2023 ISWI Instrument Updates

Presentations:

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

Operational statuses

- AMMA
- CIDR
- RENOIR

AWESOME

Presented by

Shing Fung on behalf of 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 update process is now underway, to modernize for next decade

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

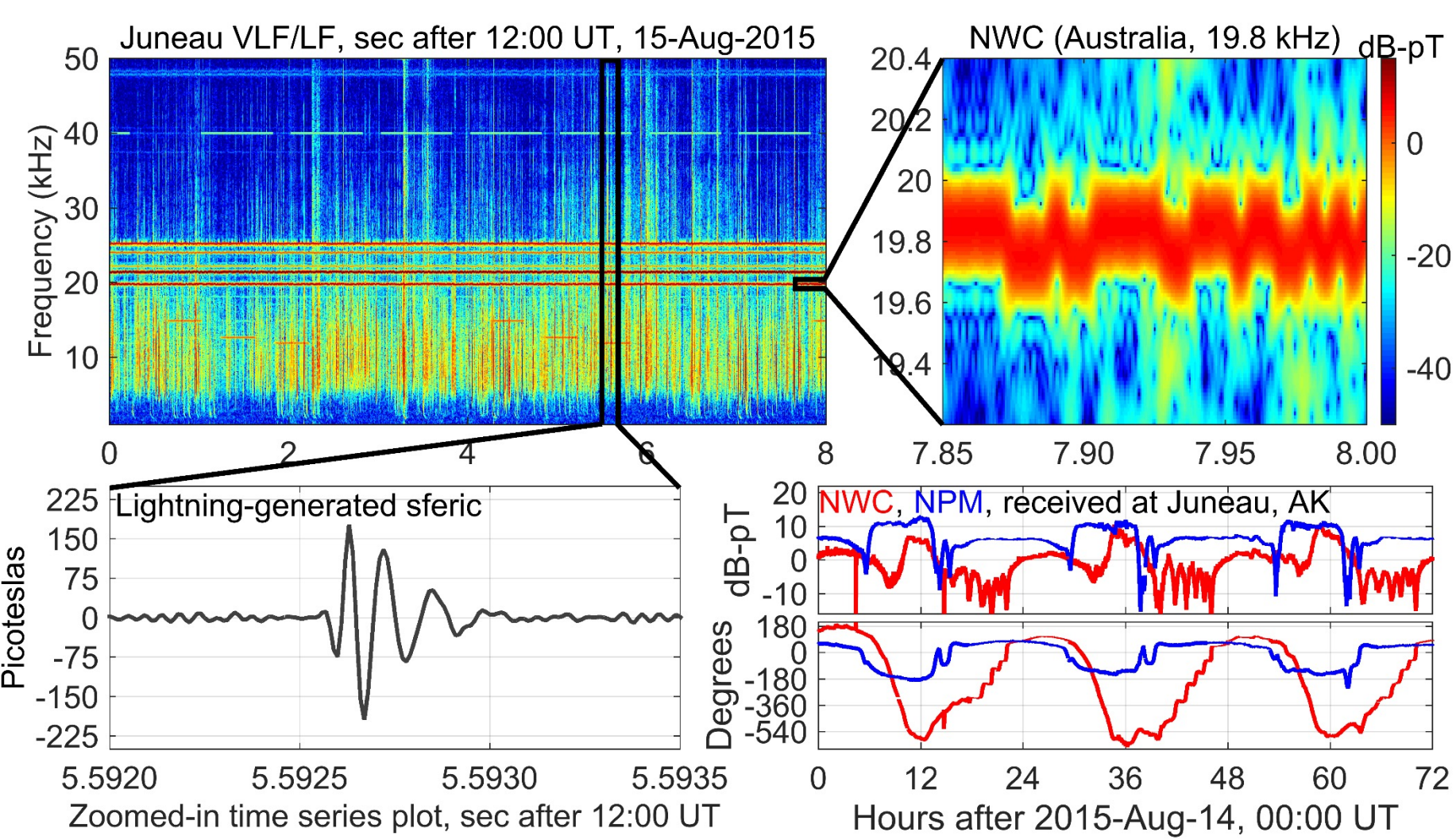
Challenges, if any: COVID prevented us from maintaining some sites, creating a backlog of sites that needed to be fixed after 2 years. We have made some progress digging out of that.

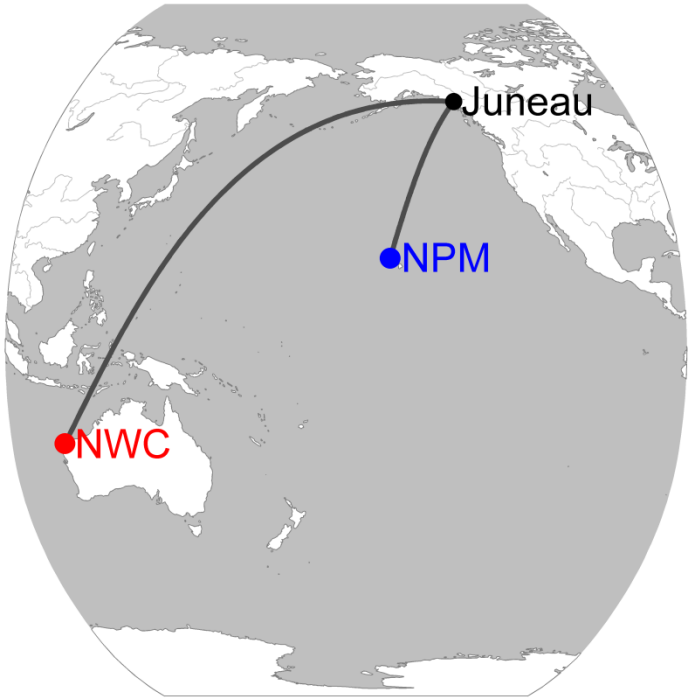
Capacity Building Activity Updates

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”





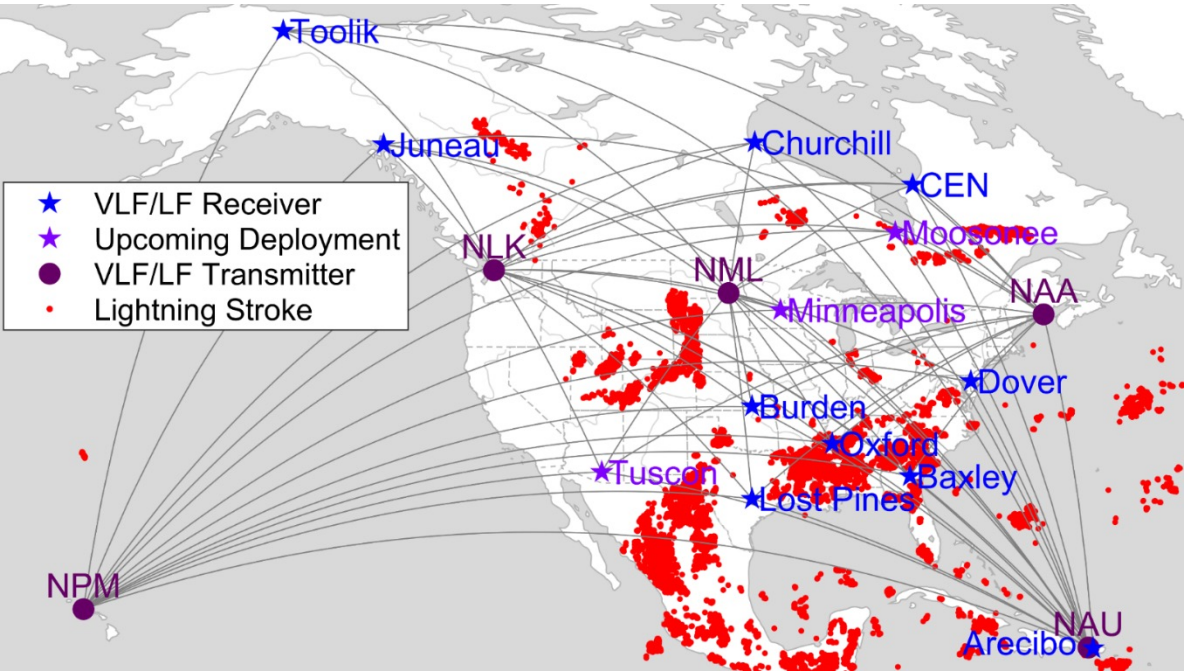
- LF data dominated by “sferics” from lightning, and naval radio stations

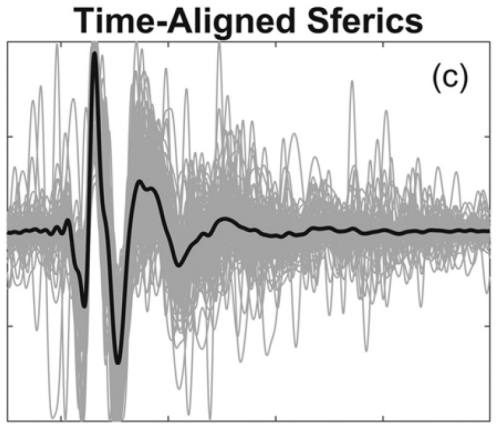
D-Region Mapping with Transmitters, Lightning

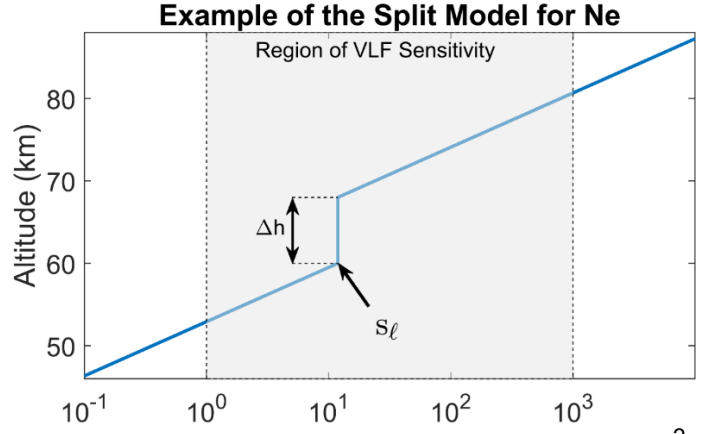
Nicholas Gross, Morris Cohen (2020), VLF Remote Sensing of the D-Region Ionosphere Using Neural Networks, Journal of Geophysical Research Space Physics, 124, http://doi.org/10.1029/2019JA027135

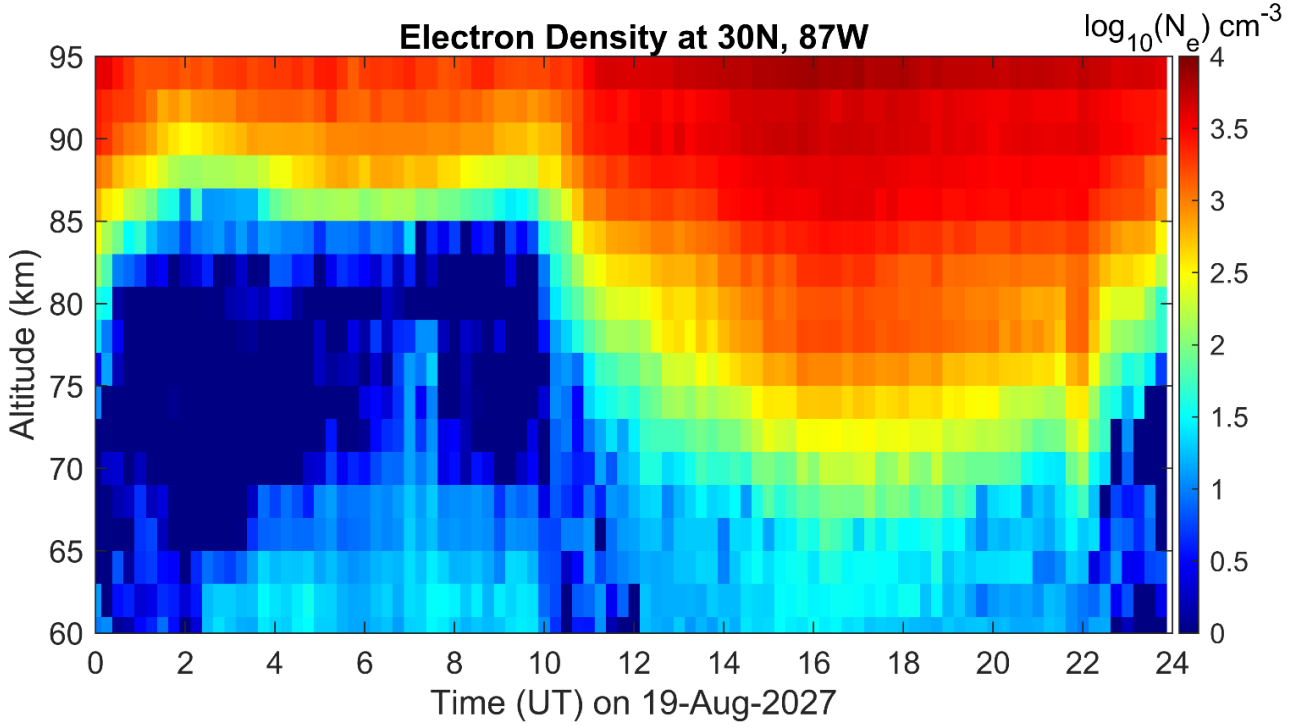
Jackson McCormick, Morris Cohen (2021), A new four-parameter D-region Ionospheric Model, *Journal of Geophysical Research Space Physics*, http://doi.org/10.1029/2021JA029849

David Richardson, Morris Cohen (2023), Unifying VLF Transmitter and Sferic Modeling Efforts via Tomography, *Journal of Geophysical Research Space Physics*, https://doi.org/10.1029/2023JA031989

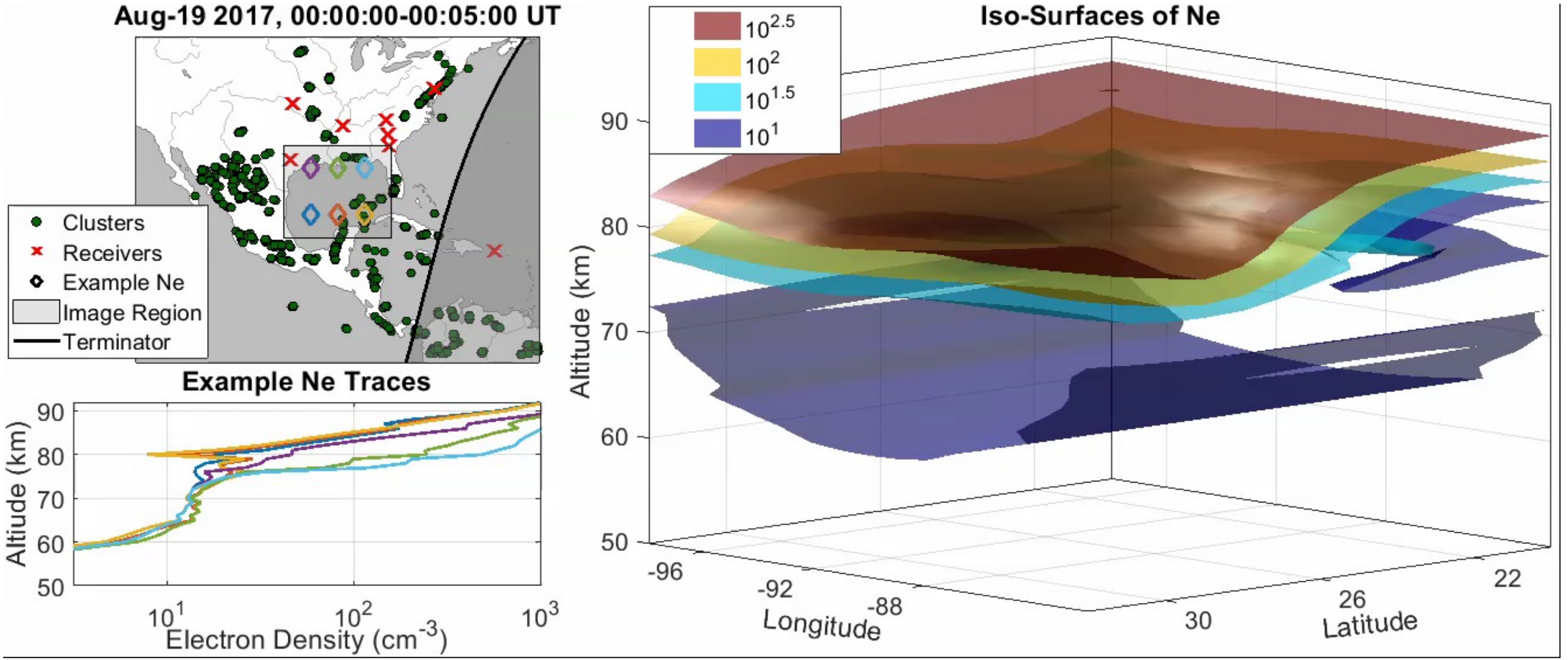




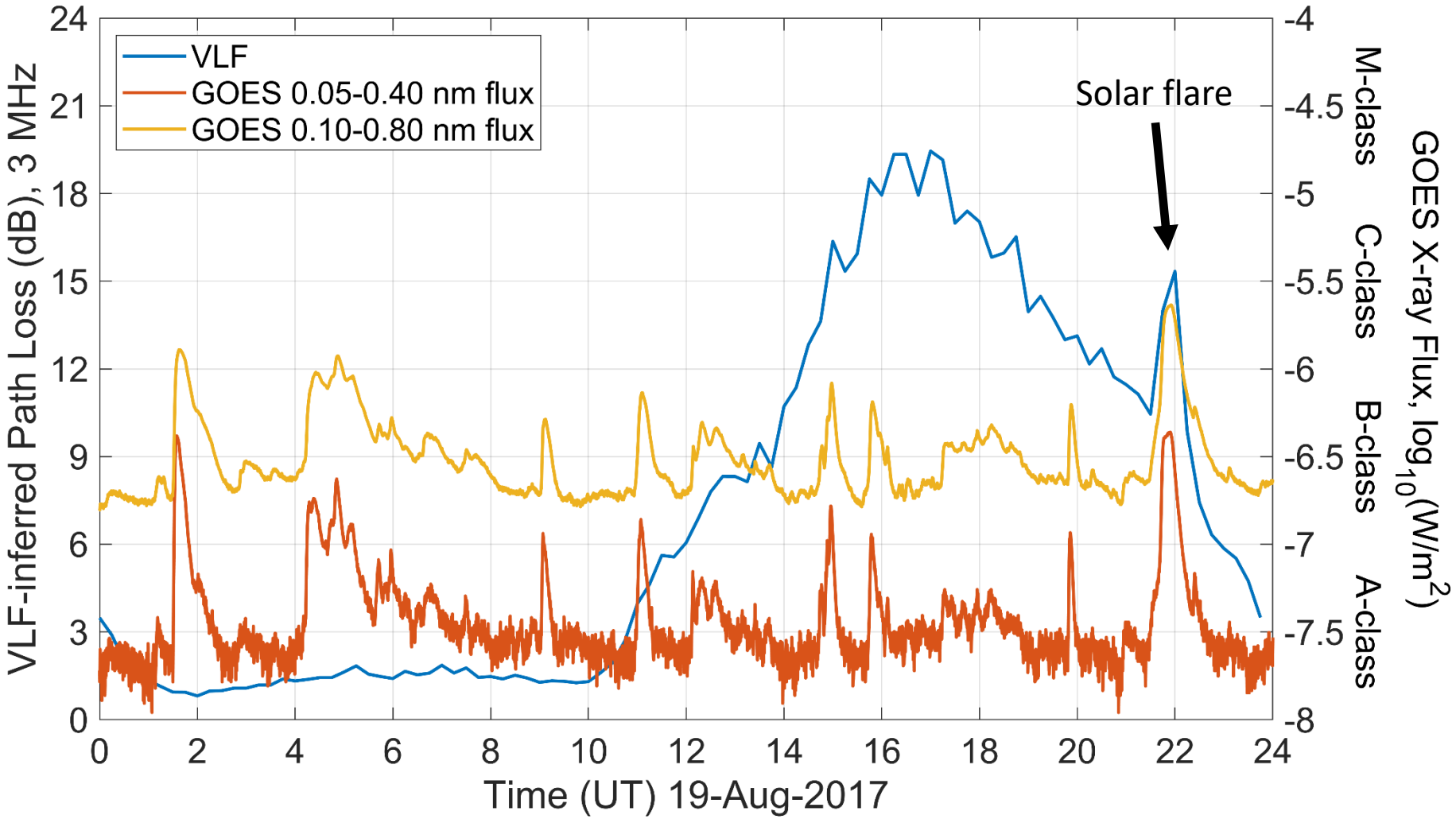




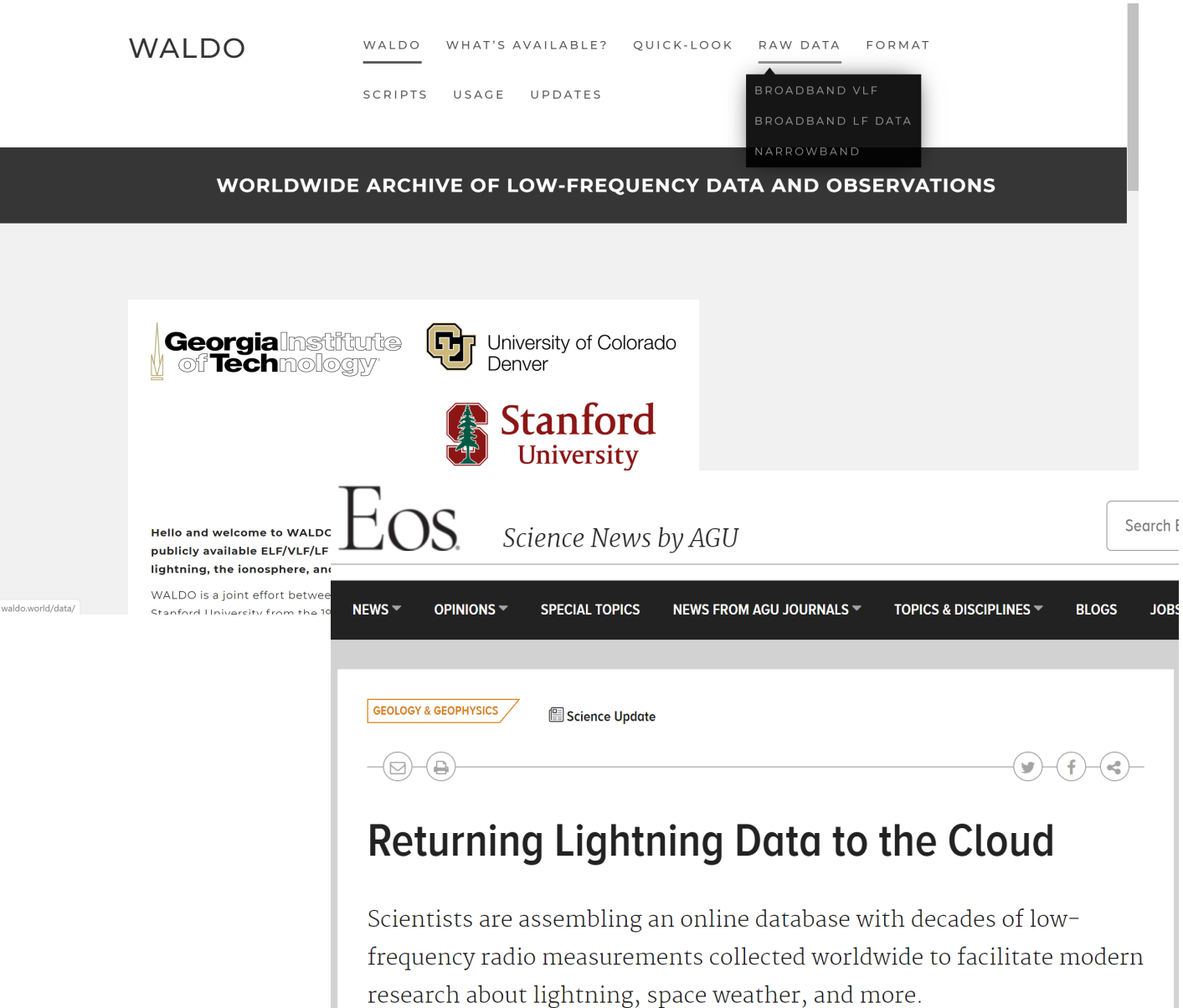
Using Lightning-VLF as an Ionospheric Probe Wave



HF Absorption Inferred from VLF Measurement



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.

GIFDS

Presented by

Daniela Banys

ISWI Instrument & Data Product Updates (1/2)

Instrument name: GIFDS
Global Ionospheric Flare Detection System

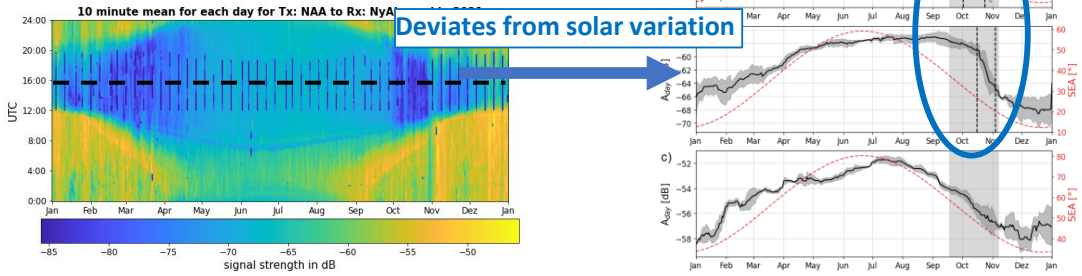
PI / Tech Lead/POC: Dr. Daniela Banyś
(German Aerospace Center – DLR)

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

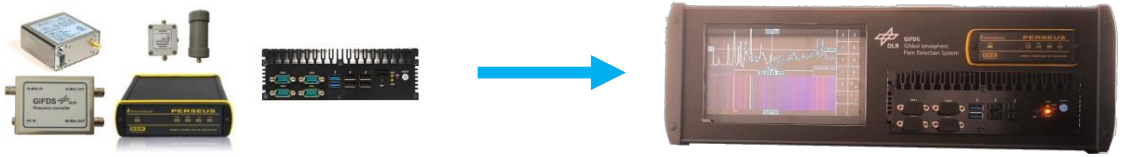
Joint project AMELIE:
Analysis of the **ME**sosphere and **L**ower **I**onosphere fall **E**ffect (DLR + IAP)



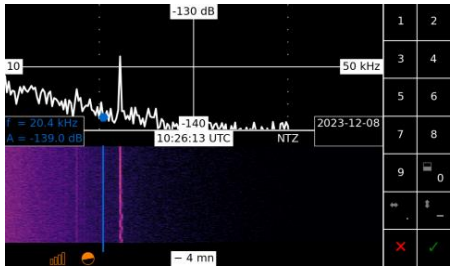
Hansen et al. (2024)

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



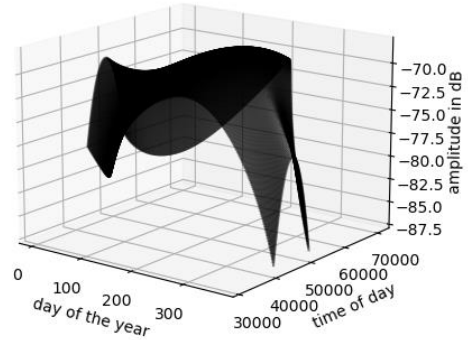
Data product updates: new software will allow an increase of the sampling rate from 1 to 10 Hz



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: Huntsville: 15 – 30 June 2024 + Neustrelitz: 1- 14 Juli 2024
https://www.dlr.de/de/aktuelles/nachrichten/2023/04/international-space-weather-camp-2024-jetzt-bewerben

ISWI Instrument & Data Product Updates (2/2)

Instrument name: GIFDS
Global Ionospheric Flare Detection System

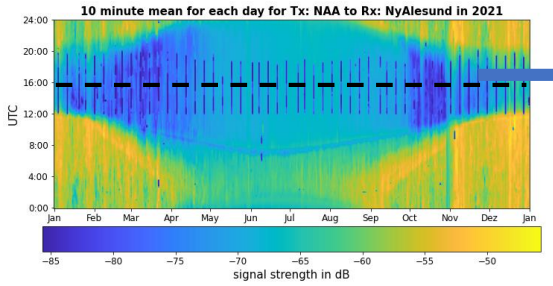
PI / Tech Lead/POC: Dr. Daniela Banyś
(German Aerospace Center – DLR)

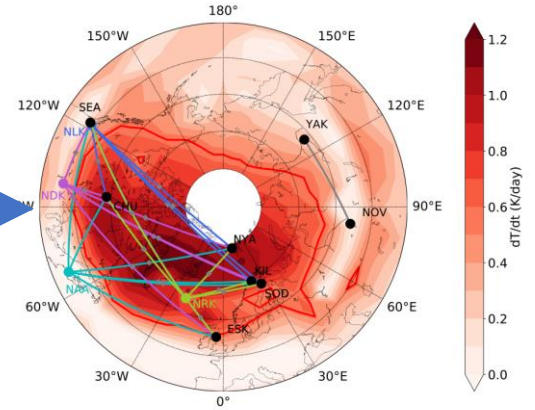
Objectives:

- 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)



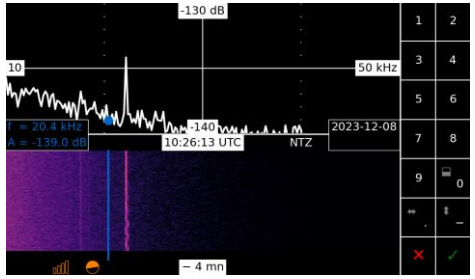


Wendt et al. (2023)

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

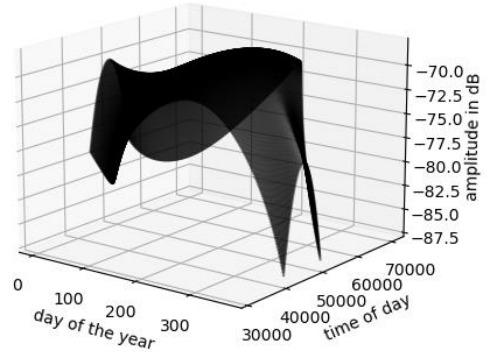
Data product updates: new software will allow an increase of the sampling rate from 1 to 10 Hz



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: Huntsville: 15 – 30 June 2024 + Neustrelitz: 1- 14 Juli 2024
https://www.dlr.de/de/aktuelles/nachrichten/2023/04/international-space-weather-camp-2024-jetzt-bewerben

LISN

Presented by

Shing Fung on behalf of Cesar Valladares

ISWI Instrument & Data Product Updates (1/2)

Instrument name: Low-latitude ionospheric Sensor Network

PI: Cesar E ValladaresPlease indicate changes

Tech Lead/POC: Cesar delaJara, cdelajara@igp.gob.pe

Science objectives: Nowcasting and forecasting of plasma depletions and scintillations over South America.

Measurement objectives: Ionospheric density profiles using ionosonde and oblique sounding receivers, Magnetometers, and GNSS receivers deployed across South America.

Science Activity Updates

I am continuing with the project on nearly 1-kilometer irregularities and searching for the instability mechanism that initiates this type of irregularities. I am presently using the SAMI2 program and studying the possible role of Ion temperature gradients.

Another project involves measurements of LS-TADs using GOCE measurements and LS-TIDs using TEC.

Instrument and Data Product Updates

Instrument updates: We have installed 6 new Septentrio GNSS receivers in Peru. 11 Receivers have been shipped to Brazil for installation by INPE and IBGE

Station updates: GNSS receivers in Jicamarca, San Bartolome, Lima (U. Catolica), Cuzco, Jaen, and Piura (all in Peru).

Data product updates: Maps of TEC and Scintillations using 4 constellations over South America

Challenges, if any: Deployment in remote sites, finding reliable Internet, overcoming bureaucratic regulations in countries like Peru.

Capacity Building Activity Updates

A graduate student presented a final defense and graduated in January 2023. Dr. Purbi Adhya worked under my supervision for three years; during this time, she learned about space weather and determined the precise behavior of plasma bubbles during intense, moderate, and weak magnetic storms.

I am presently helping UTD graduate students to advance in their research efforts.

ISWI Instrument & Data Product Updates (2/2)

- **Publications in the current reporting year**

- Valladares, C. E., Chen, Y.-J., Hairston, M., Chau, J. L., & Dhanya, R. (2023). Observation of scintillation enhancements and large-scale structures within the equatorial ionization anomaly during a sudden stratospheric warming event. *Journal of Geophysical Research: Space Physics*, 128, e2022JA030985. https://doi.org/10.1029/2022JA030985
- Adhya, P., & and C. E. Valladares, (2023) Magnetic storm effects on the occurrence and characteristics of plasma bubbles, under review *Journal of Geophysical Research: Space Physics*. DOI: 10.1029/2023JA031292.
- Bukowski, A., Ridley, A., Huba, J. D., Valladares, C., & Anderson, P. C. (2024). Investigation of Large Scale Traveling Atmospheric/Ionospheric Disturbances using the coupled SAMI3 and GITM models. *Geophysical Research Letters*, 51, e2023GL106015. https://doi.org/10.1029/2023GL106015

Paper submitted
- Valladares, C.E. and J. V. Eccles (2023), the Tropical Total Electron Content Anomaly, submitted to *Earth, Planets and Space Sciences*.

- **Presentations in the current reporting year**
- Several presentations at CEDAR-2023, AGU-2023, EPB-India, IAGA-2023, U. Catolica-2023

MAGDAS

Presented by

Kirolosse Girgis

ISWI Instrument & Data Product Updates (1/2)

Instrument Name: MAGDAS

PI(s): **Prof. Akimasa Yoshikawa & Dr. Shuji Abe**
Data Handler: Dr. Kirolosse Girgis

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 to MAGDAS is **10** in 2023.

Instrument and Data Product Updates

Instrument updates: We plan to install this year three magnetometers in Vietnam (BCL), South Africa (DRB), and Indonesia (BWJ).

Station updates: We plan this year to visit Brazil and Malaysia to maintain and re-operate some stations.

Data product updates: We registered our data information to IUGONET and SuperMAG. We plan to assign the DOIs to our data through the University's Library. We assigned two DOIs for MCQ and DVS station data through the Australian Antarctic Data Centre (AADC): doi:10.26179/sxny-2m16, doi:10.26179/knze-t915

Capacity Building Activity Updates

We accepted **4** foreign visitors in 2023.

- Guest Professors/Senior Researchers:
    1. Prof. Dr. Abraham Chian, University of Adelaide, Australia, National Institute for Space Research, Brazil
    2. Dr. Andreas Keiling, University of California, Berkeley, USA
- Researchers/Students:
    1. Sri Lanka (1)
    2. Kenya (1)

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

Umar, R., A. N. Dagang, N. S. I. Roslan, S. N. A. Syed Zafar, MH Jusoh**, A Yoshikawa, S Abe**, T Uozumi, *Response of the geomagnetic horizontal component during solar events at RANAU station*, Indian Journal of Physics, 97, 3735-3744, 2023 doi:10.1007/s12648-023-02721-z

Takla EM, Maryanto S, **Yoshikawa A,** Uozumi T., *Latitudinal dependence of Pc3-4 amplitudes across the dip equator along the 210º Magnetic Meridian*, Annals of Geophysics, 66(3-4):GM323, 2023 doi:10.4401/ag-8979

M. Arslan Tariq, L. Liu, M. Shah, Y. Yang, W. Sun, M. A. Shah, R. Zhang, **A. Yoshikawa**, *Longitudinal variations of ionospheric responses to the February and April 2023 geomagnetic storms over American and Asian sectors*, Advances in Space Research, in press doi:10.1016/j.asr.2023.12.039

Nur Dalila K. A., M. H. Jusoh, S. Mashohor, A. Sali, **A. Yoshikawa**, N. Kasuan, M. H. Hashim, M. A. Hairuddin*, Bibliographic dataset of literature for analysing global trends and progress of the machine learning paradigm in space weather research*, Data in Brief, 51, 2023 doi:10.1016/j.dib.2023.109667

Pappoe, J. A., **A. Yohikawa**, A. Kandil, A. Mahrous, *A machine learning approach combined with wavelet analysis for automatic detection of Pc5 geomagnetic pulsations observed at geostationary orbits*, Advances in Space Research, 2023, in press, doi:10.1016/j.asr.2023.11.001

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) Thermospheric winds, and (3) auroras at subauroral latitudes and polar cap. 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

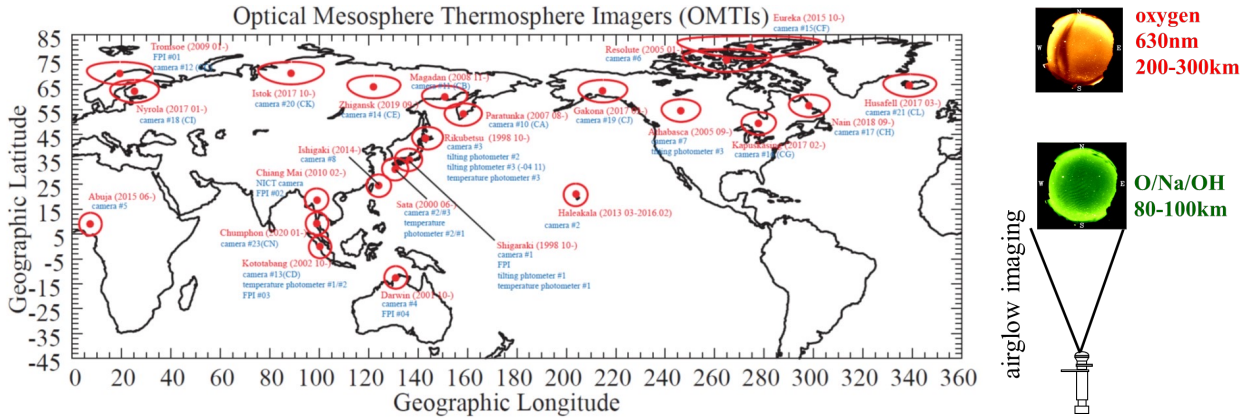
Instrument updates: new low-cost cameras based on WATEC-CCD and ZWO-CMOS are being developed (see 3rd page of this slide) .

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

- International Colloquium on Equatorial and Low-Latitude Ionosphere (ICELLI 2023) , Sep 4 - 8, 2023, Kwara, Nigeria
- Iberian Space Science Summer School, Jun 26 - 30, 2023, Coimbra, Portugal
- ICTP-SCOSTEP-ISWI School and Workshop on the Predictability of the Solar-Terrestrial Coupling - PRESTO, May 29 - Jun 2, 2023, Trieste, Italy
- A JSPS core-to-core program is going on from April 2021 to March 2024 to support capacity building activities in some Asian and African countries. Scientists and students from India, US, Nigeria, and Ethiopia, visited ISEE in 2021-2023 under this JSPS framework and by the SCOSTEP Visiting Scholar (SVS) program.

ISWI Instrument & Data Product Updates (2/2)

Publications in 2023

Gravity waves (GWs) and Medium-Scale Traveling Ionospheric Disturbances (MSTIDs)

- **Kawai et al., 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.**
- **Tsuboi et al., Statistical Analysis of the Horizontal Phase Velocity Distribution of Atmospheric Gravity Waves and Medium-Scale Traveling Ionospheric Disturbances in Airglow Images over Darwin (12.4S, 131.0E), J. Geophys. Res., 128, https://doi.org/10.1029/2022JA030769, 2023.**
- **Tsuboi et al., Statistical Analysis of the Horizontal Phase Velocity Distribution of Atmospheric Gravity Waves and Medium-Scale Traveling Ionospheric Disturbances in Airglow Images over Sata (31.0N, 130.7E), Japan, J. Geophys. Res., 128, https://doi.org/10.1029/2023JA031600, 2023.**

Thermospheric winds

- **Oyama et al., Geomagnetic activity dependence and dawn-dusk asymmetry of thermospheric winds from 9-year measurements with a Fabry-Perot interferometer in Tromsø, Norway, Earth Planets, Space, in press, 2023.**
- **Oyama et al., IMF dependence of midnight bifurcation in the thermospheric wind and ionospheric ion velocity at auroral latitudes based on 9 winter measurements in Tromsoe, Norway, Geophys. Res. Lett., 50, e2023GL104334. https://doi.org/10.1029/2023GL104334, 2023.**

Auroras, SAR arcs, polar cap patches, and isolated proton auroras with Pc1 pulsations

- **Hosokawa et al., A ground-based instrument suite for integrated high-time resolution measurements of pulsating aurora with Arase, J. Geophys. Res., 128, e2023JA031527, https://doi.org/10.1029/2023JA031527, 2023.**
- **Chen et al., Correspondence of Pi2 pulsations, aurora luminosity, and plasma flux fluctuation near a substorm brightening aurora: Arase observations, J. Geophys. Res., 128, https://doi.org/10.1029/2023JA031648, 2023.**
- **Gololobov et al., Multi-event conjugate measurements of the SAR arc detachment from the auroral oval using DMSP satellites and an all-sky camera at Athabasca, Canada, J. Geophys. Res., 128, https://doi.org/10.1029/2022JA030544, 2023.**
- **Eriksen et al., On the Creation, Depletion, and End of Life of Polar Cap Patches, J. Geophys. Res., 128, https://doi.org/10.1029/2023JA031739, 2023.**
- **Lyons et al., Unsolved problems: Mesoscale Polar Cap Flow Channels' Structure, Propagation, and Effects on Space Weather Disturbances, Frontiers Astronomy and Space Sciences, in press, 2023.**
- **Hirai et al., Spatio-temporal characteristics of IPDP-type EMIC waves on April 19, 2017: Implications for loss of relativistic electrons in the outer belt, J. Geophys. Res., 128, https://doi.org/10.1029/2023JA031479, 2023.**
- **Tian et al., Ionospheric modulation by EMIC wave driven proton precipitation: observations and simulations, J. Geophys. Res., 128, https://doi.org/10.1029/2022JA030983, 2023.**

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

Development of low-cost cameras

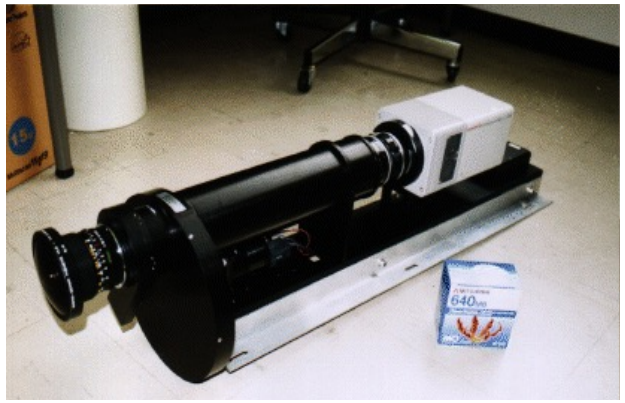
Optics

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

Ryan Hamel

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

1. Horizon Europe programmes actively support RION:

- **T-FORS** in progress: TID activity forecast using ionosonde-based coordinated measurements
- **DISPEC** started on 1 Jan 2024: Scientific exploitation of space Data for improved Ionosphere SPECification
  - Advanced methodologies for ionosonde networks

2. PECASUS: MUF depression alerts for ICAO (civil aviation, safety messaging)

3. D-region density and absorption: Research groups in USA and Hungary report promising results using Digisonde data

Instrument and Data Product Updates

Instrument updates:

Station updates: **continuing loss of the real-time sensor data availability for diplomatic reasons. Access to 66% of the original RION network is now suspended (41 out of 69)**

- No RT data service from India, China, Russia, and USA

Data product updates:

- **Important: RION data are now available at UDL, https://unifieddatalibrary.com/**
- **New standard SAO version 6 for ionosonde data exchange** is in preparation for release in 2024; based on JSON

Capacity Building Activity Updates

PITHIA-NRF Training School "Plasmasphere-Ionosphere-Thermosphere Data Infrastructure",

- Rome, 29 May to 1 June 2023
  - Lecture: "Modeling HF Communications with RayTRIX and IRTAM"
  - Student competition: "MUF Depression Alerts to Civil Aviation"

T-FORS Training School "TID activity forecast using ML"

- Brussels, 5-9 February 2024
  - Lecture: "Natural Language Processing for an AI-driven Ionosphere Forecast by Historic Analogy"
  - Student competition: "Comparative study of resources for managing HF communications"

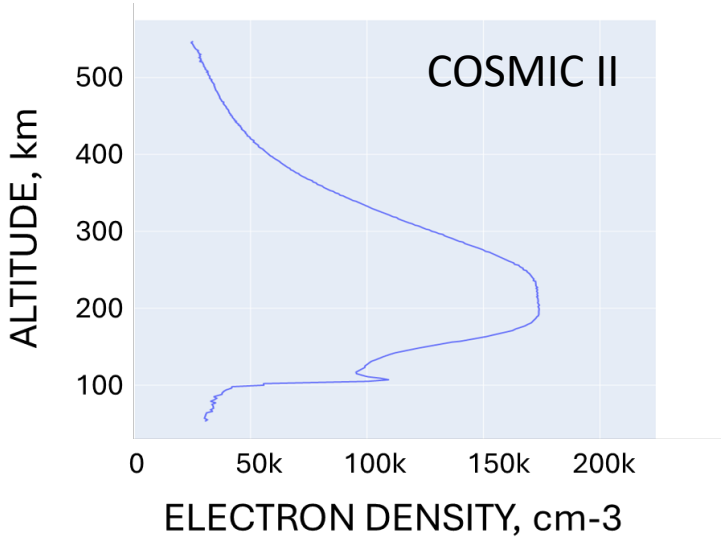
ISWI Instrument & Data Product Updates (2/2)

FLAT-NOSE IONOSPHERE?

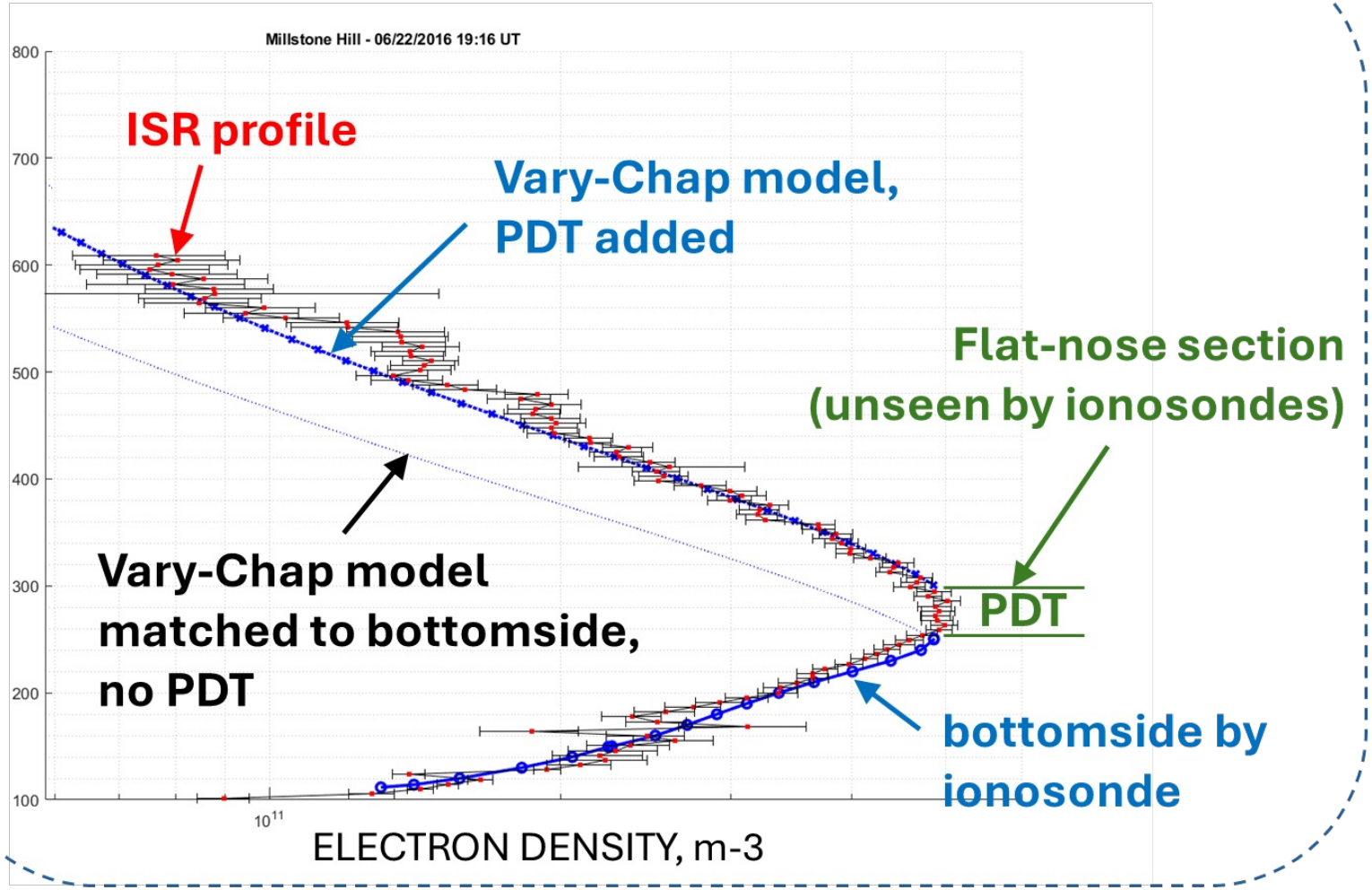
Evidence growing from observations of the peak density area of the ionosphere that there is an altitude interval around the peak where peak density is nearly constant

FLAT-NOSE instead of POINTED-NOSE?

Shammat, M. O., Reinisch, B. W., Galkin, I., Erickson, P. J., Weitzen, J. A., & Rideout, W. C. (2024). Characterizing plasma Peak Density Thickness in the Ionosphere: A single-site multi-instrument study. Radio Science, 59, e2023RS007658. https://doi.org/10.1029/2023RS007658



PEAK DENSITY THICKNESS (PDT), a.k.a. "flat-nose"



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 continues to be the GOLD standard for validating sensors on the COSMIC-2 satellites (6 satellites in 24° inclination 520 km orbit). This includes the TGRS GNSS radio occultation (RO) sensor, the tri-frequency beacon and the IVM in situ density observations. SCINDA data will continue to be used to support the development of complex algorithms to exploit RO data for space weather applications, potentially one of the most important new data sources in ionospheric science.

Instrument and Data Product Updates

Instrument updates: Most recently SCINDA has explored the development of low-cost GNSS receiver technology working under the auspices of a UN ICG subcommittee.

Station updates: The sensors installed at four sites last year continue to operate virtually flawlessly (Jicamarca, Peru; Cuiaba and Sao Luis, Brazil and Ascension Island, S.A.)

Data product updates: We have recently been investigating new relatively wideband signals from a communications satellite operating near 400 MHz. The initial look at these signals is quite fascinating as we are seeing the dynamic frequency dependence of scintillation for the first time.

Capacity Building Activity Updates

The SCINDA program is completing a successful demonstration of updated technology and discussions with sponsors on possible new installations will occur between March and June 2024. The exciting results from the low-cost GNSS receivers showing good quality measurements for all relevant space weather parameters (intensity and phase scintillation, TEC) suggest that a network of low-cost receivers could be achieved and we will investigate this possibility. Additionally, the entire SCINDA database will be transitioned to an open access database in 2024.

SEVAN

Presented by

Shing Fung on behalf of A. Chilingaryan

9 SEVAN units expands to 6 countries. In 2023 SEVAN detector was installed at Environmental research station Scheefernhaus (Zugspitze, 2650 m) . Network data (1 minute time series for 10 years) containts unique information on Solar andHhigh-energy Atmospheric physics

A.Chilingaryan, T.Karapetyan,B.Sargsyan, S.Abovyan, D.PokhsrarayanCosmic Ray Division of A I Alikhanyan National Laboratory, Armenia

Final location of the SEVAN module in Kugelhim, where ≈10 other neutron detectors are operated

SEVAN unit installed near the top of the Zugspitze (2962 m), a site with a long history of atmospheric research in April 2023.

Time series of Thunderstorm Ground Enhancement observed by SEVAN light detector at Zugspitze.

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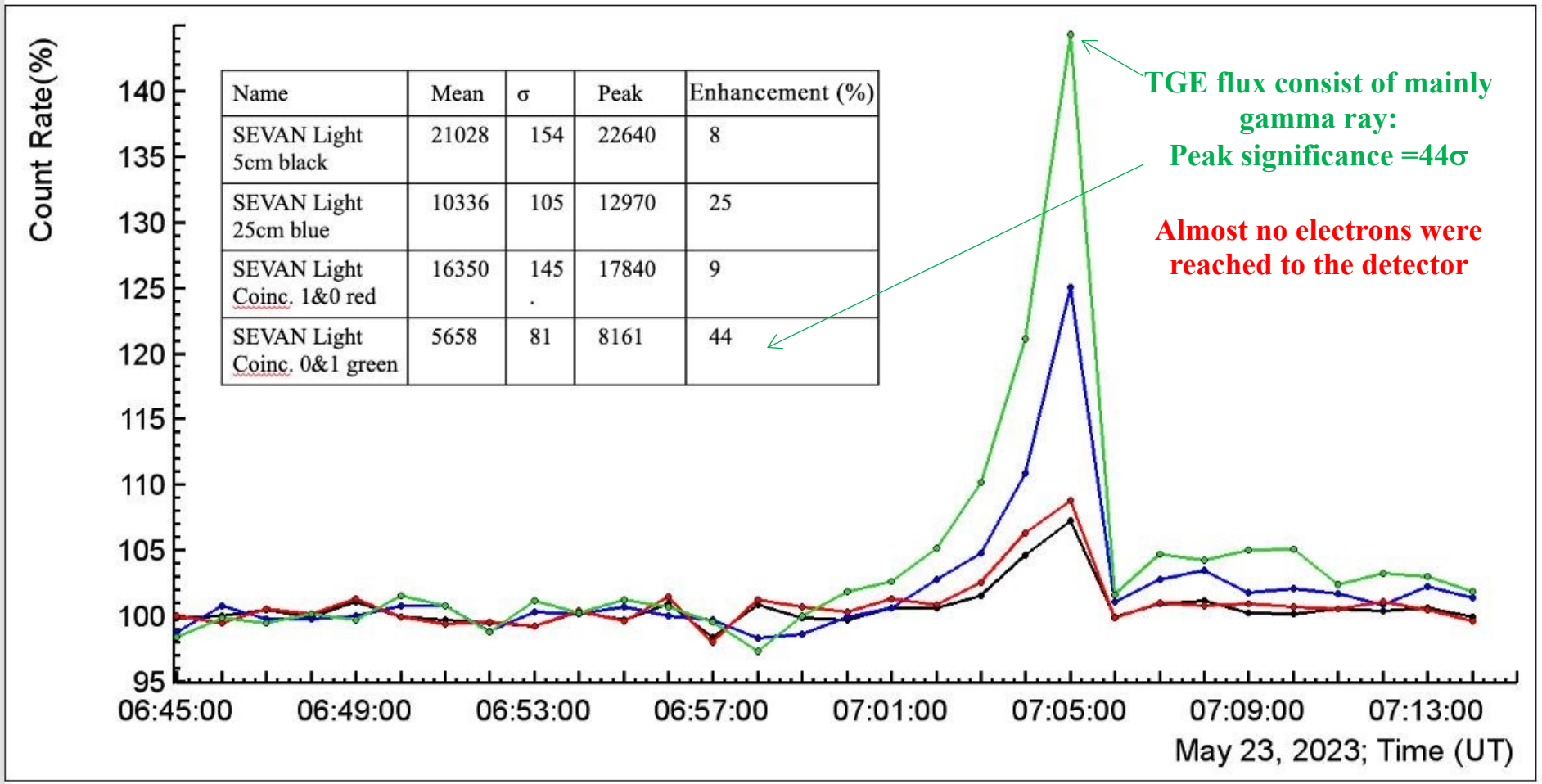

Name	Mean	σ	Peak	Enhancement (%)
SEVAN Light 5cm black	21028	154	22640	8
SEVAN Light 25cm blue	10336	105	12970	25
SEVAN Light Coinc. 1&0 red	16350	145 .	17840	9
SEVAN Light Coinc. 0&1 green	5658	81	8161	44

The electric field within the clouds that accelerates electrons stops over 100 meters above the detectors. Because of the dense air, electrons cannot reach the ground. However, gamma rays are much more enhanced because gamma rays attenuate slower than electrons. This enhancement is more significant and is increased by coincidence "01" since it vetoes cosmic ray charged particles by the upper (veto) scintillator; see the inset of Figure for more details

ISWI Instrument Operational Statuses

The following instruments have never provided (a) PDMPs for the ISWI data policy or (b) instrument updates. They also have not responded to any email communication.

- AMMA
- CIDR
- RENOIR

Are they (a) still in operations, and (b) still part of ISWI?