2nd Cryonet-Asia Workshop
Salekhard, Russian Federation
(2-5 February 2016)

WMO Rolling Review of Requirements (RRR)

Etienne Charpentier
Chief, WMO Observing Systems Division
WMO Application Areas

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

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
  - ...
Rolling Review of Requirements (RRR) and Evolution of Global Observing Systems

Application Areas

User requirements

Observing Systems Capabilities (Space & Surface) (OSCAR)

Critical review

Statements of Guidance (gap analysis)

Impact Studies (e.g. NWPS)

Priorities, cost effectiveness

Long term vision of global observing systems

Implementation Plan (EGOS-IP)

Members’ and Space Agencies Observation Programmes
The critical atmospheric variables that are not adequately measured by current or planned systems are (in order of priority):

- **wind profiles** at all levels outside the main populated areas
- **temperature and humidity profiles** of adequate vertical resolution in cloudy areas, particularly over the poles and sparsely populated land areas
- satellite based rainfall estimates
- **snow equivalent water content**
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 4 languages
Ocean related actions of the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) (1/2)

C8  Continued adherence to WMO data sharing principles irrespective of origin of data, including data provided by commercial entities

C13 Establish capacity building strategies for observing systems in developing countries

G1  Traceability of meteorological observations and measurements to SI or WMO standards

G2  Global exchange of hourly data which are used in global applications

G3  Global exchange of sub-hourly data in support of relevant application areas

G4  Exchange of observations according to the WIGOS standards
Implement as soon as possible a comprehensive cryosphere observing network of reference sites “CryoNet”

Provide, as far as possible, a real-time or near-real-time exchange of the cryospheric data from CryoNet. Follow the GCW, WIGOS and WIS practices for implementing this dissemination, and the standard quality assessment practices and archiving.

Include observations of key hydrological variables (liquid and solid precipitation, evaporation, snow depth, snow water content, lake and river ice thickness, water level, water flow, soil moisture) into an integrated system for a consistent observation, processing and exchange, following the WIGOS standards.

Increase ice buoy data coverage on the northern polar cap
Observing System Capability Analysis and Review tool (OSCAR) – oscar.wmo.int

- An evolution of the former WMO-CEOS Database and “GOS Dossier” on the space-based GOS
- Was initiated through the WMO Space Programme in cooperation with former CBS ET-ODRRGOS in support of WMO Rolling Review of Requirements (RRR)
  - Technology free observational users requirements
  - Observing systems capabilities
  - Gap analysis originally done with Excel sheet
OSCAR/Requirements

- Repository of Technology Free Observations User Requirements for
  - 14 Application Areas
  - 28 Layers in Atmosphere, Ocean, Terrestrial and Outer Space domains
  - 8 Regional dimensions (global, global ocean, global land, coastal areas, regional, sub-regional, local, point)
  - 260 variables
  - 2 Cross cutting themes (cryosphere, volcanoes)
  - 585 user requirements recorded in the database

- For each Application Area, designated focal points have limited editing rights on the database

- After review and endorsement, these changes become visible to the public

- Process overseen by CBS IPET-OSDE
User requirements for observation (OSCAR/Requirements)

This database is the official repository of requirements for observation of physical variables in support of WMO Programmes and Co-sponsored Programmes. These requirements are maintained by the focal points designated for each application area.

It is the foundation of the Rolling Requirements Review (RRR) process overviewed by the Inter-Programme Expert Team on Observing System Design and Evolution (IPED-OSDE) of CBS. [More information]

The requirements are regularly reviewed by groups of experts nominated by these organizations and programmes. For WMO, this process is conducted by the Inter-Programme Expert Team on Observing System Design and Evolution (IPED-OSDE) and its designated focal points for each of the Application areas.

In addition, Themes offer an additional, cross-cutting view on variables and requirements.

Using the database

To explore the database, you can use the "Quick Search" in the top right corner, when looking for a specific variable or Application area. You can also consult the full tables accessible through the top menu, and use the filter options provided.

The database is open for consultation. Editing is only possible by designated focal points, after login.

For any questions or clarifications regarding the content of the database, please directly contact the respective focal point. A list of all focal points can be found on the Application areas page.

Definitions

Requirements are expressed for geophysical variables in terms of 5 criteria: uncertainty, horizontal resolution, vertical resolution, observing cycle, timeliness, and stability (where appropriate).

For each of these criteria the table indicates 3 values determined by experts:

- The "threshold" is the minimum requirement to be met to ensure that data are useful
- The "goal" is an ideal requirement above which further improvements are not necessary
- The "breakthrough" is an intermediate level between "threshold" and "goal" which, if achieved, would result in a significant improvement for the targeted application. The breakthrough level may be considered as an optimum, from a cost-benefit point of view, when planning or designing observing systems.

The "uncertainty" characterizes the estimated range of observation errors on the given variable, with a 68% confidence interval (1σ).
## Requirements for SLP (OSCAR Database)

http://www.wmo-sat.info/oscar/variables/view/10

### Requirements defined for Air pressure (at surface) (10)

This table 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**.

<table>
<thead>
<tr>
<th>ID</th>
<th>Variable</th>
<th>Layer</th>
<th>App Area</th>
<th>Uncertainty</th>
<th>Stability/decade</th>
<th>Hor Res</th>
<th>Ver Res</th>
<th>Obs Cyc</th>
<th>Timelessness</th>
<th>Coverage</th>
<th>Conf Level</th>
<th>Val Date</th>
<th>Source</th>
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<td>Near Surface</td>
<td>Global NWP</td>
<td>0.5 hPa</td>
<td>1hPa</td>
<td>15 km</td>
<td>100 km</td>
<td>6 h</td>
<td>6 min</td>
<td>Global land</td>
<td>firm</td>
<td>2003-02-10</td>
<td>John Eyre</td>
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<td>251</td>
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<td>Near Surface</td>
<td>Global NWP</td>
<td>0.5 hPa</td>
<td>1hPa</td>
<td>15 km</td>
<td>100 km</td>
<td>6 h</td>
<td>6 min</td>
<td>Global ocean</td>
<td>firm</td>
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<td>John Eyre</td>
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<td>335</td>
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<td>High Res NWP</td>
<td>0.5 hPa</td>
<td>1hPa</td>
<td>1 km</td>
<td>5 km</td>
<td>30 min</td>
<td>15 min</td>
<td>Global land</td>
<td>firm</td>
<td>2010-02-01</td>
<td>T Montimerie</td>
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<tr>
<td>336</td>
<td>Air pressure (at surface)</td>
<td>Near Surface</td>
<td>High Res NWP</td>
<td>0.5 hPa</td>
<td>1hPa</td>
<td>1 km</td>
<td>5 km</td>
<td>20 min</td>
<td>15 min</td>
<td>Global ocean</td>
<td>firm</td>
<td>2010-02-01</td>
<td>T Montimerie</td>
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<tr>
<td>417</td>
<td>Air pressure (at surface)</td>
<td>Near Surface</td>
<td>Marine biology</td>
<td>10 hPa</td>
<td>1hPa</td>
<td>20 km</td>
<td>50 km</td>
<td>24 h</td>
<td>3 h</td>
<td>Global ocean</td>
<td>firm</td>
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<td>GOOS JPO</td>
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<td>Air pressure (at surface)</td>
<td>Near Surface</td>
<td>Ocean Applications</td>
<td>0.5 hPa</td>
<td>1hPa</td>
<td>10 km</td>
<td>25 km</td>
<td>30 min</td>
<td>15 min</td>
<td>Global ocean</td>
<td>firm</td>
<td>2011-03-07</td>
<td>Ali Mafimbo (JCOMM)</td>
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<tr>
<td>488</td>
<td>Air pressure (at surface)</td>
<td>Near Surface</td>
<td>Ocean Applications</td>
<td>1 hPa</td>
<td>1hPa</td>
<td>1 km</td>
<td>10 km</td>
<td>60 min</td>
<td>3 h</td>
<td>Global ocean</td>
<td>firm</td>
<td>2011-03-07</td>
<td>Ali Mafimbo (JCOMM)</td>
</tr>
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<td>Air pressure (at surface)</td>
<td>Near Surface</td>
<td>Climate-AOPC</td>
<td>0.5 hPa</td>
<td>0.65 hPa</td>
<td>10 km</td>
<td>200 km</td>
<td>3 h</td>
<td>3 h</td>
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<td>reasonable</td>
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<td>AOPC</td>
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<td></td>
<td>firm</td>
<td>2013-12-05</td>
<td>J van der Meulen</td>
</tr>
</tbody>
</table>
OSCAR/Requirements data model

- Criteria for storing observational user requirements
- For an application area, variable, vertical layer, horizontal coverage, and domain:
  - Horizontal resolution
  - Vertical resolution
  - Uncertainty
  - Observing cycle
  - Timeliness
  - Stability
- For each criterion
  - “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, and optimal cost/benefit
Requirement = f (Application, Variable, Vertical Layer, Horiz coverage)

**APPLICATIONS**

- Space Weather
- Hydrology
- Agriculture
- Ocean appl
- Atm chemistry
- GCOS
- Nowcasting
- HR NWP
- Global NWP

**VARIABLES**

- Atm. Temp
- Specific humidity
- Cloud Type
- Precipitation
- Ozone profile
- Sea-ice thickness
- Wave spectrum
- Leaf Area Index
- Soil moisture
- Proton flux
- Electron density

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**THEMES**

- Basic
- Clouds
- Aeosols
- Ocean
- Land
- Space

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**Vertical layers**

- Ionosphere
- Land Surface
- Open ocean (Upper)
- Low Stratosphere
- High Troposphere
OSCAR/Space

- **Factual information:**
  - > 600 satellites
  - > 800 instruments (including ~ 260 for space weather)
  - Regularly updated based on input from space agencies including the reports to CGMS and ET-SAT

- **Expert assessments:**
  - Mapping of instruments to variables with degree of relevance (rated 1 to 5)
  - Mapping with WMO-defined target capabilities (rated 1 to 5)
(1) Factual information content

- Name, purpose
- Mass, power
- Orbit (type, alt, ECT, lon)
- Launch date, end date, status
- Data access, telecom
  - Detailed status, dates
  - Link to details

- Name, purpose
- Mass, power
- Type, description, scan mode
- Resolution FOV, coverage
- Status
- Spectral characteristics
Satellite: GOES-R

Instrument: ABI

<table>
<thead>
<tr>
<th>Acronym</th>
<th>ABI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full name</td>
<td>Advanced Baseline Imager</td>
</tr>
<tr>
<td>Type of Instrument</td>
<td>01. Moderate-resolution optical imager</td>
</tr>
<tr>
<td>Purpose</td>
<td>Multi-purpose VIS/IR imagery and wind derivation by tracking clouds and water vapour features</td>
</tr>
<tr>
<td>Short description</td>
<td>18 channels, balanced VIS, NIR, SWIR, MWIR and TIR [see detailed characteristics below]</td>
</tr>
<tr>
<td>Background</td>
<td>Replacing IMAGER flown on GOES 8 to 15</td>
</tr>
<tr>
<td>Scanning Technique</td>
<td>Mechanical, 3-axis stabilised satellite, E-W continuous, S-N stepping</td>
</tr>
<tr>
<td>Resolution</td>
<td>Changing with channel (see table)</td>
</tr>
<tr>
<td>Coverage / Cycle</td>
<td>Full disk every 15 min, 3000 x 5000 km2 (&quot;CONUS&quot;, Continental U.S.) in 5 min, 1000 x 1000 km2 in 30 s</td>
</tr>
<tr>
<td>Mass</td>
<td>338 kg</td>
</tr>
<tr>
<td>Power</td>
<td>450 W</td>
</tr>
<tr>
<td>Data Rate</td>
<td>86 Mbps</td>
</tr>
<tr>
<td>Providing Agency</td>
<td>NOAA</td>
</tr>
<tr>
<td>Utilization Period:</td>
<td>2015-2035</td>
</tr>
<tr>
<td>Last update:</td>
<td>2012-09-05</td>
</tr>
</tbody>
</table>

Satellites this instrument is flying on:

- Geostationary Operational Environmental Satellite - 3rd generation (NOAA)
  - GOES-R (2015 - 2026)
  - GOES-S (2017 - 2028)
  - GOES-T (2019 - 2030)
  - GOES-U (2024 - 2035)

Contribution to Space Capabilities:

The instrument contributes to the following Capabilities, as identified in the "Vision for the GOS Implementation Plan for the Evolution of Global Observing Systems":

- Multi-purpose VIS/IR imagery from GEO

Tentative Evaluation of Measurements:

The following list indicates which measurements can typically be retrieved from this category full Gap Analysis by Variable, click on the respective variable.

Note: table can be sorted by clicking on the column headers.
## Tentative Evaluation of Measurements

The following list indicates which measurements can **typically** be retrieved from this category of instrument. To see a full Gap Analysis by Variable, click on the respective variable.

*Note: table can be sorted by clicking on the column headers.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Relevance for measuring this Variable</th>
<th>Operational Limitations</th>
<th>Processing maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar EUV flux</td>
<td>2 - very high</td>
<td>Referring to the Photosphere</td>
<td>Consolidated methodology</td>
</tr>
<tr>
<td>Solar X-ray flux</td>
<td>2 - very high</td>
<td>Referring to the Photosphere</td>
<td>Consolidated methodology</td>
</tr>
</tbody>
</table>
### Measurement Timeline for Solar EUV flux

**Definition:**
Integrated EUV flux over the solar disk

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</thead>
<tbody>
<tr>
<td>FTU</td>
<td>3 very high</td>
<td>SOHO</td>
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<tr>
<td>EXIS</td>
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<td>GOES-R</td>
<td>137W</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>EXIS</td>
<td>2 very high</td>
<td>GOES-T</td>
<td>137W</td>
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<td>SUVI</td>
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<td>GOES-R</td>
<td>137W</td>
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<td>SECHI-EUV</td>
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<td>STEREO-2</td>
<td>23.44</td>
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<td>Solar Orbiter</td>
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**All instruments for measuring Solar EUV flux**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Relevance of Measurement</th>
<th>Processing Maturity</th>
<th>Operational Limitations</th>
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<tbody>
<tr>
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<td>Consolidated methodology</td>
<td>Referring to the Photosphere</td>
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<td>PHoKA</td>
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</tbody>
</table>

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IPET-WIFI SG-OD & OSCAR-RRR workshop, Offenbach, 6-8 July 2015
**New instrument-variable mapping principle**

Instrument design requirements e.g.:
- Spectral bands
- Bandwidth
- No of channels
- Polarization
- Scanning mode
- Etc..

<table>
<thead>
<tr>
<th>Variable 1</th>
<th>Variable 2</th>
<th>Variable 3</th>
<th>Variable 4</th>
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Objective assessment

Science-based rules

IPET-WIFI SG-OD & OSCAR-RRR workshop, Offenbach, 6-8 July 2015
OSCAR/Surface – [oscar.wmo.int/surface](oscar.wmo.int/surface)

- An evolution/modernization of WMO No. 9, [Volume A](Volume A), Observing Stations and WMO Catalogue of Radiosondes
- Meant to become the official repository of WIGOS Metadata required for international exchange
  - One-stop-shop for surface- and space-based observing instruments & platforms metadata
  - Allows user to understanding observational data
  - Allows to identify potential synergies
  - A tool for developing countries willing to use OSCAR as their primary WIGOS metadata database
- A database for recording surface-based observing systems capabilities for the purpose of the RRR (WIGOS KAA#3)
  - Objective gap analysis / critical review
  - A tool for planning evolution of the observing system
  - Monitoring evolution of capabilities, compare with plans, look at progress
OSCAR/Surface - oscar.wmo.int/surface
Thank you for your attention