Guidance on WIGOS Data PArtnerships

**DRAFT 1.9**

**ICG-WIGOS-7**

**Dec 2017**

ICG-WIGOS/Task Team on WIGOS Data and Partnerships

|  |  |  |  |
| --- | --- | --- | --- |
| Co-Chair Task Team WIGOS Data and Partnerships: Mike Manore ([mike.manore@canada.ca](mailto:mike.manore@canada.ca)) | | | |
| Secretariat contact: Igor Zahumensky ([izahumensky@wmo.int](mailto:izahumensky@wmo.int)) | | | |
| Version | Summary of changes | Reviewers | Date |
| 0.1 | Initial Draft   * partial document for initial comment on scope, tone, content | TT-WDP | Oct 2016 |
| 0.2 | Editorial and content updates  Section added:   * Data Use and Sharing | TT-WDP | Dec 2016 |
| 1.0 | Draft (in progress) for ICG-WIGOS-6  Sections added:   * Mechanisms for Exchange of External Data; Technical Management of Constrained Data | TT-WDP ICG-WIGOS | Jan 2016 |
| 1.1 | Sections added:   * Archive; Cyber Security   Sections updated:   * Establishing and Sustaining External Data Relationships + Annex 1; WIGOS Metadata | TT-WDP  WEdB | Feb 2017 |
| 1.2 | - standardization of term – ‘partnership’  Sections updated:   * Archive; Cyber Security | TT-WDP  WEdB | Mar 2017 |
| 1.3 | - document history added  Comments from R Stringer WEdB incorporated  - standardization of terms – ‘non-NMHS’, ‘observational data’  Section removed:   * Links to Other WMO activities; Supplementary Documents/ Outreach Material | TT-WDP  WEdB | Apr 2017 |
| 1.4 | Comments from Jitze VM, Jose A, Updated Annex 1 |  | Apr 2017 |
| 1.5 | Minor editorial for EC-69 | WIGOS-PO | Apr-May 2017 |
| 1.6 | draft Sect. 4.4.1 added, minor editorial updates | MM | Aug 2017 |
| 1.7 | Update of 5.2, 4.4.1 (now as a new 4.5), minor edits and comments | TT-WDP-2 | 20-22 Sep 2017 |
| 1.8 | Sect 3.3.3 added, Sect. 5.7 shortened/revised, minor editorial adjustments throughout | MM | Nov 2017 |
| 1.9 | Sect 4.5 updated with HMEI input, Sect. 5.7 modified, inclusion of minor comments from WEdB | MM, WEdB | Dec 2017 |

**Contents**

1 Introduction 1

2 Purpose and Scope 1

2.1 Purpose and Scope of Guidance 1

2.2 Explanation of Terms 2

2.3 Intended audience 2

2.4 Future updates of this guidance 2

3 Principles 3

3.1 Data Sharing for Mutual Benefit 3

3.1.1 NMHSs 3

3.1.2 Non-NMHS Operators 4

3.2 WIGOS Observational Data Quality 5

3.3 Roles and Responsibilities 6

3.3.1 NMHSs 6

3.3.2 Regional Associations and Regional WIGOS Centres 6

3.3.3 Non-NMHS Partners 7

4 General Guidance 7

4.1 Non-NMHS observational data of relevance to WIGOS and national observing systems 7

4.1.1 WIGOS Requirements 7

4.1.2 National Observational Requirements 8

4.2 Data Use and Sharing 8

4.3 Legal Considerations (liability) 10

4.4 Establishing and Sustaining Observation Partnerships 10

4.5 Commercial Arrangements 11

5 Technical Guidance 13

5.1 WIGOS Station Identifiers 13

5.2 WIGOS Metadata 14

5.3 OSCAR/Surface – WIGOS metadata entry and maintenance 15

5.4 Mechanisms for exchange of observational data 16

5.4.1 Exchange Format 16

5.4.2 Data Access Mechanisms 17

5.5 WIGOS Data Quality Monitoring and Incident Management 18

5.6 Technical Management of Constrained-Use Observations 19

5.7 Archive 20

5.8 Cyber Security 21

6 Annex 1 – A Model for Non-NMHS Observational Data Exchange 22

# 1 Introduction

The WMO Integrated Global Observing System (WIGOS) provides a framework for 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.

The WIGOS framework enables the integration of various WMO and partner surface- and space-based observing systems – i.e., 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), which include WMO contributions to co-sponsored systems (GCOS, GOOS, GTOS) and the GFCS and GEOSS - which 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 non-NMHS and non-traditional sources including other government organizations, non-governmental organizations, research institutions, volunteer networks, and private sector operators.

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 seen as an opportunity to strengthen national observing systems to better support national objectives, needs and priorities.

# Purpose and Scope

## Purpose and Scope of Guidance

WIGOS guidance material is developed to provide practical advice to Members on the interpretation and application of the technical regulations contained in Volume I (WMO-No. 49) and the Manual on the *WMO Integrated Global Observing System* ([WMO-No. 1160](http://www.wmo.int/pages/prog/www/wigos/documents/WIGOS-RM/1160_en.pdf))[[1]](#footnote-2) (hereafter referred to as “the Manual on WIGOS”). The purpose of this document is to provide specific guidance related to incorporating and sharing observations from non-NMHS sources into the WIGOS framework. It highlights the potential benefits and challenges of data from non-NMHS providers, and clarifies the roles and expectations of NMHSs in integrating these data in compliance with WIGOS technical regulations.

In keeping with the incremental approach to WIGOS implementation, this guidance has an initial focus on surface-based meteorological observations (primarily from manual and automatic weather stations), although the principles and general guidance are broadly applicable to other observation types. These surface stations are considered to be the most numerous and widely available sources of non-NMHS observations and therefore represent a significant opportunity to enhance overall national (and in turn global) observation sets. Furthermore, several WMO communities are already migrating their specialized observing programmes to be compliant with WIGOS (e.g., GAW, JCOMM, others….), including with their non-NMHS partner organizations.

The implementation of WIGOS, including the integration of observations from non-NMHS sources, is related to and influenced by a large number of activities across WMO including the Vision for WIGOS 2040, the observational requirements to support the Global Climate Observing System (GCOS) and the implementation of the Global Framework for Climate Services (GFCS), various activities to strengthen data management practices within several Technical Commissions, and the Commission on Basic Systems-Led Review on Emerging Data Issues, among many.

## Explanation of Terms

Within WIGOS, ‘observations’ and ‘observational data’ refer to the result of the evaluation of one or more elements of the physical environment. These terms include observational ‘metadata’ - descriptive information about observational data that is needed to assess and interpret the observations or to support the design and management of observing systems and networks. Observations and metadata may be represented in paper or electronic format, but now predominantly refer to electronic representations handled by information and communication technology (ICT).

In this guidance ‘non-NMHS observational data’ refers to observations and metadata that are collected by organizations outside an NMHS. ‘Non-NMHS operators’ and ‘partners’ refers to the organizations or individuals outside NMHSs which operate observing systems or networks. The nature of the relationship between an NMHS and a non-NMHS operator can vary widely - from a partnership for mutual benefit to a commercial contract - however the generic term ‘partnership’ is used in this document to cover the full range of these relationships.

## Intended audience

This guidance presents both *general* and *technical* information related to the integration of observational data from non-NMHS sources into WIGOS.

Sections 3 and 4 are intended primarily for use by NMHS Directors and NMHS senior management. These sections provide the *Principles* and *General Guidance* of relevance to NMHSs in establishing and maintaining partnerships with non-NMHS operators.

Section 5 is intended primarily for use by NMHS observing system managers. This section provides *Technical Guidance* on how to integrate observational data from non-NMHS operators in compliance with the Manual on WIGOS.

## Future updates of this guidance

As WIGOS evolves through its Pre-operational and Operational Phases the guidance will be updated. This core guidance will be supplemented by a growing body of case studies, best practices, and outreach materials as the experience of Members with non-NMHS observations within WIGOS expands.

# Principles

## Data Sharing for Mutual Benefit

Observational data from non-NMHS sources are of high interest to NMHSs to supplement NMHS observations in order to improve the quality and value of NMHS and WMO products and services. Yet there must also be motivation for non-NMHS providers 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, based on improved mutual understanding of organizational goals and strengthened collaboration.

### NMHSs

NMHSs are typically supported by their national governments to establish and operate an observing system to support their core mandate. Depending on the national situation, the NMHS is often responsible for weather and climate observations, and may also be responsible for hydrologic, ocean, and other observations The increased demand for hydrometeorological services and products at ever finer spatial scales has led to a growing demand for spatially denser and more integrated observations across these domains. At the same time many NMHSs are facing increasing logistical and economic challenges in supporting their current observing systems, and they may be unable on their own to deploy observing networks that meet these new requirements. In this context it is logical for NMHSs to look to non-NMHS operators as sources of observational data.

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 NMHS products and services. Furthermore, there is the broader goal to improve the quality of global products and services through the exchange of observational data across WMO in compliance with WMO regulations. In this context the motivations of NMHSs to enter into observational data partnerships include:

* fill observation gaps
  + to increase the density and timeliness of observations especially in high impact locations or observation sparse regions, or for parameters not observed by the NMHS
  + to improve access to real-time observations of current conditions for situational awareness and nowcasting
* cost-efficiency
  + to gain access to observations at no- or low-cost
  + to gain access to observing sites with existing power and communications infrastructure
  + to gain access to non-NMHS secure and monitored observing sites (e.g., to prevent vandalism)
  + to reduce the infrastructure and operating costs through contracting out of station operations
* 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
  + to improve observation quality assessment and quality control by using redundant and/or diverse sources of observations
  + to raise the overall quality and reliability of national observations through outreach to non-NMHS operators, training, promotion of standards, and potentially national policies or regulations
* 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 with other organizations and the general public

### Non-NMHS Operators

Non-NMHS operators have invested in observing systems 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 needs; consequently the motivations to share observational data with NMHSs or internationally with WMO Members are also very diverse.

The motivations for non-NMHS operators for observational data partnerships with NMHSs include:

* 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
* access to other observations
  + observational data are contributed to NMHSs in order to leverage access to a larger pool of contributed observations from other national sources, or to access the global observational data exchanged among WMO Members
* business opportunity
  + the commercial sector wishes to sell or licence observational data to NMHSs on a for profit or cost recovery basis
* association with a public-good programme
  + the visible contribution of observational data to a recognized national or international public-good programmes lends significant credibility to many observing programmes and is frequently leveraged to justify funding
* 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
* 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
* volunteerism
  + observational data are contributed by organizations or citizens as a contribution to the public good or scientific record
* 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

Many observational data partnerships are voluntary and rely on the mutual interest and good will of the participants to make the partnership work. Nevertheless, well documented agreements 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*. See Section 4.4 – *Establishing and Sustaining Observation* Partnerships.

## WIGOS Observational Data Quality

Observation quality is one of the most frequently expressed concerns about observational data from non-NMHS sources. Knowledge of the quality of observations is an important factor in the credibility and authority of NMHS and WMO products and services, so the use of non-NMHS observational data obtained without sound knowledge of the procedures used for collection and processing is considered by many as a risk to the quality of NMHS and WMO programmes.

The historic approach by WMO to observational data quality has been a ‘controlled and documented quality’ approach. Quality is managed through well-defined, end-to-end technical standards and recommended practices to which NMHSs and other operators are expected to adhere, thereby controlling quality through rigorous process. For non-NMHS observational data, many operators are unaware, unable, or unwilling to adhere to WMO standards which are often considered too stringent or expensive for their internal requirements. As a result the real quality of much non-NMHS observational data is largely unknown.

On the other hand there are many non-NMHS organizations that operate well-controlled systems to high standards and provide high-quality, well documented observational data, for example for aviation, road weather, wind energy, and hydrologic applications, among others. Some organizations also operate under the ISO/IEC 17025:2005 standard (General requirements for the competence of testing and calibration laboratories) to satisfy their business requirements. Another example of the adoption of standards is the MeteoSwiss Classification Procedure for Automatic Weather Stations which is applied to non-NMHS operators’ stations at the time of inspection[[2]](#footnote-3)*.*

To address the issue of observational data quality, WIGOS has adopted an approach based on the principle of documented ‘known quality’. This approach seeks to maximize the descriptive metadata associated with an observation in order to allow the user to understand how the observational data was produced and to assess its appropriateness for the intended application, including whether the observations are not suitable – for example for the measurement of extremes of long-term climate monitoring. This approach accommodates the real-world variability of observational data from different observing system operators and supports the informed use of observations for multiple applications. A principal tool to support the ’known-quality’ approach is the WIGOS Metadata Standard [[3]](#footnote-4)[;](http://www.wmo.int/pages/prog/www/wigos/documents/WIGOS-RM/1160_en.pdf) also see Section 6.2 of this document).

The adaptability of WIGOS to a range of observation systems and practices is especially relevant to non-NMHS operators where compliance with equipment and operating standards is known to be uneven or lacking. Providing metadata is a fundamental requirement of WIGOS, and adherence to the WIGOS Metadata Standard is mandatory for data to be exchanged internationally by WMO. NMHSs, however, may choose to permit the use of a sub-set of the standard in order to simplify and encourage the exchange of observations for national applications *(see Sect 5.2 – Technical Guidance – WIGOS Metadata).*

## Roles and Responsibilities

The successful integration and use of observations from multiple sources requires the actions of several entities within the WIGOS framework. These include NMHSs, regional associations, Regional WIGOS Centres (RWCs), and the non-NMHS partners that contribute data to WIGOS.

### NMHSs

As national authorities for weather, water and climate information NMHSs have a national leadership role in the continued improvement of national observing capabilities which build on WIGOS principles and practices.

The principal roles of NMHSs with respect to non-NMHS observations include:

* lead the implementation of WIGOS at the national level through the development of a National Observing Strategy and a National WIGOS Implementation Plan
* manage the assignment of WIGOS Station Identifiers for national stations
* engage and encourage national non-NMHS operators to contribute their observations to a consolidated pool of observational data for the benefit of all at the national, regional, or global level
* articulate and explore with non-NMHS operators the benefits of contributing observational data to NMHS and WMO programmes
* develop and maintain agreements with non-NMHS operators using suitable mechanisms (e.g., MOUs, contracts, etc.) which articulate the benefits of the partnership and which specify the roles and responsibilities of the participants
* encourage and support the use of WIGOS standards (such as the WIGOS metadata standard) and tools (such as OSCAR/Surface) to the greatest extent possible for national observations
* assess the relevance, quality, and sustainability of non-NMHS observations to support national and global programmes
* for observations of high global value, facilitate non-NMHS operators to be compliant with the WIGOS metadata standard to enable international exchange
* support outreach and training on WIGOS, for instance on WIGOS standards, recommended practices and procedures, mechanisms for observational data exchange, etc.
* support effective observational data management, and/or observational data sharing
* encourage and support the implementation of adequate cyber security mechanisms

### Regional Associations and Regional WIGOS Centres

Regional associations and WIGOS Regional Centres are uniquely positioned to support WIGOS implementation beyond national borders.

The principal roles of regional associations with respect to non-NMHS observations include:

* management of the Regional Basic Synoptic Network (RBSN) and the Regional Basic Climatological Network (RBCN) and the anticipated future transition to a Regional Basic Observing Network (RBON)
* identify issues and opportunities of regional importance where cross-border coordination of non-NMHS observations would be beneficial *(*e.g., across international watersheds, e.g., *La Plata Basin WIGOS-SAS case study)*
* establish regional/sub-regional coordination mechanisms to support cross-border WIGOS activities, including the coordination of observational data from non-NMHS sources and, potentially, coordinate the response to observational data incidents identified by the WIGOS Data Quality Monitoring System (WDQMS)

In addition Regional WIGOS Centres (RWCs) will play a critical role in advancing the implementation of WIGOS within their region (or sub-region) and will be providing regional coordination and technical support to Members

### Non-NMHS Partners

The contribution of observations by non-NMHS organizations is generally voluntary, but there are expectations of partners to support an effective WIGOS. Partners may be supported by NMHSs in performing these roles (see Section 4.3.1)

The principal roles of non-NMHS WIGOS partners include:

* identify and share observations of relevance to support national priorities, and potentially to share internationally
* provide WIGOS metadata in order to inform the appropriate use of the observations
* maintain WIGOS metadata up-to-date and inform the NMHS of any changes to observing systems in a timely manner
* develop and maintain an agreement with the NMHS (or other collaborating organization) which articulates the benefits of the partnership and which specifies the roles and responsibilities of the participants
* implement (to the greatest extent possible) NMHS and WMO standards and guidelines regarding the collection of observations and data management

# General Guidance

## Non-NMHS observational data of relevance to WIGOS and national observing systems

The overall aim of gaining access to observational data from non-NMHS sources is to increase the number of relevant observations to support national and WMO programs. But what kind of observational data should be pursued and what factors should be considered in assessing non-NMHS observational data opportunities?

### WIGOS Requirements

The observational requirements to support WMO programmes are established through the Rolling Review of Requirements process[[4]](#footnote-5) and critical gaps in the observing system are identified in Statements of Guidance. For Members, the key reference for observational requirements and systems for WIGOS is the Observing Systems Capability Analysis and Review Tool (OSCAR).

The **OSCAR/Requirements** database[[5]](#footnote-6) is the official repository of [requirements](https://www.wmo-sat.info/oscar/requirements) for the observation of geophysical [variables](https://www.wmo-sat.info/oscar/variables) in support of all activities of WMO and its various co-sponsored Programmes. The database provides a listing of the observational requirements for all WMO application areas (as listed in the Manual on WIGOS). The geophysical variables are described, as well as minimum and desirable figures for the uncertainty of the measurement, resolution, frequency and timeliness.

The **OSCAR/Surface** module[[6]](#footnote-7) is the official repository of WIGOS metadata for all surface-based observing stations and platforms registered with the WMO. The module provides a description of the observing site (through WIGOS metadata) and an interactive map to display the geographic location of observing sites. It is mandatory that stations be registered in OSCAR/Surface for observations to be exchanged internationally.

These tools may also be used to support assessments of the adequacy of existing observing systems to meet the needs of specific application areas, and to identify parameter and geographic gaps. Future releases of OSCAR are planned to include some level of automated analysis tool to provide further assistance with such assessments.

### National Observational Requirements

WMO Members frequently have observational requirements beyond those specified in OSCAR in order to support national programmes and priorities. These observations are typically required to support more geographically-detailed information, and/or to support applications of high national impact such as agriculture, transportation, or flood forecasting. The requirements are driven by the needs of the specific application, the local environment and climatology, and by the national importance of the application.

National or local observational requirements may or may not be formalized, but local importance has often already provided the motivation to non-NMHS organizations to establish their own observing capabilities – for instance by agriculture or water management agencies. As a result, existing non-NMHS operated observing systems are often already well aligned with national or local interests and likely to be of high relevance to NMHSs as well. These observations may also help address gaps in meeting WMO requirements and the opportunity for international exchange of these data should be pursued. Citizen-operated or other stand-alone sites may also provide additional sources of observations to supplement the observations those from more formal institution sources.

## Data Use and Sharing

As signatories to the WMO Convention, Members of the Organization have committed to ‘facilitate worldwide cooperation in the establishment of networks of stations for the making of meteorological observations as well as hydrological and other geophysical observations related to meteorology’[[7]](#footnote-8).

Also, through their adoption of Resolution 40 (Cg-XII)[[8]](#footnote-9) they have committed to ‘broadening and enhancing the free and unrestricted international exchange of meteorological and related data and products’, and through adoption of Resolution 25 (Cg-XIII)[[9]](#footnote-10) to ‘broadening and enhancing, whenever possible, the free and unrestricted international exchange of hydrological data and products, in consonance with the requirements for WMO’s scientific and technical programmes’. Resolution 60 (Cg-17)[[10]](#footnote-11) further extends these principles to the exchange of climate observational data to support the Global Framework for Climate Services (GFCS).

Alongside these long-standing commitments WMO Members also approved the Manual on WIGOS including the Observing Network Design Principles. One of these principles explicitly describes the expectation to make observational data available: ‘Observing networks should be designed and should evolve in such a way as to ensure that the observations are made available to other WMO Members, at space-time resolutions and with a timeliness that meet the needs of regional and global applications.’

It is clear therefore that the case for increasing the amount of observational data that is shared is very strong, and indeed is the underpinning infrastructure on which the services of NMHSs are built. It is also clear, however, that there remain significant barriers to the free exchange of observational data. A foundational principle of WIGOS is to expand the global observing systems beyond those historically operated by NMHSs and to include networks operated by other entities, public as well as private. These additional networks may operate under a wide range of data policies:

* Some governments have committed to releasing taxpayer-funded data under an open licence, either through the auspices of an Open Data Charter or an equivalent instrument. This simplifies the use and exchange of data, including observational data, from these sources because there are few restrictions on use or re-use.
* Private operators are increasingly offering their observations (typically surface-based observations, GPS-Radio Occultation, and aircraft data) to NMHSs for use in the generation of products and services. The license terms are typically more restrictive than those in the above category and they may not allow onward sharing and exchange. Members are encouraged to pursue licence terms that at minimum support Members’ obligations regarding the exchange of observational data, and wherever possible permit the Open or broadest exchange.
* There has been a significant increase in the amount of observational data generated by private citizens in recent years. Data policies are often imposed by the operators of the data portal to which the individual chooses to submit their observations (e.g. Weather Underground). The sharing of these observational data amongst NMHSs can be challenging, however the observations are often free to view and download via the web.

As NMHSs consider how best to implement WIGOS in their national context a comprehensive assessment should be conducted to understand what observational data could be available to support national interests and priorities. This could then inform a national implementation plan to use existing partnerships, create new partnerships where necessary, and ensure that the benefit of these observations can be realized.

## Legal Considerations (liability)

Many non-NMHS operators that contribute observations to NMHSs or WMO programmes do so for the public good on a voluntary and best-effort basis. In general, these contributing organizations expect that they should not assume any legal risks as a consequence of any incorrect or missing observations. This is considered a reasonable expectation and should be a principle supported by NMHSs. For instance, the operator of a Volunteer Observing Ship should not risk a legal claim for Third-Party liability in the event that inaccurate or missing observations were a contributor in some way to a marine incident. If voluntary contributors of observational data were required to assume legal risks from their observations it would limit their willingness to contribute and consequently reduce the benefits to all.

The WIGOS metadata provides a tool for users to assess the limitations and appropriate uses of observational data, and NMHS quality control procedures and the WIGOS Data Quality Monitoring System will endeavour to detect erroneous values. But the risk of faulty decision making and legal action as result of flawed observational data provided by an external operator is still possible.

Most Members, their NMHSs, and other government organizations are protected from such liabilities by national regulations. This immunity, however, cannot normally be transferred to non-government organizations so NMHSs should seek to find mechanisms within their national laws to reduce the liability risks to non-government partners in order to reduce or negate this potential barrier. For data that may be acquired and subsequently distributed by the NMHS through a partnership agreement, it may be possible through the agreement to transfer such risks to the government or otherwise limit the risks to external partners.

There is a second dimension to liability to be considered in observational data partnerships. The participants may wish protection in the event that an action by one participant causes damage to the other - for instance physical damage to equipment. Between agencies of the same government these risks are often assumed by the participants, or mechanisms for recourse are clearly defined in advance in a partnership agreement. For partnerships with non-government operators, clear definitions and limitations of liability should be included in a partnership agreement, although NMHSs may wish to only consider liability in the event of misconduct or wilful negligence (versus accidental damage) in order to minimize barriers to cooperation. By example, MeteoSwiss has successfully incorporated issues of liability in the Terms and Conditions of its agreements with its non-NMHS partners[[11]](#footnote-12)*.*

## Establishing and Sustaining Observation Partnerships

Section 3.1 identifies ‘mutual benefit’ as a core principle and summarizes the motivations for NMHSs and other operators to enter into a partnership. And while external observational data contributed by partners are often thought to be ‘free’ or ‘low-cost’, there are considerations for NMHSs concerning the value, internal costs, and sustainability of these arrangements. Similarly, commercial observations also come with considerations regarding value for money, restricted-use licensing, and sustainability.

The Australian Bureau of Meteorology (BoM) has developed a framework to address the incorporation of non-NMHS observations into their operations[[12]](#footnote-13) including a practical step-by-step process to assess, approve, and manage these observational data. A summary of this process is presented in [Annex 1 - *A Model for Non-NMHS Observational Data Exchange*](#Annex1).

The process is relevant for situations where the NMHS is seeking contributions of observations from non-NMHS sources, as well as for instances where an NMHS is approached by a non-NMHS operators with offers to contribute observations.

## Commercial Arrangements

An alternate mechanism to acquire observations from non-NMHS sources is through supply arrangements with the commercial sector. These are formal contractual agreements, in contrast to the cooperative arrangements with voluntary partners. Commercial arrangements may be developed with companies whose primary business is selling meteorological observations and services, or with companies that collect meteorological observations to support their own business activities (e.g., transportation, agriculture, dam operations, etc.) and then offer to sell them as a supplemental source of revenue. The commercial sector can have strong technical capabilities and can often be more agile than government organizations in offering modern observing technologies, and so may be an attractive option to establish or enhance an observing capability. A commercial arrangement may be for observational data only (i.e., a ‘data buy’) or may include more comprehensive services such as the supply of observing equipment, installation and maintenance, quality assurance, and observational data management.

Should NMHSs choose to use a commercial arrangement, the following should be considered.

**Purpose of the Network**

Commercial networks may be “independently” developed or “collaboratively” developed. Independently developed networks are created for a specific business purpose by the commercial operator that is not connected to the NMHS. For example, a beverage bottling company may develop a network to monitor the availability, quantity, and quality of their water source. They may be willing to share this observational data with the NMHS, but may not consider any additional technical requirements such as WIGOS Metadata Standards and they may impose restrictions of use and redistribution of the data. The NMHS generally has little or no implementation or operational risk, but the risk of data availability can be high if the business requirement of the operator is not sustained, or release of the observations negatively impacts a commercial advantage.

Collaboratively developed networks are created to meet the specific needs of the NMHS, while leveraging the infrastructure and technical capabilities of a commercial partner to obtain observations in a more cost-effective fashion or with less implementation or operational risk to the NMHS. These collaborative networks are established to meet the specific technical and operational needs of the NMHS and therefore can be more easily established to meet WIGOS requirements. For example, a private company may have existing sites, telecommunications infrastructure, and the technical capacity to develop and operate an observation network to NMHS specifications. Collaboratively developing this network enables a ‘data buy’ arrangement for the NMHS. Risk of implementation and operation is transferred to the private partner, while data quality can be monitored and ensured to NMHS specifications. Longer term agreements increase the sustainability of such partnerships for both parties.

**Long-Term Value**

When assessing the value of a commercial arrangement the long-term costs to the NMHS must be considered. These include the cost in relation to establishing the capability within the NMHS itself, the duration of the contract, any supplemental costs (e.g., telecommunications, land leases, etc), and the ownership and maintenance of equipment at the end for the contract. The decision to proceed with a commercial supply arrangement should be supported by a sound business case which examines all costs, risks, and comparisons to alternatives, if available. It is recommended that performance requirements (such as observation availability, timeliness, quality, etc.) be specified in the statement of requirements. As a commercial contract, enforceable penalties for non-performance may also be considered.

Guidance to assist the definition of requirements is under development in association with the International Association of the HydroMeteorological Equipment Industry (HMEI)[[13]](#footnote-14) and will be published by the WMO Commission for Instruments and Methods of Observation (CIMO).

**Ownership and Use**

A key consideration is ownership of the observational data and metadata, and any constraints on their use and sharing. Often, the ownership and intellectual property rights of commercial observational data remain with the company and a licence is provided to use the observations for specific purposes. For instance, the observations may be used internally by a NMHS to produce forecasts and climate analyses, but the observational data itself may not be sharable with others, including other NMHSs. The value of sharing observations in the national and international context is universally recognised and Members are encouraged to carefully consider the terms of commercial arrangements and their support of WMO Resolutions and data sharing principles.

The duration of the licence is also an important consideration when the commercial observations are to be archived for the climate record. Data supply arrangements should specify the right to store and use the data in perpetuity, not just for real-time use or for the duration of the supply arrangement. Similarly, if the supply arrangement includes proprietary data management or data access tools, provisions to access the data beyond the validity of the contract should be considered. Data formats and processing systems should be built on open standards/open source to enable ongoing access to observational data and tools (i.e., avoidance of closed, proprietary formats and tools)

**Sustainability**

Because commercial contractual arrangements are normally of limited duration (e.g., 5 -10 years) consideration should be given to the long-term sustainability of the observations – both to support current NMHS operations and to maintain an uninterrupted climate record. Further, the commercial provider themselves may cease operations during the period of the contract, or be unable or unwilling to renew the contract at the end of the term.

To mitigate these risks the following should be considered in the supply agreement:

* mechanisms for the transfer of equipment to the NMHS at the end of the contract or end of company operations
* long-term financial planning for the sustainment of an observing capability beyond the current contract, including periodic refresh of the technology
* the sustainment of technical capability within NMHS to assume operation, maintenance, and life cycle management of equipment, where required
* consideration of the commercial operator’s business environment in order to assess the risk that an operator may suddenly modify the technical implementation, increase prices, or cease operations altogether

**Accountability**

The public accountability for the quality and authority of observational data will normally remain with an NMHS even if they choose to outsource through a commercial supply arrangement. Careful consideration should be given at the beginning of the commercial arrangement to the equipment specification, quality assurance measures and oversight of the services to protect this public accountability.

# Technical Guidance

After agreement is reached with a non-NMHS partner there are several technical matters to be addressed to enable the exchange and management of the observational data. These include the assignment of station identifiers, the collection and maintenance of metadata, the technical mechanisms for the exchange of observational data, data management and archive, and issues of cyber security.

The regulatory and guidance material of WIGOS does not normally address technical matters of data processing and data management as these are covered under the WMO Information System (WIS) and various other activities of the Technical Commissions. However, technical matters of specific relevance to WIGOS Observational data partnerships are presented here for completeness.

## WIGOS Station Identifiers

Guidance on the format and use of WIGOS station identifiers is available in the Guide to WIGOS[[14]](#footnote-15). In general, the NMHS (through the authority of the Permanent Representative and administered through the WIGOS Focal Points) has the role to issue identifiers to national stations - including those operated by entities outside the NMHS. In this way the NMHSs provide a coordination function for the management of station identifiers in order to avoid confusion or duplication.

WIGOS station identifiers are mandatory for stations to be registered in OSCAR/Surface[[15]](#footnote-16) and for the data to be exchanged internationally.

The structure of WIGOS station identifiers essentially provides for a limitless number of codes and is well suited to supporting both NMHS and non-NMHS stations. Because there are no constraints on the number of available codes the new standard provides the opportunity to use a single, consistent station identifier scheme across all observing systems in a country regardless of operator. Such an approach could unify and simplify the tracking of national observing capabilities and could reduce the complexity of the supporting data management and processing systems. NMHSs should strongly consider a nationally-coordinated approach when assigning WIGOS station identifiers including to non-NMHS operators.

The process to register station identifiers for non-NMHS stations is the same as for NMHS stations. Non-NMHS stations that were previously registered in WMO-No. 9, Vol. A, will be migrated automatically via OSCAR/Surface. Non-NMHS stations that were not previously registered must be registered with a new WIGOS Station Identifier.

## WIGOS Metadata

The purpose of WIGOS metadata is to provide the details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting the observation, as well as managing the station and its observing program. As noted earlier, WIGOS metadata is essential to support the WIGOS principle of ’known quality’. Figure 1 summarizes the principles, content, and Member expectations in supporting WIGOS metadata.



Figure 1: Overview of the WIGOS Metadata Standard

For observations to be exchanged internationally, metadata needs to adhere to the WIGOS Metadata Standard (WMO-No. 1192) and be registered in OSCAR/Surface. This requirement applies equally to observations from NMHS and from non-NMHS stations.

The WIGOS Metadata Standard is very comprehensive as it is designed to meet a broad range of WMO operational and scientific requirements, and the scope of information required to fully comply with the standard is substantial. The effort involved in collecting and maintaining this information may be perceived as a significant barrier to some non-NMHS operators which may deter the contribution of valuable observations.

To facilitate compliance, the WIGOS Metadata Standard has included certain flexibilities:

* *Optional* elements which “should” (vs “shall”) be reported, and
* some *Mandatory* elements which may be reported as “not applicable”, “unknown”, or “not available” with an explanation as to why the information is not available.

These options provide considerable flexibility and can be used to maximize the international exchange of observations, although progress towards fully complete metadata is always encouraged. NMHSs can play a key role in assisting data providers to comply with the standard. Among the actions NMHSs should consider with partners are:

* raising awareness of the WIGOS quality principles, the WIGOS Metadata Standard, and their benefits
* providing expertise and assistance to partners in the collection of WIGOS metadata, including periodic review and update
* metadata entry and maintenance in OSCAR/Surface on behalf of the partner

International exchange of observations may not be possible for reasons of quality, reliability, or data ownership, or there may not be a strong international demand. For instance, observations from a national energy company may be made available for internal use by the NMHS to support national forecast products, but not authorized to be re-distributed outside the NMHS. Even if there is not the need or it is not feasible to exchange observations internationally, NMHSs are still encouraged to follow the WIGOS Metadata Standard as a consistent tool for coordinated national observing systems and to develop its use among non-NMHS operators to the degree possible.

In these situations, NMHSs can support the national exchange of observations with a sub-set of WIGOS Metadata Standard elements, which over time may grow to become fully compliant and eligible for international exchange. This approach will increase overall compliance and awareness of the standard, facilitating additional international exchange over time.

In assessing what initial sub-set of WIGOS Metadata Standard elements may be appropriate for national applications it is useful to consider the different uses of observations and the varying quality demands of each application. For example, observational data for a safety-critical use (such as aviation) or climate monitoring which demand a much higher level of quality.

## OSCAR/Surface – WIGOS metadata entry and maintenance

A key responsibility of WIGOS observing system operators is to supply and maintain accurate WIGOS metadata in the OSCAR/Surface database. Typically, NMHSs are the authorized users of OSCAR/Surface (through their National Focal Points) and will undertake this responsibility for NMHS stations. Data entry and maintenance may be through the OSCAR/Surface web interface or through a machine-to-machine interface for NMHSs with existing metadata management systems*.*

In the case of non-NMHS observing sites it is expected the NMHS will take responsibility for maintenance of metadata in OSCAR/Surface on behalf of partners. The National OSCAR/Surface Focal Points will have the training and expertise to manage OSCAR/Surface metadata and are best positioned to ensure the accuracy and coherence of these metadata for national observing capabilities. At present there are no defined standards for the accuracy of WIGOS Metadata (a possible future development), so National OSCAR/Surface Focal Points are encouraged to work with partners to strive for the highest achievable accuracy to support the intended use of the observations. For instance, the accuracy and completeness of metadata is higher to support long-term climate monitoring than or Numerical Weather Prediction. The regular review and update of OSCAR/Surface with WIGOS metadata for non-NMHS stations should be an integral part of agreements with partners.

## Mechanisms for exchange of observational data

Once station identifiers and metadata have been established, the actual transfer of observational data can occur. To support the principle of mutual benefit the technical mechanisms for the exchange of observational data should be bi-directional, i.e.:

* for the NMHS to receive observations from partners
* for the NMHS to provide access to observations. Ideally the observations made accessible by the NMHS is a consolidation of observations from many suppliers, quality assessed, in a consistent format, and offered through standards-based interfaces

In this context the WMO Hydrological Observing System (WHOS) is intended to provide an additional capability as a federated resource for National Hydrological Services. WHOS is built around two fundamental components: service providers and service consumers. Although service consumers can directly connect to service providers to request and receive observational data and products, a third component, a service broker, is introduced to facilitate discovery and access across different service providers by providing mediation services. WHOS provides advanced data access and analysis capability through the use of web services using standardized data formats and service types, together with common formats and services with the aim to improve interoperability between clients and server interfaces.

The exchange of data involves two elements: a) the exchange format and b) the data access mechanism.

### Exchange Format

The WMO Information System (WIS) defines standards for the discovery and operational exchange of data among WMO Members (e.g., the WIS Discovery Metadata standard, Table-Driven Code Forms, e.g. BUFR, etc.). However, these standards are quite complex, unique to the WMO, and not widely used by non-NMHS organizations. Instead, there are many formal and *de-facto* standards for data exchange with partner organizations that are commonly used because of their ease of use, practicality, and wide acceptance across numerous communities. These range from the manually-initiated exchange of simple CSV files to fully-automated, dynamic queries through geospatial web services.

Given the diversity of partners and technology environments there is no firm guidance on specific standards or tools, and the choice of exchange format may be dependent on the telecommunications protocol being used. Desirable characteristics of an exchange format include:

* open – based on open, non-proprietary, industry-wide standards
* portable – can operate on any platform or Operating System
* stable – it has a large user base / community which will encourage long-term stability and availability
* supportable – it is supported by a large number of open source or commercial implementations
* self-describing – the format and content are fully described within the exchanged file

Common formats used for the exchange of hydrometeorological data today include, but are not limited to:

* Web form – manual input of data on a web site or smart phone app
* CSV - Comma-Separated Values
* XML – e.g. OGC Observations and Measurements (O&M), WaterML2, or other derivatives of the OGC Geography Markup Language (GML)
* JSON - JavaScript Object Notation
* NetCDF - Network Common Data Form
* HDF - Hierarchical Data Format

The use of open, non-proprietary exchange formats facilitate vendor-neutral and multi-application access whether using off-the-shelf tools or custom solutions. For example, the open source Geospatial Data Abstraction Library (GDAL)[[16]](#footnote-17) provides read/write/translation capability for hundreds of formats for both raster (model output, satellite imagery) and vector (alerts, observations) data. GDAL also provides the underpinning for numerous data access and visualization tools, both open source and commercial.

The use of open exchange formats with wide vendor and community support reduces the barriers to hydrometeorological data across the domain and into new information communities, and is encouraged.

### Data Access Mechanisms

Regardless of the exchange format the transfer of data requires a mechanism to upload and/or download. The ubiquity of the Internet has provided a telecommunications backbone that lowers the barrier to data transfer, but there is still a range of access mechanisms of varying sophistication and complexity. The desirable characteristics of data exchange formats (e.g., open, portable, stable, etc.) are equally applicable to data access mechanisms.

Common data access mechanisms for meteorological data exchange include, but are not limited to:

* human interface:
  + data entry on a web form (desktop or phone app)
  + file transfer by email attachment (manual send)
  + file transfer via neutral data sharing service (e.g., iCloud, Dropbox)
* machine-to-machine interface:
  + file transfer by email attachment (automated send)
  + automated download (data 'pull' from SFTP or Web Accessible Folder (WAF) sites)
  + automated subscription service (event-based 'push' of data from the provider)
  + geospatial web services (dynamic, just-in-time access through client/server environment and tools) based on international standards (OGC, ISO)[[17]](#footnote-18)

Like the choice of exchange format, the choice of access mechanism depends on the technical environments of the NMHS and partner and whether the access will be machine-to-machine or through human interaction. The choice should also be made with consideration of the operational reliability and timeliness of the transfer, for instance to meet global Numerical Weather Prediction (NWP) cut-off times of <2-3 hours. In general, automated transfer by email attachment is not recommended because of frequent issues with reliability (e.g. emails not being sent, not received, or blocked or misplaced by email filters). Furthermore, the use of secure transmission protocols (e.g., SFTP and SSH) is recommended to reduce security vulnerabilities (see Section 5.8 - Cyber Security). These decisions need to be jointly made by the NMHS and external supplier in order enable and sustain a secure operational data transfer.

## WIGOS Data Quality Monitoring and Incident Management

The Manual on WIGOS specifies that Members shall ensure the quality control of WIGOS observations. This includes the application of *real-time* quality control prior to the exchange of observations via the WMO Information System (WIS), and *non-real-time* quality control prior to archiving. These requirements apply equally to observations from both NMHSs and non-NMHS sources that are to be exchanged internationally, and are also highly recommended for observations that are to be used only for national purposes.

Many NMHSs already have quality control procedures in place to support these requirements for NMHSs observations, and it is recommended that the same procedures be applied to non-NMHS observations for consistency and to minimize the effort to maintain separate procedures and tools. Guidelines on quality control procedures for observations from automatic weather stations are available at the *Guide to the Global Observing System* (WMO-No. 488)[[18]](#footnote-19), Appendix VI.2. Quality control considerations and procedures for climate observations are available in the WMO Guide to Climatological Practices (WMO-No. 100)[[19]](#footnote-20).

In addition to procedures applied by NMHSs, the WIGOS Data Quality Monitoring System (WDQMS) will also routinely monitor and report on observation data anomalies (incidents) that are discovered by the global Numerical Weather Prediction (NWP) centres. Once operational, these reports will be distributed to inform Members and Regional WIGOS Centres of incidents and to initiate corrective actions with the provider of the observations.

Incident Management for non-NMHS observations should be handled in as similar a fashion as possible to the NMHS’s own observations. The staff handling incidents at the NMHS should be instructed on how fast they should react in case of an incident and the point-of-contact at the partner organization. The incident management mechanisms vary from organization to organization and it is recommended to jointly define procedures as part of the observational data agreement.

## Technical Management of Constrained-Use Observations

As noted earlier, non-NMHS observations may have constraints on their use or sharing. Thespecifics of any constraints should be clearly defined in the agreement with the provider. It is of high importance that these conditions be respected in order to maintain the reputation of the NMHS as a trusted partner, and to maintain the willingness of external providers to contribute observations. Furthermore, it may have legal consequences if the terms of an agreement are breached. Functionality within an NMHS data management system is therefore required to manage observations with constraints.

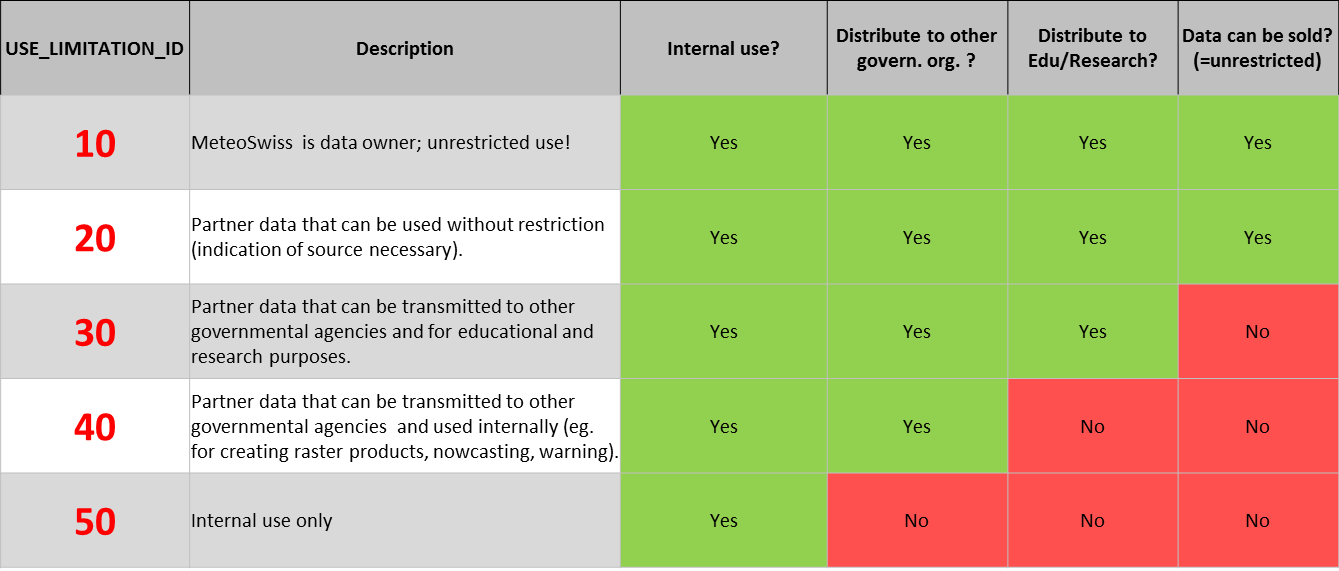
The WIGOS Metadata specifies two parameters under Category 9: *Ownership and Data Policy* than can be used to detect observational data that require special consideration in processing.

**Parameter 9-01 - Supervising Organization**: a mandatory parameter that provides the name of organization who owns the observation

**Parameter 9-02 - Data Policy**: a mandatory parameter that provides details relating to the use and limitations surrounding the observation imposed by the supervision organization. This parameter currently defines three observation policy conditions:

* WMO Essential – Resolution 40/25 observations with no constraints on use   
  [WMO\_DataLicenceCode = 0]
* WMO Additional – Resolution 40/25 observations with constraints on use that need to be researched through other documentation  
  [WMO\_DataLicenceCode = 1]
* WMO Other – other observations with constraints not set by WMO policy   
  [WMO\_DataLicenceCode = 2]

Use of these parameters enables constrained observations to be detected in NMHSs processing systems, but these systems must also be able to interpret and use this information in accordance with the data policy of the provider. The three WMO\_DataLicenceCodes may be insufficient to adequately cover all the observation policy variations across multiple partner organizations, so additional internal tools may be required to add precision to the processing flow. By example, MeteoSwiss has implemented a hierarchical 5-level framework that assigns an internal USE\_LIMITATION\_CODE to manage various levels of constraints. The hierarchical approach has facilitated the technical implementation - i.e., a limited, but adequate, set of use cases is defined and constraints are applied progressively with the use of single USE\_LIMITATION\_ID code.

**MeteoSwiss example of a technical framework for the management of constrained data**

## Archive

Observations from non-NMHS sources are often used to support near-real-time applications and services, but these observations may also offer opportunities to enhance the climate record[[20]](#footnote-21). The WMO Guide to Climatological Practices (WMO-No. 100)[[21]](#footnote-22) outlines the basic principles and practices important in climate services, including guidance on climate observations, stations and networks (Chapter 2) and on climate data management (Chapter 3). Regarding non-NMHS observations, considerations to matters of data quality, longevity of the observation record, and long-term preservation and access are important, as well as matters of the inter-comparability of observations. The WIGOS Metadata Standard is designed to capture information relevant to data quality and long-term intercomparability, so attention to populating and maintaining the metadata records for both NMHS and non-NMHS climate observations is paramount.

The technical management of observational data for archive purposes also requires special consideration. Observational data to support near-real-time applications are typically managed within an operational database and arrangements are normally required to transfer these data (including metadata) to a separate climate data management system (CDMS) and/or to an International Data Centre. In archiving non-NMHS observations it is important to be able to distinguish between the different sources of data (through metadata fields or through separate databases) as there may be significant differences in the quality of data and metadata which could impact climate analyses and services. The subject of archive of externally-sourced data will be covered in detail in the Manual on Climate Data Management planned for publication in 2018.

The above applies to data available in digital formats, but it is important to recognise that much historical data may exist only in hard copy (paper) forms. Guidance on securing and archiving hard copy records and images is provided in Guidelines on Best Practice for Climate Data Rescue (WMO No 1182)[[22]](#footnote-23).

## Cyber Security

Cyber security is an area of concern due to growing threats to the integrity, reliability, and privacy of information systems and data. The World Wide Web and more recently social networks have improved cooperation between WMO Members and have also facilitated the exchange of information with many new observational data providers. In parallel to these positive changes an increasing number of cyber security threats are present everywhere throughout the Internet. Because of its widespread use the Internet has unfortunately become a medium of choice for disseminating unwanted information and for launching electronic attacks against organizations and their information assets. It is therefore necessary for NMHSs to recognize these risks and to protect their information systems in order to maintain operational data processing and to securely exchange information.

In exchanging information with non-NMHS operators, WMO Members must be aware of cyber security threats and take measures to protect their information system. As all WMO Members are interconnected, it is essential that each Member take appropriate measures to secure its information exchange and ensure that he will not be the cause of further security problems within the WMO Information System (WIS).

Security standards and best practices have already been adopted by a large number of WMO Members for securing the exchange of information within WIS. The Guide to Information Security Technology (WMO-No. 1115)[[23]](#footnote-24) outlines the basic concepts and principles of information security and provides a broad overview of the main information technology security components, processes and best practices. The principles described in the Guide can be used to exchange data with non-NMHS providers in order to ensure the consistency of security practices within the WMO community.

At the national level, cyber security requirements and implementations are increasingly being defined by organizational or national authorities and, in general, NMHSs are required to comply with these requirements. The security requirements of non-NMHS organizations can vary widely and may sometimes be in conflict with those of the NMHS. Access to observational data across firewalls is a common challenge as organizations typically restrict outside access to their systems. A frequently-used solution is to establish data repositories outside firewalls and to require the use secure transmission protocols (e.g., HTTPS, SFTP, SSH).

# Annex 1 – A Model for Non-NMHS Observational Data Exchange

The following describes a generic model for the exchange of observational data from non-NMHS-owned and -operated networks into NMHS data systems[[24]](#footnote-25). Figure A1 is a schematic representation of the model.

**Part One**

**Step 1** Decide the appropriateness of observational data for exchange using a policy for **selecting non-NMHS observational data** based on five fundamental questions:

* + **Value** – Why invest to deliver impacts and value to the NMHS (and the non-NMHS observational data supplier)?

The NMHS may assess value in three different areas: network contribution, quality of the data, and the relationship with the data supplier. For example:

1. how the observational data is planned to be used, and provide value   
   (for example, impact on NMHS models, products and services),
2. the extent and NMHS’ reliance on the observations   
   (can the observation be sourced elsewhere?)
3. required observational data quality
4. the influence of the prior relationship with the non-NMHS party

Detailed questions about value may include:

1. why do we want the information?
2. what do we need to know to judge the value of the information?
3. how do we know the information is adding value (what is the Key Performance Indicator)?
4. is the observational data filling a spatial or temporal gap in the current network or is it providing redundancy?
5. what is the quality of the observational data? (will it satisfy the requirements of particular users? If not, is there sense in the observational data’s collection, archival or quality control?)
6. are there risks in having too much observational data?
7. can lower quality be accepted in observation sparse areas or where observational data is critical to a product?

The value proposition may also be considered by the observational data supplier. For example, data suppliers recognise the key benefits of providing their observational data to a NMHS:

1. it promotes access of their data to a much wider audience
2. promotes their own reputation by working in association with the NMHS
3. there is wide recognition of the potential for the NMHS to add much value to the data through assimilation into products and services, particularly forecasting tools and models.

The final stage of the value assessment is to make a preliminary determination of which tier the observational data belongs. This will assist with related decisions on many data requirements, the nature of an agreement and intellectual property rights.

There are a number of tools needed to aid in this stage of the decision process, including:

1. a policy for deciding value based on the concepts in this process including the ability to assess the value of relationships,
2. user requirements that articulate the frequency, reliability, and the spatial distribution etc. of data needed,
3. a network design which reflects the users spatial requirements for a particular observational data type
4. quality standards and criteria for the observational data for tiers
   * **Metadata** – Does the NMHS know enough about the observational data to make effective use of it?

Metadata that defines observational data elements, quality and currency is critical to determine to which tier the observational data will contribute and its use by the NMHS and others. The WIGOS Metadata standard provides a comprehensive set of metadata elements and its use is mandatory for data that will be exchanged internationally among WMO Members, and a recommended practice for observational data to be exchanged nationally.

The supply and maintenance of metadata is crucial to the ongoing assessment of observation quality by the NMHS. Consideration should be given on how often metadata data needs to be updated by the supplier (e.g. when there are changes and or annually).

Consider obtaining metadata for each tier level, and an assessment of the risks associated with not having metadata. Ensure appropriate storage, access and reporting on metadata and a mechanism for external agencies to submit and update metadata records.

* + **Restrictions** – Can the NMHS use the observational data in the way that it wants? For example, are there any terms of use? Are there any restrictions to Intellectual Property?

Some providers of observational data may wish to place restrictions on redistribution and/or restrict it to internal use by the NMHS. These observational data can be useful to support NMHS national products, but ideally NMHSs should encourage arrangements that are consistent with Open Data principles and which permit broad sharing and reuse. Key considerations include:

1. standard *Open Data Licence* or other open source agreement
2. understanding of the NMHS appetite for risk
3. a priority rating on the value of the observational data
   * **Implementation** – Can the NMHS access and manage the observational data and metadata?

Once the value and usefulness of the observational data has been determined the next question is its accessibility and the NMHS’s capacity to implement the ingest of observational data and its use.

For example:

1. can the data be displayed? And can it be afforded?
2. can the data be delivered securely?
3. can the data be archived and can quality control of the data be implemented?

Key information needs may include:

1. the format, volumes and information content of the observational data
2. transmission security
3. estimates of communications costs
4. estimates of integration costs
   * **Agreement** – Does the NMHS and the partner have the mutual ability to manage the relationship into the future?

An agreement promotes a consistent direction for:

1. relationship management
2. monitoring the relationship
3. ongoing assurance of required observational data quality (through maintenance of metadata)
4. the longevity of the data supply arrangement

It is important that both parties understand their mutual commitments and impact. Most importantly the agreement should include points of review and renewal to ensure regular contact between the organisation and the supplier and a healthy working relationship.

**Step 2 Assess and approve non-NMHS observational data** for ingestion using a process that ensures:

The requestor (e.g. NMHS data user) assesses the appropriateness of the non-NMHS observational data using the above guidance.

The NMHS evaluates the request for approval. This may involve a cost / benefit analysis and a risk assessment.

Assessment may include

1. reliability of the observational data source (particularly for operational use)
2. terms of use
3. metadata availability
4. compliance or compatibility with NMHS systems
5. regimes for site inspections, validation and maintenance
6. data life-cycle,
7. costs of observational data use and maintaining an ongoing relationship
8. observational data access and archiving
9. willingness to enter into formal agreements

**Part Two**

**Step 3** Develop an **observational data supply agreement**. A means by which the NMHS can mitigate identified risks and ensure the continued supply of data as negotiated.

**Part Three**

**Step 4** Commence the technical **ingestion and processing of non-NMHS observational data** using standard and approved methods for data formats and transport (in alignment with NMHS policies and processes).

**Step 5 Ongoing management of the observational data supply arrangement**, including ongoing observational dataquality checking, alerts, metadata updates, observational dataarchive (and retention) and application by the NMHS – informed by the use of classification schemes (e.g. network tiering or flags).

**Figure A1**: **Non-NMHS Observational Data Exchange Model**



1. <https://library.wmo.int/opac/doc_num.php?explnum_id=4065> [↑](#footnote-ref-2)
2. <https://library.wmo.int/opac/doc_num.php?explnum_id=3719> [↑](#footnote-ref-3)
3. <https://library.wmo.int/opac/doc_num.php?explnum_id=3653> [↑](#footnote-ref-4)
4. <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html> [↑](#footnote-ref-5)
5. <https://www.wmo-sat.info/oscar/observingrequirements> [↑](#footnote-ref-6)
6. <https://oscar.wmo.int/surface/index.html> [↑](#footnote-ref-7)
7. Basic Documents, No. 1 (WMO Convention, Article 2) (<http://library.wmo.int/opac/doc_num.php?explnum_id=3137>) [↑](#footnote-ref-8)
8. <http://library.wmo.int/pmb_ged/wmo_827_en.pdf> ; <https://library.wmo.int/pmb_ged/wmo_837_en.pdf> [↑](#footnote-ref-9)
9. <http://library.wmo.int/pmb_ged/wmo_902_en.pdf>; <https://library.wmo.int/pmb_ged/wmo_925e.pdf> [↑](#footnote-ref-10)
10. <https://library.wmo.int/opac/doc_num.php?explnum_id=3138> [↑](#footnote-ref-11)
11. <http://www.meteoswiss.admin.ch/home/measurement-and-forecasting-systems/land-based-stations/automatisches-messnetz/partnernetze.html> [↑](#footnote-ref-12)
12. <http://www.wmo.int/pages/prog/www/wigos/documents/Principal_Docs/Third-party_Data_Implementation_Project_-_Final.pdf> [↑](#footnote-ref-13)
13. *Editorial* n*ote: The link will be provided in due course* [↑](#footnote-ref-14)
14. <http://www.wmo.int/pages/prog/www/wigos/WGM.html> [↑](#footnote-ref-15)
15. <https://oscar.wmo.int/surface/index.html> [↑](#footnote-ref-16)
16. [www.gdal.org](http://www.gdal.org) [↑](#footnote-ref-17)
17. [www.wmo.int/pages/prog/www/WIS/documents/MOAWMO\_OGC.pdf](http://www.wmo.int/pages/prog/www/WIS/documents/MOAWMO_OGC.pdf) [↑](#footnote-ref-18)
18. <https://library.wmo.int/pmb_ged/wmo_488-2013_en.pdf> [↑](#footnote-ref-19)
19. <http://library.wmo.int/pmb_ged/wmo_100_en.pdf> [↑](#footnote-ref-20)
20. The “climate record” should be broadly interpreted in the context of this document as any form of meteorological, oceanographic, hydrological, cryospheric, etc. observations with a time-series component. [↑](#footnote-ref-21)
21. <http://library.wmo.int/pmb_ged/wmo_100_en.pdf> [↑](#footnote-ref-22)
22. <https://library.wmo.int/opac/doc_num.php?explnum_id=3318> [↑](#footnote-ref-23)
23. <http://library.wmo.int/pmb_ged/wmo_1115_en.pdf> [↑](#footnote-ref-24)
24. This model has been developed, implemented and applied by the Bureau of Meteorology (Australia). [↑](#footnote-ref-25)