AROSS

Arctic Rain on Snow Study (A Systematic Pan-Arctic Analysis of Rain on Snow and Extreme Precipitation Events and their Impacts on Human-Environment Systems)

https://nsidc.org/rain-on-snow

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Areas of contribution

Polar atmospheric processes

Modelling and forecasting

Observations

Land processes

Data archiving

Outreach

Policy-relevant / cultural aspects

Economic aspects

Societal and/or behavioural aspects

Summary

When rain falls on an existing cover of snow, followed by cold temperatures, or falls as freezing rain, it can leave a hard crust. Surface melt followed by cold can do the same. There is growing evidence that such events are becoming more common in the rapidly warming Arctic, and it is increasingly recognized that they can have

pronounced impacts on Arctic wildlife, domesticated reindeer, and human activities, like travel.

Rain on snow events have sometimes resulted in large die-offs of reindeer because the icy crust makes it difficult for reindeer to find forage and their movements may be inhibited. The Arctic Rain on Snow Study (AROSS), a collaboration between the University of Colorado Boulder, the Alaska Pacific University, the University of Lapland and involving extensive community engagement and co-production of knowledge, seeks to better understand the distribution, severity, and changes in the frequency of rain on snow events and melt-refreeze events in the Arctic and their impacts, with a focus on hunting and in particular, reindeer herding livelihoods.

Description

Recent years have seen growing interest in Rain on Snow (ROS) and extreme cold season precipitation events in the Arctic. For example, November 2006 saw a massive reindeer mortality episode on the Yamal Peninsula; a similar event occurred in 2013. Both were associated with ROS events, which caused an ice crust to form on the snow, greatly interfering with foraging [Forbes et al., 2016]. Such events represent a threat to reindeer husbandry, an important livelihood across many Arctic regions.

Arctic precipitation is projected to increase through the 21st century, in part due to reduced sea ice cover that enhances surface evaporation in winter and cold-season precipitation falling as rain will likely become more common [Rennert et al., 2009; Bartsch et al., 2010]. Confident detection (and prediction) of ROS events and extreme cold season precipitation events is challenging. Information can be obtained from meteorological stations [Langlois et al, 2017], but the network is sparse, and the Arctic has a highly heterogeneous landscape and climate. Station coverage over the Arctic Ocean is especially meager, but events here may have important influences on sea ice thermodynamic processes and satellite detection of ice coverage.

Consistent detection of ROS and extreme cold season precipitation events all across the Arctic is needed. ROS detection from satellite microwave retrievals (both passive and active) shows considerable promise [Bartsch et al., 2010; Dolant et al., 2016, 2017; Langlois et al., 2017]. However, retrieval algorithms use threshold values that require tuning with respect to observations and are unlikely to hold everywhere as weather effects and snowpack properties influence the retrievals. Without other information, one cannot be confident that an event actually occurred, let alone whether it has significant ecologically and/or socio-economically impacts.

With projected increases in ROS and winter rainfall events, there is a need to advance collaborative research capacity at the local scale to document, understand and monitor such events. Different regions, communities, cultures, and wildlife will respond differently owing, in part, to differences in climate, land cover, subsistence systems, and adaptive capacities. As a starting point for understanding local knowledge, experiences, and responses to ROS and extreme precipitation events, we will work with subsistence hunters, Indigenous community members, and herders in Nunavut, Alaska, Russia, and Finland. Through our collaboration with them, and by facilitating collaboration between them, we will gather observations, knowledge, and information that will provide validation for science-based detection, exchange of knowledge, and better understanding of local knowledge of such events, insights into impacts and modes of response, and a means for comparisons across regions.

The project has six objectives:

1) Develop a database (period 1979-present) of the location, timing and intensity of ROS and extreme cold season precipitation events spanning the entire Arctic (land and ice-covered ocean).

2) Analyze this database to understand the preferred location and timing of ROS and extreme precipitation events, variability in ROS frequency and intensity, recent changes and their links with patterns of temperature and atmospheric circulation.

3) Assess through case studies how documented ROS or extreme precipitation events were forecasted at least 5-7 days out.

4) Assess likely future changes in ROS and extreme precipitation statistics.

5) Quantify the impacts of events on semi-domesticated reindeer, Arctic wildlife (caribou, polar bears and seals), and subsistence livelihoods across Arctic regions. This will be done through documenting local knowledge about ROS events, facilitating an exchange of knowledge between local experts and visiting project scientists, and co-producing expert systems models to evaluate how such events impact social-ecological systems in terms of timing, geographic scale, land cover, and existing human practices.

6) Develop an online Data and Knowledge Hub as a resource on the state of knowledge of Arctic ROS and extreme precipitation events and their impacts, also serving as a project website and the project's extension to the US Arctic Observing Network.

References

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Rennert, K.J., G. Roe, J. Putkonen, and C.M. Bitz, 2009: Soil thermal and ecological impacts of rain on snow events in the circumpolar Arctic, J. Climate, 22, 2302-2315.
Langlois, A., C.A. Johnson, B. Montpetit, et al., 2017: Detection of rain-in-snow (ROS) events and ice layer formation using passive microwave radiometery: A context of Peary Caribou habitat in the Canadian Arctic, Rem. Sens. Env., 189, 84-95.

Timeline

2019-09-15 - 2024-08-31

User relevant aspects

Knowledge exchanges between project scientists and Indigenous experts (especially reindeer herders and harvesters), and between Indigenous experts across the Arctic.

Regional emphasis

Northern hemisphere: Yes

Southern hemisphere: No

Key project deliverables

- Database (1979-present) of the location, timing and intensity of ROS and extreme cold season precipitation events spanning the entire Arctic (land and ice-covered ocean).
- Knowledge exchange visits between visiting scientists and Indigenous knowledge holders (reindeer herders, harvesters)
- Knowledge exchange between Indigenous experts from across the Arctic (Nunavut, Finland, Russia, Alaska)
- Online Data and Knowledge Hub related to ROS events and impacts

Data management

-National Snow and Ice Data Center (NSIDC), University of Colorado Boulder
-Exchange for Local Observations and Knowledge of the Arctic (ELOKA) (NSIDC)
Geophysical data will be made freely available. Access to and sharing of local and traditional knowledge is constrained because we are working with human subjects. We will work closely with project participants and community organizations to determine what information can be made available
to the public and where the information should best be archived (including locally). If communities are in agreement, a metadata inventory description will be provided to the ELOKA data management system based at NSIDC.

Is data provided to WMO Global Telecommunication System

No