



TC4 Newsletter Vol. 11, April 2013

Inside this Issue

Article 1: Imaging observation of the Earth's upper atmosphere by ISS-IMAP.....	1
Article 2: Gravity Wave Modeling in the Mesosphere, Thermosphere and Ionosphere...	3
Highlights on Young Scientists: Airglow imaging of mesospheric and ionospheric dynamics.....	5
Short news: International CAWSES-II Symposium, abstract submission started.....	6
List of upcoming meetings.....	6

Article 1

Imaging observation of the Earth's upper atmosphere from the international space station by ISS-IMAP

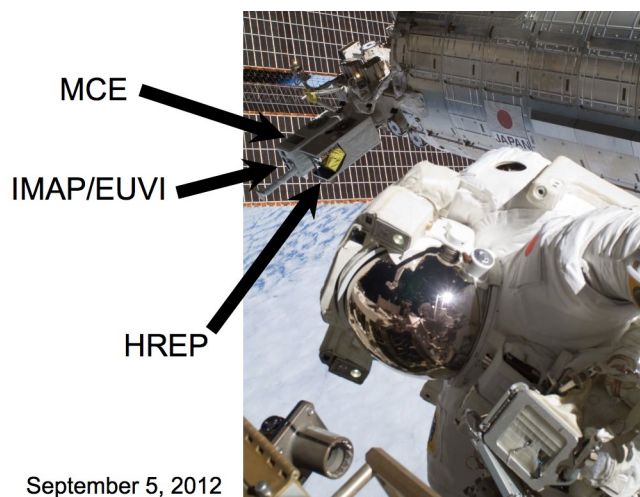
Akinori Saito¹, Atsushi Yamazaki², Takeshi Sakanoi³, Ichiro Yoshikawa⁴, Mamoru Yamamoto¹, Takumi Abe², Makato Suzuki², Yuichi Otsuka⁵, Hitoshi Fujiwara⁶, Makoto Taguchi⁷, Takuji Nakamura⁸, Mitsumu K Ejiri⁸, Kikuchi Masayuki⁸, Hideaki Kawano⁹, Huixin Liu⁹, Kazuyo Sakanoi¹⁰, Mamoru Ishii¹¹, Minoru Kubota¹¹, Takuya Tsugawa¹¹, Kazuaki Hoshino¹²



Akinori Saito

1. Department of Geophysics, Kyoto University, Kyoto, Japan. 2. JAXA/ISAS, Sagami-hara, Japan. 3. Tohoku University, Sendai, Japan. 4. University of Tokyo, Tokyo, Japan. 5. Nagoya University, Nagoya, Japan. 6. Seikei University, Tokyo, Japan. 7. Rikkyo University, Tokyo, Japan. 8. NIPR, Tokyo, Japan. 9. Kyusyu University, Fukuoka, Japan. 10. Komazawa University, Tokyo, Japan. 11. NICT, Tokyo, Japan. 12. ENRI, Tokyo, Japan.

Observation of the ISS-IMAP (Ionosphere, Mesosphere, upper Atmosphere, and Plasmasphere mapping) mission was commenced in October 2012 after its initial check out. ISS-IMAP is a space-borne mission to elucidate the mesoscale structures in the ionosphere, the mesosphere, and the plasmasphere by imaging observations. It consists of two imaging instruments on the Exposed Facility of Japanese Experiment Module of the International Space Station (EF of ISS-JEM). One of the imagers is VISible-light and Infrared spectrum imager (VISI) that observes the airglow in 730nm (OH, Alt. 85km), 762nm (O₂, Alt 95km), and 630nm(O, Alt.250km) in the nadir direction. The other imager is Extra UltraViolet Imager (EUVI) that observe the resonant scattering of 30.4nm (He⁺) and 83.4nm (O⁺) in the limb direction. The objective of this mission is to clarify the energy transport process by the structures whose horizontal scale is 50-500km in the Earth's upper atmosphere, and the effect of the structures and disturbances on the space-borne systems. ISS-IMAP will measure the following three parameters in the lower latitude region than 51 degrees in



September 5, 2012

Figure 1. Multi-mission Consolidated Equipment (MCE) that contains ISS/IMAP imagers is attached on the exposed-facility of Japanese experimental modules, KIBO, of the international space station. The black flaps of IMAP/EUVI can be seen on the side of MCE. HREP by NASA is next to MCE. Photo Courtesy of the Image Science & Analysis Laboratory, NASA Johnson Space Center <http://eol.jsc.nasa.gov/>

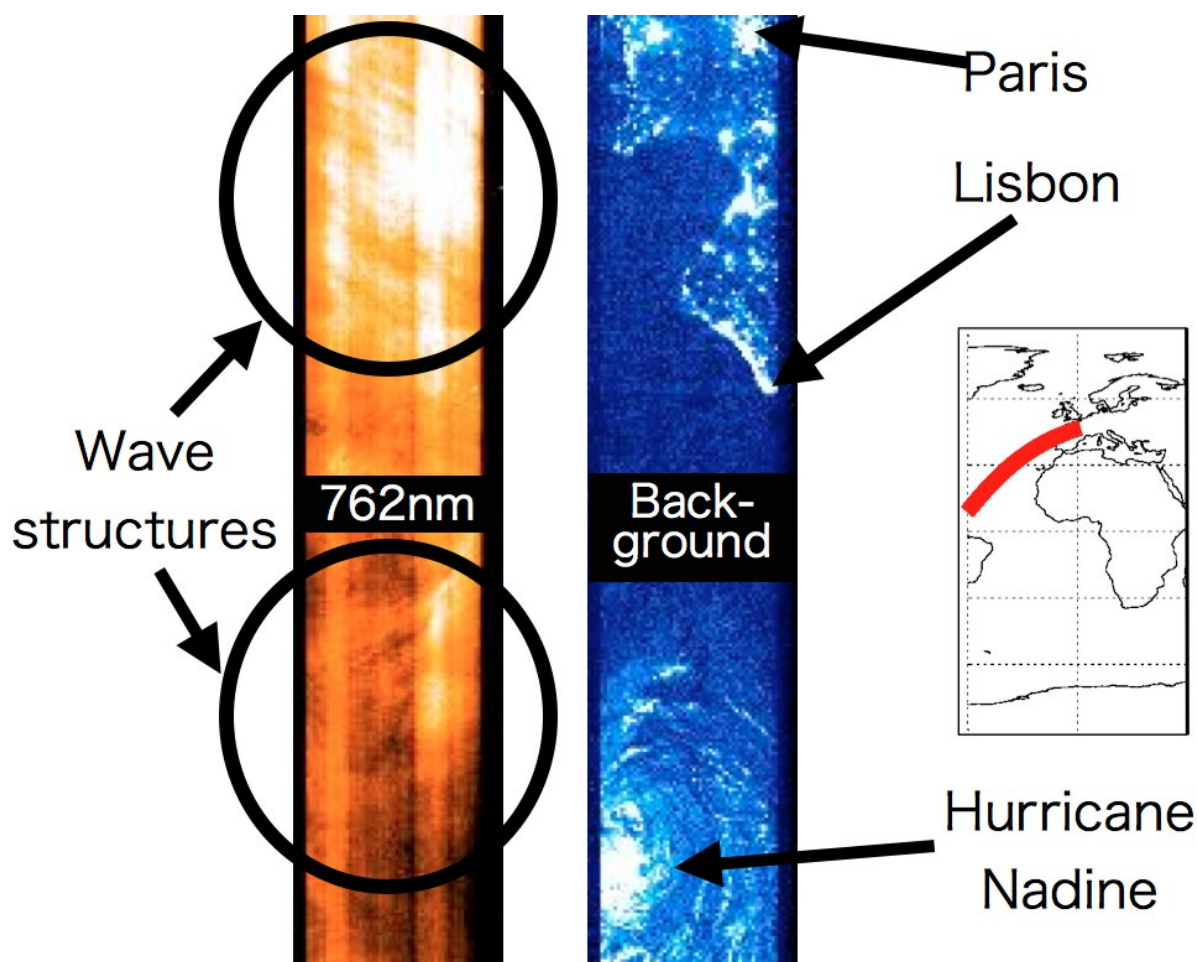


Figure 2. VISI observation during the initial check out on September 25, 2012. 762nm emission (Left), background continuum emission (Middle), and the ISS orbit (Right).

geographic: (1) distribution of the atmospheric gravity waves in the mesosphere and the lower thermosphere, (2) distribution of the ionized atmosphere in the ionospheric F-region, (3) distribution of O⁺ and He⁺ ions in the ionosphere and plasmasphere.

Figure 1 is a picture of the ISS-IMAP instruments on ISS. VISI and EUVI are installed in the Multi-mission Consolidated Equipment (MCE) that is a unit containing five missions including ISS-IMAP and GLIMS, a lightning and TLE observation. It is attached on EF of ISS-JEM. The apertures of EUVI direct the backward of ISS, and the apertures of VISI are on the bottom side of MCE. Observed data of VISI during the initial check out on September 25, 2012 is shown in Figure 2. The left hand side panel shows the observation of the emission in 762nm, and the middle panel shows the background continuum emission. In the background, the back scattering of the moon light from clouds is seen. During this observation ISS flew over hurricane

Nadine on the Atlantic Ocean. The orbit of ISS during this observation is shown on the right hand side. City lights of Europe are also seen in the top portion of the background continuum emission. In 762nm, the city lights and the backscatter of the moonlight were not detected because of the absorption by the atmosphere in this wavelength. The structures that are seen in 762nm are the structures of the airglow around 95 km altitude. Several wave structures are captured in this observation, and they would be caused by the atmospheric gravity waves. The stripes along the ISS trajectory are caused by the difference of sensitivity among the observational bins. Now we calibrate the data. The other observations of VISI and EUVI also function properly. The planned period of the observation is three years. Conjugate observation with ground-based networks is crucial, and comparison with models is also important. After calibration of the data, we will provide the data for the collaborative studies.

Article 2

Gravity Wave Modeling in the Mesosphere, Thermosphere and Ionosphere

Michael P. Hickey

Department of Physical Sciences, Embry-Riddle Aeronautical University, Daytona Beach, Florida, USA



Micheal P. Hickey

Acoustic-gravity (AGWs) waves are ubiquitous features of Earth's (and other) atmospheres. One of the most remarkable features of these waves is their ability to transport energy and momentum over considerable vertical distances. The fact that atmospheric density decreases with increasing height leads to a general considerable increase of wave amplitude for upward propagating waves, meaning that waves of lower atmospheric origin can have profound influences on the overlying atmosphere.

Rapid motions of air with associated compressions tend to produce a spectrum dominated by fast moving acoustic waves having large vertical wavelengths which consequently do not become convectively unstable as they propagate upward. These fast waves can survive the effects of winds (critical levels) and may propagate well into the thermosphere before being viscously dissipated. Slower motions of tropospheric air, such as those due to wind flow over topography, tend

to produce a spectrum dominated by slower moving gravity waves having fairly short vertical wavelengths. Some of these may become convectively unstable as their amplitudes grow with increasing height or they may be absorbed at critical levels by mean winds. The surviving GWs may be observed in the mesosphere (often in airglow observations), and faster gravity waves can propagate into the thermosphere/ionosphere system before being viscously dissipated.

Fast GWs (phase speeds ~ 200 m/s) capable of reaching the thermosphere can be produced by tsunamis (Artru et al., 2005). Based on inferred source amplitudes, the spectral full-wave modeling of the author suggests that the GWs can achieve velocity and temperature amplitudes of several tens of m/s and K, respectively (see Figure 1). The resulting electron density perturbations (Figure 2, left panel) can also be large ($\sim 50\%$), especially for GWs propagating in the meridional direction at mid-latitudes, collisionally driving ions (and elec-

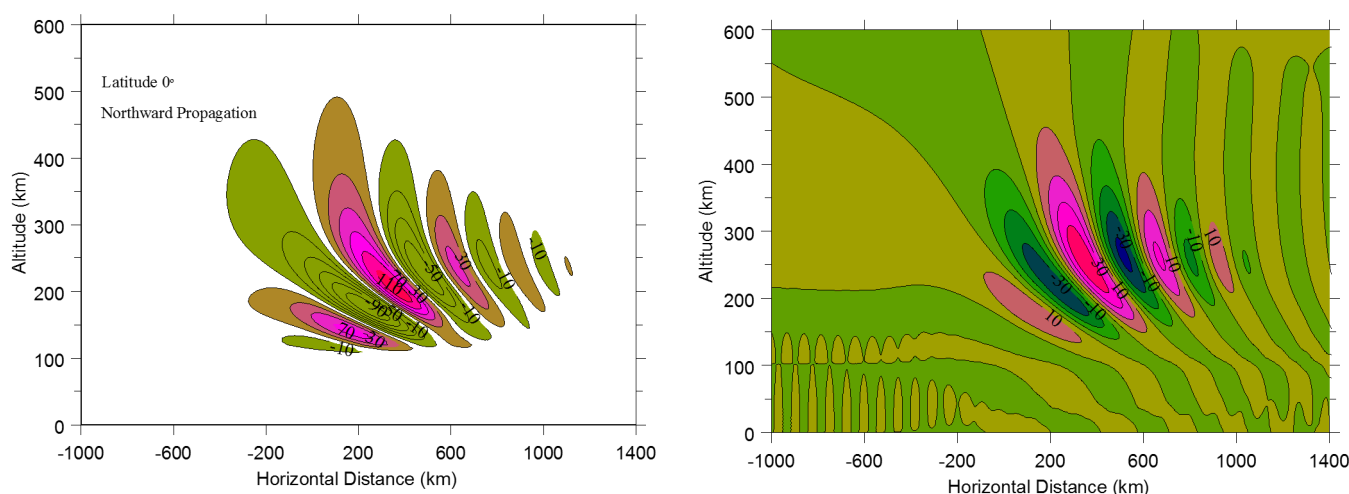


Figure 1. Thermospheric response to a tsunami-driven gravity wave disturbance. Temperature perturbations (in K, left panel) and vertical velocity fluctuations (in m/s, right panel) are large, achieving maximum values of approximately 130 K and 30 m/s, respectively. [After Hickey et al., 2009, 2010]

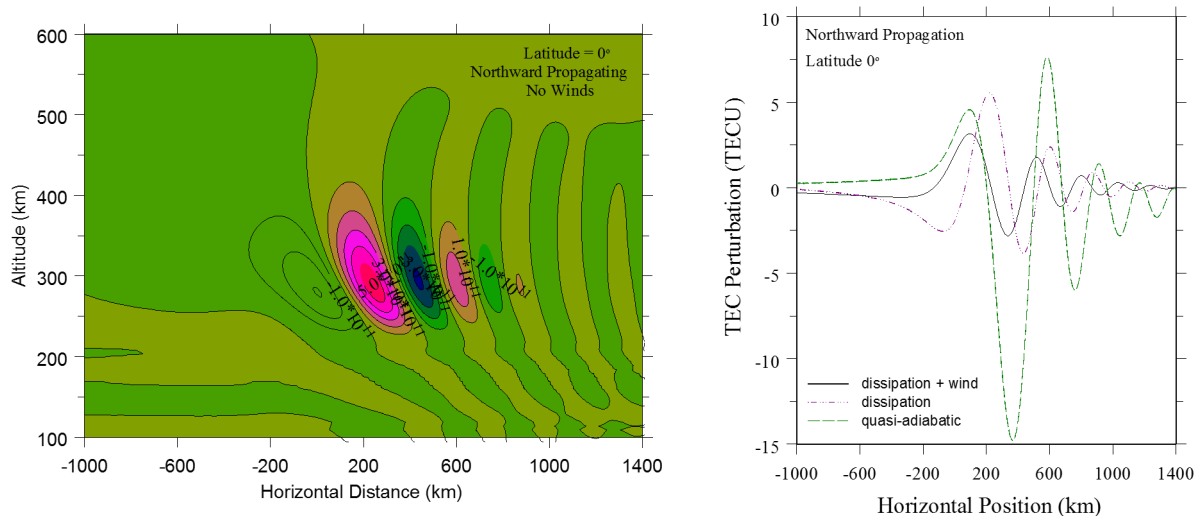


Figure 2. Electron density (left) and total electron content (right panel) fluctuations due to the tsunami-driven gravity wave shown in Figure 1. [After Hickey et al., 2009]

trons) upward along magnetic field lines. The associated fluctuations of the total electron content (TEC) can also be large (Figure 2, right panel). Such ionospheric disturbances having the expected characteristics of tsunami-driven gravity waves have been observed following tsunamis using GPS observations of inferred TEC (Galvin et al., 2012; Komjathy et al., 2012). Simulations also predict that tsunami-driven GWs will impact the airglow (Hickey et al., 2010a), including the mesospheric OH emission (Figure 3, left panel), which has subsequently been verified by observation (Makela et al., 2011), and the OI 6300 thermospheric emission (Figure 3, right panel), which has yet to be verified observationally.

Earthquakes leading to tsunami production may also produce Rayleigh waves that effectively produce acoustic waves in the atmosphere, which are also observed in the ionosphere (Rolland et al., 2011). Radar observations of the ionosphere often reveal variations of acoustic (infrasound) periods (Crowley et al., 2012), which are sometimes associated with hurricanes (Vadas and Crowley, 2010). More modeling is required to better understand these sources, ionospheric interactions, and to infer the impact of wave dissipation on the mean state (Hickey et al., 2010b).

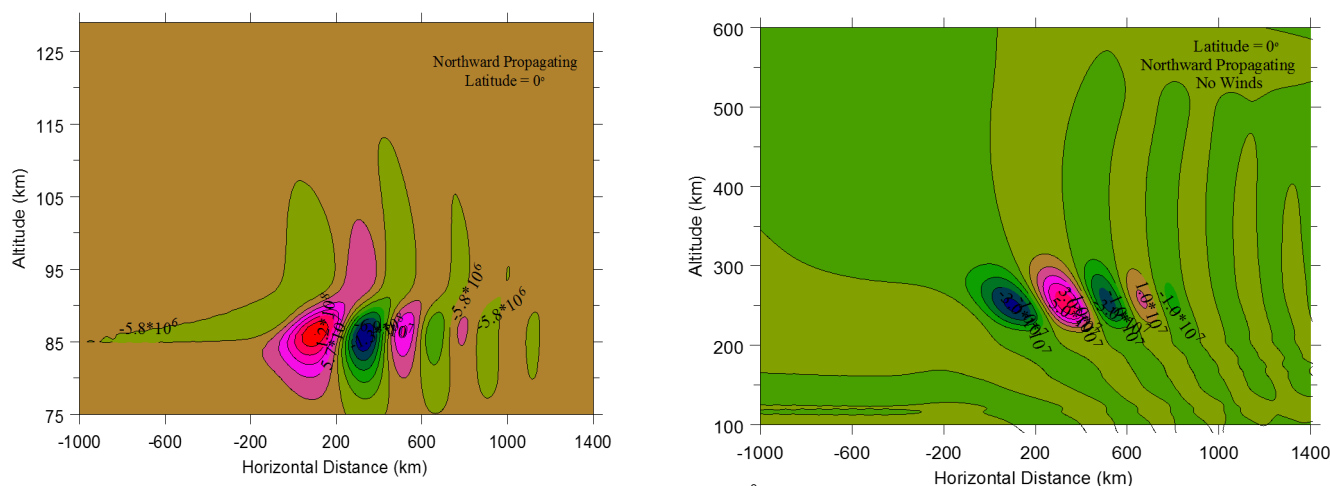


Figure 3. OH volume emission rate (left panel) and OI 6300Å volume emission rate (right panel) fluctuations due to the tsunami-driven gravity wave disturbance shown in Figure 1. [after Hickey et al., 2010]

Highlights on Young Scientists

Airglow imaging of mesospheric and ionospheric dynamics

Viswanathan Lakshmi Narayanan

Equatorial Geophysical Research Laboratory,
Indian Institute of Geomagnetism, Tirunelveli, India.



Viswanathan L. Narayanan

My research focuses on small-scale dynamical events occurring in the upper mesosphere and large-scale plasma processes occurring in the nocturnal ionosphere. I work primarily with all-sky imaging of nightglow emissions observed over Indian region. Figure 1 shows images of different types of phenomena studied by me. For detailed investigations of the high frequency gravity waves, instabilities and bore-like fronts occurring in the mesosphere, complementary wind information obtained from MF radars and temperature measurements made by SABER/TIMED instrument are often used. To study the ionospheric phe-

nomena like equatorial plasma bubbles (EPBs) and EIA reverse fountain, ionosonde observations are often utilized along with airglow images.

The following are some of the interesting recent results: High frequency gravity wave characteristics over South India during all the seasons were studied for the first time using OH imaging. The study highlighted the role of oppositely directed background winds in causing wave reflections and evanescence for short horizontal wavelength waves (Figure 2). Recently, role of large scale wavelike structures (LSWS) in triggering of the EPBs is gaining wider attention. One of our case

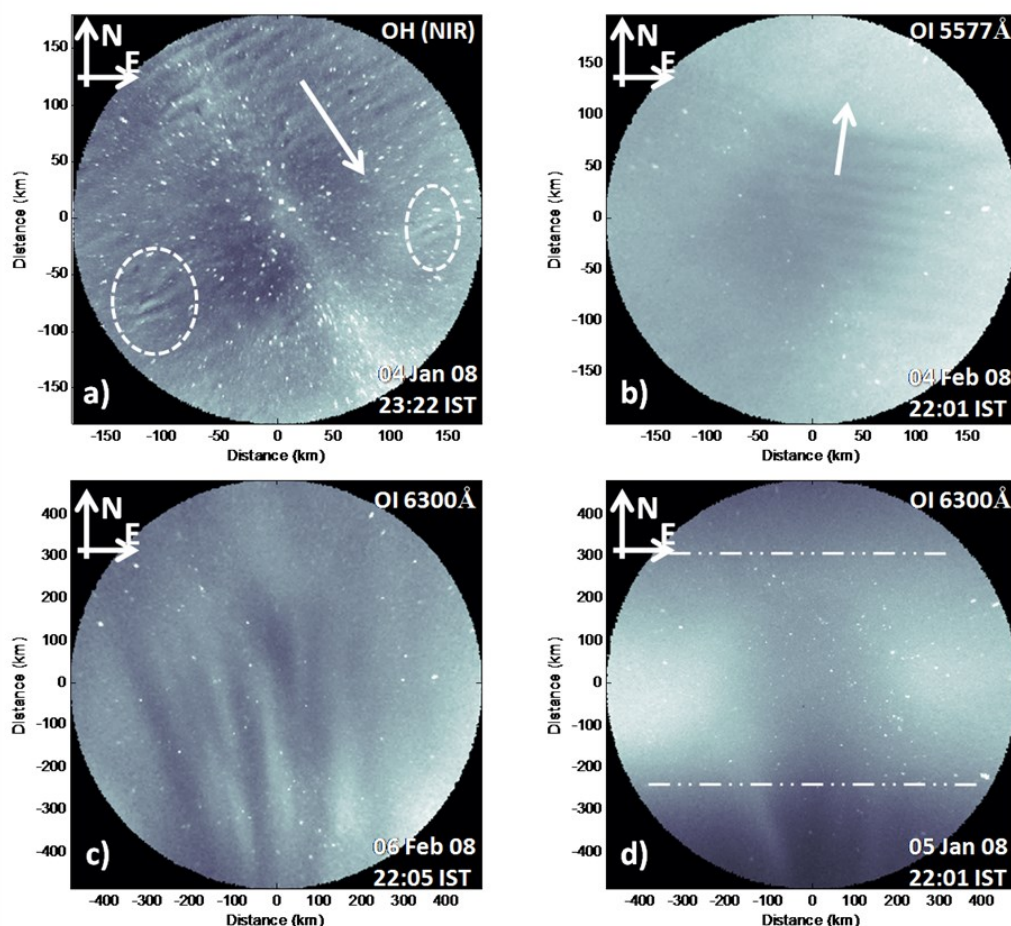
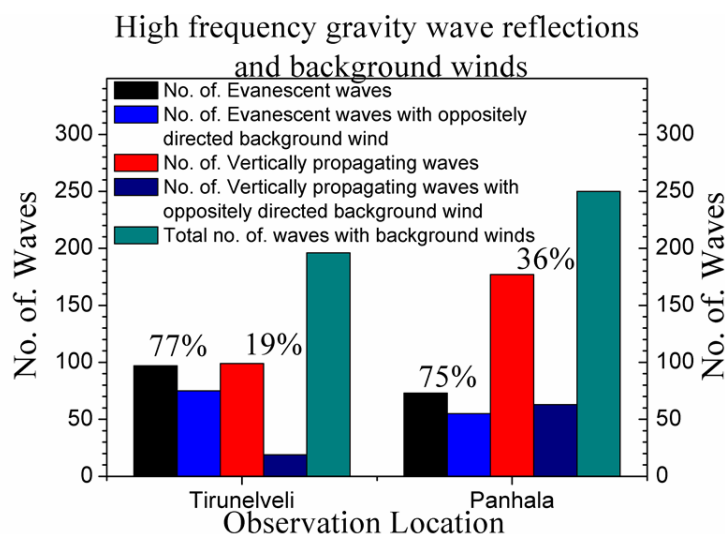


Figure 1. Examples for different types of phenomena observed in airglow imaging. Raw images obtained from Panhala (16.8oN; 74.1oE; 11.1oN dip) are projected on equidistance grid at respective airglow heights. a) Shows high frequency gravity waves whose propagation direction is shown by the arrow and the ellipses highlight instability features called ripples, b) mesospheric bore with a clear intensity separation, c) plasma depletions associated with EPBs, d) crest of EIA seen as enhanced airglow band within the dash-dot lines.

studies has illustrated that mere presence of LSWS do not always trigger EPBs whereas combination of two wave modes appear to trigger EPBs more efficiently. Our further analysis implies that though LSWS and post sunset rise of bottomside ionosphere play important roles in the generation of EPBs, they alone are not sufficient enough to account for the day-to-day variability of the EPBs.

(Right) Figure 2. Observations of vertically propagating and evanescent waves along with those propagating against the mean flow. The plot indicates that oppositely directed background winds Doppler shift intrinsic wave frequencies beyond local buoyancy frequency thereby bringing about wave reflections. This effect will not be significant for waves with horizontal wavelengths $> \sim 50$ km.



Short News

International CAWSES-II Symposium

(Nov.18-22, 2013, Nagoya), abstract submission started

Kazuo Shiokawa

The abstract submission page has now been opened for the International CAWSES-II Symposium which will be held on November 18-22, 2013, at Nagoya, Japan.

<http://www.stelab.nagoya-u.ac.jp/cawses2013/>

This International CAWSES-II Symposium hosted by SCOSTEP will provide an excellent opportunity to discuss the scientific accomplishments of CAWSES-II and look forward to SCOSTEP's future programs at a moment toward the end of its five-year period.

Deadlines:

Abstract submission deadline: June 30, 2013

Financial support request deadline: June 30, 2013

Early registration deadline: 24:00 (UT) on August 31, 2013

Session structures:

Tutorial Lectures

Panel 1: Long time change/trend of the sun-earth system

Panel 2: Variability of the sun-earth system

Panel 3: Beyond the CAWSES-II

SS-1: Solar Influences on Earth's Climate

SS-2: Geospace Response to Altered Climate

SS-3: Short-term Solar Variability and Geospace

SS-4: Geospace Response to Lower Atmospheric Waves

SS-5: eScience and Informatics Successes and Challenges for CAWSES-II

Upcoming meetings related to CAWSES-II TG4

Conference	Date	Location	Contact Information
Workshop on Whole Atmosphere Coupling during Solar Cycle 24,	July 14-17, 2013	Jhongli, Taiwan	http://www.ss.ncu.edu.tw/~watm24/
12th Scientific Assembly of IAGA	Aug. 26-31, 2013	Yucatan, Mexico	http://www.iaga2013.org.mx/
First COSPAR Symposium 2013	Nov. 11-15, 2013	Bangkok, Thailand	http://www.cospar2013.gistda.or.th/
International CAWSES-II Symposium	Nov. 18-22, 2013	Nagoya, Japan	http://www.stelab.nagoya-u.ac.jp/cawses2013/

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.

Editors: Michi Nishioka (nishioka_at_nict.go.jp)
Kazuo Shiokawa (shiokawa_at_stelab.nagoya-u.ac.jp)
Solar-Terrestrial Environment Laboratory, Nagoya University
Tel +81-52-747-6419, Fax +81-52-747-6323
This newsletter is also available on the web at
http://www.cawses.org/wiki/index.php/Task_4