

ROMEX: Status and First Lessons Learned

Presented to CGMS-52 Plenary Session

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Executive Summary of the WP

The International Radio Occultation Working Group (IROWG) community proposed a collaborative effort to explore the impact of RO observations during the 2022 IROWG Workshop:

Radio Occultation Modeling Experiment (ROMEX)

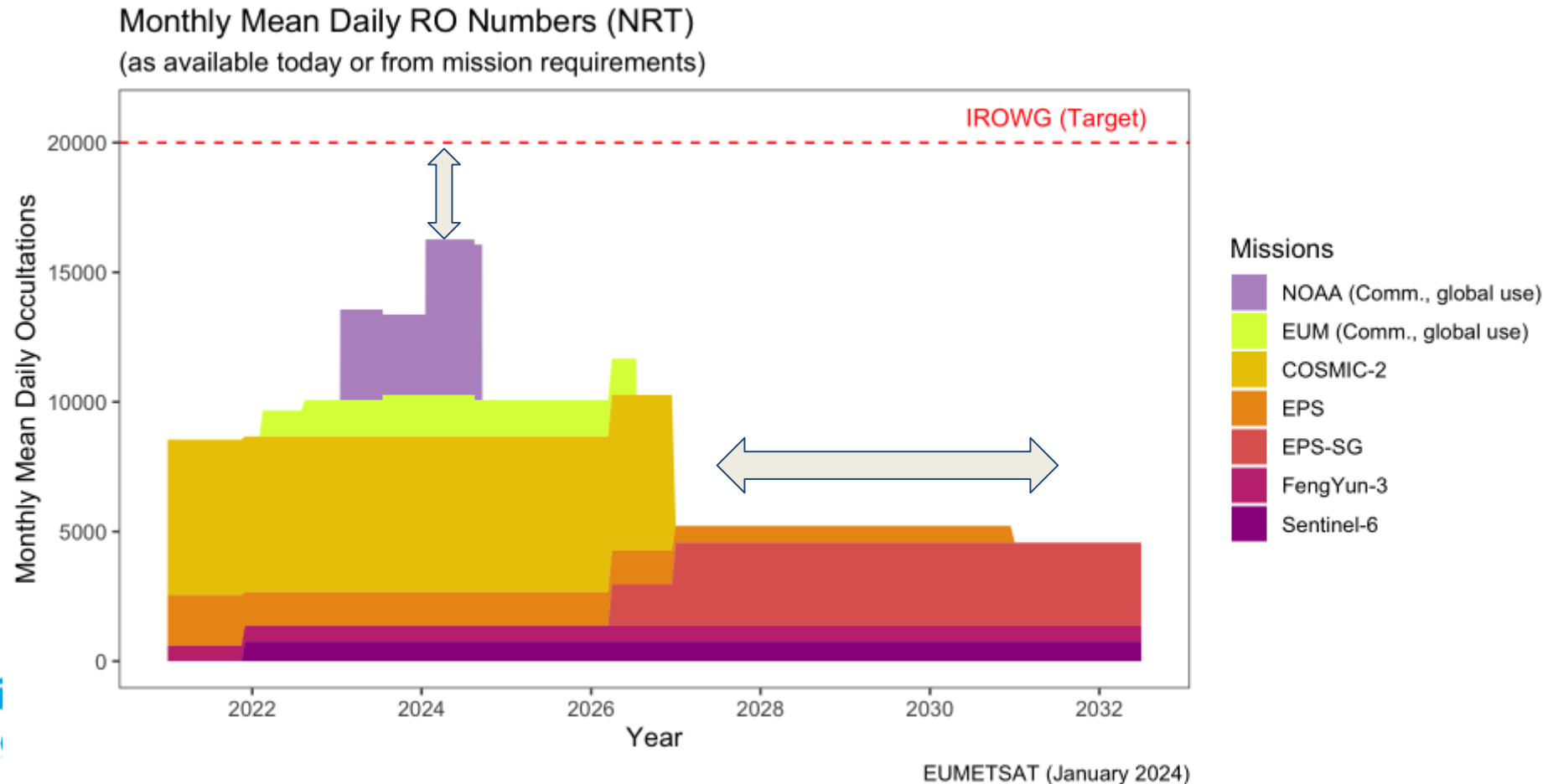
ROMEX seeks to quantify the benefit to NWP of increasing the quantity of RO observations using additional observations that were not available to weather centers for their real-time operational systems.

While ROMEX is advancing towards NWP experiments, this talk summarizes the first lessons learned from ROMEX:

- Acquiring and licensing data required extensive efforts with commercial providers and agencies.
- All datasets exhibit high quality sufficient for NWP experiments with proper data processing and quality control.
- Mixing datasets from different providers requires expertise on the customer/user side.
- Rawer-level data (e.g., Level 0 and Level 1) are needed for consistent data quality.
- Commercial data may face critical risks in global coverage and uniform distribution in space and time due to "launches of opportunity."

Radio Occultation Model Experiment (ROMEX)

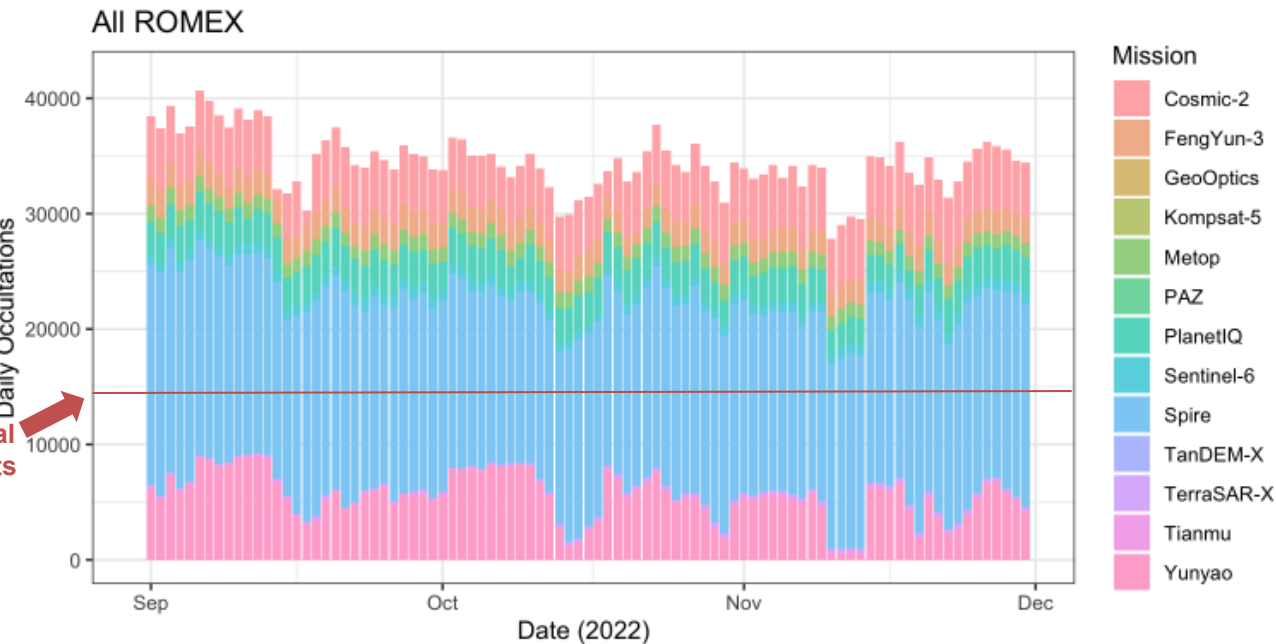
During the 9th IROWG Workshop in September 2022, IROWG endorsed a collaborative effort to collect as many RO observations as possible and to perform RO experiments within the IROWG community. This initiative aims to address pressing technical and programmatic questions and to inform near- and long-term strategies for RO missions and acquisitions by all CGMS partners.



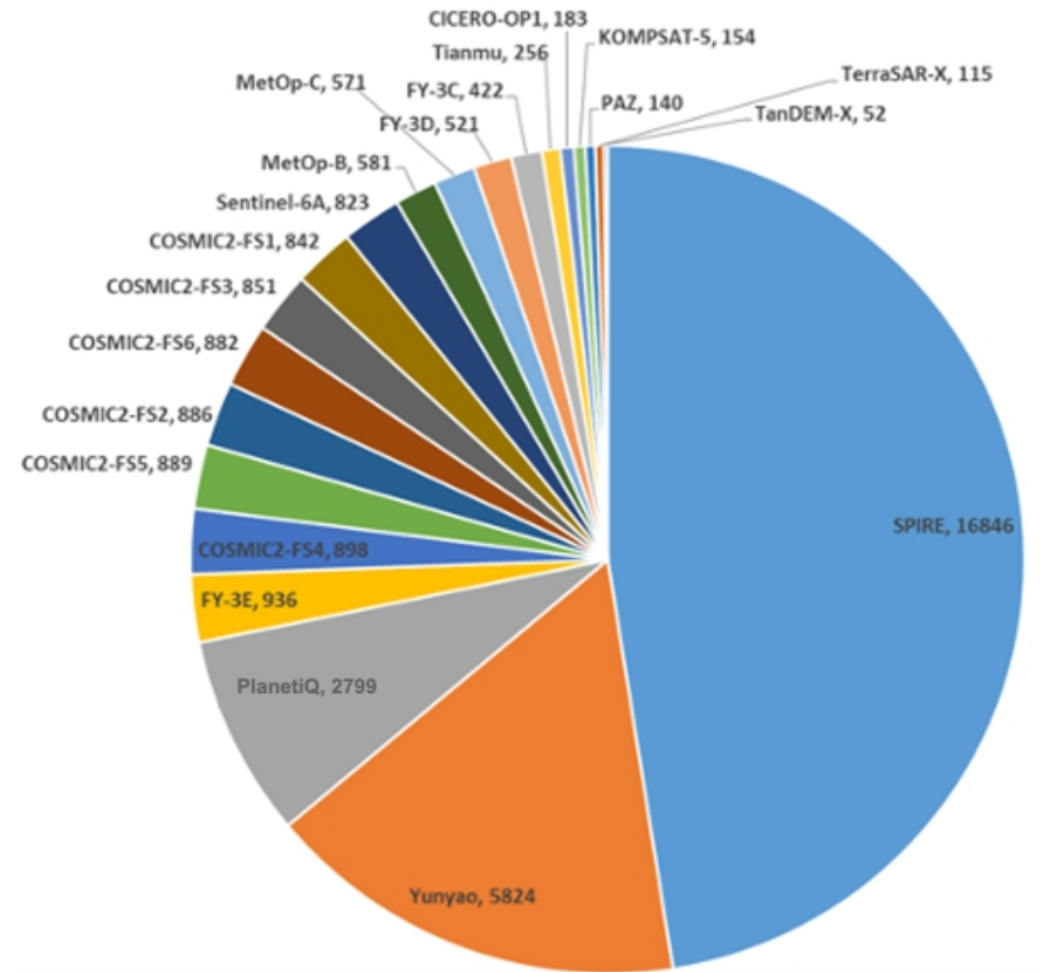
Collection of ROMEX Observations

Processed data were released to ROMEX participants in February 2024 through the ROM-SAF

- **30,000~40,000** profiles per day for Sep-Nov 2022
- Data collected from CGMS agencies and commercial providers
- Processing performed by EUMETSAT ROM-SAF, UCAR and NOAA STAR



(C. Marquardt, EUMETSAT)



(E-H. Kim, KMA)

RO Processing and Initial Assessment

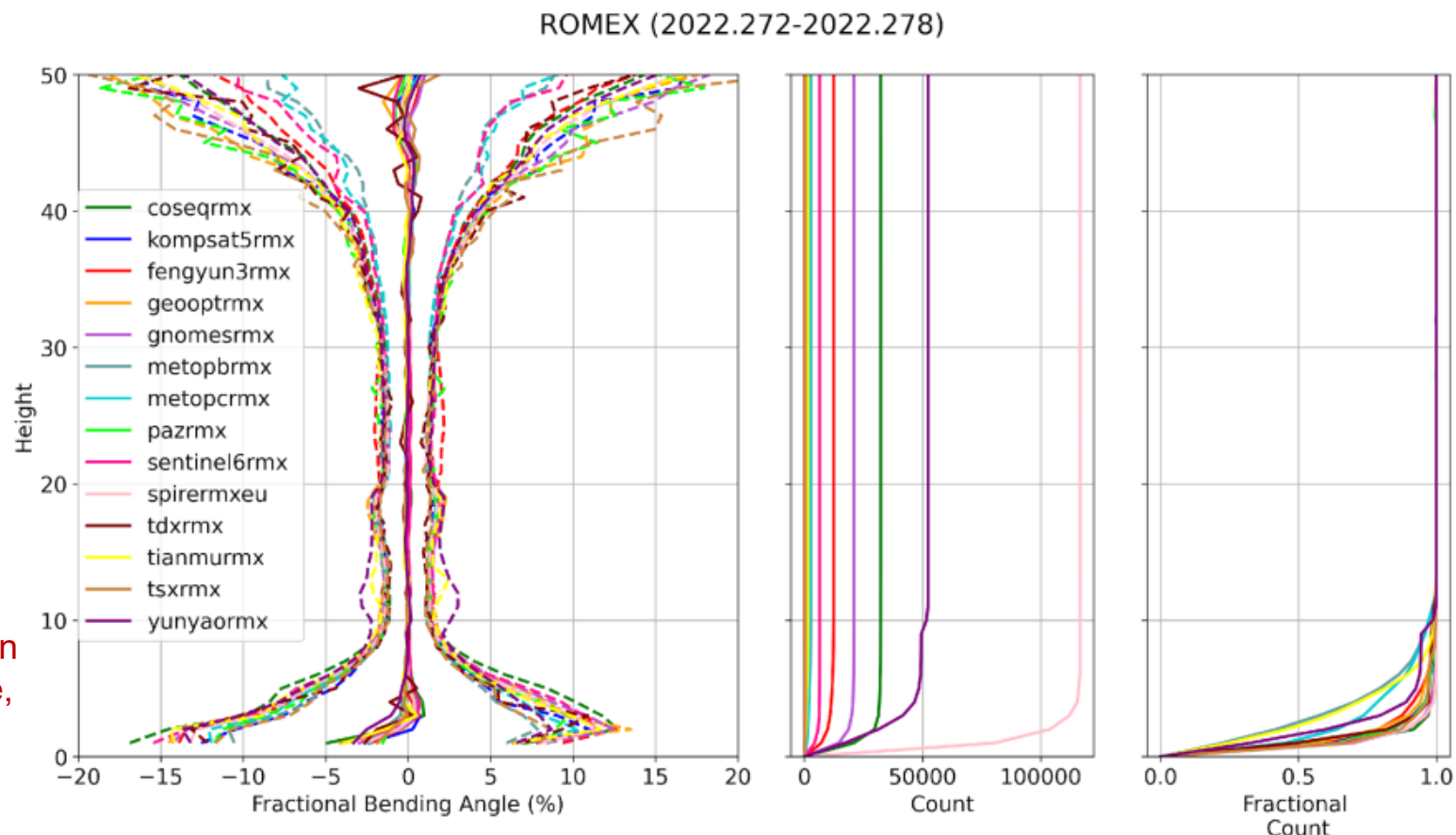
Analysis of various ROMEX missions by different groups confirms:

- All datasets exhibit high quality sufficient for ROMEX experiments.
- Differences between data from different processing centers require further analysis and are currently managed by quality control procedures at NWP centers.

Data collected from 13+ RO satellite missions differing in their orbits, instruments, spatial and local time coverage, processing procedures, and availability.

Global Bending Angles vs. ECMWF (All ROMEX Missions)

Example week shows generally consistent mean and st dev vs. altitude



(J-P Weiss, UCAR/COSMIC)

First Lessons Learned (I)

Acquiring and licensing data from different resources require extensive effort:

- Involved complex negotiations with commercial providers and agencies for data sharing and donations.
- Government support and funding were crucial for accessing certain commercial datasets.
 - NASA shifted its Spire data to a global license for the ROMEX period.
- Formalizing legal arrangements with data providers and users, including agencies, was an iterative, sometimes lengthy process.
- Overall response from data providers, data processing centers, and NWP centers has been very positive, with minimum extra funding.



First Lessons Learned (II)

All datasets demonstrate high data quality suitable for ROMEX experiments, but contingent upon appropriate data processing and quality control.

- Mixing datasets from different providers, especially commercial vendors, demands expertise to evaluate data quality and reprocess data sets.
- Maintaining expertise on the customer side, such as within agencies, is critical for consistent application across all missions and datasets.

First Lessons Learned (III)

To achieve consistent data quality:

- Reprocessing from Level 1 data (excess phase) was required for some missions.
- Some issues remain that require Level 0 data for reprocessing.

Additionally, during IROWG discussions, it was noted that:

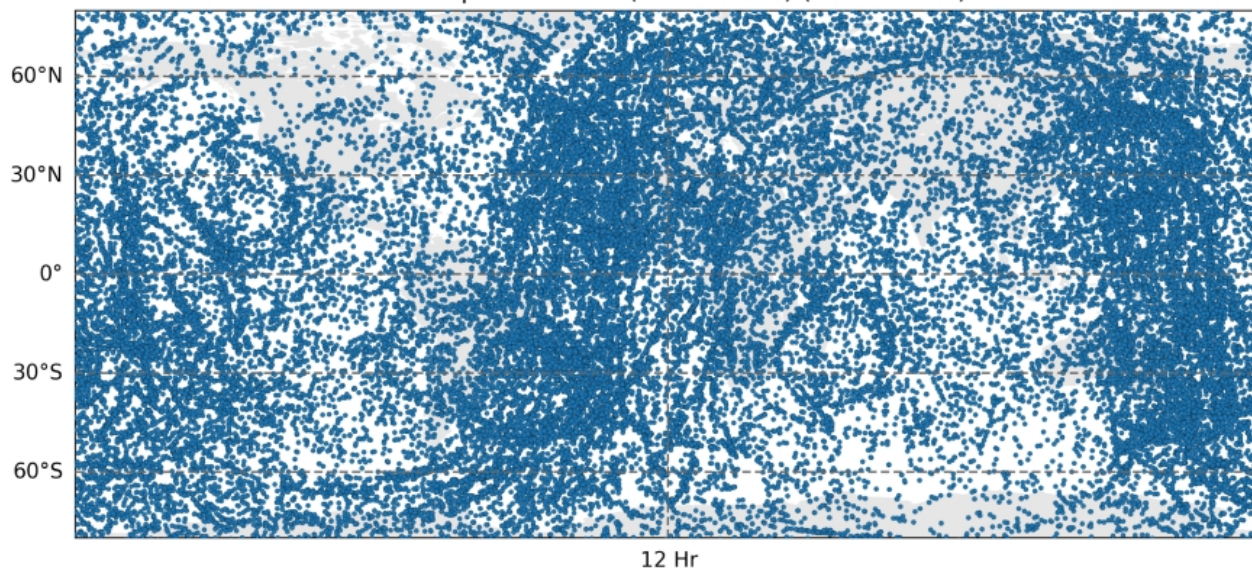
- For long-term studies like climate monitoring, having Level 0 data is crucial for maintaining consistency in data processing.
- To mitigate the risk of data loss due to vendor discontinuation, customers are advised to archive low-level data, including Level 0 data.

First Lessons Learned (IV)

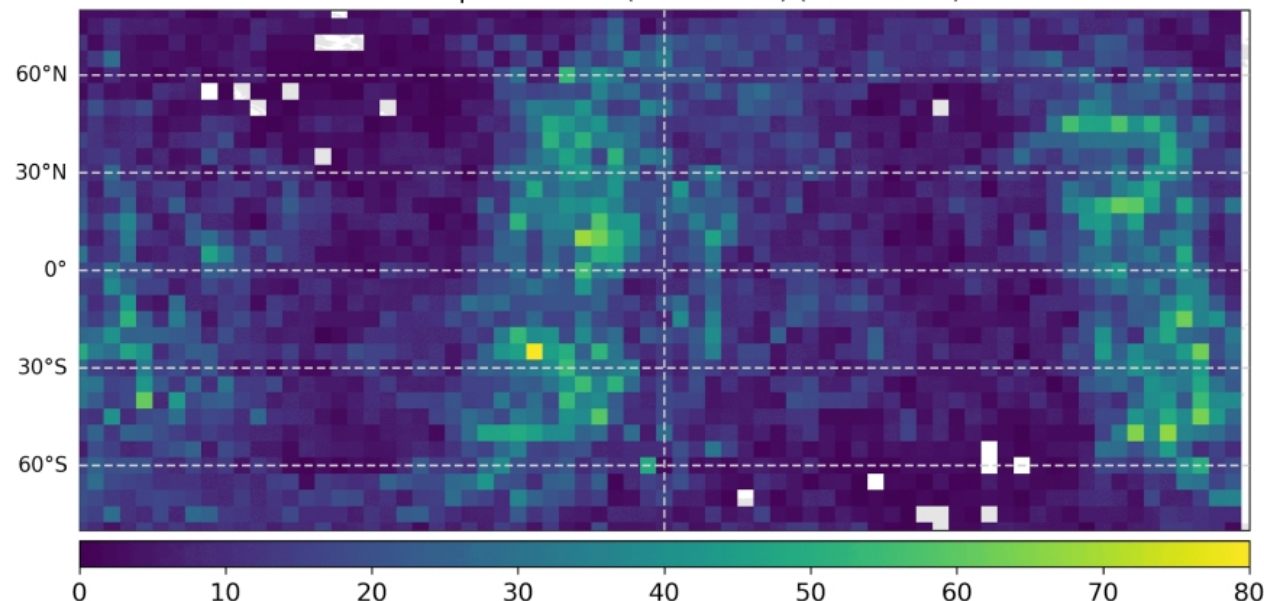
- ROMEX revealed that the local time coverage is a potential risk for using commercial data – “launches of opportunity”
- Proposed Reference HLPP 1.2.9 modification: Advance the atmospheric radio occultation constellation, with the long-term goal of providing 20000 occultations per day **with uniform spatial and local time coverage** on a sustained basis

Local Time Coverage (All ROMEX Missions)

Occ Map Local Time (All Missions) (2022-09-01)



Occ Map Local Time (All Missions) (2022-09-01)



Showing daily occultation locations (left) and daily count in 5x5 deg lat/lon bins (right)

Summary and Plans

- ROMEX has progressed well since last year.
- RO data providers have sent their Level 1-2 data (excess phase, bending angle) to EUMETSAT.
- ROMEX collected 30,000-40,000 RO profiles per day for September-November 2022.
- EUMETSAT has processed all the data and submitted the bending angle data to ROM-SAF.
- ROMEX data have been evaluated by several centers and shown to be of sufficient quality and useful for NWP.
- The NWP community has begun downloading the data since mid-February and commenced experiments. Initial results are quite positive.
- In the next few months, IROWG will continue to coordinate ROMEX NWP experiments while addressing a few technical and scientific issues. Additional data processing from various processing centers will provide more insights into data cross-validation.

We expect more conclusive results by IROWG-10 on September 12-18, 2024, in Boulder, CO, US.

Participating Institutions

Data providers:

CMA (China)
EUMETSAT (EU)
GeoOptics (US)
NASA/Spire (US, EU)
NOAA (US)
NSSC/Tianmu (China)
PlanetIQ (US)
UCAR (US)
Yunyao (China)

Processing and assessment:

AER
CMA
CWA (formerly CWB)
DMI
DWD
ECCC
ECMWF
EUMETSAT
IEEC
ISRO
KMA
Meteo France
NASA
NCEP/EMC
NESDIS/SAE/CDP
NOAA/OAR/QOSAP
NESDIS/STAR

NRL
NSSC/CAS
Spire
UCAR
UK MetOffice
UMD/CISESS
NESDIS/STAR
NRL
NSSC/CAS
Spire
UCAR
UK MetOffice
UMD/CISESS
UW



Some of us met in person at the IROWG ROMEX Workshop, 17-19 April 2024, hosted by EUMETSAT, Darmstadt, Germany