The Coordination Group
for Meteorological Satellites

CGMS

CGMS FUTURE DIRECTION 2022+
POSITION PAPER THEME:
FUTURE OBSERVING (HYBRID) SPACE INFRASTRUCTURES

Lead: EUMETSAT

TOPIC DESCRIPTION AND RATIONALE FOR CGMS ENGAGEMENT

We are entering an era where hybrid space infrastructures become more and more important for supporting key application areas: NWP, climate, disaster response.

Hybrid space infrastructure may consist of:

- Platforms (large/small/nano)
- Instrument classes (reference or lower performance)
- Orbits (SSO, Drifting, HEO etc.)

And involve different ownership/management models (government, intergovernmental, PPP, commercial)

There are several areas where CGMS could engage to answer the following questions:

- How do we ensure that the components of the hybrid space infrastructures remain complementary?
- The balance between public vs private?
- How do we maximize the impact of the CGMS satellites as part of larger hybrid space infrastructures ?
- How do we ensure CGMS is engaged in these rapidly evolving developments?
- How do we ensure equal access to data from hybrid space infrastructures?

For several observation types, hybrid space infrastructures will in future, provide a large contribution to fulfilling the WIGOS 2040 vision, for example

- Radio-occultation
- Microwave
- GHG emissions
- Wind

In the context of CGMS, in line with the Vision 2040 for the WIGOS, a hybrid space infrastructure could be understood as consisting of 3 main components:

- A backbone system (the main GEO and LEO (EM, AM and PM) satellites)
- Complementary constellations:
  - Smaller satellites operated by CGMS members in intermediate or drifting orbits and also satellites and constellations operated by national agencies
- Data Buy (smaller satellites and constellations under the control of the private sector)

There is also a component of research and development missions – covered by another thematic area.

Regarding data buy, this could be covered by the theme '*Relationship with private sector*', where CGMS could ensure maximum user benefit, when individual members consider data buy opportunities.

Commented [AT1]: NASA input:
While the focus is on space, it's important to recognize that space systems do not exist in an observational vacuum, and it's important to pay attention to the calibration/validation infrastructure and also that of input knowledge that comes from other measurement approaches (e.g., surface-based measurements). We should be thinking about how the collective cal/val infrastructure can be mutually supportive so that we can all "help validate each other" – and where certain input sets are needed (e.g., the terrestrial reference frame that is so important for surface altimetry and gravimetry) that we pay attention to assuring the long-term quality (and improvement!) of the input information. It's important that there be good coordination in the respective communities for things like intercomparisons of observations and the algorithms used to generate geophysical parameters from observable quantities (for products not obtained from radiance assimilation)

Another question to answer is: Does the WIGOS 2040 vision describe hybrid space infrastructures well, and also as part of integrated space and surface based observing systems.

LONG- AND MEDIUM-TERM GOALS FOR CGMS

The long term goal is that all CGMS activities should take into account the hybrid nature of an integrated system.

Medium-term goals for CGMS include:

- Identifying all hybrid space infrastructures for the different observation types
- Demonstrating that the impact of CGMS contributions, as part of the integrated system, explicitly considering data buy
- Addressing such aspects as orbit coordination and harmonized data access to ensure the different components of the hybrid space infrastructures provide a seamless operational service to the users
- A critical review of WIGOS 2040 with respect to hybrid systems
  - For example 2040 WIGOS refers to the space-based observing system component as 4 subcomponents:
    1. Backbone system with specified orbital configuration and measurement approaches
    2. Backbone system with open orbit configuration and flexibility to optimise implementation
    3. Operational pathfinders and technology & science demonstrators
    4. Additional capabilities

It is proposed to choose a specific case to examine the various facets of the hybrid space infrastructure. Microwave is good initial case, as it involves all the elements defining a hybrid space infrastructure (platform, instrument, orbit) and also management. The experience gained during this test case could be applied to other hybrid space infrastructure e.g. Radio-occultation, GHG emissions, Wind and others.

IMPACT ON CGMS ACTIVITIES

Looking at the activities identified in the previous section, for MW constellations as a test case:

1. Identification of all current MW constellations, and those planned for the next few years (already in the CGMS baseline, potential complimentary constellations, and potential data buys) (**WGIII**)
2. Assess the performance and impact of the identified MW constellations (**WGII** via the International TOVS working group (ITWG) and the International Precipitation Working Group (IPWG))
3. The coordination of hybrid MW constellations (also when to use data buy and when to use complementary constellations) - using the WIGOS vision as an initial reference point. (**WGI**)
4. A review of Data Access to hybrid constellations identifying any gaps and propose mechanisms to fill the gaps (**WGIV**)
5. A critical review of WIGOS 2040 with respect to MW hybrid systems (**WGIII**)

IMPLICATIONS ON CGMS STRUCTURE AND KEY DOCUMENTS

A small task team could be formed to coordinate with WGI, II, III, IV, to address the MW constellation test case and present the outcome to CGMS-52.

This activity may impact the following documents:

- CGMS Baseline
- CGMS High-Level Priority Plan

IMPACT ON EXTERNAL INTERFACES

Coordination would also be required with the following external interfaces to optimise synergies and avoid duplications:

- CEOS would contribute via the virtual constellations.

Noting that how CGMS interacts with the private sector is covered by the dedicated theme:

- *Relationship with private sector (lead NOAA)*

FURTHER WORK

Based on the Lessons Learned from this test case, CGMS members may identify other observation types which may benefit from such a hybrid approach and then address them.