WGIII Risk Assessment Action
IROWG to Assess the Impact of the Decline in COSMIC Data Availability

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Coordination Group for Meteorological Satellites

IROWG INTERNATIONAL RADIO OCCULTATION WORKING GROUP

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Action Item

Action #	Actionee	AGN item	Description	Action feedback/closing document	Deadline	Status
54.01p_wgiii	IROWG	WGIII	IROWG to assess the impact of the decline in COSMIC data availability, possibly distinguishing between the respective contributions of low- and medium-inclination orbit, and analysing the number of RO required to mitigate the risk	4 June 2026 - A follow-up call will be arranged to better understand how the action item supports agency priorities - IROWG can help coordinate an assessment - The timeline for completing the assessment depends on the detailed plan for conducting the assessment	End of 2026 (9th WGIII RAWS: 24-26 Feb 2027)	**OPEN**

Timeline & Actions Taken by IROWG

Coordination & Clarification

2 - 4 June: CGMS-54 plenary assigned Action 54.01p_wgiii to IROWG.

17 June: WGIII leadership provided written clarification on scientific scope.

29 June: Coordination meeting held with CGMS Secretariat and working group leads.

Community Engagement

16 July: Internal circular solicited member inputs including publications, reports, ongoing studies, and planned work.

15 Sept: IROWG-11 plenary discussions clarified question wording and developed initial responses based on community input.

Post-IROWG-11: Continue collection of supporting materials and follow-up discussions through meeting reports and email exchanges. Initial responses are being further refined as additional results and evidence become available

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Feedback from WGIII: Scope & Key questions

WGIII has indicated that
"we do not need IROWG to weigh in on the potential acquisitions strategies for data, but rather to provide information about what data is needed to maintain capabilities and/or mitigate loss of COSMIC-2.The purpose of the action is for IROWG to provide information to WGIII in advance of the next Risk Assessment to inform WGIII discussion/evaluation of risk posed by degradation/loss of COSMIC-2 and, if needed, discussion of potential contingencies to mitigate loss of COSMIC-2. **The questions WGIII would like the IROWG to answer are**:

1. From a scientific perspective, what is the minimum number of equatorial (low inclination) RO needed to maintain current performance of operational NWP
2. Define what they mean by low inclination (clarify the orbital characteristics for low inclination so we can be sure we are all talking about the same thing)
3. Identify if there are options to use increases in the number of non-low inclination RO to mitigate the loss of COSMIC 2 and if so, to be specific about how many additional occultations (be specific about number and distribution needed). "

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IROWG's Role and Approach to Support the WGIII Risk Assessment

- IROWG recognizes that, as an international scientific working group relying on voluntary contributions, it can encourage but not require its members or the broader community to undertake new assessments. Rather, its role is to provide scientific recommendations, facilitate coordination, and compile community-contributed work to support the WGIII risk assessment.
- IROWG responses should be grounded in existing scientific evidence, supplemented by further assessments where appropriate.
- IROWG welcomes relevant publications, technical reports, presentations, ongoing or planned studies, and operational or research experience that can inform the scientific assessment of the impact of declining COSMIC-2 observations.
- IROWG continues to identify and collect relevant supporting materials contributed during and following IROWG-11 as they become available.

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Question 1: Minimum Equatorial RO for NWP

1. From a scientific perspective, what is the minimum number of equatorial (low inclination) RO needed to maintain current performance of operational NWP

From a scientific perspective, a minimum of approximately **6,000** occultations per day is considered necessary to mitigate the loss of COSMIC-2 for operational NWP. These observations should be **evenly distributed in local time** and follow a **prescribed meridional distribution**, with observations **uniformly occupying the COSMIC-2 latitude band** (approximately 40°S-40° N). The specific distribution of orbits should be defined based on user requirements including the desired revisit characteristics. For space weather applications, additional requirements need to be considered (see item 3).

Question 2: Low-Inclination Definition

2. Define what they mean by low inclination (clarify the orbital characteristics for low inclination so we can be sure we are all talking about the same thing)

There is no universally standardized definition of a low-inclination orbit. For the purposes of this assessment, IROWG suggests using an inclination of 30° as the upper threshold for defining a low-inclination orbit. For example, COSMIC-2 satellites are operated on orbits with an inclination of 24°.

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Question 3: Mitigation via Non-Low Inclination Orbits

3. Identify if there are options to use increases in the number of non-low inclination ~~RO~~ satellites to mitigate the loss of COSMIC 2 and if so, to be specific about how many additional ~~occultations~~ satellites (be specific about number and distribution needed).

Question 3: Mitigation via Non-Low Inclination Orbits (Cont.)

Existing studies suggest that observations from higher-inclination or sun-synchronous orbits (SSOs) could help mitigate the loss of COSMIC-2, although their effectiveness is application-dependent.

For operational **NWP**, approximately **two to three times the number of satellites (i.e, 12-18 satellites) in SSO or mid-inclination orbits** could provide a local time coverage equivalent to that of COSMIC-2 in the tropics, but would require satellites to be **distributed across separate and evenly distributed orbital planes**.

A similar factor applies to **TEC** applications, with the additional requirement of approximately **30-minute latency**.

For **scintillation** applications, ionospheric measurements from SSO are less effective by approximately a factor of three in geolocating scintillation events, due to the orientation of the RO geometry. Therefore, approximately **nine times the number of satellites from SSO, with additional requirement of approximately 30-minute latency,** may be required to maintain comparable effectiveness for scintillation applications.

Additional Notes

- Evidence-based initial response: IROWG has compiled available studies, community assessments, and operational experience to address WGIII's questions on the impact of declining COSMIC-2 data availability and potential mitigation options.
- Limitations: The assessment is largely based on current operational NWP experience. It does not yet establish whether, or to what extent, increased RO observations at higher latitudes could compensate for the loss of tropical observations. The available studies also use different assumptions, orbit configurations, and performance metrics, limiting direct comparisons.
- Interpretation: The estimates should be viewed as guidance based on currently available evidence, rather than definitive constellation-design requirements. Requirements may differ across applications, including NWP and space weather.
- Next steps: IROWG will continue collecting relevant studies, results, and operational experience from the community, encourage further assessments where appropriate, and incorporate additional evidence into future discussions.

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Additional Slides

Selected Supporting Studies Available at the Time of Report Preparation

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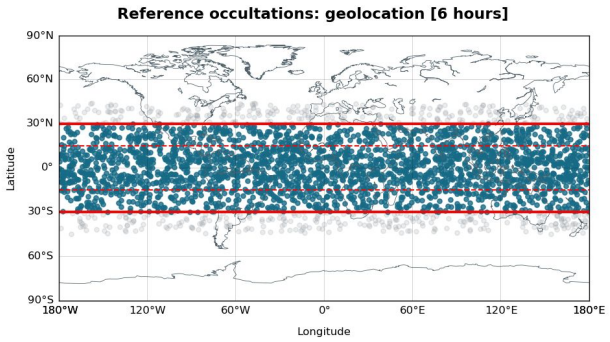
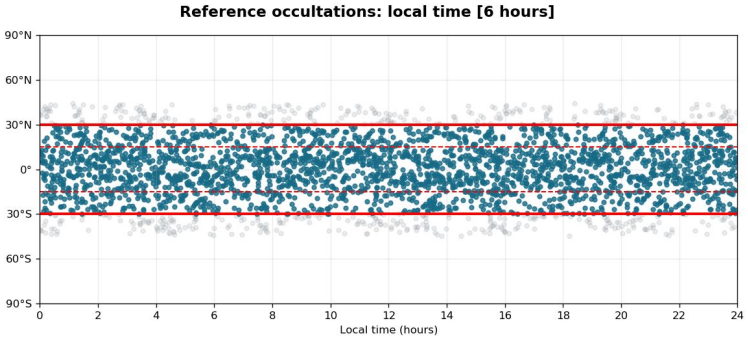
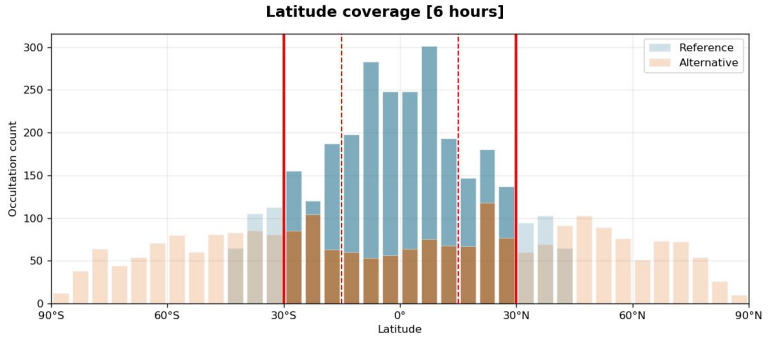
EUMETSAT

- Sancho, F., C. Marquardt, A. von Engeln, P. Cozinheiro, E. Lasota, F. Martín Alemany, R. Notarpietro, S. Padovan, S. Paolella, and V. Rivas Boscán, Analysis of Potential Alternatives to COSMIC-2 Occultations, 11th International Radio Occultation Working Group (IROWG-11) Workshop, September 2026 (Updated results provided on November 10, 2026)

COSMIC-2

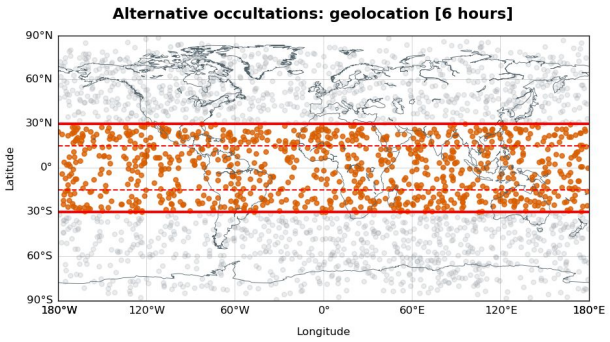


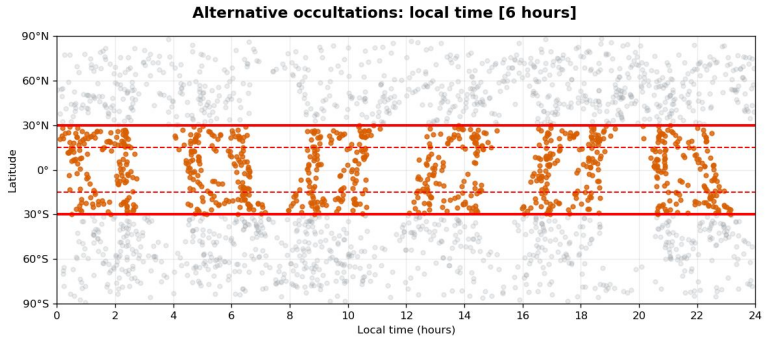


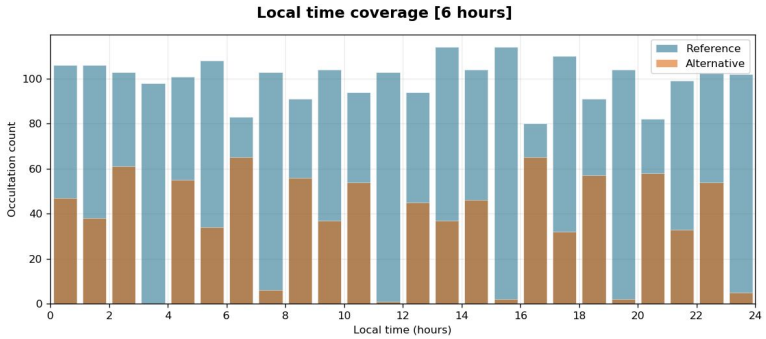


SSO: 3 planes

1 satellite per plane, 1hr separation between planes, Max Azimuth: 65deg

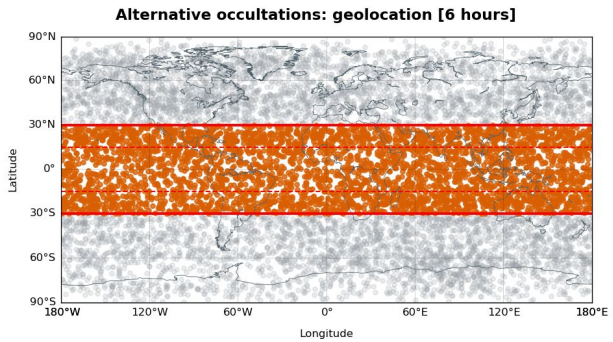


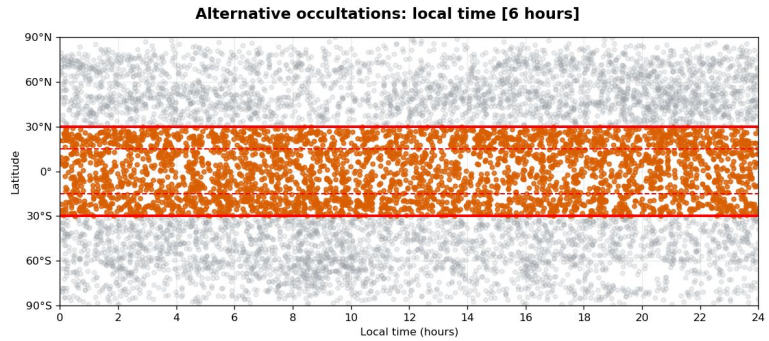


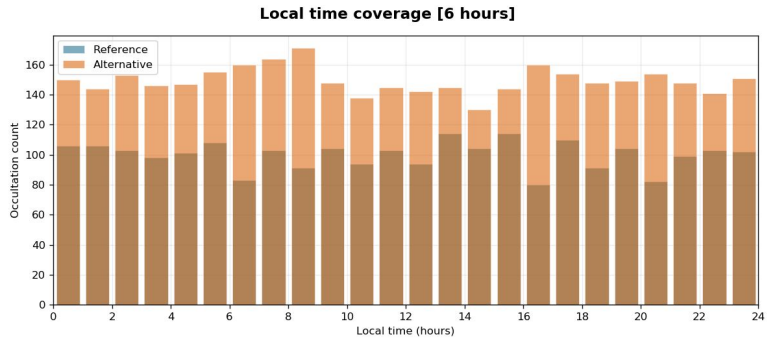


SSO: 12 planes

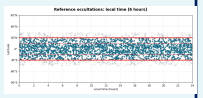
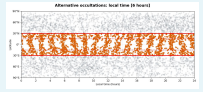
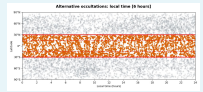
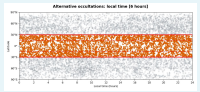
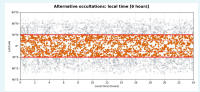
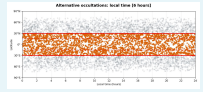
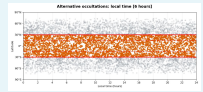
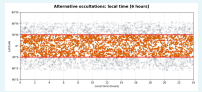
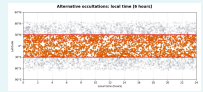
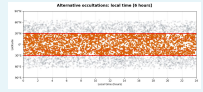
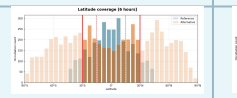
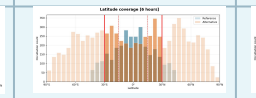
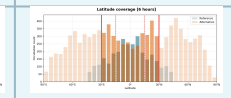
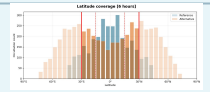
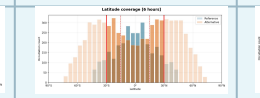
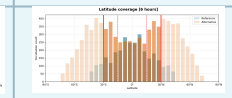
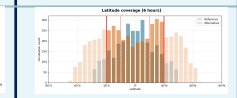
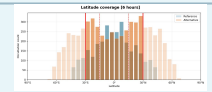
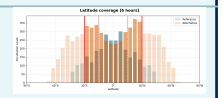
1 satellite per plane, 1hr separation between planes, Max Azimuth: 65deg







EUMETSAT (Cont)

	Reference	Polar Sun-synchronous			53deg inclination			45deg inclination		
Number of **evenly spaced** planes	6	8	10	12	8	10	12	8	9	10
Daily occultations (15ºS – 15ºN)	5884	4152	5164	6256	4108	5056	6124	4832	5544	6180
Daily occultations (30ºS – 30ºN)	9588	9544	11904	14348	9616	12152	14388	11452	12856	14360
Daily occultations (global)	11768	25948	32300	38896	21820	27312	32788	21364	23988	26668
Occultation distribution in local time (6 hours)										
Latitude bin coverage (6 hours)										

- Reminder: Alternative scenarios assume **four** GNSS constellations vs. the **three** used by COSMIC-2 (which does not track Beidou).
- Similar number of tropical occultations as COSMIC-2 with even distribution in local time requires, for the analysed scenarios:
  - About **twice the amount of satellites** in evenly distributed orbital planes.
  - Between **two and four times** the amount of global **occultations**.
- **Mixed polar + mid-inclination constellations do not help reduce the number of required satellites** or orbital planes due to the nature of the gaps in local time (fixed for polar, moving for mid-inclination).

NOAA

- NOAA NESDIS, 2025: Radio Occultation Architecture Analysis of Alternatives, Phase 1: Executive Summary. NESDIS-RPT-8010.1, January 2025. Link here
- Laudier, N., C. Barsoum, W. Gullotta, S. Schnee, J. P. Weiss, M. R. Gasbarro, C. Pan, and G. Peltzer, 2026: NOAA NESDIS Global Navigation Satellite System Radio Occultation Planning for the Future. 22nd Symposium on Operational Environmental Satellite Systems and 27th Conference on Satellite Meteorology, Oceanography, and Climatology, 106th AMS Annual Meeting, American Meteorological Society

The NOAA AoA study evaluated whether conventional sun-synchronous orbits (SSOs) could provide a COSMIC-2-like alternative using **rideshare launches**, assuming only t**hree available local-time configurations** (early morning, morning, and afternoon). Using a 30°S–30°N equal-area grid and a maximum 18-month deployment period with a 200-km altitude differential, the study found that **three orbital planes with six satellites each (18 total)** could meet the **specified refresh/distribution and deployment requirements**. However, the resulting coverage was bimodal, with some local-time bins overpopulated and others underpopulated, leaving gaps in local-time coverage. Thus, even this configuration does **NOT ensure balanced temporal sampling** comparable to COSMIC-2.

NASA

- Privé, N. C., C. Barsoum, D. Hunt, M. J. Murphy, R. Anthes, W. Gullotta, and N. Laudier (2026), Impact of Two Radio Occultation Constellations on Numerical Weather Prediction: Polar-Orbits Only and Mixed Polar-Equatorial Orbits, *Earth and Space Science*, *13*(10), doi:10.1029/2026ea005114.
- Privé, N., **C. Barsoum**, D. Hunt, M. Murphy, R. Anthes, W. Gullotta, and N. Laudier, 2026: Spatiotemporal Resolution in Radio Occultation: The Interdependent Design Loop Between Weather Model Performance and Constellation Design. 11th International Radio Occultation Working Group (IROWG-11) Workshop, September 2026.

Using OSSEs, the study compared polar-only and mixed polar-equatorial RO constellations, each providing 14,000 profiles per day. These **represent contrasting orbital sampling approaches rather than an optimization of constellation architecture or a replication of COSMIC-2**'s coverage and temporal distribution. The mixed configuration generally delivers greater **NWP benefits through improved tropical coverage and more uniform local-time sampling**, while polar-only orbits retain advantages near the poles. The results **highlight the importance of geographic and temporal sampling**, beyond total daily profile numbers, in future RO constellation design.