

Seasonal variations of thermospheric nonmigrating tides observed by CHAMP and GRACE

Seasonal variations of thermospheric nonmigrating tides observed by CHAMP and GRACE

Jiyao Xu^{1*}, Wenbin Wang², Jia Yue², Hanli Liu², Ruiping Ma¹
XU, Jiyao^{1*}, Wenbin Wang², Jia Yue², Hanli Liu², Ruiping Ma¹

¹State Key Laboratory of Space Weather, Center for Space Science and Applied research, CAS, ²High Altitude Observatory, National Center for Atmospheric Research, Boulder, CO 30307, USA.

¹State Key Laboratory of Space Weather, Center for Space Science and Applied research, CAS, ²High Altitude Observatory, National Center for Atmospheric Research, Boulder, CO 30307, USA.

In this paper, we present a new method of extracting nonmigrating tides from thermospheric density using CHAMP and GRACE data. The seasonal variations of the global structures of nonmigrating tides of the thermospheric densities near the altitudes of CHAMP and GRACE are obtained using multi-year observations of these two satellites. The results show that the strongest nonmigrating diurnal tides are eastward with zonal wavenumber 3 (DE3), westward with zonal wavenumber 2 (DW2), eastward with zonal wavenumber 2 (DE2) and eastward with zonal wavenumber 1 (DE1). The primary nonmigrating semidiurnal tides are eastward with zonal wavenumber 2 (SE2), westward with zonal wavenumber 3 (SW3), westward with zonal wavenumber 1 (SW1) and eastward with zonal wavenumber 1 (SE1). The seasonal variations for each tidal mode are investigated in this work. We also study the wave-4 structure of the neutral density in the upper thermosphere in detail, which is mainly by the eastward semidiurnal tide with zonal wavenumber 2 (SE2) and the eastward diurnal tide with zonal wavenumber 3 (DE3). SE2 is the main cause of the wave-4 structure at middle latitudes and is asymmetry in phases in the two hemispheres. On the other hand, DE3 is the major driver of the wave-4 structure in the tropical region. The superposition of these two tides results in strong hemispheric asymmetries in the 4-peak structure as well as asymmetries between midday and midnight.

Long-term variability of mean winds and its oscillations in the mesosphere and lower thermosphere within $\pm 22^\circ$

Long-term variability of mean winds and its oscillations in the mesosphere and lower thermosphere within $\pm 22^\circ$

Venkateswara Rao Narukull^{1*}, Toshitaka Tsuda¹, D.M. Riggin², S. Gurubaran³
Venkateswara Rao Narukull^{1*}, TSUDA, Toshitaka¹, D.M. Riggin², S. Gurubaran³

¹Research Institute for Sustainable Humanosphere, Kyoto University, Uji, Japan, ²Colorado Research Associates/NWRA, Boulder, ³Equatorial Geophysical Research Laboratory, Indian Institute of Geomagnetism, Tirunelveli, India

¹Research Institute for Sustainable Humanosphere, Kyoto University, Uji, Japan, ²Colorado Research Associates/NWRA, Boulder, ³Equatorial Geophysical Research Laboratory, Indian Institute of Geomagnetism, Tirunelveli, India

Long-term variability of mean zonal and meridional winds in the Mesosphere and Lower Thermosphere (MLT) are studied at seven locations using MF radar observations from Kauai (22° N, 154° W), Tirunelveli (8.7° N, 77.8° E), Christmas Island (2° N, 157° W), and Pameungpeuk (7.4° S, 107.4° E) and meteor radar observations from Koto Tabang (0.2° S, 100.3° E), Jakarta (6° S, 107° E), and Rarotonga (21.2° S, 159.7° W). Locations with nearly similar latitudes such as Christmas Island and Koto Tabang, and Jakarta and Pameungpeuk are treated as single location (Ignoring longitudinal difference) and the data are appended at each latitude to get long-term data. Thus, we have five distinct latitudes. The length of the data is different at different latitudes and spans a maximum of two decades between 1990 and 2010.

The zonal wind shows a distinct semiannual oscillation (Mesospheric SAO) at all locations. The annual mean zonal winds within $\pm 9^\circ$ are westward biased and are eastward biased outside. The quasi-biennial variability of MLT winds (called MQBO) is observed at all locations. The amplitude of MQBO is maximum over the equator (6-8 m/s) and decreases with increasing latitude. Long-term variability of MQBO is studied which shows that the MQBO strength is more during 1991-1997 than during 2004-2010 period. The MSAO basically shows a biannual modulation. The mean meridional winds show a distinct annual oscillation at all locations. But, the time at which winds change direction (from north to south or south to north) is different at different latitudes. Furthermore, the meridional winds show similar long-term variability at conjugate locations of Tirunelveli and Jakarta-Pameungpeuk.

キーワード: Mesosphere, MLT dynamics, Long-term studies, MF radar, Meteor radar, MQBO

Keywords: Mesosphere, MLT dynamics, Long-term studies, MF radar, Meteor radar, MQBO

Longitudinal and Geomagnetic Activity Modulation of the Equatorial Thermosphere Anomaly Longitudinal and Geomagnetic Activity Modulation of the Equatorial Thermosphere Anomaly

Lei Jiuhou^{1*}
JIUHO, Lei^{1*}

¹University of Science and Technology of China, Hefei, China (leijh@ustc.edu.cn)

¹University of Science and Technology of China, Hefei, China (leijh@ustc.edu.cn)

Recent observations of thermosphere mass density from satellites have revealed new features of the Equatorial Thermosphere Anomaly (ETA) which enable much more in-depth investigation of its characteristics and its coupling to the more research-established Equatorial Ionosphere Anomaly (EIA). Our recent study (Lei et al., J. Geophys. Res., 2012) has revealed that the field-aligned ion drag mainly contributes to the ETA trough, but has little effect on the ETA crests. However, the formation of the ETA crests is attributed to plasma-neutral heating which has two peaks in the topside ionosphere aside the magnetic equator. This invited talk will highlight the simulated results from the thermosphere-ionosphere-mesosphere-electrodynamics general circulation model (NCAR-TIMEGCM) to demonstrate the relative contributions of the non-migrating tides and geomagnetic field configuration on the longitudinal variations between the ETA and the EIA. Meanwhile, the different longitude/UT dependence between the ETA and the EIA associated with geomagnetic activity is also presented.

キーワード: Equatorial Thermosphere Anomaly, Longitudinal Variation, Geomagnetic Activity Modulation, Lower Atmosphere Tides

Keywords: Equatorial Thermosphere Anomaly, Longitudinal Variation, Geomagnetic Activity Modulation, Lower Atmosphere Tides

中緯度と低緯度における大気光画像と熱圏風の南北共役点観測 Geomagnetic conjugate observations of airglow images and neutral winds in the low and middle latitude thermosphere

塩川 和夫^{1*}, 福島 大祐¹, 大塚 雄一¹, 西岡 未知², 久保田 実², 津川 卓也², 長妻 努², フィル・ウィルキンソン³
SHIOKAWA, Kazuo^{1*}, FUKUSHIMA, Daisuke¹, OTSUKA, Yuichi¹, NISHIOKA, Michi², KUBOTA, Minoru², TSUGAWA, Takuya², NAGATSUMA, Tsutomu², Phil Wilkinson³

¹ 名古屋大学太陽地球環境研究所, ² 情報通信研究機構, ³ IPS Radio and Space Services

¹Solar-Terrestrial Environment Laboratory, Nagoya University, ²National Institute of Information and Communications Technology, ³IPS Radio and Space Services

In 2010-2011, we have installed four Fabry-Perot interferometers and four all-sky cooled-CCD airglow imagers at two pairs of geomagnetic conjugate stations at low and middle latitudes. The pairs are Kototabang, Indonesia (0.2S, 100.3E, magnetic latitude (MLAT): 10.6S) and Chiang Mai, Thailand (18.8N, 98.9E, MLAT: 8.9N) at low latitudes, and Darwin, Australia (12.4S, 131.0E, MLAT:22.1S), and Sata/Shigaraki, Japan (Sata: 31.0N, 130.7E, MLAT: 21.2N, and Shigaraki: 34.8N, 136.1E, MLAT: 25.4N) at middle latitudes. These pairs are suitable for investigation of hemispheric coupling of ionospheric structures. In this presentation, we show some initial results of conjugate observations of plasma bubbles and medium-scale traveling ionospheric disturbances and associated neutral winds at these two pairs of conjugate stations.

キーワード: 磁気共役点, プラズマバブル, 中規模伝搬性電離圏擾乱, 大気光イメージング, ファブリ・ペロー干渉計, 熱圏風
Keywords: magnetic conjugate points, plasma bubble, MSTID, airglow imaging, Fabry-Perot interferometer, thermospheric wind

Simulated longitudinal variations in the E-region plasma density induced by non-migrating tides

Simulated longitudinal variations in the E-region plasma density induced by non-migrating tides

Zhipeng Ren^{1*}, Weixing Wan¹, Libo Liu¹, Jiangang Xiong¹
REN, Zhipeng^{1*}, Weixing Wan¹, LIU, Libo¹, Jiangang Xiong¹

¹Institute of Geology and Geophysics, CAS

¹Institute of Geology and Geophysics, CAS

Based on the GCITEM-IGGCAS model and tides from TIMED/SABER observations, the longitudinal variations of the E-region plasma densities, which is induced by non-migrating tides, are investigated. We simulated the intra-annual variation of the E-region plasma density, and found that equinoctial E-region plasma density shows an obvious wavenumber-4 longitudinal structure both in Equinox and in June Solstice, and a wavenumber-3 longitudinal structure in December Solstice. Our simulations suggest that DE3 tide can drive the wavenumber-4 structure in E-region plasma density, and DE2 tide can drive the wavenumber-3 structure. O₂⁺ controls the longitudinal variations of total ions density at lower E-region, and NO⁺ mainly controls that at higher E-region. We also noticed that the longitudinal variations of O₂⁺ and of NO⁺ show obvious phase differences.

キーワード: Longitudinal variation, E-region plasma density, non-migrating tides

Keywords: Longitudinal variation, E-region plasma density, non-migrating tides

Acoustic Gravity Waves Triggered by the 22 July 2009 Total Solar Eclipse Acoustic Gravity Waves Triggered by the 22 July 2009 Total Solar Eclipse

Jann-Yenq Liu^{1*}, Yang-Yi Sun¹, Koichi C.H. Chen², Chien-Hong Lin³, Ho-Fang Tsai⁴
LIU, Jann-Yenq^{1*}, Yang-Yi Sun¹, Koichi C.H. Chen², Chien-Hong Lin³, Ho-Fang Tsai⁴

¹Institute of Space Science, National Central University, Chung-Li, Taiwan, ²Department of Geophysics, Graduate School of Science, Kyoto University, Kyoto, Japan, ³Department of Earth Science, National Cheng Kung University, Tainan, Taiwan,

⁴GPS Science Application Research Center, National Central University, Chung-Li, Taiwan

¹Institute of Space Science, National Central University, Chung-Li, Taiwan, ²Department of Geophysics, Graduate School of Science, Kyoto University, Kyoto, Japan, ³Department of Earth Science, National Cheng Kung University, Tainan, Taiwan,

⁴GPS Science Application Research Center, National Central University, Chung-Li, Taiwan

It has been predicted that the Moon shadow, the cooling region, sweeping over the atmosphere with a supersonic speed could trigger bow waves since 1970. The longest total solar eclipse within next hundred years occurring on 22 July 2009 sweeps over the Eastern Asia region during the noontime period. Frequency-amplitude analyses are applied to study ionospheric TEC (total electron content) derived from ground-based GPS receivers in Taiwan and Japan. We not only find the feature of the predicted bow wave but also the stern wave on the equator side of the eclipse path, as well as the stern wake right behind the Moon shadow boat. The bow and stern waves are formed by acoustic gravity waves of periods about 3 and/or 5 minutes traveling equatorward with a phase speed of about 100s m/s in the ionosphere.

キーワード: Acoustic Gravity Waves, Total Solar Eclipse, GPS TEC

Keywords: Acoustic Gravity Waves, Total Solar Eclipse, GPS TEC

皆既日食時に衛星 DEMETER で観測された電子・イオン密度変動 English Variation of Ne and Ni observed by DEMETER during the solar eclipses

望月 香織^{1*}, 鴨川 仁¹, 柿並 義宏²

MOCHIZUKI, Kaori^{1*}, KAMOGAWA, Masashi¹, KAKINAMI, Yoshihiro²

¹ 東京学芸大学物理学科, ² 北海道大学大学院理学研究院附属地震火山研究観測センター

¹Dpt. of Phys., Tokyo Gakugei Univ., ²Institute of Seismology and Volcanology, Hokkaido University

We investigate ionospheric dynamics of solar eclipses during French satellite DEMETER operation by using Ne/Te and Ni/Ti data of French satellite DEMETER, of which altitude is around 660 km. In particular, on July 22, 2009, one of DEMETER orbits crossed eclipse zone, and the distance closest to the total eclipse area was approximately 200km. Just before the total solar eclipse, middle-scale traveling ionospheric disturbance (MSTID) over Japan occurred from GPS-TEC data. At the same time, DEMETER also recorded decrease of Ne and Ni associated with MSTID. After MSTID, however, Ne and Ni decreased due to a shadow of the moon when the satellite entered eclipse zone. After that, Ne and Ni enhanced possibly associated with eclipse-origin gravity waves traveling along the magnetic field line. In addition, we compare the results in East-Asia and with other eclipses.

Keywords: Total solar eclipse, Ion density, Electron density

Statistical analysis of the ionospheric responses to solar flares in solar cycle 23 Statistical analysis of the ionospheric responses to solar flares in solar cycle 23

Huijun Le^{1*}, Libo Liu¹, Weixing Wan¹
LE, Huijun^{1*}, Libo Liu¹, Weixing Wan¹

¹Institute of Geology and Geophysics, Chinese Academy of Sciences

¹Institute of Geology and Geophysics, Chinese Academy of Sciences

In this study, we studied the ionospheric responses to solar flares during 1999-2006 by using the GOES 0.1-0.8nm Xray, 26-34nm EUV, and GPS/TEC in the worldwide. The statistical results show the TEC enhancements are highly related to the solar zenith angle (SZA). The smaller SZA would result in the greater TEC responses. The TEC response is not highly related with the X-ray flux (the correlation coefficient 0.6), which is due to that the ionospheric response is not only related to the X-ray flux level, but also related to the flare location on solar disc. The limb flare has less effect on the ionosphere than the central flare. The reason for this is that the main ionization source EUV flux has such flare location dependence. The statistical results show that the flare location effect decreases with decreasing flare X-ray class. The results also show that the TEC enhancement does not linearly increase with X-ray flux. Its uprising amplitude increases with X-ray flux. The TEC response also has slight latitude dependence: it decrease with latitude. And the TEC response has significant seasonal dependence. The maximum response occurred at equinox and the minimum response at summer.

キーワード: solar flare, Ionospheric response, EUV flux, limb effect

Keywords: solar flare, Ionospheric response, EUV flux, limb effect

Discrepant EUV-Proxy Correlations on Solar Cycle and Solar Rotation Timescales and the Manifestation in the Ionosphere Discrepant EUV-Proxy Correlations on Solar Cycle and Solar Rotation Timescales and the Manifestation in the Ionosphere

Yiding Chen^{1*}, Libo Liu¹, Weixing Wan¹
CHEN, Yiding^{1*}, Libo Liu¹, Weixing Wan¹

¹Institute of Geology and Geophysics, Chinese Academy of Sciences

¹Institute of Geology and Geophysics, Chinese Academy of Sciences

The variations of solar EUV irradiance significantly affect the ionosphere. Solar proxies are used to indicate EUV variations when direct EUV observation is unavailable. SOHO/SEM 26-34 nm EUV observations, the F10.7 and Mg II proxies, and ionospheric data were collected to investigate the variability of solar EUV and proxies and its manifestation in the ionosphere. Both EUV and proxies show significant variations on solar cycle (long-term) and solar rotation (short-term) timescales, but the correlations of EUV and proxies on the two timescales are discrepant. Short-term EUV-proxy correlations are poorer than the long-term correlations and variable during the solar cycle; the slopes of short-term EUV against proxies vary from solar rotation to solar rotation, and they are generally lower than those of long-term EUV against proxies. EUV and proxies show discrepant evolutions during the episode of major active regions, which is primarily responsible for the poorer short-term EUV-proxy correlation and the variable short-term EUV-proxy slope. Mg II is a better proxy than F10.7 for 26-34 nm EUV owing to its better indications for short-term EUV. Global electron content (GEC) significantly responds to the long and short-term variations of EUV. Accordingly, the correlations between short-term GEC and proxies are poorer and obviously lower than those between short-term EUV and proxies, and short-term GEC-proxy slopes are lower than the long-term slopes. F10.7 and Mg II are improved by combining the daily and 81-day averaged components of them with weighted factors which are designed to decrease the difference between long and short-term EUV-proxy slopes. The improved proxies can effectively upgrade the indications of proxies for solar EUV.

キーワード: Solar EUV Irradiance, Solar Proxy, Ionosphere

Keywords: Solar EUV Irradiance, Solar Proxy, Ionosphere

The changes in the ionosphere during the recent deep solar minimum The changes in the ionosphere during the recent deep solar minimum

Libo Liu^{1*}, Yiding Chen¹, Huijun Le¹, Weixing Wan¹
LIU, Libo^{1*}, Yiding Chen¹, Huijun Le¹, Weixing Wan¹

¹Institute of Geology and Geophysics, Chinese Academy of Sciences

¹Institute of Geology and Geophysics, Chinese Academy of Sciences

The solar activity is low and extremely extended in 2007-2009, with a highest record of spotless days in 2008 since the finding of the ionosphere. It is a critical issue that whether or not this deep solar minimum brought serious influences on the Earth's space environment.

To explore what happened in the ionosphere during the deep minimum, we analyzed the historical records of ionospheric parameters (the F2 layer critical frequency foF2, E-layer critical frequency foE and F-layer virtual height h'F) observed by global ionosondes. A comparative study is performed to evaluate the difference in the ionosphere between recent deep minimum (2008-2009) and past solar minima. The analysis indicates that the moving 1-year mean foF2 at most ionosonde stations went to the lowest during cycle 23/24 minimum. The solar cycle differences in foF2 minima display local time dependence, being more negative during the daytime than at night. In contrast, a complex picture presents in global h'F and foE. Evident reduction exists prevailing in moving 1-year mean h'F at most stations, while no huge differences are detected at several stations. A compelling feature is the increase in foE at some stations, which requires independent data for further validation.

In addition, the ionograms recorded by a DPS ionosonde at Jicamarca (12.0o S, 283.2o E) are also collected and manually scaled these data to retrieve F-layer parameters and electron density profiles. Compared to 1996-1997, the seasonal median values of foF2 were identified to be remarkably reduced during the deep solar minimum. It is the first time to find that lower values prevail at most times in 2008-2009 in the F2-layer peak height (hmF2) and Chapman scale height (Hm). In contrast, the bottom-side profile thickness (B0) in 2008-2009 shows higher values than that in 1996-1997 at some daytime intervals, although it is also smaller during the rest times. Furthermore, the ionogram-retrieved electron density profiles demonstrate that the ionosphere in 2008-2009 is contracted strongly at altitudes above hmF2 and more perceptible in the afternoon hours. The decrease in Ne is strongest in September equinox and weakest in June solstice.

Quantitative analysis indicates that record-low foF2 can be explained principally in terms of the decline in solar extreme ultraviolet (EUV) irradiance recorded by SOHO/SEM, which suggests low solar EUV being the prevailing contributor to the unusual low electron density in the ionosphere during cycle 23/24 minimum. It also verifies that a quadratic fitting still reasonably captures the solar variability of foF2 at such low solar activity levels. The reduction in solar EUV input from solar minimum to minimum mainly contributes to the ionospheric responses, but the involved ionospheric processes are competed and variable in different time scales and played roles in the complicated variations in different seasons and altitudes.

Acknowledgments. The authors would like to thank B. W. Reinisch of the Center for Atmospheric Research, University of Massachusetts Lowell for the ionogram data of DIDBase. Ionosonde data are provided from National Institute of Information and Communications Technology, Institute of Solar-Terrestrial Physics of Russia, and from SPIDR. The F10.7 index is also downloaded from the SPIDR website. The SEM/SOHO EUV data is downloaded from the web site: http://www.usc.edu/dept/space_science/. The CELIAS/SEM experiment on the Solar Heliospheric Observatory (SOHO) spacecraft (SOHO is a joint European Space Agency and US NASA mission). This research was supported by National Natural Science Foundation of China (41074112, 41174137) and National Key Basic Research Program of China (2012CB825604).

キーワード: ionosphere, solar activity, solar cycle, critical frequency, deep solar minimum

Keywords: ionosphere, solar activity, solar cycle, critical frequency, deep solar minimum

Study of the Atmosphere-Ionosphere Coupling Using Observations of FORMOSAT-3/COSMIC

Study of the Atmosphere-Ionosphere Coupling Using Observations of FORMOSAT-3/COSMIC

Charles Lin^{1*}, Loren C. Chang², Jia-Ting Lin³
LIN, Charles^{1*}, Loren C. Chang², Jia-Ting Lin³

¹Department of Earth Science, National Cheng Kung University, Tainan, Taiwan, ²Institute of Space Science, National Central University, Chung-Li, Taiwan, ³Institute of Space, Plasma and Astrophysic Science, National Cheng Kung University, Tainan, Taiwan

¹Department of Earth Science, National Cheng Kung University, Tainan, Taiwan, ²Institute of Space Science, National Central University, Chung-Li, Taiwan, ³Institute of Space, Plasma and Astrophysic Science, National Cheng Kung University, Tainan, Taiwan

Recent studies have shown that the ionospheric plasma structure is modulated by modification of the ionospheric dynamo due to upward propagating atmospheric tides of troposphere origins as well as planetary waves generated during the stratospheric sudden warming (SSW) period. These effects of lower atmospheric origins modify the ionospheric electrodynamic and result in longitudinal, latitudinal, and altitudinal variations of the low-latitude equatorial ionization anomaly (EIA). In this study, three-dimensional electron density observations derived from GPS radio occultation sounding of FORMOSAT-3/COSMIC during 2007-2010 are utilized to study the annual and monthly variations of the ionospheric tidal signatures for comparison with existing tidal modes derived from neutral atmospheric parameters observed in the mesosphere lower thermosphere (MLT) region. Meanwhile, this study also investigates the SSW effects to low-latitude ionosphere based on the constructed three-dimensional electron density maps. According to the stratospheric temperature observation of FORMOSAT-3/COSMIC, the SSW occurs every year during 2007-2010 but the occurring months and durations are different. The ionosphere response to the SSW effect is expected to vary due to these year-to-year differences in the stratosphere.

キーワード: Atmosphere-Ionosphere Coupling, FORMOSAT-3/COSMIC
Keywords: Atmosphere-Ionosphere Coupling, FORMOSAT-3/COSMIC

Effects of Sudden Stratosphere Warming on the ionosphere Effects of Sudden Stratosphere Warming on the ionosphere

小山 孝一郎^{1*}, Jhong -Ting Zhou², Jia-Ting Lin³, Mei-Lang Hsue⁴, Charles Lin²
OYAMA, Koichiro^{1*}, Jhong -Ting Zhou², Jia-Ting Lin³, Mei-Lang Hsue⁴, Charles Lin²

¹Plasma and Space Science Center, NCKU, Taiwan, ²Department of Earth Science, National Cheng Kung University, Taiwan, ³Institute of Space, Astrophysical and Plasma Sciences, National Cheng Kung University, Taiwan, ⁴Department of Physics, National Cheng Kung University, Taiwan

¹Plasma and Space Science Center, NCKU, Taiwan, ²Department of Earth Science, National Cheng Kung University, Taiwan, ³Institute of Space, Astrophysical and Plasma Sciences, National Cheng Kung University, Taiwan, ⁴Department of Physics, National Cheng Kung University, Taiwan

Effect of the large sudden stratospheric warming which occurred in January 2009 on the ionosphere is studied by using COSMIC ionosphere data. The SSW2009 is unique because stratosphere warming occurs in two longitude regions ; 1. Longitude zone ranging from 30E to 30W(30EW), and 2. Longitude zone ranging from 150 E to 150W(150EW), and the highest increase of the temperature among the recent winters.

The temperature increased steeply from 215 K on the 19 January, 2009, peaked on 23 rd January, and then gradually reduced. While the temperature increase at 10 hpa shows the maximum in the longitude zone of 30EW during the period 19-30 January, very similar pattern of SSW feature is seen in 150EW which is opposite side of 30 EW. The effect of SSW on the NmF2 (maximum electron density) is recognized even before the temperature steep increase at 10 hpa. During SSW, reduction of temperature in low latitude appears, and , NmF2 reduces shows the minimum when temperature shows the minimum except midlatitude. Minimum of electron density shifts to late local time after 09-12 Local time. In midlatitude variation of temperature is not recognized, and reduction of NmF2 is not recognized or small. Similar latitudinal and local time feature of the ionosphere is recognized in all latitude zone, not only in 30 EW as well as 150E band.

The largest effect is found in low latitude in the afternoon. Variation of ionosphere (GIM TEC, COSMIC TEC, nmF2 by COSMIC) changes in phase in all latitude zone s well as in local time. GIM TEC is less sensitive to SSW, which suggests the more interaction in lower part of the ionosphere. A big jump of NmF2 in the local time zone 06-09 is found in 14 and 36 DOY both in 30 EW, and in 150 EW, but not in another longitude zones, which seem to be produced by SSW effect. The study is also extended to southern hemisphere.

キーワード: F region, Ionosphere, Stratosphere, Sudden warming

Keywords: F region, Ionosphere, Stratosphere, Sudden warming

グローバル電離圏電流系の成層圏突然昇温への応答

Response of the global ionospheric current system to stratospheric sudden warmings

山崎 洋介^{1*}, 湯元 清文¹, Liu Huixin¹, ダニエル マクナマラ², 廣岡 俊彦¹, 魚住 禎司¹, 北村 健太郎³, 阿部 修司¹, 池田 昭大¹

YAMAZAKI, Yosuke^{1*}, YUMOTO, Kiyohumi¹, LIU, Huixin¹, Daniel McNamara², HIROOKA, Toshihiko¹, UOZUMI, Teiji¹, KITAMURA, Kentarou³, ABE, Shuji¹, IKEDA, Akihiro¹

¹九州大学, ²マニラ観測所, ³徳山工業高等専門学校

¹Kyushu University, ²Manila Observatory, ³Tokuyama College of Technology

Recent studies have shown the possible impact of the stratospheric sudden warming (SSW) on the ionospheric weather, and have attracted much attention as new evidence of the vertical atmospheric coupling. During SSWs, the counter-electrojet, a reversal of the equatorial electrojet from eastward to westward, is often observed, indicating the amplification of the semidiurnal tide. In the past studies, however, the observations were limited to the equatorial region, and thus it was not clear whether the tidal amplification is a local or global effect. In the present study, the response of the global ionospheric current system to SSWs is examined. The global ionospheric current systems during winter-time SSWs of 2001-2002 and 2002-2003 are derived from ground magnetometer data of the Circum-pan Pacific Magnetometer Network (CPMN). Our results show that the occurrence of the counter-electrojet during these SSWs is due to an addition of the enhanced lunar current system that extends over both the Northern and Southern Hemispheres.

キーワード: 電離圏, 成層圏突然昇温, 大気鉛直結合, 潮汐風とプラネタリー波, 地磁気, グローバル観測

Keywords: Ionospheric dynamics, Stratospheric sudden warming, Vertical coupling of the Earth's atmosphere, Tides and planetary waves, Geomagnetic field, Global observation

Comparison between GAIA model and COSMIC-TIMED/SABER observations: stratospheric warming event in 2009

Comparison between GAIA model and COSMIC-TIMED/SABER observations: stratospheric warming event in 2009

陣 英克^{1*}, 三好 勉信², Dora Pancheva⁴, Plamen Mukhtarov⁴, 藤原 均³, 品川 裕之¹

JIN, Hidekatsu^{1*}, MIYOSHI, Yasunobu², Dora Pancheva⁴, Plamen Mukhtarov⁴, FUJIWARA, Hitoshi³, SHINAGAWA, Hiroyuki¹

¹ 情報通信研究機構, ² 九州大学, ³ Bulgarian Academy of Sciences, ⁴ 成蹊大学

¹National Institute of Information and Communications Technology, ²Kyushu University, ³Bulgarian Academy of Sciences,

⁴Seikei University

We compare results from a whole atmosphere-ionosphere coupled model, GAIA, and from the COSMIC and TIMED/SABER observations during 2008/2009 northern winter season. The GAIA model has assimilated meteorological reanalysis data by a nudging method. The comparison shows excellent agreements in the major features from the stratosphere to the ionosphere including the growth and decay of the major stratospheric sudden warming (SSW) event in 2009. During the major SSW period, a pronounced semidiurnal variation in TEC and its local-time phase shift similar to the previous observations are reproduced by the model and COSMIC observation. The model suggests that the TEC variation is caused by an enhanced semidiurnal variation in the EXB drift, which is probably related to an amplified semidiurnal migrating tide (SW2) in the lower thermosphere. The model and TIMED/SABER observation show that the SW2 tide amplifies at low latitudes from the stratosphere to the thermosphere as well as the phase variation. Possible mechanisms are discussed.

キーワード: シミュレーション, 大気圏, 電離圏, 成層圏突然昇温, 大気波動, 衛星観測

Keywords: simulation, ionosphere, atmosphere, stratospheric sudden warming, atmospheric wave, satellite observation

Sq 電流系に於ける 3次元カウリングチャンネルモデル 3D-Cowling Channel Model in the Sq Current System

吉川 顕正^{1*}, 魚住 禎司¹, 湯元 清文¹

YOSHIKAWA, Akimasa^{1*}, UOZUMI, Teiji¹, YUMOTO, Kiyohumi¹

¹九州大学 宙空環境研究センター

¹Space Environment Research Center, Kyushu University

Cowling channel formation mechanism in the 3D-Sq current system using two-current layer model of Hall and Pedersen current is proposed.

In the earth's ionosphere, formation of Cowling channel is quite universal phenomena in which a continuity of Hall current generated by the magnetospheric or atmospheric dynamo is broken. In the high-latitude regions, horizontal gradient of Hall conductance becomes a necessary condition for Cowling channel formation and vertical gradient of Hall conductance also becomes important in the low and mid-latitude regions. Although generation mechanism of Cowling channel is different between the high latitude region and the low-mid latitude regions, their primary structure and energy circulation role has following universality:

(1) The Cowling channel is essentially formed by the upper Pedersen current layer and lower Hall current layer, which are connected through a field-aligned current. The channel is composed of a pair of two current systems; one is 3D-Cowling current directly coupled to the dynamo region and the other is 3D-meridional current, which encircles Cowling current system.

(2) For preserving the Cowling channel, the Cowling current system absorbs electromagnetic energy from generator and supplies holding energy of meridional current system. In each current system, Pedersen current layer becomes an energy sink, while Hall current layer acts as an energy sink in the Cowling current system and as an energy source in the meridional current system.

(3) Connection between Pedersen current layer and Hall current layer through the field-aligned current is indispensable condition for describing Poynting vector between energy sources and energy sinks.

In this paper, we will show that in addition to the well-known substorm-auroral electrojet and equatorial electrojet, Sq-current system in the low and mid latitude ionosphere is also a result of formation of Cowling system.

Zonal Drift Velocities of 3-m Field-aligned Irregularities of Layer-type and Clump-type Plasma Structures in Es Region

Zonal Drift Velocities of 3-m Field-aligned Irregularities of Layer-type and Clump-type Plasma Structures in Es Region

Yen-Hsyang Chu^{1*}, Kuo-Feng Yang², Chien-Ya Wang³
CHU, Yen-Hsyang^{1*}, Kuo-Feng Yang², Chien-Ya Wang³

¹Institute of Space Science, NCU, Taiwan, ²Institute of Spae Science, NCU,Taiwan, ³Department of Physics, CCU, Taiwan
¹Institute of Space Science, NCU, Taiwan, ²Institute of Spae Science, NCU,Taiwan, ³Department of Physics, CCU, Taiwan

The use of interferometer technique implemented in a VHF coherent scatter radar with relatively broad antenna beam pattern in the azimuth direction makes it possible to reveal zonal drift velocity of 3-meter field-aligned irregularities (FAIs) inside a moving plasma structure at kilometer scale. In this article, we find for the first time the systematic difference in the zonal drift velocities of the 3-m FAIs between layer-type and clump-type plasma structures in sporadic E (Es) region. There is an evident tendency for the 3-m FAIs in the layer-type plasma structure to drift in the same zonal direction as the moving plasma structure. However, the correlation between the drift velocity of the 3-m FAIs and the moving direction of the large scale plasma structure is indistinct for the clump-type plasma structure. The meridional electric field estimated from the 3-m FAI zonal drift velocity is pointed in the northward/upward (southward/downward) direction for the layer-type plasma structure moving in the west (east) direction. Statistical results show that the mean value of the meridional electric field inside the layer-type plasma structure is approximately 2.7-2.8 mV/m, about 3 times larger than that for the clump-type plasma structure. Physical processes responsible for the formations of the layer-type and clump-type plasma structures are discussed in this article. It is believed that neutral wind shear is very likely the main cause of the layer-type plasma structure formation, while the clump-type plasma structure may be associated with the propagating gravity wave.

キーワード: 3-m field-aligned irregularities, Es plasma structure, zonal drift velocity, neutral wind shear, gravity wave, interferometer method
Keywords: 3-m field-aligned irregularities, Es plasma structure, zonal drift velocity, neutral wind shear, gravity wave, interferometer method

電離圏全電子数差精密測定による電離圏不規則構造の研究

Small-scale irregularities in the ionosphere studied by precise ionospheric TEC difference measurement

齋藤 享^{1*}, 藤田 征吾¹, 吉原 貴之¹, 大塚 雄一²

SAITO, Susumu^{1*}, FUJITA, Seigo¹, YOSHIHARA, Takayuki¹, OTSUKA, Yuichi²

¹ 電子航法研究所, ² 名古屋大学太陽地球環境研究所

¹Electronic Navigation Research Institute, ²STEL, Nagoya University

In the ionosphere there are various kinds of ionospheric irregularities associated with different ionospheric phenomena. They have been studied by in-situ measurements, radar measurements, or radio scintillation techniques. However, it was not easy to study the structures of small-scale ionospheric irregularities with a scale size of a few hundred meters which known to cause scintillation of GNSS signals at the L-band effectively.

We have developed a method to estimate the difference in the ionospheric total electron contents (TECs) between two GNSS receivers even at very short baselines of a few hundred meters. Since this method is based on single-frequency measurements, it can be applied in disturbed conditions where the L2 signal is not available. With this method, difference in TECs between two stations can be estimated with an accuracy of 0.02 TECU or 3mm in ionospheric delay at GPS L1 frequency (1.57542 GHz).

We applied this method to data obtained at Ishigaki Island (24.3N, 124.2E), Japan. We have installed five GNSS receivers in Ishigaki with mutual distances from 0.08 m to 1.57 km. We have detected very dynamic variations of small-scale irregularities associated with plasma bubbles. Furthermore, we have succeeded in detecting spatial TEC fluctuations in non-disturbed conditions.

This method appear to be promising in studying various kinds of small-scale irregularities in everywhere in the ionosphere.

Keywords: ionosphere, small-scale irregularities, TEC gradient, advanced GNSS technique, plasma bubble, Es layer

Conjugate observations of mid-latitude travelling ionospheric disturbances by HF radars Conjugate observations of mid-latitude travelling ionospheric disturbances by HF radars

Grocott Adrian^{1*}, Keisuke Hosokawa², Steve Milan¹, Natsuo Sato³, Akira Sessai Yukimatu³
GROCOTT, Adrian^{1*}, Keisuke Hosokawa², Steve Milan¹, Natsuo Sato³, Akira Sessai Yukimatu³

¹University of Leicester, ²University of Electro-Communications, ³National Institute of Polar Research

¹University of Leicester, ²University of Electro-Communications, ³National Institute of Polar Research

We present a survey of travelling ionospheric disturbances (TIDs) observed at mid-latitudes in the northern and southern hemispheres by the Wallops Island and Falkland Islands SuperDARN HF radars. Observations were made during the 18 month operational interval of the Falkland Islands radar between March 2010 and September 2011. Statistics of the radar ground backscatter, in which the signatures of TIDs are manifest, will be presented along with an analysis of the TID spectral and propagation characteristics. Observed periods were in the range 30 - 60 minutes, corresponding to frequencies of 0.3 - 0.6 mHz. Wavelengths were generally in the range 250 - 400 km with phase speeds in the range 50 - 200 m s⁻¹. These values are within the ranges typically associated with medium-scale gravity waves. We discuss these results in terms of hemispheric, seasonal and diurnal variations, as well as in terms of their relationship to the local topography and large-scale geomagnetic activity.

キーワード: Travelling Ionospheric Disturbance, HF radar, Conjugate observations

Keywords: Travelling Ionospheric Disturbance, HF radar, Conjugate observations

Study of tri-band beacon signal scintillation for new LITN Study of tri-band beacon signal scintillation for new LITN

Tung Yuan Hsiao^{1*}, L.-C. Tsai², C. H. Liu³
HSIAO, Tung Yuan^{1*}, L.-C. Tsai², C. H. Liu³

¹Dept. of Information Technology, Hsing Wu College, Taiwan, ²Center for Space and Remote Sensing Research, NCU, Taiwan,
³Academia Sinica, Taiwan

¹Dept. of Information Technology, Hsing Wu College, Taiwan, ²Center for Space and Remote Sensing Research, NCU, Taiwan,
³Academia Sinica, Taiwan

Beginning from 2006, seven ground stations located at Chung-Li (25.136N, 121.539E), Chiayi (23.5661N, 120.466E), CheCheng (22.725N, 120.544E), Kinmen (24.411N, 118.292E), Manila (14.262N, 121.043E), Pontianak (-0.003N, 109.366E) and Itu Aba Island (10.06N, 114.350E) within the tropical regions were set up to receive beacon signals from six FORMOSAT-3/COSMIC (P. A. Bernhardt et. al, 2000), C/NOFS and other NNSS-like satellites. By applying the differential Doppler technique on three quadrature components of the three-band beacon signals, we were able to obtain total electric contents (TEC) values and scintillation along the radio path through the ionosphere. In this study, we explore the low latitude scintillation near midnight, and approach the correct location of the F region step by step using a simple optical model when the radio signals traveled through them. The data shows scintillations at low-latitude have high correlation with months when Kp less than 3. They are usually happened at May-June and December-February less than the other months. On the contrary, scintillations are normally more frequent during the equinoctial months of August?October and March?April. Finally, we compare seasonal and solar activity dependence using a statistical analysis of the collected data between all stations.

キーワード: Ionosphere, Scintillation, Ionospheric irregularity
Keywords: Ionosphere, Scintillation, Ionospheric irregularity

Monitoring of seasonal variability of the ionosphere over Japan region on the base of GPS and COSMIC RO measurements

Monitoring of seasonal variability of the ionosphere over Japan region on the base of GPS and COSMIC RO measurements

Zakharenkova Irina^{1*}, Cherniak Iurii¹, Shagimuratov Irk¹, Andrzej Krankowski²
ZAKHARENKOVA, Irina^{1*}, CHERNIAK, Iurii¹, SHAGIMURATOV, Irk¹, Andrzej Krankowski²

¹West Department of IZMIRAN, ²University of Warmia and Mazury in Olsztyn, Poland

¹West Department of IZMIRAN, ²University of Warmia and Mazury in Olsztyn, Poland

Knowledge of the state of the upper atmosphere, especially its ionospheric part and its diurnal and seasonal variations, is a very important. Different radio methods and techniques are applied in order to study the ionosphere variability and structure. Nowadays the majority of the ionospheric research activities are base on the measurements of GPS radio signals. Data provided by ground-based GPS receivers allows to estimate values of vertical total electron content (TEC) up to the 20,200 km. GPS measurements onboard Low Earth Orbiting satellites provide possibility to study ionospheric electron density distribution on a global scale. This paper presents results of the joint analysis of GPS/GLONASS observations and FORMOSAT-3/COSMIC radio occultation (RO) measurements at the extended solar minimum of cycle 23/24 over Japan region. COSMIC RO data for different seasons corresponded to equinoxes and solstices of 2007-2009 (March, June, September and December) were analyzed. All selected RO electron density profiles were integrated up to the height of 700 km (altitude of COSMIC satellites), the monthly median estimates of ionospheric electron content (IEC) were retrieved with use of spherical harmonics expansion. Also there was selected several GPS stations located in north-south direction at Japan region. Monthly medians of TEC values were calculated from diurnal variations of GPS TEC estimates during considered month. Joint analysis of GPS TEC and COSMIC data allows us to extract and estimate electron content corresponded to the ionosphere (IEC) and to analyse redistribution of electron content between bottom and topside parts of IEC as well as PEC (plasmaspheric electron content) for different seasons of 2007-2009. Percentage contribution of PEC to GPS TEC indicates the clear dependence from the time and varies from a minimum of about 25-30% during day-time to the value of 50-60% at night-time of winter season. Contribution of bottomside IEC has minimal values during winter season in compare with summer season (for both day and night time). The obtained results were compared with TEC, PEC and IEC estimates retrieved by Standard Plasmasphere-Ionosphere Model (SPIM, <http://ftp.izmiran.ru/pub/izmiran/SPIM/>) that has the plasmasphere extension up to 20,000 km (GPS orbit altitude). A fair agreement was found between SPIM-derived TEC and GPS TEC for Japan region for solar minimum period.

We acknowledge the University Corporation for Atmospheric Research (UCAR) for providing the COSMIC Data and IGS community for GPS permanent data. This work was supported by Russian Federation President grant MK-2058.2011.5.

キーワード: Ionosphere, GPS, FORMOSAT-3/COSMIC, Radio occultation

Keywords: Ionosphere, GPS, FORMOSAT-3/COSMIC, Radio occultation

VHF coherent scatter radar observations of mid-latitude E- and F-region field-aligned irregularities over South Korea

VHF coherent scatter radar observations of mid-latitude E- and F-region field-aligned irregularities over South Korea

Young-Sil Kwak^{1*}, Tae-Yong Yang², Hyosub Kil³, Young-Deuk Park¹
KWAK, Young-Sil^{1*}, Tae-Yong Yang², Hyosub Kil³, Young-Deuk Park¹

¹Korea Astronomy and Space Science Institute, ²University of Science and Technology / Korea Astronomy and Space Science Institute, ³Johns Hopkins University, Applied Physics Laboratory

¹Korea Astronomy and Space Science Institute, ²University of Science and Technology / Korea Astronomy and Space Science Institute, ³Johns Hopkins University, Applied Physics Laboratory

We examine the mid-latitude F-region field-aligned irregularity (FAI) activity during 2010 - 2012 by using the VHF coherent scatter radar data in Daejeon (36.2N, 127.1E; dip latitude 26.7N), South Korea. The VHF radar has been operated since December 2009 and provides a unique opportunity to investigate the variability of the FAI activity with local time, season, solar flux, and magnetic activity. Our preliminary results show that E- and F-region FAIs appear frequently: interesting daytime irregularities, continuous echoes during the post-sunrise period and Quasi-Periodic (QP) echoes at nighttime for E region; strong post-sunset and pre-sunrise FAIs for F region. For one event, we observed the association of the F-region FAIs with a medium-scale traveling ionospheric disturbance (MSTID). Additionally, we also present seasonal and local time variations of occurrence of mid-latitude E- and F-region FAIs during low solar activity period, January 2010 - April 2012. It is worth to note our occurrence result since long term observation over a year in the mid-latitude has not yet been carried out. Our study extends to the investigation of the correlations between the irregularities in the equatorial region and middle latitudes and between the conjugate F regions, and the causal linkage of the FAIs with the E-region perturbations. For this purpose, we analyze the VHF radar and C/NOFS data during 2010 - 2011.

キーワード: VHF ionospheric radar, FAIs, mid-latitude

Keywords: VHF ionospheric radar, FAIs, mid-latitude

PEM08-22

会場:301B

時間:5月22日 14:05-14:20

Study of ionosphere-thermosphere coupling using the SuperDARN Hokkaido radar and Asian sector ground-based network Study of ionosphere-thermosphere coupling using the SuperDARN Hokkaido radar and Asian sector ground-based network

西谷 望^{1*}, SuperDARN Hokkaido radar group¹
NISHITANI, Nozomu^{1*}, SuperDARN Hokkaido radar group¹

¹Solar-Terrestrial Environment Laboratory, Nagoya University

¹Solar-Terrestrial Environment Laboratory, Nagoya University

The SuperDARN Hokkaido radar, one of the mid-latitude SuperDARN radars and the only one in the Asian sector, is a powerful tool for studying ionosphere-thermosphere coupling ranging from 40 to 80 geomagnetic latitudes. Several topics of ionosphere-thermosphere coupling using the SuperDARN Hokkaido radar together with other Asian ground-based instrument, such as traveling ionospheric disturbances and coseismic ionospheric disturbances, will be presented.

キーワード: thermosphere, ionosphere, SuperDARN, Hokkaido radar, large-scale traveling ionospheric disturbance, coseismic ionospheric disturbance

Keywords: thermosphere, ionosphere, SuperDARN, Hokkaido radar, large-scale traveling ionospheric disturbance, coseismic ionospheric disturbance

WINDs キャンペーン - リリウム放出実験 - WINDs Campaign -Lithium Releases from Sounding Rockets in the Thermosphere-

渡部 重十^{1*}, 阿部 琢美², 古田 裕規¹, 羽生 宏人², 柿並 義宏¹, 山本 真行³

WATANABE, Shigetou^{1*}, ABE, Takumi², FURUTA, Yuuki¹, Hiroto Habu², KAKINAMI, Yoshihiro¹, YAMAMOTO, Masayuki³

¹ 北海道大学, ² 宇宙科学研究所, ³ 高知工科大学

¹Hokkaido University, ²ISAS, ³Kochi University of Engineering

Though the ionization rate is less than 1% in the region of thermosphere, the dynamics of neutral atmosphere is strongly controlled by the plasma. However, the direct observation on the coupling process between neutral atmosphere and plasma is not yet performed in detail. JAXA/ISAS launched successfully S-520-23 and S-520-26 sounding rockets from Kagoshima Space Center (KSC) on September 2, 2007 and January 12, 2012, respectively. The rocket experiments are called WINDs (Wind measurement for Ionized and Neutral atmospheric Dynamics study) Campaign. The purpose is to investigate the neutral atmosphere - plasma coupling process in the thermosphere and ionospheric E and F-regions. The rocket installed Lithium Ejection System (LES) as well as instruments for plasma drift velocity, plasma density and temperature and electric and magnetic fields. The atomic Lithium gases were released at altitudes between 150km and 300km in the evening for S-520-23 and at altitude of ~100km in the morning for S-520-26. The Lithium atoms scattered sunlight by resonance scattering with wavelength of 670nm. The neutral winds and atmospheric gravity waves in the thermosphere were estimated from the movements of Lithium clouds observed by CCD imagers on ground. From the diffusion of Lithium clouds, we estimated neutral density and temperature in the thermosphere.

キーワード: 熱圏電離圏結合

Keywords: IT coupling

夕方、明け方、昼間熱圏におけるリチウム放出口ケット実験 Lithium release rocket experiments in evening, dawn, and daytime thermosphere.

山本 真行^{1*}, 渡部 重十², 羽生 宏人³, 阿部 琢美³, LARSEN Miguel F.⁴, 山本 衛⁵, 横山 竜宏⁵, 柿並 義宏²
YAMAMOTO, Masa-yuki^{1*}, WATANABE, Shigeto², Hiroto Habu³, ABE, Takumi³, LARSEN, Miguel F.⁴, YAMAMOTO,
Mamoru⁵, YOKOYAMA, Tatsuhiko⁵, KAKINAMI, Yoshihiro²

¹ 高知工科大学, ² 北海道大学, ³ 宇宙航空研究開発機構, ⁴ Clemson 大学, ⁵ 京都大学 生存圏研究所

¹ Kochi University of Technology, ² Hokkaido University, ³ JAXA, ⁴ Clemson University, ⁵ RISH, Kyoto University

Several kinds of chemical release experiments were successfully carried out and established before 1970's by onboard chemical release canisters of many kinds of gaseous metals and Tri-Methyl- Aluminum (TMA). The TMA release technique has been used in many nighttime rocket campaigns in 4 decades mainly in U.S., however, the Lithium canister technique was not maintained afterwards. Recently, Lithium release experiments in midlatitude thermosphere in evening, dawn, and daytime were carried out in 2007, 2011, and 2012, respectively. In 2007, we rebuilt a Lithium Ejection System (LES) for Japanese sounding rocket program, WIND campaign. The experiment was successful by newly developed LES in Japan, resulting neutral wind profile in evening thermosphere in wide altitude range between 115 km and 400 km. The WIND campaign opened a new 3-D view of thermospheric atmosphere, suggesting interesting boundary at about 180 km as is changing main composition of neutral atmosphere from nitrogen molecule to atomic oxygen. By the resonant scattering mechanism, atomic Lithium can emit red light (670.8 nm wavelength) based on its specific characteristics in the case of sunlit condition. So, evening and dawn sky was reasonable condition for thermospheric imaging and wind measurement by Lithium release, moreover, it has been considered the technique could be applied on daytime experiments because of strong efficiency of the resonant scatter by Lithium.

After the WIND campaign, we started U.S.-Japan collaborative rocket program, Daytime Dynamo campaign with NASA/GDSC and Clemson University for obtaining daytime thermospheric wind, WIND-2 campaign for dawn thermospheric wind, as well. The Daytime Dynamo campaign was carried out at Wallops Flight Facility (WFF), NASA (VA, U.S.A.) on July 10, 2011 and the WIND-2 campaign was at Uchinoura Space Center (USC), JAXA (Kagoshima, Japan) on Jan. 12, 2012. Two rocket launches were successful, however, daytime Lithium imaging was failed, whereas the dawn imaging was halfway in success. One of the reason of losing Lithium images in Daytime Dynamo would be strict S/N condition due to the small separation angle between the Sun and the center of the FOV (Field of View) of Lithium imagers in the morning condition (10:00 LT). Whereas, in the WIND-2 campaign, two of three onboard LES were failed to release the Lithium gas, resulting in imaging of only one Lithium trail in lower thermosphere between 76 km and 127 km.

Here, we will present a review talk about previous and recent Lithium release experiments with showing currently facing problems and some considerable solutions for daytime wind measurement to be held in near future.

キーワード: リチウム放出実験, 観測ロケット, 熱圏中性大気風, WIND-2 キャンペーン, Daytime Dynamo キャンペーン
Keywords: Lithium release experiment, sounding rocket, thermospheric neutral wind, WIND-2 campaign, Daytime Dynamo campaign

ロケット / 地上観測を用いた中規模伝搬性電離圏擾乱の観測キャンペーン Sounding rocket/ground-based observation campaign to study Medium-Scale Traveling Ionospheric Disturbances (MSTID)

山本 衛^{1*}, 齊藤 昭則², 横山 竜宏¹, 大塚 雄一³, 山本 真行⁴, 阿部 琢美⁵, 渡部 重十⁶, 石坂 圭吾⁷, Larsen Miguel⁸, Pfaff Rob⁹, Bernhardt Paul¹⁰

YAMAMOTO, Mamoru^{1*}, SAITO, Akinori², YOKOYAMA, Tatsuhiro¹, OTSUKA, Yuichi³, YAMAMOTO, Masa-yuki⁴, ABE, Takumi⁵, WATANABE, Shigeto⁶, ISHISAKA, Keigo⁷, Miguel Larsen⁸, Rob Pfaff⁹, Paul Bernhardt¹⁰

¹ 京都大学生存圏研究所, ² 京都大学大学院理学研究科地球物理学教室, ³ 名古屋大学太陽地球環境研究所, ⁴ 高知工科大学工学部電子・光システム工学科, ⁵ JAXA 宇宙科学研究所, ⁶ 北海道大学大学院理学院宇宙理学専攻, ⁷ 富山県立大学工学部情報システム工学科, ⁸ Clemson University, ⁹ NASA/GSFC, ¹⁰ NRL

¹ Research Institute for Sustainable Humanosphere, Kyoto University, ² Department of Geophysics, Graduate School of Science, Kyoto University, ³ Solar-Terrestrial Environment Laboratory, Nagoya University, ⁴ Electronic and photonic systems engineering, Kochi University of Technology, ⁵ JAXA/Institute of Space and Astronautical Science, ⁶ Department of CosmoSciences, Hokkaido University, ⁷ Toyama Prefectural University, ⁸ Clemson University, ⁹ NASA/GSFC, ¹⁰ NRL

An observation campaign is under preparation. It is to launch sounding rockets S-520-27 and S-310-42 from Uchinoura Space Center of JAXA, while ground-based instruments measure waves in the ionosphere. The main purpose of the study is to reveal seeding mechanism of Medium-Scale Traveling Ionospheric Disturbances (MSTID). The MSTID is enhanced in the summer nighttime of the mid-latitude ionosphere. The MSTID is not only a simple reflection of atmospheric waves to the ionosphere, but includes complicated processes including the electromagnetic coupling of the F- and E-regions, and inter-hemisphere coupling of the ionosphere. We will measure ionospheric parameters such as electron density and electric fields together with neutral winds in the E- and F-regions. TMA and Lithium release experiment will be conducted with S-310-42 and S-520-27 rockets, respectively. The observation campaign is planned in summer 2012 or 2013. In the presentation we will overview characteristics of MSTID, and show plan and current status of the project. We also touch results from the sounding rocket S-520-26 that was launched on January 12, 2012. We will show results of the rocket-ground dual-band beacon experiment.

キーワード: 観測ロケット, 地上観測, 中規模伝搬性電離圏擾乱, 観測キャンペーン

Keywords: sounding rocket, ground-based experiment, Medium-Scale Traveling Ionospheric Disturbances, observation campaign

トッブサイド電離圏高密度領域で観測される電子密度・温度の正相関 Positive correlation between electron density and temperature in high density region of the topside ionosphere

柿並 義宏^{1*}, 渡部 重十², 劉 正彦³, Balan Nanan³, Liu Huixin⁴

KAKINAMI, Yoshihiro^{1*}, WATANABE, Shigetō², LIU, Jann-Yenq³, BALAN, Nanan³, LIU, Huixin⁴

¹ 北海道大学地震火山研究観測センター, ² 北海道大学大学院理学院宇宙理学専攻, ³ 台湾国立中央大学太空研究所, ⁴ 九州大学理学研究院地球惑星科学専攻

¹Institute of Seismology and Volcanology, Hokkaido University, ²Department of Cosmospice, Hokkaido University, ³Institute of Space Science, National Central University, ⁴Department of Earth and Planetary Science, Kyushu University

Electron temperature (T_e) in the ionosphere is determined by the heat balance between the heating by photoelectrons, cooling through Coulomb collisions with ions and heat conduction along the magnetic field lines. Many studies have shown a negative correlation between the electron density (N_e) and T_e during daytime because cooling through Coulomb collision increases with increase of N_e . In this study, the correlation between T_e and N_e observed by the Hinotori satellite and other satellites. Although the results show the well-known negative correlation between daytime N_e and T_e when N_e is low, when the daytime N_e is significantly high ($>10^6 \text{ cm}^{-3}$), the correlation turns positive irrespective of latitude, longitude, season, solar flux levels and magnetic activity levels. The results suggest that an additional heat source(s) is involved for the positive correlation between N_e and T_e . Since T_e also increases with increasing magnetic dip latitude in the same N_e range, T_e does not correlate with in-situ N_e , which suggests the integrated N_e along the magnetic field lines from the ground to 600 km altitude in one hemisphere are important for T_e in the topside ionosphere. Therefore, the additional heat source seems to be related the integrated N_e . Although the mechanism for the positive correlation is not well understood, the results imply that the T_e in the topside ionosphere is controlled more by the integrated N_e than by in-situ N_e or F2-peak N_e .

キーワード: 中低緯度電離圏, 電子温度, 電子密度, トッブサイド電離圏, 電離圏プラズマ熱収支

Keywords: mid-low latitude ionosphere, electron temperature, electron density, topside ionosphere, heat budget of ionospheric plasma

Imaging observation of the Ionosphere, mesosphere, and plasmasphere from ISS Imaging observation of the Ionosphere, mesosphere, and plasmasphere from ISS

齊藤 昭則^{1*}, 山崎 敦², 坂野井 健³, 吉川 一朗⁴

SAITO, Akinori^{1*}, YAMAZAKI, Atsushi², SAKANNOI, Takeshi³, YOSHIKAWA, Ichiro⁴

¹ 京都大学大学院理学研究科地球物理学教室, ² 宇宙航空研究開発機構 宇宙科学研究所, ³ 東北大学大学院理学研究科惑星プラズマ・大気研究センター, ⁴ 東京大学

¹Dept. Geophysics, Kyoto University, ²Institute of Space and Astronautical Science / Japan Aerospace Exploration Agency,

³Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, ⁴The University of Tokyo

ISS-IMAP (Ionosphere, Mesosphere, upper Atmosphere, and Plasmasphere mapping) mission is a space-borne imaging mission to elucidate the Earth upper atmosphere, the mesosphere, the ionosphere, the thermosphere and the plasmasphere. It is a scientific mission that uses two imaging instruments on the Exposed Facility of Japanese Experiment Module on the International Space Station, EF of ISS-JEM. The development of the scientific instruments have been completed in 2011. The observation is planned to be started in 2012. It will make imaging observation of the Earth's upper atmosphere with visible-light and infrared spectrum imager (VISI) and extra ultraviolet imager (EUVI). The objective of this mission is to clarify the physical mechanism of the following three processes: (1) energy transport process by the atmospheric structures whose horizontal scale is 50-500km in the upper atmosphere (2) process of the plasma transport up to 20,000km altitude (3) effect of the upper atmosphere on the space-borne engineering system. ISS-IMAP will measure the following three parameters in the lower latitude region than 50 degrees: (1) distribution of the atmospheric gravity wave in the mesopause (87km), the ionospheric E-region (95km), and the ionospheric F-region (250km) (2) distribution of the ionized atmosphere in the ionospheric F-region (3) distribution of O⁺ and He⁺ ions in the ionosphere and plasmasphere. VISI will observe the airglow of 730nm (OH, Alt. 85km), 762nm (O₂, Alt 95km), 630nm(O, Alt.250km) in the Nadir direction. EUVI will measure the resonant scattering of 30.4nm [He⁺] and 83.4nm [O⁺]. Its field-of-view is 15 degrees, and points the limb of the Earth to observe the vertical distribution of the ions. The scientific objectives and current status of the ISS-IMAP mission will be introduced in the presentation.

Keywords: ISS, Ionosphere, Mesosphere, Plasmasphere, JEM, MCE

Simulation of Airglow Observations with IMAP/ VISI on the International Space Station Simulation of Airglow Observations with IMAP/ VISI on the International Space Station

Septi Perwitasari^{1*}, Takeshi Sakanoi¹, Yuichi Otsuka², Yusuke Akiya³, Akinori Saito³

PERWITASARI, Septi^{1*}, SAKANNOI, Takeshi¹, OTSUKA, Yuichi², AKIYA, Yusuke³, SAITO, Akinori³

¹PPARC, Tohoku University, ²STEL, Nagoya University, ³Geophysics Dept, Kyoto University

¹PPARC, Tohoku University, ²STEL, Nagoya University, ³Geophysics Dept, Kyoto University

The Visible and near-Infrared Spectral Imager (VISI) of the IMAP mission has been developed and ready to be launched onto the International Space Station (ISS) in summer 2012. VISI will be operated in the night-side hemisphere in the range of +/- 51 deg. GLAT, and measure the airglow emissions of OI at 630 nm, the OH Meinel band at 650 nm and the O2 atmospheric band (0-0) at 762 nm at an altitude of ~400 km with typical spatial resolution of 16-50 km. Since the influence of cloud reflections of moon light is overlapped with the airglow pattern in the visible wavelength range, the precise subtraction of the cloud influence is a key issue of this mission. Therefore, a simulation work to study on how much the surface albedo on the cloud top will affect the data is critically important. We carried out the simulation of O2 airglow pattern including cloud albedo under realistic conditions of VISI measurement since the O2 airglow is the primary candidate for measurement of gravity wave modulated airglow emission that is only visible from space. The height profile of volume emission rate of O2 airglow was estimated with the MSIS model, and then the airglow intensity was integrated along the line-of-sight direction. The cloud pattern was based on the realistic data measured with a geostationary climate satellite. We will report the quantitative effect of cloud albedo on the airglow pattern, and discuss the physical parameters those expected to be derived from the VISI data.

キーワード: ISS-IMAP, VISI, airglow simulation, O2 atmospheric band (0-0)

Keywords: ISS-IMAP, VISI, airglow simulation, O2 atmospheric band (0-0)

MAGDAS 地磁気観測ネットワークを用いた中間圏-熱圏-電離圏結合過程の研究 Mesosphere-Thermosphere-Ionosphere coupling research by using MAGDAS network

阿部 修司^{1*}, 湯元 清文¹, 河野 英昭², 吉川 顕正², 魚住 禎司¹, 池田 昭大¹, 山崎 洋介³, 前田 丈二¹
ABE, Shuji^{1*}, YUMOTO, Kiyohumi¹, KAWANO, Hideaki², YOSHIKAWA, Akimasa², UOZUMI, Teiji¹, IKEDA, Akihiro¹,
YAMAZAKI, Yosuke³, George Maeda¹

¹九州大学宙空環境研究センター, ²九州大学大学院理学研究院地球惑星科学部門, ³九州大学大学院理学府地球惑星科学専攻

¹Space Environment Research Center, Kyushu University, ²Department of Earth and Planetary Sciences, Kyushu University,

³Department of Earth and Planetary Sciences Graduate School of Sciences, Kyushu University

MAGNETIC DATA ACQUISITION SYSTEM/CIRCUM-PAN PACIFIC MAGNETOMETER NETWORK (MAGDAS/CPMN: Yumoto et al, 1996, 2001, 2006, 2007) is a ground magnetometer network all over the world. It conducted by the Space Environment Research Center (SERC), Kyushu University. It mainly consists of three magnetometer chains, and a part of 210 degrees Magnetic Meridian chain and Magnetic Equator chain are located in Asia region. In addition, we have three Frequency Modulated-Continuous Wave (FM-CW) radar along the 210 magnetic meridian includes Asia region. Long-term observational data can be used to clarify the Sun-Earth coupling system, including Mesosphere-Thermosphere-Ionosphere.

We calculate the equatorial electrojet index (EE-index) every day, and open it to public. The equatorial electrojet is caused by the ionospheric current flowing along the narrow channel (~3 degrees in latitudinal range) of the enhanced ionospheric conductivity, called Cowling conductivity. We developed the EE-index to quantify the scale of magnetic disturbances in the equatorial region using MAGDAS/CPMN data. The ionospheric equivalent current pattern using the MAGDAS data is also useful for the study of MTI coupling. At high latitudes the ionospheric currents are joined with field-aligned currents from the solar wind region into the magnetosphere, and the electro-dynamics is dominated by the influences of solar wind-magnetosphere interaction processes. On the other hand, the ionospheric current at middle and low latitudes is generated by the ionospheric wind dynamo, which produces global current vortices on the dayside ionosphere. By using the MAGDAS ionospheric current pattern and empirical model, the global electromagnetic coupling processes at all latitudes can be clarified.

In this paper, we will introduce the overview of the MAGDAS project, and how data from MAGDAS can be used to research of Mesosphere-Thermosphere-Ionosphere coupling.

Keywords: magnetometer, FM-CW radar, network observation, equatorial electrojet, geomagnetic index

IUGONETで開発されたメタデータデータベース・統合解析ツールを用いた超高層大気研究

Upper atmospheric researches using metadata database and data analysis software developed by the IUGONET project

新堀 淳樹^{1*}, 小山 幸伸³, 能勢 正仁³, 堀 智昭², 大塚 雄一², 林 寛生¹, 津田 敏隆¹

SHINBORI, Atsuki^{1*}, KOYAMA, Yukinobu³, NOSE, Masahito³, HORI, Tomoaki², OTSUKA, Yuichi², HAYASHI, Hiroo¹, TSUDA, Toshitaka¹

¹ 京都大学生存圏研究所, ² 名古屋大学太陽地球環境研究所, ³ 京都大学大学院理学研究科付属地磁気資料解析センター
¹RISH, Kyoto Univ., ²STEL, Nagoya Univ., ³DACGSM, Kyoto Univ.

地球の超高層大気は、下から中間圏、熱圏・電離圏、プラズマ圏、及び磁気圏から構成されているが、これらの領域はお互いに独立でなく、複雑な物理過程を通じて、物質交換、運動量とエネルギー輸送過程によって強く結合している。特に、電離圏-熱圏-中間圏 (MTI) 領域における大気の化学反応や力学過程は、外部と内部要因 (例えば、太陽放射、太陽風、宇宙線、大気波動と潮汐波動) の両方によって引き起こされる。そのため、超高層大気の長期変動のメカニズムを調べるためには、分野をまたがる多種多様かつ異なる位置と高度で取得した地上観測データが必要とされる。しかしながら、一般にはそれらの観測データまたはデータベースは、そのデータを取得した個々の機関によって維持され、そのグループに対してのみ利用可能であったため、そのグループ属さない研究者の多くは、そのデータに関する情報不足から容易にそれらにアクセスし、解析できるような環境になかった。この問題を解決するために、東北大学、国立極地研究所、名古屋大学、京都大学、及び九州大学が連携した超高層大気長期変動の全球地上ネットワーク観測・研究 (IUGONET) プロジェクトが2009年から開始された。ここでは、プロジェクト参加機関が保有する長期の地上観測データのメタデータ (観測期間、装置の種類、データの所在地、など観測データに関する情報) のデータベースを構築するとともに、THEMIS 衛星データ解析ソフトをベースにした統合解析ソフトウェア (UDAS) を開発している。このメタデータ・データベースによって横断的に検索・取得が可能となり、異なる大気層にまたがる現象の総合解析や新しい超高層大気研究が促進されることが期待される。これによって、インドネシアに展開されている MF レーダーや流星レーダーから取得された赤道の熱圏下部・中間圏 (MLT) 領域における長期の中性風データの取得とそのデータベースへのアクセスが容易になった。これらの観測データは、現在、京都大学生存圏研究所のデータベースのホームページ (<http://database.rish.kyoto-u.ac.jp/arch/iugonet/index-idr.html>) で公開されており、1992年10月から現在までのデータが取得できるようになっている。なお、数値データに関しては、テキストと netCDF 形式、高度-時間プロットについては、gif または png 形式で提供されている。また、IUGONET プロジェクトでは、我々が開発したプロダクトの性能を評価するために、メタデータ・データベース検索と統合解析ツール (UDAS) を用いて、超高層大気の長期変動に関するサイエンス研究が進められている。講演では、IUGONET プロジェクトの概要とインドネシアの MF/流星レーダーのデータベース、及びアジア領域における地磁気静穏日変化の振幅と MLT 領域の中性風の長期トレンドに関する研究を紹介する。

キーワード: 太陽放射, 地磁気静穏日変化, 電離圏電気伝導度, 熱圏中間圏, IUGONET, 解析ソフト

Keywords: Solar radiation, Geomagnetic solar quiet daily variation, Ionospheric conductivity, Thermosphere-mesosphere, IUGONET, Analysis software

アジア・オセアニア宇宙天気アライアンスと電離圏データ処理技術 Asia-Oceania Space Weather Alliance: AOSWA

村田 健史^{1*}, 長妻 努¹, 亘 慎一¹, 津川 卓也¹, 西岡 未知¹, 丸山 隆¹

MURATA, Ken T.^{1*}, NAGATSUMA, Tsutomu¹, WATARI, Shinichi¹, TSUGAWA, Takuya¹, NISHIOKA, Michi¹, MARUYAMA, Takashi¹

¹ 情報通信研究機構

¹NICT

For our studies of the ionosphere, GPS-TEC data analysis is one of the effective methodologies. More than 6000 GPS data files are independently provided every day from several organizations over the world through the Internet. To create GPS-TEC maps from these GPS data, data file crawling is inevitable. It is not easy, however, since the data publication policies are independently regulated at each organization, and we need to catch up with the change of the policies.

In NICT we have developed a new system to collect such GPS data files automatically. Based on the collected data files, we are successfully creating both global and regional GPS-TEC maps. It should be noted that the system can detect a change of the data publication policy, and we can adjust the data crawling settings and/or parameters.

For more dense and precise GPS-TEC maps, we need to involve more data from new GPS receivers. Since there is no standard and public GPS data format, we have implemented an application to make data suitable for our GPS-TEC maps. We have begun to provide this application, which would help our global and regional GPS-TEC maps with higher spatial resolutions or for the new regions where there have no GPS-TEC maps.

To promote such an application and data exchange, a regional collaboration is important. The Asia-Oceania Space Weather Alliance (AOSWA) was established in 2010 with 13 associated organizations from 7 countries (<http://aoswa.nict.go.jp>) including NICT (National Institute of Information and Communications Technology). The AOSWA has two major objectives; to make progress in collaborative research and practical operations of space weather forecasting.

The AOSWA workshop was held in Chiang Mai, Thailand from February 22nd to 24th as a first regional/international workshop for researchers and operators of space weather forecast in Asia-Oceania countries. The subjects of the workshop are both operational and scientific, including research in ionospheric and magnetospheric science, solar wind and other space weather related phenomena.

Regional workshop in the Asia-Oceania area plays an important role for improvement of space weather forecasting services. The research efforts, operational collaboration, data exchanges, and some competitions will lead to further development of space weather activities; a primary goal of the workshop.

Keywords: Asia-Oceania Space Weather Alliance, AOSWA, GPS-TEC, ionosphere