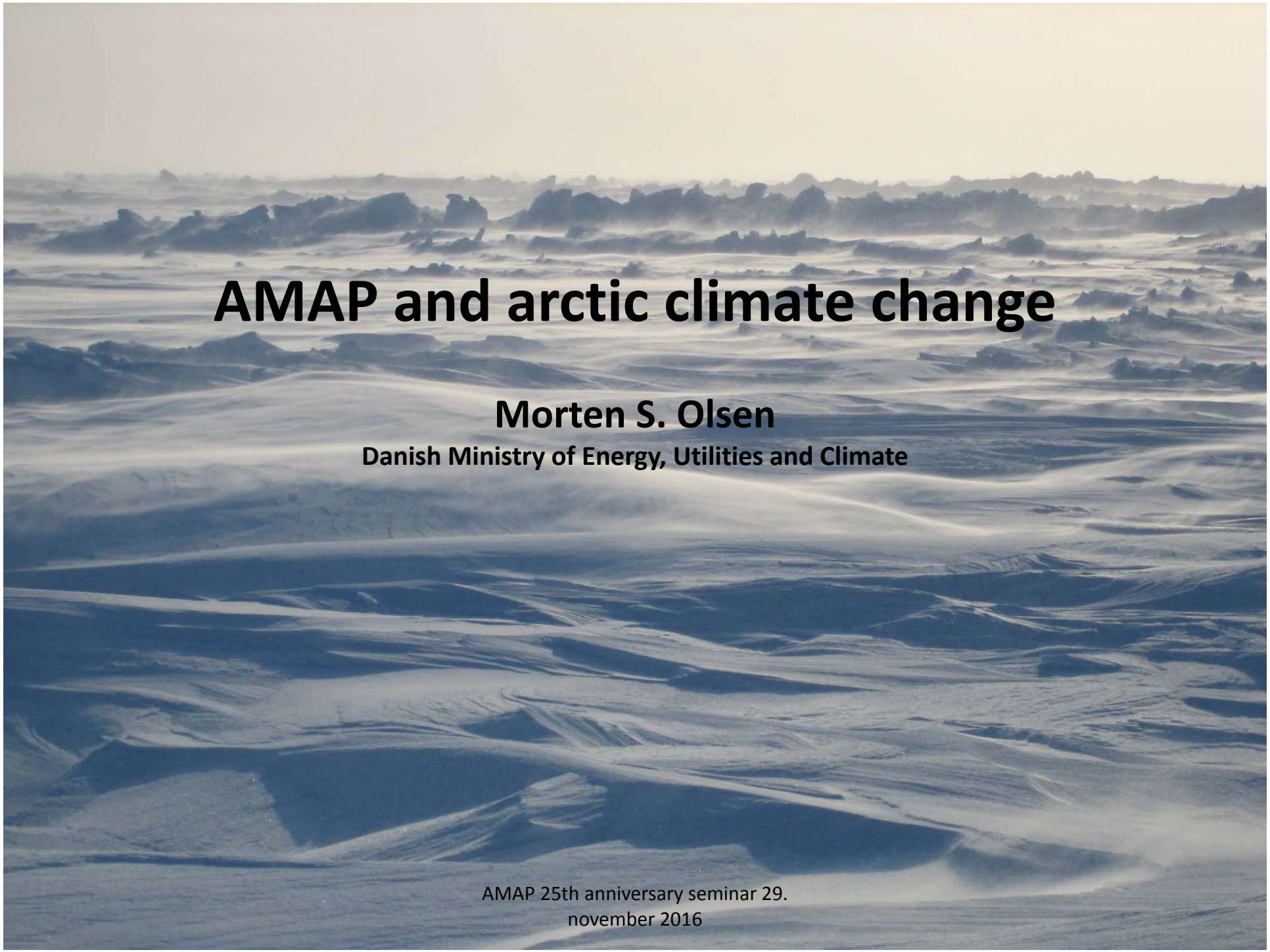


AMAP and arctic climate change

Morten S. Olsen
Danish Ministry of Energy, Utilities and Climate

AMAP 25th anniversary seminar 29.
november 2016

Arctic Climate Change Impacts

1997 2004/2005 2011 2017

Arctic Pollution Issues, 1997

The **effects of global climate change on Arctic temperatures and precipitation patterns are very difficult to predict**, but most studies suggest that the Arctic, as a whole, will warm more than the global mean.

- Warming will cause substantial decreases in the extent of snow and sea ice and in the thickness of the ice.
- Sea ice is critical to energy exchange between ocean and atmosphere
- So far the Greenland Ice Sheets does not seem to be shrinking but melting ice caps and warmer water could raise sea level
- Higher temperatures could disrupt permafrost
- Southern invaders might out-compete native species
- The Arctic affects the global climate
- Winds and water currents are likely to change
- Greenhouse gas emissions are global

Arctic Climate Impact Assessment 2005

Although some regions have cooled slightly the overall trend is a substantial warming over the last few decades.

1. **Arctic climate is now warming rapidly and much larger changes are projected.**
2. **Arctic warming and its consequences have worldwide implications.**
3. Arctic vegetation zone are very likely to shift, causing wide-ranging impacts.
4. Animal species diversity, ranges, and distribution will change.
5. Many coastal communities and facilities face increasing exposure to storms.
6. Reduced sea ice very likely to increase marine transport and access to resources.
7. Thawing ground will disrupt transportation, buildings, and other infrastructure.
8. **Indigenous communities are facing major economic and cultural impacts**.
9. Elevated ultraviolet radiation levels will affect people, plants, and animals.
10. Multiple influences interact to cause impacts to people and ecosystems.

Snow, Water, Ice and Permafrost in the Arctic 2011

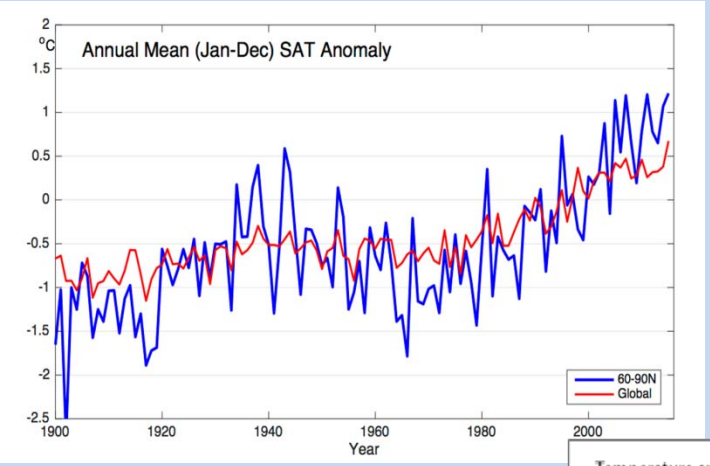
The past 6 years have been the warmest period ever recorded in the Arctic

- **Climate-cryosphere interactions may now be accelerating warming**
- Large bodies of ice are melting faster
- Changes in the cryosphere cause **fundamental changes in the Arctic ecosystems**
- Cryospheric change affects Arctic livelyhoods and living conditions.
- **Changes in the cryosphere are not the only driver of change in the Arctic.**
- Changes in the Arctic Cryosphere have impacts on global climate and sea level
- **Adaptation is urgent and needed at all leve**ls
- Cutting GHG emissions globally is urgent
- Uncertainties can be reduced by further reseach


PERMAFROST
ARCTIC COUNCIL
AMAP
CAFF
UArctic
International Conference on Arctic Science:
Bringing Knowledge to Action
April 24-27, 2017 Reston, Virginia, USA
SECOND CALL FOR PARTICIPATION
2017Conference@amap.no

The Arctic is home for millions and it is part of the global system.

Temperature



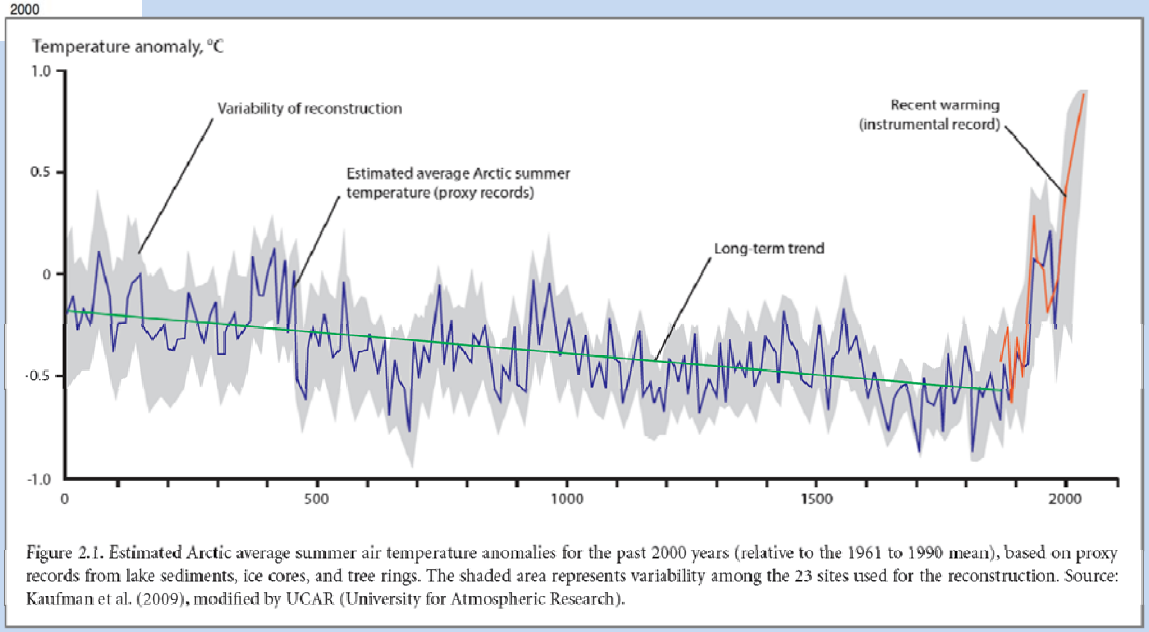
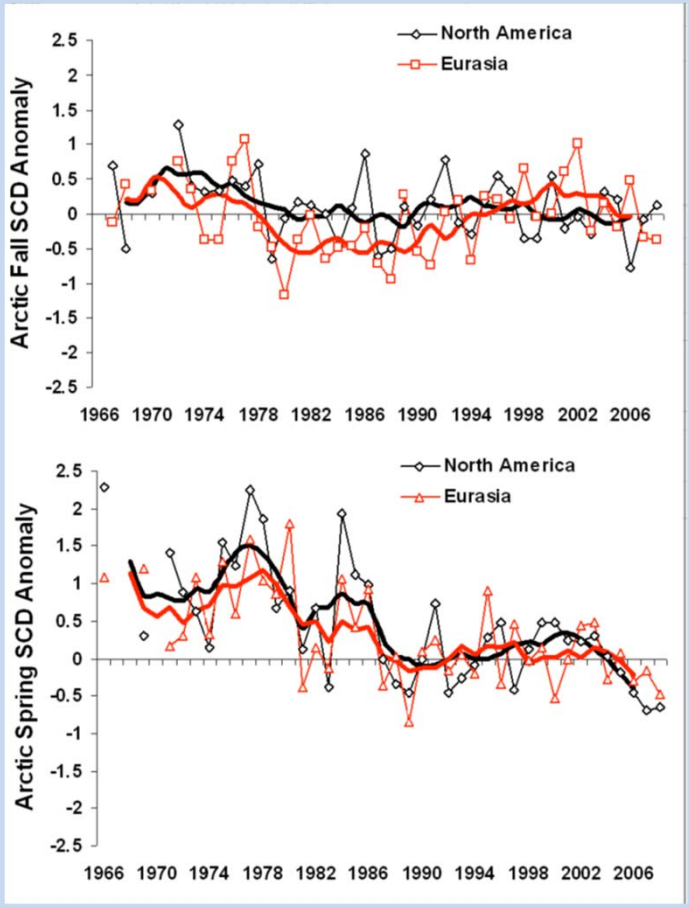
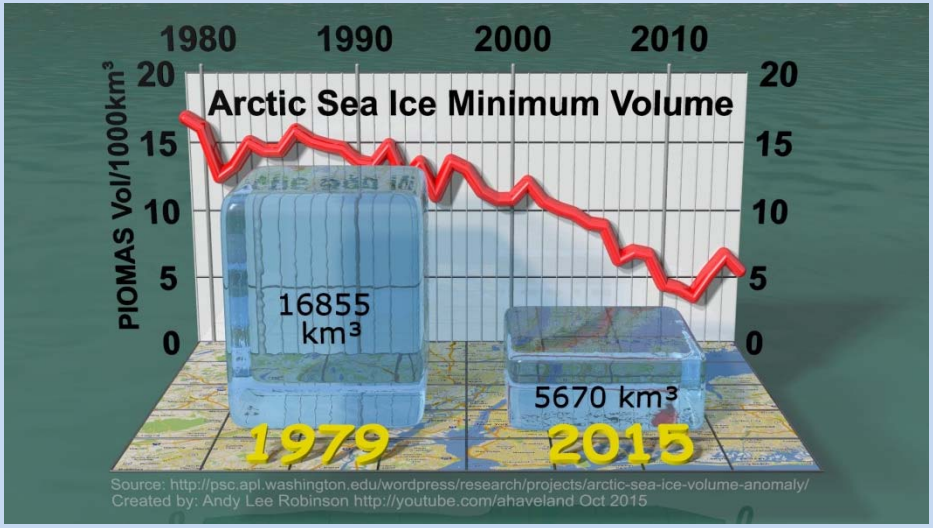


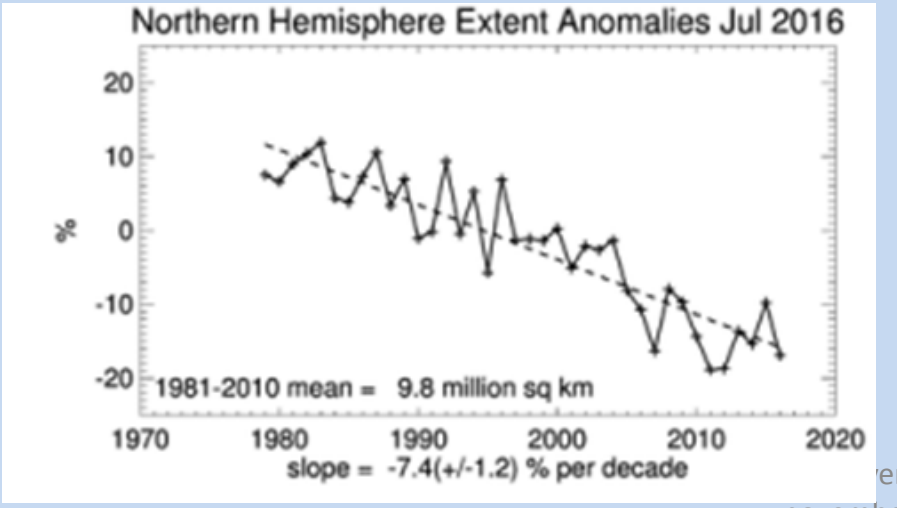
Figure 2.1. Estimated Arctic average summer air temperature anomalies for the past 2000 years (relative to the 1961 to 1990 mean), based on proxy records from lake sediments, ice cores, and tree rings. The shaded area represents variability among the 23 sites used for the reconstruction. Source: Kaufman et al. (2009), modified by UCAR (University for Atmospheric Research).

The extend and duration of Snow cover has decreased across the Arctic and permafrost is warming

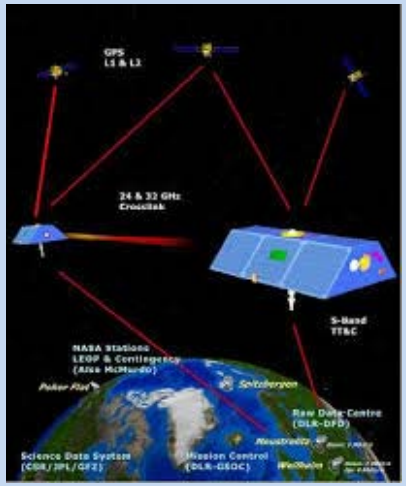


Arctic Sea Ice





- Changes in heat absorbtion
- Changes in heat exchange to the atmosphere
- Changes in carbon dynamics
- Changes in light conditions
- Changes in habitat
- Changes in accesability
-


GPS
L1 & L2
24 & 32 GHz
Crosslink
S-Band
TT&C
NASA Stations
LEOP & Contingency
(Alice Springs)
(Alice McMurdo)
Poker Flat
Svalbard
Raw Data Centre
(DLR-DFD)
Science Data System
(CSR / JPL / GFZ)
Mission Control
(DLR-GSOC)

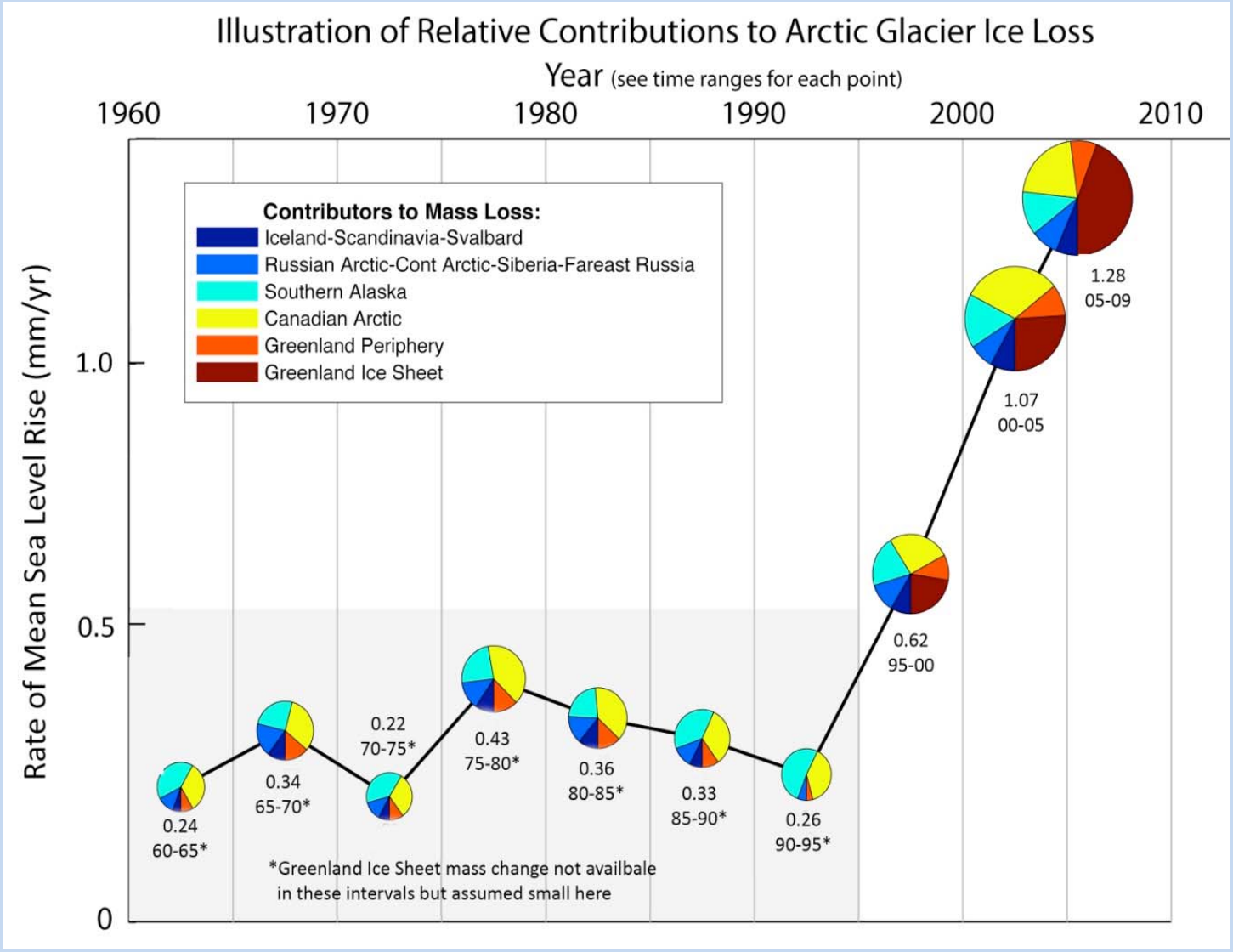
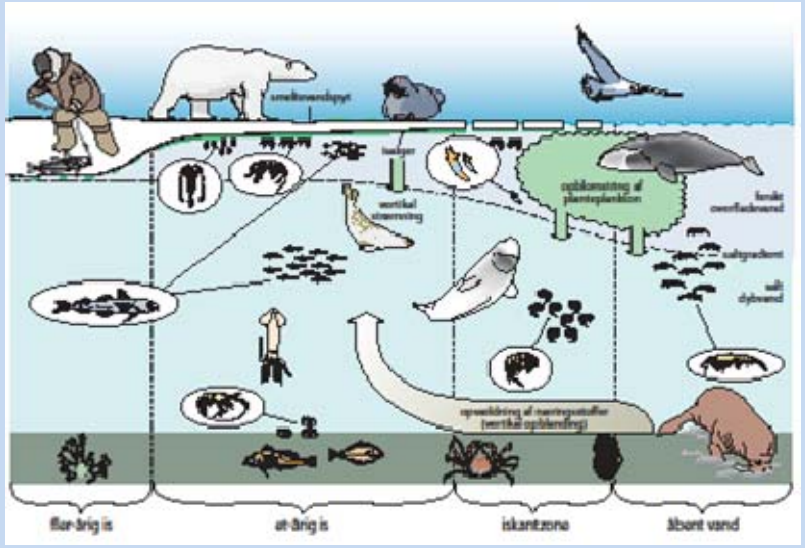


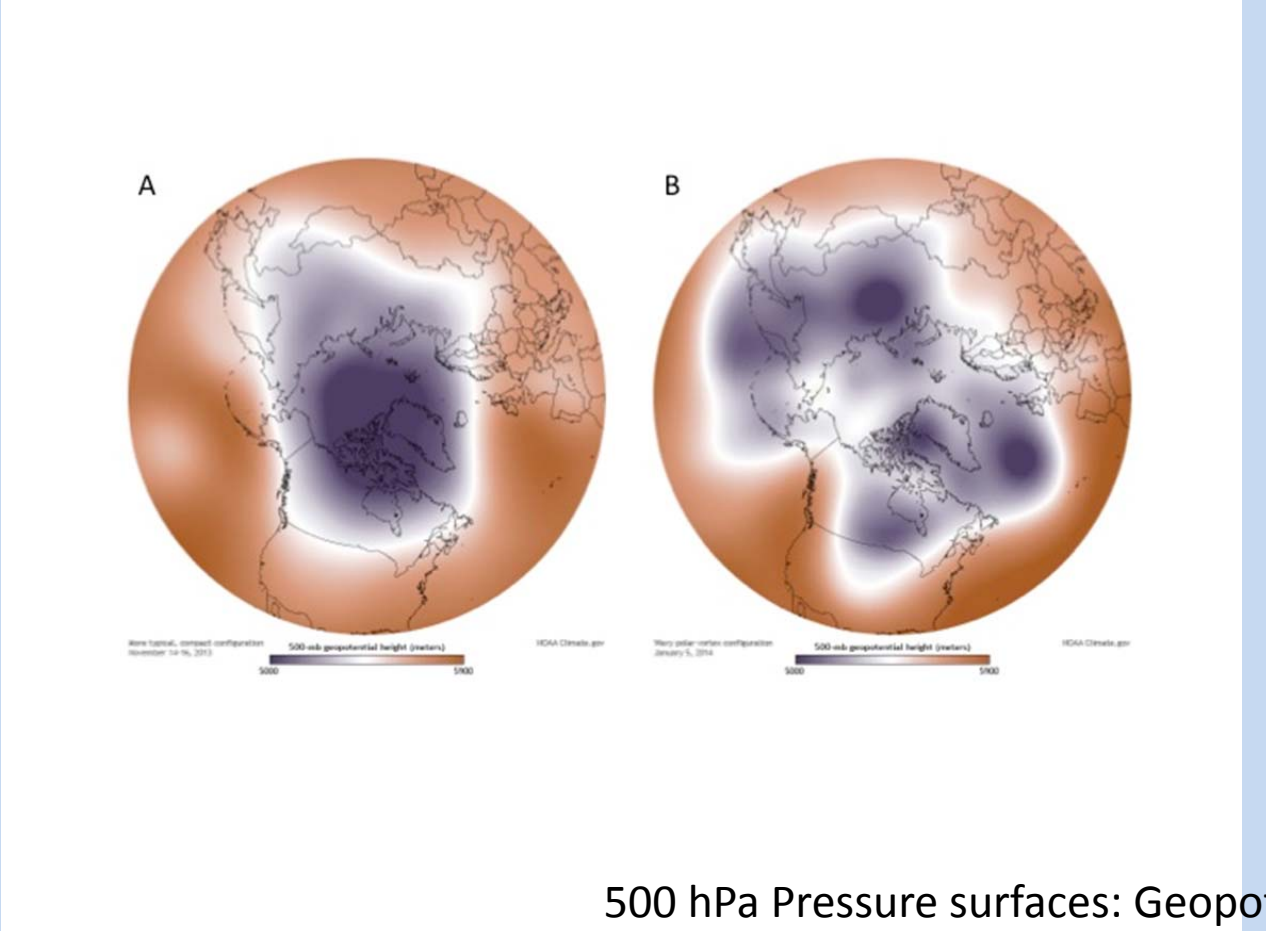
Illustration of Relative Contributions to Arctic Glacier Ice Loss
Year (see time ranges for each point)
1960
1970
1980
1990
2000
2010
Rate of Mean Sea Level Rise (mm/yr)
0
0.5
1.0
Contributors to Mass Loss:
Iceland-Scandinavia-Svalbard
Russian Arctic-Cont Arctic-Siberia-Fareast Russia
Southern Alaska
Canadian Arctic
Greenland Periphery
Greenland Ice Sheet
0.24
60-65*
0.34
65-70*
0.22
70-75*
0.43
75-80*
0.36
80-85*
0.33
85-90*
0.26
90-95*
0.62
95-00
1.07
00-05
1.28
05-09
*Greenland Ice Sheet mass change not availbale
in these intervals but assumed small here

- **All parts of the cryosphere respond to a warming Arctic and major parts are responding much faster than anticipated**
- **We are witnessing a ongoing shift in the temporal and spacial distribution of water in its solid, liquid and vapour states.**

Local and regional changes

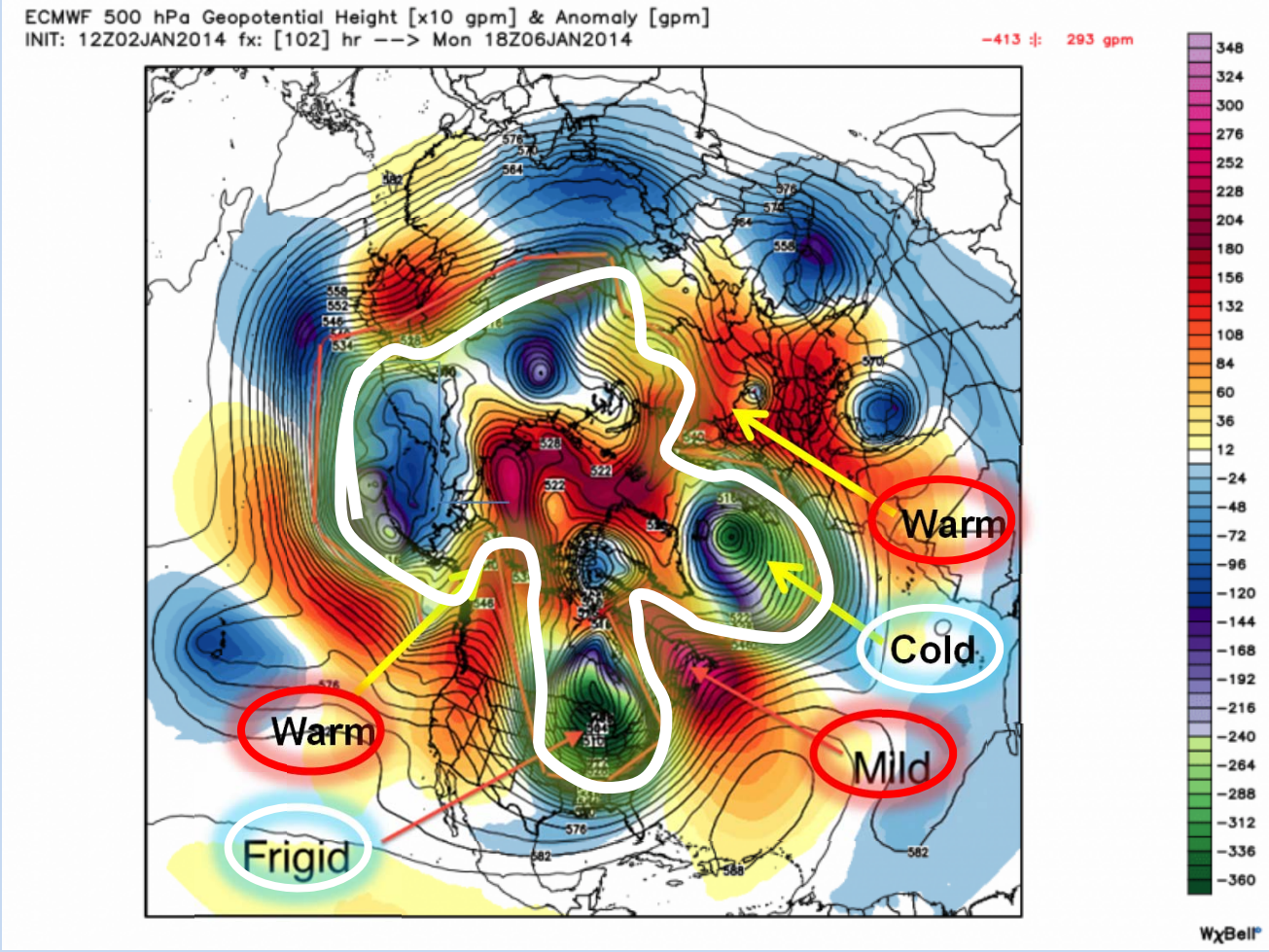


Changing impacts on lower latitude weather?

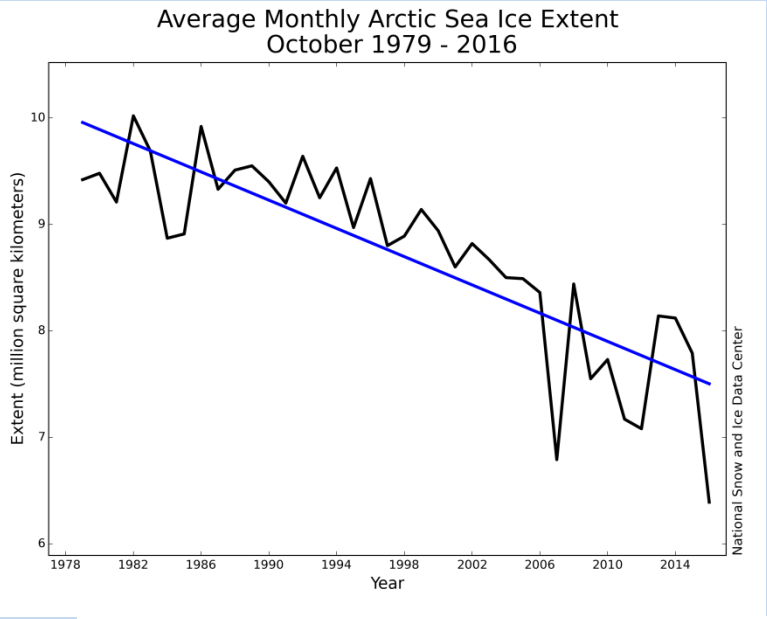


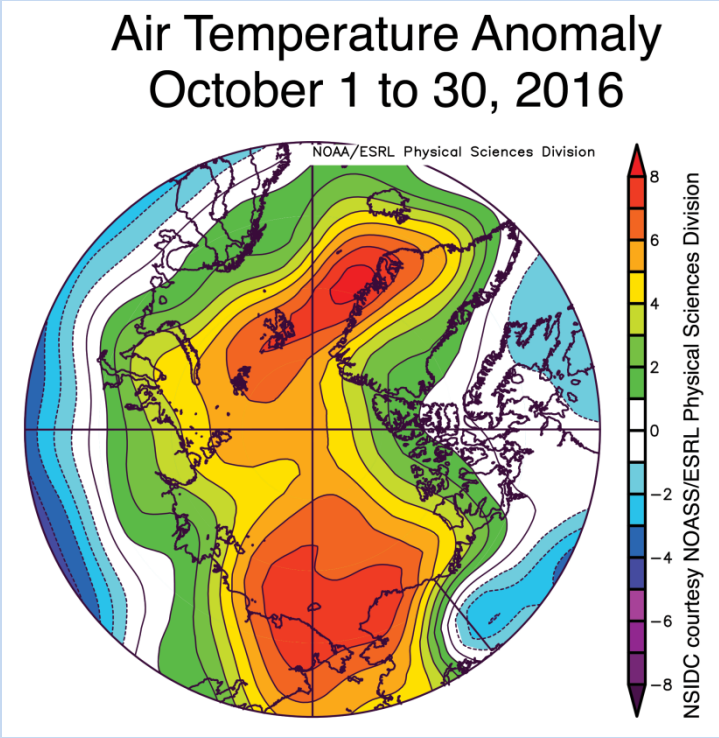
500 hPa Pressure surfaces: Geopotential Heights

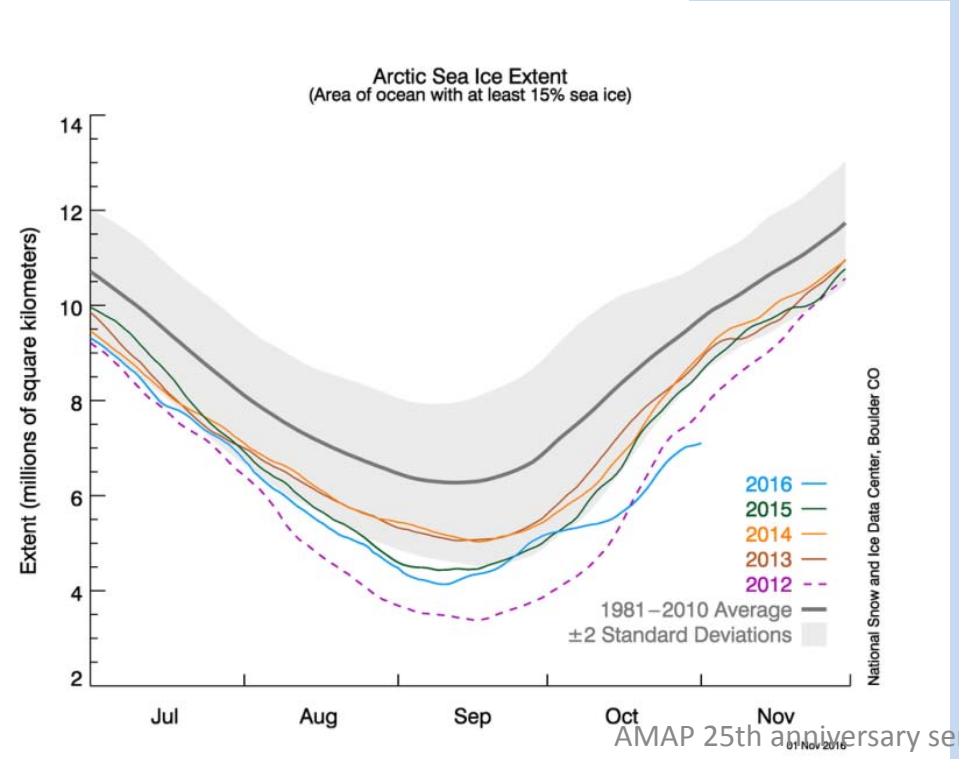
Attack of the Polar Vortex – Early January 2014



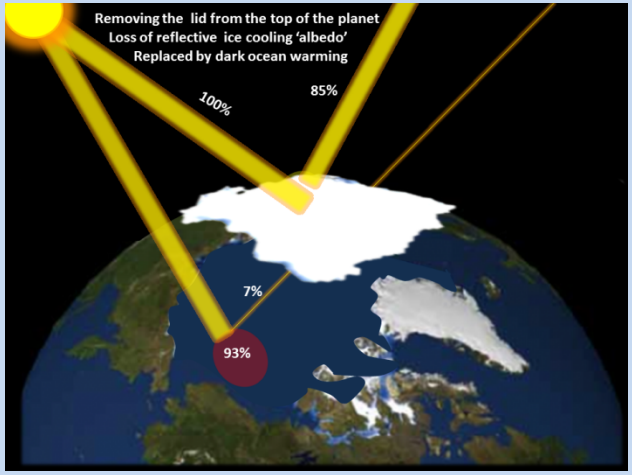
Feedbacks

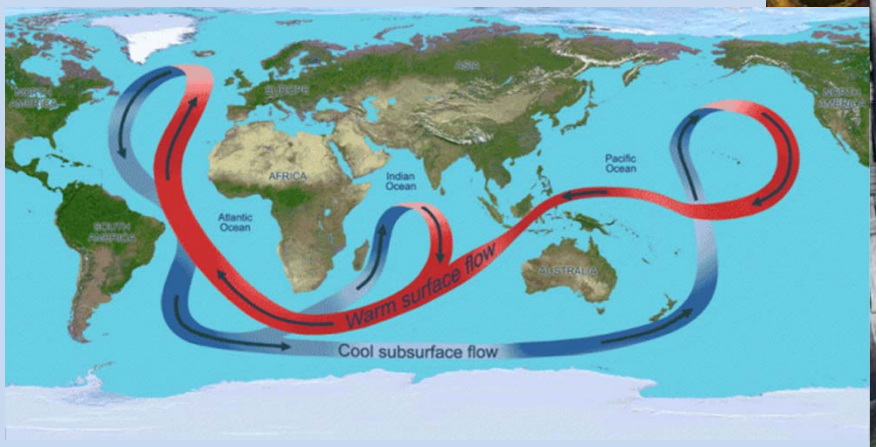

Average Monthly Arctic Sea Ice Extent
October 1979 - 2016
Extent (million square kilometers)
Year
National Snow and Ice Data Center


Air Temperature Anomaly
October 1 to 30, 2016
NOAA/ESRL Physical Sciences Division
NSIDC courtesy NOASS/ESRL Physical Sciences Division


Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)
Extent (millions of square kilometers)
2016
2015
2014
2013
2012
1981–2010 Average
±2 Standard Deviations
Jul
Aug
Sep
Oct
Nov
National Snow and Ice Data Center, Boulder CO

Global connectivity





Concluding remarks

- Changes in the arctic cryosphere are happening fast
- Changes fundamentally impact Arctic living conditions and have major impact on global living conditions
- We are trying to understand complex cause-effect relationships in a changing and previously inaccesable system
- Understanding of trends, variability and interactions limited by temporal and spacial resolution (and integration?)
- Needs for interdiciplinary monitoring and reseach
- AMAP has played a pivotal role in assessing and synthesising knowledge
- Impacts on IPCC and public awareness have been big
- Continous need to synthesize and assess consequenses of arctic climate change
- And for public outreach

Thank you!