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

TG4 Newsletter

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Article 1

About the CAWSES-II Task Group 4

"What is the geospace response to variable inputs from the lower atmosphere?"

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Kazuo Shiokawa

Jens Oberheide

The space weather of Earth's upper neutral and ionized atmosphere is strongly influenced by high-latitude energy input due to magnetosphere-ionosphere coupling, and solar radiation variability. A variety of new evidence now demonstrates unequivocally that the geospace environment owes a substantial amount of its variability to waves forced in the lower parts of Earth's atmosphere. An exciting new realization is that persistent tropical rainstorms produce large longitudinal and local time variations in bulk geospace properties: temperature, wind, density, chemical composition, airglow and plasma density, to name a few. Non-Sun-synchronous (nonmigrating) tides carry energy and momentum from the troposphere upwards and produce the so-called "wave-4" structures around the equator. Gravity waves generated by hurricanes and typhoons may seed plasma bubbles in the low latitude ionosphere. Geospace variability induced by lower atmospheric waves hence competes with solar and magnetic driving from above. The extent to which the effects are transmitted to the magnetosphere is yet to be resolved.

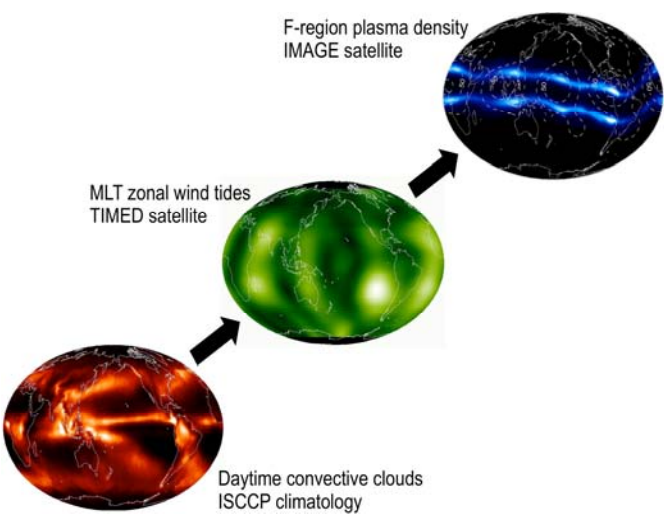

Figure 1. Persistent tropical weather systems cause global wave structures throughout the ITM system.

CAWSES-II(*) Task Group 4 (TG4, 2009-2013) will therefore elucidate the dynamical coupling from the low and middle atmosphere to the geospace including the upper atmosphere, ionosphere, and magnetosphere, for various frequencies and scales, such as gravity waves,

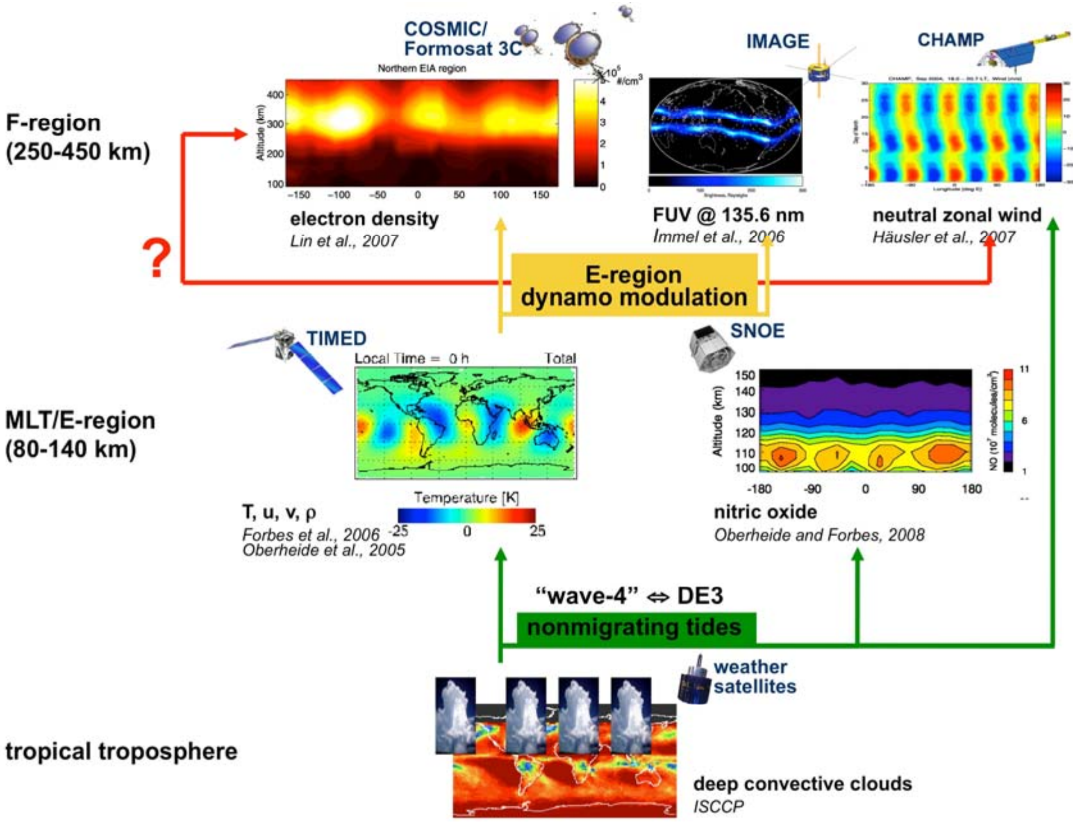

Figure 2. Coupling from the troposphere to the ionosphere through tides.

tides, and planetary waves, and for equatorial, middle, and high latitudes. Attacking the problem clearly requires a systems approach involving experimentalists, data analysts and modelers from different communities. For that purpose, the most essential part of TG4 is to encourage interactions between atmospheric scientists and plasma scientists on all occasions. This TG4 newsletter is aimed for the TG4-related scientists to know each other and their projects.

Four projects are established in TG4:

Project 1: How do atmospheric waves connect tropospheric weather with ITM variability? (ITM=Ionosphere-Thermosphere-Mesosphere) (Project leaders: Mangalathayil A. Abdu. (Brazil) / Jorge Chau (Peru) / William Ward (Canada))

Project 2: What is the relation between atmospheric waves and ionospheric instabilities? (Project leaders: Jon Makela (USA) / Hisao Takahashi (Brazil))

Project 3: How do the different types of waves interact as they propagate through the stratosphere to the ionosphere? (Project leaders: Dora Pancheva (Bulgaria) / Mamoru Yamamoto (Japan))

Project 4: How do thermospheric disturbances gen-

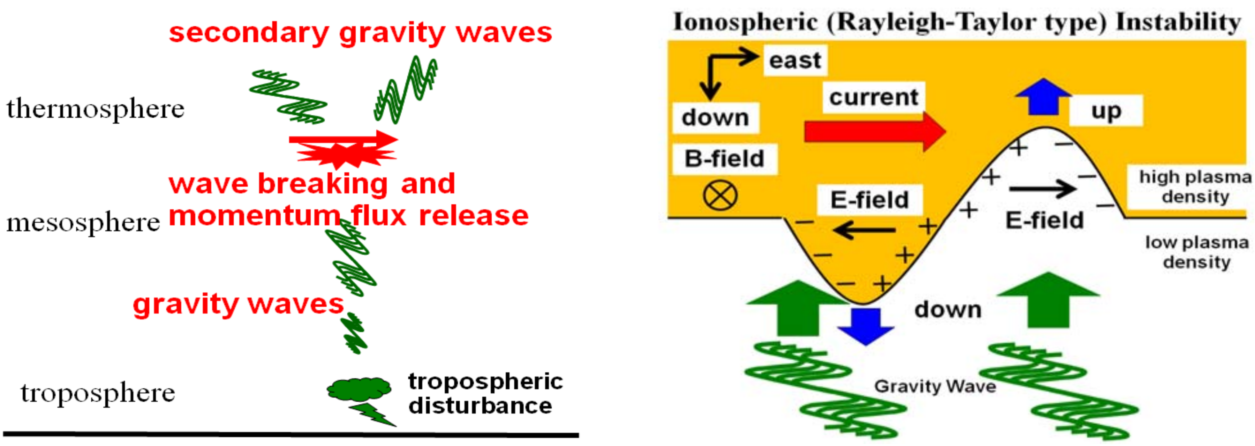

Figure 3. Gravity wave propagation and release of momentum flux in the thermosphere (left) and further seeding of the ionospheric instability (right).

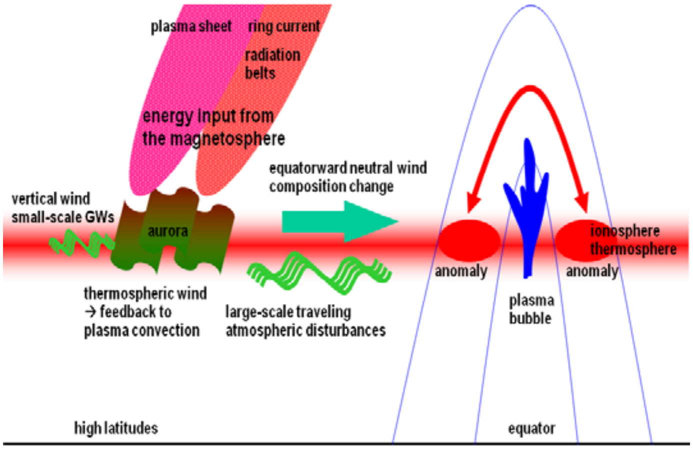

Figure 4. Cause and effects of thermospheric waves and disturbances generated by auroral processes.

erated by auroral processes interact with the neutral and ionized atmosphere? (Project leaders: Hitoshi Fujiwara (Japan) / Mike Kosch (UK))
A joint project with TG2 (lead TG2) is also proposed for the topic of Project 5: How does climate change affects atmospheric waves in the ITM?

Under TG4, several campaign observations are taking place, including the continuation of the CAWSES tidal campaigns, a global campaign associated with stratospheric sudden warmings, and longitudinal network observations of mesosphere-ionosphere coupling.

(*) CAWSES-II (2009-2013) is the second phase of the international Climate And Weather of the Sun-Earth System program sponsored by SCOSTEP (Scientific Committee on Solar-Terrestrial Physics) established with an aim of significantly enhancing our understanding of the space environment and its impacts on life and society. The main functions of CAWSES are to help coordinate international activities in observations, modeling, and applications crucial to achieving this understanding, to involve scientists in both developed and developing countries, and to provide educational opportunities for students of all levels. CAWSES-II is organized around four Task Groups and two activities.

TG1: What are the solar influences on the Earth's climate?
TG2: How will geospace respond to an altered climate?
TG3: How does short-term solar variability affect the geospace environment?
TG4: What is the geospace response to variable inputs from the lower atmosphere?
Capacity Building
Virtual Institute

Article 2

Instrumentation and science at Jicamarca and LISN for CAWSES-II TG4

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Jorge L. Chau

Here we present a summary of current and future instrumentation clustered around the Jicamarca Radio Observatory (JRO), located under the magnetic equator, including the Low latitude Ionospheric Sensor Network (LISN) that spans most of the South American continent. As we describe below, this instrumentation and the science we pursue are closely connected to the main question of CAWSES-II Task Group 4 (TG4), i.e., *What is the geospace response to variable inputs from the lower atmosphere?* At JRO alone (76.7^{o}W) we are able to measure vertical profiles of the neutral dynamics from the lower troposphere up to the mesosphere with the MST radar technique. In collaboration with Clemson University we have recently installed a Fabry-Perot Interferometer (FPI) that measures the horizontal neutral wind components and neutral temperature at the bottom of the nighttime *F* region. We also measure the zonal and vertical electric fields as well as the electron density, electron and ion temperature and ion composition using the incoherent scatter radar (ISR) technique from 200 to 1000 kms.

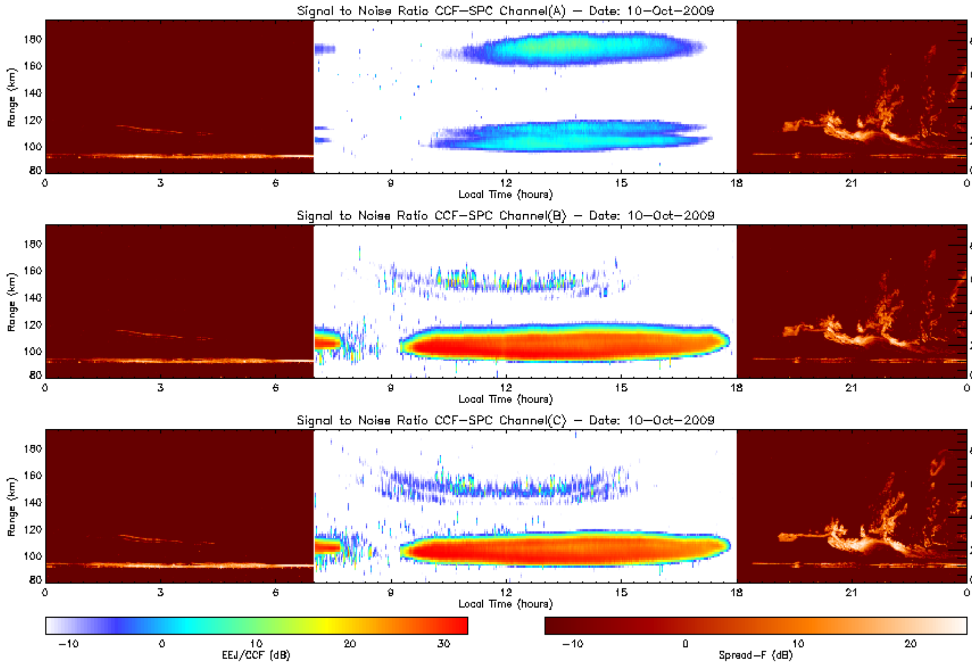

Figure 1. Range-time intensity of a typical day over Jicamarca with the JULIA radar, in local time. During the night we observe from 0 to 1000 km (right axis), and during the day we observe below 200 km in altitude (with the main Jicamarca antenna, middle and bottom panel) and range (with a small Yagi array).

Daytime zonal electric fields of the *F* region are obtained with the JULIA radar mode from 150-km echoes, as well as from ground-based magnetometers. As part of LISN we are installing magnetometers at other longitudes: Huancayo (75^{o}W), Puerto Maldonado (69^{o}W), and Alta Floresta (56^{o}W). The latter is installed in collaboration with INPE (Brazil). This magnetometer network will allow us to measure the daytime zonal electric fields at different longitudes and therefore help us resolve space and time ambiguities. In addition to these atmospheric and ionospheric parameters, with the JULIA mode we routinely measure plasma irregularities in the *E*, valley and *F* regions, including the so-called equatorial spread *F* (ESF) irregularities (Figure 1). Using the radar interferometer mode in addition to the intensity of the irregularities, we can measure the zonal drift. Recently we have added to this mode a radar imaging mode that allows us to get high resolution (time, altitude, and space) measurements inside the illuminated beam (see for example Figure 2).

The JRO measurements are being complemented by a variety of optical and radio instruments. As part of our collaboration with Clemson University, there are two

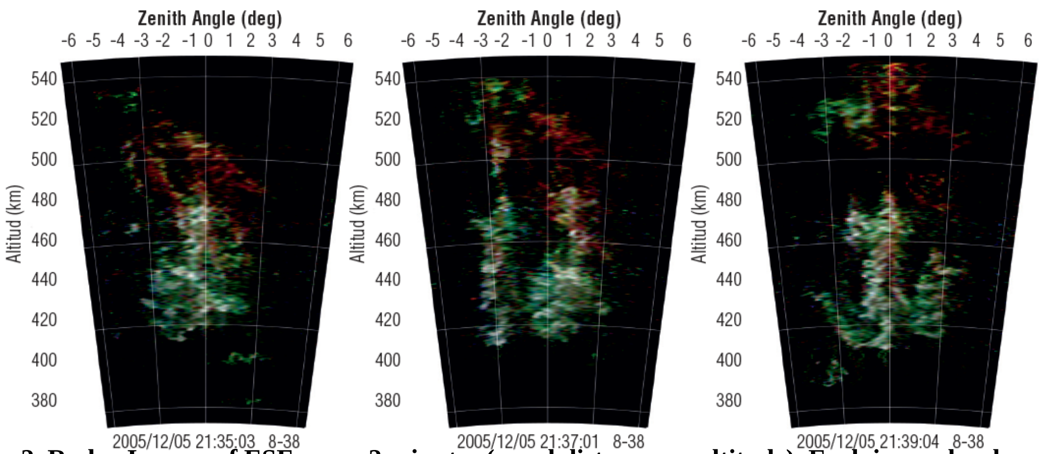

Figure2. Radar Images of ESF every 2 minutes (zonal distance vs. altitude). Each image has been obtained after integrating 10 seconds. Colors present Doppler information (red: away from the radar, green: no radial velocity, Blue: towards the radar).

more FPIs installed in Peru (SOFDI in Huancayo and one in Arequipa). Besides allowing a better spatial coverage, the three FPIs can be used in bistatic or tristatic configurations to achieve common volume neutral measurements in the *F* region. SOFDI will also provide daytime measurements of thermospheric winds and temperatures. The LISN instrumentation consists of more than 40 dual-frequency GPS receivers installed in different parts of South America, the ground-based magnetometers mentioned above, and 4 state-of-the-art-digital ionosodes (one already installed and three will be installed in the following months). When combined with other existing GPS networks, comprehensive Total Electron Content (TEC) maps over South America can be obtained (Figure 3). In Table 1, we present a summary of this instrumentation, including the main parameters they measure, the frequency of observations, and how they are related to the different projects of TG4.

Our capabilities are indeed important for the different projects of TG4, particularly projects 1, 2, and 3. We are not only able to contribute with important measurements at the lower altitudes, but we are also able to measure the direct effects in the E region, as well as (a) the indirect effects of the E region dynamo in the local F region and at other longitudinal sectors, and (b) the direct effects of vertically propagated waves/tides in the upper ionosphere, including the seeding of ESF irregularities. For example, we have recently shown that the equatorial ionosphere is affected during sudden stratospheric warming in the polar regions. The understanding of the physical mechanisms connecting these two events will required the use of numerical and coupled models.

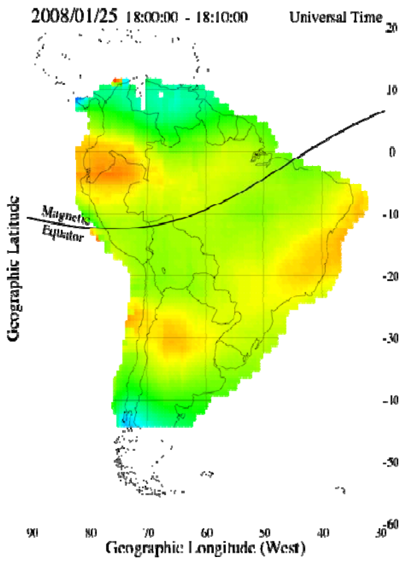

Figure 3. TEC map over South America during a sudden stratospheric warming event. The map has been obtained with more than 100 GPS receivers, including LISN.

Table 1. List of instruments of clustered around Jicamarca.

Instrument	Parameter	Region	Time Coverage	Annual Coverage	Regional Coverage	TG4 Projects
ISR	Ne, Te, Ti, Vz, Vx, %	Ionosphere	24	1000 hours	JRO	1,2,3
MST	U,V,W	Troposphere, Stratosphere, Mesosphere	24 (T,S), daytime (M)	> 10 days	JRO	1,3
JULIA	Irregularity intensity, Vz, Vx	Ionosphere	24	4000 hours	JRO	2,3
JULIA-150	Vz	Ionosphere	Daytime	150 days	JRO	1,3
FPI (Arequipa, SOFDI, JRO)	U,V, Tn	Bottom *F region*	Nighttime Daytime (SOFDI)	> 100 days	Peru	2
Magnetometers (JRO, LISN)	Vz	Ionosphere	Daytime	365 days	77°, 75°, 69°, 56° West	1,3
LISN GPS	TEC, scintillations	Ionosphere	24	365 days	South America	1,2,3
Ionosondes (JRO, LISN)	TEC, scintillations	Ionosphere	24	365 days	77°W, 69°W	1,2,3

Article 3

Towards a new phase of understanding the vertical coupling from ground to topside

Wave-4 workshop: from bottom to top, bridging views from two ends; RISH, Kyoto University, Kyoto, Japan, Feb. 22-23, 2010.

H. Liu
Research Institue for Sustainable Humanosphere (RISH), Kyoto University, Kyoto, Japan

Huixin Liu

Discovered in 2005 by Drs. E. Sagawa and T. Immel and colleagues, "wave-4" rapidly became a keyword for atmosphere/ionosphere research, followed by an ever-increasing pool of publications. Today, although the DE3 tidal component is generally accepted to be the primary driver for this structure seen from satellite perspective, essential aspects await clarifications. Furthermore, the "wave-4" has so far been investigated in a topside-down approach. That is, although the exciting source sits deep in the tropical troposphere, it was first identified 300 km high up in the ionosphere. The thermosphere-ionosphere community has been enjoying inferring and interpreting tides like DE3 from their top-to-bottom perspective. But how do specialists in meteorology and lower atmosphere see this process from their bottom-to-top perspective? The workshop provided a forum for view-exchange and critical examination of processes in corresponding fields.

Workshop presentations covered tidal theory, ground and satellite observations, and numerical simulations. Dr. Sagawa introduced IMAGE airglow observations, along with humorous telling on the scenario of the "wave-4" discovery. Intensive discussions were followed on various aspects: the incompleteness of the classical tidal theory (S. Kato); differences between EEJ's wave-4 signature seen by satellite and those by the MAGDAS ground magnetometer network (Yumoto & Yamazaki); global distribution of lightening and alternate routes of upward energy propagation by global electric circuit (Takahashi & Yamashita); wave-4 global distribution of gravity waves and its potential effect on the upper atmosphere (T. Tsuda); gravity wave dissipation and related instability in the MLT region (T. Nakamura); tidal propagation and semidiurnal tides' contribution to wave-4 (Y. Miyoshi); dynamo processes in the E and F region (H. Jin); competition of ion-neural interaction and neutral-neutral interaction in the thermosphere-ionosphere system (H. Liu); topside ionosphere processes (T. Maruyama, Y. Kakinami); strength and weakness of various atmosphere general circulation models in describing wave-4 structure (H. Fujiwara).

Photo 2. View-exchange over French wine

Photo 1. Participants with sunshine on the roof

Three major problems are identified. First, how to improve the incompleteness of tidal theory. Second, how do gravity wave distribution affect the non-migrating tides. Third, how to explain the dimensional dependence of ion-neutral and neutral-neutral coupling. These questions call for urgent investigation and provide clear direction for the next phase of research on the vertical coupling of the whole atmosphere.

The workshop enjoyed more than 30 participations including meteorologists, atmospheric scientists, and plasma physicists. Its informal style greatly promoted presentations on a wide range of results, published and non-published, reviews, insightful comments, and off-the-beaten-track but inspiring ideas. This gave a substantial initiation for broader-spectrum cross-field collaborations towards a new phase of understanding the coupling of atmospheric layers from ground to topside.

Organizers: Huixin Liu, Takuji Nakamura, Yasunobu Miyoshi, Shigeto Watanabe, and Mamoru Yamamoto

Short News 1

CAWSES-II/ TG-4/ Project 2 first report (30/05/2010)

Jonathan J. Makela[1] and Hisao Takahashi[2]

[1]University of Illinois at Urbana-Champaign, USA,
[2]Instituto Nacional de Pesquisas Espaciais, Brazil

Update 1

The first SpreadFEx2 measurement campaign was conducted from 11 September through 30 November 2009. Data from six sites throughout Brazil were collected, including measurements made by several imaging systems, ionospheric sounders, meteor and coherent scatter radars, GPS receivers, and a Fabry-Perot interferometer. These data are being analyzed to investigate the upward coupling of gravity waves to the development of equatorial irregularities. Meetings to discuss the data and results are planned at the upcoming CEDAR Workshop (Boulder, CO, USA; 20-25 Jule 2010) and COSPAR Scientific Assembly (Bremen, Germany; 18-25 July 2010).

Update 2

Plans are underway to conduct a coordinated measurement campaign to study the longitudinal variability of upward coupling and its effect on the development of equatorial irregularities. The campaign will run from 1 September through 12 November 2010 and will focus on the region encircling the globe within 20 degrees of the magnetic equator. From the measurement of ionospheric and mesospheric parameters, we expect to gain useful information on the longitudinal variability in gravity waves, planetary waves, and related equatorial spread-F occurrence. Participants have already been identified in South America, Africa, India, and the western Pacific/Oceania. Additional interested parties, especially those who could contribute additional measurements, should contact the project leaders (Hisao Takahashi: hisaotak_at_laser.inpe.br; Jonathan Makela: jmakela_at_illinois.edu).

Short News 2

Novel optical instrument needs a new home

Mike Kosch
Physic Dept., Lancaster University, UK

A Scanning Doppler Imager (SDI) is an all-sky Fabry-Perot interferometer, which observes thermospheric neutral temperatures and winds in all directions simultaneously, typically every 1-5 minutes. The SDI runs completely autonomously and is programmable over the internet. Its main advantages are that it: (1) removes spatial-temporal ambiguities, and (2) can observe with meso-scale resolution, typically 50/100 km in the E/F-regions. Currently, there are only 4 SDIs in the world. The LaTrobe-Lancaster SDI, currently in Mawson, Antarctica, is running out of funding and we are looking for a new partner to host it. Please contact me for more information (m.kosch_at_lancaster.ac.uk).

Short News 3

Announcement -JGR special issue COUPLING1

Larisa Goncharenko
Haystack Observatory, MIT, MA, USA

A special section of Journal of Geophysical Research, titled "Coupling Between the Lower and Upper Atmosphere" (COUPLING1), is currently in progress, with submission window closed on March 31, 2010. This special section is devoted to understanding the details of the coupling mechanisms between the lower atmosphere (troposphere, stratosphere) and upper atmosphere (thermosphere and ionosphere). This is a first joint issue between JGR-Space Physics and JGR-Atmospheres, with ~20 papers currently in press or under review. Most contributions are based on presentations made at the special sessions at the Joint Assembly (Toronto, Canada, May 2009) and CEDAR workshop (Santa Fe, New Mexico, USA, June 2009).

Upcoming meetings related to CAWSES-II TG4

Conference	Date	Location	Contact Information
SCOSTEP-12	Jul. 12-16, 2010	Berlin, Germany	http://www.iap-kborn.de/ SCOSTEP2010
COSPAR	Jul. 18-25	Bremen, Germany	hhtp://www.cospar2010.org/
TG4 business meeting	Jul. 22, 2010	Bremen, Germany	
ISSI workshop	Sep. 27 - Oct. 1, 2010	Bern, Switzerland	http://www.issibern.ch/ workshops/earthplasma
CAWSES-II TG4 conference on "Vertical coupling from stratosphere to ionosphere" (IAGA/ICMA/CAWSES-II)	Feb. 14-18 2011	Prague, Czech	
IUGG	Jun. 28 - Jul. 7, 2011	Melbourne, Australia	http://www.iugg2011.com/ relatedlinks.asp
ISEA-13	Mar. 12-17, 2012	Paracas, Peru	http://jro.igp.gob.pe/isea13/

From the Editor

Michi Nishioka,
Editor of the CAWSES-II TG4 newsletter
Solar-Terrestrial Environment Laboratory, Nagoya University, Aichi, Japan

It is great pleasure to issue the first CAWSES-II TG4 newsletter. The purpose of the newsletter is to provide rapid communication among TG4 members and others. I really appreciate all writers of articles in this issue.

Editing this newsletter is my first work after coming back to Japan from Boston. I was in Boston as a post-doc under the supervision of Drs. Sunanda and Santimay Basu who are "parents" of the CAWSES program. It is an honor for me to work for CAWSES-II.

I hope you enjoyed reading this issue. I also welcome any article and your feedback on any aspect for this newsletter to nishioka_at_stelab.nagoya-u.ac.jp.

Issued by Michi Nishioka (nishioka_at_stelab.nagoya-u.ac.jp)
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