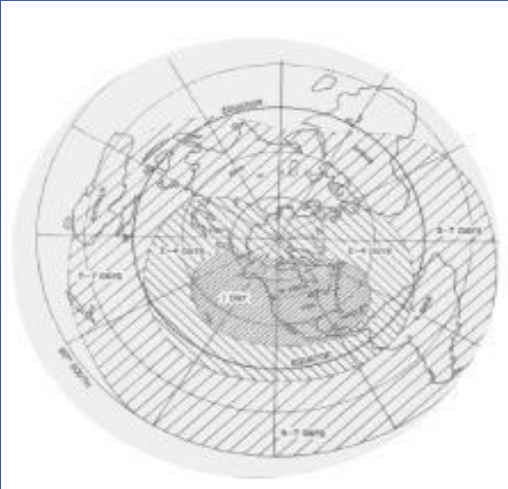


THE WMO GLOBAL BASIC OBSERVING NETWORK-GBON

ABOUT GBON

Reliable weather forecasts and climate analyses are essential for public services that help save lives, protect property and foster economic prosperity. This is all made possible by continued access to a wealth of real-time environmental observations from the entire globe.

Whilst many regions provide a reliable feed of observational data, some areas under-report or have a sub-optimal observing network density. Recognizing the essential role played by these observations, the World Meteorological Organization (WMO) has recently (June 2018) decided to proceed with the design of a Global Basic Observing Network (GBON), to be proposed to its Members for approval at the 18th World Meteorological Congress in 2019. This rapid development cycle is testament both to the importance and to the urgency of resolving these issues.



The provisions within the GBON design are based on up-to-date observational requirements for global Numerical Weather Prediction (NWP) as defined by technical experts working under the WMO Commission for Basic Systems and the Global Climate Observing System. Drawing on 20 years of NWP observational data impact studies coordinated by WMO, the provisions specify - in clear, quantitative terms - the obligations of WMO Members to acquire and exchange these critically needed observations: which parameters to measure, how often, at what horizontal and vertical resolution, and which measurement techniques to use.

BACKGROUND

Global Numerical Weather Prediction - where does the weather and climate data come from?

Since the early 1960's, WMO has coordinated the acquisition and international exchange of meteorological observations in support of weather and climate services worldwide via the Global Observing System of its World Weather Watch Programme.¹

¹ To predict the weather, modern meteorology depends upon the near-instantaneous exchange of weather information across the entire globe. Established in 1963, the World Weather Watch - the core of the WMO Programmes - combines observing systems, telecommunications facilities, and data-processing and forecasting centres operated by Members to make available the meteorological and related environmental information needed to provide efficient services in all countries.

Since that time, the advent of high performance computing and other advanced technologies has transformed weather forecasting from a manual, local task into a globally connected, quantitative process. Complex computer simulations are now routinely fed with millions of measurements provided by a plethora of instruments in space, in the air, based on land, or on in the ocean.

All of today's quantitative weather forecast and climate analysis products - even down to the finest local scales and immediate "nowcasting" time ranges - ultimately rely on global-scale NWP. This therefore acts as a backbone for everything that a modern weather and climate service does.

Global NWP systems are large-scale undertakings: millions of lines of computer code running on some of the fastest supercomputers available, ingesting tens of millions of observations every day. They require gigabit communication lines and petabytes of storage capacity, and typically have hundreds of staff developing, testing, running and diagnosing them. Reliable, real-time access to observational data from the entire globe is critical to the quality of the output from these systems.

Satellites provide global coverage and can measure parameters for both atmosphere and surface, and satellite data make a very substantial contribution to forecast skill. However, global NWP systems still have a critical reliance on surface-based observations for certain key parameters that cannot yet be reliably measured from space: in particular atmospheric surface pressure, the vertical distribution of winds and sub-surface ocean parameters. Surface-based observations are essential over land, over snow and ice surfaces, and they continue to play important roles for

CURRENT STATUS

The international exchange of observations in meteorology has a long history and has evolved significantly over time. The most frequently cited articulation of WMO policy on this is found in Resolution 40, adopted by the 11th World Meteorological Congress in 1995, and codified in WMO Publication 644, the Manual on the Global Observing System. However, both Res. 40 and WMO 644 arguably fall short of their intended goal by not specifying “hard numbers” for Members to comply with.

This problem has been further exacerbated by the lack of sustained real-time monitoring of data delivery, and by the decision of WMO to leave it to its six Regions - and thus ultimately to individual Members - to specify their requirements and design and implement their own networks accordingly. The lack of a clearly articulated global design and the absence of global compliance monitoring have led to an unrealistic, inflated perception of compliance among the WMO Members, and it has allowed persistent inhomogeneity across in the globe in the volume of observations internationally exchanged.

calibration and validation of space-based data.

Whilst space agencies provide millions of observations daily to global NWP, substantially improving forecast skill, this is no excuse for WMO Members to neglect their responsibilities for operating and exchanging data from surface-based observing networks. Any lack of observations over one area is known to negatively impact the quality of the forecast and analysis products, not only in the area of missing data but elsewhere on the globe as well. Missing or non-reporting stations, glitches in telecommunication, or excessively restrictive national data policies thus all have an adverse impact both locally and globally. Such gaps in coverage amount to lost opportunities for National Meteorological and Hydrological Services (NMHSs) to deliver the best possible warning and monitoring information to their constituencies.



Figure 1. Surface land pressure observations received by one or more GNWP centres (DWD, ECMWF, JMA or NCEP) on June 17 2018, 18Z; fully reporting stations shown in green, partly reporting stations in orange, minimally functioning stations in red, silent (non-reporting) stations in black.

The WMO Integrated Global Observing System (WIGOS) has recently developed a Data Quality Monitoring System, by which data delivery to four global NWP centres is now monitored around the clock, in near-real time. The figure 1 above shows a typical example of the current data availability as measured by the System. The inhomogeneity across the globe in both network density and reporting practice is striking, and the large data voids (areas without any dots on the map), and the prevalence of dots shown in colours other than green both amount to significant lost opportunities to provide better services.

MEMBERS COMPLIANCE WITH GBON

→THE NUMBERS



WMO Members can be divided into three broad categories, in terms of expected compliance with GBON and its impact on national observing and data sharing practices:

I. Those already compliant with the proposed GBON provisions. This group is estimated to include roughly 20-25% of the Members. There is no significant impact to those Members, other than the positive of receiving more observations and better products.

II. Those currently not in full compliance but who already have data that - if internationally exchanged - would make them compliant with GBON. This group of countries is estimated to include 25-30% of the Members. However, since

some of the largest countries in the world fall in this group, it represents a much larger proportion in terms of land area. The main impact on this group is likely to be either on data policy or on telecommunication, depending on the country in question, and is expected to be mostly minor.

III. Those currently not in a position to comply with GBON due to lack of resources. This group includes many developing countries, perhaps half of all WMO Members. In order for GBON to be successful, these Members will need international assistance, in some cases on an interim basis, while in other cases semi-permanent mechanisms will need to be developed.

NATIONAL IMPACT OF GBON: ROLE OF INTERNATIONAL DEVELOPMENT EFFORTS

Overall, the most significant impact of GBON is expected to be a major strengthening of global observational data availability, with all that will follow in terms of availability of better products and services at global, regional, national and local levels. However, it must also be acknowledged that with GBON come new, or at least more clearly articulated obligations that will require additional effort by some Members.

Most, if not all, of the countries belonging to the third group shown above are either current or potential targets for various types of internationally funded development projects, either of a bilateral nature or through multilateral finance mechanisms. If designed and implemented appropriately, these projects could contribute substantially to the GBON implementation. This would be especially valuable in data-sparse areas where the additional observations would make a marked impact on global NWP, and therefore on forecast quality.

Many internationally funded, observations-related development projects are “country-driven”. They are based on national weather and climate risks, observing capabilities and national desires to improve them, and the unique capabilities and needs of individual NMHSs. To some extent this approach is politically driven, and therefore it may not be easy to change. However, it risks ignoring the inherently trans-boundary nature of weather and climate, both in their manifestations and in the activities we as humans need to undertake when trying to understand and predict them. Many of the obstacles to effective weather and climate information service provision - especially in relation to observations - are characterized far less by national uniqueness than they are by global commonality.

Access to high-quality NWP products and reliable climate analyses is foundational to any modern weather or climate service, and ensuring that the NWP systems are fed by comprehensive sets of

reliable observations is therefore in the self-interest of these same services. However, since the link between local observations and the local quality of NWP outputs is often poorly understood, especially in NMHSs in some developing countries, data delivery from these countries often falls short. When designing projects, it should therefore be the responsibility of the international development community - and certainly of WMO whenever it is involved - to ensure that the requirements for global NWP are addressed, alongside any local requirements of the countries concerned. At the same time, the NMHS should be supported to identify and, if possible, quantify the national benefits of international data exchange, in terms of both improved services and increased economic productivity.

In terms of staff, the WMO Secretariat is a relatively small organization, so it is unrealistic to expect that it can be directly involved in all capacity development projects with observing components. However, where possible, the Organization should seek to implement framework agreements with the major funding agencies and implementing partners, under which the GBON regulatory material would be used in project design, implementation and evaluation.

Many projects struggle to clearly demonstrate their impact, and often this is directly tied to a lack of helpful metrics defined at the outset and incorporated in project results frameworks. However, since WMO will monitor GBON data delivery 24/7, incorporating GBON standards into projects offers the opportunity to define simple, quantitative metrics of success that are directly linked to end user benefits. Monitoring will include overall “colour of the dots on the map”, along with performance by station, by station type, by country, including averages, trends, etc. So a very simple measure of the impact of a given project could be, for instance, a “before and after” map display of GBON data delivery.

SUMMARY AND CONCLUSION

With the implementation of GBON, WMO is poised to take an important step in improving observational support for critical global NWP and climate analysis systems. In large parts of the developed world, GBON requirements are already met, and in other parts they will be easy - or at least not overly onerous - to meet. However, in many developing countries they will be impossible to meet using current national resources alone. Fortunately, the international community is ready to help, as evidenced by the sheer number of currently ongoing or imminent development projects involving observing systems.

Many of these projects tend to be designed individually, without mutual coordination or a common strategy, even though meteorology by its very nature lends itself best to a global approach. If accepted in the development community, GBON could fill a void by helping to guide projects toward solutions that address both global and local needs.

As a component of WIGOS, GBON comes with robust technical monitoring and management systems and tools, which could be used to track the impact of individual projects. Shifting project design and evaluation metrics from “number of observing stations purchased and installed” to “number of observations delivered in real-time to global NWP” may have its challenges; but to do so could well turn out to be truly transformational not just for the WIGOS but for all stakeholders in the Global Weather Enterprise.

Annex: Proposed GBON initial requirements specification

This specification has been prepared based on advice from the main Global NWP Centres. If adopted, it will be updated regularly as observations requirements continue to evolve.



For all GBON platforms listed above, Members SHALL disseminate what is observed (and available for dissemination) up to a resolution of 15 km horizontally and hourly temporally (the current goal requirements for Global NWP).