

## Key IROWG outcomes and recommendations to CGMS plenary

Presented to CGMS-49, Plenary, Results from IROWG-8 (April 7-13, 2021)

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# IROWG-8 Science Highlights (1)

- The “GPS” RO Technique is now a true “GNSS” RO Technique, where **signals from all GNSS constellations** are being exploited.
- A **better penetration into the lowest kilometers** allows for studying the **planetary boundary layer** – including tropospheric **water vapor**.
- GNSS-RO data with **high spatial and temporal resolution** allow for unprecedented studies of **atmospheric** and **ionospheric** phenomena.

# IROWG-8 Science Highlights (2)

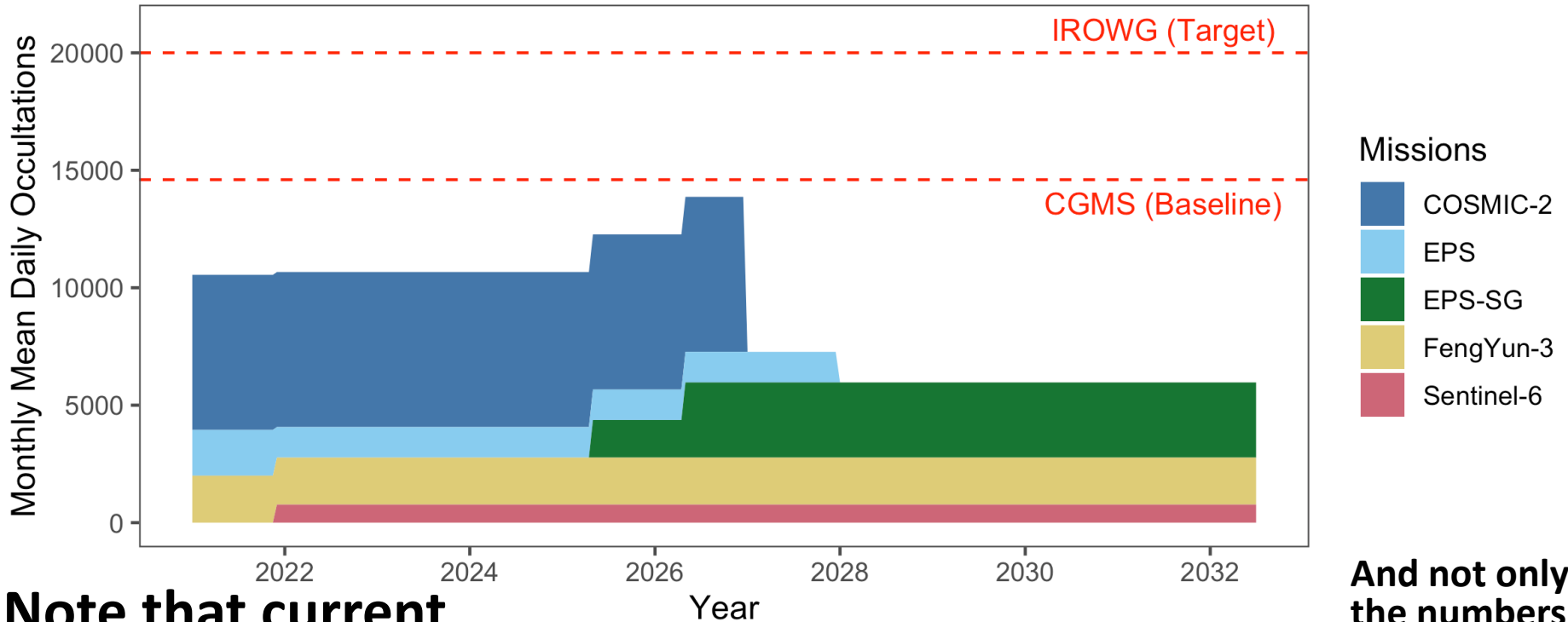
- GNSS-RO data demonstrate **high impact in NWP** – not only in the UTLS, but **also in the lower troposphere** (water vapor). This impact clearly increases with the number of high-quality profiles – without any sign of “saturation”.
- **Commercial GNSS-RO missions** have reached **operational quality** (at least in the **UTLS**), and could **help to close the identified gaps in geographic and local-time coverage** – provided that they are **made available for the scientific community**.
- GNSS-RO climate data advance **climate change monitoring** and contribute to the **upcoming IPCC assessment report**.

# IROWG Concerns

- IROWG appreciates the HLPP goal to “*Advance the atmospheric Radio Occultation constellation, with the long-term goal of providing **20 000 occultations per day on a sustained basis***”.
- But at the same time, the CGMS risk assessment is already aware that there is a **high risk of not even meeting the CGMS baseline after COSMIC-2**. This is foreseen for the time after 2030 - but it could happen earlier, and furthermore, the actual profile numbers show that the baseline cannot be met right now, and will not be easily met in the near future (see next slide).
- Commercial data *could* help to fill this gap – but only if they are made available, and if they have sufficient geographic and local-time coverage.

# Future Status of RO

Expected Monthly Mean Daily Radio Occultation Numbers  
(WMO/OSCAR with updates)



**Note that current actual numbers are smaller**

**Coordination Group for Meteorological Satellites**

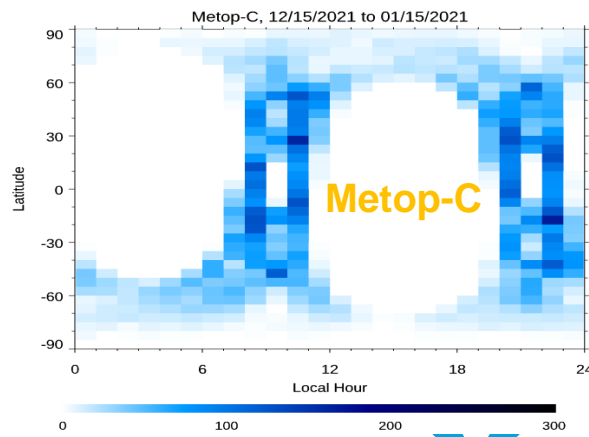
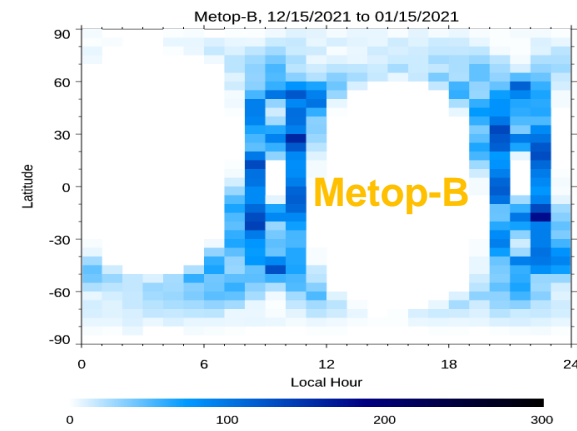
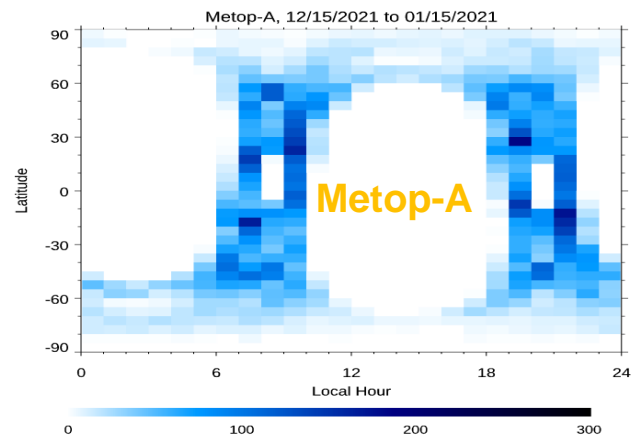
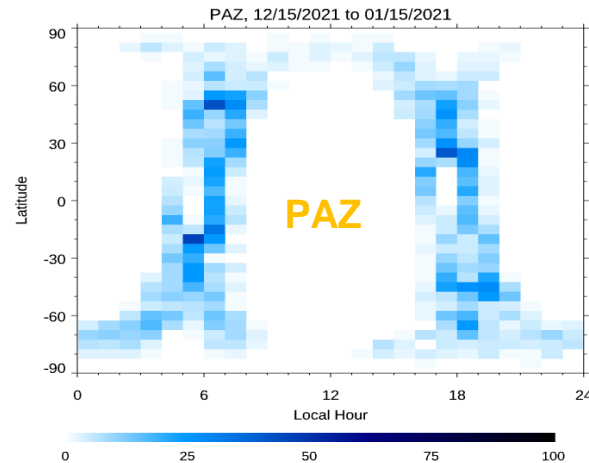
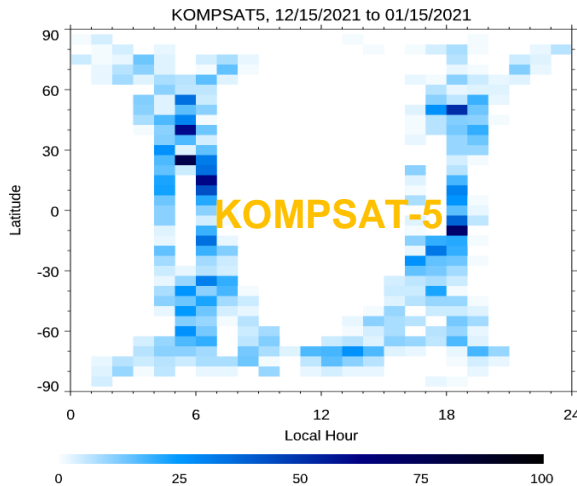
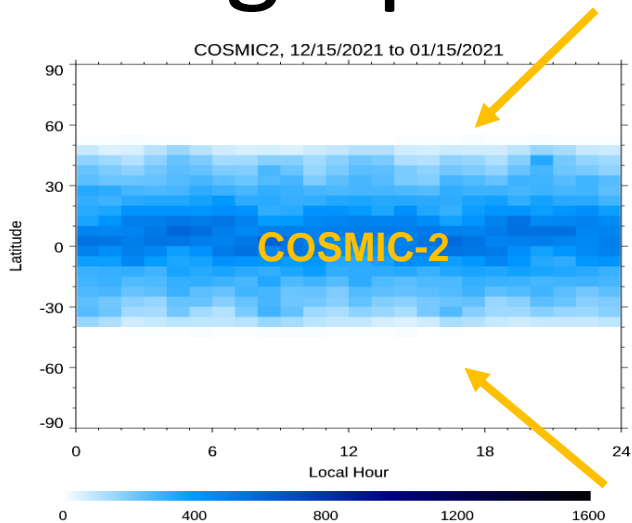
- Predicted numbers based on WMO/OSCAR
- Only operational missions with secured funding
- Nominal (baseline) mission performance
- GNSS constellations nominal

EUMETSAT (April 2021)

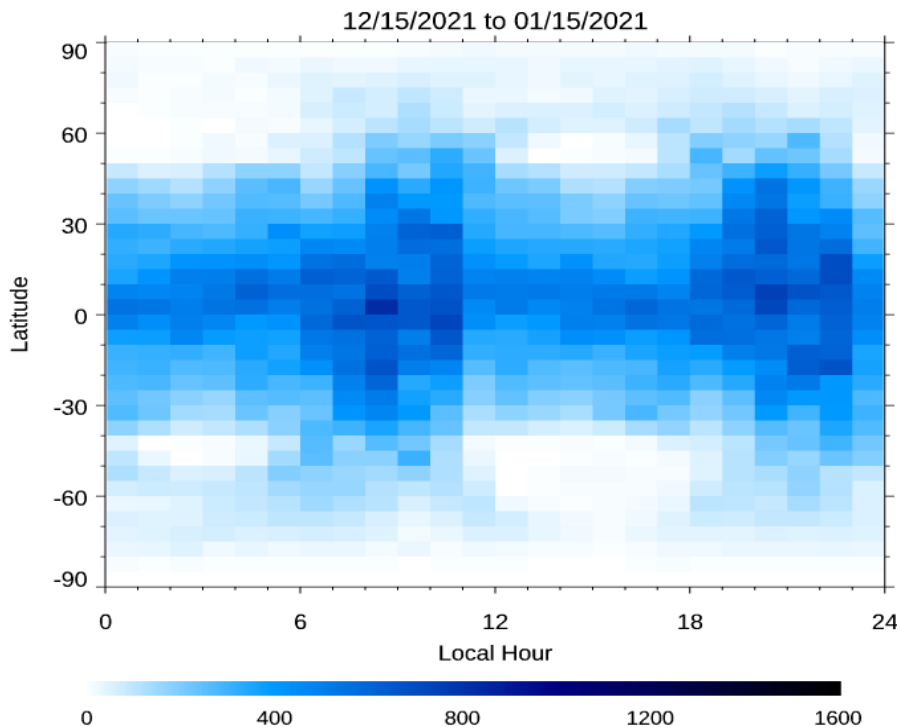
**And not only the numbers matter ...**



# Geographic and Local Time Coverage

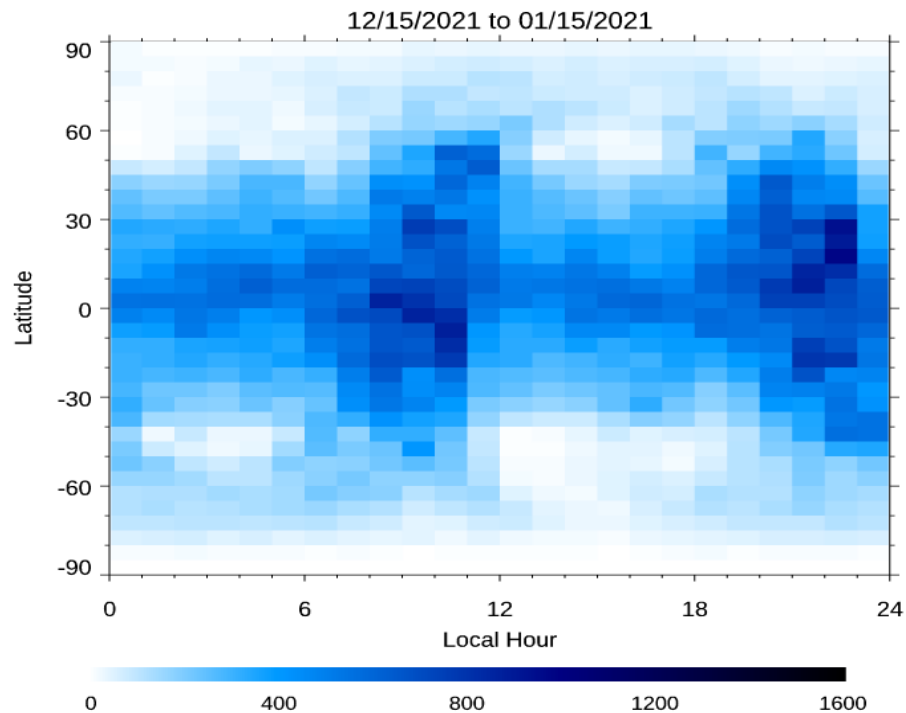


# Geographic and Local Time Coverage

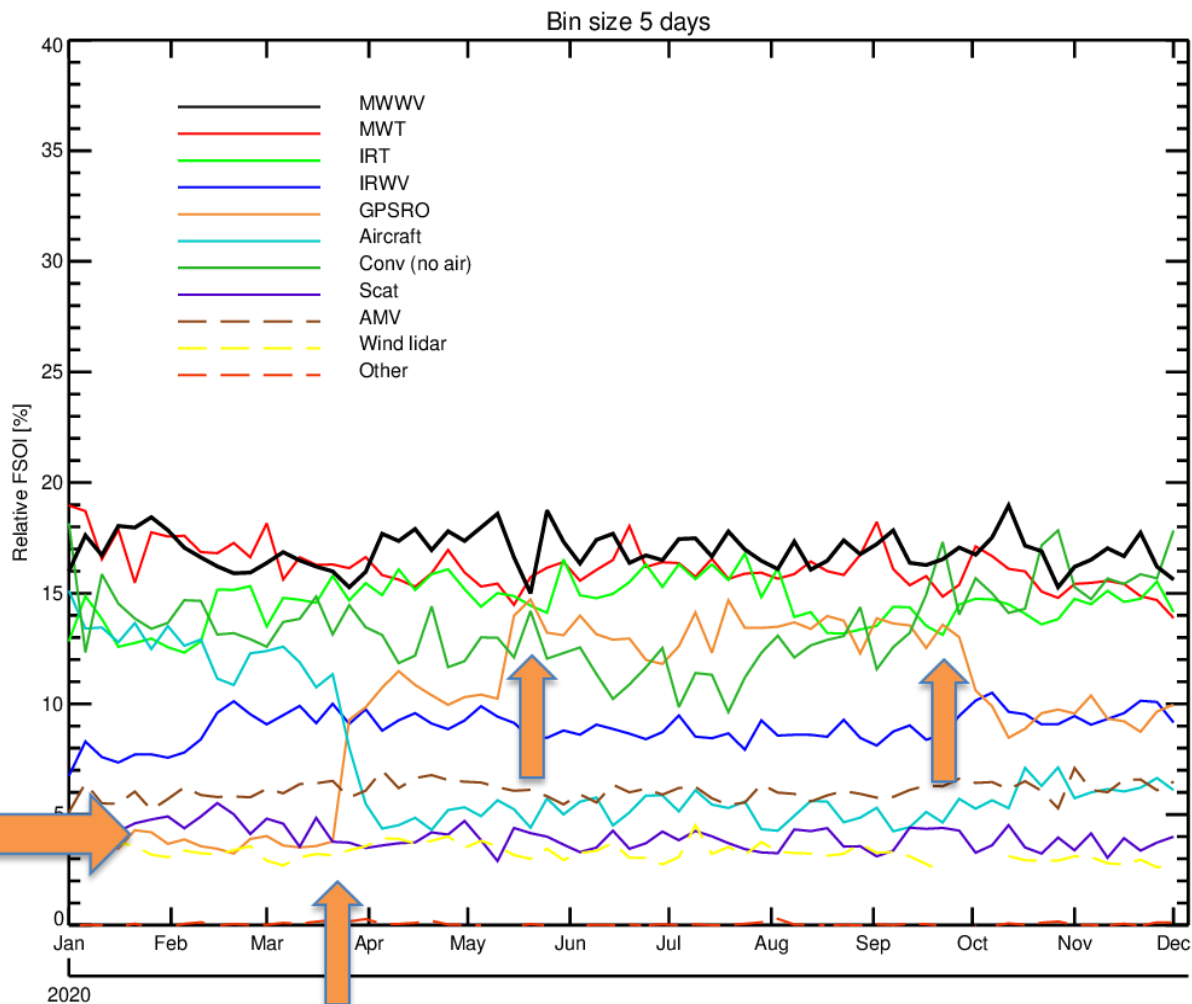


COSMIC-2 + 3 Metops + Kompsat-5 + PAZ

Note that this is **not** a good sampling of the diurnal cycle ...



COSMIC-2 + 3 Metops + Kompsat-5 + PAZ  
+ SPIRE + GeoOptics



Spire May 13 End of Spire data provision

COSMIC-2 March 25

## Impact of RO data in NWP

### Integrated measure of 24 hour forecast impact at ECMWF



### Impact increases clearly with # of RO profiles, no saturation



# IROWG-8 Discussions

- **Radio Frequency Interference (RFI)**, e.g. through GPS jammers, has been identified as a major problem.
- All of the sub-groups recognized the **importance of Level 0 (raw) data**. Raw data **should be included in data purchase plans** from commercial providers. **A working group will be formed** to develop an **exchange format for raw data**.
- **A working group will be formed** – how best to extract profile information in the planetary boundary layer.
- New RO data probe the lower troposphere better than before. **A task force for the lower troposphere will be established**. RO-derived water vapor shall be further explored as a climate variable.

# Main Recommendations IROWG-8 (1)

- (1) IROWG reaffirms that all providers of RO observations should classify these as **essential** in the sense of **WMO Res 40**. IROWG stresses the importance of **free, timely and unrestricted access in real time to essential RO data**, and free and unrestricted access to **archived raw data** (including auxiliary data). \*
- (2) IROWG continues to recommend that **WMO** and **CGMS** should **coordinate any GNSS-RO data purchases**. Specifically, we suggest **convening a meeting of all agencies considering procuring these data**, in order to discuss if, how and when the current 20,000 daily target will be met with **global and full local time coverage**.

\* Note that Rec. (1) can be **updated** to reflect WMO policy changes, e.g. **essential** ==> **core** data, at least for the 20,000 “backbone constellation”

# Main Recommendations IROWG-8 (2)

- (3) IROWG recommends that CGMS encourages technology and retrieval developments for improving **planetary boundary layer profiling** from GNSS-RO and their utilization in NWP data assimilation – and the further exploration of **RO-derived water vapor as a climate variable**.
  
- (4) Per CGMS priority HLPP 1.1.4 (optimized system for atmospheric and ionospheric RO observations), IROWG recommends that CGMS encourages on-going and future GNSS RO and non-RO missions, including potential commercial providers of RO observations, to **incorporate a complete set of ionospheric measurements**.