

Developing a Snow Cover Component for the WMO Global Cryosphere Watch

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EXTENDED ABSTRACT

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BACKGROUND

In June of 2011, the World Meteorological Organization (WMO) Congress (Cg-XVI) approved the implementation of a Global Cryosphere Watch (GCW). This decision was made in recognition of the important role of the cryosphere in the global climate and hydrological systems and the wide-ranging impacts associated with a changing cryosphere. The main objective of GCW is to provide authoritative, understandable, and useable data, information, and analyses on the past, current and future state of the cryosphere. At the first GCW implementation meeting in Geneva in November 2011, a decision was made to initiate a snow cover monitoring pilot “Snow-Watch” project under GCW in collaboration with several meteorological centres. The presentation at the ESC summarized below provided some initial thinking about potential GCW Snow-Watch pilot projects to address some of the key gaps/needs.

CHALLENGES

There are some major challenges to provide authoritative, reliable scientific data and information on the snow cover to meet user needs:

- Snow cover information is collected at differing spatial and temporal scales. For example, point snow depth measurements (ruler or automated snow sensor); bi-weekly snow surveys of snow water equivalent (SWE); snow cover information from satellite and reanalysis datasets, gridded station data using different interpolation methods.
- Snow cover data are often fragmented (e.g., different satellite sensors, data maintained in separate national archives that may or may not be shared, differing observing methods across countries, etc.).
- There are institutional and technical barriers to sharing real-time observations. For example, China does not place in-situ snow depth observation on the WMO Global Telecommunication System; near real-time snow depth observations made in Canada by volunteer observers cannot be incorporated in the Canadian Meteorological Centre operation snow analysis because key meta-data are not provided with the observations.

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- User needs for snow cover information are diverse and cover a wide range of spatial and temporal scales (e.g., real-time weather and hydrological forecasting, applied climatological studies, climate monitoring).

GCW represents a window of opportunity to focus on some key gaps/needs for snow cover monitoring in North America and elsewhere.

SOME IDEAS FOR GCW “SNOW-WATCH” ACTIVITIES IN NORTH AMERICA:

The following are some preliminary thoughts about potential GCW activities that could be carried out in North America (NA) to address some of the challenges noted above.

Development of NA historical gridded snow depth and SWE datasets for applied studies, climate monitoring, and model evaluation

Needs

Snow loads for national building codes, ground frost penetration, water resource management, agriculture (e.g., winter kill, soil moisture recharge), evaluation of climate and hydrological models, forest fire risk, etc.

Challenges

Cessation of daily snow depth measurements at many sites in Canada with the longest periods of record, shift from manual to automated snow depth measurements at many sites, and increased regionalization of data collection activities in Canada.

Potential role for GCW

Promote development of NA gridded snow depth and SWE archive and reanalysis datasets at about 10 km resolution. This would complement ongoing activities to provide high resolution gridded air temperature and precipitation datasets for Canada and the US.

Develop recommendations for real-time use of automated snow depth observations

Need

Automated snow depth sensors have replaced manual measurements at many sites over the last 20 years. Real-time users of these data have encountered a number of “QC issues” that result in data being consistently rejected at some locations.

Potential Role for GCW

Work with manufacturers, network operators, technical staff and users to develop procedures for real-time use of automated snow depth sensors (the Meteorological Service of Canada is currently examining the use of multiple sensor arrays).

Increase real and near real-time flow and access to *in-situ* snow depth observations

Need

A large volume of daily snow depth observations made by climate observers are not available for real-time applications.

Opportunity

Snow depth anomalies vary over longer time-scales than many other meteorological elements, so the timeliness constraint could be relaxed somewhat to accommodate snow depth observations. Climate observations in Canada and the US are now being provided via internet-based reporting (COOLTAP and COOP), so there is potential to use these data in near real-time (within 24 hours).

Issues

Canadian COOLTAP data are not tagged with critical meta-data (location, elevation) which precludes them from being incorporated in the CMC snow depth analysis.

Potential Role for GCW

Promote development and exchange of real-time climate data between Canada and the US; demonstration project to examine the impact of COOLTAP and COOP snow depth data on the quality of operational snow analyses (e.g., compare snow analysis performance with and without the additional data stream).

4. Real-time intercomparison of operational snow cover products

Need

Multiple snow cover products exist, but how well do they agree with each other? Is a multi-dataset ensemble more robust? Reliable information on snow depth/SWE anomalies has widespread applications in water resources and strategic planning.

Potential Role for GCW

Initiate a snow cover product intercomparison project to provide feedback to product developers on potential biases and errors in products. This would also provide users with greater access to information on the seasonal evolution of snow cover area and accumulation anomalies. Figure 1 provides an example of real-time monitoring of snow cover extent anomalies with the NOAA-IMS and Canadian Meteorological Centre (CMC) operational snow analyses. Figure 2 show an example of the seasonal evolution of monthly snow depth anomalies from the CMC operational daily snow depth analysis for 2011–2012 snow season.

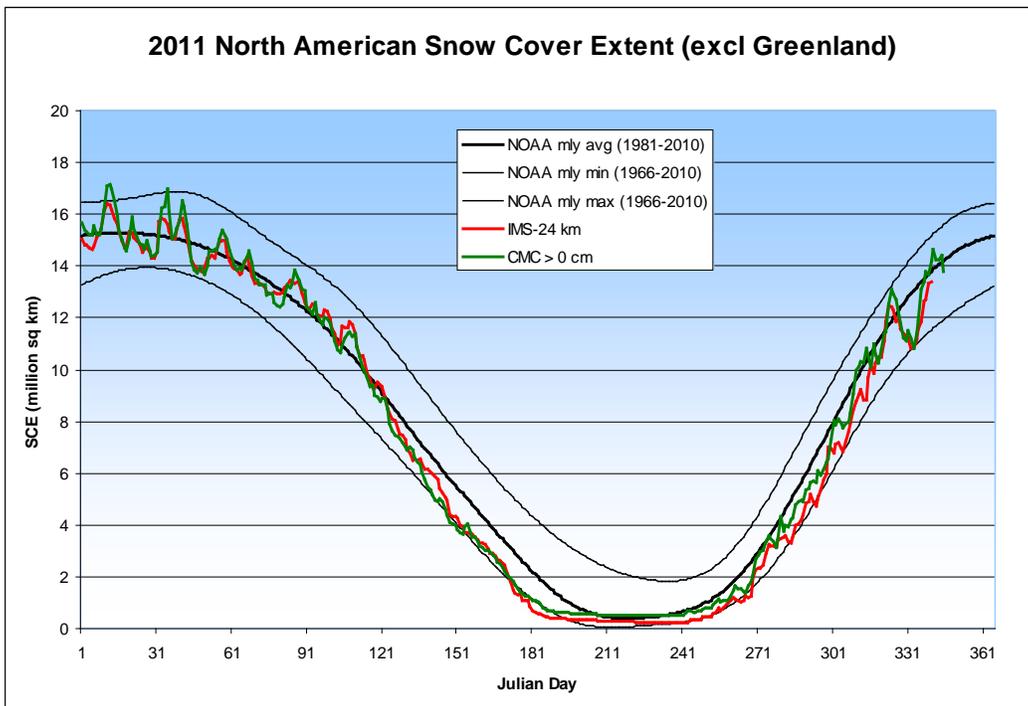


Figure 1. Seasonal variation in North American daily continental snow cover extent (million km²) from the NOAA-IMS 24 km analysis and the CMC daily snow depth analysis. Complete snow cover was assumed to exist in CMC grid cells with snow depth > 0. The maximum and minimum range for snow cover is based on

a spline fit to monthly maximum and minimum snow cover extent from the NOAA-CDR dataset over 1966–2010 period.

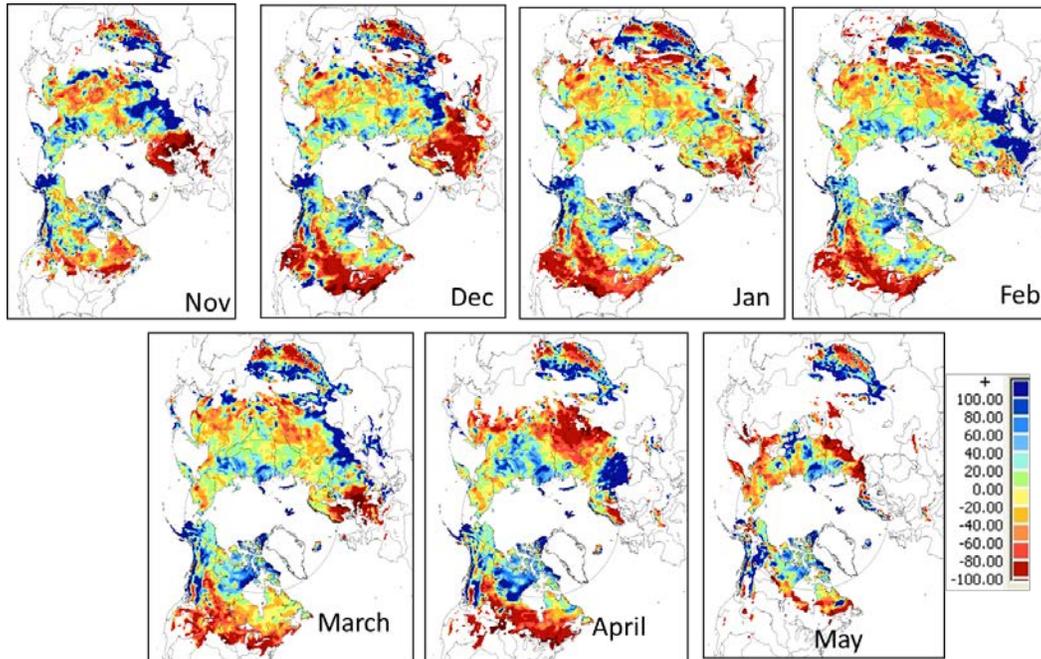


Figure 2. Seasonal evolution of monthly snow depth anomalies (% of 1999–2010 average) over the 2011–2012 snow season from the CMC daily snow depth analysis. Below-average snow depths developed early in the season over most of the US and southern Canada and persisted through the entire snow cover season.

CONCLUSIONS

GCW represents an internationally-recognized framework for addressing a number of key common issues and challenges for improved snow cover monitoring and products. The Eastern Snow Conference (ESC) can play an important role in developing GCW-snow initiatives in North America:

- ESC is an internationally recognized forum for snow-related science and applications.
- ESC brings together the research, operational and user communities.
- ESC has major strengths in snow observation science (in-situ, satellite).
- ESC has a history of promoting best practices (e.g., snow surveying methods).
- ESC has high potential to entrain young scientists to contribute to key gaps/issues.

Environment Canada is proposing to host a GCW *SnowWatch* meeting in Canada in early 2013 to explore potential pilot projects.