

Italian Contribution to Space Weather

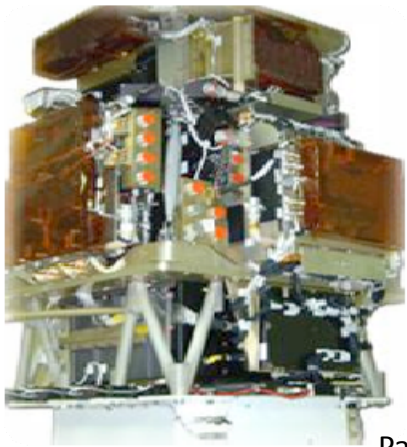
Vincenzo Romano

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vincenzo.romano@ingv.it

Thanks to:

Mauro Messerotti (INAF), Daniel Biron (ITAF-COMET), Paola De Michelis (INGV), Francesca Zuccarello (Uni CT), Alessandro Bemporad (INAF), Ester Antonucci (INAF), Domenico Di Mauro (INGV). Marco Pietrella (INGV), Anna Milillo (INAF), Francesco Berilli (Uni TOV), Mirko Piersanti (Uni AQ), Federica Marcucci (INAF), Lucilla Alfonsi (INGV), Massimo Materassi (ISC-CNR)

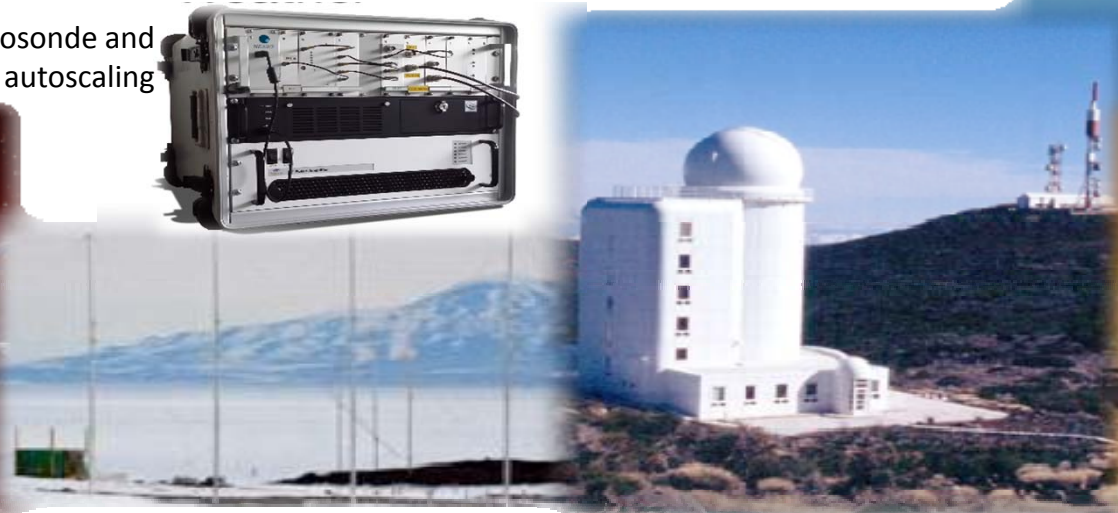


Pamela

Ionosonde and
autoscaling



Solar Orbiter



SuperDarn



Themis

UN COPUOS 53rd Session STSC February 2016.

Outline

- Italian strategic Initiatives
- Solar physics to Space Weather
- Interplanetary space physics to Space Weather
- Solar-Terrestrial physics to Space Weather
- Upper atmosphere physics to Space Weather

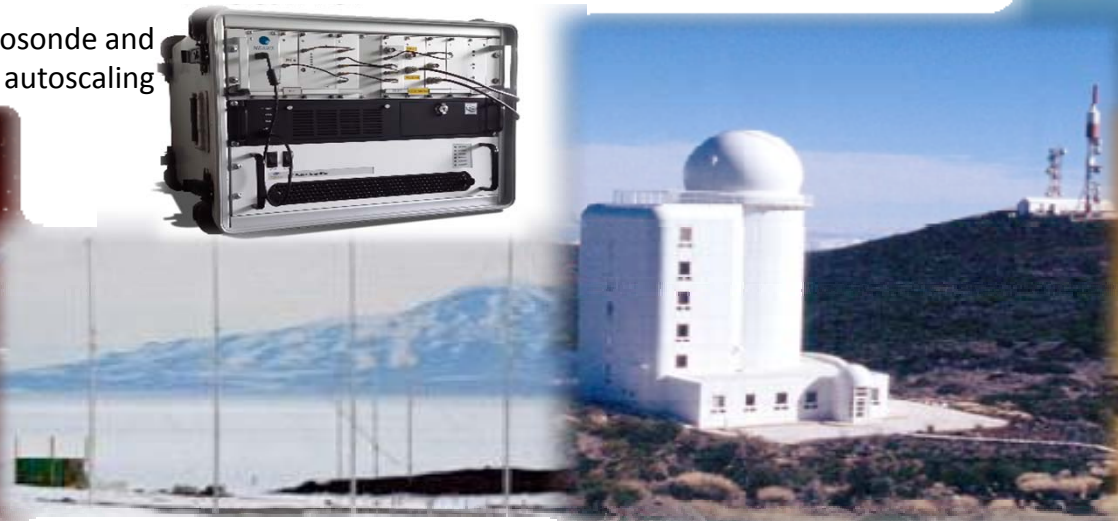


Pamela



Solar Orbiter

Ionosonde and
autoscaling

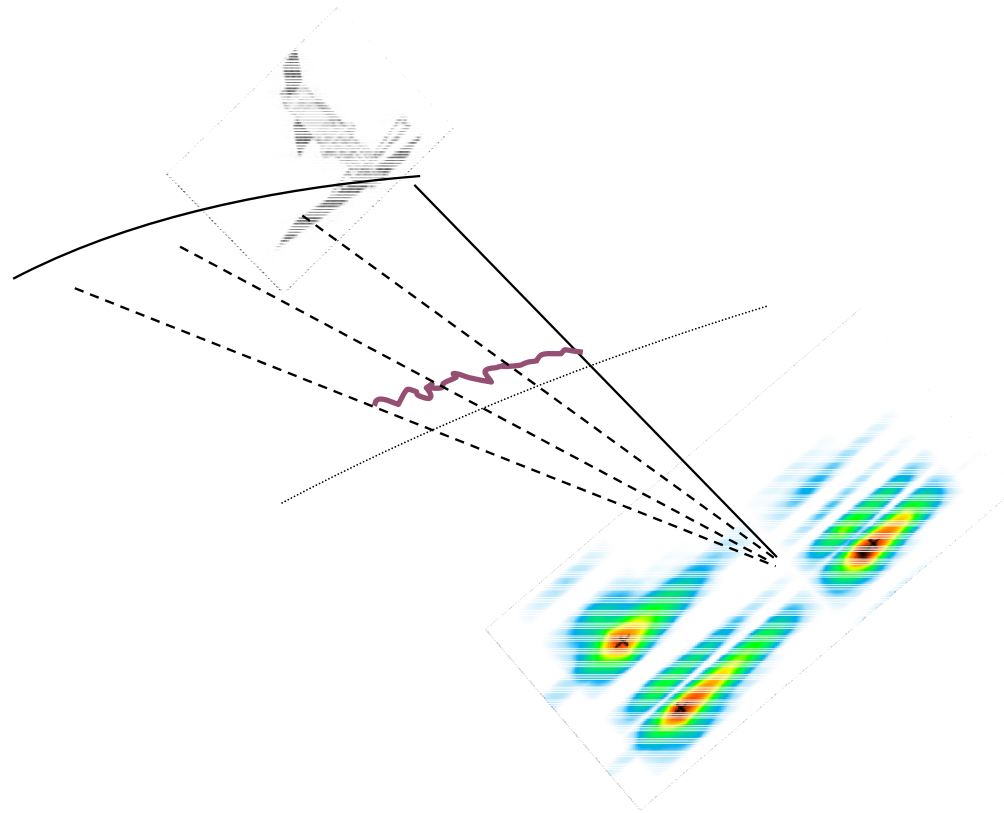


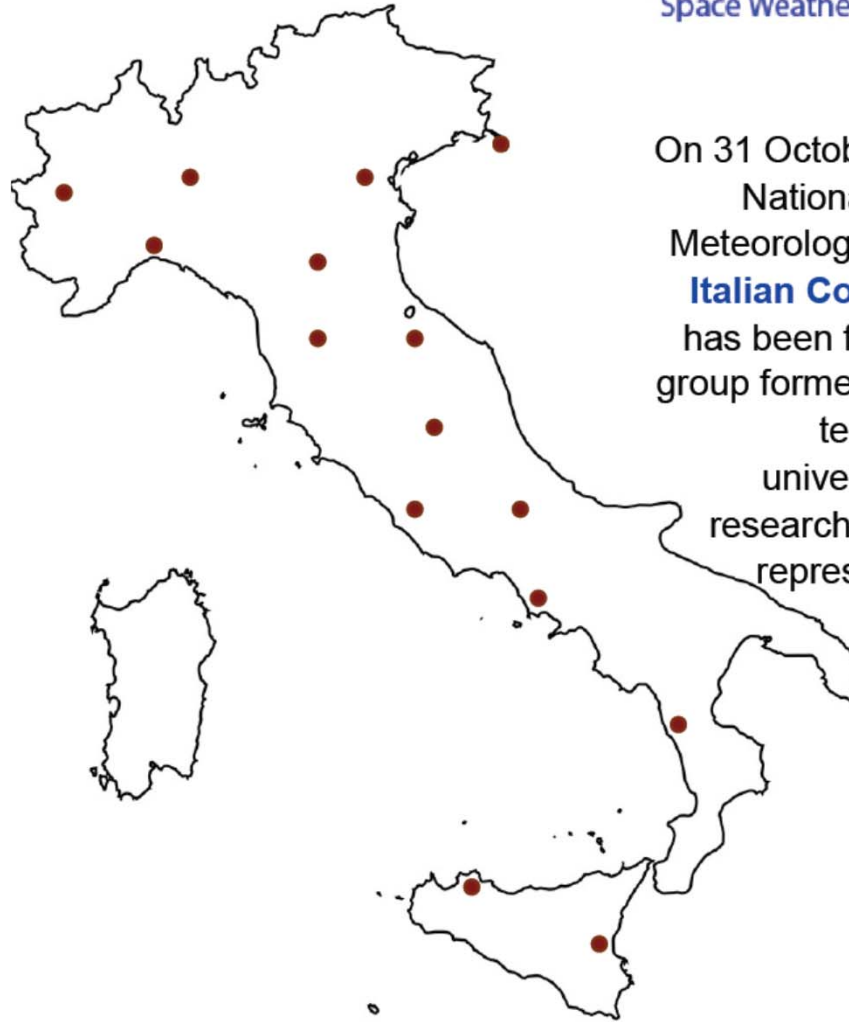
SuperDarn



Themis

Italian Space Weather strategic initiatives

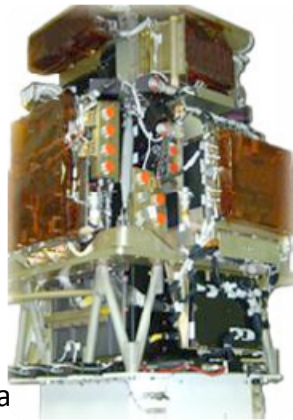




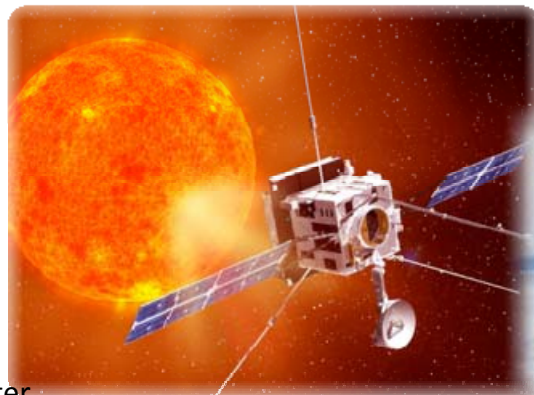
On 31 October 2014 the Italian National Group for Space Meteorology (**Space Weather Italian Community, SWICO**) has been founded as interest group formed by scientists and technologists of both universities and national research institutions and by representatives of Italian industries.

Observational, theoretical studies and modeling

- Solar physics from photosphere to corona and solar irradiance
- Interplanetary medium physics: structures, turbulence and propagation of CMEs and SEPs
- Solar wind-magnetosphere coupling and interaction
- Magnetospheric-Ionospheric dynamics
- Ground based magnetic field variations
- Forecasting and nowcasting modelling
- Planetary Space Weather



Pamela



Solar Orbiter

Ionosonde and autoscaling



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World Meteorological Organization Congress

Resolution 38 (Cg-17) — “Four-year Plan for WMO Coordination of Space Weather Activities”.

Since 2012 Italy joined the WMO Space Weather initiative

Inter-programme Coordination Team on SW, ITAF – INAF - INGV



World Meteorological Organization
Weather • Climate • Water

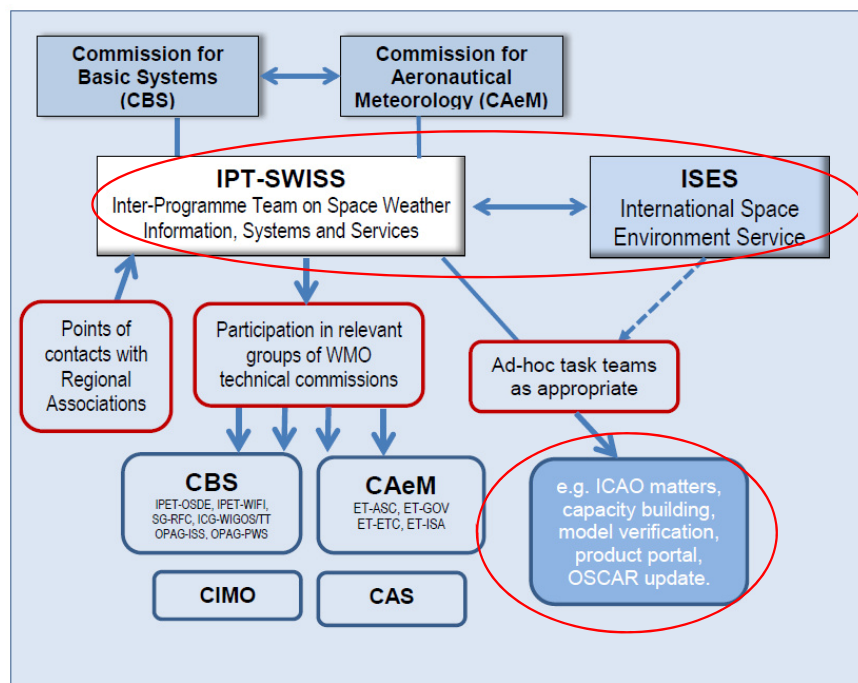
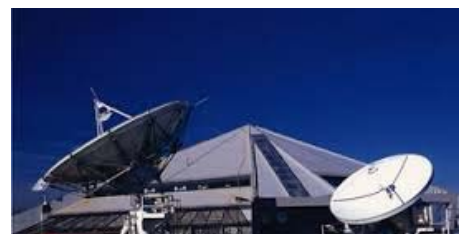


Figure 2: Proposed organization of space weather activities.



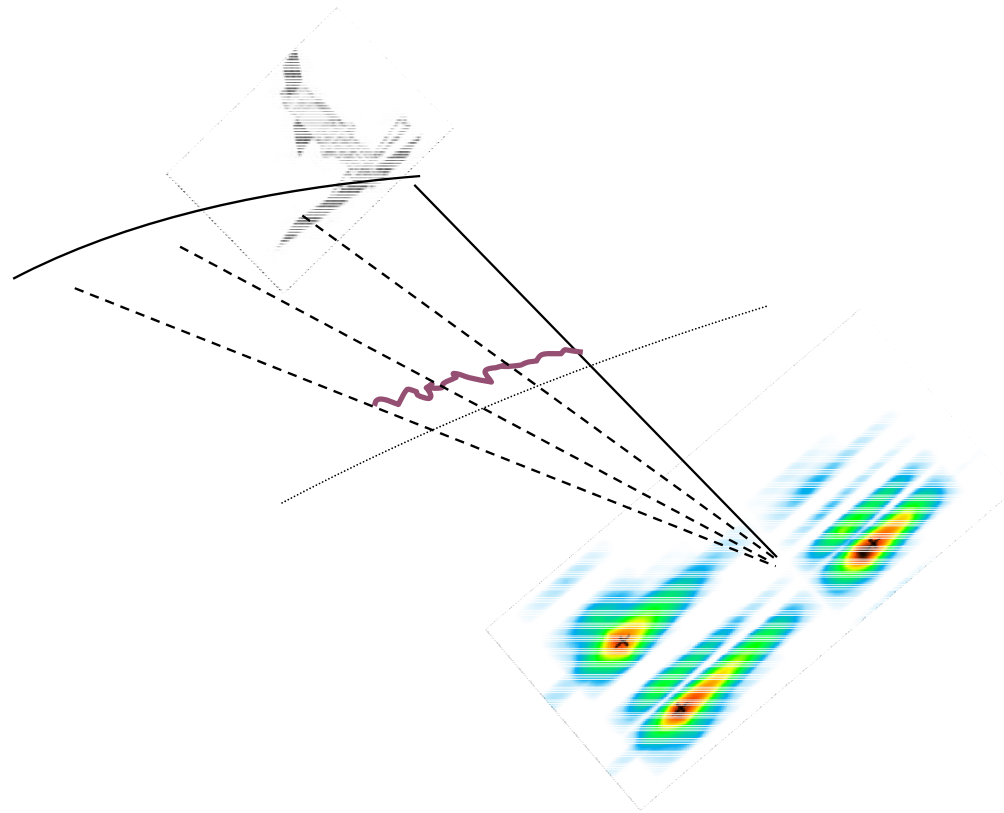
Space Weather italian initiative for operations

SW nowcasting and safety support



Space Weather knowledge is not only for safety but also for capacity augmentation, as weather.

Solar physics to Space Weather





Solar Physics activities in Trieste

ESA Space Weather Working Team,
Steering Board Member



European Space Weather Week
Programme Committee, Chair



NATO Science for Peace (SfP) Project
984894 on "Ionospheric Monitoring",
Co-Director



The screenshot shows the Trieste Solar Radio System website. At the top, it says "Trieste Solar Radio System". Below this, there are several sections:

- Navigation:** "Near Real-Time Radio Data" and "Coronal Radio Surveillance" buttons.
- News:** A headline: "A NEW SOLAR RADIO MONITORING SYSTEM FOR SWx BASED ON e-CALLISTO UNITS IS BEING SETUP BY DR. ENG. A. MARASSI. NRT DATA WILL BE MADE AVAILABLE SHORTLY."
- Main Content:** A central panel titled "Coronal Radio Surveillance" featuring a graphic of the sun and a radio dish. To the left is a menu: Monitor, Indices, Radio Archive, Web Cam, Operational Status. To the right is another menu: News, Project, Instrumentation, Sample Data, Space Weather, Italiano.
- Footer:** A navigation bar with links: ::EGSO_SolarEventCatalogue :: Links :: Contacts :: Data policy :: Disclaimer :: Credits
- Table:** A table titled "NRT Solar Radio Noise" showing SRN and predicted values for various frequencies.
- Logos:** INAF, ESA, and SWCNET logos at the bottom.

NRT Solar Radio Noise						
Freq [MHz]	237	327	408	610	1420	2695
SRN	Q	Q	Q	Q	L	L
predicted	Q	Q	M	Q	L	L

Last update: 29 Jul 2010 16:38 UTC

M. Bilal, V. Alberti, A. Marassi, E. Cianca, **M. Messerotti**, *Performance assessment of GPS receivers during the September 24, 2011 solar radio burst event*, J. of Space Weather and Space Climate, **5**, A32, 16 pp., 2015.

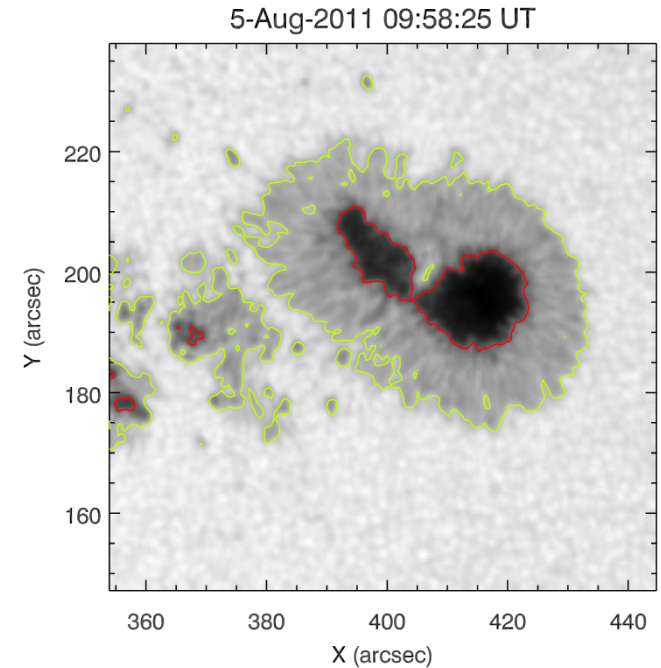
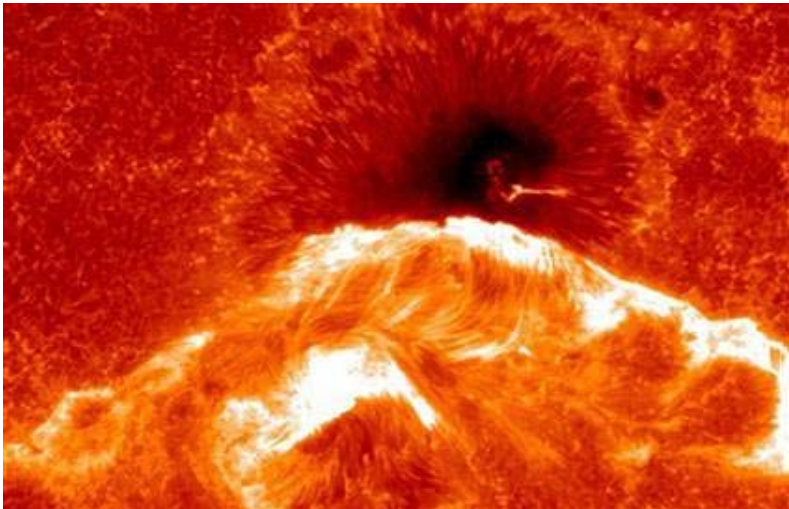
Solar Physics Group in Catania

Personnel

V. Capparelli (UniCT), A. Compagnino (UniCT), M. Falco (UniCT), S.L. Guglielmino (UniCT), M. Murabito (UniCT), P. Romano (INAF), F. Zuccarello (UniCT).

Main Research Fields




Participation in the European Solar Telescope Design Phase; Emergence of magnetic flux tubes in the solar atmosphere; Formation and evolution of solar active regions; Flares and Coronal Mass Ejections: drivers and effects on the space environment; 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.

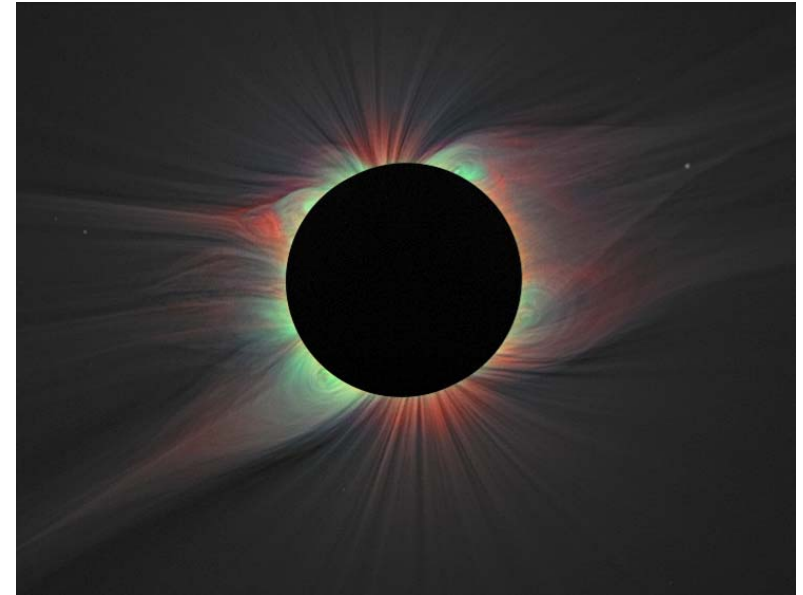
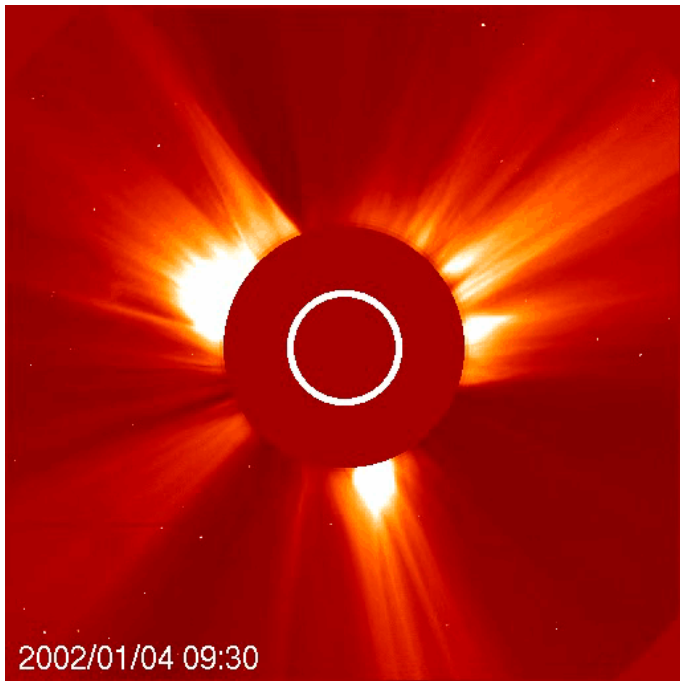
Solar Physics Group in Catania

Project Name	Short description	Role	Timeline
SOLARNET 	The project brings together and integrates the major European research infrastructures in the field of high-resolution solar physics, in order to promote their coordinated use and development (FP7)	Responsible for WP30: Networking Activities (Leader: F. Zuccarello)	2013 April 1 – 2017 March 31
F-CHROMA 	To acquire, analyse and interpret ground- and space-based observational data of solar flares, test these against model predictions, and create an archive of solar flare observations and models (FP7)	Responsible for WP5: Joint analysis of space-based and ground-based observations (Lead: F. Zuccarello)	2014 January 1 – 2016 December 31
Metis 	WL and UV Coronagraph for ESA-Solar Orbiter spacecraft → first close-up (0.3 AU) observations of coronal plasmas	Participant to Science Team	Launch: October 2018, nominal mission 7.5 years

Solar Physics Group in Turin

Main Research Fields

- Physics of the solar corona, understanding the origin and evolution of the main drivers of Geomagnetic Storms on Earth: Solar Wind and Coronal Mass Ejections (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 based observations.

Solar Physics Group in Turin

On-going experimental projects

Project Name	Short description	Role	Timeline
Metis 	WL and UV Coronagraph for ESA-Solar Orbiter spacecraft → first close-up (0.3 AU) observations of coronal plasmas	Leader of the international science consortium (PI: E. Antonucci)	Launch: October 2018, 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: 2019, 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: June 2016
ESCAPE 	Coronagraph in Antarctica (Concordia base) → first long-term coronal magnetic fields monitoring	Leader of the italian instrument consortium (Co-PI: S. Fineschi)	Deployment: 2017, nominal duration 3 years

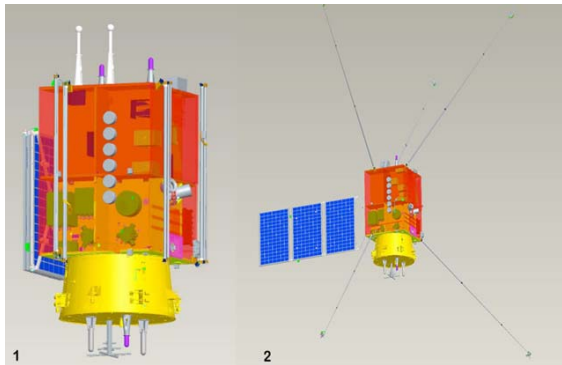


University of Rome Tor Vergata

<https://www.fisica.uniroma2.it/solare>

F. Berrilli, M. Casolino, D. Del Moro, L. Giovannelli, R. Forte, M. Lovric, M. Martucci, M. Mergè, L. Narici, V. Penza, G. Pucacco, F. Pucci, A. Rizzo, S. Scardigli, R. Sparvoli

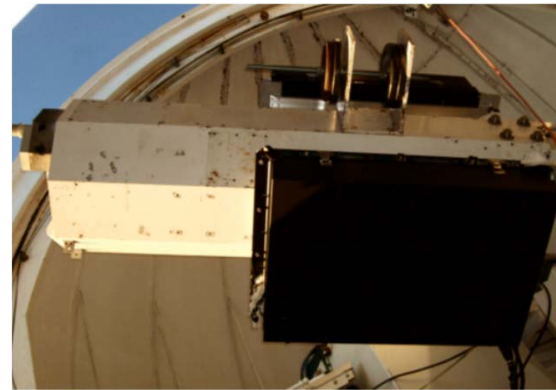
Main Projects: FP7-EST, FP7-SOLARNET, H2020-GREST, EU-REACT-SPARC, EU-Ionosphere Prediction Service, PAMELA, ALTEA, CSES
Activity: Solar Dynamics and Activity, Sun-Earth interaction, Space Weather, Improve tools for solar synoptic observations and particle detection.



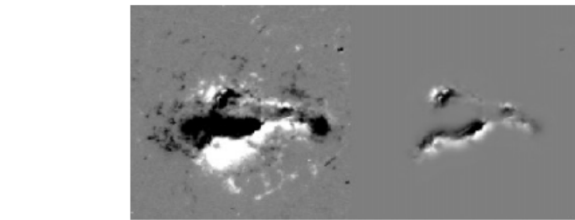
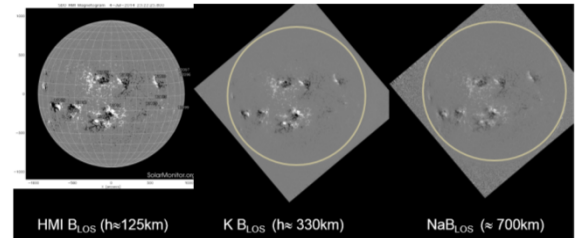
Italian Collaboration to CSES
 China Seismo-Electromagnetic Satellite



PAMELA satellite in orbit since 2006



Magneto Optical filters at Two Heights (**MOTH**) instrument
 University of Hawaii, USA
 Jet Propulsion Laboratory, Japan
 Eddy Company, USA

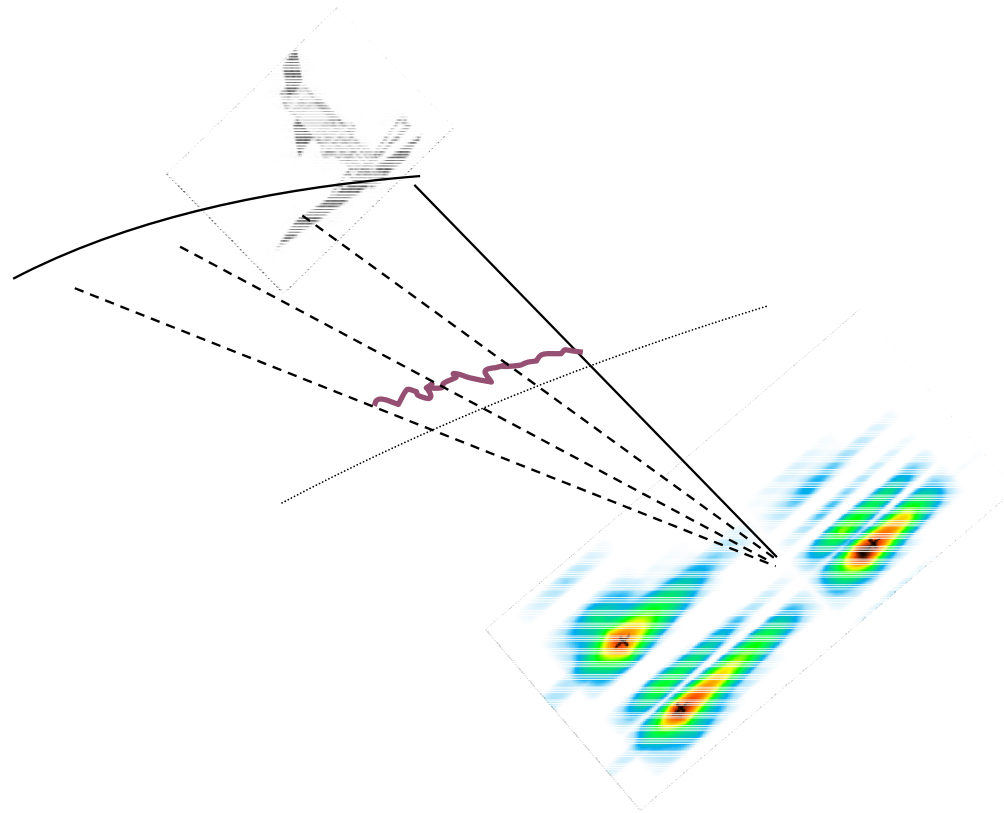


Automated Solar Flare Forecasting with multiline MOTH synoptic magnetograms

PAMELA collaborations

- Cosmic Rays Laboratory, Moscow Engineering and Physics Institute, Moscow, Russia
- Laboratory of Solar and Cosmic Ray Physics, P.N. Lebedev Physical Institute Academy of Sciences, Moscow, Russia
- Ioffe Physical Technical Institute, St. Petersburg, Russia
- Physics Department of Siegen University, Germany
- Royal Institute of Technology, Stockholm, Sweden

Interplanetary space physics to Space Weather

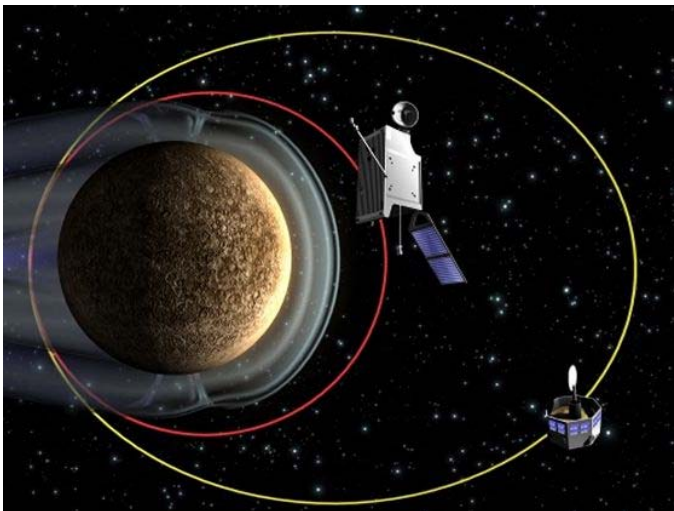


Interplanetary Space Physics Group @ INAF/IAPS

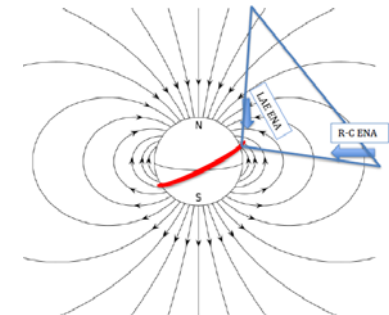


Solar Orbiter - A high-resolution mission to the Sun and inner heliosphere. The ISP group participates to the SWA, a plasma feature instrument suite, with the responsibility of the development of the on board DPU.

Super Dual Auroral Radar Network international network of HF ionospheric radars dedicated to the study of the magnetosphere-ionosphere system - The ISP group is responsible for the Dome C East radar located at the research station Dome Concordia in Antarctica.

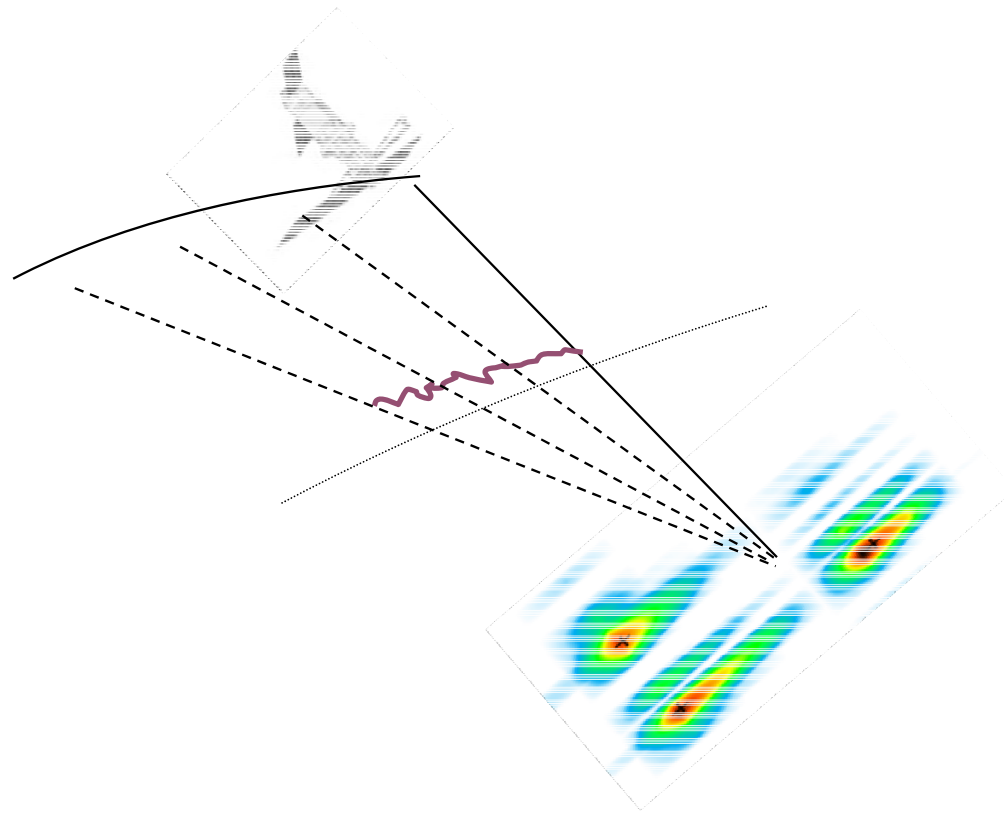


BepiColombo an ESA mission to Mercury – The ISP group is involved in the MEA (Mercury Electron Analyzer) and SIXS (Solar Intensity X-ray and particle Spectrometer) experiments onboard Mercury Magnetospheric Orbiter and Mercury Planetary Orbiter, respectively.



PROPOSAL: Development of an ENA sensor, namely **ENAMISS**, to be uploaded on the International Space Station for continuous magnetosphere observation

Solar-Terrestrial physics to Space Weather

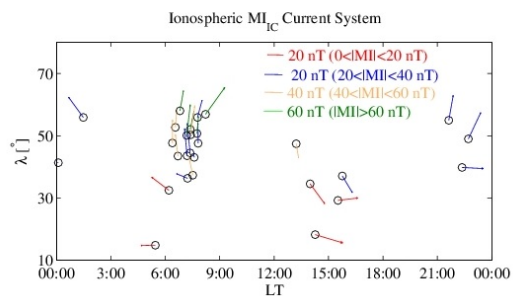
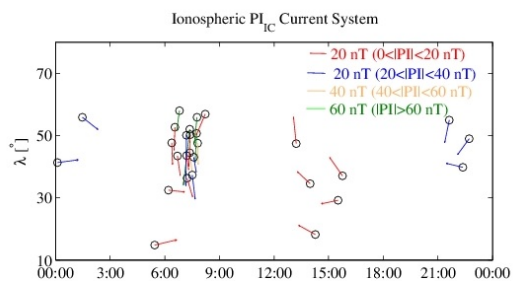




Analysis of the ground-based and magnetospheric response to active Solar Wind (SW) conditions

EMMA (European Meridional Magnetometer Array)

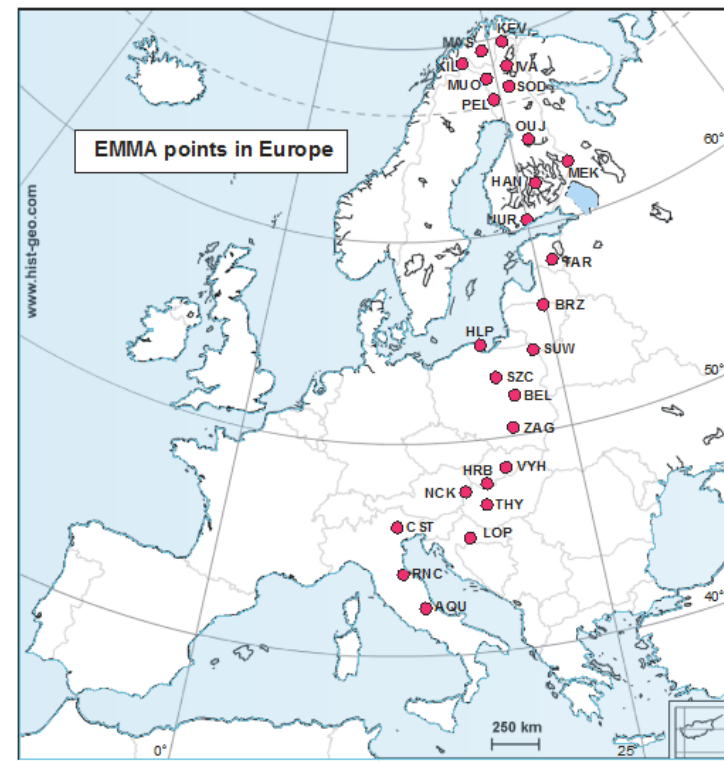
25 stations, $1.6 < L < 6.1$



Example of the reconstruction of the ionospheric current flow pattern during November 11, 2000 SI event.

Scientific collaborations

- Geological and Geophysical Institute of Hungary, **Hungary**
- Electrical Engineering Department, New Mexico Tech, **USA**
- Institute of Geophysics-PAS, **Poland**
- Finnish Meteorological Institute, **Finland**
- Space Research Institute (IWF), Graz, **Austria**
- School of Mathematical and Physical Sciences, University of Newcastle, Callaghan, New South Wales, **Australia**.
- Physics Department, University of Calabria, Rende (CS), **Italy**.
- National Institute for Geophysics and Volcanology INGV, Rome, **Italy**.
- National Research Council, Institute for Complex Systems ISC-CNR, Florence, **Italy**.

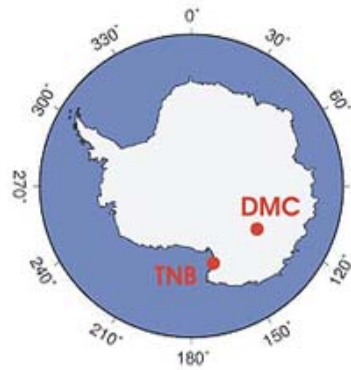


Lichtenberger, J., M. A. Clilverd, B. Heilig, M. Vellante, J. Manninen, C. J. Rodger, A. B. Collier, A. M. Jørgensen, J. Reda, R. H. Holzworth, R. Friedel, and M. Simon-Wedlund (2013), The plasmasphere during a space weather event: first results from the PLASMON project, *J. Space Weather Space Clim.*, 3, A23, doi: <http://dx.doi.org/10.1051/swsc/2013045>.

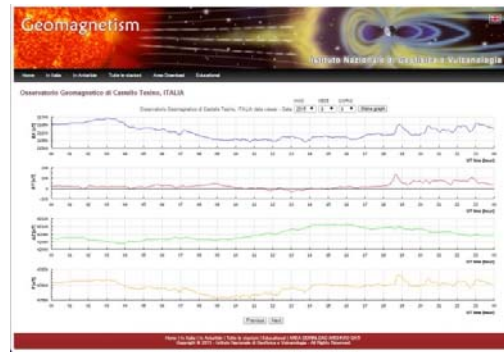
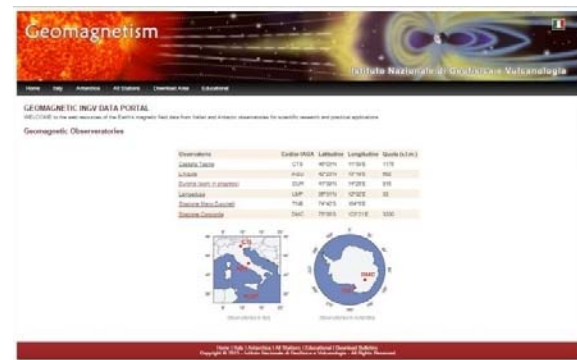
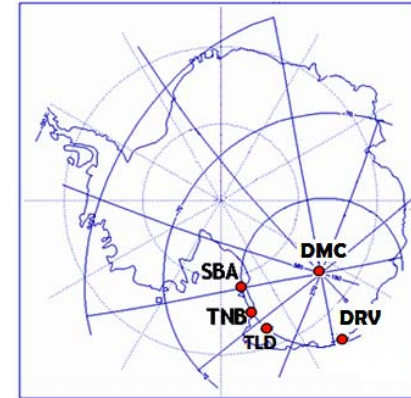
Villante, U., S. Di Matteo, and M. Piersanti (2015), On the transmission of waves at discrete frequencies from the solar wind to the magnetosphere and ground: A case study, *J. Geophys. Res. Space Physics*, 120, doi:10.1002/2015JA021628.

Geomagnetic Observatories

Italy

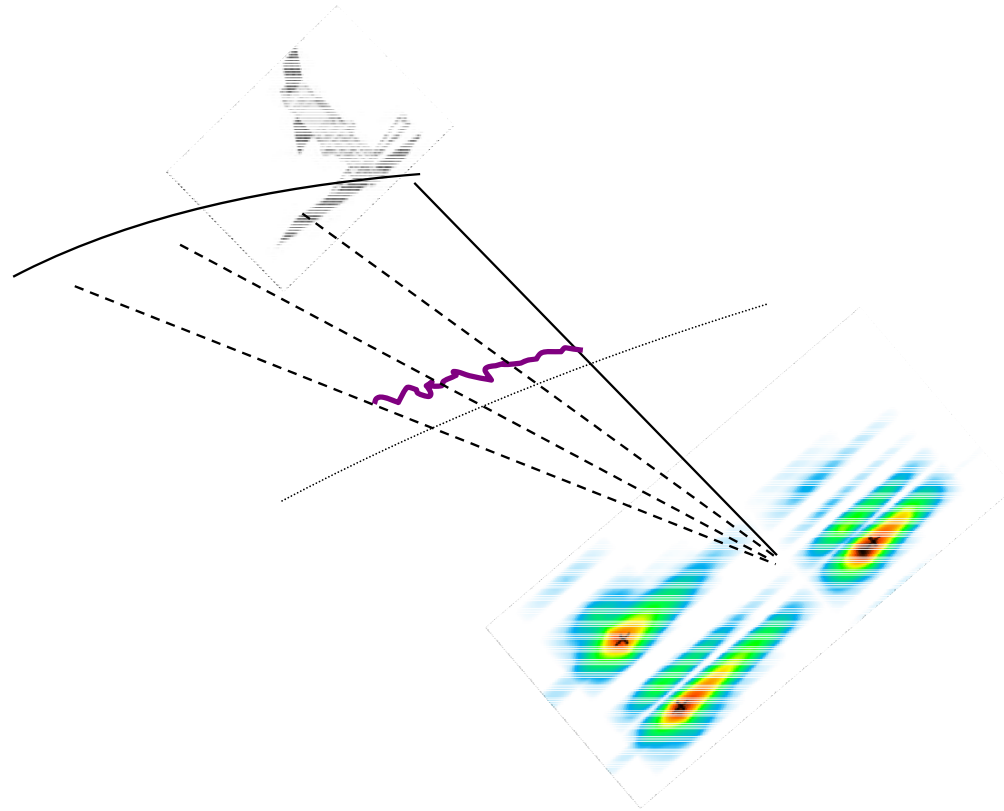


Antarctica

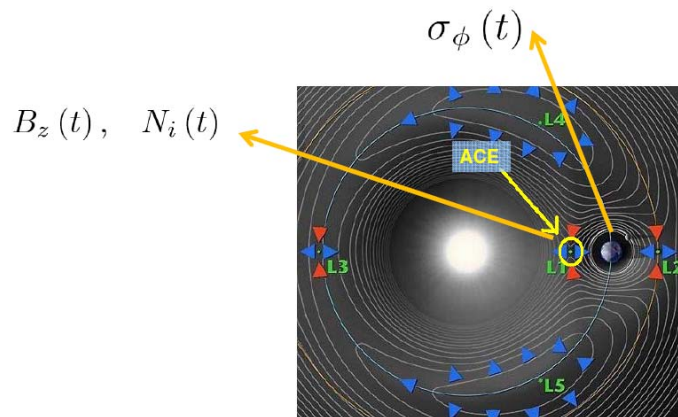


Observatory data are available at the following URL address:
<http://geomag.rm.ingv.it>

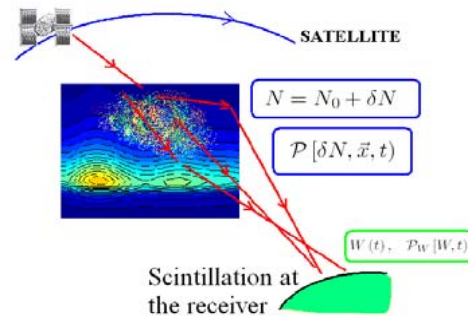
Upper atmosphere physics to Space Weather



National Research Council (Institute for Complex Systems) Recent Activities:



Predictive Space Weather via information theory tools for data analysis



Ionospheric irregularity sensing through multi-scale analysis of radio scintillation on GNSS signals

- Space Research Centre of the Polish Academy of Science, Warsaw, **Poland** (ionospheric irregularities and radio scintillation)
- Centre for Theoretical Physics of the University of Marseille, **France** (dissipative Magneto-Hydro-Dynamics)
- University of Bath, **UK** (information theory analysis tools applied to Space Weather)

INGV GNSS receivers network

- First receiver installed at Ny-Alesund (Svalbard) on 2003
- Polar ionosphere
 - Svalbard islands (3)
 - Antarctica (4)
- Mid latitude ionosphere
 - Chania (Crete)
 - Huelva (Spain) – stopped
 - Huelva station moved to Lampedusa
- Equatorial Ionosphere
 - Tucuman (Argentina)



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

[eSWua](http://www.eSWua.ingv.it)

www.eSWua.ingv.it

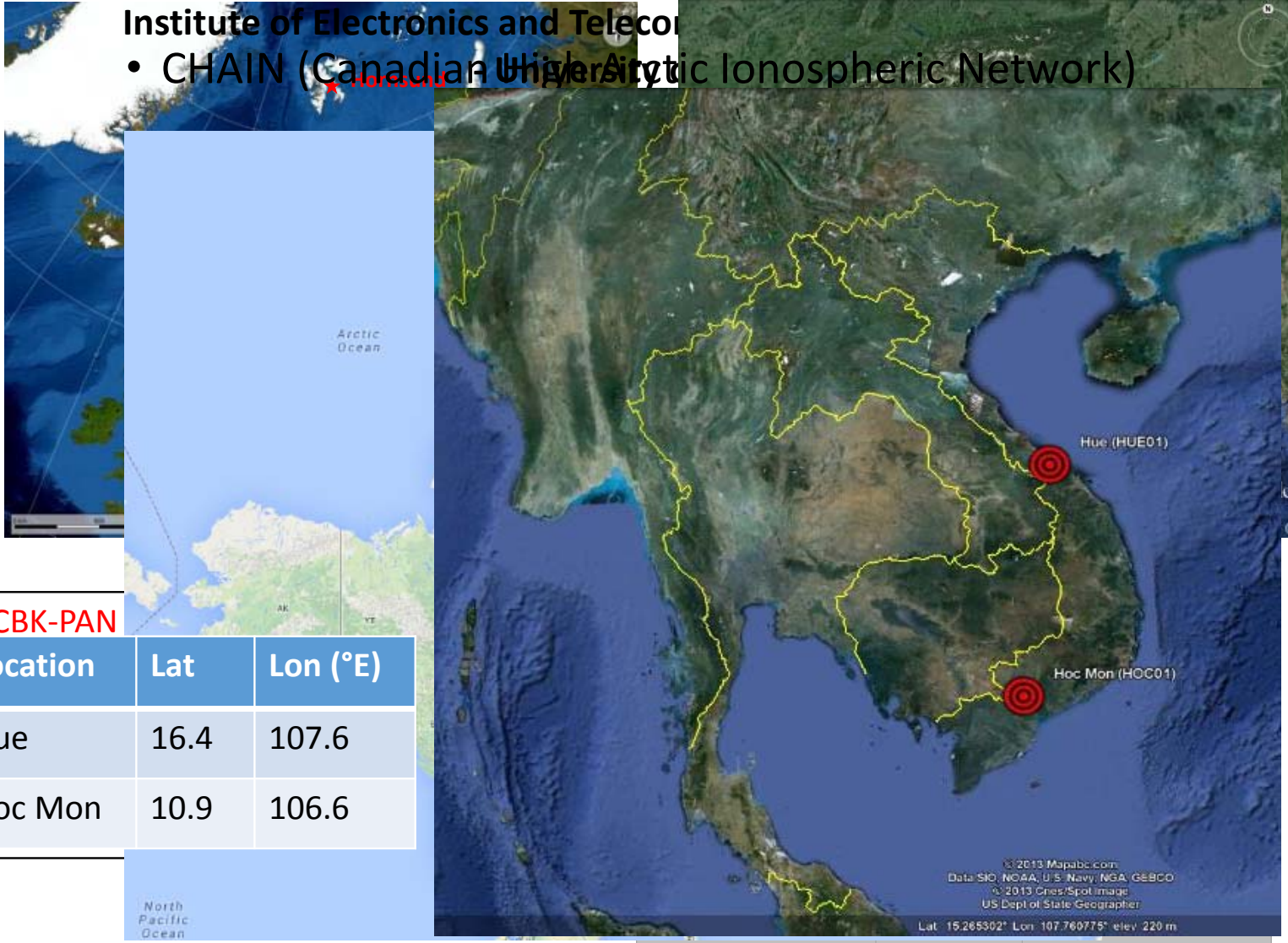


INGV
terremoti
vulcani
ambiente

ISTITUTO NAZIONALE
DI GEOFISICA E VULCANOLOGIA

INGV network partners

- Institute of Electronics and Telecommunications Research Center
- CHAIN (Canadian High Arctic Ionospheric Network)



Most relevant past and on-going projects

CALIBRA: Countering GNSS high Accuracy applications Limitation due to ionospheric disturbance in BRAzil, FP7–GALILEO–2011–GSA–1

TRANSMIT: Training Research and Applications Network to Support the Mitigation of Ionospheric Threats, FP7-ITN Marie Curie

ESPAS: Near-Earth space data infrastructure for e-science, FP7-Research Infrastructure

MISW: Mitigation of space weather threats to GNSS services, FP7-Space

ERICA: EquatoRial Ionospheric Characterization in Asia, ESA-ALCANTARA

MIMOSA2: Monitoring Ionosphere Over South America, ESA-ALCANTARA

DemoGRAPE: Demonstrator of GNSS Research and Application for Polar Environment, PNRA

GRAPE: GNSS Research and Application for Polar Environment, SCAR

GINESTRA – MIMOSA - MEDSTEC COMPETENCE SURVEYS WITHIN THE ESA ALCANTARA INITIATIVES

MIMOSA2

Monitoring Ionosphere Over South America to support high precision applications

ERICA

EquatoRial Ionosphere Characterization in Asia



WHO
WITH



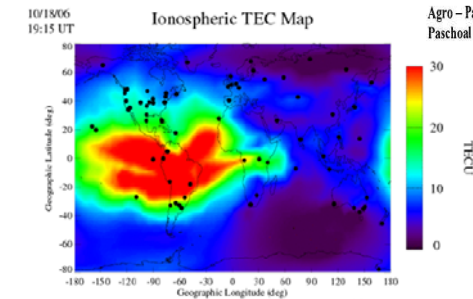


CALIBRA: Countering GNSS high Accuracy applications Limitation due to ionospheric disturbance in BRAzil
 FP7-GALILEO-2011-GSA-1a

- CALIBRA builds on the **outcomes** of CIGALA
- Mitigate impact of **ionospheric disturbances**
 - Scintillation
 - TEC variations
- Focus on **high accuracy** GNSS positioning techniques
 - Better than **10cm**
- Address applications in **Brazil**
- Devise commercially applicable solutions
- Implementation at **receiver level**
- Provide **reassurance** for users of GNSS at low latitudes



Agro - Pastoral
 Paschoal Campanelli S/A

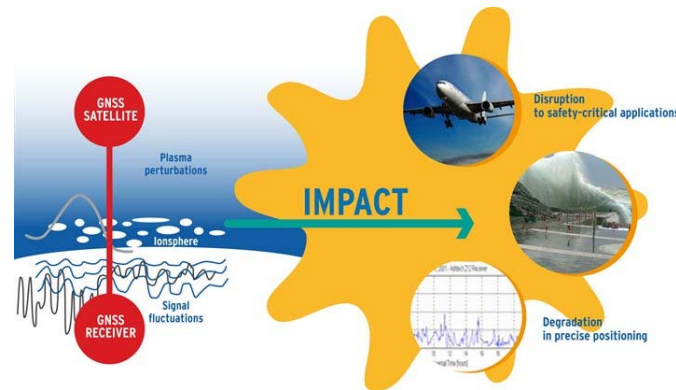


TRANSMIT

TRAINING RESEARCH AND APPLICATIONS NETWORK TO SUPPORT THE MITIGATION OF IONOSPHERIC THREATS

An FP7 Marie Curie Initial Training Network. The project addresses in particular ionospheric threats to Global Navigation Satellite Systems (GNSS) and related applications, in areas such as civil aviation, marine navigation and land transportation.

TRANSMIT is a 4-year project and involves the recruitment of 16 young researchers across its partners





Near-Earth space data infrastructure for e-science

A platform to integrate heterogeneous data from earth's thermosphere, ionosphere, plasmasphere & magnetosphere

- Supports the systematic exploration of multipoint measurements from the near-Earth space through homogenised access to multi-instrument data
- Provides access to 40+ datasets from : Cluster, EISCAT, GIRO, DIAS, SWACI, CHAMP, SuperDARN, FPI, magnetometers INGV, SGO, DTU, IMAGE, TGO, IMAGE/RPI, ACE, SOHO, PROBA2, NOAA/POES, etc.
- Supports data visualization, search, statistics, modelling

ESPAS User Interface is accessible through
<http://www.espas-fp7.eu>
 Next ESPAS release: in October 2013
 Final ESPAS release: in April 2015



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