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| WEATHER CLIMATE WATER | **World Meteorological Organization**  **COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS**  **Second Session** 24 to 28 October 2022, Geneva | **INFCOM-2/INF. 6.3.1(1)** |
| Submitted by: SC-IMT Chair  7.X.2022 |

## WMO INFORMATION SYSTEM (WIS) 2.0 IN A BOX

The Executive Council, with [Resolution 22 (EC-73)](https://library.wmo.int/doc_num.php?explnum_id=11008/#page=365), endorsed the WMO Information System 2.0 (WIS 2.0) implementation plan and recognized the importance of establishing projects to verify the soundness of the WIS 2.0 principles in the context of international data sharing and to demonstrate the benefits of WIS 2.0 for the Members. As a result, eleven projects were established covering the areas of data exchange, data discovery, Earth System domain and support to Least Developed Countries (LDCs) and small island developing states (SIDS). In September 2021, a WIS 2.0 demonstration projects workshop was held (see [Annex 1](#_ANNEX_1:_WIS)). The workshop concluded that the principles establishing the WIS 2.0 technical framework are significantly effective in fostering international data sharing. Furthermore, the workshop proposed establishing a project called WIS2 in a box, intended to facilitate the adoption of WIS 2.0. The project was established in November 2021 as an open-source project providing a reference implementation for the Members willing to adopt open-source solutions.

The Standing Committee for Information Management and Technology recognized that the industry’s engagement is critical to foster the successful implementation of WIS 2.0. Therefore, in June 2022, a workshop to introduce WIS 2.0 to Industry (see [Annex 2](#_ANNEX_2:_INTRODUCE)) was held to present WIS 2.0 implementation plan and to promote the WIS2 in a box project. The interest from the industry was significant, and there is the expectation that some private companies will contribute to the WIS2 box software and foster the successful transition to WIS2.

**Development approach**

The WIS2 in a box project was started in November 2021 to provide a system to share data using the WIS2 framework. The Secretariat set up a small team with the technical lead offered by Canada. The collaboration with the Standing Committee on Information management and Technology has been continuous and instrumental in developing the system in compliance with the WIS 2.0 technical specifications. The development of the system in parallel with the definition of the technical regulations gave the opportunity to verify that the provisions were fit for the purpose and implementable with open standards and open-source software.

WIS2 box is implemented using cloud technology to offer the flexibility of being deployed on private/public cloud or on-premises. It constitutes a turn-key solution that can be installed on any platform and configured to satisfy the needs of operational centres. The system is based on existing open-source software widely used in the operations of some WMO Members. It allows Members to share data internationally and nationally using message queuing protocols (MQP) and Web services in compliance with WIS2 technical regulations. The WIS2 box also provides Web APIs complying with Open Geospatial Consortium (OGC) standards, making access to data extremely easy from all common languages (Python, R, ...) and many open-source and proprietary programs (Excel).

WIS2 in a box is an open-source project with [Apache 2.0 license](https://www.apache.org/licenses/LICENSE-2.0) permitting free use, commercialization, and modifications. The software is openly available from its repository <https://github.com/wmo-im/wis2box> and documentation is available from <https://docs.wis2box.wis.wmo.int>. A demonstration instance of WIS2 box is accessible at <http://demo.wis2box.wis.wmo.int>.

In Figure 1 the implementation roadmap of the project is reported. WIS2 box was ready to be installed on Amazon Web Services in early April to support the experimental observation exchange project in Malawi. The continuous evolution of the software has allowed the implementation of WIS2 required features and a fully WIS2 compliant version will be available by December. WIS2 box will be a key component of the WIS 2.0 pilot phase.

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**Figure 1: WIS2 in a box implementation roadmap**

**Malawi use case**

Department of Climate Change and Meteorological Services (DCCMS) in Malawi manages 23 manual weather stations providing 2 or 4 observations per day, and 44 Campbell Scientific Automatic Weather Stations (AWS), providing data through a GSM connection and Internet.

The data transmitted on GTS and received by the Global Data Processing and Forecasting Centres (GDPFS) Centres in January 2021 can be visualized on the WMO Data Quality Monitoring System ([https://wdqms.wmo.int](https://wdqms.wmo.int/)) and are reported in Figure 2. However, in January 2021, only two stations reported, on average, two daily observations with a significant gap compared to the hourly data required for the Global Basic Observing Network (GBON). The low spatial and temporal availability of surface data impacts the quality of the forecast provided by the GDPFS centres and has to be addressed to provide better predictions and more precise information for early warning systems.

The Secretariat initiated a project with Malawi DCCMS, Campbell Scientific, and Amazon to implement a continuous and reliable provision of hourly real-time data from 44 AWS to GDPFS centres in Binary Universal Form for the Representation (BUFR) format through WIS 2.0 MQP. The project started with an ad-hoc implementation in the public cloud using Amazon Web Services and software provided by Campbell. It was recognized that the solution adopted was unsuitable to be deployed in other countries and was not compliant with WIS 2.0 principles. The establishment of the WIS2 in a box project offered the opportunity to provide a turn-key solution, and at the same time, Malawi was a good use case to build the WIS2 box, ensuring that it was fit for the need of LDCs. Therefore the WIS2 in a box was initially developed around the Malawi project and started providing data through WIS2 channels in April 2022.

The deployment of the WIS2 box for Malawi is currently made on Amazon Web Services. Nevertheless, there is a physical box under development that DCCMS could deploy on their premises if the cloud is not seen as a feasible long-term solution. WIS2 box system uses cloud technology and can be deployed in the public or private cloud or on-premises.

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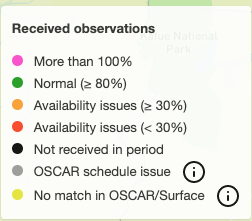
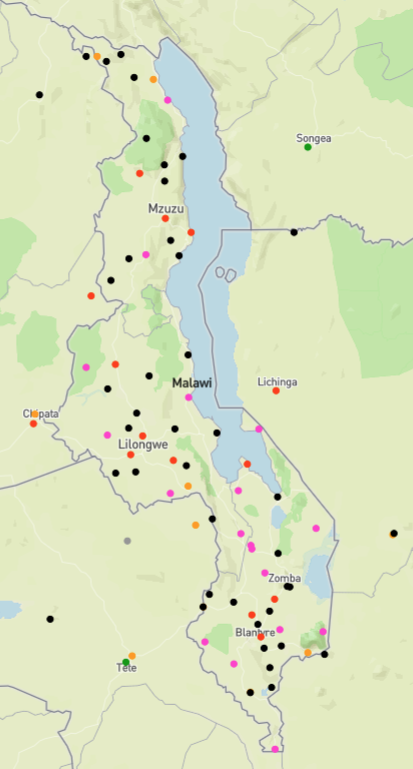
**Figure 2:** [**https://wdqms.wmo.int**](https://wdqms.wmo.int) **showing number of daily pressure observations from Malawi stations in January 2021.  
Black dots – > no observations, red dots – > 2 observations**

The data are transmitted directly from the stations, in CSV (comma separated values) format, to an FTP server, then converted to BUFR, and published through MQPs and Web API.

The WIS2 box offers two different options for using the data:

1. MQP in combination with a Web server. A user subscribes to the MQP broker to receive notifications of new data available. The notification message has a URL pointing to a Web server from which the user can download the data in BUFR format;
2. OGC API exposed via a Web server. With a Python or R script, the user can query the API and receive the data decoded. The script can process or plot the data without decoding the BUFR message. Other programs like QGIS or Excel can connect to the OGC API and use the data.

The number of observations shared has significantly increased with the implementation of the WIS2 box, but it was not able to exchange data from all 44 stations because many of them are not operational or not connected for several issues. In addition, other problems are affecting the regular transmission due to the lack of maintenance of the stations. However, Figure 3 shows a significant improvement in data transmission, with several stations transmitting hourly data continuously. Figure 3 shows 19 stations exchanging hourly data with a significant increment in the number of observations delivered to GDPFS centres daily.



**Figure 3:** [**https://wdqms.wmo.int**](https://wdqms.wmo.int) **showing number of daily pressure observations from Malawi stations in June 2022.**

# ANNEX 1

# WIS 2.0 DEMONSTRATION PROJECTS PROGRESS REPORT

The WIS 2.0 demonstration projects workshop was held on 13–14 and 20–21 September 2021. More than 120 participants from all the Regional Associations and many different WMO programmes attended the virtual sessions.

Presentations for 11 WIS2 demonstration projects were made during the workshop. Copies of these presentations can be found at [WIS2 demonstration projects](https://wmoomm.sharepoint.com/sites/Infrastructure/Shared%20Documents/Forms/AllItems.aspx?FolderCTID=0x01200024130F26396A0E47BF2E682E49302769&id=%2Fsites%2FInfrastructure%2FShared%20Documents%2FWIS%20DIM%2FWIS%20IM%2FWIS2%2E0%2FWIS%202%2E0%20Demonstration%20Projects%20Workshop%2FPresentations%2FFinal%20version%20PDF&viewid=3648449e%2D2515%2D442f%2Dbbed%2Df3cb98fb3221)

The discussion covered the four topic areas:

***Data exchange***

Four projects were identified to explore modern technologies, MQP, commonly used for data exchange on the Internet of Things (IoT), messaging applications for mobile phones, and Web applications:

* Experimental WIS 2.0 data exchange for data in WMO CF-NetCDF profiles
* Exploring the use of MQPs for GTS data exchange
* Global Information System Centre (GISC) Tokyo cloud project
* EUMETNET Supplementary Observations Data-Hub (E-SOH)

***Data Discovery***

To enable a rich search experience for each user by using metadata standards, allowing the discovery of authoritative data through commercial search engines (Google, Bing, Yahoo, Baidu) and dedicated portals, Two WIS 2.0 demonstration projects were presented on this topic are:

* Discovery metadata exchange and harvesting
* GISC Beijing Web services catalogue

***Earth systems domain***

Three projects are presented in this topic as systems designed to serve specific communities linked to different Earth System domains:

* Global Cryosphere Watch
* Open access to the GTS (OpenGTS)
* WMO Hydrological Observing System (WHOS)

***Supporting least developed countries (LDC) and SIDS***

The projects presented in this topic are designed to lower the barrier to entry for LDCs and SIDS:

* Interconnection of GISC Casablanca to the National Meteorological Centres within its area of responsibility
* WIS 2.0 Malawi AWS data exchange.

**Highlights from the workshop**

The workshop noted that the use of open standards, free and open-source software in the projects was significant. The adoption of cloud-native or cloud-ready solutions was a constant theme. The workshop also highlighted the effectiveness of ready-made software and turn-key solutions to simplify the adoption of WIS 2.0 standards and speed up the transition from WIS/GTS to WIS 2.0.

The projects proved that WIS 2.0 is beneficial for both developed and developing countries because it provides lower barriers for data sharing and simplified access to data and information.

The workshop concluded that a comprehensive WIS 2.0 component for LDCs and SIDS would be instrumental for the implementation phase. This component called "WIS 2.0 in a box" should be ready to be used with minimal configuration and based on cloud technologies to provide the options to be deployed indistinctively on cloud services or on-premises.

# ANNEX 2

# INTRODUCE WIS 2.0 TO THE INDUSTRY WORKSHOP

A workshop to introduce WIS 2.0 to Industry was held online on 22 June 2022. More than 206 participants from Industry, National Meteorological and Hydrometeorological Services, and Academia attended this workshop. The aim of the workshop is to introduce WIS 2.0, its implementation plan, and WIS2 in a box, to the industry to prepare for the transition and to explore opportunities for synergies to foster WIS 2.0 implementation in a short time frame.

Almost 206 participants from 47 countries attended this workshop: 55 experts from Industry, 108 representatives from National and Meteorological Services (NMHS), 23 from international organizations, 14 from Academia, and six others.

The objectives of the workshop were:

* Socialize WIS 2.0 architecture and implementation plan
* Discuss “WIS2 in a box” purpose, technical characteristics, and development model
* Synergize with the private sector on WIS 2.0 implementation and transition from GTS.

The Workshop’s agenda covered three major sections including data exchange challenges, WIS 2.0 introduction, and WIS2 in a box presentation and demonstration.

**Data Exchange challenges**

The October 2021 Extraordinary Session of the World Meteorological Congress approved the amendments to the Technical Regulations related to the establishment of the GBON and WMO Unified Data Policy. That will significantly increase the volume, frequency, and variety of information.

During the past fifty years, the GTS has maintained a continuous real-time exchange of essential data, providing observations to the GDPFS centres and disseminating processed information to NMHSs. Despite some evolution of the technologies used for data exchange, the GTS has kept its basic technical foundations unchanged. The emergence of increasingly rapid, high bandwidth global connectivity through the Internet now offers new opportunities for the future evolution of the GTS.

The implementation of WIS, commencing in 2007, meant that users worldwide could, in principle, search and access data freely or request permission from the data owners. However, despite enabling the publication of many datasets from GTS and other sources, WIS has never totally fulfilled its original purpose of providing easy access to WMO data.

As a consequence of this limitation of WIS and GTS, The Data Quality Monitoring System (WDQMS) shows that the inhomogeneity across the globe in both network density and reporting practice is striking, and the large data voids amount to significant lost opportunities to provide better services. WIS has to evolve to provide the foundation to support these services.

**Introduction of WIS 2.0**

The growing variety and volume of data used by NMHSs make the current WIS data discovery and access methodologies an unsuitable solution for Earth System monitoring and prediction. The adoption and integration of lightweight open standards and protocols, cloud technologies, and the public Internet provide low-barrier infrastructure, data, and services, resulting in easy and approachable data sharing for all of the WMO community and beyond. To leverage these technologies and address the issues of the current version of WIS, the Standing Committee on Information management and Technology (SC-IMT) was focused on designing the architecture of WIS 2.0. During the workshop, the chair of SC-IMT, introduced the WIS 2.0. This presentation helped the participants understand the concept of WIS 2.0, as well as its objectives, benefits, impact, and the overall implementation processes, the management requirements for the WIS 2.0, and the key activities areas for its implementation. WIS 2.0 introduced a new concept for data exchange to meet all WMO programmes. This concept is based on the use of global shared services in order to provide low-latency global data sharing that enables the WMO community to easily deliver value-added services to their users and provide facilities that enable users to work with high-volume data in-situ rather than require download for local use. The use of open standards and web services enable WIS 2.0 to become a system interoperable. Before migration to WIS 2.0, scheduled for 2024, an experimental phase is planned to test and improve the WIS2 architecture elements in 2023. The aim of this pilot phase is to provide a small-scale test involving the new concept of WIS 2.0 in a less critical context before rolling it on a large scale.

The implementation of WIS2 will proceed according to the following timeline:

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**WIS2 in a box demonstration**

To make the data accessible to all NMHSs, especially those of less developed countries, to the external organizations fostering research and supporting the evolution of WMO programmes, and to the growing community of other potential users worldwide, a comprehensive WIS 2.0 component, based on the open-source license, has been designed. This component called "WIS 2.0 in a box" should be ready to be used with minimal configuration (plug and play) and based on cloud technologies to provide the options to be deployed indistinctively on cloud services or on-premises. A presentation and a demonstration of the WIS2 in a box system were made during the workshop. The purpose of the demonstration was to show the ease of use of this platform. Through a series of easy manipulations, the participants discovered the different functionalities of the system: data collection, conversion to BUFR, access control, and data visualization. They also saw the ease of interoperability of this platform with several tools and applications such as R, QGIS, Excel...

**Highlights from the workshop**

The participants in the workshop took note of WIS 2.0 architecture and its implementation plan. There was a great agreement that WIS 2.0 will provide low-barrier infrastructure, data, and services, resulting in easy and approachable data sharing for all of the WMO community and beyond. The workshop noted that the engagement of the industry is needed to foster the successful implementation of WIS 2.0. It was agreed that The GTS to WIS2 transition cannot be successful without the involvement of the industry in providing solutions to the various technical problems encountered by WMO Members.

## There was a general consensus that this Workshop was an excellent start to identifying common topics that can productively support innovation and accelerate the adoption of advanced Weather, Water, and Climate technologies. The participants expressed a strong desire to maintain the momentum started by this Workshop, which was understood to include more extensive discussion around the topics presented and build a good start for a long-term engagement. The workshop concluded that a series of workshops along WIS 2.0 lines described above may be one means to maintain momentum.

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