Workshop on the management of observational user requirements for the evolved Rolling Review of Requirements in the context of WMO's Earth System approach (RRR-Requirements)

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Proposed Prioritization concept in WMO's Rolling Review Requirement (RRR)

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Background:

The WMO's RRR process captures the observational requirements ranges for a variety of application areas. Examples include the requirements for the measurement of atmospheric temperature for global NWP, sea-ice concentration, precipitation, etc. These requirements are currently expressed in terms of 6 criteria (or attributes): uncertainty, horizontal resolution, vertical resolution, observing cycle, timeliness, and stability (where appropriate). For each of these criteria, the requirements are captured in a table containing three values determined by experts: these are (1) "threshold" the minimum requirement to be met to ensure that data are useful, (2) "goal" is an ideal requirement above which further improvements are not necessary, (3) "breakthrough" is an intermediate level between "threshold" and "goal" which, if achieved, would result in a significant improvement for the targeted application. **FIGURE 1** (see the **APPENDIX**) illustrates the structure of such requirements with examples. **FIGURE 2** provides further examples with the columns re-ordered and coloured to better illustrate how they define the required observational datastream and the associated attributes.

These requirements defining which geophysical observations are needed for a certain application, and their associated attributes, are meant to provide information from experts (as compiled by the Points of Contact, PoCs, in each Application Area) to provide guidance to observing systems designers and networks architects to optimize their designs and networks. However, these requirements are currently not prioritized. In the absence of prioritization of requirements, the relative importance of the requirements and their attributes is not known to sensors' designers and network planners, leaving an important gap in the guidance to those architects and designers to really know how to optimize their concepts and networks.

Incentives to Capture Requirements and their Prioritization:

There is value in including the notion of prioritization in the RRR process as this prioritization could be useful to those designing and deploying observing systems (both space and surface-based). For example, in situations where budget constraints are such that not everything is affordable at the breakthrough level, it is informative to know whether one observation should be prioritized over another in terms of meeting users' requirements at the breakthrough or threshold or goal levels. Or, for a specific observation required, it is also useful to know the relative importance of the particular attributes. In case of technology constraints (in terms of mass, volume, power and cost), during the design of a specific sensor, engineers would likely appreciate knowing whether spatial resolution for example (requiring bigger antennas) is more or less important than the precision of the measurement (usually driving designs with additional spectral channels). It is important to note that implicitly, if no priority is given, all requirements (and their attributes like resolution, temporal refresh, etc.) are considered to be of equal importance.

In summary, knowing these priorities help the observations systems owners and networks designers by letting them know where to emphasis R&D and investment based on prioritization of requirements. It is assumed that the applications users' community is more adept to estimate these priorities than the designers of the observations systems and networks.

It should be noted that the ultimate expression of priorities for new initiatives is provided in the High Level Guidance document and the Statements of Guidance (SoGs) on which it builds. Priorities recorded against observations and their attributes that we refer to in this document and archived in the OSCAR database along with the requirement, are specific to individual application areas.

Additional attributes:

A Requirement defines the sought-after observational datastream in terms of the variable and the domain (vertical layer/s and horizontal coverage) to be sampled. However an observing system (network/fleet/constellation/programme/mission) designer may seek to optimize the tradeoff between the sampling of the specified domain and the quality characteristics of the measurements, and the User (Application Area) may wish to convey the extent to which this is acceptable. To enable this, two additional attributes are proposed as illustrated in **FIGURE 3**.

Suggesting a Mechanism to Prioritize the Requirements:

The mechanism suggested here calls for associating priorities for all requirements that get generated through the RRR process and archived in the OSCAR system. The priorities are meant for:
(1) The Requirement in total *e.g., does an application value more the near-surface temp. than moisture for instance? Does that application have a higher priority for near-surface temp. than temp. in the planetary boundary layer or the free troposphere? Does that application have a higher priority for near-surface temp. over global land areas than over global ocean areas?*
(2) The six (or the now proposed eight) attributes of the Requirement *e.g., for a given Requirement, does the application area value one attribute more than another, e.g. does it value more the spatial resolution than vertical resolution or/and than the uncertainty?*

We suggest calling these priorities the *Application-dependent Technical Priorities (ATP)* and should be defined to convey, for a given application area, the relative importance between the requirements and, for a given requirement, the relative importance between the attributes. These priorities (or weights) should be a numerical value between 0 and 1, that can be used for optimizing network design purposes. They should be defined with a minimum level of granularity i.e., enough to be useful but not too complex to assign. The table below contains the suggested definition of the different priorities.

Priority Value (weight)	**Description**
1.0	**Core (1):** The requirement (or criteria) is **absolutely critical** for the application, so meeting at least the breakthrough requirements where technical solutions exist, must be the highest priority. Where breakthrough requirements are not already being met by existing capability, research and development plans should be actively seeking to address the gap as a high priority
0.8	**Recommended (0.8):** The requirement (or criteria) is **essential** for the application so should meet at least the breakthrough requirements where technical solutions exist. Where breakthrough requirements are not already being met by existing capability, research and development plans should be actively seeking to address the gap, but with a lower priority than those requirement identified as Core
0.6	**Useful (0.6):** The requirement (or criteria) is **useful** for the application, but not absolutely essential. Meeting the breakthrough requirements where technical solutions exist, should be a medium priority, but meeting the threshold requirement should be a high priority. Where threshold

	requirements are not already being met by existing capability, research and development plans should be actively seeking to address the gap, but with a lower priority than requirements identified as Recommended or Core
0.4	**Marginally useful (0.4):** The requirement (or criteria) is **not essential** for the application. Meeting the threshold requirements where technical solutions exist, should be a low priority. Where threshold requirements are not already being met by existing capability, research and development plans should not be actively seeking to address the gap, but opportunities arising should be considered
0.2	**Not currently useful (0.2):** There is no current identified use of the requirement (or criteria), but some use may be identified in the future.
0.0	**Not useful (0):** There is no current or future identified use of this requirement (or criteria).

Note: priorities for requirements and their attributes are sometimes scientifically inter-connected. In other words, the specific requirement (and associated priority) for the attributes (of vertical resolution, uncertainty, horizontal resolution, timeliness, observing cycle, etc.) sometimes vary depending on the ranges of the other attributes. It is important to note that this inter dependency applies to both priorities and requirements ranges. Despite this caveat, it is believed however that the requirements' ranges (and priorities) are still very important and informative to the observing systems and networks owners. They should be considered as *first degree assessment* of ranges of requirements and their priorities, with the caveat that there are nuances related to the fact that there are spatial, temporal and situational variations of the requirements and priorities.

How to Implement the Prioritization into the RRR Process and OSCAR system:

The priorities, for each application area, should be handled in a fashion similar to how the requirements are handled: how they are collected, how they are vetted, and how they are archived and maintained. The main entity and person(s) responsible for gathering the priorities should be the same point of contact (PoC) in charge of collecting the requirements.
In OSCAR, it is recommended that (1) a priority value be associated with each recorded requirement (to be interpreted vertically, i.e. between requirements), and (2) a priority value be associated with each of the attributes of each requirement (to be interpreted horizontally, i.e. between the attributes). By default, a priority value of 1.0 will be assigned to each requirement and associated attributes. The person(s) in charge of updating/maintaining the requirements ranges should therefore be able to update the priorities and modify the default values.

It is recommended that all documentation related to the (1) RRR, (2) SoG, (3) WIGOS manuals, (4) PoC guide, etc. be updated to reflect the notion of the Prioritization described in this document.

APPENDIX: ILLUSTRATIONS OF REQUIREMENTS IN THE OSCAR DATABASE

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
244	Accumulated precipitation (over 24 h)	Near Surface	Global NWP	0.5 mm 2 mm 5 mm		10 km 30 km 100 km		60 min 3 h 12 h	24 h 5 d 30 d	Global	firm	2009-02-10	John Eyre
245	Aerosol column burden	TC	Global NWP	10 % 20 % 50 %		15 km 50 km 250 km		60 min 6 h 24 h	6 min 30 min 6 h	Global	tentative	2009-02-10	John Eyre
246	Aerosol mass mixing ratio	MUSM	Global NWP	10 % 20 % 50 %		15 km 50 km 250 km	0.2 km 3 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h	Global	tentative	2009-02-10	John Eyre
247	Aerosol mass mixing ratio	FT	Global NWP	10 % 20 % 50 %		15 km 50 km 250 km	0.2 km 3 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h	Global	tentative	2009-02-10	John Eyre
248	Aerosol mass mixing ratio	UTLS	Global NWP	10 % 20 % 50 %		15 km 50 km 250 km	0.2 km 3 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h	Global	tentative	2009-02-10	John Eyre
249	Aerosol mass mixing ratio	PBL	Global NWP	10 % 20 % 50 %		15 km 50 km 250 km	0.2 km 3 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h	Global	tentative	2009-02-10	John Eyre
250	Air pressure (near surface)	Near Surface	Global NWP	0.5 hPa 1 hPa 1 hPa		15 km 100 km 500 km		60 min 6 h 12 h	6 min 30 min 6 h	Global land	firm	2009-02-10	John Eyre

This table shows all requirements.It can be sorted by clicking on the column headers. The filter on the right allows to display only specific requirements. Filter instructions
Note: In reading the values, goal is marked blue, breakthrough green and threshold orange

Export » Filter table

Id	Variable	Layers	App Area	Theme(s)	Uncertainty	Stability / decade	Hor Res	Ver Res	Obs Cyc	Timeliness	Coverage	Conf Level	Source	Comment
455	Wind speed (near surface)	Near Surface	Nowcasting / VSRF		1 m/s 1.4 m/s 3 m/s		1 km 5 km 20 km		5 min 15 min 60 min	5 min 15 min 60 min	Global land	reasonable	P. Ambrosetti	
456	Wind speed (near surface)	Near Surface	Nowcasting / VSRF		1 m/s 1.4 m/s 3 m/s		5 km 10 km 50 km		15 min 30 min 3 h	15 min 30 min 60 min	Global ocean	firm	P. Ambrosetti	
457	Wind vector (near surface)	Near Surface	Nowcasting / VSRF		1 m/s 2 m/s 5 m/s		5 km 10 km 50 km		5 min 15 min 60 min	5 min 15 min 60 min	Global land	firm	P. Ambrosetti	
458	Wind vector (near surface)	Near Surface	Nowcasting / VSRF		1 m/s 2 m/s 5 m/s		5 km 10 km 50 km		15 min 30 min 3 h	15 min 30 min 60 min	Global ocean	firm	P. Ambrosetti	

FIGURE 1:
(a) extract from the OSCAR-Requirements database showing Requirements numbered 244 to 250. Requirement number 247 shows that the "Global NWP" application area requires "Aerosol mass mixing ratio" in the "Free Troposphere" layer with "Global" coverage. The "Horizontal Resolution" attribute for this Requirement indicates a threshold value of 250km, a breakthrough value of 50km, and a goal value of 15km;
(b) extract from the OSCAR-Requirements database showing Requirements numbered 455 to 458. Requirement number 455 shows that the "Nowcasting/VSRF" application area requires "wind speed (near surface)" in the "near surface" layer with "Global land" coverage. Requirement number 456 shows that the "Nowcasting/VSRF" application area requires "wind speed (near surface)" in the "near surface" layer with "Global ocean" coverage, having different values for the attributes than for the same variable in the same vertical layer over "Global land" areas.

ID	***Requirement definition***				***Requirement attributes***					
	User	***Observational datastream***			***Performance level: blue=goal; green=breakthrough; orange=threshold***					
No.	***Application Area***	***Variable***	***Vertical Layer/s***	***Horizontal Coverage***	***Uncertainty***	***Stability***	***Horizontal Resolution***	***Vertical Resolution***	***Observing Cycle***	***Timeliness***
255	GNWP	T	FT	Global	0.5 K 1 K 3 K		15 km 100 km 500 km	0.3 km 0.5 km 1 km	60 min 6 h 24 h	6 min 30 min 6 h
256	GNWP	T	UTLS	Global	0.5 K 1 K 3 K		15 km 100 km 500 km	0.3 km 1 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h
257	GNWP	T	PBL	Global	0.5 K 1 K 3 K		15 km 100 km 500 km	0.3 km 1 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h
…										
739	Space Weather	Electron differential directional flux	Geo, Leo, Meo	Global	5 % 10 % 25 %		45 degrees 90 degrees 180 degrees		60 sec 5 min 10 min	60 sec 10 min 100 min
740	Space Weather	Electron differential directional flux	L1	Global	5 % 10 % 25 %		360 degrees 360 degrees 360 degrees		60 sec 5 min 10 min	60 sec 10 min 100 min
…										

731	Aeronautical Meteorology	Precipitation intensity at surface (solid)	Near Surface	Point (Comments: At the aerodrome)	0.1 mm/h 0.2 mm/h 1 mm/h				30 min 60 min 2 h	5 min 10 min 30 min

FIGURE 2:
Extract from the OSCAR-Requirements database showing a small selection of Requirements, with columns re-ordered and coloured to show in green the Requirement definition (the User and their required datastream) and following that, shaded blue, the Requirement attributes (threshold, breakthrough and goal levels of performance for the six attributes).

ID	*Requirement definition*				*Requirement attributes*							
	User	*Observational datastream*			*Performance level: blue=goal; green=breakthrough; orange=threshold*							
No.	*Application Area*	*Variable*	*Vertical Layer/s*	*Horizontal Coverage*	*Layer/s quality*	*Coverage quality*	*Uncer-tainty*	*Stability*	*Horizontal Resolution*	*Vertical Resolution*	*Obs. Cycle*	*Timeliness*
255	GNWP	T	FT	Global	100 % 70 % 30%	100 % 80 % 40%	0.5 K 1 K 3 K		15 km 100 km 500 km	0.3 km 0.5 km 1 km	60 min 6 h 24 h	6 min 30 min 6 h
256	GNWP	T	UTLS	Global	100 % 70 % 30%	100 % 80 % 50%	0.5 K 1 K 3 K		15 km 100 km 500 km	0.3 km 1 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h
257	GNWP	T	PBL	Global	100 % 70 % 30%	100 % 70 % 30%	0.5 K 1 K 3 K		15 km 100 km 500 km	0.3 km 1 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h
…												

739	Space Weather	Electron differential directional flux	Geo, Leo, Meo	Global	100 %	100 %	5 % 10 % 25 %		45 degrees 90 deg 180 deg		60 sec 5 min 10 min	60 sec 10 min 100 min
740	Space Weather	Electron differential directional flux	L1	Global	At L1 Not at L1	100 %	5 % 10 % 25 %		360 deg 360 deg 360 deg		60 sec 5 min 10 min	60 sec 10 min 100 min
…												
731	Aeronautical Meteorology	Precipitation intensity at surface (solid)	Near Surface	Point (Comment: At the aerodrome)	Full compl-iance with siting / exposure standards	Full compl-iance with siting / exposure standards Representative of aerodrome	0.1 mm/h 0.2 mm/h 1 mm/h				30 min 60 min 2 h	5 min 10 min 30 min

FIGURE 3:
This modified version of Figure 2 has two additional columns, introducing two new Requirement attributes "Layer/s quality" and "Coverage quality". This gives the option to the User to indicate whether, if the datastream falls short of delivering the specified vertical layer/s and/or horizontal coverage in some respect, it may still offer a threshold or breakthrough level of performance. Since the vertical layer/s and horizontal coverage are specified using terms having a variety of characteristics and further qualified using free-form comments, the specification of "Layer/s quality" and "Coverage quality" can take a variety of forms. In all cases, however, the "goal" value in all cells must be defined as "100 %", or "As specified", or other appropriate entry having the same meaning.

ID	*Requirement definition*				*Requirement attributes*							
	User	*Observational datastream*			*Priority=red. Performance level: blue=goal; green=breakthrough; orange=threshold*							
No. Pr.	*Application Area*	*Variable*	*Vertical Layer/s*	*Horizontal Coverage*	*Layer/s quality*	*Coverage quality*	*Uncer-tainty*	*Stability*	*Horizontal Resolution*	*Vertical Resolution*	*Obs. Cycle*	*Timeliness*
255 1.0	GNWP	T	FT	Global	100 % 70 % 30% 1.0	100 % 80 % 40% 1.0	0.5 K 1 K 3 K 1.0		15 km 100 km 500 km 1.0	0.3 km 0.5 km 1 km 1.0	60 min 6 h 24 h 1.0	6 min 30 min 6 h 1.0

256 1.0	GNWP	T	UTLS	Global	100 % 70 % 30% 1.0	100 % 80 % 50% 1.0	0.5 K 1 K 3 K 1.0		15 km 100 km 500 km 1.0	0.3 km 1 km 3 km 1.0	60 min 6 h 24 h 1.0	6 min 30 min 6 h 1.0
257 1.0	GNWP	T	PBL	Global	100 % 70 % 30% 1.0	100 % 70 % 30% 1.0	0.5 K 1 K 3 K 1.0		15 km 100 km 500 km 1.0	0.3 km 1 km 3 km 1.0	60 min 6 h 24 h 1.0	6 min 30 min 6 h 1.0
…												
739 1.0	Space Weather	Electron differential directional flux	Geo, Leo, Meo	Global	100 % 1.0	100 % 1.0	5 % 10 % 25 % 1.0		45 degrees 90 deg 180 deg 1.0		60 sec 5 min 10 min 1.0	60 sec 10 min 100 min 1.0
740 1.0	Space Weather	Electron differential directional flux	L1	Global	At L1 Not at L1 1.0	100 % 1.0	5 % 10 % 25 % 1.0		360 deg 360 deg 360 deg 1.0		60 sec 5 min 10 min 1.0	60 sec 10 min 100 min 1.0
…												
731 1.0	Aeronautical Meteorology	Precipitation intensity at surface (solid)	Near Surface	Point (Comment: At the aerodrome)	Full compl-iance with siting / exposure standards 1.0	Full compl-iance with siting / exposure standards Represent-ative of aerodrome 1.0	0.1 mm/h 0.2 mm/h 1 mm/h 1.0				30 min 60 min 2 h 1.0	5 min 10 min 30 min 1.0

FIGURE 4:
This modified version of Figure 3 shows in red the addition of relative priority ratings. All priorities are set to 1.0 by default, which is the maximum of the possible values between 0.0 to 1.0, until changed by the User. The values have no meaning other than as a rating of relative priorities between the attributes within one Requirement (one row of blue cells) or, in the case of the general priority overall for the Requirement, as a rating of relative priorities between the different Requirements of this particular User / Application Area.