The Scientific Committee on Solar Terrestrial Physics (SCOSTEP)

Nat Gopalswamy
President, SCOSTEP

“Strengthening international solar-terrestrial science for the benefit of society”

June 8-14 2019 Sofia, Bulgaria
What is SCOSTEP?

- SCOSTEP was established by ICSU in January 1966 as the Inter-Union Commission on Solar-Terrestrial Physics (IUCSTP).

- In September 1978, the XVIIth ICSU General Assembly ratified SCOSTEP's current constitution and SCOSTEP became a Scientific Committee of ICSU (aka interdisciplinary body).

- SCOSTEP is charged with the long-term responsibility of promoting international interdisciplinary programs of finite duration in solar-terrestrial physics. Specifically,
  - to develop and sustain student interest in Sun-Earth connections
  - to promote efficient exchange of data and information between solar and terrestrial scientists in all countries
  - to seek projects and programs that cross over traditional boundaries of physical regions and focused scientific disciplines

- SCOSTEP is engaged in science, capacity building, and public outreach to achieve the above objectives in cooperation with COSPAR, IAGA, IAMAS, IAU, IUPAP, SCAR, URSI, and WDS.
SCOSTEP & ICSU (Now International Science Council - ISC)

• SCOSTEP is one of the 17 Interdisciplinary bodies of ICSU

• Other bodies with overlapping interests: interdisciplinary bodies (COSPAR, CODATA, SCAR, WDS) and scientific unions (IAGA/IUGG, IAMAS, IAU, IUPAP, URSI)

• SCOSTEP Bureau consists of representatives from all these scientific bodies (except CODATA), making it a truly interdisciplinary body

• SCOSTEP is the only organization running scientific research programs of broad interest and implications to life on Earth
What Does SCOSTEP do?

- Runs long-term international interdisciplinary scientific programs in solar terrestrial physics since 1966
- Interacts with national and international programs involving solar terrestrial physics activities
- Engages in Capacity Building activities such as the annual Space Science Schools and SCOSTEP Visiting Scholar Program, Workshops
- Outreach activities (comics books; public lectures; UN Committee on Peaceful Uses of Outer Space (UNCOPUOS))
- Disseminates new knowledge on the Sun-Earth System and how the Sun affects life and society
- Quarterly Newsletters
- Website: [www.yorku.ca/scostep](http://www.yorku.ca/scostep)
- Symposia
- Quadrennial Solar Terrestrial Physics (STP) Symposia
- Scientific papers in refereed journals
School Report

Smt. Kasturbai Walchand College of Science & Arts, Rajnemi Campus,
Sangli, Maharashtra 416416, India

http://www.iiap.res.in/meet/school_meet/index.php
International School on Space Science

• 28 lectures by 23 Professors from USA, Japan, India, and Norway on Sun-to-Earth topics
• ISWI Instruments workshop conducted by 8 scientists from USA, India, Japan, and Switzerland
• There were 120 applications. 74 students were selected. Participants were from China, Egypt, Ethiopia, India, Indonesia, Ivory Coast, Kenya, Korea, Nigeria, Philippines, Rwanda, Thailand, Uganda, and Vietnam
• The lecturers interacted with 100s of high school students

Full report available: http://www.iswi-secretariat.org
Interactive Tutorial on Python – the free Software for Data Analysis

The school involved tutorials, lectures, hands-on activities, and instrument workshop
Capacity Building: One-day School

- Lectures by international experts that attended the VarSITI-2017 symposium
- Prepared students to absorb more of the symposium presentations
- Continued interaction between students and lecturers during the symposium
- Long-term collaboration
COSPAR Capacity Building Workshop on Shock Waves from the Sun May 21 - June 1, 2018, Mekelle, Ethiopia

- The main objective of the COSPAR Capacity-Building Workshops is to encourage the scientific use of space data by scientists in developing countries.
- The Mekelle workshop involved analysis of data from SOHO, STEREO, ACE, and Wind missions in conjunction with ground based radio data from ISWI instruments.
- 35 PhD students from Ethiopia, African countries, and other countries in the region attended.
- Scientists from Ethiopia, Greece, India, Italy, UK, USA lectured and ran hands-on activities in analyzing space- and ground-based data.
- Agencies interested in space weather co-sponsored.
SCOSTEP Visiting Scholar (SVS) Program

- The objective is to train young scientists and graduate students from developing countries in established laboratories of solar terrestrial physics for 1-3 months
- Funding: SCOSTEP will provide the airfare, while the hosting lab will provide the living expenses (lodging, meals, ground transportation, visa fees and other incidentals)
- Frequency: At least four scholars each year, one each related to the four VarSITI themes
- Launched in January 2015
- More labs have come forward to host SCOSTEP Visiting Scholars
- 30 students benefited so far

SVS Selection Committee

Nicole Vilmer (France) Chair
Mike Taylor (USA)
Babatunde Rabiu (Nigeria)
Alejandro Lara (Brazil)
Aki Yoshikawa (Japan)
Paul Baki (Kenya)
There were excellent nominations for Distinguished Scientist Awards. SCOSTEP Awards committee finalized the following scientists:

- **Professor Dr. Sami Solanki (Germany)**
- **Distinguished Scientist**

- **Dr. Nicholas Michael Pedatella, USA**
- **Distinguished Young Scientist**

- **Dr. Brent Carter, Australia**
- **Distinguished Young Scientist**

- **Dr. Xin Cheng, China**
- **Honorable Mention**

SCOSTEP Distinguished Scientists with SCOSTEP Executives
SCOSTEP Outreach: Comic Books

- To raise the awareness of general public on selected scientific topics (currently 9)
- Translated into many languages
- Blanks for new languages
- Available online: yorku.ca/scostep


- Long-term variation of the Sun, geomagnetic activity, and climate
- Coupling between the Earth's atmosphere and space and its relation to quiet and active Sun
- Understanding Earth's space environment and its connection to Space Weather
- Sun to Earth campaign events study
- Atmospheric response to solar variability and modulation of its impact on timescales from minutes to decades
- Data archiving and analysis tools
SCOSTEP 14th Quadrennial Solar-Terrestrial Physics Symposium
July 9 – 13, 2018 Toronto, Canada

• 150 scientists from 26 countries
• Presentations available online:
  http://www.scostepevents.ca/sessions-and-abstracts/presentations-according-to-session/

Publications to be combined with those of the closing symposium

COSPAR . IAGA . IAMAS . IAU . IUPAP . SCAR . URSI . WDS
SCOSTEP Focus

- Four channels of energy flow
- International
- **Interdisciplinary**
- Not doable by a single group or country
- Need *ALL* Scientific unions
- Good focus for funding agencies
Half a Century of SCOSTEP Programs

Solar Variability and SCOSTEP Scientific Programs

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

Dawn of Space Age

SCOSTEP Starts

IMS

SMY

MAP

STEP

SRAMP

PMOS

EPIC

ISCS

VarSITI

CAWSES

PRESTO 2019

IGY 1960

IQSY

1970

1980

1990

2000

2010

IHY, IPY

SILSO graphics (http://sidc.be/silso) Royal Observatory of Belgium 2017 October 2
Variability of the Sun and Its Terrestrial Impact (VarSITI)

varsiti.org
launched on
January 13, 2014

2014-2018

Four Major Projects

http://www.youtube.com/watch?v=couR4MyxNPY

Nat Gopalswamy
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),
✓ ROSMIC (Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate).
VarSITI 2014

1,293 views

https://www.youtube.com/watch?v=couR4MyxNPY
SCOSTEP is an ICSU Interdisciplinary Body tasked with the responsibility to organize long-term scientific programs in solar terrestrial physics and Variability of the Sun and Its Terrestrial Impact (VarSITI) is that program for the period 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 in May 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:

1) SEE (Solar evolution and Extrema)
2) ISEST (International Study of Earth-affecting Solar Transients/MiniMax24)
3) SPEcIMEN (Specification and Prediction of the Coupled Inner-Magnetospheric Environment), and
4) ROSMIC (Role Of the Sun and the Middle atmosphere/ thermosphere/ionsphere in Climate).

VarSITI Co-Chairs:
Prof. Katya Georgieva, Bulgaria
Prof. Kazuo Shiokawa, Japan
Highlights

- **VarSITI** brought together worldwide resources, including space- and ground-based data, virtual data bases, distributed modelling centers, and theories to make rapid progress in the projects.
  
  - Encourages communication among sub-disciplines
  
  - Runs a dedicated website, quarterly newsletter, organizes symposia
  
  - 132 data bases relevant to STP research have been documented in [http://www.varsiti.org](http://www.varsiti.org)

  - Has supported ~50 professional meetings; conducted two VarSITI symposia

  - Significant presence in Quadrennial Symposia (STP13, STP14)

  - About 100 refereed articles published in 4 years
Significant Meetings (Publications)

- 2014 STP13 in Xi’An China (JGR)
- 2016 First VarSITI General Symposium, Albana, Bulgaria (JASTP)
- 2017 Second VarSITI General Symposium, Irkutsk, Russia (JASTP)
- 2018 STP14 in Toronto, Canada (TBD)
- 2019 VarSITI Final Symposium, Sofia, Bulgaria (TBD)
- Also, Project-specific workshops and publications
- ISSI working groups
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 Physics: Earth-affecting solar transients
• JASTP: long-term changes and trends in the upper atmosphere
• JASTP: Special issue of the VarSITI-2016 symposium
• JASTP: Special issue of the VarSITI-2017 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)
• More to come (this symposium + Reviews)
Quarterly update on the VarSITI program and developments in Solar Terrestrial Physics

- 21 volumes
- archived at varsiti.org
- Science articles
- Young scientist highlights
- short news items
PRESTO: 3 Pillars - 9 Focus Areas

1. Sun, Interplanetary Space and Geospace
   1.1 Occurrence and properties of flares and CMEs/CIRs and the propagation of CMEs/CIRs from the Sun to the Earth
   1.2. Predictability of interplanetary shocks and energetic particle flux enhancements
   1.3. Predictability of substorms and storms
   1.4. Solar wind-magnetosphere coupling and internal magnetospheric dynamics

2. Space Weather and Earth System
   2.1 Multiscale vertical and horizontal coupling between atmospheric regions and its effects on space weather
   2.2 Effect of atmospheric waves on the global circulation in the middle and upper atmosphere

3. Solar Activity and its Influence on Climate
   3.1 Understanding and predicting solar activity
   3.2 Sub-seasonal to decadal variability of the terrestrial system
   3.3 Centennial variability of the terrestrial system

PRESTO: Predictability of the variable Solar-Terrestrial Coupling
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NSP Committee
Ioannis Daglis (Greece) Chair
Daniel Marsh (USA)
Loren Chang (Taiwan)
Sergio Dasso (Argentina)
Sarah Gibson (USA)
Katja Matthes (Germany)
Dibyendu Nandy (India)
Olga Khabarova (Russia)
Annika Seppälä (New Zealand)
Rémi Thiéblemont (France)
Qiu-Gong Zong (China)
Emilia Kilpua (Finland)
Space Weather and Earth System

- Solar wind, CIR & CME
- Geomagnetic storms & substorms
- High-energy particles
- Orbit change
- Satellite anomaly
- Aurora
- Plasma bubbles
- Ionospheric disturbances
- GNSS positioning
- Geomagnetically induced currents
- Atmospheric waves
- Climate change
- Radio communication
Solar Activity and its Influence on Climate

Interplanetary space

Magnetosphere

Ionosphere
Thermosphere

Mesosphere

Stratosphere

Troposphere

Total solar irradiance (TSI)

UV emission

Energetic particle precipitation

Chemical-dynamical coupling

Dynamical coupling

Atmospheric oscillations

Anthropogenic effects

Ozone

Temperature

HOx

NOx

Solar dynamo

Solar energetic particles

magnetospheric particles

Sea surface temperature variability

NASA

L. Gray
Projects and Working Groups

- Annual Symposia
- ISSI Working Groups
- Special sessions
- Support related meetings
- Special Issues of journals
- Books
- Capacity Building

Generic Organizational Chart
SCOSTEP has been running long-term scientific programs over half a century that accumulate new knowledge in solar terrestrial physics

VarSITI is the current scientific program that has engaged more than 1000 scientists worldwide during 2014-2018

The legacy will be publications, including the output of the present symposium and the final review in Nov 2019

The next scientific program is PRESTO: Predictability of the Variable Solar Terrestrial Coupling

SCOSTEP programs will continue to be closely associated with capacity building activates: Schools, Workshops, and SVS programs

Remember to nominate deserving colleagues for service and science achievements