

## Recent Activities of CAWSES-II

SCOSTEP Bureau Meeting  
May 6, 2013  
ISSI, Bern, Switzerland

Toshitaka Tsuda (RISH, Kyoto University, Japan)  
Joeseeph Davila (NASA/GSFC, US)

### CAWSES II: Towards Solar Maximum, 2009-2013

CAWSES II addresses:

- Fundamental questions of how the coupled Sun-Earth system operates on timescales of minutes to millenia
- Questions that require coordinated inter-disciplinary international effort



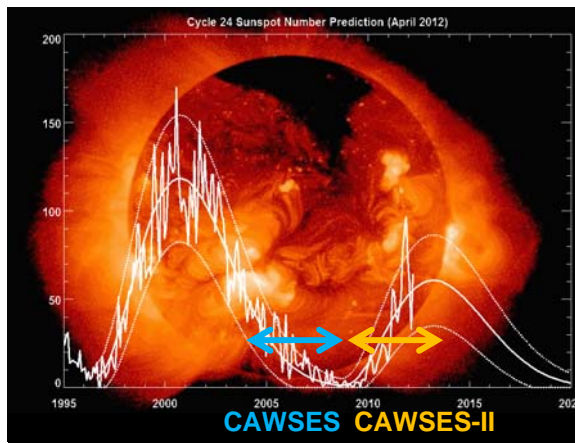
#### Co-Chair of CAWSES-II

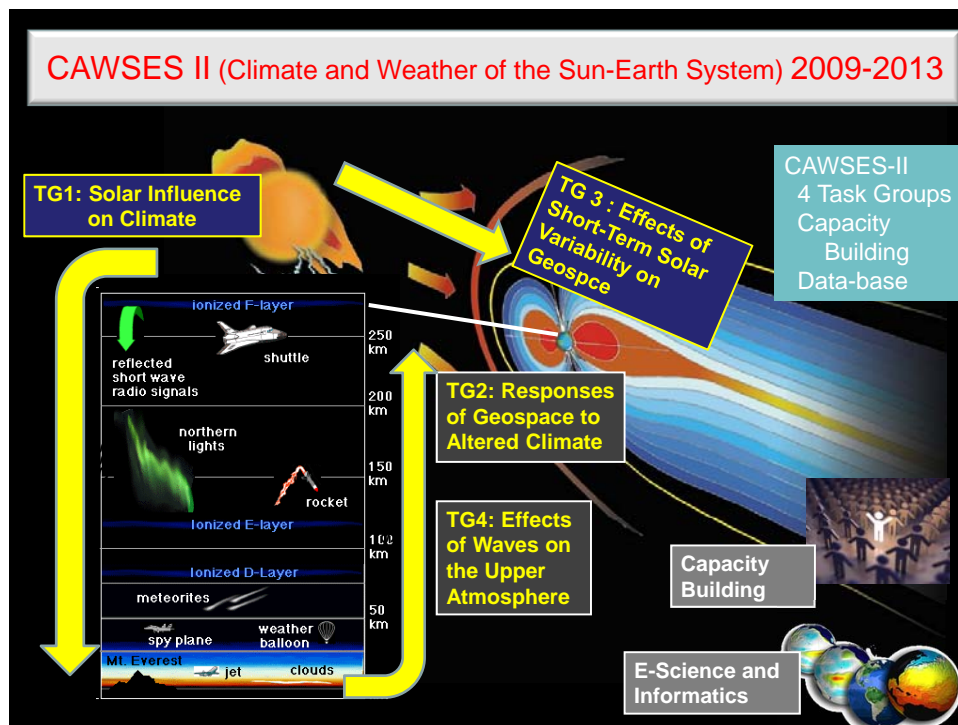
2009-10:

Susan Avery &  
Alan Rogers

2011-13:

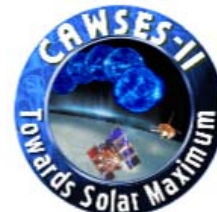
Joe Davila (NASA/GSFC) &  
Toshitaka Tsuda (Kyoto-U)





## Task Group Leaders of CAWSES II

One leader (\*) is additionally invited to each TG after April 2012.



**TG1: What are the solar influence on the Earth's climate?**

**Katja Matthes, Annika Seppälä, Cora Randall\*** (Apr 2012 - )  
(2009-2011: Joanna Haigh, Ilya Usoskin)

**TG2: How will geospace respond to an altered climate?**

**Dan Marsh, Jan Lastovicka, G. Beig\*** (Apr 2012 - )

**TG3: How does short-term solar variability affect the geospace environment?**

**K Shibata, Joe Borovsky, Yihua Yan\*** (Apr 2012 - )

**TG4: What is the geospace response to variable inputs from the lower atmosphere?**

**Jens Oberheide, Kuzuo Shiokawa, S. Gurubaran\*** (Apr 2012 - )

### CAWSES-II Related Meetings in 2012-2013 (1/2)

#### 2012

- The 13<sup>th</sup> ISEA (International Symposium on Equatorial Aeronomy), March 12-16, 2012, Paracas, Peru (TG4)
- The 13<sup>th</sup> MST Radar Workshop, March 19-23, 2012, Kühlungsborn, Germany (TG4)
- Second CAWSES II, TG 2 Workshop: Modeling Polar Mesospheric Cloud Trends Lab. Atmos. & Space Phys., May 3-4, 2012, Univ. Colorado, Boulder, US (TG2)
- JpGU (Japan Geoscience Union) Assembly, Session on CAWSES-II/ISWI, May 20-25, 2012, Chiba, Japan
- CEDAR, Session on Thermosphere – Ionosphere Climate, June 2012, NM, US (TG2, TG4)
- 39<sup>th</sup> COSPAR, July 14-22, 2012, Mysore, India
  - CAWSES II Business Meeting, July 21 (All TGs)
  - TG2 Business Meeting, July 20 (TG4)
  - C2.2: Whole Atmosphere Wave Coupling and Interaction Processes (TG4)
  - D2.1: CMEs in the Rising Phase of Solar Cycle 24 (TG3)
  - D2.4: Solar-Wind Fine Structure: Its Physical Properties, its Origin, and its Effect on the Earth's Magnetosphere (TG3)

### CAWSES II Business Meeting, 39<sup>th</sup> COSPAR, Mysore, India Date: July 21, 2012, 9:30-13:30, Room B1 007

1. Address from SCOSTEP: Nat Gopalswamy
2. Overview of CAWSES-II: T. Tsuda
  - report from previous meeting during EGU
  - CAWSES related meetings in 2012
3. Report on highlights from TGs (30 min. each)
  - TG1: Katja Matthes, Annika Seppala, Cora Randall  
(\* A report from Annika Seppala)
  - TG2: Jan Lastovicka\*, Dan Marsh, G. Beig
  - TG3: K. Shibata\*, Joe Borowski, Yihua Yan
  - TG4: Jens Oberheide\*, Kazuo Shiokawa\*, S. Gurubaran\*
  - CAWSES in India: P. Balrama Rao, M.V. Ratnam\*
4. Future meetings
  - ISWI/MAGDAS in Bandung, September 2012 (NG, MY)
  - CAWSES/ISWI session at ISSTP in Pune, November 2012 (JD, NG)
  - CAWSES symposium in Nagoya, November 2013 (KS, TN, MY)

### CAWSES-II Related Meetings in 2012-2013 (2/2)

#### 2012

- [AOGS/AGU-WPGM](#), August 13-17, 2012, Singapore
- 7<sup>th</sup> IAGA/ICMA/CAWSES Workshop on Long-Term Changes and Trends in the Atmosphere, September 11-14, 2012, Buenos Aires, Argentina (TG2)
- [HEPPA/SOLARIS-2012](#) Workshop, NCAR, Boulder, Colorado, September 9-12, 2012 (TG1)
- [ISWI/MAGDAS](#) School on Space Science, September 17-26, 2012, Cipanas/Bandung, Indonesia (SCOSTEP, ICSU grant)
- **ISSTP 2012**: International Symposium on Solar-Terrestrial Physics, November 6-9, 2012, Pune, India (All TGs)
- Chapman Conference on longitudinal and hemispheric dependence of space weather, November 12-16, 2012, Addis Ababa, Ethiopia (TG3)

#### 2013

- TOSCA Science School, Impact of solar variability on climate, March 11-15, 2013, Thessaloniki, Greece (TG1)



The International Symposium on Solar-Terrestrial Physics (ISSTP 12)  
November 6 - 9, 2012

[Indian Institute of Science Education and Research \(IISER\), Pune, India](#)



- ✓ About 130 people attended that included ~20% of students
- ✓ About 30 papers have been submitted to a special issue of the Bulletin of Astronomical Society of India.

**5 Nov 2012 Tutorial Session**

09:00	<b>Solar Interior</b> Dr. H M Antia
10:00	<b>Solar Dynamo</b> Dr. Dibyendu Nandi
11:00	<b>Solar Atmosphere</b> Dr. R Erdelyi
12:00	<b>CMEs/ICMEs</b> Dr. Nandita Srivastava
14:30	<b>Solar Wind and IP Medium</b> Dr. P K Manoharan
15:30	<b>Magnetosphere-Ionosphere Coupling</b> J.-P St-Maurice

**6 Nov 2012 Inaugural Session**

09:00	<b>Opening remarks</b> Dr. K. Ganesh Director, IISER Pune
09:10	<b>Remarks</b> Prof Siraj Hasan, co-chair, SOC, ISSTP 2012
09:20	<b>Remarks</b> Dr N Gopalswamy, co-chair, SOC, ISSTP 2012
09:30	<b>Remarks</b> Prof Sunil Mukhi, Head, Physics division, IISER Pune
09:30	<b>Vote of thanks</b> Dr Prasad Subramanian, chair, LOC

**Regular Oral Sessions**

Time	6 Nov 2012	7 Nov 2012	8 Nov 2012
9:30-11:00	<b>Solar Dynamo/Interior</b> Chair : Petrus Martens Dibyendu Nandi (invited) H. M. Antia (invited) P Janardhan (contributed) Sushant Mahajan (contributed)	<b>Solar Interior, Transition Region &amp; Corona</b> Chair : S S Hasan Durgesh Tripathi (Invited) R Erdelyi (contributed) A K Srivastava (contributed) Sreejith P (contributed) Srividya S (contributed)	<b>Coronal Structure and Dynamics</b> Chair : R Erdelyi Petrus C Martens (invited) P F Chen (invited) D Banerjee (contributed)
11:30-13:00	<b>Magnetosphere-Ionosphere Coupling</b> Chair : A. Bhattacharyya K Shiokawa (invited) S G Kanekal (invited) J.-P St-Maurice (contributed) Jeni Victor N (contributed)	<b>Flares &amp; CMEs</b> Chair : Dave Webb E Kontar (invited) Prasad Subramanian (contributed) Nandita Srivastava (contributed) Avijeet Prasad (contributed)	
14:30-16:00	<b>Atmosphere-Ionosphere Coupling</b> Chair : JP St. Maurice A Bhattacharyya (invited) A K Patra (invited) K K Grandhi (contributed) S Sridharan (contributed)	<b>Space weather &amp; Climate I</b> Chair : K. Shiokawa D Webb (invited) N Gopalswamy (invited) A Lara (contributed) Vidya Charan Dwivedi (contributed)	<b>Visit Giant Meter Wave Radio Telescope</b>
16:30-18:00	<b>New Facilities</b> Chair : J Davila NLST (S S Hasan) MAST (P Venkatakrishnan) Aditya (J Singh)	<b>Space weather &amp; Climate II</b> Chair : Nat Gopalswamy D Fontaine (invited) D Pallamraju (invited) T Ogino (Contributed) A K Sinha (Contributed)	
18:30	<b>Cultural Program</b>	<a href="#">The Faint Young Sun Paradox</a> Public Lecture : Petrus Martens	

	ISSTP SCOSTEP/CAWSES Session, November 9		
	Time	Program	Speaker
<ul style="list-style-type: none"> <li>✓ Introduction of CAWSES</li> <li>✓ Highlights from each TG</li> <li>✓ CAWSES national programs (India, Korea, Japan, China, Brazil)</li> <li>✓ Discussion of future science programs</li> </ul>	09:00	Introduction	J. Davila
		Summary of Decadal	Shri Kanekal
	09:30	TG1 Summary	Cora Randall
	10:00	TG2 Summary	
		Gufran Beig	
	11:00	TG3 Summary	A. Asai
	11:30	TG4 Summary	
		K. Shiokawa	
	CAWSES India – A. Bhattacharyya		
		Solar Activities Solar influence on climate (theme-1)	P. K. Manoharan-
	13:30	Space weather and climate (theme-2)	D. Pallam Raju
		Atmospheric coupling processes (theme-3)	S. Gurubaran
	14:30	CAWSES in Japan	M.V. Ratnam
	14:50	CAWSES in Korea	T. Ogino
	15:10	CAWSES in China	Y.-D. Park
	15:30	CAWSES in Brazil	Yihua Yan
		CAWSES in France	J.-P. Raulin
	15:50	D. Fontaine	
	16:30	Panel Discussion: What Should be the Next SCOSTEP Scientific Program?	N. Gopalswamy J. Davila (Moderator) D. Nandi K. Shiokawa J.-P. St-Maurice G. Beig

### **Future CAWSES-II Related Meetings in 2013**

- JpGU (Japan Geoscience Union) Assembly, Sessions on Space weather, MLT dynamics, etc, May 19 - 24, 2013, Chiba, Japan
- IAU Symposium No. 300, "Nature of prominences and their role in Space Weather", June 10 - 14, 2013, Paris, France, SOC chair, Brigitte Schmieder, (TG3)
- Space Climate Symposium-5, June 15-19, 2013, Oulu, Finland (TG1)
- International Study for Earth - Affecting Solar Transients (ISEST), June 17-20, 2013, Hvar, Croatia, SOC Member: Jie Zhang (TG3)
- AOGS (Asia Oceania Geoscience Society) 10th Annual Meeting (AOGS2013), Brisbane, June 24-28, 2013
- Workshop on Whole Atmosphere Coupling during Solar Cycle 24, July 14-17, 2013, National Central University, Taiwan (TG4)
- IAGA 2013, 12th Scientific Assembly, Mérida, Yucatán, México, August 26 -31, 2013
- International CAWSES-II Symposium, November 18-22, 2013, Nagoya, Japan, (All TGs)





**SCOSTEP**  
International  
**CAWSES-II**  
Symposium  
**Nagoya Japan**  
November 2013 **18-22**

**Panel Discussions**  
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

**Special Sessions**  
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

**Important Dates**  
Abstract submission deadline: June 30, 2013  
Financial support request deadline: June 30, 2013  
Early registration deadline: August 31, 2013

Conveners:  
T. Nakamura, K. Shikama, M. Yamamoto, and N. Goswami  
Web: <http://www.stelab.nagoya-u.ac.jp/cawses2013/>  
E-mail: [cawses13@stelab.nagoya-u.ac.jp](mailto:cawses13@stelab.nagoya-u.ac.jp)

Sponsored by: 

- ✓ Abstract submission: June 30, 2013
- ✓ Financial support request: June 30, 2013
- ✓ Early registration: August 31, 2013

## TG1



### What are the solar influences on the Earth's climate?

- Solar variability drives the Earth's environment on time scales ranging from minutes to millennia. Feedbacks are inherent in the Earth system and may amplify the direct forcing effects from the Sun.
- The influence of this solar variability on Earth's climate is a key issue of IPCC, and one that continues to be highlighted by policy makers, climate change skeptics, and the media.

**Report from TG1 leader (Annika Seppala)****TG1**

1. Recent topic  
Joint TG1, COST TOSCA, SPARC HEPPA-SOLARIS white paper is submitted.
2. Meetings/sessions  
**HEPPA-SOLARIS Workshop, Oct 2012**  
TOSCA Workshop: From the Stratosphere to the Ionosphere, Nov 2012  
WCRP/SPARC: Stratosphere-Troposphere Processes and their Role in Climate, Apr 2013  
COST TOSCA session in EGU, Apr 2013  
Space climate symposium, Jun 2013  
17th Conference on the Middle Atmosphere, Jun 2013  
Session S1 "Solar Activity and its Manifestations in the Whole Heliosphere", European Week of Astronomy and Space Science (EWASS), Jul 2013.  
IAGA, Aug 2013  
ESA Living planet symposium, Sept 2013  
Session AS12 "Sun- Earth interactions", European Meteorological Society Annual Meeting, Sept 2013.
3. observation campaigns, intensive data analysis, etc.  
HEPPA Model-Measurements Intercomparison (MMI), for the polar winter 2008-9
4. capacity building activities  
TOSCA Training school on Solar variability and its impact on climate, Thessaloniki, 10-15 March 2013, <http://sun2climate.sciencesconf.org>

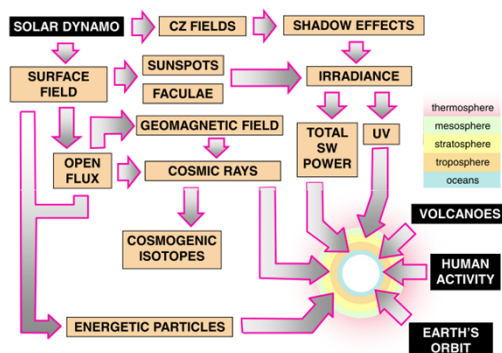
**4<sup>th</sup> International HEPPA Workshop in conjunction with SPARC/SOLARIS**  
**9-12 October 2012, National Center for Atmospheric Research, Boulder, CO, USA**

**TG1**

**HEPPA: High Energy Particle Precipitation in the Atmosphere**  
**SOLARIS: SOLAR Influences for SPARC(Stratospheric Processes and their Role in Climate)**

Workshop focused on observational and modeling studies of the influences of solar radiation and energetic particle precipitation on the atmosphere and climate. Bringing together two established international communities: **HEPPA** and **SOLARIS**.

Gray et al.: SOLAR INFLUENCE ON CLIMATE



**Figure 20.** Schematic overview showing various climate forcings of the Earth's atmosphere, with factors that influence the forcing associated with solar variability (irradiance and corpuscular radiation) shown in more detail on the left-hand side, as discussed in section 2.



## TG2



### How will the geospace respond to an altered climate?

- Radiative, chemical, and dynamical forcing from below contributes to disturbances of the upper atmosphere.
- In response to **rising greenhouse gas concentrations, cooling in the middle atmosphere** will alter the complex physical and chemical processes of this region. Patterns of cooling and contraction of the upper atmosphere are emerging from model studies and observations, consistent with a strong connection to changes in the lower atmosphere.
- Rising greenhouse gas concentrations alter the ionosphere in a variety of ways and could be transmitted to the magnetosphere.
- These changes may have unforeseen consequences for space-related technologies and societal infrastructures.

### Report from TG2 Leaders (G. Beig, Jan Lastovicka)

TG2

#### Key questions – projects

#### (1) How do changes in tropospheric wave generation and their propagation through a changing atmosphere affect the dynamics of the MLT (two subprojects)?

The key open question of long-term changes and trends in the middle and upper atmosphere and the ionosphere. Limited progress. However, now it is clear that **trends in dynamics and atmospheric wave activity may be regionally substantially different.**

#### (2) How the MLT and higher regions respond to anthropogenic and natural changes –TRENDS?

- Impact of stratospheric ozone changes has been specified ; it is important in the MLT region.
- Greenhouse gases are the main driver of long-term trends.
- There is also indirect effect of solar activity – trends in thermospheric density are much stronger under solar minimum conditions.
- Trends in thermospheric density will cause a substantial increase of space debris at LEO satellite heights resulting in increasing number of satellite-damaging collisions.

**Key questions – projects****TG2**

(3) Are PMC/NLC frequency and brightness trending due to changes in T and water vapor? Do they differ between the hemispheres?

- Satellite measurements (SBUV) dating back to 1979 shows a significant long-term trend in mesospheric cloud (MLC) activity and brightness. Trends are well pronounced at very high latitudes, whereas they are statistically insignificant at noctilucent cloud (NLC) latitudes.
- Models for the first time quantitatively reproduced long-term changes of PMCs.

**Important meetings**

- A Brainstorming Session; SCOSTEP-Future, 7th Workshop on “Long term Changes and Trends in the Atmosphere”, Buenos Aires, September 13, 2012.
- The TREND community (IAGA, IAMS/ICMA and CAWSES) decided to come up with a white paper on “Atmospheric TRENDS” to form a basis of new program of SCOSTEP after 2013.

**TG3****How does short-term solar variability affect the geospace environment?**

- Short-term solar variations directly and abruptly affect the space weather. Electromagnetic radiation drives the ionosphere, while solar particulate outputs penetrate through space, interact with the magnetosphere and upper atmosphere, and even produce disturbances at Earth's surface. A systems approach is crucial to understand and forecast space weather.

TG3

## Report from TG3 leader (Kazunari Shibata)

1. Recent Meetings/Sessions
  - Peru-Japan FMT workshop, March 10-15, 2013, Hida Astronomical Observatory, Kyoto University, Japan.
  - 2<sup>nd</sup> Joint Session of Japan-Korean Astronomical Society Meeting on Space Weather and Space Climate, March 20-22, 2013, ASJ Spring Meeting at Saitama, Japan
2. Observation Campaigns.
  - MiniMax24 joint event study (organized by Manuela Temmer and Nat Gopalswamy)
3. Important Publications
  - Asai et al. (2012) ApJ Lett. 745, 18L, First Simultaneous Observation of H alpha Moreton Wave, EUV Wave, and Filament/Prominence Oscillations
  - Maehara et al. (2012) Nature, 485, 478, Superflares on Solar-Type Stars

TG3

## 4. International Collaboration Project

- CHAIN (Continuous H Alpha Imaging Network)  
In Addition to Peru, Saudi-Arabia decided to install FMT (Flare Monitoring Telescope)
- International Study for Earth - Affecting Solar Transients (ISEST) –  
SOC Members: Jie Zhang (USA) et al.
- 5. Future Important TG3 Meetings
  - Japan Geoscience Union (JpGU) Assembly, Space weather Session, May 19 - 24, 2013
  - IAU Symposium No. 300, "Nature of prominences and their role in Space Weather", June 10 - 14, 2013, Paris (France) (SOC - chair, Brigitte Schmieder)
  - Hinode - 7 meeting, November 11 - 15, 2013, Takayama (Japan) (SOC-chair, Kazunari Shibata)

## TG4



### What is the geospace response to variable waves from the lower atmosphere?

- A variety of new evidence suggests that tropospheric weather is an important ingredient in space weather. Equatorial ionospheric densities are modulated by atmospheric waves driven by persistent tropical rainstorms. Radio waves generated by lightning strokes in the rainstorms interact with radiation belt particles to clear a "safe" zone between the inner and outer belts in the magnetosphere.
- Atmospheric gravity waves generated by hurricanes and typhoons may seed plasma bubbles in the low latitude ionosphere. The extent to which the effects of this quiescent atmospheric variability are transmitted to the magnetosphere is yet to be resolved.

**TG4 Business Meeting**, 20 July 2012 at 39<sup>th</sup> COSPAR, Mysore, India

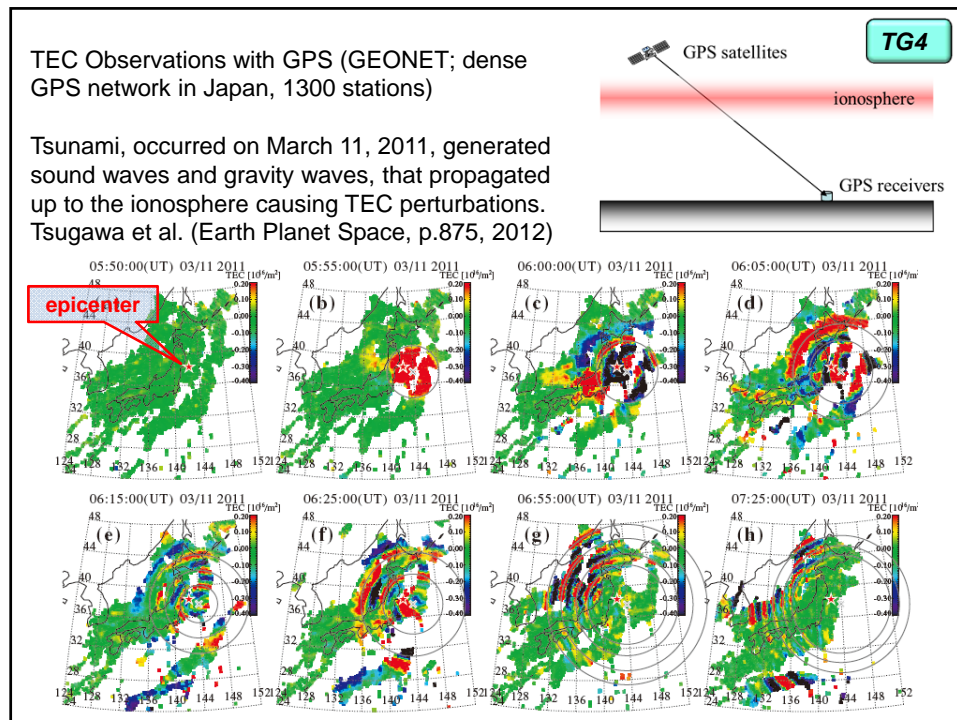
**TG4**

Key issues (A summary was published in TG4 newsletter No 10)

1. Support for long-term storage of CAWSES campaign data. This was also brought up during the general CAWSES-II business meeting.
2. The urgent need for data from Africa and approaches for capacity building there.
3. LONET campaign (Profs. Takahashi and Makela). Results will be presented at the CAWSES-II symposium in Nagoya

#### Important Publications

- ✓ A special issue of "Recent Progress in the Vertical Coupling in the Atmosphere-Ionosphere System" (Ed. D. Pancheva, P. K. Knizova, K. Shiokawa and W. Wan) J. Atmos. Solar-Terrestrial Phys. Vol. 90–91, p 1-222, December 2012.  
<http://www.sciencedirect.com/science/journal/13646826/90>  
(The 4<sup>th</sup> IAGA/ICMA/CAWSES-II TG4 Workshop on Vertical Coupling in the Atmosphere-Ionosphere System", Feb 14-18, 2011, Prague)
- ✓ T. Bosinger, J. LaBelle, H. J. Opgenoorth, J.-P. Pommereau, K. Shiokawa, S. C. Solomon, and R. A. Treumann (editors), Dynamic coupling between Earth's atmospheric and plasma environments, Space Sciences Series of ISSI, Vol. 42, Springer, 2013.
- ✓ The quarterly TG4 newsletters, published by Nagoya University are regularly distributed via email and through the TG4 webpage  
[http://www.cawses.org/wiki/index.php/Task\\_4](http://www.cawses.org/wiki/index.php/Task_4)  
Each newsletter includes at least one article from young scientists.



### White Papers submitted to the ISSI/SCOSTEP Forum

The nine proposals are, at least in part, related to Task Groups of CAWSES-II, although they are not necessarily discussed at each TG.

#### TG1

[Role of Solar Variability in Climate](#), Annika Seppälä (Finland)

[Solar-Terrestrial Evolution & Climate Connections](#), P. Martens (US), D. Nandi (India)

#### TG1 & TG3

[Abnormal PhEnomena and Cycles in Sun-Earth System \(APECSES\)](#)

Vladimir Kuznetsov (Russia, IAGA), Vladimir Obridko

#### TG3

[Coronal Heating and the Acceleration of the Solar Wind](#)

Mahboubeh Asgari-Targhi (US), Mari Paz Miralles (UK)

[Specification and Prediction of the Coupled Inner Magnetospheric Environment \(SPeCIMEN\)](#), Jacob Bortnik (US), Craig J. Rodger (New Zealand)

#### TG2

[Atmospheric trends](#), G. Beig (India), J. Laskovicka (Czech), D. Marsh (US)

#### TG2 & TG4

[Data Assimilation for the Thermosphere and Ionosphere](#), Mihail Codrescu (NOAA)

#### TG4 & TG2

[Role Of the Middle Atmosphere/Lower Thermosphere in Climate \(ROMIC\)](#), Franz-Josef Lübken (Germany)

#### TG1-4

[Proposal for new program from Japanese SCOSTEP committee](#), T. Ogino (Japanese SCOSTEP Committee)

#### Summary of CAWSES-II from April 2012 to present

- ✓ TGs have promoted scientific topics of CAWSES-II in 2012 by coordinating observation campaigns (SOMCOSE, LONET, MinMax etcc), data analysis, model comparisons, etc.
- ✓ New members of TG leaders contributed greatly to TG activities:  
     TG1: Annika Sepala, Cora Randall, TG2: G. Beig, TG3: Yihua Yan, TG4: S. Gurubaran
- ✓ Regional activities of CAWSES-II are executed as a national program, which could be extended more beyond 2014. For example, Brazil, Korea, Germany, India, China, Japan, etc.  
     Esp., India: lower and middle atmospheric processes, space weather & applications  
     China: solar physics, and ground-based observation facilities  
     Japan: 46 key subjects by Japanese Science Council "Solar-Terrestrial Coupling Processes"
- ✓ Collaboration with other programs, like WCRP/SPARC, ISWI, WDS, etc, is enhanced.
- ✓ Capacity building: International schools, like ISWI/MAGDAS in Indonesia; TOSCA science School. Partial travel support for young scientists
- ✓ Data exchange: Support for long-term data storage and effective data-exchange system are required. STP data are unique/uncommon, so not documented well. Therefore, the large amount of data are kept unused. (Japanese IUGONET: common property system for meta data)
- ✓ TGs organized a number of meetings and CAWSES related sessions at a large assembly, like COSPAR, ISSTP, IAGA, AOGS, JpGU, IAU, etc. Some of them are held as an overall CAWSES-II sessions.
- ✓ Yet, interaction among the four TGs is not fully conducted. Toward the end of CAWSES-II, we will strategically promote mutual understating of four TGs, then we discuss key outcomes from CAWSES-II as well as future perspective.
- ✓ CAWSES-II Nagoya symposium in November 2013 will become a good opportunity to summarize the CAWSES results, and investigate what we need to seek more beyond 2014.

#### CAWSES-India; 3-day national workshop (4/30-5/2) (report by S. Gurubaran)

1. Solar Influence on Climate (lower and middle atmospheric processes)
2. Space Weather and Climate: Science and Applications
3. Atmospheric Coupling Processes

The CAWSES-India program gave a platform for researchers working on various topics to come together and carry out coordinated studies on several outstanding problems.

1. Relationship between the solar cycle and the Indian Summer Monsoon, heavy rainfall events and surface temperature - efforts are being made to understand this relationship through a 3D global simulation model
2. Sun-Earth connection and space weather studies carried out from the IPS observations using the Ooty Radio Telescope in coordination with several other ground-based studies - the peculiarities of the recent solar cycle have been brought out in terms of the speed and the density turbulence of the solar wind
3. ELF/VLF and optical remote sensing of lightning induced disturbances in the near-space environment - the peculiarities of low latitude whistlers and the observations of sprites made for the first time in India were the highlights of this work
4. Relationship between stratospheric ozone, planetary waves in the middle atmosphere and tides in the mesosphere examined and new results emerged
5. Comprehensive analysis of Tropical Tropopause Layer (TTL), its dynamics and its role in the formation of cirrus carried out with a series of the first-of-its-kind coordinated balloon experiments from two latitude stations, Gadanki and Thumba (Trivandrum) and several new findings reported

As a follow-up to Phase-2 of CAWSES program in the country, we will evolve a national program with strong international participation this time - we anticipate that one or more components of the forthcoming activity would be part of the international CAWSES program with Indian scientists taking lead in those emerging areas.