CAWSES: Climate and Weather for Sun-Earth System– II http://www.cawses.org/wiki/index.php/Main_Page
Task Group4 : What is the geospace response to variable inputs from the lower atmosphere?

TG4 Newsletter

Vol. 7, Jan. 2012

Inside this Issue

Article 1

A Brief Introduction to Meridian Project in China

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Chi Wang

To develop an understanding of near-Earth space's response to solar activities and the coupling among different layers in geospace, China has initiated a ground base program to monitor China's geospace environment. Called the Meridian Space Weather Monitoring Project (or Chinese Meridian Project), the effort consists of a chain of 15 ground-based observatories located roughly along 120°E longitude and 30°N latitude. Each observatory is equipped with multiple instruments to measure key parameters such as the baseline and time-varying geomagnetic field, as well as the middle and upper atmosphere and ionosphere from about 20 to 1000 kilometers. Starting in 2012, the project will collect data for at least 11 years, providing the wide-range, continuous, and multiparameter data sets needed to guide model developments, which in turn will better describe and predict the characteristics and dynamics of the geospace environment.

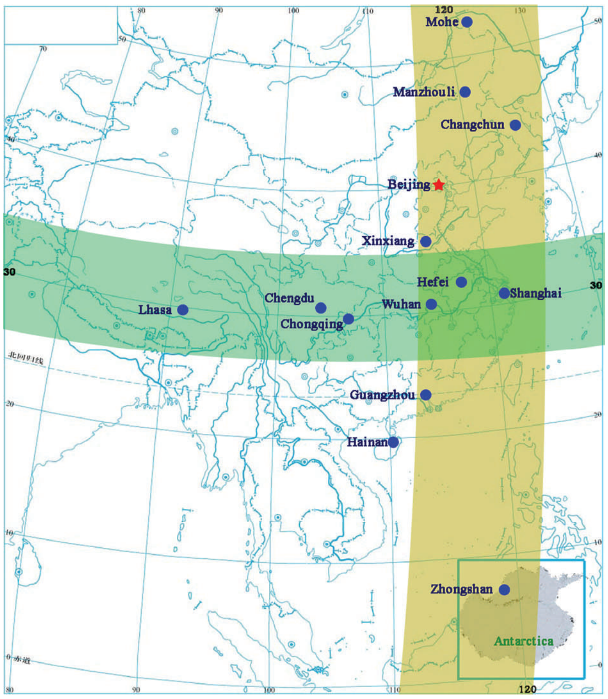

Figure 1. Distribution of observatories that form the Meridian Project (yellow band traces stations along 120°E; green band shows stations close to 30°N).

The Meridian Project is funded by China's National Development and Reform Commission as part of a series of major scientific infrastructure construction projects. With a planning and construction period spanning

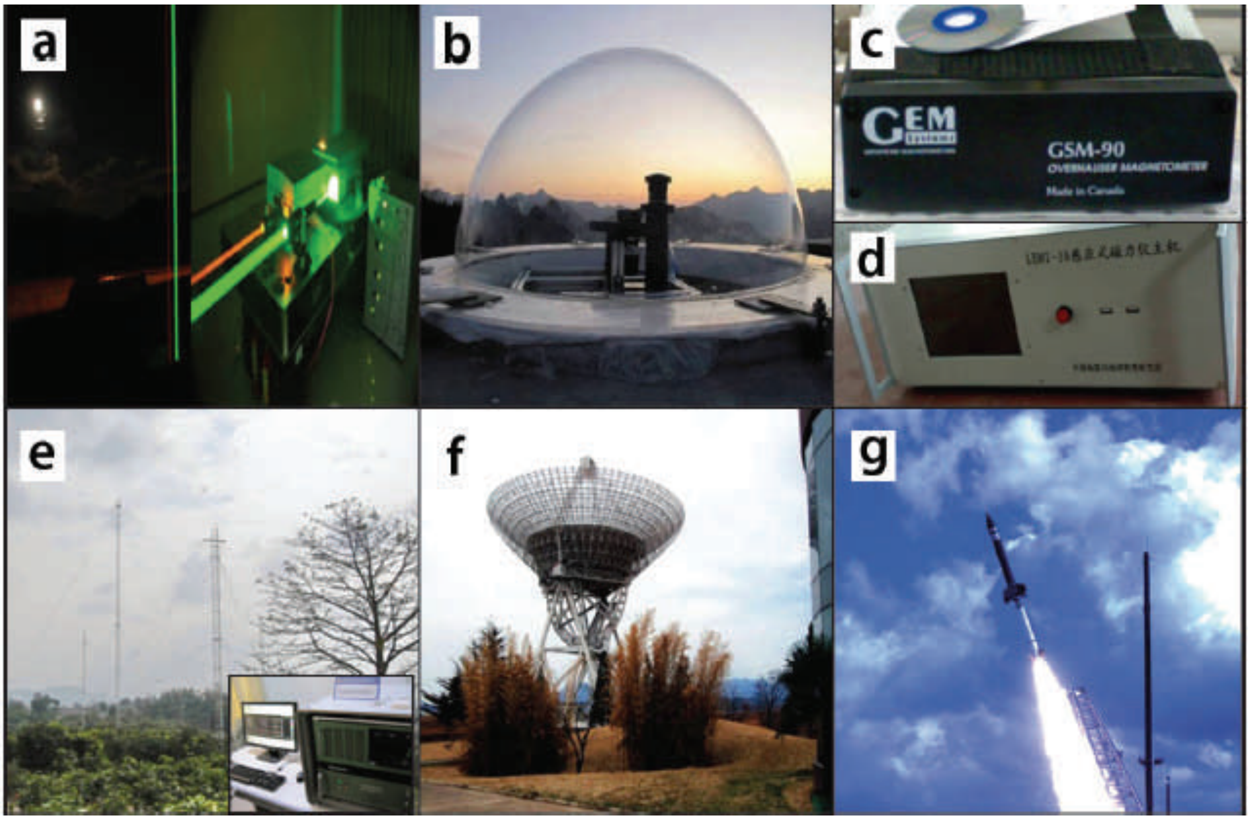

Figure 2. Examples of the observational instruments to be deployed in the Meridian Project, including (a) lidar (light detection and ranging), (b) all-sky airglow imagers, (c) Overhauser magnetometers, (d) induction magnetometers, (e) digital ionosondes (digisondes), (f) radar to monitor interplanetary scintillation, and (g) sounding rockets.

from 2006 to 2011, its total budget is 167 million yuan (about US$24 million). The project is a joint effort of teams from 12 research institutes and universities in China, led by the Chinese Academy of Sciences' Center for Space Science and Applied Research (CSSAR). Construction of observatories for the Meridian Project started in January 2008 and is expected to be finished by December 2011. The project's chain of observational stations begins in the north with a station in the city of Mohe. The rest run south roughly through Beijing, Wuhan, Guangzhou, and the island of Hainan (with instruments at Hikou, Fuke, and Sanya) and extend to China's Zhongshan station in Antarctica (see Figure 1). Aside from the station in Antarctica, the stations are located roughly 4°-5° of latitude, or about 500 kilometers apart. A chain of stations is also being constructed roughly following 30°N, spanning from Lhasa to Shanghai. Instruments at these stations include magnetometers, traditional and digital ionosondes (digisondes), incoherent scatter radars, high-frequency backscatter radars, mesosphere-stratosphere-tropospthereradars, meteor radars, lidar (light detection and ranging), Fabry-Perot interferometers (FPI), and aurora spectrographs (see Figure 2). Through these observations, the Meridian Project will better parameterize the geomagnetic field; the geoelectric field; the presence of cosmic rays; the density, temperature, composition, and winds of the middle to upper atmosphere; the density and temperature of electrons and ions in the ionosphere; the total electron content (TEC) over each station; irregular structures and plasma drift in the ionosphere; and the solar wind speed in interplanetary space. The overarching framework of the Meridian Project consists of three interconnected systems necessary for successful space weather operations in China: a space environment monitoring system, a data and communications system, and a research and forecast system. The space environment monitoring system is responsible for making measurements of the space environment from the ground using magnetometers and optical and radio instruments, and for making in situ measurements using sounding rockets. The data and communications system is in charge of collecting, transferring, processing, storing, and distributing data in quasi real time. The research and forecast system will coordinate observations, develop relevant data analysis and space weather forecasting tools, and promote international collaborations.

Article 2

Korea Astronomy and Space Science Institute Activities for the Upper Atmospheric Research

Young-Sil Kwak

Korea Astronomy and Space Science Institute, Daejeon, Korea

Young-Sil Kwak

To meet the growing demand for space weather information for domestic satellites and communication systems, the Korea Astronomy and Space Science Institute (KASI) has recently established the Korean Space Weather Prediction Center (KSWPC). Scope of the project includes extension of ground observation system, construction of space weather database and networking, development of prediction models, and space weather studies. As a part of the project, studies for an improved understanding of the physics of the mid-latitude upper atmosphere are carried out by operating new instruments, such as a magnetometer, a very high frequency (VHF) ionospheric coherent scattering radar, an all-sky imager, and a scintillation monitor in Korea.

The VHF coherent scattering radar is the first ionospheric radar in South Korea, constructed in collaboration with the Republic of Korea Air Force. The radar consists of 24 five-elements Yagi antennas and observes E and F region irregularities (those at ~85-450 km in altitude) in a single frequency of 40.8 MHz, with a peak power of 24 kW. To detect the coherent backscatter from the E- and F-region irregularities, the radar beam is oriented at 48° zenith angle due to magnetic north,

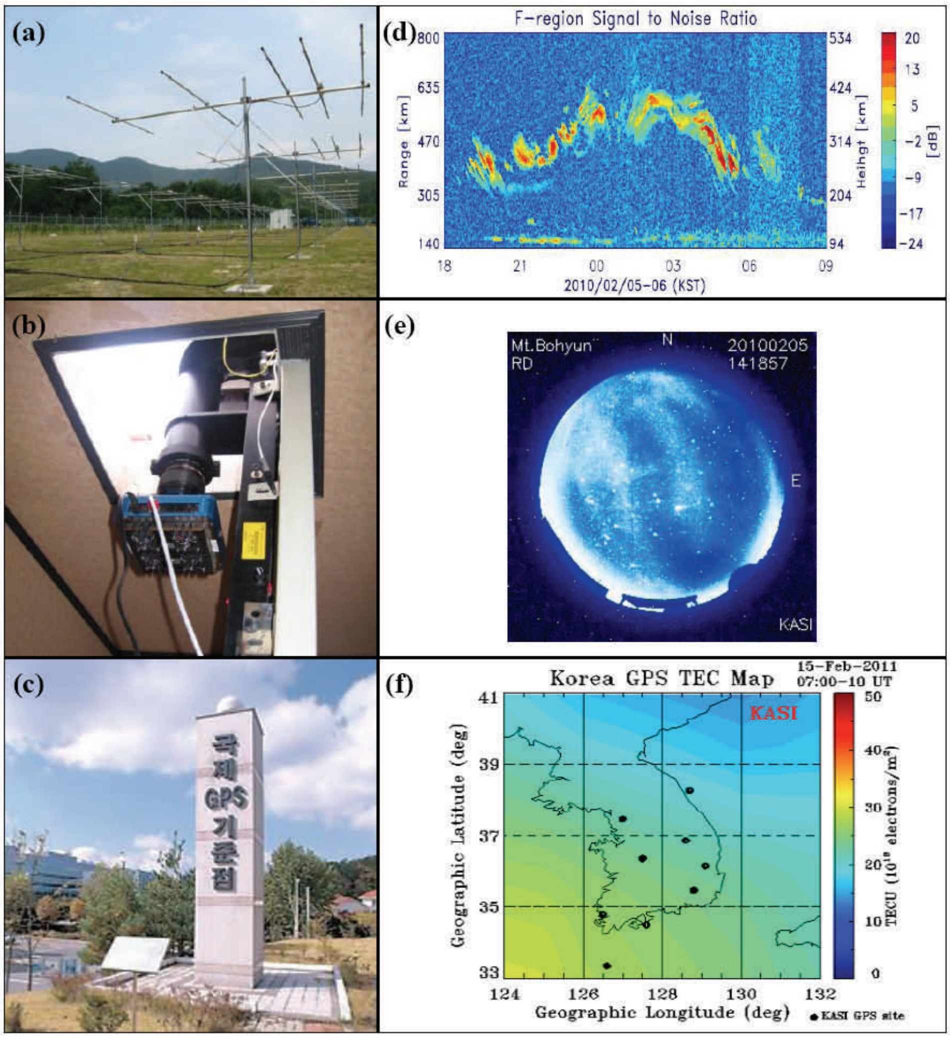

Figure 1. Several observational facilities operated by the Korea Astronomy and Space Science Institute (KASI) along with sample data: (a) very high frequency (VHF) ionospheric coherent scattering radar, (b) all-sky imager, (c) IGS GNSS reference site located at KASI headquarter, (d) F-region ionospheric irregularity observed on 5 February 2010 over the Korean peninsula, (e) F-region airglow found at about 250 km in altitude on 5 February 2010 over the Korean peninsula, (f) GPS TEC map over the Korean peninsula on 15 February 2011.

which satisfies the field perpendicularity condition at that height region. Half-power full beam widths in azimuth and zenith directions are 10° and 22°, respectively. The radar has been operating on a routine basis, sampling alternately the E and F regions one minute by one minute. The inter-pulse periods (IPPs) for the E- and F-region experiments are 2.5 ms and 6.6 ms, respectively, and the pulse widths are 6μs and 32μs, respectively. The range resolutions of the VHF radar measurements for E and F regions are 900 m and 4.8 km, respectively. The radar has been operated continuously at Daejeon city (36.18°N, 127.14°E, dip latitude 26.7°N) in South Korea since December 2009 and provides a unique opportunity to investigate the variability of the mid-latitude FAI activity with local time, season, solar flux, and magnetic activity.

An all-sky imager is operated at Mt. Bohyun since March 2008 to take the photograph for upper atmospheric layer through appropriate filters with specific airglow or auroral emission wavelengths (557.7nm green line at 100 km, 630.0 nm red line at 250 km). The all-sky imager provides horizontal results for upper atmospheric phenomena such as disturbance, propagation of gravity wave and aurora. Scintillation Monitor (SCINTMON) has been also operated in KASI building in Dajeon since January 2008 for monitoring the ionospheric scintillations on GPS L-band signals estimating irregularity of the ionospheric density. SCINTMON receiver measures the ionospheric amplitude and phase scintillations on GPS L-band signals and is operated in a real-time Linux environment.
KASI also has GNSS network of 9 sites in South Korea. Using local KASI GNSS network of 9 sites and IGS GNSS sites in Korea, Japan, China, and Taiwan, the 2-D Total Electron Content (TEC) maps in the region of the Korea Peninsula and the Northeast Asia are respectively produced to monitor the spatial and temporal variations of the ionospheric electron density for space weather. The mid-latitude ionospheric climatology and ionospheric storms have been studied using the 15-years GNSS TEC values that are measured from IGS DAEJ and JEJU sites of KASI GNSS network.

Furthermore, KASI plans to expand its observations to the polar upper atmosphere by installing new instruments at Jang Bogo Station, South Korea's planned Antarctic station located in Terra Nova Bay (74.37°N, 164.12°E). Scheduled to begin operation in 2014, this station will allow South Korean scientists including KASI to monitor both the polar cap and the auroral oval, depending on the time of day or magnetic activity.

Article 3

Longitudinal Variability of Ionospheric TEC Depletions over South America

Hisao Takahashi

Hisao Takahashi[1], Ricardo Y.C. Cueva[1], Eurico R. de Paula[1], and Cesar E. Valladares[2]
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2. Institute for Scientific Research, Boston College, USA

CAWSES II TG 4 longitudinal network (LONET) campaign has been carried out during the September-November period, the first one in 2010 and the second one in 2011. We thank all of the participants who have given special attention to collect the data from ionosondes, magnetometers, GNSS receivers, radars and optical instruments. Campaign metadata sheets of 2010 are already available and those of 2011 are in preparation.
In this short report, we would like to present recent results on the longitudinal and day to day variability of the total electron content (TEC) depletions over the South America. The data presented, January 2010, are not exactly corresponding to the campaign period. However, longitudinal variability of plasma depletion is one of our main subjects to investigate. Therefore we believe that the information presented here would help CAWSES TG 4 participants to evaluate their data and compare with the other data.

In order to find out plasma depletions over the South America, the data collected by four GPS networks over the continent were used: those are LISN (Low latitude ionospheric Sensor Network), OSU-CAP (Ohio State University Central and Southern Andes GPS Project), SIRGAS (Geocentric Reference System for the Americas) and IGS (International GNSS Service), in a total of 127 stations. In Figure 1 the observation sites are plotted. Figure 2 presents a map of distribution of the TEC depletion in the night of January 28-29 and 29-30, 2010. In order to identify the plasma depletion from the observed TEC variations, depletion amplitudes larger than 1 TEC unit ($10^{16}/m^2$) and its time interval between 10 and 120 minutes were selected. The data analysis procedure was similar to that has been reported by Seemala and Valladares (Radio Science, 46, 2011).

The plasma depletion map of January 28-29, 2010 (Fig. 2, left panel) displays two distinct areas of the depletion activity, one over the western coast of Chile and the other over the north eastern side of Brazil. Much less activity or even no activity over the central part of South America can be seen. In the next day (January 29-30, 2010), on the other hand, the active areas rather spread out over the continent. This sort of longitudinal and day to day variability of the TEC depletions strongly suggests longitudinal dependence of the seeding process and developing conditions of the plasma irregularities, such as plasma bubbles and gravity waves. It would be very interesting to compare these results with the other longitudes, over Africa, Indian and Indonesian sides.

Acknowlegements: The GPS data presented in this note have been collected by LISN, OSU-CAP, SIRGAS and IGS networks.

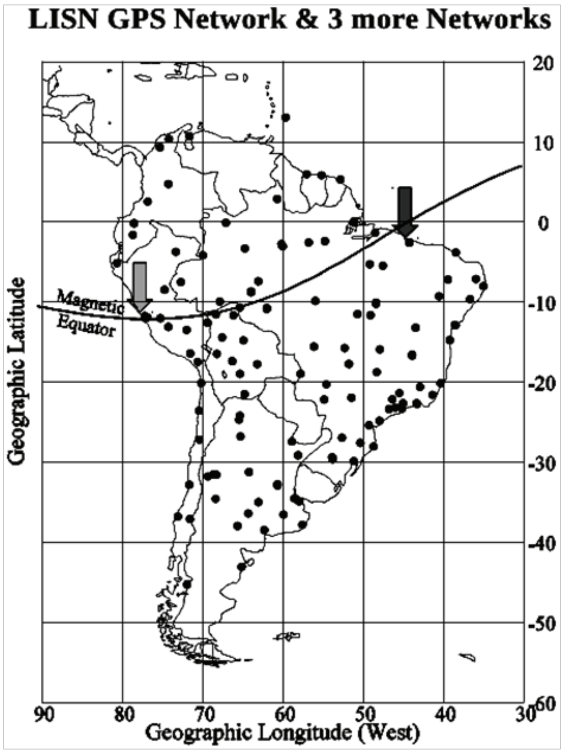


Figure 1: LISN and 3 more GNSS Network sites. The arrows are indicating the Jicamarca and São Luís digisonde locations.

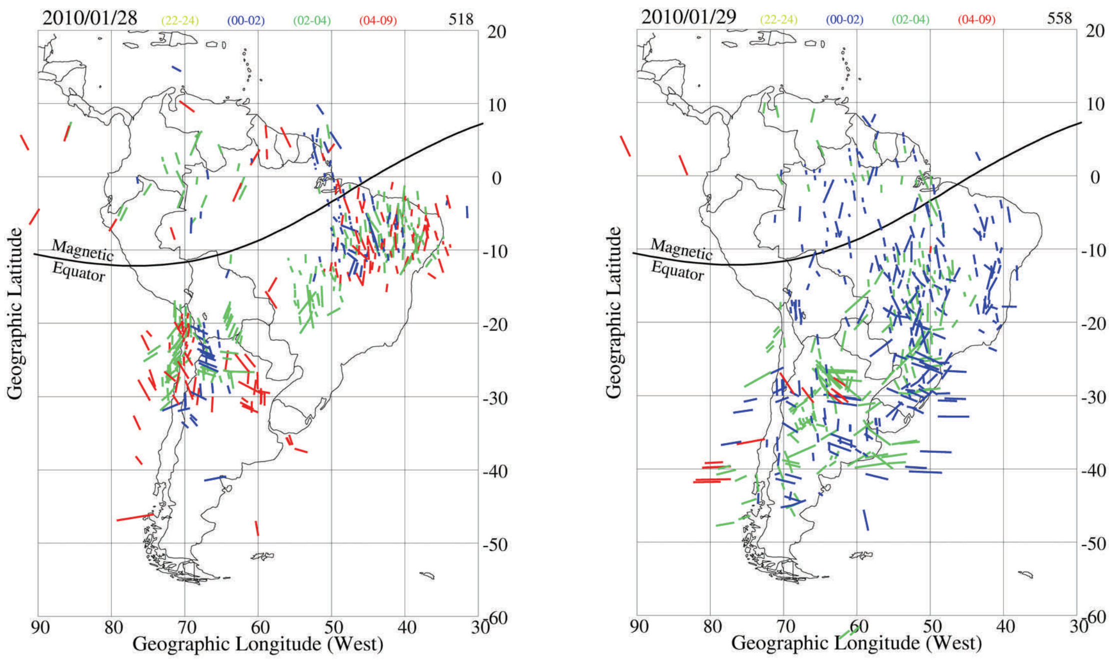


Figure 2. TEC depletions (color bars) observed over South America in the night of January 28-29, 2010 (left panel) and January 29-30, 2010 (right panel). Different color bars indicate different time zones: 22-24 UT (light green), 00-02 UT (blue), 02-04 UT (green) and 04-09 UT (red).

Article 4

The 10th Workshop on Layered Phenomena in the Mesopause Region Highlights Major Advances in Understanding Mesospheric Ice Layers

Scott Bailey [1], James Russell [2], Matthew DeLand [3], Brentha Thurairajah [1], Wayne Scales [1], and Franz-Josef Luebken[4]
1. Virginia Tech, 2. Hampton University, 3. SSAI, 4. Leibniz Institute of Atmospheric Physics

The 10th Layered Phenomena in the Mesopause Region workshop was held on October 24-27, 2011 on the campus of Virginia Tech University in Blacksburg, Virginia. The LPMR workshops have been held each two to three years over the last three decades, alternating between US and European locations. Their goal is to advance our understanding of ice layers in the region of the mesopause and the environment in which they form. Researchers from all perspectives participated, including those doing ground-based, rocket and satellite measurements, laboratory and modeling studies, and theoretical investigations of mesospheric ice phenomena and their coupled dynamical, radiative, chemical, and plasma environment. 40 participants enjoyed the comfortable, informal and collaborative environment that is

Figure 2. The participants of the 10th LPMR Workshop at Virginia Tech. Not shown are James M. Russell III and invited keynote speaker John J. Olivero.

a hallmark of the LPMR workshops. Support was provided by SCOSTEP, the International Committee on the Middle Atmosphere (ICMA), NASA, and Virginia Tech.

Mesospheric ice layers (or clouds) appear at high latitudes in the summertime, and have received increasing attention over the last several decades due to evidence that their numbers and brightness are increasing, and the ensuing debate over whether these increases are related to rising levels of greenhouse gases in the atmosphere or for other reasons. This growing interest has led to major advances in understanding which are reflected in the progress discussed at the 2011 LPMR workshop. New radar and lidar facilities in Antarctica promise to be a valuable resource for observational studies. New satellite data sets and innovative data analysis techniques were also discussed, such as tomographic imaging and coordinated observations with airplanes. Modeling studies have provided significant advances regarding the microphysical nature of the clouds, the role of dynamics - especially gravity waves, and insight about long-term trends in the clouds.

Models are now able to simulate the long-term increase observed by satellites in cloud occurrence frequency and brightness, and they suggest that while mesopause temperatures do not appear to have a significant trend in recent decades, the compression of the upper atmosphere due to overall cooling impacts water vapor so as to yield more and brighter clouds. However, other studies of observed short- and long-term variability in the clouds suggest that temperature controls many aspects of their seasonal behavior. An interesting connection is observed between ice in the summer mesosphere and temperatures in the winter stratosphere. Strong evidence also suggests that water vapor exhausted from the space shuttle engines during launch can, on some occasions, lead to increases in mesospheric ice. The impact of this result on long-term trends is not yet clear.

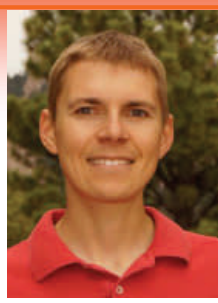
An important outcome of the workshop is the formation of six sub-working groups to pursue focused areas where further work is needed. The topics are: unifying the many data sets; understanding observations of ice particle size distributions; the role of small scale forcing such as gravity waves and turbulence; the role of tides and local time variability; the role of metal layers and surface chemistry; and global connections.

A special issue of the Journal for Atmospheric and Solar Terrestrial Physics has been proposed to publish results from the workshop. The next LPMR workshop is planned for summer 2013 at the University of Leeds, England.

Highlights on Young Scientists

Short-Term Variability in the Longitude Structure of the Mesosphere and Lower Thermosphere

Nicholas Pedatella
High Altitude Observatory, National Center for Atmospheric Research



Nicholas Pedatella

Vertically propagating waves of lower atmospheric origin can significantly impact the ionosphere and thermosphere. It is therefore vital to develop a comprehensive understanding of these waves in the mesosphere and lower thermosphere (MLT), where they achieve large amplitudes and influence the generation of electric fields. The characteristics of tides in the MLT are well studied on seasonal scales. However, comparatively little is known about day-to - day tidal variability in the MLT.

Recently, my research has focused on understanding these short-term variations. Figure 1 presents an example of SABER temperature observations during a strong quasi-two day wave (QTDW) event, along with the contribution due to the QTDW, nonmigrating tides, and waves due to QTDW-tide nonlinear interaction. The longitude variability is clearly a combination of several waves, and, furthermore daily changes will occur due to

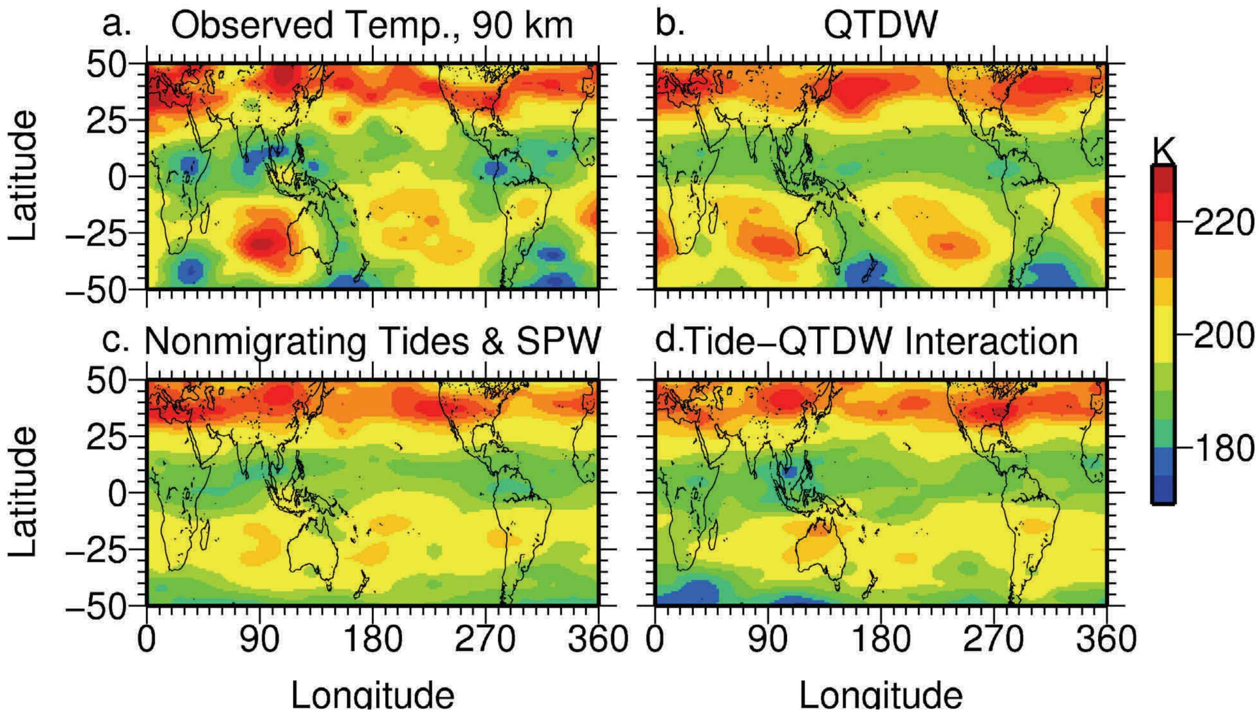


Figure 1. Average latitude and longitude temperature variations at 90 km. for odd numbered days from 17-25 January 2006. Only odd days are used to capture one cycle of the QTDW. The individual panels correspond to: (a) SABER observed temperature, (b) the contribution from the QTDW, (c) the contribution from nonmigrating tides and stationary planetary waves, and (d) the contribution from the QTDW-- ‑ tide nonlinear interaction. (After Pedatella and Forbes [2011, *Journal of Geophysical Research*, in press.])

the QTDW. Short-term variability can also be studied using numerical models. By forcing the NCAR Thermosphere-Ionosphere ‑ Mesosphere-Electrodynamics General Circulation Model (TIME-GCM) lower boundary with a six ‑ day wave as well as migrating and nonmigrating tides, the model produces short ‑ term variations in the diurnal migrating tide (DW1) and diurnal eastward propagating wavenumber-3 nonmigrating tide (DE3) as can be seen in Figure 2. These variations, along with those in Figure 1, can subsequently drive short-term variability in ionospheric longitude structures. The emphasis to- date has primarily been on understanding nonmigrating tides in the MLT along with their ionospheric impact on seasonal scales. It is clear that short-term variability also occurs, and it is important to develop a thorough understanding of these day ‑ to ‑ day variations.

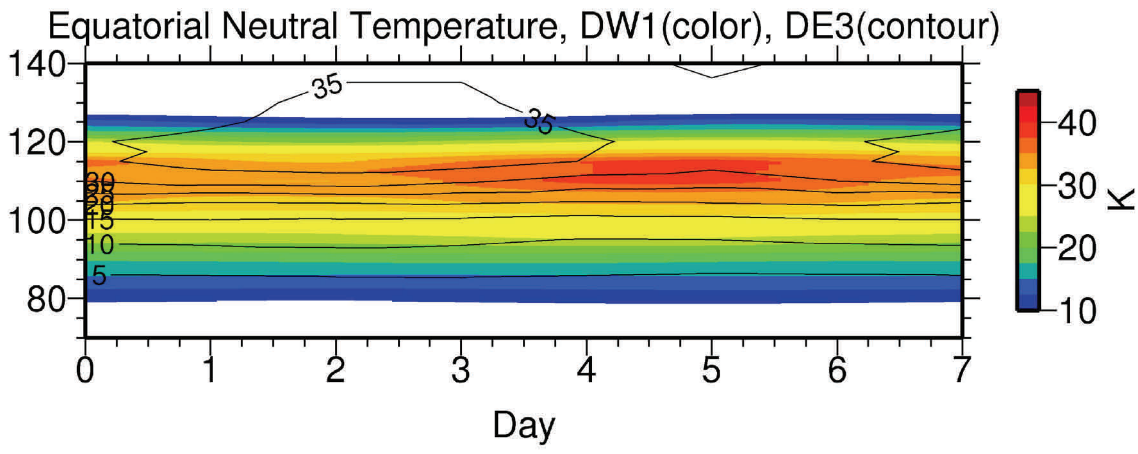


Figure 2: TIME ‑ GCM simulated equatorial neutral temperature variations for DW1 and DE3. The model lower boundary was forced with a six ‑ day westward wavenumber-1 planetary wave, which generates a six ‑ day periodicity in the tides.

Short News 1

2012 – Session C2.2: Whole Atmosphere Wave Coupling and Interaction Processes

Jens Oberheide
Clemson University, SC, USA

This symposium focuses on troposphere to ionosphere multi-scale wave coupling processes. New measurements, modeling results and analysis techniques are encouraged, including electrodynamic and chemical studies. We also invite contributions from CAWSES-II/TG4 ("What is the geospace response to variable inputs from the lower atmosphere?") activities. In particular, studies in the following areas are most welcome.

1. Global structure, variability and sources of GW, PW and tides.
2. Secondary wave generation, propagation and their effects on the neutral and ionized atmosphere.
3. Neutral-ionosphere coupling processes.
4. Ionosphere-Thermosphere-Mesosphere response to lower and middle atmosphere variability.
5. Polar dynamics and coupling to lower latitudes.

Organizing Committee:
Jens Oberheide (Clemson University, MSO), Takuji Nakamura (NIPR, DSO), Damian Murphy (Australian Antarctic Division), Hisao Takahashi (INPE), Mike Taylor (Utah State University), Jiyao Xu (Chinese Academy of Sciences), S. Gurubaran (Indian Institute of Geomagnetism, Erdal Yigit (University of Michigan)

Abstract Deadline: 10 February 2012

Duration: 3 full days

Location: Mysore, India, 14-22 July 2012

Contact: Jens Oberheide (joberhe_at_clemson.edu)

Short News 2

TG4 Business Meeting at COSPAR

Jens Oberheide
Clemson University, SC, USA

A TG4 Business Meeting will be held during the COSPAR meeting. Time and location will be announced before the conference via TG4 email. All TG4 members and interested colleagues are invited to attend.

Upcoming meetings related to CAWSES-II TG4

Conference	Date	Location	Contact Information
ISEA-13	Mar. 12-17, 2012	Paracas, Peru	http://jro.igp.gob.pe/isea13/
13th international workshop on technical and scientific aspects of MST radars	Mar. 19-23, 2012	Kuehlungsborn, Germany	http://www.iap-kborn.de/MST13/
39th COSPAR Scientific Assembly	Jul. 14-22, 2012	Mysore, India	http://www.cospar-assembly.org
CAWSES-II2013 Symposium	Nov 18-22, 2013	Nagoya, Japan	

The purpose of this newsletter is to make more communications among scientists related to the CAWSES-II Task Group 4 (particularly between those of the atmosphere and the ionosphere). **The editors would like to invite you to submit the following articles to the TG4 newsletter.**

Our newsletter has four categories of the articles:

1. Articles— ~500 words and four figures (maximum)
   on campaign, ground observations, satellite observations, modeling, workshop/conference/symposium report, etc
2. Highlights on young scientists— ~200 words and two figures
   on the young scientist's own work related to CAWSES-TG4
3. Short news— ~100 words
   announcements of campaign, workshop, etc
4. List of planned workshop

Category 2 (Highlights on young scientists) helps both young scientists and TG4 members to know each other. Please contact the editors for recommendation of young scientists who are willing to write an article on this category.

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