-3/COSMIC to the most recent developments on FORMOSAT-7/COSMIC-2

*JANN-YENQ Liu[1]

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The FORMOSAT-3 Project is also named Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC), or FORMOSAT-3/COSMIC (F3/C) for short. The project is targeted to place six micro-satellites into six different orbits with 72-deg inclination at 700~800 kilometer above the earth ground. These satellites orbit around the earth to form a low-earth-orbit constellation that conduct radio occultation (RO) by receiving signals transmitted by the 24 US GPS satellites. The satellite observation covers the entire global ionosphere, providing over 2,500 global RO sounding data (electron density and S4 scintillation profiles) per day since 15 April 2006. This for the first time allows scientists observing the 3D ionospheric electron density structure and dynamics. Simultaneous F3/C RO observations and ground-based receiver measurements of International GNSS (global navigation satellite system) Service (IGS) further initiate constructing three different models for monitoring (near real-time), nowcasting (few minutes to hours), and forecasting (few hours to days) the ionospheric weather resulted from the space weather (solar disturbances, solar winds, magnetic storms, etc.); the atmospheric severe weathers (typhoons, fronts, volcano eruptions, etc.); and the lithosphere weather (earthquakes, tsunami, etc.). The monitoring model is combining the total electron content (TEC) or the GNSS satellite signal scintillations of F3/C and ground-based IGS observations to construct an advanced GIM (global ionospheric map) to report the ionospheric bias and develop L-band scintillation models for communication, positioning, and navigation applications. The nowcast model is a global 3D ionospheric data assimilation model based on the Gauss-Markov Kalman filter with an existing background model to assimilate the TEC observations from the ground-based IGS receivers and space-based F3/C to output the global electron density for coming few minutes to hours. On the other hand, to carry out a long-term forecast, the neutral compositions in the atmosphere should be taken into consideration. Therefore, to develop a forecast model assimilating the observations of F3/C and IGS ground-based receivers into a neutral-ion coupled model. Following the F3/C, FORMOSAT-7/COSMIC (F7/C2) consists of six small-satellites with 24-deg inclination and about 500 km altitude will be launched in 2019. The developed models with F7/C2 RO by receiving signals transmitted by the GPS/GLONASS satellites and IVM (ionospheric velocity meter) plasma measurements as well as ground-based IGS GNSS data shall significantly improve the space weather monitoring/nowcast/forecast in the near future.

Keywords: ionospheric space weather, FORMOSAT-3/COSMIC, FORMOSAT-7/COSMIC, Kalman filter

A morphological study on the relationship between electron density fluctuations and magnetic fluctuations observed by low altitude satellites in low and middle latitudes

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Polar orbiting low-altitude satellites such as the Swarm satellites observe magnetic and electron density fluctuations in low and middle latitudes along satellite orbit. The magnetic fluctuations typically have the period about 10-30seconds along satellite orbit and they are mostly small-scale field-aligned current effects and named as 'magnetic ripples'. They are supposed to be generated in lower ionosphere by dynamo mechanism caused by neutral atmospheric waves from lower atmosphere. On the nightside, they still exist with smaller amplitude because of lower ionospheric conductivity. Plasma bubbles also exist on the nightside and they normally accompany magnetic fluctuations to keep pressure balance. If we trace down to the dynamo layer around 120km altitude from magnetic ripples and compare the electron density fluctuations, they correspond better than the correspondence on the orbit. This indicates vertical propagation of atmospheric waves which causes both magnetic ripples and electron density fluctuations. On the other hand, in well-developed plasma bubbles, plasma density fluctuation and magnetic fluctuation occur at the same location on the orbit. In this study, we present morphological relationship between the two phenomena. That is, we investigate how magnetic ripples relate to plasma bubbles.

キーワード：磁気リップル、電離層電子密度、プラズマバブル
Keywords: magnetic ripples, ionospheric electron density, plasma bubbles

Observations of the Thermosphere and Ionosphere by the NASA GOLD Mission

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The new Global-scale Observations of the Limb and Disk (GOLD) mission is an imaging spectrograph deployed in geostationary orbit on the SES-14 communications satellite. GOLD measures airglow emitted by the Earth in the far-ultraviolet region of the spectrum from 132 to 164 nm, notably including the 135.6 nm doublet of atomic oxygen (O), and most of the LBH bands of molecular nitrogen (N_2). During the day, the ratios of the oxygen to nitrogen emissions indicate the relative column densities of O and N_2, and temperature can be inferred from the spectral shape of the LBH bands. During the night, radiative recombination emissions by the O doublet indicate the density of the ionosphere, particularly the equatorial ionization anomalies and the structured instabilities that form within them. GOLD also measures exospheric temperatures on the limb, it infers molecular oxygen densities from stellar occultations, and it can also see northern hemisphere aurora. SES-14 was launched in January 2018, the satellite achieved geostationary orbit in, and GOLD observations commenced in October. We will give an overview of the GOLD mission and show preliminary results from its first months of operations. Despite the recent quiet conditions with low solar activity, composition images reveal daily and seasonal variations, indicative of global vertical wind patterns. The equatorial ionization anomalies are seen to be surprisingly variable and dynamic, with instabilities forming on most nights, even at solar minimum. We will compare GOLD results with global general circulation models and airglow emissions modeling, and discuss how these data could be used in assimilation models of the upper atmosphere and ionosphere.

Keywords: Thermosphere, Ionosphere, Ultraviolet Imaging

全球TECに見られる磁気嵐時の中低緯度域における電子密度増大の時間・空間発展
Temporal and spatial evolutions of storm enhanced density in the mid- and low-latitude regions as seen in the variation of global total electron content

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The global electron density distribution in the ionosphere depends strongly on geographical latitude, longitude, and local time. The structure changes severely from the high-latitude to the equatorial regions associated with geomagnetic storms. The storm-time prominent ionospheric phenomena are tongue of ionization (TOI), storm-enhanced density (SED), and equatorial ionization anomaly (EIA). These phenomena are very dynamic because ionospheric electric fields and particle precipitation from the magnetosphere vary significantly during the development and decay of the geomagnetic storms. The generation mechanism of SED has been thought as local upward **E**x**B** drifts [e.g., Huang et al., 2005, Liu et al., 2016], westward plasma transportation from the nightside to the dayside by sub-auroral polarization stream (SAPS) [Foster et al., 2007], equatorward neutral winds [Anderson, 1976], and latitudinal expansion of the EIA [e.g., Kelley et al., 2004]. However, since such different mechanisms of the formation of SED have been proposed by many researchers, a comprehensive understanding of the cause of SED formation has not yet been done. In this study, we investigate the temporal and spatial evolutions of SED during the development and decay of geomagnetic storms using Global Navigation Satellite System (GNSS) Total Electron Content (TEC) data with high time and spatial resolutions, to identify the main mechanism responsible for SED. We also use solar wind data and geomagnetic indices to see the interplanetary condition and geomagnetic activity during geomagnetic storms. In the present analysis, we first calculate the average absolute TEC (ATEC) of 10 geomagnetically quiet days every month, referring to the list of quiet and disturbed days provided by GFZ. Next, we subtract the storm-time ATEC from the average ATEC and create global maps of the difference ATEC in geographical and geomagnetic coordinates. Several hours after the onset of the main phase of the geomagnetic storms, the enhanced TEC region with a narrow latitudinal width (5-10 degrees) appears at high latitudes (60-70 degrees in geomagnetic latitude (GMLAT)) of the afternoon sector (12-16 h, MLT: magnetic local time). The enhanced TEC region is located at a lower latitude of the equatorward wall of the midlatitude trough. As the geomagnetic storms grow, the enhanced TEC region expands to the nightside (~20 h, MLT) within a time scale of 20-30 minutes, and the region moves equatorward within several hours. After that, apart from the midlatitude enhanced TEC phenomena, another TEC enhancement takes place in the low-latitude region (15-30 degrees, GMLAT) on both sides of the dip equator. This observational fact cannot be explained by the latitudinal expansion of the EIA and westward transportation of a part of the higher latitude EIA by SAPS [Kelley et al., 2004; Foster et al., 2007]. As already proposed by Liu et al. [2016], the midlatitude enhanced TEC signature may be caused by upward **E**x**B** drifts that lift the ionosphere in the sunlit region to higher altitudes. In future study, we verify the effect of the localized **E**x**B** drifts on the formation of SED from a comparison between the global TEC and ionospheric plasma flow

observed by the SuperDARN radars.

キーワード：磁気嵐、電離圏、磁気嵐時の電子密度増大、赤道異常、中緯度、対流電場
Keywords: Geomagnetic storm, Ionosphere, Storm enhanced density, Equatorial ionization anomaly, Midlatitude, Convection electric field

Tidal Forcing Effects on the Zonal Variation of Solstice Equatorial Plasma Bubbles

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Equatorial plasma bubbles are elongated plasma depletions that can occur in the nighttime ionospheric F region, causing scintillation in satellite navigation and communications signals, and manifesting in ionograms as spread F. Equatorial plasma bubbles are believed to be Rayleigh-Taylor instabilities seeded by vertically propagating gravity waves. A necessary pre-condition for plasma bubble formation is believed to be a threshold vertical ion drift from the E region, which is required to produce the vertical plasma gradients conducive to such an instability. Factors affecting the zonal and seasonal variation of equatorial plasma bubbles therefore include magnetic declination, as well as the strength of the equatorial electojet, and neutral winds in the lower thermosphere controlling vertical plasma drifts via the wind dynamo. In most longitude zones, the above factors result in elevated occurrence rates of equatorial plasma bubbles during the equinoxes. The notable exception is over the central Pacific and African sectors, where equatorial plasma bubble activity maximizes during solstice. As the zonal separation of the two sectors is roughly half the Earth’s circumference, *Tsunoda et al.* (2015) hypothesized that the solstice maxima in these two sectors could be driven by a zonal wavenumber 2 atmospheric tidal component in the mesosphere and lower thermosphere (MLT). In this study, we find that the post-sunset electron density observed by FORMOSAT-3/COSMIC during the boreal summer does indeed exhibit a wave-2 zonal distribution in both the equatorial and northern mid latitude regions. The equatorial wave-2 is consistent with results expected from elevated vertical ion drift over the Central Pacific and African sectors, while the mid- latitude wave-2 is consistent with the Mid-Summer Nighttime Anomaly. Using COSMIC, the seasonal, longitudinal, and local time variation of ionospheric tidal and stationary planetary wave (SPW) components that produce zonal wavenumber 2 disturbances when viewed in a constant local time frame is examined. Numerical experiments are also carried out using the Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM) to determine the effect of the aforementioned tidal and SPW components on vertical ion drift, showing a clear wave-2 modulation of vertical ion drift when subject to forcing from wave-2 atmospheric tidal components in the mesosphere and lower thermosphere. The aforementioned results are consistent with the solstice maxima hypothesis.

Keywords: Ionosphere, Scintillation, Tides

