

The WMO Rolling Review of Requirements (RRR)

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WEATHER CLIMATE WATER
TEMPS CLIMAT EAU



WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

WMO Rolling Review of Requirements (RRR)

<http://www.wmo.int/egos>

- Addressing the requirements for all WMO applications
- Initiated in early 2000s' through the WMO Space Programme in cooperation with CEOS
- Regulated in the WIGOS Manual (WMO No. 1160, para 2.2.4 and Appendix 2.3), and GOS Manual (WMO No. 588)
Members, both directly and through the participation of their experts in the activities of regional associations and technical commissions, shall contribute to the RRR process and assist the designated Points of Contact for each application area in performing their roles in the RRR
- Commission for Basic Systems (CBS) in charge of RRR
 - Inter Programme Expert Team on Observing System Design and Evolution (IPET-OSDE)
 - Chairperson, Erik Andersson, ECMWF



WMO Application Areas

Definition: an activity involving primary use of observations, in a chain of activities which allow NMHSs or other organizations to render services contributing to public safety, socio-economic well-being and development in their respective countries, in a specific domain related to weather, climate and water. The concept of a WMO Application Area is used in the framework of the WMO Rolling Review of Requirements (RRR) and describes a homogeneous activity for which it is possible to compile a consistent set of observational user requirements agreed by community experts working operationally in this area.

1. Global Numerical Weather Prediction
2. High Resolution Numerical Weather Prediction
3. Nowcasting and Very Short Range Forecasting
4. Sub-seasonal to longer predictions
5. Aeronautical Meteorology
6. Forecasting Atmospheric Composition
7. Monitoring Atmospheric Composition
8. Providing Atmospheric Composition information to support services in urban and populated areas
9. Ocean Applications
10. Agricultural Meteorology
11. Hydrology
12. Climate Monitoring (GCOS)
13. Climate Applications (Other aspects, addressed by the Commission for Climatology)
14. Space Weather
15. Climate Science

Cross cutting:

- Global Cryosphere Watch (GCW)
- Global Framework for Climate Services (GFCS)

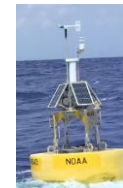
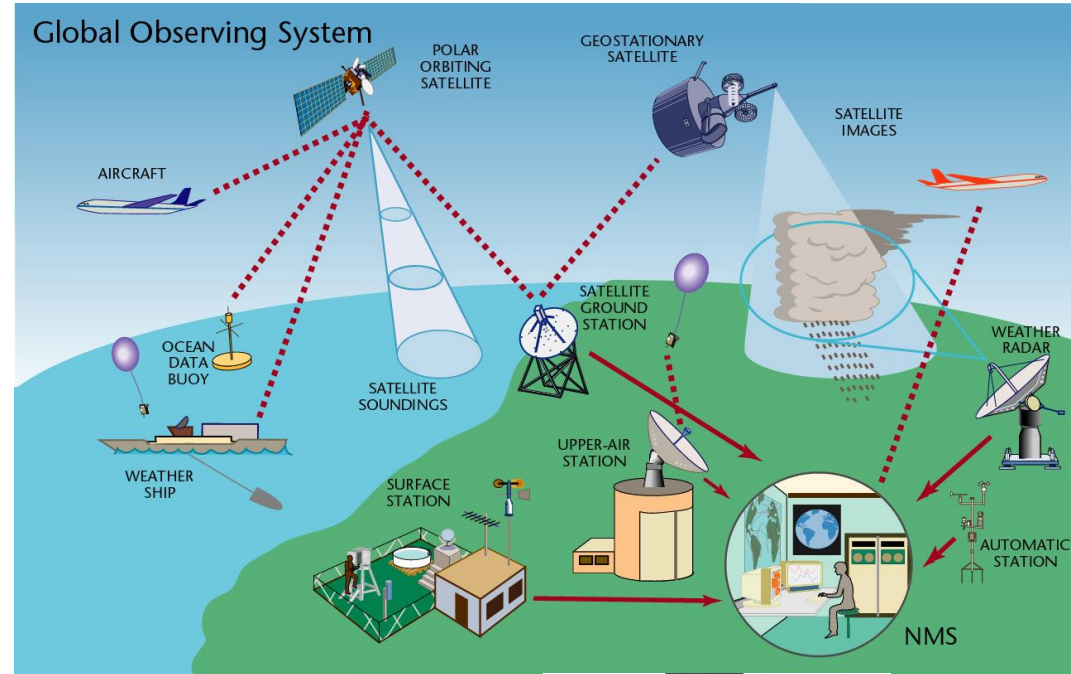
Observing systems contributing to WIGOS

- Space-based

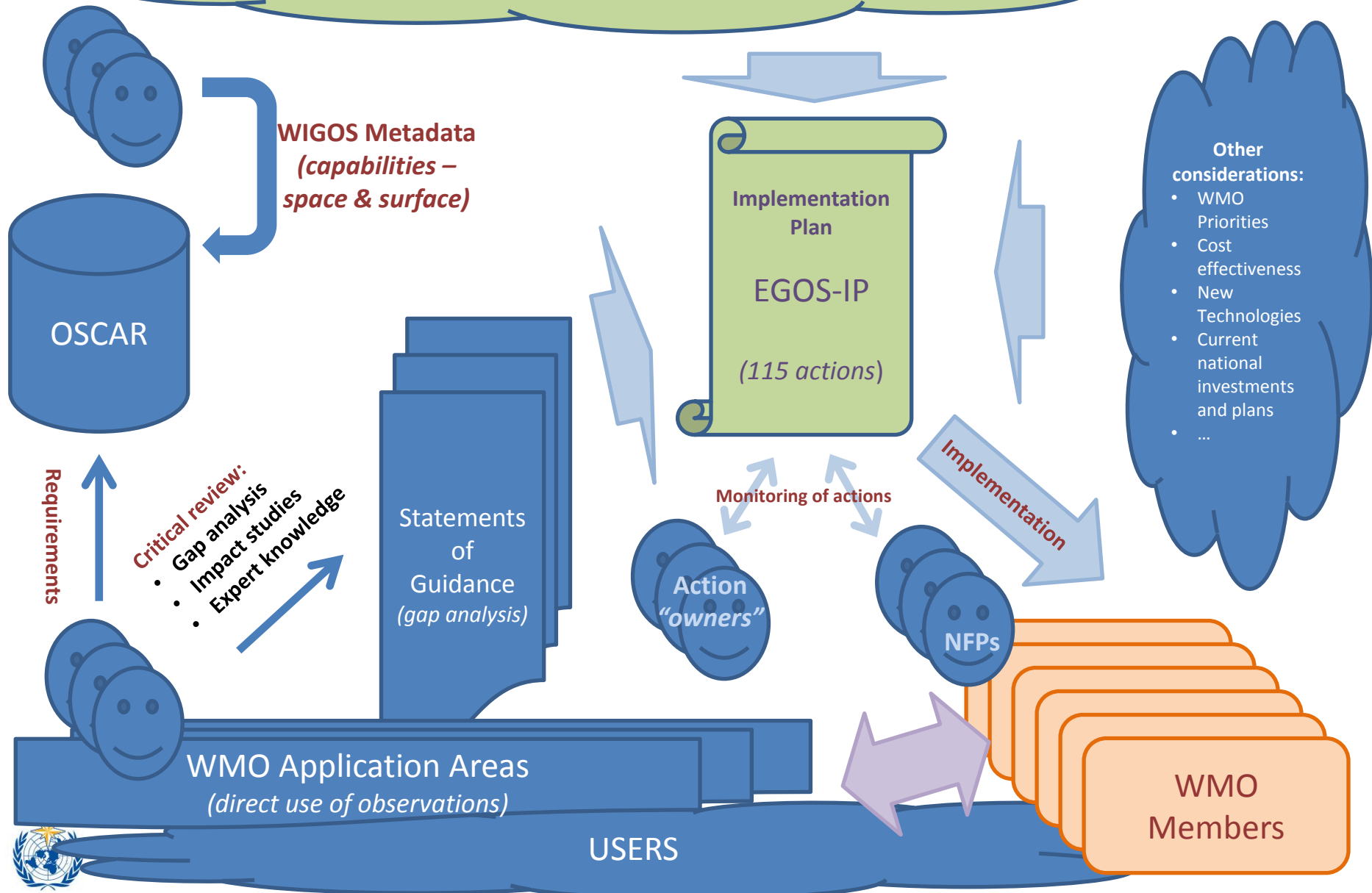
- Geostationary
- Polar orbiting LEO
- Elliptical orbit,

- Surface-based

- Surface stations (RBSN, RBCN, AWS ..)
- Climate stations (GSN)
- Upper air soundings (incl. GUAN, GRUAN)
- Wind profilers
- Weather radars
- Lightning detection systems
- Aircrafts (e.g. AMDAR)
- Aeronautical stations
- Hydrological stations (WHOS)
- Atmospheric composition, air quality monitoring (GAW)
- Cryosphere observations (GCW)
- Marine observations (drifters, floats, moorings, tide gauges, ships, gliders ...)
- Terrestrial observations (GTOS)
- Surface-based space weather observations
- GNSS radio-occultation
- ...



Global Observing Systems Vision 2025 (multidisciplinary)



The RRR process

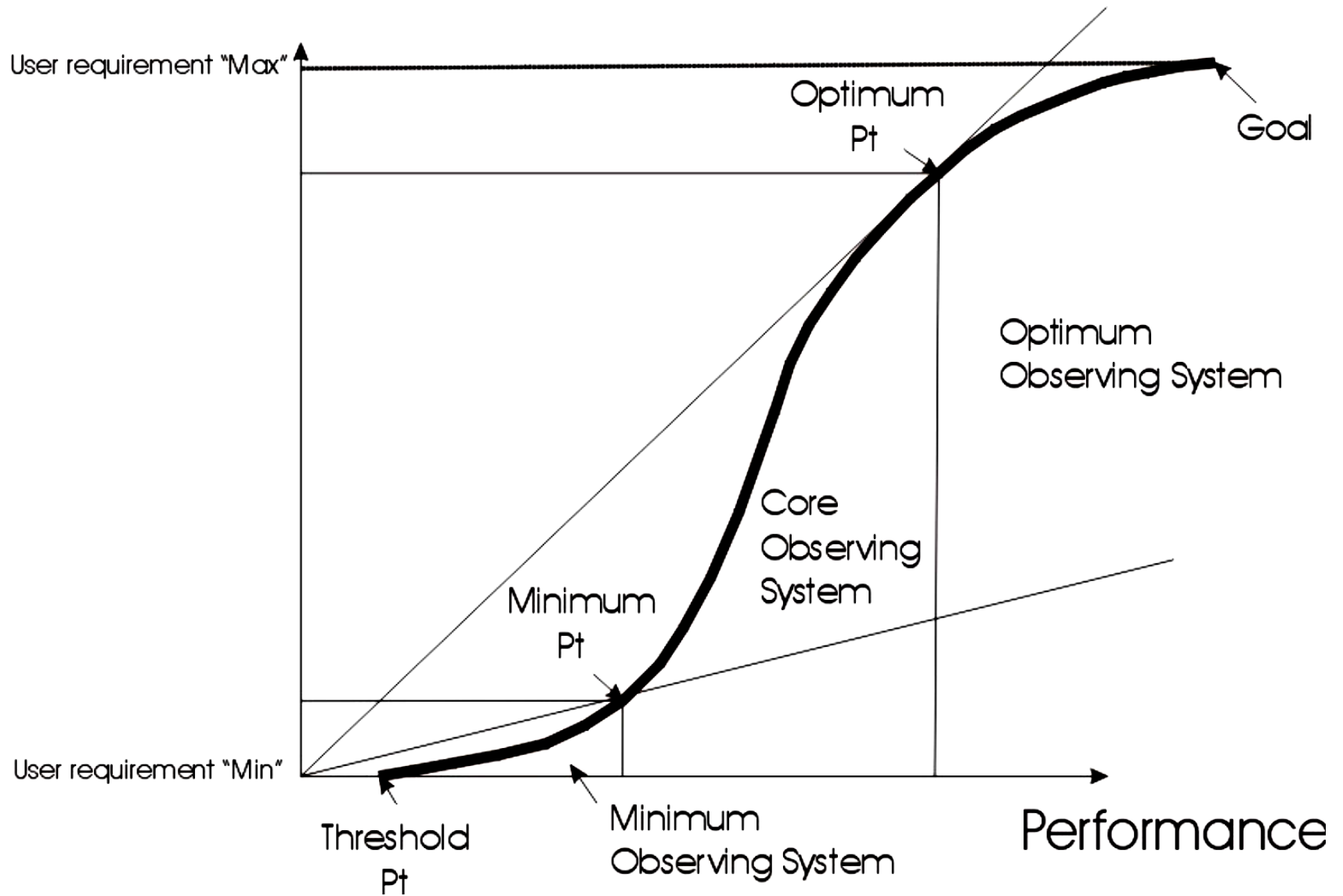
- OSCAR Platform (oscar.wmo.int) includes
 - [OSCAR/Requirements](#) (“technology free”)
 - Observing systems capabilities
 - [OSCAR/Space](#): Space-based capabilities
 - [OSCAR/Surface](#): Surface-based capabilities (operated with MeteoSwiss)
- Critical review
 - Assessing gaps by comparing capabilities vs. requirements
 - Undertaking Impact Studies, e.g.
 - Observing System Experiments (OSEs)
 - Observing System Simulation Experiments (OSSEs)
 - Forecast Error Contribution (FEC), Forecast Sensitivity to Observations (FSO), ...
 - Analysed by Experts to produce **gap analysis** and [Statements of Guidance \(SoGs\)](#)
- SoGs reviewed by IPET-OSDE
- Feeds into the [ET-EGOS Implementation plan](#), and [Vision of the GOS](#)
 - [Current EGOS-IP](#) responding to the Vision of the GOS in 2025
 - Vision for WIGOS Component Observing Systems in 2040 in development with Cg-18 approval target



How user requirements are specified in OSCAR/Requirements

- Technology free, quantitative
- For each application & each geophysical variable
 - Horizontal resolution
 - Vertical resolution
 - Accuracy
 - Observing cycle
 - Timeliness (Delay)
 - Long term stability
- For each parameter
 - “min” (or **threshold**)
 - value below which observations are worthless
 - “max” (or **goal**)
 - value beyond which improvement gives no additional value
 - “breakthrough” (or **optimum**)
 - proposed target for significant progress
 - optimal cost/benefit

Benefit





► Application: Aeronautical Meteorology

Details

Name	Aeronautical Meteorology
Description	Meteorological information in support of the safety and optimal efficiency of aviation
Corresponding Institution	World Meteorological Organization
Contact Person	Jitze Van der Meulen jitze.van.der.meulen@knmi.nl

Variables measured in this Application Area

Subdomain	Variables
Basic atmospheric	Air pressure (at surface)
	Air specific humidity (at surface)
	Air temperature (at surface)
	Atmospheric temperature
Clouds and precipitations	Height of the top of PBL
	Specific humidity
	Turbulence
	Wind (horizontal)
Aerosols and radiation	Wind speed over the surface (horizontal)
	Wind vector over the surface (horizontal)
	Cloud base height
	Cloud cover
Ocean	Cloud ice effective radius
	Cloud ice
	Cloud type
	Freezing level height in clouds
Land surface	Precipitation (liquid or solid)
	Precipitation intensity at surface (liquid or solid)
	Precipitation intensity at surface (solid)
	Precipitation type at the surface
Atmospheric chemistry	Aerosol Extinction Coefficient
	Aerosol dust concentration
Energetic particles and solar wind	Aerosol volcanic ash
	Aerosol volcanic ash (Total column)
	Meteorological Optical Range (MOR) (surface)
	Background Luminance (surface)
	Sea surface temperature
	Wind gust
	SO2
	Radiation Dose Rate



Aeronautical Meteorology Requirements (example)

Requirements defined for *Aeronautical Meteorology* (36)

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** and threshold **orange**

Id	Variable	Layer	App Area	Uncertainty	Stability / decade	Hor Res	Ver Res	Obs Cyc	Timeliness	Coverage	Conf Level	Val Date	Source
15	Atmospheric temperature	LS	Aeronautical Meteorology	2 K		50 km	0.15 km	60 min	60 min	Global	firm	2014-03-27	ET ODRRGOS
		HT		3 K		70 km	0.3 km	90 min	80 min				
		LT		5 K		100 km	0.6 km	3 h	2 h				
16	Cloud drop effective radius	Cloud-top	Aeronautical Meteorology	15 µm		50 km		60 min	60 min	Global	firm	2000-06-23	ET ODRRGOS
				20 µm		70 km		90 min	90 min				
				30 µm		100 km		3 h	2 h				
17	Cloud ice	HT	Aeronautical Meteorology	10 %		50 km	0.15 km	60 min	60 min	Global	firm	2000-06-23	ET ODRRGOS
		LT		15 %		70 km	0.3 km	90 min	90 min				
				25 %		100 km	0.6 km	3 h	2 h				
20	Cloud liquid water (CLW)	LT	Aeronautical Meteorology	10 %		50 km	0.15 km	60 min	60 min	Global	firm	2000-06-23	ET ODRRGOS
				15 %		70 km	0.3 km	90 min	90 min				
				25 %		100 km	0.6 km	3 h	2 h				
21	Specific humidity	LT	Aeronautical Meteorology	5 %		50 km	0.15 km	60 min	60 min	Global	firm	2000-06-23	ET ODRRGOS
				7 %		70 km	0.3 km	90 min	90 min				
				10 %		100 km	0.6 km	3 h	2 h				
22	Wind (horizontal)	HT	Aeronautical Meteorology	2 m.s ⁻¹		50 km	0.15 km	5 min	60 min	Global	firm	2000-06-23	ET ODRRGOS
				2.7 m.s ⁻¹		63 km	0.238 km	6 min	84 min				
				5 m.s ⁻¹		100 km	0.6 km	10 min	3 h				
23	Wind (horizontal)	LS	Aeronautical Meteorology	2 m.s ⁻¹		50 km	0.15 km	5 min	60 min	Global	firm	2000-06-23	ET ODRRGOS
		LT		3 m.s ⁻¹		70 km	0.3 km	7 min	90 min				
				5 m.s ⁻¹		100 km	0.6 km	10 min	3 h				
681	Background Luminance (surface)	Near Surface	Aeronautical Meteorology	50 %				36 sec 108 sec	36 sec 108 sec	Global	firm	2011-06-14	J van der Meulen
682	Meteorological Optical Range (MOR) (surface)	Near Surface	Aeronautical Meteorology	5 m 7 m 10 m				36 sec 108 sec	36 sec 108 sec	Global	firm	2011-06-14	J van der Meulen
688	Aerosol dust concentration	HT LT Near Surface	Aeronautical Meteorology							Global	tentative	2012-05-08	J van der Meulen
717	Aerosol volcanic ash	LT	Aeronautical Meteorology							Global	firm	2013-12-05	J van der Meulen

Statements of Guidance *(gap analysis)*

- **The Statement of Guidance interprets the output of the critical review as a gap analysis and identifies priorities for action:** the most feasible, beneficial and affordable initiatives to deal with the identified gaps or shortcomings in WMO observing systems for an application area. This draws on the subjective judgement and experience of the Points of Contact, the experts and other stakeholders they consult within their application area.
- This stage of the RRR requires the **Points of Contact to coordinate** with their application area community and stakeholders, as needed, in order to produce, review and revise the Statement of Guidance for the application area.



Statement of Guidance for Aeronautical Meteorology

- Developed (coordinated) by PoC for Aeronautical Meteorology, Dr Jitze van der Meulen
- Latest version : June 2016
- Support to air traffic safety in first place
- Then support to efficiency & capacity for economical and environmental benefits



Statement of Guidance for Aeronautical Meteorology – Summary 1/2

- **Locally higher vertical resolution** is required for **development and verification of turbulence forecast algorithms as well as in support of future 4D trajectory planning of aircraft**. Enhanced collection of aircraft data (e.g. AMDAR / ADS-B / Mode-S) may improve accuracy in support of more efficient ATM in the terminal areas of busy airports
- **For warnings**, satellite imagery and higher-level products such as multi-spectral images, provide good guidance for location and intensity of convection. However **scanning radars in networks combined with lightning detection systems currently have the cycle times of less than 10 min required for air traffic control and supporting air traffic management**. It is expected that the **next generation of geostationary satellites with more frequent scanning capabilities** in conjunction with improved lightning imagers is getting closer to these requirements
- **For turbulence and gravity wave detection and prediction**, current **in-situ instruments** have acceptable vertical resolution, but are **not available in sufficient density for all areas of the globe**. The AMDAR / ADS / Mode-S is a data source with a high potential to fill existing data gaps in the medium term, water vapour imagery is beginning to show potential for subjective detection of steepening waves and vorticity advection, leading to Clear Air Turbulence



Statement of Guidance for Aeronautical Meteorology – Summary 2/2

- **For forecasts and warnings** in the wider terminal area, **in-situ and ground-based remote sensing technology** has the potential to meet requirements, but its **high cost inhibits general, global availability**. In particular, the possible extension of data requirements for new terminal forecasts and warnings for the larger approach-and departure areas, to be developed in close collaboration with ICAO, meso-networks, including lightning detection, LIDAR and Doppler WXR (increasingly with dual-polarization functionality) coupled with Nowcasting algorithms, may become necessary for larger airports. Deployment of automatic instruments for measuring conventional parameters at airport such as surface wind, pressure, visibility and cloud will also need continuous improvements. In support of winter operations, runway pavement temperature measurements should be envisaged. Freezing point depression and runway (surface) condition measurements could be envisaged as well.
- **For en route forecasts for VFR flights**, **ground based observations are not meeting the required data density except for some densely populated areas**. Satellite imagery and specialized products have acceptable horizontal resolution, but lack the information on visibility and ceiling height for low cloud.
- **For forecasts and real time nowcasting in the terminal zone** ground based observations shall be as required and documented in the WMO Technical Regulations (WMO-No. 49, Vol. II). In practice these requirements are fully met, although the **transition from human (visual) observations to fully automated observations is challenging** resulting in a reconsideration of observational requirements. To improve short-term forecasts high resolution (in time and space) NWP models are introduced, modeling in real time the atmosphere above the aerodrome and its vicinity. This practice requires **new observation technologies to support model initialization**, developed for atmospheric research and mainly with remote sensing.
- **For the detection of volcanic ash clouds and eruptions**, **satellite and ground based remote-sensing has significant detection and quantitative determination capability**. Close cooperation with the CTBTO in using seismic and sonic data is improving the detection of volcanic eruptions in remote areas.



Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)

- A result of the RRR process taking into account gap analyses for all WMO Application Areas, cost-effectiveness of observing systems, and the priorities of the Organization
- A key document providing Members with clear and focused guidelines and recommended actions in order to stimulate cost-effective evolution of the observing systems to address in an integrated way the requirements of WMO programmes and co-sponsored programmes
- Available on WMO website in 5 languages
 - <http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip>

115 EGOS-IP Actions

13 Overarching and cross-cutting actions (C1 to C13)

- e.g. C8 - For WMO and co-sponsored observing systems, ensure continued adherence to WMO data sharing principles irrespective of origin of data, including data provided by commercial entities

59 Surface-based observing systems actions (G1 to G59)

- E.g. G22 - Continue the development and operational implementation of humidity sensors as an integrated component of the AMDAR system to ensure that humidity data is, processed and transmitted in the same way as wind and temperature
- E.g. G23 - Enhance and extend the capability to report observations of atmospheric turbulence and icing variables as an integrated component of the AMDAR system and in line with the requirements of the relevant programme areas and data users
- E.g. G45 - Increase the deployment, calibration and use of dual polarization radars in those regions where it is beneficial

35 Space-based observing systems actions (S1 to S35)

- e.g. S6 - Maintain and develop the GSICS inter-comparisons and inter-calibrations between GEO and LEO sensors on an operational basis.

8 Space weather actions (W1 to W8)

- E.g. W2 - To coordinate and to standardize the existing ground-based solar observation data, and to expand them where required for redundancy, and to develop a common data portal or virtual observatory within the WIS

Current focus of WMO regarding RRR

1. CBS monitoring implementation of EGOS-IP actions by Members and identified agents
2. CBS providing additional guidance to Members for better addressing the gaps (i.e. in addition to EGOS-IP)
3. Updating observational user requirements in OSCAR/Requirements and the Statements of Guidance (liaison with identified Points of Contact)
4. Making sure observing systems capabilities are up to date in OSCAR/Surface and OSCAR/Space
5. Conducting impact studies per list of science questions identified by CBS-16 per Recommendation 31 (CBS-16) and Decision 24 (EC-69)
6. Development of new WIGOS Vision 2040 (to replace the current Vision for the GOS in 2025) – target Cg-18 in 2019



More information

Website:

<http://www.wmo.int/pages/prog/www/OSY/GOS-redesign.html>

Vision for the GOS in 2015:

<http://www.wmo.int/pages/prog/www/OSY/gos-vision.html>

Statements of Guidance:

<http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html#SoG>

EGOS-IP:

<http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip>

OSCAR: <http://oscar.wmo.int>

Contact : echarpentier@wmo.int

Thank you Merci



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