Polar Climate

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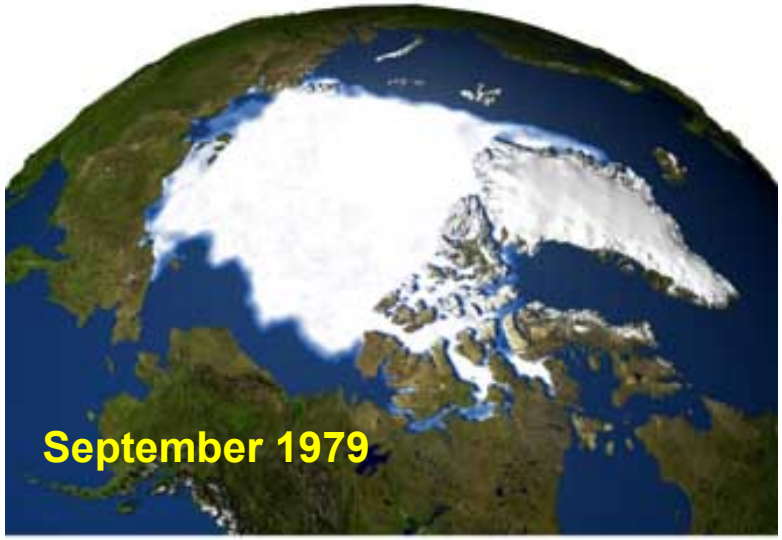
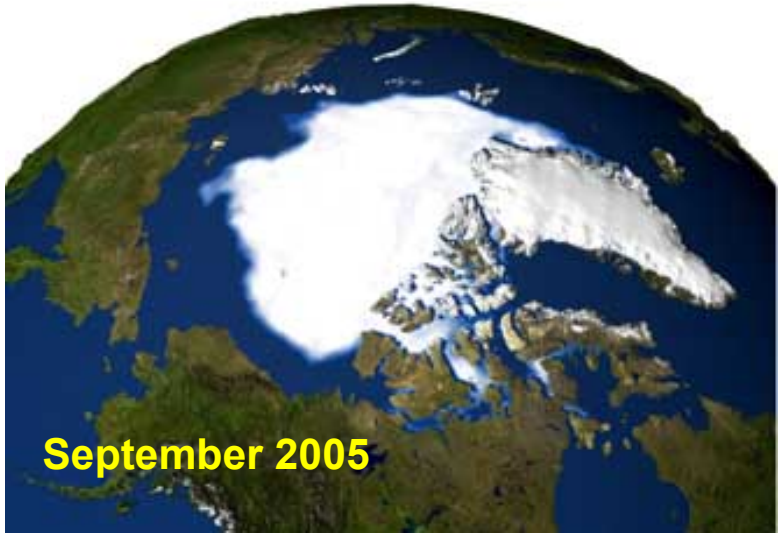
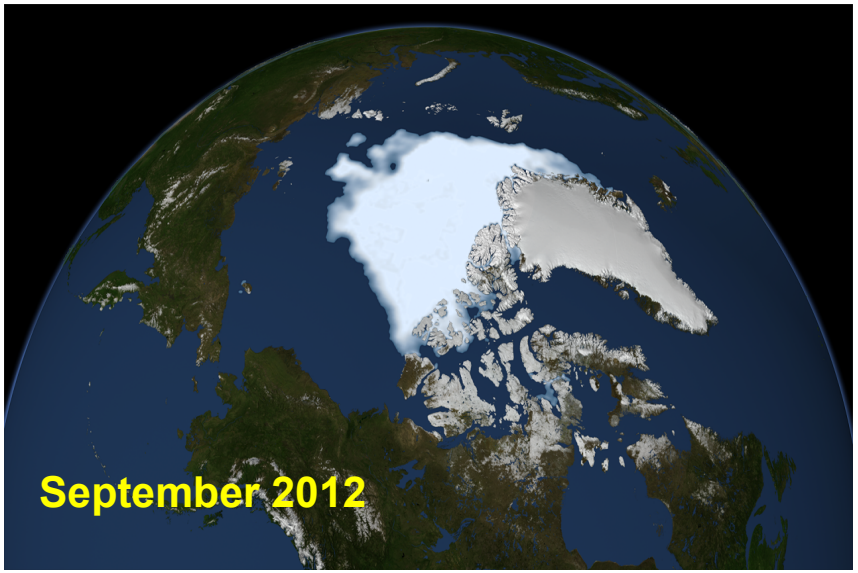
- **Record lows of sea ice extent have consecutively occurred**

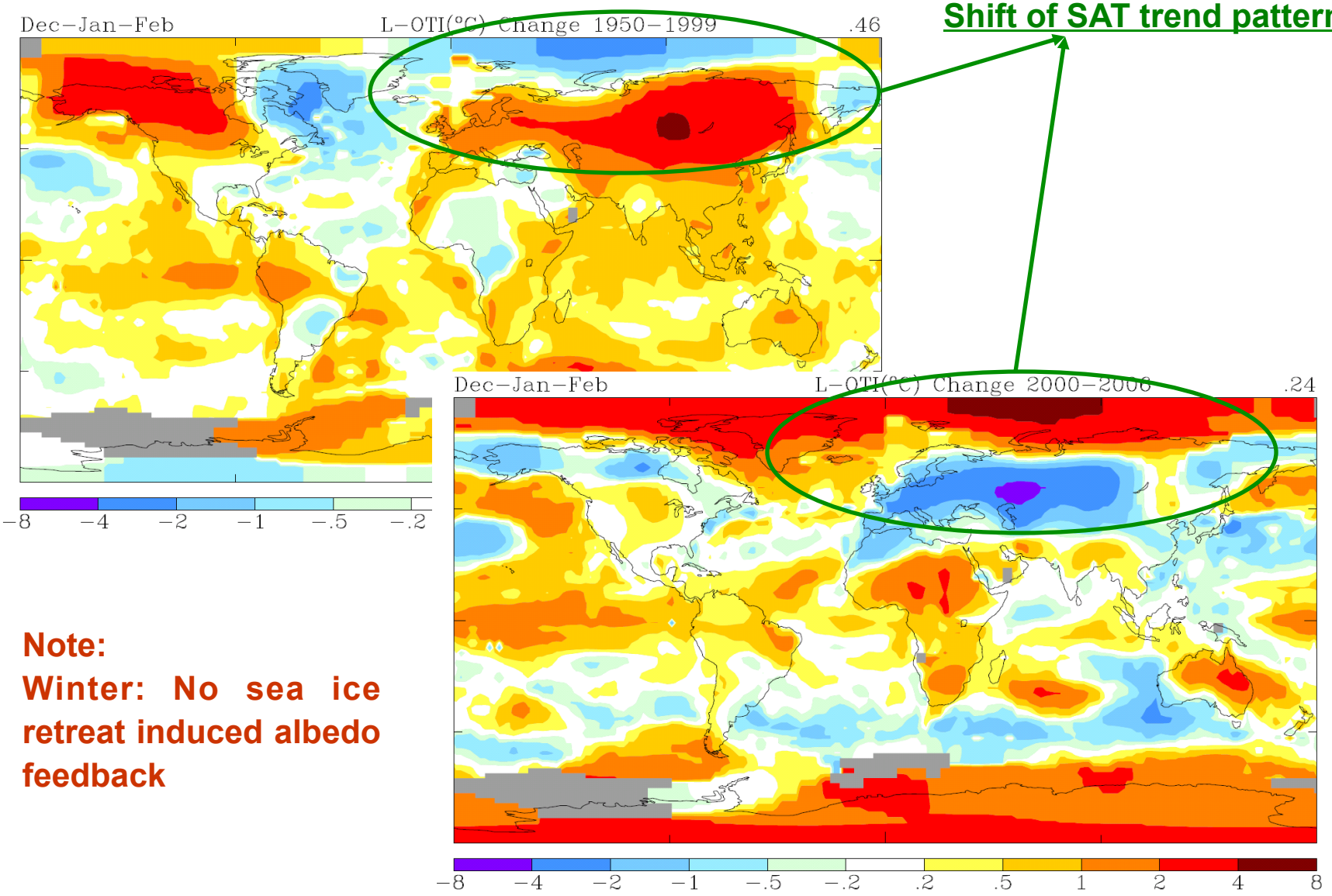






NASA

- **Surface temperature increase has been further amplified over Arctic**

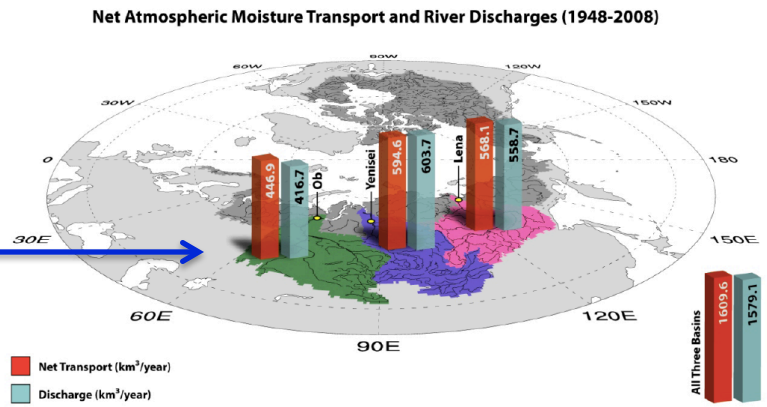


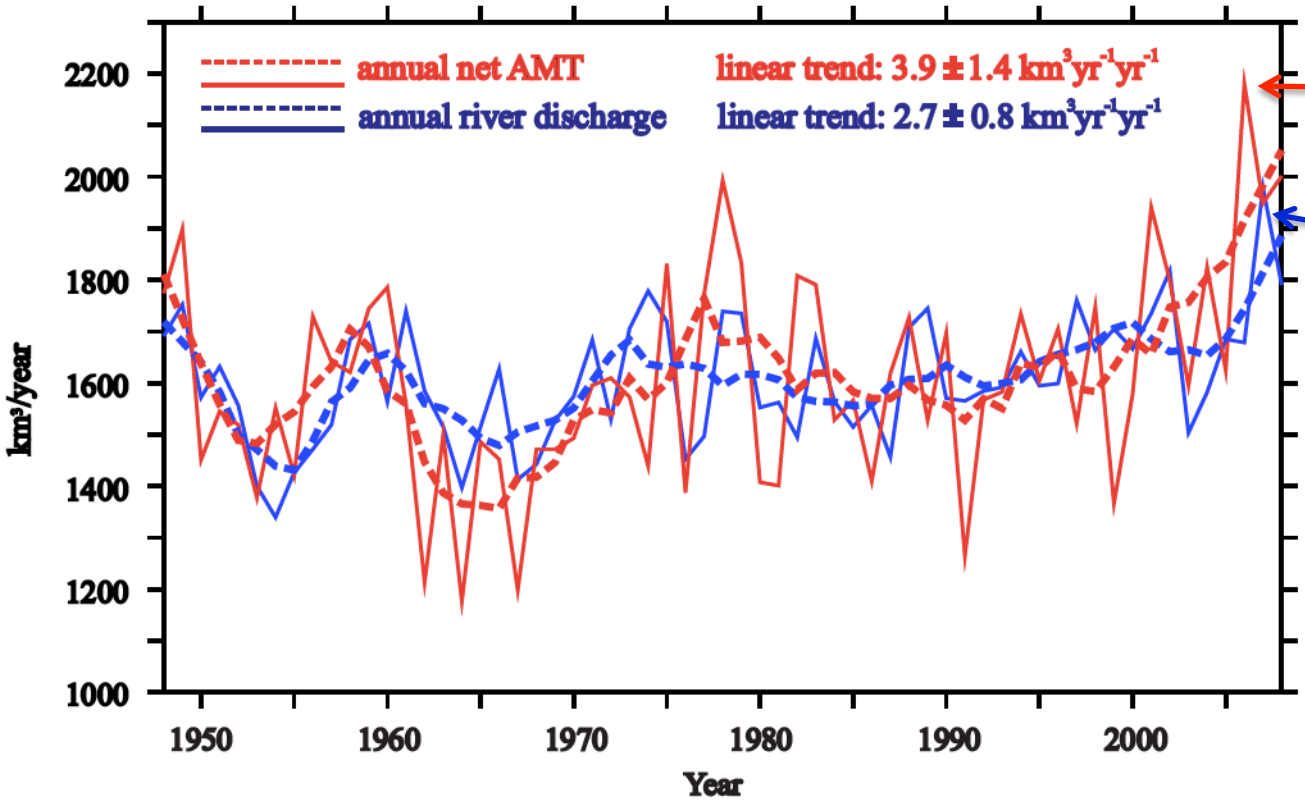
Shift of SAT trend pattern

Note:
Winter: No sea ice retreat induced albedo feedback

- **Poleward atmospheric moisture transport and Arctic river discharges have been enhanced**

Three Largest Eurasian Arctic Rivers: Lena, Yenisei, and Ob



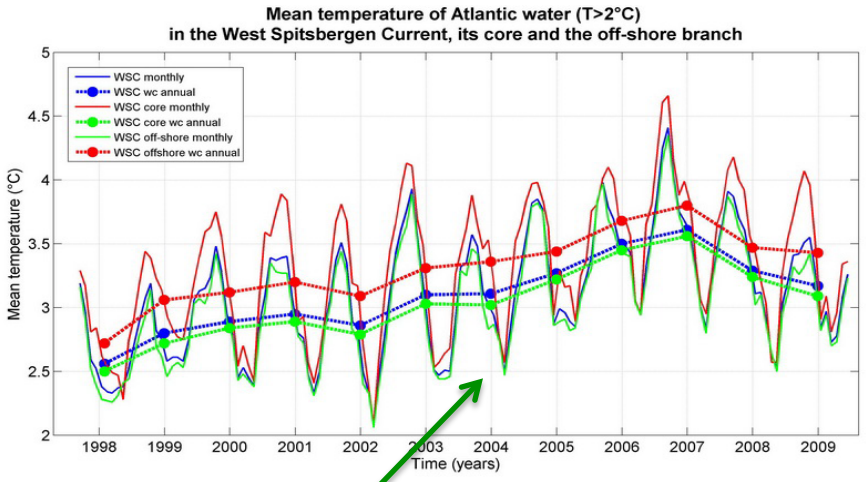


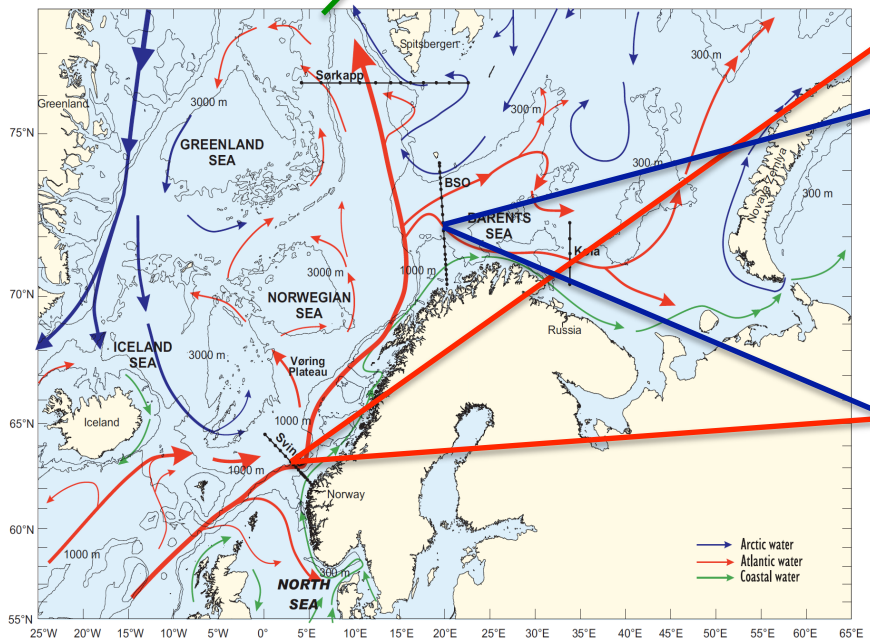
Record high transport

Record high discharge

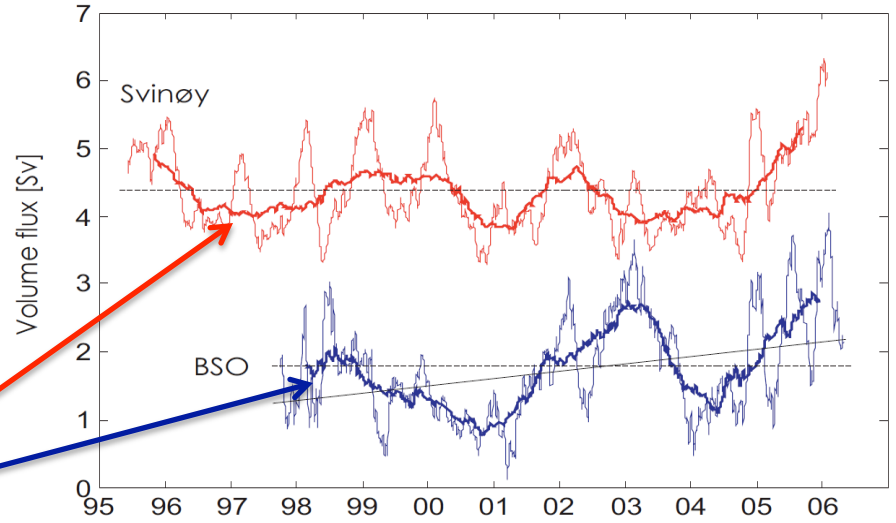
Zhang et al., 2013

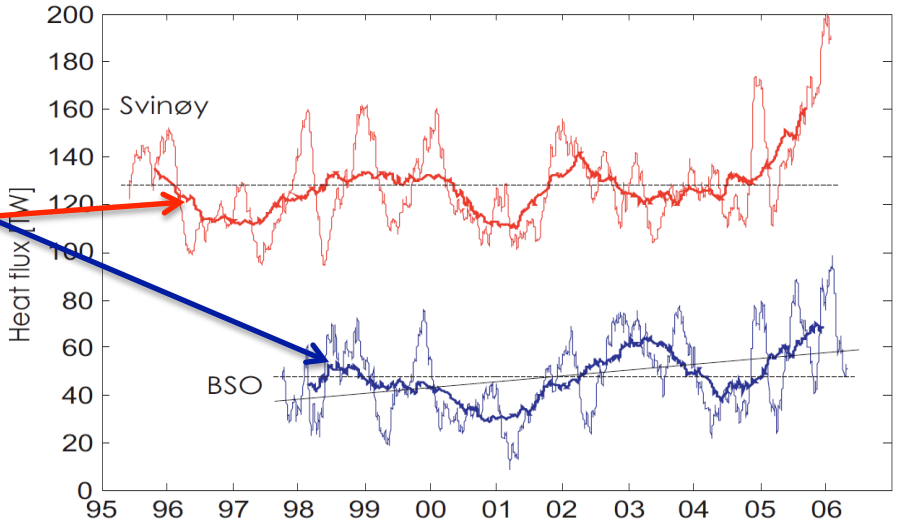
- **Atlantic warm water intrusion has been enhanced**





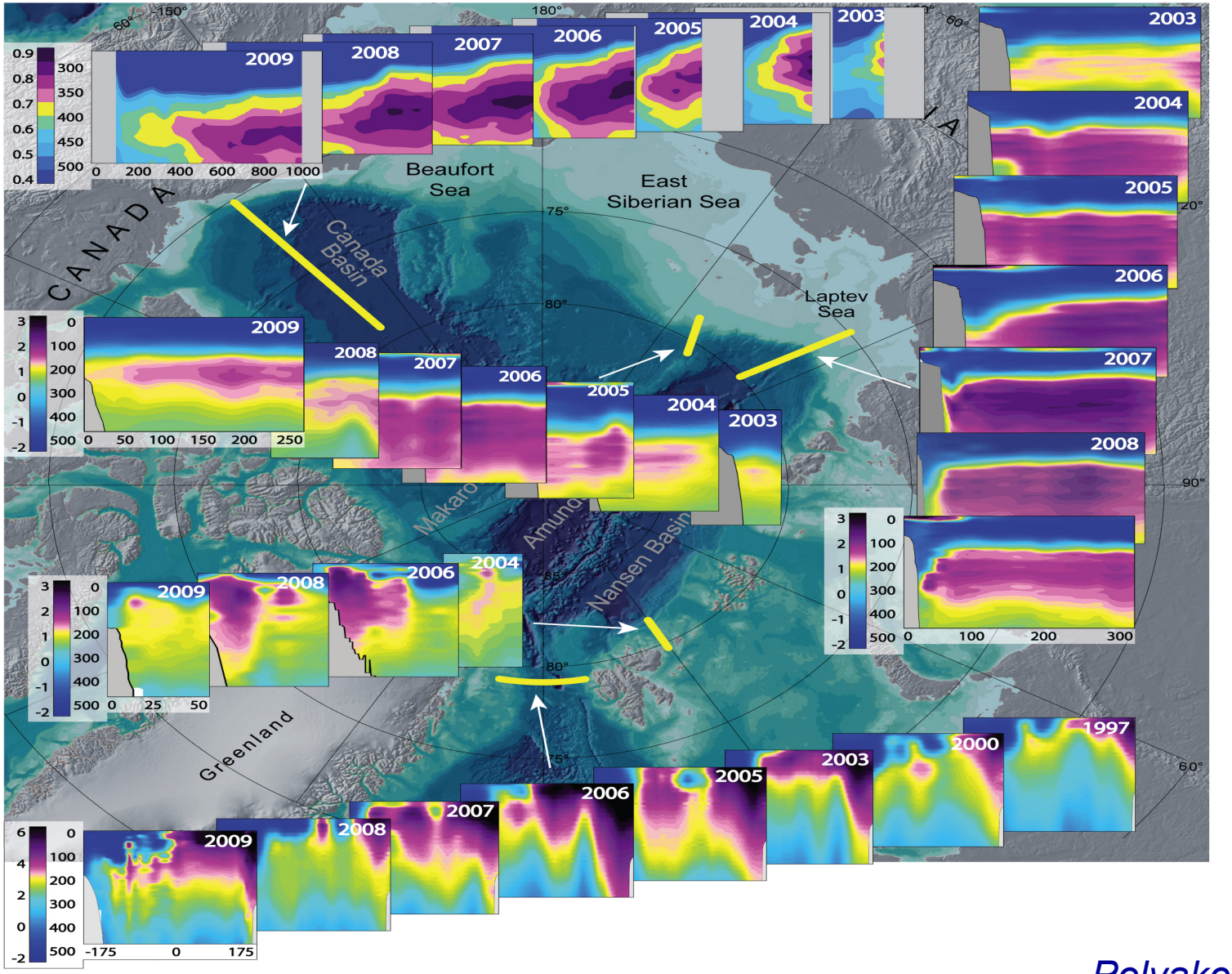
Beszczynska-Möller et al.





Skagseth et al.

- **Atlantic layer temperature has been increased**



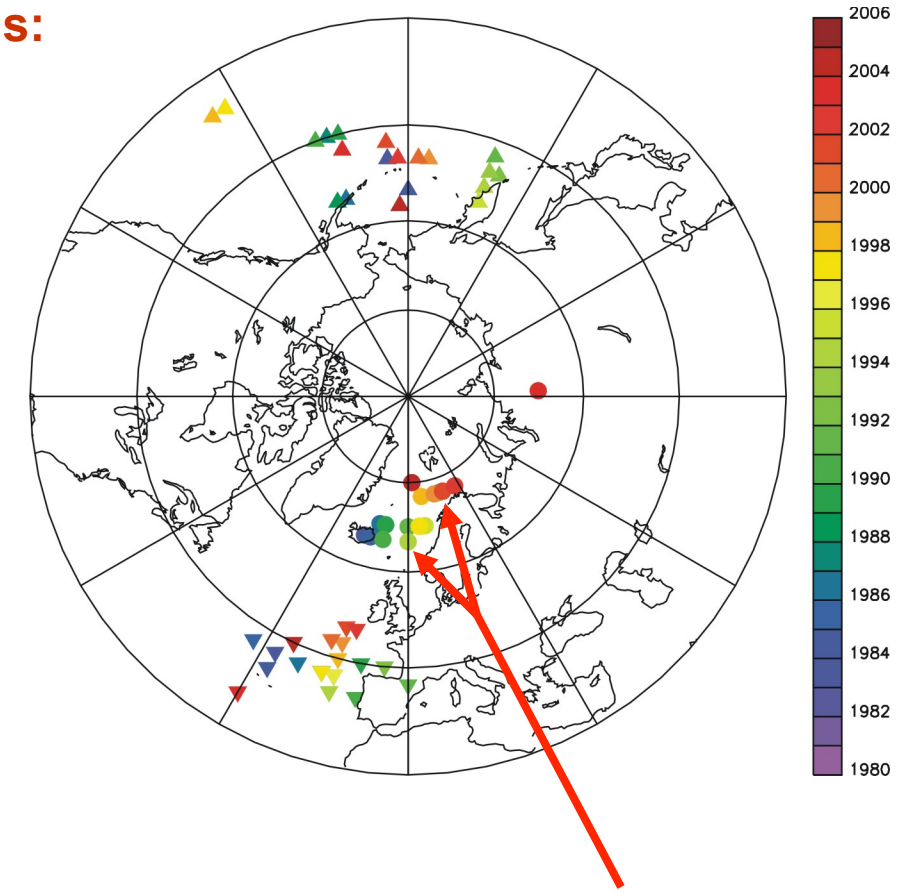
Polyakov et al., 2011

- **Atmospheric circulation pattern shift and the Arctic Rapid change Pattern (ARP)**

Running EOF/PC (Rn-EOF/PC) analysis:

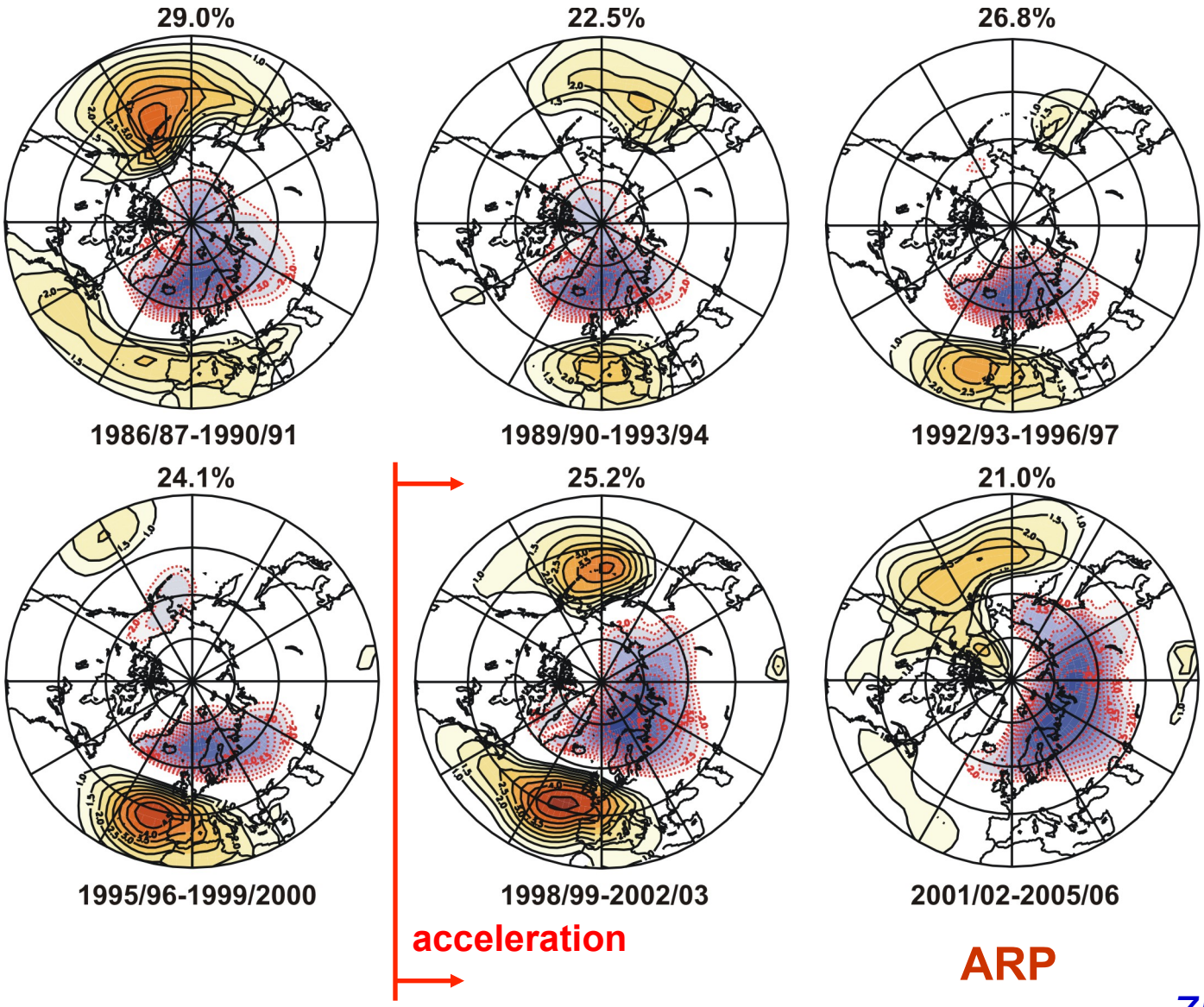
- **30-winter-month running window**

- **EOF/PC analysis seeks spatially- and temporally-coordinated pattern that explains maximum variance and identifies centers of action**



Zhang et al., 2008

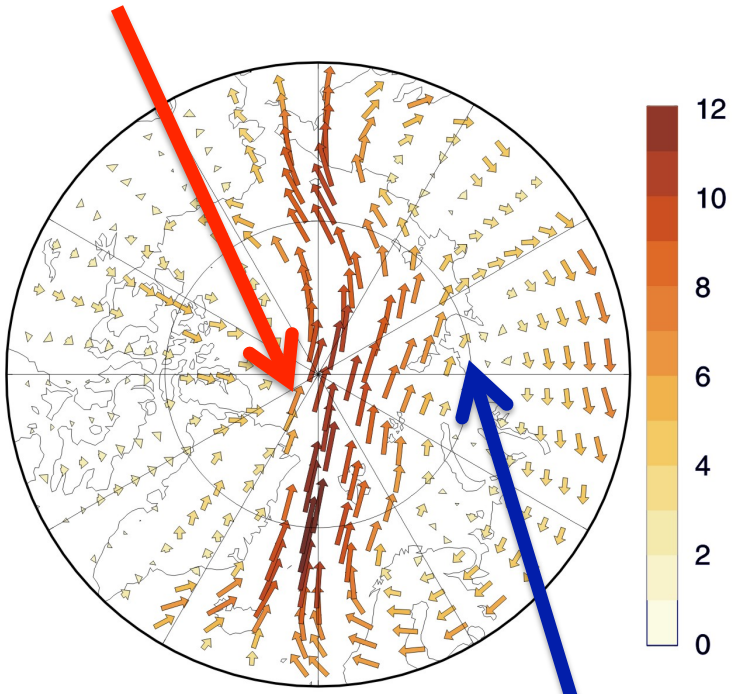
- **Atmospheric circulation pattern shift and the Arctic Rapid change Pattern (ARP)**



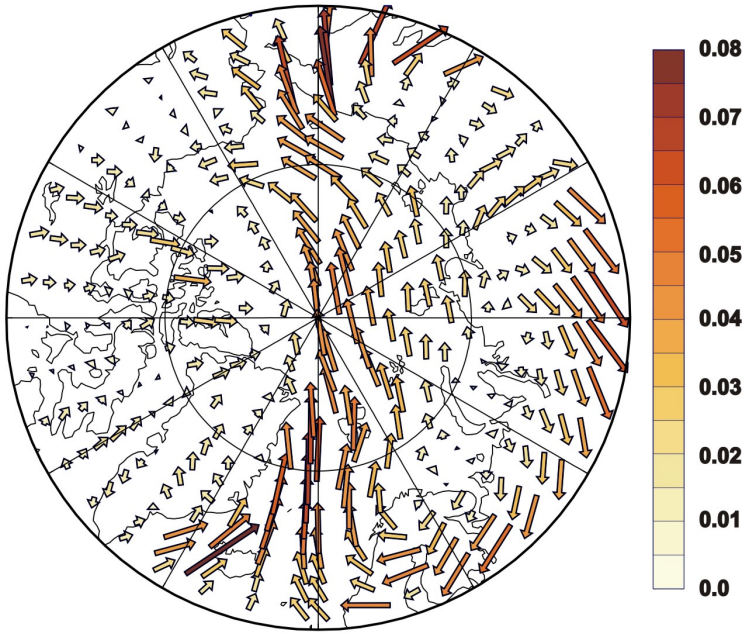
Zhang et al., 2008

- **ARP has enhanced Arctic-midlatitude climate interactions**

provided a shortcut of atmosphere and ocean heat transport into the central Arctic from the midlatitude



Heat transport regressed onto winter ARP index (surface - 850 hpa)

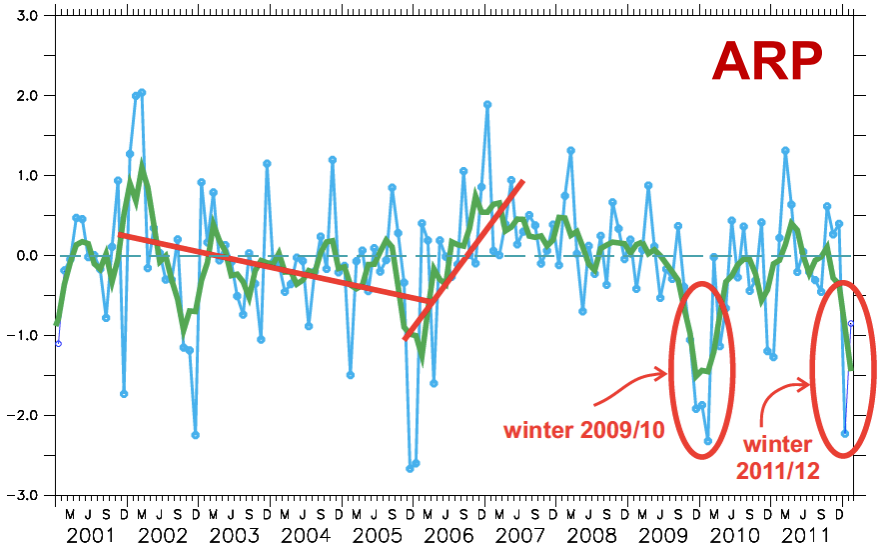


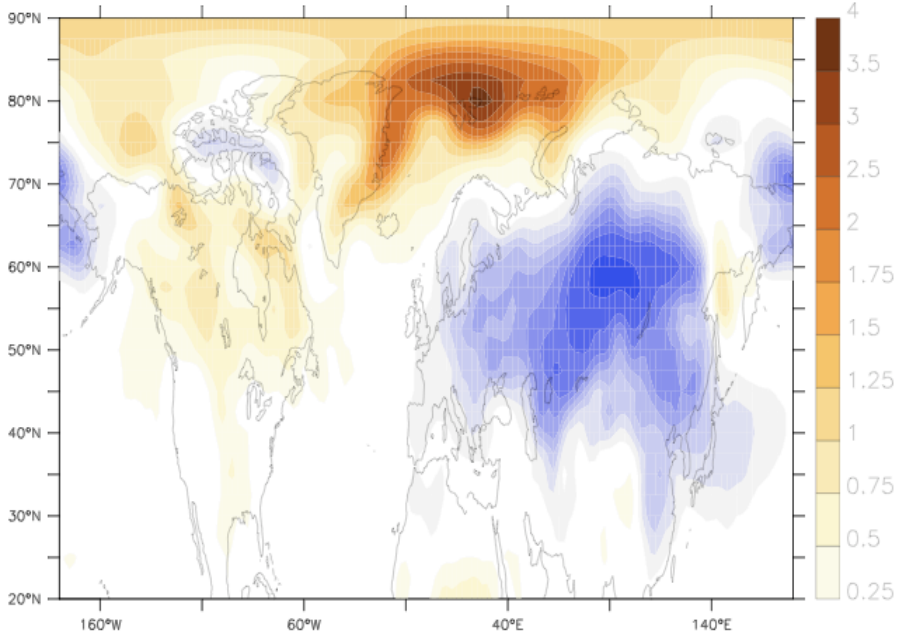
Surface wind stress regressed onto winter ARP index

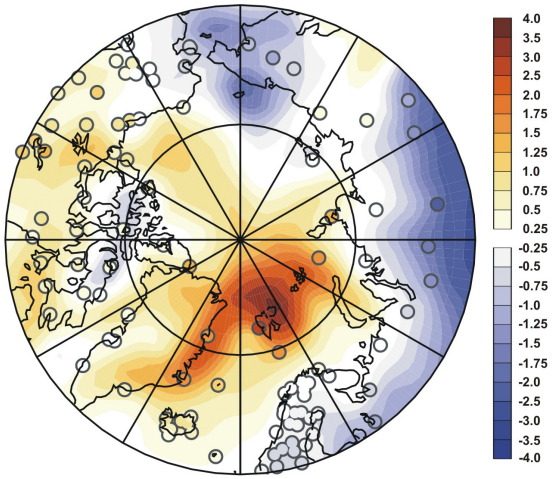
re-circulate cold polar air to the midlatitude from Arctic

Zhang et al., 2008

- **ARP has not only orchestrated rapid changes in the Arctic climate system but also played driving role in midlatitude climate**





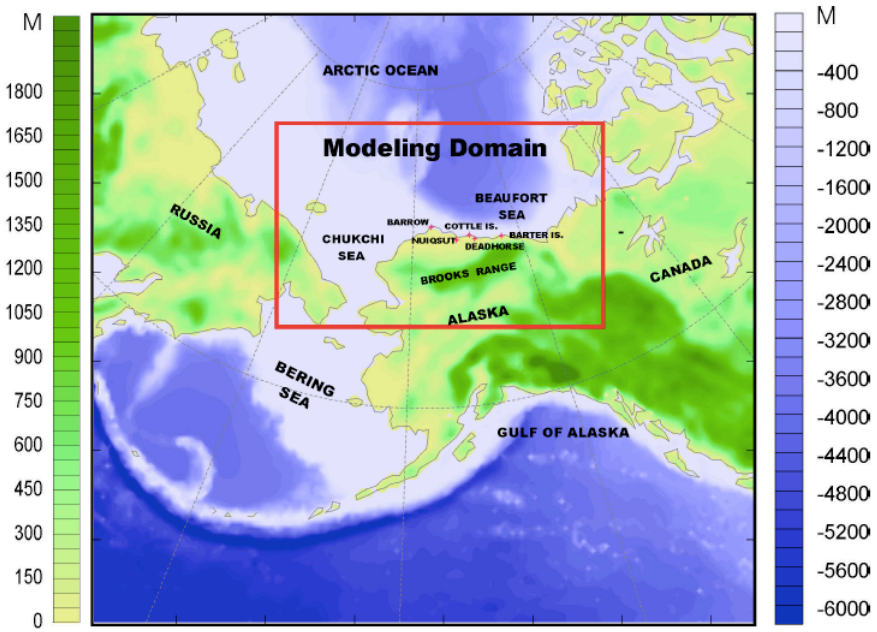


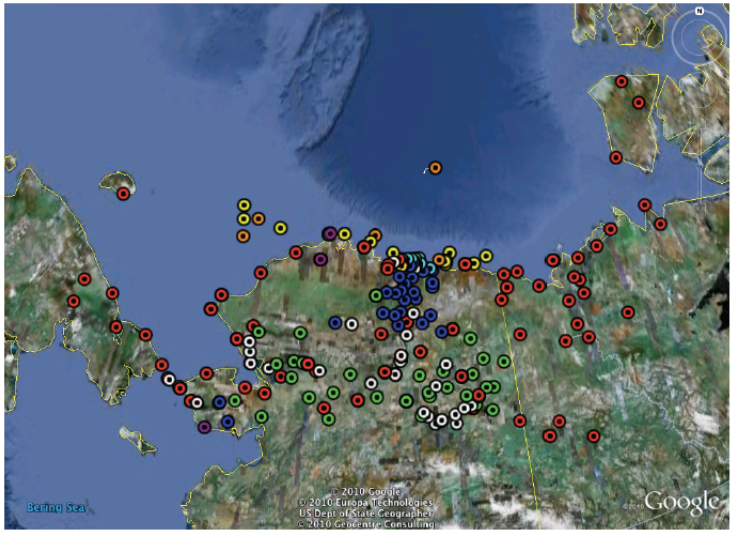
Winter Surface Air Temperature Regressed onto ARP Index

ARP driven surface air temperature Anomalies

Zhang et al, 2008, 2012

- **The Chukchi-Beaufort seas High-resolution Atmospheric Reanalysis (CBHAR)**



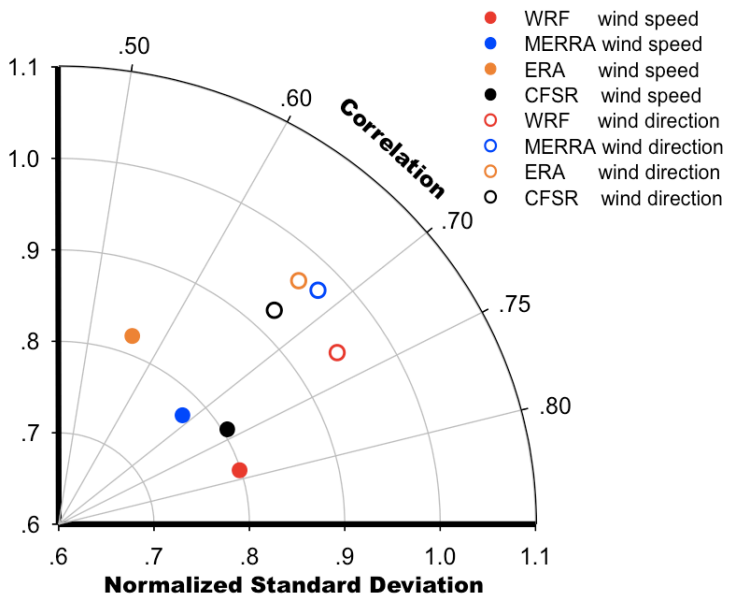


Model: WRF-ARW

Data product:

Spatial resolution: 10 km

Temporal resolution: 1 hour



Polar Climate Discussion Points

Questions:

- What physical mechanisms/processes triggered/drove acceleration of sea ice reduction and poleward heat transport increase?
- What caused the changes in spatial structure of the atmospheric circulation leading mode or weather patterns?
- Why were synoptic-scale and meso-scale weather systems intensified over the Arctic?
- How does large-scale atmospheric circulation dynamics condition physical processes to cause accelerated Arctic warming and sea ice decrease?
- What is the relative role of local albedo feedback and poleward heat and moisture transport in the amplified warming of the Arctic Ocean?
- What role does the warmed Arctic play in the midlatitude weather extremes, such as cold winter weather events?
- How does the warmed Atlantic and Pacific ocean layers release heat to overlying sea ice and atmosphere?

Polar Climate Discussion Points

Observations needed or needed to improve:

- Long-term estimate of sea ice thickness covering the entire Arctic Ocean
- Spatially-well covered atmospheric observations, in particular vertical profile data
- Snow cover and depth data (recent publication showing some uncertainties across different data sets).
- Energy budgets from satellite data (consistence throughout the time)
- Improved data assimilation/reanalysis at higher resolutions