Space Weather Activities in Argentina

Dr. M. Graciela Molina (1)
Dr. Sergio Dasso (2)

1. FACET-UNT and CONICET
2. IAFE (UBA-CONICET) and DCAO (FCEN,UBA)

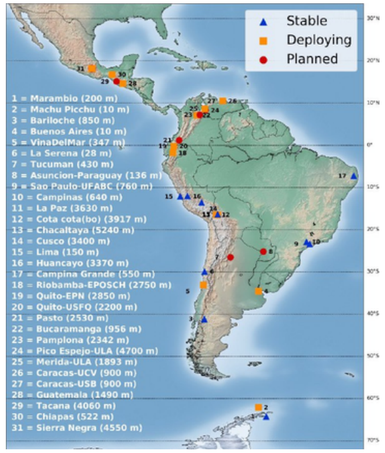
SPACE WEATHER ACTIVITIES IN ARGENTINA

Research Groups and Programs

- from low (~ 15 dip) to high lat (Antarctica)
- > number of instruments in the South Hemisphere
- Not Centralized

http://lagoproject.net/

- SWx program
- ML program
- Cosmic Rays



https://www.argentina.gob.ar/ciencia/conae

- Argentina Space Program: SWx panel
- Working in collaboration with other groups
- Instrumentation in space (SABIAMAR-SAOCOM-etc)

https://www.smn.gob.ar/

- Instrumentation deployment (e.g. magnetometers, meteorological stations, lidar, etc)
- Instrument Networks
- Service oriented and 7/24 operations

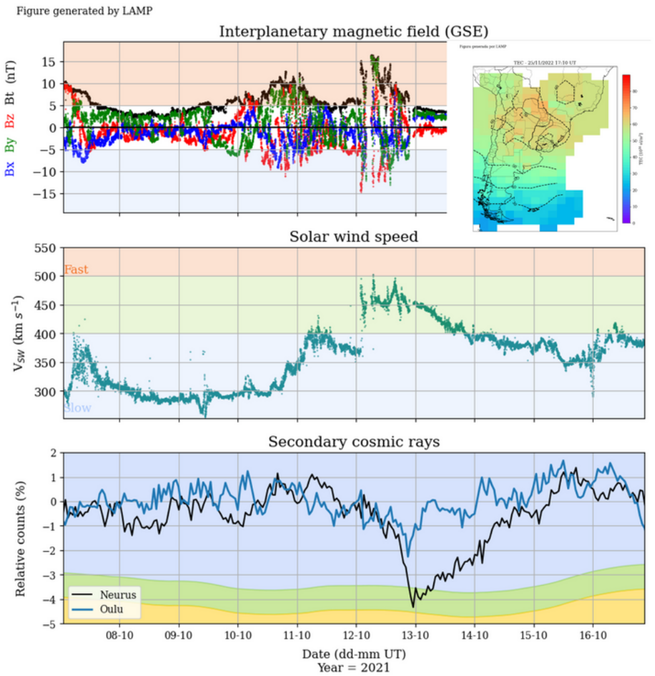
https://www.ign.gob.ar

- Argentinean network of GNSS recievers, covering all the Argentina surface

CONICET + **Universities**

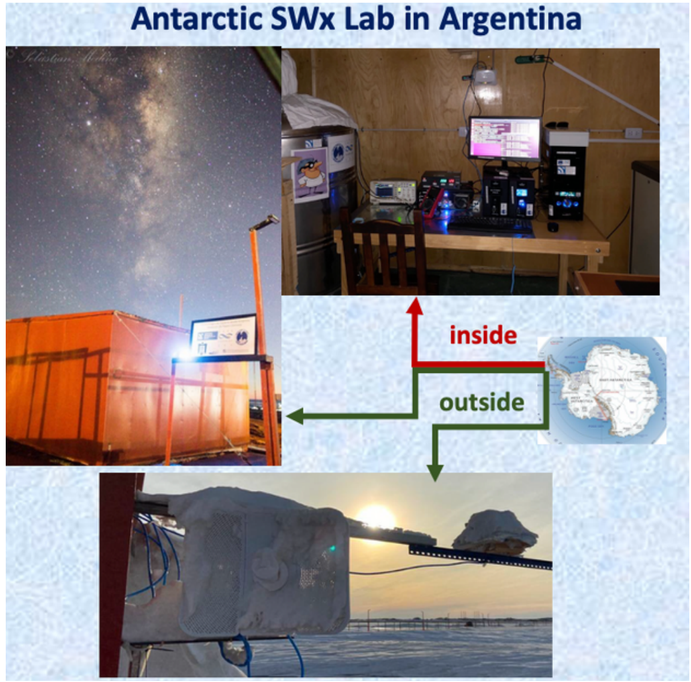
- Many research groups working in the full Sun-Earth system (UNLP, IAFE, UBA, UNT, UTN, US, UM, UNC, etc)
- Human Resources (PhD programs, Courses, etc)
- Infrastructure

Laboratorio Argentino de Meteorología del esPacio (LAMP)



Space Weather Laboratory for Argentina

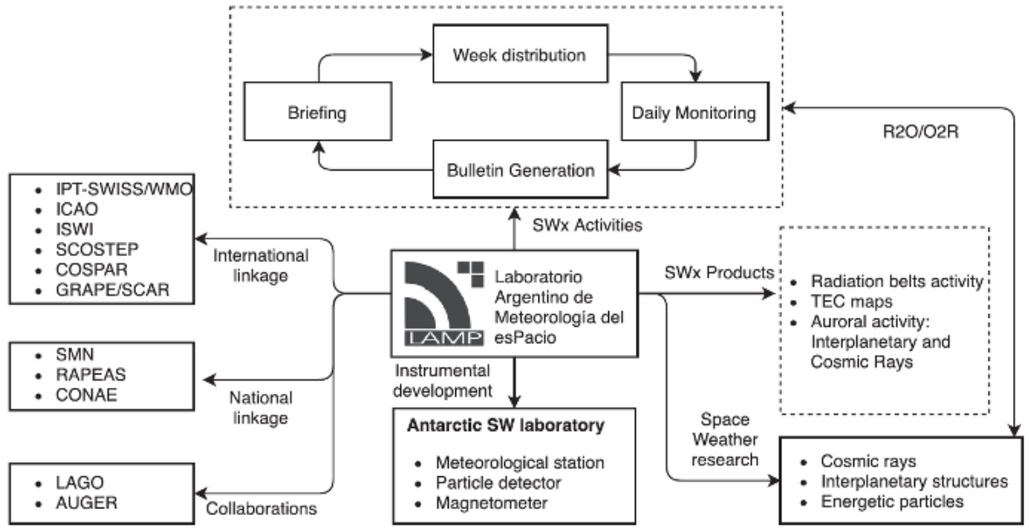
- Daily monitoring and publication of a weekly Bulletin reporting SWx conditions
- web-site offering 14 operative real-time products (Sun-SolarWind-radiationBelts-Bge-Ionosphere-CRs)
- Antarctic SWx laboratory: Different operative SWx instruments (24/7) with 5 minutes real-time
- LAMP is the Regional Warning Center of ISES
- Capacity Building: Regional Training Center of WMO (~10 SWx training courses last 5 years).
- Participation in SWx groups: WMO-ET-SWx, LAGO, AGATA-SCAR, PSW-COSPAR, ISWI, E-SWAN, ALAGE, PRESTO-SCOSTEP, ROB-Belgium, etc.



spaceweather.at.fcen.uba.ar
www.iafe.uba.ar/u/lamp

INSTITUTIONS

- UBA
- IAFE (CONICET)
- IAA (DNA) - Antarctic Institute



Meeting at ISSI-Beijing. Definition of PRESTO

References:

Dasso+2015, Proc. of Science, 105
Lanabere+2020, JASR, 65, 2223
Dasso+2020, ESWS-instrumentation, 4
Lanabere+2021, Bull. Arg. Astron, 62, 4
Gulisano+2021, Bull. Arg. Astron, 62, 280

Tucumán Space Weather Center (TSWC)

https://spaceweather.facet.unt.edu.ar/
/spaceweatherargentina/

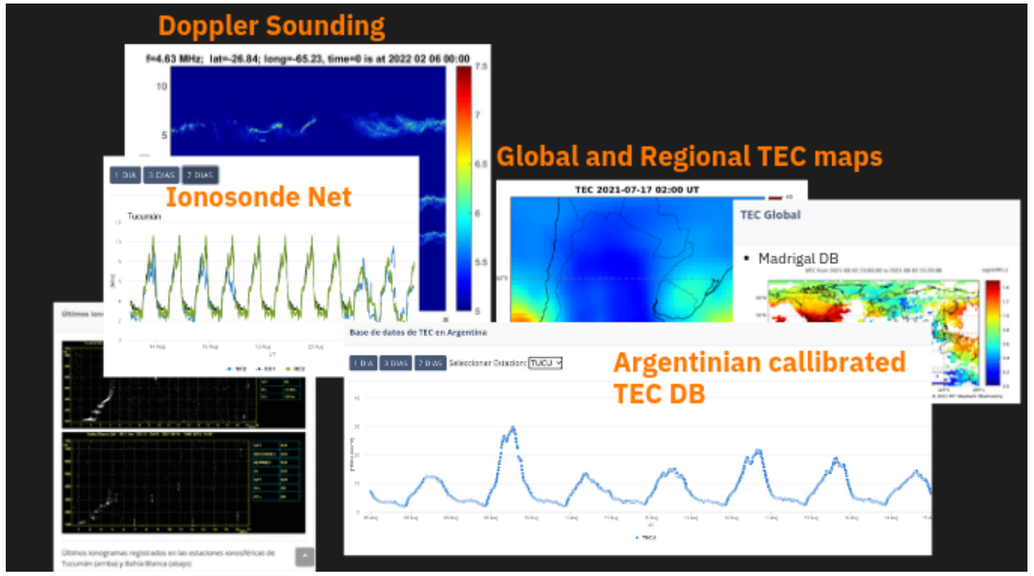
INSTITUTIONS

- FACET- UNT
- UTN - Tucumán
- UTN - Bahia Blanca

CAPACITY BUILDING

- SWx Postgraduate Curricula (UNT)
- LAGO meeting (cosmic rays- feb22)
- International Workshop on ML for SWx: Fundamentals, Tools and Future Prospects

- SWx continuous monitoring.
- Ionogram validated DB [Arg-Chile]
- TEC calibration service [on request & on the web]
- Automatic AGWs detection
- ML-based ionospheric forecasting (global & regional).
- Tailored Software Development & Data infrastructure for SWx. UNT-ICTP-INGV-Univ. Newcastle
- Participation in SWx committe/panels: ISWI - PRESTO/SCOSTEP - CONAE - RAPEAS - ALAGE - LAGO, etc



INSTRUMENTATION

- Real-time - 24/7
- Radar design and development (ionosonde, OTH)
- Ionospheric data for civil aviation: PECASUS Consortium (FMI, INGV) for ICAO

- **2 Iono sounders** - (low and mid lat). UNT-INGV-UTN.
- **2 GNSS receivers Tuc and Usuahia** (multi- freq & multi-constellation). UNT-INGV-SMN.
- **1 Magnetometer** (SA Net). UNT-INPE
- **1 Continous 3D Doppler** System (TIDs/AGWs). UNT-CAS. [upgraded in 2022]
- **1 Riometer**

Summary & future steps

- Different institutions in Argentina carry out complementary SWx activities. In this sense, Argentina has a non-centralized system with major capacities in LA.

- During the last years Argentina reached a critical point, and now it is ready to develop a National Operative Center for Space Weather.

Next steps

- To create a national center for capacity building in SWx
- Strengthen the SWx instrument network throughout the region
- Establish a national network of SWx institutions, with the aim of forming an Argentine operational SWx center.
- Enhance data and computing infratructure

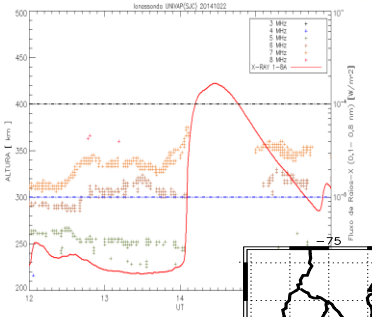
Brazil

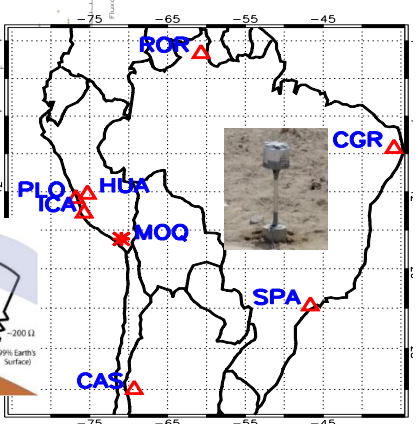
Jean-Pierre Raulin

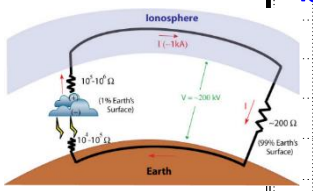
ISWI Related Research Activites at CRAAM/Mackenzie – CRAAM Team

Reported by Jean Pierre Raulin

- **Monitoring the lower (D-region) ionosphere – SAVNET Network (part of ISWI)**
  - Full upgrade of SAVNET in 2023: Home-made hardware, totally new software based on SDR
  - C/D region, Ozone screening, long-term (Ly-α) and short-term (flares)
  - solar activity monitoring, AMAS region, cosmic GRBs, seismic-EM effects



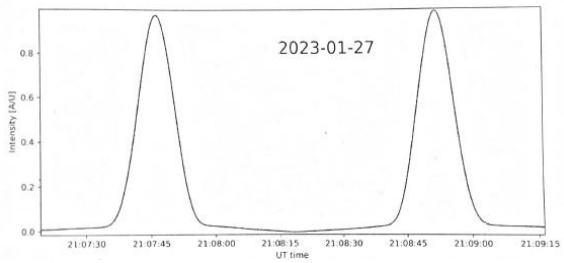


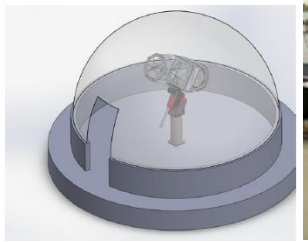


- **HF (1-30 MHz) Absorption**
  - D-RAP (empirical and incomplete) model: do miss blackouts and/or produce false alarms
  - GIANT4 → vertical profiles of e/i production
  - Compute explicitly HF absorption
  - Check consistency with low-latitude riometers, and ionosonde records
  - Monitoring and alerts of radio Blackouts during solar flares

- **Monitoring the Global Atmospheric Electric Circuit (GAEC)**
  - AFINSA Network (part of ISWI)
  - AFINSA records reproduce quite well Universal Carnegie Curve
  - Quality of AFINSA records → include AFINSA in a larger worldwide network: GLOCAEM
  - GAEC: Interface between outer geospace and ground

- **New High Altitude 15 THz Solar Photometer (HATS), now installed**
  - Installed at OAFA, San Juan, Argentina, 2023, January, 27 1st solar scans
  - High-Frequency (non-thermal) solar flare spectra
  - Dynamics of chromospheric (quiescent and flaring) plasmas
  - Origin of WL flare ?





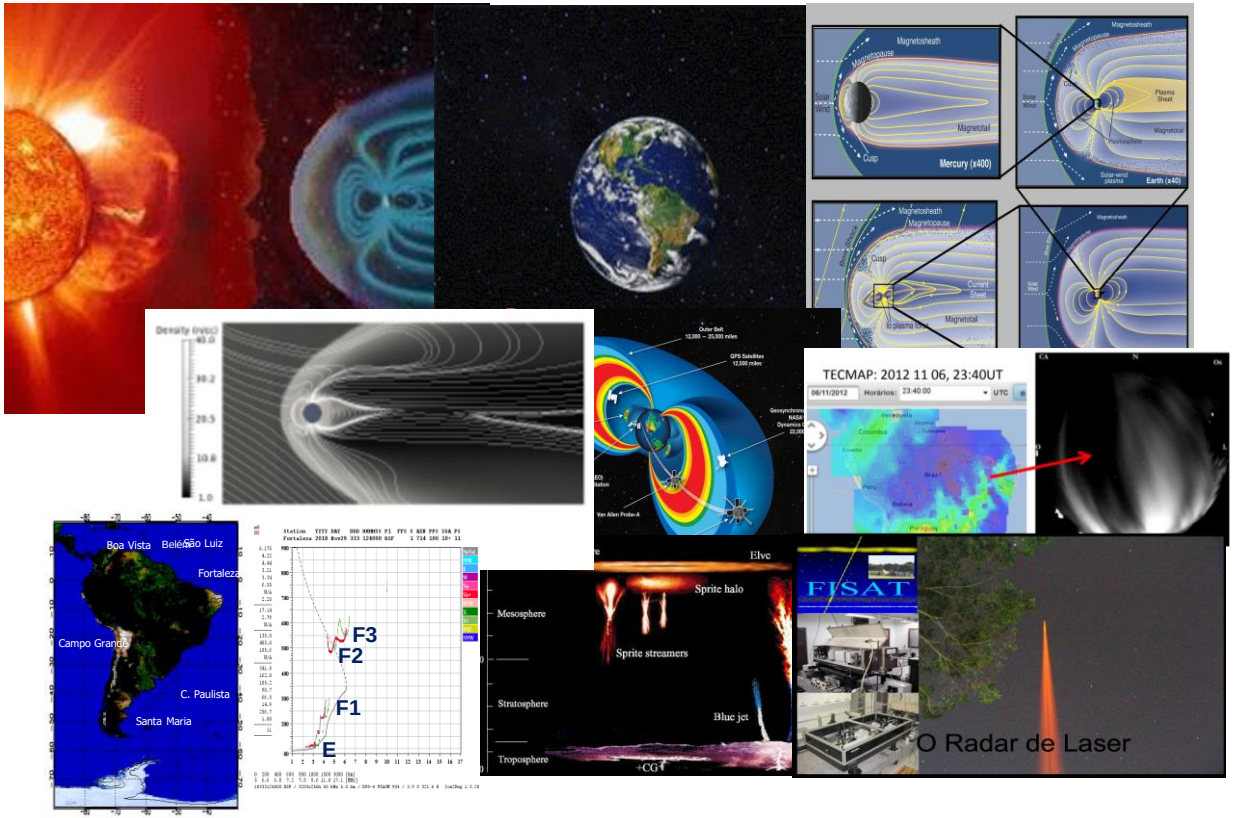
ISWI related activities developed by the Heliophysics, Planetary Sciences and Aeronomy Division at INPE

Reported by Alisson Dallago

Main Research Projects:

- Galileo Solar Space Telescope - GSST;
- Earth Radiation Belts Dynamics
- Planetary Magnetospheres
- Ionospheric Simulations using SUPIM-INPE model
- Galactic Cosmic Ray variability using the GMDN network
- Ionospheric studies using radio instruments and GNSS receivers
- Middle and Upper atmosphere studies using LIDAR, Meteor Radars and Airglow instruments
- Transient Luminous Events (TLEs) observations using LEONA Network

GSST - Galileo



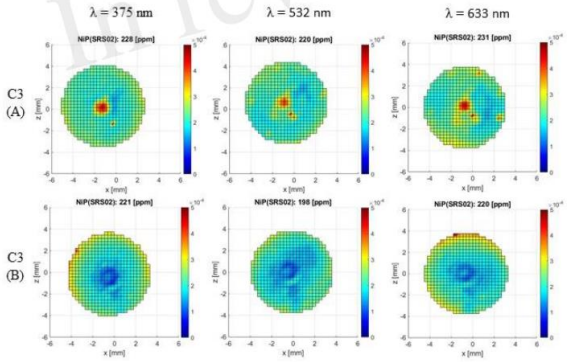
ISWI related activities developed by the Heliophysics, Planetary Sciences and Aeronomy Division at INPE

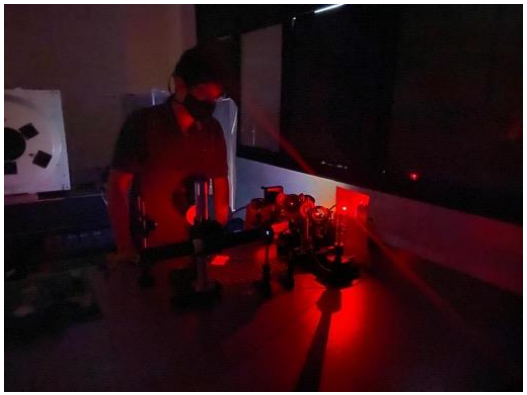
Reported by Alisson Dallago

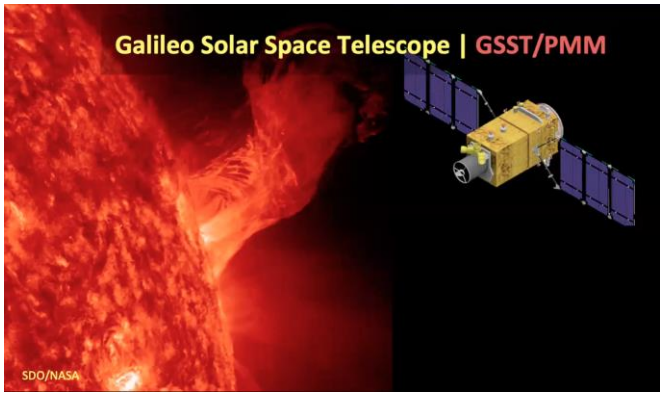
Instrument Development for the GSST Mission

Galileo Solar Space Telescope - GSST is a proposed space mission for Investigating the Links between the Solar Surface, Corona, and Inner Heliosphere by measuring the solar magnetic field, the Total Solar Irradiance and the impacts at the geospace. It includes a ground segment for solar observation prototype development.

- Characterization of the Proof-of-Concept Prototype Cameras.
- Design, Implementation and Characterization of Cavit for Absolute Radiometer.
- Preliminary study of the use of Multi-Mission Platform (PMM) developed by INPE for the GSST mission.
- Holographic filter development for the GSST mission







Public outreach

- Podcast interviews: “Ciência sem Fim” https://youtu.be/63N8hs-Opes and Astrotubers
- Institutional videos (GSST/PMM https://youtu.be/ctbjNbyyLnI and ACATMOS https://youtu.be/4oNxW_uxaSM)
- Space Physics Schools https://youtu.be/lCabpCuIE5Q and International Space Science School (https://www.gov.br/inpe/en/events/colage/2022/isss)

ISWI Related Research Activites at DICEP/INPE

Reported by Joaquim Costa

Instruments network and Services in Latin America

Instruments

Solar

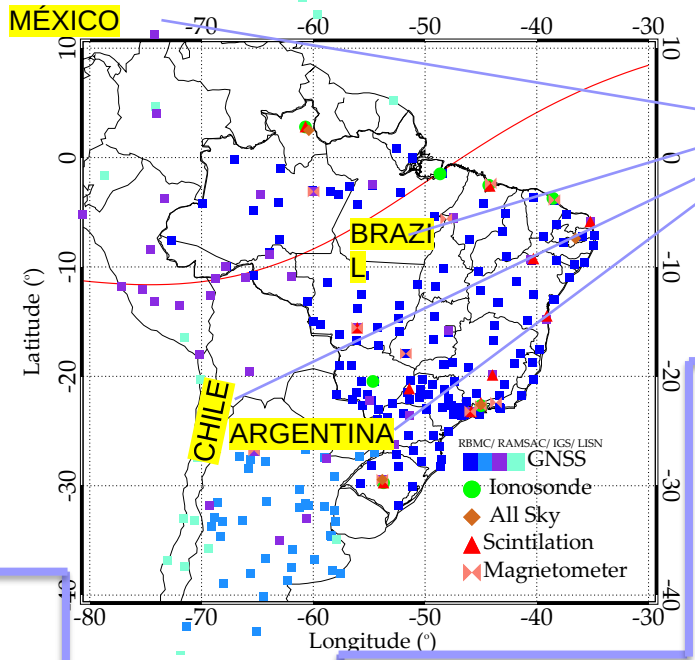
Telescopes

All-Sky imagers

GNSS receivers

Magnetometers

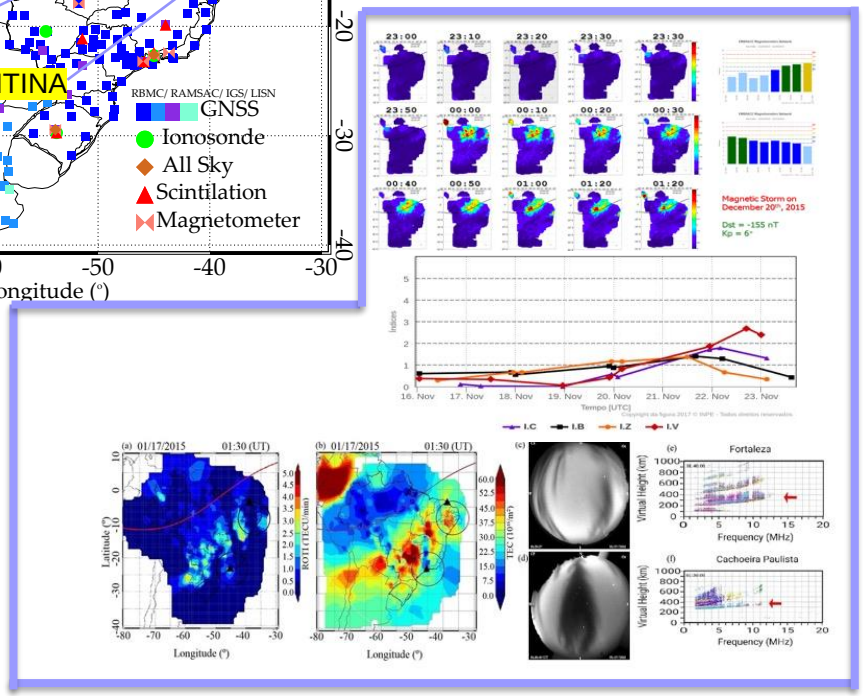
Cosmic Ray Detectors



International Cooperation

All4Space

Products



Data Sharing

https://embracedata.inpe.br/

Data distributed in the EMBRACE portal in **near real time !**

Reported by Joaquim Costa

Index of /

Name	Last modified	Size
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ionosonde/	2022-04-26 14:37	-
magnetometer/	2022-04-28 09:12	-
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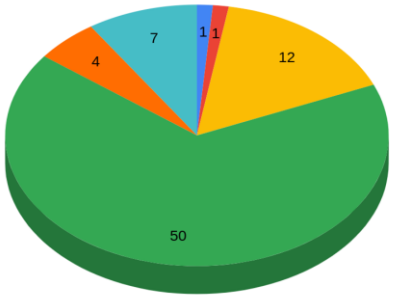
SPORT

Coming soon

Embrace Operation Report - First Semester 2022

QUANTITY OF USERS - FIRST SEMESTER 2022



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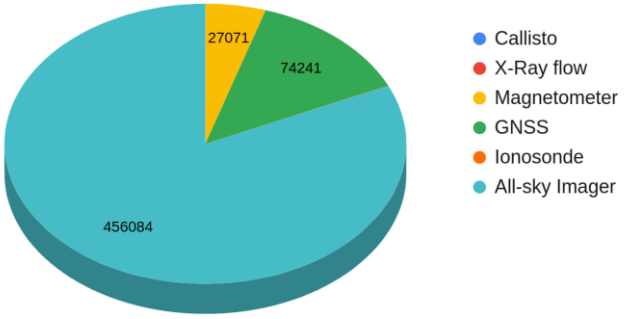


Space Weather Activities in México

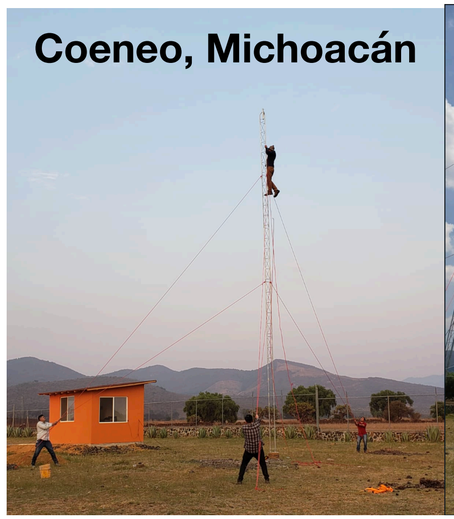
E. Aguilar-Rodriguez (National Coordinator)

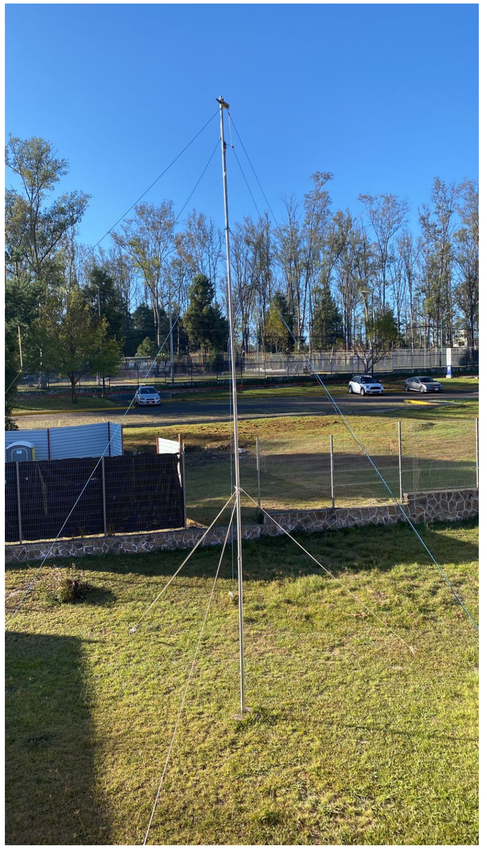
SCiESMEX
Servicio de Clima Espacial - MX

LANCE
Laboratorio Nacional
de Clima Espacial

Ionosonde network

SCiESMEX
Servicio de Clima Espacial - MX





Morelia, Michoacán

@sciesmex

www.sciesmex.unam.mx

e-Callisto Solar Spectrometers

MEXICO-LANCE-A is near about to be relocated in Ensenada, Baja California.

MEXICO-LANCE-B is planned to be moved to Chiapas state. Collaborative efforts are under way with local institutions.

MEXART is operating normally.

MEXICO-FCFM-UANL is back in operation. Some technical aspects are being addressed.

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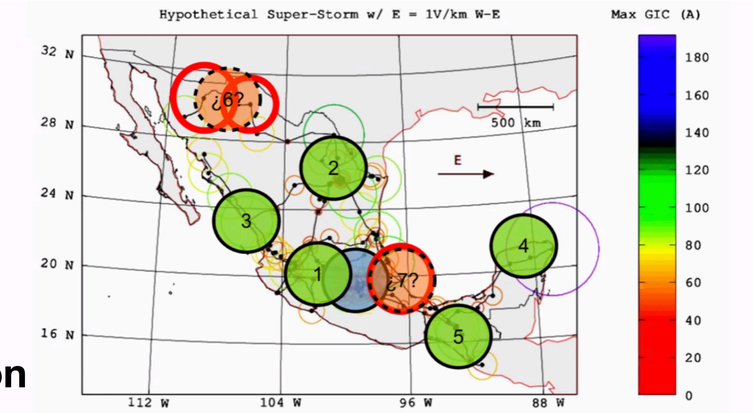
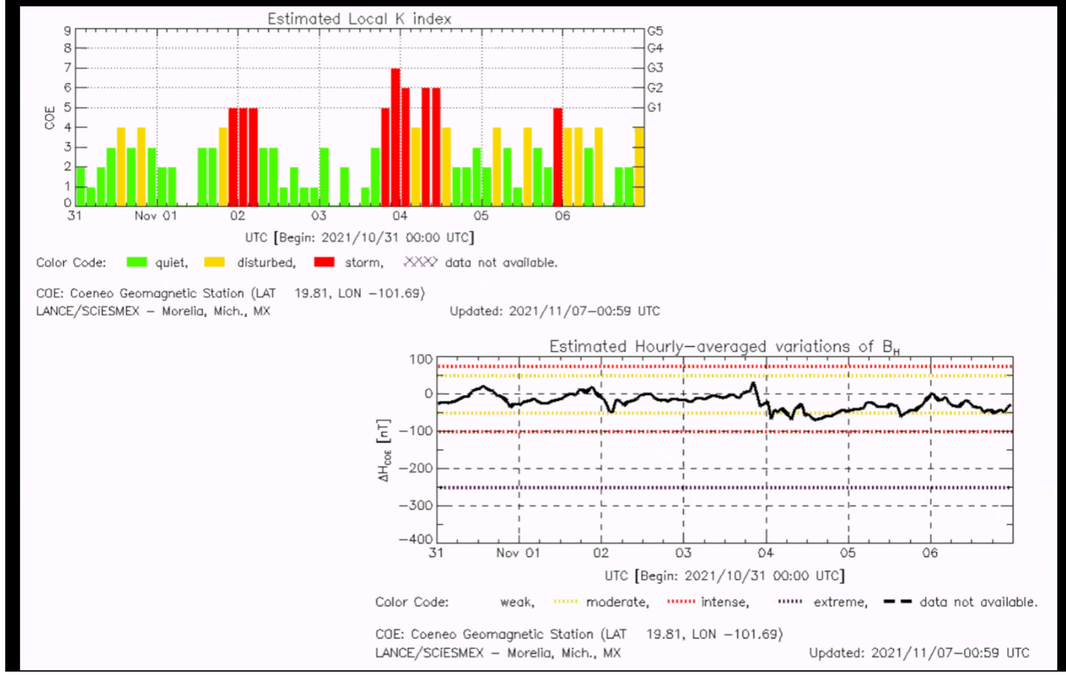
www.sciesmex.unam.mx

Magnetometer network



Planned distribution



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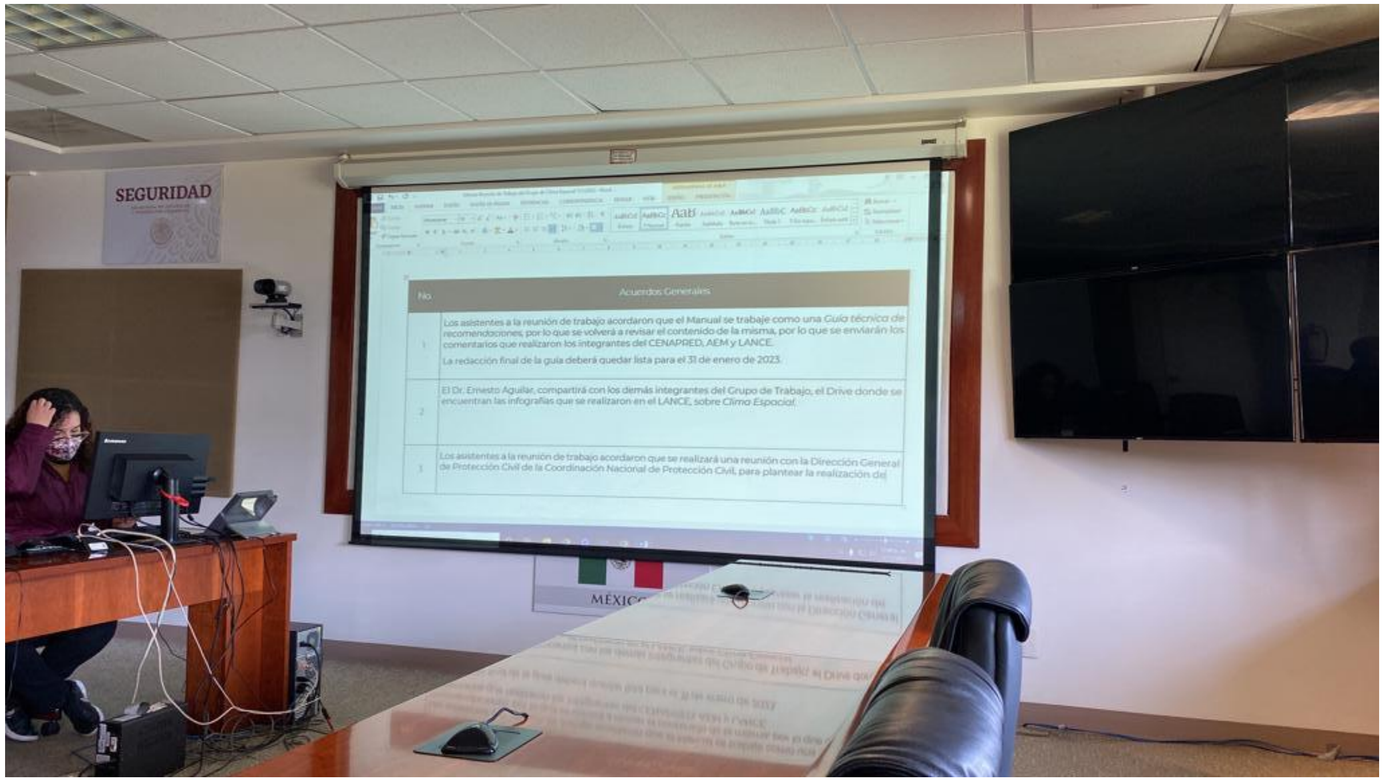
Working group on SW public policy



International Space Weather Initiative (ISWI) Vienne Feb - 2023

Walter R. Guevara Day

Universidad Nacional Mayor de San Marcos

Lima-Perú

Peru

Index

- Instruments
- Projects
- Teaching
- Institutions

Instruments

- VLF antennas, Loops and vertical
- Cherenkov tanks
- CALLISTO spectrometer
- Atmospheric Electric Field Meter
- Magnetometers
- Radars
- Optical telescope
- Radio telescope
- Ionospheric radar
- GNSS receivers
- Ionosondas
- Radar multi static
- Airglow cameras – Fabry-Perot interferometers
- FMT - Solar Monitor Telescope

Projects

- VLF wave monitoring: Solar flares, earthquake predictions, ozone variations.
- Atmospheric Electric Field Monitoring: Determine radon variation for earthquake predictors.
- Network of magnetometers.
- Red e-CALLISTO: Solar flares.
- Study of ionospheric scintilations (GNSS)
- Measurement of variations in Earth's magnetic fields caused by ionospheric processes (disturbances in the equatorial electrojet)
- Total Electron Content (TEC) measurements
- Participation of the international project CHAIN (Continuous H-alpha Imaging Network)

Teaching

Universidad Nacional Mayor de San Marcos

- Development of undergraduate and postgraduate courses.
  - Solar-terrestrial physics
  - Advanced topics
  - Astrophysical Plasma
- Implementation of the Astronomy Research Group (GIA)
  - Line of Research: Space Weather

- Undergraduate and postgraduate thesis.
  - Collaboration with researchers from Brazil, Argentina, Australia, Germany, Japan.

Institutions

- Instituto Geofísico del Perú - IGP
- Comisión Nacional de Investigación y Desarrollo Aeroespacial - CONIDA
- Universidad Nacional de Ica - UNICA
- Universidad Nacional Mayor de San Marcos - UNMSM

Thanks

wguevarad@unmsm.edu.pe

Space Weather Activities in the USA

D. Webb & E. Yizengaw, ISWI U.S. NCs

- **ISWI Instrument Programs with U.S. Leads *[probably needs updating]:***
  - African Meridian B-field Education and Research (**AMBER**); E Yizengaw and M. Moldwin
  - Atmospheric Weather Education System for Observation and Modeling of Effects (**AWESOME**) and Sudden Ionospheric Disturbance Monitor (**SID**); M. Cohen, U.S. Inan and D. Scherrer
  - Boston University All-Sky Imaging Network (**BU_ASI**); M. Mendillo and C. Martinis
  - Coherent Ionospheric Doppler Receivers (**CIDR**); A. Mahrous (Egypt) and T.W. Garner (US)
  - Low-latitude Ionosphere Sensor Network (**LISN**); C. Valladeres
  - Remote Equatorial Nighttime Observatory for Ionospheric Regions (**RENOIR**); J.J. Makela
  - Realistic Ionosphere (**RI**); B. Reinisch and I. Galkin
  - Scintillation Network Decision Aid (**SCINDA**); K. Groves

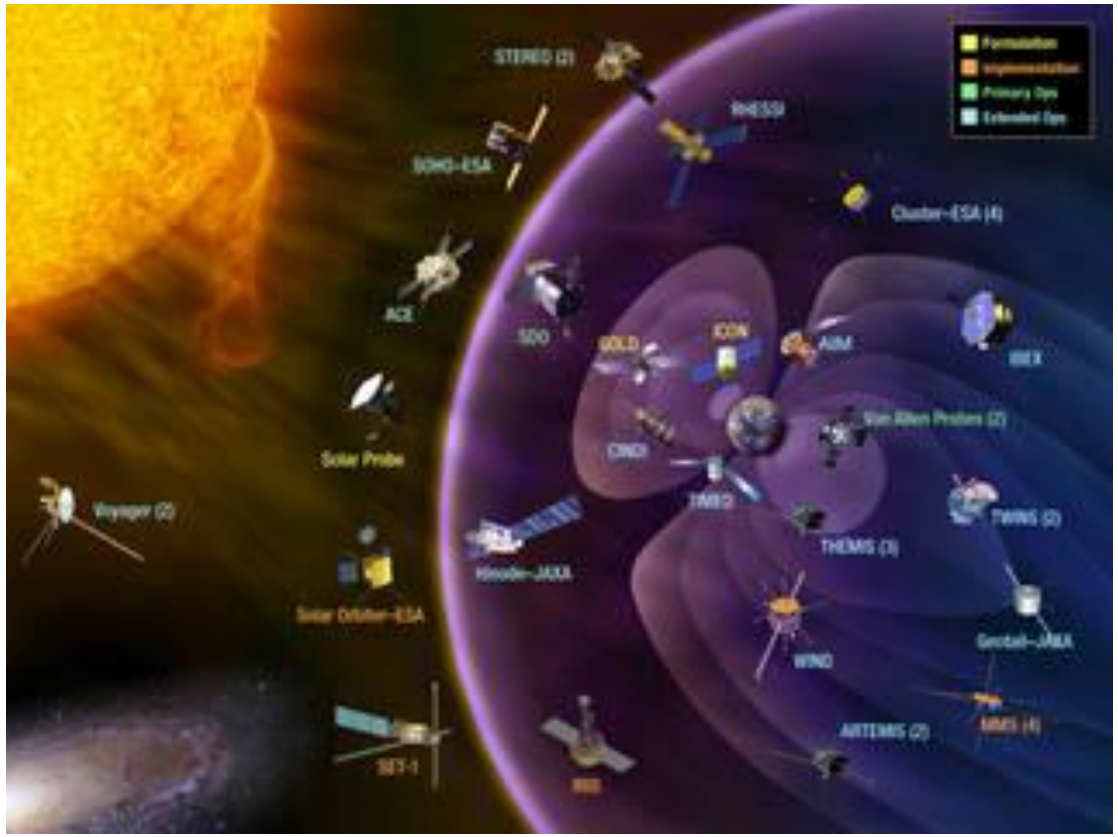
- **The U.S. national space weather activity is a coordinated effort of different federal agencies, including NASA, NSF, NOAA, USGS, AFRL, and NRL.**

- **NASA** helps to coordinate these agencies through the **National Space Weather Strategy and Action Plan.** This is as additional program to the existing LWS program.

- **NASA Living With a Star program.** This year the LWS focused science topics were: 1) Beyond F10.7: Quantifying Solar EUV Flux and its Impact on the Ionosphere – Thermosphere – Mesosphere System and 2) Coupling of the Solar Wind Plasma and Energy to the Geospace System.

- **Space weather schools in the U.S.** The 2022 Heliophysics Summer School was held remotely in August, operating from UCAR, Boulder, CO. It ran for 2 weeks and covered a wide range of topics from solar imaging and in-situ observations to modeling to magnetosphere and ionosphere effects.

- The **Heliophysics Systems Observatory** is a fleet of many space missions that act as a single "observatory" to observe Sun and measure its space weather.



- Still-operating imaging spacecraft: SOHO, STEREO-A, SDO, IRIS, and GOES-16; In-situ measurements made by ACE, WIND and DSCOVR, all at L1.

- Parker Solar Probe (2018) measures solar wind near Sun (≤ 10 Rs).

- Solar Orbiter (2020) has suite of in-situ and imaging instruments to observe Sun ≤ 0.28 AU and eventually out-of-the-ecliptic. SolO is ESA mission with NASA support; PSP is NASA mission with ESA support.

- Planetary missions that make SW measurements: MAVEN at Mars, and ESA's BepiColumbo flying by Venus and Mercury. The HSO has led to many papers related to SWx as solar cycle 25 activity increases.

- **Community Coordinated Modeling Center (CCMC)** is a multi-agency partnership performing research and development for next-generation space science and space weather models. CCMC held its 10th Community Workshop at U. Maryland, College Park, MD in June. Topics included community and agencies support and strategic planning, model on-boarding, heliophysics models beyond Earth and the Solar System, and support for open science and education.

- **National Science Foundation (NSF)** has a continuing SWx program that funds research activities that are focused on SWx impacts and support the National SWx Program.
  - NSF also supports the Solar, Heliospheric, and INterplanetary Environment (**SHINE**) group activities. SHINE held its 2022 Workshop in Honolulu, HI in June.

- **National Academy of Science (NAS)**, for the first time, included "Space Weather Science and Applications" as a separate panel in the ongoing 2024-2033 Decadal Survey for Solar and Space Physics study.
  - The NAS established "The Space Weather Roundtable" committee, which includes senior managers, decision makers, and scientists, to discuss activities that will facilitate advances in the scientific understanding of space weather phenomena and its impact.

- **National Oceanic & Atmospheric Admin. (NOAA)** established the Space Weather Advisory Group to pursue the PROSWIFT Act, in consultation with other relevant Federal agencies, and advise the Space Weather Interagency Working Group.
  - NOAA's SWx activities are centered at the **SWx Prediction Center (SWPC)** in Boulder, CO.
  - SWPC hosts an annual SWx Workshop, last year held virtually in April.

- **U.S. Air Force space weather program** operates through its Research Lab (AFRL). Basic research funding is via its Office of Scientific Research (AFOSR).
  - AFOSR basic research on the solar-terrestrial environment supported under Space Science program and covers activity from the Sun through Earth's magnetosphere and radiation belts to the mesosphere and lower thermosphere region.
  - In Dec. AFRL & NASA launched a cube satellite named petitSat from the ISS. The mission is to study the ionosphere to provide insight into SWx disturbances and their impact on navigation and communication systems.

- **Space Weather Activities at the Dec. 2022 AGU Meeting:**
  - One Space Weather Session (***SA22A: Space Weather Challenges in the Near-Earth Geospace***). Focused on disturbances of ITM systems, considered as the main source of many SWx effects in geospace, such as disruption in trans-ionosphere radio signals due to absorption, scintillation and changes in propagation path as well as LEO satellite position errors due to variations in atmospheric drag. **Nine interesting oral and many poster papers were presented**.
  - The Space Weather Advisory Group held a Town Hall meeting ***(TH15E: The Space Weather Advisory Group (SWAG) User Needs Survey)*** to provide a summary of the planned User Needs survey including user sectors of focus, the survey schedule and baseline questions. Four user sectors to be examined in survey's first year include: 1) Global Navigation Satellite System (e.g., GPS), 2) Space Situational Awareness/-Space Traffic Management-Coordination, 3) Human Space Flight, and 4) Research. The survey's goal is to identify SWx research, observations, forecasting, prediction, and modeling advances required to improve SWx products.