Understanding drivers of recent Arctic tundra vegetation changes.

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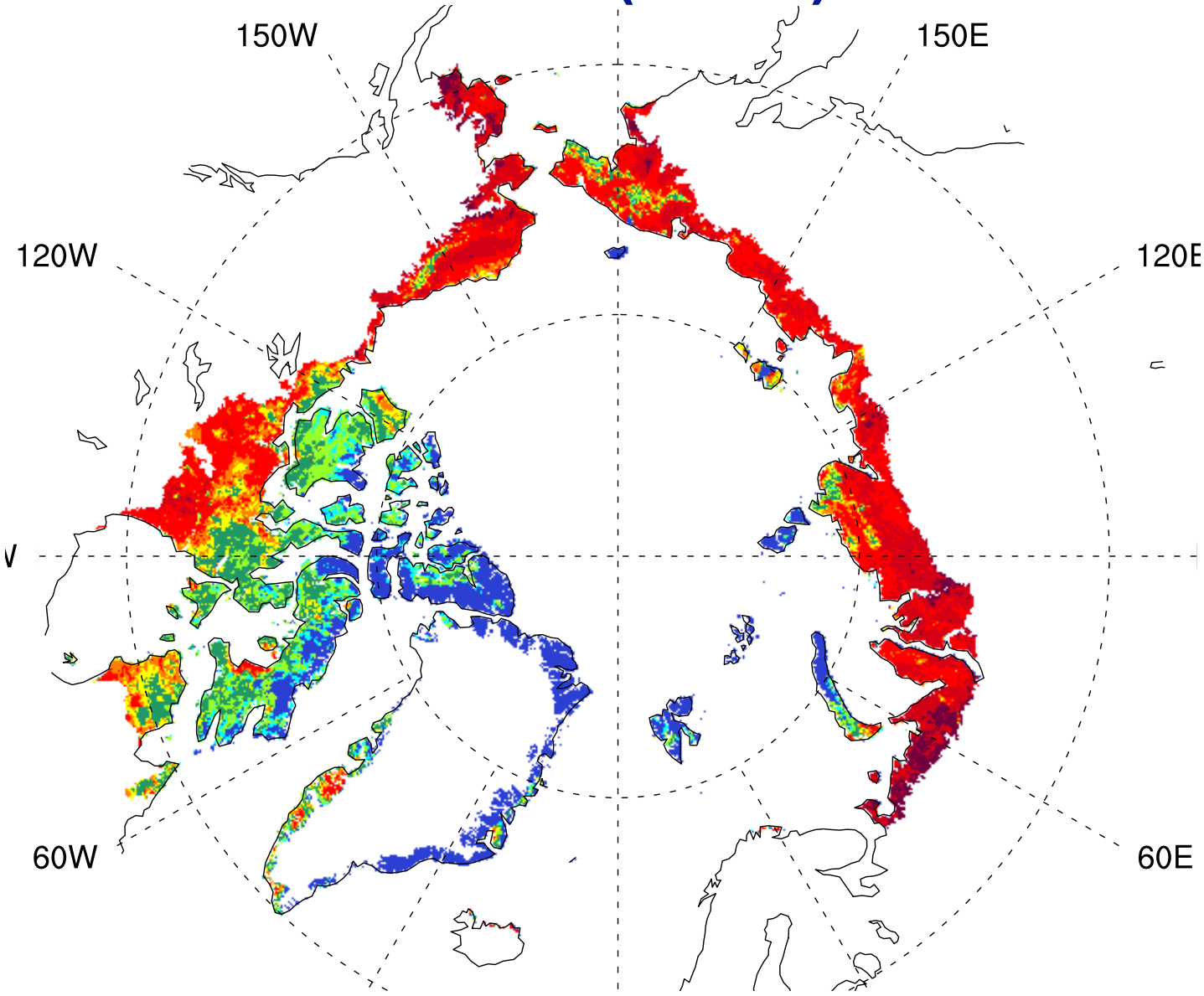
Main Findings

- Arctic vegetation has become 'greener' & is linked to ice
- This greening has varied in strength throughout the Arctic tundra & causes are complex!

Mean MaxNDVI (82-10) linked to Mean Sea Ice



Circumpolar Arctic Vegetation Map

80% of the Arctic tundra (3.2 million km^2) < 100km from ocean

Remote sensing data & methods

Data: 1982-2010 (29 yrs, weekly)

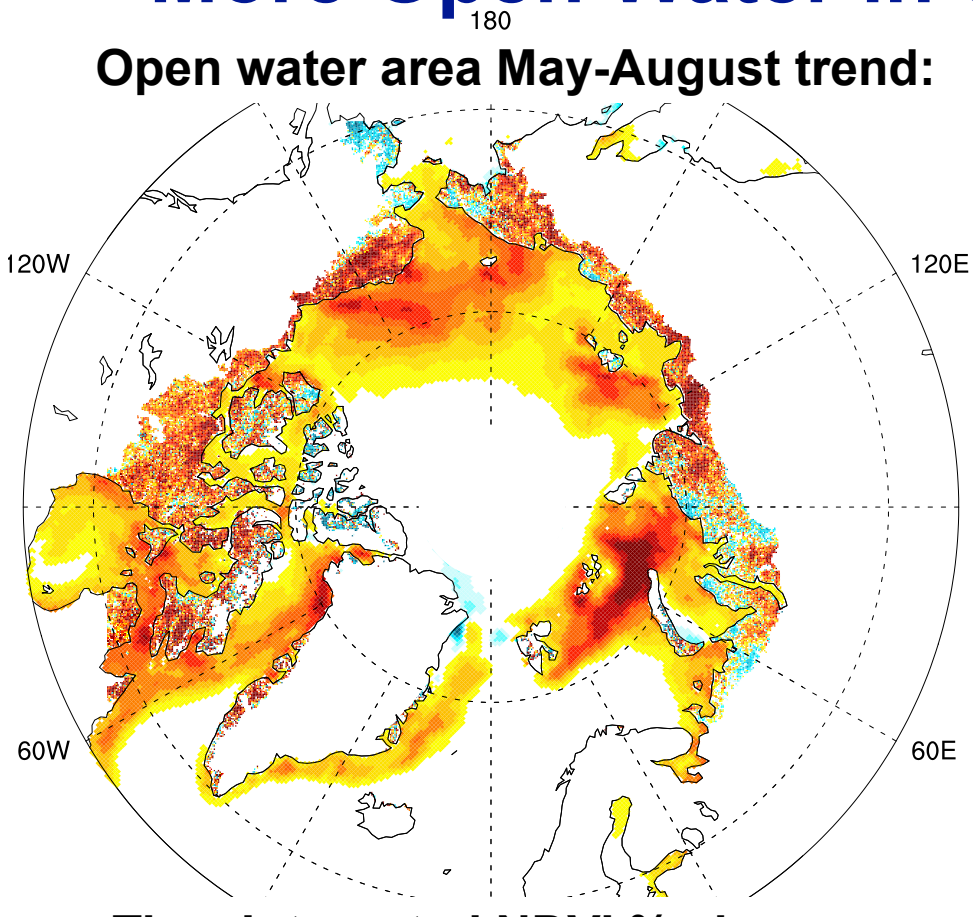
- **Passive Microwave Sea Ice Concentration (25km)**
- **AVHRR Land Surface Temp. (25-km)**
- **Gimms NDVI 3g (Max and Integrated) (14-km)**

New version that is corrected for Arctic

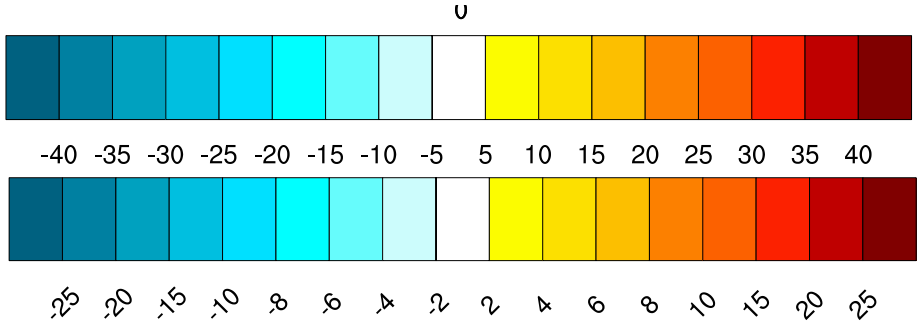
- **Divided Arctic Ocean (Treshnikov, 1985) to examine trends and variability in 50/100-km ocean - full tundra land domains**

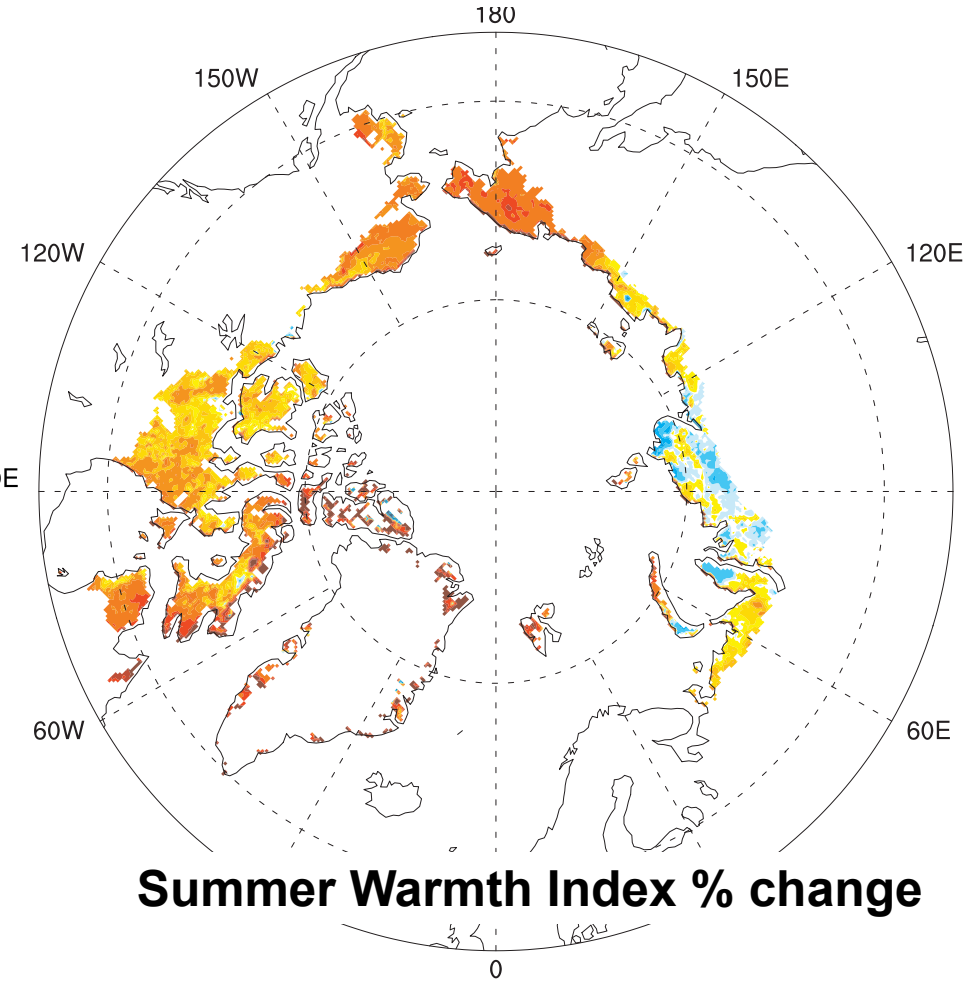
Trends 1982-2010 indicate:
More Open Water in Summer ==> Higher NDVI

Open water area May-August trend:



Time Integrated NDVI % change





Summer Warmth Index % change

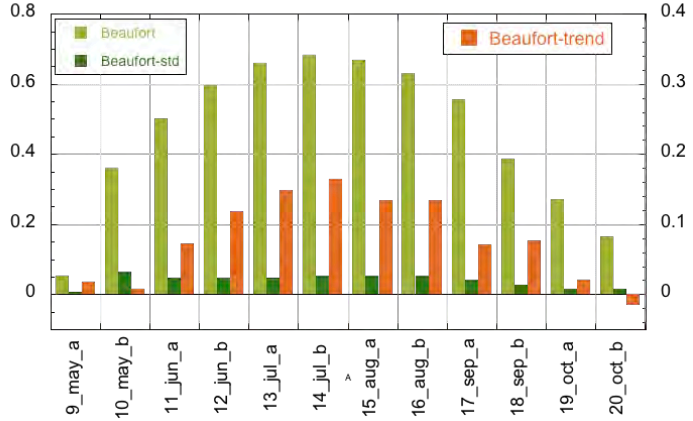
[Updated from Bhatt et al. 2010]

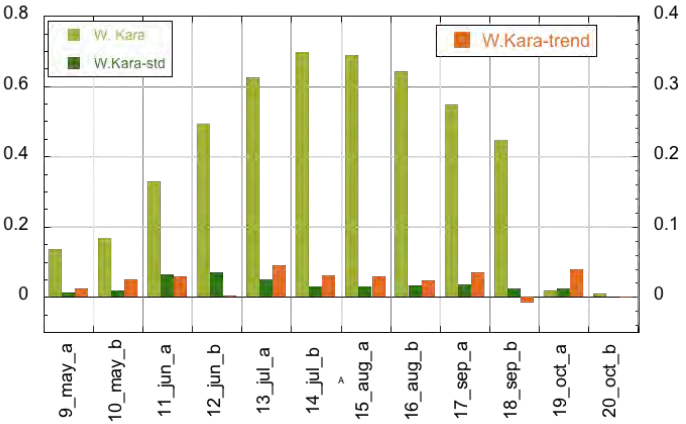
Contrasting NDVI Seasonality/Trends in Beaufort and W. Kara

Beaufort

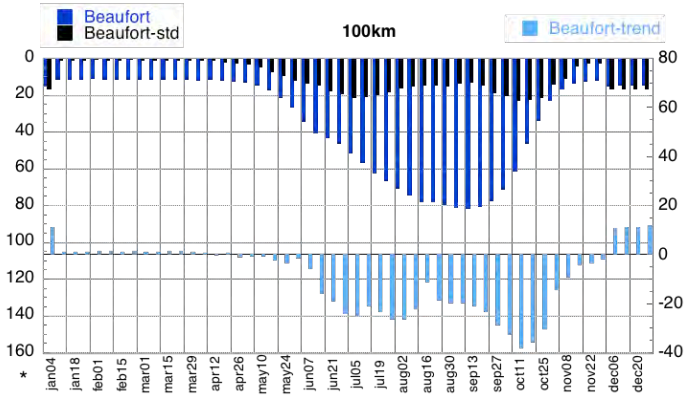
1982-2010

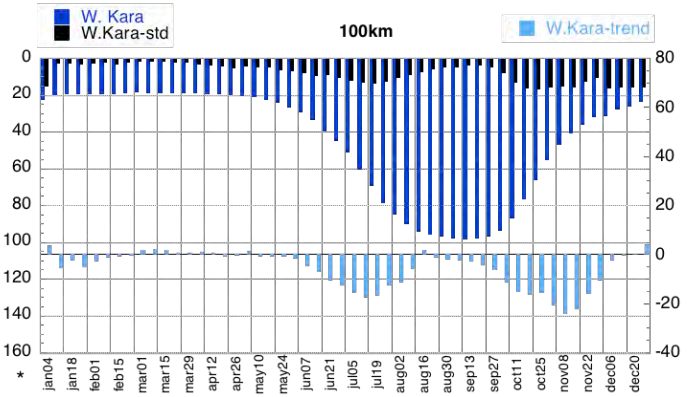
W. Kara



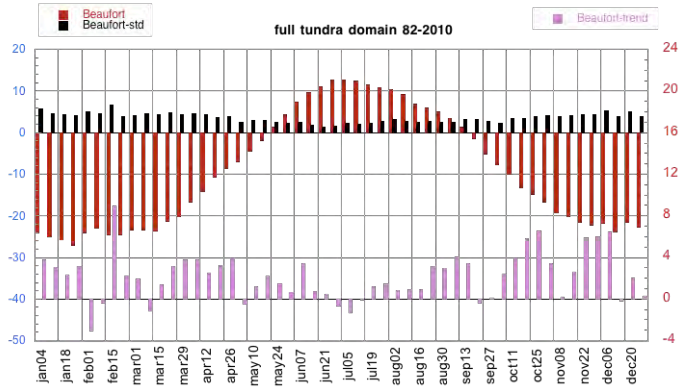


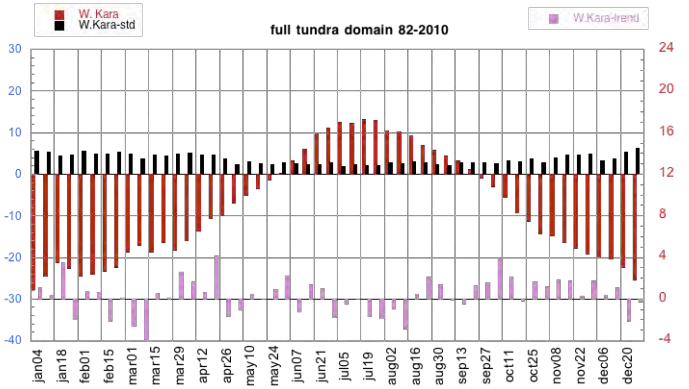
Bi-weekly MaxNDVI





Weekly Sea ice

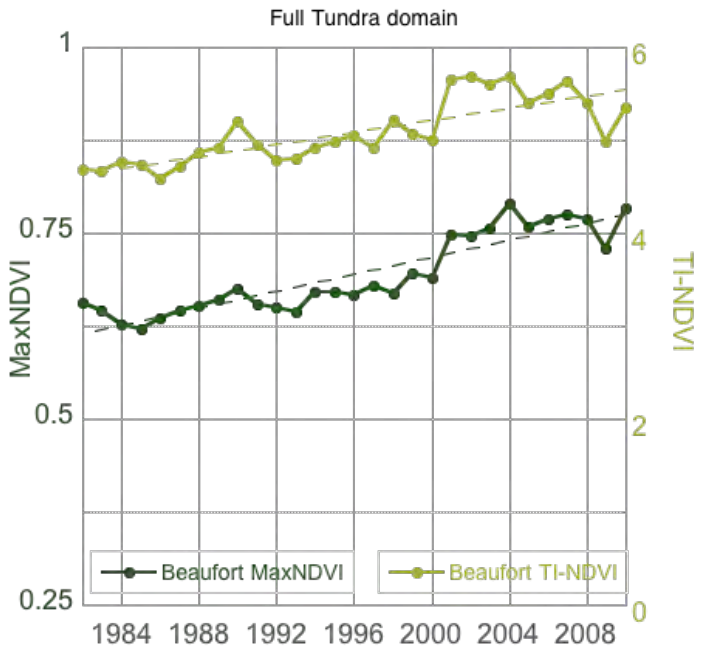




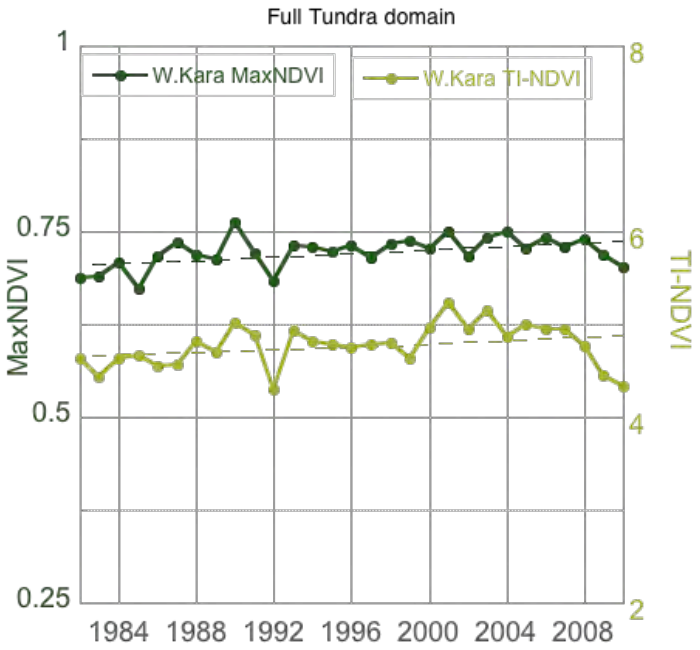
Weekly T surface

Contrasting NDVI Variability/Trends in Beaufort and W. Kara

Beaufort

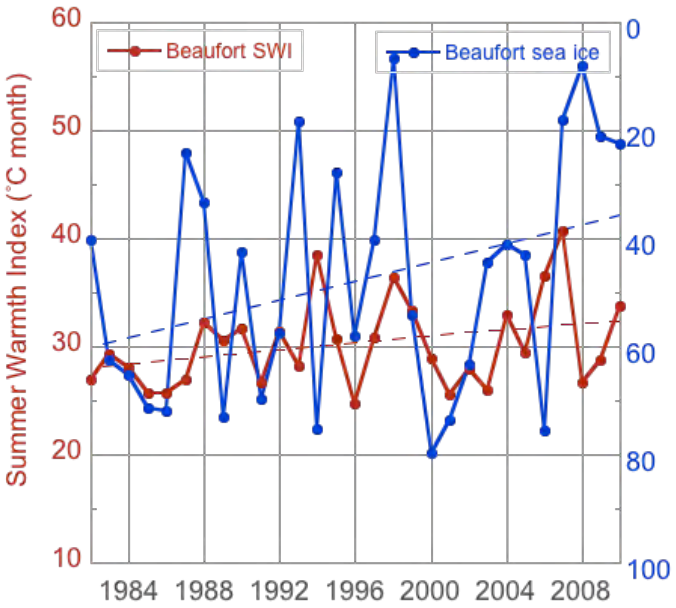


W. Kara



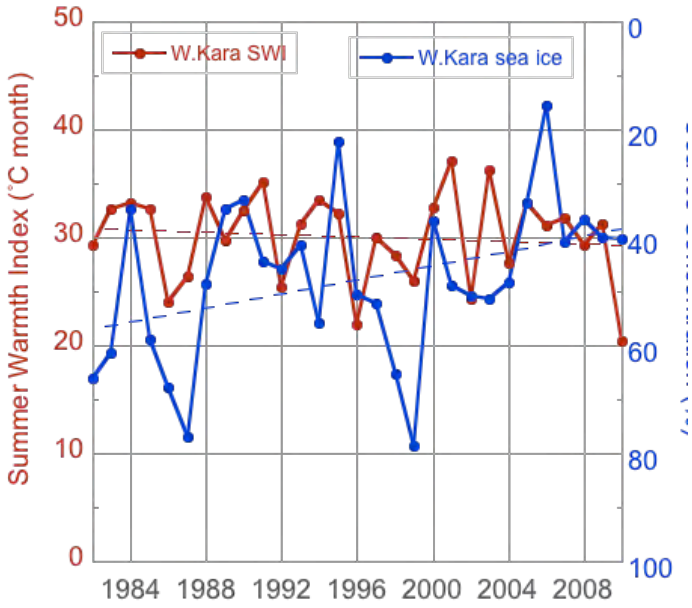
Maximum NDVI

Time Integrated NDVI



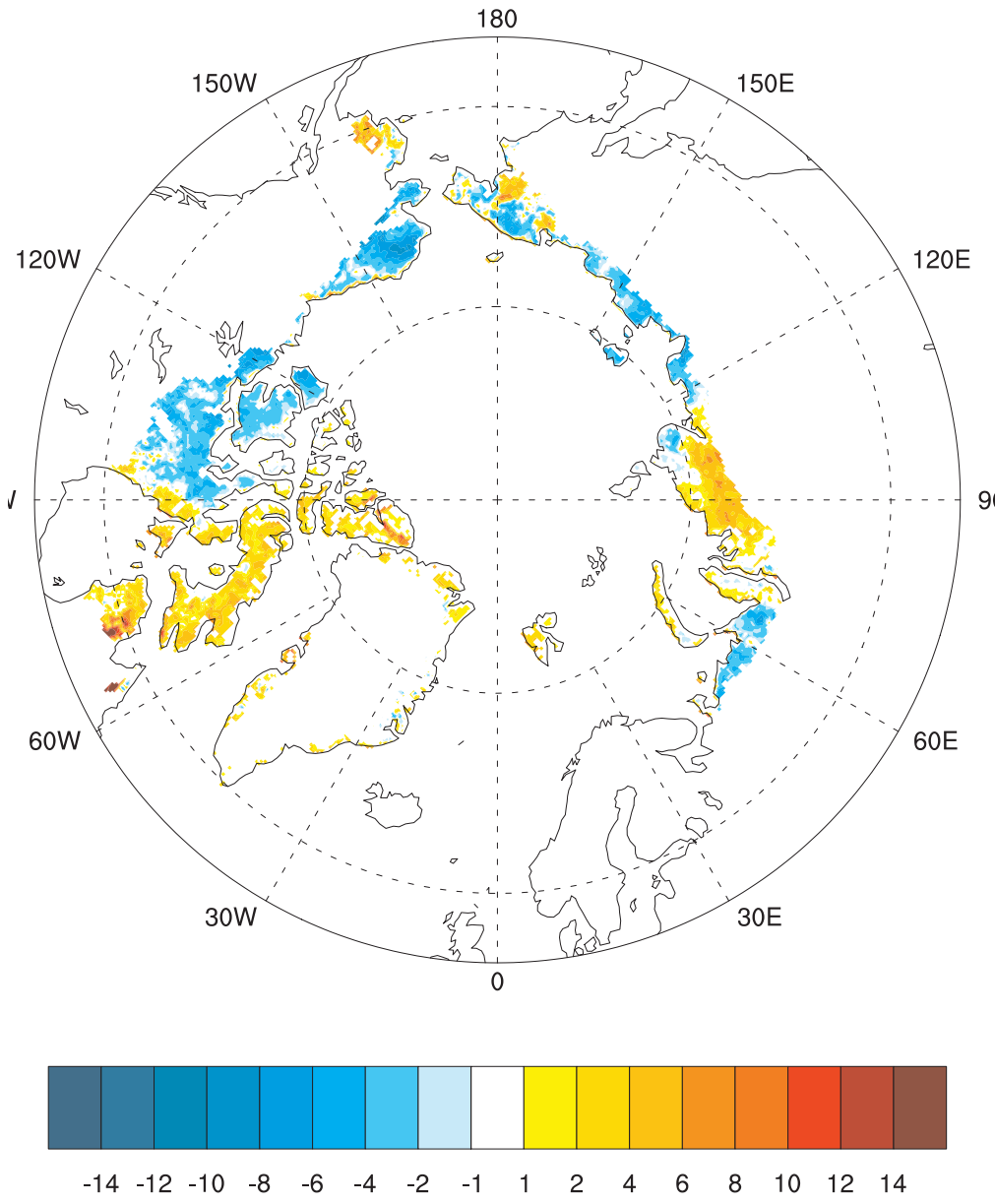
Spring 100km coastal sea ice

Summer Warmth Index

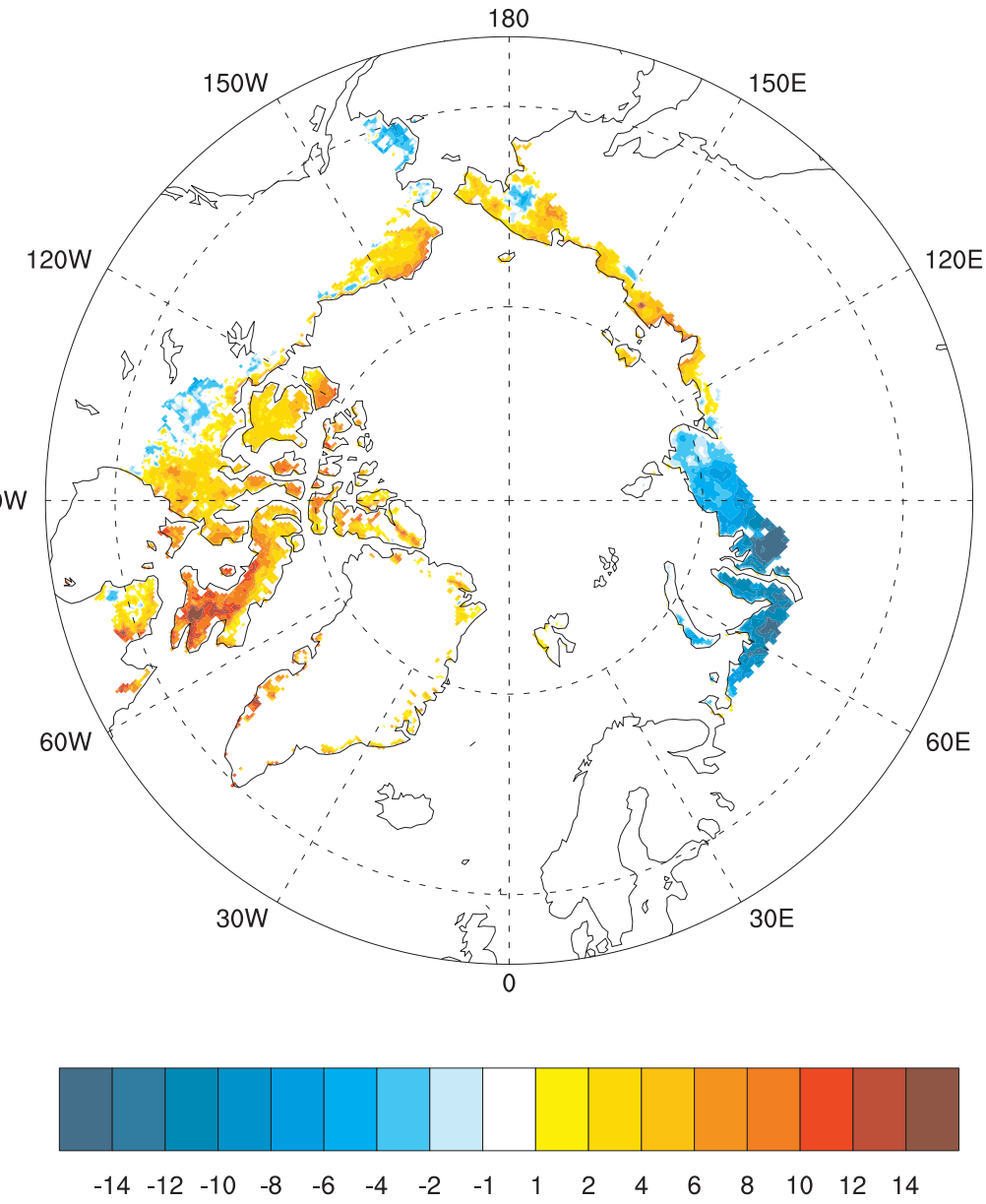


SWI anomalies in 2009 and 2010

SWI anomaly 2009

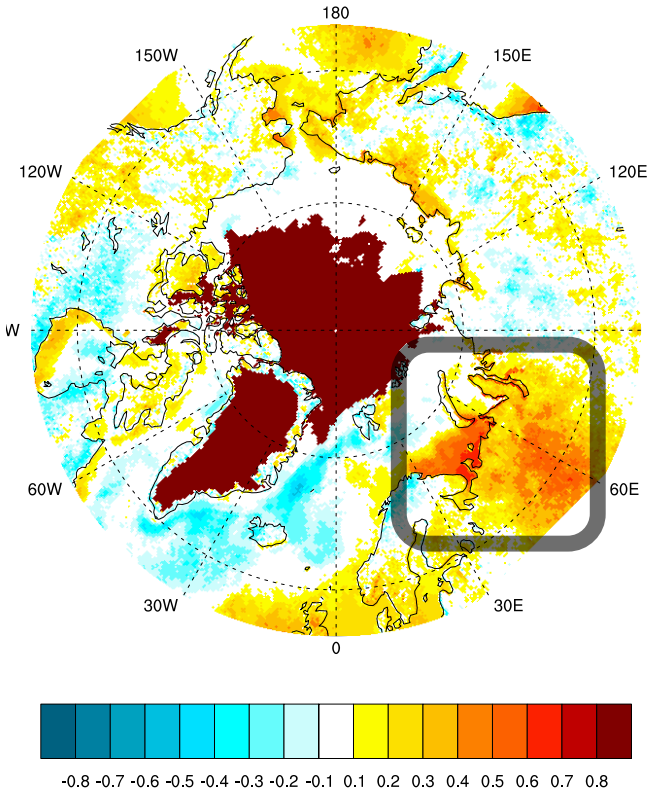


SWI anomaly 2010

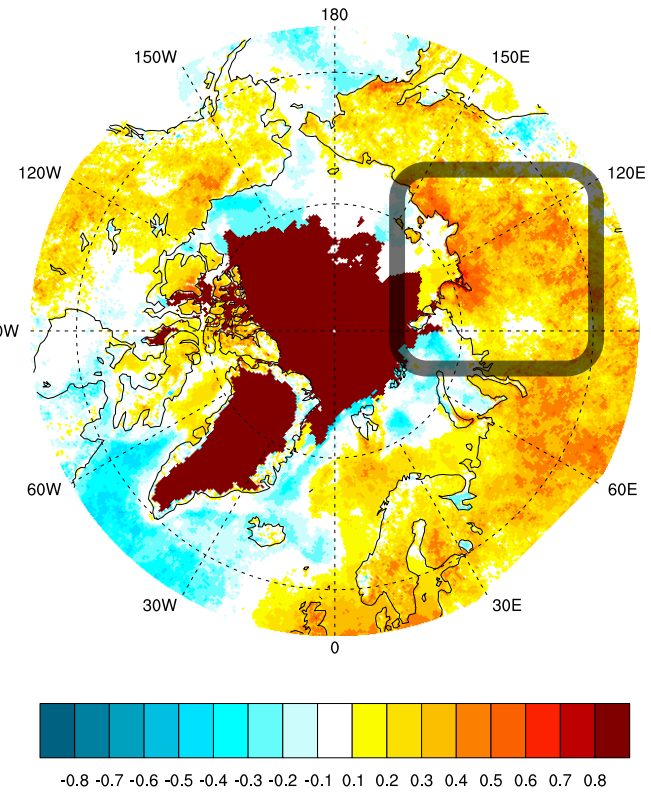


Open Water & SWI Correlations Vary with Basin

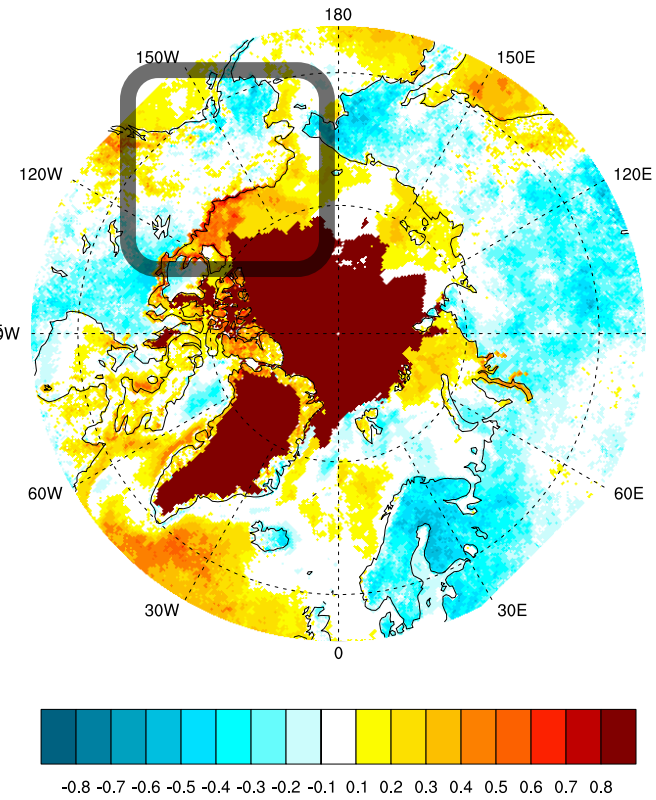
W. Kara



Laptev

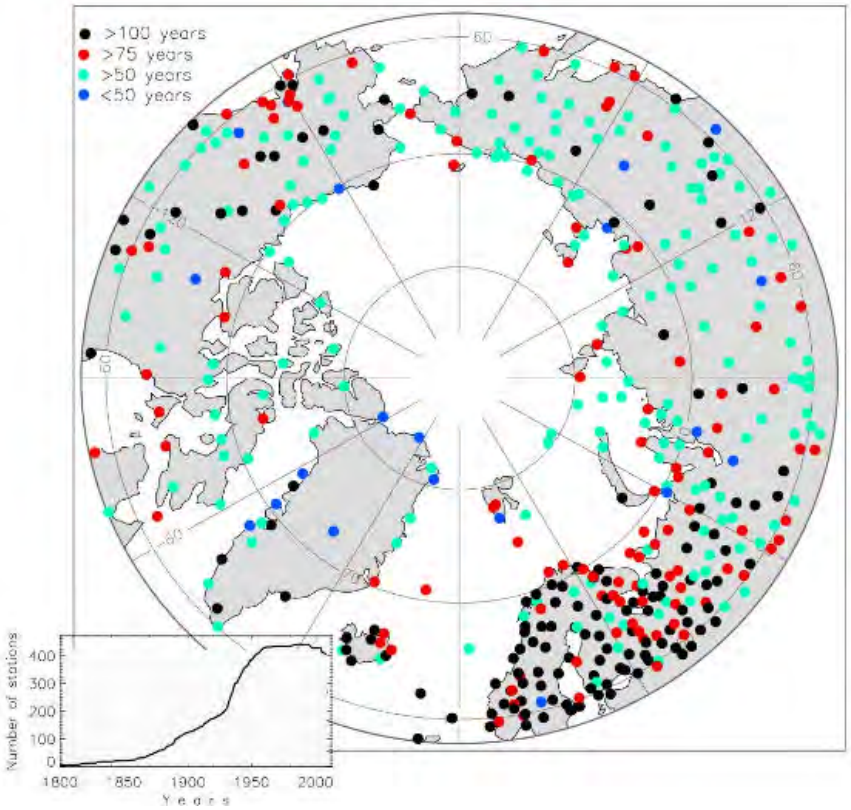


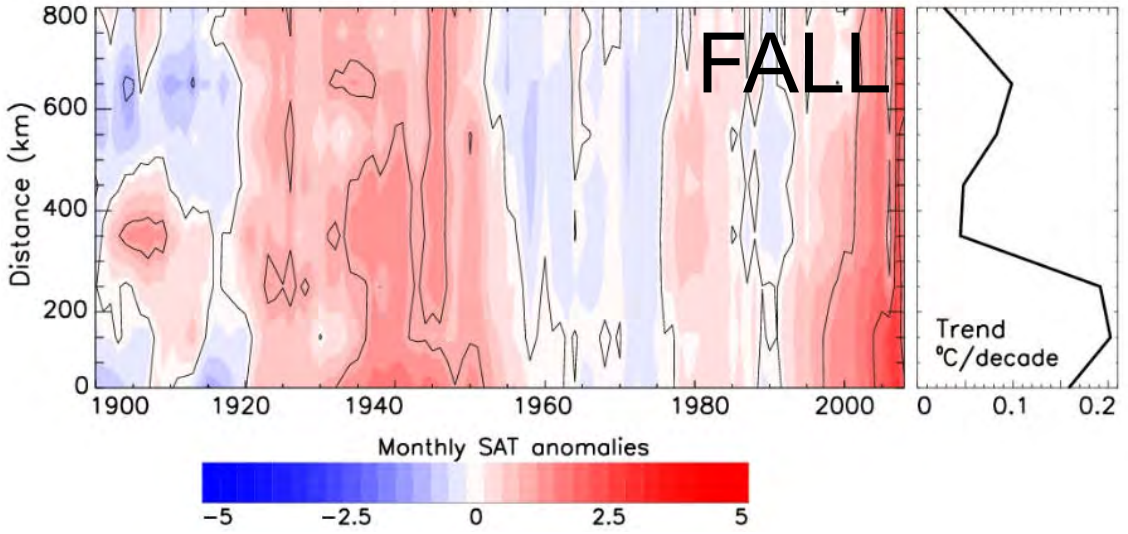
Beaufort

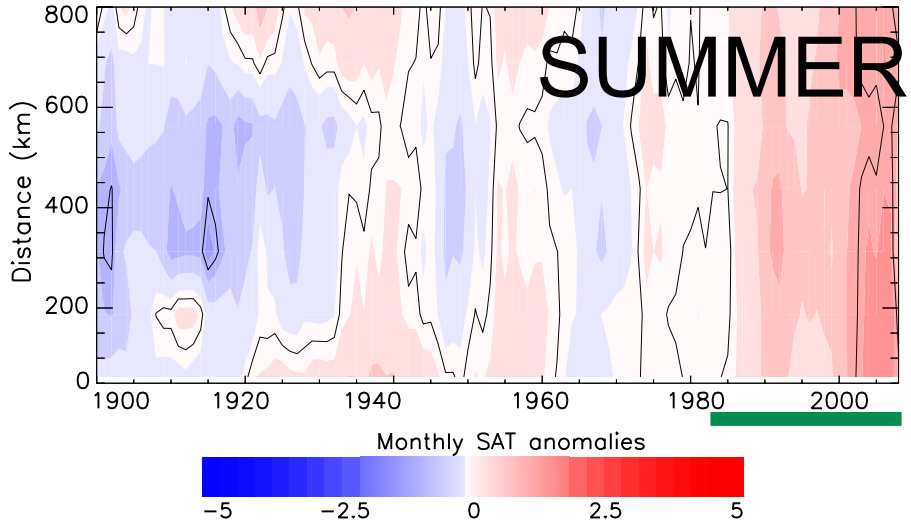


- W. Kara & Laptev: More open water, nearby land warmest
- Beaufort: More open water, nearby ocean warm, land temperatures mixed

Temperature anomaly as a function of the distance from coast shows maximum warming near coast during ice retreat





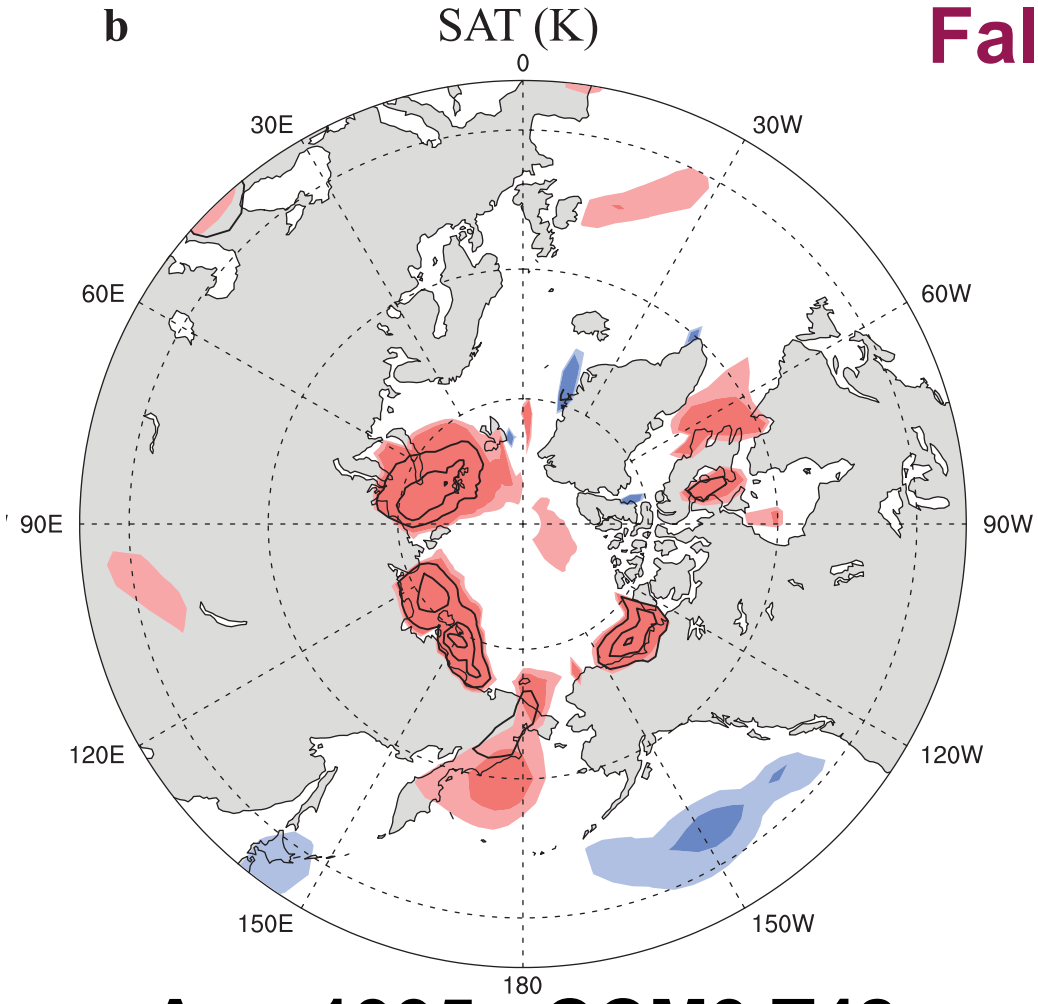


[Bekrayev et al 2010 & I. Polyakov]

Specified sea ice GCM studies suggest reduced ice warms adjacent land SAT

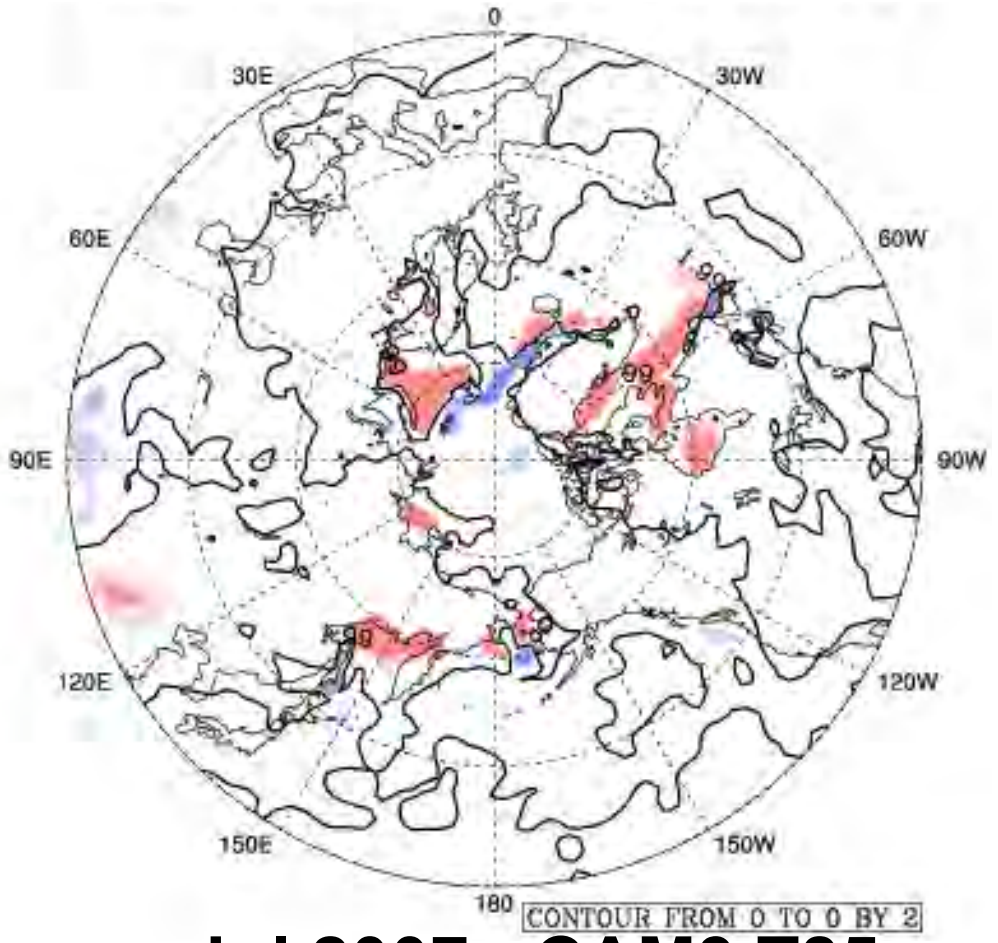
- Lawrence et al. 2008, Deser et al. 2010, Bhatt et al. 2008

Fall more than summer!



Aug 1995 - CCM3 T42

[Bhatt et al. 2008]



Jul 2007 - CAM3 T85

[Damman et al. in prep]

What is the plan?

- **Synthesize observational analysis**
  - **Develop clearer hypothesis of what is happening in each region. (e.g. Snow, clouds, & plant processes related to delayed response)**

- **Regional scale modeling**
  - **Test hypothesis for individual domains**

Conclusions

1. Ice is linked to the terrestrial changes. More analysis needed.

2. Arctic trends/anomalies vary spatially!

3. Ice probably key driver in some regions but not all.

Typical subzone A zonal vegetation at Isachsen, Ellef Ringnes Island, Nunuvut, Canada. Yellow flowers are Papaver polaris. Photo: D.A. Walker.

Thank you for your attention!

Acknowledgments

- This work was supported by NSF and NASA.
- This project is part of the Greening of the Arctic project of the International Polar Year and NEESPI.