norden

Top-level Research Initiative

SVALI

The Nordic Centre of Excellence SVALI
Stability and Variations of Arctic Land Ice

Background

Nordic glaciers are a natural laboratory for studying the response of the Earth's cryosphere to climate change. Downwasting of glaciers has accelerated globally in the last century and glaciers, other than the large polar ice sheets, have been an important cause of global sea-level rise. Rapid and accelerating changes near the margins of the large polar ice sheets in Antarctica and Greenland have recently been observed; these indicate a doubling of the rate of ice loss from Greenland since 2009, and the rate of ice loss from West Antarctica (including the Antarctic peninsula) appears to have tripled in less than a decade. This implies that the sea-level rise contribution of the large ice sheets may now be larger than that of the smaller glaciers and ice caps. Uncertainty regarding the future development of ice loss from the large ice sheets is currently the largest uncertainty about the magnitude of sea-level rise to the end of this century.

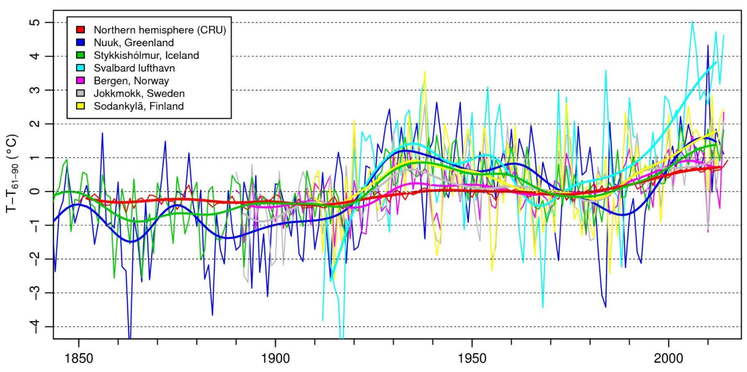

Fig. 1. Mean annual temperature deviation from the 1961–1990 average as well as a 10-year running average for six weather stations in the Nordic countries together with an estimate of the mean annual temperature of the Northern Hemisphere (Jones et al. 2012). (Data sources: Nuuk: Vinther et al., 2006 and the Danish Meteorological Institute; Stykkishólmur: the Icelandic Meteorological Office; Bergen, Svalbard airport: the Norwegian Meteorological Institute (eklima.no); Jokkmokk, Sodankylä: the U.K. Met. Office, the Swedish Meteorological and Hydrological Institute).

Fig. 2. Glaciers are sensitive indicators of variations in climate and bear witness to many large and small past climate oscillations. Glacier terminus moraines extending across a lake south of Langjökull ice cap in W-Iceland bear witness to the maximum extent of the ice cap at the culmination of the Little Ice Age near the end of the 19th century when temperatures in Iceland were more than 2° C colder than now. Photograph: Oddur Sigurðsson.

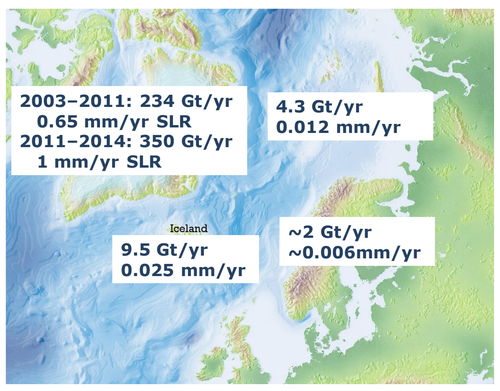

Fig. 3. Observations of the rate of net loss of ice and the corresponding contribution to global sea-level rise, given as mean yearly values for glaciers around the North-Atlantic. The contribution from Greenland for 2003–2011 is from Barletta et al. (2012), and for 2011–2014 from Helm et al. (2014). The other contributions are from Andersen (2012).

Organization of the Centre of Excellence

SVALI (2010–2016) is a Nordic Centre of Excellence based on three pillars

1. Science – cooperation between 19 Nordic universities and research institutes
2. Education – Nordic Graduate School in Glaciology and Cryosphere Science
3. Outreach

Science Themes

The research activity is organized within three main themes with three work packages each.

1. **Observing the present – baseline and changes**
   - Ice volume / mass changes
   - Changes in ice dynamics
   - Surface mass balance
2. **Understanding the physical processes**
   - Hydrology/subglacial processes
   - Calving
   - Surface/atmosphere interactions
3. **Understanding present changes and predicting the future**
   - Several different modelling approaches
   - Earth Systems Models
   - Future changes

The future of SVALI

1. SVALI will be continued as a formal network of Nordic institutes involved with cryosphere research and monitoring
2. The network will strengthen the international role of Nordic research in glaciology
3. The Nordic Graduate School in Glaciology will be continued as a joint PhD program of the participating universities
4. The outreach ice-school will be maintained

Two case studies

Simulated runoff changes, Norway

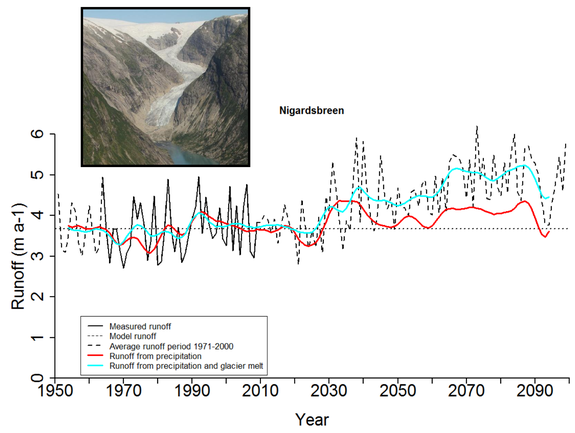

Fig. 4. Increased meltwater runoff from glaciers changes the hydrology of glacier rivers with consequences for the design and operation of hydropower plants and other infrastructure in adjacent watersheds. Simulation of mass balance, glacier dynamics and runoff from the Nigardsbreen outlet glacier in S-Norway with a Glacio-Hydrogical model (the HBV model coupled to a glacier retreat model) shows that the area of the glacier will be reduced by 70% in 2100 and runoff from the currently ice-covered area will increase by approximately 25%. The model is forced with downscaled temperature and precipitation fields from a global climate simulation (ECHAM5, A1B). From Melvold et al. (NVE).

Remote sensing of Greenland ice loss

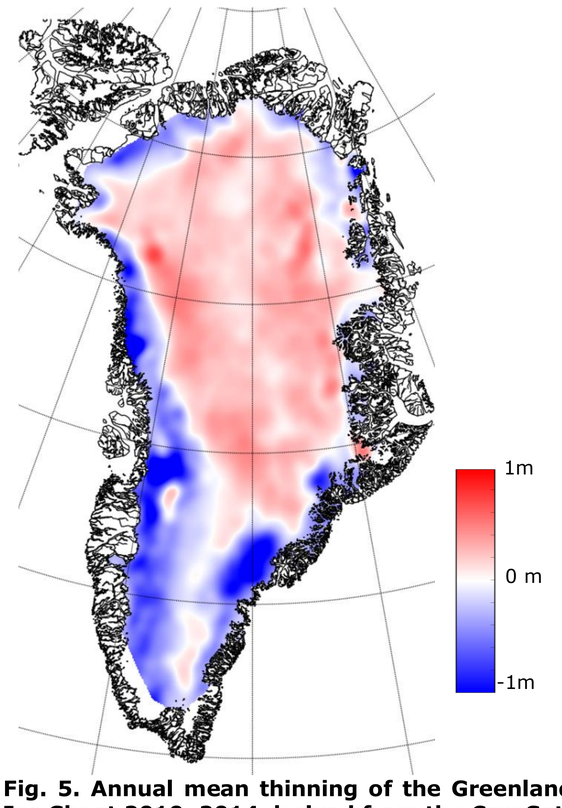

Fig. 5. Annual mean thinning of the Greenland Ice Sheet 2010–2014 derived from the CryoSat-2 ESA satellite with a novel processing method developed within SVALI. The corresponding rate of sea-level rise is estimated as 0.66 mm SLR/yr for this period. From Nilsson (2015).

Process studies: surges and jökulhlaups

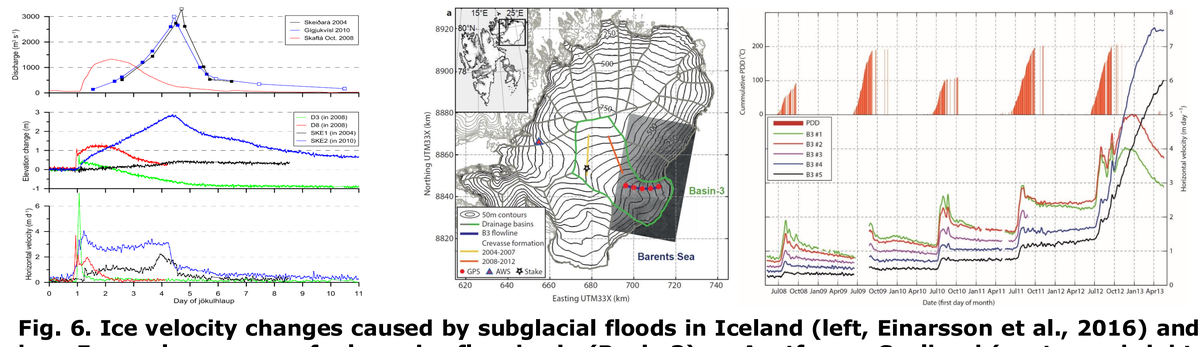

Fig. 6. Ice velocity changes caused by subglacial floods in Iceland (left, Einarsson et al., 2016) and by a 5-year long surge of a large ice flow basin (Basin 3) on Austfonna, Svalbard (center and right, Dunse et al., 2015), show the importance of subglacial water on ice movement. Summer melt during the surge on Svalbard drives repeated glacier speed-up cycles.

Outreach to schools

Fig. 7. The ice-school (*www.isskolen.dk/wp*) is an e-learning tool for pupils in schools, available in all the Nordic languages, incl. Greenlandic, plus English, German and French. It provides an introduction to glaciology focusing on glaciers in the SVALI countries, interactive quiz-based learning, and an opportunity to "meet" SVALI PhD students and learn about their research.

More information: www.ncoe-svali.org

Acknowledgments

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