
K. Shiokawa and K. Georgieva
International interdisciplinary programs in solar-terrestrial physics operated by SCOSTEP

1976-1979: IMS (International Magnetosphere Study)
1979-1981: SMY (Solar Maximum Year)
1982-1985: MAP (Middle Atmosphere Program)
1998-2002: Post-STEP (S-RAMP, PSMOS, EPIC, and ISCS)
2004-2008: CAWSES (Climate and Weather of the Sun-Earth System)
2009-2013: CAWSES-II (Climate and Weather of the Sun-Earth System-II)
2014-2018: VarSITI (Variability of the Sun and Its Terrestrial Impact)
Solar Variability and SCOSTEP Scientific Programs

International sunspot number $R_i$: monthly mean and 13-month smoothed number

- Dawn of Space Age
- IGY
- IQSY
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010
- IHY
- IGY
- IQSY
- SMY
- MAP
- STEP
- SRAMP
- PMOS
- EPIC
- ISCS
- CAWSES
- VarSITI

SILSO graphics (http://sidc.be) Royal Observatory of Belgium 2015 February 1
VarSITI has 4 scientific projects

International Study of Earth-Affecting Solar Transients (ISEST)/MiniMax24

How do coronal mass ejections (CMEs) and corotating interaction regions (CIRs) propagate and evolve, drive shocks and accelerate energetic particles in the heliosphere?

Solar Evolution and Extrema (SEE)

1) Are we at the verge of a new grand minimum? If not, what is the expectation for cycle 25?
2) Does our current best understanding of the evolution of solar irradiance and mass-loss resolve the “Faint Young Sun” problem? What are the alternative solutions?
3) What is the largest solar eruption/flare possible? What is the expectation for periods with absence of activity?

Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC)

1) What is impact of solar forcing of the entire atmosphere? What is the relative importance of solar irradiance versus energetic particles?
2) How is the solar signal transferred from the thermosphere to the troposphere?
3) How does coupling within the terrestrial atmosphere function (e.g. gravity waves and turbulence).
4) What is the impact of anthropogenic activities on the Middle Atmosphere, Lower Thermosphere, Ionosphere (MALT)?
5) What are the characteristics of reconstructions and predictions of TSI and SSI?
6) What are the implications of trends in the ionosphere/thermosphere for technical systems such as satellites.

Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)

Can the state of the Earth’s inner magnetosphere be specified and predicted to high accuracy, based on inputs from the Sun and solar wind?

VarSITI Leaflet (distributed in Dec 2015)
Solar Evolution and Extrema (SEE)

Piet Martens,
(Smithsonian Astrophysical Observatory, USA)

Vladimir Obridko,
(IZMIRAN, Russia)

Dibyendu Nandi,
(IISER Kolkata, India)
• How well do we understand how Sun works?
• Can we predict Sun’s activity? Are we entering a grand “Maunder-type” minimum, or just a secular “Dalton-type” minimum? Input for climate models.

Dikpati and Gilman, 2006

Predictions of sunspot cycle 24
Gopalswamy et al. (APJ, 2016): unusual polar B filed in cycle 25 (north B is delayed to develop)

Lines indicate the drop in $B$ (1b) between the 22/23 and 23/24 minima. The vertical lines mark the times of reversal completion (north: N, 2015 September; south: S, 2014 June). The last $B = 0$ time was during CR 2158 (2014 December 8 to 2015 January 4) in the north and a year earlier in the south (CR 2146—2014 January 15 to February 11). Note that the reversal occurs earlier in the south, which is different from Cycle 23.
Hotta et al. (Science, 2016): High-resolution modeling of solar magnetic field at high Reynolds numbers (small scale dynamo acts as large diffusivity).
International Study of Earth-Affecting Solar Transients ISEST/MiniMax24

International Study of Earth-affecting Solar Transients
ISEST

Jie Zhang,
(George Mason University, USA)

Manuela Temmer,
(UNIVERSITY OF GRAZ, Austria)

Nat Gopalswamy,
(Lab. for Solar & Space Physics, NASA/GSFC, USA)
Anomalous Expansion of CMEs in Cycle 24

Cycle-24 CMEs are 52% wider for V=1000 km/s

Cycle 23 (n=273)
1996/05/10–2001/07/09
r=0.56, W=0.09V+30.9

Cycle 24 (n=214)
2006/12/01–2014/01/31
r=0.71, W=0.17V+19.7

Gopalswamy et al. (GRL, 2014): CME size difference by different background pressure condition in Cycle 23 and 24.
(a) Central filament channel as observed in SDO/AIA 304 Å around the main sunspot of NOAA 11305 before the flare-CME on 1 October 2011. (b) NLFF model magnetic field lines outlining the observed filament channel. The color-coded background resembles the SDO/HMI vertical magnetic field, scaled to ±2 kG ±2 kG. (c) Orientation of the coronal magnetic field (orange arrows) in a vertical cut through the model volume above the path outlined as a white solid line in (b). (d) Orientation of the coronal magnetic field as in (c), but with the magnitude of the total electric current density shown as color-coded background.

GCS modeling results using the simultaneous view from three spacecraft (STEREO B left, LASCO middle, and STEREO A right) on 1 October 2011.

Left: Interplanetary propagation of the CME under study (red line) tracked using SATPLOT j-maps. Top right: Conversion result from the derived elongation angle using several methods with different assumptions on the CME geometry (FP, HM, SSE – for more details see Section 2.4). Bottom right: DBM graphical output (swe.uni-graz.at) using the parameters derived from the GCS model fit as initial values.
Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)

*Specification and Prediction of the Coupled Inner-Magnetospheric Environment*  
SPeCIMEN

Jacob Bortnik,  
(Dept. of Atmospheric and Oceanic Sciences  
UCLA, USA)

Craig Rodger,  
(University of Otago,  
New Zealand)
In a–e the highly energetic electrons measured by REPT sensors throughout the mission never seem to extend inwards of $L \approx 2.8$. This forms a particularly clear and sharp boundary for the ultrarelativistic electrons as shown in c–e.
Fennel et al. (GRL, 2015): Van Allen Probes show that the inner radiation zone contains no MeV electrons:

L* versus time spectrograms of MagEIS electron fluxes from five selected energies taken by Van Allen Probe A during 24 February to 31 March 2013.
Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC)

F.-J. Lübken,
(Leibniz-Institut für Atmosphärenphysik, Germany)

Annika Seppälä,
(Finnish Meteorological Institute, Finland)

William Ward,
(University of New Brunswick, Canada)
How well do we understand solar variability effects on the middle and lower atmosphere?

Solar versus anthropogenic Influence on Climate in the Context of Weak Solar Activity

Gray et al. (Rev. Geophys., 2010)
Andersson et al. (Nature Comm., 2014): First evidence for radiation belt electron precipitation impact on atmospheric ozone in long term.
She et al. (AnnGeo, 2015): long-term trend of mesopause temperature based on 25-year Na-lidar measurements.

Figure 2. Linear temperature trend from the quarter century data set with 11- and 7-parameter analyses, respectively denoted as F-11P(90-14_Avg) in black solid circles and F-7P(90-14_Avg) in black open circles. Shown for comparison are those data published based on an 18-year data set denoted as F-11P(90-07) in red solid squares and F-7P(90-07) in open red squares.

She et al. (AnnGeo, 2015): long-term trend of mesopause temperature based on 25-year Na-lidar measurements.
We encourage more communication between solar and heliosphere scientists and Earth’s magnetosphere, ionosphere, and atmosphere scientists.

- Campaign data analysis from the Sun to the Earth
- Web pages (www.varsiti.org)
- Mailing lists (>900 members are registered)
- Newsletters
- Meetings (financial support is available)
Good Afternoon.

Welcome to: Variability of the Sun and Its Terrestrial Impact (VarSITI)

© VarSITI 2013

Variability of the Sun and Its Terrestrial Impact

The VarSITI program is the next scientific program of SCOSTEP (2014-2018)

VarSITI was defined based on a community effort in the form of a forum organized by the International Space Science Institute (ISSI) in Bern during May 7-8, 2013. The VarSITI program will strive for international collaboration in data analysis, modeling, and theory to understand how the solar variability affects Earth.

The VarSITI program will have four scientific elements that address solar terrestrial problems keeping the current low solar activity as the common thread:

- SEE (Solar Evolution and Extrema),
- MiniMax24/ISEST (International Study of Earth-affecting Solar Transients),
- SPEcIMEN (Specification and Prediction of the Coupled Inner-Magnetospheric Environment), and
- ROSMIC (Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate).
VarSITI web-site  http://www.varsiti.org/

44370 visits from October 1, 2013 to April 24, 2017

Visits from 14 to 24 April
CAMPAIGNS

- **ISEST/MiniMax24**

  **Goals and objectives:** Understand the propagation of solar transients through the space between the Sun and the Earth, and develop space weather prediction capability

  **The key question:** How do coronal mass ejections (CMEs) and corotating interaction regions (CIRs) propagate and evolve, drive shocks and accelerate energetic particles in the heliosphere?

  **Approach:** coordinated investigation of selected Earth-affecting solar transient events including CMEs, CIRs, flares, and energetic particle events

  **Period:** ongoing for the whole duration of the VarSITI program
First campaign observations for Arase and ground-based observations

• **Goals and objectives**: Study of acceleration and loss of particles in the inner magnetosphere and their wave-particle interactions

• **Approach**: Coordinated investigations of the inner magnetosphere by the Arase and other inner-magnetospheric satellites with ground-based network instruments

• **Period**: March 21-April 2017
A collection of solar-terrestrial databases at VarSITI’s web site

VarSITI-Related Database Resources
Discussed at SCOSTEP-WDS Workshop on Sept.28-30, 2015
Last modified 11/22/2016 17:22:37

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>database-comprehensive (7)</td>
</tr>
<tr>
<td>[3]</td>
<td>database-muti (10)</td>
</tr>
<tr>
<td>[5]</td>
<td>model and ground-based observation (1)</td>
</tr>
<tr>
<td>[7]</td>
<td>model (2)</td>
</tr>
<tr>
<td>[9]</td>
<td>satellite observation (future) (3)</td>
</tr>
<tr>
<td>[2]</td>
<td>database visualisation tool (4)</td>
</tr>
<tr>
<td>[4]</td>
<td>data analysis resources (6)</td>
</tr>
<tr>
<td>[6]</td>
<td>model and satellite observation (1)</td>
</tr>
<tr>
<td>[8]</td>
<td>satellite observation (33)</td>
</tr>
<tr>
<td>[10]</td>
<td>ground observation (63)</td>
</tr>
</tbody>
</table>

The list below has 130 different Databases
Print 🖨 (18pages) or download as Excel file 📄 (28KB)
Development of new databases supported by VarSITI – 4 in 2016

**VarSITI Grants**
Creation of databases supported by VarSITI in 2016

**Databases**

**Sunspot Database from Original Drawings**
*Expected Result*: Catalog of sunspot numbers

**Catalog of large-scale solar wind phenomena during 2001-2015**
*Expected Result*: Catalog of large-scale phenomena in the solar wind from OMNI2

**Wave Indices in the Magnetosphere**
*Expected Result*: Construction and dissemination of wave indices as indicators of turbulent energy transfer into the magnetosphere
*Developer*: Institute of the Physics of the Earth (Moscow, Russia)

**EUV global waves observed in the sun**
*Expected Result*: Web-based list of identified EUV global waves (*The CorPITA database*)
*Developer*: University College London, (London, UK)
Development of new databases supported by VarSITI – 5 in 2017

VarSITI Grants
Creation of databases supported by VarSITI in 2017

Databases

Database for assessment of radiation doses in the Earth's atmosphere, related to GLE events
Topic: Ground Levels Enhancement (GLE) events, ISEST/Minimax24
Developer: University of Oulu, Finland

Database for atmospheric and whistler events detected in the Russian Far East
Topic: VLF whistlers and atmospherics, SPeCIMEN
Developer: IKIR, FEB RAS, Russia

Database on the Forbush effects and interplanetary disturbances to study Solar-Terrestrial relationship
Topic: Cosmic Ray, ISEST/Minimax24
Developer: IZMIRAN, Russia

Complex Catalogue of High Speed Streams andGeomagnetic Storms During Solar Cycle 24 (2009 - 2016)
Topic: high-speed stream and storm, ISEST/Minimax24
Developer: Institute of Geodynamics of the Romanian Academy (IG-AR), Romania

Database of Directivity Functions for neutron monitors
Topic: Cosmic Ray, ISEST/Minimax24
Developer: Yerevan Physics Institute, Armenia
Digitization of 29,296 Drawings of Sunspots on the Solar Disk made at the Zürich Observatory since 1883

1894
April 3
Forbush-effects and interplanetary disturbances to study Earth-affecting solar transients

Space Weather Prediction Center in IZMIRAN in two versions – in Russian and English
16 topical meetings and sessions supported by VarSITI in 2016

+ one canceled (COSPAR in Istanbul)
The most important event in 2016

• First VarSITI General Symposium 06-10 June, Albena, Bulgaria

157 scientists from 29 countries

Aim: to overview the progress of various activities in the four projects at the midpoint of the five-year program, especially to promote the interconnection among these projects

Summarized in: Special Issue of Journal of Atmospheric and Solar-Terrestrial Physics to be published in 2017
We expect that the next two cycles will not be high, but not a beginning of a grand Maunder type minimum. It is most likely that cycle 25 will be of the same height as cycle 24, and the next one may be a bit lower. There is some probability of a Dalton type minimum.
Long-Term Changes and Trends in the Atmosphere

9th IAGA - ICMA/IAMAS - ROSMIC/VarSITI/SCOSTEP workshop on Long-Term Changes and Trends in the Atmosphere

Kühlungsborn, 2016

Dear colleagues and friends,

welcome to the trend workshop in Kühlungsborn, which is probably the most beautiful sea resort in

appr. 120 participants from 16 countries
6th IAGA/ICMA/SCOSTEP Workshop on Vertical Coupling in the Atmosphere-Ionosphere System

25-29 July, 2016, Taipei, Taiwan

A special issue of the Journal of Atmospheric and Solar-Terrestrial Physics
9 VarSITI supported meetings in 2017

Meetings (ordered by date)

- **Data Analysis Workshop on** Coronal Mass Ejections and Solar Radio Bursts, Coronal and Interplanetary Shocks: Data Analysis from SOHO, Wind, and e-CALLISTO Data.  
  *February 19–25, 2017*, Mekelle University, Mekelle, Ethiopia  
  supported by VarSITI [web-address](#)

- **40th annual Seminar on** Physics of the auroral phenomena.  
  *March 13–17, 2017*, Apatity, Murmansk region, Russia  
  supported by VarSITI [web-address](#)

- **Seminar on** The 10 years of operation of High resolution Neutron Monitor Database-NMDB.  
  *March 20–22, 2017*, Athens, Greece  
  supported by VarSITI [web-address](#)

- **ISSI Forum on** Consistency of the Solar Radius: outstanding unsolved points.  
  *first semester of 2017*, Switzerland  
  supported by VarSITI [web-address](#)

- **The 2nd VarSITI Symposium**.  
  *July 10–15, 2017*, Irkutsk, Russia  
  supported by VarSITI [web-address](#)

- **IAU Symposium 335** Space Weather of the Heliosphere: Processes and Forecasts.  
  *July 17–21, 2017*, Exeter, UK  
  supported by VarSITI [web-address](#)

- **13th International Workshop on** Layered Phenomena at the Mesopause Region (LPMR).  
  *September 18–22, 2017*, Kühlungsborn, Germany  
  supported by VarSITI [web-address](#)

- **ISEST/MiniMax24 Workshop on** International Study of Earth-affecting Solar Transients.  
  *September 18–22, 2017*, Jeju Island, Korea  
  supported by VarSITI [web-address](#)

- **AGU Chapman Conference** Particle Dynamics in the Earth's Radiation Belts.  
  *September 25–29, 2017*, Biarritz, France  
  supported by VarSITI [web-address](#)
The most important event in 2017

- **Second VarSITI General Symposium 10-15 July, Irkutsk, Russia**

  Initially planned as a regional meeting but upgraded to a General VarSITI symposium

  235 abstracts are submitted

  Will discuss the hottest topics in solar-terrestrial physics and the progress of the VarSITI program an year before its completion
A dedicated international workshop on studying Earth-affecting Solar Transients

http://kswrc.kasi.re.kr/Workshop/isest2017/
VarSITI newsletters

Publish:

- Articles
- Highlights of young scientists
- Short news
- Meeting schedule

4 issues per year

Editors

Kazuo Shiokawa
Katya Georgieva

Newsletter secretary

Mai Asakura
VarSITI Registration Sheet for mailing list

<table>
<thead>
<tr>
<th>first name</th>
<th>last name</th>
<th>e-mail address</th>
<th>country</th>
<th>interest of projects (choose as many as you like)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE ISEST/Minimax SPeCIMEN ROSMIC ALL</td>
</tr>
</tbody>
</table>

Please sign your name and e-mail address to register into the VarSITI mailing list
VarSITI-related special issues

- JGR: VarSITI Special Section in JGR-Space Physics
- EPS: Global Data Systems for the Study of Solar-Terrestrial Variability (from SCOSTEP-WDS workshop)
- JASTP: ISSI/VarSITI Forum on Solar activity in the following decades
- Solar Phys.: Earth-affecting solar transients
- JASTP: Special issue of the VarSITI-2016 symposium

- EPS: 12th international conference on substorms (ICS-12)
- JASTP: special issue of vertical coupling workshop (Antalya workshop)
- JGR: Geospace system responses to the St. Patrick's Day storms in 2013 and 2015 (CEDAR based)
- AnnGeo: International Symposium of Equatorial Aeronomy (ISEA-14)
A Topical Issue on “Earth-affecting Solar Transients” is being published in Solar Physics Journal

Edited by Jie Zhang, Xochitl Blanco-Cano, Nariaki Nitta, Nandita Srivastava

42 articles submitted in 2016
- 16 articles accepted/published
- 20 articles under review
- 6 articles rejected
VarSITI has 4 scientific projects:

**International Study of Earth-Affecting Solar Transients (ISEST)/MiniMax24**

How do coronal mass ejections (CMEs) and corotating interaction regions (CIRs) propagate and evolve, drive shocks and accelerate energetic particles in the heliosphere?

**Solar Evolution and Extrema (SEE)**

1) Are we at the verge of a new grand minimum? If not, what is the expectation for cycle 25?
2) Does our current best understanding of the evolution of solar irradiance and mass loss resolve the “Faint Young Sun” problem? What are the alternative solutions?
3) What is the largest solar eruption/flare possible? What is the expectation for periods with absence of activity?

**Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC)**

1) What is impact of solar forcing of the entire atmosphere? What is the relative importance of solar irradiance versus energetic particles?
2) How is the solar signal transferred from the thermosphere to the troposphere?
3) How does coupling within the terrestrial atmosphere function (e.g. gravity waves and turbulence).
4) What is the impact of anthropogenic activities on the Middle Atmosphere, Lower Thermosphere, Ionosphere (MALTi)?
5) What are the characteristics of reconstructions and predictions of TSI and SSI?
6) What are the implications of trends in the ionosphere/thermosphere for technical systems such as satellites.

**Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)**

Can the state of the Earth’s inner magnetosphere be specified and predicted to high accuracy, based on inputs from the Sun and solar wind?
study and better understand solar-terrestrial processes!