Recent Italian advances in Space Weather

Vincenzo Romano[1], Yenca Migoya-Orue[2], Christina Plainaki[3]

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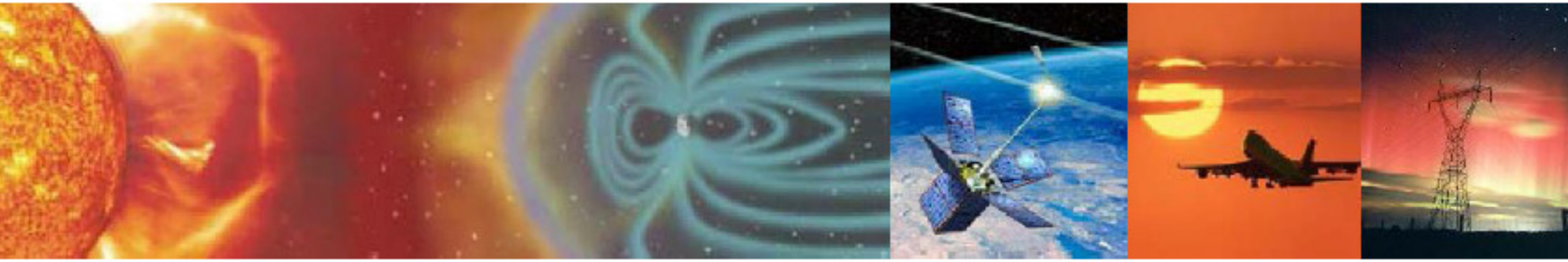
[3] International Centre for Theoretical Physics yenca@ictp.it

[2] ASI – Agenzia Spaziale Italiana christina.plainaki@asi.it

Thanks to:

cilla Alfonsi (INGV), Alessandro Bemporad (INAF), Francesco Berrilli (UTOV), Claudio Cesaroni (INGV), Giuseppe Consolini (INAF), niele Biron (COMet), Lili Cafarella (INGV), Paola De Michelis (INGV), Alfredo Del Corpo (UNIVAQ), Piero Diego (IAPS), Domenico Di uro (INGV), Catia Grimani (UNIURBINO), Stefania Lepidi (INGV), Federica Marcucci (INAF), Mauro Messerotti (INAF), Yenca Migoya-Orue (ICTP), Filippo Rodriguez (Telespazio), Paolo Romano (INAF), Luca Spogli (INGV), Roberta Tozzi (INGV), Umberto Villante (UNIVAQ), Francesca Zuccarello (Uni CT), Enrico Zuccheretti (INGV).

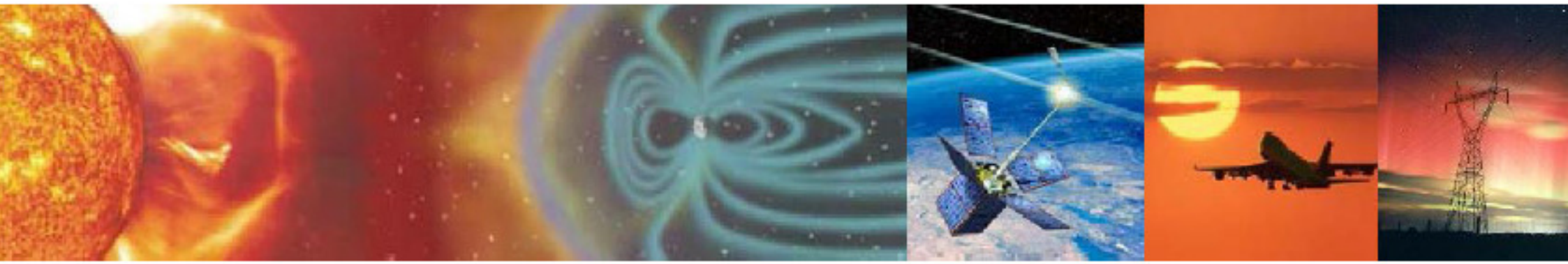


UN COPUOS 56th Session STSC February 2018

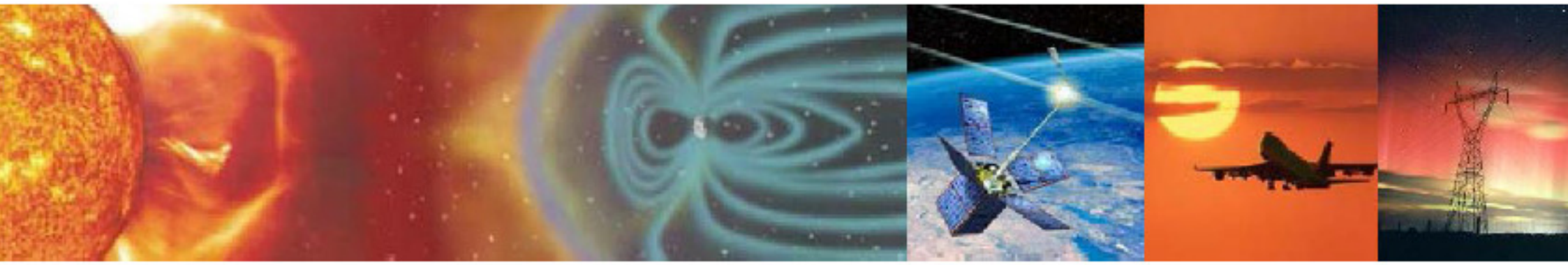
Outline

Space weather-related thematic areas

- Italian strategic Initiatives
- Research and Technology Development in the fields of:
  - Solar physics
  - Interplanetary space and Solar-Terrestrial physics
  - Geomagnetism
  - Upper atmosphere physics



Italian Space Weather strategic initiatives



SWICO

Space Weather Italian Community

Italy at United Nations – Office for Outer Space Affairs

degli Affari Esteri
erazione Internazionale
FARNESINA

agenzia spaziale italiana

Istituto Nazionale di Geofisica e Vulcanologia

United Nations
Office for Outer Space Affairs

UNITED NATIONS
Committee on the Peaceful Uses of Outer

GV and ASI are the Italian representatives at the Space Weather Expert Group of
OPUOS (Committee on the Peaceful Uses of Outer Space)

pert Group on Space Weather is
tended till 2021.
orkplan is in terms of examining
ture international coordination for
ace weather

Roadmap for international coordination and information exchange on space weather events

A. Product and service selection

B. Information communication protocol

C. Response procedures

D. Product sustainment and improvement and risk assessments

E. Improved understanding of fundamental physical processes w cause extreme space weather

F. Promote capacity building for space weather in COPUOS Mem States

Italy at ISWI

INGV and ICTP are the Italian co-coordinators in ISWI (International Space Weather Initiative).

is a program of international cooperation to nce the space weather science by a combination of ument deployment, analysis and interpretation of e weather data from the deployed instruments in unction with space data, and communicate the ts to the public and students.

http://www.iswi-secretariat.org/

I Secretariat

tive Director

at Gopalswamy

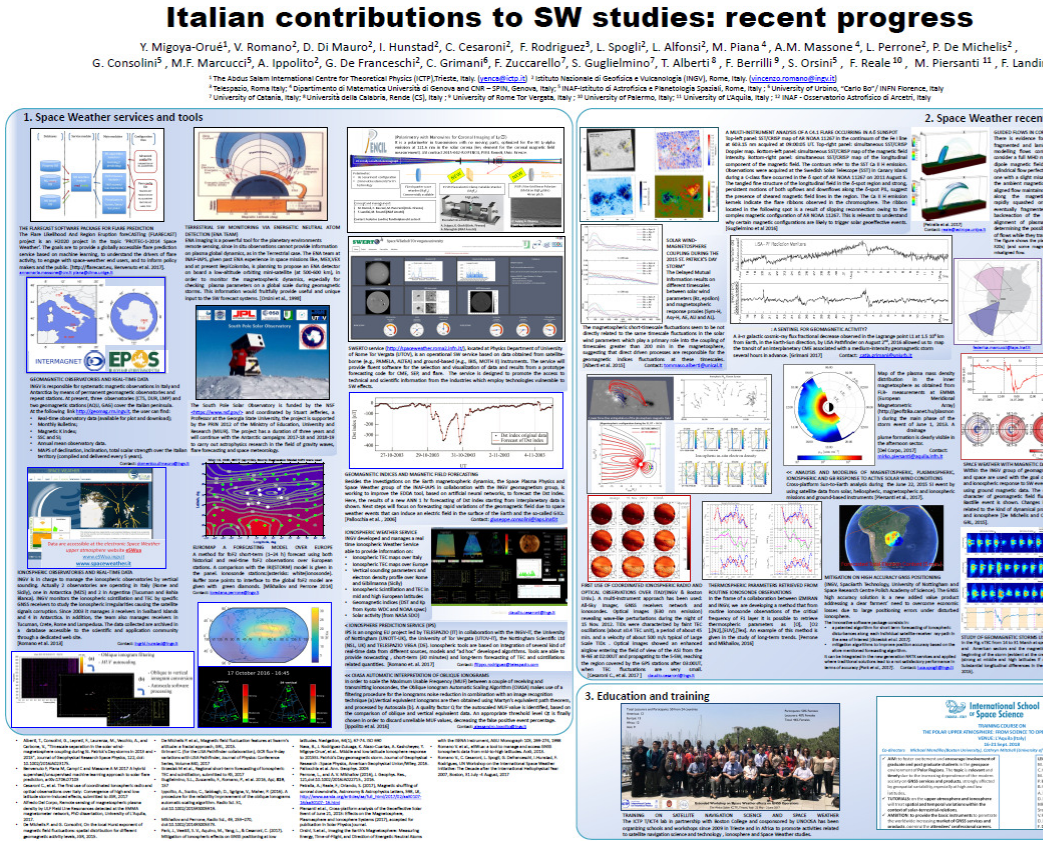
Physics Laboratory NASA/GSFC

d Nations Office for Outer Space Affairs Liaison

harafat Gadimova

ffice for Outer Space Affairs

a International Center



Yenca Migoya-Orue, Vincenzo Romano et al.

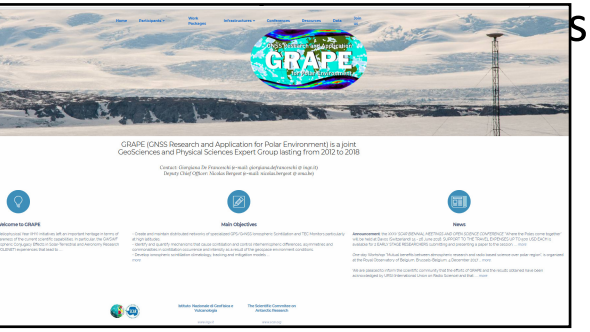
"**Italian contributions to SW studies: recent prog**

Poster at ISWI workshop, August 2017, Boston Co

Italy at SCAR – Scientific Committe for Antarctic Research

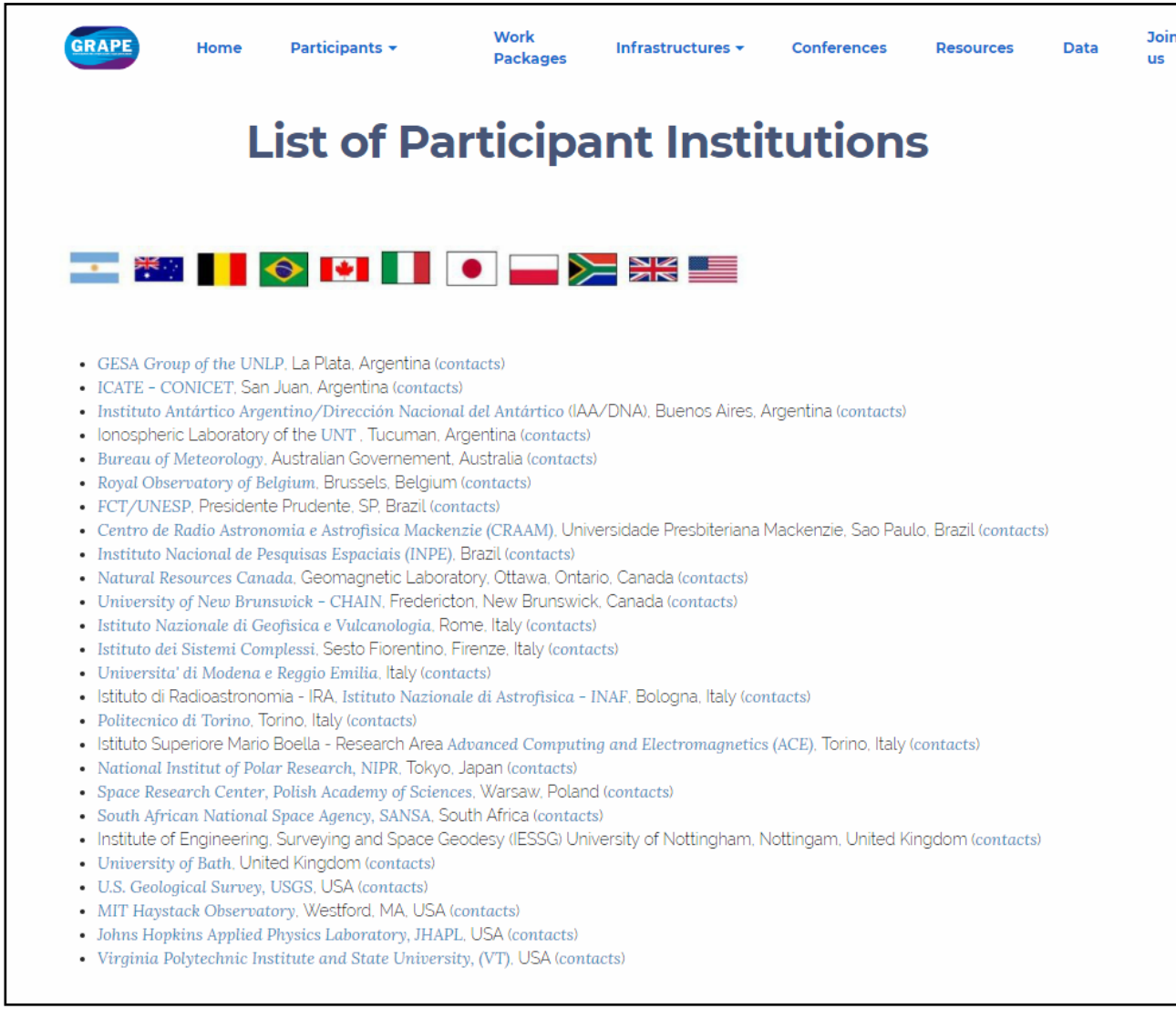
Italy leads the SCAR expert group called GRAPE (GNSS Research and Application for Polar Environment).
GRAPE is a joint GeoSciences and Physical Sciences Expert Group lasting from 2012 to 2018

s are involved.



http://www.grape.scar.org

n Objectives
ISS ionospheric network coordination
velop space weather tools
estigate physical mechanism
trieve tropospheric PWV



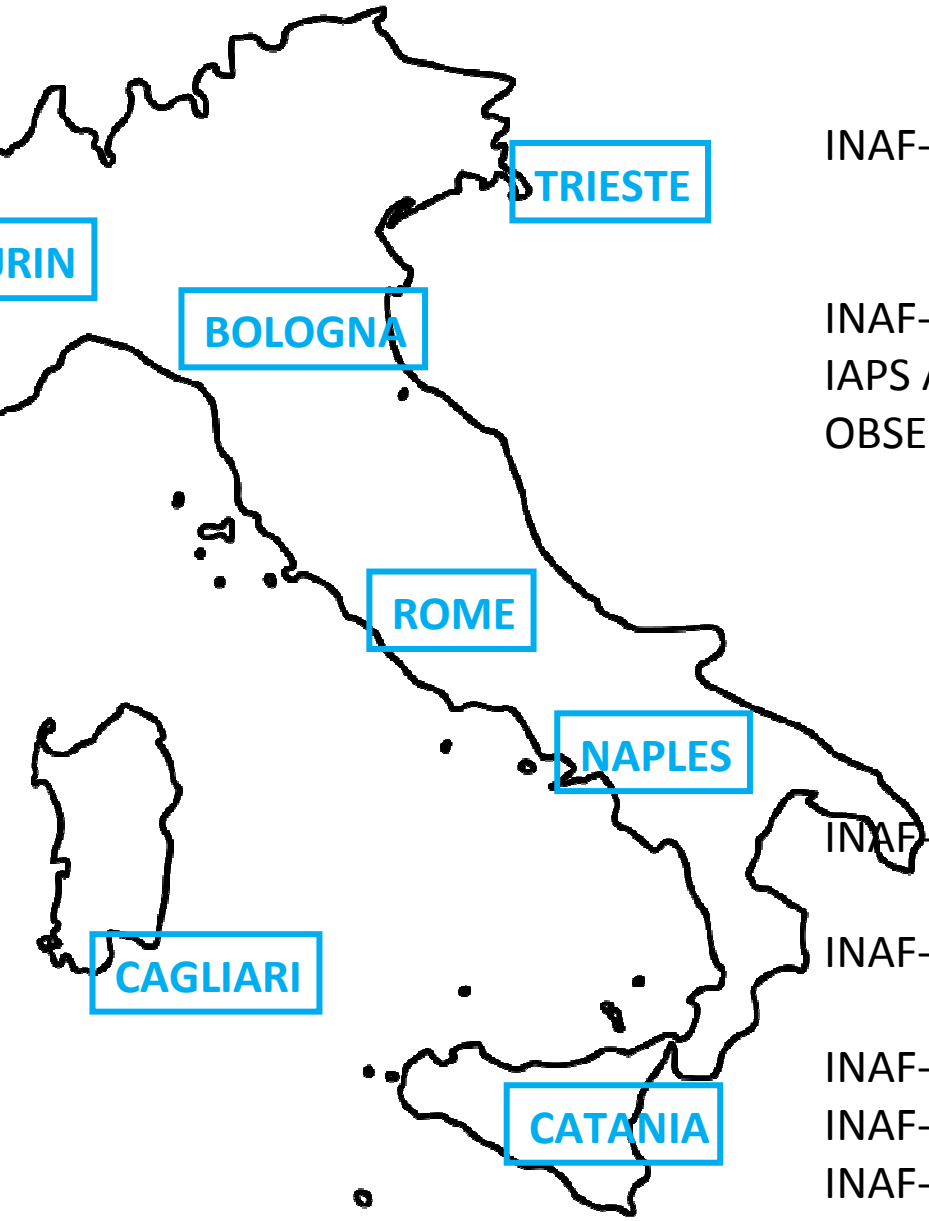
Italy at ICAO

in collaboration with ENAC (the Italian Civil Aviation
ority) is member of the PECASUS European consortium
oved as one of the three **SPACE WEATHER INFORMATION
AL PROVIDERS IN SUPPORT OF INTERNATIONAL AIR
GATION**

*US SWxC will provide information on prevailing and forthcoming SWx
visories compatible with the standardized ICAO formats. The
ries will be given by a 24/7 service and in the areas of:*
Frequency (HF) communications
*vigation and surveillance based on Global Navigation Satellite
s (GNSS), and*
ation exposure at flight altitudes
llite Communication

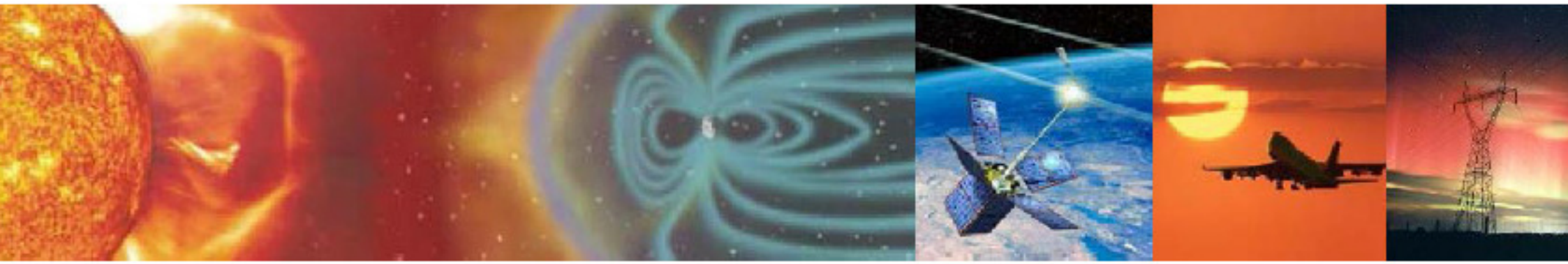
Company/Organization	Country
Finnish Meteorogical Institute (FMI)	Finland
Solar-Terrestrial Centre of Excellence (STCE)	Belgium
Met Office (UKMO)	United King
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)	Germany
Royal Netherlands Meteorological Institute (KNMI)	Netherland
Centrum Badan Kosmiccznych Polskiej Akademii Nauk (SRC)	Poland
Istituto Nazionale di Geofisica e Vulcanologia (INGV)	Italy
Seibersdorf Labor GmbH (SL)	Austria
The Cyprus Department of Meteorology (DoM)	Cyprus

INAF National Space Weather Service Network (NSWS



INAF-TURIN	• HELIOSPHERIC DATA AND SWX CENTRE • SOHO & SOLAR ORBITER/METIS DATA ARCHIVES
INAF-TRIESTE	• TRIESTE SOLAR RADIO WEATHER CENTRE • SOLAR RADIO ARCHIVE
INAF-ROME IAPS AND OBSERVATORY	• SVIRCO NEUTRON MONITOR • DOME C EAST HF RADAR IN ANTARCTICA (SUPERDARN • MAGNETOSPHERIC AND IONOSPHERIC OBSERVATIONS • SOLAR WIND AND IONOPHERE PLASMA SIMULATOR (S • SOLAR ACTIVITY MOF MONITOR (SAMM) • PRECISION SOLAR PHOTOMETRIC TELESCOPE (PSPT) • HR SPECTROPOLARIMETER IBIS DATA ARCHIVE • HISTORICAL SOLAR IMAGES DIGITAL ARCHIVE
INAF-NAPLES	• SOLAR HR MOF IMAGING (VAMOS)
INAF-CATANIA	• SOLAR HR WL AND H-ALPHA IMAGING
INAF-CAGLIARI INAF-BOLOGNA INAF-CATANIA	• K-BAND HR SOLAR RADIO IMAGING

Solar physics and Space Weather



pace Weather Research Activities in ASI

n: C. Plainaki, A. Ippolito, M. Giardino, B. Negri, M. Castronuovo

Research Fields and Activities

nd Galactic Cosmic Ray physics

terplanetary propagation

LE coupling processes physics

heric disturbances investigations and upper here physics;

ary space weather (PSW) physics, with special sis on the study of plasma-atmosphere interactions in an system

on of payload science objectives for future SW and issions

nation of the national Space Weather Working Group

ds

etical and Numerical Modelling;

Analysis;

pation in projects related to circum- rial SW or PSW

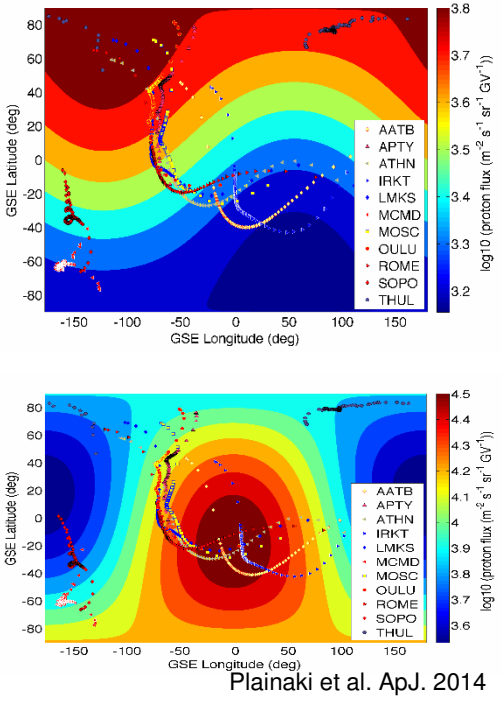
larOrbiter/METIS

ICE

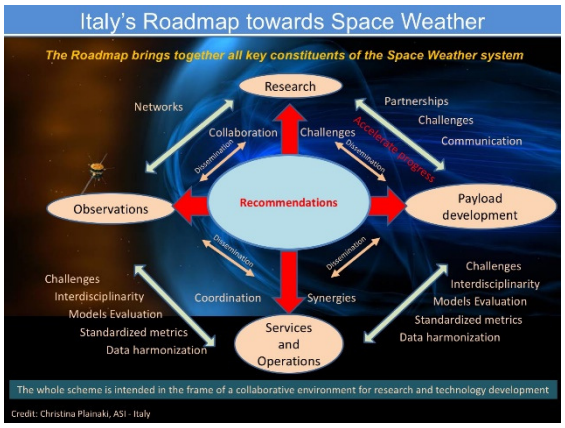
UNO

XA BepiColombo/SERENA

Model-derived spatial distribution of the primary *1 GV* SEP flux on 17 May 2012



Plainaki et al. ApJ. 2014



Recently, the **ASI Space Weather Working Gro** proposed through the creation of a related Roadı long-term strategy for the development of Space Weather scientific activities in Italy. In the contex strategy, the Italian Space Agency aims to asses possibility to develop a **National Scientific Spac Weather Data Center (ASPIS[1])**, to host the exis tools and related data archives obtained by the I space weather assets, to encourage **synergies** between different science teams with interest in field and to **motivate innovation** and **new miss concept development**.

References

[1]ASPIS stands for Asi SPace weather InfraStruc

Plainaki, C., Negri, B., Castronuovo, M., (2017). *Propos national Space Weather Infrastructure*, SAIT 2017, Pado (Italy);

Plainaki, C., Negri, B., Castronuovo, M., A. Antonelli (20 *Towards an Italian Space Weather Infrastructure: the A project*, EGU2018-5239, EGU General Assembly 2018

Plainaki, C. and the ASI Space Weather Working Grou Roadmap towards Space Weather Science", ASI Space Workshop, 18 Dec 2018

Plainaki, C. and the ASI Space Weather Working Grou "ASPIS towards future perspectives in the field of Space Weather ", ASI Space Weather Workshop, 18 Dec 2018

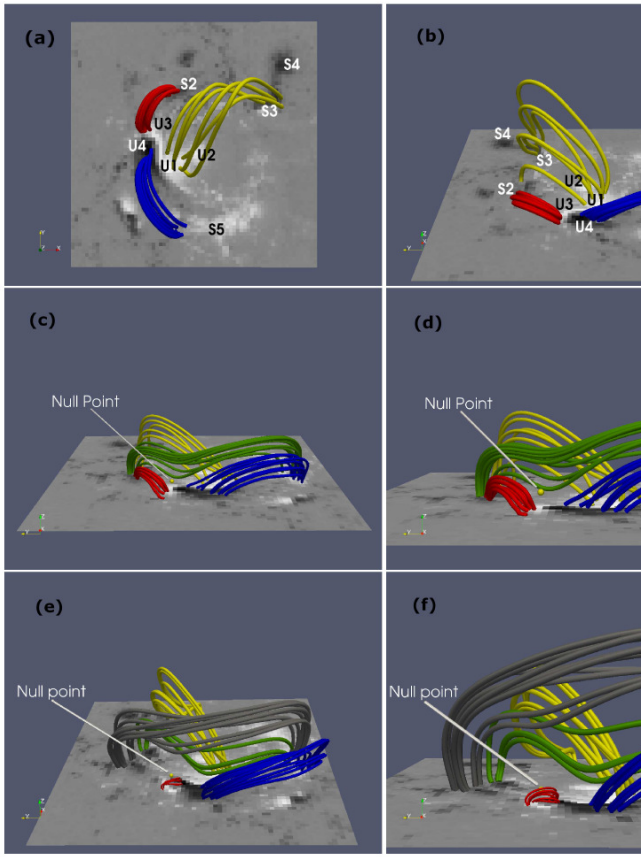
Solar Physics Group in Catania

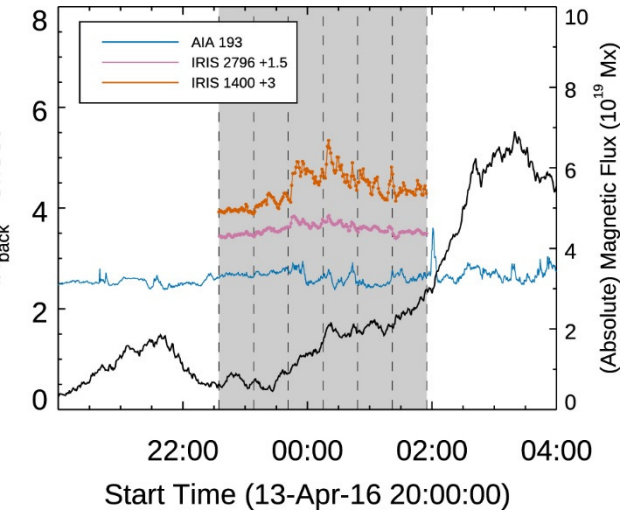
rsonnel

Dolei (INAF), M. Falco (INAF), S.L. Guglielmino (UniCT), P. Romano (INAF), D. Spadaro AF), R. Ventura (INAF), F. Zuccarello (UniCT).

ain Research Fields

rticipation in the European Solar Telescope Design Phase; Participation in the ar Orbiter mission; Participation to the ESA - Space Situational Awareness ogram; Emergence of magnetic flux tubes in the solar atmosphere; Formation d evolution of solar active regions; Flares and Coronal Mass Ejections: drivers, rly coronal propagation and effects on the space environment; ar Wind source regions, Space Weather.





Methods

- Coordinated observing Campaigns between ground-based and space-based satellites
- Analysis of spectroscopic and spectro-polarimetric data acquired from space and ground.
- Design and development of new instrumentation for future ground-based observations.

Solar Physics Group in Catania

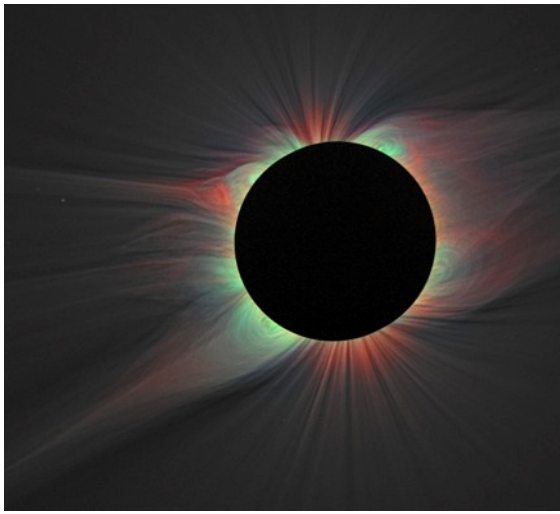
Project Name	Short description	Role	Timeline
PRE-EST	To provide both the EST international consortium and the funding agencies with a detailed plan regarding the implementation of the European Solar Telescope.	Participation of UniCT and INAF-OACt Teams	2017 April 1 – 2021 March 3
SOLARNET	To integrate the major European infrastructures in the field of high-resolution solar physics and to define the exploitation of the future 4-meter European Solar Telescope.	Participation of UniCT and INAF-OACt Teams	2019 January 2022 Decembe
Metis	WL and UV Coronagraph for ESA-Solar Orbiter spacecraft → first close-up (0.3 AU) observations of coronal plasmas	Participation to Science Team	Launch: Febru 2020, nominal mission 7.5 ye
ESCSOLAR-2	To provide near real-time full-disc images of the photosphere at 656.78 nm and of the chromosphere at 856.28 nm to the portal of ESA Space Situation Awareness Space Weather.	Participation of INAF-OACt Equatorial Spar Team	2017 Decembe – 2019 June 10

ito et al., ApJ, in press
et al., A&A, in press
no et al., Sol. Phys., 294, 4, 2019
lmino et al., ApJ, 871, 82, 2019
ito et al., ApJ, 855, 58, 2018
lmino et al., ApJ, 856, 127, 2018
lmino et al., IAUS, 340, 251, 2018
et al., A&A, 612, A84, 2018
no et al., ApJ, 852, L10, 2018

Solar Physics Group in Turin

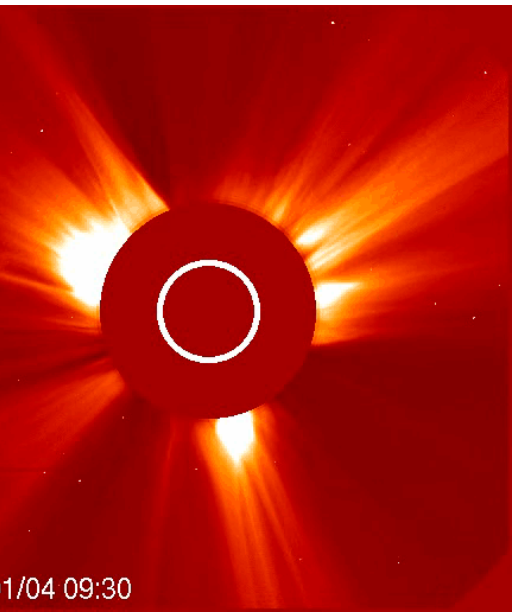
onnel

onucci, S. Fineschi, A. Bemporad, C. Benna, G. Capobianco, M. Casti, F. Frassati, S. Giordano, dini, A. Liberatore, S. Mancuso, G. Massone, G. Nicolini, R. Susino, D. Telloni, L. Zangrilli.



in Research Fields

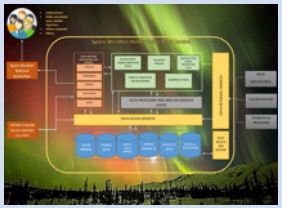
sics of the solar corona, understanding the origin and evolution of the drivers of Geomagnetic Storms on Earth: Solar Wind and Coronal Mass ions (CMEs).



Methods

- Coordination of observational campaigns from space and ground (total solar eclipses)
- Development of diagnostic techniques for the analysis of coronagraphic and spectroscopic data acquired from space and ground.
- Development of new instrumentation for future space missions and ground b observations.

Solar Physics Group in Turin

Project	Short description	Role	Timeline
METIS 	**WL and UV Coronagraph for ESA-Solar Orbiter** spacecraft → first close-up (0.3 AU) observations of corona	Leader of the international science consortium (PI: M. Romoli)	Launch: February 2020, nominal mission 7.5 years
ASPIICS 	**WL coronagraph for ESA-PROBA3** satellite → first eclipse-like, long-term observations of the inner corona	Italian leader for Formation Flying metrology (Lead Co-I: S. Fineschi)	Launch: 2022, nominal mission 2 years
SCORE 	**Helium Sounding rocket coronagraph** → first determination of coronal Helium abundance	Leader of the italian instrument consortium (PI: S. Fineschi)	First launch: September 2009, Second launch: 2020
ESCAPE 	**Coronagraph in Antarctica** (Concordia base) → first long-term coronal magnetic fields monitoring	Leader of the italian instrument consortium (Co-PI: S. Fineschi)	Deployment: Antarctic summer 2018/2019, duration 3 years
SW HELIOSPHERIC DATA CENTER 	**Heliospheric Data Centre** is a joint ALTEC & INAF-OATo effort → evolve the **SOLAR** (Soho Long-term Archive), and develop a **Heliospheric Space Weather Centre for forecast**	Hosted and maintained by ALTEC, developed in joint collaboration with INAF Turin Observatory	Established in 2017, currently under development

Solar Physics in Trieste

National Institute For Astrophysics
Astronomical Observatory of Trieste

TSRWC
te Solar Radio Weather Centre

ESA Space Weather Working Team, Steering Board Member

European Space Weather Week Programme Committee, Chair

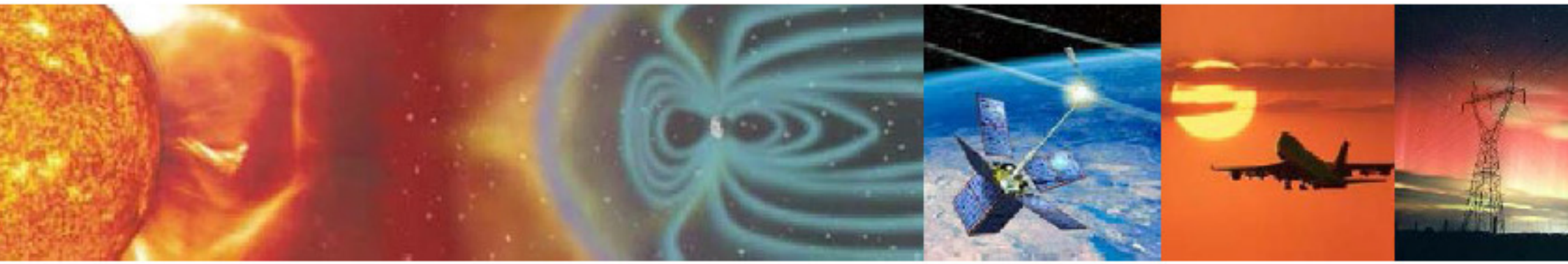
ESF ESSC WG on “Assessment and Consolidation of Space Weather in Europe”

NATO SCI-318 RSM on “The Space Domain and NATO Operation: A Critical S&T Review”, Programme Committee

Solar Orbiter/METIS
Co-Investigator, Responsible for the Italian segment data handling

Senior Advisor for Space Weather to the INAF President and INAF Science Director

Interplanetary space and Solar-Terrestrial physics



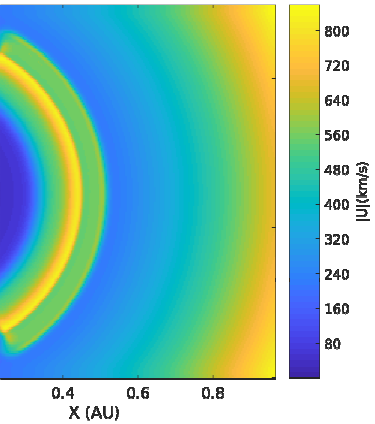
University of L'Aquila

M. Vellante, P. Francia, M. De Lauretis, E. Pietropaolo, A. Piancatelli,
A. Del Corpo, S. Di Matteo, G. Napoletano, U. Villante

research fields:

Remote monitoring of the cold plasma in the inner magnetosphere

EMMA (European quasi-Meridional Magnetometer Array)
27 stations, 1.6 < L < 6.2

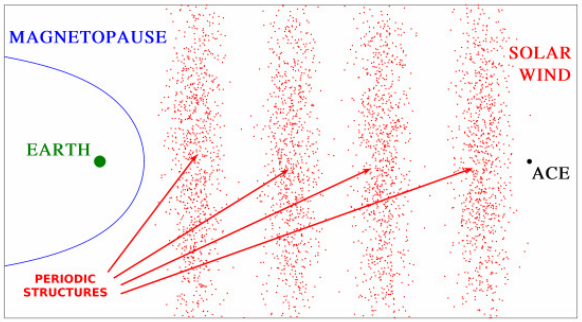


CME travel time forecasting from coronagraphic images and models

Solar wind-magnetosphere-atmosp
interactions at polar latitudes

GEOWAVES experiment at Concordia Station,
Antarctica

ULF experiment at Zucchelli station, Terra Nova
Antarctica



Identification of fluctuations at disc
frequencies in the solar wind and i
the magnetosphere

tific collaborations:

ute of Geophysics-PAS, Poland
ogical and Geophysical Institute of Hungary,
ary

- ❑ *Finnish Meteorological Institute, Finland*
- ❑ *Space Research Institute (IWF), Austria*
- ❖ *University of Rome Tor Vergata, Italy*

- ➢ *National Institute for Astrophysics, Italy*
- ➢ *National Institute for Geophysics and Volcanology*
- ✓ *NASA Goddard Space Flight Center, MD, USA*

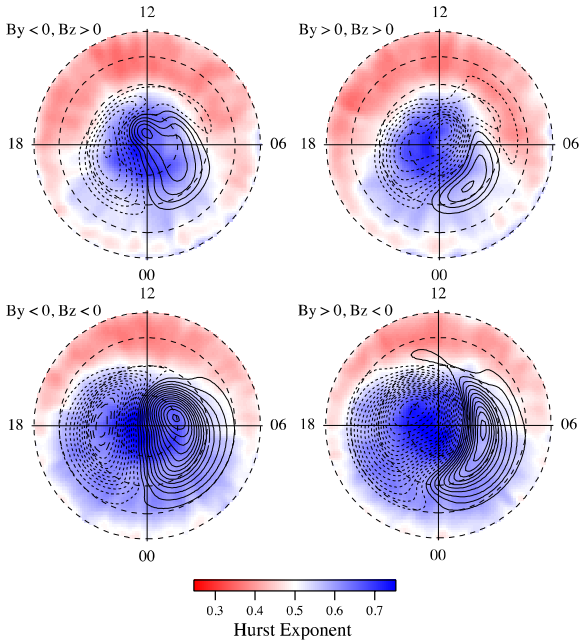
Solar-Terrestrial Physics at INGV

Personnel: Paola DE MICHELIS, Igino COCO, Fabio GIANNATTASIO, Lucia SANTARELLI, Roberta TOZZI

Science: Ionospheric Turbulence

tification of proxies of the magnetospheric and ionospheric responses pace weather events oriented to the *forecast of magnetosphere and sphere dynamical status*. In particular of those proxies related to the elopment of ***turbulence in the ionosphere*** since it ***strongly impacts on operability of all communication systems affected by the ionospheric ium***.

SA has recently funded a project within EO program to characterise IoNospheric TurbulENce level by Swarm constellation (INTENS)

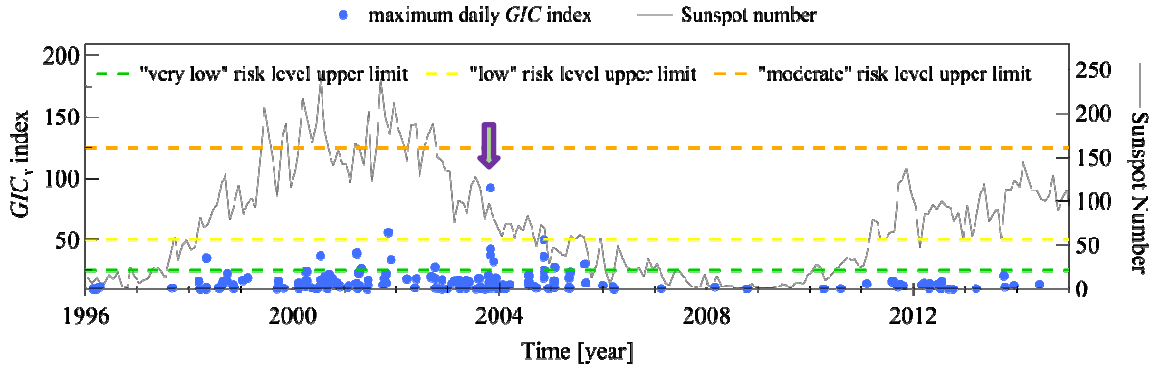


De Michelis et al., JGR, 2017

parison between the average spatial distributions of Hurst exponent nated by Swarm magnetic data and the convection patterns obtained using rDARN.

Science: Geomagnetically Induced Currents

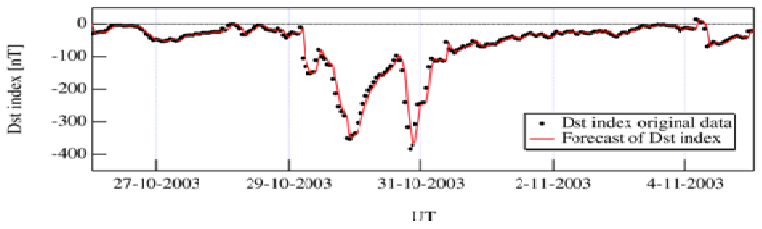
GIC index is a proxy of *geomagnetically induced currents* (GIC). GIC index estimation using 1-m magnetic data recorded in Italy (during the last two solar cycles) has been performed fo ***preliminary risk assessment of GIC over the Italian Territory***. Results has shown that *the impac space weather on the power grids in Italy, as well as in the Mediterranean countries, needs a dee assessment including the consideration of coastal effects, ground conductivity, and failure reports*



Space Weather, 2019

GIC index estimated from the magnetic observatory of Castello Tesino (Northern Italy). A ''moderate'' risk damage due to GIC has been reached during the 2003 Halloween geomagnetic storm.

Tool: Dst index Forecasting



Present stage of the tool: ***forecast 1 hour in advance of Dst index*** starting from interplanetary and magnetospheric data using neu networks.

University of Urbino and INFN – Florence

pace mission dedicated to environmental studies and LISA contribution t space weather

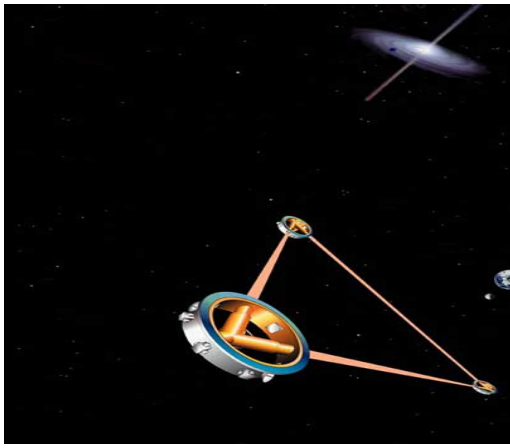
Personnel

- C. Grimani, S. Benella, M. Fabi, M. Villani
- **Main Research Fields**
- Solar activity and solar polarity modulations of galactic cosmic-ray fluxes
- Galactic cosmic-ray flux short-term variations
- Monte Carlo simulations of the role of galactic and solar cosmic rays in limiting the instrument performance in space
- LISA contribution to both space weather science and space weather: multi-point cosmic-ray and solar energetic particle observations at 1 a.u., 50×10^6 km behind Earth after 2034

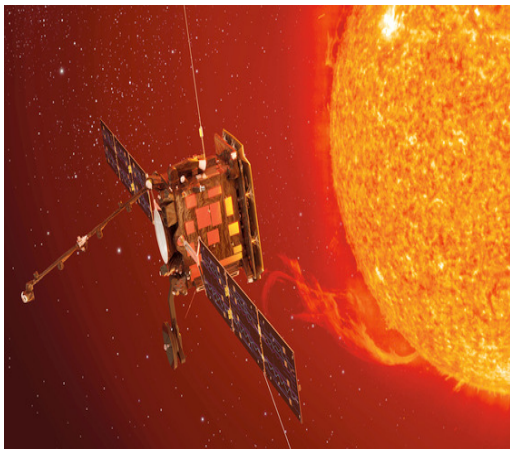
Methods

- The Fluka Monte Carlo program was used to estimate the test mass charging aboard the LISA Pathfinder mission and the dose released in the METIS coronagraph to be flown aboard the Solar Orbiter. See https://pasme.uniurb.it

ESA LISA



ESA Solar Orbiter

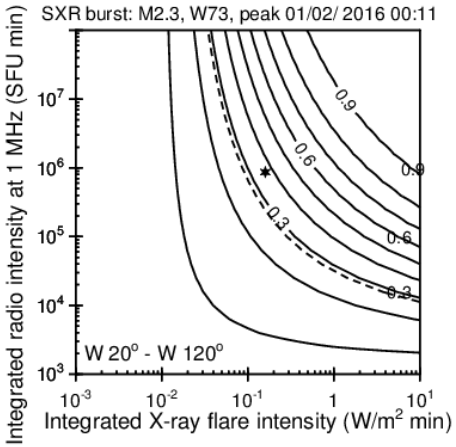


Physics of Space Plasmas and Space Weather @ INAF/IAPS – PSPSW Group

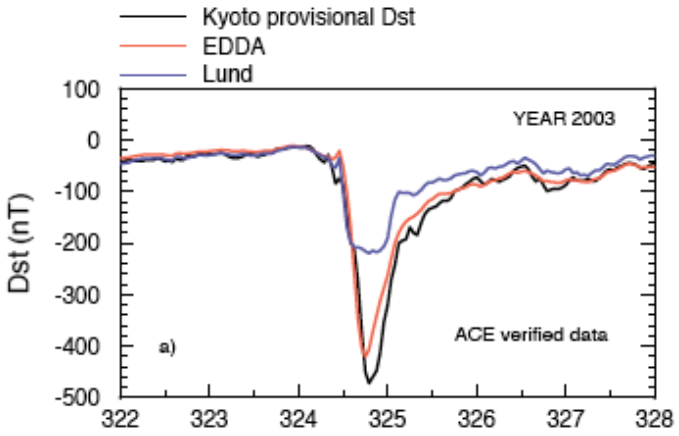
T. Alberti, A. Aronica, I. Bertello, D. Brienza, R. Bruno, G. Consolini, E. De Angelis, R. De Marco, P. Diego, M. Laurenza, F. Lazza
V. Mangano, M.F. Marcucci, S. Massetti, A. Milillo, A. Mura, S. Orsini, G. Pallocchia, V. Quattrociocchi, F. Re, R. Rispoli, N. Vert

***Research Fields*:**

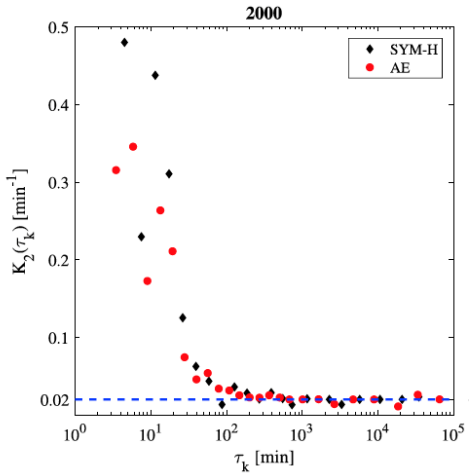
- *Solar wind and interplanetary space plasma physics and dynamics;*
- *Solar-wind/magnetosphere and planetary environment interaction;*
- *Solar Energetic Particles acceleration, propagation and forecast of particle flux;*
- *Auroral observations;*
- *Geomagnetic activity forecast; magnetospheric/ionospheric and geomagnetically induced currents modeling*
- *Planetary Space Weather and effects of the solar variability on Earth's and planetary environment;*
- *Studies of ionospheric parameters through INAF-IAPS plasma chamber;*
- *Galactic Cosmic Rays modulation and impact on space missions and high energy astrophysical hazards for habitability.*



ability countour-plot for SEP forecast by ESPERTA el [**Alberti et al., 2017**]



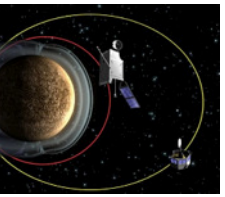
A sample of Dst forecast by EDDA model [**Pallocchia et al., 2006**]



Forecasting horizon as estimated by Kolmogorov ent as a function of timescale [**Consolini et al., JGR, 2018**

Physics of Space Plasmas and Space Weather @ INAF/PSPSW

Solar Orbiter - A high-resolution mission to the Sun and inner heliosphere. The PSPSW group has a CoPi-ship in the plasma suite SWA (Solar Wind Analyzer) with the commitment of providing the common DPU (Dat Processing Unit) for the whole suite. The PSPSW group participates to SWA, a plasma feature instrument suite, wi the responsibility of the development of the on board DPU.



BepiColombo an ESA mission to Mercury – The PSPSW group has the Pi-ship of the SERENA (Search for Exospheric Refilling and Emitted Natural Abundances) particle package on Mercury Planetary Orbiter and is involve in the MEA (Mercury Electron Analyzer) and SIXS (Solar Intensity X-ray and particle Spectrometer) experiments onboard Mercury Magnetospheric Orbiter and Mercury Planetary Orbiter, respectively. The **ELENA** sensor, part of **SERENA** package, has been almost fully developed at INAF/ PSPSW with the participation of CNR and IRAP.

Super Dual Auroral Radar Network international network of HF ionospheric radars dedicated to the study of the magnetosphere□ionosphere system - The PSPSW group is responsible for the Dome C East radar located at the research station Concordia (Dome C – Antarctica). During the 2018-2019 Antarctic campaign a new radar, manage by the IAPS PSPSW group, Dome C North, has been installed at the Concordia research station in collaboration wi CNR and funding by the Italian PNRA.

The plasma chamber developed at INAF/IAPS is an facility capable to reproduce a large volume ionospheric environment, which is particularly suitable to perform studies on a variety of plasma physics subjects

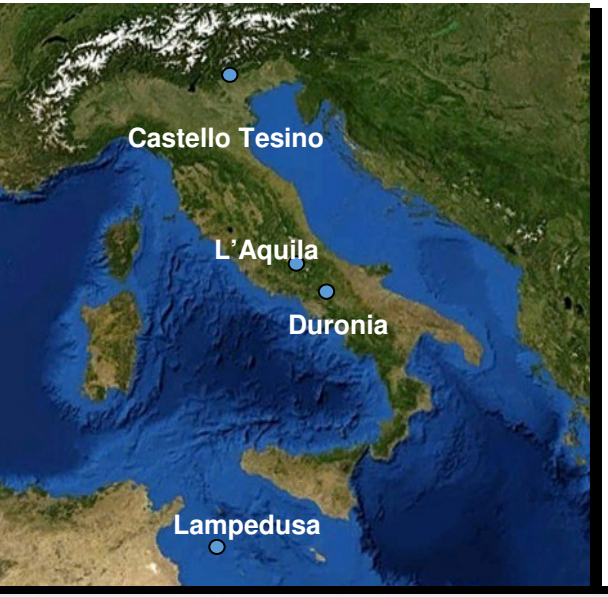
CSES (China Seismo-Electromagnetic Satellite) is a scientific mission dedicated: to monitoring electromagnetic field and waves, plasma and particles perturbations of the atmosphere, ionosphere and magnetosphere induced by seismic events

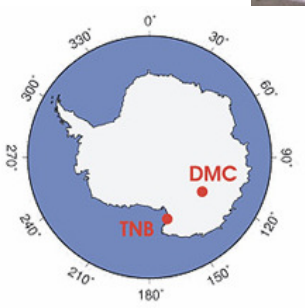
The **SVIRCO** is the Roma Tre/INAF-IAPS observatory dedicated to the study of cosmic rays modulation and relativistic SEP generation. It provides real time data to the "Real-time database for high-resolution neutron monitor measurements" (NMDB) and to ESA-SSA for Space Weather services.

Geomagnetism

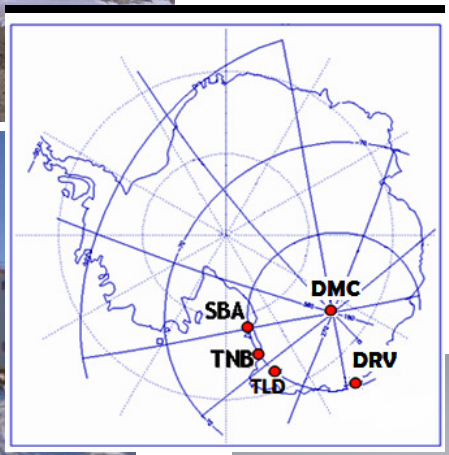
eomagnetic Observatories

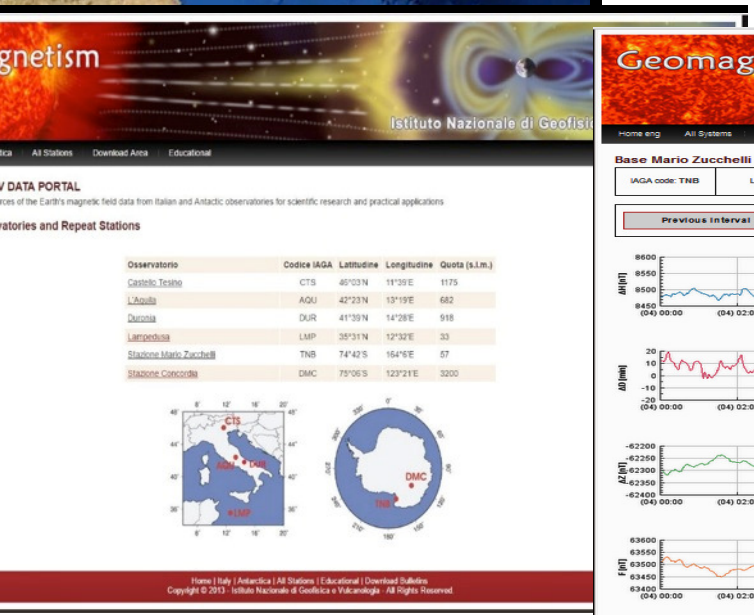
Italy

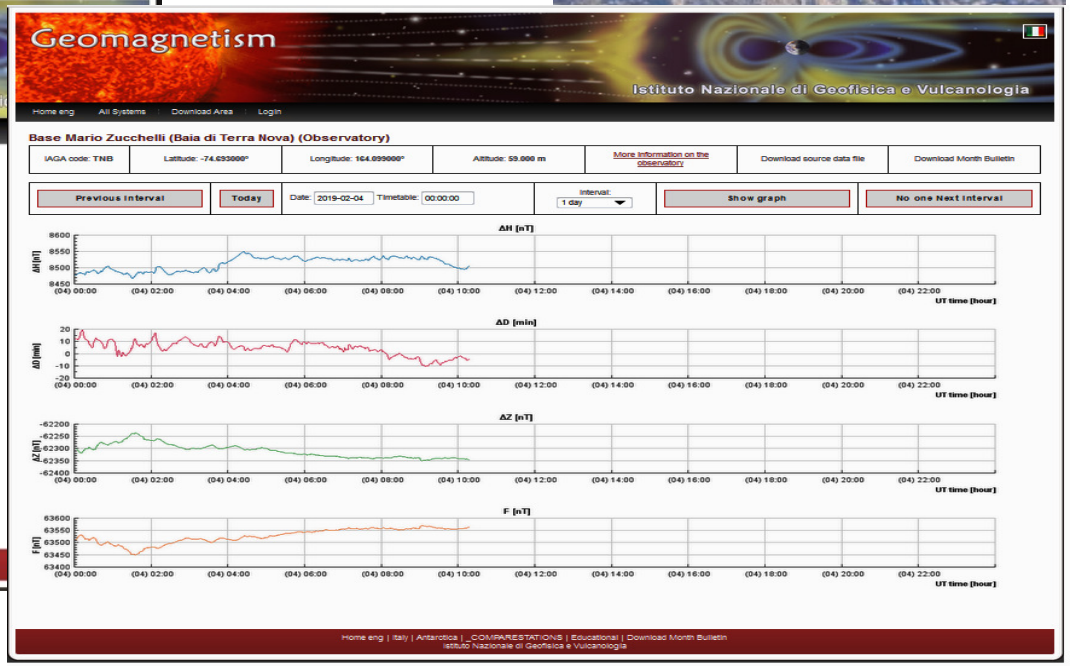




Antarctica







Observatory data are availab
in real time at the following
URL address:
http://geomag.rm.ingv.it

Upper atmosphere physics

Ionospheric Observatories

Istituto Nazionale
Geofisica e Vulca

UNIVERSIDAD TECNOLOGICA NACIONAL

Gibilmanna (Italy)

Rhombic Antennas
(TX and RX)

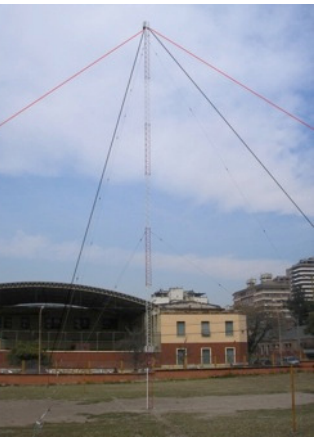
AIS - INGV

Rome (Italy)

AIS - INGV

Antennas (TX and RX)

S. Miguel de Tucumán and Bahia Blanca (Argentina)



Delta Antennas
(TX and RX)

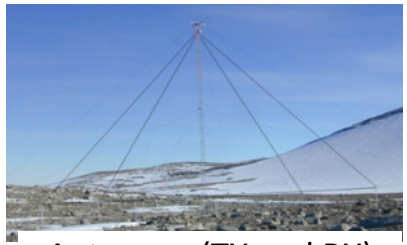
AIS – INGV

with

AUTOSCALING

Mario Zucchelli Station (Antarctica)

AIS - INGV



Antennas (TX and RX)

Space Weather forec

Achievement of forecas and nowcasting th dimensional (3-D) elect density mapping of ionosphere.

EUROMAP forecasting mo 24 hours in advance FORECASTING OF CRITI FREQUENCY OF F2 LAYER

INGV GNSS receivers network for ionospheric scintillation and TEC (including Galileo)

irst receiver installed at Ny-Alesund (Svalbard) on 2003

olar ionosphere

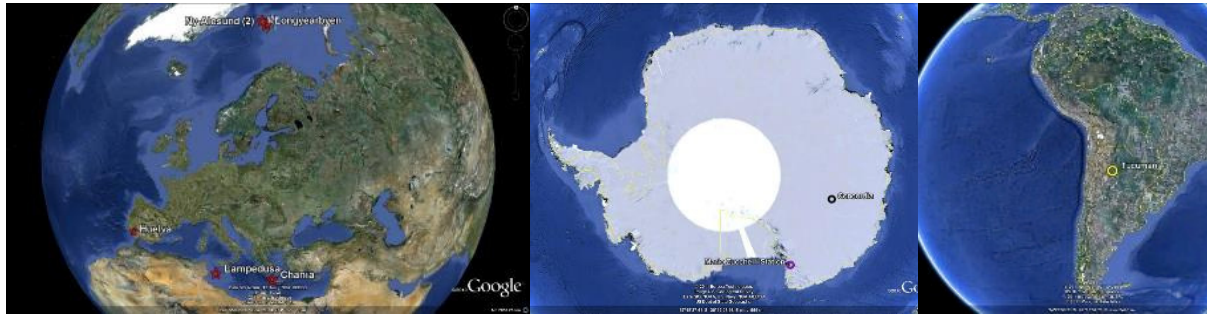
- Svalbard islands (3|NyAlesund, Longyearbyen)
- Antarctica (5 | MZS, Concordia, SANAE)

Mid latitude ionosphere

- Chania (Crete)
- Lampedusa (Sicily, Italy)

quatorial Ionosphere

- Tucuman (Argentina)
- Sao Paulo (Brazil)



are accessible at the *electronic Space Weather upper atmosphere* website

eSWua

www.eSWua.ingv.it

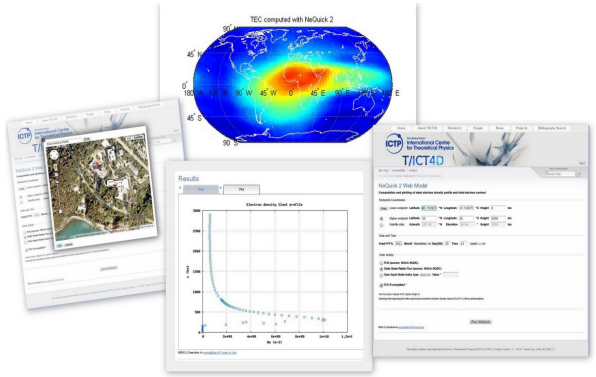
www.spaceweather.it

The Abdus Salam
International Centre
for Theoretical Physics

SW studies in the ICTP @Trieste

eQuick Ionospheric model

NeQuick recommended by ITU-R for trans-
ospheric RP applications (Rec.P531).
Basis of the model for the GALILEO single
quency ionospheric correction algorithm.
eQuick recommended by ICG Working
oups.



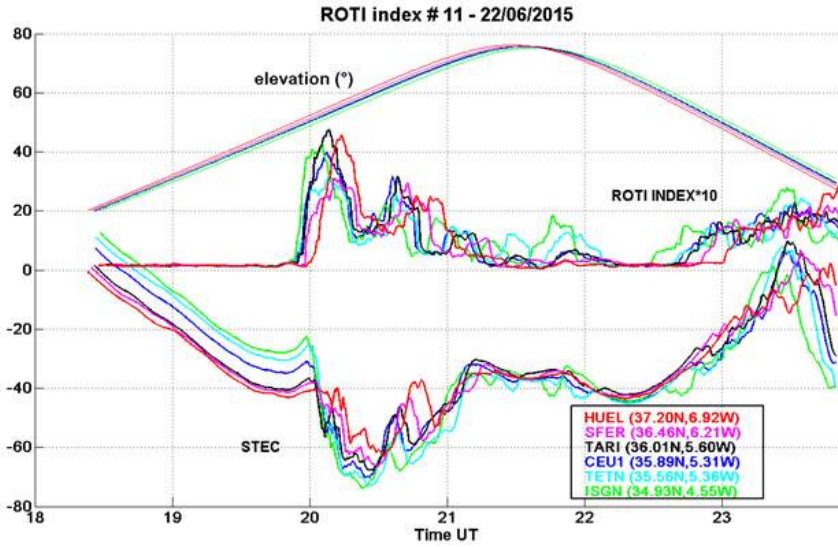
ICTP Web services: http://t-ict4d.ictp.it/: NeQuick 2 online and TEC online calibration

Last Publications related to SW studies:

J.N. Yao, B. Nava, O.K. Obrou, S.M. Radicella (2018). *Validation of NeQuick2 model over West African equatorial region using GNSS-derive Total Electron Content data.* Journal of Atmospheric and Solar-Terrestri Physics, 181, A, 2018.

Kashcheyev, A., Migoya-Orué, Y., Amory-Mazaudier, C., Fleury, R., Nava Alazo-Cuartas, K.,Radicella, S. M. (2018).Multivariable comprehensive analysis of two great geomagnetic storms of 2015. Journal of Geophysi Research: Space Physics, 123, 2018.

KSHOP ON SPACE WEATHER EFFECTS ON GNSS OPERATIONS AT LOW LATITUDES, ICTP, Trieste, Italy 23 – 4 May 2018 The ICTP in partnership with Boston College and cosponsored by UNOOSA has been izing schools and workshops since 2009 in Trieste and in Africa to promote activities related to satellite ation science and technology, ionosphere and Space Weather studies.



Rate of change of total electron content index (ROTI), STEC and elevation angle computed for links to PRN#11 at 6 GPS stations located at middle latitudes on day 22 June 2015 showing a plasma bubble occurrence.

The Abdus Salam
International Centre
for Theoretical Physics

United Nations Educational, Scientific and Cultural Organization

IAEA International Atomic Energy Agency

SW studies in the ICTP @Trieste

International Space Weather Initiative Workshop 2019

ICTP

20 - 24 May 2019
Trieste, Italy

Further information:
http://indico.ictp.it/event/8682/
smr3202@ictp.it

The International Space Weather Initiative (ISWI) is a programme of international cooperation to advance space weather science by a combination of instrument deployment, analysis of space weather data from these instruments in conjunction with other data, and the communication of such results.

The ISWI activities are coordinated by a Steering Committee, supported by its Secretariat. A ISWI newsletter is published by the International Center for Space Weather Science and Education (ICSWSE) of Kyushu University, Japan, and the ISWI website is maintained by the Bulgarian Academy of Sciences (www.iswi-secretariat.org).

The aims of the workshop are deployment of instruments in developing nations and analysis of space weather data. A particular focus will be on new research results and findings and to encourage greater cooperation in developing partnerships and ISWI networks. International experts will lecture at the workshop.

The International Committee on Global Navigation Satellite Systems (ICG), Boston College and the Scientific Committee on Solar Terrestrial Physics (SCOSTEP) and the US Institute of Navigation are co-sponsors of this workshop.

Topics:

- Instrumentation;
- Solar Physics;
- Magnetosphere, Ionosphere, and Thermosphere;
- Solar-Terrestrial Coupling and Space Weather;
- Space Weather effects on Global Navigation Satellite Systems (GNSS);
- New Space Weather scientific results;
- Capacity-Building, Education and Outreach.

Directors:

R DENISTT, ISR, Boston College
S. GADIMOVA, ICG, UNOOSA
N. GOPALSWAMY, NASA
S. RADICELLA, ICTP

Local Organizer:

B. NAVA, ICTP

How to apply:

Online application:
http://indico.ictp.it/event/8682/

Female students and scientists are encouraged to apply.

Grants:

A limited number of grants are available to support the attendance of selected participants, with priority given to participants from developing countries. There is no registration fee.

Deadline:

15 February 2019

ICTP International Centre for Theoretical Physics

Workshop on Ionospheric Forecasting for GNSS Operations in Developing Countries: Findings and Challenges

ICTP

27 - 31 May 2019
Trieste, Italy

Further information:
Activity URL: http://indico.ictp.it/event/8686/
smr3204@ictp.it

The workshop will give an introduction to Global Navigation Satellite Systems (GNSS) operations and the impact of the ionosphere on them. It will concentrate on forecasting ionosphere conditions with focus on Total Electron Content. Its relevance for developing countries will be highlighted.

Ionosphere weather forecasts, that depend strongly on the ability to forecast Space Weather events that reach the Earth, are increasingly needed for radiocommunications, satellite navigation and positioning operations. This is becoming as relevant as it is weather forecast in meteorology. The state of the art in forecasting ionosphere conditions is far behind the level of accuracy reached by weather forecasts in the troposphere. Part of this limit is that the coupling of the ionosphere with the lower regions of the atmosphere is not adequately known, particularly in low latitudes where most of the developing countries are located.

Topics:

- Introduction to GNSS operations
- Ionospheric impact on GNSS operation
- Ionospheric weather: coupling of the ionosphere from above and below
- Ionosphere forecast: findings and challenges
- Computer Laboratory Work (data analysis of different ionosphere scenarios)

Directors:

R DENISTT, ISR, Boston College
S. RADICELLA, ICTP
B. NAVA, ICTP

Local Organizer:

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ICTP International Centre for Theoretical Physics

nosphere Prediction Service

https://ips.gsc-europa.eu

TELESPAZIO
a LEONARDO and THALES company

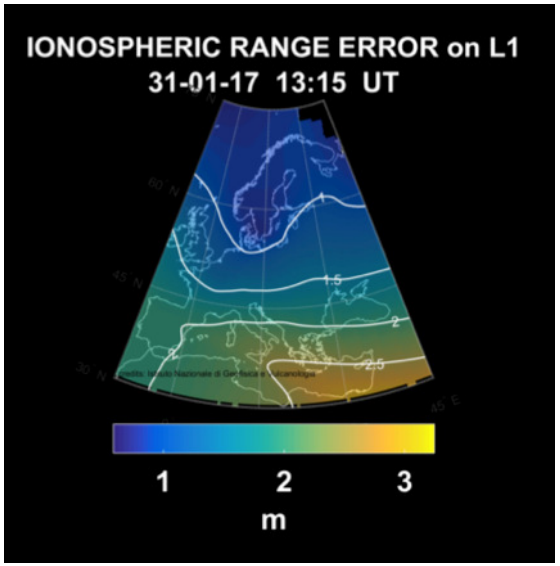
IPS Ionosphere Prediction Service

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

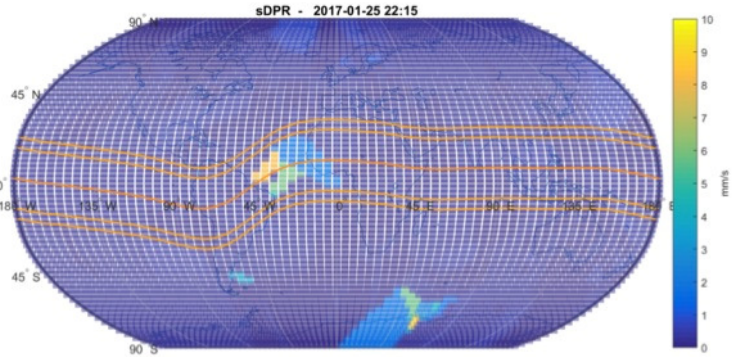
NSL

Università di Roma Tor Vergata

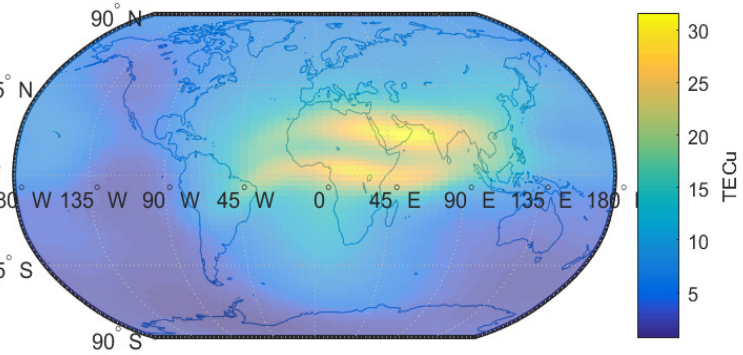
Nowcasting IRE over Europe



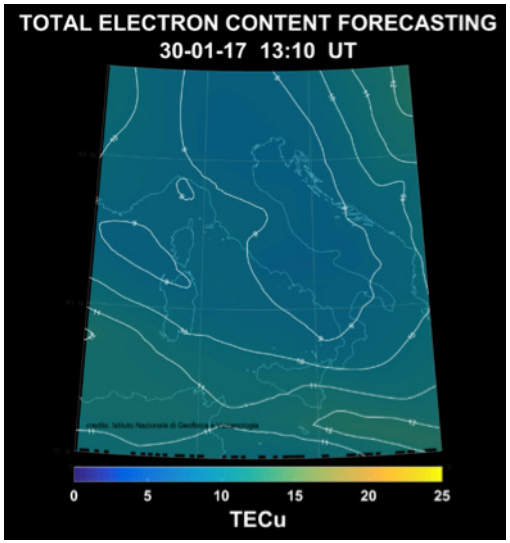
Nowcasting PSI at global level



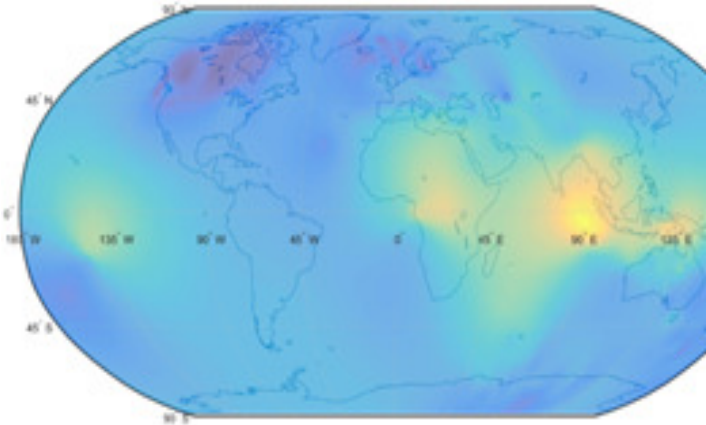
term forecasting TEC at global level



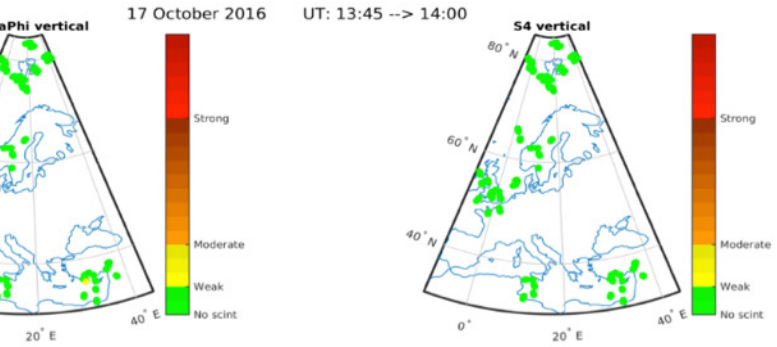
Short term forecasting TEC over Italy



Nowcasting TEC at global level

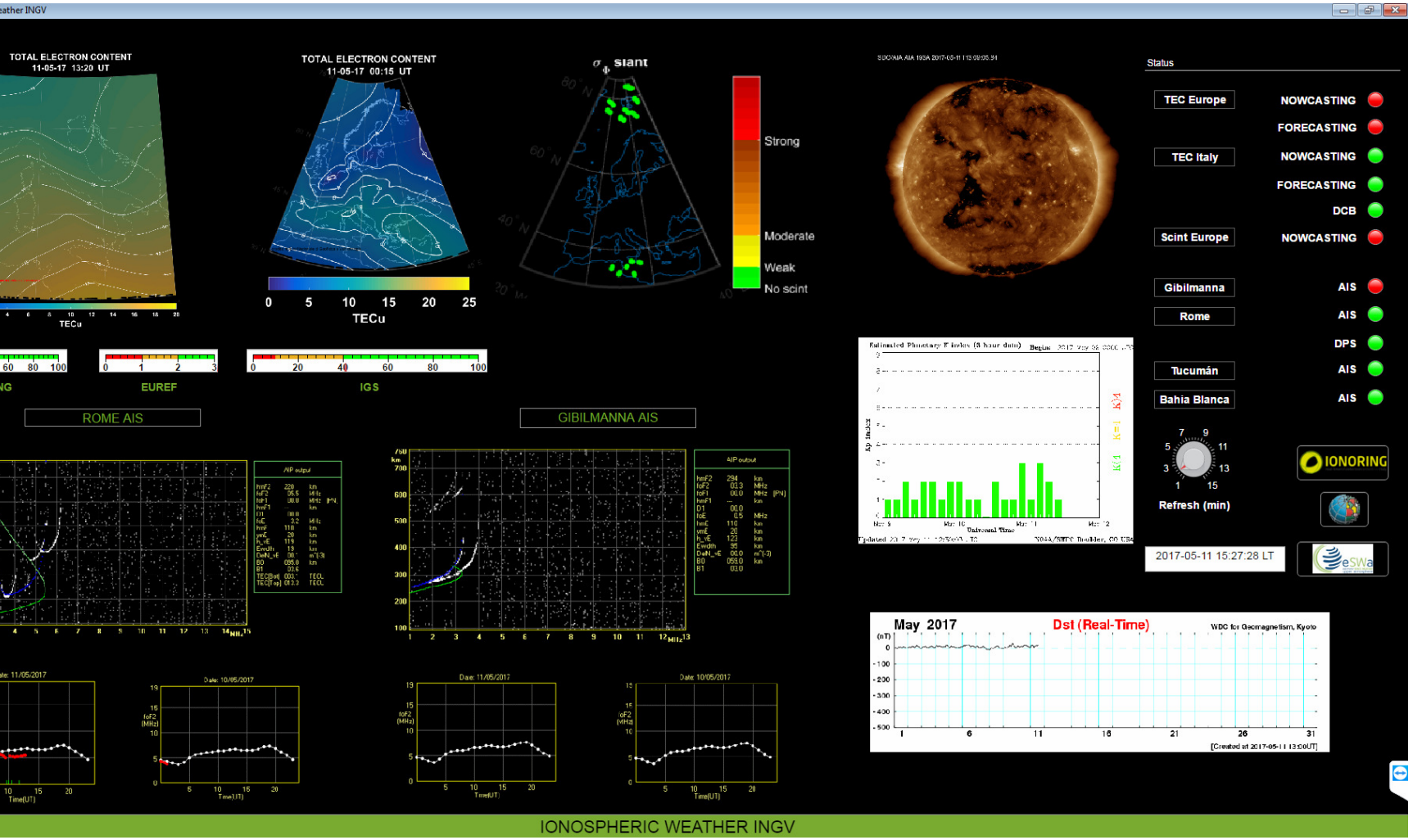


casting scintillation indices over Europe



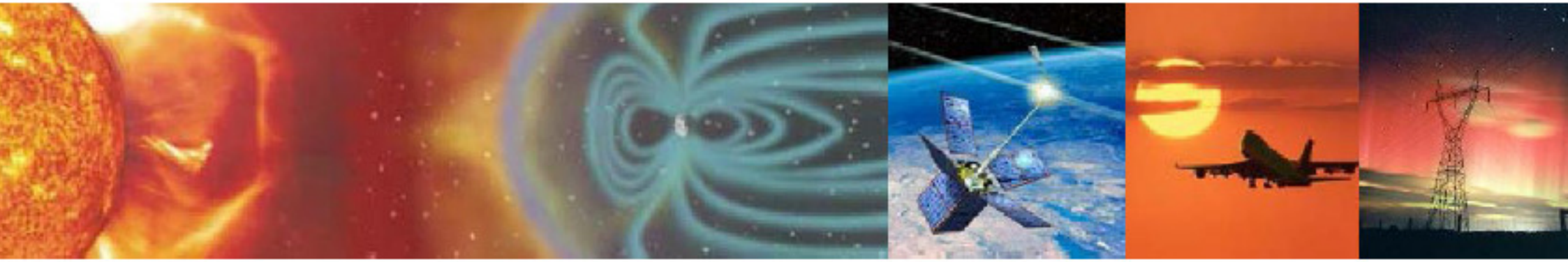
stituto Nazionale di
Geofisica e Vulcanologia

IONOSPHERIC WEATHER SERVICE



w.eswua.ingv.it
w.spaceweather.it

The ionospheric weather service at ionolab at INGV



THANK YOU!

vincenzo.romano@ingv.it
yenca@ictp.it
christina.plainaki@asi.it