

**WORLD METEOROLOGICAL ORGANIZATION**

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**COMMISSION FOR BASIC SYSTEMS**  
OPEN PROGRAMMME AREA GROUP ON  
INTEGRATED OBSERVING SYSTEMS

ITEM: 7.3.2

**INTER PROGRAMME EXPERT TEAM ON  
OBSERVING SYSTEM DESIGN AND EVOLUTION  
(IPET-OSDE)  
*First Session***

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GENEVA, SWITZERLAND, 31 MARCH – 3 APRIL  
2014

## **ROLLING REVIEW OF REQUIREMENTS AND STATEMENTS OF GUIDANCE**

### **STATEMENTS OF GUIDANCE**

#### **ADEQUACY OF EXISTING SOGS IN RESPONDING TO GLOBAL CRYOSPHERE WATCH (GCW) OBSERVING REQUIREMENTS**

*(Submitted by Jeff Key (USA))*

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### **SUMMARY AND PURPOSE OF DOCUMENT**

The document provides information on the adequacy of existing Statements of Guidance in responding to Global Cryosphere Watch (GCW) Observing Requirements.

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### **ACTION PROPOSED**

The Meeting is invited to note the information contained in this document when discussing how it organises its work and formulates its recommendations.

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**References:** Current versions of the Statements of Guidance  
<http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html#SOG>

IGOS, 2007. Integrated Global Observing Strategy Cryosphere Theme Report - For the Monitoring of our Environment from Space and from Earth. Geneva: World Meteorological Organization. WMO/TD-No. 1405. 100 pp. [http://igos-cryosphere.org/docs/cryos\\_theme\\_report.pdf](http://igos-cryosphere.org/docs/cryos_theme_report.pdf)

## DISCUSSION

### 1. BACKGROUND

1.1 The 16<sup>th</sup> World Meteorological Congress approved the development of a Global Cryosphere Watch (GCW) in 2011. GCW implementation began later that year. Recent progress includes the design and initial site selection of the surface network, called *CryoNet*; an inventory of existing measurement practices for snow, ice, and permafrost properties; the initiation of satellite intercomparisons for snow cover; and the compilation of observational requirements for the cryosphere. See Doc 6.1 for an update on GCW activities.

1.2 GCW observational requirements have not yet been finalized. They will draw on various sets of existing user requirements. The most comprehensive set of observational capabilities and requirements for the cryosphere is contained in the Integrated Global Observing Strategy (IGOS) Cryosphere Theme Report published in 2007. It is available at <http://igos-cryosphere.org> and on the GCW website at <http://globalcryospherewatch.org>. The IGOS Cryosphere requirements are available in a searchable table on the GCW website ([http://www.globalcryospherewatch.org/reference/obs\\_requirements.php](http://www.globalcryospherewatch.org/reference/obs_requirements.php)). The IGOS Cryosphere Theme work will be continued by GCW.

1.3 GCW's observational requirements will become part of the WMO Rolling Review of Requirements (RRR) and will be accessible through the WMO's Observing Systems Capability Analysis and Review Tool (OSCAR). A cryosphere theme has been created in the RRR. The RRR is specified in the Manual on the Global Observing System (WMO-No.544), the Guide to the Global Observing System (WMO-No. 488), and described further at <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html>.

### 2. CRYOSPHERE VARIABLES IN THE STATEMENTS OF GUIDANCE

3.1 The cryosphere variables listed in each Statement of Guidance (SoG) report (Doc 7.3.2 (x)) are given below. These variables may be currently used, planned for use, or needed but not yet available. Some variables are in OSCAR for a particular application area but not in the corresponding SoG; e.g., Hydrology has sea ice cover and elevation entries in OSCAR.

- **Global Numerical Weather Prediction (NWP)** - Sea ice cover, sea ice type, sea ice thickness in the long term, snow cover, snow depth, snow mass (e.g., snow water equivalent, SWE), sea and lake ice surface temperature, surface albedo, precipitation
- **High Resolution Numerical Weather Prediction** - Sea ice cover, sea ice thickness in the long term, snow cover, snow water equivalent (more important for high-resolution NWP than global NWP), snow on ice (less important for high-resolution NWP because most models do not cover those areas)
- **Aeronautical Meteorology** - Precipitation/snowfall

- **Nowcasting and Very Short Range Forecasting (VSRF)** – Sea ice cover, snow cover, snow water equivalent, lake-sea-ice surface temperature; all with the same requirements as High-Resolution NWP
- **Atmospheric Chemistry** – No cryosphere variables mentioned
- **Ocean Applications** – Sea ice: cover, type/form, concentration, thickness, motion
- **Agrometeorology** – (not available)
- **Hydrology and Water Resources** – Snow cover, snow depth, snow water equivalent, glaciers (unspecified), precipitation
- **Seasonal & Inter-Annual Forecasting (SIAF)** – Snow cover, snow depth, sea ice cover, sea ice concentration, sea ice thickness
- **Global Climate Observing System (GCOS)** – Essential Climate Variables (ECVs; in most cases these are variable categories rather than specific properties): snow cover, glaciers and ice caps, ice sheets, permafrost, sea ice, albedo
- **Climate** – (Specific variables are not listed)
- **Space Weather** - No cryosphere variables mentioned

### 3. CRYOSPHERE VARIABLES IN IGOS CRYOSPHERE AND OSCAR

3.1 The cryosphere variables listed in the IGOS Cryosphere Theme Report and/or in the OSCAR database are given in Table 1. This list constitutes most, but not all, of the snow, ice, and permafrost properties that are of interest for various applications. Their importance to each application varies considerably.

3.2 Requirements for some variables in IGOS Cryosphere and in OSCAR vary significantly. For example, the threshold for sea ice thickness varies from 1 cm (Climate-OOPC) to 200 cm (CliC). Snow cover uncertainties range from 10% to 50% with spatial resolutions from 0.5 km to 250 km. This emphasizes the importance of identifying the application.

Table 1. Cryosphere variables for which observational requirements exist in the IGOS Cryosphere Theme Report (2007) and/or in the Observing Systems Capability Analysis and Review Tool (OSCAR).

<b>Cryosphere Element</b>	<b>Variable</b>	<b>IGOS</b>	<b>OSCAR</b>
Sea Ice:	Sea ice thickness	*	*
	Sea ice motion	*	*
	Sea ice surface characteristics	*	*
	Snow depth on ice	*	*
	Sea ice cover	*	*
	Sea ice surface temperature	*	*

	Sea ice extent/edge	*	
	Sea ice concentration	*	
	Leads/polynyas	*	
	Ice age	*	
	Ridge height	*	
	Melt onset, duration of melt	*	
	Volume/Mass flux	*	
	Sea ice elevation		*
	Sea ice type		*
Snow:	Snow cover	*	*
	Snow depth	*	*
	Snow water equivalent	*	*
	Snow status (wet/dry)		*
Freshwater Ice:	Freshwater ice concentration	*	
	Freshwater ice areal extent	*	
	Freeze-up and break-up date	*	
	Freshwater ice thickness	*	
	Snow depth on freshwater ice	*	*
	Areal extent of floating/grounded ice	*	
	River ice jams and dams	*	
	Flooding extent caused by jams/dams	*	
	River icings (aufeis)	*	
Ice Sheets:	Ice sheet margin	*	
	Grounding line	*	
	Surface accumulation	*	
	Basal melt magnitude	*	
	Basal melt distribution	*	
	Surface elevation	*	
	Surface elevation change	*	
	Snow/Firn density	*	
	Snow grain size and shape	*	
	Ice sheet surface temperature	*	
	Internal temperature	*	
	Gravity field	*	
	Surface velocity field	*	
	Vertical velocity variation	*	
	Ice sheet thickness	*	
	Internal layer depth	*	
	Iceberg calving rate	*	
	Changes in ice sheet morphology	*	
	Ice sheet topography	*	
	Surface melt extent	*	
	Surface melt duration	*	
	Ice sheet mass change	*	
	Geothermal heat flux	*	
Glaciers:	Glacier area	*	
	Glacier topography	*	*
	Glacier velocity	*	
	Glacier dammed lakes	*	

	Facies, snowline	*	
	Accumulation	*	
	Glacier mass balance	*	
	Glacier ice thickness	*	
	Glacier cover		*
Icebergs:	Limit of iceberg area	*	
	Concentration of icebergs	*	
	Iceberg position	*	
	Iceberg size	*	
	Iceberg draft	*	
	Iceberg mass	*	
	Iceberg velocity	*	
Permafrost:	Permafrost (general)		*
	Permafrost thermal state	*	
	Permafrost thickness	*	
	Permafrost distribution	*	
	Downslope creeping velocity	*	
	Annual surface elevation change	*	
	Ground ice volume	*	
	Active layer depth	*	
	Soil temperature	*	
	Surface temperature	*	
	Soil moisture	*	
	Duration of thaw	*	
	Seasonal frost heave / thaw subsidence	*	
	Onset of seasonal freezing	*	
	Duration of freeze	*	
	Distribution of seasonal freezing	*	
	Coastal retreat	*	
	Isostatic vertical motion	*	
	Wind speed and direction	*	
	Storm surge	*	
	Sediment transport	*	
	Ice scouring depth	*	
	Subsea permafrost distribution	*	
	Subsea permafrost thickness	*	
Precipitation:	Snowfall amount	*	
	Precipitation / Snowfall rate	*	
	Precipitation type	*	*
	Snow particle size	*	
	Precipitation intensity at surface		*
	Accumulated precipitation		*
Other:	Snow/ice albedo	*	*
	Snow/Ice surface temperature	*	

#### **4. SUMMARY AND RECOMMENDATIONS**

4.1 There are considerable differences between the lists of cryosphere variables from the IGOS Cryosphere Theme Report, the entries currently in OSCAR's cryosphere theme, and those that the various application areas above have identified in their SoGs. Specific requirements, such as uncertainty and spatial resolution, for some variables in the IGOS Cryosphere Theme Report and in OSCAR vary significantly.

4.2 It should be noted that the Polar Space Task Group (PSTG) has recently begun compiling space-based observational requirements for the polar regions. To date, the focus has been on the cryosphere as observed from Synthetic Aperture Radar (SAR) instruments.

4.3 Recommendations are:

1. GCW will identify application areas for each variable in the IGOS Cryosphere list (Table 1 above). New application areas for OSCAR may be suggested. Note that GCW itself is not an application area as it is too broad.
2. Requirements for non-cryosphere variables will be identified for some application areas, as appropriate.
3. GCW may engage the cryosphere community to update the IGOS Cryosphere requirements. This would be a major endeavor.
4. GCW will work with the application areas and the PSTG to clarify their needs and to resolve any ambiguities and inconsistencies in cryosphere requirements.

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