



norden

Top-level Research Initiative



Monitoring the Accelerating Mass Loss of Arctic Glaciers

Stability and Variations of Arctic Land Ice (SVALI)
Nordic Center of Excellence

Top-level Research Initiative:
Interaction between Climate Change and the Cryosphere

18 Nordic partners, 2011–2016

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Icelandic Meteorological Office, Iceland

www.ncoe-svali.org



SVALI focuses on the area around the North Atlantic Greenland, Iceland, Scandinavia, Svalbard



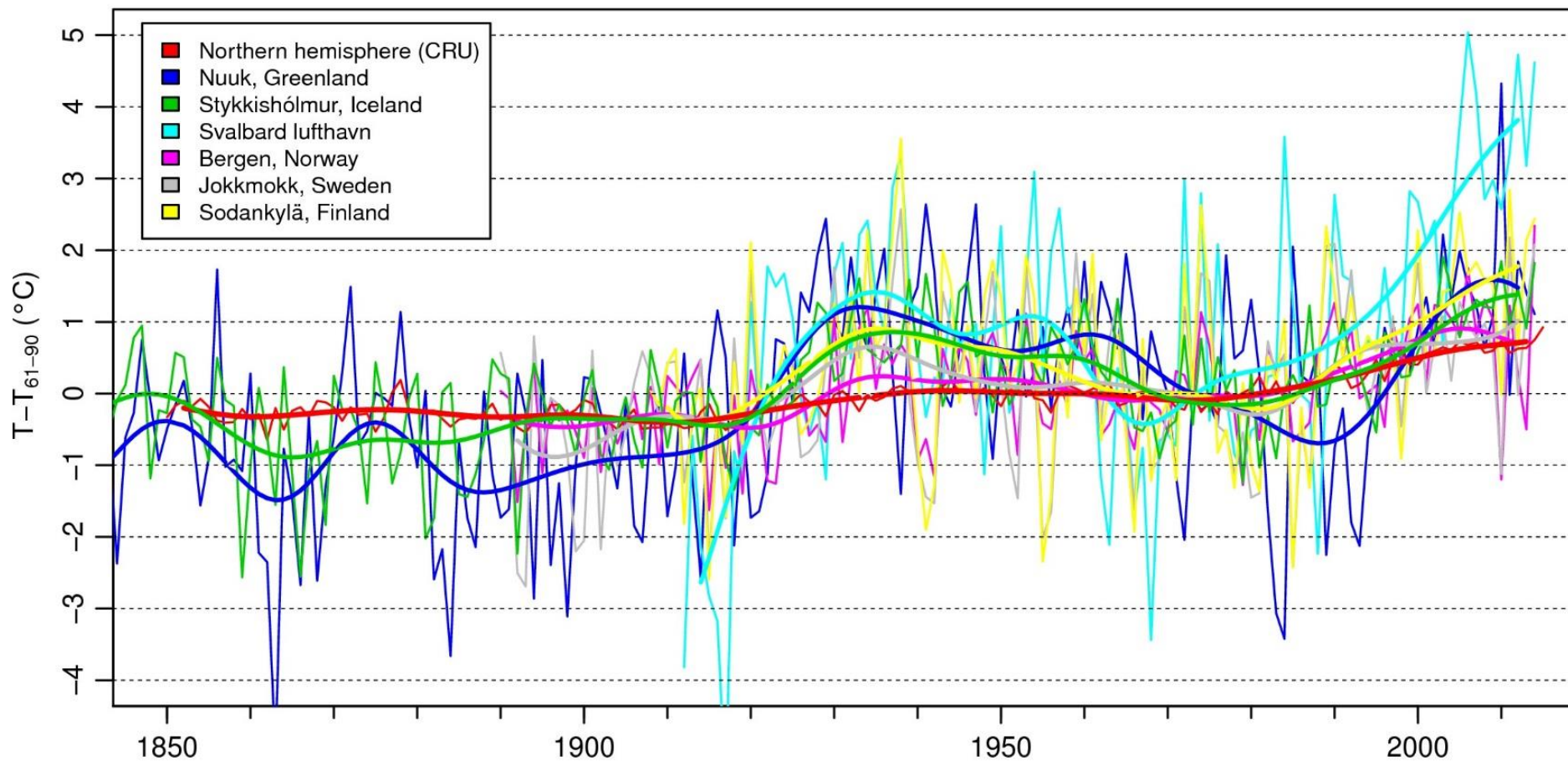


Glaciers in the Nordic countries

- Range in size from **small mountain glaciers**, through the **intermediate-size ice caps of Svalbard and Iceland** to the **Greenland Ice Sheet**, the second largest body of ice on Earth
- Many are easily accessible for studying processes that are important for the global response of the cryosphere to climate changes
- **Large settled areas in the Nordic countries are affected by climate-change induced variations in glaciers**



The climate in the Nordic area is characterized by large variations in temperature





Glaciers are sensitive indicators of variations in climate



Langjökull, W-Iceland
Photo: O. Sigurðsson



SVALI is based on three pillars

1. Science – cooperation between 19 Nordic universities and research institutes
2. Education – PhD school
3. Outreach





Science Themes

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

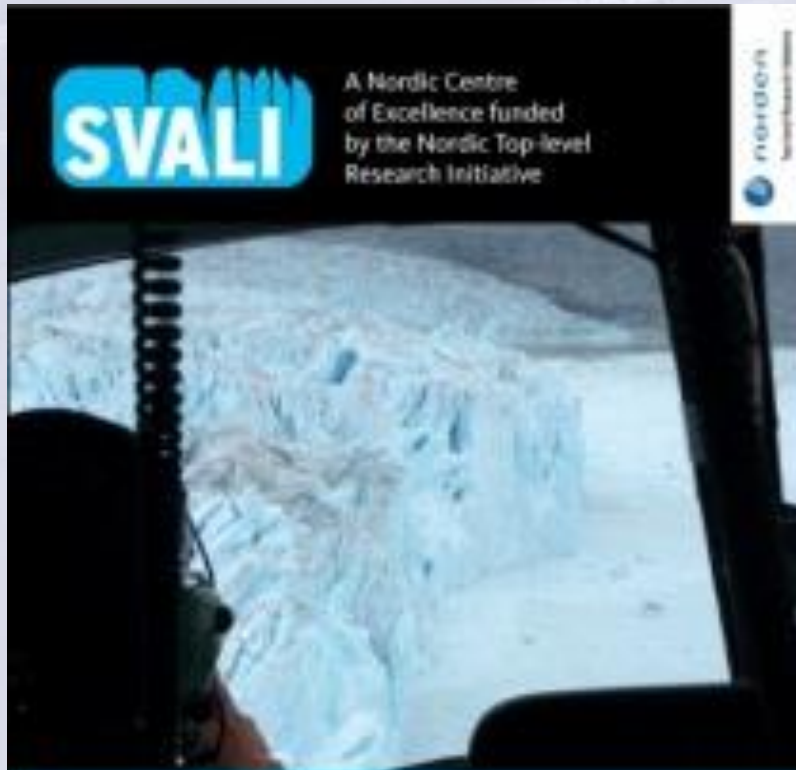
3. Understanding present changes and predicting the future

- Several different modelling approaches
- Earth Systems Models
- Future changes

SVALI Interim reports



A Nordic Centre of Excellence funded by the Nordic Top-level Research Initiative



Interim report of current rates of changes of land ice in the Arctic/N-Atlantic region

Stability and Variations of Arctic Land Ice

2012



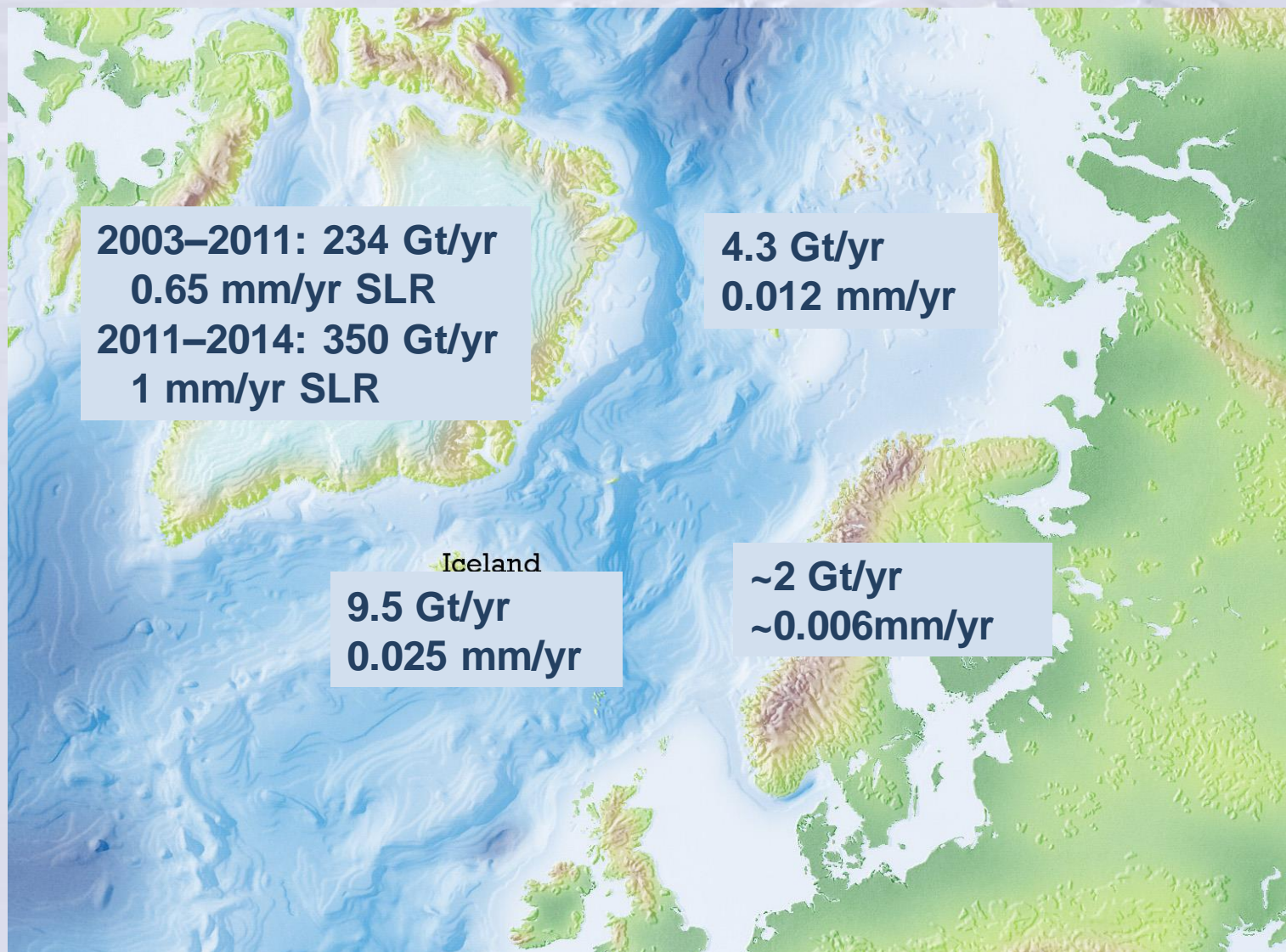
Interim report of dynamic changes of land ice in the Arctic and North-Atlantic region

Stability and Variations of Arctic Land Ice

2014



Rate of ice loss after 2000





Ice volume/mass changes:
Development of improved
algorithms for processing of
satellite remote sensing data

Greenland Ice Sheet 2010–2014

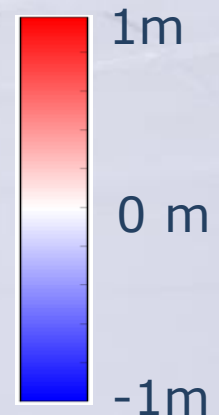
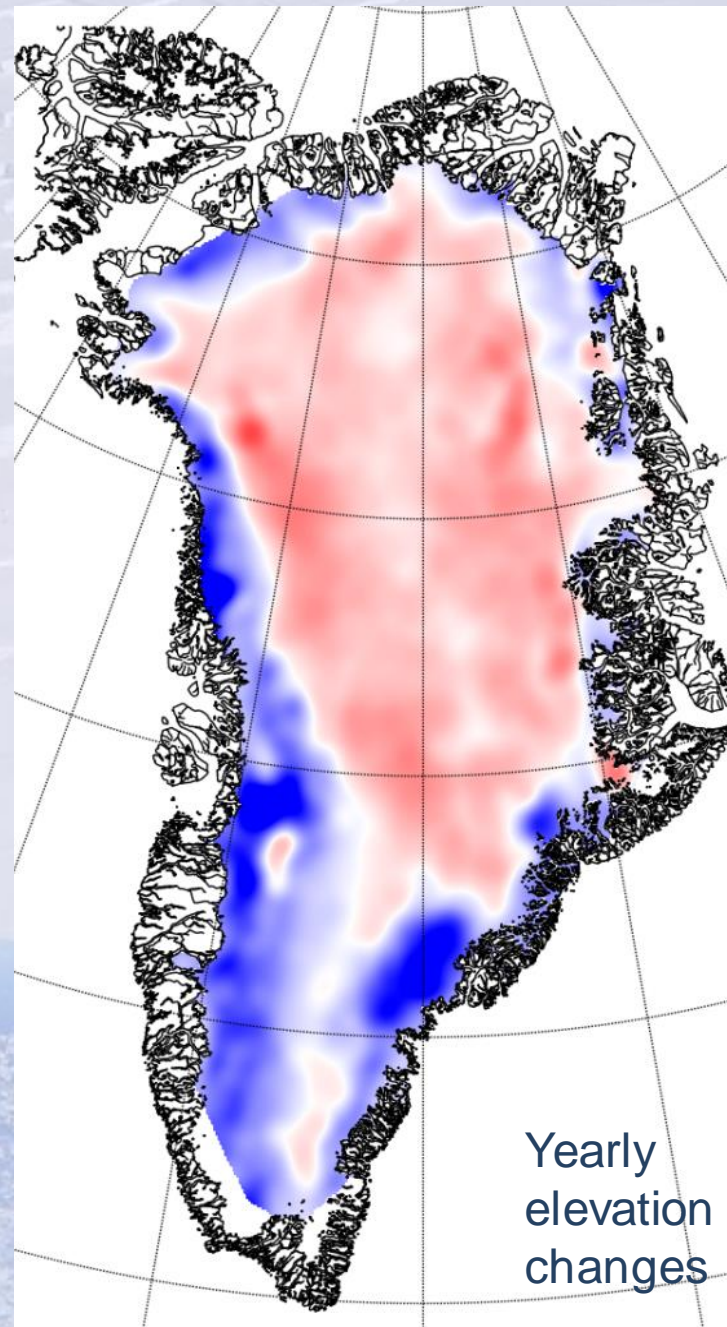
CryoSat-2 dH/dt

$$\delta V = \int_A \delta h / \delta t$$

$$\Delta M = \partial V / \partial t * \rho$$

$$\Delta M = -240 \pm 28 \text{ Gt/yr}$$

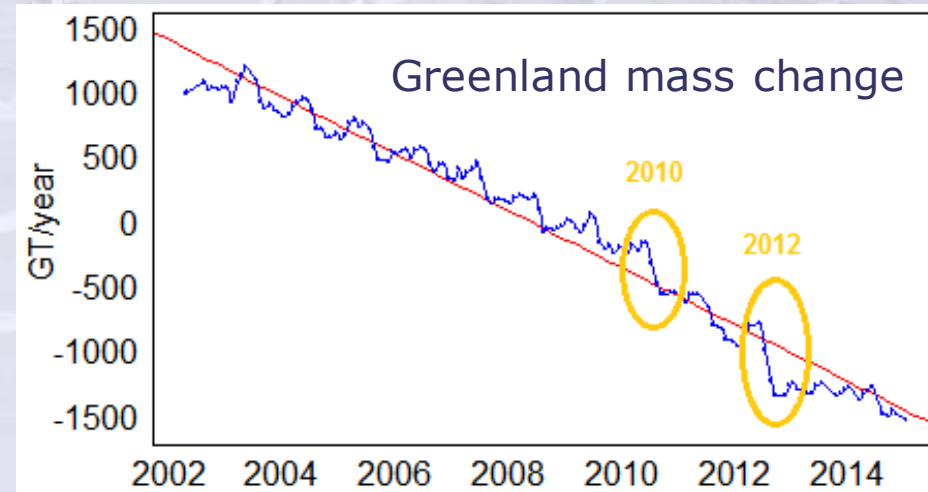
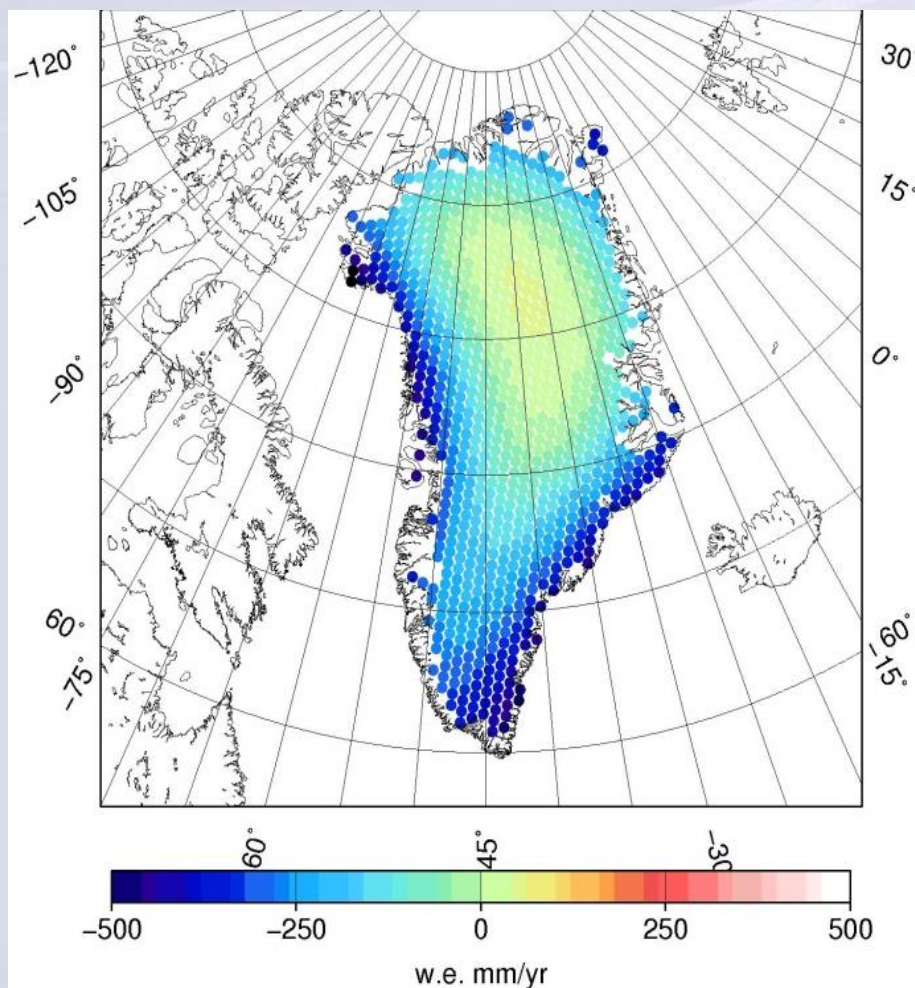
or 0,66 mm SLR/yr



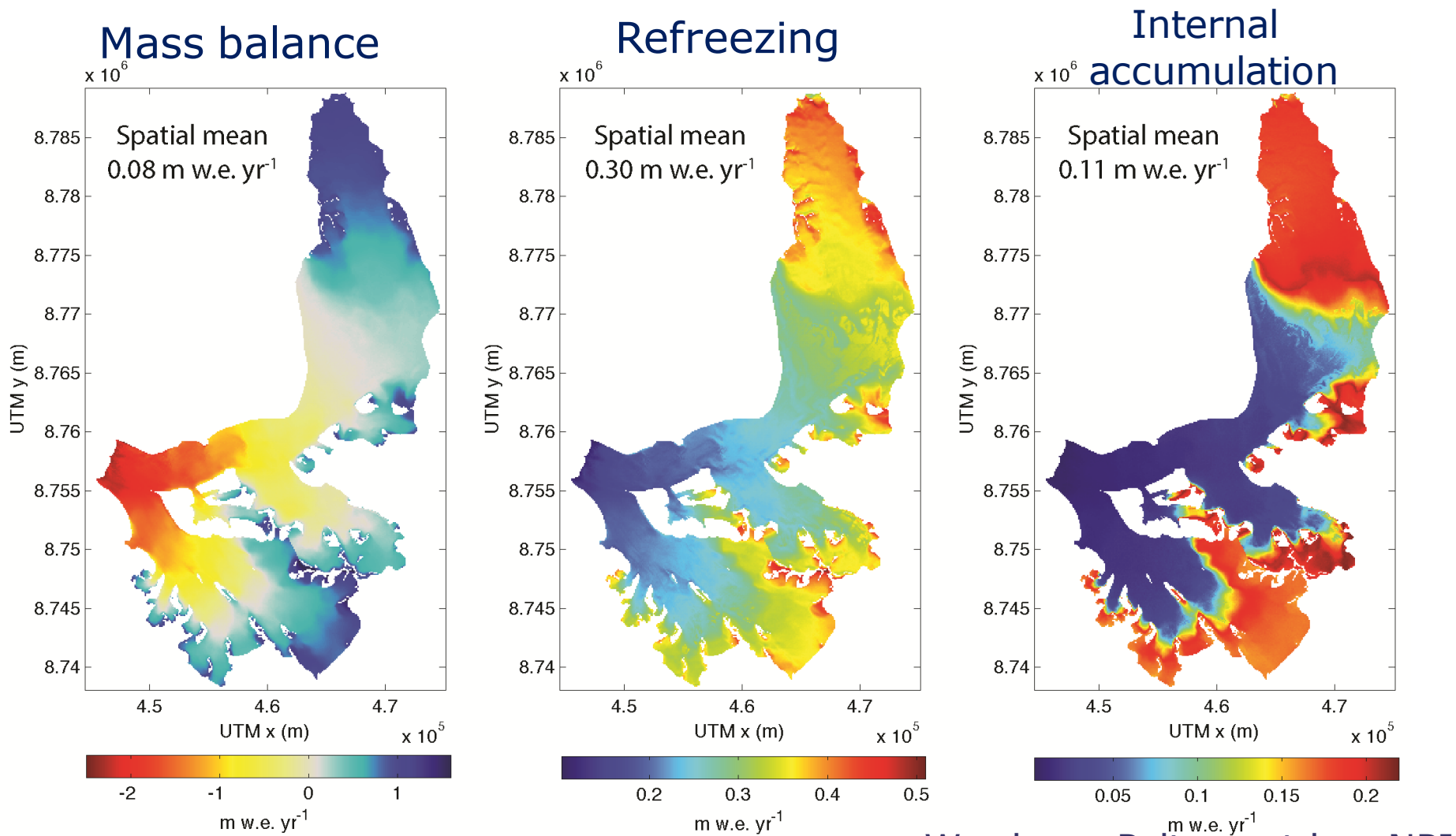
Yearly
elevation
changes



Ice mass changes: Direct measurement by the GRACE satellite mission (DTU Space)



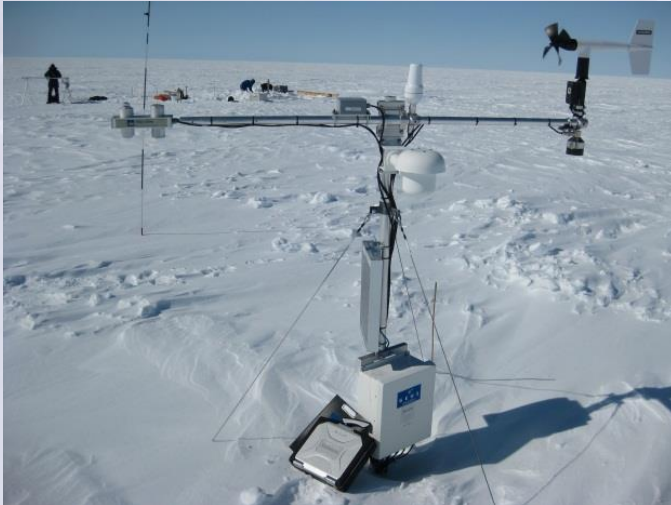
Study of mass balance components Svalbard, Kongsbreen 1961–2012 mean



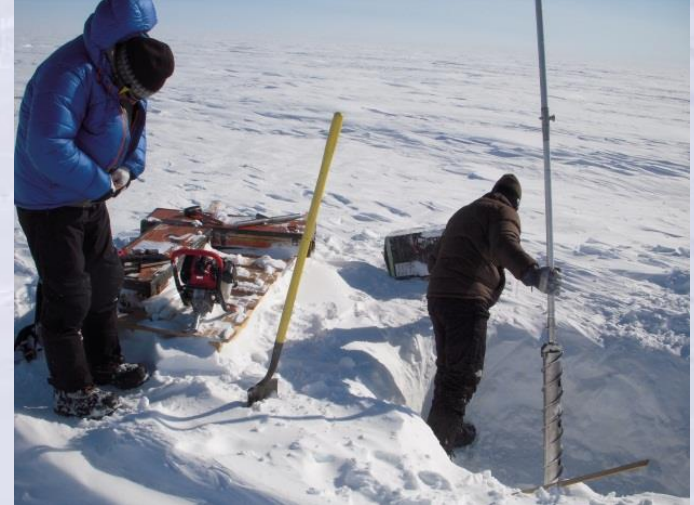


SPLAZ – SVALI field campaign

Automatic weather station for melt modelling



Firn cores for density profiles



Snow pits for accumulation



Firn core for studying refreezing

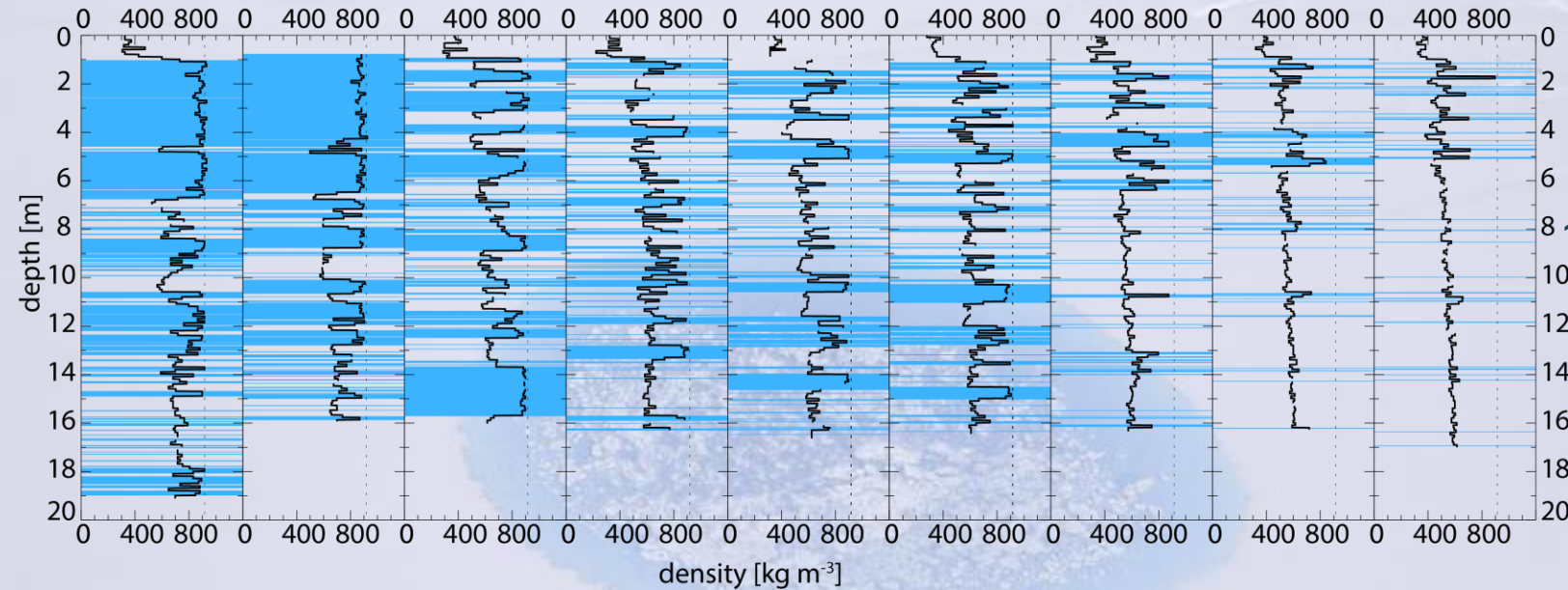


Melt water retention on the Greenland ice sheet

- Retention in firn limits runoff and is one of the least understood components of surface mass balance
- Impermeable layers / deep percolation / shallow percolation

1 **2** **3**

1848 m 1845 m 1954 m 2060 m 2113 m 2124 m 2146 m 2263 m 2361 m



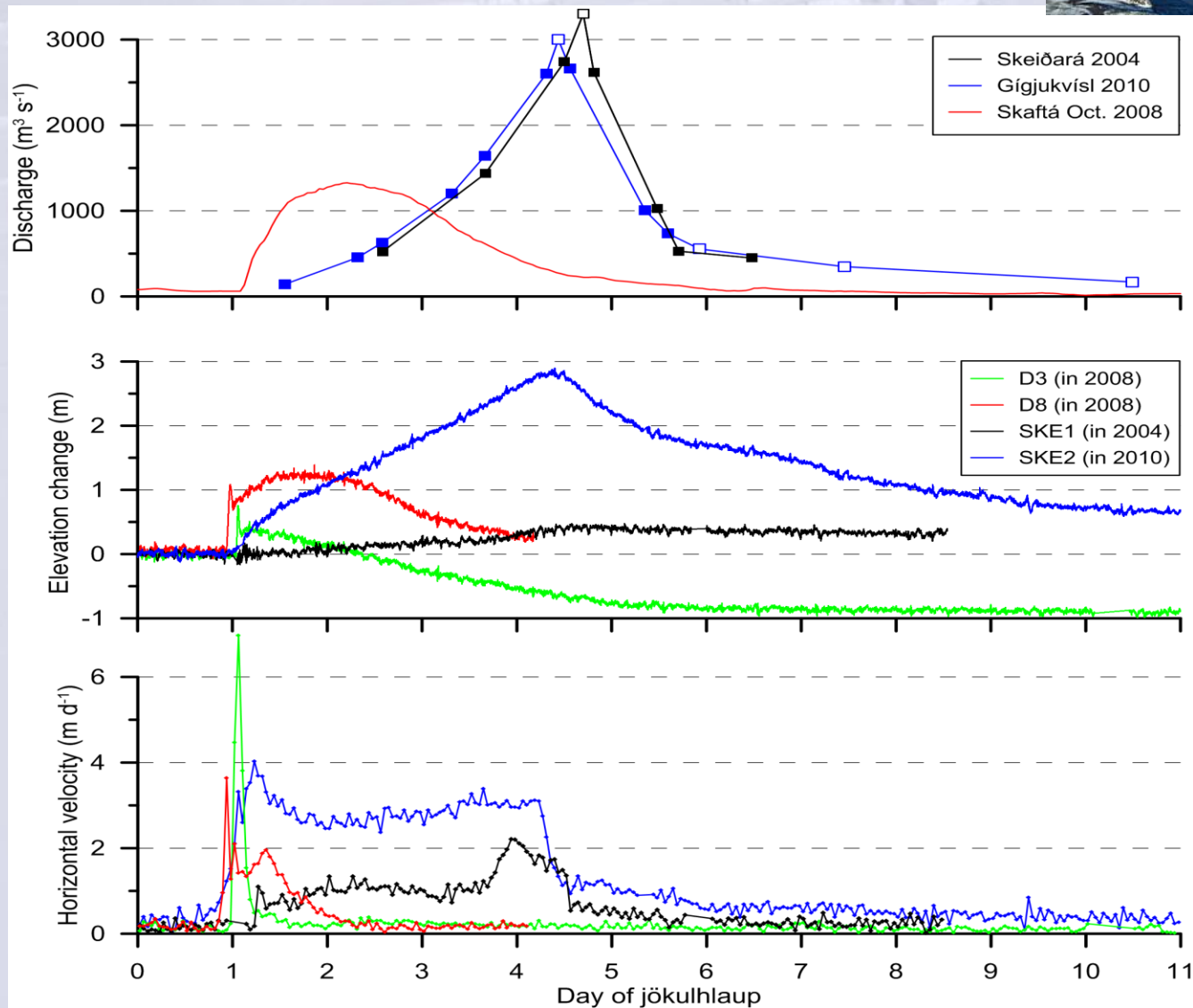
Traverses
2012, 2013

1850 m a.s.l.

2350 m a.s.l.



Effect of jökulhlaups in Iceland on glacier motion measured with GPS



From B. Einarson, IMO, and E. Magnússon, UI



Model improvements

Improve the underlying physical processes

DMI, ARTEK, GEUS, UU, FMI, UH, UL, UI

- **Albedo**

- Sensitivity tests and updates
- Implementation of updated albedo scheme in HIRHAM5
- Snow albedo study in WRF.

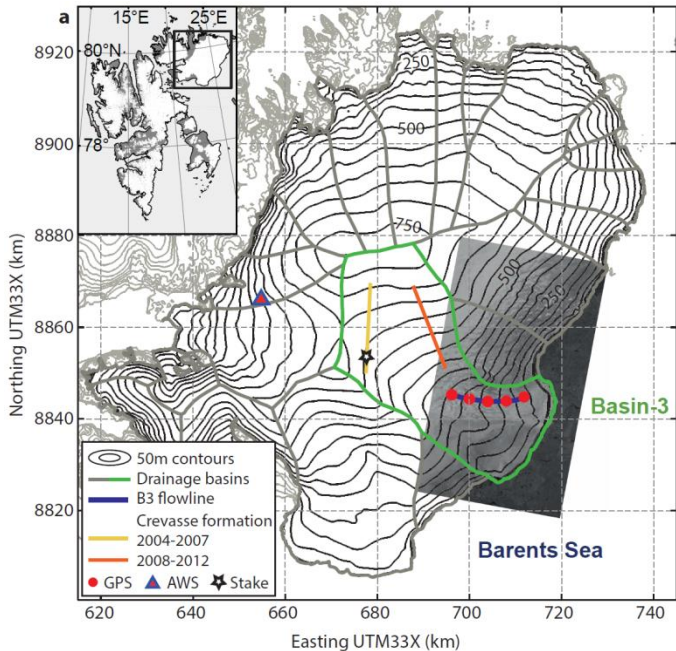
- **Water retention**

- Implement results from measurements
- Implementation and testing of retention and refreezing in HIRHAM5
- Evaluation of refreezing parameterization in RCMs.

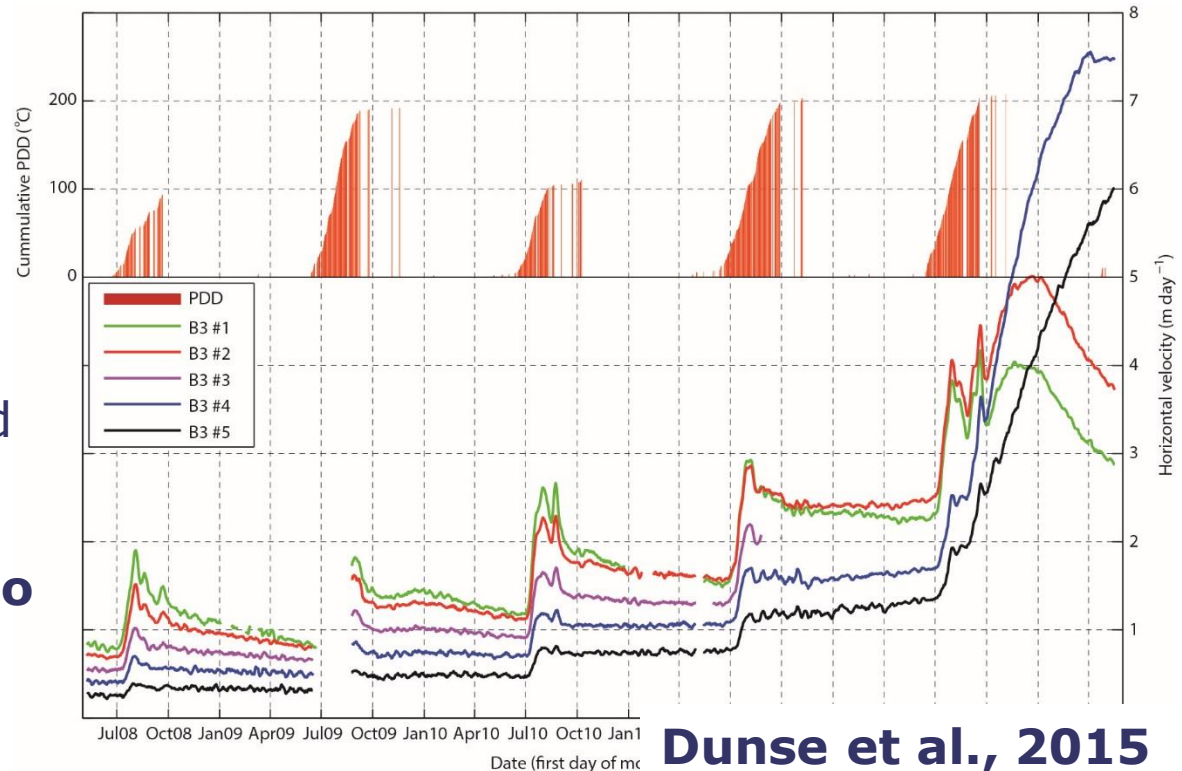
- **Model comparisons**

- HIRHAM5 Regional Climate Modelling (P-T): Greenl. and Svalb.at 5km
- HIRHAM model, ESM EC-Earth, RACMO model at IMAU (Netherlands)

Understanding dynamics is crucial to constrain uncertainties in projections



- Surge initiation of Basin-3, Austfonna, observed by GPS (and satellite radar)
 - annual summer melt drives multi-annual stepwise acceleration



Dunse et al., 2015

Meltwater effects not limited to hydraulic lubrication

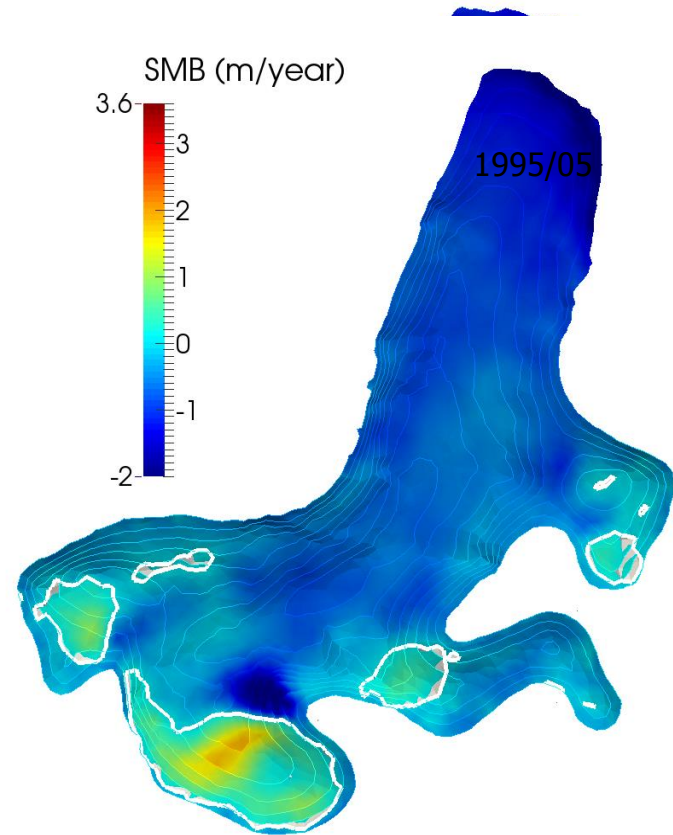
➤ **cryo-hydrologic warming contributes to thermal regulation of Basin-3 surge**

Midtre Lovénbreen, Svalbard



- Elmer/Ice full Stokes prognostic simulation (Zwinger & Moore, 2009)
 - Starting from 1977 DEM + 53 years
 - Conservative SMB forcing: averaged stake measurements 1968 – 2002 (Kohl et al. 2002)
 - Temperature field 1977 steady state conditions (Wadham & Nuttall, 2002)
 - Accounting for refreezing using a P_{\max} model (Wright et al., 2007)
- Current investigation (I. Välisuo, FMI):
 - diagnostic simulations using average of DEM's to obtain $\frac{\partial h}{\partial t}$, h , $\frac{\partial h}{\partial x}$, $\frac{\partial h}{\partial y}$, (u, v, w)
 - Inversely obtaining SMB

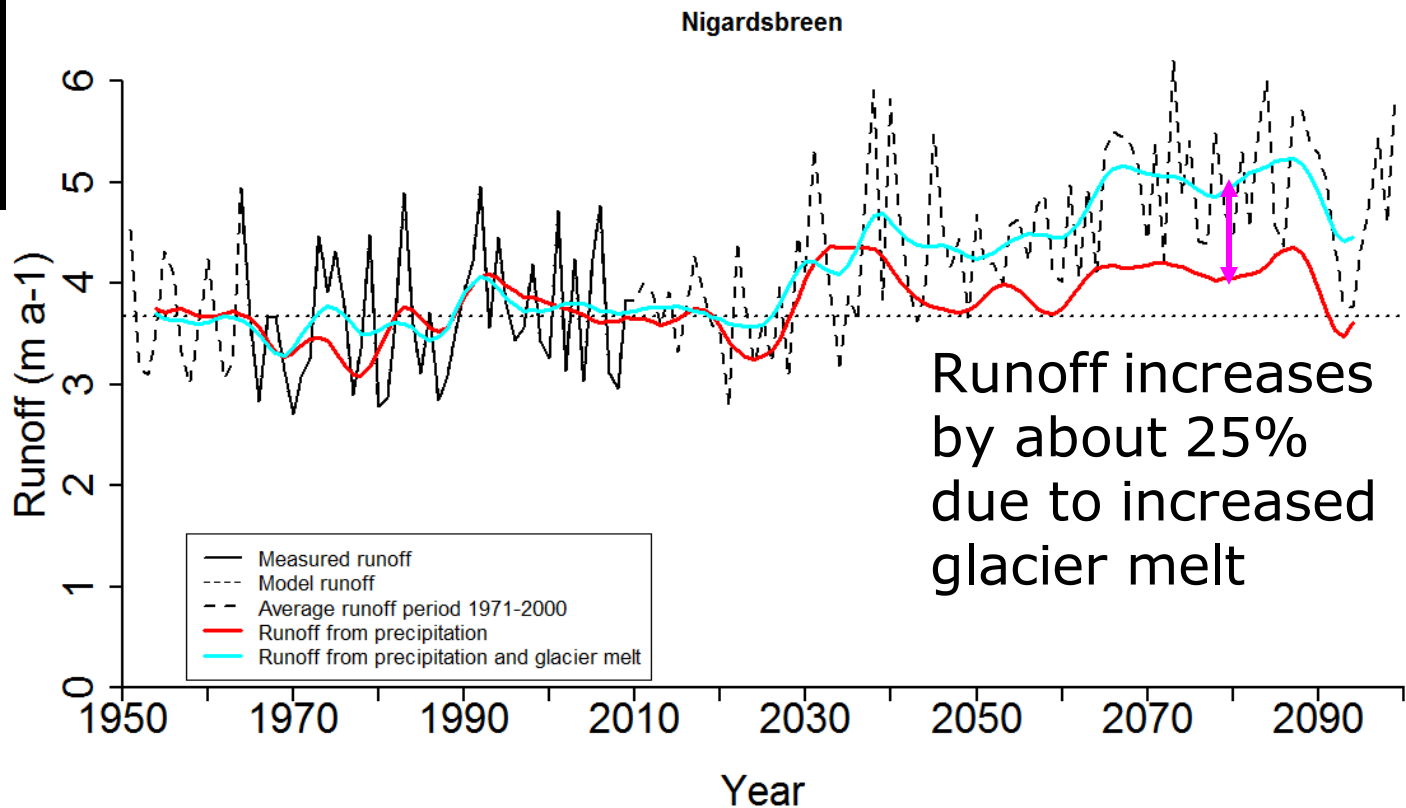
$$\text{SMB} = \left(\frac{\partial h}{\partial t} + u \frac{\partial h}{\partial x} + v \frac{\partial h}{\partial y} - w \right)$$



Runoff changes for Nigardsbreen, Norway



In 2100 glacier area is reduced by 70%

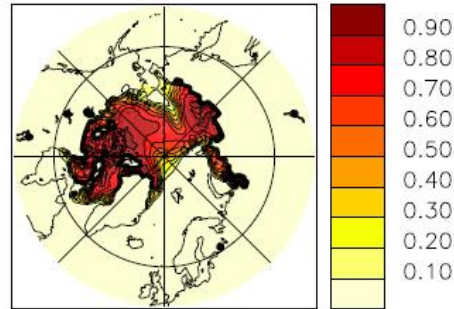


Important to include a dynamic ice sheet in Earth System Models



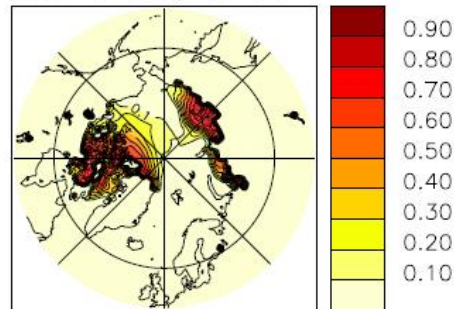
EC-EARTH – PISM

4xCO2A Coupled SIC 03



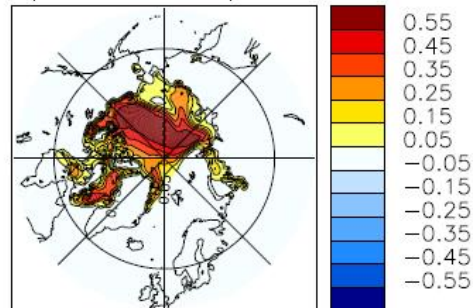
EC-EARTH

4xCO2A Uncoupled SIC 03

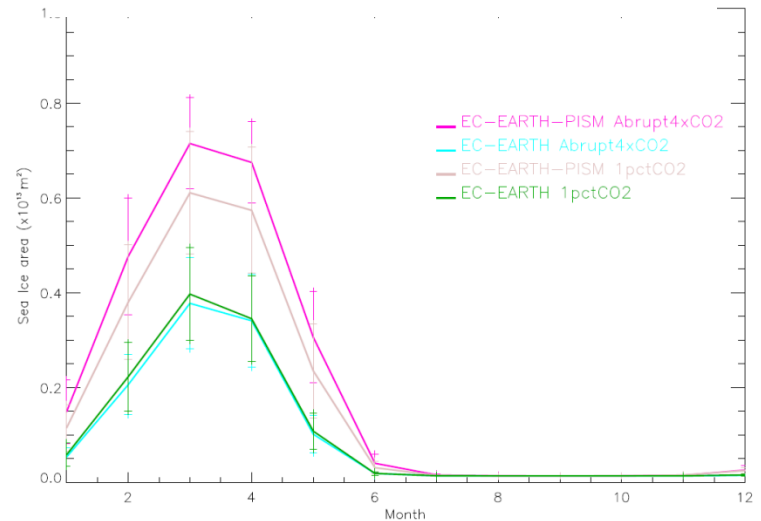


EC-EARTH – PISM
minus
EC-EARTH

Coupled – Uncoupled 03

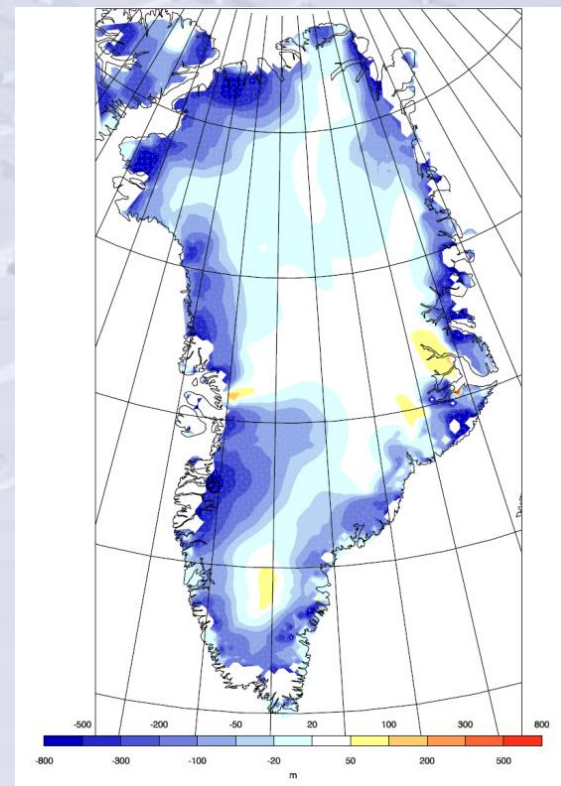
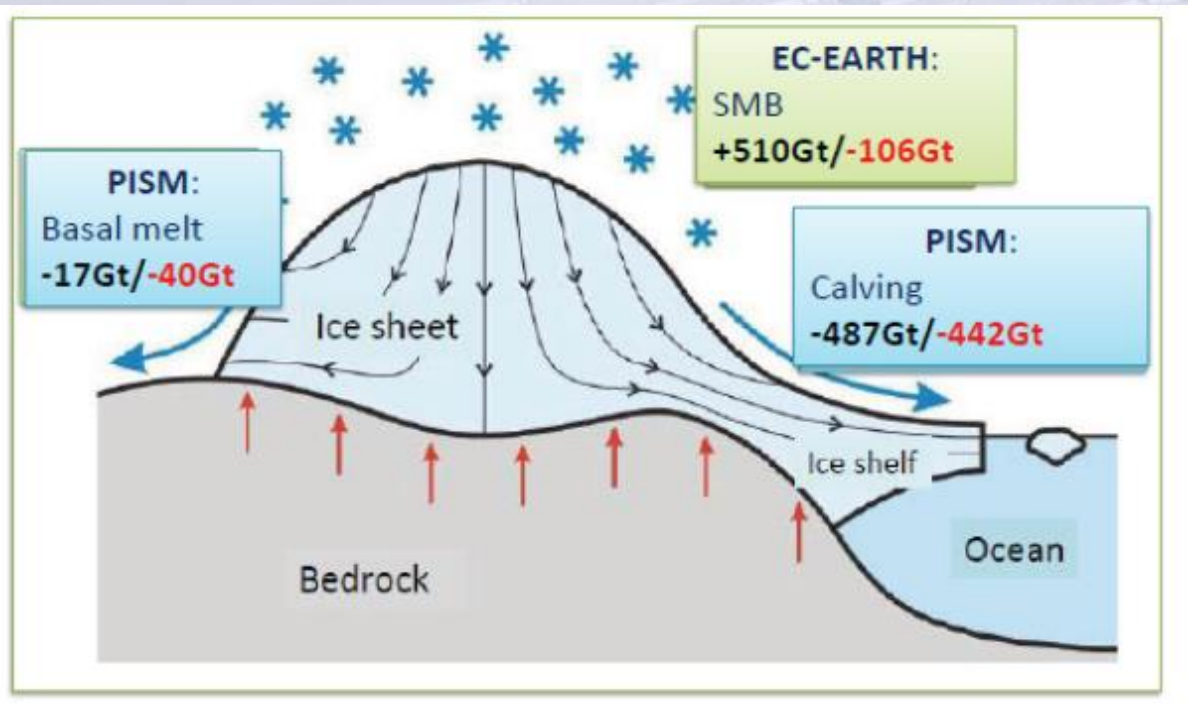


Seasonal variability in sea ice



In the uncoupled model the winter sea is much less in a warmer scenario

EC-Earth-PISM Mass Balance



- Pre-industrial conditions (**black**) ice volume is nearly constant.
- Abrupt $4\times\text{CO}_2$ (**red** numbers), the surface melt increases more than the precipitation
- 1% /yr to $4\times\text{CO}_2$

- Maximum ice losses at the margins (up to 500m).
- Ice thickness increases in some areas (more P)

The SVALI Graduate School



http://ncoe-svali.org/phd_school

- 10 PhD students and 7 Pos.docs paid by SVALI. + 14 associated PhD-students PhD courses
- 17 joint SVALI PhD-courses are listed in 2013/2014
- Workshops, Summer schools and special courses
- The PhD programme will exceed the lifetime of SVALI. A Graduate School Agreement was signed by all 9 SVALI universities in 2013

Outreach: The Global Cryosphere Watch



← → ↻ | globalcryospherewatch.org



Global Cryosphere Watch

Home About News Cryosphere Now Surface Satellites Activities Outreach Reference Data

Highlights



CryoNet is taking shape! After workshops in Vienna, Beijing, and Santiago de Chile, many stations have been proposed and preliminarily accepted, to be approved by WMO Congress in June 2015.



CryoNet is taking shape



Cryosphere in the News

Japanese whaling ships depart for hunt
30 November 2015, 10:43 pm
bbc.co.uk

Brief communication: Getting Greenland's glaciers right – a new data set of all official Greenlandic glacier names
30 November 2015, 5:00 pm
the-cryosphere.net

At Least 15 Die in Texas and Kansas as Winter Storms Pummel Plains
30 November 2015, 12:58 pm
rss.nytimes.com

Drone Helps Scientists Investigate Disappearing Ice
30 November 2015, 1:47 am
feeds.nbcnews.com

Review: Southern surveyor
30 November 2015, 1:00 am
cosmosmagazine.com

Turning ice into fire: Ireland goes for drama

[More Cryosphere in the News »](#)

The Cryosphere Now

Sea and Freshwater Ice	
Snow and Solid Precip	
Glaciers & Ice Caps	
Ice Sheets	

GCW News

Second SnowPEX Workshop (2015-09-21)

Strong endorsement of GCW by WM Congress (2015-06-25)

Successful WMO Congress Polar Panel Discussion (2015-05-31)

17th WMO Congress and GCW (2015-05-18)

CryoNet is taking shape! (2015-05-18)

GCW Portal (Catalogue) will be down briefly on 12 May 2015 (2015-05-11)

Inform the public!

- Websites
- Social media
- Media contact
- Newsletters
- Press releases
- Talks

POLAR PORTAL
MONITORING ICE AND CLIMATE IN THE ARCTIC

Home **Greenland** Arctic Sea Ice Weather News About Polar Portal

Sitemap Print page På dansk Tweet 3

GREENLAND

Welcome to the new arctic monitoring web-site
The Danish Arctic research institutions present updated knowledge on the condition of two major components of the Arctic: The Greenland Ice Sheet and the sea ice

[Surface conditions](#)

[Glacier front positions](#)

[Total mass change](#)

[Understanding the Greenland Ice Sheet](#)

[More ice-monitoring products](#)

[Links](#)

Surface conditions

Daily updates on the surface conditions on the Greenland Ice Sheet. See where it is melting and where the ice sheet is growing – and compare with the total melt from the surface in previous years. See also satellite measurements of the surface reflectivity.

Glacier front positions

See animations of satellite images of major outlet glaciers of the Greenland Ice Sheet. You can compare the updated images with the positions of the glaciers in the mid-1980s and in the year 2000.

Total mass change

Follow the total mass balance of the Greenland Ice Sheet. Weekly updates on the contribution to global sea-level. See animations that show how the ice sheet grows and diminishes through the year.

Reports from the Greenland ice sheet

2013 Season report
All in all, 2013 has been a year with large melting from both the Greenland Ice Sheet and the Arctic sea ice – but not nearly as large as the record-setting year of 2012.
November 18, 2013.

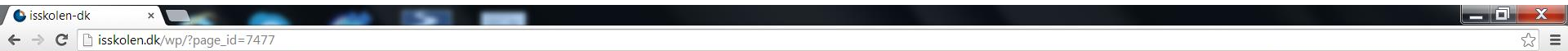
Ice Sheet Melt Above Long Term Average for July.
Ruth Mottram, Jason E. Box, Peter L. Langen, Polar Portal.
July 29, 2013

Greenland ice sheet climate before summer 2013.
Jason E. Box, Peter L. Langen, Signe Bech Andersen, Polar Portal.
June 18, 2013

© 2014 - DMI, DTU, GEUS.

DMI DTU GEUS

Outreach: Isskolen.dk/wp



Islandska Dansk Suomi Svenska Norsk Bokmål English



HOME
Welcome

ABOUT ICE
Online textbook

THIS PAGE
For teachers

ABOUT
Contact

Welcome to The Ice School

An e-learning website for children aged 12 to 14, giving a basic introduction to ice and climate change.

STUDENTS CLICK HERE

TEACHERS CLICK HERE

CONTACT

If you have comments or questions please write in English, Danish, Swedish or Norwegian to isskolen@geus.dk

ABOUT

This page is published by SVALI in collaboration with PROMICE and maintained at GEUS

↑ top



Ice on land

- › Ice sheet
- › Ice caps
- › Glaciers
- › Where is the ice?
- › Summary

Glacier formation

When ice melts

Why is the ice melting

Following the scientists

List of concepts

Exercises and experiments

Movies, links and fun

Sitemap

Ice on land

You have probably heard about glaciers before. A glacier is a large volume of ice on land, but the word glacier is actually just one of many for ice on land.



Copyright SVALI

This is Gigjökull, a glacier in Iceland. We will come back to Gigjökull in a moment...

We are now going to learn about the three most important forms of ice on land:

- Ice sheet
- Ice cap
- Glacier

NEXT



KOTI
Tervetuloa

TIETOA JÄÄSTÄ
Verkko-oppikirja

SIVU
Opettajille

TIETOA MEISTÄ
Yhteystiedot

Jää kuivalla maalla

- › Mannerjäätikkö
- › Lakijäätiköt
- › Jäätiköt
- › Missä jäätä on?
- › Yhteenveto

Muodostuminen ja käyttäytyminen

Kun jää sulaa

Miksi jää sulaa?

Tutkijan jalanjäljissä

Lista käsitteistä

Tehtäviä ja kokeita

Videoita, linkkejä ja muuta kivaa

Sitemap

Jää kuivalla maalla

Olet varmaan kuullut jäätiköistä aiemminkin. Jäätikkö on suuri määrä jäätä kuivalla maalla, mutta jäätikkö on itse asiassa vain yksi monista termeistä, joilla jäämuodostumia kuivalla maalla kutsutaan.



Copyright SVALI

Kuvassa on Gigjökull, jäätikkö Islannissa. Palaamme siihen tuota pikaa...

Opit kohta lisää kolmesta tärkeimmästä jäämuodostumasta kuivalla maalla. Ne ovat:

- Mannerjäätikkö
- Lakijäätikkö
- Jäätikkö

SEURAAVA



Ice-school

- E-learning to be used by the pupils in schools
- An introduction to glaciology
- Available in all Nordic languages, incl. Greenlandic, plus English, German and French
- Focusing on glaciers in the SVALI countries
- Interactive quiz based learning
- Meet the PhD students

Outreach: Ilulissat Climate Days, June 2-5



- Changes of the Greenland ice sheet (ice sheet, glacier and sea ice changes), and impact on society
- SVALI Nordic Center of Excellence – final conference
Attracted 180 scientists, ph.d. students, stakeholders ...

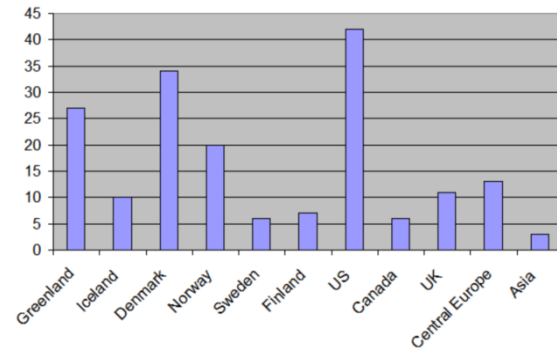


Greenland Minister Mala Høy Kuko

<http://www.polar.dtu.dk/english/Ilulissat-Climate-Days>

Sessions:

- Cryosphere changes: Observations and Impact on Society
- Climate Change and Society
- Greenland, Arctic and Antarctic Ice Cap Changes
- Space Measurement of Cryosphere Changes
- Observations and Models
- Stability and Variations of Arctic Land Ice



**Participant
distribution
(total: 179)**





The future of SVALI



1. SVALI will be continued as a 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



norden

Top-level Research Initiative



Foto: Anne Riiser

Thank you for listening