TG4 Newsletter Vol. 4, March 2011

Inside this Issue

Article 1: The equatorial Electrojet : a tool for sensing tidal effects …..…… 1
Article 2: Middle and upper atmosphere research in the State key Lab of Space Weather of China……..……….. 2
Article 3: 4th IAGA/ICMA/CAWSES-II TG4 Workshop on Vertical Coupling in the Atmosphere/ionosphere system…..……… 4
Highlights on Young Scientists: Thermospheric effects of lower atmospheric small-scale gravity waves …………… 6
Short News 1: Tidal Campaign…...……..…….………………………………… 7
Short News 2: Call for nominations for the 2011 S&S Basu award……….. 7
List of upcoming meetings…………………………………...……….……… 8

Article 1

The equatorial electrojet: A tool for sensing tidal effects

Hermann Lühr
GFZ, German Research Centre for Geosciences, Potsdam, Germany

Hermann Lühr

The equatorial electrojet (EEJ) is an intense current in the ionosphere confined to a narrow latitude range along the dip-equator. Although it has been studied for many decades, only satellite measurements from Ørsted, CHAMP, and SAC-C advanced our understanding considerably. The actual global picture of the EEJ was provided for the first time by the empirical model EEJM-1 and lately the improved EEJM-2 model (for details see http://www.geomag.us/models/EEJ.html and Alken and Maus (JGR 2008)). From this model the actual longitudinal current density distribution emerged, and it highlighted the distinct seasonal dependence. A prominent feature is the four-peaked longitudinal structure showing up during the months around August, which is attributed to non-migrating tidal effects.

Figure 1 shows in the upper panel the average EEJ current density distribution for noon-time conditions, as derived from CHAMP measurements. There is an outstanding ribbon of strong eastward current flowing along the dip-equator. In the lower panel the average EEJ intensity for the month of September is shown in a longitude versus local time frame. In that diagram four intensity peaks are clearly outstanding. They are well separated by 90° in longitude. Lühr et al. (JGR 2008) had identified that longitudinal pattern as caused by the

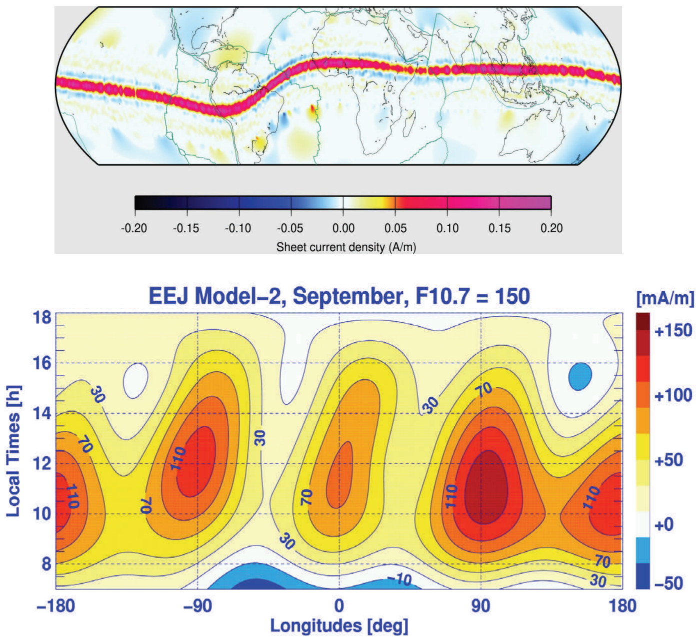

Figure 1. Current density distribution of the equatorial electrojet (EEJ). Top: Location of the eastward current channel. Bottom: Average current density distribution during September.

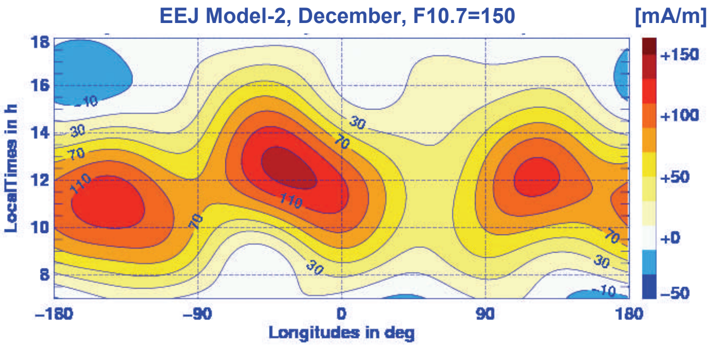

Figure 2. Longitudinal distribution of EEJ intensity during December.

non-migrating diurnal eastward propagating tide with zonal wavenumber-3, in short DE3. Such a prominent four-peaked longitudinal pattern can, however, only be found in the EEJ during the months July, August, September. At other seasons, e.g. December solstice, the longitudinal distribution of the EEJ intensity is quite different (see Fig. 2).

In the meantime it is generally accepted that the DE3 tidal mode is excited by deep tropical convection in the troposphere. The EEJ thus provides an opportunity to monitor certain meteorological phenomena. Of particular interest might be to track the day-to-day variability of DE3 intensity. However, this is not possible from satellite measurements. Here magnetic observatories at the dip-equator may help with their continuous recordings. Now that we know the global signature of the DE3 tidal wave in the EEJ, information about the tides can be extracted from ground-based measurements. From Figure 1 we can deduce that at certain longitudes large diurnal variations occur, e.g. 90°W and 90°E. At other longitudes, e.g. 50°W and 40°E, the change of the EEJ intensity over a day is much smaller. This difference in diurnal variation is attributed primarily to the effect of the DE3 tidal wave.

Here we recommend making use of EEJ recordings from suitably located observatories for monitoring the variability of the DE3 effect on the ionosphere. The azimuthal gradient of the diurnal variation derived from the horizontal component, H, can be used for determining the tidal wave amplitude. According to Figure 1, examples for suitable station pairs might be: Huancayo – east coast of Brazil, Ivory Coast – Addis Ababa, India – Vietnam. The proposed DE3 monitoring is expected to work well during the months around August. At other seasons (see December in Fig. 2) dominant longitudinal structures show up at other locations. Never the less, the DE3 tidal forcing of the ionosphere is an important driver for many phenomena. Therefore, a continuous monitoring of the DE3 intensity through the EEJ can be regarded as a valuable contribution to the Task Group 4 activities.

Article 2

Middle and upper atmosphere research in the State key Lab of Space Weather of China

Jiyao Xu
State Key Laboratory of Space Weather, Center for Space Science and Applied research, Chinese Academy of Sciences, Beijing, China.

Jiyao Xu

The State Key Laboratory of Space Weather, founded in 2006, is the first state key laboratory in the field of space physics in China. The middle and upper atmosphere research is one of the key areas identified by the Lab, and is closely related to CAWSES-II Task Group 4 (TG4), i.e., what is the geospace response to variable waves from the lower atmosphere? Our research group, Group of the middle & upper atmospheric aeronomy study, focuses specifically on the following topics: coupling between the lower atmosphere and upper atmosphere; interaction between the photochemistry and dynamics; propagations of tides, planetary waves, and gravity waves; the response of the middle and upper atmosphere to solar activity; methods and techniques of studying the middle and upper atmosphere using numerical modeling and remote sensing methods. Ground-based and satellite observation data were used for these studies.

There has been significant progress for the atmospheric ground-based observations in the Lab in last two years, supported by the Meridian Project of China. Both pas-

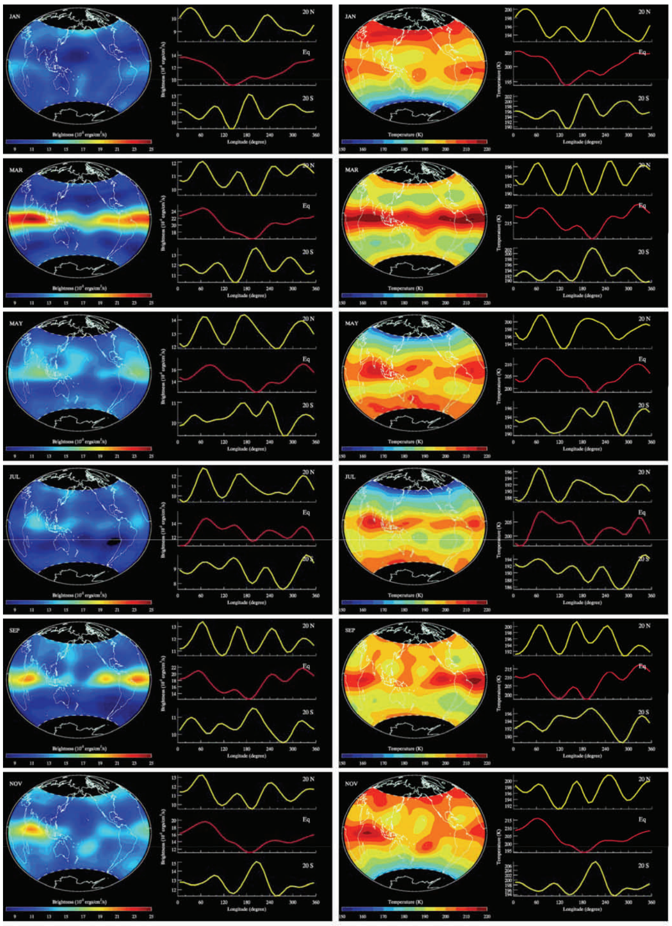

Figure 1. Maps of average 2.0 μm OH night airglow brightness (left) and temperature at 87 km (right) for 6 months averaged from 2002 to 2008; 55°N to 55°S. Their longitudinal distributions at 20°S, 0° and 20°N are also shown. (from Xu et al., GRL, 2010)

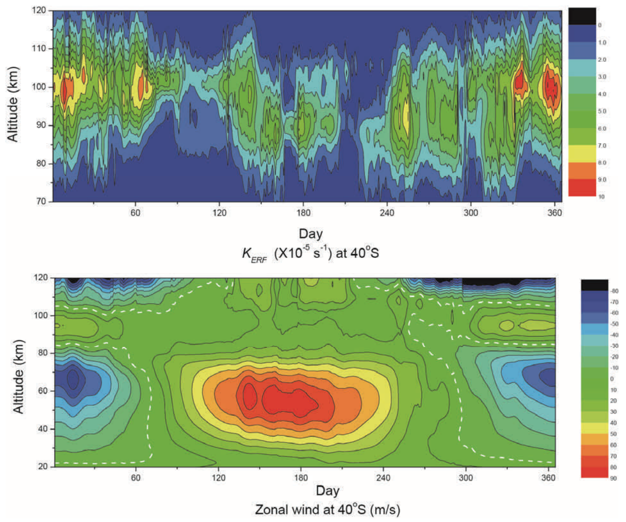

Figure 2. The mean annual cycle of equivalent Rayleigh friction coefficient (upper panel) and the zonal mean zonal wind (lower panel) at 40°S. The white dashed line in the lower panels denotes the zero wind. (from Xu et al., JGR, 2009)

sive and active instruments for the middle and upper atmosphere observations have been constructed and are in operation, which include all sky airglow cameras, an FP interferometer, lidars, and a meteor radar [*Wang, 2010, Space Weather*].

One of the focuses of our recent investigations is tidal waves, in particular, the global structure, the sources, the dissipation and the impacts of the tides. The evidence of the modulations of migrating and non-migrating tides on the airglow emission was given [*Gao et al., 2010, J. Geophys. Res.; Xu et al., 2010, Geophys. Res. Lett.*] from the similarity between the airglow emission and the temperature distributions. Figure 1 shows the modulations of tides on the OH nightglow observed by TIMED/SABER. The seasonal variations of the global distribution of the mesopause altitude and structure and the modulation by tides were investigated [*Xu,*

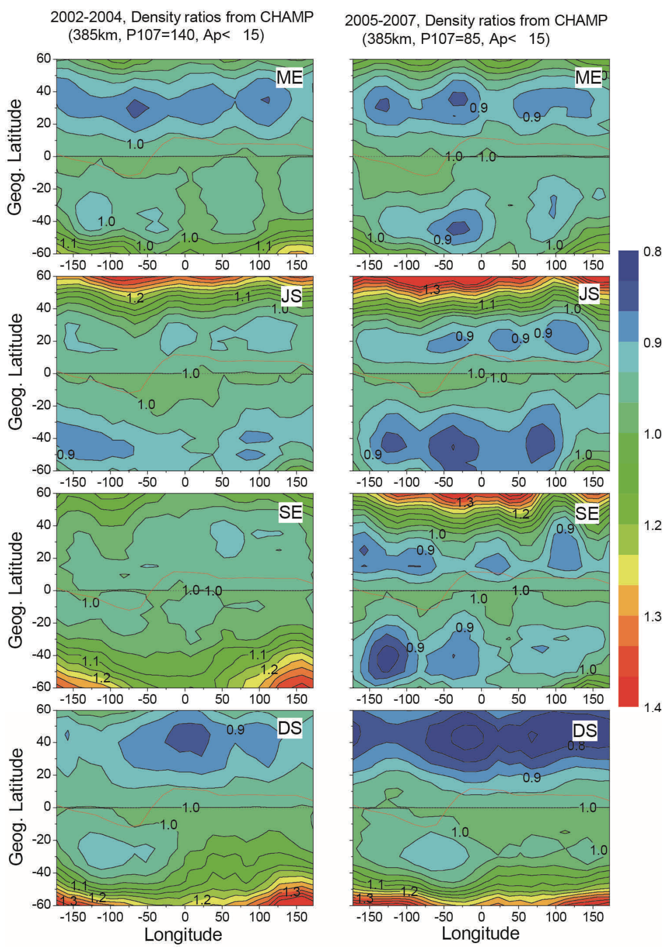

Figure3. Longitudinal variations of the normalized mass density (385 km) in different seasons for solar maximum (left) and minimum (right) conditions. Each season includes 91 days centered at either equinox or solstice. The red lines indicate the location of magnetic dip equator. (from Ma et al., JGR, 2010)

et al., 2007, J. Geophys. Res.]. The TIDI and SABER data aboard satellite TIMED were used to study the global structure of tides and the tidal damping, which is described by equivalent Rayleigh friction (ERF), in MLT region. The results show that the seasonal variation of the ERF is consistent with the seasonal variation of the zonal mean wind and the maximum ERF generally coincides with the altitudes of strongest wind reversal in the mesopause region [*Xu et al., 2009a, 2009b. J. Geophys. Res.*]. We have studied the nighttime equatorial mass anomaly (NEMA，See Figure 2) of the thermospheric density observed by CHAMP [*Ma et al., 2010, J. Geophys. Res.*]. We found that the mass density had longitudinal structures with 2, 3, or 4 peaks, depending on season and solar activity. The results show evidence that the NEMA was probably the results of upward propagating non-migrating tides from the lower atmosphere [see Figure 3]. The features of the sources of tides produced by ozone heating have been studied by our group as well [*Xu et al., 2010, J. Geophys. Res.*]. Based on the analysis of the satellite observations, an empirical model of the tidal forcing induced by ozone heating was constructed. This model can be used as input for the simulation study on tides. The ground-based observation data were also utilized to study the seasonal variation of tides and planetary waves [*Jiang et al., 2008 J. Geophys. Res. , 2009 Ann. Geophys*].

Article 3

4th IAGA/ICMA/CAWSES-II TG4 Workshop on Vertical Coupling in the Atmosphere/Ionosphere System

Petra Koucká Knížová
Institute of Atmospheric Physics, Academy of Sciences of the Czech Republic, Czech Republic

P. K. Knížová

The Earth's atmospheric regions are intricately coupled to one another via various dynamical, chemical, and electrodynamic processes. However, the manner in which the couplings take place due to varying energy inputs from the Sun and from the lower atmosphere is a question that remains to be understood. The coupled effects can be studied in terms of the modulation of the waves from lower to upper atmosphere as well as from low-to high-altitudes, electrodynamic and compositional changes, and plasma irregularities at different latitudinal regions of the globe due to the varying energy inputs. The MLT region is a critical region in the coupling between the lower/middle atmosphere and the upper atmosphere/ionosphere. It is here that physical processes filter and shape the flux of waves ascending through the mesosphere into the overlying

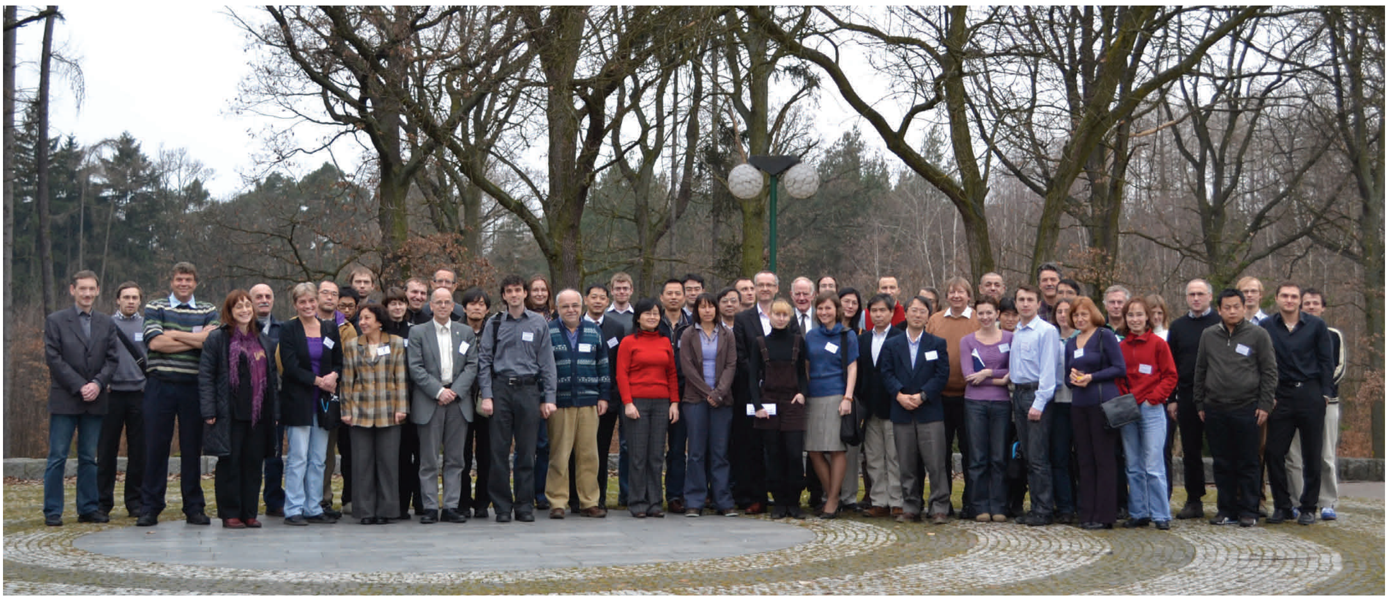

Figure 1. All participants to the workshop

thermosphere. On the other hand it is reasonable to presume that there might be a link between solar variability and the changes in the middle atmosphere and climate variables.

The 4th IAGA/ICMA/CAWSES-II TG4 meeting brought together many scientists dealing with both the middle and upper neutral atmosphere phenomena and experts occupied by the ionospheric research. These scienticfic communities presented their recent results and assessed/debated ongoing issues relating to the theoretical, modelling and observational aspects of all kind of processes which transfer energy and momentum from the lower atmosphere to the upper atmosphere and ionosphere and vice versa. The attention was mainly paid to the principle mechanisms of the vertical coupling in the atmosphere and the manner in which the coupling takes place. The presented papers reported both theoretical and empirical recent results concerning the coupling mechanisms through dynamics, composition and electrodynamics. The **coupling processes in the middle atmosphere** (Coupling through planetary waves, mean flows and temperature variability; Gravity wave and tidal forcing of the middle atmosphere; The role of dynamics, solar variability and greenhouse gasses on the chemical structure and feedback processes) and **coupling processes in the atmosphere/ionosphere system (**Dynamical forcing of the ionosphere from below; Electrodynamic coupling and plasma instabilities; the role of electrical processes in the coupling) represents two main topics of the workshop.

The 4th workshop of 4th IAGA/ICMA/CAWSES-II TG4 Workshop on Vertical Coupling in the Atmosphere/ Ionosphere System took place in Prague, Czech Republic, on 14-18 February, 2011. The workshop was organized by the Institute of Atmospheric Physics ASCR, Prague. The workshop was attended by 75 participants from 16 countries, including 28 students and young scientists under 35 from 9 countries. In total, 79 papers were presented, from which 16 were solicited presentations. Organizing Committee is grateful for the scientific sponsorship and financial support provided by the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP), International Union of Geodesy and Geophysics (IUGG), International Association of Geomagnetism and Aeronomy (IAGA), International Commission on the Middle Atmosphere (ICMA) and International Union of Radio Science (URSI) for the 4th IAGA/ ICMA/CAWSES-II TG4 Workshop on Vertical Coupling in the Atmosphere/Ionosphere System. Financial grants were used to partialy support 14 young scientists and 11 senior scientists in need.

The 4th workshop of 4th IAGA/ICMA/CAWSES-II TG4 Workshop allowed the participants to discuss during the session and also during social events.

Figure 3. One of the social events, beer tasting.

Figure 2. Discussion during a poster session

Highlight on Young Scientists

Thermospheric effects of lower atmospheric small-scale gravity waves

Erdal Yiğit
Center for Space Environment Modeling, University of Michigan, MI, USA
Atmospheric Physics Laboratory, University College London, UK

Erdal Yiğit

As a PhD student at the University College London, I experienced great exposure to gravity waves (GWs) in Fall 2007 when I was visiting Alexander S. Medvedev at the Max Planck Institute for Solar System Research in Katlenburg-Lindau.

While working on GWs and their parameterizations in atmospheric models, I noticed how challenging it is to bridge the communication gap between lower and upper atmospheric scientists. However, this communication is necessary, as small-scale GWs are generated in the lower atmosphere and can propagate into the thermosphere above the turbopause and the study of their effects thus requires expertise in different areas.

Historically, GW parameterizations have been designed to incorporate the effects of unresolved GWs in middle atmosphere models, thus they typically lacked appropriate mechanisms to attenuate waves in the thermosphere. Having extended a GW parameterization that is based on the earlier works of Alexander S. Medvedev to the thermosphere *[Yiğit et al., 2008, J. Geophys. Res.]*, it was for the first time possible to physically account for GW dissipation up to the upper thermosphere.

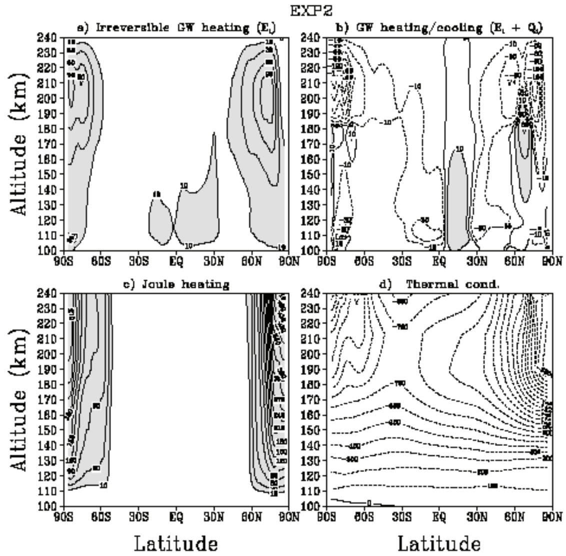

Figure 2. Zonal mean gravity wave thermal effects (heating/cooling in K/day) and comparison with Joule heating and thermal conduction at June solstice simulated with the extended GW scheme implemented in CMAT2 *[Yiğit and Medvedev, 2009].*

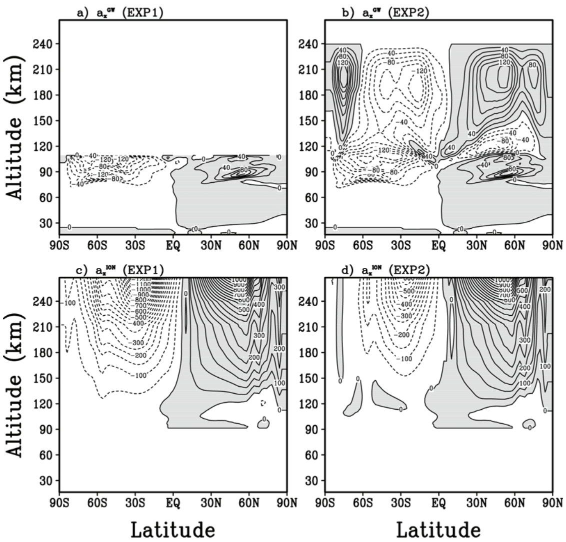

Figure 1. Zonal mean zonal gravity wave drag (m/s/day) and its comparison with ion drag at June solstice simulated with the extended spectral nonlinear parameterization using the Coupled Middle Atmosphere-Thermosphere-2 (CMAT2) model *[Yiğit et al., 2009]*. In EXP1, GW activity is cut off at the turbopause while in EXP2 GW effects are calculated everywhere.

My modeling studies with the extended GW scheme demonstrated that GWs produce significant dynamical effects in the thermosphere upto F2-layer altitudes *[Yiğit et al., 2009,Geophys. Res. Lett.]*, competing with ion drag (Figure 1). Also, GWs produce appreciable thermal effects *[Yiğit and Medvedev, 2009, Geophys. Res. Lett.]*, cooling the upper thermosphere by more than 150 K/day (Figure2). These studies suggest that the GW effects should be considered in the momentum and energy budget studies of the upper atmosphere and interaction between the lower and upper atmospheric communities is of great importance for better understanding atmospheric vertical coupling.

Short News 1

Announcement - Tidal Campaign

William Ward
Department of Physics, University of New Brunswick, Fredericton, Canada.

The first Tidal Campaign of CAWSES 2 will take place from the beginning of August to the end of October 2011. It will support the August Incoherent Scatter Radar campaign being lead by Scott England and target several several scientific problems:

1) Tidal propagation from the troposphere to the MLT region.
2) The self consistency of temperature and wind tides.
3) Airglow variability due to tides.
4) Tidal penetration into the thermosphere and associated electrodynamic effects.

Ground based and satellite observations of tidal variations in wind, temperature, airglow, and ionospheric parameters are solicited. Anyone interested in participating should contact William Ward at wward@unb.ca.

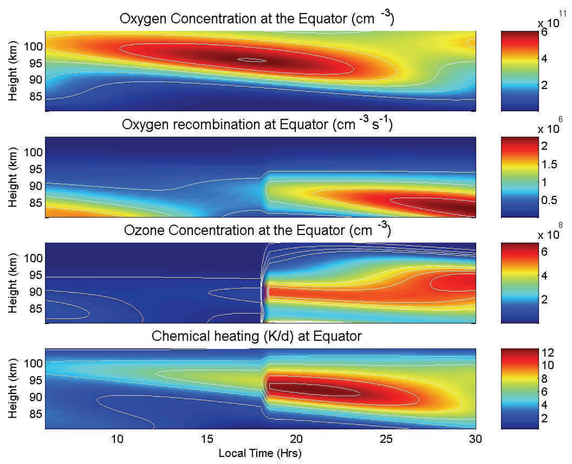

Figure 1. Simulation of the local time effects of the migrating diurnal tide at the equator on various parameters during equinox. This simulation uses moderate tidal amplitudes to perturb a background atmosphere generated from MSIS and includes the effects of solar radiation on ozone. It provides an indication of the extent of tidal influences in this region of the atmosphere.

Short News 2

Call for Nominations for the 2011 Sunanda and Santimay Basu Award

David Hysell
Earth and Atmospheric Sciences, Cornell University

The Space Physics and Aeronomy (SPA) Section of the American Geophysical Union (AGU) is seeking nominations for the Sunanda and Santimay Basu Award in Sun-Earth Systems Science. This award is presented annually to honor an individual young scientist from a developing nation for making outstanding contributions to research in Sun-Earth Systems Science that further the understanding of both plasma physical processes and their applications for the benefit of society. The award is open to scientists who received their Ph.D. degree after 1 June 2004 and currently live and work in developing nations. Consideration is to be given to candidates who have overcome obstacles in attaining their research objectives.

The Space Physics and Aeronomy Section will invite the recipient to present a paper at AGU's Fall Meeting in San Francisco, California. Travel funds and living expenses will be provided to attend the meeting, where the recipient will also receive a certificate of appreciation and three years' membership to AGU. The award will be presented at the SPA dinner, for which the awardee will receive a complimentary ticket. The awardee will also be announced in *Eos*.

Nominations should be prepared by an AGU member or other geoscientist who is knowledgeable of the candidate's qualifications and include the following information:

- nominator's name and title, address and contact numbers;
- nominee's name and title, institutional affiliation, and address;
- a statement (not to exceed 2 pages) of the action(s) or achievement(s) for which the candidate is nominated;
- two letters of support from AGU members or from other recognized geoscientists belonging to institutions other than that of the nominee;
- a curriculum vitae (not to exceed 3 pages).

A list of previous recipients of the award can be found at: http://www.agu.org/about/honors/section_fg/spa/
The deadline for receipt of the nomination package is **15 May 2011**.

Send nominations to:
American Geophysical Union Attn:
Danica Williams, Member Relations Coordinator
2000 Florida Avenue, NW, Washington DC 20009 USA
Tel: +1-202-777-7513
E-mail: dwilliams@agu.org

You can also contact the Chair of the Sunanda and Santimay Basu Award Committee with questions: Professor David Hysell (david.hysell_at_cornell.edu)

Upcoming meetings related to CAWSES-II TG4

Conference	Date	Location	Contact Information
AGU Chapman Conference on Modeling the Ionosphere/Thermosphere System	May 9-12, 2011	Charleston, South Carolina, USA	http://www.agu.org/meetings/chapman/2011/dcall/index.php
2011 Joint CEDAR-GEM Workshop	Jun.26-Jul.1, 2011	Santa Fe, New Mexico, USA	http://cedarweb.hao.ucar.edu.wiki/index.php/2011_Workshop:Main
IUGG General Assembly	Jun.28-Jul.7, 2011	Melbourne, Australia	http://www.iugg2011.com/
AOGS2011	Aug. 8-12, 2011	Taipei, Taiwan	http://www.asiaoceania.org/
URSI General Assembly	Aug. 13-20, 2011	Istanbul, Turkey	http://www.ursigass2011.org/
ISEA-13	Mar. 12-17, 2012	Paracas, Peru	http://jro.igp.gob.pe/isea13/

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_stelab.nagoya-u.ac.jp)
Kazuo Shiokawa (shiokawa_at_stelab.nagoya-u.ac.jp)
Solar-Terrestrial Environment Laboratory, Nagoya University
Tel +81-52-747-6418, Fax +81-52-747-6323
This newsletter is also available on the web at
http://www.cawses.org/wiki/index.php/Task_4