Status and way forward on the WIGOS Vision 2040 update

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Executive summary of the WP

The update to the WMO Integrated Global Observing System (WIGOS) vision, for the 2050 timeframe, is being developed. The vision is scoped to encompass both the surface and the space components, as well as the integration between the two. A representative (but small-enough to be agile) core team was put together by WMO to this end, with the purpose of finalizing the product in 2026. Many driving factors for this vision were identified including technology evolution, applications/users needs, the future landscape of observing systems providers including non-traditional systems and commercial providers. This effort is expected to provide the community with a vision that will help coalesce efforts toward a cohesive, complementary global observing system. The vision, should be as well-informed and technically accurate as possible, and should inspire the community to design, evolve and deploy a complementary global observing system that addresses the needs of the future, and leverages the emerging opportunities. Several rounds of discussions, reviews and a face-to-face meeting took, leading the first zero-order draft of the vision. The purpose of this presentation is to inform the CGMS community of this effort, and to seek inputs, thoughts, ideas, and other contributions. It also aims at sharing some of the preliminary findings so far.

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WIGOS Vision update group membership

Group members:

- Sid Boukabara (WMO/ET-EOSDE/RRR, NWP, NASA, US)
- Shannon Kaya (WMO/SC-ON, MSC, Canada)
- Sean Burns (CGMS, EUMETSAT, Europe)
- Mary-Jane Bopape (SAEON, GBON, South Africa)
- Jianxia Guo (GSRN, CMA, China)
- Fiona Smith (WMO ET-SSU chair, Australia)
- Lihang Zhou (WMO ET-SSU co-chair, US)
- Elian Wolfram (Ground Based Network, Argentina)
- Mike Seablom (Office of Technology, NASA, US)
- Tony McNally from ECMWF (NWP, ESP, Europe)
- Osamu Ochiai (CEOS, JAXA, Japan)
- Junhong Wang (WMO SC-MINT, MesoNet, US)

- **WMO secretariat support:**
  - Albert Fischer
  - Jitsuko Hasegawa
  - Natalia Donoho
  - Heikki Pohjola
  - Mikael Rattenborg
  - Jesse Andries
  - Zoya Andreeva
  - Kruno Premec
  - Nicolas Rivaben

- **Invited members:**
  - Paolo Ruti
  - Stephan Bojinski
  - Agnes Lane

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General Goal of the Vision

"The Vision for WIGOS in 2050 presents a likely scenario of how user requirements for observational data may evolve over the next 25 years, and an ambitious, but technically and economically feasible vision for an integrated observing system that will meet them. It provides high-level targets to guide the evolution of the WIGOS in the coming decades. It anticipates a fully developed and implemented WIGOS framework that supports all activities of WMO and its Members within the general areas of weather, climate and water."

Drivers for WIGOS Vision update

❖ **The major drivers should include, but not exclusively:**

- Applications Requirements evolution,
- Technology Evolution and Innovation (H/W, Data, AI, etc)
- Evolution of Observing systems (surface and Space)
- Expected evolution of public/private sectors in this field
- Other drivers as deemed relevant by the team

WIGOS Vision Update Effort: Overview and Status

- A small and agile but representative team was setup, representing various regions of the globe, several fields of expertise, and several sectors of users and applications
- The scope of the vision was defined and a ToR drafted
- Kick off meeting for the WIGOS vision drafting team took place in January 2025
- Several meetings have been conducted, either as a team, or as sub-groups dedicated to specific topics
- Two surveys were conducted: one for members of the vision team and one for several thematic/users/Earth system domain communities:
  - GCOS (AOPC, TOPC),
  - Ocean (GCOS/OOPC),
  - Atmospheric composition (GAW and G3W communities),
  - Cryosphere (AG-GCW, GCW community),
  - Terrestrial (GCOS/TOPC),
  - Hydro (AG-Hydro, TT-EHN community),
  - Regional networks (WG chairs of RBON design groups), Space Wx.
- Several community engagement activities conducted or planned: E.g. CGMS WGs, CGMS plenary, CEOS, Joint CEOS/CGMS WG on Climate, ET-EOSDE, ET-SSU, ET-SWx, GCOS steering meeting
- Conducted the first face-to-face meeting (April 28-29, 2025) : brainstorming, foresight exercises, discussions, etc.
- Identification of special topics of interest : Citizen data, IoT/IoA observing systems, AI impact, commercial data trends,
- Consolidation of preliminary thoughts, ideas and outcomes of debates, into zero-draft document, being matured.

High-Level Findings 1/2

- The value of Earth observations, such as those coordinated through WIGOS, will likely increase because of the increasing reliance of applications relevant to society well being, to the economy, for disasters prevention, etc.
- Significant changes occurring in the global observing systems (space and surface): driven by major trends in users expectations and applications requirements, in technology advances including sensors miniaturization and affordability, and a resulting explosion of new platforms hosting these instruments: IoT, IoA, Citizen data, etc
- The trend toward an Earth system approach will likely continue, creating a new set of observations requirements.
- AI in particular, seems to have already disrupted the value chain of the observing systems from how we merge multiple sources of observations all the way to how the end-user is expected to digest the applications outputs.
- AI is now recognized as transformational. There are AI agents/assistants for research, for coding, etc. Emergence of AI for global weather prediction but also hyper-focalized individual, specific Earth-related applications? How will that impact the observing systems of the future? It is not clear yet, but indications point to more 'hunger' for data than from traditional applications/systems.
- There is an increase in types (and number) of users expected to benefit from the observing systems of the future.
- Significant challenges exist in tapping into increasing volume of non-traditional observing systems. Surmounting these challenges has the potential to offer a path to these observing systems to become part of mainstream observations, adding value to the global observing system in terms of coverage, temporal refresh, and variety

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High-Level Findings 2/2

- These challenges include the decentralized nature of the non-traditional observing systems and the difficulty convincing members to share local data with no obvious link to global applications.
- Challenges include also the fragmented landscape of the surface based network coordination, done generally with a geographic or a thematic focus in mind.
- Surface and Satellite components, together, if integrated properly, will offer the various users and applications an increased value, superior to the sum of their separate values.
- The WIGOS document will ideally be short and straight to the point, but will be complemented by a peer -review publication that will go into more details about the rationale, the trends, the driving factors that shape the WIGOS vision in the 2050 timeframe, etc.
- Toward an integrated constellation of observing systems composed of public and private assets, surface and space components
- Direct fiscal constraints will likely continue to be a factor, but that should the trend for finding innovative approaches to enhance the global observing system capability (i.e doing more with less).

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Preliminary Findings: Surface Component

- Significant increase in the value of surface based observing systems as both complementing (increased coverage, etc.) and supporting (cal/val, enhanced resolution, etc.) asset to space-based component.
- Far from being overtaken by the space component (as it is sometimes speculated), the surface component seems to be creasing in value and importance in the global observing system. In part because of the AI trend that is making leveraging various surface based observing systems easier.
- Expanded capability of the surface component (new parameters or enhanced coverage): Snow water equivalent, groundwater, atmospheric composition profiling, geomagnetic field variation, etc
- Emphasis on increased quality, spatial coverage and density (especially in urban areas) of the surface component due to technology advances, lower cost and miniaturization, and the explosion of new platforms: Citizen data, IoT, IoA, etc.
- Increased emphasis on traceability, stability and continuity for climate monitoring purposes. Perhaps we should view these aspects at the network level? (quantity vs quality).
- Major challenge in the surface component (as opposed to space) is the difficulty to coordinate the decentralized systems. Likely recommendations in the vision.
- There will likely be a proposed tier-approach to account for the surface component in 2050 vision similar to the space component in the 2040 vision. To account for backbone component, and leverage opportunistic observing systems
- The *integration* of surface and space components will likely a major focus in the coming years/decades.

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Preliminary Findings: Space Component

- Technology advances will likely continue to enhance the capabilities in terms of spatial resolution, quality, ability to perform high-resolution vertical profiling.
- The balance between private and public sector will continue to evolve toward a healthy balance, but the expectation is that the two components will continue to co-exist.
- The multiplication of smallsats/cubesats will likely continue, enhancing the temporal refresh of the global coverage, perhaps with a mixture of quality/quantity combination. The performance of the global constellation will likely be viewed as a whole (quality/quantity).
- Additional platforms of opportunity will likely be explored as pathfinder missions
- It is not clear yet whether the space component backbone system of 3 polar orbits will still be needed in the 2050 timeframe, or replaced by a vision of a more flexible constellation, driven more by the higher temporal refresh (sub-hourly?)

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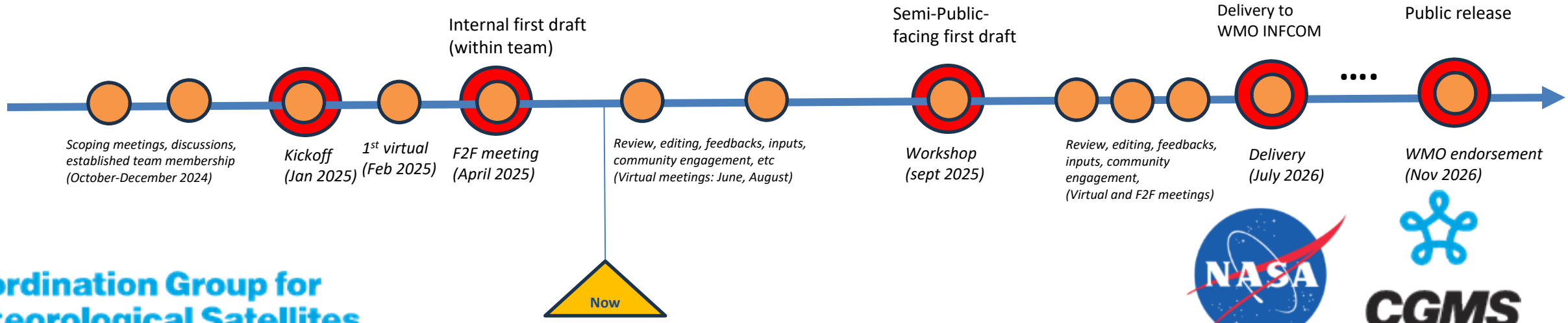
Next Steps and Timeline

- First (zero-order) version of the vision was developed in April 2025 and is being matured
- Two virtual Meetings in June, August 2025 to finalize the 1st version of the draft to be reviewed at September workshop (hosted by EUMETSAT)
- Joint meeting in September with WMO Application Areas AAs PoCs and ESACs coordinators
- Fine tuning, accounting for feedbacks, will continue afterward.
- More engagement and more technical feedbacks is being (and will continue to be) sought from various communities
- Formal Review will happen in stages, starting shortly after September and continuing until:
- Formal Delivery to WMO INFCOM in July 2026
- Formal endorsement by INFCOM in November 2026.



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Key issues of relevance to CGMS:

- Drafting the WIGOS 2050 vision is on-going. Multiple rounds of community engagements and an in-person workshop have occurred and/or scheduled with both the space and surface components communities
- The space component of the vision is being led by a team of experts with a variety of expertise (space architecture design, science of remote sensing, satellite data/products use, etc.)
- Many representatives from CGMS member agencies are part of this drafting team.
- It is the variety of the backgrounds and the tension between the views (within the team and through various community engagements), covering the evolution of the technology aspect, the applications/users observational needs, the surface and space components, etc. to assess what is likely going to be desired, what is likely going to be possible, that will allow us to have a well-informed, useful vision for the future.
- The WIGOS vision drafting team looks forward to the CGMS consolidated position, which is expected to be a critical input for this effort. The input regarding the Tier-based approach is particularly important. Was that useful in the 2040 vision? was it too constraining or was it a good anchor target to have? Did it hit the right balance between being specific while not restricting architecture design optimization?
- It is expected that next occurrences of the CGMS HLPP will be influenced by the WIGOS vision update