

Historical and current climate
in the Arctic:
Impact on glaciers and ocean

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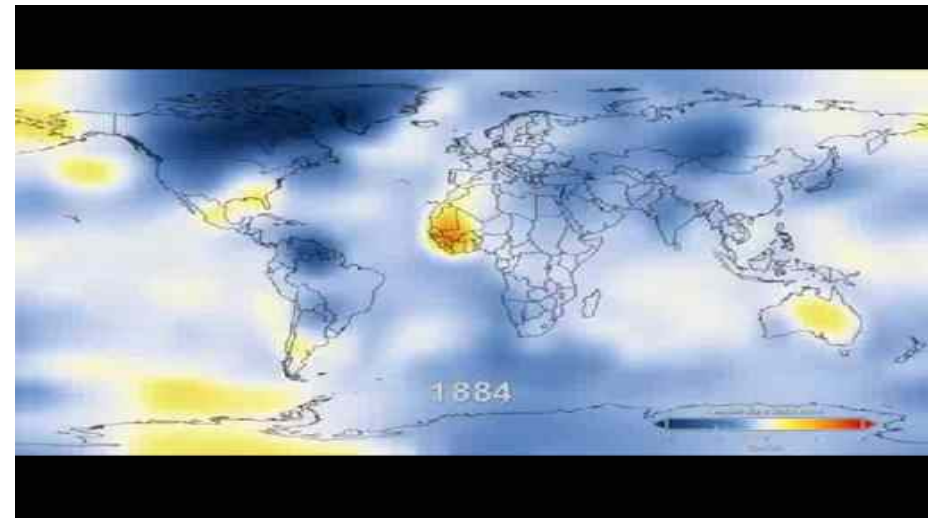
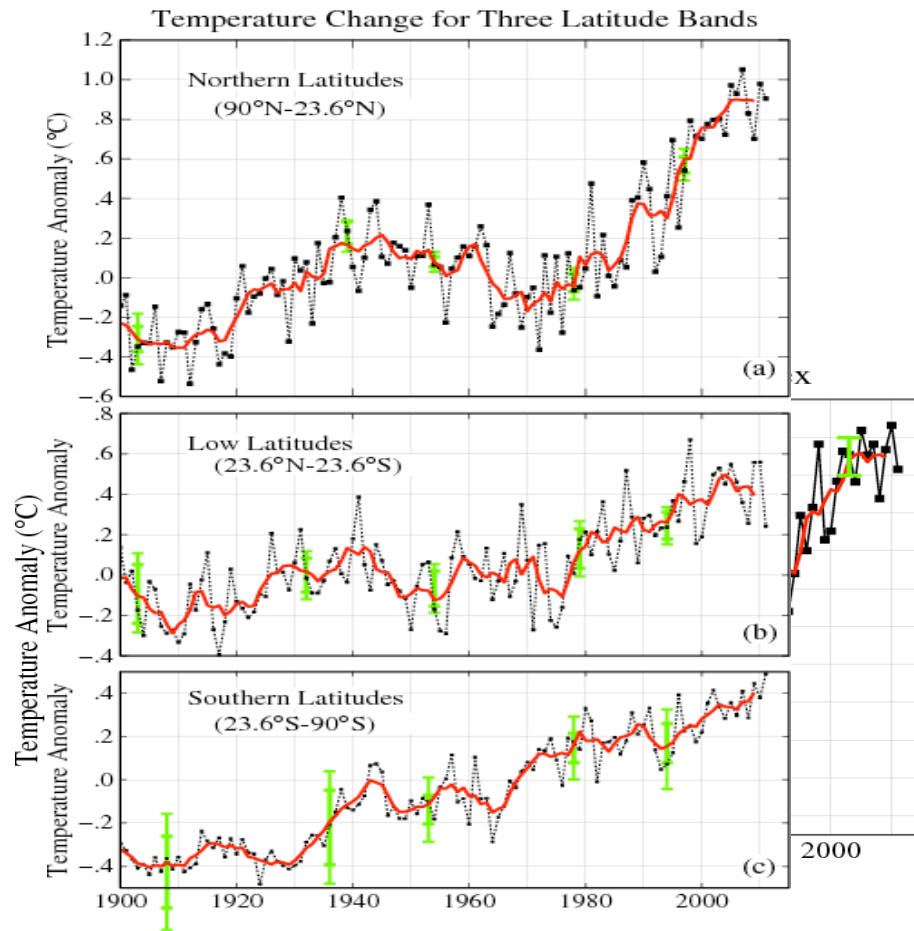
Photo: C. Morrell

Centre for Ice and Climate - VISION

To contribute to an improved understanding of the present and past warm interglacial periods by studying ice cores, and developing models to explain observations and predict the ice sheet response to climate change.



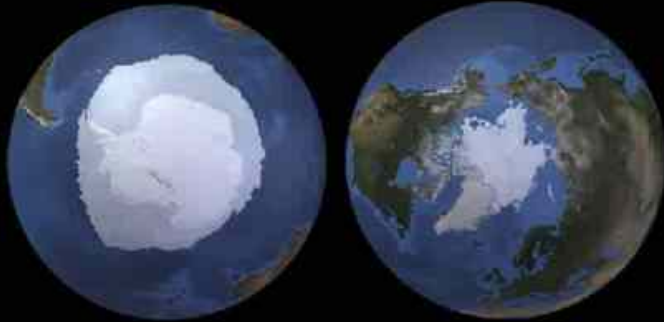
The global temperature has increased 0.57°C since the reference period 1951-1980



Source: J.Hansen, NASA GISS

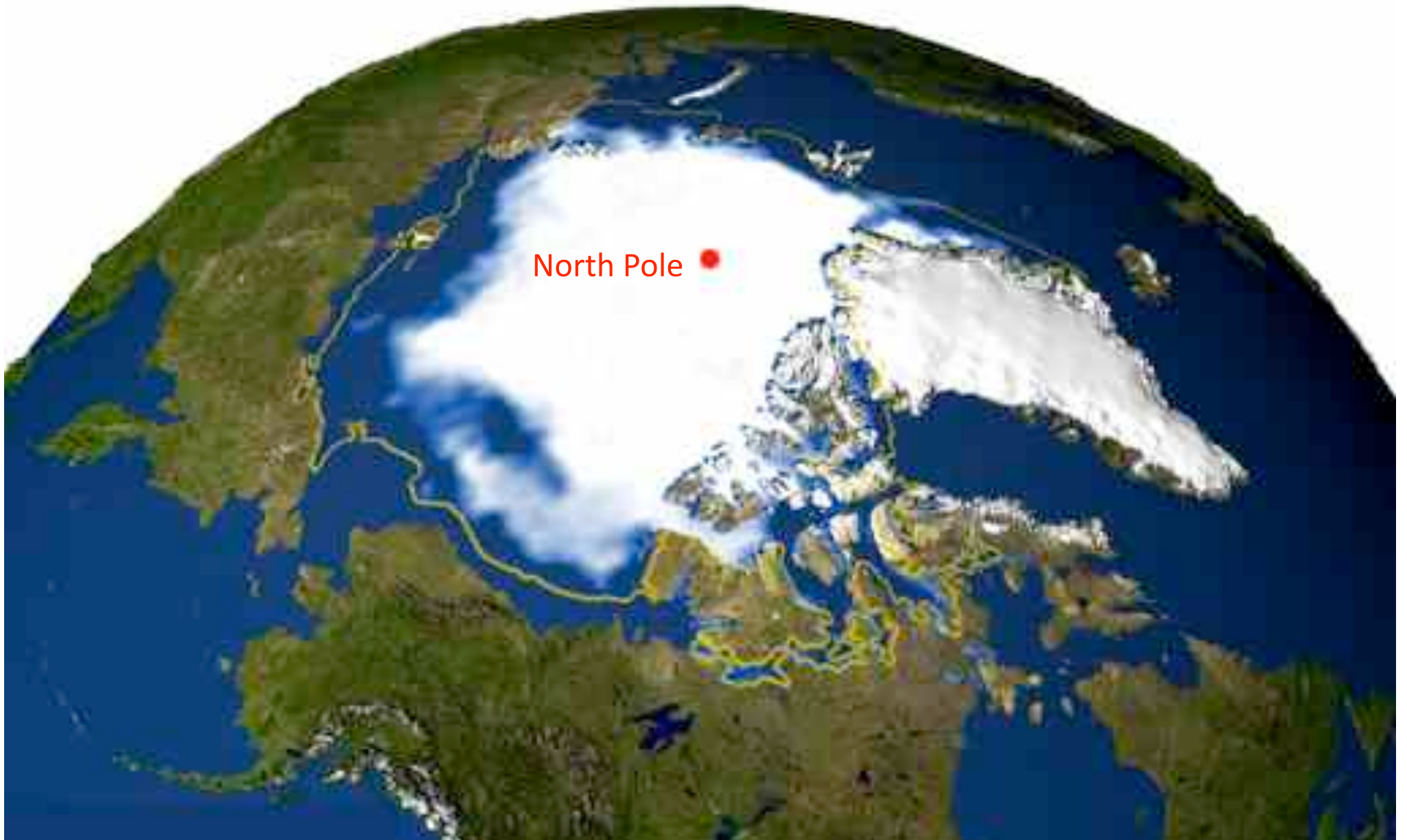
Where is the ice?

2010
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug



	Area (mill. km ²)	Volume (mill. km ³)	Sea Level Equivalent (m)
Greenland	1.71	2.95	7.4
Antarctica	12.1	29	73
Ice Caps and Glaciers	0.68	0.18	0.6
Sea Ice	25	0.05	0

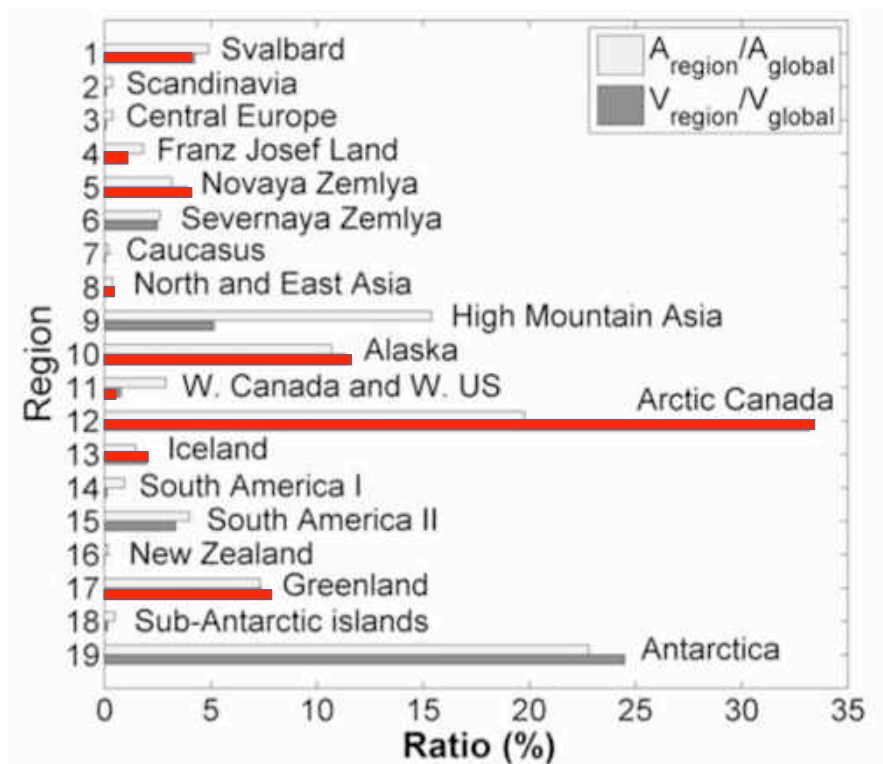
The Ice in the Arctic



Athabasca Glacier 1919 and 2005

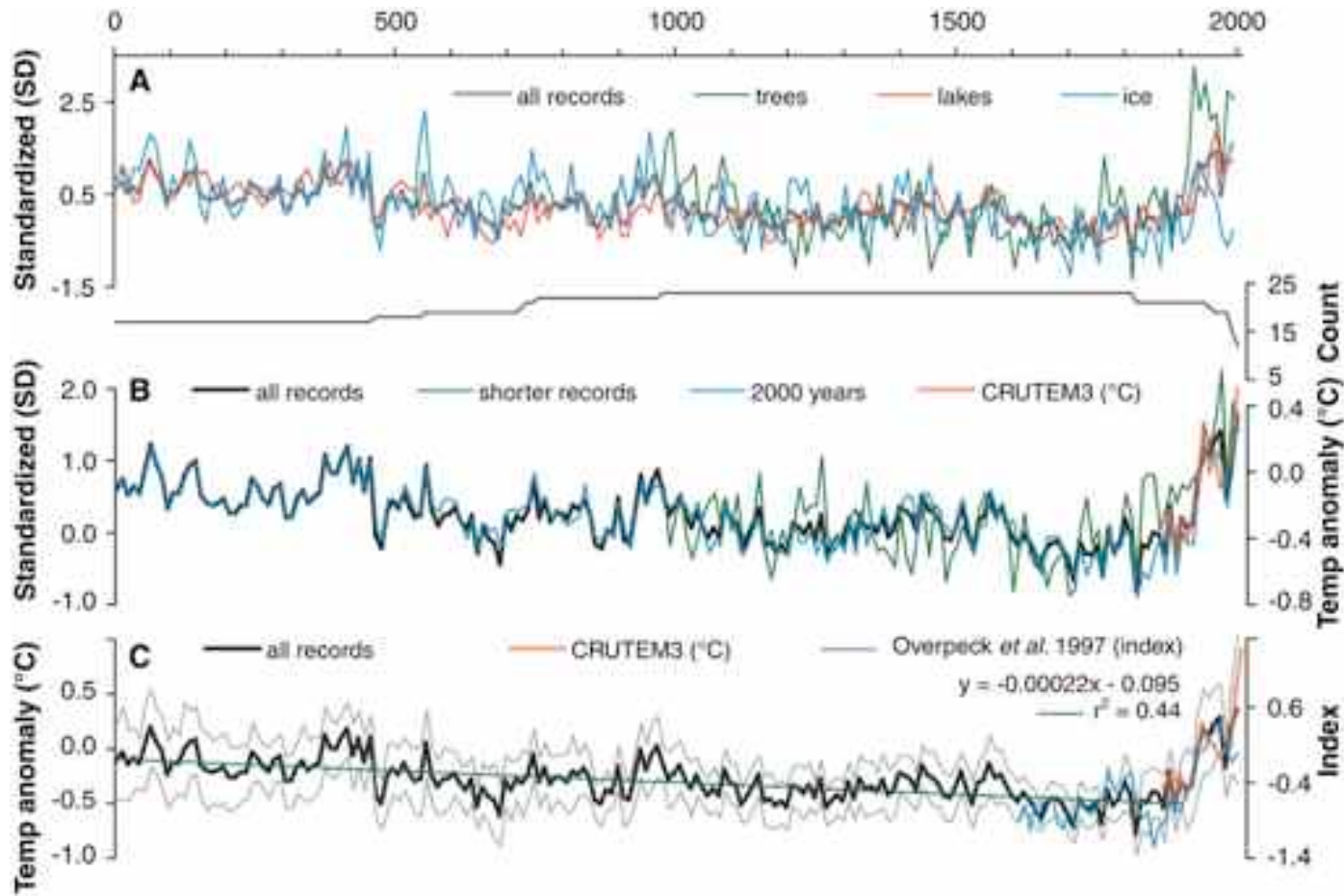


The volume Arctic Glaciers corresponds to 0.4 m sea level (67% of the global glaciers)



Radic and Hock, JGR, 2010

Arctic Temperatures the last 2k

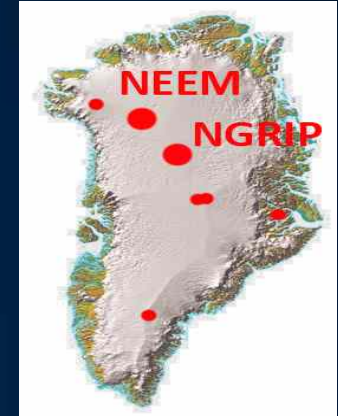


The present Arctic temperatures are the warmest during the last 2000 years

Kaufman, Science, 2009

NEEM

Deep ice core drilling



NEEM nations



Logistics by:
DK group
NSF OPP



2008





Danish deep ice core drill

Drill length: 13 m

Ice core diameter: 9.8 cm

Ice cores: 3.5 m

Ice thickness: 2545 m

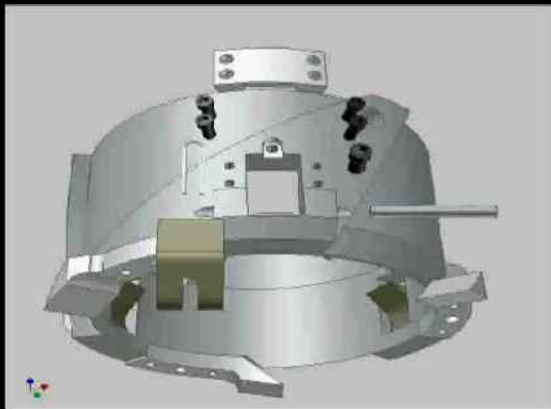
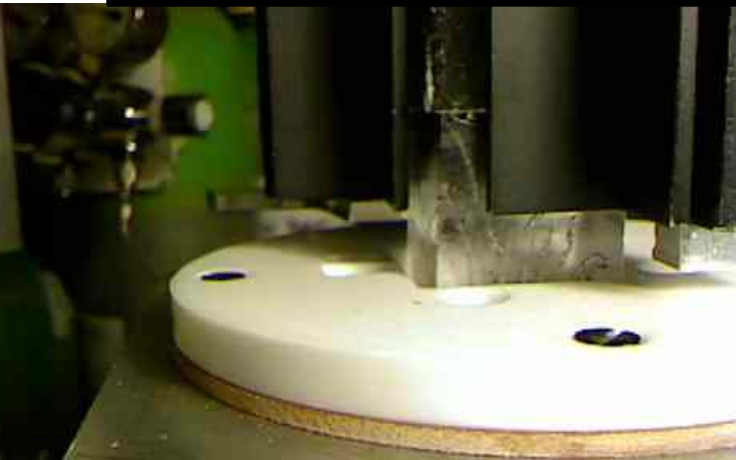




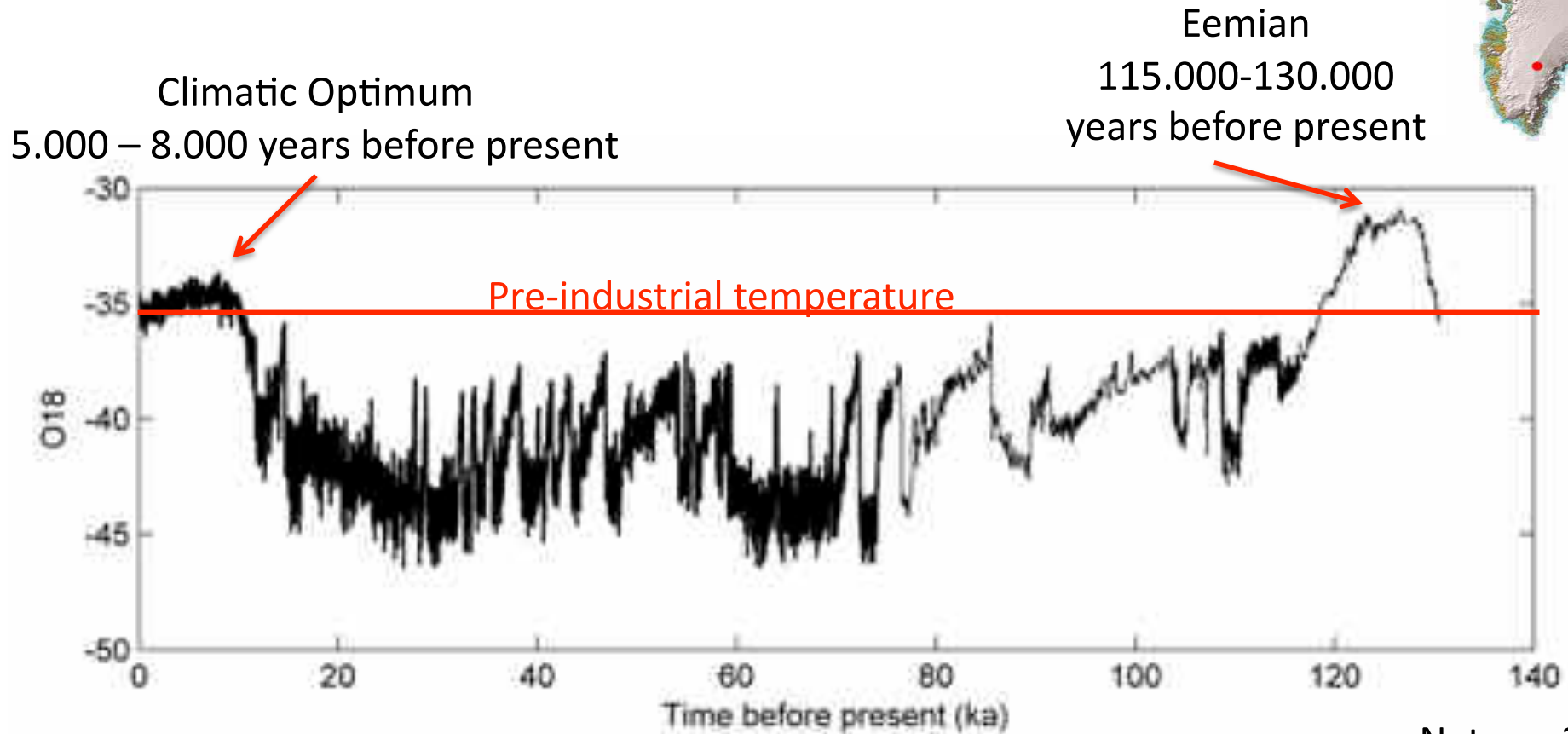
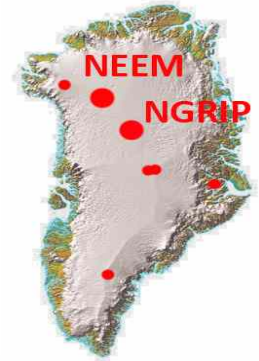
Photo: C. Mo

The water isotopes are measured online at NEEM using laser technology

The ice is melted and water vapour is injected into the instrument where laser ring-down technology measures the water isotopes online

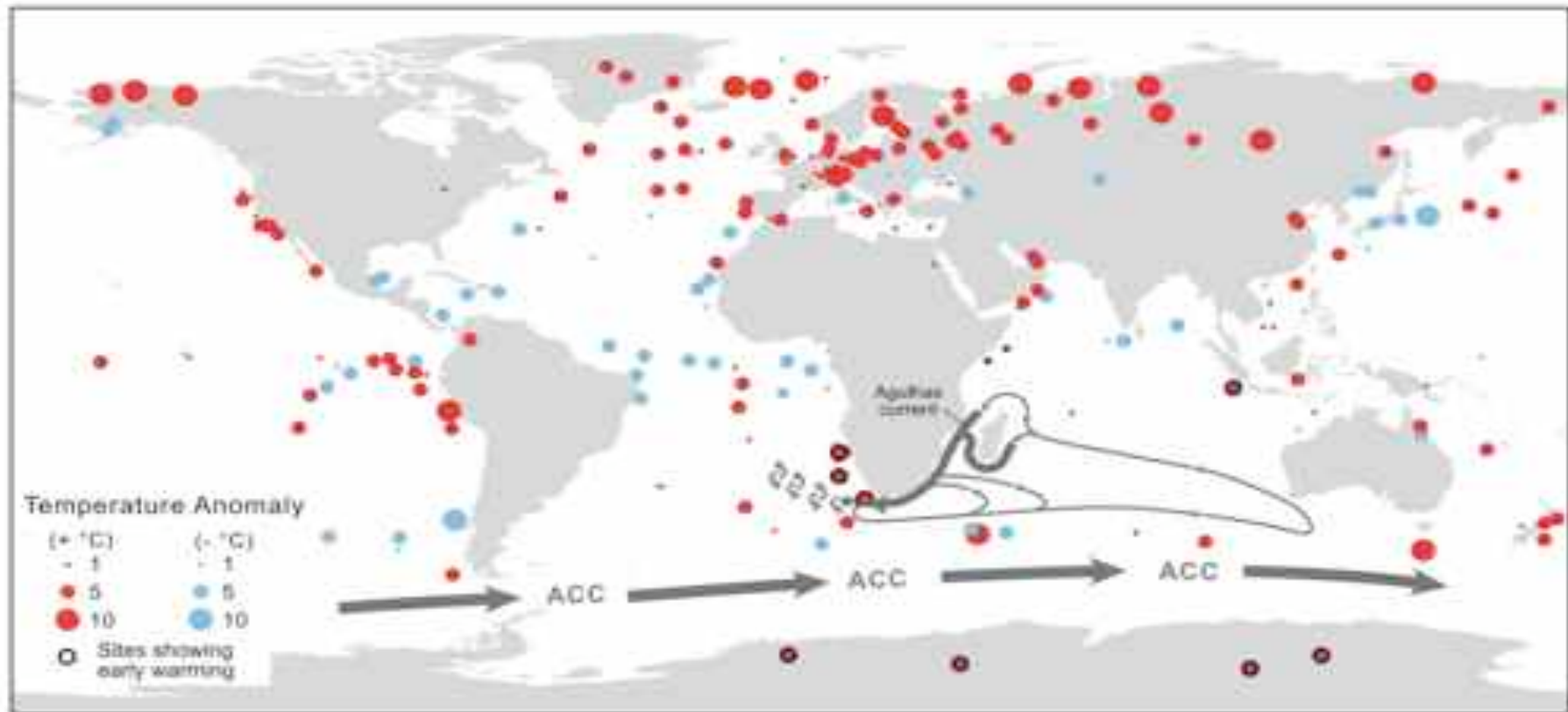


NEEM climate record reaches 128 ka back

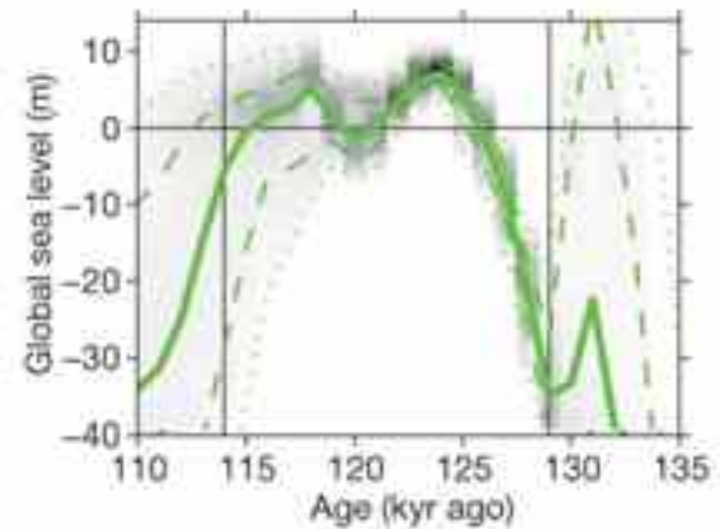


Nature, 2013

The Eemian has been a warm period in the Arctic



During the Eemian the sea level was 6-9 m above the present



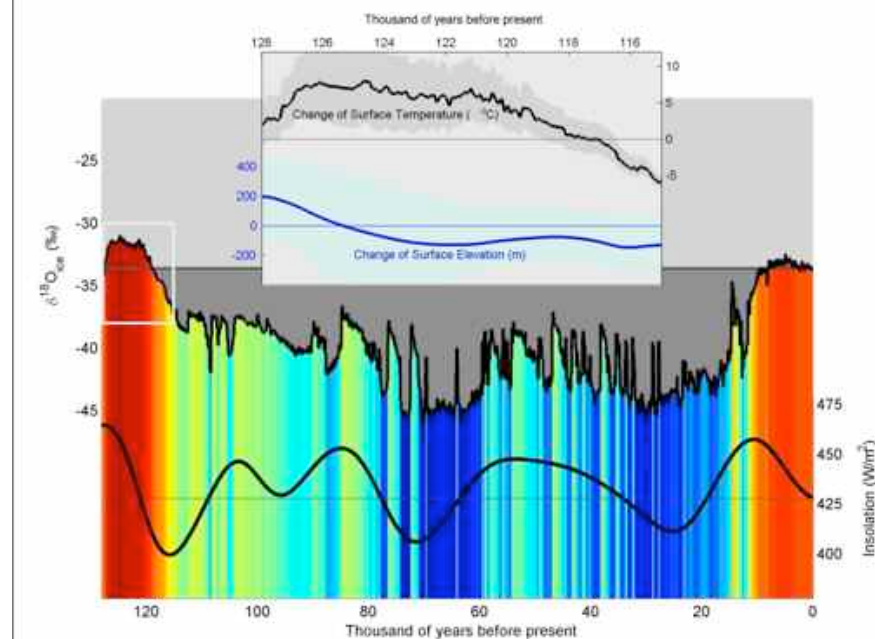
Kopp, Nature, 2009

Temperature and elevation change during the Eemian

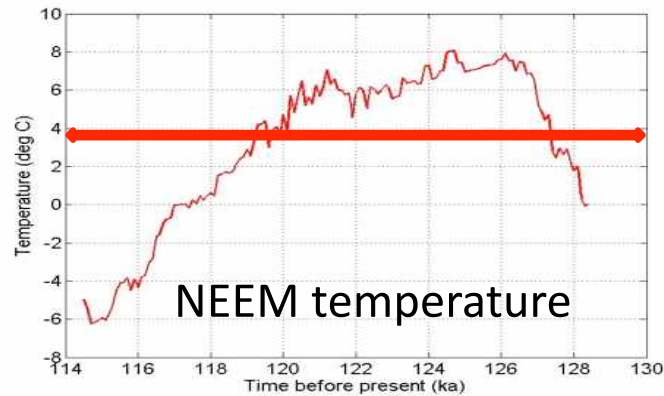
8 °C warmer 124.000 years before present

The ice reduced thickness with 400 m in the period 128.000 to 122.000 years before present (6 cm/yr)

At 122.000 before present the thickness stabalized on a thickness 150 m less than the present.

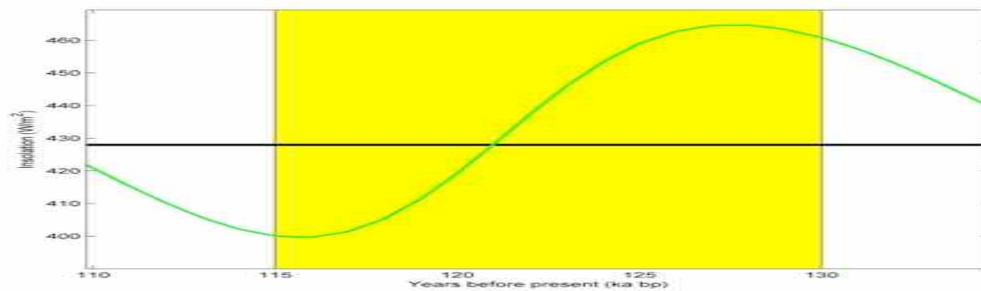


Temperature and elevation change during the Eemian



Warmest precipitation weighted annual temperature change of 8 °C is found at 124-126 ka.

At 120 ka temperatures become colder than the present



Summer Insolation, 70N

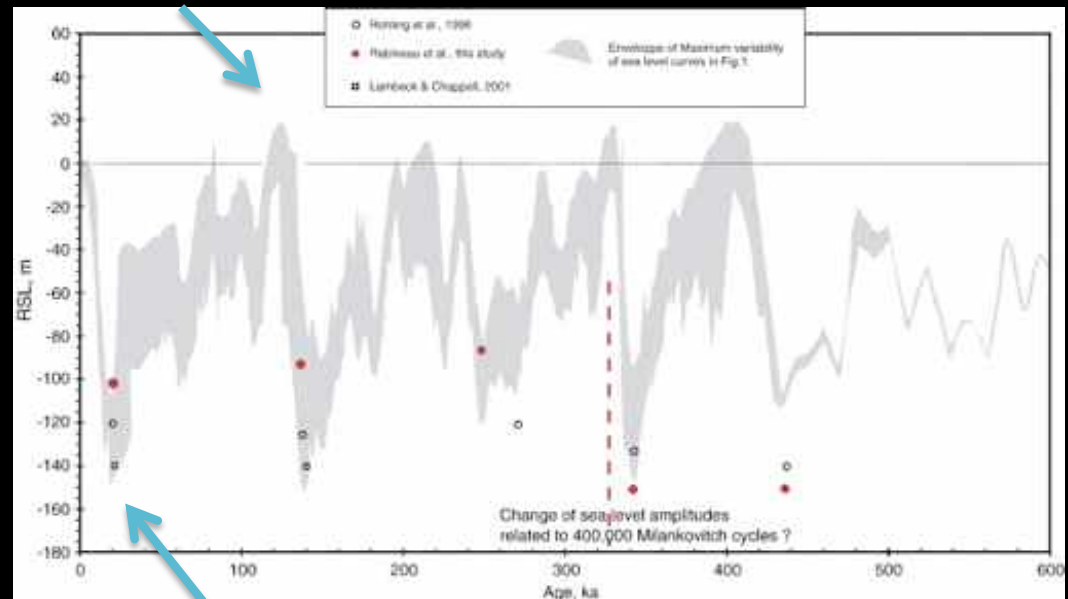
The average temperature change 115-128.5 ka is 3.5 °C.



25.000 years ago ice sheet were present over North Europe and America

The sea level was 140 m lower than today

The Eemian

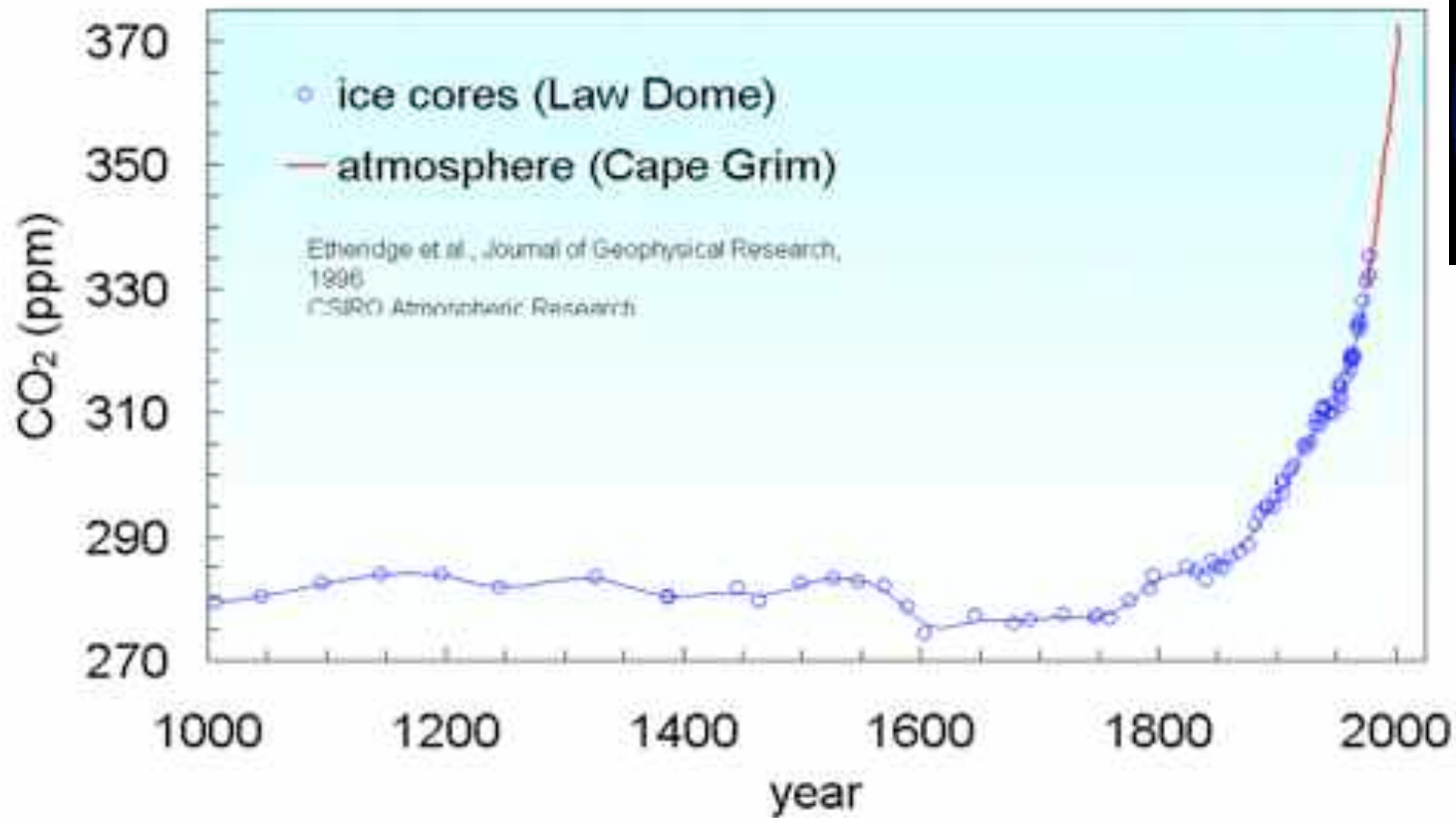


25.000 years ago

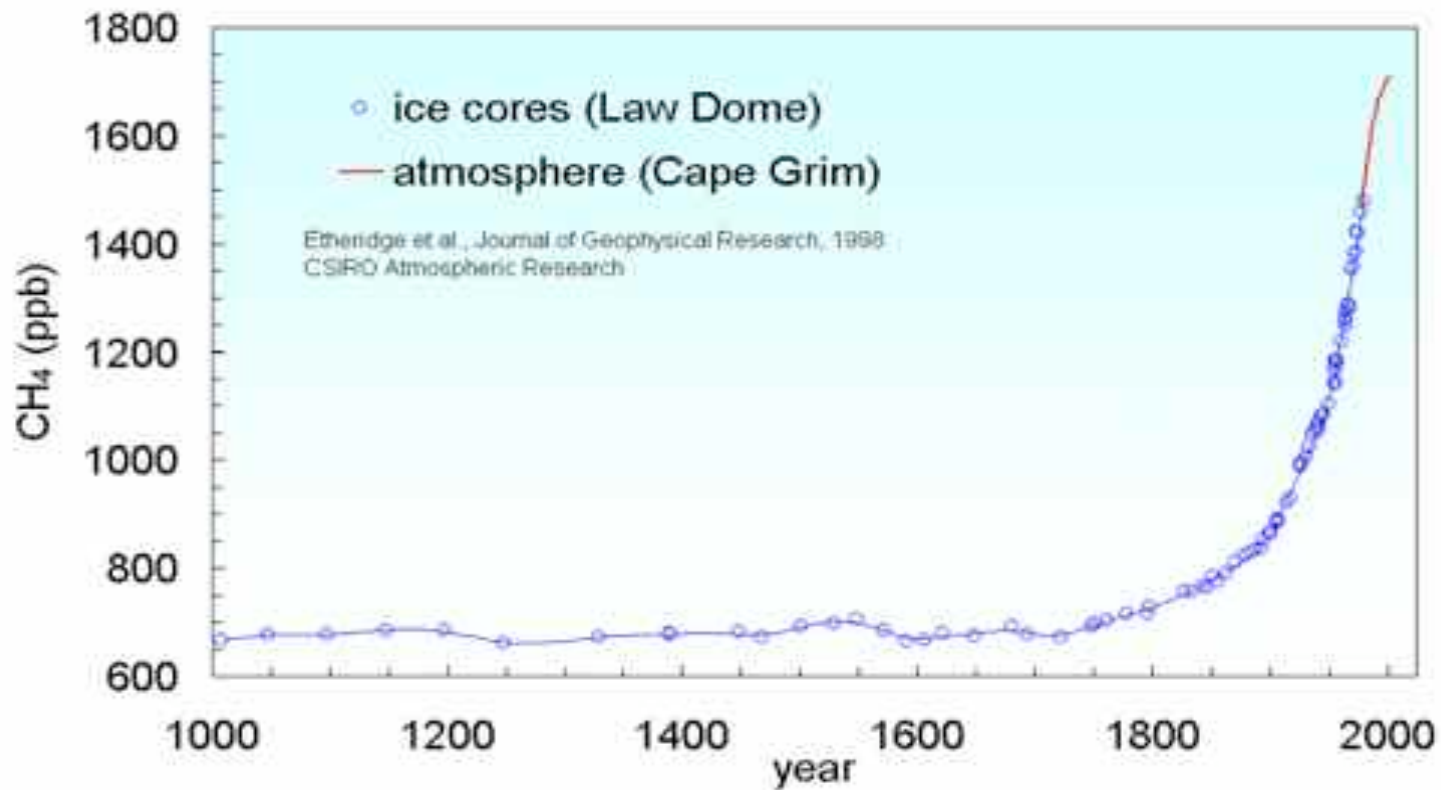


The air bubbles in ice contain samples of the past atmosphere

The recent increase in Carbon Dioxide (CO₂)

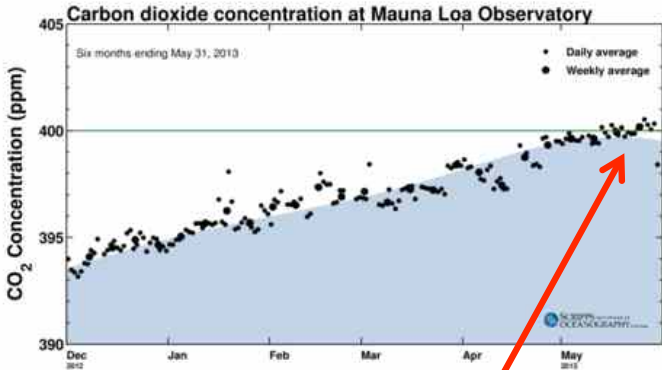
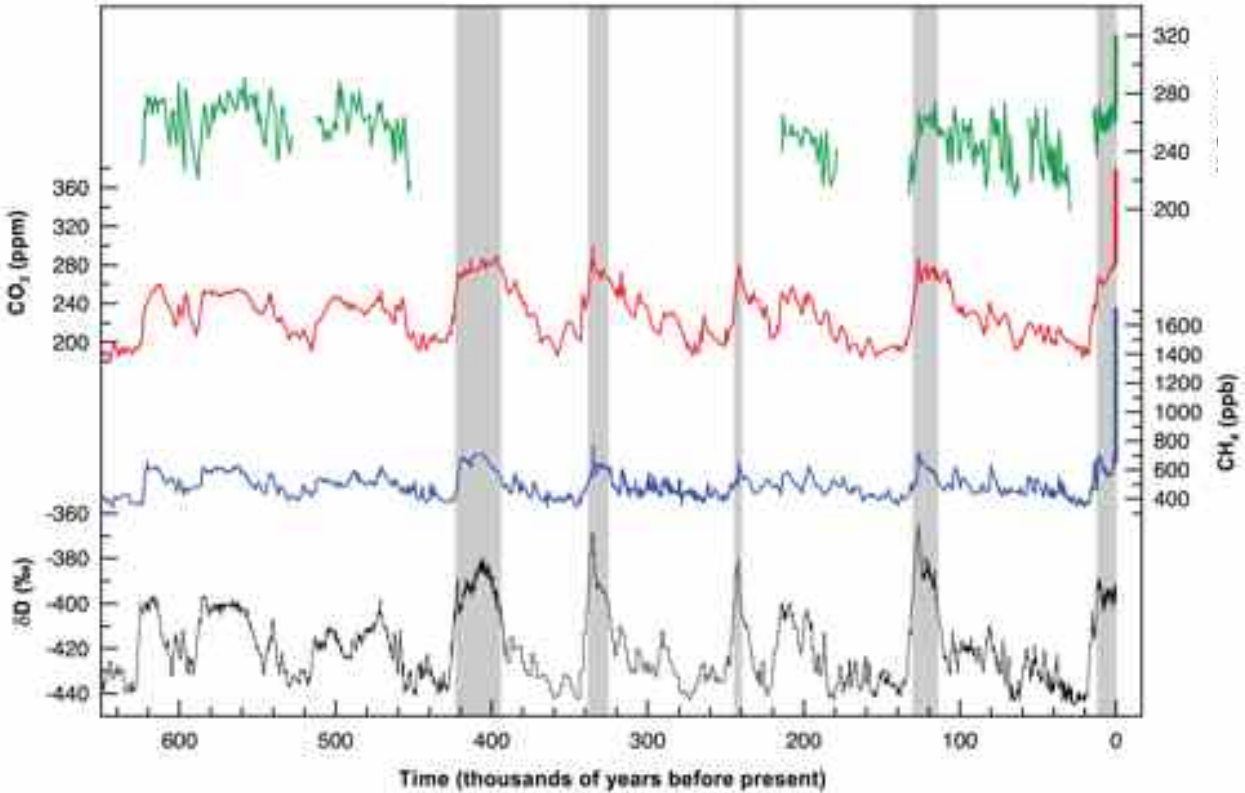


The recent increase in Methane (CH₄)



Greenhouse concentrations the last 600.000 years

GLACIAL-INTERGLACIAL ICE CORE DATA



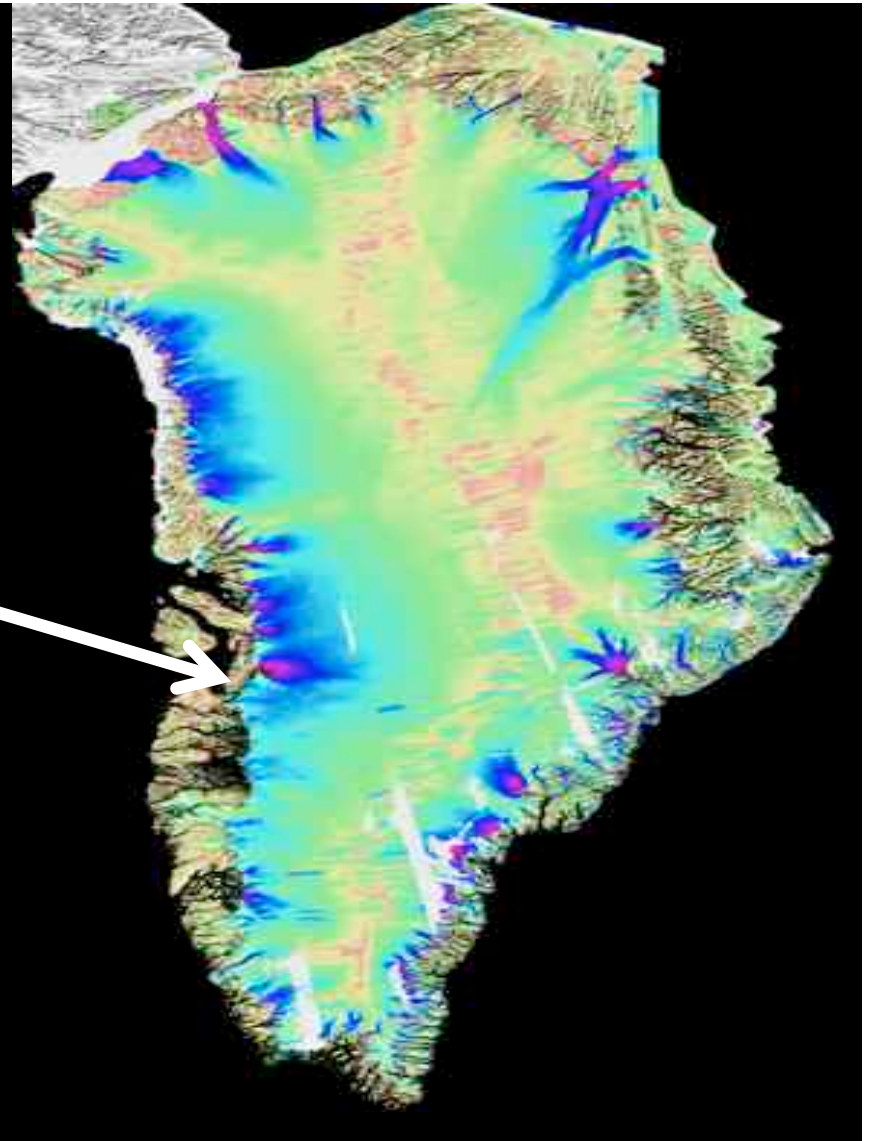
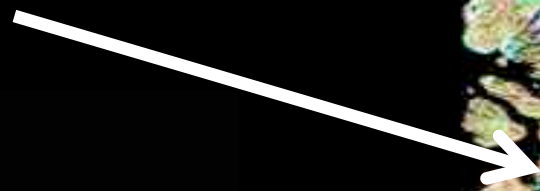
7 May 2013:
CO₂ concentration of 400 ppm

50% loss of mass by melt at the margin of the ice sheet



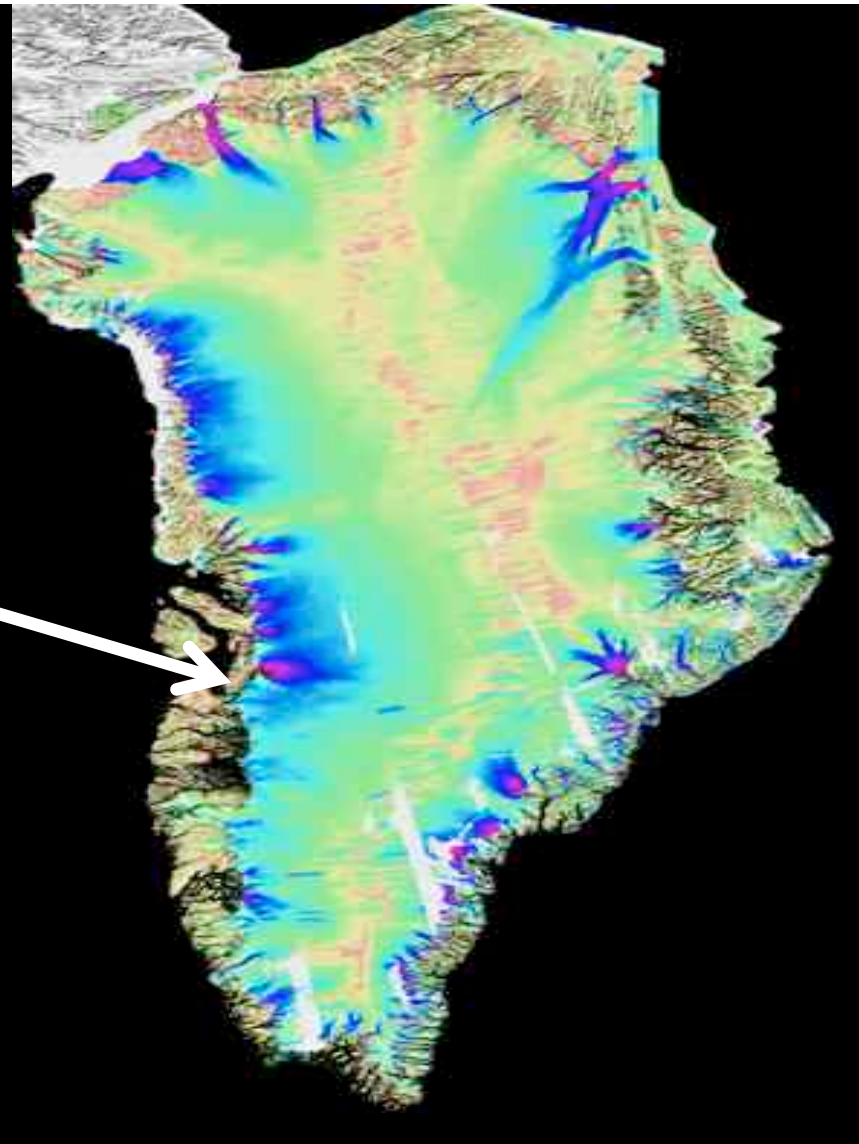
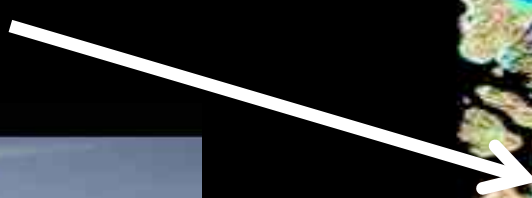
**50% loss of mass by
ice discharge from
fast flowing ice supplying
icebergs to the fjords and
ocean**

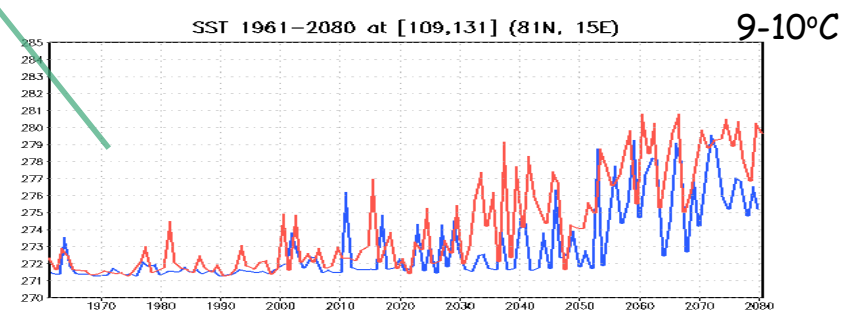
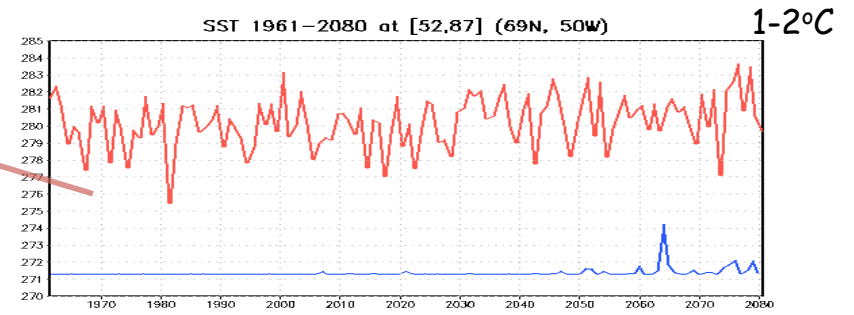
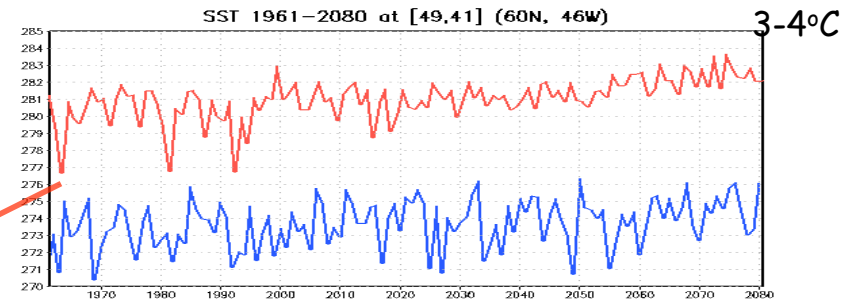
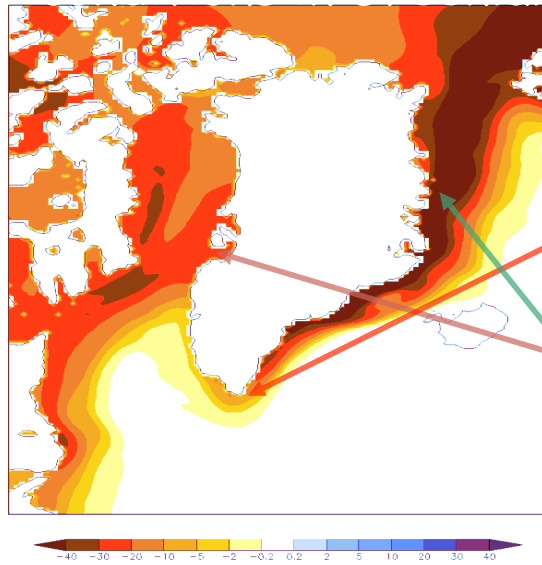
**Jakobshavn
Ice Stream**



**50% loss of mass by
ice discharge from
fast flowing ice supplying
icebergs to the fjords and
ocean**

**Jakobshavn
Ice Stream**





Algal pigments from space



Rysgaard

Balance:

Accumulation: +560 Gt/yr

Melt -400 Gt/yr

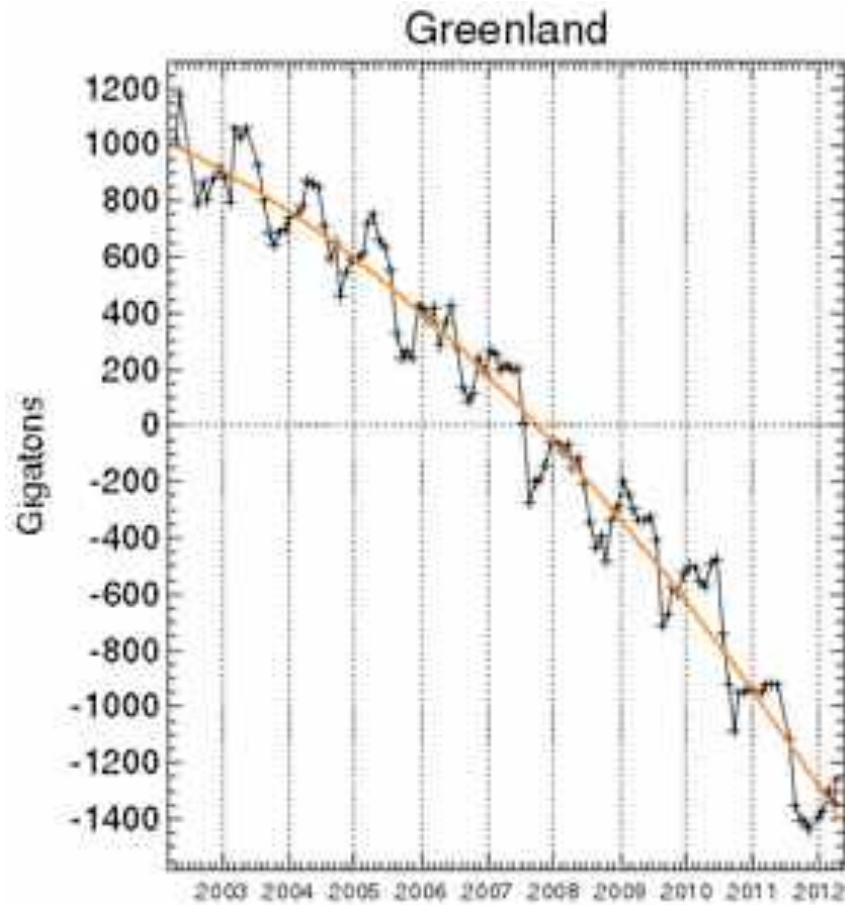
Ice Discharge -400 Gt/yr

Greenland is losing 240 Gt/yr
at present.

(SLR: 0.7 mm/yr)

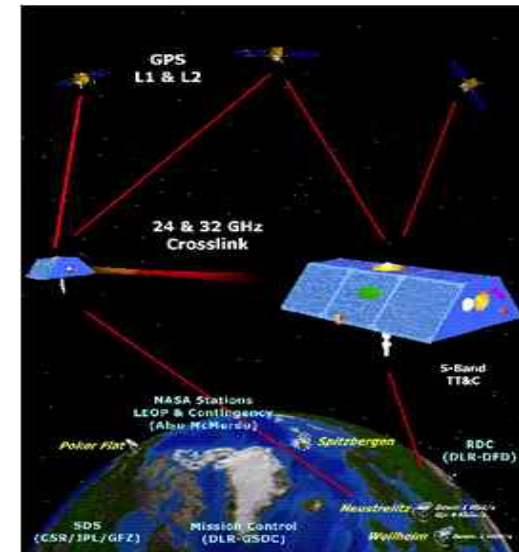


GRACE – Greenland Loss of Mass



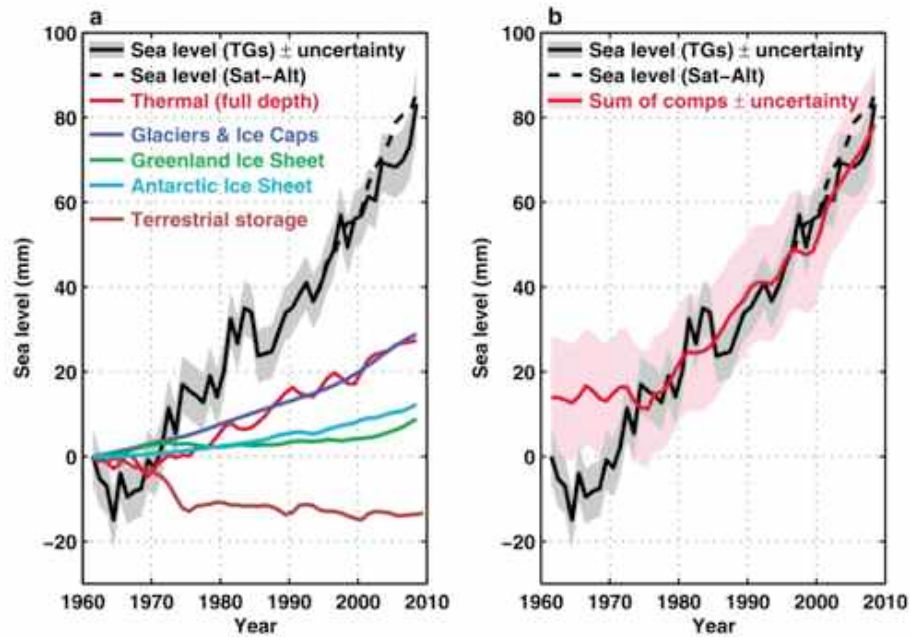
Rignot, GRL, 2011
Acceleration: 21.9 Gt/yr²

GRACE

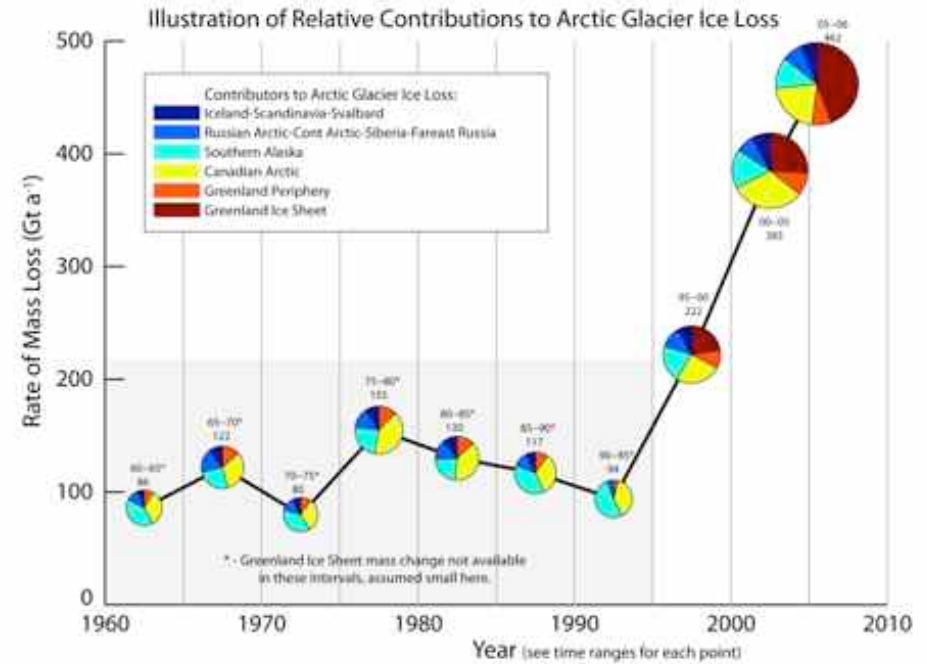


Sasgen, EPSL, 2012
2003-2010: 240 Gt/yr

Contributions to sea level rise

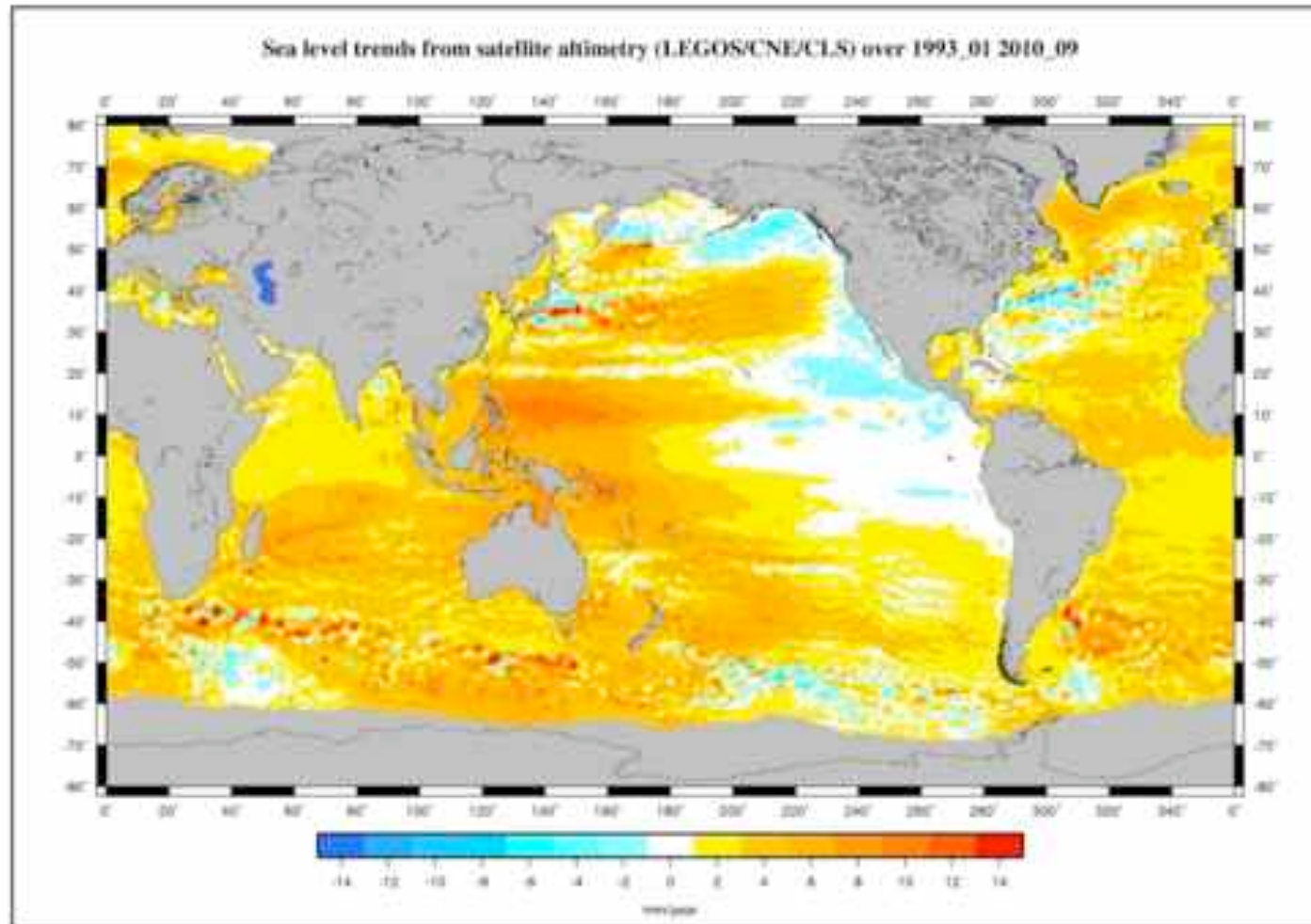


Shephard, Science, 2012)



SWIPA report, AMAP, 2012)

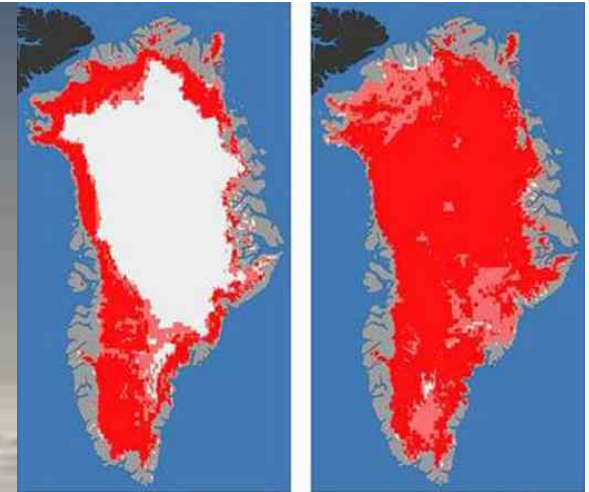
Observations of sea level rise 1993-2010



NEEM July 2012



Rain Bow at NEEM



8 July 2012

12 July 2012

NASA infrared satellite images

We saw rain and melt at the NEEM site during the extreme warm event in July 2012. Melt will be more common in a future warmer climate – as during the Eemian

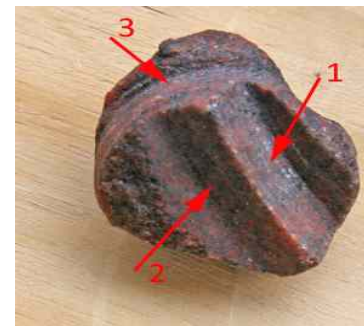
Water and Basal sediments from NEEM



2010



2011



2012

Ice cutters and rocks!



NEEM Dome on ski











Thanks for your attention

