ICARP III Activity - Reporting Template

Title of activity

Arctic winter snow changes: Recent Developments and a Roadmap for Observing, Modeling and Determining Impacts

Type of activity	**Date**	**Place**
1. Workshop	16-17 October 2014	European Environment Agency, Copenhagen
2. Multi-author paper	On-going	-
3. Session at ISAR-4/ICARP III meeting	30 April 2015	Toyama, Japan

Main organizer(s) (name and/or organization) and additional partners

IASC Cross-cutting activity arranged primarily through the Terrestrial Working Group
INTERACT
AMAP
CliC
GEO Cold Regions

Abstract[1]

Snow is a critically important and rapidly changing fundamental characteristic of the Arctic but it has too often been over-looked in major environmental assessments. Changing snow dynamics challenge the methodology of measuring snow on the ground and remotely and it makes prediction very difficult. However, predictions are important because of the numerous impacts of changing snow. Consequently, an IASC-led workshop was held in Copenhagen to document recent progress in this field and develop a road-map for future Arctic snow studies. Over 30 international participants attended a two-day workshop and many relevant partners were represented. Indigenous perspectives were included and four APECS members attended. Three main focal points for presentations were snow observing, modelling and impact studies while breakout groups assessed priority research and monitoring priorities and identified key areas for developing cross cutting activities. The output is to be published in a peer-reviewed, wide circulation journal. This paper focuses on determining the role of snow for Earth-system processes, the Arctic system, ecosystems, species, potential feedbacks and societal impacts and establishes how snow can better be described to support interdisciplinary studies. A session on snow at ISAR-4/ICARP III was motivated by the participants and the various parts of the paper will be presented at the meeting in Toyama. The hitherto rather neglected issue of changes in snow cover and its multiple consequences is being successfully elevated. In addition, INTERACT and other organisations will seek to *implement* key priorities for monitoring and research formulated at ICARP III.

Main contributions to ICARP III[2] in terms of the ICARP III priorities[3]

[1] Provide a short summary of the activity

The main activities of this group address three of the key ICARP III activities explicitly, and the fourth implicitly, as follows.

1. Identify Arctic science priorities for the next decade.
   The workshop in Copenhagen and subsequent activities are explicitly compiling recommendations for priority actions for the next decade. The wide-ranging recommendations build on the platform developed by SWIPA in 2011 and are being formulated as contributions to, rather than overlaps with, on-going major initiatives. The recommendations will be finalized after the meeting in Toyama and published in an appropriate international journal.
2. Coordinate various Arctic research agendas.
   Many of the contributors to the activities are representatives of major international organisations that have a mission and capacity to implement some of the key recommendations in a coordinated way. Although the activity will not be a coordinating body *per se*, it will facilitate the participating organisations, such as northern research stations, to initiate key recommended research and monitoring programmes using standard and new methods and technology while identifying appropriate archives and users for the data.
3. Inform policy makers, people who live in or near the Arctic and the global community
   Many of the participating organisations have dedicated outreach channels. Participants represent a huge geographical scale from local concerns of Indigenous Peoples and Arctic Residents to the Earth System scope of climate modelling and GEO (Group on Earth Observations) activities and outreach will be facilitated at all levels.
4. Build constructive relationships between producers and users of knowledge
   The participants in the "snow" activities represent a range of interests from knowledge providers (Indigenous Knowledge and scientific approaches to observing, modelling and impacts) to various users of knowledge. These include research and monitoring initiatives that seek new techniques to measure various aspects of snow; the modelling community that seeks additional ground data; and the impacts community that seeks projections of future snow conditions. As the impacts community is wide-ranging from reindeer herding to urban development, the potential users of the knowledge are diverse and numerous. This activity has already forged new links between the major communities.

Key messages so far

There have been important recent developments in methodology/technology in observing snow, in modelling snow and in understanding the impacts of a changing snow cover. An important development is the rapidly developing understanding of extreme weather events in winter that result in temporary melt and have numerous ecological and societal impacts.

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[2] List a few key statements (findings, priorities, recommendations) that you would like to see reflected in the overarching ICARP III products

[3] ICARP III priorities:

- identify Arctic science priorities for the next decade
- coordinate various Arctic research agendas
- inform policy makers, people who live in or near the Arctic and the global community
- build constructive relationships between producers and users of knowledge

Despite these advances, numerous challenges remain. Although the final list is still in development, it is clear that:-

- There are large spatial scaling issues that need to be resolved, from snow grain characteristics to the Circum-Arctic region to the full Earth System. Feed-backs between soil, plants and the atmosphere respond to changing snow conditions at a meter scale while modelling most often starts at hundreds of square meters. We require more manual measuring stations and development of models and remote sensing tools that can detect snow depth differences across small scale landscape topography.

- The temporal evolution of the Arctic snowpack throughout an entire winter is poorly investigated, specifically the evolution of ice crusts.

- There are uncertainties in observing activities including paucity of ground-based, year-round measurements and technological difficulties that need to be resolved in microwave and SAR (Synthetic Aperture Radar) remote sensing techniques.

- The effects of physical properties of the snowpack on sea ice have been measured but by out-dated methods and understanding of the snow-on-sea ice feedback is poor.

- Effects of earlier or late snowmelt impacts on human well-being, such as degree of availability of pathogens of humans, livestock and agriculture, are unclear.

- For snow precipitation modelling, reliable measurements of total precipitation and solid precipitation fractions are crucial for properly driving snow models. Therefore, more precipitation measuring stations are required to meet the needs of the modelling community.

- Additional effort is required by ecologists to scale up their measurements, for the modelling community to scale down and that both request snow data at the correct scale. Most important is that both communities establish a dialogue to facilitate measurements to be taken at the correct scale.

- From an ecosystem perspective there is a pressing need to identify when the largest changes in snow conditions will occur; e.g., start, middle or late winter. Furthermore, we need to identify which species are most responsive to such winter snow changes as shifts in community composition, due to winter climate change, will impact growing season ecosystem processes and surface feedback to climate.

- An open dialogue needs to be established to facilitate information exchange between society and the science community. Particularly, the facilitation of observations on what communities identify as key snow-driven environmental and socioeconomic changes and the consequences of extreme snow-related events and conditions.

- The Arctic science community is well integrated and coordinated by various

organisations but their agendas for research and monitoring, for example of snow cover, are often difficult to implement independently. Our current activity includes organisations that can together implement inter-comparable responses to the current agenda being developed while ensuring that the observing, modelling and impacts communities interact more closely.