



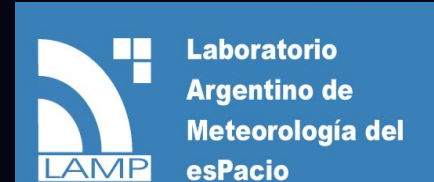
Work and Recent Developments of AASWO (Argentinean Antarctic Space Weather Observatory)

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Space Weather Operational Activities



- Weekly distribution system
- Daily monitoring
- Bulletin generation
- Briefing

Subscription alert system by email

- Geomagnetic storm
- Solar radiation storm
- Radio Blackout
- Particle storm

BOLETIN SEMANAL DE LAS CONDICIONES EN METEOROLOGIA DEL ESPACIO	
Fecha: 14/11/2022 Observador: Santos	
CONDICIONES DEL SOL	
Regiones activas	13, 3137 (N27), 3139 (N28), 3140 (N23), 3141 (N14), 3142 (N25), 3143 (S13), 3144 (S25), 3145 (N23), 3146 (N22), 3147 (S11), 3148 (S32), 3149 (N22), 3150 (N21)
Apogeo coronal	1. Sobre el hemisferio sur, con gran extensión longitudinal. El día 17 y 18 alcanza su máxima área de 7.0%. El día 19 se posicionó frente a La Tierra.
Fulguraciones solares	total B9, B10, C17, M2, X8. Máxima del período M1.6 el día 19 a las 12.56 UT.
Eyecciones de masa coronal	Se observaron varias eyecciones coronales de masa. Particularmente las eyecciones ocurridas el 19 de Noviembre a las 12.56 UT, 17.11 UT, 20.03 UT se espera que alcancen a la Tierra durante el día 22, generando impactos menores o sin impacto.
Partículas energéticas	Sin eventos.

- Structure based on **traditional meteorologic bulletins**
- Covering most of the SW areas (**sun- interplanetary medium - magnetosphere- ionosphere**)
- Uninterrupted generation since **2016**

<http://spaceweather.at.fcen.uba.ar/2/boletines.html>



Overview of LAMP Argentina

1

Real-time Data

Continuous monitoring of space weather conditions.

2

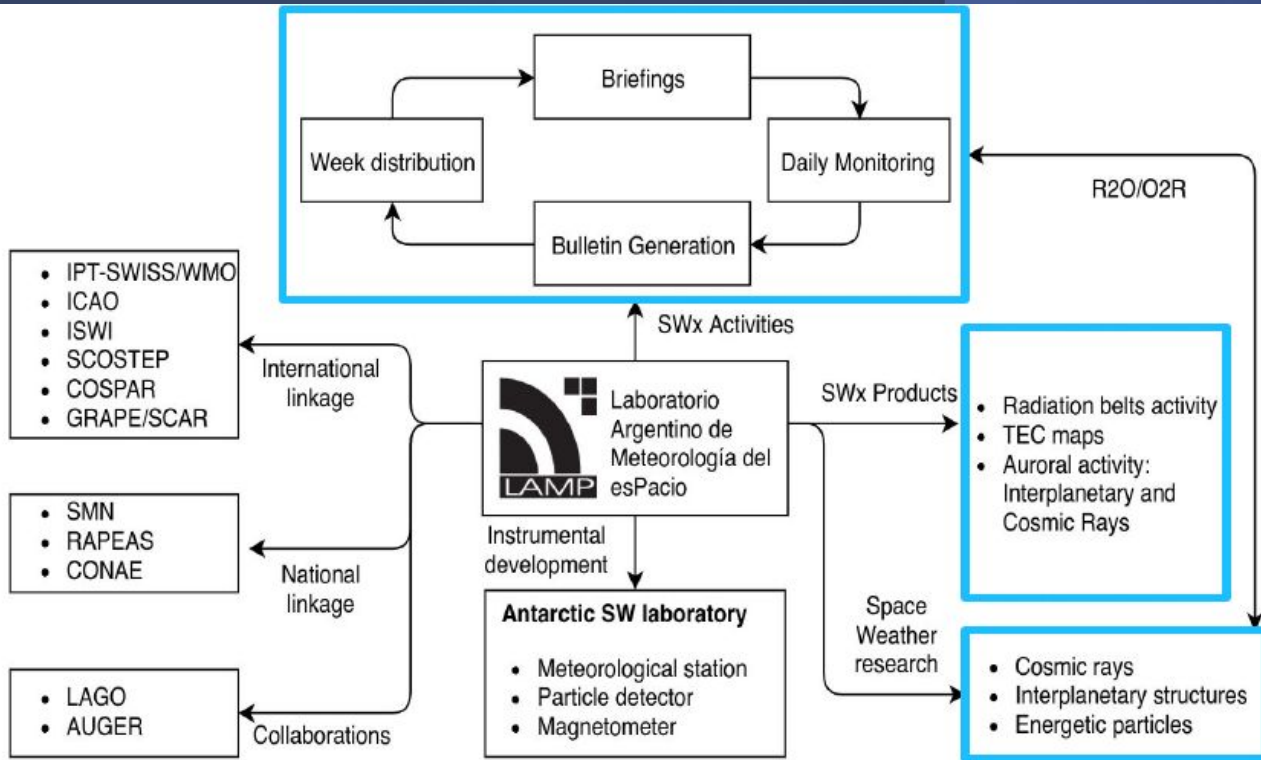
Early Warnings

Issuing timely alerts for geomagnetic storms.

3

Collaboration

Partnering with global and regional institutions.



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Space Weather products (R20)



- 14 products from the different physical processes involved:

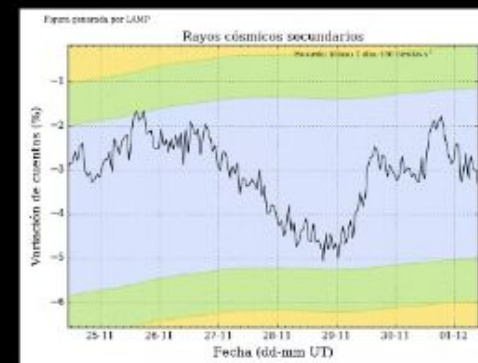
(solar, interplanetary medium, radiation belt, geomagnetic field, ionosphere, cosmic rays).

- own products with added value
- developed as part of different thesis and publications



<http://spaceweather.at.fcen.uba.ar/2/>

Cosmic rays at the Antarctic Peninsula



12

Data Sources for LAMP Bulletins

LAMP Products

Data from LAMP's instruments.

Public Data

Information from global institutions.

Regional Data

Data from Argentinian institutions.



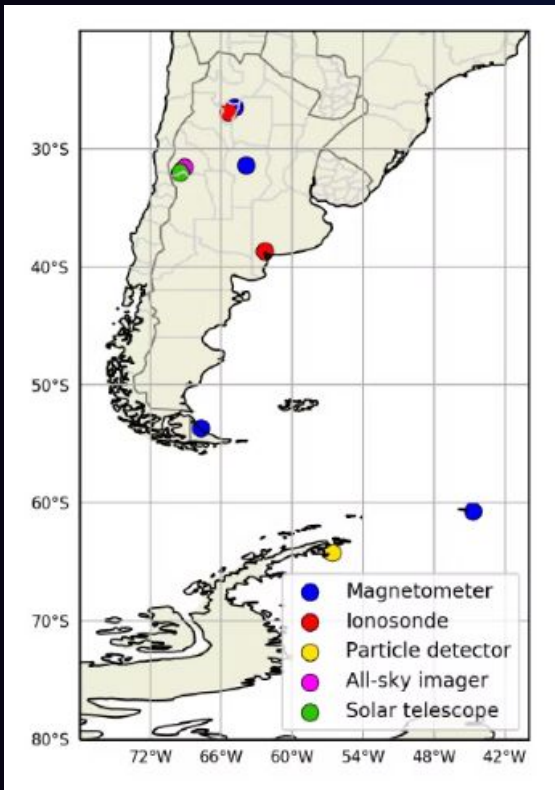
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Analyzing Data for Bulletins

LAMP Products

LAMP analyzes data from its own products also.

LAMP access to data from several Instruments



Instrument	Location	Latitude	Longitude	Institution
Solar telescope	El Leoncito - San Juan	31.8S	69.3W	MPI/IAFE/OAFA
Particle detector	Marambio - Antarctic	64.2S	56.3W	LAMP/LAGO
Magnetometer	Pilar - Córdoba	31.4S	63.9W	SMN/INTERMAGNET
Magnetometer	Orcadas - Antarctic	60.7S	44.7W	SMN/INTERMAGNET
Magnetometer	Rio Grande - Tierra del Fuego	53.8S	67.8W	UNLP/EMBRACE
Magnetometer	S. M. Tucumán - Tucumán	26.8S	65.2W	UNT/EMBRACE
Magnetometer	San Martín Antarctic base	68.1S	67.1W	IAA
Magnetometer	Belgrano 2 Antarctic base	77.8S	24.5W	IAA
Ionosonde	S.M. Tucumán - Tucumán	26.9S	65.4W	UNT/INGV
Ionosonde	Bahia Blanca - Buenos Aires	38.7S	62.3W	UNT/INGV
All-sky imager	El Leoncito - San Juan	31.8S	69.3W	BU

Public Data

It also uses public data offered by different institutions.



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Influence of solar wind disturbances on the variability of low-energy cosmic ray (CR) flux at Earth

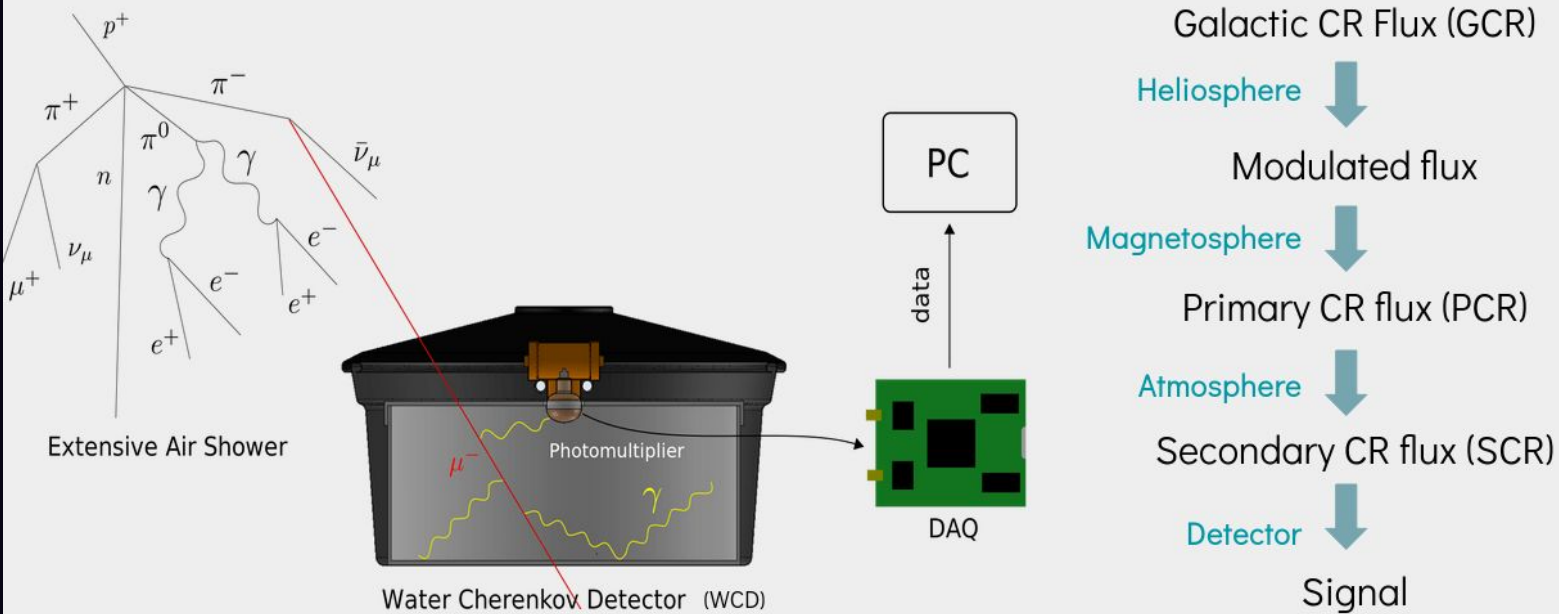


Figure taken from <https://halley.uis.edu.co/fuego/en/el-proyecto/>

The Antarctic Peninsula offers a unique location for the study of cosmic rays because lower-energy PCR (with energies ≥ 2 GeV) can reach the atmosphere.

Specifications

- Typical PCR energies observed: several tens of GeV.
- Sensitivity mainly to the muonic and the electromagnetic (em) components of the SCR.
- 3 DAQ systems (Red Pitaya STEMLab working in an FPGA mode), local meteorological station, telemetry system.
- These WCDs have been working in an autonomous way and without interruption.
- Both detectors are part of the AASWO (Argentinean Antarctic Space Weather Observatory), led by LAMP (Laboratorio Argentino de Meteorología del esPacio), and are also part of a Latin American collaboration called LAGO (<http://lagoproject.net>).

Scientific Objectives

- Study of astroparticles as tracers of SWx in an interdisciplinary approach.
- Analysis of the modulation of GCR from solar wind and magnetosphere regular & transient conditions.
- Study of atmospheric cascades at ground level and connections with atmospheric physics.
- Analysis of FDs (Forbush Decreases) which are significant reductions of the CR flux due to Interplanetary Coronal Mass Ejections (ICMEs) or other interplanetary structures) and GLEs (Ground Level Enhancements).



Water Cherenkov detector set up



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Argentine Antarctic Space Weather Observatory (AASWO)

LAMP operates a 24/7 Antarctic Space Weather Obs. with 2 Nodes

First node located at the Argentine Marambio Station ($64^{\circ}14'28''\text{S}/56^{\circ}37'31''\text{W}$)

Second node located at San Martín Station ($68^{\circ}7'48''\text{S}/67^{\circ}6'3''\text{W}$)



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Marambio and San Martin Stations

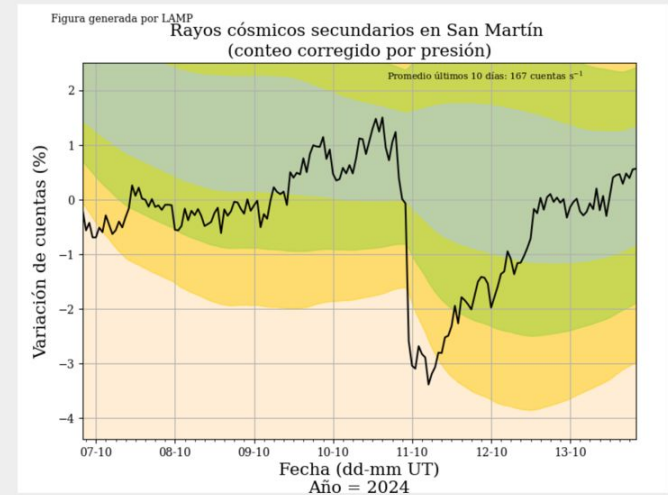
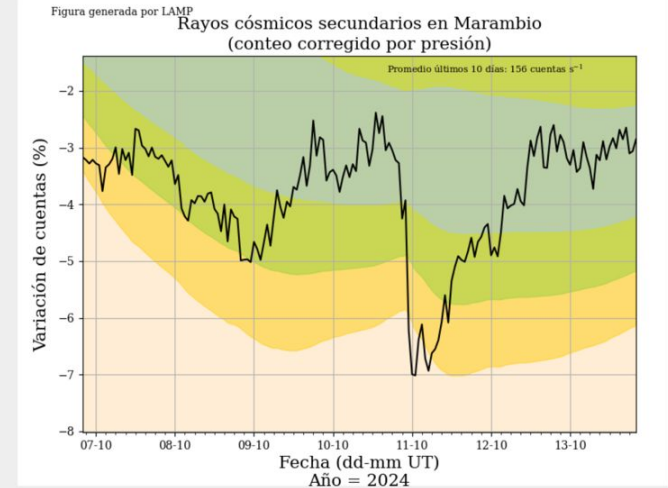
Laboratory Details

LAMP runs a 365/24/7 theri Antarctic Space Weather laboratories .
It includes particle detectors.

Magnetometers and a meteorological station.

5-minute real-time access to data.

Working 24/7.



Simultaneous measurements at both stations!

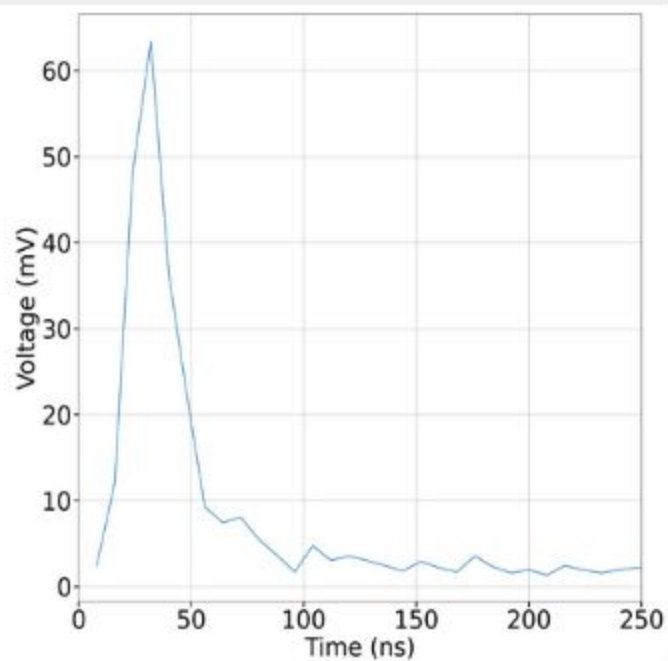


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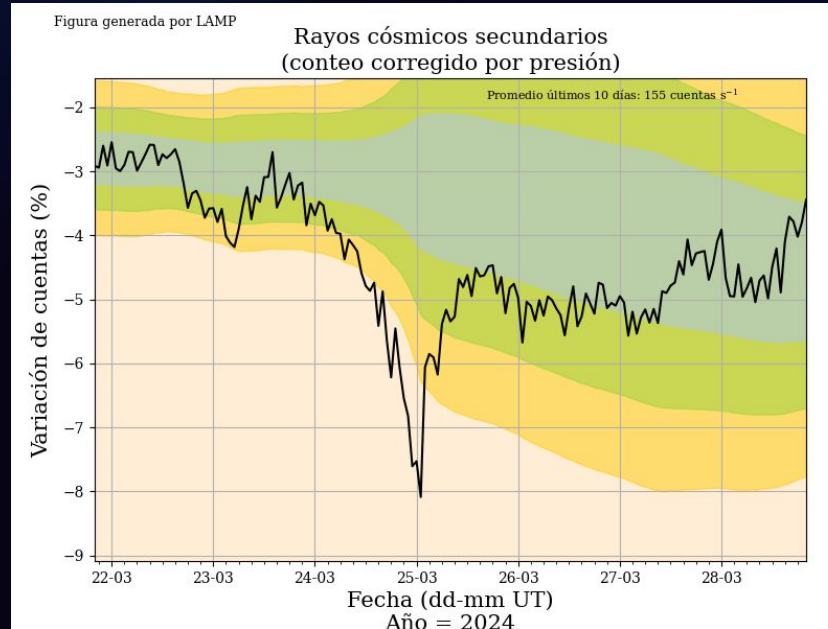
Data analysis

- Energy deposited by a particle inside the detector generate a **voltage pulse**
- The pulse area or **charge** is proportional to the energy deposited by each particle
- The pulse charge is a useful feature to **discriminate** between different particles

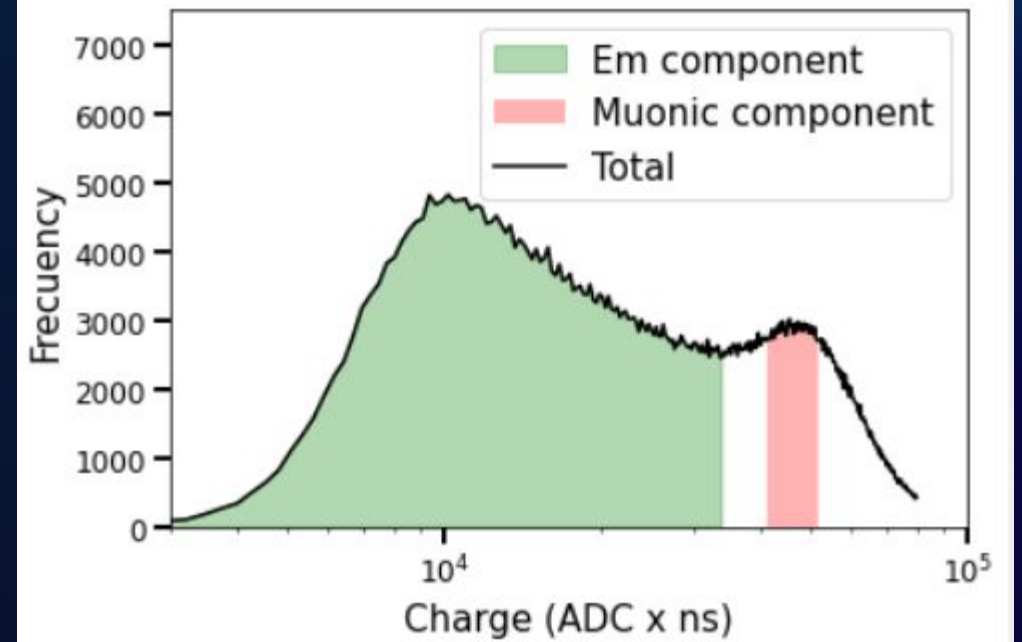
Pulse Area \equiv Charge



Typical pulse observed by the detector



CR flux measurements Marambio Station



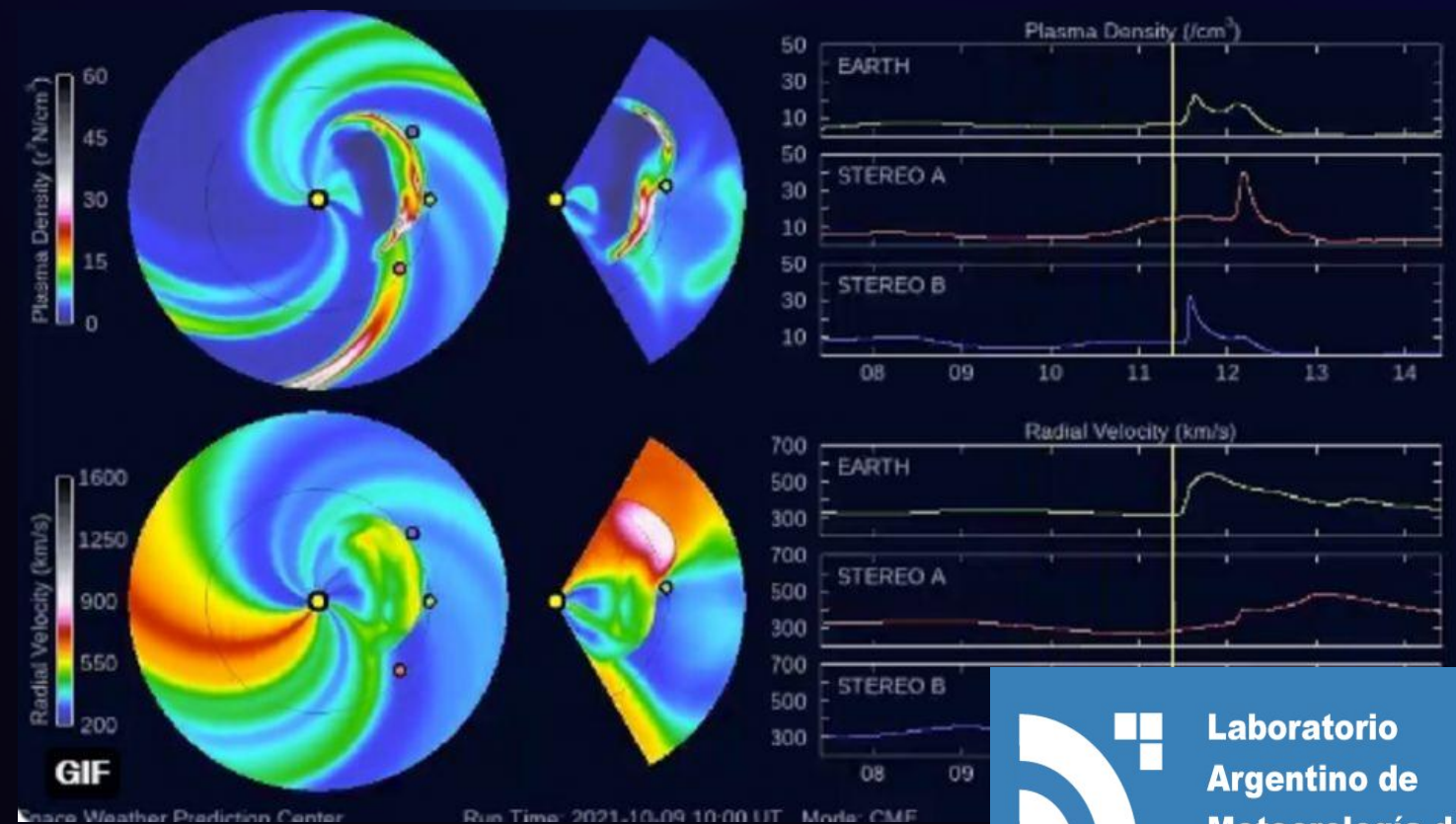
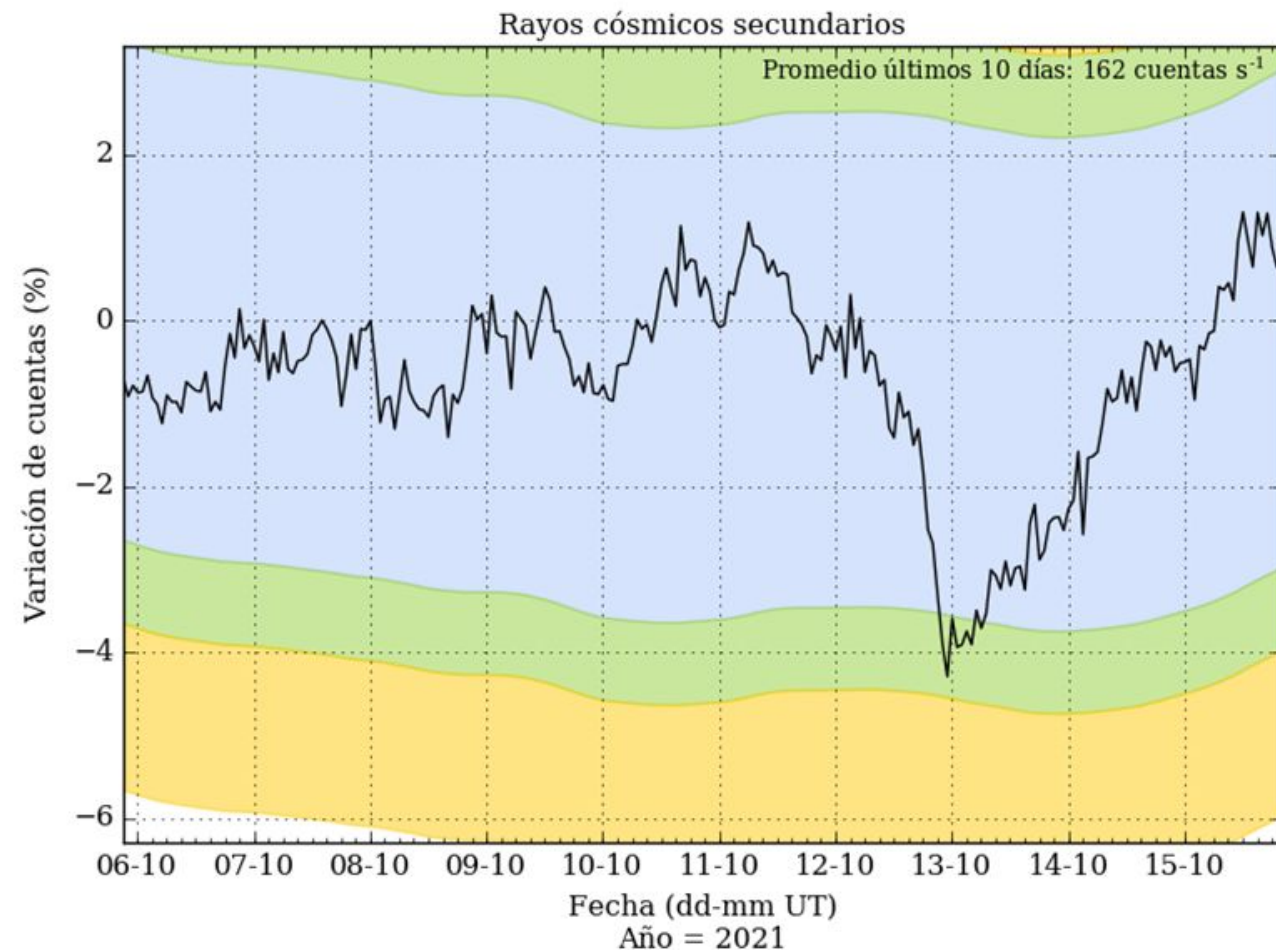
Hourly histogram of the SCR deposited energy into the detector at Marambio base

Forbush decrease from a CME Earth directed that arrived on October 11th 2021

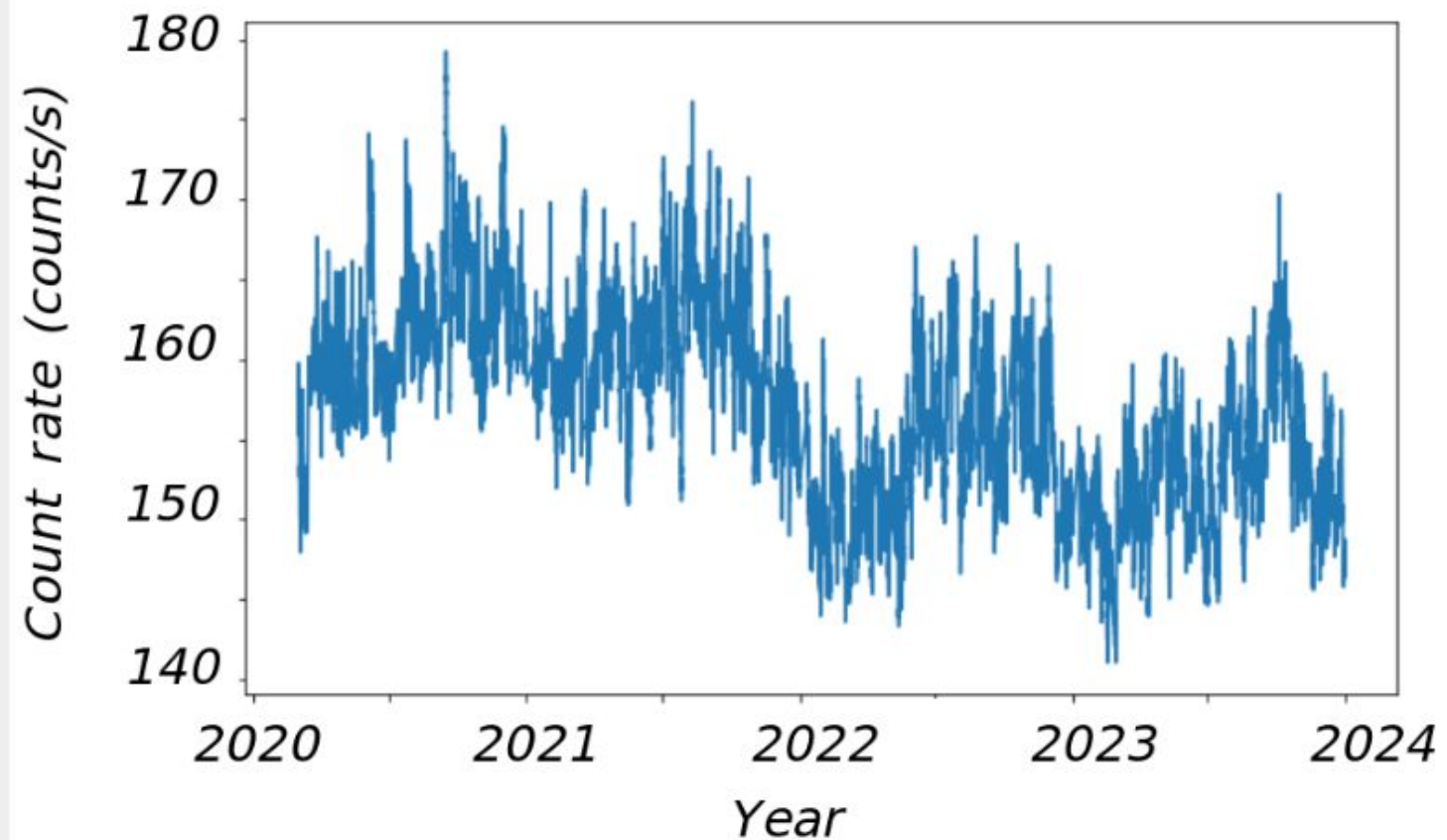
http://spaceweather.at.fcen.uba.ar/2/r_cosmicos.html

coronal mass ejection (CME) heading towards the Earth, October 11 causing a geomagnetic storm. The origin of this storm comes from the active sunspot AR2882 that produced a large M1.6-class solar flare and an ejection of this CME directed at our planet.

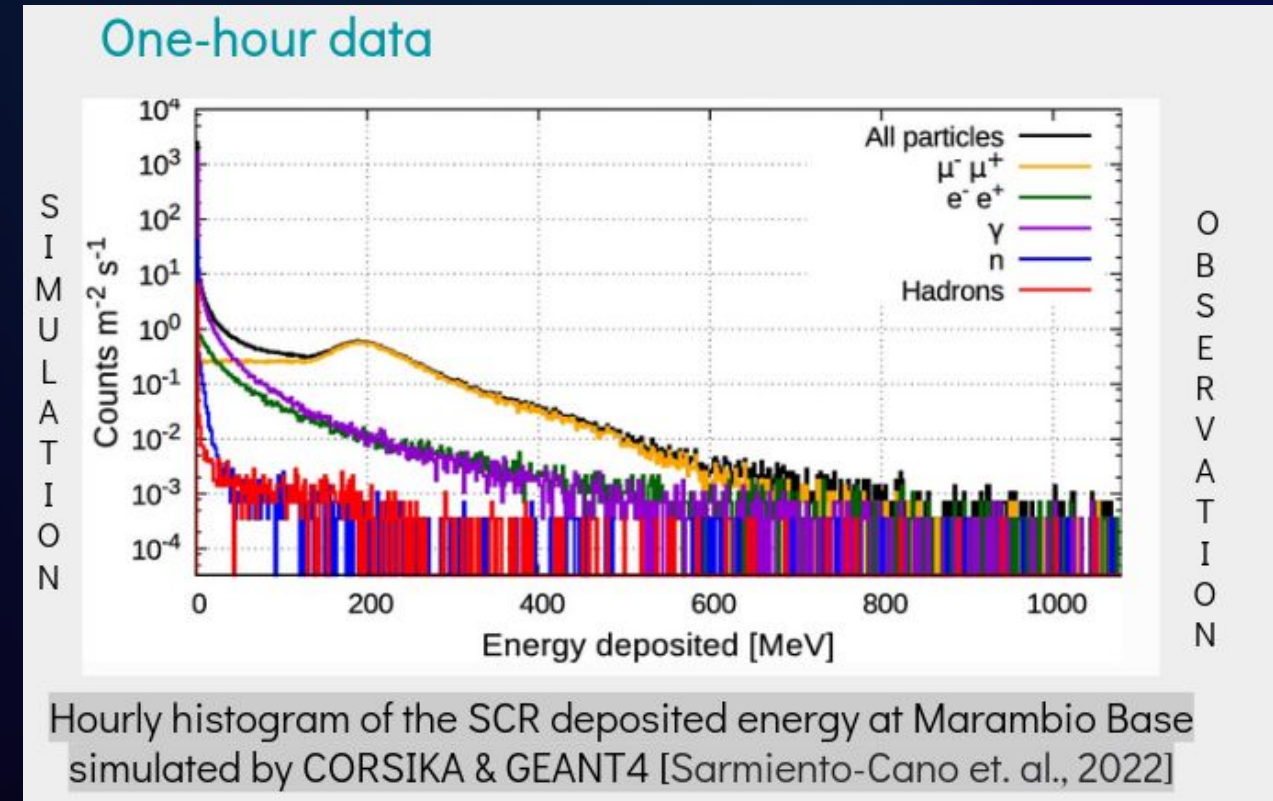
Figura generada por LAMP



Long term data at Marambio Station

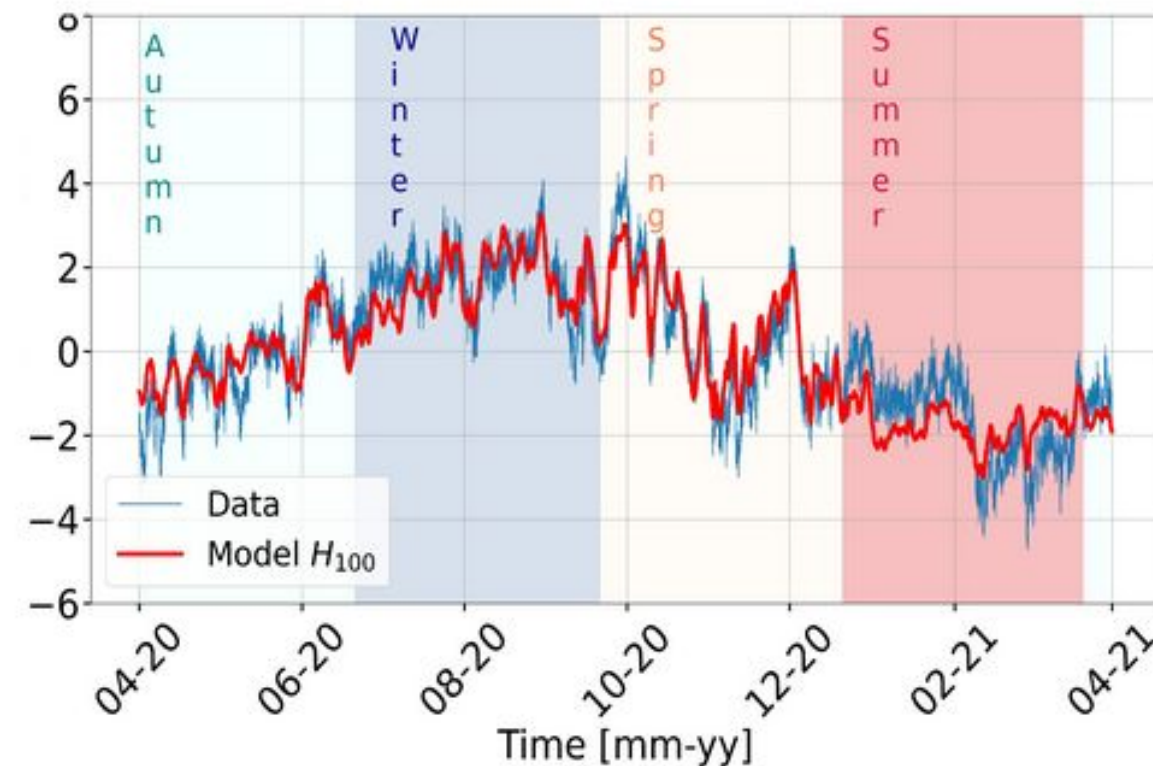
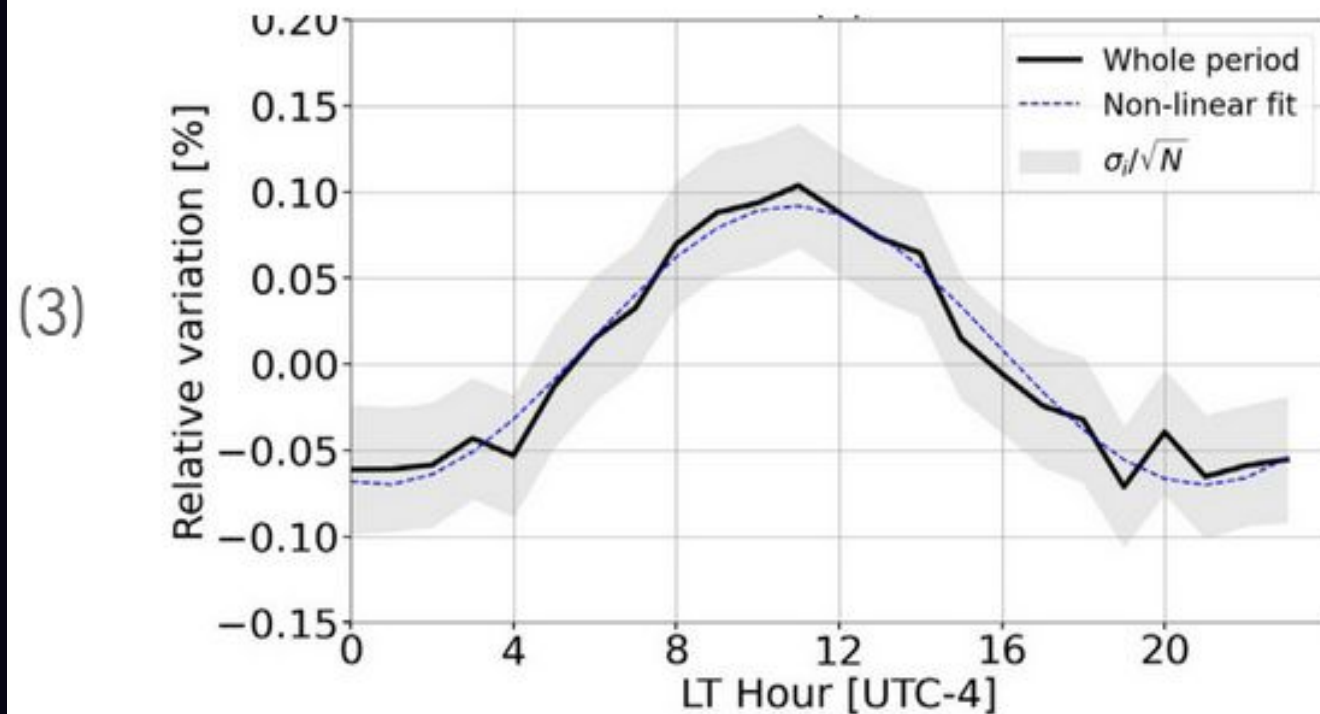


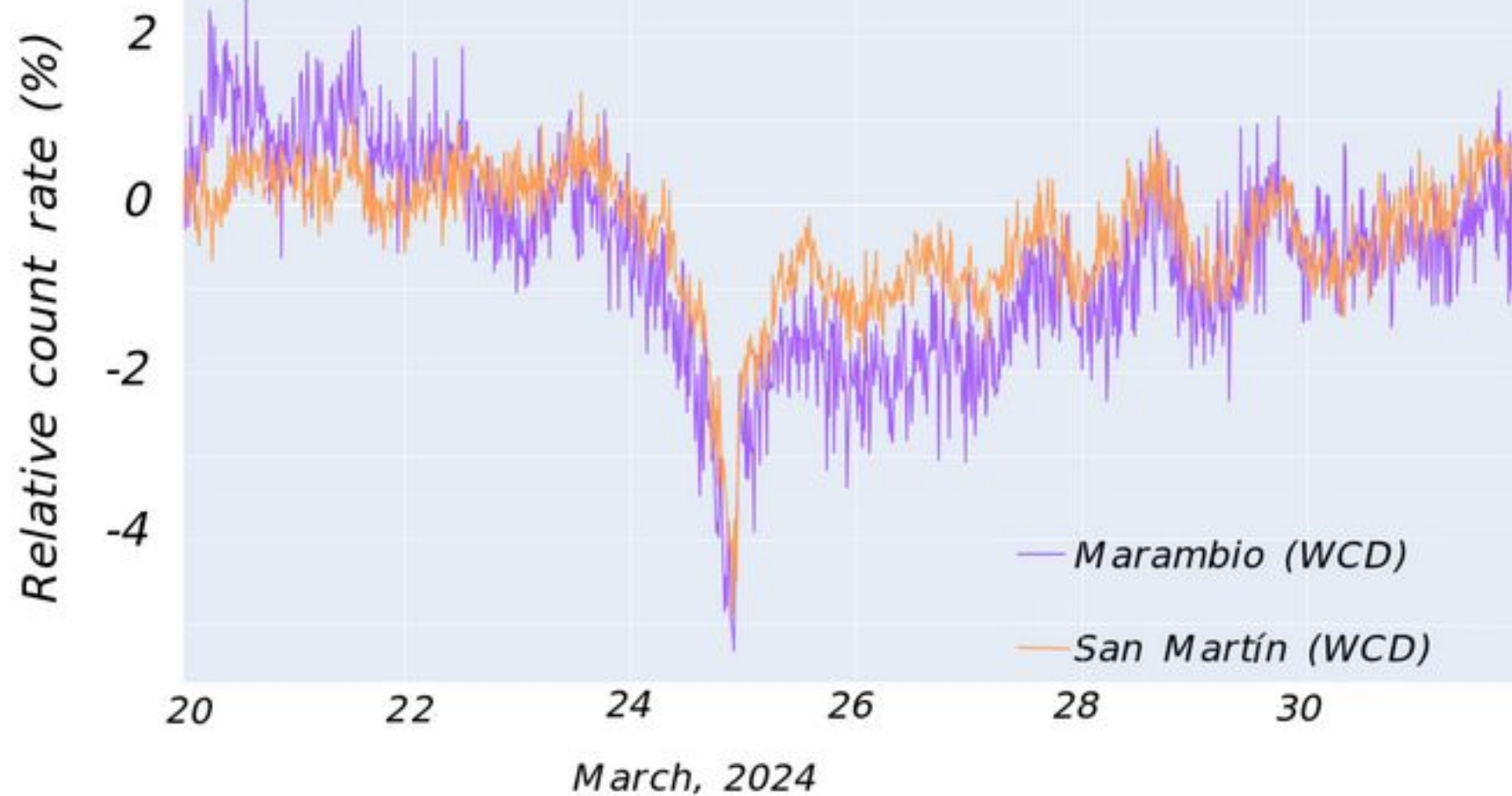
CORSIKA simulations: hourly histogram



Regular variabilities observed at Marambio Station

- (1) Anticorrelation with solar cycle (~11 years)
- (2) Atmospheric variations (barometric pressure and vertical temperature profile, highest correlation around 12 - 16 km)
- (3) Diurnal variation produced by a spatial anisotropy of the GCR flux in the interplanetary medium
[see N. A. Santos et. al., 2023]





Transient variabilities

(4) Forbush decrease observed due to the passage of a interplanetary coronal mass ejection on March 24, 2024, which generated a severe geomagnetic storm

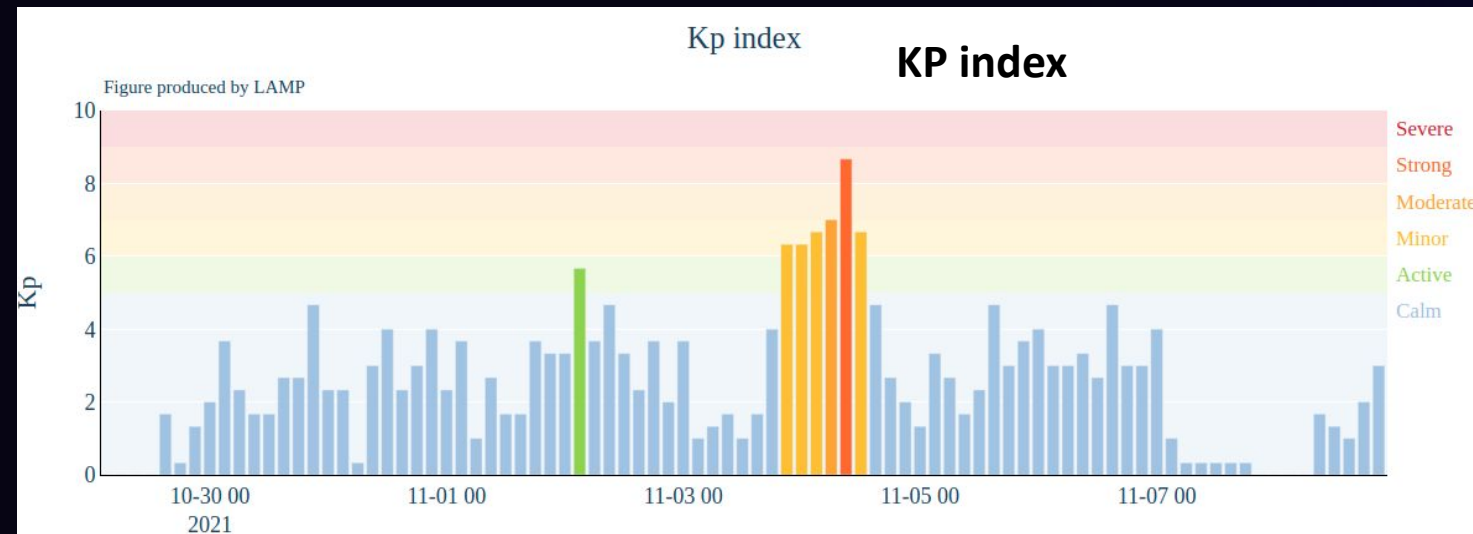
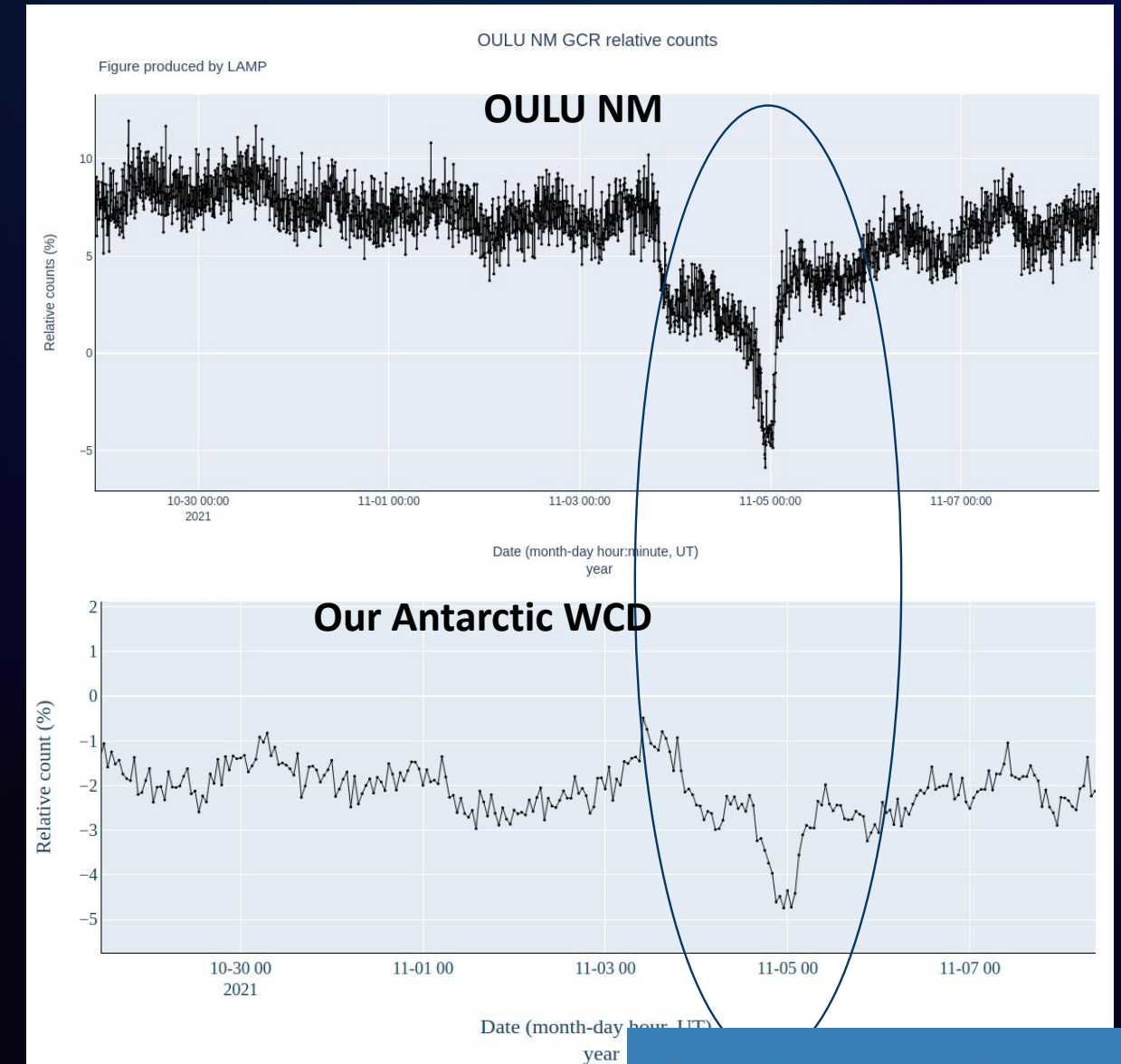
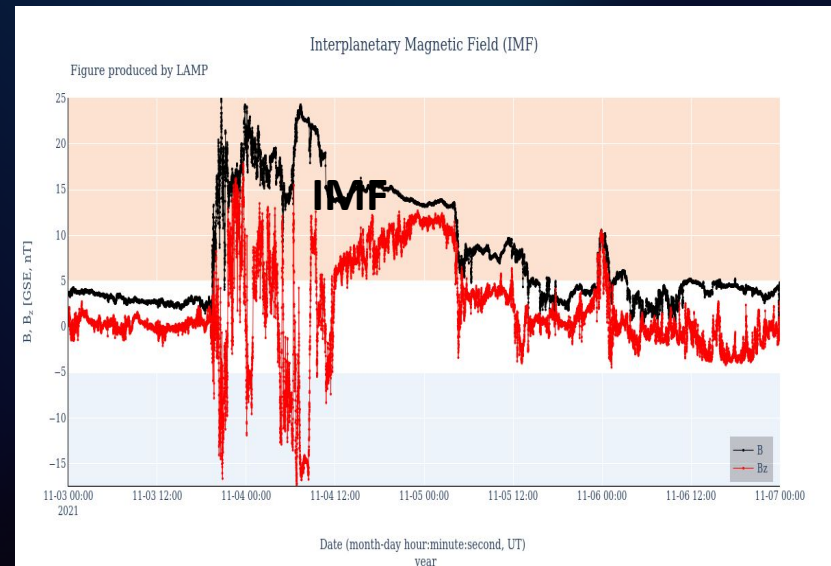
New development: historical data-base (O2R)

Forbush decrease observed by the Marambio WCD at Antarctica

Example:

ICME

4th November
2021



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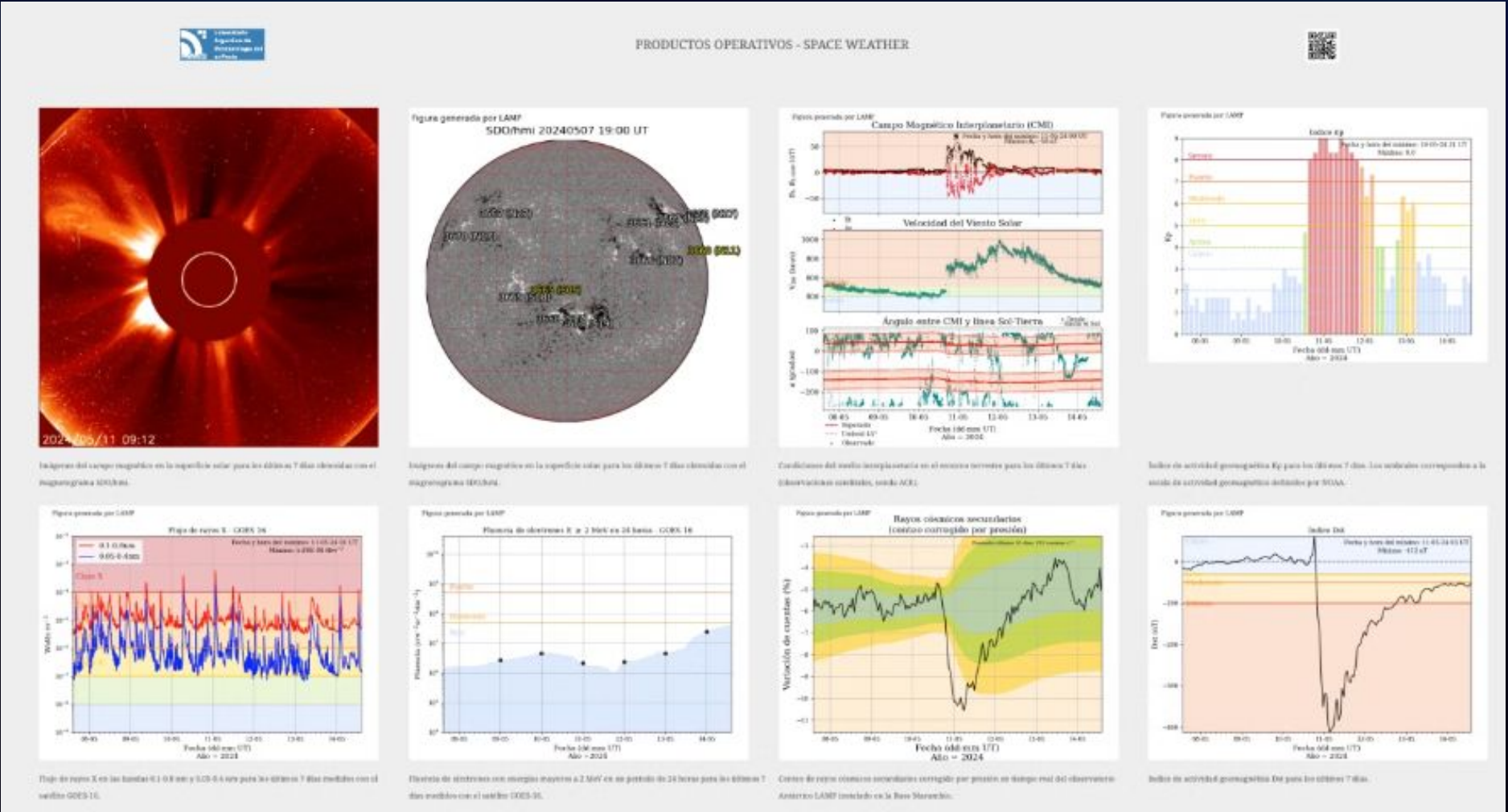
Monitoring the May 2024 Superstorm

1 Close Monitoring
Careful tracking of the May 2024 event.

2 Timely Alerts
Issuing alerts as needed.

3 Briefings
Holding briefings during the event.

Dashboard offered in the LAMP Website for May 2024



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Website and Data Server Upgrades



LAMP has updated its building offices in 2021.

The main data processing and storage server has also been upgraded.



spaceweather.at.fcen.uba.a



www.iafe.uba.ar/u/lamp



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