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| WEATHER CLIMATE WATER | **World Meteorological Organization**  **COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS**  **First Session (Third Part)** 12 to 16 April 2021, Virtual Session | **INFCOM-1(III)/ Doc. 5.1.1(1)** |
| Submitted by: Secretary-General  26.III.2021  **DRAFT 2** |

**AGENDA ITEM 5: TECHNICAL REGULATIONS AND OTHER TECHNICAL DECISIONS**

**AGENDA ITEM 5.1: Recommendations from INFCOM Standing Committees and Study Groups**

***AGENDA ITEM 5.1.1: Standing Committee on Earth Observing Systems and Monitoring Networks (SC‑ON)***

**Satellite Data Requirements for Global   
Numerical Weather Prediction**

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| **Summary** | |
| Reference: | [Decision 9 (INFCOM-1(II)](https://meetings.wmo.int/INFCOM-1-III/SitePages/Session%20Information.aspx) |
| Strategic Objective: | 1.4, 2.1, 2.2 |
| Recommended by: | SC-ON |
| Recommended for: | ☐ Adoption without debate ☒ Adoption with debate |
| Financial implications: | Operating Plan 2021, Output N/A |
| Content: | 1 Decision |
| Related INF(s): | N/A |
| Main changes to previous version: | [For DRAFT 2, 3, etc. and APPROVED versions only] |

# DRAFT DECISION

## Draft Decision 5.1.1(1)/1 (INFCOM-1(III))

### Satellite Data Requirements for Global Numerical Weather Prediction

**The Commission for Observation, Infrastructure and Information Systems** **decides** to adopt the Satellite Data Requirements for global Numerical Weather Prediction (NWP) as a formal WMO Position Paper.

See the [annex](#_Annex_to_draft_1) to the present decision.

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Decision justification:

(1) [Resolution 34 (Cg-18)](https://library.wmo.int/index.php?lvl=notice_display&id=21440#.X6FpS4hKg2w) - Global Basic Observing Network (GBON), which is a subset of the surface-based subsystem of the WMO Integrated Global Observing System (WIGOS), used in combination with the space-based subsystem and other surface-based observing systems of WIGOS, to contribute to meeting the requirements of global NWP, including reanalysis in support of climate monitoring,

(2) [Decision 39 (EC-70)](https://library.wmo.int/index.php?lvl=notice_display&id=20626#.X6FpiIhKg2w) - Outcomes of the fourteenth session of the WMO Consultative Meeting on High-level Policy on Satellite Matters, in which the Executive Council, by recognizing that space-based observations are now playing and will continue to play a critical role in the ability of all Members to deliver vital services to help save lives, protect property and foster economic growth, thereby require [Hong Kong, China]that these observations be addressed under policies for international data exchange,

(3) [Decision 38 (EC-70)](https://library.wmo.int/index.php?lvl=notice_display&id=20626#.X6FpiIhKg2w) - Development of a WMO position on critical satellite data, in which the Executive Council requested the Commission for Basic Systems (CBS) to finalize the Position Paper, which outlines from the satellite user perspective which types of satellite data should be considered critical for the protection of life and property,

(4) While GBON only addresses the surface-based and in situ data contributing to meeting the requirements of global NWP underpinning WMO applications, including reanalysis in support of climate monitoring, a similar effort is required to establish the necessary space-based data complementing GBON.

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## Annex to draft Decision 5.1.1(1)/1 (INFCOM-1(III))

## Satellite Data Requirements for Global Numerical Weather Prediction

*(WMO Infrastructure Department, draft, 9 March 2021)*

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| Executive Summary The increasing demand for more advanced satellite data and products to support services across all WMO activity areas, the evolving satellite data requirements to support advances in Earth system modelling and prediction, including integration of supporting cross-disciplinary data, as well as the diversification of data providers, have triggered a renewed attention to the issue of data access and availability. Consequently, the eighteenth session of the World Meteorological Congress (Cg-18), called for a review of WMO Data Resolutions as expressed in Resolutions 40, 25 and 60. In addition, at Cg-18, WMO established the Global Basic Observing Network (GBON). GBON is a subset of the surface-based subsystem of the WMO Integrated Global Observing System (WIGOS), used in combination with the space-based subsystem and other surface-based observing systems of WIGOS, to contribute to meeting those requirements.  This document serves as the WMO response to the Coordination Group for Meteorological Satellites (CGMS) Action 47.02 “*WMO to provide a report at next CGMS on baseline requirements for satellite products for global NWP, to trigger a CGMS discussion on status of delivery of such observations and possible improvements in the future and inclusion in the CGMS baseline document”.* It reflects the WMO position on the baseline satellite data requirements as expressed by the global NWP community and identifies the backbone and additional data and associated user requirements needed to complement the GBON in meeting a backbone observation system for global Numerical Weather Prediction (NWP). Whilst Global NWP underpins many WMO application areas, this paper does not address observation user requirements in other application areas other than those met via their use in Global NWP, and it is recommended to address these in separate position papers. |

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### Introduction

Extensive developments in remote sensing over the last three decades have led to more advanced, timely, and diverse satellite observations. This, combined with an evolving need for cross-disciplinary data to support Global NWP to support Earth system modelling and prediction, as well as the diversification of data providers, and new applications of Global NWP such as climate reanalysis, have triggered a renewed attention to the issue of data access and availability. The Earth system approach in Global NWP relies heavily on satellite data as defined in the Vision for the WMO Integrated Global Observing System in 2040 WIGOS VISION ([WMO-No. 1243](https://library.wmo.int/index.php?lvl=notice_display&id=21716#.YFL1f69KiUk)) (hereafter referred to as WIGOS Vision 2040).

Here NWP includes Earth system aspects of Numerical Weather Prediction where they support the goal of operational weather forecasting, but in this paper excludes Earth System Numerical Prediction in its own right. It is important to recognize weather prediction now needs a description of the full Earth system and hence Earth system observations.

This Position Paper uses some terminology consistent with the nomenclature of the WMO Vision 2040. In the WIGOS Vision 2040 the term **“backbone”** is defined to identify the user requirement for satellite data and products required by state-of the art global NWP forecast systems to support the WMO application areas, including protection of life and property. In addition, national and international agencies may operate innovative observations which may not have been envisaged in the Vision, and make these available, and some are subsequently used in Global NWP. There is no commitment to these in the WIGOS Vision 2040, so they are not backbone, but they become valuable to users. The term **“Additional”** describes these satellite data and products. Once established and used, the user requirement by global NWP for these is the same as for backbone observations, to support WMO programmes at the global, regional and national levels to assist other Members in the provision of services in their countries.

Furthermore, the document consolidates the key principles WMO recommends space agencies consider with respect to the collection and provision of backbone satellite data to complement the GBON in meeting the basic needs of global NWP supporting operational meteorology and other application areas. It should be noted that the full exploitation of the capabilities of space-based observations can only take place if supported by adequate high-quality in situ and surface-based observations as provided by GBON and other networks e.g. the Global Ocean Observing System.

### Purpose of this document

This Position Paper serves as the WMO response to the Coordination Group of Meteorological Satellites (CGMS) Action 47.02 *“WMO to provide a report at next CGMS on baseline requirements for satellite products for global NWP, to trigger a CGMS discussion on status of delivery of such observations and possible improvements in the future and inclusion in the CGMS baseline document”*.

This Position Paper reflects the user requirements for backbone and additional satellite data recommended to support global NWP and outlines the baseline satellite data required for global NWP as expressed in the two tables below: Backbone Satellite Data for Global NWP and Additional Satellite Data for Global NWP. Moreover, this Position Paper provides CGMS Members with a consolidated list of the principles, standards and best practices from key WMO publications most relevant to space segment providers.

This backbone data is to support state-of-the-art global NWP systems within an Earth system modelling approach across the WMO application areas as defined by the WMO Rolling Review of Requirements and Statements of Guidance[[1]](#footnote-1), including the protection of life and property. In addition, this document is intended to guide the associated updates to the Manual on the WMO Integrated Global Observing System ([WMO-No. 1160](https://library.wmo.int/index.php?lvl=notice_display&id=19223#.YFJbuq9KiUk)).

### Background

Today, global NWP model systems underpin most WMO application areas. Whilst this paper only focused on global NWP user requirements, users of other application areas often benefit from the investment in satellite data via global NWP. Therefore, if we address global NWP user requirements, we partly meet requirements in other application areas. This is particularly true now that global NWP takes an Earth system approach. However, it is important to recognize that these application areas will have additional requirements not reflected here, and different to global NWP user requirements. It would be useful to develop position papers to reflect this wider use of satellite observations across all WMO application areas.

The rapid pace of technological advancement in Earth remote sensing provides new opportunities for the provision of observations within the WMO Integrated Global Observing System (WIGOS). The opportunities include access to cross-disciplinary data collected by WMO Members, innovative approaches facilitated by the sharing of detailed technical specifications and metadata, and the potential for cost-effective access to data from commercial and research missions. Fully exploiting these opportunities to maximize benefits from global NWP will necessitate new approaches to cross-disciplinary data sharing within and among Member states, clear delineation between backbone and additional satellite data and products, exploration of public-private partnerships and mitigate the risk:

● Members will remain responsible for the implementation of space-based observational needs consistent with the prevailing WMO data sharing policies as well as the principles and best practices for the collection, sharing and archiving of satellite data outlined in the *Manual on the WMO Integrated Global Observing System: Annex VIII to the WMO Technical Regulations* ([WMO-No. 1160](https://library.wmo.int/index.php?lvl=notice_display&id=19223#.YFJbuq9KiUk)) and CGMS — *WMO Guidelines on Best Practices for Achieving User Readiness for New Meteorological Satellites* ([WMO-No. 1187](https://library.wmo.int/index.php?lvl=notice_display&id=19875#.YFJbb69KiUk), 2017 Edition). Members can maximize the value of space-based observations to the WMO community by working across their respective governments and with private sector partners to highlight, inter alia, the principles outlined in this Position Paper;

● Minimize limitations on the exchange of backbone satellite data, at a minimum meeting the data sharing requirements of the prevailing WMO data sharing resolutions;

● Sustain backbone and additional satellite observations and products for long-term national or regional programmes, essential to meet national, regional, or global requirements;

● Provide detailed technical specifications of all space-based observing systems to support the traceability, reliability, and credibility of the science behind the data, and encourage user uptake and readiness; and

● Consider innovative solutions for the efficient and cost-effective exchange of the diverse types and increasingly large volumes of data from new satellite systems.

International exchange of observational data among Members in near real-time and as soon as possible after launch has been critical for the significant advances over the past decades witnessed in meteorology and related sciences, having led to improved skills of global prediction model systems and improved numerical forecasts and warnings. The success of weather forecasting and warnings relies on the near-real time availability of global observational data because they are a prerequisite for weather forecasting with numerical models. There is strong inter-dependence among global production centres and National Meteorological or Hydrological Services (NMHSs) in delivering and exchanging high-quality forecast products. Many studies on the benefit of observations — notably on satellite observations — have demonstrated how much modern societies gain from weather forecasting and continuous weather awareness, e.g. for risk reduction and planning of many weather dependent activities. This has been achieved mainly due to global cooperation, duly considering the global nature of the discipline. Global data exchange will remain a key prerequisite to inform global and regional applications, and the data policies of satellite data providers should facilitate such exchange. Finally, it should also be noted that increasing volumes of global satellite data may in the future present challenges to exchange the global data in real or near real-time.

WMO guides the provision of observational data by all Members through defined data policies, standards, data sharing resolutions and best practices for user readiness highlighting the importance of data quality and interoperability standards, and advocating full visibility of the science behind the data.

Future evolution of the global NWP user requirements

This Position Paper captures the established requirements for the exchange of satellite data for global NWP today with a view to the next 5–10 years, as confirmed by WMO Expert Teams, relevant international working groups and leading NWP workshops such as the 7th WMO Workshop on the Impact of Various Observing Systems on NWP (NWP7) and the 22nd International TOVS Study Conference (ITSC). Furthermore, the Position Paper aligns itself with the WMO Rolling Review of Requirements and the WIGOS Vision 2040. As Earth system monitoring and global NWP will, with a stronger coupling between different domains of the Earth system, continue to evolve in the coming years, data from existing or new sensors that previously have not been part of the backbone system, will become such. It is important to note that this Position Paper will have to be reviewed regularly by the key entities in order to maintain a user-focused consensus on the requirements and discussed with the CGMS Space Agencies for their consideration regarding the CGMS baseline.

It is therefore foreseen that the WMO Expert team on Satellite Systems (ET-SSU) and Utilization will maintain ownership of the user requirements and will review their adequacy on a regular basis and propose new releases to the Position Paper as required. Such reviews and updates will be aligned with major user events discussing the impact of observations, in particular the space-based component, on global NWP and Earth system modelling, specifically those mentioned above, and would take place at a minimum every four years. WMO commits to provide CGMS with an update in 4 years, or when there is a significant evolution in the use of satellite data in global NWP, update to the relevant WMO data sharing policies and/or associated technical regulations, whichever comes first.

Principles for Backbone and Additional Satellite Data

3.7 The following principles, should apply to Members providing backbone satellite data and products from the users’ perspective. The reference is to the associated principles as given in the *Manual on the WMO Integrated Global Observing System* ([WMO No. 1160](https://library.wmo.int/index.php?lvl=notice_display&id=19223#.YFL4ZK9KiUk)). Furthermore, the WMO *Guidelines on Best Practices on Achieving User Readiness for New Meteorological Satellites* ([WMO-No. 1187](https://library.wmo.int/index.php?lvl=notice_display&id=19875#.YFL4q69KiUk)), are relevant to principles 3, 5 and 6:

**Principle 1 (WM4.5.2.1):** Share globally with all global NWP centres all backbone satellite data acquired for global NWP in real time or near real-time consistent with WMO Data Policy.

Rationale: International exchange of meteorological and related data has been the foundation for advances of the meteorological enterprise and will continue to be critical for state-of-the-art global NWP that benefits all Members.

**Principle 2 (WM4.5.3.1):** Document instrument characteristics and processing steps.

Rationale: Understanding all aspects of the basic observational data is critical to ensure their correct usage and positive contribution in applications. For this purpose, information about instrument properties and advance notification on their change over time (due to degradation, for example) is required to be able to discern observing system effects from changes in the observable, and to quantify uncertainty.

**Principle 3 (WM4.8.4.1):** Engage with users and document potential impact on applications when developing new satellite systems, products, or ground systems.

Rationale: Providers of satellite data should directly address and respond to user requirements in the definition phase of the satellite system and ensure the demonstration of the potential positive impact in applications.

**Principle 4 (WM4.5.3.1):** Document algorithms and information to support user validation and calibration of the data.

Rationale: To correctly apply data and products, and to validate uncertainties, information about the algorithms and validation and calibration procedures is critical.

**Principle 5 (WM4.8.3.1):** Provide information on planned and achieved data timeliness, data format and processing tools availability.

Rationale: Users need to know the time delay between acquisition and availability of data with users, as well as the data format and metadata that are indispensable to correct data. Many users benefit from processing tools delivered alongside data, especially if they do not have their own processing and analysis systems.

**Principle 6 (WM4.5.1.1):** Provide timely pre-operational data to users before formal release.

Rationale: To accelerate and streamline the ingestion of data from new or upgraded space-based systems into applications, users require a preview of various forms of preliminary data with associated information on data quality. These include synthetic data, simulated data, proxy data, and pre-operational data.

**Principle 7 (WM4.5.3.3):** Maintain and provide unrestricted access to satellite data archives including all relevant metadata pertaining to the location, orbit parameters and calibration procedures used.

Rationale: Members should allow unrestricted and user-friendly access to archived data, including metadata consistent with WIGOS Metadata Standards, to enable non-real-time applications, and the generation of climate data records. Quality assurance processes, version control and regular reprocessing of data should be the norm.

**Principle 8 (WM4.1.5):** Plan for sustained data provision.

Rationale: Operational WMO applications require the provision of data on a long-term basis: climate applications require multi-year datasets which are generally based on the continuity of comparable observing approaches; NWP centres’ investments in data exploitation are generally only cost-effective if the data are available for a long time period (typically five years).

**Principle 9 (WM4.3.1.3):** Provide calibrated data with complete and traceable estimates of stability and uncertainty that are linked to the International System of Units (SI) standards.

Rationale: NWP and reanalysis assimilation procedures rely on information on random and structural errors of the assimilated data. The same applies for providers that use satellite data to derive Essential Climate Variables.

**Principle 10 (goes beyond WM4.1.5[[2]](#footnote-2)):** Maintain space-based assets beyond the design lifetime as long as they provide value added observations on a safe and affordable basis as determined by the operating agency.

Rationale: As new satellites are launched in order to ensure continuity of space-based observations, it is important to note that the older satellites are not only valuable as providing parallel data for the transition or as a backup capability, they also may provide significant valuable data of their own. This has been repeatedly demonstrated by several operational satellite systems and it is therefore important to maintain those satellites, and their data processing systems, at an operational level with NRT access to the data when feasible. Prior to decisions on satellite termination, satellite operators should engage with the user community to establish the value of the data.

Description of the space-based observing system components

3.8 This section provides the description of the space-based components as given in the WIGOS Vision 2040 ([WMO-No. 1243](https://library.wmo.int/index.php?lvl=notice_display&id=21716#.YFL1f69KiUk)). It is introduced here to improve readability of this document and in order to provide the reader with an easy access to the terminology used in the subsequent tables.

3.9 The proposed space-based component consists of four main subcomponents. Three of these are applicable to the WIGOS Vision 2040. The fourth includes additional capacities and capabilities that may emerge in the future.

3.10 Rather than giving strict stipulations for each subcomponent, a balance has been struck between providing enough specificity to describe a robust and resilient system and accommodating potential new capabilities arising from unanticipated opportunities.

**Subcomponent 1:** Backbone system with specified orbital configuration and measurement approaches:

* This subcomponent shall provide the basis for Members’ commitments and should respond to their vital data needs,
* It shall build on the current CGMS baseline (CGMS Baseline — Sustained contributions to the Global Observing System, Endorsed by CGMS-46 in Bengaluru, June 2018, CGMS/ DOC/18/1028862, v.1, 20 December 2018) but have fully deployed (global) coverage and newly maturing capabilities,

**Subcomponent 2:** Backbone system with open orbit configuration and flexibility to optimize implementation:

* This subcomponent shall be the basis for the open contributions of WMO Members and shall respond to target data goals,

**Subcomponent 3:** Operational pathfinders and technology and science demonstrators:

* This subcomponent shall respond to research and development needs,

**Subcomponent 4:** Additional capabilities:

* This subcomponent shall include additional contributions by WMO Members, as well as from the academic and private sectors.

3.11 The division of the observing capabilities into four subcomponents does not imply sequential priorities, that is, it is not expected that all Subcomponent 1 systems will necessarily be realized before elements of other subcomponents are addressed.

3.12 The main distinction between the various subcomponents is the current level of consensus about the optimal measurement approach, especially the demonstrated maturity of that approach: there is stronger consensus for the capabilities included in Subcomponent 1 compared to those in Subcomponent 2, and so forth. It is likely that the boundaries between the groups will shift over time, for instance, some capabilities currently listed in Subcomponent 2 could transfer to Subcomponent 1.

The following table defines the set of **backbone** satellite data that are required in near-real time by global Numerical Weather Prediction (NWP) systems, underpinning WMO application areas, and made available to all global NWP centres consistent with WMO Data Policy. These are a subset of the overall capabilities defined within the WIGOS Vision 2040, and mainly captured in subcategories 1 and 2 therein. The performance of the instruments should be adequate to provide the required observational capabilities with known accuracy and uncertainty, e.g. radiances with appropriate information content useful to global NWP modelling systems. The detailed requirements are captured by the WMO Rolling Review of Requirements and maintained in the WMO Observing System Capability Analysis and Review Tool (OSCAR) Database[[3]](#footnote-3).

**Table 1: Backbone Satellite Data for global NWP**

|  |  |  |
| --- | --- | --- |
| **Geostationary core constellation with a minimum of five satellites  providing complete Earth coverage** | | |
| **Type of satellite sensors** | **WIGOS Subcomponent** | **Products** |
| Multi-spectral VIS/IR imagery with rapid repeat cycles | **1** | Radiance products, Atmospheric Motion Vectors (AMVs), Aerosol Optical Depth (AOD), Sea Surface Temperature (SST) |
| IR Hyperspectral I Sounders[[4]](#footnote-4) | **1** | Radiance products, AMVs |
| **Sun-synchronous core constellation satellites in three orbital planes  (morning, afternoon, early morning)** | | |
| **Type of satellite sensors** | **WIGOS Subcomponent** | **Products** |
| VIS/IR imagery | **1** | Radiance products and geophysical products (e.g. Aerosol Optical Depth (AOD), Atmospheric Motion Vectors (AMVs), Sea Surface Temperature (SST) |
| IR Hyperspectral Sounder | **1** | Radiances |
| Microwave Sounder | **1** | Radiances |
| Microwave Imagery | **1** | Radiances, SST, total column water vapour, clouds, precipitation, sea ice |
| Scatterometer | **1** | Backscattering cross-sections and ocean surface vectors winds, soil moisture |
| **Sun-synchronous satellites at three additional (any other than above)  equatorial crossing times for improved robustness and improved time sampling** | | |
| **Type of satellite sensors** | **WIGOS Subcomponent** | **Products** |
| Microwave Sounder | **2** | Radiances |
| Hyperspectral Infrared Sounder | **Not currently reflected in WIGOS Vision 2040** | Radiances |
| Wide-swath radar altimeters and high altitude, inclined, high-precision orbit altimeters | **1** | Sea surface height, wind and waves, ice freeboard |
| Global Navigation Satellite System (GNSS) radio-occultation (basic constellation) | **1** | Bending angle, refractivity |
| UV/VIS/NIR sounders, nadir and limb | **1** | Ozone, aerosol properties |
| IR dual-angle view imagers | **1** | SST |

The following table defines the set of **additional** satellite data that are required by global NWP underpinning WMO application areas and made available to all global NWP centres consistent with WMO Data Policy. These are a subset of the overall capabilities defined within the WIGOS Vision 2040, and mainly captured in subcategories 1 and 2 therein. The performance of the instruments should be adequate to provide the required observational capabilities with known accuracy and uncertainty, e.g. radiances with appropriate information content beneficial to NWP might be useful to add. The detailed specifications of the instruments are captured by the WMO Rolling Review of Requirements and maintained in the WMO (OSCAR) Database[[5]](#footnote-5).

**Table 2: Additional satellite data for global NWP**

|  |  |  |
| --- | --- | --- |
| **Data from Low-Earth orbiting satellites** | | |
| **Type of satellite sensors** | **WIGOS Subcomponent** | **Products** |
| Multiangle, multipolarization radiometers | **2** | Radiance products and geophysical products (e.g. Aerosol Optical Depth (AOD)) |
| Precipitation Radar | **1** | Backscatter, Precipitation rate |
| Scatterometer | **Not currently reflected in WIGOS2040** | Backscattering cross-sections and ocean surface vector winds, soil moisture |
| Radio-occultation | **3 and 4[3]** | Bending angle, refractivity |
| SAR imagers | **1** | Sea ice |
| Absolutely calibrated broadband radiometers and total solar irradiance and solar spectral irradiance radiometers | **1** | Radiance |

The following table defines the set of **emerging** satellite data that are likely to be required by global NWP underpinning WMO application areas in the near future based on existing research missions or planned advances in operational missions.

**Table 3: Emerging satellite data for global NWP**

|  |  |  |
| --- | --- | --- |
| **Geostationary core constellation with a minimum of five satellites providing complete Earth coverage** | | |
| **Type of satellite sensors** | **WIGOS Subcomponent** | **Products** |
| Lightning mapper[[6]](#footnote-6) | **1** | Strike density |
| **Data from Low-Earth orbiting satellites** | | |
| **Type of satellite sensors** | **WIGOS Subcomponent** | **Products** |
| Wind lidar | **Currently 2** | Backscatter, extinction, Line-of-sight winds |
| Cloud lidar | **2** | Backscatter, extinction |
| Cloud radar | **1** | Reflectivity |
| Sub-mm imagery | **2** | Clouds |

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1. See <https://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html> [↑](#footnote-ref-1)
2. The principle expresses a user requirement from the perspective of ensuring that global NWP is performing at the highest possible level and that the benefits, not only from Space Agency investments, but also the user investments in data utilization, is maximized. [↑](#footnote-ref-2)
3. <https://www.wmo-sat.info/oscar/requirements> [↑](#footnote-ref-3)
4. The WIGOS Vision 2040 states hyperspectral sounding from 5 geostationary orbits. The realization of that capability has started, but only 2–3 orbital slots are currently considered to be filled in the coming decade. [↑](#footnote-ref-4)
5. See <https://www.wmo-sat.info/oscar/requirements> [↑](#footnote-ref-5)
6. The WIGOS Vision 2040 states hyperspectral sounding from 5 geostationary orbits. The realization of that capability has started, but only 2–3 orbital slots are currently considered to be filled in the coming decade. [↑](#footnote-ref-6)