The Way Forward for the Cryosphere Theme

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GEO UIC Meeting
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The cryosphere is global

~100 countries have cryospheric components

It includes snow, sea ice, lake and river ice, glaciers, ice caps, ice sheets, permafrost and seasonally frozen ground, and solid precipitation.
Disappearing glaciers menace water supplies

Inuit say spring in the Arctic is becoming more dangerous

Thawing permafrost, GHG emission and coastal erosion

Tourism at risk

Melting Ice sheets, glaciers and global sea level rise

Floods feared as glaciers melt

Polar bears could face extinction as global climate change warms the Arctic

Socio-economic Impacts

Relevance to GEO SBAs:

- Disasters: ★★★
- Health: ★★★
- Energy: ★★★★★
- Climate: ★★★★★
- Water: ★★★★★
- Weather: ★★★★★
- Ecosystems: ★★★★★
- Agriculture: ★★★
- Biodiversity: ★★★
- + Transport: ★★★★★★★

**Note:** The rating scale ranges from 1 to 5, with 5 being the highest relevance.
Workshops were held in Canada, Japan, and the Netherlands, 2005-2006. Contributions from ~80 people in 17 countries, the basis of an evolving cryosphere community of practice that started with WCRP CliC and SCAR.

Chinese translation soon!
### Proposed Implementation in Three Timeframes

<table>
<thead>
<tr>
<th>Observing System Type</th>
<th>Implementation Action Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Space Infrastructure</strong></td>
<td>Near Term IPY: 2007-2008</td>
</tr>
<tr>
<td>Space Infrastructure Near Surface; AUV/UAVs In Situ Infrastructure Data and Data Management Integrative Actions</td>
<td>Ensure coordinated interagency planning of the IPY Polar Snapshot (plan for SAR/InSAR; high-resolution Vis/IR; and optimization of coverage in respect to IceSat laser cycles) and continuity in higher-level polar data products for an IPY legacy dataset.</td>
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### Details

#### 2007-2009, IPY.
- CliC IPY project “The State and Fate of the Cryosphere”. GEO Task CL-06-05; various IPY projects, particularly GIIPSY and WMO Space Task Group.

#### 2010-2015.
- Preserve the legacy of the IPY observing and information systems; expand to the global cryosphere; realize concepts for space observing systems. *WMO Global Cryosphere Watch; SAON.*

#### After 2015.
- Implement previously recommended space missions that fill key observational gaps, as well as routine in situ observations of such essential parameters.
Accomplishments & Activities

• The IGOS Cryosphere Theme assessment resulted in improved coverage of cryospheric elements in the GCOS Implementation Plan and contributed to the GCOS-CEOS plan for satellite-based products.
• Began efforts to ensure an IPY legacy through the GEO Work Plan.
• Influenced the satellite mission planning process resulting in:
  – Approval of three orbital cycles of coordinated, experimental inter-satellite (ERS-SAR and Envisat ASAR) SAR interferometry.
  – Approval of the GMES Sentinel-3A SAR altimeter mission that will provide sea-ice thickness measurements.
  – Approval of RADARSAT MiniMAMM (Modified Antarctic Mapping Mission) SAR mapping of Antarctica.
  – Approval of CryoSat-2 with a re-launch in 2009.
• Developed new satellite products for real-time applications, e.g., sea ice concentration, thickness, and motion from MODIS. New acquisitions through GIIPSY.
• Contributed to the planning of ongoing SCAR scientific research projects (ISMASS, ASPeCT, PPE, and AGCS).
  ❖ Fed directly into SAON (Sustaining Arctic Observing Networks) and the Arctic Council’s SWIPA project (Snow, Water, Ice, and Permafrost in the Arctic).
  ❖ Inspired the WMO Global Cryosphere Watch.

The community involvement in CryOS gave it the credibility needed for these accomplishments...the first time this has been done internationally for the cryosphere. The community that started with CliC and SCAR expanded through CryOS.
The 15th WMO Congress (May 2007) welcomed the proposal of Canada that WMO will create a Global Cryosphere Watch which would be an important component of the IPY legacy. Congress requested the WMO Inter-commission Task Group on IPY to establish an ad-hoc expert group to explore the possibility of creation of such global system and prepare recommendations for its development.

Where are we now? The Global Cryosphere Watch

A legacy of IPY

A component of WIGOS

A legacy of WCRP/CliC in the area of observations

A contribution to GEOSS
GLOBAL CRYOSPHERE WATCH:

observation, monitoring, assessment, product development, research through to prediction

**Mission:**

- implement the IGOS Cryosphere Theme (CryOS);
- support reliable, comprehensive observations through an integrated observing approach;
- provide the scientific community with the means to **predict** the future state of the cryosphere;
- facilitate the **assessment of changes** in the cryosphere and their impact; support decision making and environmental policy development;
- provide authoritative information on the current state and projected fate of the cryosphere for use by the scientific community, media, public, decision and policy makers.
(Note: These are not official logos!)
For GEO we need to follow the entire “Thread”

**Societal Benefit**

**Decision Topic**

**How will changes in the cryosphere impact sea level?**

- Societal impact reports
- Sea level trends
- Glacier and ice sheet state
- Glacier and ice sheet elevation change, surface melt, gravity, etc.
- Cryosphere monitoring and assessments

**Information Products and Services**

- Fully coupled ice sheet models (currently inadequate)
- Regional models that represent glacier variability
- Climate Models (accumulation, ablation currently inadequate)

**Science Knowledge and Models**

- CEOS measurements
  - Ice sheet/cap topography and rate of change
  - Ice stream velocity
  - Glacier extent
  - Glacier and ice sheet mass balance
  - Ice sheet calving rate
  - Snow cover
  - Ice surface energy budget
  - Geoid measurements
  - Continental rebound

**Measurements**

- EPA impact reports
- IPCC Scenario Impact Assessments
- Research products (e.g., GRACE mass change, passive microwave melt, ice velocity)
- WMO Global Cryosphere Watch
- World Glacier Monitoring Service

**Instruments and Missions**

- Research models, e.g., Community Ice Sheet Model
- Climate models & reanalyses:
  - ECMWF, NCEP, JMA reanalyses
  - Hadley Centre
  - NOAA GFDL (Princeton) Global Coupled Climate Model
  - NASA GISS Global Climate Model

**Contributions from N CEOS instruments and M missions.**
The cryosphere community was established through WCRP CliC and ICSU SCAR. It was expanded through the IGOS Cryosphere Theme, one of the last themes to be established. It is being expanded further through GCW and (potentially) GEO with increased emphasis on societal benefits.
What the UIC can do

- Suggest ways to better integrate the existing cryosphere community into the GEO/GEOSS framework.

- Help connect us with GEO activities that have cryosphere components or interests.

- Help fill the CoP “circle” by identifying gaps and suggesting ways to fill them.