Variability of the Sun and Its Terrestrial Impact

the new SCOSTEP's scientific program

Scientific Committee on Solar-Terrestrial Physics

Katya Georgieva and Kazuo Shiokawa

VarSITI co-chairs

Nat Gopalswamy

SCOSTEP president

SCOSTEP
Scientific Committee on Solar-Terrestrial Physics

Scientific Committee on Solar-Terrestrial Physics

A Scientific Committee under ICSU

Principal tasks:

- **to promote international interdisciplinary programs in solar-terrestrial physics, and to organize and coordinate such programs of interest to, and approved by, at least two of the following bodies: IAU, IUGG, IUPAP, URSI, and COSPAR. Each specific program is normally of finite duration;**
- **to define the data relating to these programs that should be exchanged through the World Data Centers;**
- **to provide advice as may be required by the ICSU bodies and World Data Centers concerned with these programs;**
- **to work with other ICSU bodies in the coordination of symposia in solar-terrestrial physics, especially on topics related to SCOSTEP's programs.**

SCOSTEP
Scientific Committee on Solar-Terrestrial Physics

International interdisciplinary programs in solar-terrestrial physics operated so far by SCOSTEP

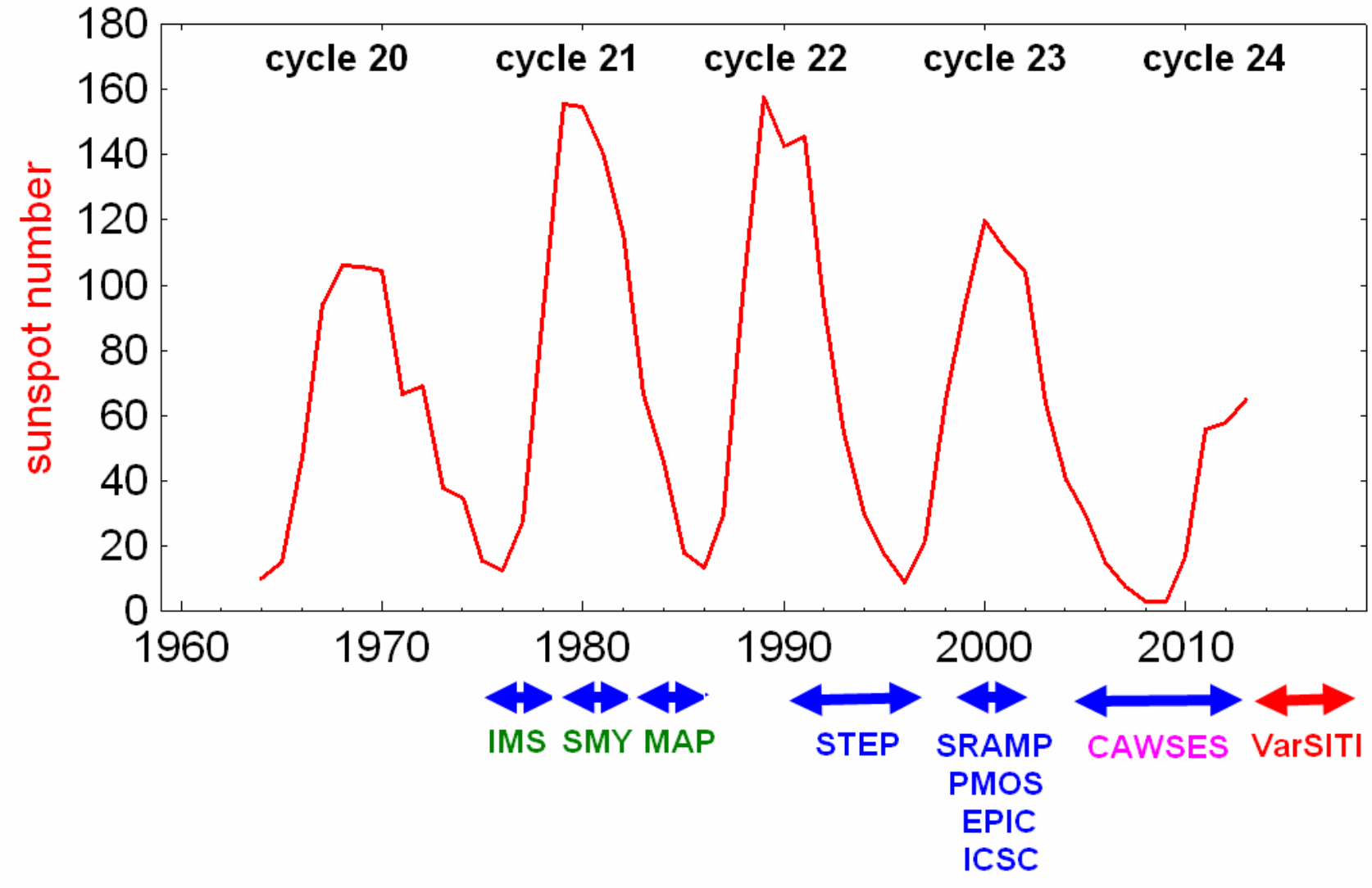
- **1976-1979** IMS: International Magnetospheric Study
- **1979-1981** SMY: Solar Maximum Year
- **1982-1985** MAP: Middle Atmosphere Program
- **1990-1997 STEP: Solar-Terrestrial Energy Program**
- **1998-2002 SRAMP: STEP-Results, Applications and Modeling Phase**
- **1998-2002** PSMOS: Planetary Scale Mesopause Observing System
- **1998-2002** EPIC: Equatorial Processes Including Coupling
- **1998-2002** ISCS: International Solar Cycle Study
- **2004-2008 CAWSES: Climate and Weather of the Sun-Earth System**
- **2009-2013 CAWSES-II: Climate and Weather of the Sun-Earth System-II**

CAWSES-II ended in the end of 2013
How the new program was created

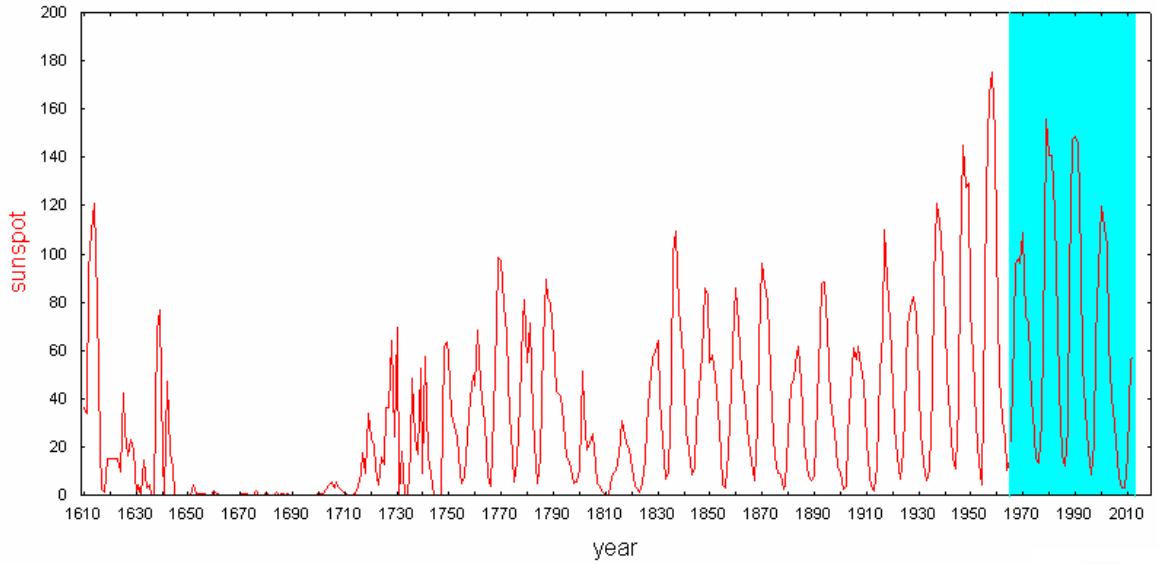
- White papers were solicited for international, interdisciplinary programs that can produce significant results in 4-5 years.
- 9 papers were received until the end of 2012
- 27 international experts were invited (including the SCOSTEP Bureau and white-paper authors) to meet at the International Space Science Institute (ISSI) in Bern to brainstorm during May 7-8, 2013
- The ISSI forum on SCOSTEP defined the new scientific program named **VarSITI: Variability of the Sun and Its Terrestrial Impact**
- Variability involves from the lifetime of the Sun to day-to-day solar events (Space Weather and Climate)

ISSI Forum on the next scientific program of SCOSTEP, May 7-8, 2013, ISSI, Bern, Switzerland

The basic challenge: Sun is entering a period of low activity

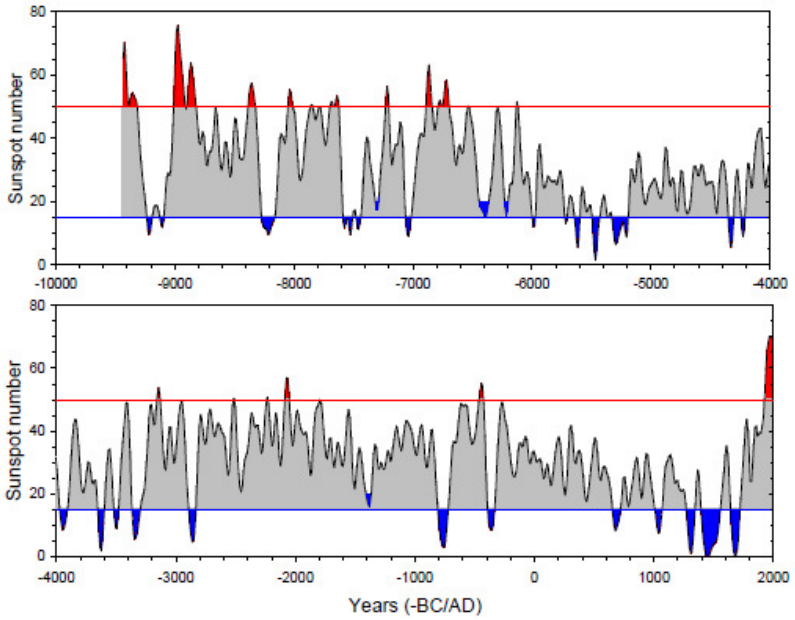


Most of the observations during the "space era" and the resulting theory are made during the recent modern grand maximum of solar activity



Maybe we are not entering a period of unusually low activity, but instead the recent high activity was unusual

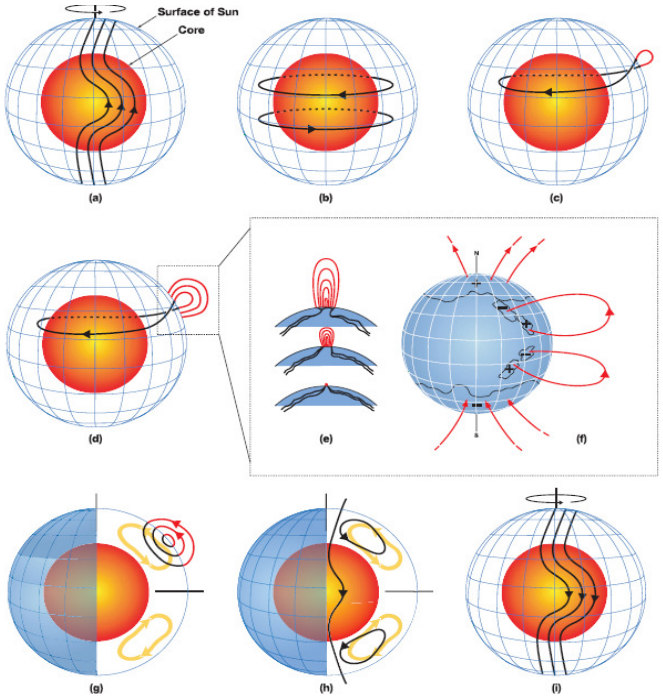
Will what we know about the Sun and solar-terrestrial influences prove true during low or "normal" solar activity?



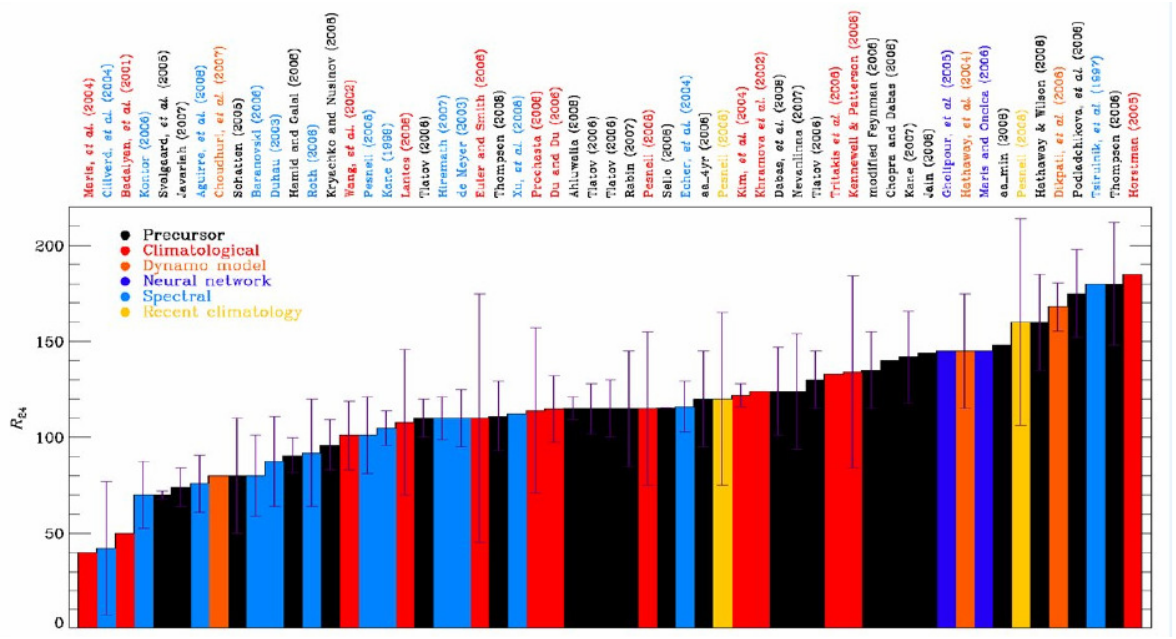
Usoskin et al., 2007

Problems: 1. the Sun

- 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.



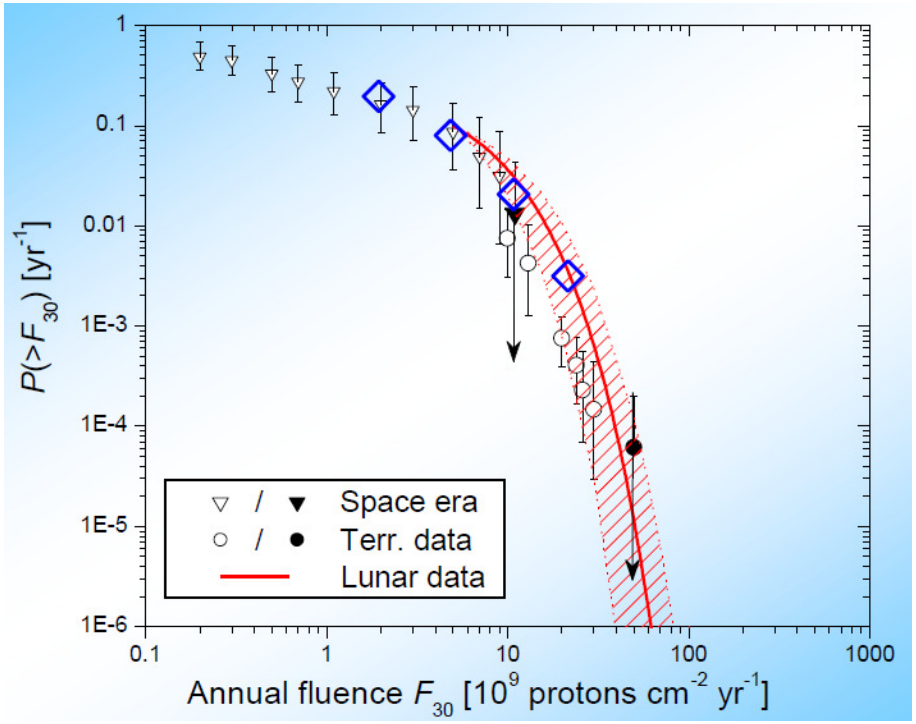
Dikpati and Gilman, 2006



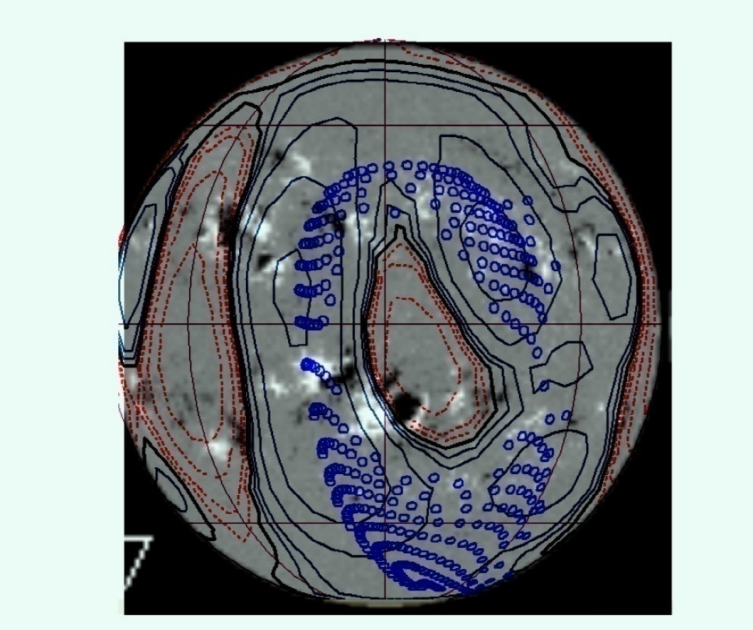
Predictions of sunspot cycle 24

Problems: 1. the Sun

- Can we forecast solar extreme events? How extreme can they be?



(Usoskin, 2013)



Forecast?

Concept of Global Complexes of Activity

(Obridko, 2014)

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)

SEE kick-off meeting

Sunny beach, Bulgaria, 26-30 May 2014

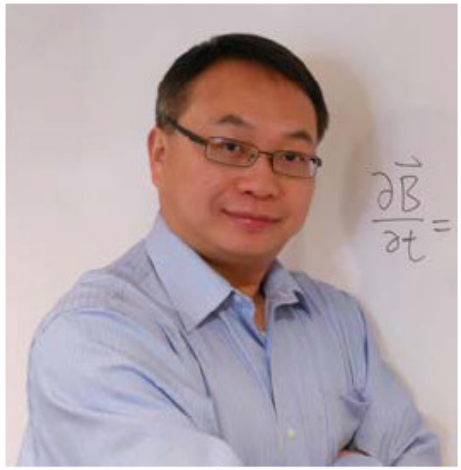
Problems: **2. the solar transients**

Geoeffective solar events: occurrence, properties, propagation, space weather effects

- Can we predict the initiation and arrival of a CME?
- Can we predict a CME's magnetic field based on its solar origin?
- Do we know what happens to CMEs and CIRs during their way from the Sun to the Earth?

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)

Campaign study to integrate theory, simulations and observations

Data base of Earth affecting solar transient events: compiled by ISEST/MiniMax24, SPeCIMEN, ROSMIC, individual scientists:

- “textbook” events
- “problem” events (e.g. stealth CMEs)

Special session at STP-13 on 18 October

Problems: **3. the magnetosphere**

- 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

- We need a series of coupled related models that quantitatively predict the state of the inner magnetosphere

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)

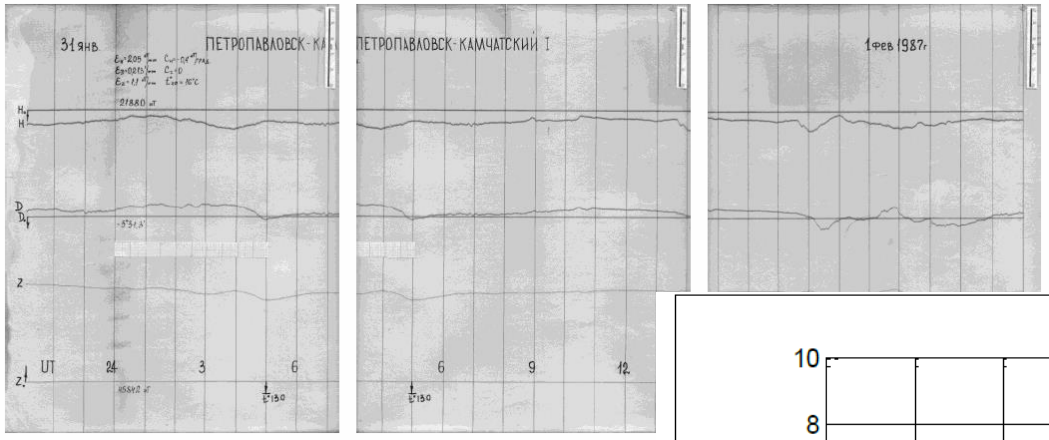
Craig Rodger,
(University of Otago,
New Zealand)

SpeCIMEN kick-off meeting:

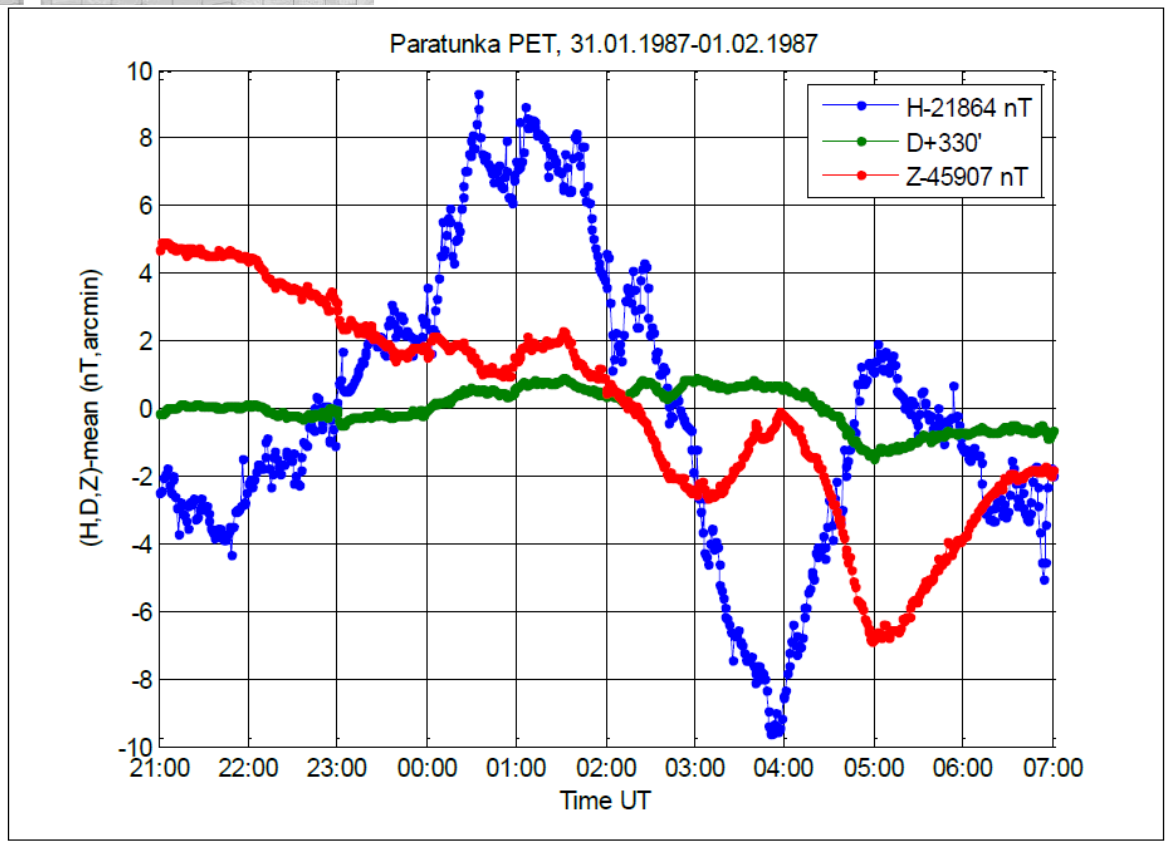
"Geospace revisited"

Rhodes island, Greece, 15-20 September 2014

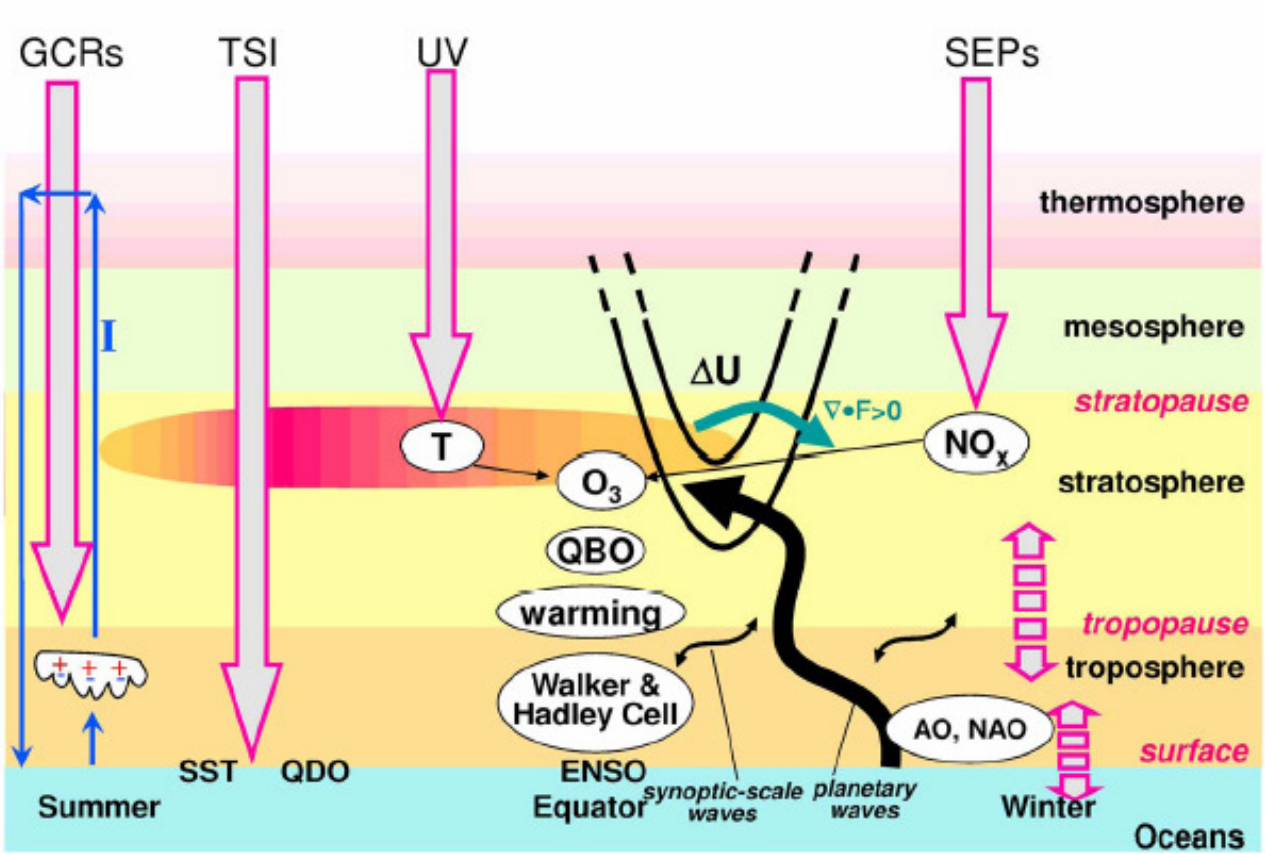
Digitalization of images of old analogue magnetograms of Geophysical observatory Paratunka in Kamchatka (1967-2006)



Transferred to WDC Moscow and Kyoto



Problems: **4. the climate**



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

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)

HEPPA-SOLARIS meeting

Baden-Baden, Germany, 5-9 May 2914

Variability of solar irradiance and energetic particle precipitation

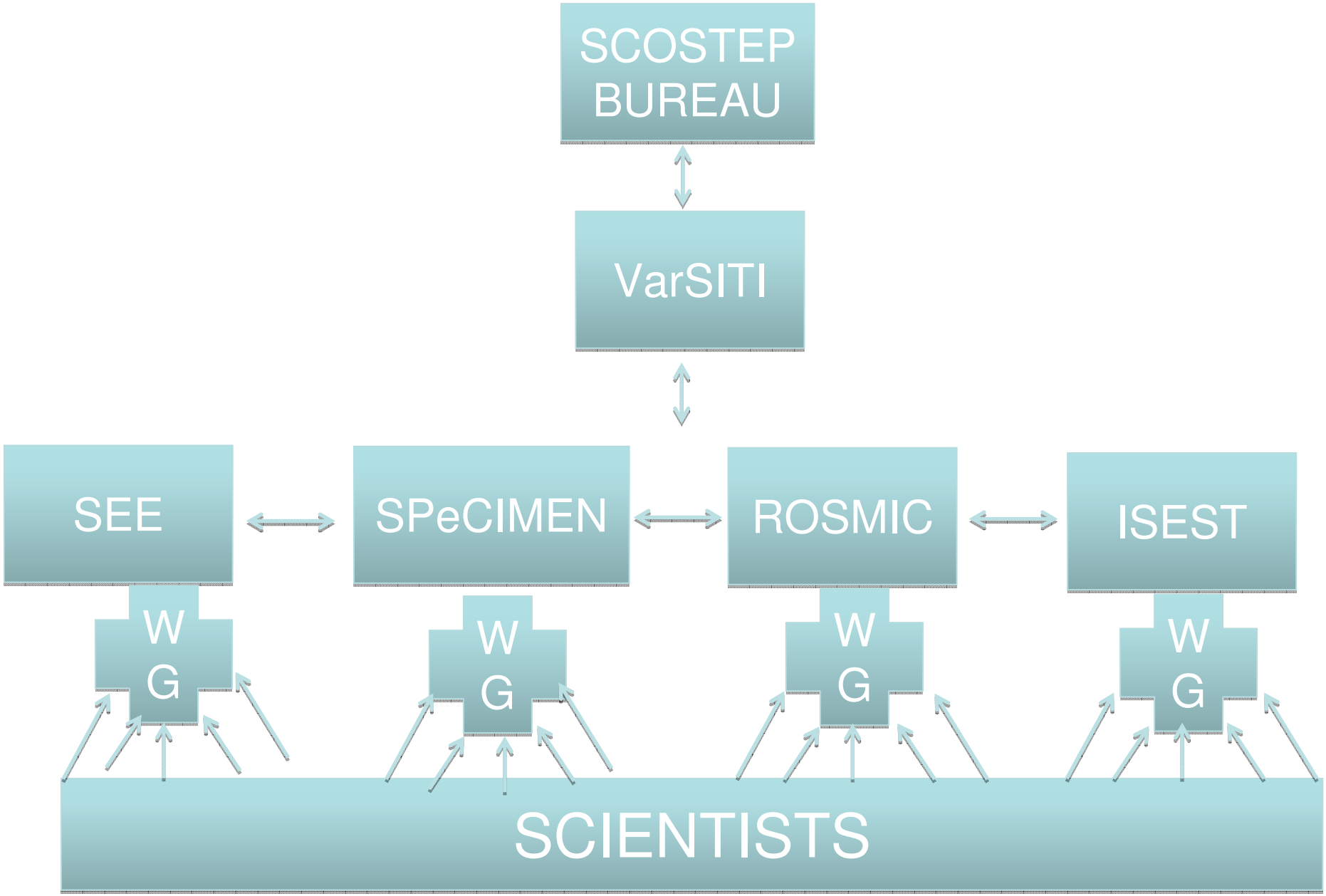
Observed and modeled impact of solar impact on atmosphere and climate

Prediction of future scenarios under weakening Sun

The impact of energetic particles on regional climate in the North Atlantic can be comparable to that of radiation and must be included in models.

Four Elements of VarSITI

- Solar Evolution and Extrema (SEE)
- International Study of Earth-Affecting Solar Transients (ISEST)/MiniMax24
- Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)
- Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC)

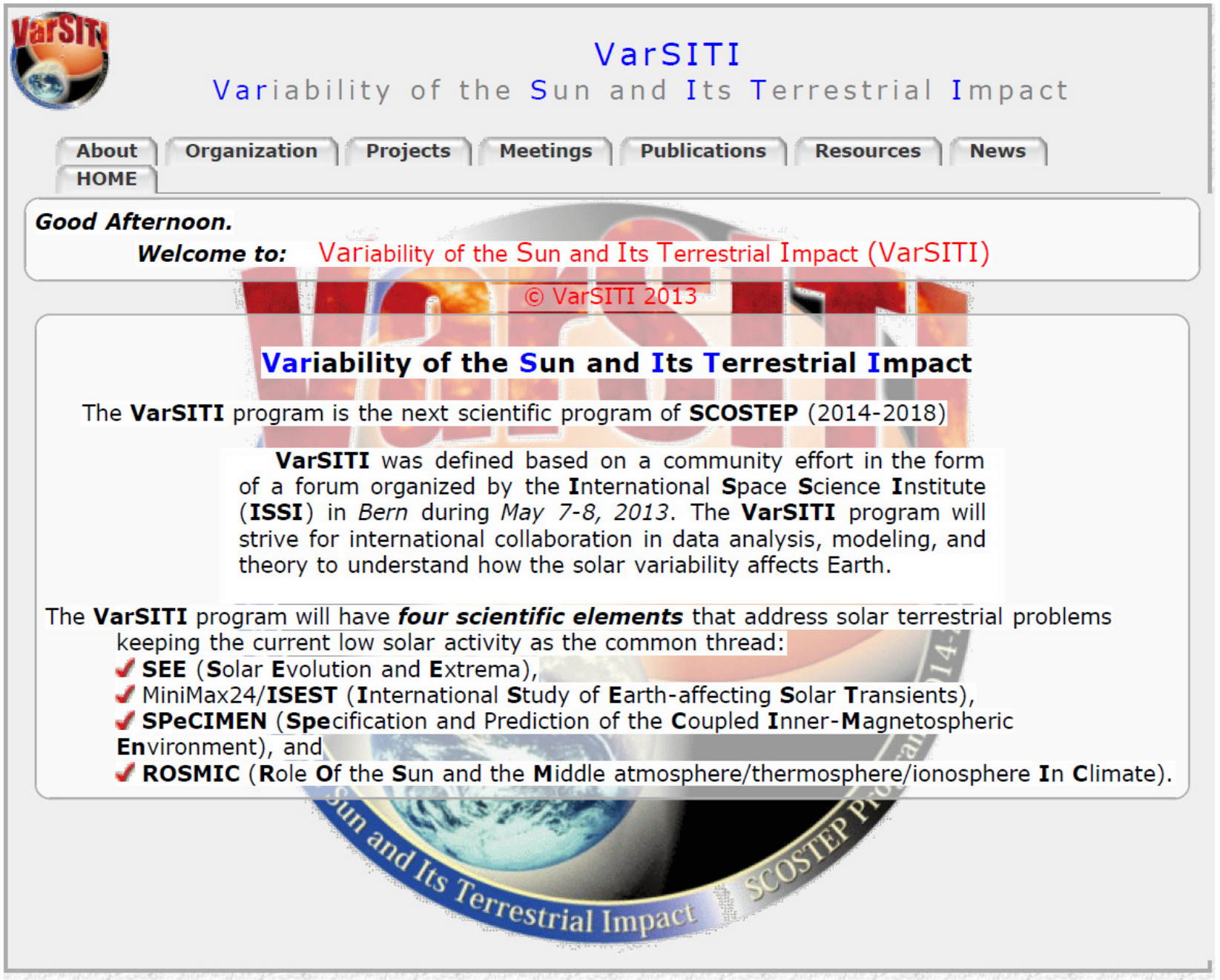

SCOSTEP
BUREAU
VarSITI
SEE
SPeCIMEN
ROSMIC
ISEST
W
G
W
G
W
G
W
G
SCIENTISTS

VarSITI (Variability of the Sun and Its Terrestrial Impact) 2014-2018

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 (currently 466 members are registered)**
- **Newsletters**
- **Meetings (financial support is available)**

www.varsiti.org



Variability of the Sun and Its Terrestrial Impact (VarSITI)
SEE / ISEST-Minimax24 / SPeCIMEN / ROSMIC
http://www.varsiti.org/

Vol. 1, March 2014

VarSITI Newsletter

Inside this issue

Article 1:

About the VarSITI

Variability of the Sun and Its Terrestrial Impact


Katya Georgieva


Kazuo Shiokawa

K. Georgieva[1] and K. Shiokawa[2]
[1]Space Research and Technologies Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2]Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan

The last solar minimum in 2008-2009 and the current solar maximum of sunspot cycle 24 show much lower activities compared with the previous two solar cycles 22 and 23. The scientists in the solar-terrestrial physics are watching very low solar activities and their consequences on Earth, which have never been observed since modern scientific measurements become available. The current solar dynamo theories are unable to predict the long-term solar activity variations. It is not clear whether the last deep solar minimum and the current low solar maximum may signal the end of the recent period of relatively high solar activity, and what long-term solar activity variations we can expect in the future. Moreover, it is not clear to which extend our present understanding of how the Sun influences the geospace, which is based on instrumental observations taken during only the recent period

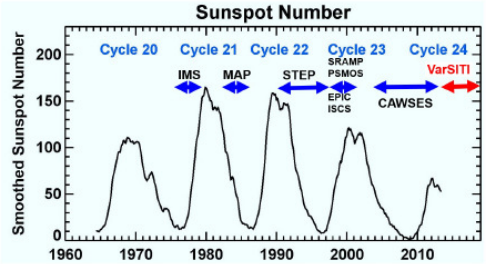


Figure 1. Variation of sunspot numbers and SCOSTEP programs. VarSITI is carried out during the lowest solar activities since the modern scientific observations become available.

Variability of the Sun and Its Terrestrial Impact (VarSITI)
SEE / ISEST-Minimax24 / SPeCIMEN / ROSMIC
http://www.varsiti.org/

Vol. 2, July 2014

VarSITI Newsletter

Inside this issue

Project SEE/ISEST/ROSMIC

Article 1:

Coordinated investigations of solar, planetary radio emission, solar wind and Earth's ionosphere carried out in Ukraine with the world's largest radio telescopes

A. A. Konovalenko[1], N. N. Kalinichenko[1], O. A. Lytvynenko[2], V. V. Dorovskii[1], V. N. Melnik[1], A. I. Brazhenko[3], V. V. Zakharenko[1], A. A. Stanislavskii[1], and V. A. Shepelev[1]
[1]Institute of Radio Astronomy of NASU, Kharkov, Ukraine
[2]Observatory URAN-4 of Institute of Radio Astronomy NASU, Odessa, Ukraine
[3]Poltava gravimetrical observatory of institute geophysics NASU, Poltava, Ukraine


Konovalenko Alexander · Kalinichenko Nikolay · Lytvynenko Oleg · Dorovskii Vladimir · Melnik Valentin · Brazhenko Anatoly · Zakharenko Vyacheslav · Stanislavskii Alexander · Shepelev Valery

Ukraine has a substantial experimental base of radio remote sensing for research of VarSITI problems. First of all the base includes the largest in the world decameter radio telescope UTR-2 and the URAN system of radio telescopes (Figure 1).

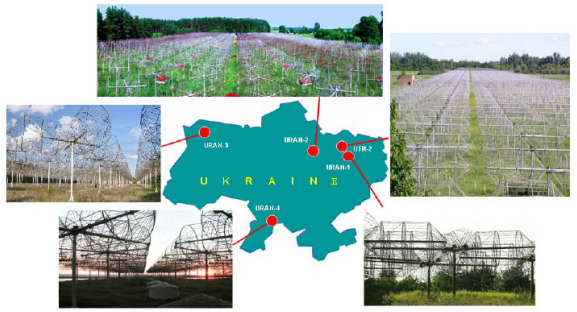


Figure 1. URAN decameter radio telescopes system on Ukraine map: Radio telescopes UTR-2 URAN-1, URAN-2, URAN-3 and URAN-4. They operate at the frequencies from 9 to 32 MHz.

Distributed through the VarSITI mailing list

Variability of the Sun and Its Terrestrial Impact (VarSITI)
SEE / ISEST-Minimax24 / SPeCIMEN / ROSMIC
http://www.varsiti.org/

Vol. 3, October 2014

VarSITI Newsletter

Inside this issue

Project ROSMIC

Article 1:

The Swarm mission: Understanding the space environment in the changing Earth's magnetic field

C. Stolle[1] and R. Floberghagen[2]
[1]Helmholtz Centre Potsdam, GFZ, German Research Centre for Geosciences, Potsdam, Germany
[2]European Space Agency, ESRIN, Frascati, Italy


Claudia Stolle


Rune Floberghagen

The interaction between the upper atmosphere and the geomagnetic field is important for both of them. The location of ionospheric currents and the direction of plasma drifts, but also partly the direction of thermospheric winds depend on the shape of the geomagnetic field. Their amplitude and therefore also effective energy deposition through, e.g., Joule heating are governed by the field's strengths. In turn, currents that result from the atmospheric dynamo or from steep plasma density gradients amplify the magnetic field. Hence, simultaneous observations of the magnetic field in high precision and of plasma and thermospheric parameters have largely advanced our understanding of processes in the upper atmosphere (e.g., Olsen and Stolle, 2013; Lühr et al., 2011).

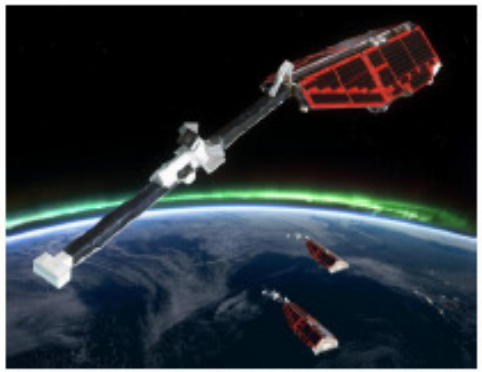


Figure 1. Artist illustration of Swarm satellites (credit: to ESA).

VarSITI Registration Sheet for mailing list

VarSITI Registration sheet		Date:	Meeting name:	
Please sign your name and e-mail address to register into the VarSITI mailing list				
first name	last name	e-mail address	country	interest of projects (choose as many as you like)
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL
				SEE ISEST/Minimax SPeCIMEN ROSMIC ALL

Meetings related to VarSITI (some support funding is available)

Conference	Date	Location	Contact Information
8th IAGA/ICMA/SCOSTEP Workshop on Long-Term Changes and Trends in the Atmosphere	Jul. 28-31, 2014	Cambridge, UK	www.antarctica.ac.uk/trends2014
Asia Osceania Geosciences Society (AOGS) 11th Annual Meeting	Jul. 28-Aug. 1, 2014	Sapporo, Japan	http://www.asiaoceania.org/aogs2014/
40th COSPAR Scientific Assembly	Aug. 2-10, 2014	Moscow, Russia	https://www.cospar-assembly.org/
5th IAGA/ICMA/SCOSTEP Workshop on Vertical Coupling in the Atmosphere-Ionosphere System	Aug. 11-15, 2014	Antalya, Turkey	http://5thiagaworkshop.akdeniz.edu.tr/en
31st URSI General Assembly and Scientific Symposium	Aug. 16-23, 2014	Beijing, China	http://www.chinaursigass.com/
12th Asia-Pacific Regional IAU Meeting (APRIM 2014)	Aug. 19-22, 2014	Daejeon, Korea	http://www.aprim2014.org/
AGU Chapman Conference on Low-Frequency Waves in Space Plasmas	Aug. 31-Sep. 5, 2014	Juju Island, Korea	http://chapman.agu.org/spaceplasmas/waves-spaceplasmas/
14th European Solar Physics Meeting	Sep. 8-12, 2014	Trinity College, Dublin, Ireland	http://www.espm14.ie/
International Conference on "Geospace Revisited"	Sep. 15-20, 2014	Rhodes, Greece	http://geospacerev.space.noa.gr/
2nd ANGWIN Workshop	Sep. 22-24, 2014	Logan, UT, USA	
SCOSTEP's 13th Quadrennial Solar-Terrestrial Physics Symposium (STP 13)	Oct. 12-17, 2014	Xi'an, Shanxi, China	http://stp13.csp.escience.cn/dct/page/1
New Challenges in the Study of the Impact of Solar Variability and on Climate	Oct. 13-17, 2014	Trieste, Italy	
12th International Conference on Substorms (ICS-12)	Nov. 10-14, 2014	Ise-Shima, Japan	http://www.stelab.nagoya-u.ac.jp/ICS-12/
International School on Space Weather, GNSS, GIS Internet and Data base	Nov. 10-21, 2014	University of Koudougou, Burkina Faso	

Database development is also important for VarSITI.

- **Discussion for coordination between SCOSTEP and WDS (World Data System) is going on.**

- **IUGONET meta-database (a Japanese consortium) (http://www.iugonet.org/)**

IUGONET: Inter-university Upper atmosphere Global Observation NETwork

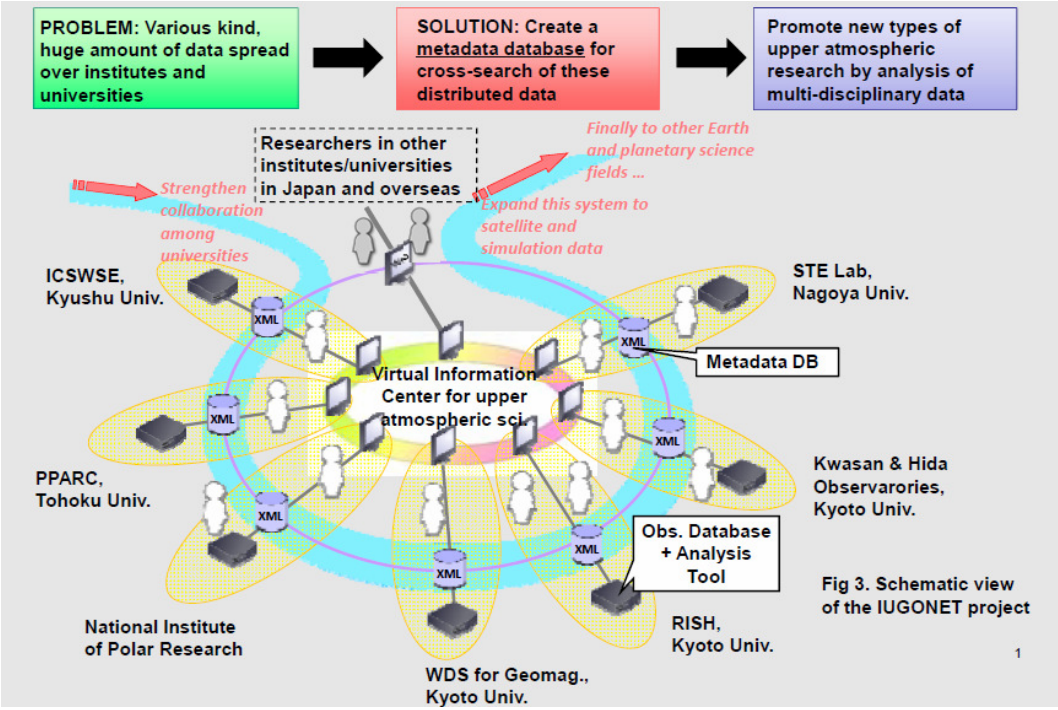


Fig 3. Schematic view of the IUGONET project

Hayashi et al. (Data Science Journal, 12, WDS179-WDS184, doi:10.2481/dsj.WDS-030, 2013)