2023 ISWI Instrument Updates

Presentations:

- AWESOME
- CHAIN
- eCallisto
- GIFDS
- LISN
- MAGDAS
- OMTIs
- RION
- SEVAN
- SCINDA

AWESOME

Presented by

Morris Cohen

ISWI Instrument & Data Product Updates (1/2)

Instrument name: AWESOME

PI: Morris Cohen, Georgia Institute of Technology

Tech Lead/POC: Morris Cohen

Science objectives: Very Low Frequency (VLF, 3-30 kHz) radio remote sensing of D-region ionosphere (70-90 km), solar flares, electron precipitation, lightning

Measurement objectives: Quantify the electron density of the D-region ionosphere and its response to space weather

Science Activity Updates

Georgia Tech is pioneering techniques to use a network of VLF receivers to produce full images of the D-region electron density profile as a function of latitude and longitude. Current coverage area is Gulf of Mexico and Southeast USA, but newly funded projects will allow us to expand further. Eventual goal is full global coverage.

Instrument and Data Product Updates

Instrument updates: Instrument

Station updates: International deployments of new Georgia Tech version have begun, with recent deployments in Svalbard, Japan, France, Israel. Others on the way.

Data product updates: Many 100s of TB of raw data are now being released publicly at http://waldo.world, along with tools to view the data

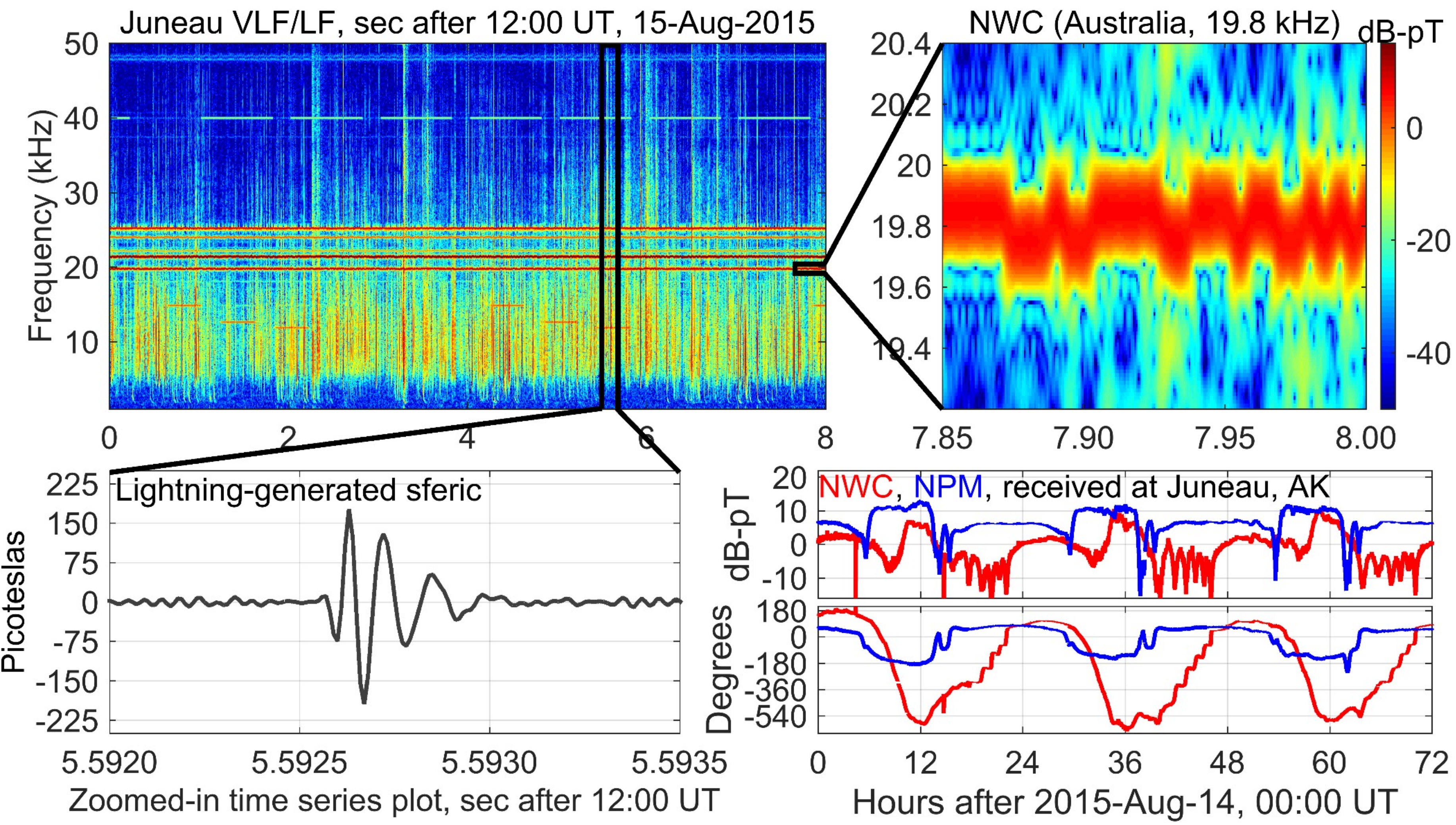
Challenges, if any: COVID delayed several international deployments. Russia-Ukraine war ended transfer of data from a site in Russia.

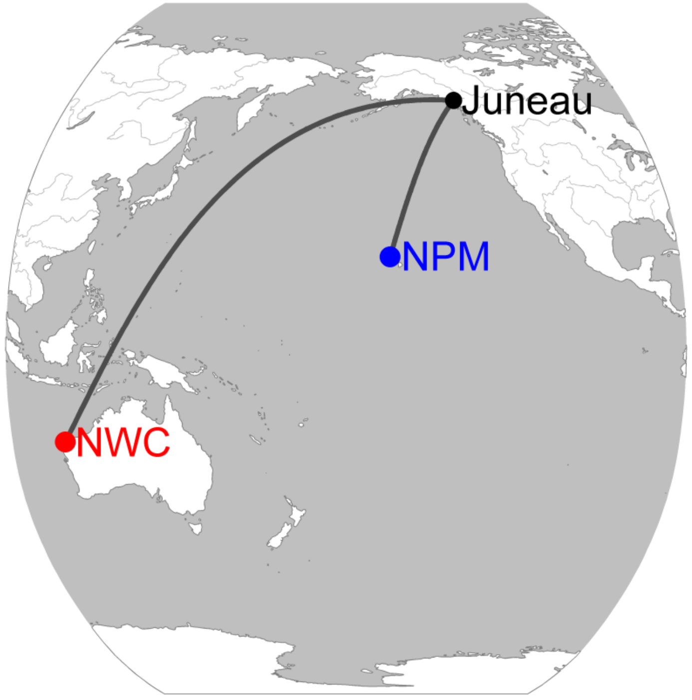
Capacity Building Activity Updates

The WALDO site already includes full access to all the data, as well as data viewers for both MATLAB and python.

A set of scientific tutorials and data exercises previously developed in ~2008 are being revamped, updated, and will be posted to WALDO in coming months, allowing new users to quickly get up to speed with the latest scientific questions.

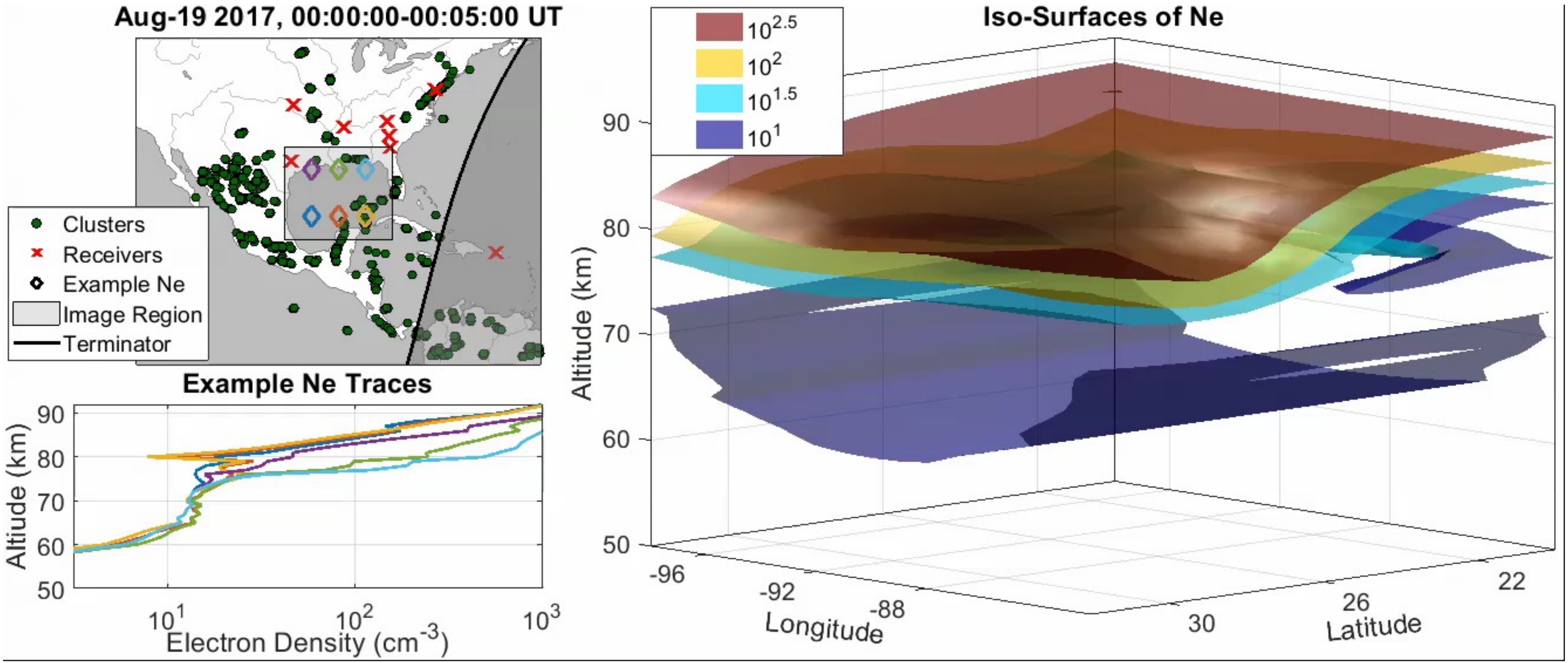
Example of LF Data from "AWESOME"



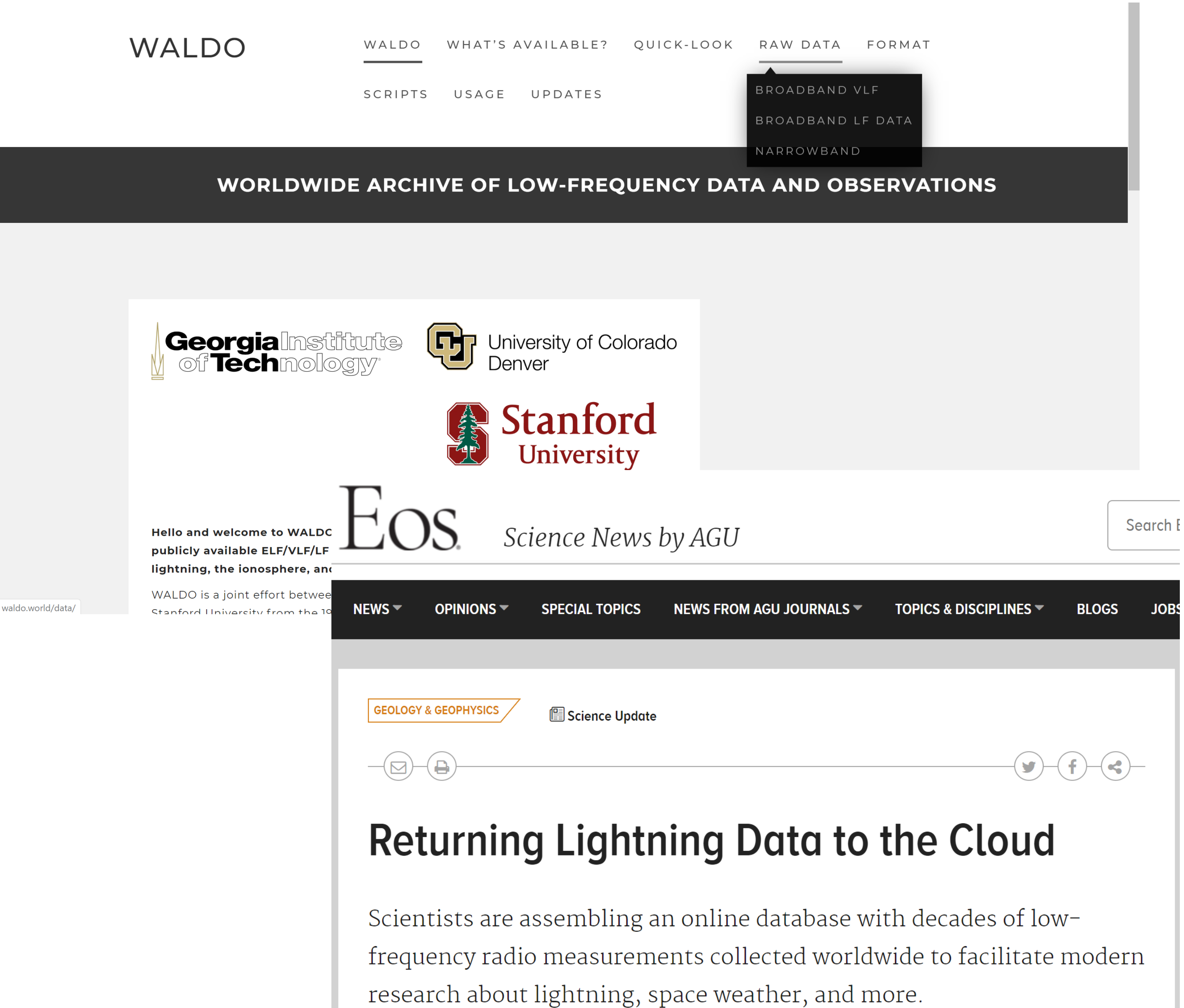


- LF data dominated by "sferics" from lightning, and naval radio stations

Using Lightning-VLF as an Ionospheric Probe Wave



Public Release of Data on WALDO



- **http://waldo.world**
- World Archive of Low-frequency Data and Observations
- Includes decades of historic data (Stanford) and more recent data (Georgia Tech)
- All data is freely available for download. No password or permission required.
- Website allows small-batch download, but more direct access is possible where needed.

CHAIN

Presented by Shing Fung
on behalf of
Satoru UeNo

ISWI Instrument & Data Product Updates (1/2)

Instrument name: CHAIN (Continuous H-Alpha Imaging Network)

PI: No Change (K. Ichimoto & S. UeNo)

Tech Lead/POC: Please indicate changes

Science objectives: Please indicate changes

Measurement objectives: Please indicate changes

Science Activity Updates

Under the CHAIN project, Peruvian researchers and Japanese researchers published the following scientific papers and presented their studies' results using our instruments:

- Otsu T., et al., 2022, ApJ 939, 98
- Namekata K., 2022, ApJ, 933, 209
- Gutierrez M.V., et al., 2021, PASJ 73, 394
- Seki D., et al., 2021, ApJ 918, 38

- Karla F. Lopez, et al., 2021, XII Latin American Conference on Space Geophysics
- Kimura N., et al., 2021, Japan Geoscience Union (JpGU) Annual Meeting
- Seki D., et al., 2021, Japan Geoscience Union (JpGU) Annual Meeting
- Denis P. Cabezas, 2021, Astronomical Society of Japan (ASJ) Annual Meeting

Instrument and Data Product Updates

Instrument updates: The main instruments of the CHAIN are Flare Monitoring Telescopes (FMT) that are solar full-disk and multi-wavelength filtergraphs. Additionally, we started to develop spectroheliograph In the Peru station from 2018 in order to detect larger Doppler-shift events (high-speed filament eruptions) than the FMT can detect. However, this development has been stopped due to the covid19 pandemic for these three years from 2020. We will finally visit Peru on Feb-25 2023, we will perform optical experiment for enlarging FOV of the spectroheliograph and resume the development.

Station updates:

Data product updates:

Challenges, if any:

Capacity Building Activity Updates

In 2023 Jan., we supported a Peruvian student (Ms. Karla F. Lopez) to enter the master's course of Mackenzie University in Brazil. She aims to enter the doctoral course of our Kyoto University in Japan after getting master's degree.

ISWI Instrument & Data Product Updates (2/2)

- Continuation of Instrument and Data Product Updates (if needed)
  We continue to obtain solar multi-wavelength H-alpha imaging data in Japan, Peru and Saudi Arabia.
- Continuation of Science Activity Updates (if needed)
  We continue to promote scientific cooperative researches between Japan and Peru, Saudi Arabia by concluding agreements between each university.
- Continuation of Capacity Building Activity Updates (if needed)
  We continue to support especially Peruvian young researchers and students to study solar physics and space weather and support them to study abroad to Japan.
  Moreover, we continue to develop new instruments for solar observation in Peru and Saudi Arabia.
- References

eCallisto

Presented by

Christian Monstein

ISWI Instrument & Data Product Updates

Instrument name: e-Callisto

PI: Christian Monstein

Tech Lead/POC: Christian Monstein

Science objectives: Understanding transient phenomenon in the solar corona

Measurement objectives: observe Sun at radio 24/7
capture as many solar radio burst as possible.
Try to mitigate interference and to improve data quality

Science Activity Updates

1st light AIRA Romania
1st light Egersund Norway

Several papers in connection with e-Callisto data

- University of Graz: Burst finder by cross-correlation
- University of Alcalá: Burst finder by AI
- University of Applied sciences: Burst finder by ML

Instrument and Data Product Updates

Instrument updates: New products (antenna tracker)

Station updates: Several, see instrument update Monstein

Data product updates: Update e-callisto.org with SSL

Challenges, if any: No funding at all and no replacement in sight for PI and Tech Lead.

Capacity Building Activity Updates

- Lead and support of individual students worldwide, working with e-Callisto data.
- Poster at SWISS SKA days 2022 in Locarno
- Workshop University of Alcalá Spain 2022-06-10
- Several requests for support and workshops from India, Malaysia, Egypt, Rwanda, Paraguay.
  But due to COVID-19 the PI could travel and PI being retired cannot apply for funding.

ISWI Instrument & Station Updates

- DLR Neustrelitz/Germany 14 new instruments low frequency and L-band 3 instruments operational
- Kiel/Germany (private user) 1 instrument
- INAF Triest/Italy 1 instrument
- University of Alcalá/Spain 1 instrument
- University of Malaya, Kuala Lumpur, Malaysia 2 new instruments
- Observatory Krumbach/Austria 1 instrument
- Egersund/Norway 1 (private user) instrument

ISWI Instrument & Station Updates

Request for quotation

- Turkey
- Arecibo upgrade for Interferometer
- Japan/Chile consortium

ISWI Instrument & Station Updates

Loss of important instrument. Currently 73 out of 209 instruments provide data

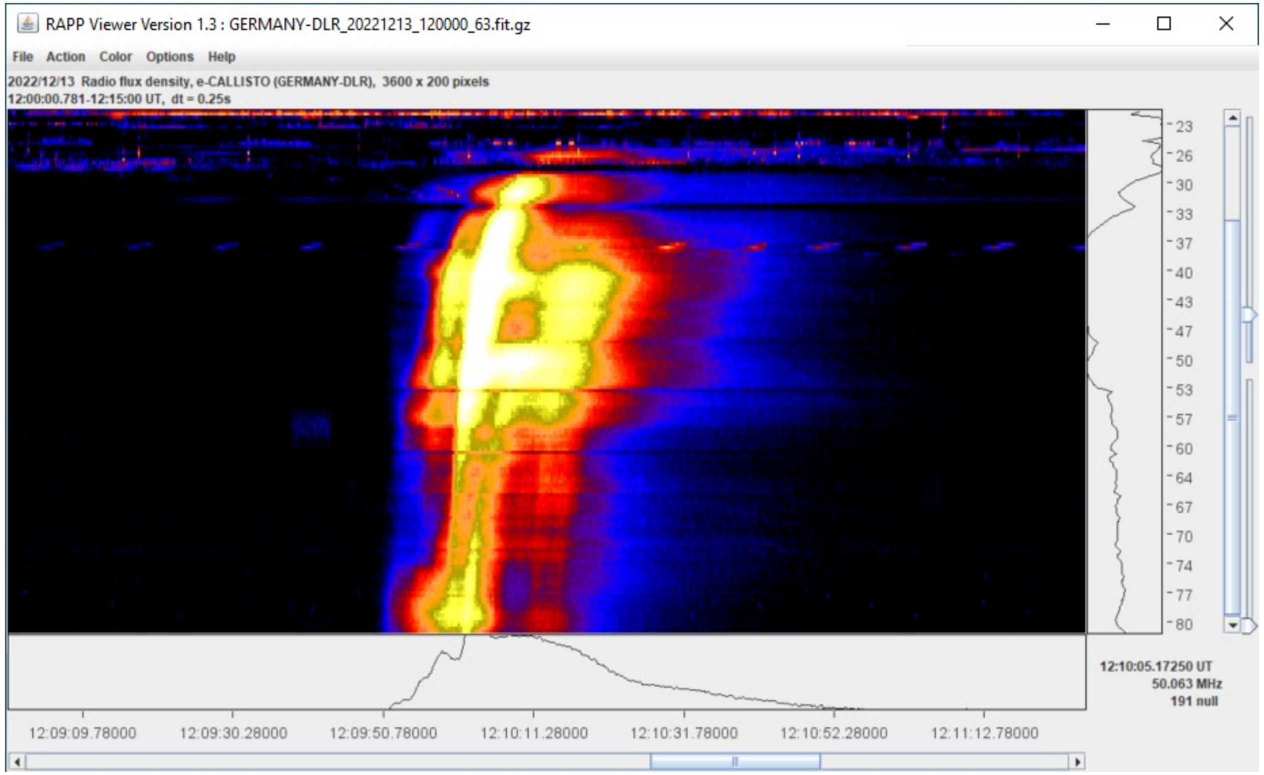
- New Zealand (radio facility was abandoned)
- Greenland (no technician who could restart computer)
- Denmark (loss of motivation)
- Czech Republic need antenna for their own instruments
- Cairo, Egypt neither SWMC nor EgSA operational
- Kenya, Rwanda, Ethiopia (Mekelle + Addis Ababa) no internet and war
- Strauss, North-West University, SA no technical capacity
- KRIM no internet due to war Russia/Ukraine
- India (Pune, Sangli, Ahmedabad, Nashik) many reasons
- USA 6 stations do not provide data
- Indonesia 2 stations lost instrument due to lightning and heavy rain
- Sri Lanka Janaka Adassuriya changed institute and cannot move instrument
- Nepal loss of motivation, internet issues and power issues
- Some others do even not respond to email (sustainability issue)

ISWI Instrument & Station Updates

Existing instrument back in operation.

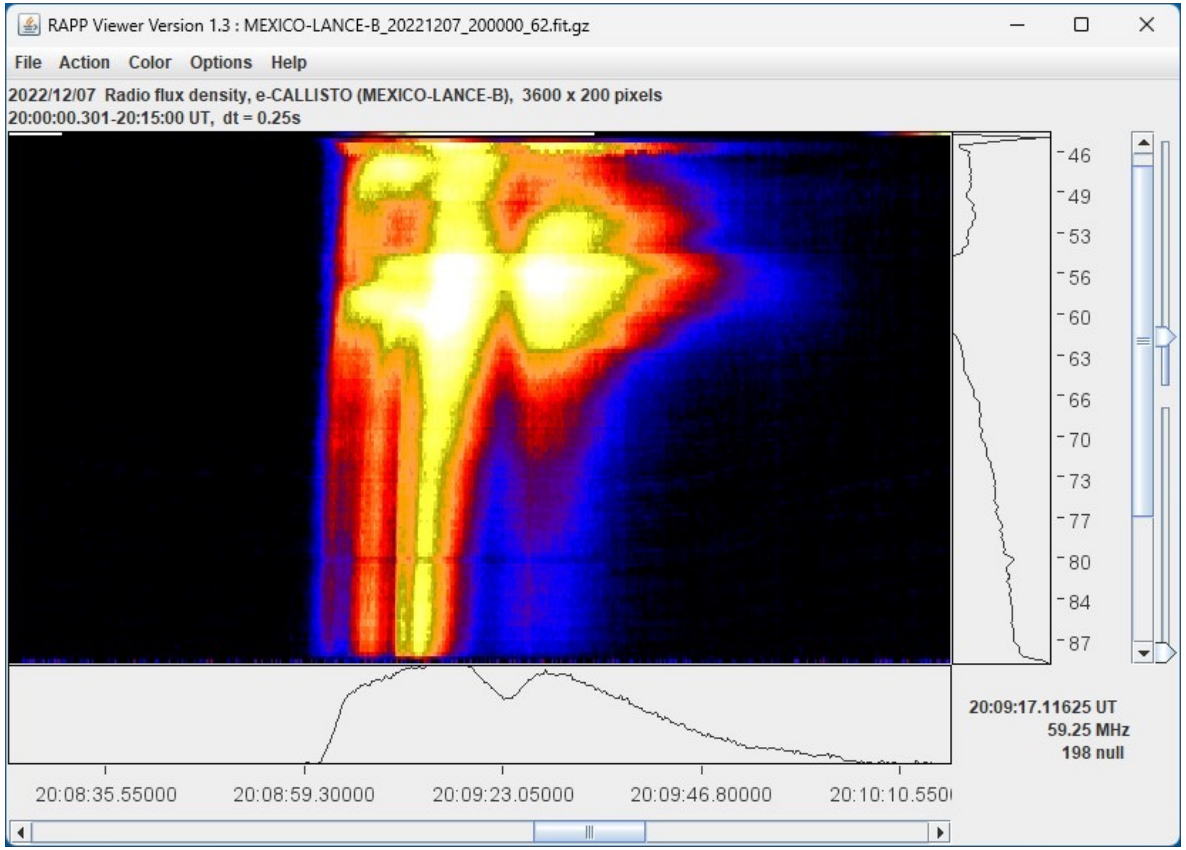
- Arecibo radio observatory, Puerto Rico after one year due to change of leader. Now P. K. Manoharan has taken over
- Siberian solar Radio Telescope SSRT after two years of silence

ISWI Instrument impressions DLR



Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)
Institut für Solar-Terrestrische Physik
Kalkhorstweg 53
17235 Neustrelitz, Germany

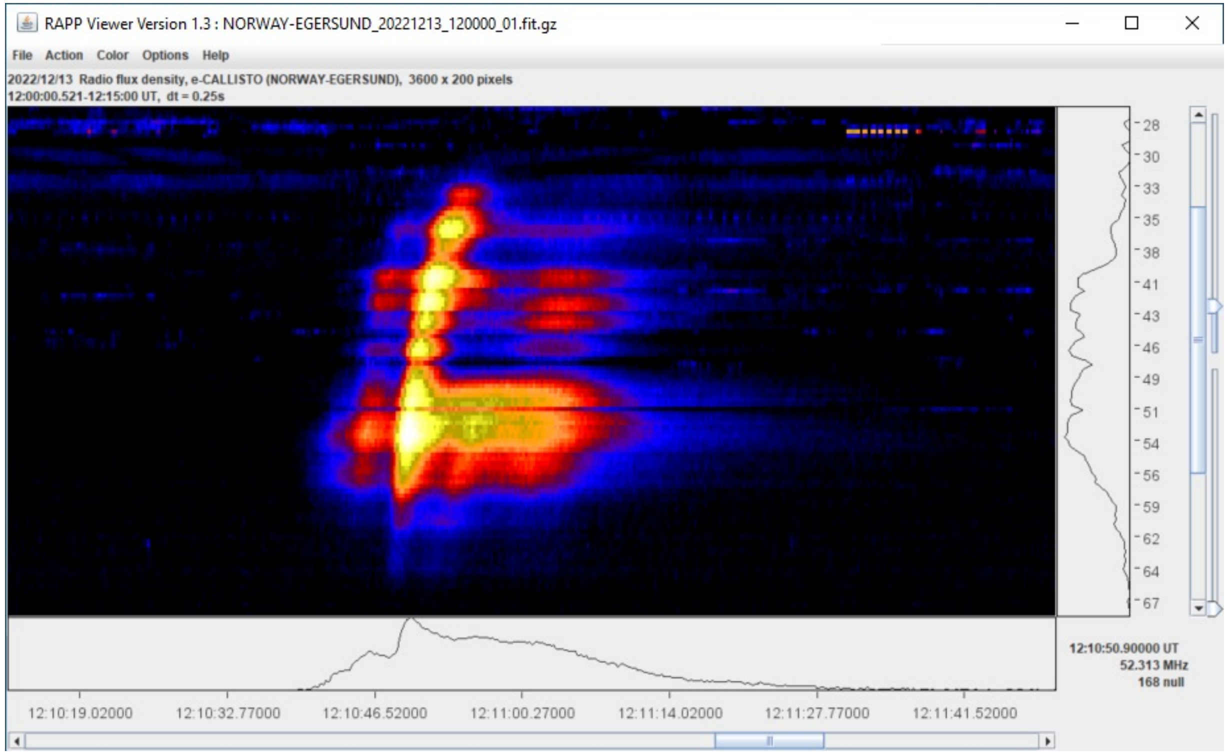
ISWI Instrument impressions Mexico



From left to right: Alexis Morales (student); Rafael Tovar (technical staff at MEXART); Ernesto Andrade-Mascote (head of technical staff at MEXART); Oscar Godines-Torres (student); Marco Medina-del-Angel (student); behind everyone Luis Maya-Sierra (technical staff)

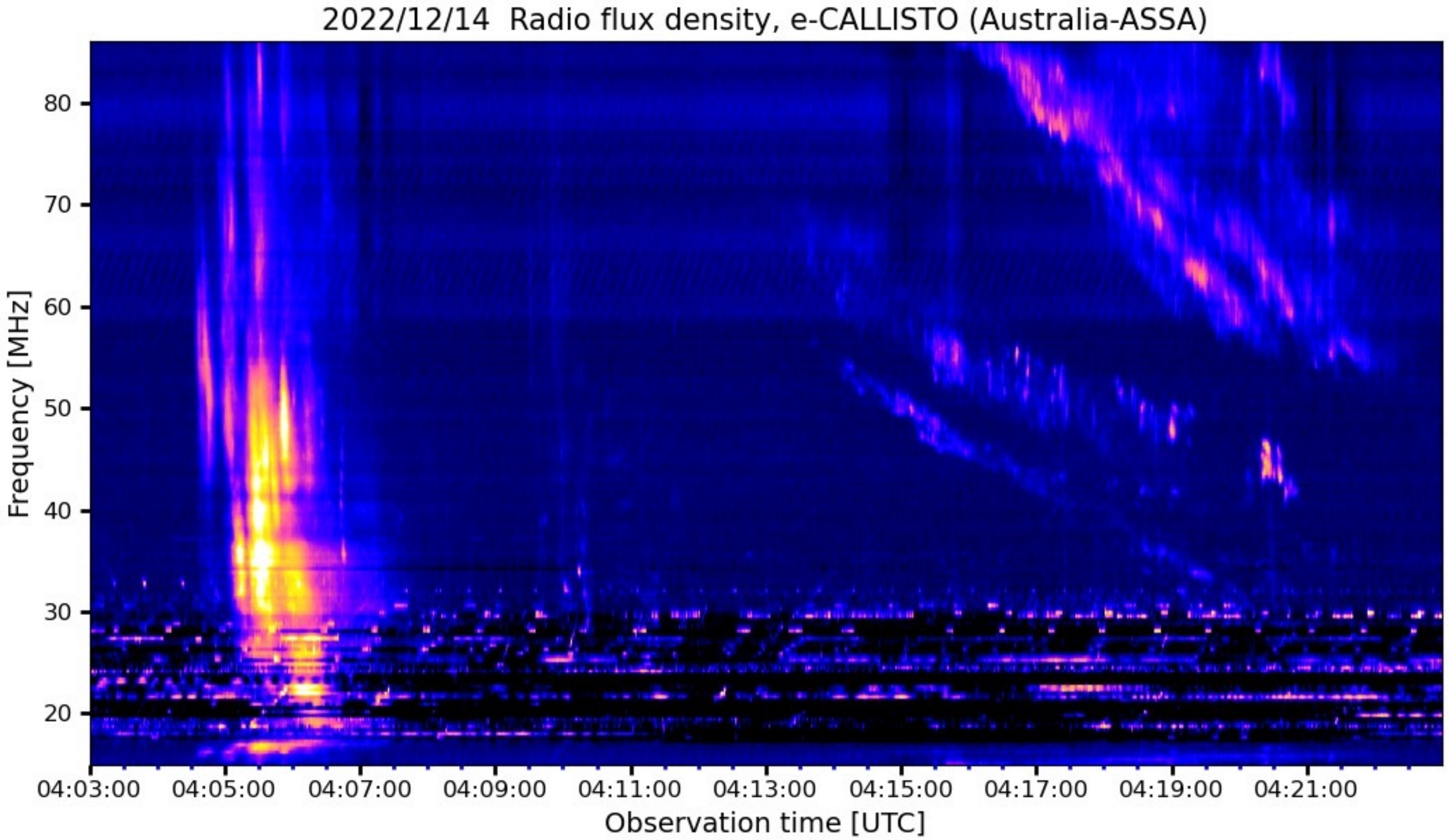
Dr. Ernesto Aguilar Rodríguez
Instituto de Geofísica
Unidad Michoacán
Antigua Carretera a Pátzcuaro #8701
Ex-Hacienda San José de la Huerta
Morelia, Michoacán, Mexico

ISWI Instrument impressions Norway

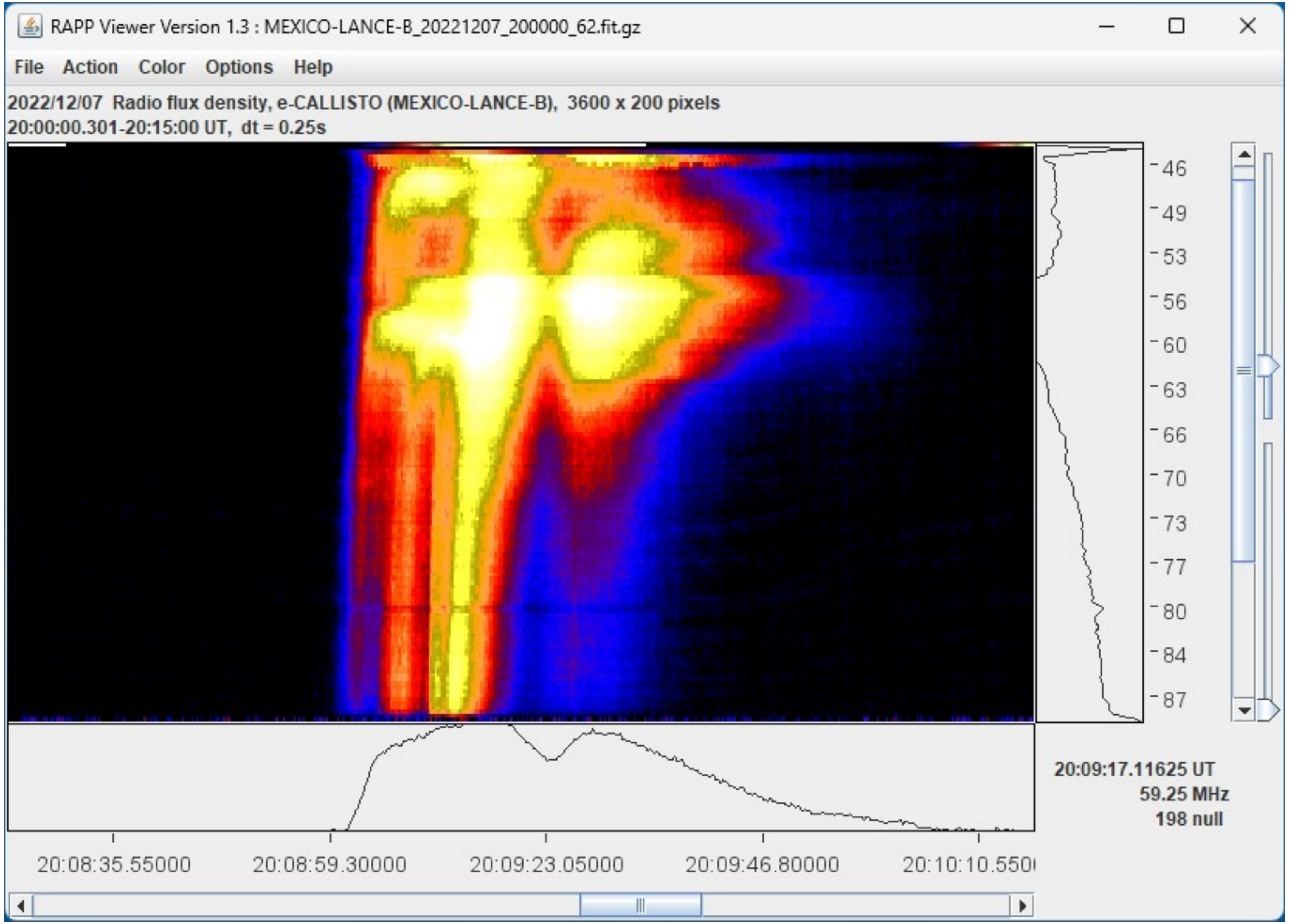


Jan Lustrup LA3EQ
Egersund, Norway

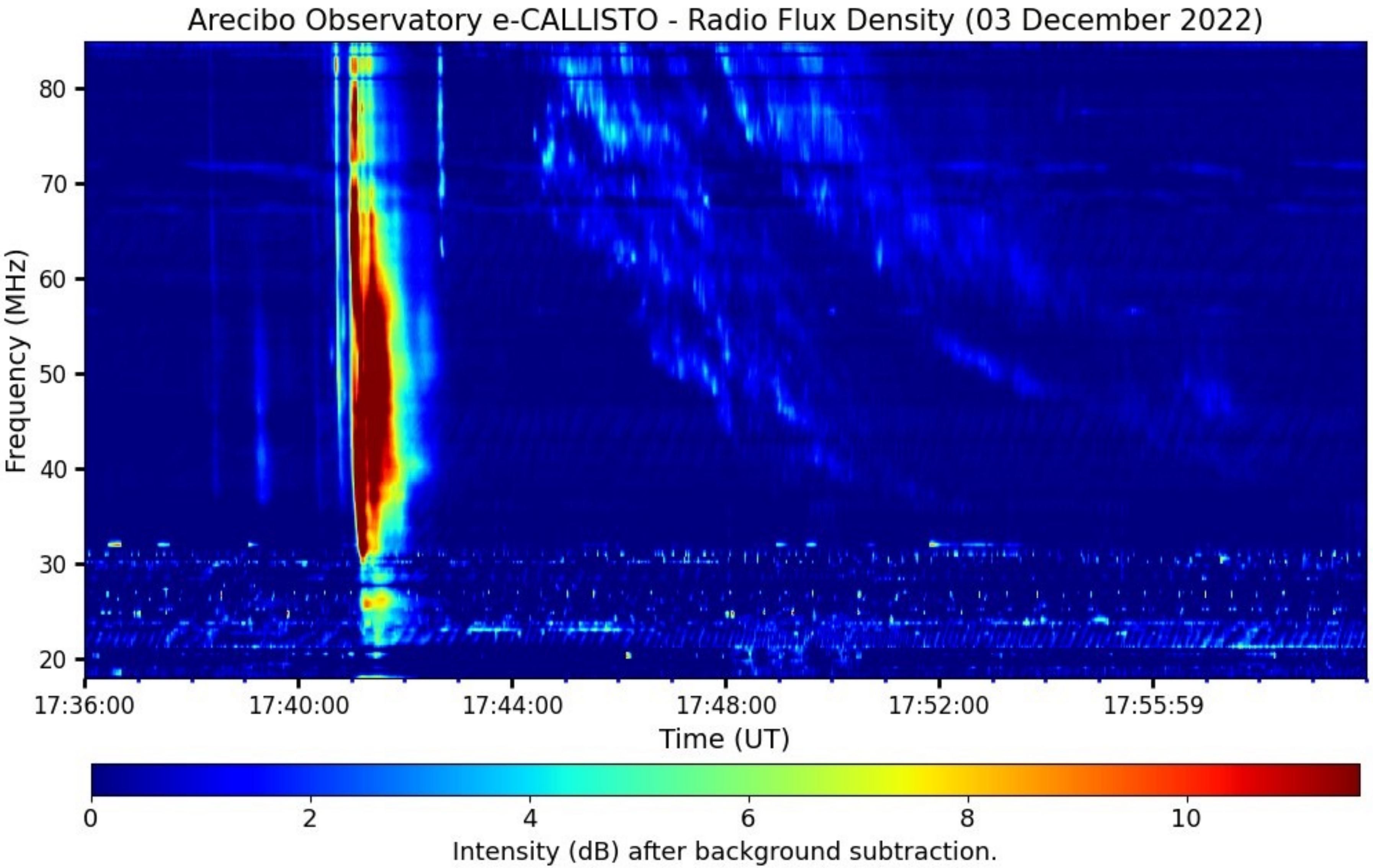
ISWI Instrument some nice observations



ISWI Instrument some nice observations



ISWI Instrument some nice observations



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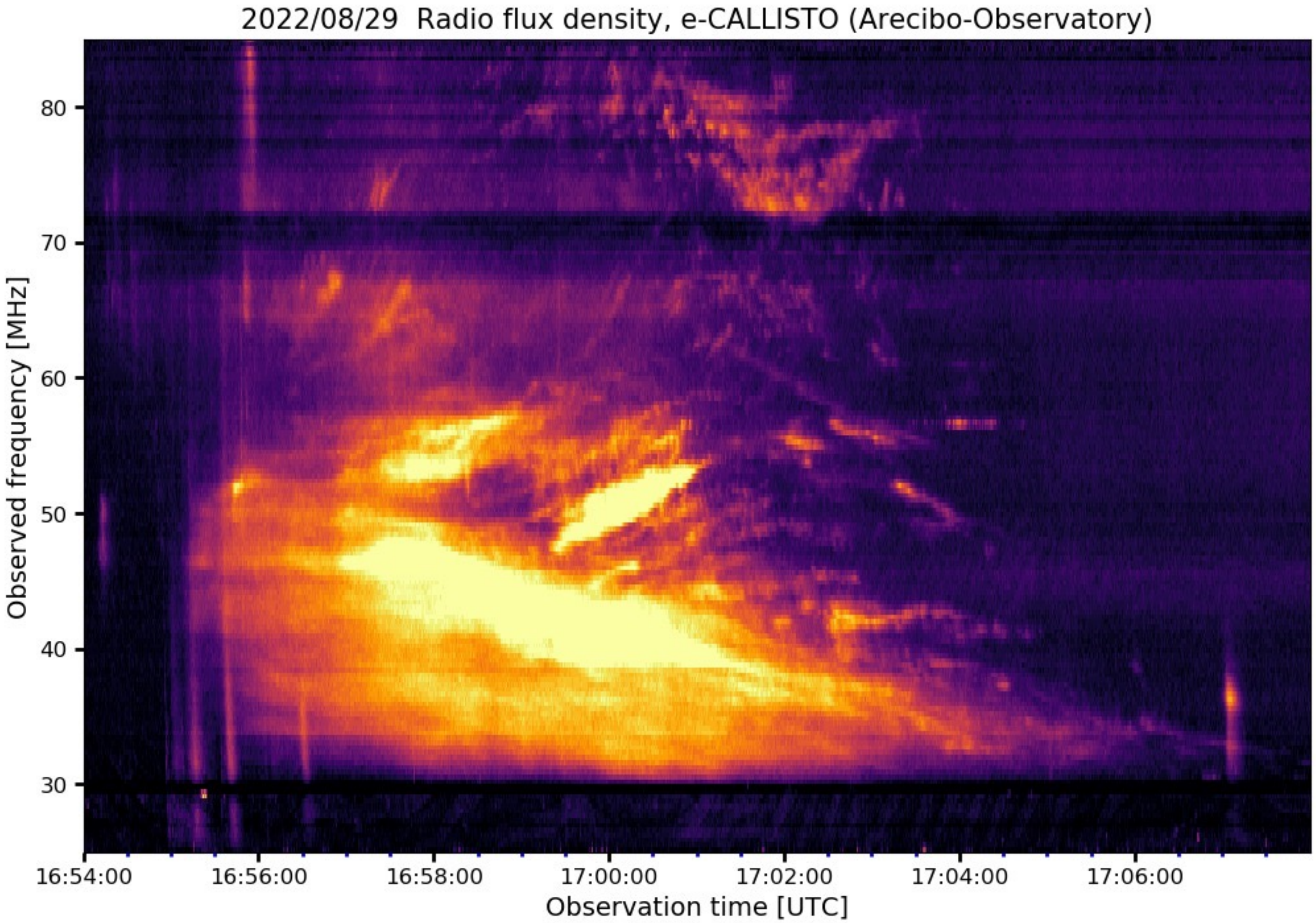

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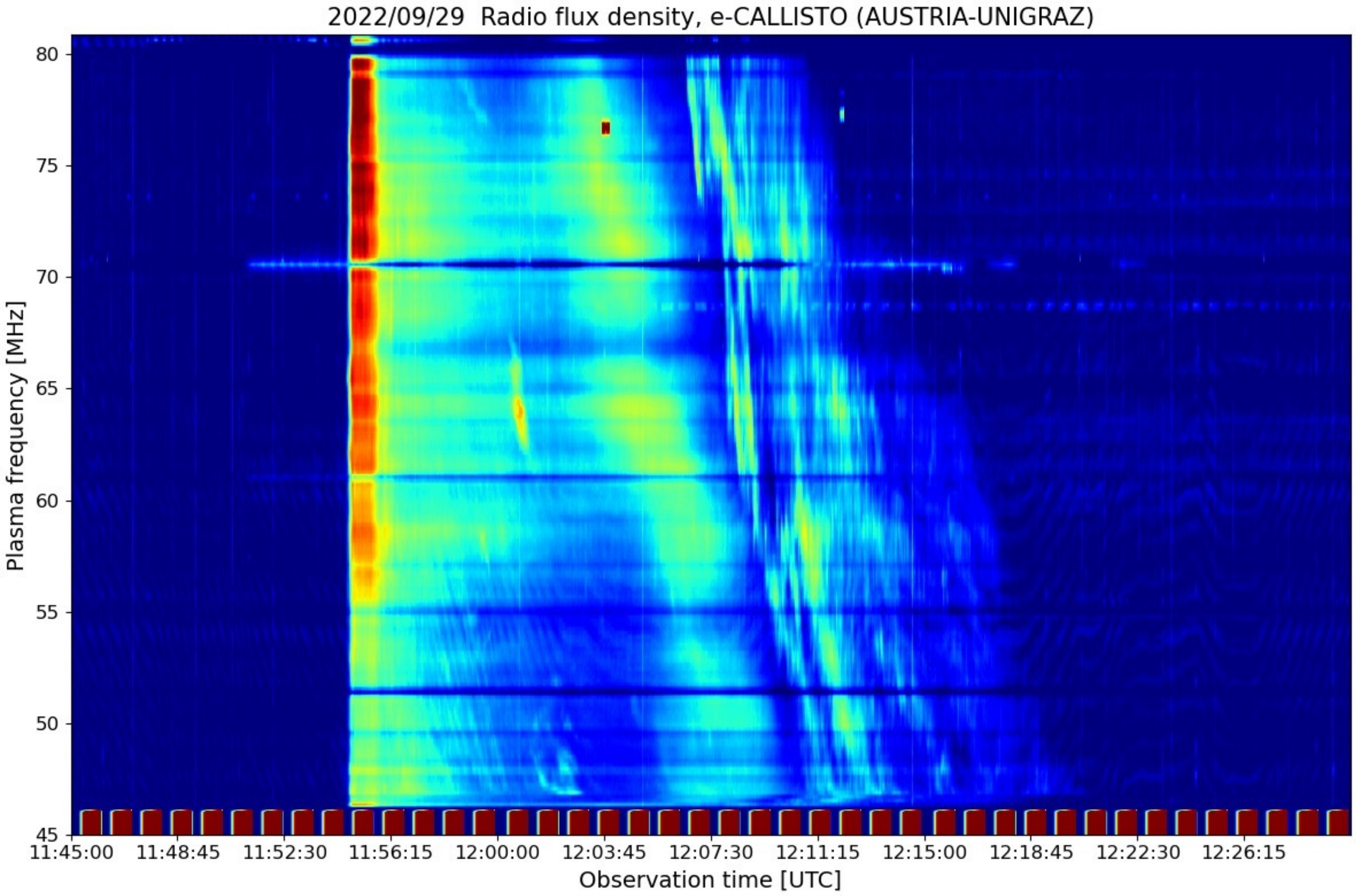
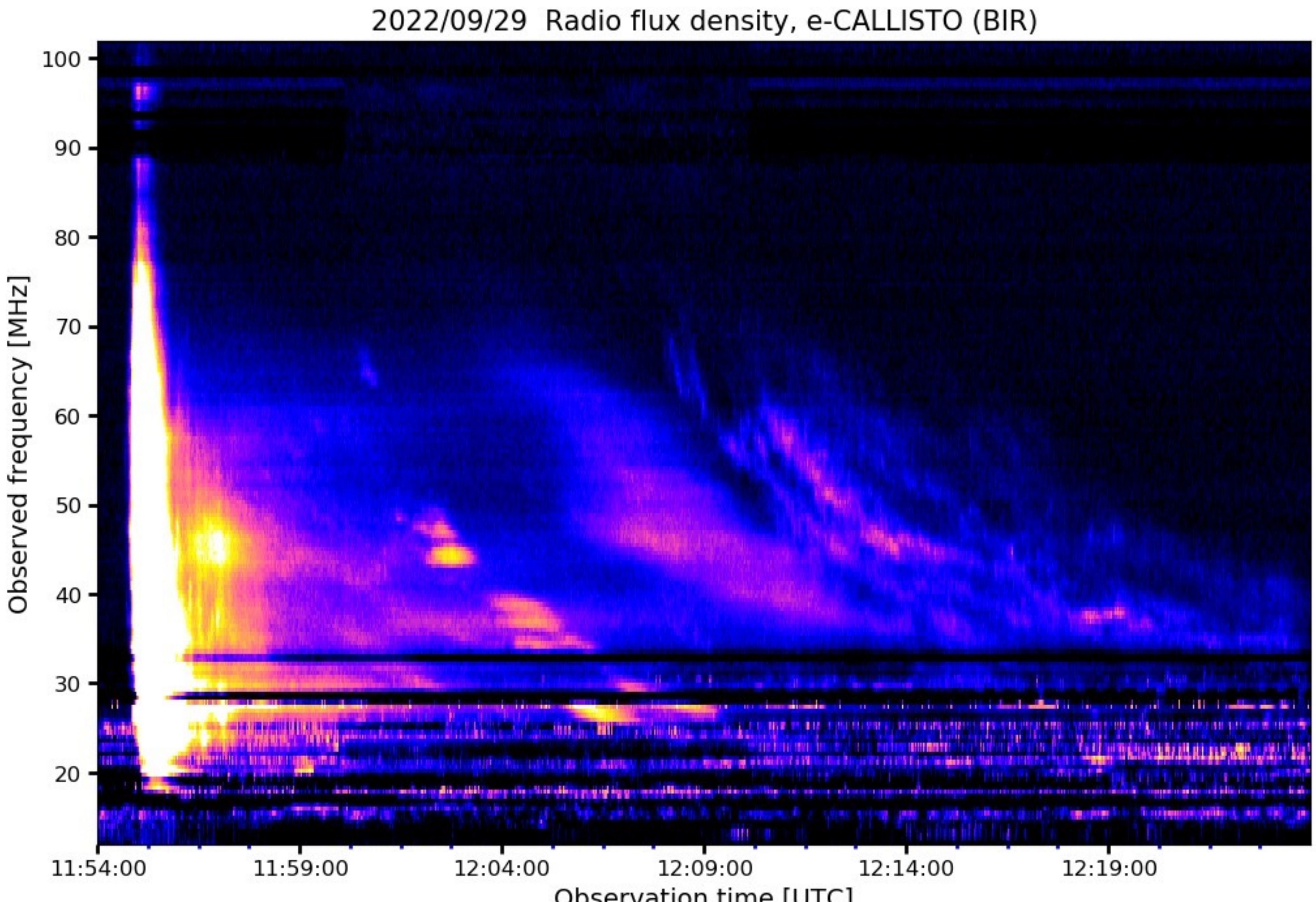
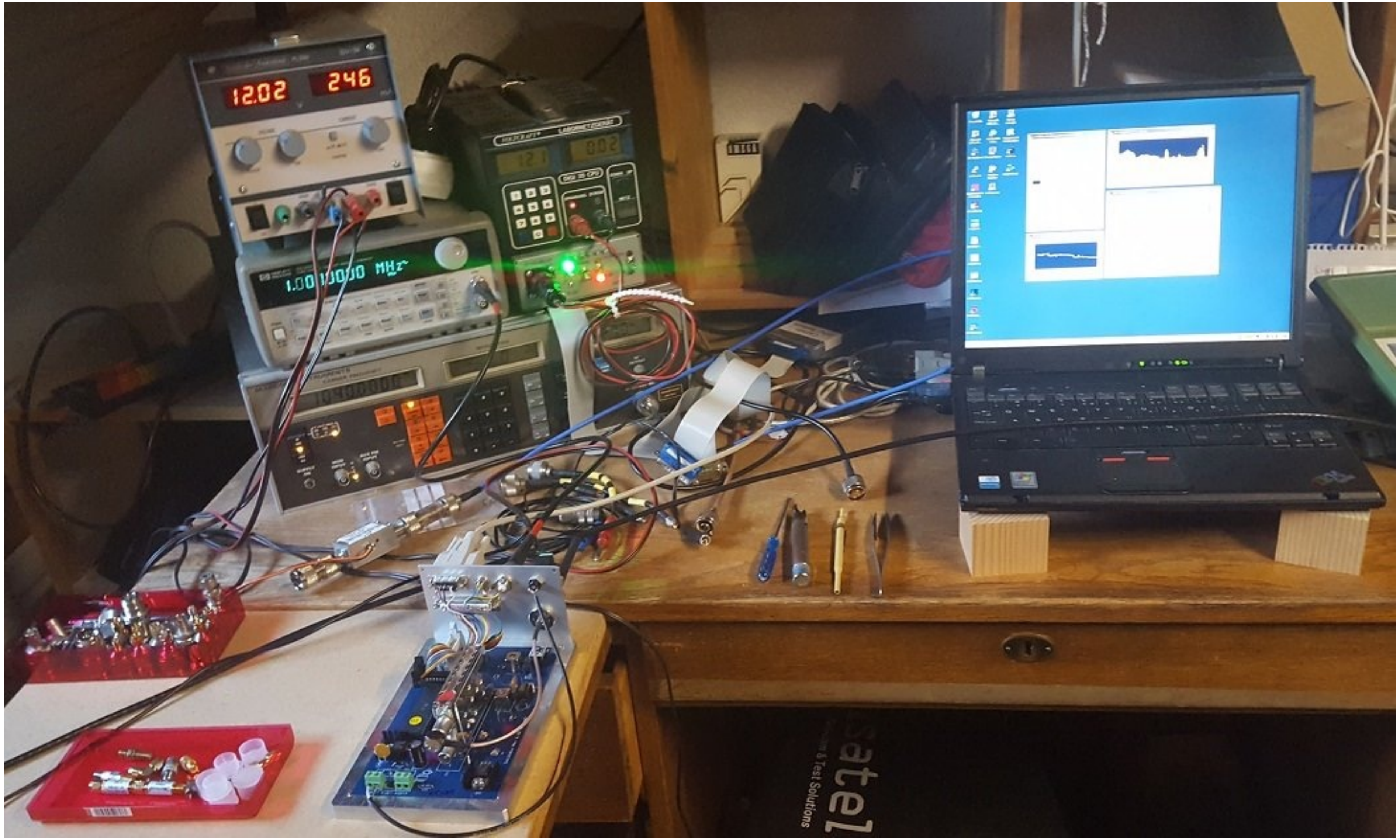


ISWI Instrument some nice observations



ISWI Instrument qualification



ISWI Instrument final testing

GIFDS

Presented by

Daniela Banys

ISWI Instrument & Data Product Updates (1/2)

Instrument name: GIFDS
Global Ionospheric Flare Detection System

PI: Dr. Norbert Jakowski and Dr. Daniela Banyś
(German Aerospace Center – DLR)

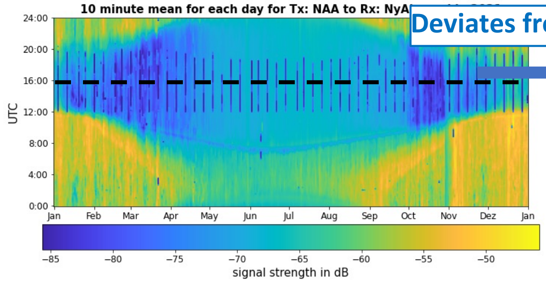
Tech Lead/POC: Dr. Daniela Banyś

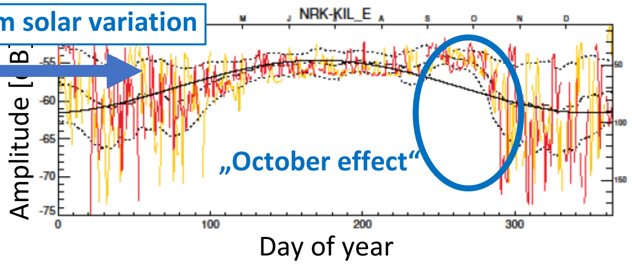
Objectives:

- Science — D-region ionospheric physics, VLF propagation
- Application — Warning for mitigating space weather impact on sensitive technologies
- Monitoring — 1 Hz / 10 Hz VLF amplitude and phase measurements

Science Activity Updates

Joint project AMELIE:
Analysis of the **ME**sosphere and **L**ower **I**onosphere fall **E**ffect (DLR + IAP)

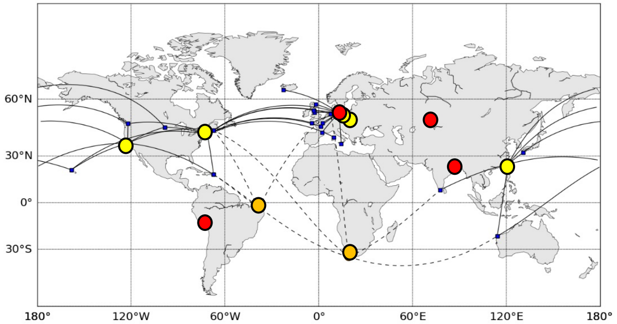




Instrument and Data Product Updates

Instrument updates: Design of a compact receiver fitting into a rack unit for safe and simple setups, easy maintenance and repairs

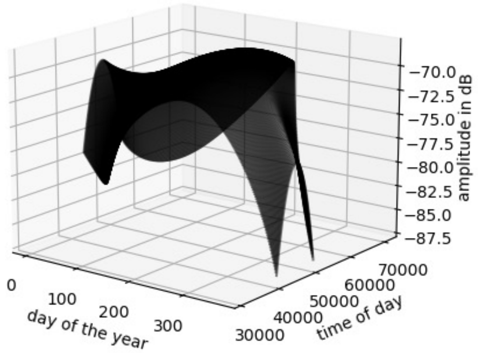
Data product updates: new software will allow an increase of the sampling rate from 1 to 10 Hz



Station updates: no updates

Capacity Building Activity Updates

ISWC: **I**nternational **S**pace **W**eather **C**amp 2022



Empirical model of daytime VLF amplitude over the year

Open for application: Hermanus: 24 June – 7 July 2023 + Huntsville: 8- 23 Juli 2023
https://www.dlr.de/content/en/articles/news/2023/01/20230109_international-space-weather-camp-2023-apply-now.html

ISWI Instrument & Data Product Updates (2/2)

Instrument name: GIFDS
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PI: Dr. Norbert Jakowski and Dr. Daniela Banyś
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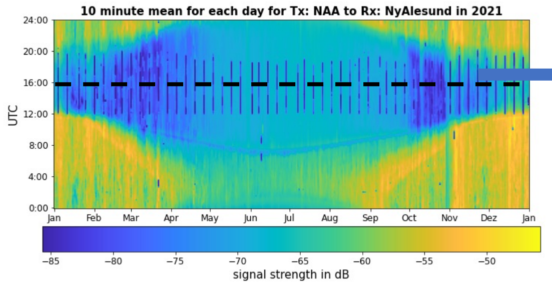
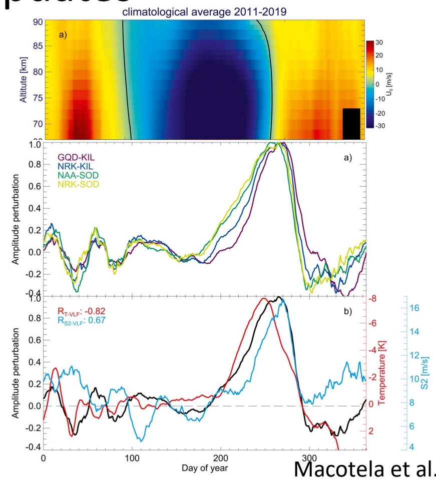




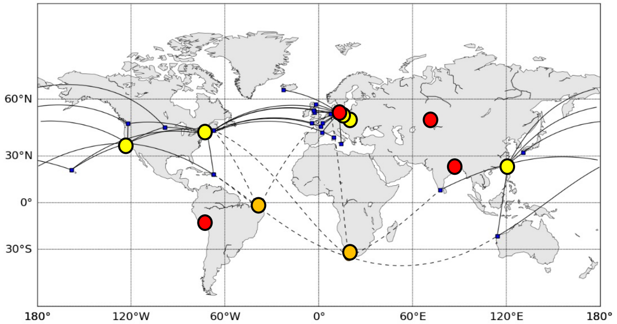
Macotela et al. (2021)

Instrument and Data Product Updates

Instrument updates: Design of a compact receiver fitting into a rack unit for safe and simple setups, easy maintenance and repairs

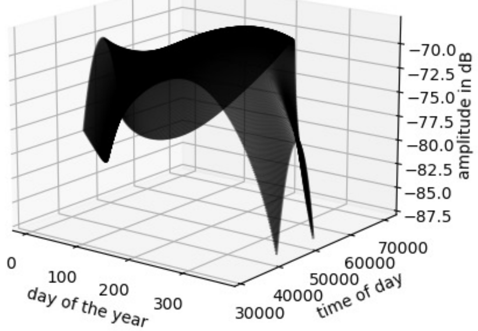
Data product updates: new software will allow an increase of the sampling rate from 1 to 10 Hz

Station updates: no updates



Capacity Building Activity Updates

ISWC: **I**nternational **S**pace **W**eather **C**amp 2022



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Open for application: Hermanus: 24 June – 7 July 2023 + Huntsville: 8- 23 Juli 2023
https://www.dlr.de/content/en/articles/news/2023/01/20230109_international-space-weather-camp-2023-apply-now.html

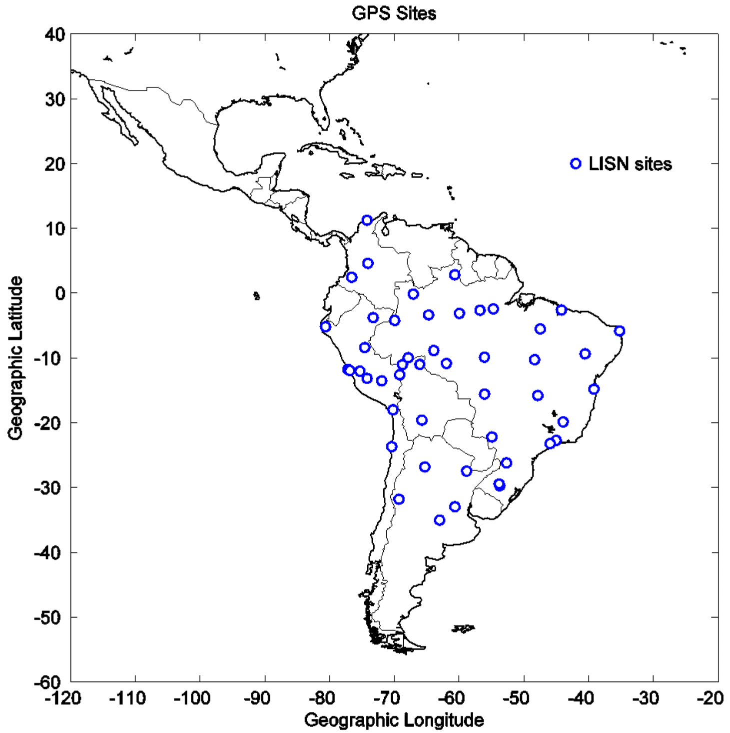
LISN

Presented by

Cesar Valladares

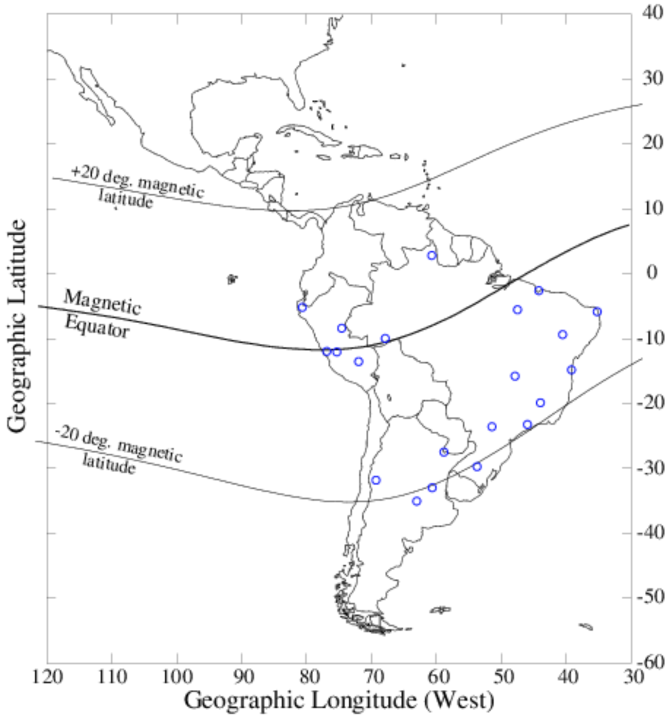
Low-latitude Ionosphere Sensor Network (LISN) of GPS/GNSS receivers

LISN GPS 2007-2016



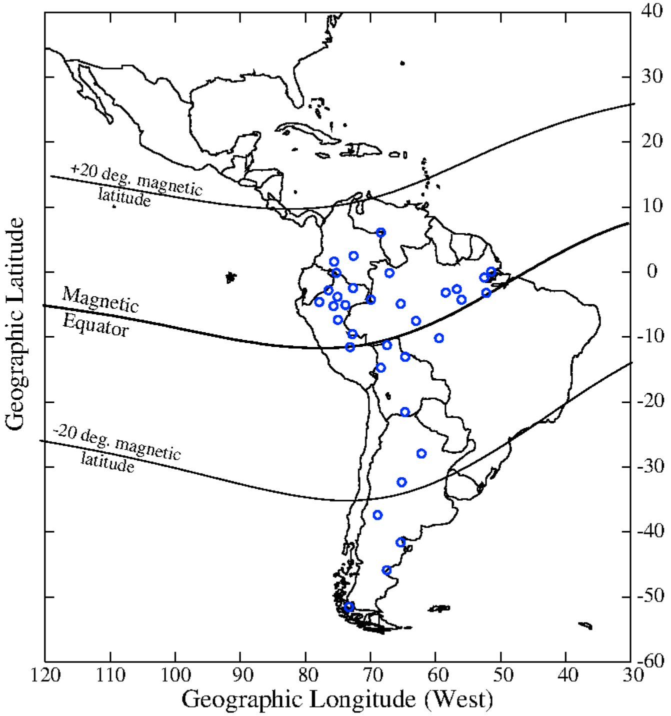
50 GPS Novatel rx

LISN GPS 2021



20 GPS receivers

AFOSR-DURIP Grant

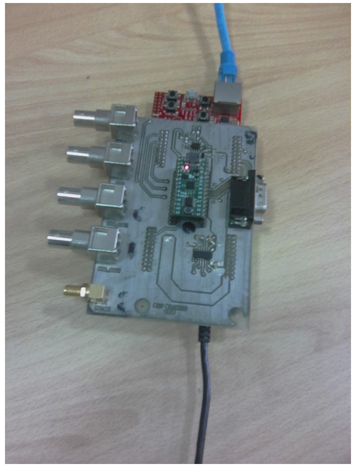


34 GNSS Septentrio PolaRx5s

http://lisn.igp.gob.pe

Design, construct, and install four (4) VIPIR ionosonde receiver stations

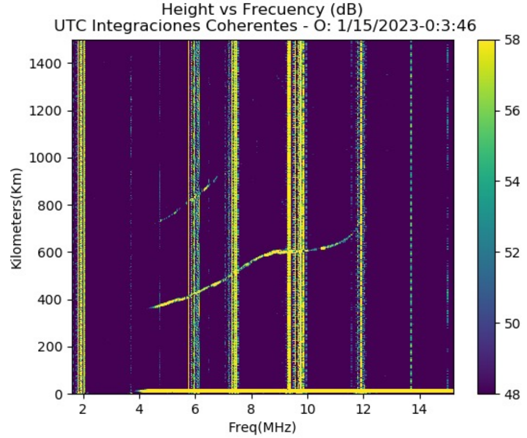
Programmable pulse generator, designed and built at the Jicamarca station.



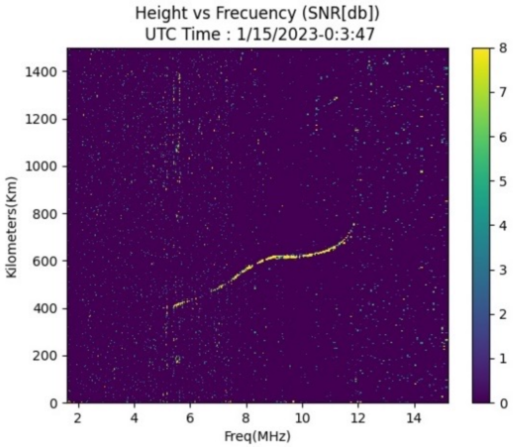
USRP N200 built by Ettus Research

Antenna systems: ALA 1530 LN, MLA 30 from Wellbrook Communications

Jicamarca ISR



Huancayo receiver

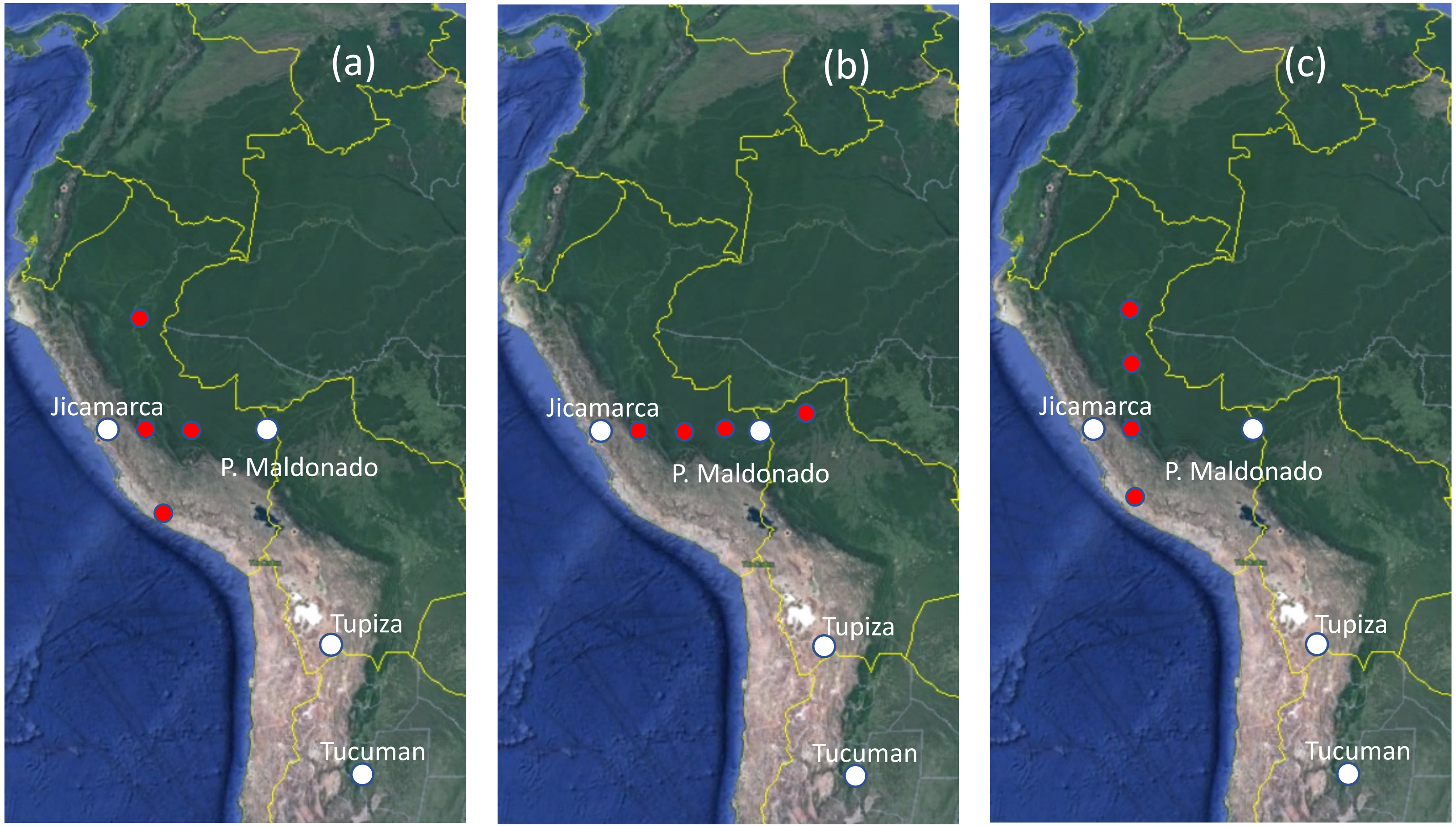


- The new system is a passive receiver that detects the signals transmitted by a VIPIR ionosonde.
- The receiver is based on an SDR device: USRP N200. It uses double polarization loop antennas and GNU radio for data acquisition.
- This relatively low-cost receiver will be employed in oblique sounding, taking advantage of the VIPIR ionosondes from the LISN-distributed observatory already operating in South America.

Four ionosonde receivers (red dots) will be added to four existing LISN VIPIR ionosondes (white dots) operating on the western side of South America.

The receivers will be arranged in different configurations. Each year a different arrangement will be implemented to investigate the best locations for tomography reconstructions and bubble studies.

VIPIR receivers (in red) will provide oblique ionograms to be uploaded to the LISN webpage (lisn.igp.gob.pe).



Tasks made available by the AFOSR grant to be conducted between 2023 and 2024

1. We will use two VIPIR ionosondes (Jicamarca & Puerto Maldonado) doing vertical sounding and four VIPIR receivers for oblique sounding. This will provide a total of 10 density profiles every 5 minutes.
2. Conduct real-time processing and display of TEC and scintillation S4 indices using ~50 GPS/GNSS receivers in South America.
3. Perform off-line tomographic reconstruction of density profiles in the area covered with GPS and VIPIR ionosondes. Density profiles provided by the vertical and oblique sounding will be used to regularize the tomographic reconstructions.
4. We will display maps of TEC, TEC depletions, scintillations, and TIDs with a 15 min resolution using the LISN server.

MAGDAS

Presented by Shing Fung
on behalf of
Akimasa Yoshikawa

ISWI Instrument & Data Product Updates (1/2)

Instrument name: MAGDAS

PI: Prof. Akimasa Yoshikawa, Co-PI: Dr. Shuji Abe

Tech Lead/POC: Dr. Teiji Uozumi

Science objectives: To understand the electromagnetic and plasma environment changes in the geospace, especially 3-D structure of equatorial electrojet (EEJ).

Measurement objectives: Global observation of ground magnetic field and ionospheric disturbances for the above science objectives.

Science Activity Updates

Number of published papers related on MAGDAS is 16 in 2022.

To accelerate our understanding of space weather physics, International Center for Space Weather Science and Education was reorganized to International research center for Space and Planetary Environmental Science （i-SPES） since April 2022. The new center director is Prof. Akimasa Yoshikawa.

Instrument and Data Product Updates

Instrument updates: We acquired four new magnetometers in 2020 (Installation them to Egypt and Russia are not yet)

Station updates: We have agreed with the construction of dense magnetometer array across the magnetic equator collaborate with Arthur C Clarke Institute for Modern Technologies and the University of Colombo, but not yet due to changing circumstances.

Data product updates: We continue to register metadata related MAGDAS to IUGONET (Inter-university Upper Atmosphere Observation NETwork) metadata database(http://search.iugonet.org/

Capacity Building Activity Updates

We have started to accept 5 young foreign researchers since last year(India1, Philippines1, Egypt2, Sri lanka1).

One of them is employed as a researcher at i-SPES.

ISWI Instrument & Data Product Updates (2/2)

- Continuation of Instrument and Data Product Updates (if needed)
- Continuation of Science Activity Updates (if needed)
- Continuation of Capacity Building Activity Updates (if needed)
- Publications & presentations in current reporting year

MH Hashim, MH Jusoh, K Burhanudin, IM Yassin, Shah Alam, NSA Hamid, ZM Radzi, A Yoshikawa, Preliminary Modelling of Solar Quiet Geomagnetic Field Average using Non-Linear Autoregressive with Exogeneous Input (NARX), Journal of Mechanical Engineering,11,2022,333-345

T Sori, A Shinbori, Y Otsuka, T Tsugawa, M Nishioka, A Yoshikawa, Generation mechanisms of plasma density irregularity in the equatorial ionosphere during a geomagnetic storm on 21–22 december 2014, Journal of Geophysical Research: Space Physics,127,2022,e2021JA030240,doi:10.1029/2021JA030240

Stephen Omondi, Akimasa Yoshikawa, Waheed K Zahra, Ibrahim Fathy, Ayman Mahrous, Automatic detection of auroral Pc5 geomagnetic pulsation using machine learning approach guided with discrete wavelet transform, Advances in Space Research,2022,doi:10.1016/j.asr.2022.06.063

Nur Izzati Mohd Rosli, Nurul Shazana Abdul Hamid, Mardina Abdullah, Khairul Adib Yusof, Akimasa Yoshikawa, Teiji Uozumi, Babatunde Rabiu, The Variation of Counter-Electrojet Current at the Southeast Asian Sector during Different Solar Activity Levels, Applied Sciences,12,2022,7138,doi:10.3390/app12147138

Gabriel Soares, Yosuke Yamazaki, Achim Morschhauser, Jürgen Matzka, Katia J Pinheiro, Claudia Stolle, Patrick Alken, Akimasa Yoshikawa, Kornyanat Hozumi, Atul Kulkarni, Pornchai Supnithi, Using principal component analysis of satellite and ground magnetic data to model the equatorial electrojet and derive its tidal composition, Journal of Geophysical Research: Space Physics,127,2022,e2022JA030691,doi:10.1029/2022JA030691

And more.

OMTIs

Presented by

Kazuo Shiokawa

ISWI Instrument & Data Product Updates (1/2)

Instrument name: Optical Mesosphere Thermosphere Imagers (OMTIs)

PI: Kazuo Shiokawa (ISEE, Nagoya University)

Tech Lead/POC: Kazuo Shiokawa

Science objectives: To investigate dynamical coupling from lower, middle, and upper atmosphere and ionosphere through gravity waves, generation and propagation of ionospheric disturbances, and auroral dynamics at subauroral latitudes

Measurement objectives: To measure two-dimensional airglow images in the mesopause region and in the thermosphere, wind and temperatures in the lower thermosphere, and airglow rotational temperatures in the mesopause region

Science Activity Updates

Several scientific results are obtained for (1) Gravity waves and Medium-Scale Traveling Ionospheric Disturbances, (2) Plasma bubbles, (3) auroras at subauroral latitudes and polar cap, and (4) Camera Development. See next page for representative references.

Full references are available at https://stdb2.isee.nagoya-u.ac.jp/member/shiokawa/ref.html

Instrument and Data Product Updates

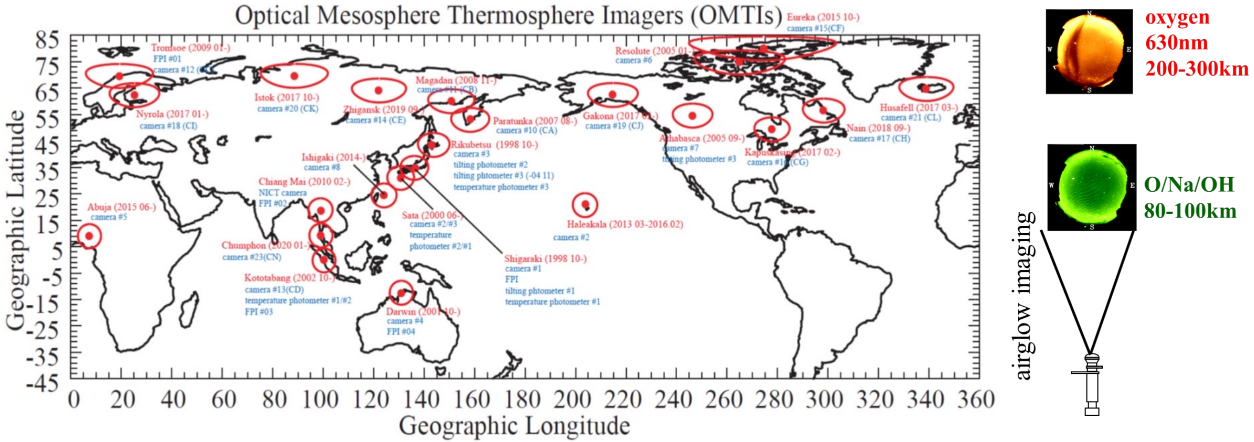
Instrument updates: new low-cost cameras based on WATEC-CCD and ZWO-CMOS are being developed (see 3rd page of this slide) .

Station updates: New stations are being planned at Ethiopia, Egypt, and Germany using these low-cost cameras.

Data products: OMTIs: https://stdb2.isee.nagoya-u.ac.jp/omti/index.html

Metadata (IUGONET): http://www.iugonet.org/index.jsp

CDF data (ERG Science Center): https://ergsc.isee.nagoya-u.ac.jp/index.shtml.en



Capacity Building Activity Updates

- PWING-ERG School was held on March 8-9, 2021, via online. https://is.isee.nagoya-u.ac.jp/pwing-erg/.
- Iberian Space Science Summer School, June 6 - 10, 2022, Online
- International Colloquium on Equatorial and Low-Latitude Ionosphere (ICELLI), Sep 19 - 23, 2022, hybrid (online and on-site at Nigeria
- A new JSPS core-to-core program is going on from April 2021 for three years to support capacity building activities in some Asian and African countries. Scientists and students from India, US, Nigeria, and Ethiopia, visited ISEE in 2022 under this JSPS framework and by the SCOSTEP Visiting Scholar (SVS) program.

ISWI Instrument & Data Product Updates (2/2)

Publications in 2022

Gravity waves and Medium-Scale Traveling Ionospheric Disturbances

- Naito, H., K. Shiokawa, Y. Otsuka, H. Fujinami, T. Tsuboi, T. Sakanoi, A. Saito, and T. Nakamura, Three-dimensional Fourier analysis of atmospheric gravity waves and medium-scale traveling ionospheric disturbances observed in airglow images in Hawaii over three years, J. Geophys. Res., 127, e2022JA030346, https://doi.org/10.1029/2022JA030346, 2022.
- Kawai, K., K. Shiokawa, Y. Otsuka, S. Oyama, M. G. Connors, Y. Kasahara, Y. Kasaba, S. Nakamura, F. Tsuchiya, A. Kumamoto, A. Shinbori, A. Matsuoka, I. Shinohara, and Y. Miyoshi, Multi-event analysis of magnetosphere-ionosphere coupling of nighttime medium-scale traveling ionospheric disturbances from the ground and the Arase satellite, J. Geophys. Res., 128, e2022JA030542, https://doi.org/10.1029/2022JA030542, 2023.

Thermospheric winds

- Oyama, S., H. Vanhamaki, L. Cai, A. Aikio, M. Rietveld, Y. Ogawa, T. Raita, M. Kellinsalmi, K. Kauristie, B. Kozelov, A. Shinbori, K. Shiokawa, T. T. Tsuda, T. Sakanoi, Thermospheric wind response to a sudden ionospheric variation in the trough: Event at a pseudo breakup during geomagnetically quiet conditions, Earth, Planets and Space, 74:154, https://doi.org/10.1186/s40623-022-01710-6, 2022.

auroras

- Ozaki, M., S. Yagitani, K. Shiokawa, Y. Tanaka, Y. Ogawa, K. Hosokawa, Y. Kasahara, Y. Ebihara, Y. Miyoshi, K. Imamura, R. Kataoka, S. Oyama, T. Chida, and A. Kadokura, Slow contraction of flash aurora induced by an isolated chorus element ranging from lower-band to upper-band frequencies in the source region, Geophys. Res. Lett., 49, e2021GL09759, https://doi.org/10.1029/2021GL097597, 2022.
- Ozaki, M., K. Shiokawa, R. Kataoka, M. Mlynczak, L. Paxton, M. Connors, S. Yagitani, S. Hashimoto, Y. Otsuka, S. Nakahira and I. Mann, Localized mesospheric ozone destruction corresponding to isolated proton aurora coming from Earth's radiation belt, Nature Scientific Report, 12:16300, https://doi.org/10.1038/s41598-022-20548-2, 2022.
- Nakamura, K., K. Shiokawa, M. Nose, T. Nagatsuma, K. Sakaguchi, H. Spence, G. Reeves, H. O. Funsten, R. MacDowall, C. Smith, J. Wygant, J. Bonnell, and I. Mann, Multi-event study of simultaneous observations of isolated proton auroras at subauroral latitudes using ground all-sky imagers and the Van Allen Probes, J. Geophys. Res., 127, e2022JA030455. https://doi.org/10.1029/2022JA030455, 2022.
- Yadav, S., K. Shiokawa, Y. Otsuka, M. Connors, Statistical study of subauroral arc detachment at Athabasca, Canada: new insights on STEVE, J. Geophys. Res., 127, e2022JA029856, https://doi.org/10.1029/2021JA029856, 2022.
- Chen, L., K. Shiokawa, Y. Miyoshi, et al., Observation of source plasma and field variations of a substorm brightening aurora at L~6 by a ground-based camera and the Arase satellite on 12 October 2017, J. Geophys. Res., 127, e2021JA030072, https://doi.org/10.1029/2021JA030072, 2022.

Full references are available at https://stdb2.isee.nagoya-u.ac.jp/member/shiokawa/ref.html

Development of low-cost cameras

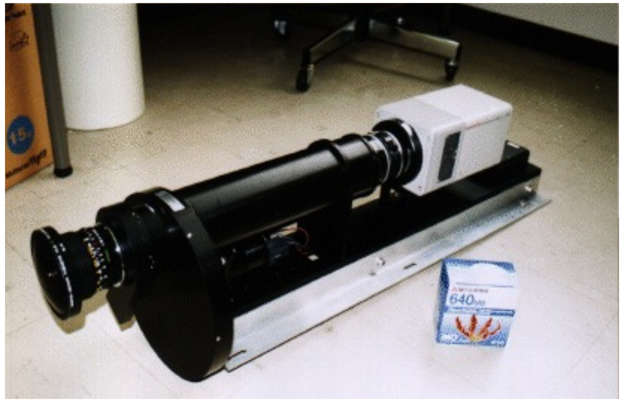
Optics

Cameras

OMTI ($91K)

Mamiya F5.6, f=24mm

KEO Sentry 3



~6,000,000yen ($55K)

Hamamatsu Photonics C9299

~4,000,000yen ($36K)

Small Cameras ($1.8-2.7K)

Fish-eye lens
(Fujinon/Edmund
FE185C057HA-1)

~100,000yen ($0.9K)

Watec
WAT-910HX

CCD

~100,000yen ($0.9K)

ZWO ASO294MM Pro

CMOS

~200,000yen ($1.8K)

RION

Presented by

Ivan Galkin

ISWI Instrument & Data Product Updates (1/2)

Instrument name: **RION (Realistic Ionosphere)**

PIs: **Prof. Ivan Galkin, Prof. Bodo Reinisch, UMass Lowell**

Tech Lead/POC: **Ivan_Galkin@uml.edu**

Science objectives: **Nowcast and forecast of 3D global plasma density in the subpeak ionosphere**

Measurement objectives: **Coordinated, prompt, and accurate specification of the ionosphere using ionosondes**

Science Activity Updates

T-FORS Horizon 2020 project: TID activity forecast using ionosonde-based coordinated measurements, to begin on 1/1/2023

Ionosonde-supported publications in 2022: **804**

Conjunction studies with GNSS, SWARM, COSMIC-2, ISR, SuperDARN

Instrument and Data Product Updates

Instrument updates: **Next-generation ionosonde models: NCU (Taoyuan, Taiwan), NIRFI (Nizhny Novgorod, Russia), low-power CubeSAT-ready platform (JHU/APL)**

Station updates: **major loss of the ionosonde data streams from Russia (16), India (4), and China (5) for diplomatic reasons**

Data product updates:

- **Standard GAMBIT ionospheric weather maps for UDL, https://unifieddatalibrary.com/**
- **Standard registration of RION products in PITHIA-NRF e-Science Centre, https://pithia-nrf.eu, http://vm1.pithia.eu:8080**

Capacity Building Activity Updates

ICTP CBW "Machine Learning for Space Weather"

- Buenos Aires, 7-11 November 2022

COSPAR CBW activity suspended in 2020-2022

- History of CCBWs: 2015, 2017, and 2019
- Upcoming CCBW: Busan, South Korea, May 2-13, 2023

International GIRO Forum activity suspended in 2020-2022

- History of IGF: 2011, 2014, 2019

ISWI Instrument & Data Product Updates (2/2)

REFERENCES:

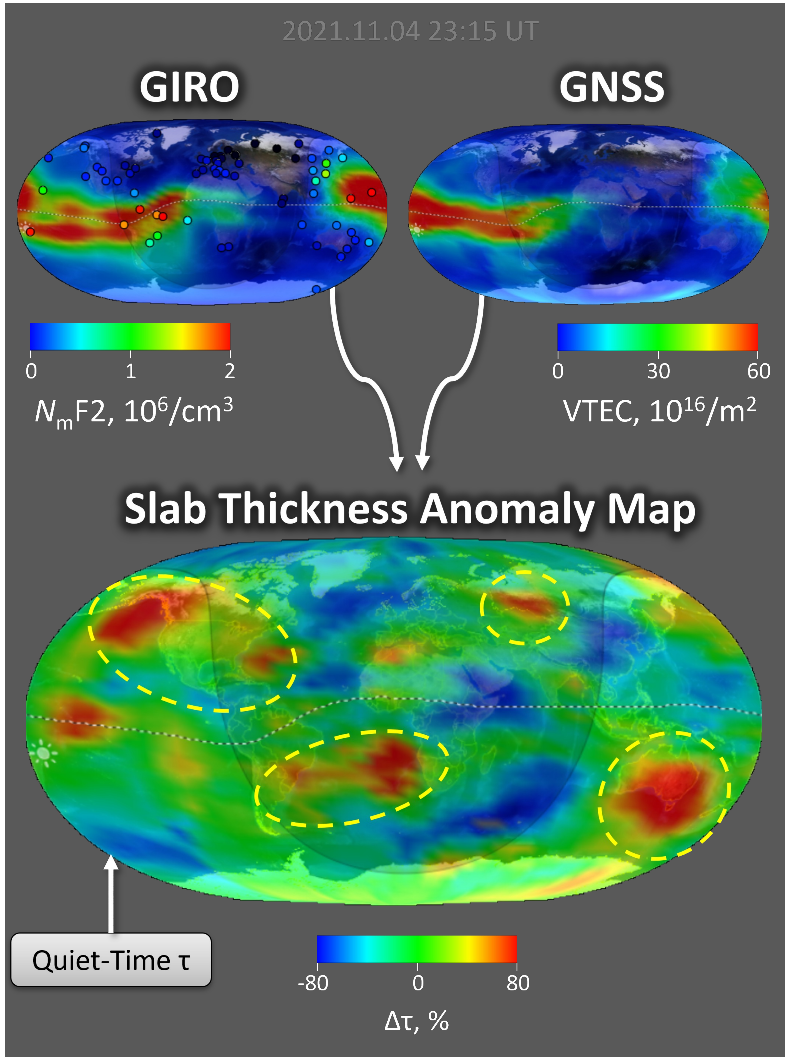
Galkin, I. (2022) Ionospheric Imaging with Ionosondes: Historical Perspective and Prospective Insight, in *100 Years of the International Union of Radio Science*, Chapter 29 URSI Commission G, pp. 520-528

Galkin, I., Froń, A., Reinisch, B., Hernández-Pajares, M., Krankowski, A., Nava, B., Bilitza, D., Kotulak, K., Flisek, P., Li, Z. and Wang, N. (2022). Global monitoring of ionospheric weather by GIRO and GNSS data fusion. *Atmosphere*, 13(3), p.371. https://doi.org/10.3390/atmos13030371

Verhulst, T.G., Altadill, D., Barta, V., Belehaki, A., Burešová, D., Cesaroni, C., Galkin, I., Guerra, M., Ippolito, A., Herekakis, T. and Kouba, D. (2022) Multi-instrument detection in Europe of ionospheric disturbances caused by the 15 January 2022 eruption of the Hunga volcano. *Journal of Space Weather and Space Climate*, 12, p.35. https://doi.org/10.1051/swsc/2022032

RION/GAMBIT: Effective Plasma Slab Thickness, τ

Deviations from expected quiet-time behavior



Color surfaces: global real-time ionosphere nowcast

GIRO and GNSS data fusion for detection of vertical plasma restructuring

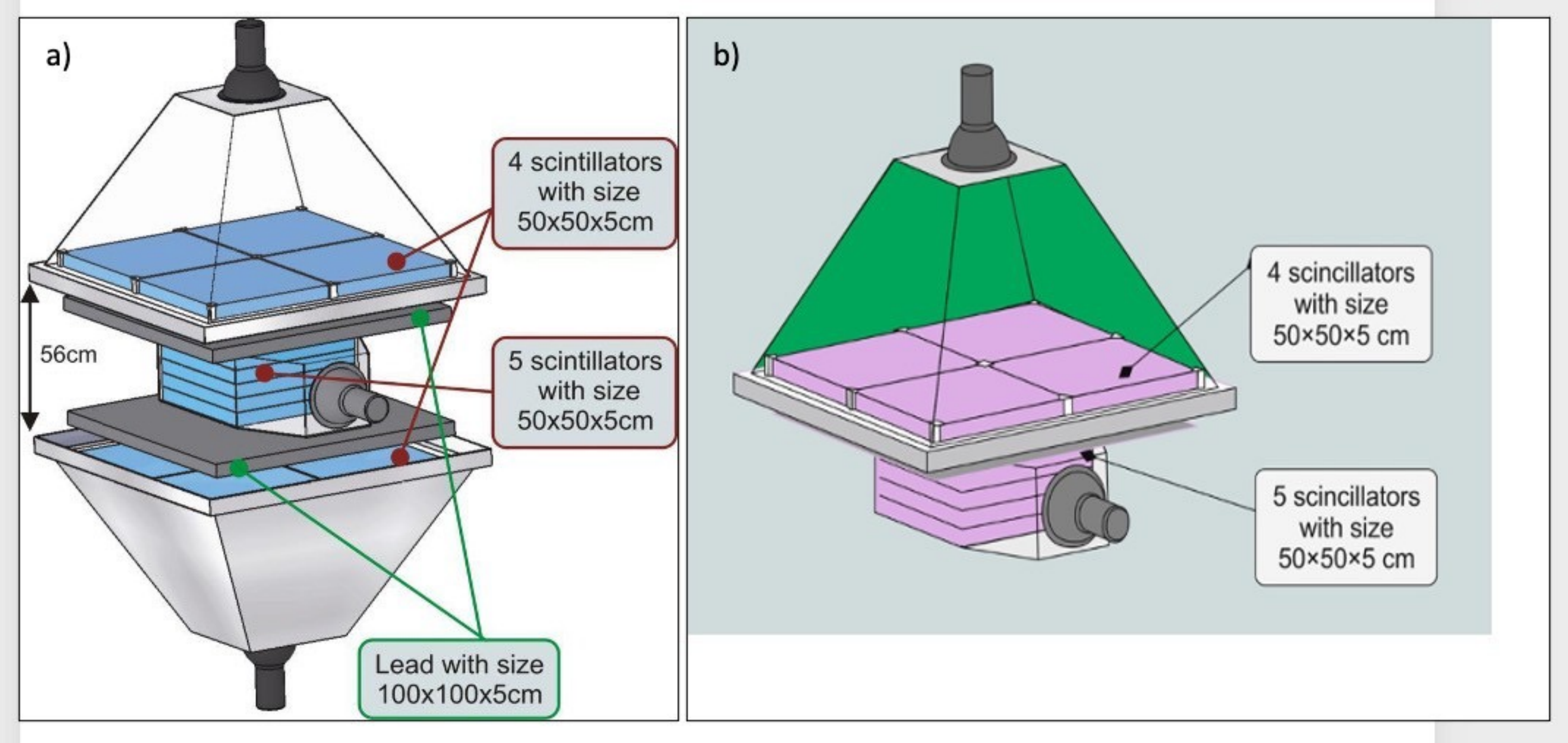
The 2021-11-04 G3 storm leaves a -80% to +80% imprint on τ

SEVAN

Presented by Tigran Karapetyan
on behalf of
Ashot Chilingarian

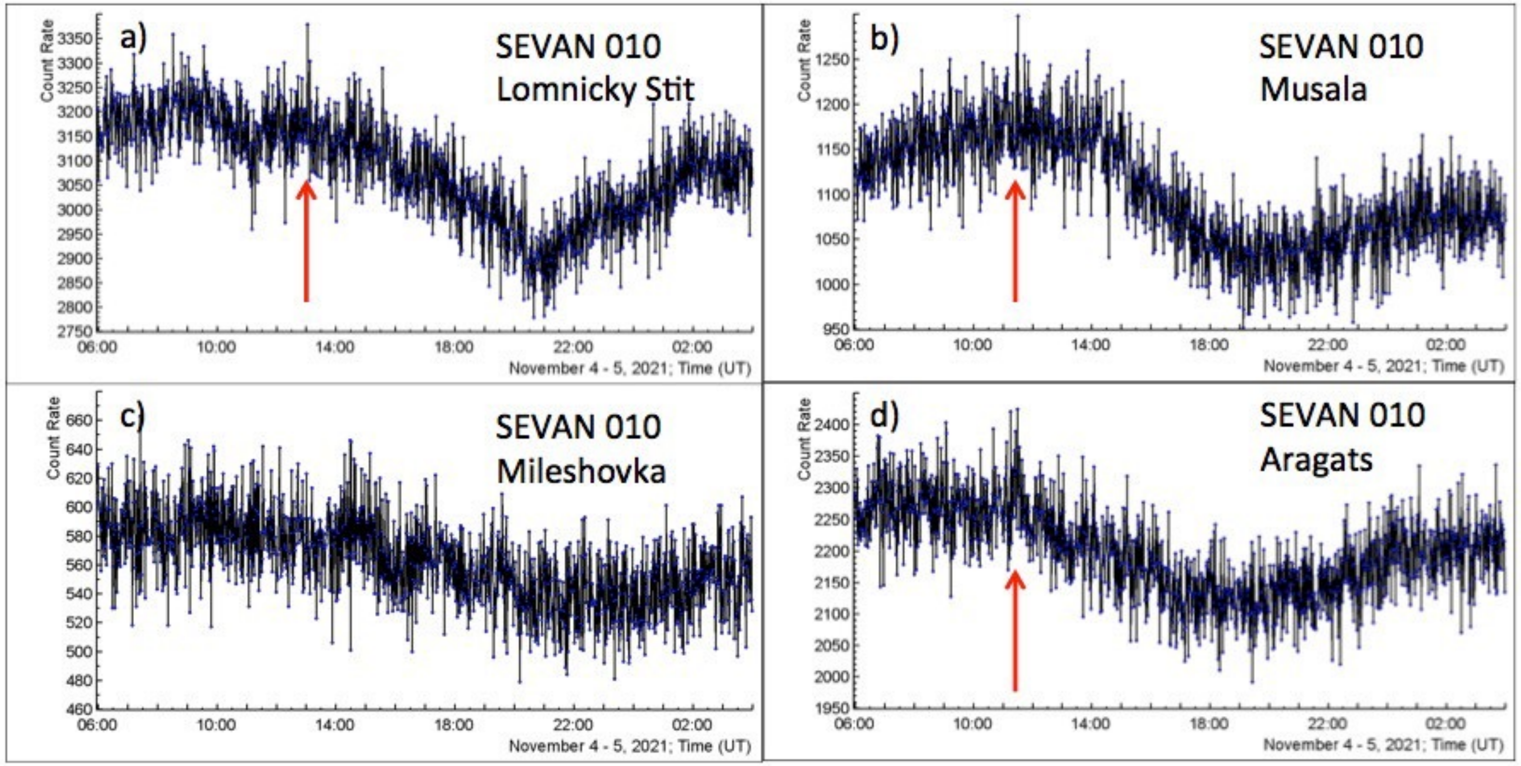
10 SEVAN units expands to 6 countries: in 2023 to be installed on Zugspitse in Bavarian Alps, shown by a big asterisk

Next SEVAN unit will be installed near the top of the Zugspitze (2962 m), a site with a long history of atmospheric research.



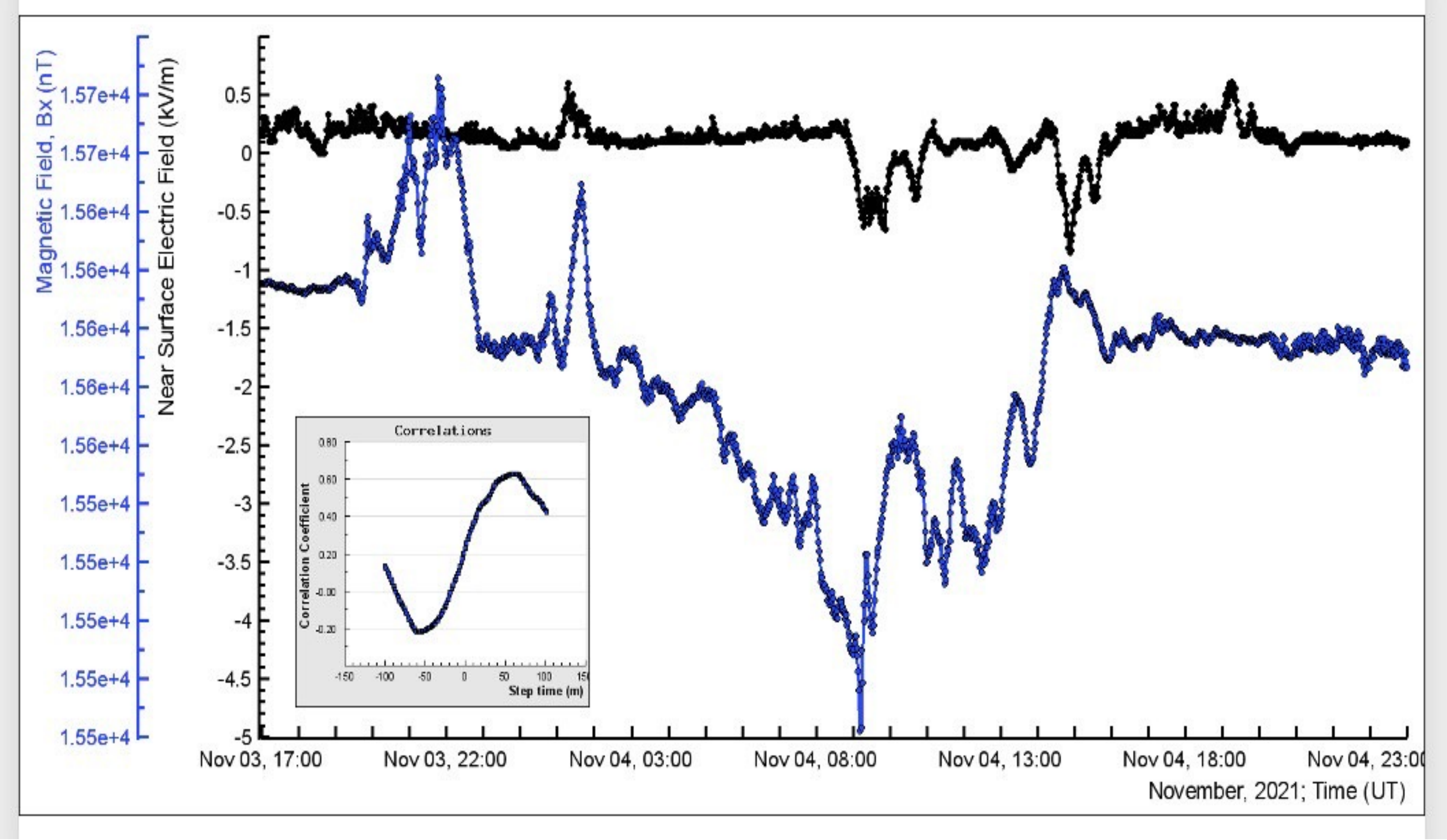
Basic SEVAN detector(a), and SEVAN-light detector (b). Due to the building constrains at UFS, SEVAN-light should be compact, shorter, and much lighter than the basic SEVAN. Thus, SEVAN-light consists only of 2 layers and the lead absorber also is not included (total weight ≈150 kg). However, we add a modernized electronics board with a logarithmic amplitude-to-digit-converter (LADC), which will provide the particle energy spectrum recovery in the range of 0.3-100 MeV. The SEVAN-light will be fully operational for high- energy atmospheric physics research, with the additional feature of measuring the energy spectrum of TGE particles. The cosmic ray variation studies, related to research in solar physics, and space weather domains will be also continued with low-energy charged and neutral particles, and their energy spectra.

1-minute time series of count rates of “010” coincidence of SEVAN layers (mostly neutrons), by arrows we show the “pre-Forbush” count rate enhancement followed by FD at



On 3-5 November 2021, occurred the largest of the current 25th solar activity cycle FD; corresponding GMS unleashed auroras as far low latitude as New Mexico (39N)! SOHO coronagraphs caught the storm cloud leaving the Sun on Nov. 2, following and overtaking a slow-motion solar flare (M1.7) in the magnetic canopy of sunspot AR2891. All coincidences of the SEVAN network registered this FD by its detectors located in Aragats, Lomnicky Stit, Musala, Mileshovka, Berlin, and Hamburg. In Fig. 3 we show FD in 1-minute time series of count rates of the “010” coincidence (mostly neutrons). The FDs at mountain altitudes (Aragats, Musala, Lomnicky Stit, all above 2500 m) are pronounced rather well, better than at lower altitude (Mileshovka, ≈800 m) and at see level (Hamburg and Berlin).

Disturbances of the X component of the geomagnetic field (blue) and near-surface electric field (NSEF, black) during FD. In the inset we show the delayed correlations histogram: NSEF disturbances are late relative to geomagnetic field disturbances by ≈50 minutes.



Last papers from SEVAN network

- [1] Chum,J.,Langer,R.,Baˇse,J.,Kollárik,M.,Strhárský,I.,Diendorfer,G.,etal. (2020). Significant Enhancements of Secondary Cosmic Rays and Electric Field at the High Mountain Peak of Lomnický SˇPt in High Tatras during Thunderstorms. Earth Planets Space 72, 28. doi:10.1186/s40623-020-01155-9
- [2]Chilingarian, A., Karapetyan, T., Zazyan, M., Hovsepyan, G., Sargsyan, B., Nikolova, N., et al. (2021c). Maximum strength of the atmos- pheric electric field. *Physical Review D, 103*, 043021. hcps://doi.org/10.1103/physrevd.103.043021
- [3] Chilingarian, A., Hovsepyan, G., Karapetyan, G., and Zazyan, M. (2021). Stopping Muon Effect and Esemaeon of Intracloud Electric Field. Astroparecle Phys. 124, 102505. doi:10.1016/j.astropartphys.2020.102505
- [4] Chilingarian, A., Hovsepyan, G., & Zazyan, M. (2021). Muon tomography of charged structures in the atmospheric electric field. *Geophysical Research Le7ers, 48*, e2021GL094594. hcps://doi.org/10.1029/2021GL094594
- [5] Chum J, Kollárik M, Kolmasˇová I, Langer R, Rusz J, Saxonbergová D and Strhárský I (2021) Influence of Solar Wind on Secondary Cosmic Rays and Atmospheric Electricity. Front. Earth Sci. 9:671801. doi: 10.3389/feart.2021.671801
- [6] A.Chilingarian, Progress of High-Energy Physics in Atmosphere (HEPA) achieved with the implementaeon of parecle physics and nuclear spectroscopy methods, 2021, 37th Internaeonal Cosmic Ray Conference, DOI: 10.22323/1.395.0366

Conclusions

- The big advantage of the SEVAN network is that FD is measured in the fluxes of different particles with various energy thresholds. The collaborative efforts of SEVAN network hosts in the measurements of the solar modulation of the GCR on mountain tops in Armenia, Slovakia, Chechia, Croatia, Bulgaria, and now also in Germany were granted by new important discoveries. The 24/7 monitoring of particle fluxes with synchronized networks of identical sensors is supported by the ADEI data analysis that stores the multivariate data in databases with open, fast, and reliable access. The visualization and online correlation analysis of the big data coming from the SEVAN network highly improved the nowcasting and forecasting of violent solar events.

- Calculated purities of the secondary cosmic ray registration for the SEVAN coincidences demonstrate the SEVAN detector's capacity to measure charged and neutral secondary cosmic ray fluxes separately, which is extremely important both for solar and atmospheric physics research. Modernization of SEVAN electronics, allowing measurement of energy spectra of neutral and charged fluxes on a minute time scale, will highly improve network abilities in research of solar modulation and atmospheric effects.

Published in 2022

- Chilingarian, G. Hovsepyan, D. Aslanyan, T. Karapetyan, Y. Khanikyanc, L.Kozliner, B. Sargsyan, S.Soghomonyan, S.Chilingaryan, D. Pokhsraryan, and M.Zazyan (2022) Thunderstorm Ground Enhancements: Multivariate analysis of 12 years of observations, Phys. Rev. D, 2022, 106, 082004 (2022).
- Chilingarian, G. Hovsepyan, T. Karapetyan, B. Sarsyan, and S. Chilingaryan, Measurements of energy spectra of relativistic electrons and gamma-rays avalanches developed in the thunderous atmosphere with Aragats Solar Neutron Telescope, Journal of Instrumentation, 17 P03002 (2022), https://doi.org/10.1088/1748-0221/17/03/P03002.
- A.Chilingarian, T.Karapetyan, H.Martoyan, et.al., Forbush decrease observed by SEVAN particle detector network on November 4, 2021, Series on Cosmic ray studies with neutron detectors, Kiel University, in press.
- T.Karapetyan, SEVAN East-European particle detector network for the solar and space weather studies, International conference on Thunderstorms & elementary particle acceleration, Prague, October 17-2.

SCINDA

Presented by

Keith Groves

ISWI Instrument & Data Product Updates

Instrument name: SCINDA

PI: Keith Groves

Tech Lead/POC: Keith Groves

Science objectives: Investigate ionospheric irregularities and their impacts on radio wave propagation

Measurement objectives: Monitor signals from radio beacon satellites and GNSS constellations focusing on fluctuations in amplitude and phase (scintillations)

Science Activity Updates

SCINDA data has been invaluable in the development and validation of numerous algorithms aiming to characterize ionospheric irregularities using space-based radio occultation data sources. In parallel, SCINDA data has been used in studies correlating scintillation and ROTI measurements with the objective of quantifying a relationship between the two parameters, such that ROTI observations can serve as a reliable proxy for S4, greatly expanding available scintillation monitoring capabilities

Instrument and Data Product Updates

Instrument updates: A new standard sensor composed of a Septentrio PolaRxs-5 and USRP-based VHF receiver system has been developed and tested for more than a year.

Station updates: New sensors have been successfully installed at four sites in the past 14 months: Jicamarca, Peru; Cuiaba and Sao Luis, Brazil and Ascension Island, S.A.

Data product updates: The new sites are measuring all available satellite constellations to include GPS, GLONASS, Galileo and Beidou. We have currently integrated GLONASS observations in SCINDA products and will be incorporating data from the other systems after performing data characterization.

Capacity Building Activity Updates

The SCINDA program is completing a successful demonstration of updated technology and expects to obtain additional resources for new systems in 2023 and beyond. New sites will focus on reliability and not low cost. In March we will be testing new low- and intermediate cost GNSS systems in a scintillation environment. We believe the future of SCINDA as it relates to ISWI will be best served with the development and proliferation of reliable low-cost systems with current or near-future technology. We are increasing our activity in that arena through the UN ICG WG C.