FMI's 10th National Snow Seminar 2022
2 Feb 2022 on Zoom

Sessions and submitted abstracts

Available at : https://nordsnownet.fmi.fi/

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Together with the FMI Snow team: **twitter.com/FMI_Snow #Lumi2022**

In collaboration with the following projects:

- **IBA-Permafrost** IBA Project - Finnish Meteorological Institute (ilmatieteenlaitos.fi)
- **LAS3R (**LAS3R | National Land Survey of Finland (maanmittauslaitos.fi)**, and**
- **NordSnowNet (**Nordic Snow Network (fmi.fi)**)**

FMI | ARCTIC CENTRE University of Lapland | SYKE Finnish Environment Institute

Ministry for Foreign Affairs of Finland | NORD SNOW NET | LAS3R

Sessions

Session 1: Climate change and cryosphere

Chair: Outi Meinander (FMI) / Moderator: Ana Alvarez Piedehierro (FMI)

IPCC 2021 report, Prof. Petteri Uotila | University of Helsinki

Invited Keynote Talk

AMAP work on climate change in the Arctic, Dr. Heïdi Sevestre |AMAP, Norway

Invited Talk

Cross border impacts of climate change in the Arctic – interactions of physical change and policy response, Prof. Mikael Hilden | Finnish Environmental Institute

Invited Talk

Towards Harmonization in Snow and Its Applications, Ali Nadir Arslan | Arctic Space Centre, Finnish Meteorological Institute

Invited Talk

Arctic Centre and examples on collaboration, Johanna Ikävalko | Arctic Centre, Rovaniemi

Invited Talk

Gap analysis of the existing Arctic science co-operations, Hanna K. Lappalainen | University of Helsinki

Invited Talk

Session 2: Snow

Chair: Leena Leppänen (Arctic Centre) / moderator: Kati Anttila (SYKE)

Recent strengthening of snow and ice albedo feedback driven by Antarctic sea ice loss, Aku Riihelä | Finnish Meteorological Institute

Using state-of-the-art surface albedo data records and satellite-based radiative kernel data, we calculate and analyze the snow and ice albedo feedback (SIAF) resulting from gains and losses in Arctic and Antarctic snow and sea ice cover during 1982-2018. We highlight the radiative impact of losses in Arctic sea ice and the earlier spring snow melt across many parts of the Northern Hemisphere, but the most striking result in the study is the remarkable radiative impact of Antarctic sea ice losses in 2016-2017 (i.e. increase in SIAF), which reversed the cooling effect resulting from the prior decade and a half of Antarctic sea ice expansion. The results overall highlight the importance of Antarctic sea ice to the global cryospheric SIAF and serve as a reminder that enhanced attention to observations and modeling of the Antarctic cryosphere is certainly required and warranted in the future.

Evaluation of Northern Hemisphere snow water equivalent in CMIP6 models during 1982-2014, Kerttu Kouki | Finnish Meteorological Institute

Seasonal snow cover of the Northern Hemisphere (NH) is a major factor in the global climate system, which makes snow cover an important variable in climate models. Previously, substantial uncertainties have been reported in NH snow water equivalent (SWE) estimates. However, our knowledge of the NH SWE has recently improved considerably with new bias corrections which reduce the uncertainty of the SWE estimate integrated over NH significantly. In this study, we have evaluated NH SWE in CMIP6 (Coupled Model Intercomparison Project Phase 6) models with observation-based SWE reference data north of 40° N for the period 1982-2014 and analyzed with a regression approach whether model biases in temperature (T) and precipitation (P) could explain the model biases in SWE. We analyzed separately SWE in winter and SWE change rate in spring. For SWE reference data, we used bias-corrected SnowCCI data for non-mountainous regions and the mean of Brown, MERRA-2 and Crocus v7 datasets for the mountainous regions.

Snow barrels based on H SAF snow extent products, Niilo Siljamo | Finnish Meteorological Institute

H SAF provides several snow extent products. H31 (MSG/SEVIRI) and H32 (Metop/AVHRR) snow extent products are based on empirical approach and has been shown to provide reliable snow extent data. However, using traditional gridded satellite snow extent products in NWP is challenging. New innovative snow barrels are under development and testing at FMI.

Statistical differences of snowfall microphysics at GPM ground validation sites, Annakaisa von Lerber | Finnish Meteorological Institute

In-situ observations are used to construct radar retrievals by building a link between the microphysical properties of scattering particles with radar observables. The observations are also utilized to validate the performance and reliability of remote sensing measurements. While monitoring snowfall on a global scale, such as in Global Precipitation Measurement (GPM) mission, a question arises about the similarity of snowfall characteristics and utilized constraints of specific retrievals. We know from the Nakaya diagram that distinct ice particles are formed under certain temperature and humidity conditions. They grow through vapor deposition, and while falling, are reshaped by the microphysical processes, such as riming and aggregation, ending up to numerous different irregular shapes and sizes. However, certain processes seem to be more frequent in some parts of the world than in others and therefore, statistically, the snowfall characteristics are dependent on the location. Since 2014, as part of the GPM ground validation program, snowfall datasets with similar instrumentation have been gathered, which provides an opportunity to study above-mentioned differences using the same methodology. In this study, we show the differences in the measured Particle Size Distributions (PSDs) and retrieved masses of snow particles between three GPM ground validation sites: Hyytiälä (Finland), CARE (Canada), and Marquette (USA); and connect these findings through Z-S relations to weather radar observations.

The building blocks of snow – how can stable water isotope data from the snowpack advance snow science?, Pertti Ala-Aho | University of Oulu

Stable water isotopes (O18, H2) are increasingly used in many fields of earth science, such as hydrology, climatology, and glaciology to understand the storage, mixing and transport of water. So far the use of stable water isotopes in snow science has been limited. This presentation outlines the potential advances using stable water isotope techniques can bring to snow research. I argue that water and snowpack isotope composition has unused potential to understand the (1) origin of snow, (2) post-depositional processes in the snowpack and (3) hydrological importance of the seasonal snowpack. ORIGIN OF SNOW: the stable water isotope composition in precipitation imprints the environmental conditions of the source and transport history of water molecules in the atmosphere. The snowpack layers can provide a proxy record for the origin and transport of the seasonal snow. POST-DEPOSITIONAL PROCESSES: phase changes modify the isotope composition of water and snow. Processes such as snow sublimation, and soil water diffusion into the snowpack can be identified and better quantified using stable water isotopes data. HYDROLOGICAL IMPORTANCE: Snowmelt can be traced in the hydrological cycle, because the water isotope values in snow (and snowmelt) are typically different from other components of the hydrological cycle. Stable water isotopes can be used to assess the importance of snow in blue water (rivers, lake) and green water (soil water, vegetation water use) resources.

Living with benefits and risks related to climate change impact on skiing conditions in Finland, Hilppa Gregow | Finnish Meteorological Institute

Climate change is impacting Finland foremost in winter but differently depending on the region in question. This is known very well by the snow technicians and sports centers who deal with snow making for skiing. The meteorological investigations show that the temperature has risen approximately 2-3 degrees as regards winters during the last 50 years. Likewise precipitation amounts have increased, as regards the winter, but this has occurred more and more in liquid form in the south. When comparing the four consecutive 30-year reference periods 1991-2020, 1981-2010, 1971-2000 and 1961-1990 there is a clear change (in percentages) especially in December and February precipitation amounts. In the future this change is advancing even faster and it is expected that the winter skiing culture may change dramatically in cities in southern and western Finland. To avoid such a change in the next 10-20 years from now, new ways to adapt to the already highly varying snow conditions are critically needed. One way is to advance decision making by relying on short and subseasonal forecasts more than before and acting even when only a minor chance to provide skiing possibilities exist. To also help the citizens to act and be aware, also communication and informing of the possibilities must be improved.

SnowAPP project: overview of the results and ongoing research, Roberta Pirazzini and Petri Räisänen | Finnish Meteorological Institute

The overarching objective of the Academy of Finland project “Modelling of the Snow microphysical-radiative interaction and its APPlications” (SnowAPP) is to develop a model frame with a unified treatment of the snow microphysics in the optical and microwave wavelength regions. To reach this objective, three field campaigns were carried out in Sodankylä in springs 2019, 2020, and 2021, each campaign lasting for about one month during the transition from dry snow to melting snow. Detailed observations of snow microstructure and layering were collocated and simultaneous with measurements of albedo and microwave brightness temperature carried out with automatic and experimental devices that provided high temporal and spectral resolution. We focused on the upper 20 cm of the snowpack, which dominates the signal measured in the optical and short microwave (89-150 GHz) wavelength regions. We present here the first results of the analysis of this unique and comprehensive dataset, including the development of a method to retrieve snow bidirectional-reflectance-factor from nadir time-lapse photos, ongoing research on the comparison of different methods to retrieve the snow microstructure, and on the developed system to automatically measure the spectral albedo in the entire solar spectrum. Model-to-measurement comparisons both for the optical and microwave regions are presented.

SIMBA - Snow & Ice Measuring Technology, Grant Phillips and Phillip Thompson | SAMS Enterprise

SAMS Enterprise manufacture novel autonomous devices that provide reliable measurement of snow and ice structure. These devices from SAMS Enterprise allow monitoring of ice or snow thickness, movement and temperature profiles, whilst resolving any air, ice or water interfaces. Originally designed for monitoring Polar sea-ice, SIMBA (Snow Ice Mass Balance Array) units comprise an autonomous platform and a chain of digital temperature chip sensors. The devices capture unique data that are not available through Satellite or other means. A standard SIMBA chain is capable of providing a temperature profile across 4.8m of length, with temperature readings made every 2cm accurate to +/- 0.0625°C. The units also incorporate data telemetry (via Iridium SBD), have in-built GPS for tracking sea-ice movement, a magnetometer for tilt and floe rotation, and a barometer for surface air pressure. When it comes to remote snowpack monitoring, depth and composition data can be easily accessed via the web interface. This technology has proved valuable to not only artic research but also has adaptions specifically to measure terrestrial snow in the fields of avalanche and flood prevention forecasting.

Snow conditions in northern Europe: the dynamics of interannual variability versus projected long-term change, Jouni Räisänen | University of Helsinki

Simulations by the EURO-CORDEX regional climate models indicate a widespread future decrease in snow water equivalent (SWE) in northern Europe. This concurs with the negative interannual correlation between SWE and winter temperature in the southern parts of the domain, but not with the positive correlation observed further north and over the Scandinavian mountains. To better understand these similarities and differences, interannual variations and projected future changes in SWE are attributed to anomalies / changes in three factors: total precipitation, the snowfall fraction of precipitation, and the fraction of accumulated snowfall that remains on ground (snow-on-ground fraction). In areas with relatively mild winter climate, the latter two terms govern both the long-term change and interannual variability, resulting in less snow with higher temperatures. In colder areas, however, interannual SWE variability is dominated by variations in total precipitation. Since total precipitation is positively correlated with temperature, more snow tends to accumulate in milder winters. Still, even in these areas, SWE is projected to decrease in the future due to reduced snowfall and snow-on-ground fractions in response to higher temperatures. Although winter total precipitation is projected to increase, its increase is smaller than would be expected from the interannual co-variation of temperature and precipitation, and therefore insufficient to compensate the lower snowfall and snow-on-ground fractions.

Session 3: Citizen Science

Chairs and moderators: Outi Meinander (FMI), Ana Alvarez Piedehierro (FMI), Leena Leppänen (Arctic Centre), and Kati Anttila (SYKE).

Organizing and facilitating crowdsourcing for satellite EO and in situ on snow and ice in catchment areas, Timo Pyhälahti | Finnish Environment Institute

Crowdsourcing in situ observations has great potential for gathering match-up data with satellite Earth observation (EO) data acquisition, not only for training AI or other EO data interpretation methods but also for complementing and verifying available data for operative decisions on flood combatting, ice break-up monitoring, hydrological drainage basing management or gathering datasets for environmental modeling. SYKE has implemented the CitobsDB open data and Open311 API system, which is available for co-operation with stakeholder mobile and web applications to organize these data collection activities. During on-going FPCUP EO-Crowd project activity, new approaches for crowdsourcing enabling services with Finnish and Estonian stakeholders are being tested with SYKE.FI/TARKKA, to interconnect in situ activities to EO data acquisition, potentially combining even definition of ICEYE SAR acquisition definitions to these activities. The key concepts include HISP, highlighting phenomena of interest in the EO data for other systems, and CSEPIN, crowdsourcing service of phenomena of interest as a pre-defined method for reacting to HISP notifications according to the defined monitoring interest calculations. In Arctic Passion, winter monitoring (Talviseuranta) is extended with these activities, including in situ crowdsourced activities on snowpack properties: Intended new datasets would include potential effects on liquid precipitation and freezing of the upper surfaces of the snowpack, which could assist in interpreting SAR images, when requested at same time as the SAR instrument overpass by using the HISP/CSEPIN technology developed in EO-Crowd.

Snow pits by citizens -ideas, plans and ways forward, Sirpa Rasmus and Leena Leppänen | Arctic Centre, Rovaniemi

Information on snow layers and snow water equivalent is needed for purposes of improving interpretation of remote sensing observations and snow model evaluations, for example. Required snow layer information includes especially the number and height of ice layers. However, currently available data is limited both spatially and temporally. CHARTER project has developed a protocol for citizens to make snow measurements to support researchers. The protocol is simplified from international standards and doable with simple equipment. It includes description of surroundings, snow depth measurements and definition of ice layers. In addition, optional is to define properties of all snow layers and measure snow water equivalent. The protocol was tested by few collaborators, but it seems to be too difficult without previous snow measurement experience. Currently, even simpler measurement protocol is under development for use of general public. Simplicity, data reliability and data coverage will be addressed in the process. In the future, collaboration with LUMA Centre and schools will be strengthened, and Arktikum Science Centre in Rovaniemi will have few snow measurement kits to be borrowed. Final form of the protocol will be adjusted depending on the used platform.

Saharan dust in Finland, Outi Meinander et al. | Finnish Meteorological Institute

Saharan dust was transported and deposited in the southern part of Finland on 23 Feb 2021. At the time, the whole country was covered with snow, and therefore the dust deposition was more easily detectable. The deposition was accompanied by freezing rain in the most southern part of the country, and snowfall further north. Here an overview of our investigations on Saharan dust in Finland is given. Our work includes a strong citizen science contribution. Acknowledgements: Academy of Finland Flagship funding (grant no. 337552).

Saharan dust on Helsinki sea ice - a NWP viewpoint, Laura Rontu | Finnish Meteorological Institute

In February 2021, during the school winter holidays, a dust greeting from Sahara arrived to Helsinki sea ice. The event can be studied with the help of Copernicus Atmosphere Monitoring Service aerosol data, that is coupled to Harmonie-AROME weather model simulations. Results of weather model experiments are shown to discuss the cloud-aerosol-radiation processes involved. Single-column model studies used to estimate the impacts, sensitivities and uncertainties.

We warmly thank all the speakers and participants of the event!

FMi’s 10th National Snow Seminar 2022 Organizing Team

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