

# A review on scientific achievements of the SCOSTEP VarSITI program (2014-2018)

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)**

**1990-1997: STEP (Solar-Terrestrial Energy Program)**

**1998-2002: Post-STEP (S-RAMP, PSMOS, EPIC, and ISCS)**

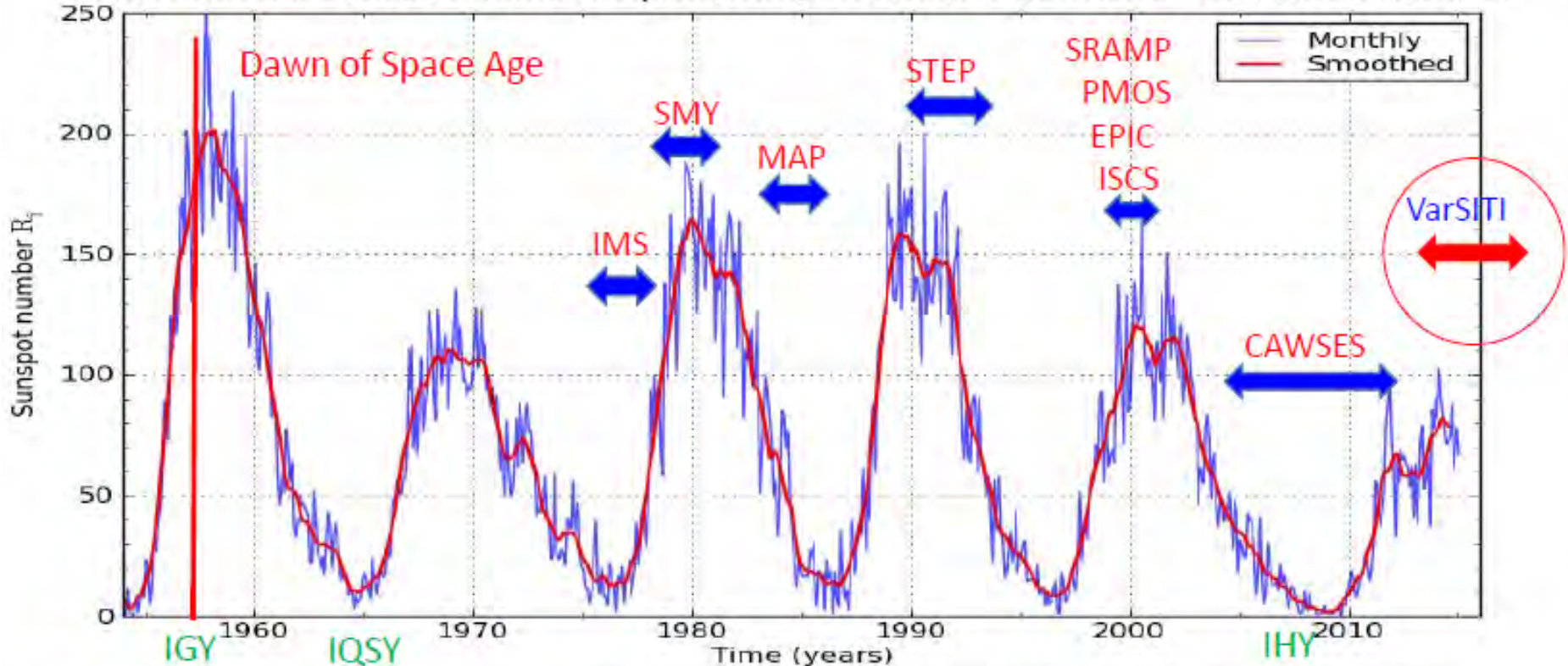
**2004-2008: CAWSES (Climate and Weather of the Sun-Earth System)**

**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



# VarSITI has 4 scientific projects

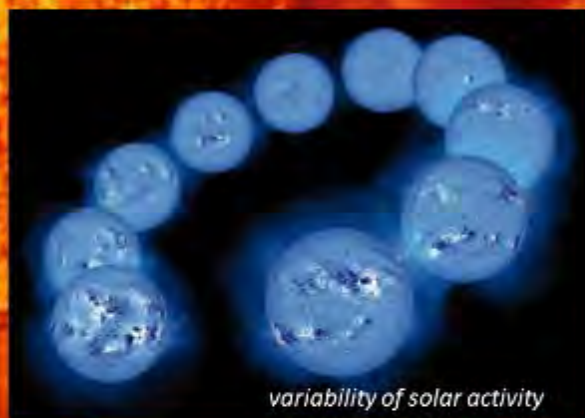
## International Study of Earth-Affecting Solar Transients (**ISEST**)/MiniMax24

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?



# Solar Evolution and Extrema (SEE)

## Solar Evolution and Extrema SEE



Piet Martens,  
(Smithsonian Astrophysical Observatory,  
USA)



Vladimir Obridko,  
(IZMIRAN, Russia)

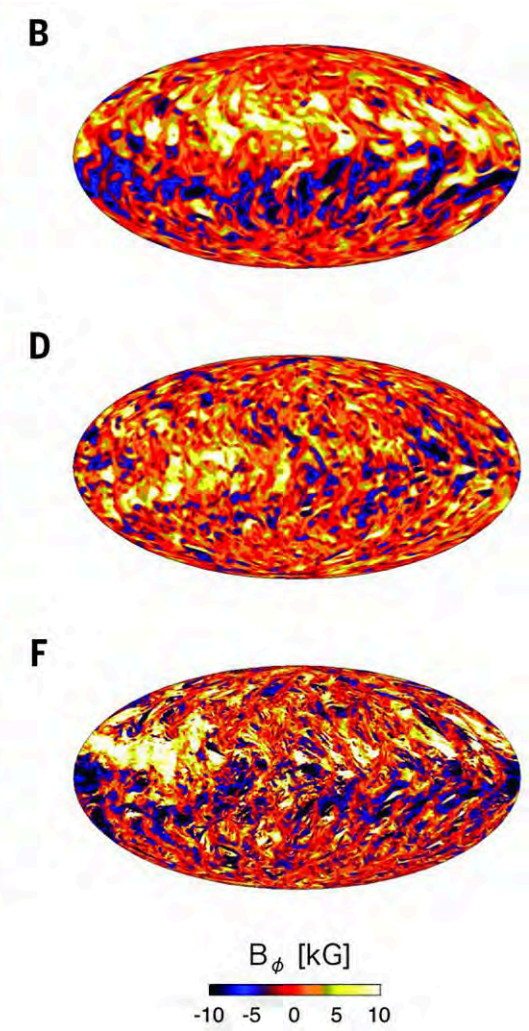
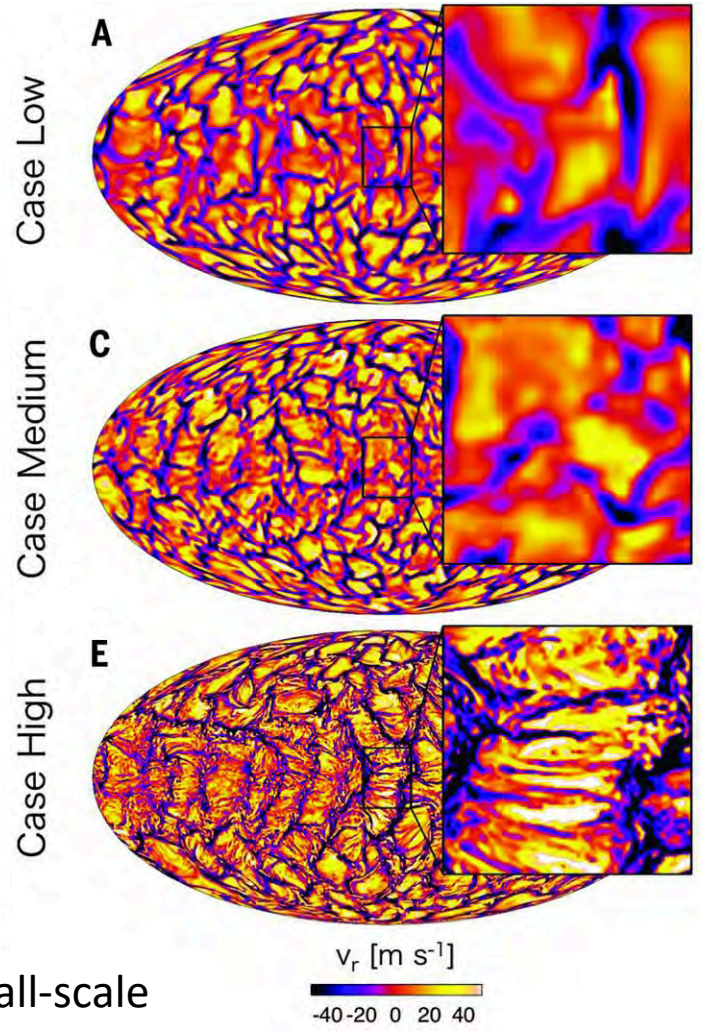
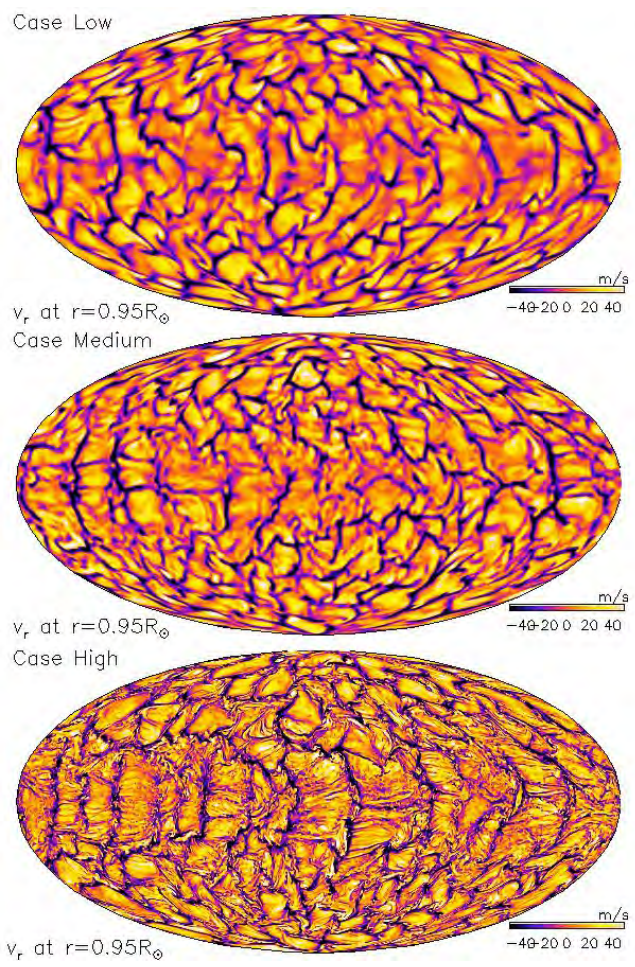


Dibyendu Nandi,  
(IISER Kolkata, India)

- 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.

**SEE**

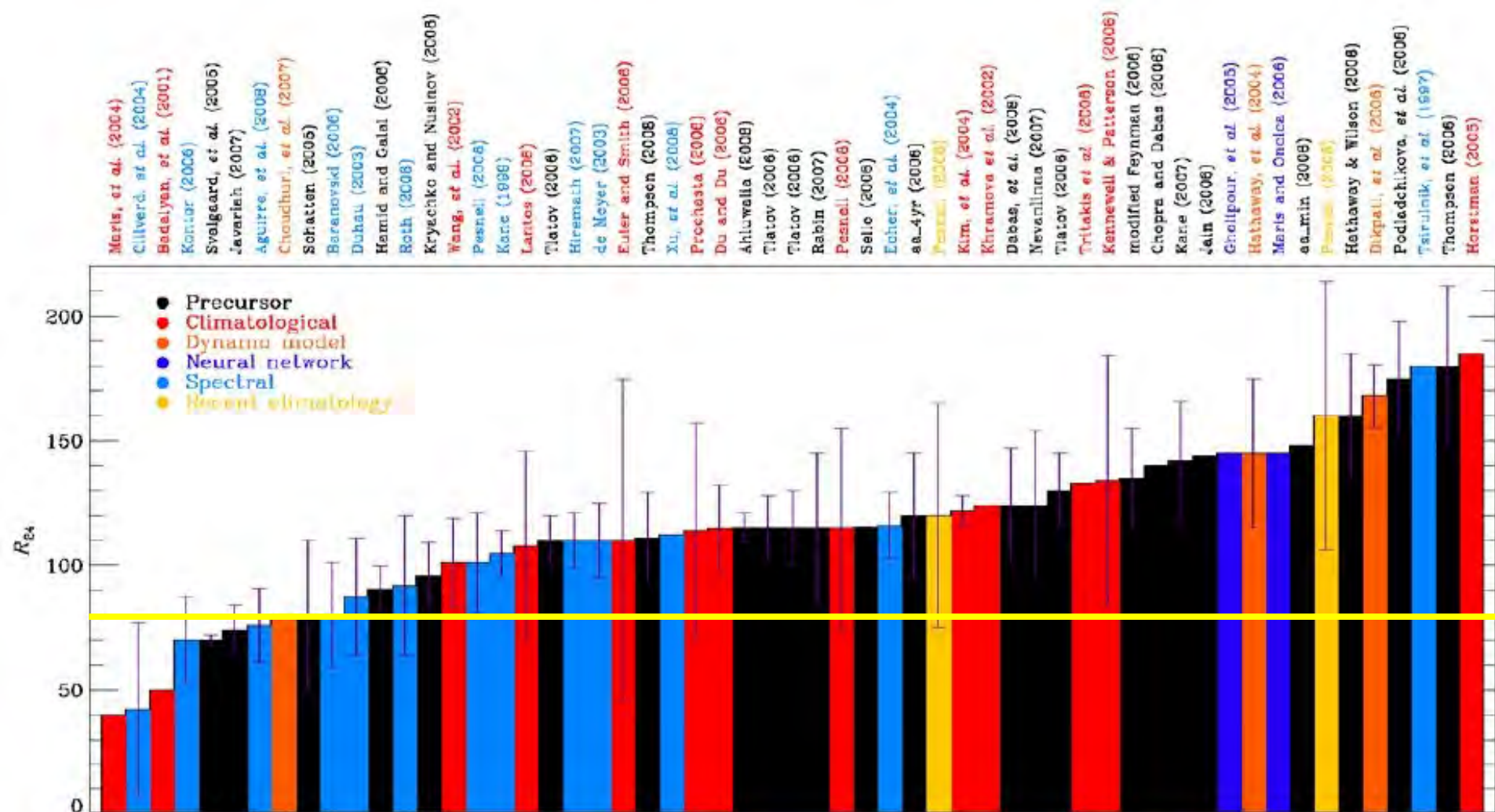
Case	Low	Medium	High	High-S
$(N_r, N_\theta, N_z)$	(64,96,288)	(64,96,288)	(256,384,1152)	(512,768,2304)
Diffusivities	Explicit	Implicit	Implicit	Implicit
Run time	50 years	50 years	50 years	500 days
Turbulent $E_{\text{mag}}$	$1.2 \times 10^6$	$1.6 \times 10^6$	$2.4(3.0) \times 10^6$	$3.4 \times 10^6$
Mean $E_{\text{mag}}$	$2.0 \times 10^5$	$6.7 \times 10^4$	$1.1(2.7) \times 10^5$	$2.3 \times 10^5$



case High clearly includes the small-scale turbulence

**Hotta et al. (Science, 2016): High-resolution modeling of solar magnetic field at high Reynolds numbers (small scale dynamo acts as large diffusivity).**

# Predictions of sunspot cycle 24



SEE

Can we predict solar activity in the following cycles?

ISSI/VarSITI Forum on future evolution of solar activity, 2016, ISSI, Bern, Switzerland



**The next two cycles will not be high, but not a beginning of a grand Maunder type minimum.**

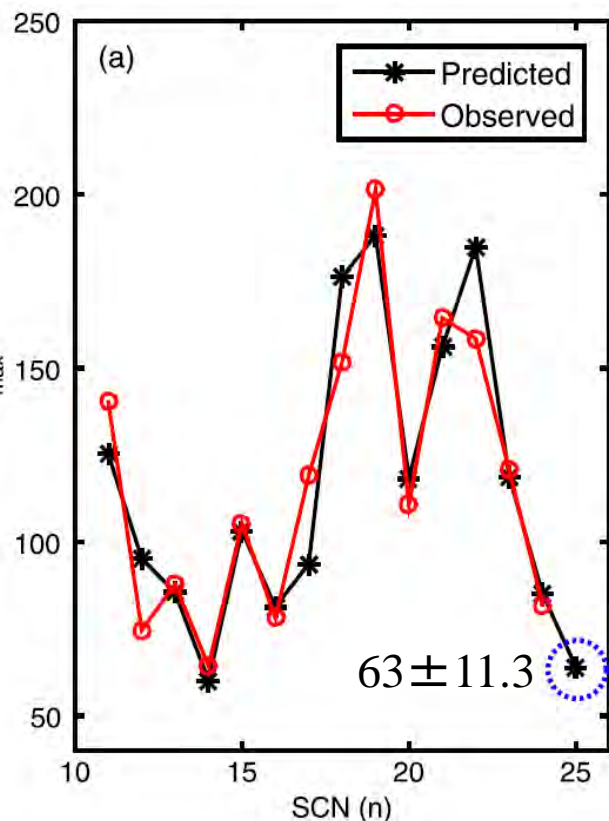
Most likely that cycle 25 will be of the same height as cycle 24, and the next one may be a bit lower.

There is **some probability of a Dalton type minimum.**

We **cannot predict** beyond cycle 25 or at most 26.

SEE

# Predictions of sunspot cycle 25



Kakad et al. (SolPhys2017)  
Shannon Entropy-Based  
Prediction of Solar Cycle 25

Cameron et al.  
(ApJ2016): Cycle 25  
prediction based on  
axial dipole moment.  
→ moderate amplitude,  
not much higher than  
that of the current  
cycle.

Iijima et al.  
(AA2017)  
Cycle 25 prediction  
based on axial  
dipole moment.

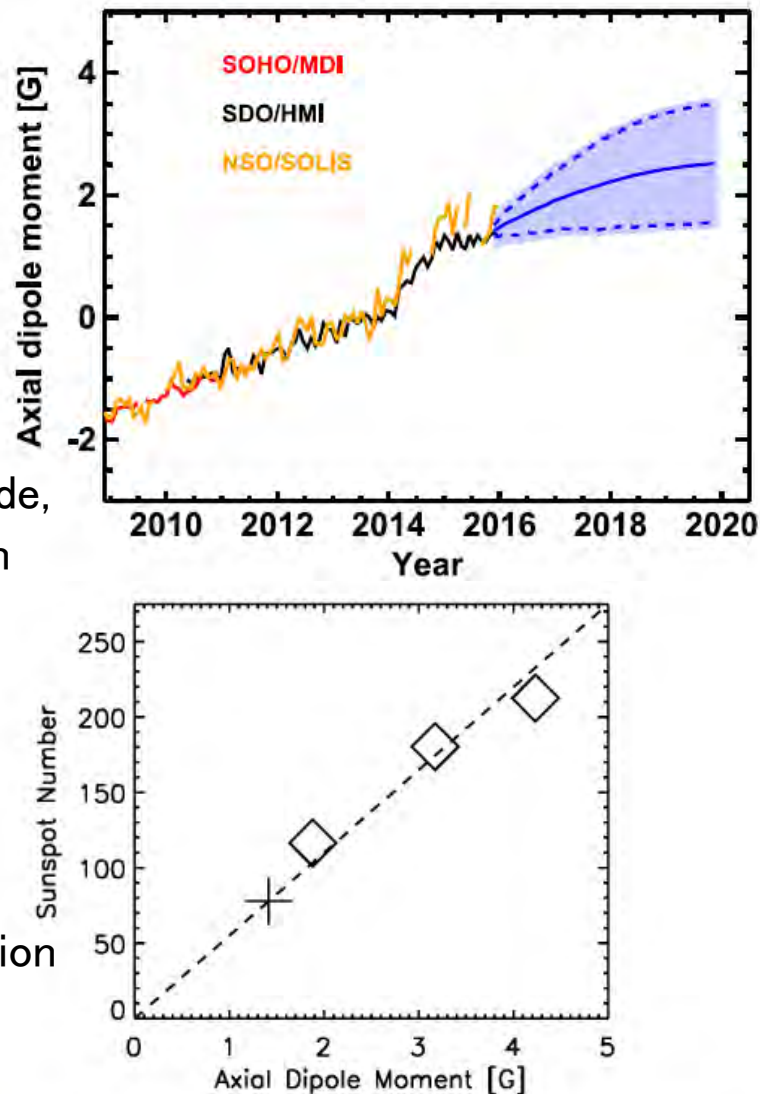
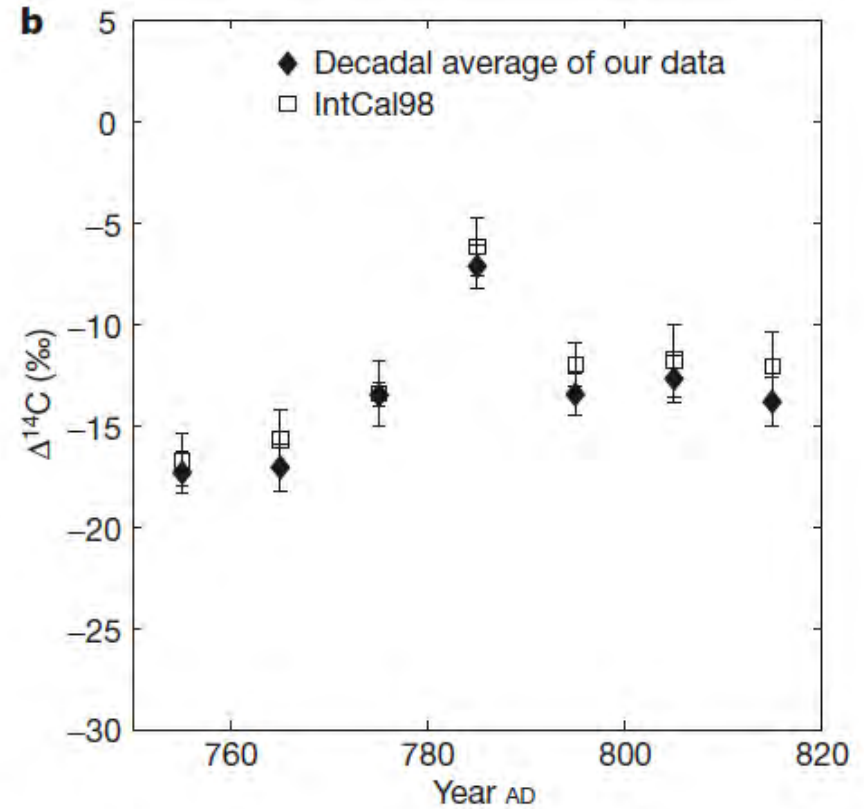
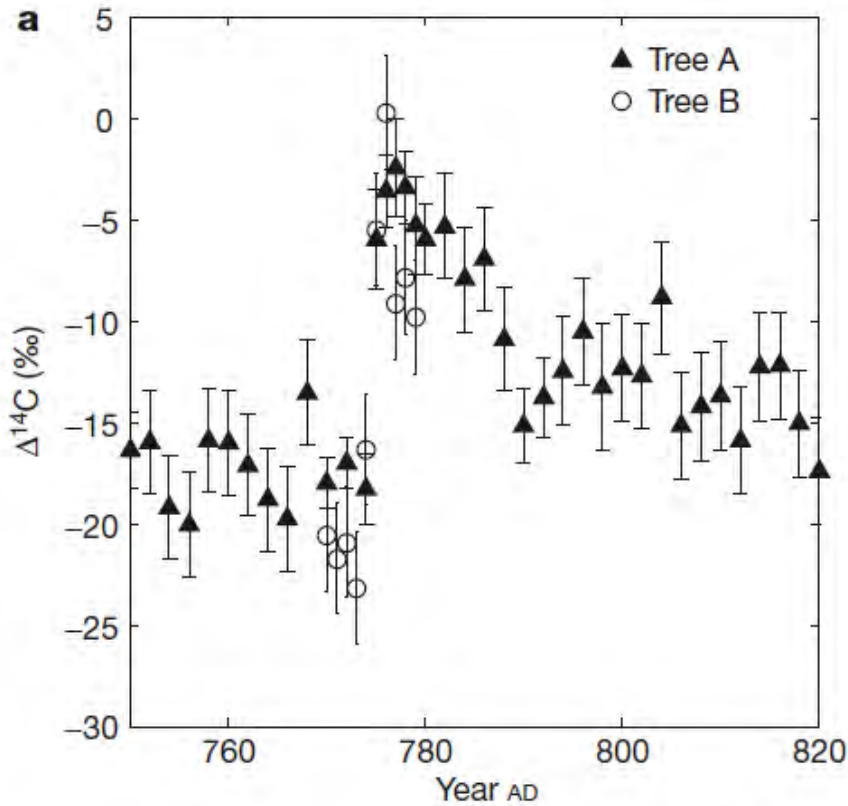


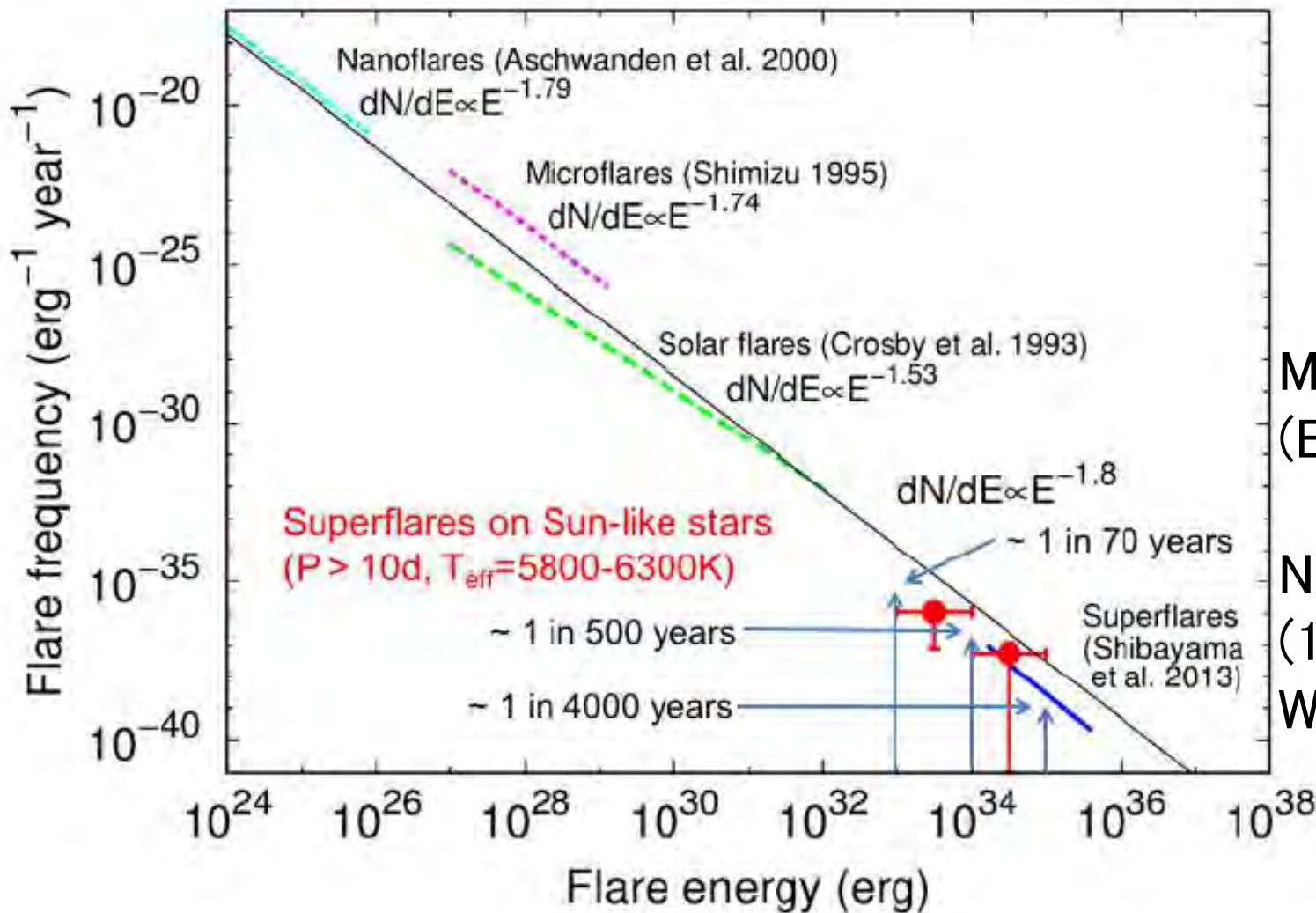
Fig. 3. Maximum value of the 13-month smoothed monthly total sunspot number in each sunspot cycle (Cycle 22, 23, and 24; diamond) and the predicted cycle amplitude in Cycle 25 (cross) as a function of the axial dipole moment at the previous minimum predicted from the magnetogram observed three years before the minimum. The least-square fit for Cycles 22, 23, and 24 that crosses the point of origin is shown as the dashed line. The correlation coefficient for Cycles 22, 23, and 24 is 0.99.

SEE



Miyake et al. (Nature, 2012)

Super flare seems to occur in AD775 from <sup>14</sup>C record in tree rings.



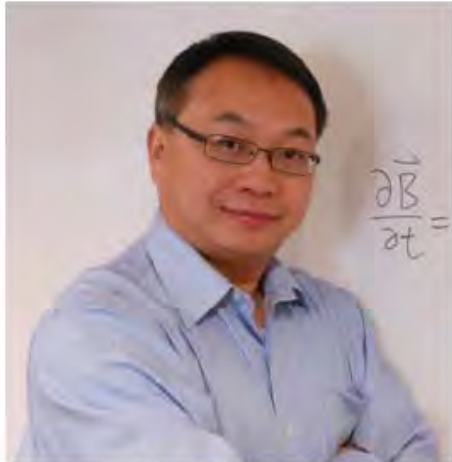
Maehara et al.  
(EPS, 2015);

Notsu et al.  
(19<sup>th</sup> Cambridge  
WS, 2016)

Stellar flare observation indicate super flares can occur.

# International Study of Earth-Affecting Solar Transients ISEST/MiniMax24

## International Study of Earth-affecting Solar Transients ISEST



Jie Zhang,  
(George Mason University,  
USA)



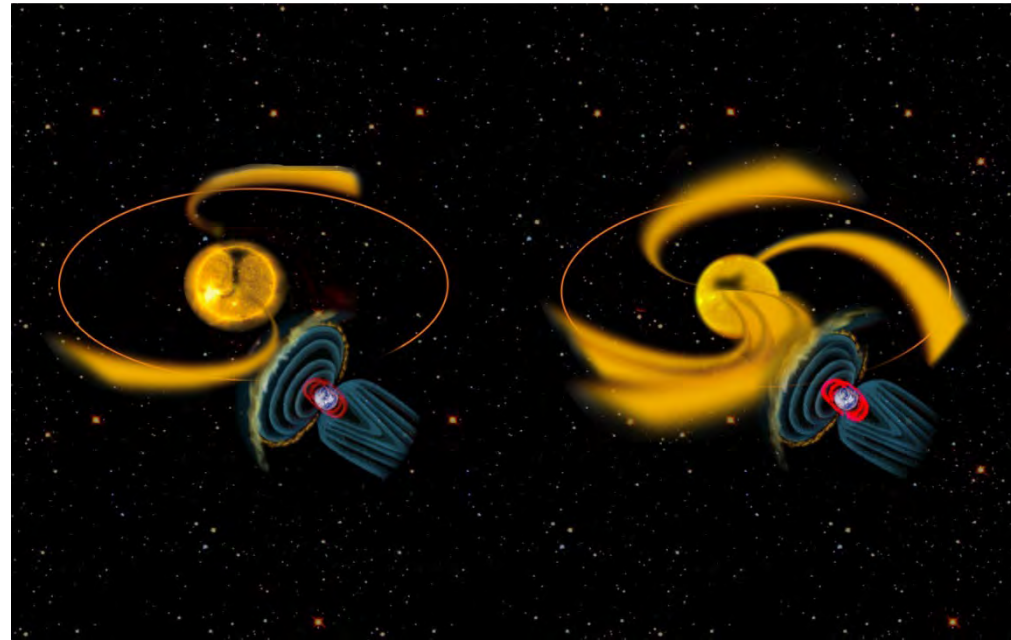
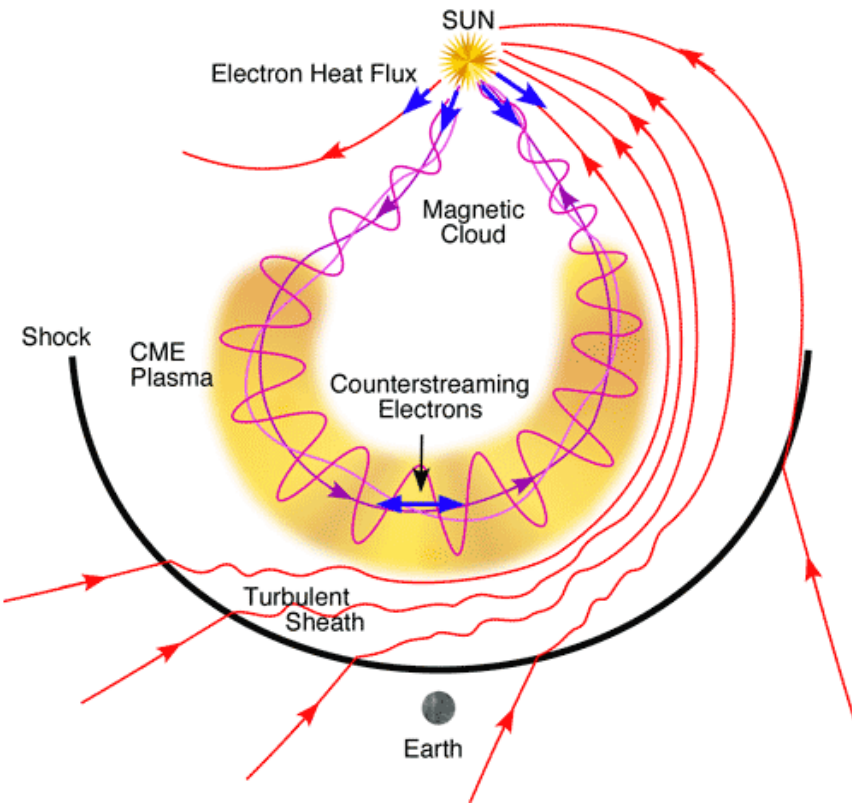
Manuela Temmer,  
(UNIVERSITY OF GRAZ, Austria)



Nat Gopalswamy,  
(Lab. for Solar & Space Physics,  
NASA/GSFC, USA)

# ISEST/Minimax24

How well do we understand the relation between solar events and the geoeffective disturbances?



Can we predict a CME's magnetic field based on its solar origin?

Can we predict a high speed stream's speed?

Do we know what happens to them during their way from the Sun to the Earth?

# ISEST/Minimax24

<http://solar.gmu.edu/heliophysics/index.php/ISEST>



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## ISEST

**This wiki is specifically for data sharing and discussion forum of the ISEST program. We encourage everyone to upload any data pertaining to ICMEs to this wiki and to discuss events freely in the discussion section of each page. Please do not alter any data that is not yours without the express permission of the uploader. For any questions of using this Wiki, email Phillip Hess at [phess4@gmu.edu](mailto:phess4@gmu.edu)**

The **ISEST/MiniMax24** (International Study of Earth-Affecting Solar Transients) is one of the four projects of the [VarSITI](#) ([Variability of the Sun and Its Terrestrial Impact](#)) program, which runs from 2014 to 2018. The VarSITI is the current scientific program of [SCOSTEP](#) ([Scientific Committee on Solar-Terrestrial Physics](#)).

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

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

**Data/theory/modeling:** Establish a database of Earth -affecting solar transient events including CMEs, CIRs, flares, and energetic particle events based on remote sensing and in-situ observations from an array of spacecraft, run observation campaigns such as MiniMax24, develop empirical, theoretical, and numerical models of CME propagation and prediction, validate models using observations.

**Anticipated outcome:** A comprehensive database of Earth -affecting solar transients will be created, and space weather prediction capability will be significantly improved.

**Co-leaders:** Jie Zhang (USA) ([jjzhang7@gmu.edu](mailto:jjzhang7@gmu.edu)), Manuela Temmer (Austria), Nat Gopalswamy (USA)

**Working Group Leaders:** (1) WG1 (Data Group): Jie Zhang (George Mason University, USA); (2) WG2 (Theory Group): Bojan Vrsnak (Hvar Observatory, Croatia); (3) WG4 (Simulation Group): Fang Shen (CSSAR, China); (4) WG4 (Event Campaign Group): David Webb (Boston College, USA); (5) WG5 (Bs Challenge Group): Spiros Patsourakos (University of Ioannina, Greece); (6) WG6 (SEP Group): Olga Malandraki (National Observatory of Athens, Greece); (7) MiniMax24 Campaign: Manuela Temmer (University of Graz, Austria)

**Scientific Organization Committee members:** (1) Ayumi Asai (Kyoto University, Japan); (2) Mario M. Bisi (RAL, UK); (3) Kyungsuk Cho (KASI, South Korea); (4) Peter Gallagher (Trinity College Dublin, Ireland); (5) Manolis K. Georgoulis (Academy of Athens, Greece); (6) Nat Gopalswamy (co-leader) (NASA/GSFC, USA); (7) Alejandro Lara (National Autonomous University, Mexico); (8) Noe Lugaz (University of New Hampshire, USA); (9) Alexis Rouillard (CNRS/IRAP, France); (10) Nandita Srivastava (Physical Research Lab, India); (11) Manuela Temmer (co-leader) (University of Graz, Austria); (12) Yuri Yermolaev (Space Research Institute, Russia); (13) Yu-Ming Wang (Univ. of Science and Technology, China); (14) David Webb (Boston College, USA); (15) Bojan Vrsnak (Hvar Observatory, Croatia); (16) Jie Zhang (co-leader) (George Mason University, USA)

### Overview

#### Data, Campaigns, WGs

- [ICME/ICME Lists](#)
- [Event Data](#)
- [WG1 \(data\)](#)
- [WG2 \(theory\)](#)
- [WG3 \(simulation\)](#)
- [WG4 \(Campaign\)](#)
- [WG5 \(Bs\)](#)
- [WG6 \(SEP\)](#)
- [MiniMax24](#)
- [varSITI Campaign](#)

#### Workshops

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- [2014 Workshop](#)
- [2015 Workshop](#)
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# ISEST/Minimax24

## Data, Campaigns, WGs

- ICME/CME Lists
- Event Data
- WG1 (data)
- WG2 (theory)
- WG3 (simulation)
- WG4 (Campaign)
- WG5 (Bs)
- WG6 (SEP)
- MiniMax24
- VarSITI Campaign

## Workshops

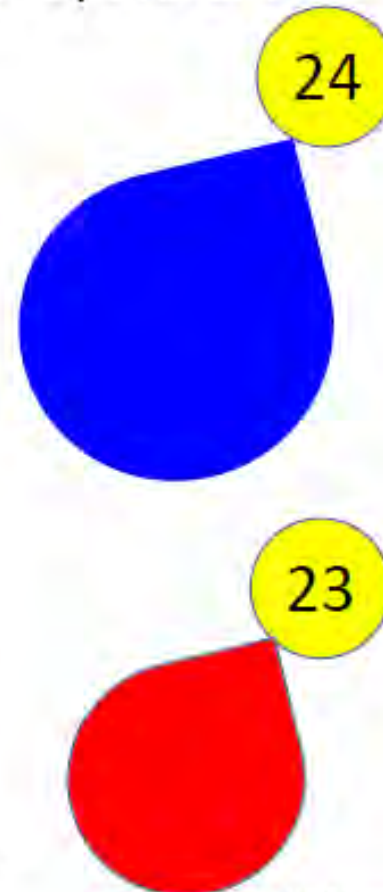
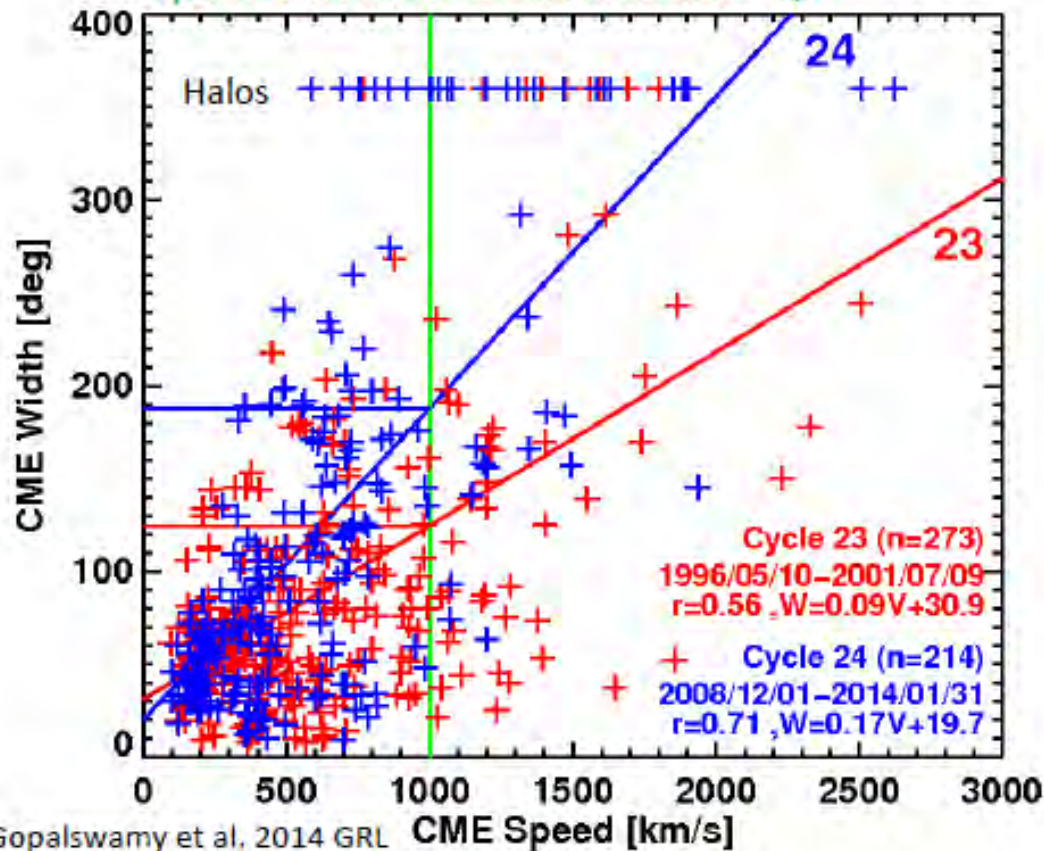
- 2013 Workshop
- 2014 Workshop
- 2015 Workshop
- 2016 Workshop
- 2017 Workshop
- 2018 Workshop
- Topic Issue

# ISEST/Minimax24

ISEST/MiniMax24

## Anomalous Expansion of CMEs in Cycle 24

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



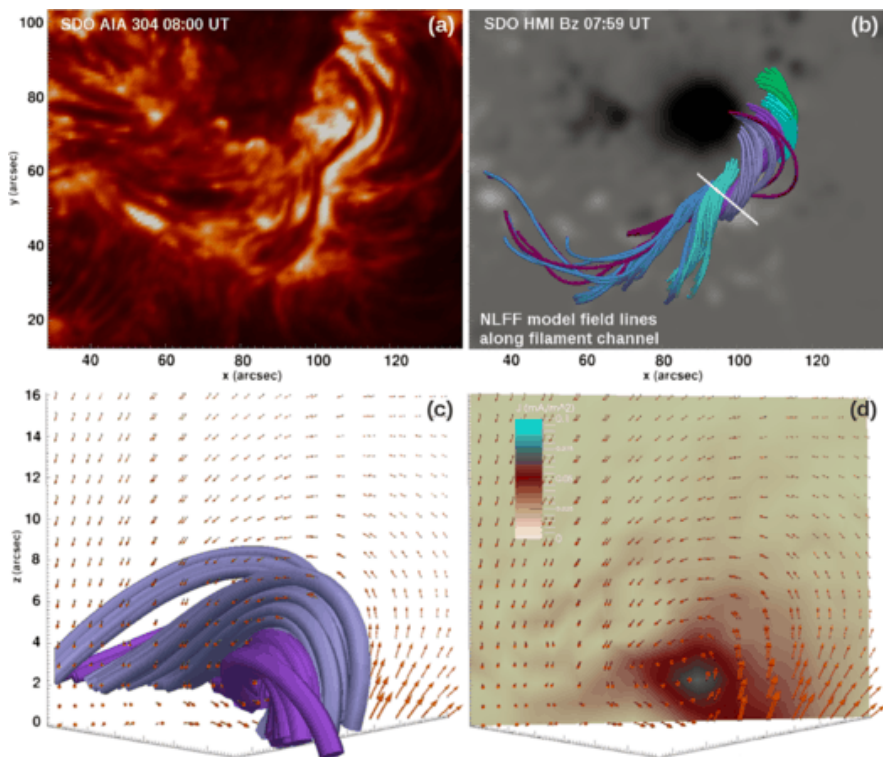
Lower outside Pressure  $\rightarrow$  larger CMEs

Higher outside Pressure  $\rightarrow$  Smaller CMEs

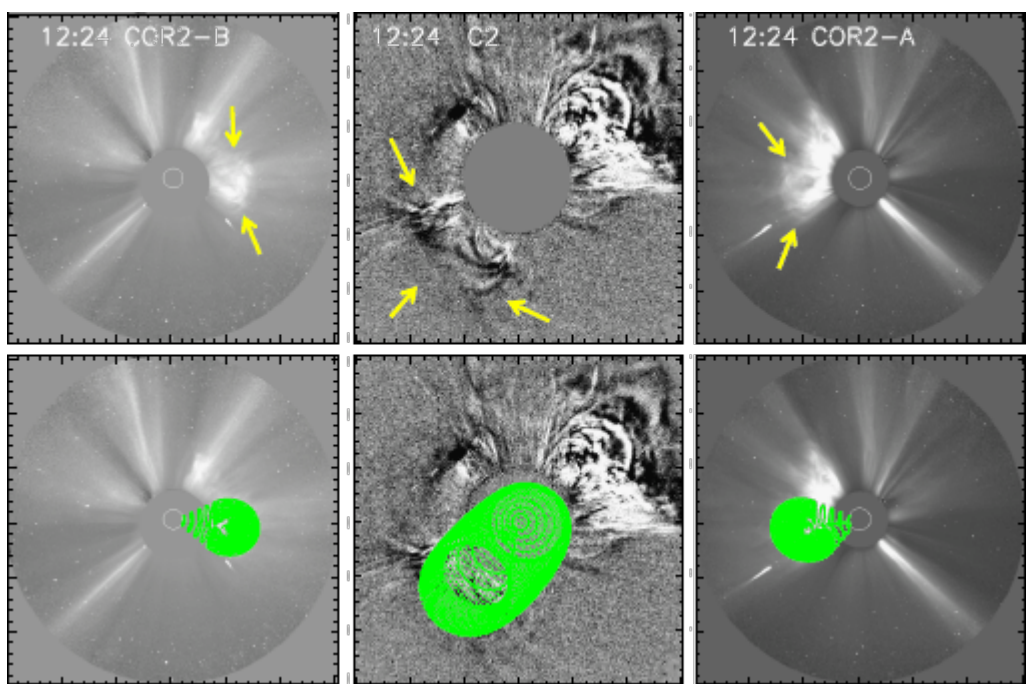
Nat Gopalswamy UHCDPOUS2015

Gopalswamy et al. (GRL, 2014): CME size difference by different background pressure condition in Cycle 23 and 24.

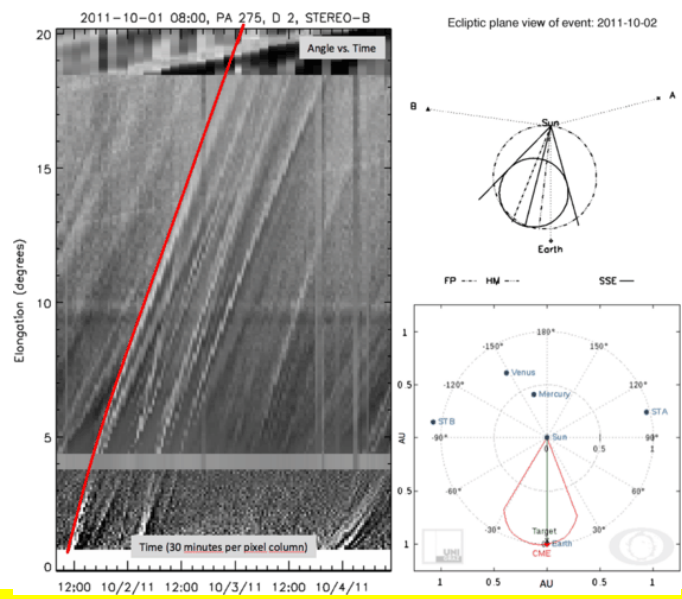
# ISEST/Minimax24



(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  $\pm 2 \text{ kG}$ . (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.

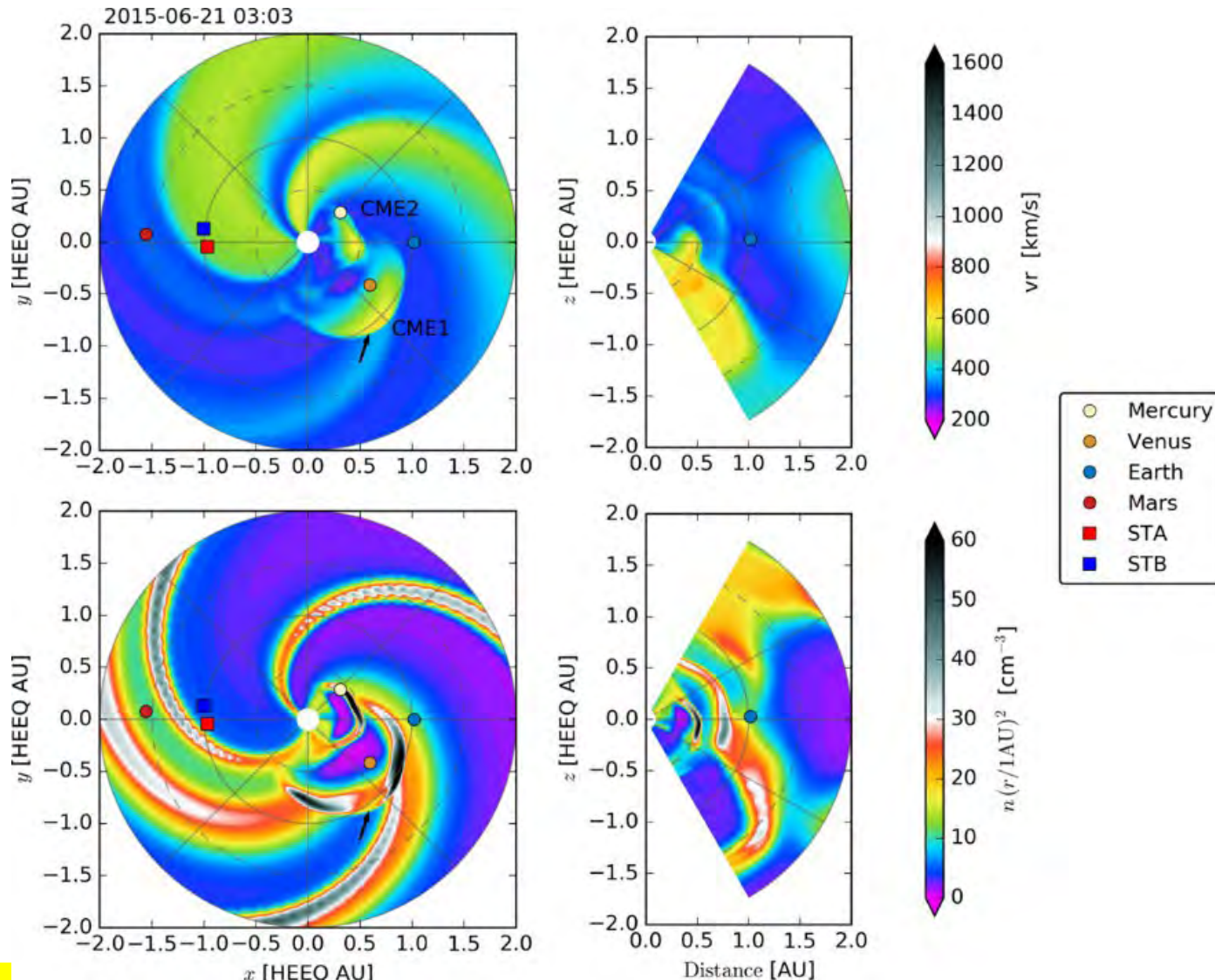


GCS modeling results using the simultaneous view from three spacecraft (STEREO B left, LASCO middle, and STEREO A right) on 1 October 2011.



Left: Interplanetary propagation of the CME under study (red line) tracked using SATPLOT j-maps. Top right: Conversion results 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.

# ISEST/Minimax24



Pomoell and Poedts (J. Space Weather Space Clim. 2018): EUHFORIA: European heliospheric forecasting information asset (3D coronal and heliospheric model)

# 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)

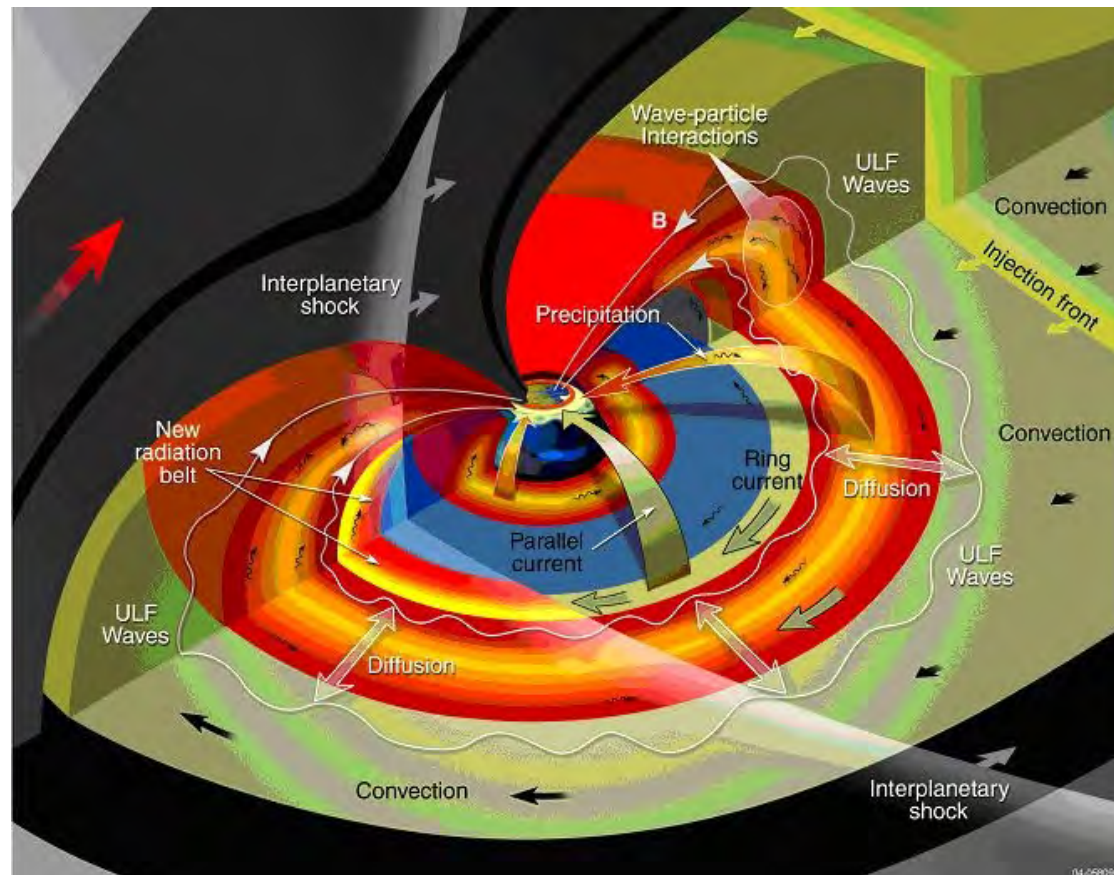


Yoshi Miyoshi,  
(ISEE, Nagoya University, Japan)



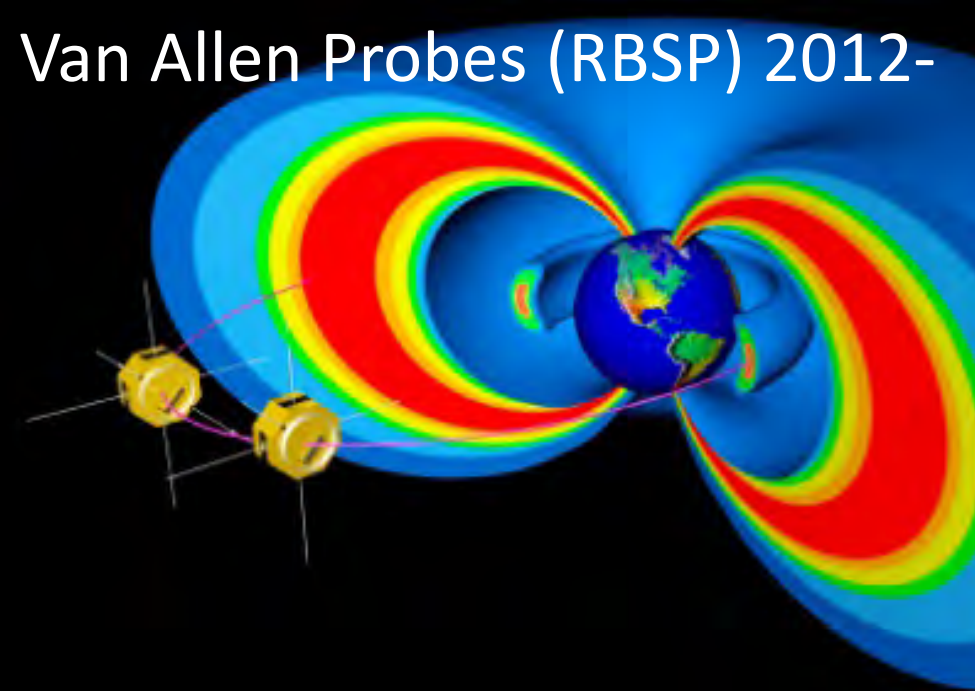
Shri Kanekal,  
(NASA/GSFC, Greenbelt, USA)

How well do we understand what happens in the Earth's magnetosphere based on inputs from the Sun and solar wind?

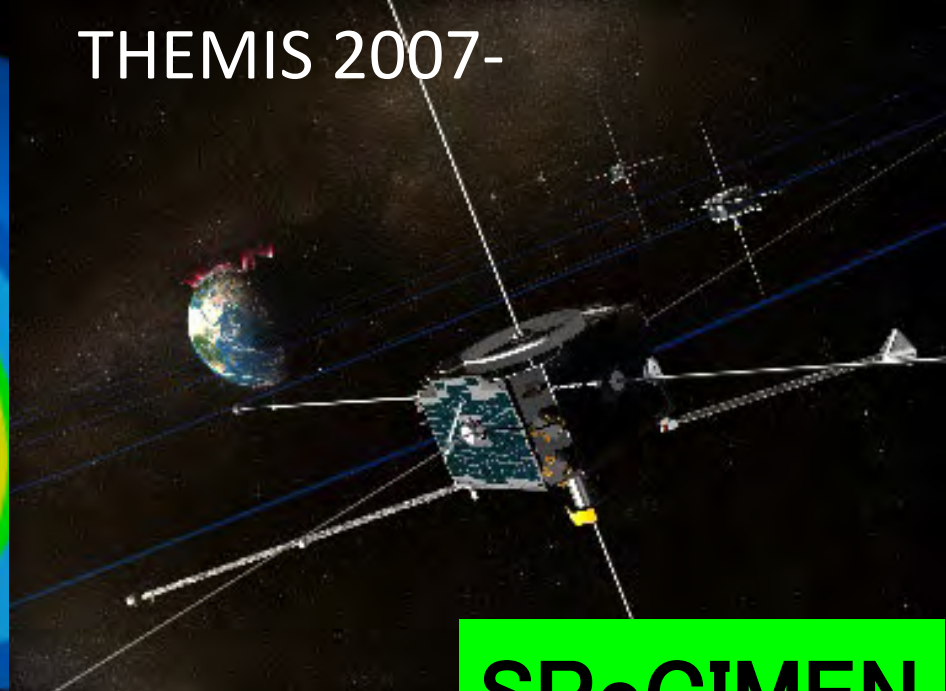


Can we go from modeling to predictions?

Van Allen Probes (RBSP) 2012-

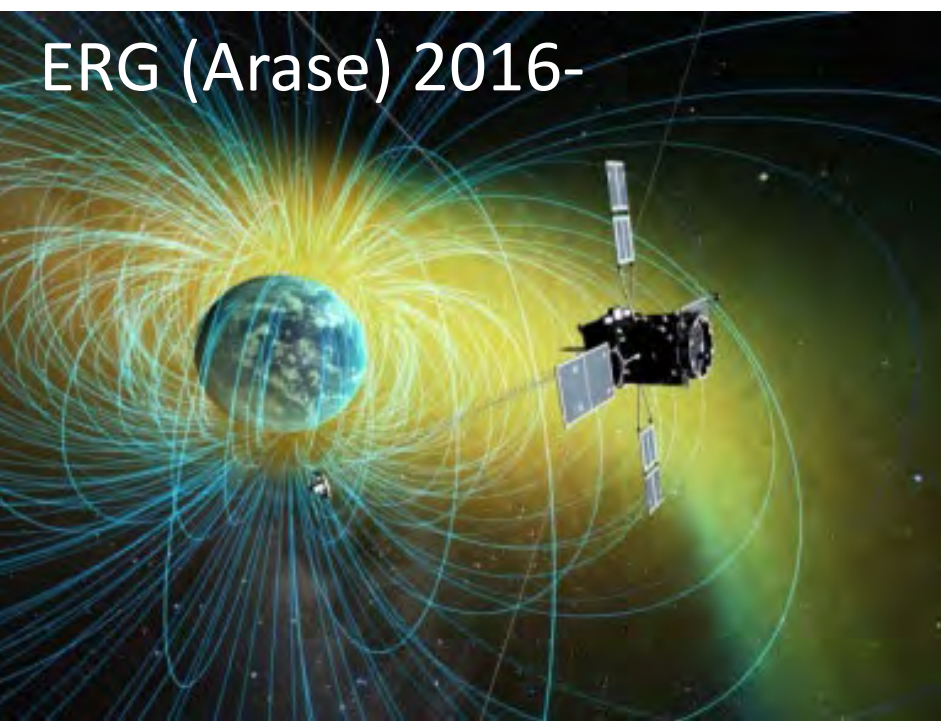


THEMIS 2007-



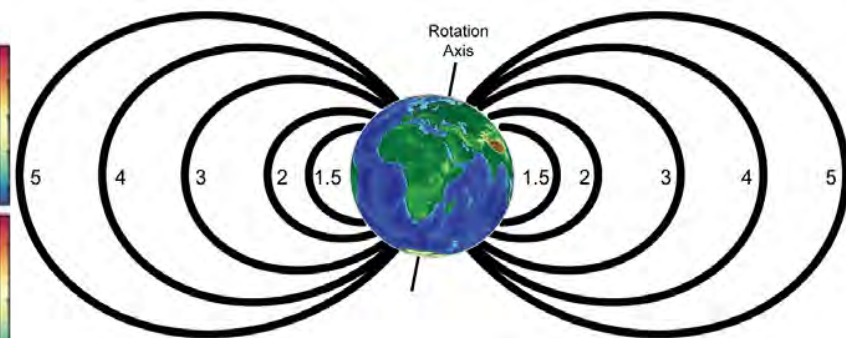
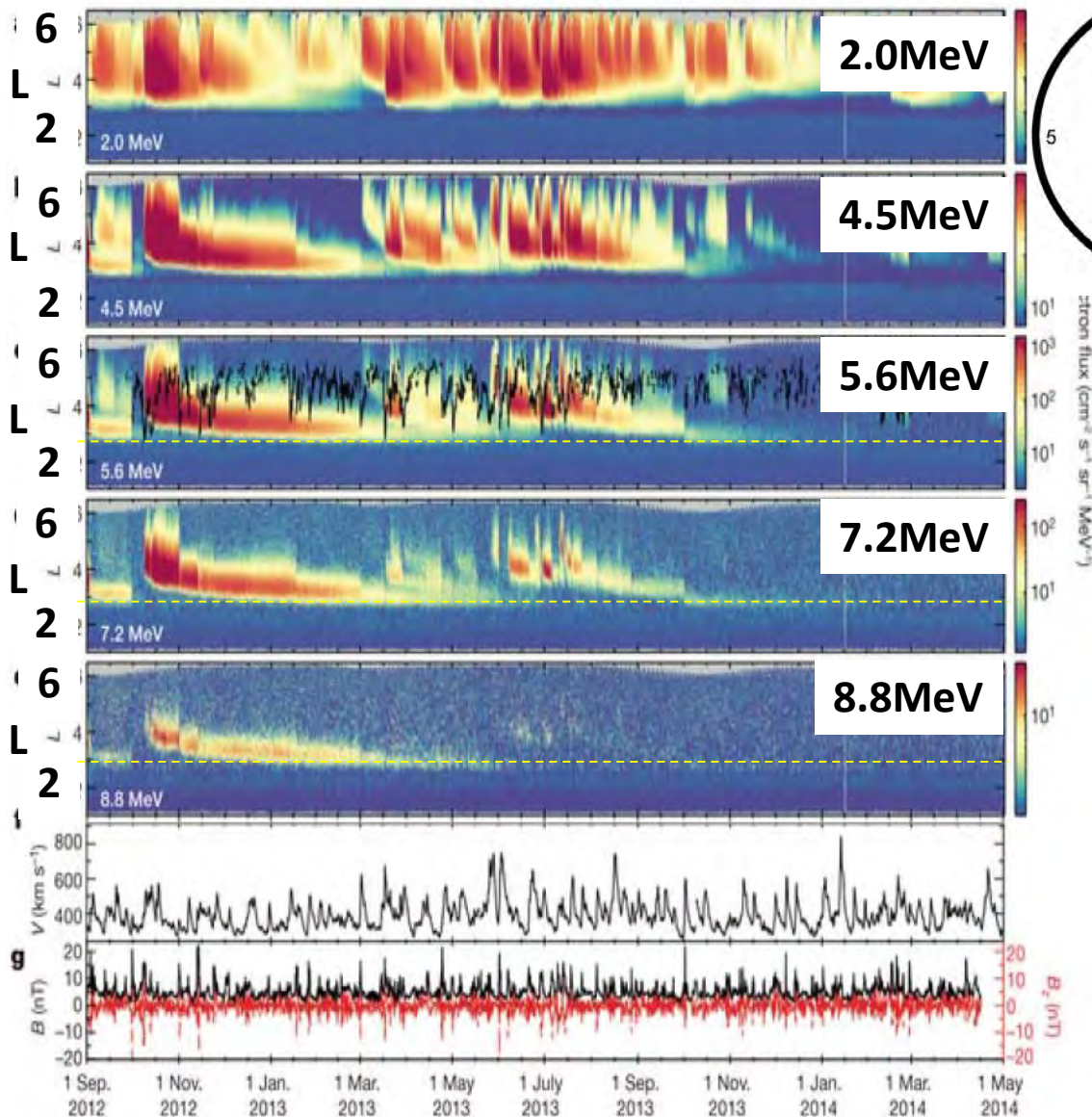
**SPeCIMEN**

ERG (Arase) 2016-



MMS 2015-





# SPeCIMEN

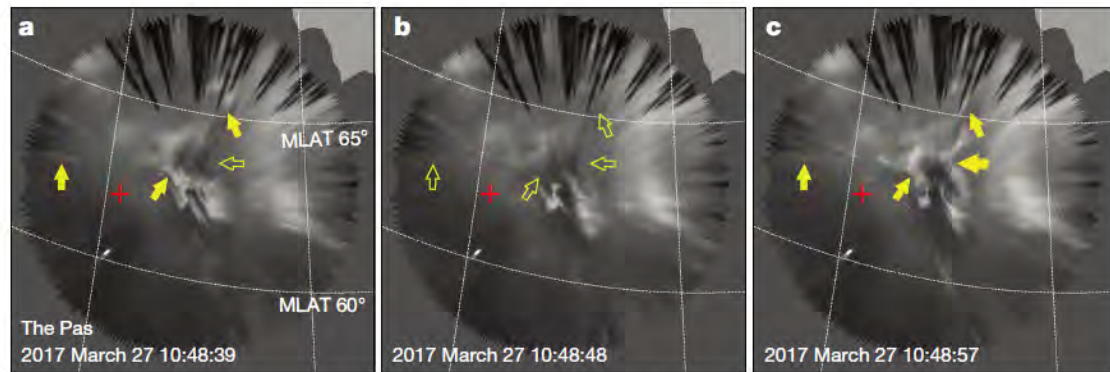
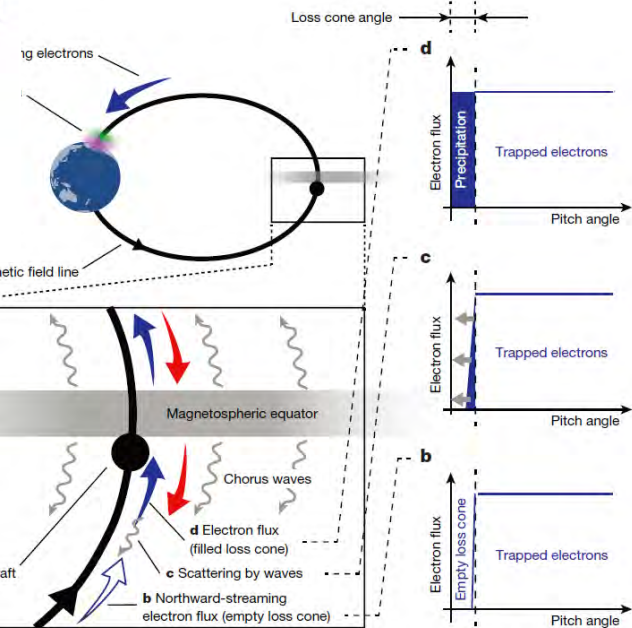
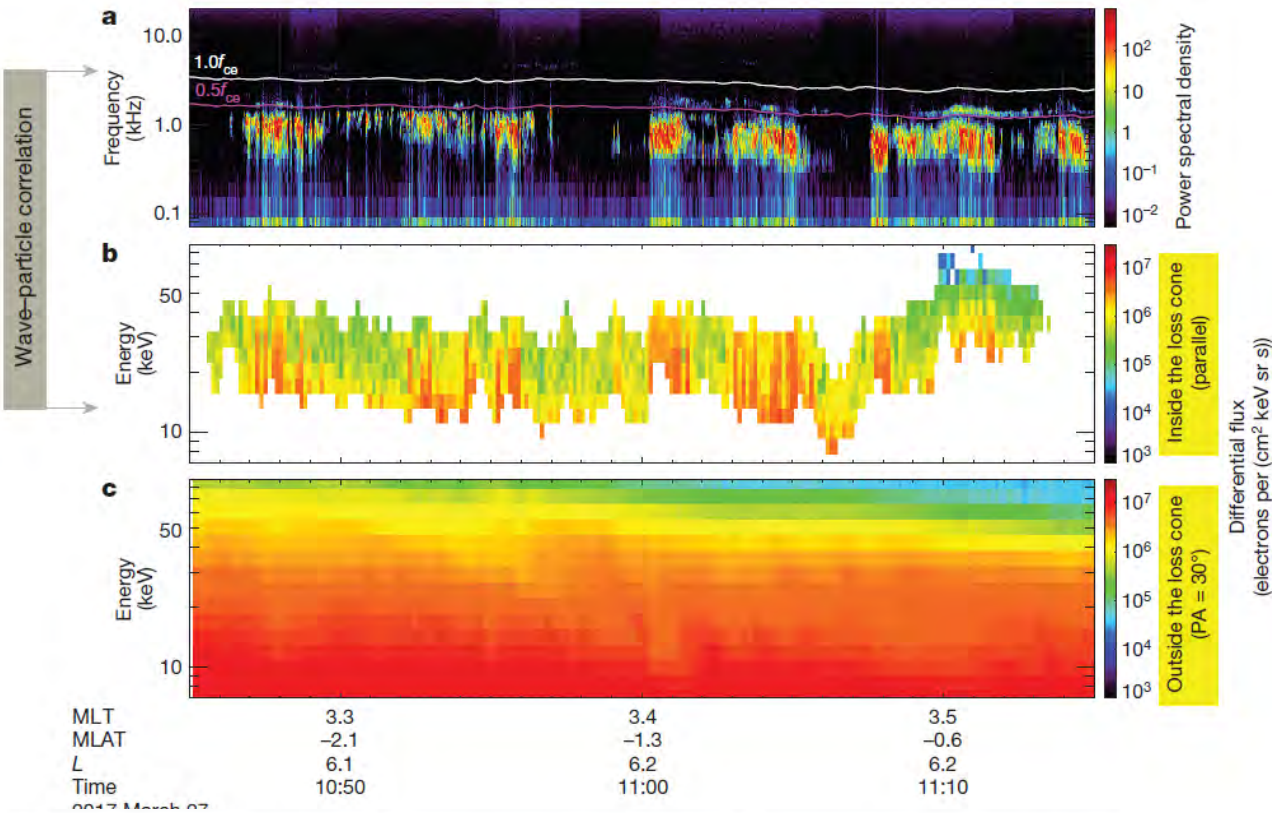
In **a–e** the highly energetic electrons measured by REPT sensors throughout the mission never seem to extend inwards of  $L \approx 2.8$ . This forms a particularly clear and sharp boundary for the ultrarelativistic electrons as shown in **c–e**.

Sep.2012

May 2014

**Baker et al. (Nature, 2014): Discovery of sharp inner boundary for the ultrarelativistic ( $E > 5\text{MeV}$ ) electrons in the Earth's radiation belts.**

# SPeCIMEN



**Kasahara et al. (Nature, 2018): Arase (ERG) show one-to-one correspondence between ELF/VLF chorus waves and electron fluxes in the loss cone.**  
**→ evidence of pitch-angle scattering to cause pulsating aurora.**

# VERSIM

(VLF/ELF Remote Sensing of Ionospheres and Magnetospheres)

[http://www.iugg.org/IAGA/iaga\\_ursi/versim/index.html](http://www.iugg.org/IAGA/iaga_ursi/versim/index.html)

Welcome to the VERSIM webpage!

We are an IAGA/IURSI joint working group focused on VLF/ELF Remote Sensing of Ionospheres and Magnetospheres

9th VERSIM workshop webpage now open! Click [here](#) for details



VLF/ELF Remote Sensing of Ionospheres & Magnetospheres  
**VERSIM in KYOTO**  
**23 - 27 Mar. 2020**



### Want to join us?

If you would like to join our mailing list please check the contact page.

### Latest News

\* VERSIM Journal Club  
Monthly discussions of VLF/ELF related papers. Want to join? Details [here](#)

\*\* 9th VERSIM Workshop  
Now accepting abstracts!

\*\*\* 2018 Newsletter  
[download!](#)

VERSIM Members, thank you for your contributions. You can read all about it [here](#).

### Related Meetings

[AGU 2018](#)  
Washington D.C., Dec 10 - 14, 2018

[IURSI AP-RASC 2019](#)  
Washington, March 05 - 15, 2019

[EGU 2019](#)  
Vienna, April 08 - 12, 2019

### Useful Links

- [Google+ Group](#)
- [VERSIM Calendar](#)

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

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



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

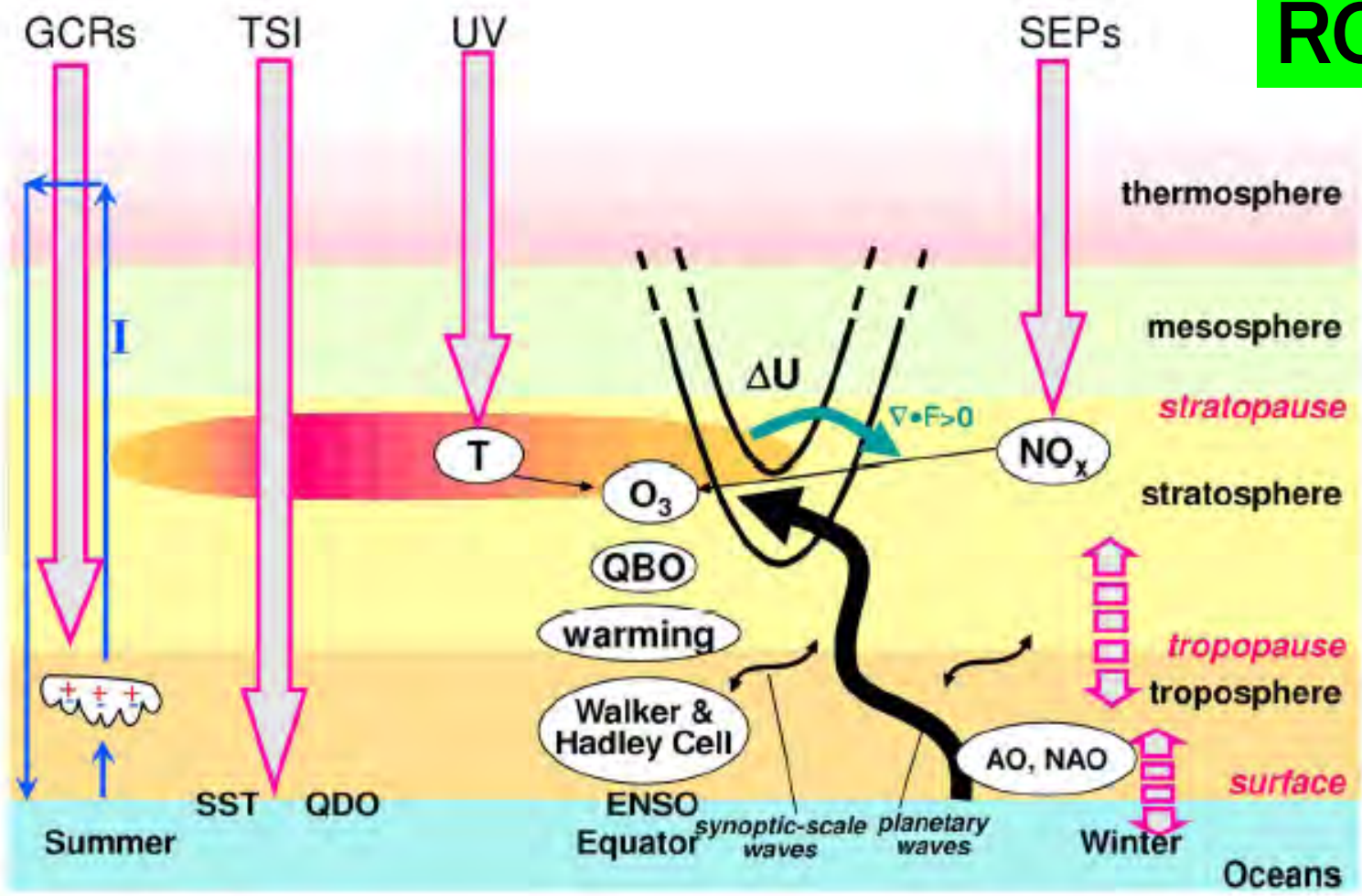


Annika Seppälä,  
(Finnish Meteorological  
Institute,  
Finland)



William Ward,  
(University of New  
Brunswick,  
Canada)

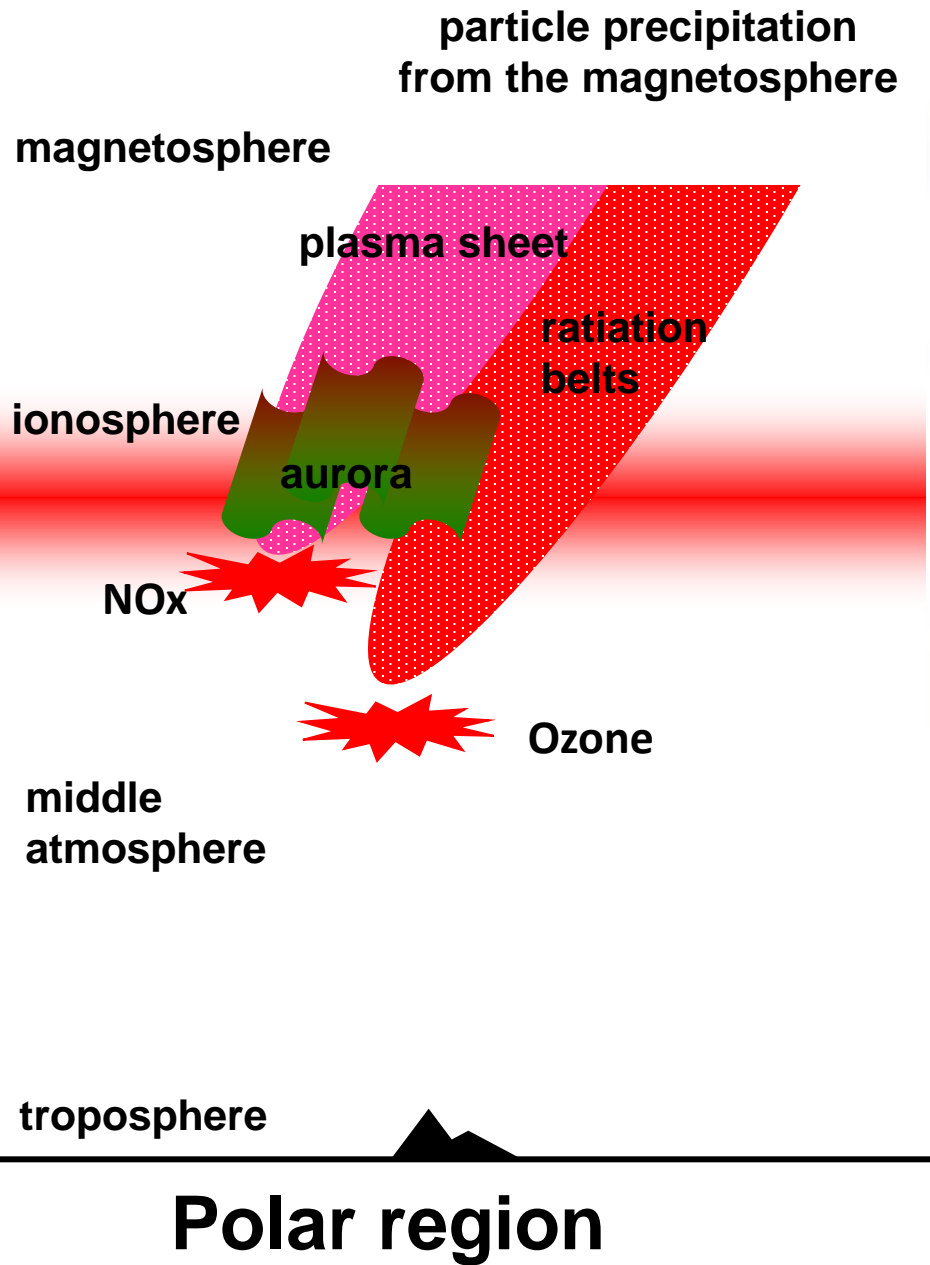
# ROSMIC



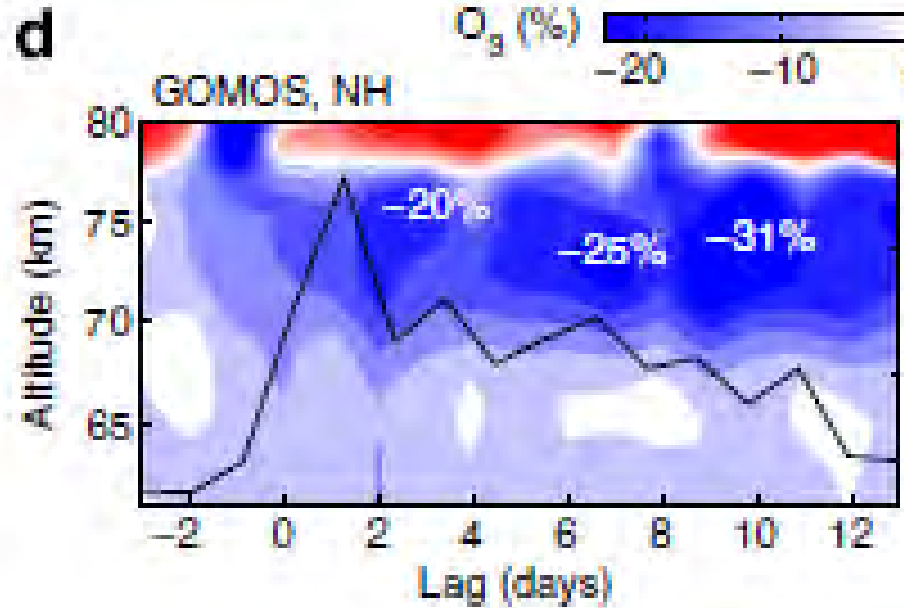
Gray et al. (Rev. Geophys., 2010)

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**



**ROSMIC**



Andersson et al. (Nature Comm., 2014):  
 First evidence for radiation belt electron precipitation impact on atmospheric ozone in long term.

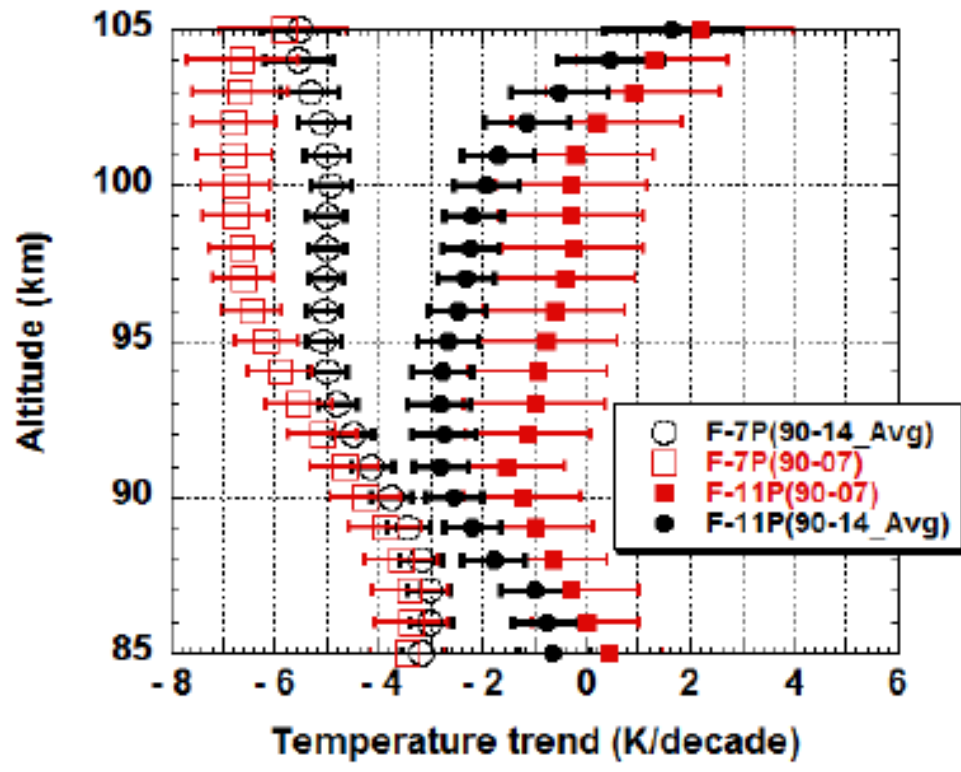
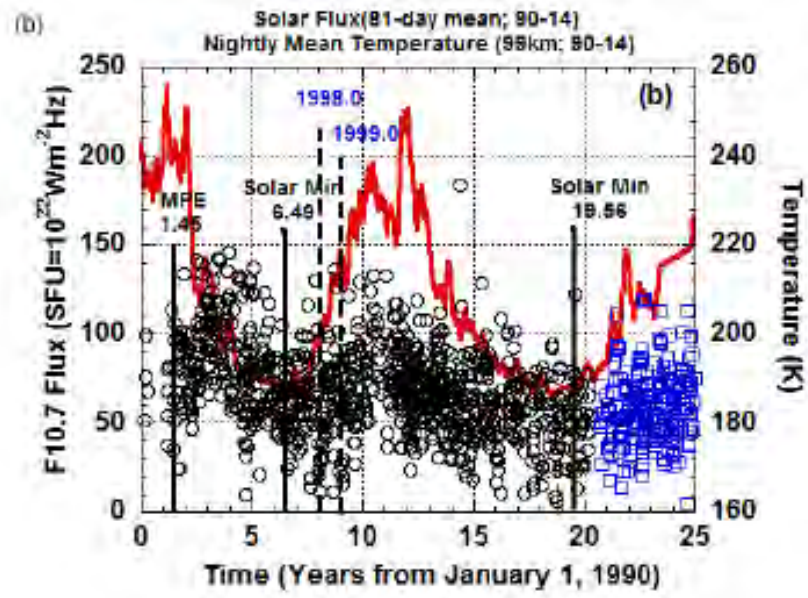
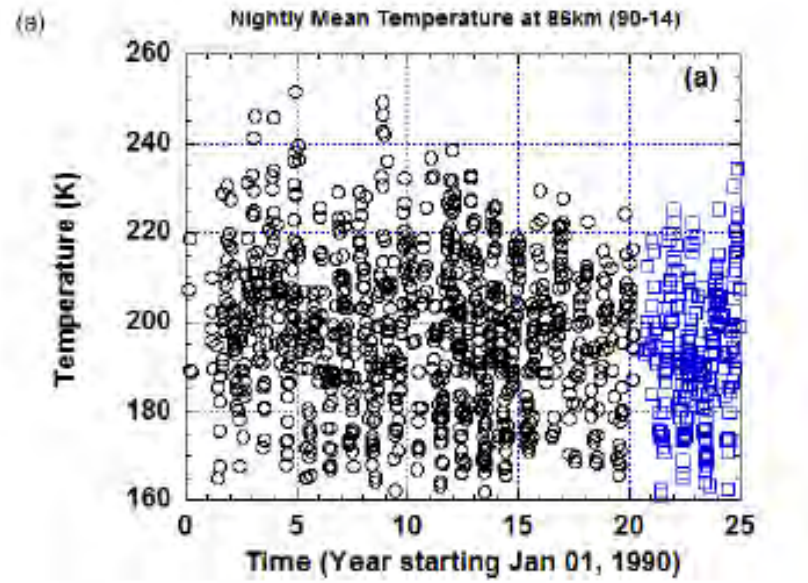


Figure 2. Linear temperature trend from the quarter century data set with 11- and 7-parameter analyses, respectively denoted as F-11P(90-14\_Avg) in black solid circles and F-7P(90-14\_Avg) in black open circles. Shown for comparison are those data published based on an 18-year data set denoted as F-11P(90-07)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

$$\rho = \rho_0 e^{(z_0 - z)/H}$$

$-\nabla p$

### Physical Processes

### Dissipative processes

[Yigit et al., 2008]

MAGNETOSPHERE

$E \times B$ , SIED,  $Q_{\perp}$   
 SPH,  $Q_{\parallel}$

THERMOSPHERE-IONOSPHERE

Ion drag  
 Molecular viscosity  
 Thermal conduction

Turbopause (~105 km)

90 km

PMC

MESOSPHERE

Nonlinear diffusion  
 Eddy viscosity

50 km

STRATOSPHERE

SSW, QBO

Radiative damping

15 km

TROPOSPHERE

Planetary waves  
 Tides, Kelvin waves

GWs

$$c_g = \frac{\partial \omega}{\partial m}$$

Sun

Challenging topics during and after VarSITI

long-term variability

short-term variability  
sunspot evolution  
coronal hole

solar dynamo evolution

axial dipole moment

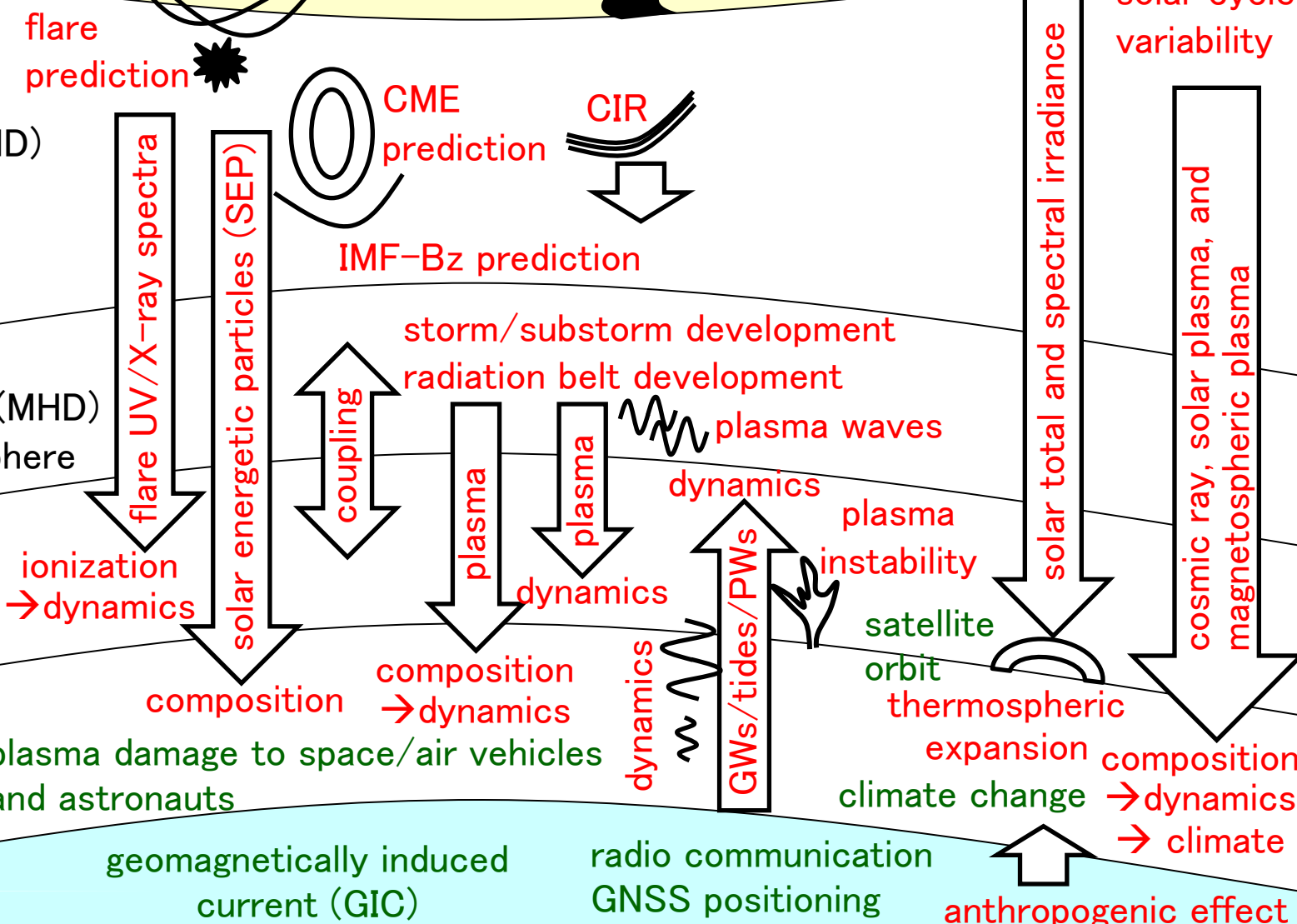
heliosphere (MHD)

magnetosphere (MHD)  
inner magnetosphere (non-MHD)

ionosphere  
thermosphere

mesosphere  
stratosphere  
troposphere

Earth



# **We encourage communications among different fields to promote interdisciplinary studies**

- (1) mailing list**
- (2) web site**
- (3) newsletter**
- (4) financial support**  
**(meetings, database, and campaign)**
- (5) database collection**
- (6) capacity building**

## (1) Mailing List (that defines the members of the program)

The VarSITI mailing list consists of the following 5 addresses.

- (a) **varsiti\_all[at]isee.nagoya-u.ac.jp**: all VarSITI
- (b) **varsiti\_see[at]isee.nagoya-u.ac.jp**: SEE
- (c) **varsiti\_isest\_minimax24[at]isee.nagoya-u.ac.jp**: ISEST/Minimax24
- (d) **varsiti\_specimen[at]isee.nagoya-u.ac.jp**: SPeCIMEN
- (e) **varsiti\_rosmic[at]isee.nagoya-u.ac.jp**: ROSMIC


\* (a) Contains all names in (b)–(e).

\* Scientists listed in this mailing list are also shown in the VarSITI website as the **members of VarSITI** and its Projects.

<b>VarSITI</b>	<b>: 1112 members from 71 countries</b>
<b>SEE</b>	<b>: 633 members from 63 countries</b>
<b>ISEST/Minimax24</b>	<b>: 774 members from 63 countries</b>
<b>SPeCIMEN</b>	<b>: 618 members from 61 countries</b>
<b>ROSMIC</b>	<b>: 823 members from 67 countries</b>

## (2) Web Site

VarSITI web-site <http://www.varsiti.org/>

 **VarSITI**  
Variability of the Sun and Its Terrestrial Impact

[About](#) [Organization](#) [Projects](#) [Meetings](#) [Publications](#) [Resources](#) [News](#)  
[HOME](#)

**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** (**S**olar **E**volution and **E**xtrama),
- ✓ **MiniMax24/ISEST** (**I**nternational **S**tudy of **E**arth-affecting **S**olar **T**ransients),
- ✓ **SPeCIMEN** (**S**pecification and Prediction of the **C**oupled **I**nnner-**M**agnetospheric **E**nvironment), and
- ✓ **ROSMIC** (**R**ole **O**f the **S**un and the **M**iddle atmosphere/thermosphere/ionosphere **I**n **C**limate).

## (2) Web Site

VarSITI web-site <http://www.varsiti.org/>

**181,591** visits from January 1, 2014 to May 31, 2019



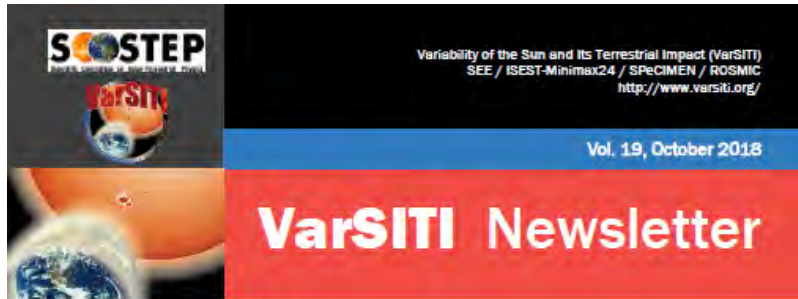
monthly visits

Geographical  
distribution of visits  
June 7-8, 2019



One specialist (Mitko Danov) was hired to construct/maintain this website by BAS and SCOSTEP grants.

# VarSITI newsletters



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

4 issues per year (up to vol.21)

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Article 1:  
**Project for Solar-Terrestrial Environment Prediction (PSTEP)**



Kanya Kusano  
Institute for Space-Earth Environmental Research (ISEE),  
Nagoya University, Nagoya, Japan

Although solar activity may significantly impact the global environment as well as socio-economic systems through variety of processes (Fig. 1), the mechanisms for solar activities and the subsequent processes have not yet been fully understood. Thus, modern society, which is supported by advanced information systems, is at a risk from severe space weather disturbances and the long-term variation of solar-terrestrial environment. Project for Solar-Terrestrial Environment Prediction (PSTEP) was launched in order to improve this situa-

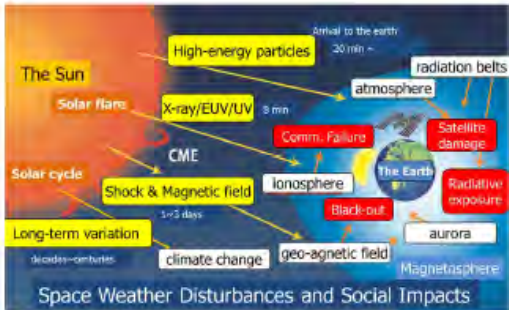


Figure 1. The subject of PSTEP study. The objective of PSTEP is to improve the feedback between the scientific research and the operational forecast of space weather disturbances and social impacts.



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One secretary was hired to edit this newsletter by ISEE. This secretary also maintain the mailing list.



#### (4) Financial Support (meetings, database, and campaign)

For the 5-year duration of the VarSITI program we have organized or supported

- **64 meetings or sessions**  
including VarSITI2016, VarSITI2017, VarSITI2019
- **16 databases**
- **1 campaign**
- **1 interdisciplinary project**





## (5) Database Collection

### A collection of solar-terrestrial databases at VarSITI's web site

Variability of the Sun and Its Terrestrial Impact  
(VarSITI) 2014-2018  
SEE / ISEST-MiniMax24 / SPeCIMEN / ROSMIC

About Organization Projects Meetings Publications Resources News HOME

 VarSITI-Related Database Resources  
Discussed at SCOSTEP-WDS Workshop on Sept.28-30, 2015  
Last modified 11/23/2017 13:04:54

The list below has 134 different Databases  
Print  (15pages) or download as Excel file  (118KB)

**Contents**

[1] <a href="#">database-comprehensive</a> (7)	[2] <a href="#">database visualisation tool</a> (4)
[3] <a href="#">database-multi</a> (10)	[4] <a href="#">data analysis resources</a> (6)
[5] <a href="#">model and ground-based observation</a> (1)	[6] <a href="#">model and satellite observation</a> (1)
[7] <a href="#">model</a> (2)	[8] <a href="#">satellite observation</a> (33=14+2+17)
[9] <a href="#">satellite observation (future)</a> (3)	[10] <a href="#">ground observation</a> (67)

This effort to collect VarSITI-related database was initiated after the SCOSTEP-WDS workshop in 2015. Co-chairs ask the VarSITI members to provide information of these databases via the VarSITI mailing list. Some database supported by SCOSTEP/VarSITI funding are also added.

# List of the collected database

database/mission name	description	URL	SEE	ISEST	SPeCIME N	ROSMIC	type	region
CDAWeb	interactive data plotting tool on web-browser for all NASA satellite data in STP	<a href="http://cdaweb.gsfc.nasa.gov/istp_public/">http://cdaweb.gsfc.nasa.gov/istp_public/</a>	○	○	○	○	database-comprehensive	sun, heliosphere, magnetosphere, ionosphere
OMNIWeb	Hourly "Near-Earth" solar wind magnetic field and plasma data, energetic proton fluxes (>1 to >60 MeV), and geomagnetic and solar activity indices.	<a href="http://omniweb.gsfc.nasa.gov/ow.html">http://omniweb.gsfc.nasa.gov/ow.html</a>	○	○	○	○	database-comprehensive	sun, heliosphere, magnetosphere, ionosphere
MADRIGAL	IS radars, MST radars, coherent-scatter radars, TEC, Fabry-Perot and Michelson interferometers, meteor and MF radars, airglow imagers, Ozone radiometers, Lidars, and ionosondes	<a href="http://madrigal.haystack.mit.edu/cgi-bin/madrigal/madInvent.cgi">http://madrigal.haystack.mit.edu/cgi-bin/madrigal/madInvent.cgi</a>		○	○	○	database-comprehensive	ionosphere, thermosphere, mesosphere, and stratosphere
Space Weather Expert Service Center	current space weather conditions (solar, space radiation, ionospheric, geomagnetic)	<a href="http://swe.ssa.esa.int/web/">http://swe.ssa.esa.int/web/</a>	○	○	○		database-comprehensive	sun, heliosphere, magnetosphere, ionosphere
WMO Space Weather Portal	solar, solar wind, ionospheric, atmospheric, geomagnetic data	<a href="http://www.wmo-sat.info/product-access-guide/theme/space-weather">http://www.wmo-sat.info/product-access-guide/theme/space-weather</a>	○	○	○	○	database-comprehensive	sun, heliosphere, magnetosphere, ionosphere
National Climate Data Center	Climate records, climate indicators, solar forcing reconstruction	<a href="http://www.ncdc.noaa.gov/">http://www.ncdc.noaa.gov/</a>	○			○	database-comprehensive	ionosphere, thermosphere, mesosphere, and stratosphere
SWENET, COSPAR catalogue	data, models, forecasts	<a href="http://www.ssg.sr.unh.edu/mag/ace/ACElists/obs_list.html">http://www.ssg.sr.unh.edu/mag/ace/ACElists/obs_list.html</a>	○	○	○	○	database-comprehensive	ionosphere, thermosphere, mesosphere, and stratosphere
SPIDR	web-based data visualization tool	<a href="http://spidr.ngdc.noaa.gov/">http://spidr.ngdc.noaa.gov/</a>		○	○	○	database visualisation tool	magnetosphere and ionosphere
ERGWAT	interactive data analysis tool on web-browser	<a href="http://ergsc.stelab.nagoya-u.ac.jp/analysis/ergwat/index.shtml.en">http://ergsc.stelab.nagoya-u.ac.jp/analysis/ergwat/index.shtml.en</a>		○	○	○	database visualisation tool	magnetosphere and ionosphere
Autoplot	data visualization tool	<a href="http://autoplot.org/">http://autoplot.org/</a>		○	○	○	database visualisation tool	magnetosphere and ionosphere
SPEDAS	data visualization tool	<a href="http://spedas.org/blog/">http://spedas.org/blog/</a>		○	○	○	database visualisation tool	magnetosphere and ionosphere
HELIO	Heliophysics Integrated Observatory	<a href="http://hfe.helio-vo.eu/Helio/">http://hfe.helio-vo.eu/Helio/</a>	○	○	○	○	database-multi	sun and heliosphere
OMNI	continuous solar wind and IMF data at IAU	<a href="http://spdf.gsfc.nasa.gov/data_orbits.html">http://spdf.gsfc.nasa.gov/data_orbits.html</a>	○	○	○	○	database-multi	interplanetary
CDPP	solar wind and magnetospheric observations from space instruments	<a href="http://cdpp.eu/">http://cdpp.eu/</a>	○	○	○	○	database-multi	interplanetary and magnetosphere
ACE Lists of	Shocks, magnetic clouds,	<a href="http://www.ssg.sr.unh.edu/mag/ace/ACElists/obs_list.html">http://www.ssg.sr.unh.edu/mag/ace/ACElists/obs_list.html</a>	○	○	○	○	database-comprehensive	ionosphere, thermosphere, mesosphere, and stratosphere

## (6) Capacity Building (Schools organized by VarSITI Co-chairs)

July 2017: Irkutsk, Russia, 35 students from 5 countries



Sept 2017: Ota, Nigeria, 38 students from 7 African countries



Sept 2015: Abuja, Nigeria, 65 students from 7 African countries



March 2018: Bandung, Indonesia, 40 students from 7 Asian countries.



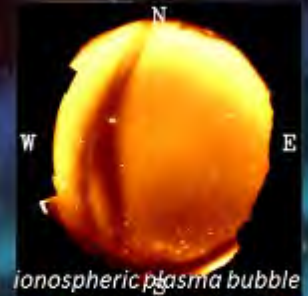
March 2015: Bandung, Indonesia, 39 students from 9 Asian countries.



# VarSITI has 4 scientific projects

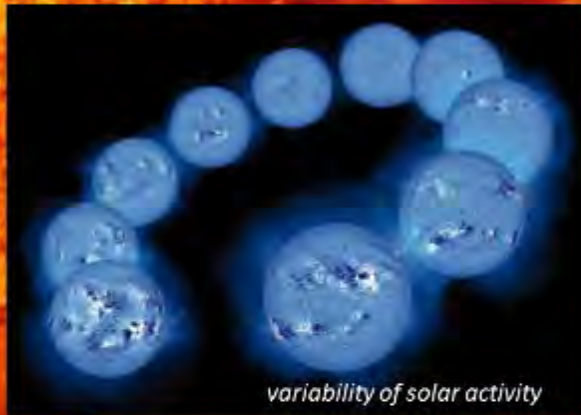
## International Study of Earth-Affecting Solar Transients (ISEST)/MiniMax24

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?





## The SCOSTEP Next Scientific Program

***PRESTO:***

**Predictability of the variable Solar-Terrestrial  
Coupling**