C A R I B B E A N

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**ANNUAL MEETING OF DIRECTORS OF METEOROLOGICAL SERVICES Doc. 5**

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**WIGOS IMPLEMENTATION**

(Submitted by the Coordinating Director)

## INTRODUCTION

1. The Meeting of Directors of Meteorological Services in 2016 (St. George's, Grenada) was informed of the WMO Integrated Global Observing Systems (WIGOS) training, which occurred in the Region during December 2015 to enable Members to participate in WIGOS pre-operational activities. The WMO Congress, at its seventeenth session, stated that WIGOs will enter its pre-operational phase during the period 2016-2019 and during that phase the following matters will be addressed:

1. The creation of National WIGOS Implementation Plans;
2. Data Partnerships;
3. Regional Basic Observation Network (RBON);
4. Satellite Skills and Knowledge for Operational Meteorologists.

**1. National WIGOS Implementation Plans**

2. At the national level, for WIGOS to deliver on its vision for "an integrated, coordinated and comprehensive observing system to satisfy, in a cost-effective and sustained manner, the evolving observing requirements of Members in delivering their weather, climate, water and related environmental services", commitments and actions are required.

3. National Meteorological and Hydrological Services (NMHSs) are expected to become the key integrators at the national level, both by strengthening their own observing systems according to the regulations and guidance provided by the WIGOS framework, and by building national partnerships and providing national leadership based on their experience in the acquisition, processing and dissemination of observational data for environmental monitoring and prediction purposes.

4. The leadership role of NMHSs in integrated observing systems and the engagement with national partners is central to the success of WIGOS implementation. WIGOS provides an opportunity to strengthen the role of NMHSs in all aspects of their national mandates, from national coordination and exchange of observations across all relevant domains (weather, climate, hydrology, ocean, atmospheric composition, cryosphere, environment, etc.) and to reinforce their status as the national meteorological and hydrological service provider of choice.

5. NMHSs are operating in a rapidly changing environment in terms of technological advances and the increasing demand for more and more diverse services from increasingly sophisticated and capable users. Technological advancements and related trends like “big data” and “crowd sourcing”, the emergence of commercial observing networks, data and service providers, and the affordability of digital technology, are all game changers that require rapid adaptation and change in behaviour from the NMHSs.

6. By Cg-18 (2019), all Members should be “WIGOS Ready” Per the Plan for the WIGOS pre-operational phase this includes:

1. OSCAR/Surface: completed WIGOS metadata of all observing stations across all WIGOS components for which observations are exchanged internationally;
2. WIGOS metadata: compliance achieved;
3. WIGOS Station Identifiers: implemented;
4. WIGOS Data Quality Monitoring System (WDQMS): national process for acting on quality problem information received from the WDQMS in place;
5. Embracing all NMHS-operated observing systems and willing partners;
6. National WIGOS governance, coordination and implementation mechanisms established;
7. Nomination of national WIGOS focal points and OSCAR focal points completed.

7. Further expected outcomes above the minimum level can be as follows:

1. Enhanced national integrated observing system delivering better and better documented observational input to support national service needs in a more cost-effective way;
2. Increased integration and open sharing of observations from WMO and non-WMO sources across national and regional boundaries;
3. Progressively improved availability and quality of WIGOS observational data and metadata;
4. Increased visibility and strengthened role of NMHSs at their national level;
5. Enhanced cooperation with partners at the national and regional levels;
6. Enhanced culture of compliance with the *Technical Regulations* (WMO-No. 49), Volume I, Part I – WIGOS and *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160);
7. Improved human and technical capacity of Members for planning, implementation and operations of WIGOS.

8. To achieve at least the minimum expected outcomes, the following key activities should take place at a national level:

1. Analysis of current and future national strategic requirements, needs and priorities, and biggest gaps in observations, systems, processes, capabilities, etc.;
2. Analysis of the national implications of the WIGOS concept of integration, partnerships, data sharing, WIGOS relevant technical regulations and culture of compliance, etc. at a national level;
3. Development of a National WIGOS Implementation Plan;
4. Critical analysis of capabilities and gaps (systems, processes, people, networks, governance, issues of compliance);
5. Specification of expected deliverables, outcomes, milestones, and key performance indicators for the national WIGOS implementation;
6. Establishment of governance and key relationships.

9. When developing a national WIGOS Implementation Plan, Members should be guided by the Key Activity Areas (KAA's) of the WIGOS framework Implementation Plan (WIP), which is available at **https://www.wmo.int/pages/prog/www/wigos/Basic-docs.html**. This comprises of the building blocks of the WIGOS framework as well as by the Regional WIGOS Implementation Plan of the respective Regional Association. WMO developed a WIGOS National Self-assessment Checklist to help Members better understand the WIGOS Framework to be implemented in their countries; to help Members in assessing their readiness for the implementation and the challenges ahead of them, but especially to recognize that WIGOS is a natural change process. The Self-assessment Checklist is also useful in assessing Member’s priorities, plans, gaps and capabilities, etc., and will provide the basis for developing an achievable national WIGOS plan. The checklist is available at **https://www.wmo.int/pages/prog/www/wigos/checklist.html**.

**2. Data Partnerships**

10. WIGOS provides a framework for the World Meteorological Organization (WMO) to define and manage the weather, water, and climate observations required to support its programmes. In particular, WIGOS enables the integration of data from a diversity of observing systems into a composite set of observations to support a broad range of WMO applications areas.

11. WIGOS provides a framework to integrate WMO observing systems: the Global Observing System (GOS), the observing components of Global Atmosphere Watch (GAW) and Global Cryosphere Watch (GCW), and the World Hydrological Observing System (WHOS), including their surface-based and space-based components, which includes all WMO contributions to co-sponsored systems (GCOS, GOOS, GTOS) and the GFCS and GEOSS. These have historically been operated by National Meteorological and Hydrological Services (NMHSs) and established partners. WIGOS also now encourages and enables the integration of observations from NMHS and non-traditional sources including other government organizations, non-governmental organizations, research institutions, volunteer networks, and private sector operators.

12. One of the aims of WIGOS is to provide a comprehensive set of reliable, authoritative and trusted observations to support improved service delivery among WMO Members. At the same time, the WIGOS framework is an opportunity to strengthen national observing systems to better support national objectives, needs and priorities.

13. Observational data from non-NMHS sources are also of high interest as a supplement to NMHS observations in order to optimize the observing networks and to improve the quality and value of NMHSs and WMO products and services. There must also be motivation for non-NMHS providers, from both the public and private sectors, to make their data available to NMHSs and potentially to the international WMO community. A key principle of successful and sustained observation partnerships is the recognition of mutual benefit, including improved mutual understanding and strengthened collaboration.

14. The overarching goal of NMHSs in gaining access to more observational data is to maintain pace with user expectations and to improve the quality and value of NMHSs products and services. The motivations for a NMHS to enter into observational data partnerships include:

1. Fill observation gaps
	* to increase the density and timeliness of observations especially in high impact locations or observation sparse regions, or to observe variables not provided by NMHS-operated systems,
	* to improve access to real-time observations of current conditions for situational awareness and nowcasting,
2. Cost-efficiency
	* to gain access to observations at no- or low-cost through contributions by non-NMHS operators,
	* to gain access to observing sites that offer power and communications capabilities provided by a non-NMHS operator,
	* to gain access to secure and monitored observing sites for station installation (e.g., to prevent vandalism),
	* to reduce the infrastructure and operating costs through contracted versus NMHS-operated stations,
3. Strengthen national observing capabilities
	* to establish a more complete and robust national observing system to support a wide diversity of NMHS and other national applications,
	* improve observation quality assessment and quality control by using redundant and/or diverse sources of observational data,
	* to raise the overall quality and reliability of observational data from non-NMHS sources through outreach, training, promotion of standards, and potentially national policies or regulations,
4. Strengthen NMHS leadership and visibility
	* to demonstrate national leadership through broad engagement and coordination, including with the general public,
	* to strengthen the commitment and effectiveness of the mission of the NMHS,
	* to reduce the occurrence of complaint or criticism through active engagement and participation.

15. Non-NMHS operators that have invested in observing systems, do so to meet the specific needs of their organizations or for other interests. Non-NMHS operators may include other government organizations, research institutions, the commercial sector, academia, voluntary organizations, and private citizens. The needs of these operators vary widely depending on the type of organization and its application; consequently, the motivations to share observational data with NMHSs or internationally with WMO Members are also very diverse.

16. The motivations for non-NMHS operators to enter into observational data partnerships with NMHSs include:

1. Operational requirements
	* observational data that are contributed to NMHSs and WMO improves the weather, water, and climate products and services that support their operational needs or interests,
2. Access to other observations
	* observational data are contributed to NMHSs in order to leverage access to a larger pool of contributed observations from national sources, or to access the global observational data exchanged among WMO Members,
3. Business opportunity
	* the commercial sector wishes to sell or licence observational data to NMHSs for profit-making,
	* the development and provision of hydrometeorological services and products,
4. Association with a public-good programme
	* the visible contribution of observational data to a recognized national or international public-goodprogrammes lends significant credibility to many observing programmes and is frequently leveraged to justify sustained funding,
5. Quality assurance and observational data management
	* observational data are contributed in exchange for authoritative quality assessment by the NMHS, and/or for long-term preservation in climate archives,
6. Technical support
	* observational data are contributed in exchange for authoritative guidance and assistance from the NMHS on technical matters such as equipment, station configurations, standards, calibration and maintenance,
7. Volunteerism
	* observational data are contributed by organizations or citizens who contribute to the public good or scientific record,
8. Operational support
	* organizations seek to transfer station operations to NMHSs in cases where they have resources to buy equipment, but have no technical capability to operate them.

17. Because there is mutual benefit, many observational data partnerships are voluntary and rely on the mutual interest and the goodwill of the participants to make the partnershipwork. Nevertheless, well-documented agreements with non-NMHS operators to define and manage the partnership are common and are highly recommended. These arrangements can vary greatly in their specific content, formality, and enforceability - ranging from best-effort *Memoranda of Understanding*, to more formal *Letters of Agreement*, to legally-binding *contracts*.

18. WMO is in the process of creating a document entitled "*Guidance on Data Partnership*," to assist NMHSs in the formulation and execution data partnerships between NMHSs and non-NMHSs.

**3. Regional Basic Observation Network**

19. The seventeenth meeting of the WMO Congress (Cg-17) decided that the development of WIGOS will continue during its pre-operational phase as one of the WMO strategic priorities in the period 2016-2019, with a focus on the regional and national implementation. As part of the regional WIGOS implementation, the Regional Basic Observation Network (RBON) is being introduced to replace the existing Regional Basic Synoptic Network (RBSN) and the Regional Basic Climate Network (RBCN) networks. Those stations which are part of the RBSN and RBCN will automatically become part of the RBON.

20. Following a workshop on RBON (Geneva, Switzerland, from 18 to 20 May 2016), the sixteenth session of the Commission for Basic Systems (CBS-16) adopted Decision 21 (CBS‑16), which endorsed the RBON Concept.

21. Corresponding standards and recommendations supported by best practices and procedures for implementation of the RBON by all regional associations are being drafted by CBS in the view to incorporate them into a new edition of the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160) in 2019.

**4. Satellite Skills and Knowledge for Operational Meteorologists**

22. Nearly all geostationary meteorological satellite systems in the world are replaced by a new generation in the 2015-2022 timeframe, by Japan, China, the United States of America, the Republic of Korea, the Russian Federation, and EUMETSAT. The new generation satellites carry advanced imagers providing at least 16 spectral channels and flexible rapid-scan capabilities, with additional innovative payloads, such as lightning mappers and sounders for some of the programmes. Other new-generation systems will be deployed in polar orbit and other orbit types in the coming decade.

23. The new generation of satellites will bring significant enhancements to satellite-based products and services delivered by NMHSs, provided that users can effectively reap their benefits: ingesting the new data types in operational schemes, with overall data volumes one magnitude higher than today, it will have a major impact on NMHSs' infrastructure, systems, applications and services, and it will require coordinated action at the scientific, technical, financial, organizational and educational levels. Timely and careful preparation by NMHSs is essential to avoid any disruption of operations upon transition to these new systems, and to ensure that NMHSs take advantage of the new capabilities effectively, and as early as possible.

24. The Seventeenth World Meteorological Congress 2015, through Resolution 37 (Cg-17), recommended “to all concerned Members to set up user preparation projects in advance of the launches of new satellite systems, in accordance with the CBS Guidelines for ensuring user readiness for new generation satellites”.

**4.1 Activities by NMHSs to Achieve User Readiness**

25. These activities should be performed by NHMSs to achieve readiness for new generation satellites.

**(a) Establishment of a User Readiness Project**

It is crucial that planning starts early and it is crucial to:

* Clearly define project outcomes and deliverables;
* Establish clear responsibilities and accountabilities;
* Ensure adequate budget is available for all activities;
* Establish a clear go-live planning for upgraded infrastructure and for new services.

26. The User Readiness Project needs to address:

* New capabilities as well as improvements of existing capabilities;
* Continuity of operational service provision, including critical path analysis for transition;
* Maximum benefits from existing assets, protection of investment;
* Maximizing value of service at all times during transition;

and must include a detailed assessment of opportunities and risks.

27. During the execution of the project, special consideration must be given to:

* Need for a dedicated project and project manager (overall accountability is important);
* Maintain contact with satellite operator for up-to-date information;
* Regular communication to key managers and project stakeholders (maintain momentum and counter misinformation);
* Monitor key project milestones and escalate when necessary;
* Ensure management support and buy in is available when needed;
* Manage expectations regarding availability of new products.

**(b) Budgeting and Planning**

28. Budgeting and planning is of paramount importance and needs to start early. A new generation satellite system can be in some cases the driver of significant infrastructure upgrades; performance requirements in terms of data acquisition, storage, network, etc. and should thus be known many years in advance in order to incorporate the necessary upgrades in the long-term evolution and investment plans. Realistic schedule margins and other provisions should be used to avoid planning difficulties, for example due to launch delays.

29. A main objective for a user organization like a NMHS, is to protect the investment made into existing operational programmes, and to understand early where additional investments are necessary or unavoidable in order to achieve readiness for the new satellite system. Therefore, early information about investment drivers is crucial for budgeting and planning purposes.

**(c) Research and Development**

30. In this context, R&D refers to the phase of activities that prepare the application of new generation satellite data from the user perspective. This typically includes development of NWP data assimilation methods using the new generation satellite data where needed, or development of new or specially tailored products for specific application areas, for instance by centres such as the EUMETSAT Satellite Application Facilities. These activities typically include analysis of the effects of instrument spectral response functions (SRF), field of view (FOV), and the radiative transfer models used to simulate instruments. The planning of such activities depends, to a large extent, on the degree of novelty of the instrument. If it is an upgraded version of an existing series, the lead times can be shortened considerably and some steps (e.g. simulated data) can be dropped completely. For totally new instruments (e.g. MTG-IRS) however, a first-guess SRF can be useful as early as two years before launch date (L‑24 months) and for these, simulated data would also be very useful.

**(d) Data Handling Development and Testing**

32. This activity includes design and procurement of new satellite reception systems, as well as upgrades to terrestrial network access (Internet and RMDCN), needed for handling increased data rates. The activity would also encompass upgrades to observational databases, short- and long-term archives, as well as to internal networks and general IT capacity for visualization, monitoring and processing.

33. It is crucial that the procurement of data handling systems starts early to enable complete testing of all technical and scientific aspects of the processing chain.

**(e)** **Data Processing Development and Testing**

34. All aspects of the processing software of satellite observations need to be adapted and potentially upgraded to accommodate data from the new satellite. This may include:

* Local processing chain of direct broadcast data into L0 and L1 products;
* Data conversion into intermediate local formats for observations databases and archiving;
* Data monitoring and assimilation into NWP models;
* Processing chain for local generation of higher-level products for specific applications;
* Integration into the operational user environment, including for instance integrated visualization applications (with satellite, radar, surface and altitude observations and model outputs) for forecasters.

35. For instance, the adaptation of NWP assimilation to the new satellite systems require a long lead time and has specific requirements regarding availability of instrument and product data.

36. The planning of such activities varies widely according to the needs and capabilities of the user organization (e.g., NMHS).

**(f) Training**

37. Different training subjects and different target groups for training exist and it is important to identify the different categories of needed training as they have different time scales and require different levels of information about the new satellite system. Generic satellite skills and knowledge for operational forecasters recommended by WMO should serve as guidance for framing training activities.

38. Identified training subjects are:

* Similarities and differences with respect to existing satellites;
* Equipment operation and maintenance;
* Interpretation of L1 data from satellite payload instruments including:
	+ Imagery interpretation;
	+ Passive sounder data usage;
	+ Active instrument usage;
* Use of software tools (for processing, analysis, and assimilation);
* Derived L2 product utilization and interpretation;
* Understanding of data formats and dissemination;
* The physical basis of remote sensing, in particular as it applies to new instruments.

39. Target groups for training are:

* Trainers (using the “train-the-trainers” approach);
* User readiness project managers;
* Operational forecasters;
* User communities in NWP and other application areas;
* Organizational managers;
* Technical support personnel;
* R&D personnel.

40. The approach for organizing training depends very much on the needs and capabilities of the user organization (e.g., NMHS) and on the organizational relationship between satellite operators and users. With the advancement of e-learning technology, emphasis is clearly shifting from long-term planned classroom training towards “just-in-time-training” based on webinars, self-study online training etc.

41. The increasing importance of continuing training activities after launch must be emphasized. Training needs to cover critical real weather situations for all seasons and it must be based on the real characteristics of the satellite systems. Emphasis should be given to training formats that can be integrated into ongoing operations, i.e. short training modules for “as it occurs” training of operational forecasters on or between shifts.

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August 2017