Status of GNSS RO Data in the AWS Registry of Open Data

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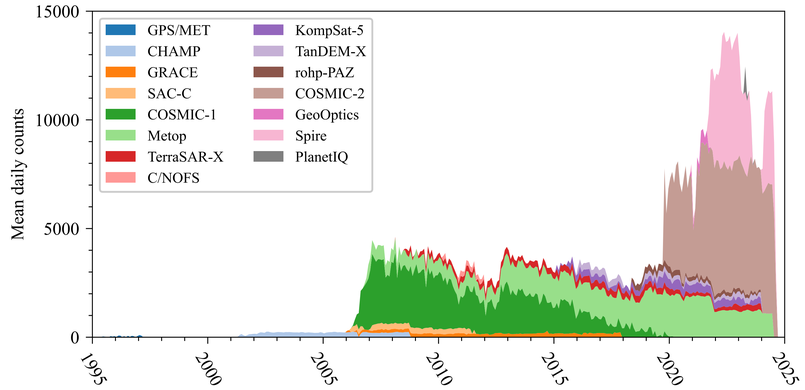
Summary

- The NASA ACCESS (Advancing Collaborative Connections for Earth System Science) Program funded an effort to collect, reformat, and catalog all publicly available GNSS radio occultation (RO) data. The project ended December, 2023.
- The project matched up all available RO soundings by transmitter/receiver/time of RO sounding.
- Data is available for query and download through the AWS Registry of Open Data, free of charge.
- RO data are contributed by
  - UCAR COSMIC Project Office
  - ROM SAF
  - NASA Jet Propulsion Laboratory (Caltech)
  - EUMETSAT
- Processing levels available:
  - calibrated/excess phase *(calibratedPhase)*
  - bending angle/refractivity *(refractivityRetrieval)*
  - thermodynamic *(atmosphericRetrieval)*
- API *(awsgnssroutils)* simplifies queries and data download.
- Archive will be perpetuated indefinitely by infusion into the NASA Goddard DAAC (GES DISC)
- Documentation and tutorials provided through GitHub.
- Two public workshops held.
- Reformatting system serving as backend for PlanetIQ data in NASA CSDA program.

Statistics

- Missions: GPS/MET, CHAMP, SAC-C, Metop, COSMIC/FormoSat-3, C/NOFS, GRACE, COSMIC-2/FormoSat-7, rohp-PAZ, KompSat-5, TerraSAR-X, TanDEM-X, GeoOptics, Spire, PlanetIQ
- Total soundings: 33,969,232
- Total storage: 29.8 TB
- Current rates: ~7,800 soundings per day (COSMIC-2, Metop, Spire), ~20 GB per day



Python API

```
pip install awsgnssroutils
```

- Python package in PyPI.
- Query, subset, and download occultation data selected according to RO mission, GNSS constellation, transmitter, receiver, date-time range, local time range, rising v. setting, contributing RO processing center, and processing level.
- High efficiency buffer: RO metadata stored on local file system.

Rotation-Collocation Capability

- The Python API contains an implementation of an extremely efficient RO collocation engine, ~1,000 times more efficient than standard brute-force searches and accurate to 98%.
- Collocations with microwave soundings AMSU-A on Metop-A,B,C, ATMS on Suomi-NPP, JPSS-1, JPSS-2; and with AIRS.
- Generates collocation data files, containing collocated RO and radiance soundings.
- Runs on Linux command line as “rotcol”.

Fun Figures

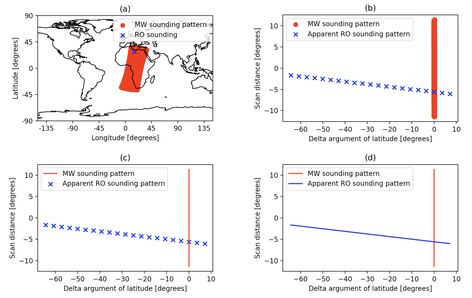


Figure 1. Illustration of rotation-collocation algorithm. (a) RO and MW soundings; (b) same but in reference frame of MW scan pattern; (c) approximate scan pattern as a line; (d) approximate “sub-occultations” as a line.

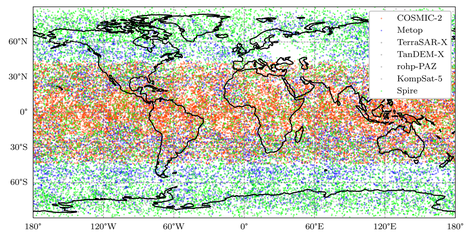


Figure 2. Collocations for the month of July, 2023, color-coded by RO mission.

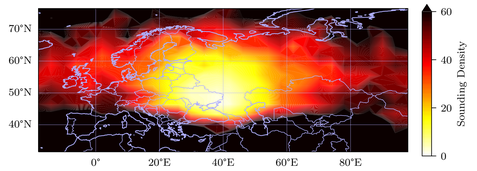


Figure 3. RO sounding density for calendar year 2023, soundings per (500 km)^2 per month.

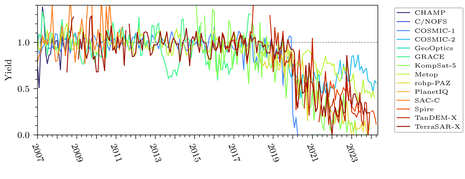


Figure 4. RO sounding yield over Ukraine by RO mission. The effective yield is computed by dividing the number of soundings in the longitude band between 40N and 65N latitude into the number of soundings in the same longitude band but also between 20E and 55E latitude and rescaling by 360/35.

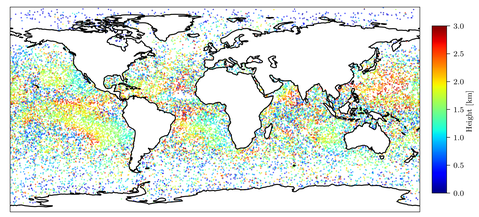


Figure 5. Scatterplot of planetary boundary layer height, 1–3 January 2023, from COSMIC-2 data as retrieved by UCAR.

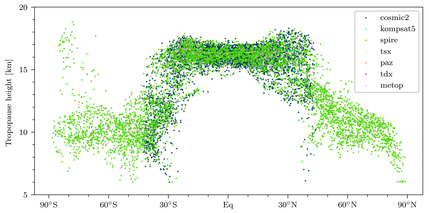


Figure 6. Lapse rate tropopause height for all RO missions as retrieved by UCAR, 12 July 2022.

Conclusions

- The AWS Registry of Open Data repository of Earth radio occultation data is active and will be so for at least 2 more years. A simple Google search will find it.
- Python API *awsgnssroutils* is very useful for query, subset, and download of RO data. Install it by “pip”.
- Infrastructure will transfer to the Goddard DAAC. Python API *earthaccess* will take over.
- Collocations are greatly enhanced by co-hosting instruments or flying tandem.

References

Leroy, S.S., A.E. McVey, S.M. Leidner, H. Zhang, and H. Gleisner, 2024: GNSS radio occultation in the AWS cloud. *Earth and Space Science*, **11**, e2023EA003021, doi: 10.1029/2023EA003021.

Acknowledgements

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