

# Inter- and intra-annual variability of NDVI and correlations to large-scale circulation patterns, sea ice, snow and cloud cover



**Tundra, Subzone A, Franz Josef Land**  
*Skip Walker, Dept. Biology UAF*

Uma S. Bhatt, [usbhatt@alaska.edu](mailto:usbhatt@alaska.edu)  
Dept. of Atmospheric Sciences,  
U. Alaska Fairbanks

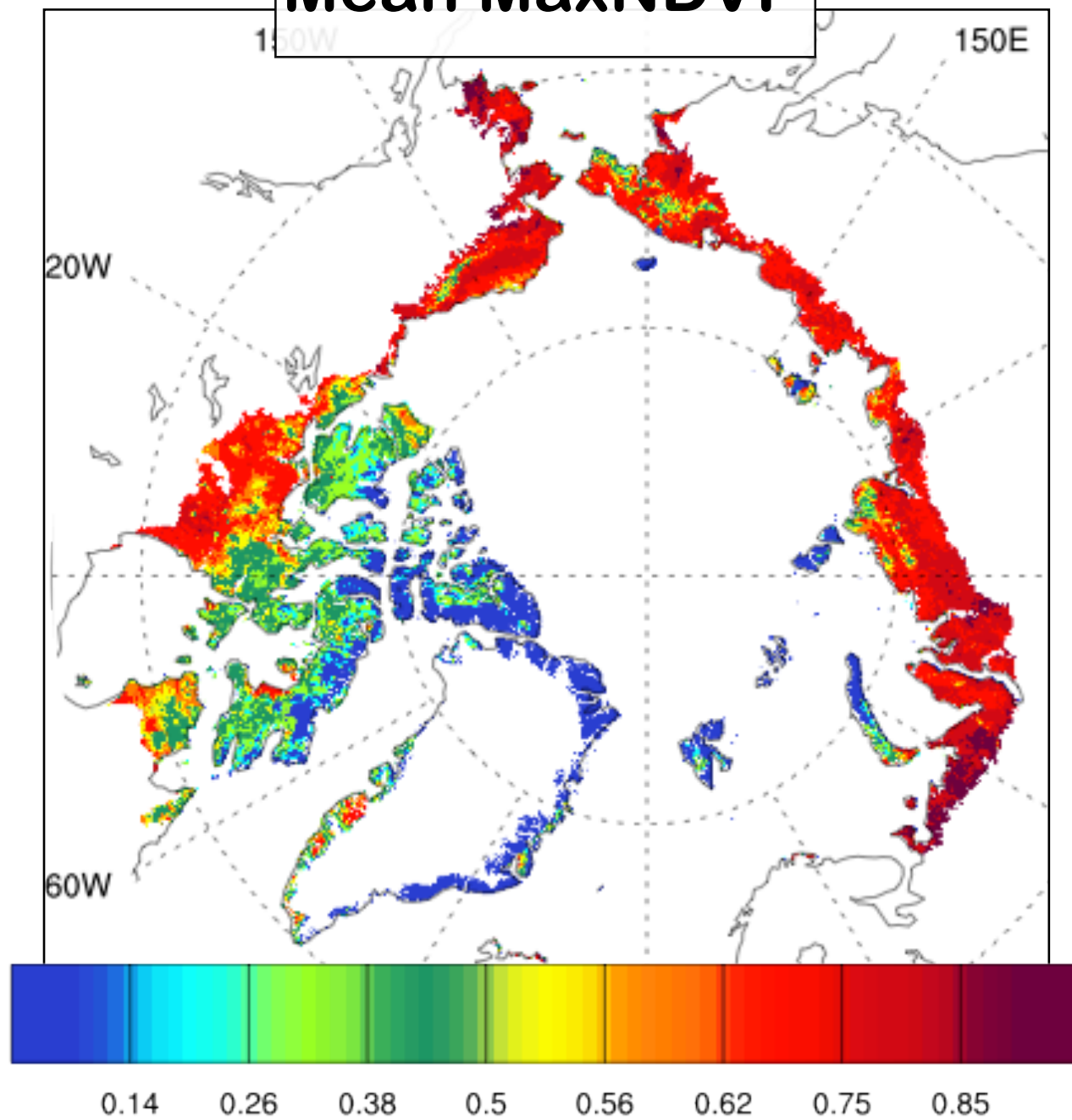
D.A. Walker, M.K. Reynolds, P. A. Bieniek, H. E.  
Epstein, J. C. Comiso, J. E. Pinzon, C. J.  
Tucker, M. A. Steele, W. Ermold, & J. Zhang

Arctic Biomass Workshop  
Fairbanks, Alaska,  
Tuesday September 2, 2014

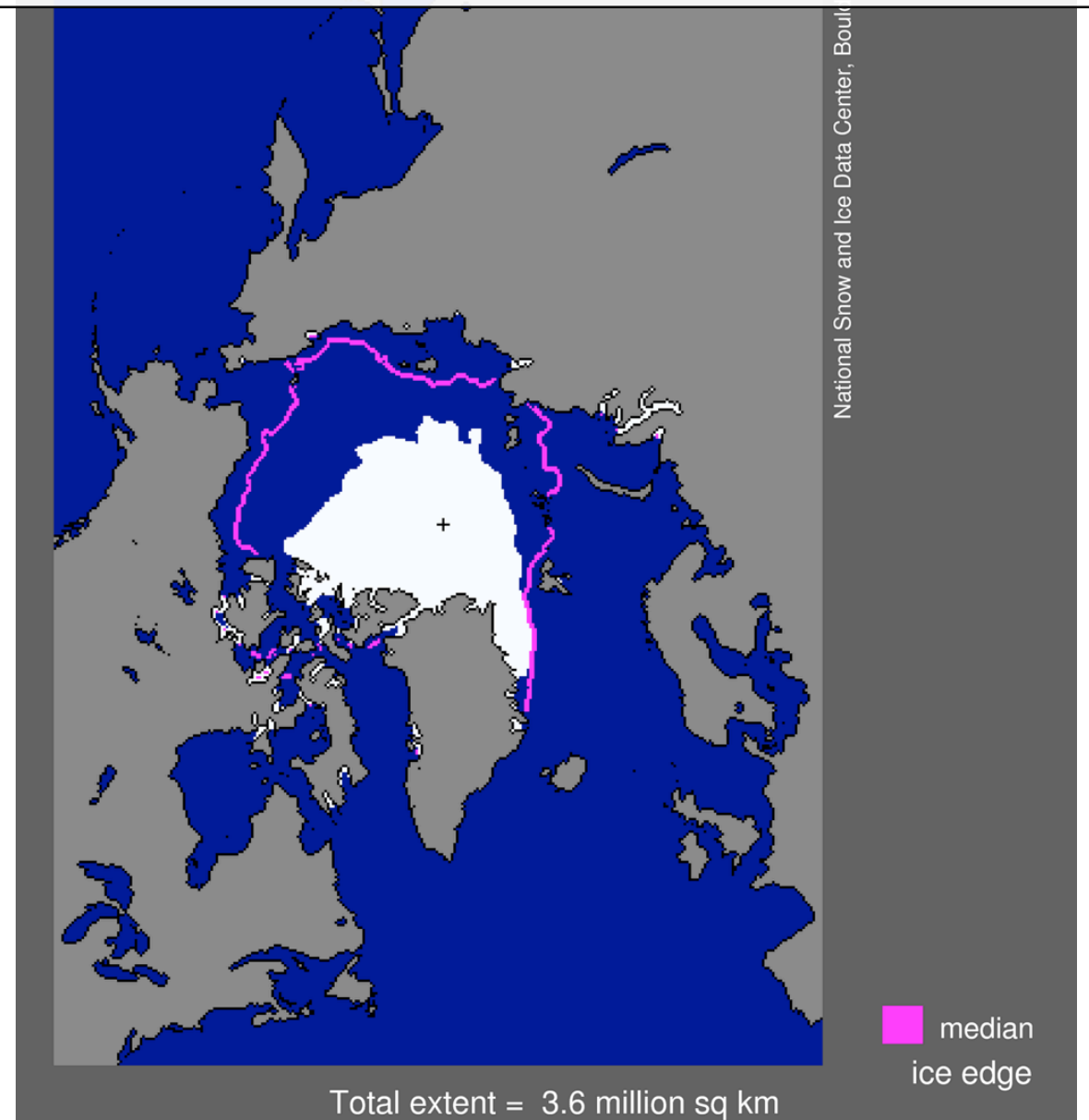
- Warming has flattened out and NDVI is declining in spring and fall.

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

Mean MaxNDVI



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



**Main PanArctic hypothesis:**  
Periods of reduced sea ice should correspond to warmer land temperatures and more rapid greening.  
[Bhatt et al. 2010]

# Remote sensing data & methods

- Data: 1982-2013 (32 yrs, weekly)
- Passive Microwave Sea Ice Concentration (25km)
- AVHRR Land Surface Temp. (25-km) **SWI**, [Comiso 2003]
- Gimms NDVI 3g+ (Max and Integrated) (14-km) Version that is corrected for Arctic, **TI-NDVI** [Pinzon et al. 2014]



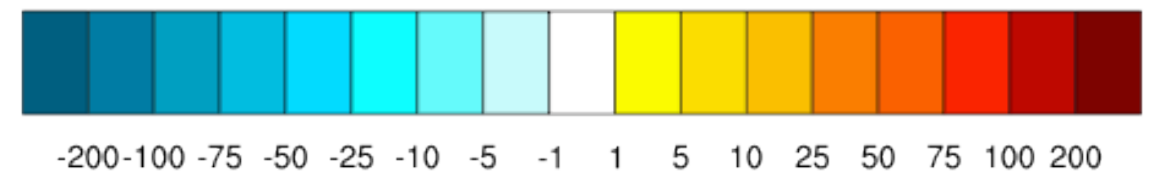
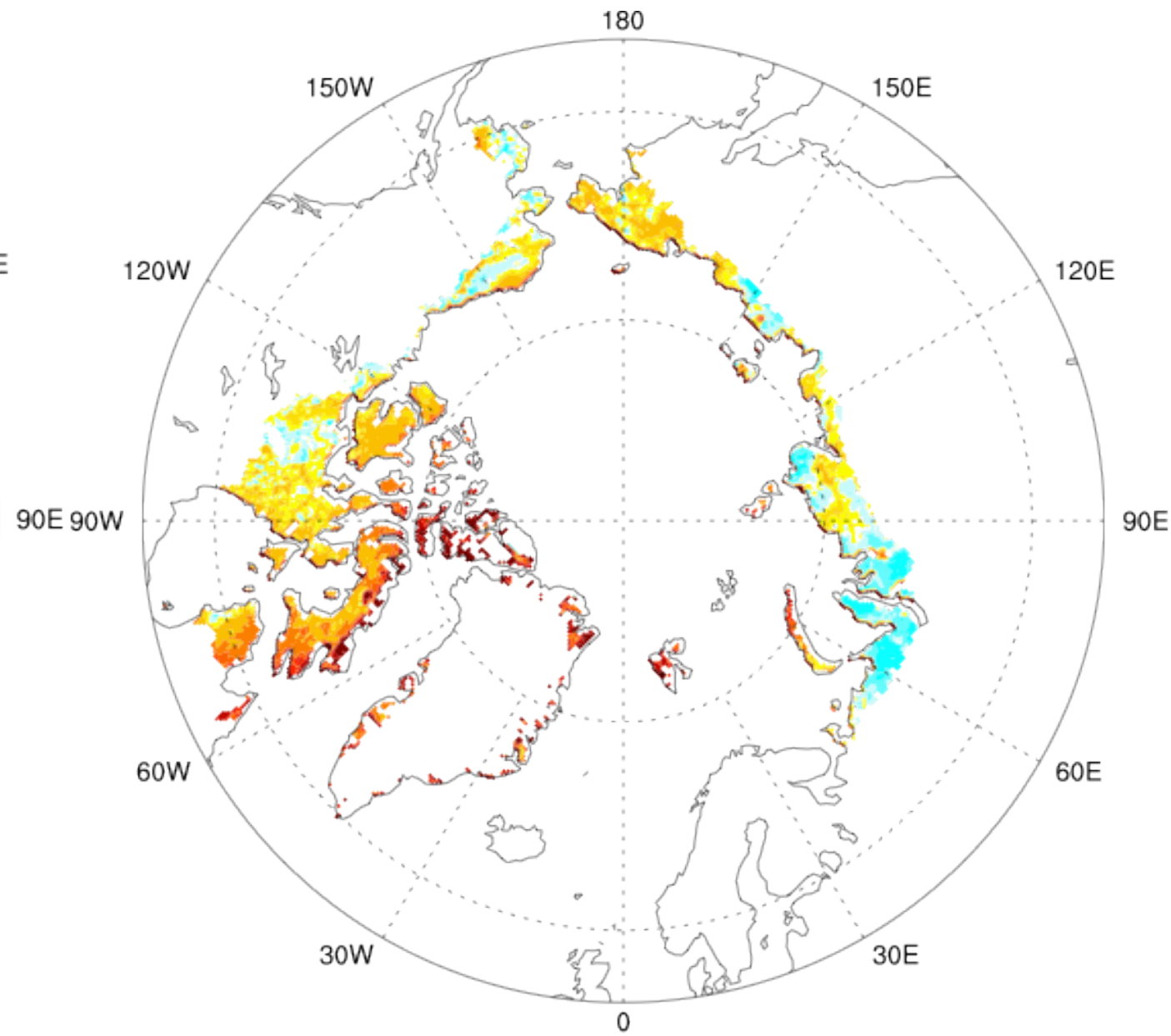
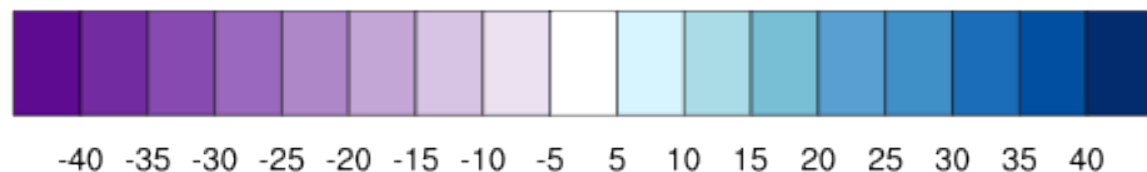
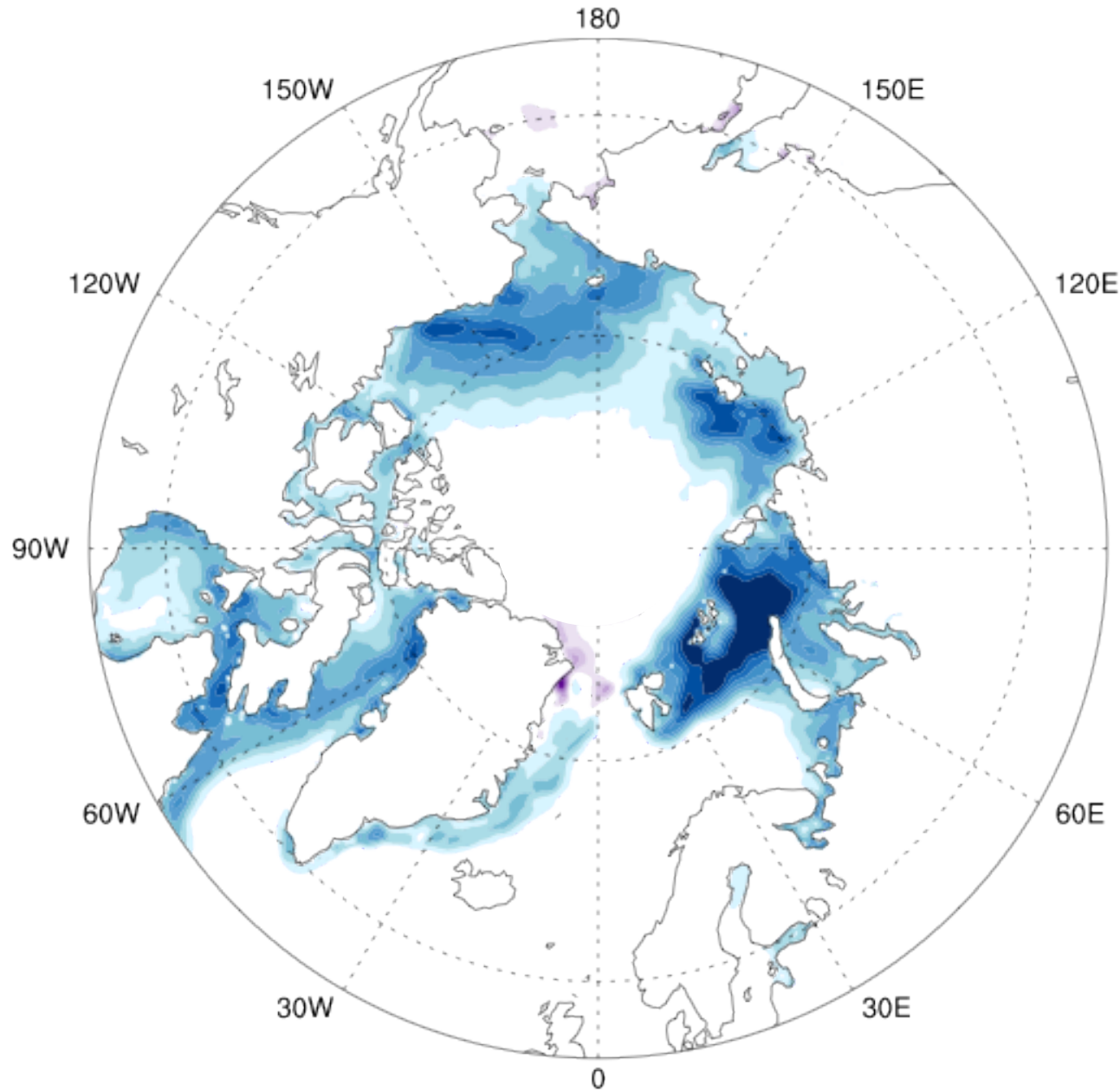
- Divided Arctic Ocean (Treshnikov, 1985) to examine trends and variability in **full tundra land domains**
- Reanalysis Sea Level Pressure
- Globsnow



# More Open Water & Nearby Land Warms

## Trends 1982-2013

Open Water (May-Aug) magnitude change (%)    Summer Warmth Index percent change (%)

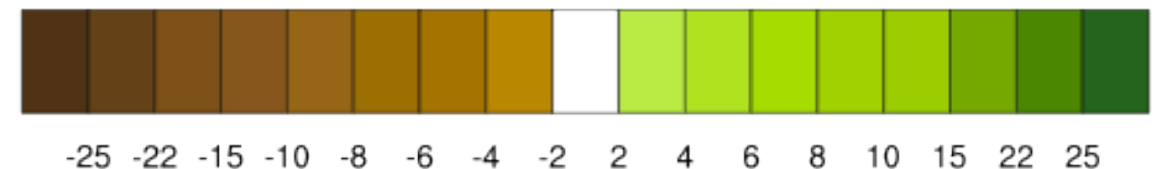
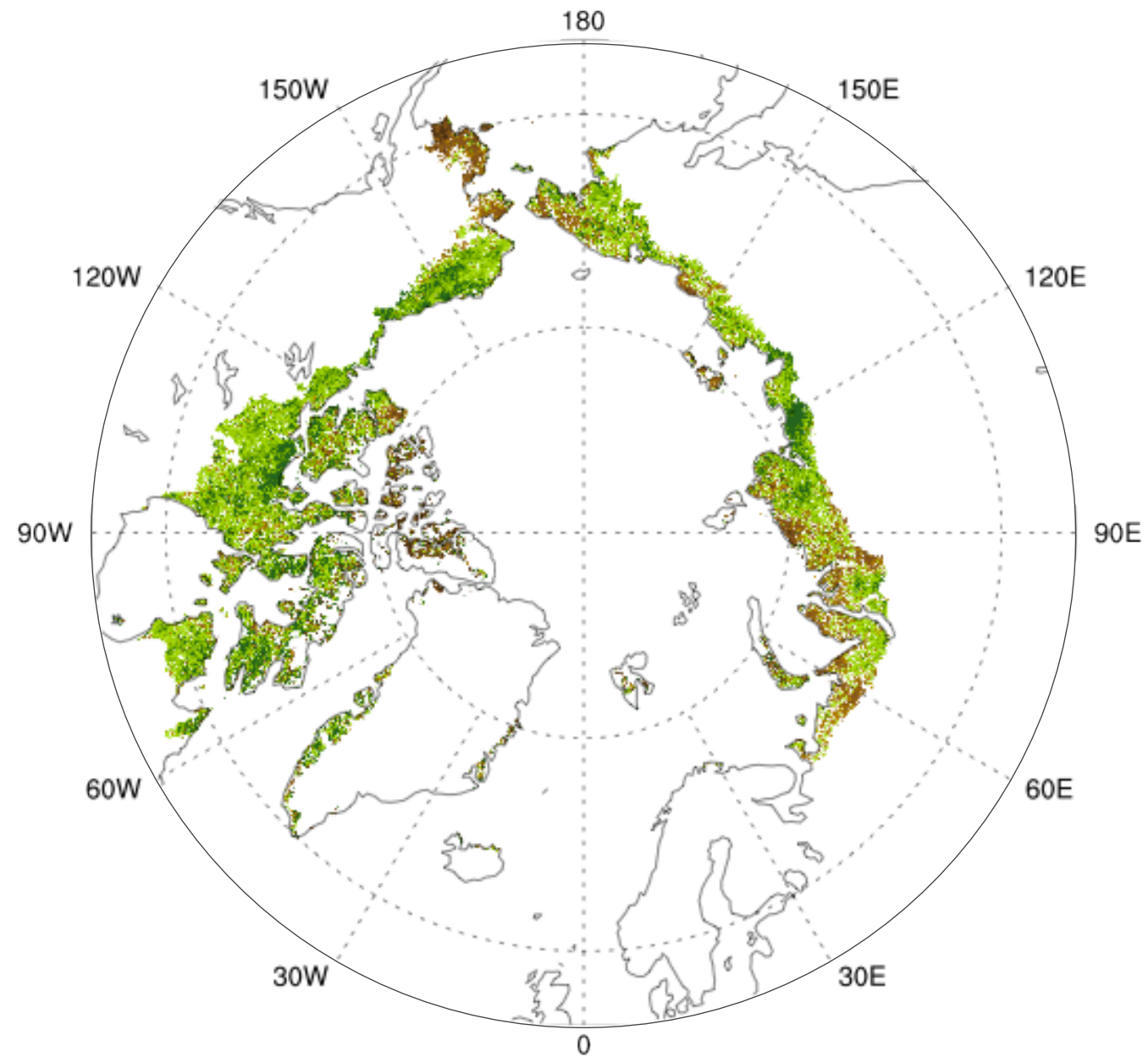
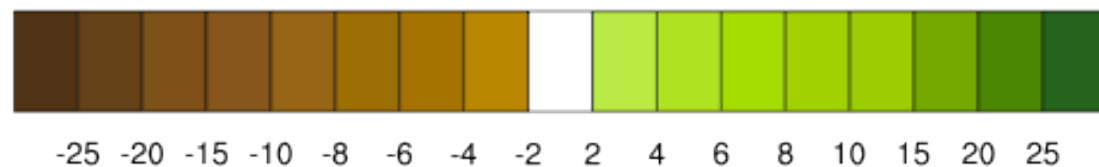
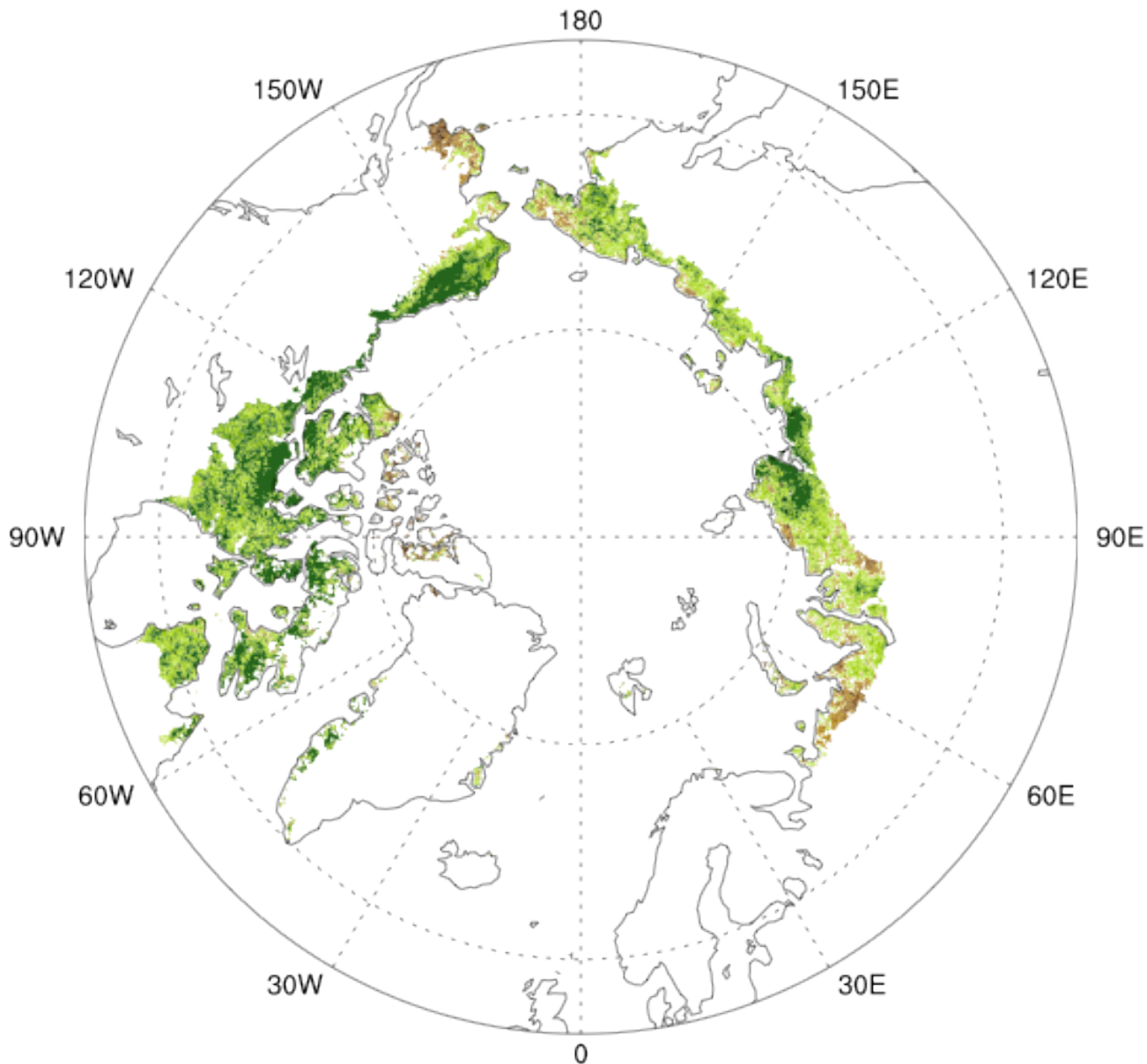


# More warmth ==> Greener Arctic Tundra

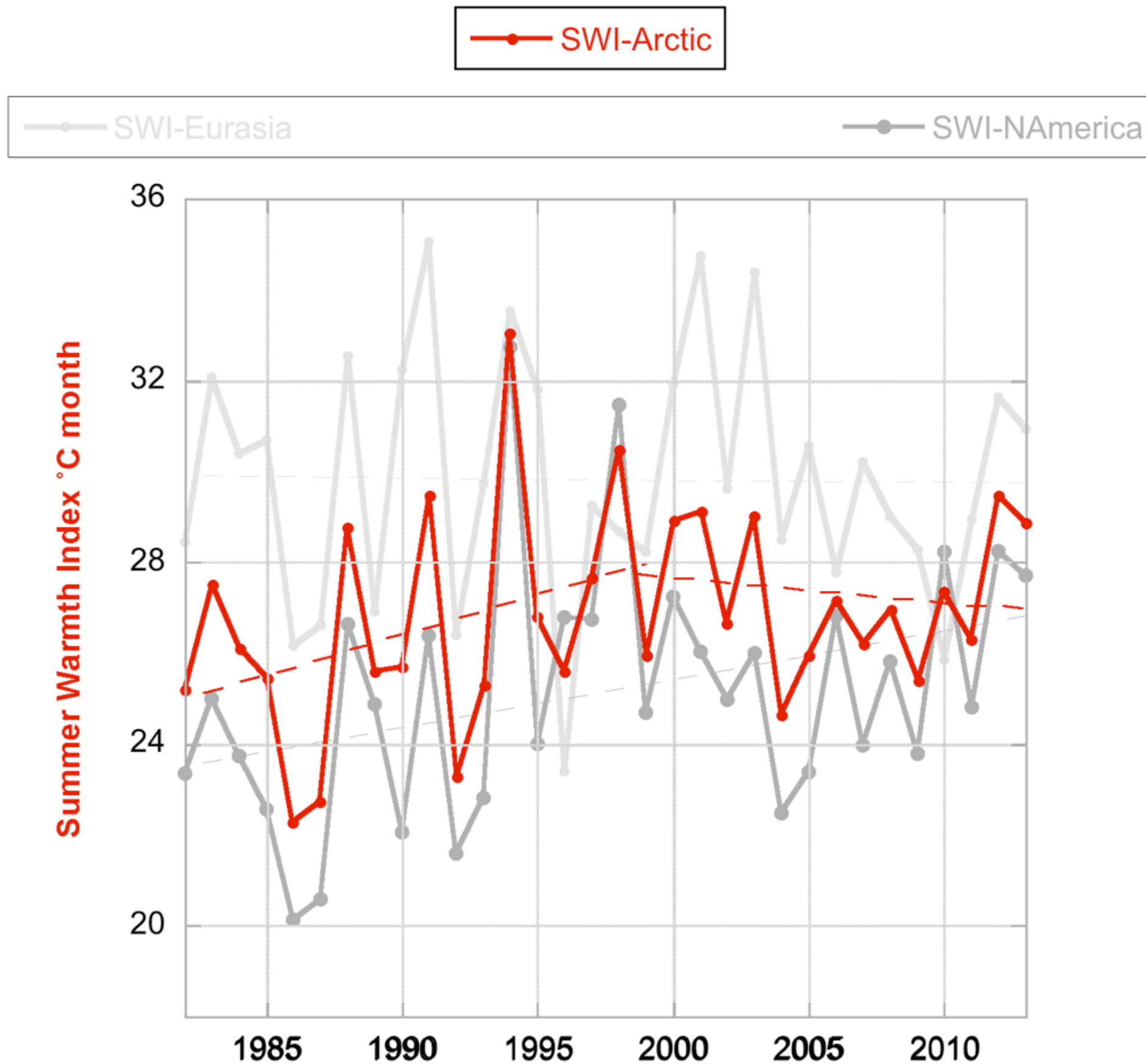
## Trends 1982-2013

MaxNDVI percent change (%)

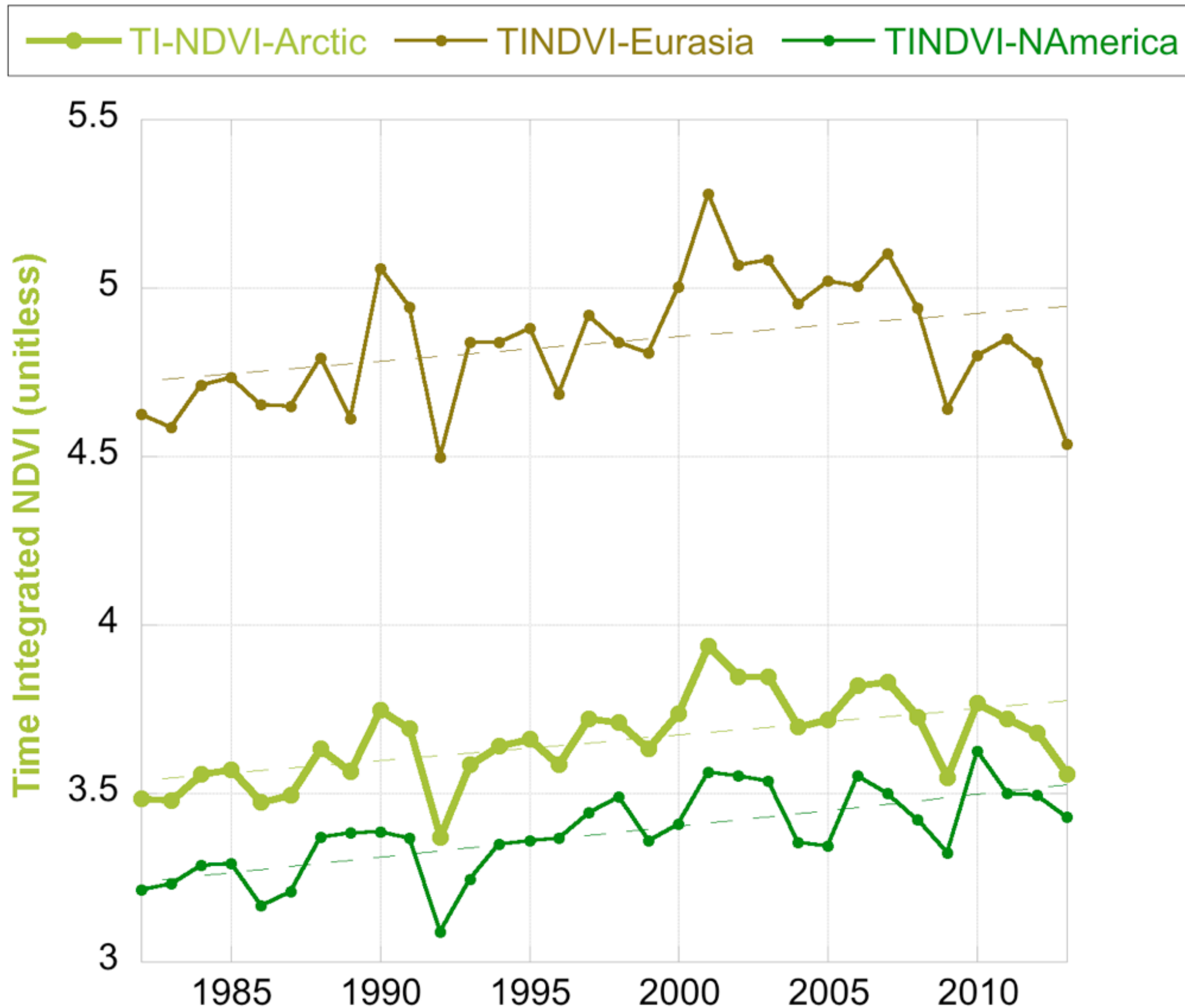
TI-NDVI percent change (%)



# Summer Warmth increases have slowed!

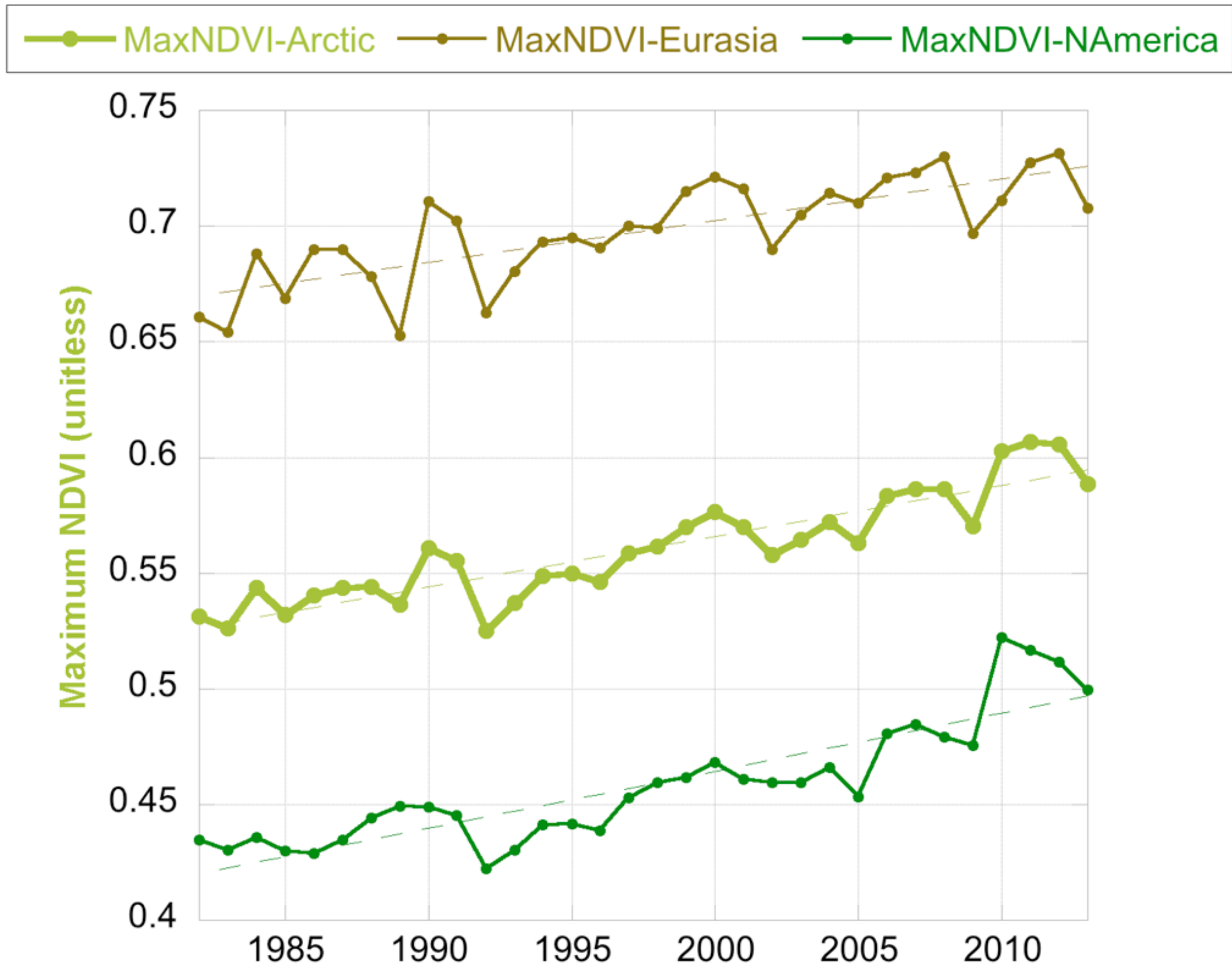


# TI-NDVI increases have slowed!





# MaxNDVI increases continue!

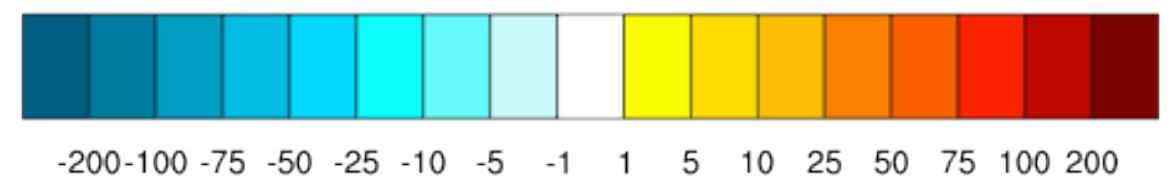
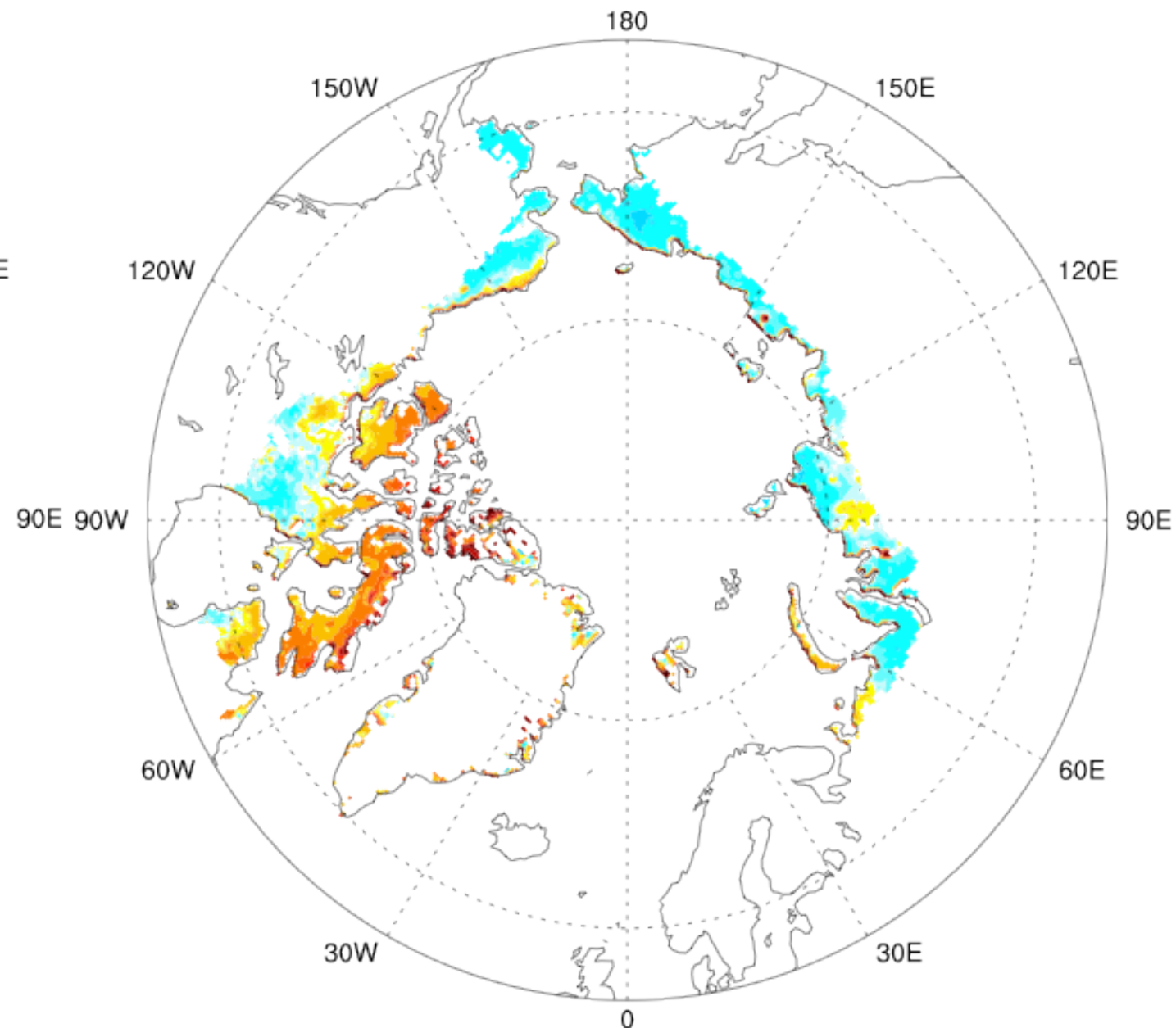
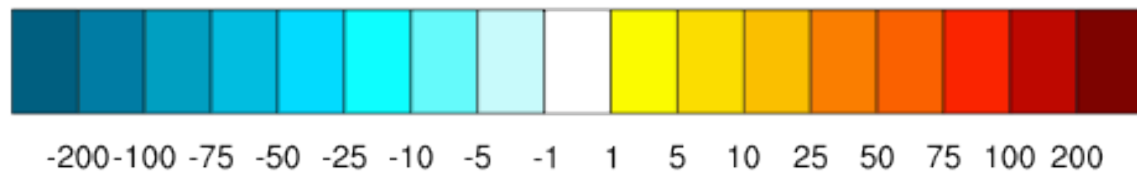
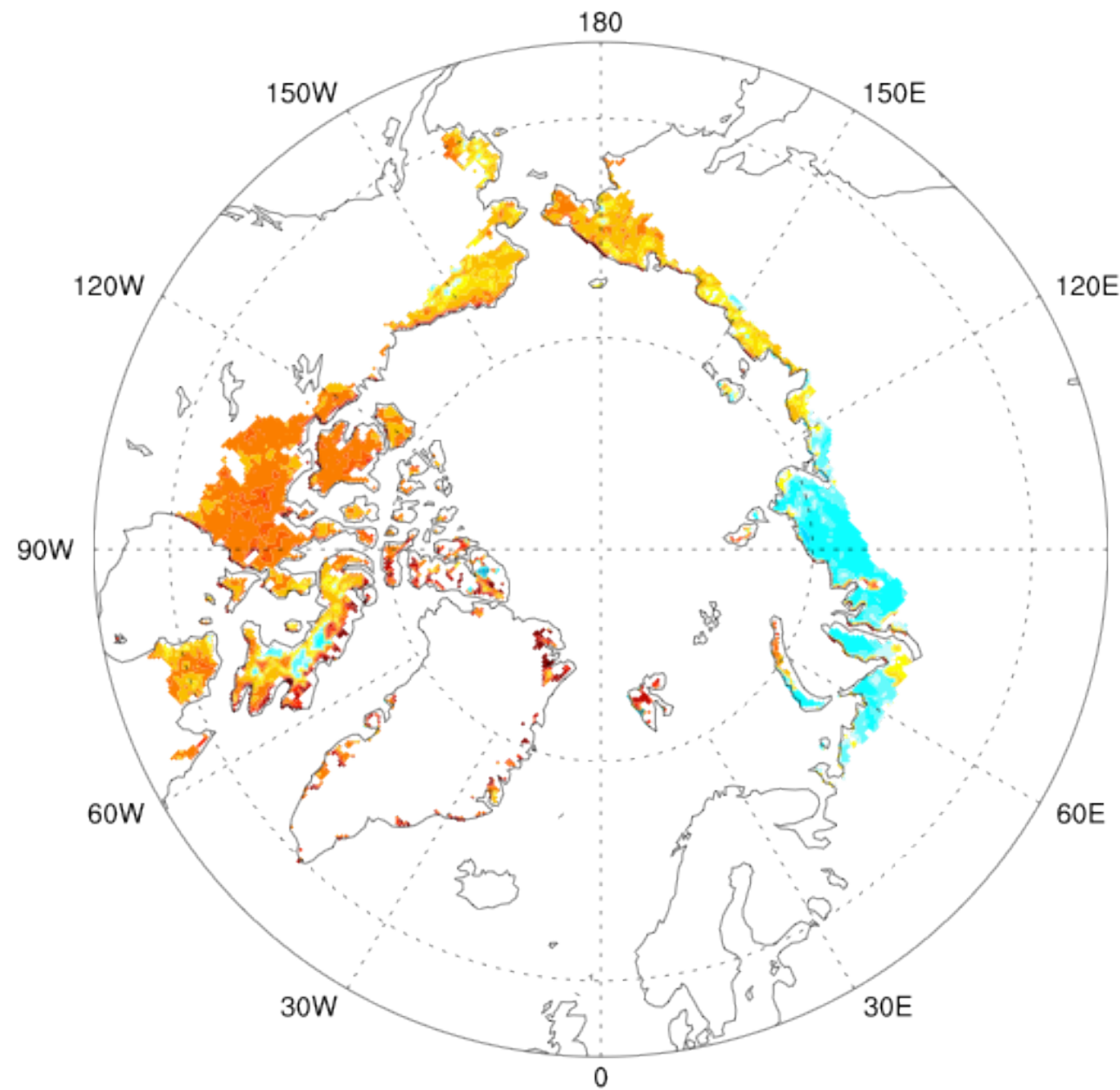




# SWI declining over recent period!

SWI 82-98

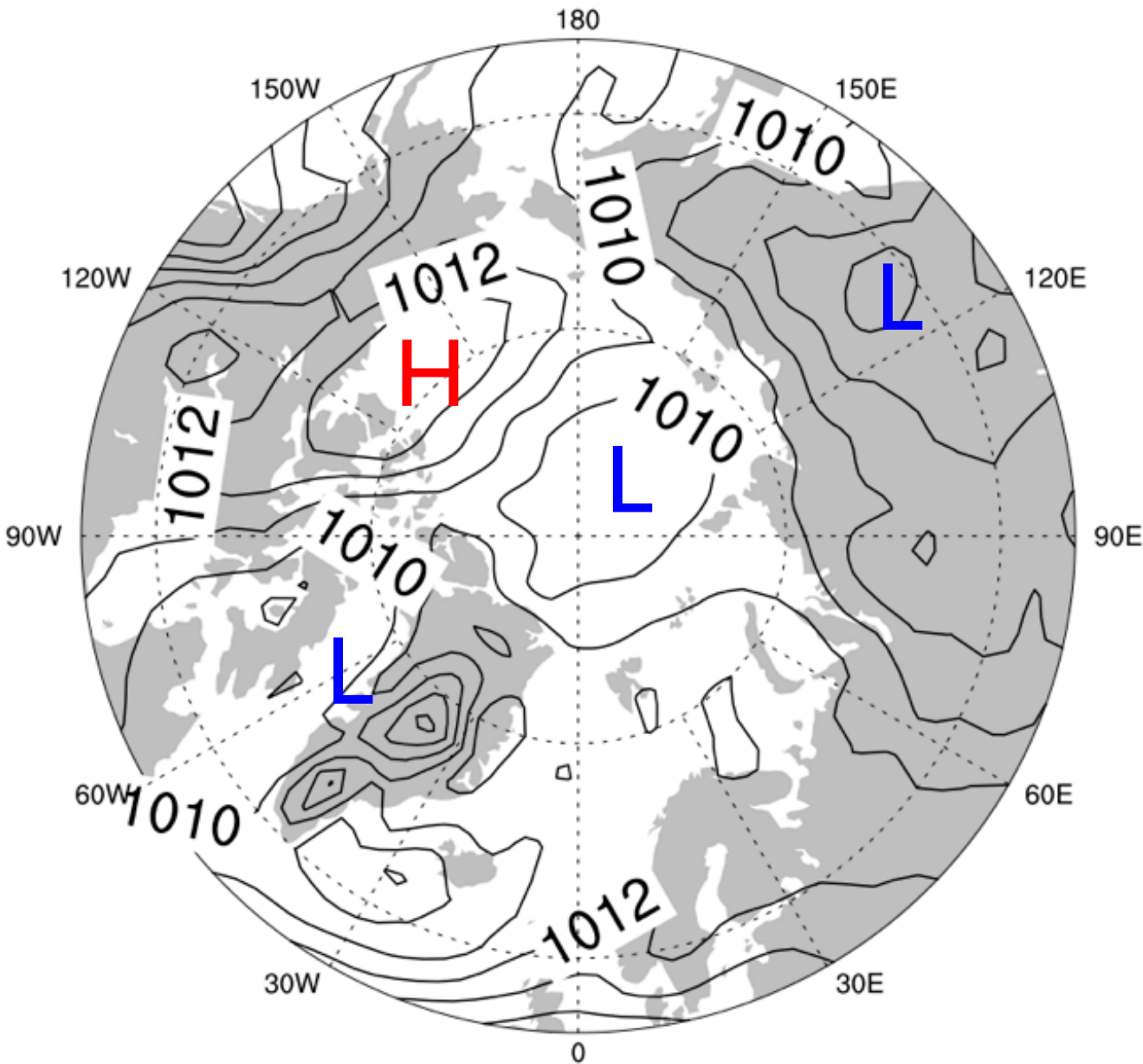
SWI 99-13



# Summer Sea Level Pressure (SLP)

Long term average

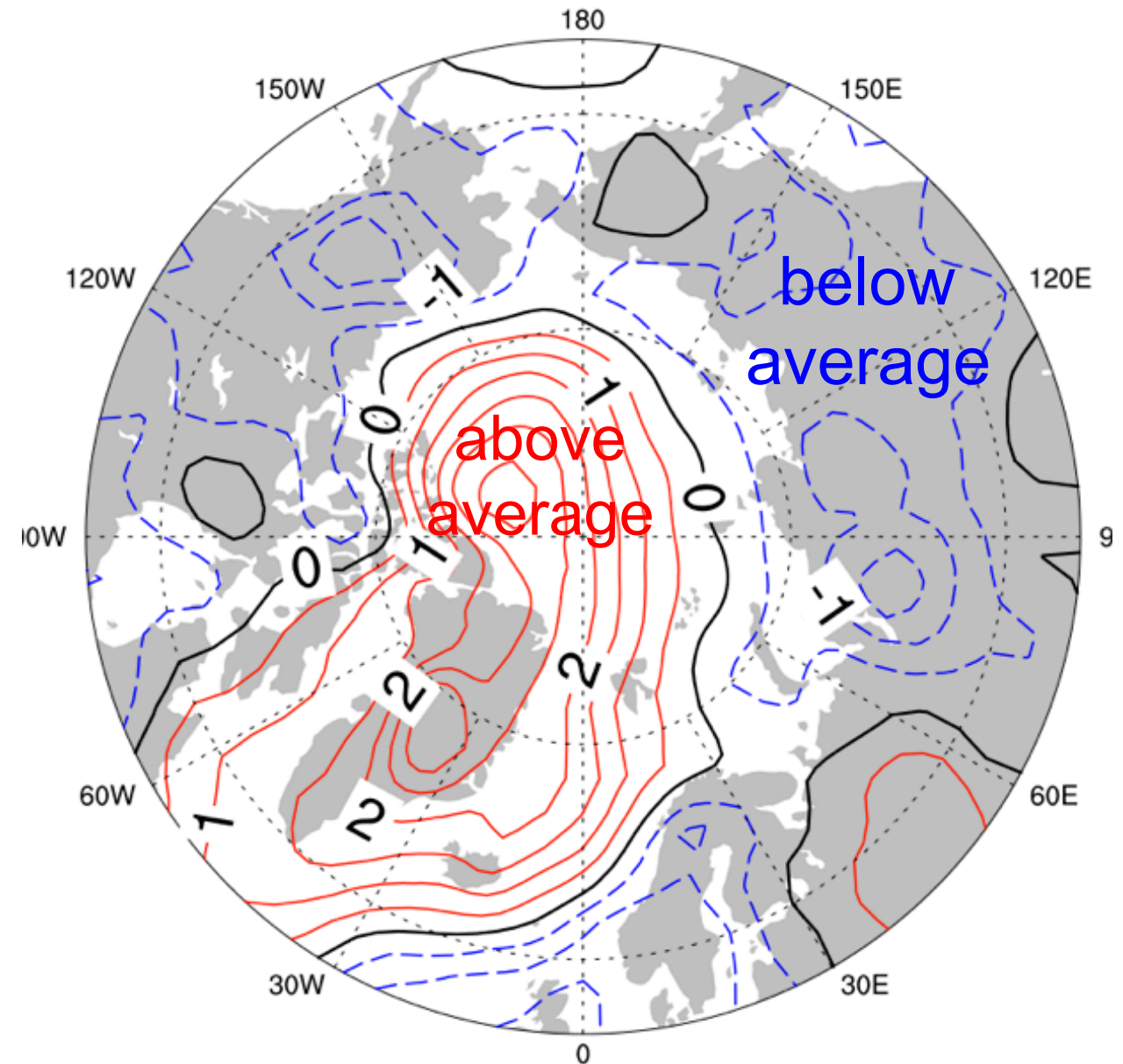
1982-2011



Climatology

SLP change

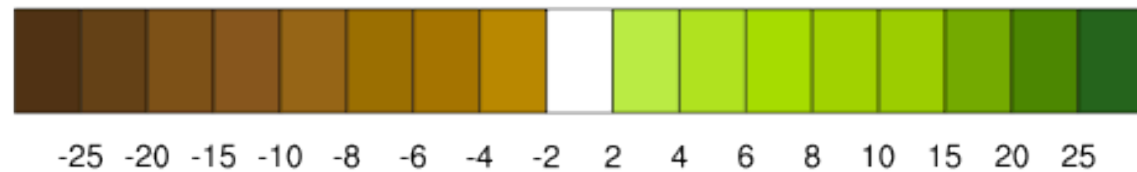
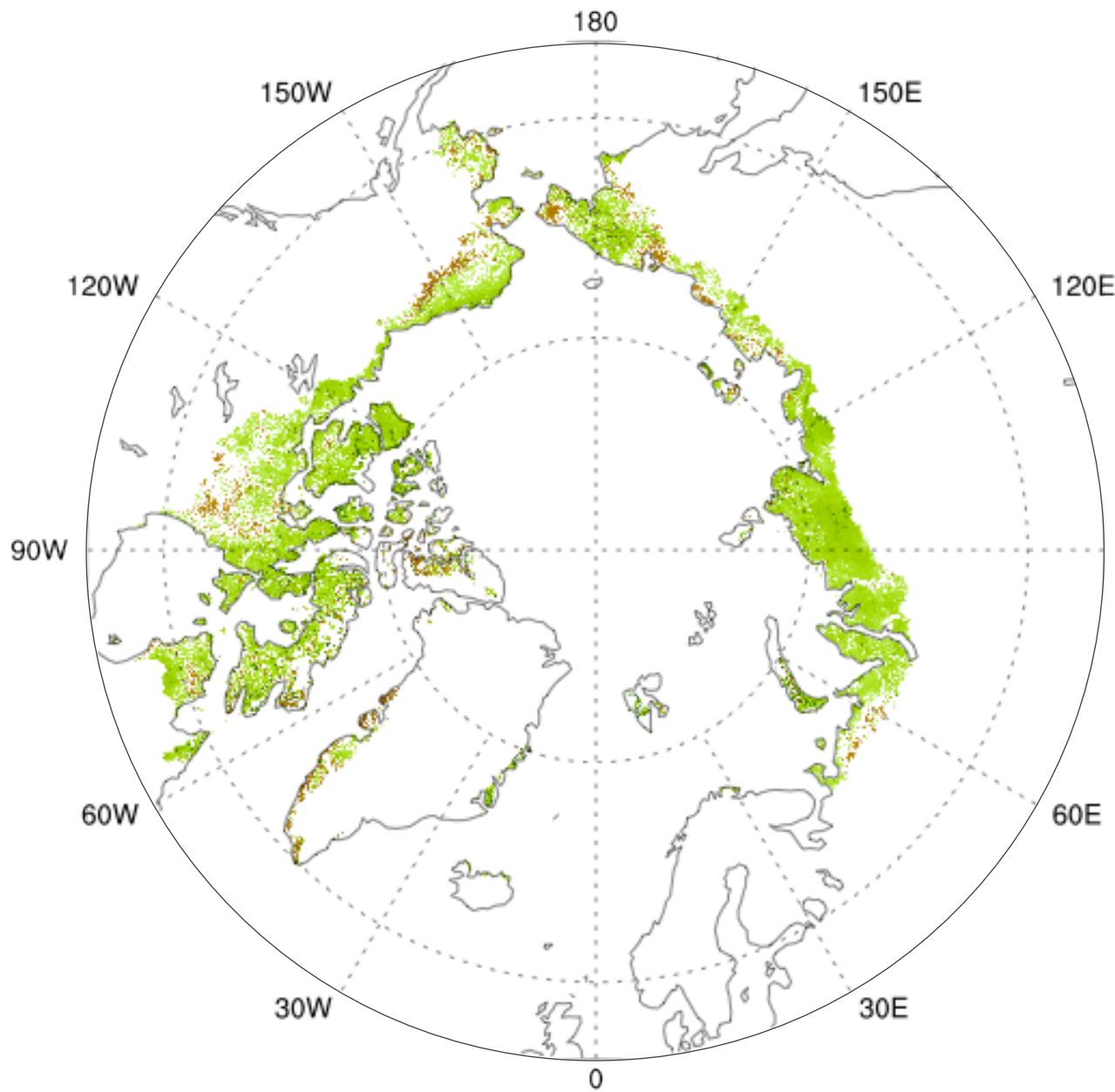
1999-2011 vs 1982-1998



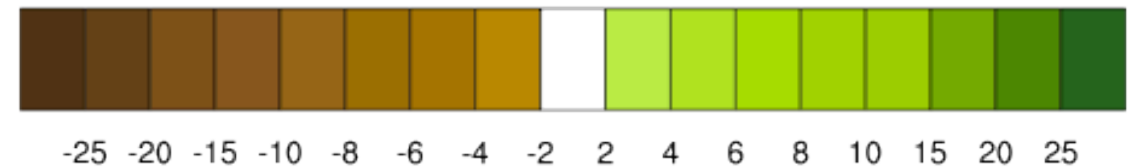
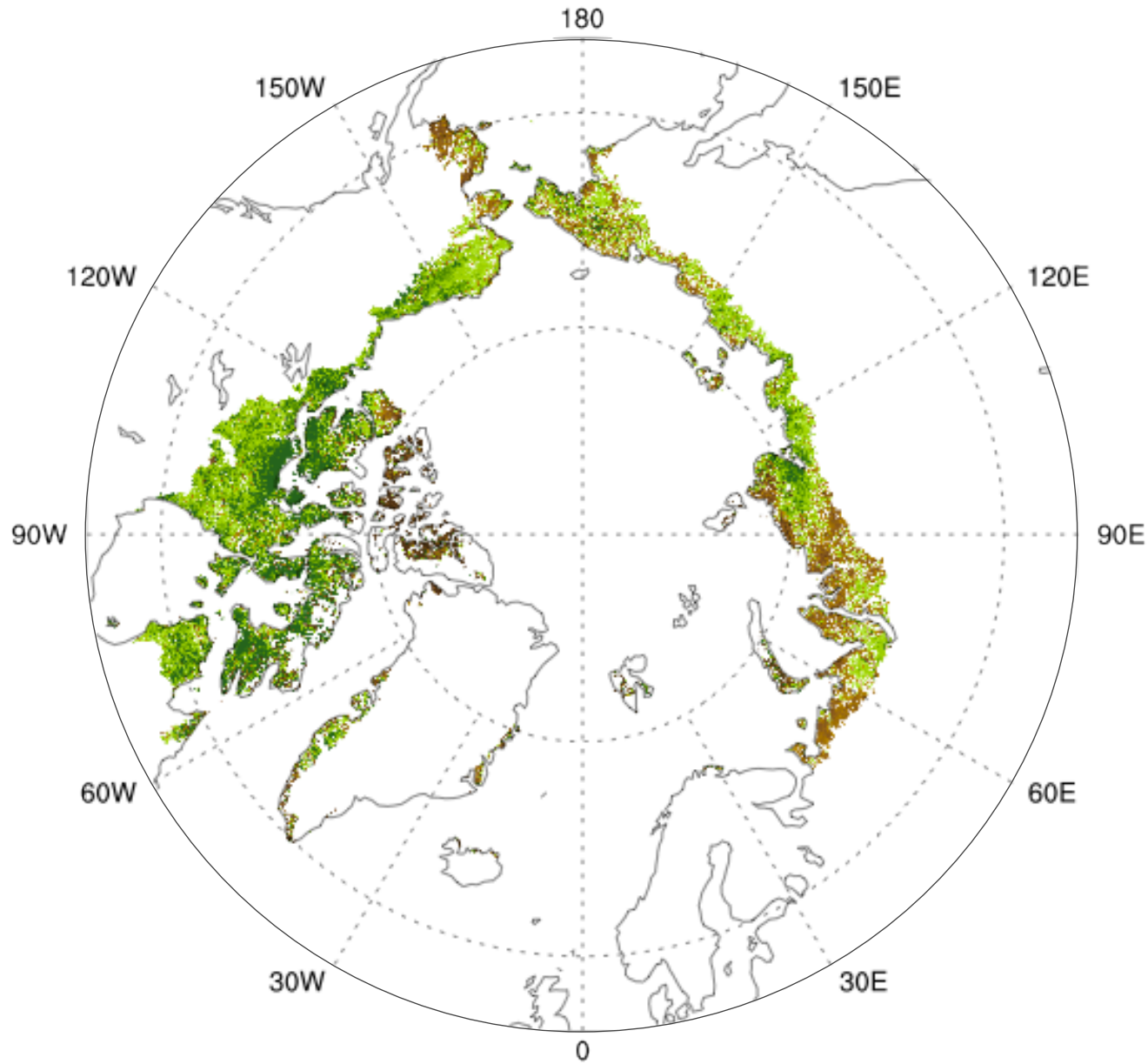
[Bhatt et al. 2013]

# MaxNDVI trends stronger over recent period!

MaxNDVI 82-98



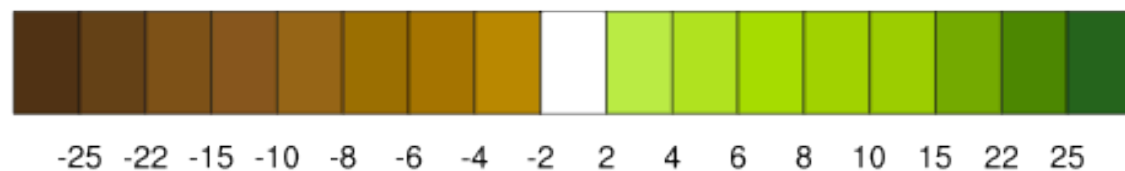
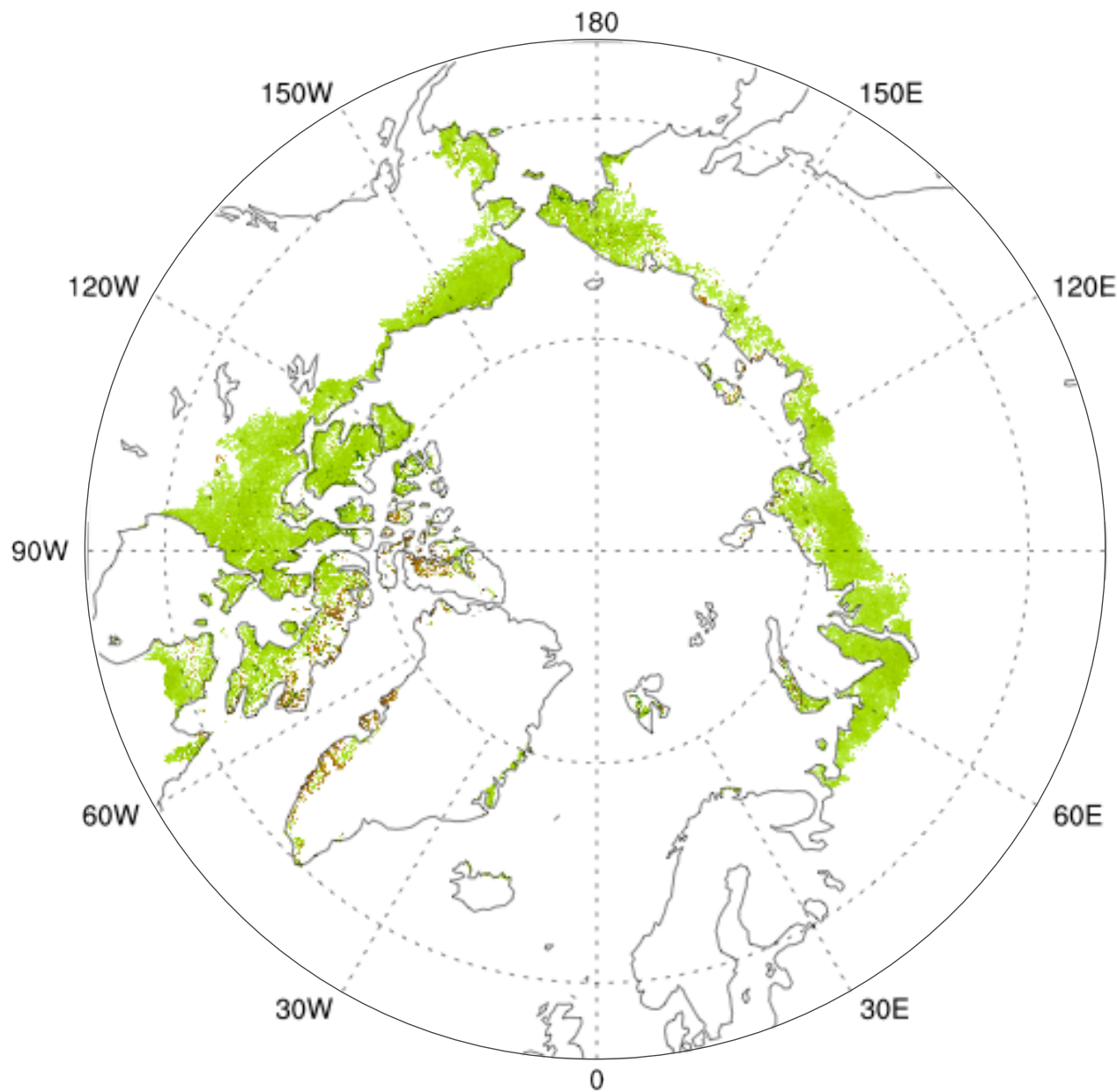
MaxNDVI 99-13



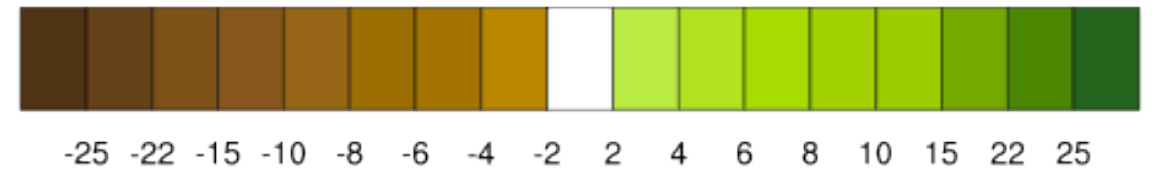
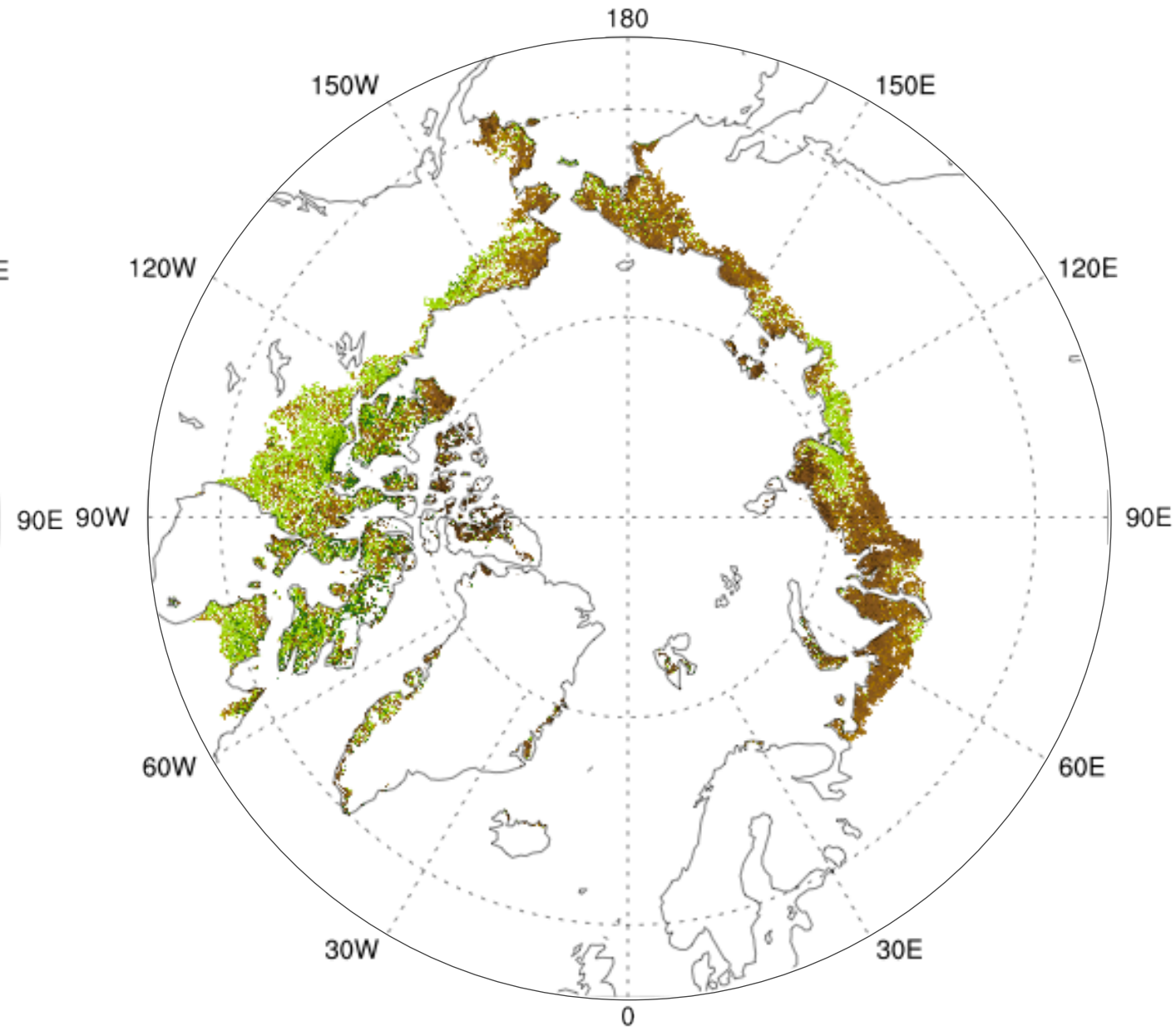


# TI-NDVI declining over recent period!

## TI-NDVI 82-98



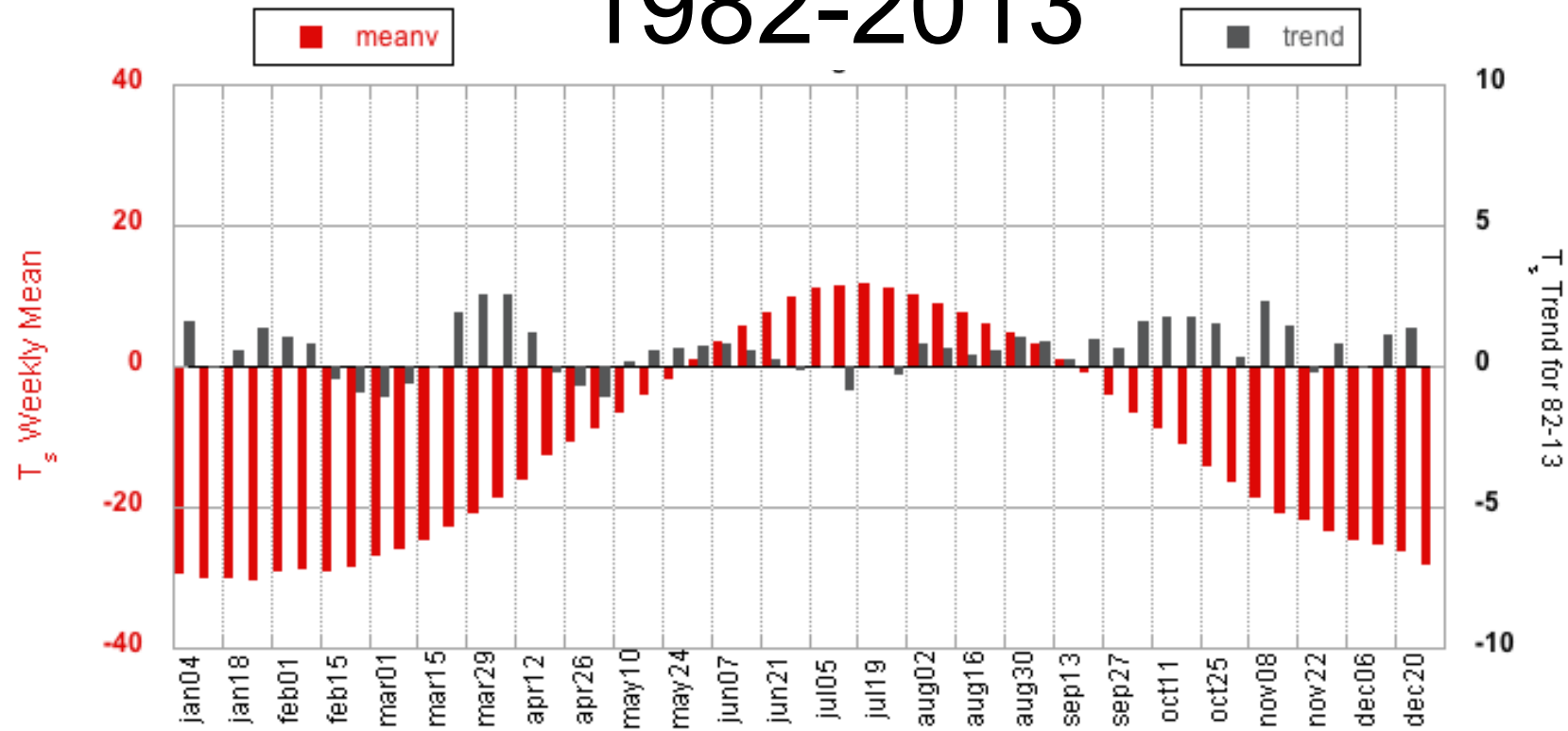
## TI-NDVI 99-13



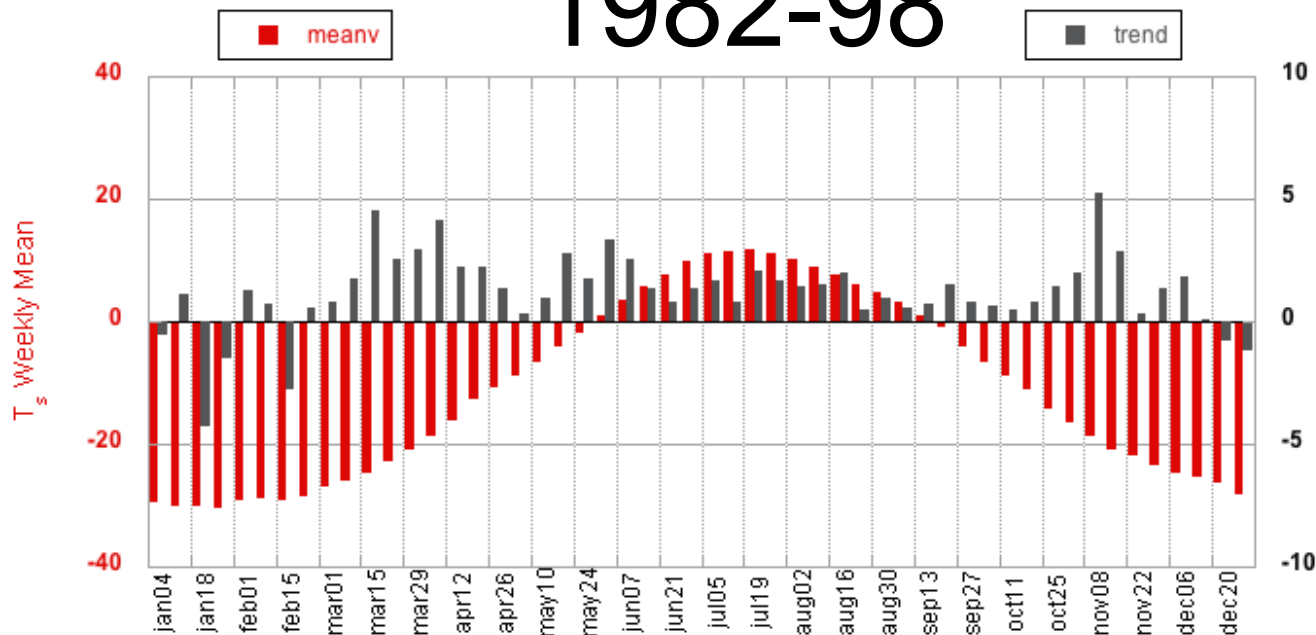


# Ts Spring/Fall warming & Mid-summer cooling

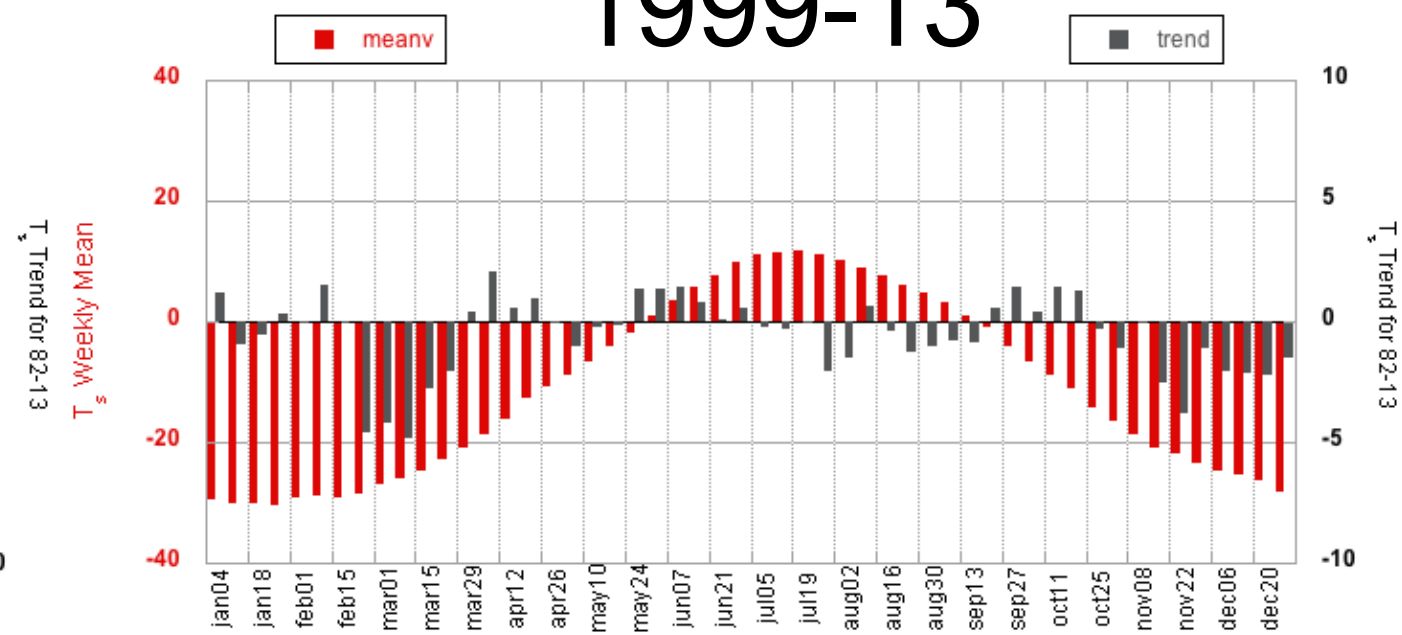
## 1982-2013



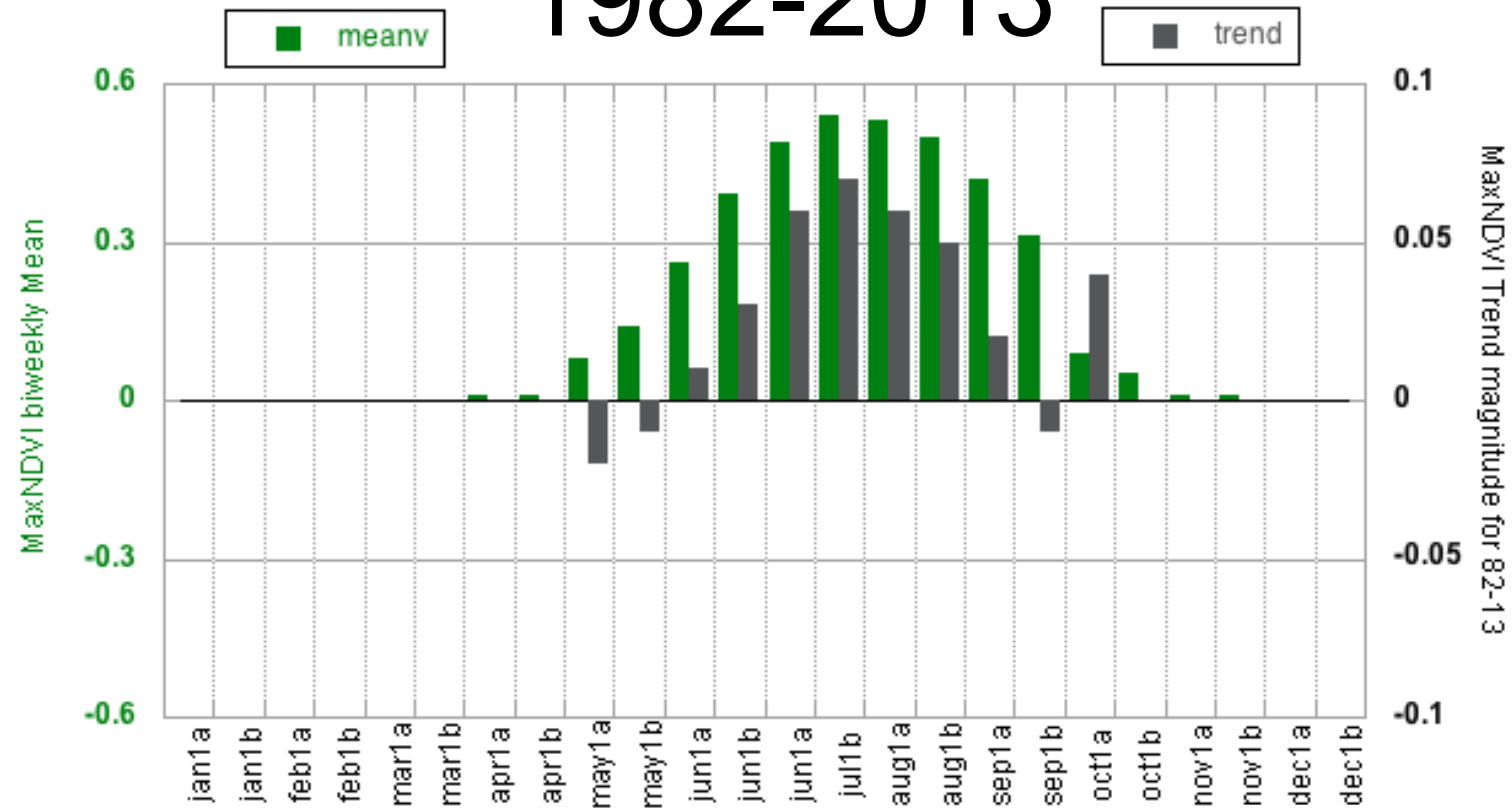
1982-98



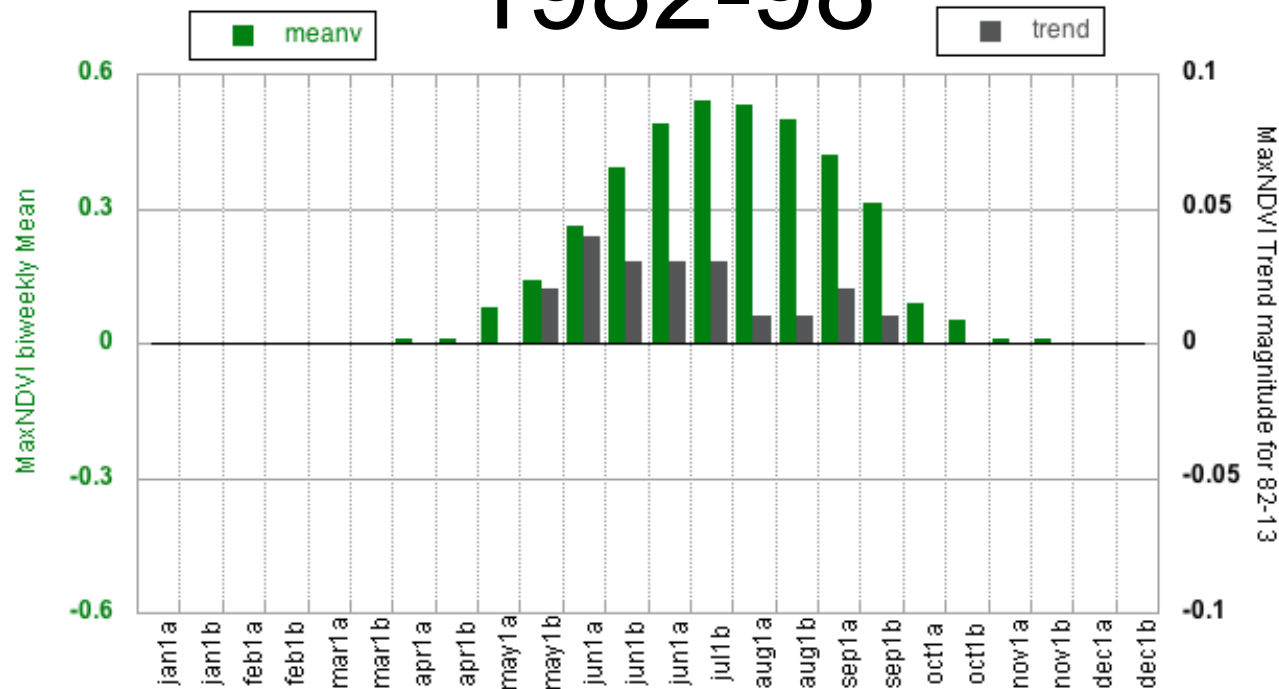
1999-13



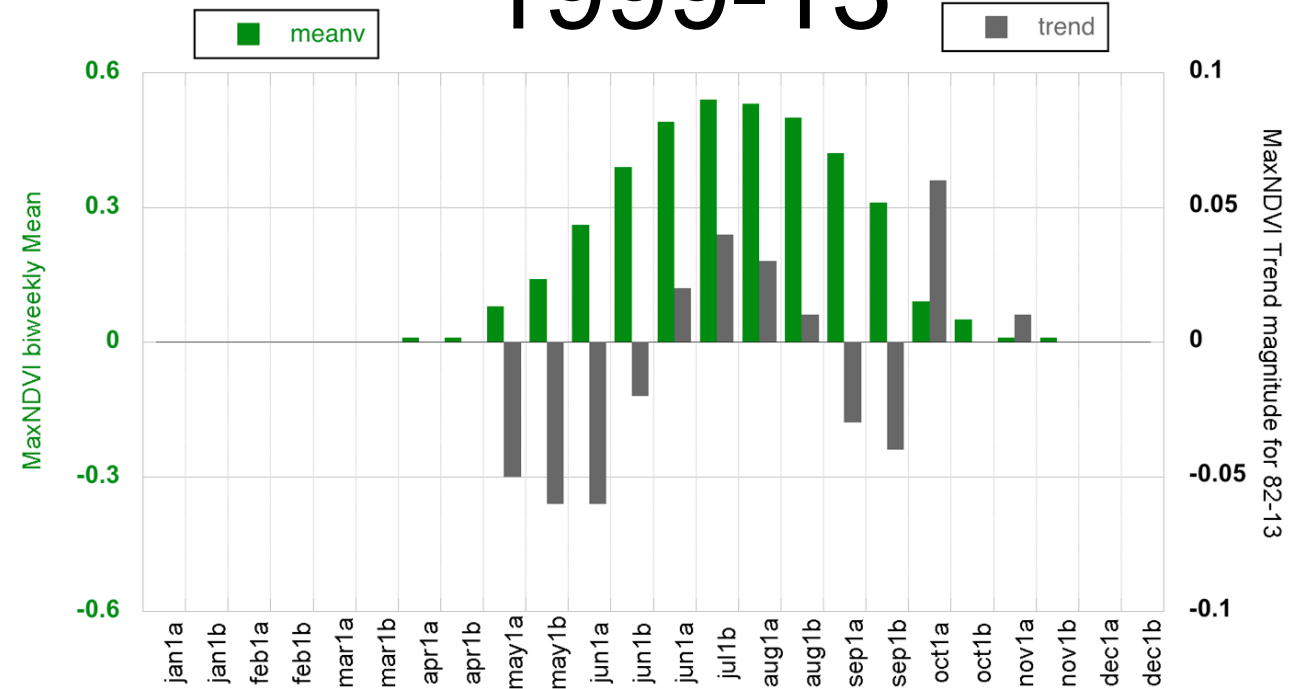
# MaxNDVI Spring/Fall decline & Peak increase 1982-2013



1982-98



1999-13



1982-1998

1999-2013

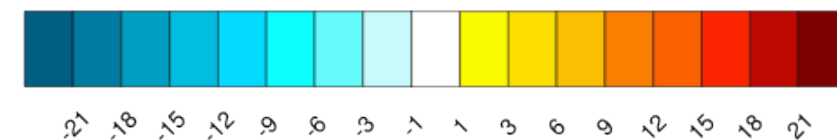
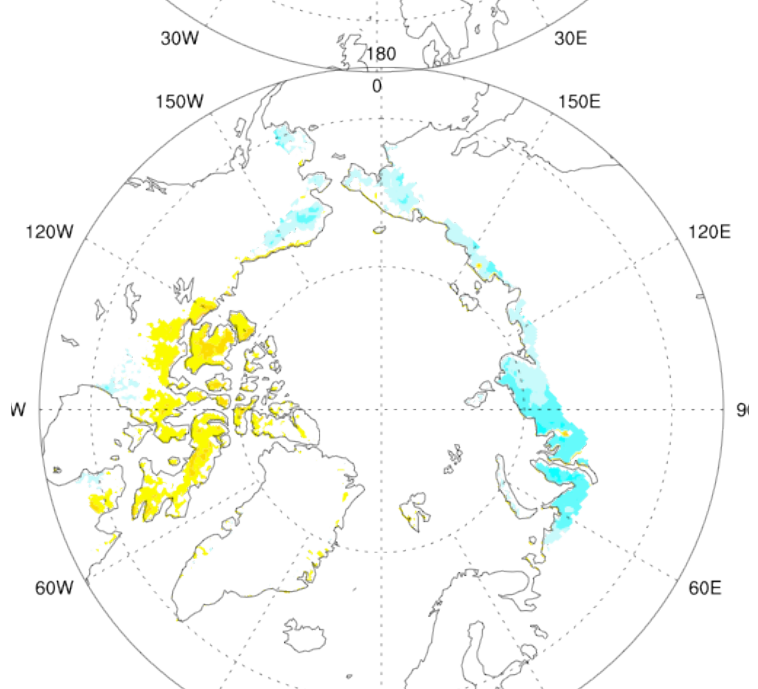
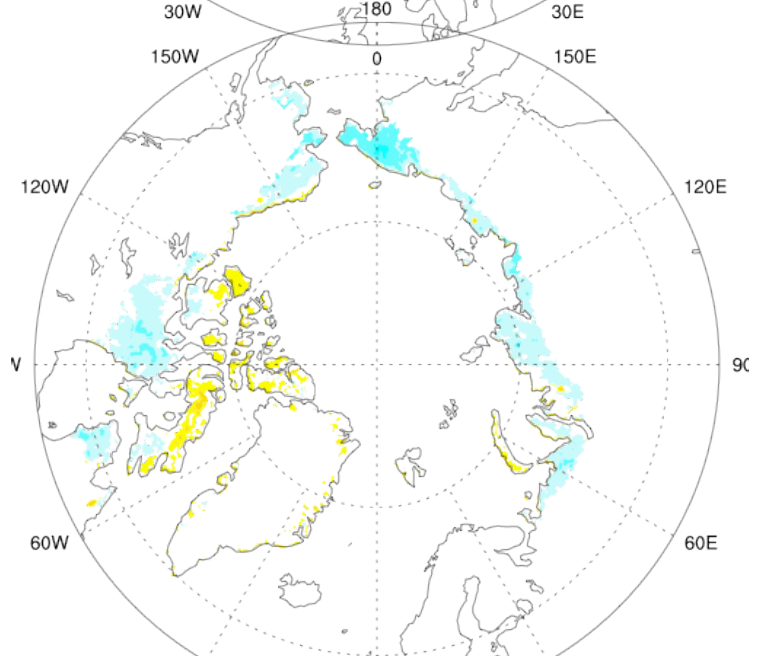
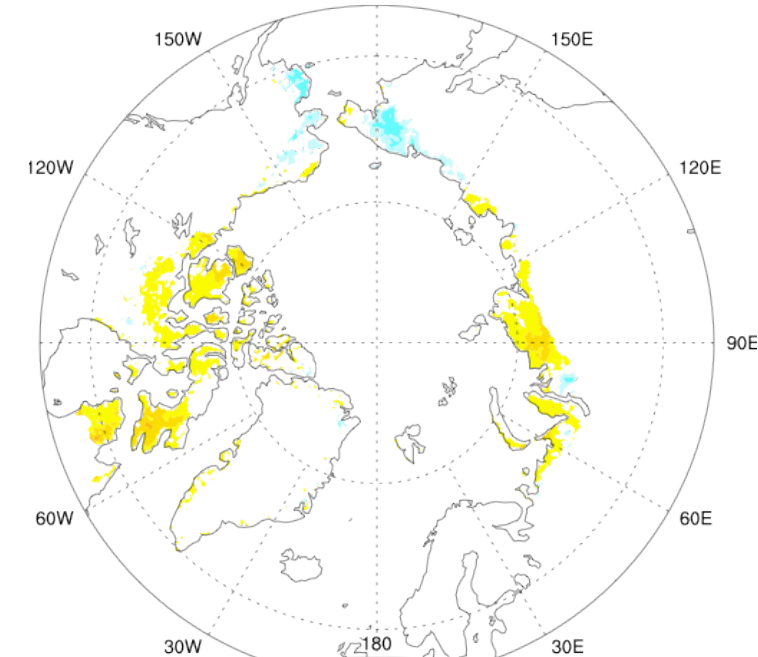
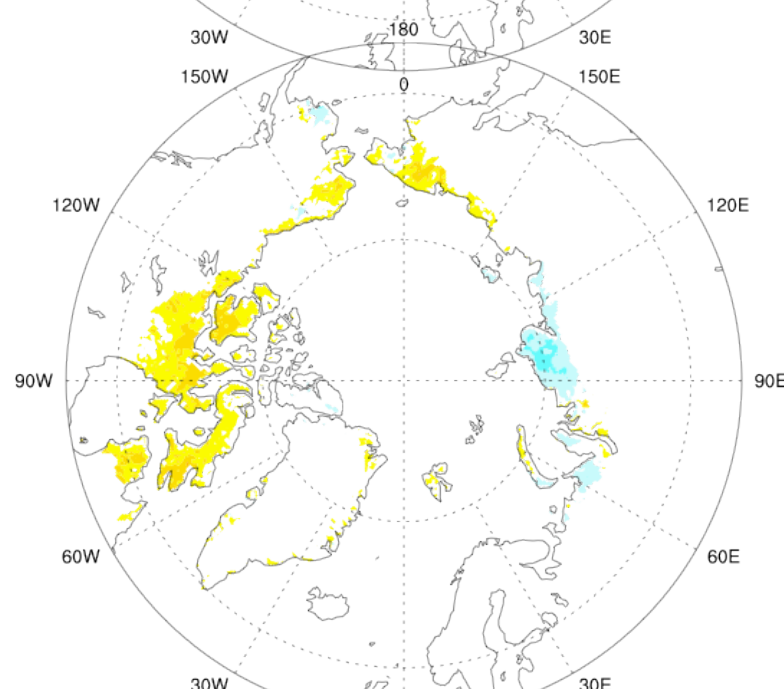
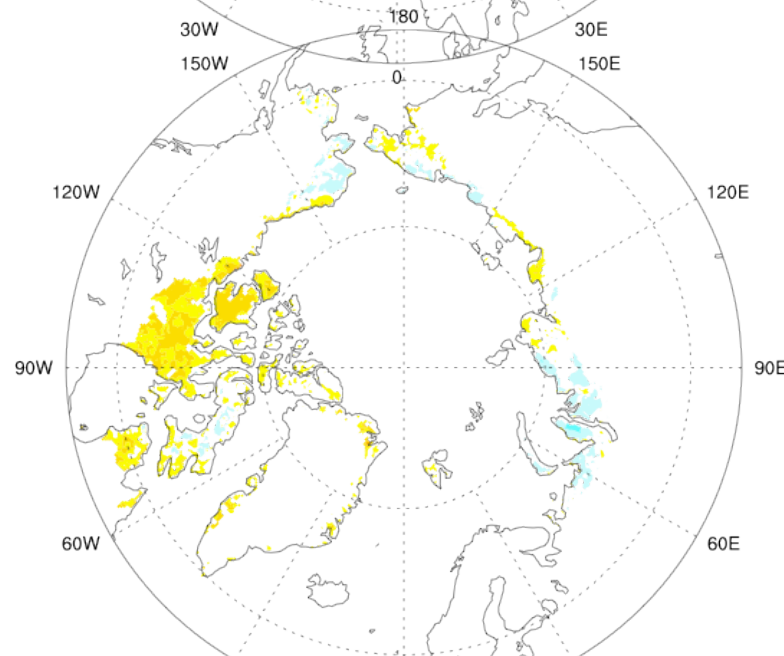
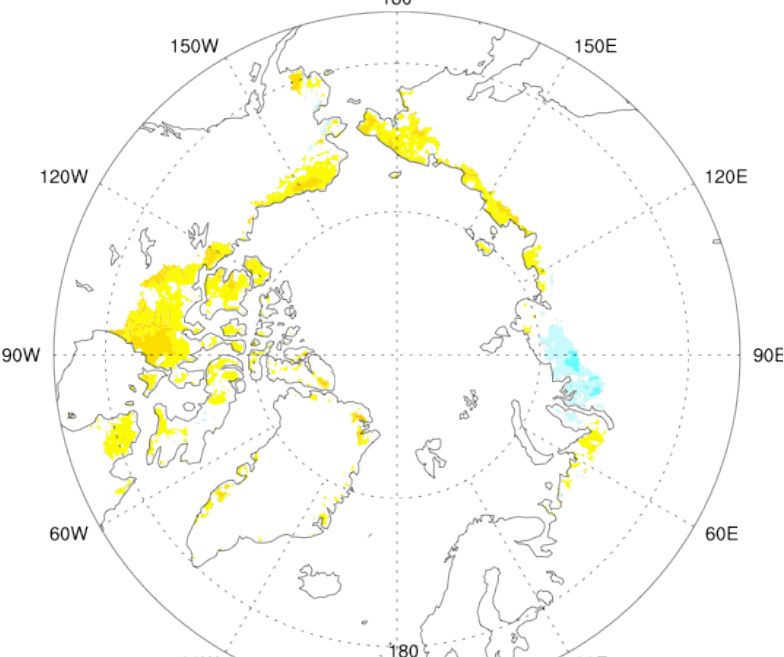
# SWI changing trends within season

- Alaska
- Taymyr
- Canadian Arch.
- July-August consistent with SLP trends

Jun

Jul

Aug

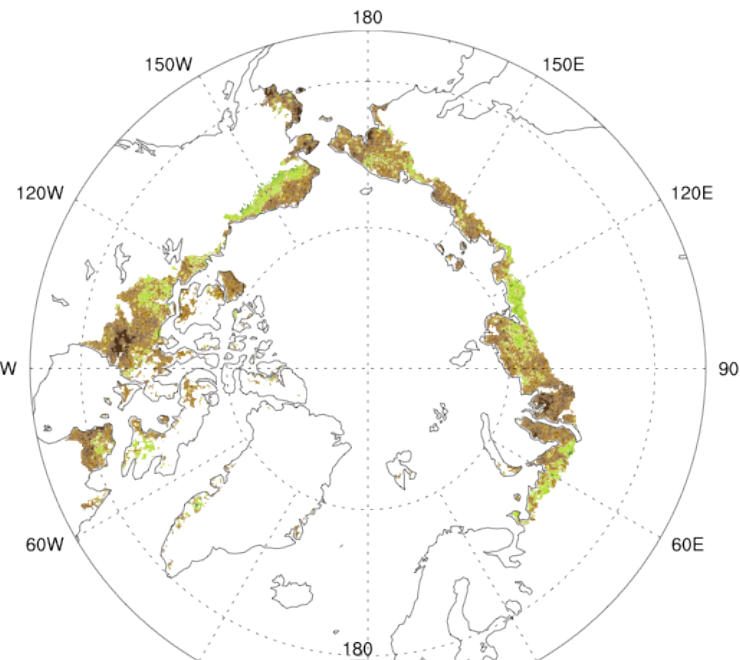
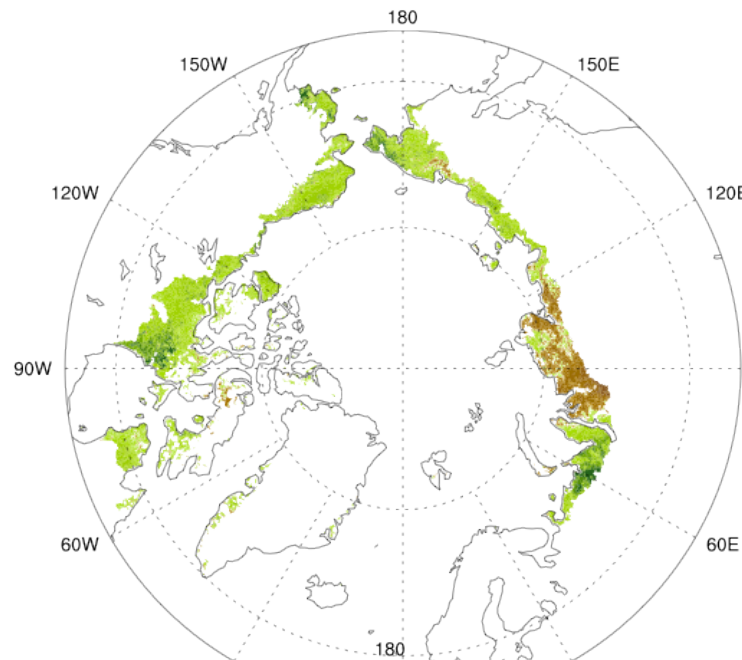




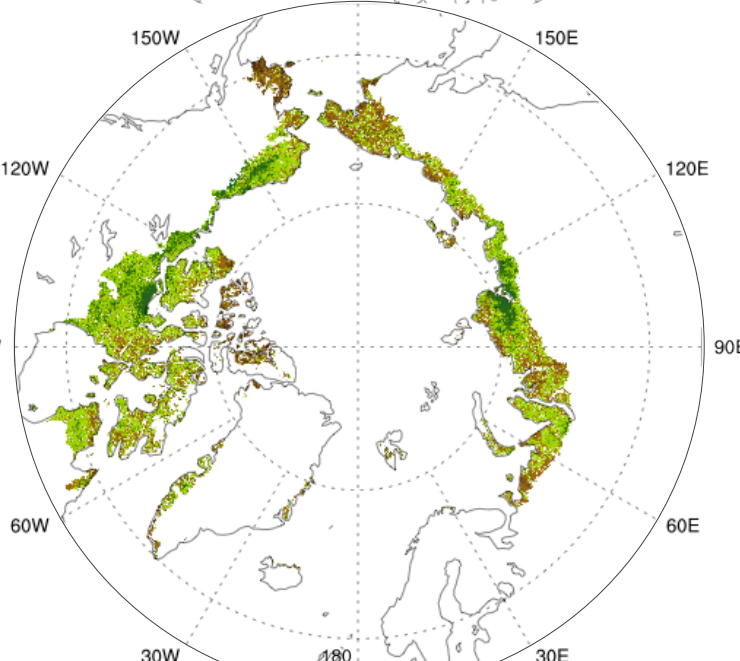
1982-1998

1999-2013

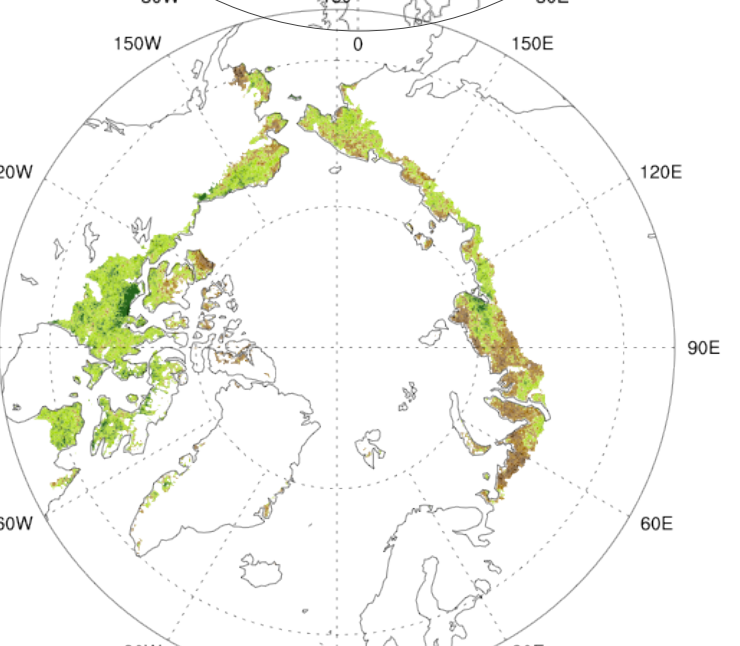
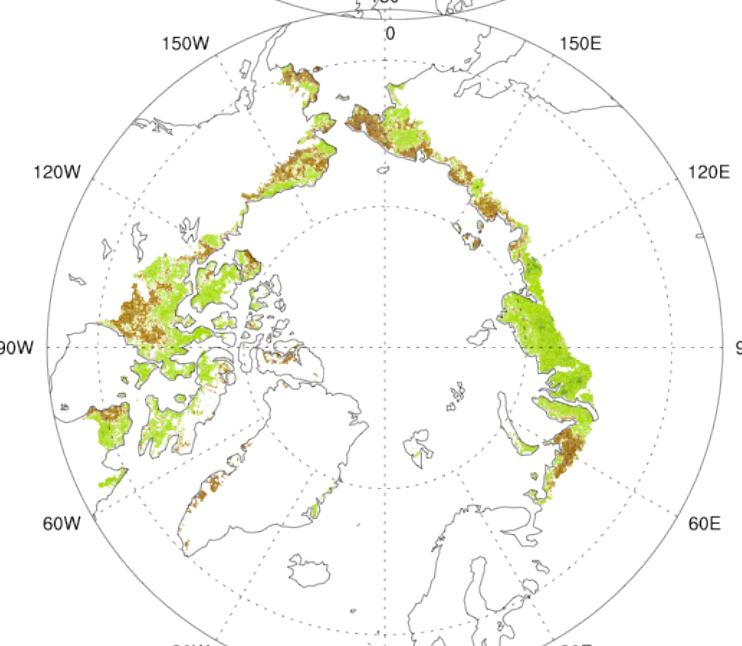
Jun



Jul

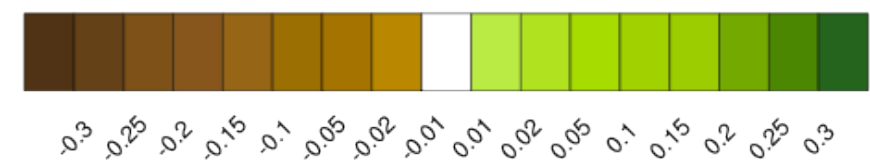


Aug



TI-NDVI  
changing  
trends within  
season

- June declines  
throughout  
domain
- July increases  
stronger &  
declines  
stronger

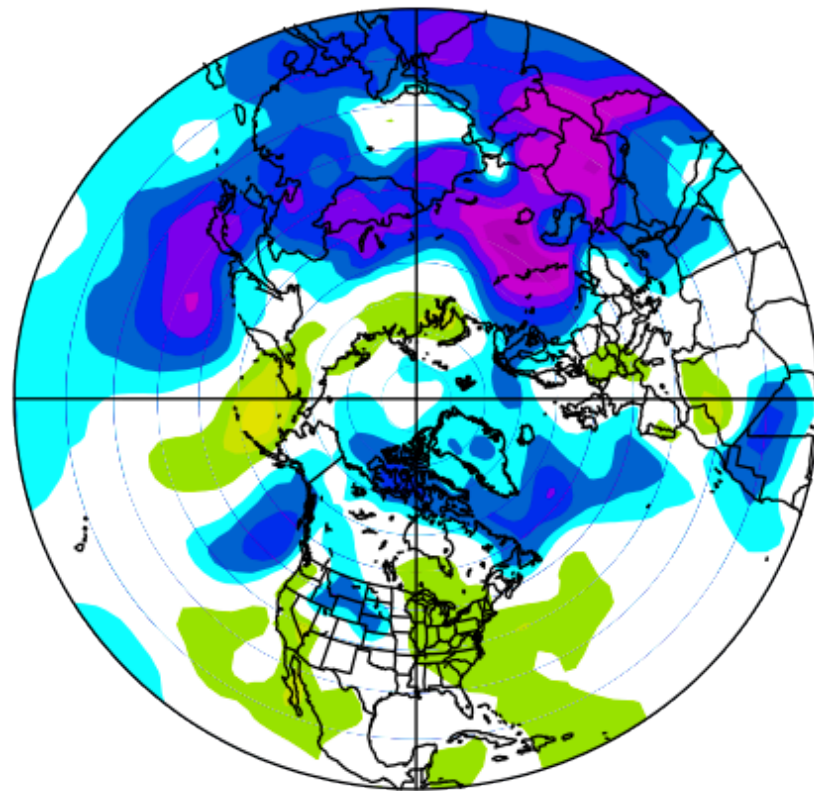




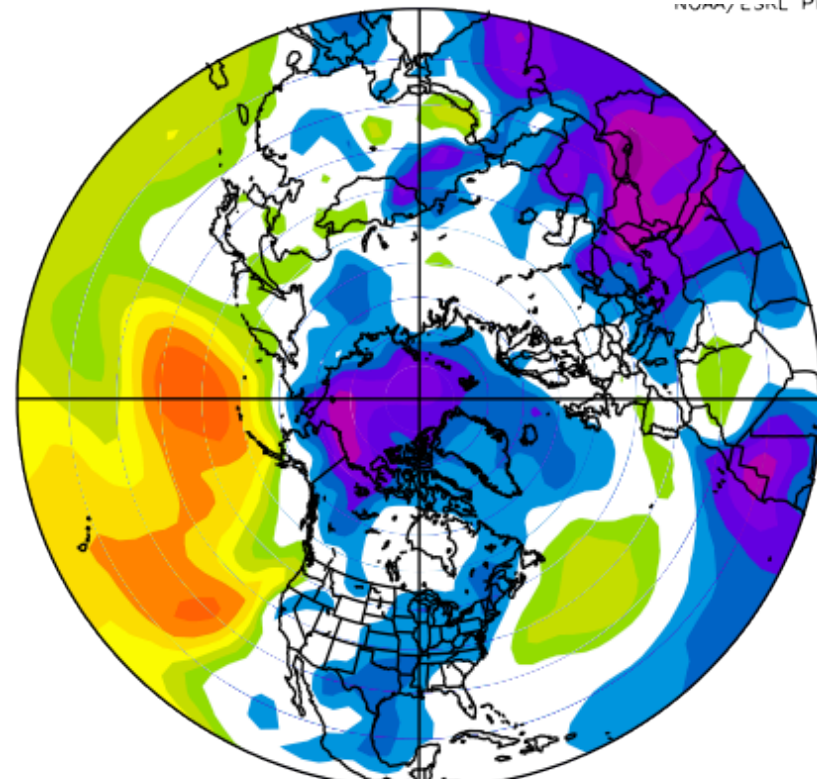
# What could be affecting the trends?

- Cooling in summer?
  - Clouds
  - More clouds due to more moisture
- Declines of Biweekly MaxNDVI in spring & fall
  - Delayed growing season start
  - Snow!

# SWI-SLP correlations Jun-Aug:Large-scale

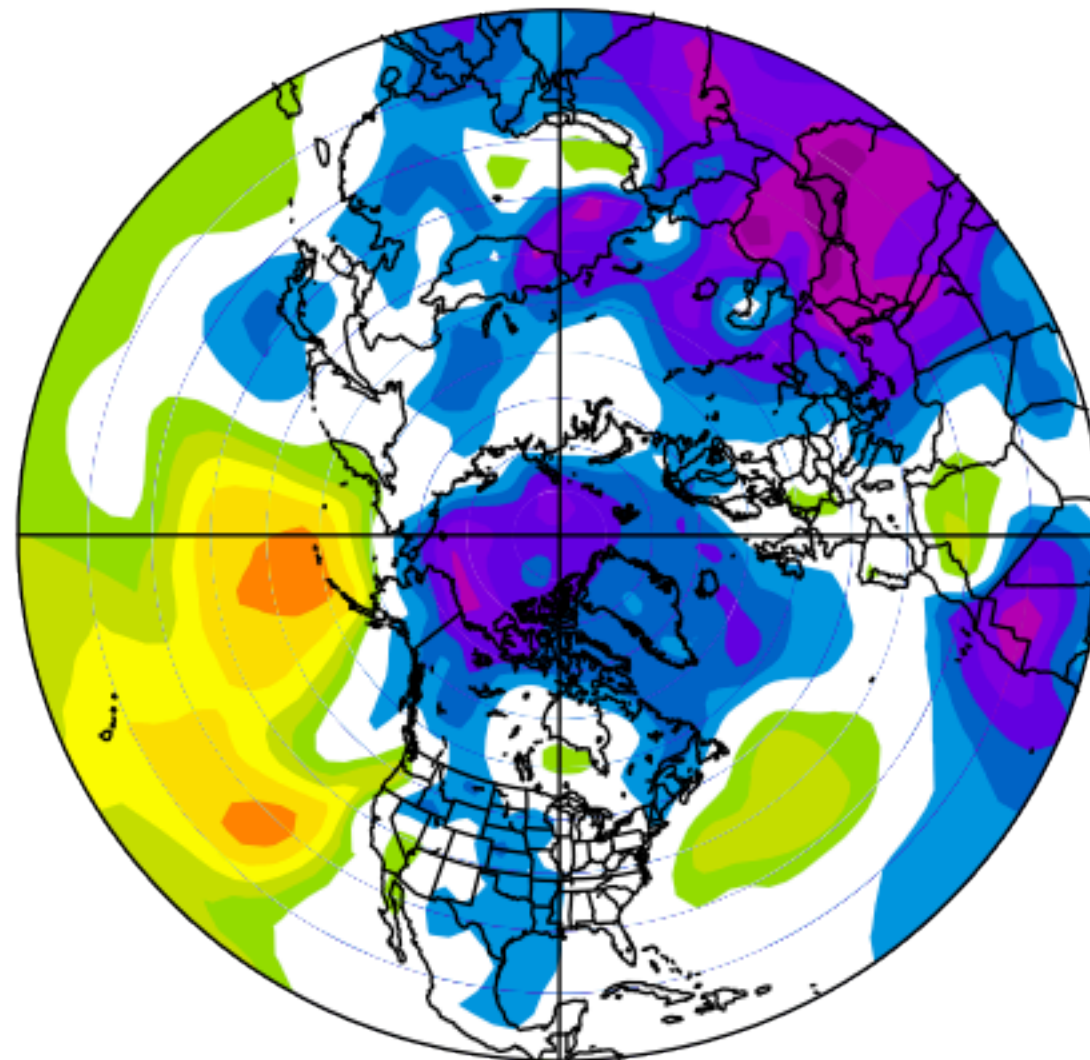


Eurasia



N.Hemisphere

Arctic SWI 82-13



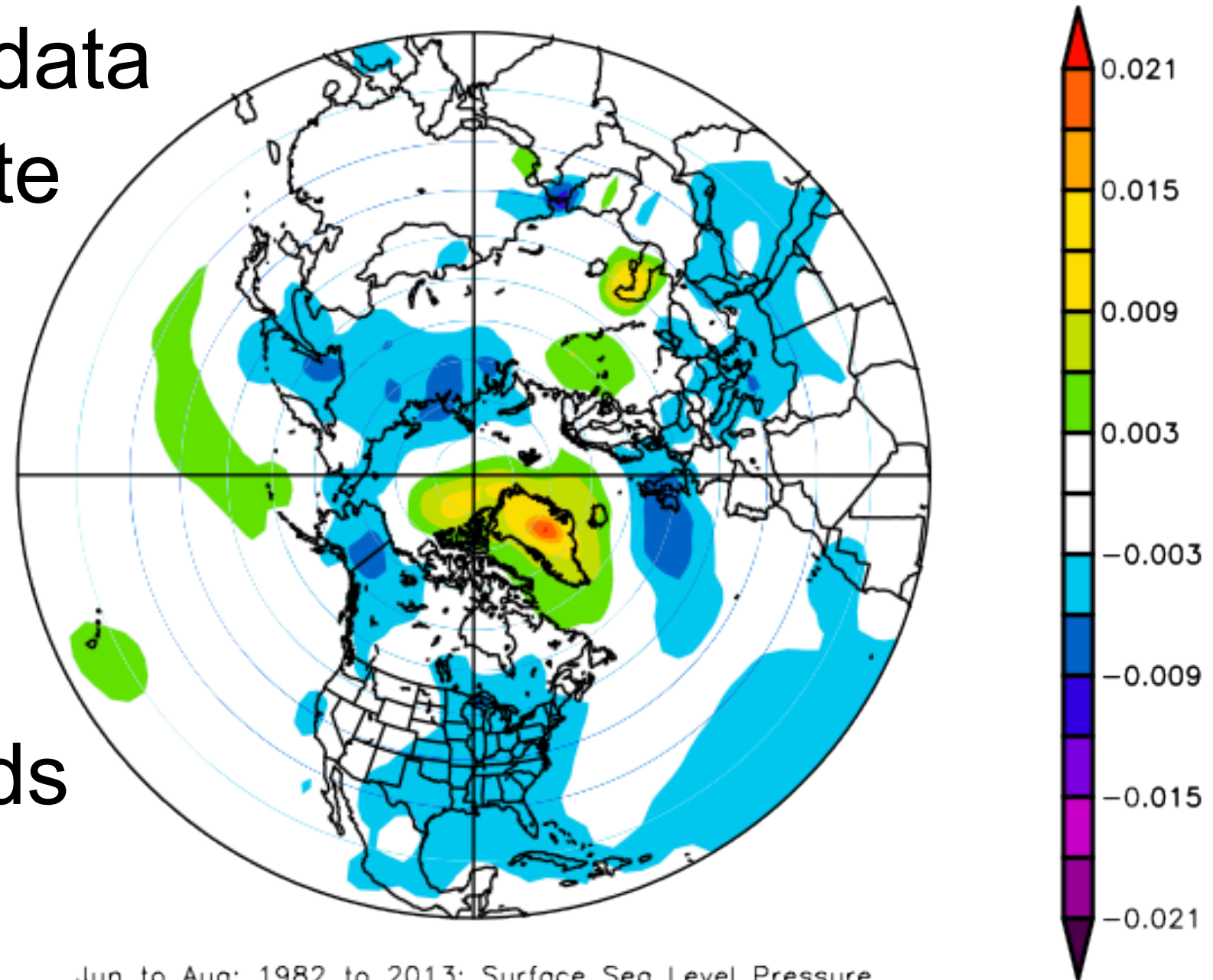
Jun to Aug: 1982 to 2013: Surface Sea Level Pressure  
Seasonal Correlation w/ Jun to Aug swinhemic.txt  
NCEP/NCAR Reanalysis

NOAA/ESRL Physical Sciences Division

# Summary

- Moisture is likely important in this changing NDVI story.
- Need good snow data
- Large-scale climate

NH JJA SLP trends  
82-13



Jun to Aug: 1982 to 2013: Surface Sea Level Pressure  
Seasonal Regression on Sea Level Pressure w/ Jun to Aug Trend

NCEP/NCAR Reanalysis

NOAA/ESRL Physical Sciences Division