GCW REPORT
No. 18 (2017)

WORLD METEOROLOGICAL ORGANIZATION

GLOBAL CRYOSPHERE WATCH

Global Cryosphere Watch (GCW) – Arctic Polar Regional Climate Centre (Arctic PRCC)

Planning Meeting

Montreal, Canada, 13 September 2017

GCW Technical Report #18 (2017)

World Meteorological Organization
Weather · Climate · Water

GCW Global Cryosphere Watch

Meeting venue:
Room André-Robert, Environment and Climate Change Canada, Place Bonaventure (800 de la Gauchetière Ouest, suite 7810, on the 7th floor), Montreal.

Chair, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 8403
Fax: +41 (0) 22 730 8040
E-mail: Publications@wmo.int

EXECUTIVE SUMMARY

The meeting of Global Cryosphere Watch (GCW) and the representatives of the Arctic Portal Regional Climate Centre (A-PRCC), the Norwegian and the Canadian nodes, respectively, took place on 13 September 2017, being hosted by Environment and Climate Change Canada.

The meeting examined the engagements between GCW and the A-PRCC, inputs from GCW (when fully operational) to the Arctic PRCC and other similar applications, through observations, best practices and Guides, data access and exchange, data rescue, outreach and training and through specific products including analyses and assessments.

Dr Barry Goodison and Mr John Parker provided overviews of the GCW and of the A-PRCC, respectively. It was noted that, although not mandatory (for formal WMO designation as an RCC), the A- PRCC countries agree to include sea-ice parameters in the forecast and analysis products and services in addition to the mandatory Temperature and (total) Precipitation elements. The door will remain open for other elements important to the pan-Arctic region (e.g. SWE, snow depth, SST, permafrost, etc.).

The group discussed the first Polar Arctic Regional Climate Outlook Forums (PARCOF), which will be held in spring 2018 and a subsequent virtual follow up is planned for September 2018. The presence or absence of ice regulates many activities in the Arctic such as transportation, fishing and hunting, tourism, resource extraction, etc., so sea-ice seasonality will drive the frequency and timing of PARCOFs.

The participants agreed that GCW should be included at pan-Arctic and Node level committees and be linked to the progress of A-PRCC and PARCOF, and the GCW Steering Group will nominate a representative.

The participants noted that the data portals for GCW, PRCC and for Year of Polar Prediction (YOPP) will be built in parallel, using the GCW Data Portal as the backbone. Countries will archive their own data. The portals will work through metadata. To facilitate the implementation of interoperability with the participating data centres, controlled vocabularies for metadata are vital. GCW will coordinate a broad engagement of scientists in development of a common terminology for data services through the data portal, the results supporting equally, the A-PRCC Portal, as well as YOPP Portal.

Dr Julie Friddell provided background on the Canadian Cryospheric Information Network (CCIN) and its relationship with GCW. CCIN is working on developing interoperability with the GCW Data Portal and would like to be able to support the Arctic PRCC.

Dr Eivind Støylen raised the issue of the current wording of the RCC mandatory functions for operational data services, namely, an RCC must 'Develop quality controlled regional climate datasets, gridded where applicable' and that the RCC must 'Provide climate database and archiving services, at the request of NMHSs' (see section 4.3). The participants requested that the WMO Secretariat clarifies whether this is applicable for the Arctic PRCC, in advance of its certification.

On the dynamic seasonal forecast of Snow Water Equivalent (SWE), it was noted that there is a need to bridge between snow on the ground and SWE to support the verification requirements. It was agreed that the GCW Snow Watch Team will identify the issues, and, in collaboration with the modelling communities, will recommend methods for verification of SWE forecasts.

Dr Kari Luojus demonstrated a new product, a daily"snapshot" of the Cryosphere (terrestrial SWE + Sea Ice) developed through EUMETSAT OSISAF and EUMETSAT HSAF. It was agreed to make these available as products on the GCW Website.

It was noted that the consideration of precipitation in terms of its liquid and solid components in forecasts and products would potentially serve users better - e.g. the hydrology sector. The need to engage users for further guidance was noted.

The participants agreed that the exchange of SWE is a priority and GCW committed to work with relevant groups to amend the BUFR code for exchanging SWE. GCW would appreciate support from PRCC in advocating the exchange of more cryosphere data, to meet specific needs.

The Arctic Change meeting (Quebec City, December 2017) would be a good opportunity for the Canadian GCW group to meet, and possibly to interact with relevant experts. John Parker will introduce the PRCC concept. Barry Goodison proposed a side session on GCW and the evolving GCW-PRCC relationship. R Brown noted that there will be a session on "Climate information for a changing climate" and a presentation on GCW will be submitted. B Goodison will represent GCW at the meeting.

Currently, the daily snow tracker images are not archived by ECCC, as they are replaced each night. FMI stores the GlobSnow daily products, but not the Canadian ones. It was agreed that J Friddell (CCIN) and R Brown/A Walker (ECCC) to explore the options for archival of snow trackers produced by ECCC, at CCIN.

It was agreed that GCW will take steps to clarify methods, resources and timing related to supporting the PRCC, e.g. the required data exchange, the portals and discovery metadata exchange, the BUFR code amendments, etc.). This will be discussed at the next Steering Group (GSG) meeting, Jan 2018. GCW will take steps, working with the PRCC Steering Group and others, to define additional analytical products, analyses, assessments and evaluations, which could be facilitated by GCW, and will be documented as part of its Products Strategy.

A priority sector for PRCC services initially will be marine transportation. GCW has linkages with IICWG through its Sea Ice Team. GCW is developing its Best Practices Guide, and, for Sea Ice, is incorporating material relevant to marine transportation.

The Arctic HYCOS is a project relevant to GCW and Arctic PRCC. It was agreed to approach the Arctic HYCOS office to scope their potential contribution to and engagement with GCW and PRCC.

With respect to GCW provision on which Essential Climate Variables (ECVs) to identify for inclusion in Arctic PRCC products and services, it was noted that there are actions assigned to GCW within the GCOS IP, on snow, glaciers, permafrost, etc. GCW will review its actions from the GCOS IP, and use this to help plan for its ECV input to the PRCC.

A list of actions and recommendations from this meeting is available in Annex 5.

The meeting ended at 17:00, on 13 September 2017.

Contents

1. ORGANIZATION OF THE SESSION

1.1 Opening of the Session

The meeting was opened on Sept 13, 2017 at 9:00 by Mr Richard Hogue, Director Forecast Systems Integration and Innovation Division of the Meteorological Service of Canada, Environment and Climate Change Canada (ECCC), who welcomed participants to Montreal and extended best wishes for a successful meeting.

Dr Barry Goodison, the meeting Chairman, noted that the implementation of the Polar Regional Climate Centre for the pan-Arctic will be guiding the next efforts to implement RCCs for the Antarctic and the Third Pole region.

On behalf of the Secretary-General of the World Meteorological Organization (WMO), Prof Petteri Taalas, Ms Rodica Nitu also welcomed participants and noted that the WMO activities focusing on the Polar and High Mountain Regions are one of the seven priorities for WMO and its Members during the current financial period. This meeting is the first formal joint session between the Global Cryosphere Watch (GCW) and Arctic Polar Regional Climate Centre (A-PRCC) communities, and the discussions should result in agreements and recommendations to facilitate the implementation of both efforts.

1.2 Adoption of the Agenda

The agenda was adopted with no change, and is attached as **Annex 1**.

1.3 Working Arrangements for the Session

The List of Participants is attached as **Annex 2**.
The group reviewed the security arrangements for the venue and agreed on the working schedule for the day.

It was noted that Julie Friddell would join in the session by WebEx.

All presentations made during the meeting are available at http://globalcryospherewatch.org/meetings/gcw-prcc2017/

2. Overview of GCW and its relevance to the Arctic PRCC

Dr Barry Goodison provided an overview of GCW, including its platform for engagement, its structure, its core areas of activity, and the potential linkages with the A-PRCC. Possible inputs from GCW (when fully operational) to the Arctic PRCC and other similar applications, would be, primarily, through observations, best practices and Guides, data access and exchange, data rescue, outreach and training and through specific products including analyses and assessments. An example of the role of GCW with respect to improvements to data exchange is the approval by WMO's Executive Council of the requirements that Members exchange snow depth data and report zero snow depth (Resolution 15 of EC-69, https://library.wmo.int/opac/doc_num.php?explnum_id=3645). In future, when other cryosphere-relevant elements need to be measured and exchanged to support operational PRCC activities, GCW will work with the interested parties in pursuing the approvals. B Goodison noted that it would be very helpful for PRCC

to identify the specific need to the appropriate WMO decision bodies, which could facilitate the engagements of relevant parties.

Dr Goodison further noted the need to pursue, to the extent possible, analysis and forecasting of precipitation as liquid and solid precipitation in addition to total precipitation. He reiterated GCW support for displaying pan-Arctic PRCC products in polar stereographic projection with the zero meridian in the centre (down) and for including sea-ice products in the Arctic PRCC functions.

The following 'Next steps' for GCW were identified, for discussion under item 4:

- Measurements from GCW surface network would support the RCC Mandatory and Highly Recommended Functions and could be used for product validation;
- GCW plans to develop its Products Strategy, reflecting needs/application areas, e.g. PRCC, satellite product validation, including development of additional products, trackers, diagnostics and data analyses, assessments of common interest;
- GCW plans to develop new multi-dataset trackers that provide more guidance on the observational uncertainty in SWE/snow cover
- Advancing the development and the interoperability of the GCW Data Portal is a key priority, focusing on the metadata vocabularies, data exchange, interoperability, and its synergy with A-PRCC Data Portal.
- GCW would benefit from having A-PRCC and WMO RAs promote improved exchange of snow data, or other cryospheric data
- GCW could assist with expertise on matters related to the cryosphere
- GCW plans to link closer with hydrology, and the work of Arctic-HYCOS is relevant to the A-PRCC.
- Active outreach and regional engagements

B Goodison highlighted the need to specifically define who the users are.

In discussion, it was noted that the Swedish Meteorological and Hydrological Institute (SMHI) is developing a pan-Arctic Hydrological prediction model that could be considered for input to the A-PRCC. With respect to the Arctic PRCC domain, it was recalled that the countries agreed on a degree of flexibility when describing Polar Regions in relation to particular subjects. For Arctic hydrological applications, for example, the A-PRCC domain could include the drainage basins of rivers flowing to the Arctic Ocean.

3. Overview of Arctic PRCC, most pertinent to the relationship with GCW

3.1 Arctic Polar Regional Climate Centre Network

Mr John Parker reviewed the fundamentals of WMO Regional Climate Centres including those functions that are mandatory for WMO designation (see **Annex 3**) and functions that are recommended but optional (see **Annex 4**), its structure[1] and division of responsibilities[2]. He noted that the Implementation Plan (IP), http://www.wmo.int/pages/prog/wcp/wcasp/meetings/PRCC_IPMeeting.html, for the A-PRCC Network was approved by WMO Executive Council in May 2017 and that the demonstration phase would likely begin in spring 2018. The IP will be a

[1] There will be three sub-regional Nodes, with Canada leading the North American Node (Canada, USA), Norway leading the Northern Europe/Greenland Node (Norway, Denmark, Iceland, Finland, Sweden), and the Russian Federation leading the Eurasian Node (Russian Federation).
[2] Each Node will conduct a significant cross-Node, or pan-Arctic PRCC function: Canada will lead production of long range forecasts (LRF), the Russian Federation will lead Climate Monitoring and Norway will lead Operational Data Services.

living document, revised as needed until the designation has been achieved and the A-PRCC is fully operational. Norway will act as the overall coordinator for the first three years. All eight Arctic Council countries have agreed to be part of the network. WMO now has observer status in the Arctic Council, which will ensure better focus in WMO, on the arctic. J Parker highlighted the A-PRCC priorities. The A-PRCC Network will seek support from the Arctic Council in its implementation. The GCW will be a key contributor and partner, as will the International Ice Charting Working Group (IICWG).

Although not mandatory (for formal WMO designation as an RCC), the A- PRCC countries agree to include sea-ice parameters in the forecast and analysis products and services in addition to the mandatory Temperature and (total) Precipitation elements. The door must remain open for further addition, when possible, of elements important to the pan-Arctic region (e.g. SWE, snow depth, SST, permafrost, etc.). Progress is underway in developing the LRF component (Canada), and in developing the data portal (Norway). Canada is also making preparations for a first Pan-Arctic Regional Climate Outlook Forum (PARCOF).

In discussion, the following points were raised:

- The data portals for GCW, PRCC and for YOPP will be built in parallel, using the GCW Portal as the backbone. Countries will look after, and archive their own data. The portals will work through metadata.
- The principal users of RCC outputs are the National Meteorological and Hydrological Services (NMHSs), who are expected to downscale and tailor information for national to local users in their countries. There might not be a requirement to downscale exactly from the pan-Arctic forecast, and to apply additional (e.g. regional) models, but the risk would be in divergence from the consensus forecast for the whole domain.
- All products developed for the three sub regions will be visible (available) across the pan-Arctic region.
- Network coordination and pan-Arctic outputs will be in English. Sub-regional products downscaled from PRCC products may be in other languages to suit national needs.
- Canada has established the Canadian Climate Change Services (CCCS), which is responsible to for decadal and longer predictions and projections. While such products and analyses are not mandatory for WMO designation, WMO strongly encourages all RCCs to assist their users with such information. This is especially recommended for the Arctic where the governments and people are all engaged in and highly aware of climate change risks and opportunities, and are experiencing change at a rate faster than in other parts of the world. As well, while the research community is working to improve the skill of prediction models at seasonal scale, some measure of sub-seasonal and longer-timeframe climate products (2-yr, decadal, etc.) is encouraged.
- Considering precipitation in terms of its liquid and solid components in forecasts and products would potentially serve users better - e.g. the hydrology sector. It would be particularly useful if it is the users themselves that raise this as a specific requirement.

3.2 Current status of the Pan-Arctic Regional Climate Outlook Forum (PARCOF)

Dr Bertrand Denis provided an overview of the WMO's Regional Climate Outlook Forums (RCOF), and plans for the first pan-Arctic forum. He noted the challenge

of dealing with eight countries and 24 time zones, and such a large[3] and climatically diverse area. It is not required that an RCC arrange RCOFs as part of their designation preparations, but there is a strong need for this type of engagement to help decision makers with climate risk management and adaptation to climate change. Objectives of the PARCOF include to:

- review the recent Arctic climate conditions and their possible impacts on the coming season;
- assess and interpret monthly and seasonal forecast products for the region (temperature, precipitation as well as various operational and experimental sea ice products) and develop outlook statements in plain language to communicate the information as well as communicating risks;
- engage with key users, decision makers and indigenous knowledge holders in a dialogue to better understand their needs and for them to explore how they can integrate the information; and
- discuss with the polar scientific community, especially those involved in the PPP and YOPP, how advances in knowledge will translate into improvements in regional-scale services delivered through the PRCC.

The presence or absence of ice regulates many activities in the Arctic such as transportation, fishing and hunting, tourism, resource extraction, etc., so sea-ice seasonality (freezing and thawing periods) will drive the frequency and timing of the PARCOFs. The first PARCOF will be held in spring 2018 and a subsequent virtual follow up is planned for September 2018.

The sources of predictability for the forecast will include sea ice concentration and volume, persistence of Sea Surface Temperature, and patterns of the Arctic and North Atlantic Oscillations (AO and NAO). LRF for temperature and precipitation will rely on the WMO Multi-Model Ensemble Long Range Forecasts, produced objectively from a combination of Global Climate Models from the WMO Global Producing Centers (GPCs-LRF). For sea ice, FRAMS (Forecasting Regional Arctic Sea Ice from a Month to Seasons), a Canadian model, funded by MEOPAR and endorsed by YOPP, should provide the PARCOF with one of the best sources of long-range Pan-Arctic sea ice predictions. As well, The Sea Ice Prediction Network (SPIN) initiative is also an excellent source of sea prediction and discussion.

The PARCOF will aim to communicate expected skill and forecast confidence, and conduct verification of past forecasts. Some capacity development will take place, and a strong effort to include a wide range of user communities and to better understand their climate needs will be made[4]. It is expected that the PARCOF Bulletin will be further refined at the National levels, for example by the application of some downscaling methods, and/or by considering additional observations not available in time to be considered in the PARCOF process. It is intended that GCW will be invited to participate in the PARCOF activities.
Action: GCW Secretariat will ensure that GCW remains connected and engaged during the preparation of the PARCOF events.

[3] The northern extent of the PRCC domain will be 90°N. The southern extent will vary based on Node requirements or the subject in question but for many purposes will be 60°N.
[4] In addition to the user involvement activities and capacity development workshops during PARCOFs, it would be of interest to define a clear feedback mechanism between the PARCOFs event. It could be through an internet forum, on-line chat, email distribution list, social networks, etc. NMHSs have already their own network that would most likely need to be formalized, strengthen and vet (that would be the case in Canada). To be sure that the PARCOF products are used and useful, we may have to perform surveys as well as visiting the users at
their work place when possible to better understand their decision-making environment.

In discussion, the following points were raised:

- Hosting the PARCOFs will rotate through the countries in the three nodes.
- The PARCOF will aim to use objective methods over subjective ones for development of the consensus forecasts.
- For practical reasons, the participating countries will initially emphasize services to the marine transportation sector; break-up and freeze-up timing will be a key need.
- The indigenous knowledge will be engaged through community involvement, e.g. in verification of freeze-up and break-up dates.

4. Linkages GCW-Arctic PRCC: products, alignment, sustained interaction

4.1 Dynamical seasonal forecasting of snow water equivalent

Bertrand Denis noted that, in principle, climate model-based seasonal forecasting systems can predict atmosphere, ocean, land and sea ice, but capabilities beyond "traditional" meteorological variables are only starting to be exploited. The Environment and Climate Change Canada – Global Prediction Centre (ECCC/GPC) Montreal uses the Canadian Seasonal to Interannual Prediction System (CanSIPS) for its operational seasonal forecasts. In examining the capability of CanSIPS to predict snow water equivalent (SWE), it has been established that SWE potential predictability derives from a tendency for SWE anomalies to persist and the model's skill in predicting future climate variations (e.g. ENSO). It would be useful to extend this evaluation to other GPCs.

Amongst the challenges to using models, e.g. CanSIPS, to predict SWE is the real time verification of the SWE forecasts which requires both gridded SWE (not snow depth), and anomalies referenced to the 1981-2010 base period. While extensive real time snow information is available, e.g. through GCW[5], none of these products exactly match the above criteria. For example, the Canadian Cryosphere Information Centre (CCIN)[6] provides snow depth anomaly maps referenced to 1998/99-2011/12 base period. Another consideration is that different gridded analyses contain different errors, and not all are suitable for verification of SWE. The highest skill has been found for quality controlled blend of 5 snow analyses which suggests similar advantages may be realized from multi-product verifications as from multi-model forecasts.

The following points were raised in discussion:

- The model produces probabilistic forecasts in three categories (above, near and below normal). Increasing the number of categories could be done, but would increase the uncertainty of each level.
- If possible, changing the model output from monthly average values to shorter time step (e.g. weekly or daily) values would provide a better preview of the likely evolution of the snowpack.
- There is a need to bridge between snow on the ground and SWE to support the verification requirements. **ACTION: GCW Snow Watch Team will identify the issues, and in collaboration with the modelling communities will recommend methods for verification of SWE forecasts.**
- ECMWF, for daily forecast output, does assimilate snow depth data, but for models providing seasonal forecasts, initial conditions are established from forcing initial atmospheric patterns and creating weather systems, not

[5] http://globalcryospherewatch.org/state_of_cryo/snow/
[6] https://ccin.ca/home/ccw/snow/current

from assimilation of real data. This might explain why the anomaly fields in the SWE forecast seem unrealistic – the system may be picking up on early condition storm tracks.

4.2 GCW Operational Data Services Part 1

Dr Øystein Godøy provided an overview of the GCW Data Portal, which is, also, the backbone of the Arctic PRCC Data Portal. He noted that the portal will not host data; it will harvest discovery metadata which will be put in a searchable index. Currently, a new Data Portal is being developed to improve its flexibility.
Contributing data centres must follow certain protocols (e.g. interoperability guidelines), to ensure the discoverability. The discovery metadata allow web-mapping of the data. The approach uses open data space, is Net centric (linkages with other data centres is vital and it implies the brokering of metadata and data), and is interdisciplinary.

The Data Portal will provide services including discovery metadata exchange (harvest, exposure, transformation), discovery metadata indexing. A human interface will allow searching, downloading, transforming and visualization, while machine services are exploited to offer visualisation and transformation for data sets. Collocated products could be developed through the transformation of individual products, when the data space can be constrained.
To facilitate the implementation of interoperability with the participating data centres, controlled vocabularies for metadata are vital. Scientists must be engaged and agree on the definition of variable metadata (semantics).
ACTION: GCW will coordinate a broad engagement of scientists in development of a common terminology for data services through the data portal.

The harvesting of metadata is based on OAI-PMH (Open Archive Initiative Protocol for Metadata Harvesting) or SoIR, which could link datasets behind the scene; Norway has some experience with it. Data management services rely on OPeNDAP (Open-source Project for a Network Data Access Protocol) for integration of data, and OGC WMS (Open Geospatial consortium Web Mapping Service Interface). OPenDAP used Common Data Models (CDM) and relies on CF (Climate and Forecast) standard names and structures.
Transformations are designed to allow users to perform comparisons of products and to extract tailored products for specific needs, using PyWPS (Python Web Processing Services), e.g. maps, time series, etc. A transformation service is required, and set criteria for transformation. As a result, the system could generate comparisons. These services are available for backend users. They are used for NetCDF, but could be used for GRIB, also.
For Human Interfaces, currently, MetNo has a new backend service for basket functionality and a metadata editor under integration. For the Machine Interface, a new OAI-PMH backend service with improved translation is being tested and a new catalog index based on SoIR, also being tested.
It is planned that for the CryoNet stations where the data is available through OPeNDAP, to test the extraction of time steps and create BUFR, and generate time series. Data conversion for ASCII files is under testing based on UNIDATA Rosetta.

4.3 Arctic PRCC Operational Data Services Part 2

Dr Eivind Støylen raised the issue of the current wording of the RCC mandatory functions for operational data services, namely, that for formal WMO designation, an RCC must 'Develop quality controlled regional climate datasets, gridded where applicable' and that the RCC must 'Provide climate database and archiving services, at the request of NMHSs' (see full wording and the associated criteria in

Annex 3). With respect to the latter requirement, it is highly unlikely that any countries contributing to and benefitting from the Arctic PRCC will require such services, all being highly developed countries with sophisticated NMHSs. With respect to the former requirement, it is not being planned to create a physical data archive, given the current advances on data exchange, so the group agreed to seek the advice of WMO on whether that wording, which is embedded in the WMO Technical Regulations, needs to be reviewed and possibly updated to cover what will be implemented by the Arctic PRCC.

ACTION: GCW Secretariat will bring the matter of the RCC mandatory requirements for operational data services to the attention of Kumar Kolli and discuss what, *if any*, actions might be needed and which groups (e.g. CCl, CBS, EC-PHORS and its STT) might need to be involved.

Norway will likely host both the web site for the pan-Arctic PRCC and the page(s) for the Northern European/Greenland (Nordic) Node. While each Node is expected to host their own web sites, in the initial stages Norway may also host the site for the North American Node (Canada to have secure editor privileges). E Støylen reviewed the early structure for the PRCC web page for the pan-Arctic domain, with a home page and links to the three sub-regional Nodes (North American, Northern Europe/Greenland (Nordic) and Eurasian). Efforts are underway to determine how best to distribute content across the Nodes. Content will include, inter alia, News including a Twitter feed, information and products for LRF (maps, consensus statements, verification information, etc.) and Climate Monitoring (bulletins, Regional Climate Watch advisories), links to data and other services and background information. Every effort will be made to highlight "Flagship products". It was agreed that additional thought is needed on how to link in GCW products and services such as fast ice or permafrost analyses, snow trackers, etc.

In discussion, the following points were raised:

- The map plotter for LRF products needs to be connected to the portal server and also to the server where the data reside.
- An agreement is needed on a limited number of map projections to be available per server. It is agreed to use polar stereographic for the pan-Arctic products, but the system should allow for other projections to meet NMHS and other needs.
- Other products could include, subject to the agreement of the countries involved, longer term climate products (2-year, decadal and longer). In the Arctic PRCC IP, Appendix 2 (Highly recommended, but not mandatory contributions), many of the PRCC countries have and have offered to contribute climate information and services for climate prediction and climate projection to meet regional needs.

4.4 Daily "snapshot" of the Cryosphere (terrestrial SWE + Sea Ice)

Dr Kari Luojus demonstrated a new product, a daily"snapshot" of the Cryosphere (terrestrial SWE + Sea Ice) developed through EUMETSAT OSISAF and EUMETSAT HSAF. K Luojus agreed that these products are appropriate for distribution via the GCW website. There are presently data gaps (e.g. over Greenland), and perhaps other data sets (SnowTel, Alberta, BC, etc.) could be added.

ACTIONS:

The daily "snapshots" of the Cryosphere (terrestrial SWE and Sea Ice) to be made available as products on the GCW Website.

GCW will work with K Luojus and EUMETSAT to address the data gaps and conversion of the data to BUFR) etc.

4.5 Canadian Cryospheric Information Network: A GCW Portal for Canada

Dr Julie Friddell provided background on the Canadian Cryospheric Information Network (CCIN) and its relationship with GCW. CCIN runs the Polar Data Catalogue. The site holds products and information on the past, present and future states of the cryosphere in Canada and the Polar regions. Since 2012, there have been new data visualizations created and released, Snow Water Equivalent for the Canadian Prairies has been continued and updated, and new work has been done on lake ice. Globe Snow has been incorporated and social media activities activated. CCIN archive hosts the snow anomaly trackers.

The Polar Data Catalogue was set up to preserve Canada's Arctic and Antarctic data and make them available for future generations. There are 2,554 metadata records - datasets on natural, social, and health sciences, policy, etc. and 2.85 million files, including 28,092 RADARSAT-1 and RADARSAT-2 satellite images of northern Canada and Antarctica. Sharing data and metadata with other polar data portals and interoperability are key aims.

In 2016, a user survey was conducted to identify requirements for snow and ice data in Canada. There was a 29% response rate from the distribution to 360 entities. A key finding is that most people prefer to have access to raw data as well as visualizations and maps/graphs. The advisory council of CCIN recommended the inclusion of new information on glaciers, sea ice, more public content specific to Canada, as well as games and animation for a young audience. It has also added social media tools. It contains a dynamic version of the Canadian SWE application and GlobSnow can be animated, looking at the full Northern Hemisphere.

The Polar Data Catalog is Canada's Antarctica Data Centre.

Improvements to the CCIN site, including increasing the areal coverage of data which are available and advertising more to increase exposure were suggested. Current and upcoming work will cover rebuilding/updating the CCIN website, outreach to increase visibility and accessibility to cryospheric data in Canada, reconciliation of keywords - GCW vs. PDC keyword dictionaries (working with GCW Data Portal), and new projects with ECCC to support to GCW.

In discussion, the following points were raised:

- GCW would like to have access to the CCIN survey, as a complement to the one done for Cryoland.
  ACTION: Anne Walker to provide the final version of the survey report prepared by CCIN for ECCC, to the GCW Secretariat.
- CCIN is working on developing interoperability with the GCW Data Portal and would like to be able to support the Arctic PRCC.
- Currently CCIN does not track users, so cannot elaborate on user profiles. In the new website it is planned to offer users a chance to comment on the site and products.
- The group agreed that non-real time data (e.g. certain CryoNet sites) should at least be discoverable through the Polar Data Catalogue. It might be useful to hold the CryoNet data at one site, but tagging the data would be more important than where the data reside.
- Standardization of data at present is not being done, but standardization of the metadata is in progress. Data doesn't need to be physically located. The most important is tagging it correctly.

- Dr Shawn Marshall proposed that it would make sense to ensure standardization of metadata and data at national level, using the work done under GCW's leadership.

4.6 Open Discussion

i) It was agreed that **GCW should have a seat on the Arctic PRCC Steering Committee**, to build collaboration from the early planning stages, to allow time for development, testing, operationalization of current and new products, ensure the data portals are working together as needed, etc.
ACTION: John Parker will recommend to Helge Tangen, Chair of the EC PHORS Services Task Team (STT) that GCW should be included at pan-Arctic and Node level committees. GCW needs to nominate a representative.

ii) Canada will be establishing a national Steering Group for PRCC implementation, with representation from ECCC, Polar Knowledge Canada, Shanna Pitter (USA) to cover issues related to the North American Node. CCIN should also be invited. Other Government of Canada departments to be invited, later, starting with the PARCOF.
It was proposed that the national GCW focal points to become part of the PRCC Steering Group, e.g. Anne Walker, for Canada.
ACTION: J Parker to invite A Walker, GCW Focal Point for Canada, as part of the Arctic PRCC Steering Group.

iii) The **Arctic Change meeting (Quebec City, December 2017)** would be a good opportunity for the Canadian GCW group to meet, and possibly to interact with relevant University people, Polar Knowledge Canada representatives, MEOPAR, John Pomeroy, etc. CCIN will have a booth. John Parker plans to attend and introduce the PRCC concept to the participants. Barry Goodison proposed a side session on GCW and the evolving GCW-PRCC relationship. R Brown noted that there will be a session on "Climate information for a changing climate" that could be a good venue for these.
ACTION:
J Friddell, R Brown, A Walker will take steps to organize an informal meeting of the Canadian GCW community at the Arctic Change meeting.
GCW to submit a presentation and be represented there. B Goodison and the Secretariat to discuss options.
B Goodison and J Parker will seek an opportunity to organize a side session on GCW and PRCC at the meeting, as needed.

iv) On the subject of sustainable and accessible data (further to the discussions under item 4.3 above) it was noted that some data holders will not allow their data to be reproduced. Some may allow their data to be used to create gridded (value added) datasets. The issue of freely available data, as required under GCW Data Protocol, remains work in progress.

v) Currently, neither CCIN nor ECCC are retaining and archiving the daily snow tracker images. They are replaced each night – produced but not preserved. Some users ask for them. FMI stores the GlobSnow daily products, but not the Canadian ones. J Friddell expressed interest in exploring the archival of snow trackers at CCIN.
ACTION:
J Friddell and R Brown/A Walker to explore the options for archival of snow trackers produced by ECCC, at CCIN.

vi) GCW would appreciate support from PRCC in advocating the **exchange of more cryosphere data, e.g. SWE**. It was noted that to change what is exchanged, the BUFR code would have to be changed and that takes time and planning. During the EC-69 (2017), Members asked when the SWE data would be exchanged.
ACTION: GCW will take steps to start the process to have the BUFR code amended for exchange of SWE (there may be more than one category of SWE to be exchanged).

vii) It was noted that GCW, during its pre-operational phase, has not focused much on analysis.
ACTION: GCW will take steps, working with the PRCC Steering Group and others, to define additional analytical products, analyses, assessments and evaluations, which could be facilitated by GCW, and will be documented as part of its Products Strategy.

viii) GCW has, to now, been pre-operational but will have to adapt to a more operational mode for interaction with and contribution to an operational PRCC.
ACTION: GCW will take steps to clarify methods, resources and timing related to supporting the PRCC, e.g. the required data exchange, the portals and discovery metadata exchange, the BUFR code amendments, etc.). This will be discussed at the next Steering Group (GSG) meeting, Jan 2018. A GSG planning session will take place in early Nov (Chair and Vice Chair of GCW Steering Group, WMO Secretariat, others).

ix) A priority sector for PRCC services initially will be marine transportation. GCW has linkages with IICWG (Vasily/AARI). GCW is developing its Best Practices Guide, and, for Sea Ice, is incorporating material relevant to marine transportation. At the 18th IICWG meeting in Sept, 2017, in Hobart, Australia, the experts of the GCW Best Practices Team, Dr. Petra Heil and Dr Penelope Wagner, will engage experts on reviewing the progress made in developing the Sea Ice Best practices guide, seeking feedback from the community for the next steps. Also, there is an opportunity to link on this topic with the Polar Space Task Group, at its session in December 2017. A first draft of the Guide on Sea Ice should be available in early 2018, for broader review.

x) Following from item 2 above, the SMHI pan-Arctic Hydrological modeling would be potentially interesting to both GCW and PRCC.
ACTION: GCW PO will contact David Gustafson to find out more about the model and its capabilities and status, and provide this information to GCW and Arctic PRCC groups.

xi) The Arctic HYCOS is a project relevant to GCW and Arctic PRCC
ACTION: GCW PO will approach the Arctic HYCOS office to scope their potential contribution to and engagement with GCW and PRCC, and provide this information to GCW and Arctic PRCC groups.

xii) For development of the user relationships for PRCC, including through the PARCOF, it would be good to explore collaboration with, inter alia, the PPP Societal and Economic Research and Applications (SERA)[7] group.

[7] The PPP Societal and Economic Research and Applications (SERA) subcommittee addresses the social-science and economics aspects of the Polar Prediction Project. Their research related to the needs for and the use of environmental information also includes decision-making processes by a diverse range of actors in polar regions and providers of environmental information. Furthermore, PPP-SERA team members and contributors intend to assess the communication between providers and users of polar weather and ice information. Hereby, the PPP-SERA subcommittee complements

ACTION: John Parker will take steps to seek collaboration with SERA proponents on user aspects of Arctic PRCC and PARCOF.

xiii) With respect to GCW provision on which Essential Climate Variables (ECVs) to identify for inclusion in Arctic PRCC products and services, it was noted that there are actions assigned to GCW within the GCOS IP, on snow, glaciers, permafrost, etc.
ACTION: GCW will review its actions from the GCOS IP, and use this to help plan for its ECV input to the PRCC.

xiv) With respect to PRCC and GCW networking within Canada, it was noted that there used to be a mechanism that brought together government, university and other groups together for discussion and information sharing. Some efforts have been made to resurrect this mechanism, but there has been little enthusiasm. A 'hook' would be helpful. Perhaps Polar Knowledge Canada would be a good intermediary in this. SAON also could be a good central point for engagement. The USA has established a NOAA funded national office for Arctic Observing Networks and this could be a good model.

5. OTHER BUSINESS

None.

6. CLOSURE OF THE SESSION

A list of actions and recommendations from this meeting is available in Annex 5.

Dr Goodison reflected on the common interests between GCW and PRCC, and expressed his appreciation for the collaboration that has been reinforced and furthered by this meeting. Participants were thanked for their valuable inputs and their enthusiastic participation in the discussions. Mr Parker thanked WMO for setting up the meeting and appreciated as well the fruitful discussions.

---

the aforementioned observation and modelling efforts of YOPP and aims at improving our understanding of user and provider needs, perspectives, values and behaviour.
http://www.polarprediction.net/yopp-activities/yopp-task-teams/ppp-sera/

7. Annex 1, Meeting AGENDA

1. ORGANIZATION OF THE SESSION

    1.1 Opening of the Session

    1.2 Adoption of the Agenda

    1.3 Working Arrangements for the Session

2. Overview of GCW and its relevance to the Arctic PRCC

3. Overview of Arctic PRCC, most pertinent to the relationship with GCW

4. Linkages GCW- Arctic PRCC: products, alignment, sustained interaction

5. Summary of outcomes for GCW, for PRCC, for Canada and next steps.

6. OTHER BUSINESS

7. CLOSURE OF THE SESSION

8. Annex 2: Provisional List of Participants

	Participant	Affiliation	e-mail
1	John Parker	Environment and Climate Change Canada Director, Canadian Ice Service Lead for A-PRCC North American Node	john.parker2@canada.ca
2	Barry Goodison	Vice Chair, GCW Steering Group Kanata, Canada	barrygo@rogers.com
3	Leslie Malone	Invited Expert Kanata, Canada	lesliemalone@rogers.com
4	Bertrand Denis	Environment and Climate Change Canada Lead PARCOF, Canada	bertrand.denis@canada.ca
5	Øystein Godøy	Norwegian Meteorological Institute Chair, GCW Data Portal Team	o.godoy@met.no
6	Eivind Støylen	Norwegian Meteorological Institute Lead, of Arctic PRCC, Norwegian Node	eivinds@met.no
7	Kari Luojus	Finnish Meteorological Institute Co-Lead, Snow Watch Team Co-Chair, GCW Integrated products WG	kari.luojus@fmi.fi
8	Ross Brown	Environment and Climate Change Canada Co-Lead, Snow Watch Team	Brown.Ross@ouranos.ca
9	Anne Walker	Environment and Climate Change Canada GCW Focal point for Canada	anne.walker@canada.ca
10	Shawn Marshall	University of Calgary Representative, Kluane Lake CryoNet station	marshals@ucalgary.ca
11	Feiteng Wang	Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Science (CAS) GCW Observation WG Representative of CAREERI CryoNet stations (China)	wangfeiteng@lzb.ac.cn
12	Julie Friddell	Canadian Cryosphere Information Network, University of Waterloo GCW Data Portal Team	julie.friddell@uwaterloo.ca
13	Eleanor Blackburn	Environment and Climate Change Canada Point of Contact for CryoNet stations (ECCC)	
14	Charmaine Hrynkiw	Environment and Climate Change Canada	charmaine.hrynkiw@canada.ca
15	Joel Fiddes	WMO Consultant	joelfiddes@gmail.com
16	Rodica Nitu	WMO Secretariat (GCW project Office)	rnitu@wmo.int

9. Annex 3: Arctic PRCC Implementation Plan, Mandatory Functions

Arctic Polar Regional Climate Centre Implementation Plan, Draft v2.1 31.01.2017,
Annex 4: Detailed Criteria for Mandatory Functions of WMO RCCs/RCC Networks
From the Manual on the GDPFS (WMO No. 485), Part II, new Appendix II-11[8]

Functions	Activities	Criteria
Operational Activities for LRF (both dynamical and statistical, within the range of 1 month to 2 year timescale, based on regional needs)	Interpret and assess relevant LRF products from Global Producing Centres (GPCs), distribute relevant information to RCC Users; and provide feedback to GPCs (see Attachment II-13)	***Product:*** assessment of the reliability and outcomes of GPCs or LCs-LRFMME products including the reasoning (making use of LC SVSLRF), for the region of interest, in the form of texts, tables, figures, etc. ***Element:*** 2-m mean temperature, total precipitation ***Update frequency:*** monthly or at least quarterly
	Generate regional and sub-regional tailored products, relevant to RCC User needs, including seasonal outlooks etc.	***Product:*** probabilities for tercile (or appropriate quantile) categories for the region or sub-region ***Element:*** 2-m mean temperature, total precipitation ***Output type:*** *rendered images (maps, charts), text, tables, digital data* ***Forecast period*:** one month up to 6 months ***Update frequency:*** 10 days to one month
	Generate consensus* statement on regional or sub-regional forecasts. **NB: A collaborative process involves discussion with experts in the region (e.g. through Regional Climate Outlook Forums (RCOFs), teleconferencing, etc.).* *Consensus is both the agreed process, and its joint conclusion, and can be that there is limited skill in the prediction for a region or sub-region*	***Product:*** *consensus statement on regional or sub-regional forecast.* ***Element:*** *2-m mean temperature, total precipitation* ***Output type:*** *report* F***orecast period*:** *a climatologically significant period (from one month to one year)* ***Update frequency:*** *at least once per year (to be defined by the region)*
	Perform verification of RCC quantitative LRF products, including the exchange of basic forecasts and hindcast data.	***Products:*** verification datasets (e.g. SVS LRF scores, Brier Skill Score; ROC; Hit Rate Skill Score) ***Element:*** 2-m mean temperature, total precipitation
	Provide on-line access to RCC products/services to RCC Users.	***Product:*** an on-line data/information portal

[8] http://library.wmo.int/pmb_ged/wmo_485-v1_en.pdf

	Assess use of RCC products and services through feedback from RCC Users.	***Product:*** analysis of feedback (which is made available using a template) ***Update frequency:*** annually, as part of a regular reporting of RCCs to WMO RAs
Operational Activities for Climate Monitoring	Perform climate diagnostics including analysis of climate variability and extremes, at regional and sub-regional scales	***Products:*** climate diagnostics bulletin including tables, maps and related products ***Element:*** Mean, Max and Min temperatures, Total precipitation; other elements (esp. GCOS essential climate variables) to be determined by the region, ***Update frequency:*** monthly
	Establish an historical reference climatology for the region and/or sub-regions	***Product:*** database of climatological means for various reference periods (e.g. 1931-60; 1951-80; 1961-90; 1971-2000; etc.) ***Spatial resolution:*** *by station* ***Temporal resolution:*** *monthly at a minimum* ***Elements:*** Mean, Max and Min temperatures, Total precipitation; other elements (esp. GCOS essential climate variables) to be determined by the region, ***Update frequency:*** at least 30 years, preferably 10 years
	Implement a Regional Climate Watch	***Products:*** climate advisories and information for RCC Users ***Update:*** whenever required, based on the forecast of significant regional climate anomalies.
Operational Data Services, to support operational LRF and climate monitoring	Develop quality controlled regional climate datasets, gridded where applicable	***Products:*** regional, quality controlled climate datasets, gridded where applicable, following CCl guidance on QA/QC procedures ***Elements:*** Mean, Max and Min Temperature, and Precipitation, at a minimum ***Temporal resolution:*** *daily* ***Update:*** monthly
	Provide climate database and archiving services, at the request of NMHSs	***Products:*** national databases with metadata, accessible to the NMHS in question (backup service, development site, etc). ***Elements:*** as determined by the NMHS ***Update:*** at the request of the NMHS
Training in the use of operational RCC products and services	Provide information on methodologies and product specifications for mandatory RCC products, and provide guidance on their use	***Products:*** *Manuals, guidance documents and information notes*. ***Update frequency:*** when methods/products are revised or introduced or discontinued
	Coordinate training for RCC Users in interpretation and use of mandatory RCC products	***Products:*** survey and analysis of regional training needs, and proposals for training activities.

NOTE: an RCC is expected to perform certain functions (e.g. for homogeneity testing; database management; metadata management, statistical evaluation of climate data, etc.) using procedures proposed in the WMO Guide to Climatological Practices and in other official Commission for Climatology Guidance documents.

10. Annex 4: RCC Highly Recommended Functions

Arctic Polar Regional Climate Centre Implementation Plan, Draft v2.1, 31.01.2017, Annex 5: RCC Highly Recommended Functions

From the Manual on the GDPFS (WMO No. 485), Attachment II-10) :

- **Climate prediction and projection**
  - Assist RCC Users in the access and use of WCRP-CMIP climate model simulations
  - Perform downscaling of climate change scenarios
  - Provide information to RCC Users for use in development of climate adaptation strategies
  - Generate, along with warnings of caution on accuracy, seasonal forecasts for specific parameters where relevant, such as: onset, intensity and cessation of rainy season; tropical cyclone frequency and intensity
  - Perform verification on consensus statements for forecasts
  - Perform assessment of other GPC products such as SSTs, winds, etc.

- **Non-operational data services**
  - Keep abreast of activities and documentation related to WMO WIS, and work towards WIS compliance and DCPC designation
  - Assist NMHSs in the rescue of climate data from outmoded storage media
  - Assist NMHSs to develop and maintain historical climate datasets
  - Assist RCC Users in the development and maintenance of software modules for standard applications
  - Advise RCC Users on data quality management
  - Conduct data homogenization, and advise RCC Users on homogeneity assessment and development and use of homogeneous data sets
  - Develop and manage databases, and generate indices, of climate extremes
  - Perform Quality Assurance/Quality Control on national datasets, on request of an NMHS
  - Provide expertise on interpolation techniques
  - Facilitate data/metadata exchange amongst NMHSs, including on-line access, through an agreed regional mechanism
  - Perform Quality Assurance/Quality Control on regional datasets

- **Coordination functions**
  - Strengthen collaboration between NMHSs on related observing, communication and computing networks including data collection and exchange
  - Develop systems to facilitate harmonization and assistance in the use of LRF products and other climate services
  - Assist NMHSs in user liaison, including the organisation of climate and of multidisciplinary workshops and other forums on user needs
  - Assist NMHSs in the development of a media and public awareness strategy on climate services

- **Training and capacity building**
  - Assist NMHSs in the training of users on the application and on implications of LRF products on users
  - Assist in the introduction of appropriate decision models for end-users, especially as related to probability forecasts
  - Promote technical capacity building on NMHS level (e.g. acquisition of hardware, software, etc.), as required for implementation of climate services

- Assist in professional capacity building (training) of climate experts for generating user-targeted products

- **Research and development**
  - Develop a climate Research and Development agenda and coordinate it with other relevant RCCs
  - Promote studies of regional climate variability and change, predictability and impact in the Region
  - Develop consensus practices to handle divergent climate information for the Region
  - Develop and validate regional models, methods of downscaling and interpretation of global output products
  - Promote the use of proxy climate data in long-term analyses of climate variability and change
  - Promote application research, and assist in the specification and development of sector specific products
  - Promote studies of the economic value of climate information

11. Annex 5: List of actions

REPORT REFERENCE	ACTION	RESPONSIBLE	DUE
3.1	GCW Secretariat will ensure that GCW remains connected and engaged during the preparation of the PARCOF events.	GCW Secretariat	on-going
4.1	GCW Snow Watch Team will identify the issues, and in collaboration with the modelling communities will recommend methods for verification of SWE forecasts.	K LUOJUS/R Brown	On-going
4.2	GCW will coordinate a broad engagement of scientists in development of a common terminology for data services through the data portal.	Ø GODØY, GCW Secretariat	2018
4.3	GCW Secretariat will bring the matter of the RCC mandatory requirements for operational data services to the attention of Kumar Kolli and discuss what, *if any*, actions might be needed and which groups (e.g. CCl, CBS, EC-PHORS and its STT) might need to be involved.	GCW Secretariat	Oct 2017
4.4	The daily "snapshots" of the Cryosphere (terrestrial SWE and Sea Ice), to be made available as products on the GCW Website. GCW will work with K Luojus and EUMETSAT to address the data gaps and conversion of the data to BUFR) etc.	K Luojus, J Key	Oct 2017
4.5	Anne Walker to provide the final version of the survey report prepared by CCIN for ECCC, to the GCW Secretariat.	A Walker	Dec 2017
4.6-i	John Parker will recommend to Helge Tangen, Chair of the EC PHORS Services Task Team (STT) that GCW should be included at pan-Arctic and Node level committees. GCW needs to nominate a representative.	J Parker	Oct 2017
4.6-ii	J Parker to invite A Walker, GCW Focal Point for Canada, as part of the Arctic PRCC Steering Group	J Parker	Dec 2017
4.6-iii	J Friddell, R Brown, A Walker will take steps to organize an informal meeting of the Canadian GCW community at the Arctic Change meeting. GCW to submit a presentation and be represented there. B Goodison and the Secretariat to discuss options. B Goodison and J Parker will seek an opportunity to organize a side	J Friddell, R Brown, A Walker B Goodison	Dec 2017

	session on GCW and PRCC at the meeting, as needed.		
4.6-v	J Friddell and R Brown/A Walker to explore the options for archival of snow trackers produced by ECCC, at CCIN.	J Friddell, R Brown, A Walker	Dec 2017
4.6-vi	GCW will take steps to start the process to have the BUFR code amended for exchange of SWE (there may be more than one category of SWE to be exchanged).	WMO Secretariat, K Luojus/R Brown	Jan 2018
4.6-vii	GCW will take steps, working with the PRCC Steering Group and others, to define additional analytical products, analyses, assessments and evaluations, which could be facilitated by GCW, and will be documented as part of its Products Strategy	Co-Chairs, Integrated Products WG GCW Chair/Vice-Chair WMO Secretariat,	Jan 2018
4.6-viii	GCW will take steps to clarify methods, resources and timing related to supporting the PRCC, e.g. the required data exchange, the portals and discovery metadata exchange, the BUFR code amendments, etc.). This will be discussed at the next Steering Group (GSG) meeting, Jan 2018. A GSG planning session will take place in early Nov (Chair and Vice Chair of GCW Steering Group, WMO Secretariat, others).	GCW Chair/Vice-Chair WMO Secretariat,	Jan 2018
4.6-x	GCW PO will contact David Gustafson to find out more about the model and its capabilities and status, and provide this information to GCW and Arctic PRCC groups.	GCW Secretariat	Dec 2017
4.6-xi	GCW PO will approach the Arctic HYCOS office to scope their potential contribution to and engagement with GCW and PRCC, and provide this information to GCW and Arctic PRCC groups.	GCW Secretariat	Dec 2017
4.6-xii	John Parker will take steps to seek collaboration with SERA proponents on user aspects of Arctic PRCC and PARCOF.	J Parker	2018
4.6-xiii	GCW will review its actions from the GCOS IP, and use this to help plan for its ECV input to the PRCC	GCW Secretariat	2018

12. Annex 6: ACRONYMS

AO and NAO -	Arctic and North Atlantic Oscillations
A (Arctic)-PRCC -	Arctic Polar Regional Climate Centre (RCC – WMO Regional Climate Centre)
BUFR -	Binary Universal Form for the Representation of meteorological data
CanSIPS -	Canadian Seasonal to Interannual Prediction System
CCCS -	Canadian Climate Change Services
CBS –	Commission for Basic Systems (WMO)
CCl –	Commission for Climatology (WMO)
CCIN -	Canadian Cryosphere Information Centre
CDM -	Common Data Models
CF -	Climate and Forecast (standard names and structures)
EC –	(WMO) Executive Council
EC PHORS –	WMO Executive Council Panel of Experts on Polar and High Mountains Observations, Research, and Services
ECCC -	Environment and Climate Change Canada
ECCC/GPC -	Environment and Climate Change Canada – Global Prediction Centre
EUMETSAT OSISAF –	EUMETSAT Satellite Application Facility on Ocean and Sea Ice
EUMETSAT H-SAF -	EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management
FRAMS -	Forecasting Regional Arctic Sea Ice from a Month to Seasons
GCW -	Global Cryosphere Watch
GSG –	GCW Steering Group
GPCs-LRF -	WMO Global Producing Centres
GRIB -	GRIdded Binary or General Regularly-distributed Information in Binary form
IICWG -	International Ice Charting Working Group
LRF -	Long Range Forecasts
MEOPAR –	Marine Environmental Observations, Prediction and Response Network
NetCDF –	Network Common Data Form
NMHSs -	National Meteorological and Hydrological Services
NOAA	National Oceanographic and Atmospheric Administration (USA)
OAI-PMH -	Open Archive Initiative Protocol for Metadata Harvesting
OPeNDAP -	Open-source Project for a Network Data Access Protocol
PARCOF -	Pan-Arctic Regional Climate Outlook Forum (RCOF - Regional Climate Outlook Forum)
PDC -	Polar Data Catalogue
PyWPS -	Python Web Processing Services
RA –	(WMO) Regional Association
SAON -	Sustained Arctic Observing Networks
SERA -	PPP Societal and Economic Research and Applications
SMHI -	Swedish Meteorological and Hydrological Institute
SPIN -	Sea Ice Prediction Network
STT –	Services Task Team (of EC PHORS)
SWE –	Snow Water Equivalent
YOPP –	Year of Polar Prediction
WMO -	World Meteorological Organization