Topical Discussion Meeting report: TDM15 “Global cooperation in ground-based ionospheric observation”

Date and time: 17:00-18:00LT, October 30, 2025

Location: Umea Folkets Hus, Room Tonsalen (hybrid style)

Conveners: Tobias Verhulst (RMI), Ivan Galkin (UML), Mamoru Ishii (NICT & Nagoya Univ.)

Number of attendees: ~40

Form of TDM: Project Feedback

Objective of the TDM

The Global Ionospheric Observation/Operation Network (GION), the global comprehensive organization for observation and operation with ionosonde has established in March 2025 on the base of UN/COPUOS recommendation. The objective of the TDM is to introduce the initial activity of GION and encourage the attendees to join this activities.

Discussion highlights

- Greeting and background (Mamoru Ishii)
  The purpose of this meeting is to introduce the activities of “Global Ionosonde Observation/Operation Network (GION)” and ask all to join us if you operate and/or use the data. After presenting the background of GION, there are presentations for introducing four successful examples for international observational cooperation and data sharing with ionosondes.

- Introduction of GION
  (Mamoru Ishii: 10min)
  The origin of discussion of GION came from the Committee on the Peaceful Uses of Outer Space, United Nations (UN/COPUOS). They published a report on “Final report of the Expert Group on Space Weather: towheads improved international coordination for space weather services”. This document provides six recommendations, and the first one says that COSPAR, ISES and WMO are invited to lead efforts to improve the global coordination of space weather activities in consultation and collaboration with other relevant actors and international organizations. To follow up this recommendation these three organizations established a team “WMO-ISES-COSPAR Coordination Team (WICCT)” and hosted “Space Weather International Coordination Forum (ISWCF) on November 17, 2023, in Geneve. In this meeting, we realized the importance of establishing

comprehensive entities which represent ground-based observation for coordination. GION has been established as the pilot project for this purpose on March 2025. GION consists of representatives and liaisons of organizations which related to ionosonde observations and conducts monthly meeting.

- Successful example of ionosonde network 1 ICAO/Subteam 8
  (Loredana Perrone: 10min)
  International Civil Aviation Organization (ICAO) started space weather information service for civil aviation since 2019. Currently four global centers (US, European consortium (PECASUS), consortium of Australia, Canada, France and Japan (ACFJ) and consortium of China and Russia (CRC) rotate the primary task every two weeks. Each center has it's own observation network and model for estimating global distribution and prediction of ionosphere which causes potential differences in issuing advisory among centers. ICAO/Space Weather Center Coordination Group (SWXCCG) set subteam 8 in January 2020 for discussing to reduce these differences in advisories and harmonizing among global centers.
  We have two theme to discuss in subteam 8. One is post significant storm event review procedure, which means that after the passing of a significant geomagnetic event, the four global centers have agreed to have a post event review meeting. We are specifically responsible for the topic of foF2/MUF depression, for which all four centers issue ICAO advisories. The work of the subteam began with the goal of establishing common rules and criteria for issuing these advisories.
  Another is share the model's output and the data which means Space weather centers push-and-pull ionospheric models hosted on the NICT(National Institute of Information and Communications Technology-Japan) server.
  The team also discussed the current difficulties in sharing real-time observations, particularly ionosonde data, and the need to identify the primary partners for any future data-sharing agreements.
  Finally, the group noted that a decision is still required regarding the access mode for the shared database and data exchange.

- Successful example of ionosonde network 2 PITHIA/NRF
  (Anna Belehaki(Remote): 10min)
  This presentation by Anna Belehaki (IAASARS/NOA) showcases the PITHIA-NRF (Plasmasphere–Ionosphere–Thermosphere Integrated Research Environment and Access Services) as a successful example of a coordinated European ionospheric

observation network. It describes how PITHIA-NRF integrates multiple ground-based and space-based facilities—ionosondes (real-time and offline), GNSS scintillation receivers (INGV, DLR), CDSS transmitters/receivers (IAP), EISCAT radars, SGO riometer and magnetometer chains, and LOFAR sites—to provide unified access to high-quality ionospheric and upper-atmosphere data.
The core of the presentation focuses on data standardization and interoperability, showing how PITHIA-NRF achieves FAIR principles (Findable, Accessible, Interoperable, Reusable). It employs the ISO 19156:2011 Observation and Measurement model, extended with a PITHIA ontology that defines physical concepts and relationships across domains. A specific example (the O-wave critical frequency foF2) illustrates how PITHIA metadata describe the phenomenon, measurand, and interaction processes in a structured way.
The presentation highlights the capabilities of the PITHIA eScience Centre (https://esc.pithia.eu/), which provides searchable and API-accessible data collections in JSON format, enabling seamless integration and reuse. It concludes that over 50 standardized ionosonde-based datasets are already available within PITHIA-NRF, ensuring compatibility with global infrastructures such as GION and WMO databases, and setting a model for coordinated ionospheric monitoring and data sharing worldwide.

- Successful example of ionosonde network 3 GIRO
  (Giorgio Picanco: 10min)
  (Presented by Giorgio Picanço, on behalf of Ivan Galkin – Space Science Laboratory, University of Massachusetts Lowell)
  This presentation introduced the Global Ionosphere Radio Observatory (GIRO) as a successful example of an international ionosonde network. It began with a global map showing the current operational status of each station. The map highlighted ionosondes transmitting data in real time, those discontinued, those in progress toward reactivation, and others classified as “no delivery” due to various adverse conditions (including political and logistical factors), “temporarily off,” or “4-hour late.”
  During this section, a specific comment arose concerning the “temporarily off” stations in Brazil. A pre-presentation exchange with INPE colleagues clarified that this situation is under resolution through ongoing collaboration and mobilization between GIRO and INPE teams.

The presentation then introduced the IDAR+ Project (Ionosonde Data Acquisition for Rescue), describing its mission to recover, digitize, harmonize, and make available ionosonde historic data from around the world. The following points were emphasized:

- Work at Lowell GIRO Data Center
- Ionosonde Data Acquisition for Rescue (2025–2028)
- Ingest retrospective ionogram records (1957–1990, SPIDR collection)
- Tapes and CD-ROMs of digisonde data
- Seeking historical ionogram files (collaborations welcome!)
- Other resources: NICT collection
- Rerun IRTAM assimilation model to produce global maps of ionospheric weather

Subsequently, the ongoing transition of the DIDBase to Amazon Web Services (AWS) was presented. This migration will significantly improve data processing speed and reliability, supported by professional cloud-computing infrastructure. The talk also highlighted the suite of GIRO tools available to the community, including DIDBase, GAMBIT (with IRTAM 3D), LOIA (and LOUiBase), Raytrix, TID Explorer, SkyLite, and IDI.

The final part presented current and future research directions at the Space Science Laboratory, particularly under “GIRO Future Work: Cooperation with GNSS topics.” These activities include ionosonde-based GNSS TEC calibration, first steps toward a near-real-time GNSS-TEC mapping system, and bubble nowcasting and forecasting.

In the discussion, participants raised questions about improvements in the automatic scaling of ionograms. Possible approaches mentioned included modeling and simulating ionogram traces based on vertical ionospheric models, and potential collaboration between institutions such as INGV and DLR to develop data augmentation and fusion methods for enhancing GNSS-derived ionospheric information.

- SAO V6 standard for the ionosonde data exchange
  (Tobias G.W. Verhulst : 10min)
  The new SAO-V6 data format for sharing ionogram-derived characteristics as well as Level 1 ionoram data itself was presented. This new standard provides several advantage:

- The new standard allows inclusion of more information compared to previous versions, e.g. the possibility to provide more than one Es layer (as foreseen in the URSI manual)
- Ionogram data itself (at data level 1) can be inclueed alongside scaled characteristics.
- The new standard is more agnostic regarding the type of instrument, autoscaler software, and profile inversion method used.
- Tehcnically, the new standard uses the more modern json format instead of XML.

The data standard together with some example code has been made available to the community.

Although the advantages of the new standard are generally recognised, especially in light of the data rescue and archival project presented before, there are some potential disadvantages. In particular, the XML scheme was self-documenting and easilly extentable, while the new standard requires keeping the json scheme up-to-date at all times.

There are also a number of developments needed to facilitate wide adoption of the new standard. Various tools will need to be updated, and data converters will have to be written. This work is currently ongoing.

- Discussion (10min led by Tobias Verhulst)
  - How about the coordination of ionosonde models?
    - There are so many ionosonde models and it is difficult to coordinate them. We will focus on the coordination of data at level 1 only. Level 0 data is usually only of interest to the developers and operators of specific instruments.
  - Extract parameters
    - There is a question about which parameters should be recorded.
    - Ionogram data have different aspects from other instruments. We need to scale various parameters from ionogram manually and/or automatically. We chose several primary parameters to put in WMO/OSCAR.
  - How to collect pictures? Data digitized project
    - Some attendees mentioned they have already scanned old, analog records. Giorgio will work with them to insert these data into the GIRO repository so they can be available to the wider community.
  - Calibration
    - In case of manual scaling there could be some biases with scalers. this information is also important and worth to record.

- Presentation sharing
  - all presentation files are on the GION web.