WMO GAW Data Management and Exchange

Ellsworth J. Welton, NASA USA

GAW Aerosol Lidar Observation Network (GALION): 2008 - current
Co-Chair since 2014, Member since 2008
Global lidar network of networks

GAW Expert Team on Atmospheric Composition Data Management
Team Member

GAW Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)
Steering Group for the Pan-American Regional Node

New: WMO Task Team on Tiered Networks (advisory group)
Network evaluation and tiering based on information quality
GAW Representative, Eventual task team member

Contact: Ellsworth.J.Welton@nasa.gov

WMO GAW Data Management

Motivation: Provide easier access to atmospheric composition network data

Proliferation of networks and ground-based data over past ~20 years

- Great for science but new problems arise
- How to find, access, and use such varied data? What is the quality? Different formats, etc
- Need for programmatic planning across networks/funding sources

Lack of globally coordinated planning among networks (all, not just lidar)

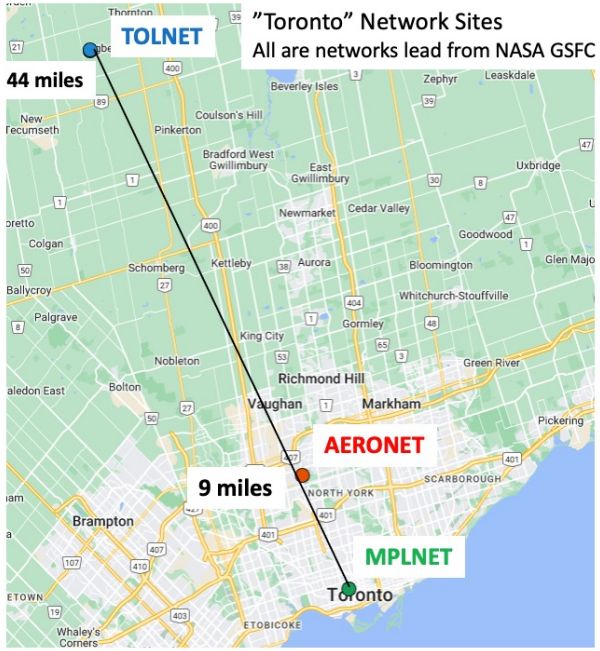
- Many driving factors, mostly funding related
- Stovepiped objectives, no time or process for integrated planning
- Site coordination is difficult across local, regional, global network goals
- Valid reasons exist that contribute to relative chaos: how to overcome?

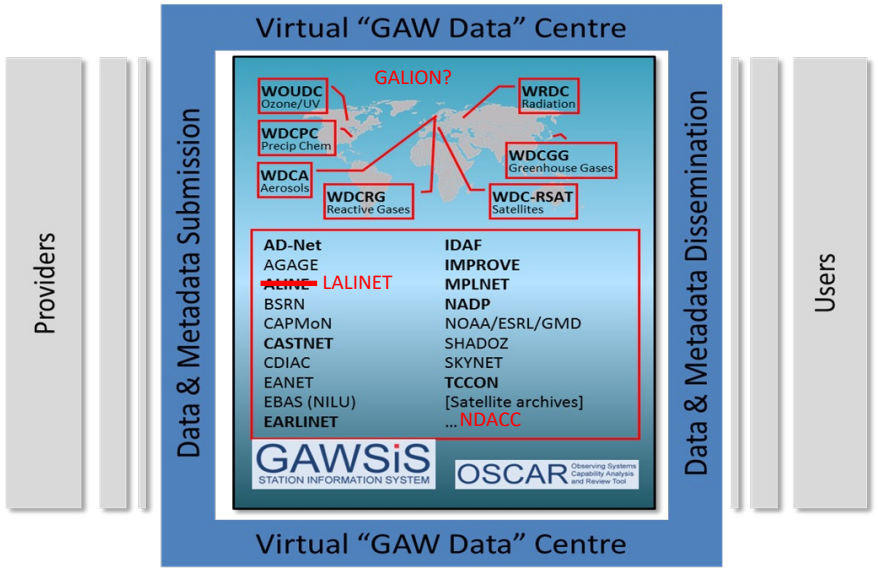
Finding data has gone from looking for your needle in a haystack to wading through a stack of different needles you didn't even know exist

- Need for a baseline of standards to avoid use of questionable data
- FAIR Data: Findability, Accessibility, Interoperability, and Reuse
  - Individual use vs large scale present different challenges
  - Univ scientist working on a paper vs ECMWF forecast validation

WMO GAW program offers a global option to coordinate and standardize

- SAGs, expert teams, data center coordination (expertise/guidance)
- OSCAR: Observing Systems Capability Analysis and Review (system/platform)
- WIGOS: Integrated Global Observing System metadata (language)
- Integration with other WMO elements (met, hydro, cryo, and NMHS and contributors)





WMO GAW Data Management

Elements of WMO data management

WMO Rolling Review of Requirements (RRR): sets and updates atmospheric composition observation requirements

WMO Observing Systems Capability Analysis and Review (OSCAR) Tool (https://space.oscar.wmo.int/observingrequirements)

WMO Integrated Global Observing System (WIGOS) Metadata Representation (WMDR) (https://codes.wmo.int/wmdr)

WMO OSCAR Surface Tool (https://oscar.wmo.int/surface/#/)

New: WMO Task Team on Tiered Networks (advisory group meeting Oct 24-26, 2023. Develop TOR, membership, etc)

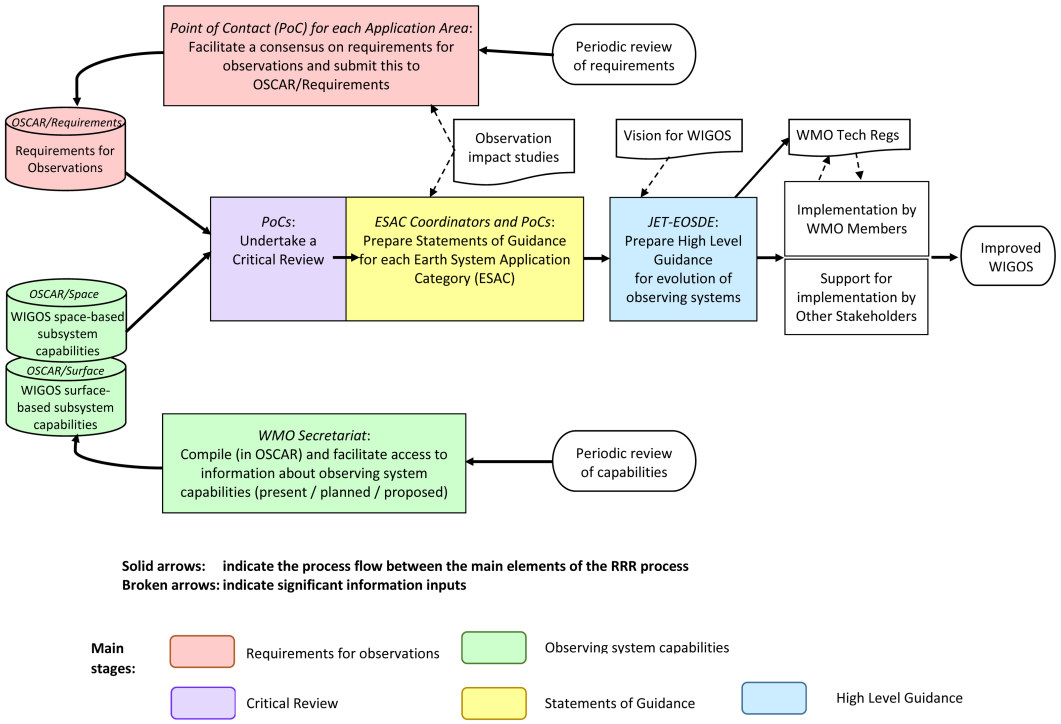
WMO GAW Data Management

Elements of WMO data management

WMO Rolling Review of Requirements (RRR): sets and updates atmospheric composition observation requirements

- GAW Science Advisory Groups (SAG) work with network evolution expert team and assemble community input
- ICAP related WMO Application Areas: Atmospheric (Climate 2.5, Composition 2.6) Forecasting and Monitoring
  - Ex: Statement of Guidance (SoG) for the Application Area: Atmospheric Composition Monitoring and Forecasting draft (2023)
    - GAW Focal Areas: Aerosols, Greenhouse Gases, Stratospheric Ozone, Reactive Gases, Total Atmospheric Deposition, UV Radiation
    - Measurement Thresholds and Goals (uncertainties, stability, spatial and temporal resolution, timeliness)

RRR Process Diagram: from WMO website



Most scientists only get involved at this stage.
Not the implementation of the requirements.

- The rest of the elements on next slides …
- To few shoulders bearing the work

WMO GAW Data Management

Elements of WMO data management

WMO Observing Systems Capability Analysis and Review (OSCAR) Tool (https://space.oscar.wmo.int/observingrequirements)

- Documents and stores the resulting observational requirements and ancillary/common requirements (layer definitions, etc)
- Mapping of requirements to application areas

Application Area 2.5: Atmospheric Climate Forecasting and Monitoring

Variable: Aerosol Optical Depth

Definition

Full name	Aerosol Optical Depth		
Definition	The AOD is the effective depth of the aerosol column from the viewpoint of radiation propagation: Vertical column integral of spectral aerosol extinction coefficient AOD = exp(-K. Δz) where K is the extinction coefficient [km^{-1}] and Δz the vertical path [km]		
Measuring Units	Dimensionless	**Uncertainty Units**	Dimensionless
Horizontal Res Units	km	**Vertical Res Units**	
Stability Units	Dimensionless (Stability /decade)		
Comment:	The AOD depends on wavelength. The GAW guidelines recommend AOD be measured at 3 or more wavelengths among 368, 412, 500, 675, 778, and 862 nm with a bandwidth of 5nm. Aerosol scattering optical depth and aerosol absorption optical depth are calculated in a corresponding fashion.		
Last modified:	2011-08-08		
Applied in OSCAR/Space Gap Analysis:	Yes		

Classification

- **Domain:** Atmosphere
  - **Sub-domain:** Aerosols and radiation
    - **Variable:** Aerosol Optical Depth
      - **Measured in Layers:**
        - TC
        - TrC
        - MUS
        - UTLS
        - FT
        - PBL
        - M
- **Cross-cutting themes:**
- **Earth System Application Categories and its related Application Areas:**
  - **2. Atmospheric Applications**
    - 2.5 Atmospheric Climate Forecasting and Monitoring
- **Unknown:**
  - Climate-AOPC (deprecated)

Requirements defined for *Aerosol Optical Depth* (3)

This tables shows all related requirements. For more operations/filtering, please consult the full list of Requirements
Note: In reading the values, goal is marked blue, breakthrough green, threshold orange
Application-dependent Technical Priority (ATP) Magenta and Relative priority of the attributes Red

Id	Variable	Layer	App Area	ATP	Uncertainty	Layer/s Quality	Coverage Quality	Stability / decade	Hor Res	Ver Res	Obs Cyc	Timeliness	Coverage	Conf Level	Val Date	Source	General Comment
63	Aerosol Optical Depth	MUS UTLS FT PBL M	Climate-AOPC (deprecated)		0.01 Dimensionless 0.015 Dimensionless 0.02 Dimensionless				1 km 2 km 10 km		24 h 2 d 7 d	7 d 14 d 60 d	Global	reasonable	2007-07-19	AOPC	
66	Aerosol Optical Depth	PBL	Climate-AOPC (deprecated)		0.01 Dimensionless 0.015 Dimensionless 0.02 Dimensionless				1 km 2 km 10 km		24 h 2 d 7 d	7 d 14 d 60 d	Global	reasonable	2007-07-19	AOPC	
807	Aerosol Optical Depth	FT PBL	2.5 Atmospheric Climate Forecasting and Monitoring		0.03 Dimensionless			0.02 Dimensionless	5 km 10 km		4 h		Global	reasonable	2019-09-26	GCOS-200: The Global Observing System for Climate: Implementation Needs (Published 2016)	Requirement for uncertainty in the GCOS IP is expressed as max (0.03; 10%)

Application Area 2.6: Atmospheric Composition Forecasting and Monitoring

Variable: Aerosol Optical Depth [550nm]

Definition

Full name	Aerosol Optical Depth [550nm]		
Definition	The integral over the geometrical path lenght of the aerosol light extinction coefficient at 550nm.In "Guide to Meteorological Instruments and Methods of Observation"2014 edition, WMO-No8:The integral over the vertical column of the aerosol light extinction coefficient." Proposed change: "The integral over the vertical column of the aerosol light extinction coefficient at 550nm"		
Measuring Units	unitless	**Uncertainty Units**	unitless
Horizontal Res Units	km	**Vertical Res Units**	km
Stability Units	(Stability /decade)		
Comment:	Defined for 550 nm wavelength		
Last modified:	2022-07-01		
Applied in OSCAR/Space Gap Analysis:	Yes		

Classification

- **Domain:** Atmosphere
  - **Sub-domain:** Atmospheric chemistry
    - **Variable:** Aerosol Optical Depth [550nm]
      - **Measured in Layers:**
        - TC
- **Cross-cutting themes:**
- **Earth System Application Categories and its related Application Areas:**
  - **2. Atmospheric Applications**
    - 2.6 Atmospheric Composition Forecasting and Monitoring

Requirements defined for *Aerosol Optical Depth [550nm]* (1)

This tables shows all related requirements. For more operations/filtering, please consult the full list of Requirements
Note: In reading the values, goal is marked blue, breakthrough green, threshold orange
Application-dependent Technical Priority (ATP) Magenta and Relative priority of the attributes Red

Id	Variable	Layer	App Area	ATP	Uncertainty	Layer/s Quality	Coverage Quality	Stability / decade	Hor Res	Ver Res	Obs Cyc	Timeliness	Coverage	Conf Level	Val Date	Source	Genera Comme
955	Aerosol Optical Depth [550nm]	TC	2.6 Atmospheric Composition Forecasting and Monitoring								60 min 28 d	60 min 12 h	Global	firm	2022-07-01	GAW Expert Team on Atmospheric Composition Network Design and	Uncertai Goal: 0.02+0.0 Uncertai Threshol 0.03+0.2

Different sources (GCOS vs ET-ACNDE)

There are inconsistencies in the RRR requirements themselves, and in their documentation. For GAW this can be better handled with coordination of RRR and more people checking OSCAR documentation (only way to see the problems)

WMO GAW Data Management

Elements of WMO data management

WMO Integrated Global Observing System (WIGOS) Metadata Representation (WMDR) (https://codes.wmo.int/wmdr)

- Need to translate and maintain OSCAR requirements as set of vocabularies and code lists for implementation, and maintain them
- Must include many additional descriptors and ancillary metadata to fully describe stations, locations, instruments, data, etc …
- Metadata is the backbone of data exchange, and supports interoperability and automation

Entry: Aerosol optical depth, TSP

Core metadata
All metadata
Download
History

stable

URI: http://codes.wmo.int/wmdr/ObservedVariableAtmosphere/325

The AOD is the effective depth of the aerosol over a specified distance, from the viewpoint of radiation propagation: Vertical integral of spectral aerosol extinction coefficient AOD = exp(-K. Δz) where K is the extinction coefficient [km-1] and Δz the vertical path [km].

Definition

description	The AOD is the effective depth of the aerosol over a specified distance, from the viewpoint of radiation propagation: Vertical integral of spectral aerosol extinction coefficient AOD = exp(-K. Δz) where K is the extinction coefficient [km-1] and Δz the vertical path [km].
label	Aerosol optical depth, TSP
notation	325
type	Concept

Register: Station/Platform operating status

Core metada
All properti
Download

stable

URI: http://codes.wmo.int/wmdr/ReportingStatus

Station/Platform operating status

Contents

Show 20 entries Filter entries:

Name	Notation	Description	Types	Status
Closed	closed	The station has been declared as closed by the responsible su...	Concept	stable
Non-reporting	nonReporting	The station is considered non-operational/non-reporting tempo...	Concept	stable
Operational	operational	The station fully complies with the reporting obligations of ...	Concept	stable
Partly operational	partlyOperational	The station partially complies with the reporting obligations...	Concept	stable
Planned	planned	The station is planned to be deployed sometime in the future,...	Concept	stable
Pre-operational	preOperational	The station is deployed and producing data but still not full...	Concept	stable
Stand-by	standBy	NA	Concept	stable
unknown	unknown	The declared operating status of this particular station/plat...	Concept	stable

Showing 1 to 8 of 8 entries Previous 1 Next

Required updates to WMDR are unreliable following OSCAR/RRR updates
Ad-hoc team had to be assembled to update atmos comp metadata (I was on it)

- This is probably required after each RRR

Process to update WMDR is lengthly and tied to WMO ops (FastTrack)

- More people involved with WMDR updates would help, go faster

There are several metadata “standards” now (WMDR, CF, GEOMS, etc). Even other competing WMO “standards”: WIS, BUFR. Community involvement is needed to reconcile and/or converge.

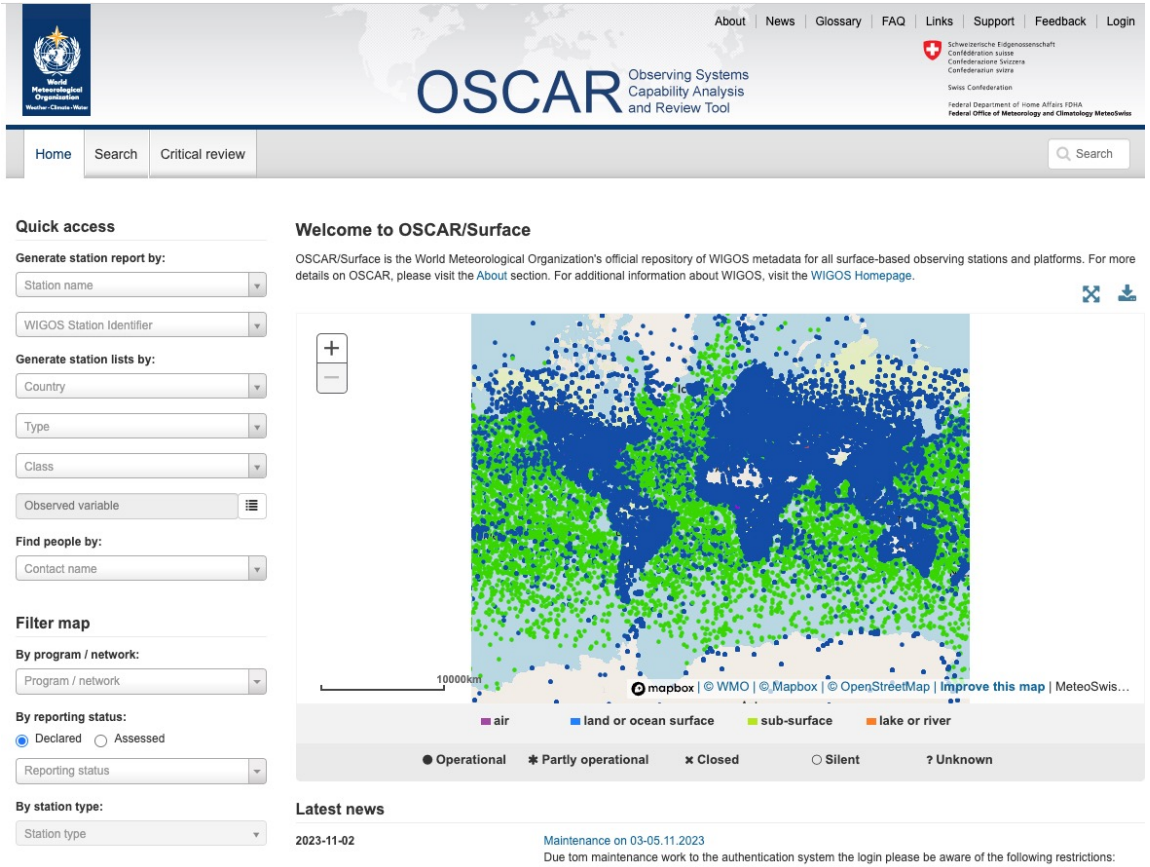
- MPLNET uses CF, but WMDR for submission of network info to OSCAR
- ICAP users have to contend with all of the above

WMO GAW Data Management

Elements of WMO data management

WMO OSCAR Surface Tool (https://oscar.wmo.int/surface/#/)

- Tool providing search and discovery for surface observations, using the RRR requirements and implemented with the metadata
- This is the human interface to the end result of the RRR process (for surface obs)
- This where data providers like myself are to store our network metadata



OSCAR surface is not implementing all new WMDR changes (variety of reasons)
OSCAR file formats (XML) and complexity of the system make entering and maintaining station information difficult

- Especially for contributing networks (outside NMHS)
- Most atmos comp station/network information in OSCAR is missing or out of date

OSCAR surface has issues, but it is the only attempt I know of to document surface observations across met, hydro, cryo, and atmos comp domains.

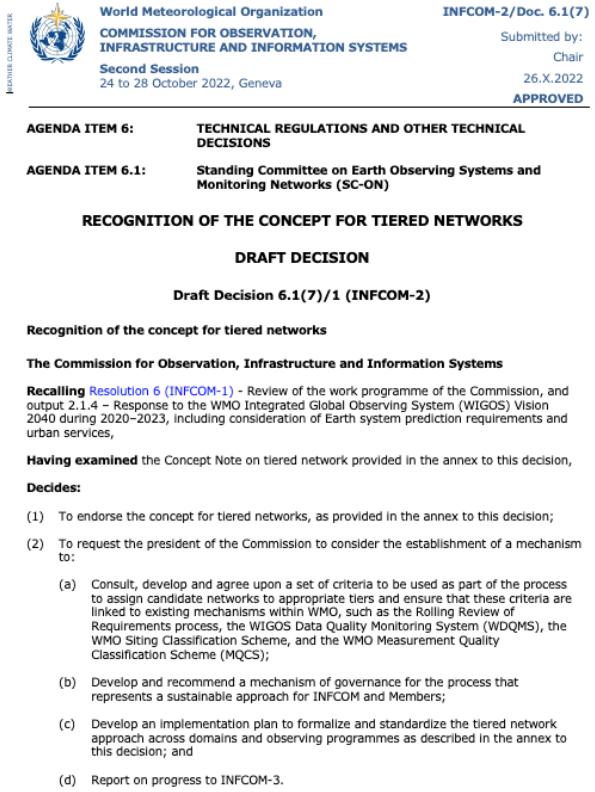
- Data users need reliable location to find quality data, especially across domains or even within atmos comp (where different networks provide different variables)
- There is a need for ability to assess our assets, look at gaps, and support programmatic planning
- More feedback from users (not just data providers submitting to OSCAR) would help. Make clear this is important to community. If not, let us (providers) know that and we'll just continue with our disparate approaches.

WMO GAW Data Management

Elements of WMO data management

New: WMO Task Team on Tiered Networks (advisory group meeting Oct 24-26, 2023. Develop TOR, membership, etc)

- Need ability to assess surface observation information quality in OSCAR surface
- Covers all domains within WMO: met, hydro, cryo, atmos comp (GAW contribution)
- Team will develop objective rating criteria to assess overall information quality networks in OSCAR
  - Criteria include: measurement quality, data management, metadata, network management, data polices/FAIR, timeliness, etc
  - Results will be assessed and weighted by application areas
  - Eventual documentation in OSCAR, WMDR and added to search options with OSCAR Surface



World Meteorological Organization
COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS
Second Session
24 to 28 October 2022, Geneva

INFCOM-2/Doc. 6.1(7)
Submitted by:
Chair
26.X.2022
APPROVED

AGENDA ITEM 6: TECHNICAL REGULATIONS AND OTHER TECHNICAL DECISIONS

AGENDA ITEM 6.1: Standing Committee on Earth Observing Systems and Monitoring Networks (SC-ON)

RECOGNITION OF THE CONCEPT FOR TIERED NETWORKS

DRAFT DECISION

Draft Decision 6.1(7)/1 (INFCOM-2)

Recognition of the concept for tiered networks

The Commission for Observation, Infrastructure and Information Systems

Recalling Resolution 6 (INFCOM-1) - Review of the work programme of the Commission, and output 2.1.4 – Response to the WMO Integrated Global Observing System (WIGOS) Vision 2040 during 2020–2023, including consideration of Earth system prediction requirements and urban services,

Having examined the Concept Note on tiered network provided in the annex to this decision,

Decides:

(1) To endorse the concept for tiered networks, as provided in the annex to this decision;

(2) To request the president of the Commission to consider the establishment of a mechanism to:

(a) Consult, develop and agree upon a set of criteria to be used as part of the process to assign candidate networks to appropriate tiers and ensure that these criteria are linked to existing mechanisms within WMO, such as the Rolling Review of Requirements process, the WIGOS Data Quality Monitoring System (WDQMS), the WMO Siting Classification Scheme, and the WMO Measurement Quality Classification Scheme (MQCS);

(b) Develop and recommend a mechanism of governance for the process that represents a sustainable approach for INFCOM and Members;

(c) Develop an implementation plan to formalize and standardize the tiered network approach across domains and observing programmes as described in the annex to this decision; and

(d) Report on progress to INFCOM-3.

This is a new effort that will likely begin in 2024

- Pending approval from INFCOM-3

Development of assessment criteria and weighting by application

- Will require assembly of assessment teams, likely thru SAGs and/or community
- Do you feel this is worthwhile? Do you want to get involved? I am the GAW representative so let me know your thoughts.

Task Team will report to INFCOM, and have to interact with elements of the entire RRR-OSCAR-WMDR process

- with representatives from across WMO (not just GAW) we might have a chance to recommend improvements

WMO GAW Data Management

Moving from Data Management and its challenges

to

Successes and Improvements that have been made

and

WMO changes coming soon

WMO GAW Data Management

Successes: WMDR Updates for Atmospheric Composition

Just some Examples from Ad-hoc team work

Observing Methods Code List: Fixed Lidar Entries

Name	Notation	Description	Types	Status
Backscatter lidar	341	Elastic backscatter light detection and ranging (lidar) typic...	Concept	stable
Differential absorption lidar (DIAL)	335	Light detection and ranging (lidar) with differential absorpt...	Concept	stable
Doppler wind lidar	142	Light detection and ranging (lidar) with Doppler capability (...	Concept	stable
High spectral resolution (HSR) lidar	342	Light detection and ranging (lidar) with high spectral resolu...	Concept	stable
Integrated path differential absorption (IPDA) lidar	320	Light detection and ranging (lidar) with integrated path diff...	Concept	stable
Polarized lidar	343	Light detection and ranging (lidar) capable of determining th...	Concept	stable
Raman lidar	143	Light detection and ranging (lidar) with Raman capability, ty...	Concept	stable

Observed Variable Code List: Added Missing Variables

Aerosol layer height	12162	Height of vertically localized aerosol layer above sea level	Concept	stable
Mixed layer height	12163	Height above the surface to which atmospheric properties (win...	Concept	stable
Height of the top of the PBL	12168	Height of the surface above ground separating the planetary b...	Concept	stable
Aerosol type	12169	Selection, out of a pre-defined set of aerosol classes, that ...	Concept	stable

Observed Variable Code List: Renamed Aerosol Vars, Cleaned up Definitions

Hygroscopic particle size growth factor	12155	A scaling factor describing the particle equivalent spherical...	Concept	stable
Particle effective diameter	12161	The area weighted mean diameter of the aerosol particles.	Concept	stable
Particle effective radius	362	The area weighted mean radius of the aerosol particles.	Concept	stable
Particle light absorption coefficient, PM1	316	A measure of light attenuation due to absorption by aerosol p...	Concept	stable
Particle light absorption coefficient, PM10	317	A measure of light attenuation due to absorption by aerosol p...	Concept	stable
Particle light absorption coefficient, TSP	318	A measure of light attenuation due to absorption by aerosol p...	Concept	stable
Particle light backscatter coefficient	12159	The fraction of incident radiative flux scattered backward at...	Concept	stable
Particle light extinction coefficient	12145	A measure of light attenuation due to scattering and absorpti...	Concept	stable
Particle light hemispheric backscatter coefficient	12158	The fraction of incident radiative flux scattered into all ba...	Concept	stable
Particle light hemispheric forward scattering coefficient	12160	Incident radiative flux scattered into all forward angles, i....	Concept	stable
Particle light scattering coefficient, PM1	322	A measure of light attenuation due to absorption by aerosol p...	Concept	stable
Particle light scattering coefficient, PM10	323	A measure of light attenuation due to absorption by aerosol p...	Concept	stable
Particle light scattering coefficient, TSP	324	A measure of light attenuation due to absorption by aerosol p...	Concept	stable
Particle mass concentration (size fractionated)	367	Mass of particles per unit volume of air, size fractionated	Concept	stable

WMO GAW Data Management

Successes: Improvements in OSCAR Surface

OSCAR Surface bugs have been fixed over time, often with user feedback (team is open, but users must be knowledgeable of the system)

Station creation involves issuing a WIGOS ID and getting approval from the national focal point (for country where site is located)

- GAW can now create IDs for program members, including contributing networks
- GAW IDs accommodate heterogeneous mix of network station names

The new Task Team on Tiered Networks offers higher level, coordinated approach to determining OSCAR problem areas and recommending solutions. Network tiering is inherently tied to the RRR and OSCAR.

WMO GAW Data Management

Future: WMO Information System (WIS) Changes

WIS has been the WMO information sharing and management system since 2012

- Utilizes the Global Telecommunication System (GTS) for data communications (collection, exchange, distribution). GTS is a closed system (NMHS), and scheduled to be decommissioned by 2030.

WIS 2.0 in the next generation WIS with substantial changes

- WIS 2.0 provides a framework for WMO data sharing in the 21st century, for all WMO members and all the WMO disciplines in domains to embrace the Earth system approach, enable the WMO unified data policy, and support the WMO global basic observing network.
- WIS 2.0 is an open system. Data providers and users outside NMHS can have access
- WIS 2.0 will gradually replace GTS, pilot phases already underway

What is WIS 2.0, what is different?

- The users of WIS 2.0 will be able to access data in real-time by subscribing to a Global Broker and receiving notifications when new data are available for download from a Global Cache or from the data provider. They will also access data directly through Web APIs (application programming interfaces), connecting their software (or their browser) and processing or visualizing data.
- Atmos Comp data providers will be able to provide data using same process as met data from NMHS (temp, pressure, etc)
    - One common system and reduces headaches for large operational centers to ingest atmos comp data

WMO GAW Data Management

Future: WMO Information System (WIS) Changes

GAW Expert Team on Atmospheric Composition Data Management has been asked to assist with WIS 2.0

- Determine topic hierarchies, provide feedback on metadata, NRT submission of atmos comp data vs delayed (use of global cache)
- GAW also can provide contributed network feedback to WIS 2.0 development

Atmospheric Composition Topic Hierarchies

- Currently Proposed
  - Observations
  - Analysis– Prediction
  - Advisories – Warnings
- Each will have sub levels (e.g. Observations/Aerosols, etc ….) that are being discussed now
- Atmos comp WIS 2.0 testing will be needed soon

Metadata

- Its unclear to me right now if WMDR will be selected for WIS 2.0 metadata, or a combination of existing, or something new

Community input and assistance from ICAP is welcome

- ICAP has members with required experience and stakes in the success of WIS 2.0
- Help with topics, structure
- Maybe a suggestion from ICAP on metadata would be helpful. Do we want yet another “standard”?
- 2030 will come around quickly