

ARCTIC PHENOLOGICAL CHANGES IN CLM

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Phenology



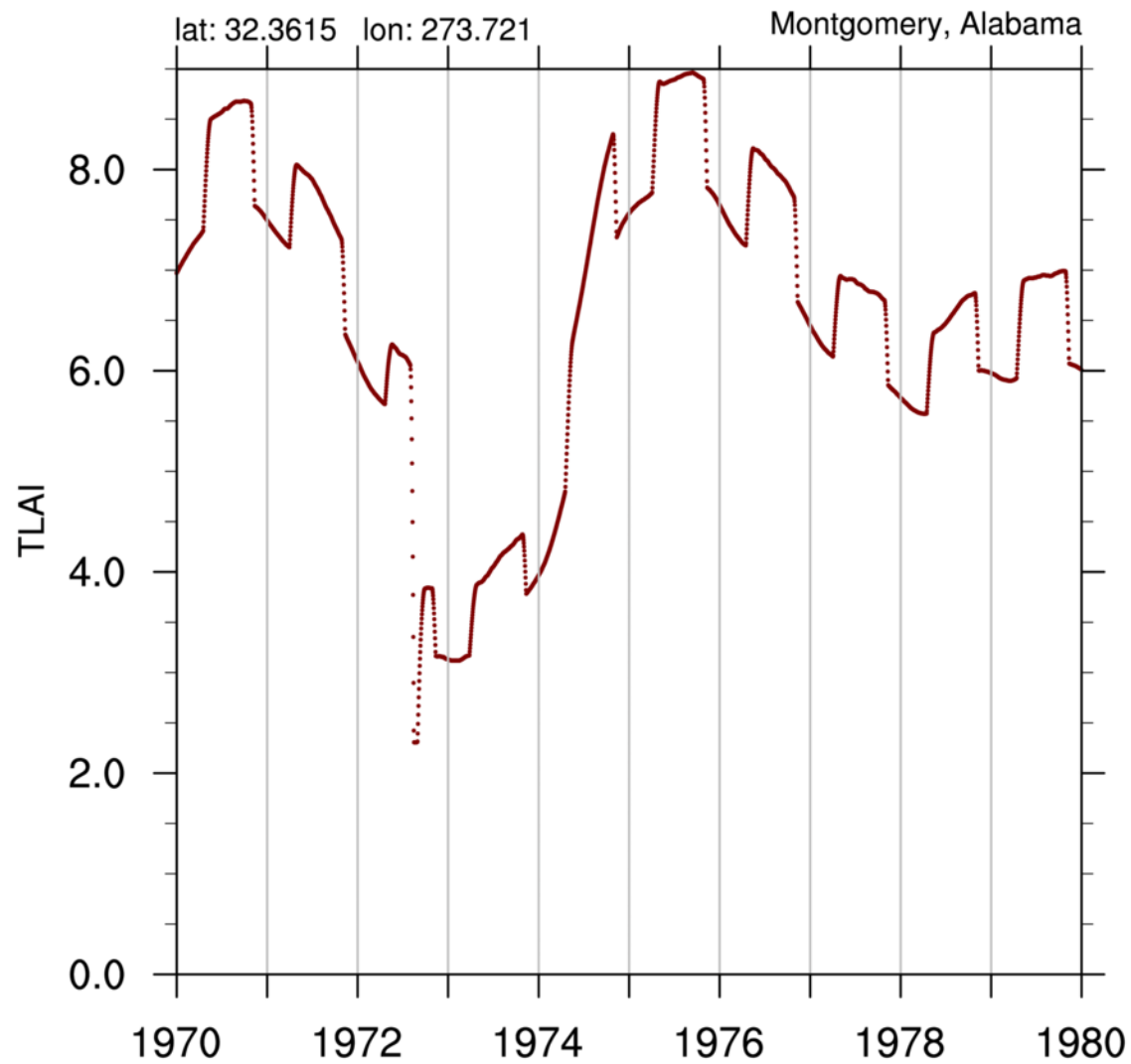
Motivation

- how well does CLM perform?
 - ▣ phenology
 - ▣ other ecosystem components
 - ▣ carbon cycle feedbacks
- local vs. remote drivers of ecosystem processes
- ecosystem relationship to extreme events

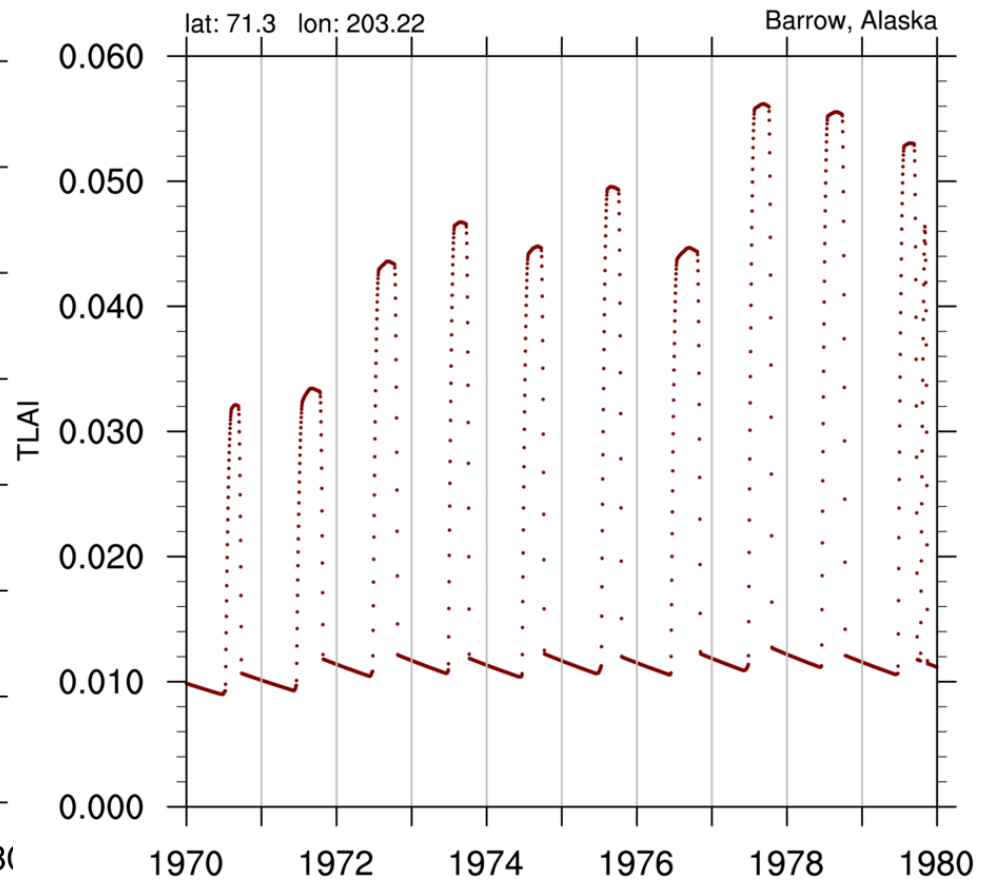
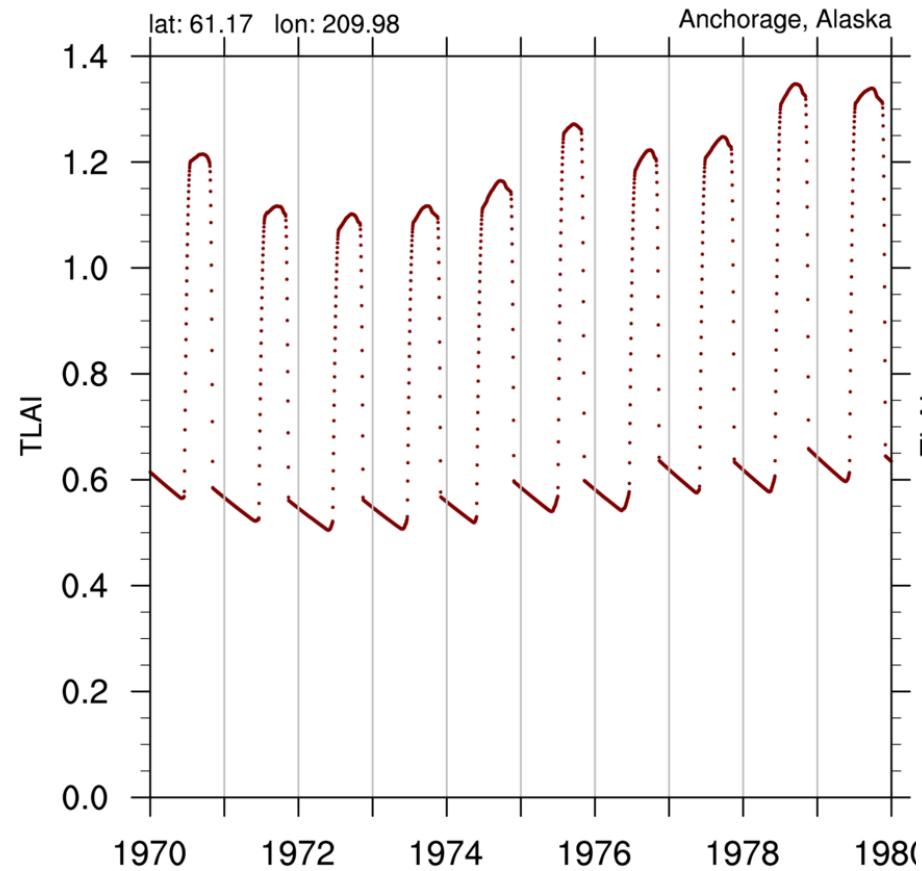
Simulations

- CLM4-CN forced with coupler data from MOAR simulations
- 1850-2004
- 2005-2100 with RCP 8.5 scenario
- terabytes of daily grid cell-level and PFT-level output

Total leaf area index (TLAI)

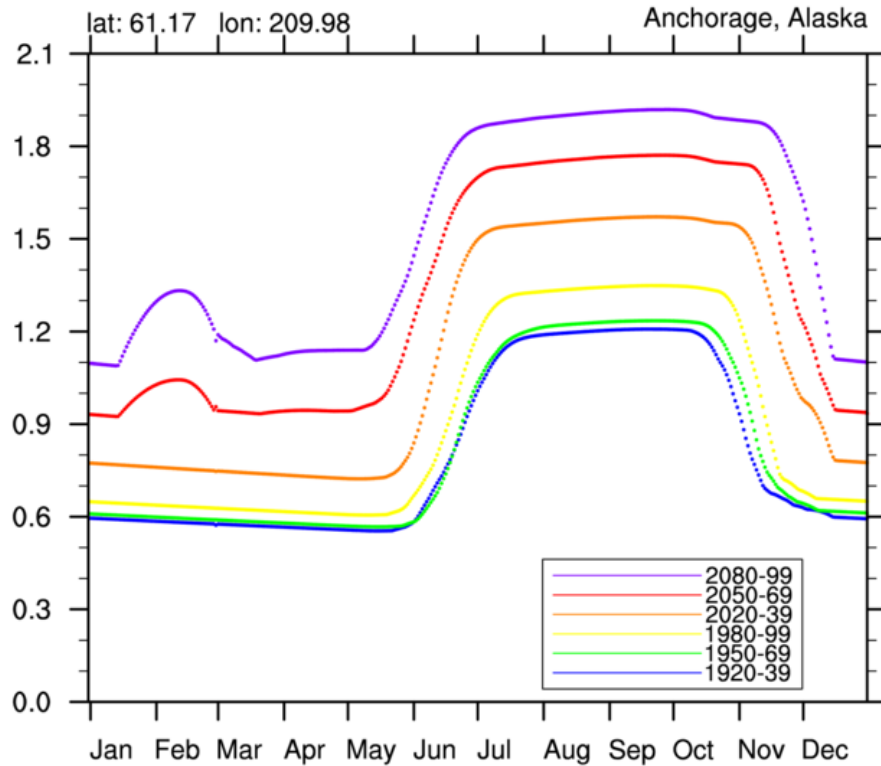


Total leaf area index (TLAI)

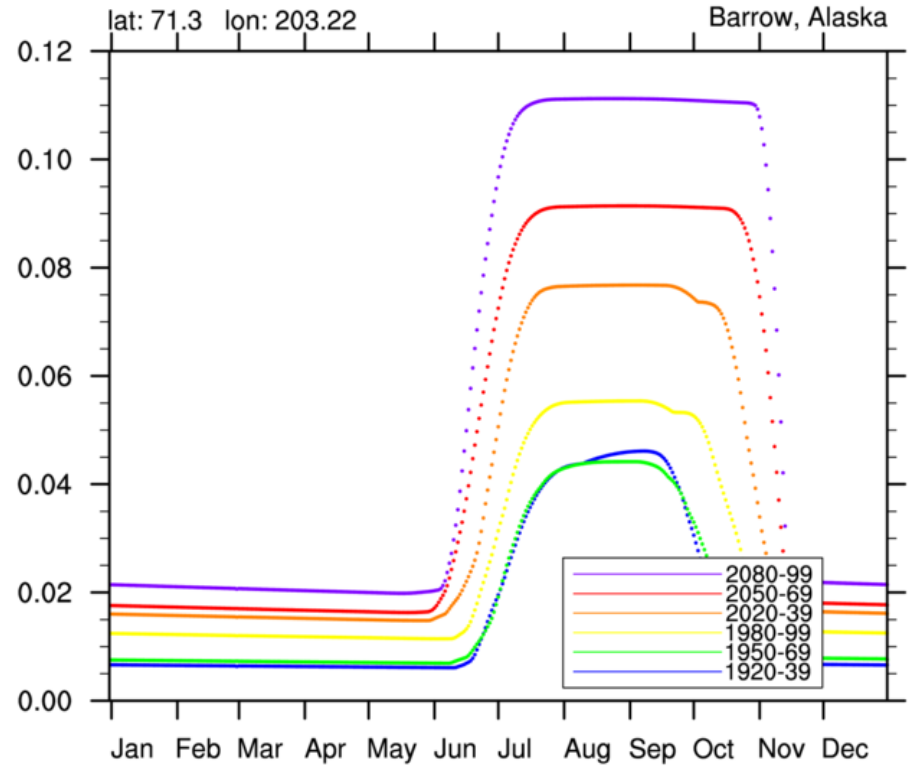


Shift in annual TLAI signal

Averaged TLAI



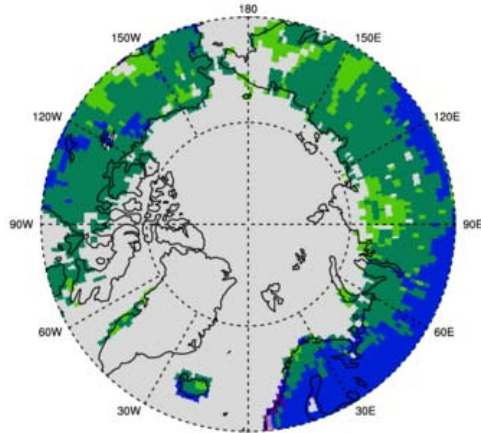
Averaged TLAI



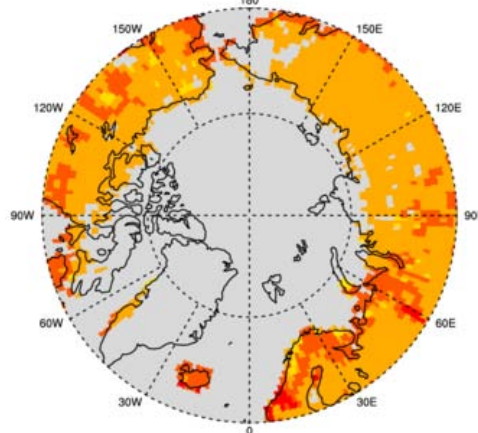
Arctic phenological dates spatially

1980-
1999

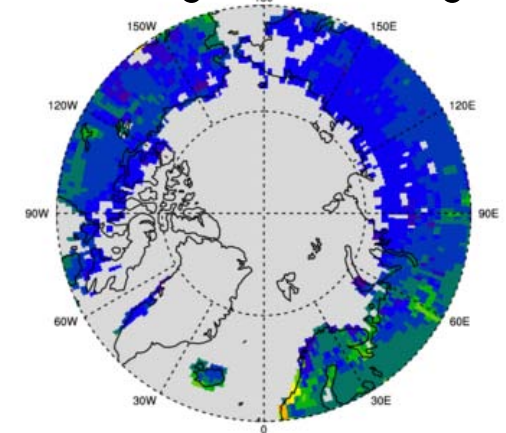
Leaf out date



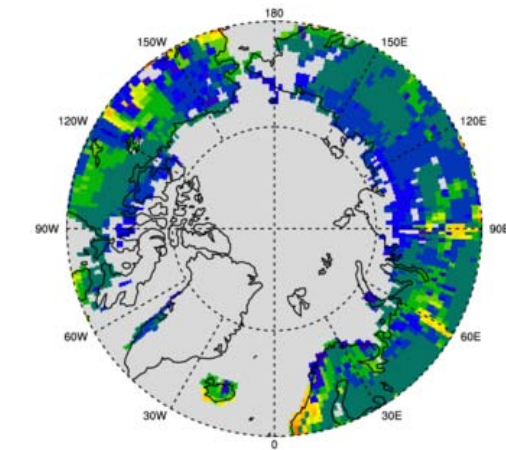
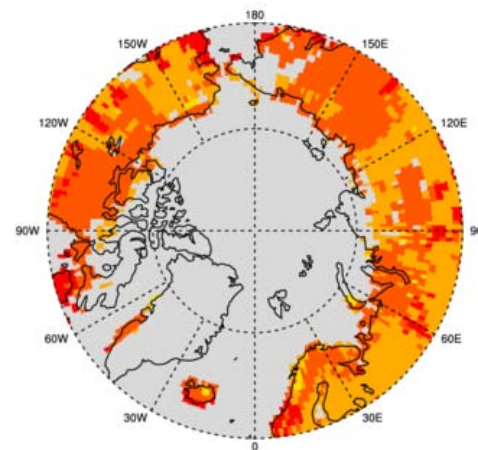
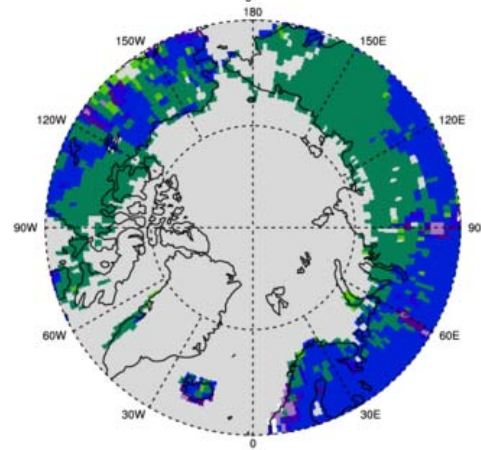
Leaf down date



Growing season length



2080-
2099



J F M A M J J A S O N D (month)

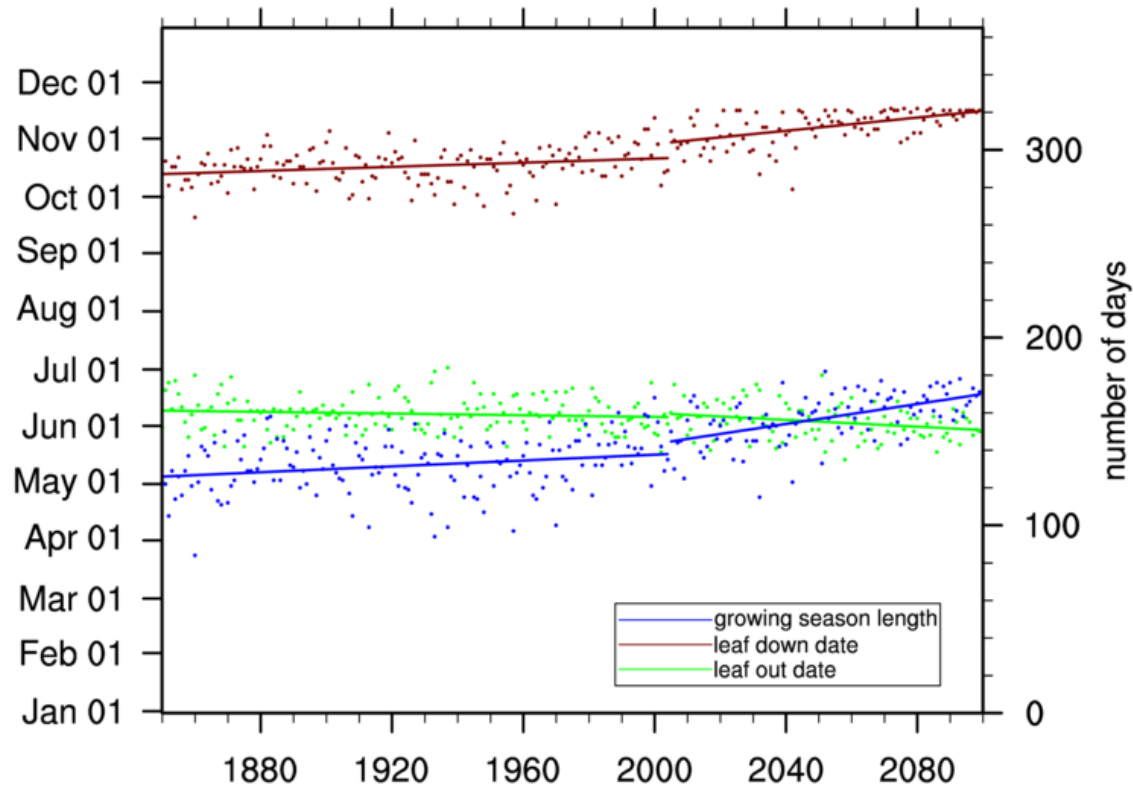


J F M A M J J A S O N D (month)



0 100 200 300 (days)

Trends in Alaskan Arctic phenological dates



leaf out date

1850-2004 days / decade: -0.23
1850-2004 trend not sig

leaf down date

1850-2004 days / decade: 0.55
1850-2004 trend sig at the 95% level

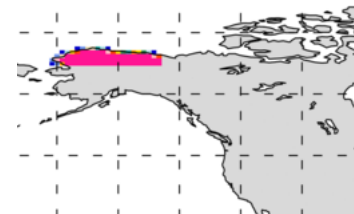
growing season length

1850-2004 days / decade: 0.78
1850-2004 trend sig at the 95% level

2005-2099 days / decade: -0.90
2005-2099 trend sig at the 95% level

2005-2099 days / decade: 1.75
2005-2099 trend sig at the 95% level

2005-2099 days / decade: 2.66
2005-2099 trend sig at the 95% level



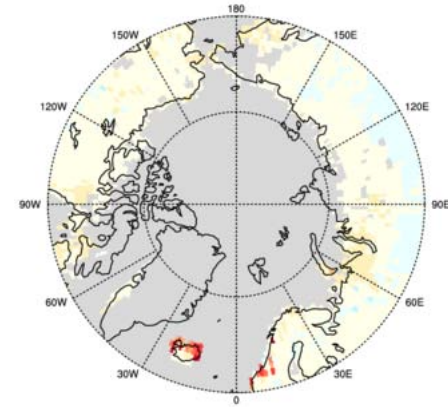
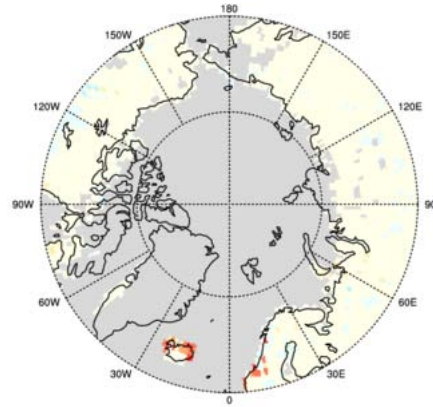
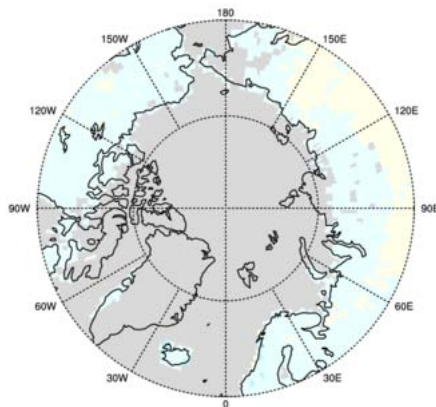
Trends in Alaskan Arctic phenological dates

Leaf out trend

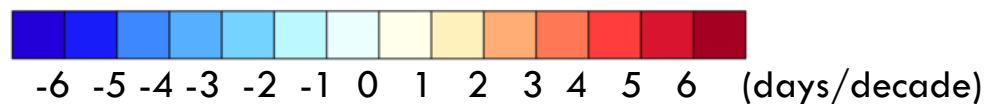
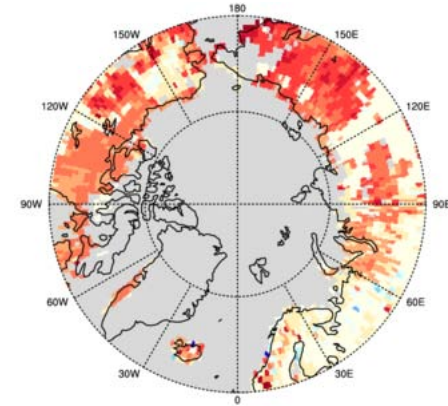
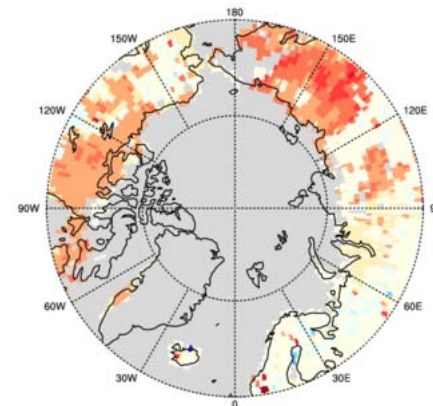
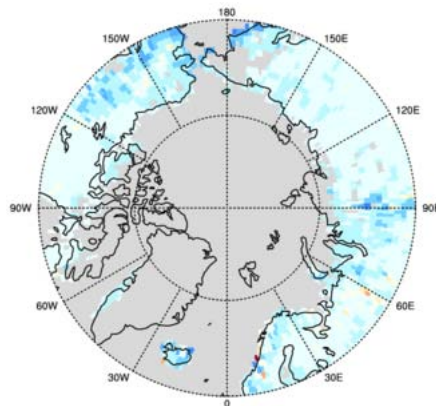
Leaf down trend

Growing season trend

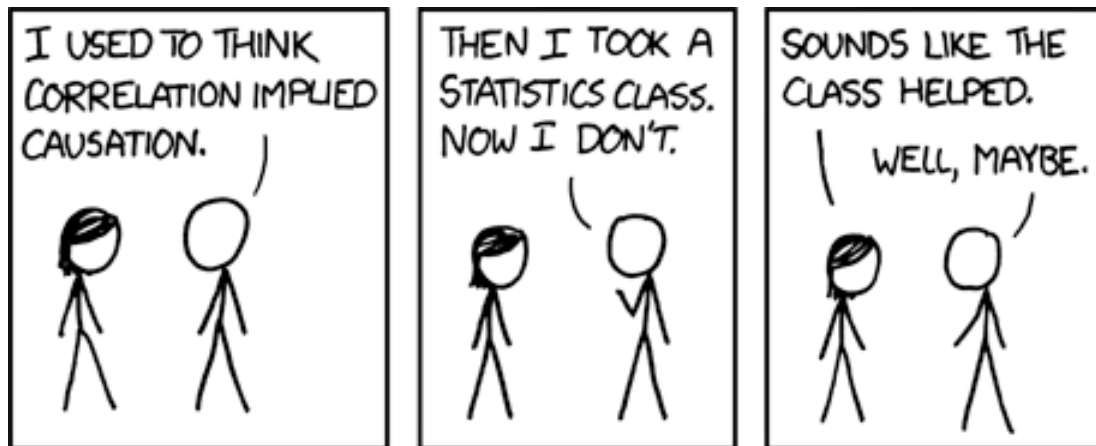
1850-
2004



2005-
2099



XKCD

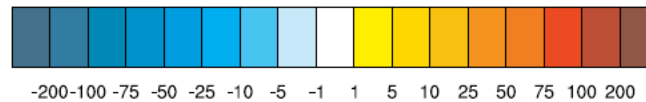
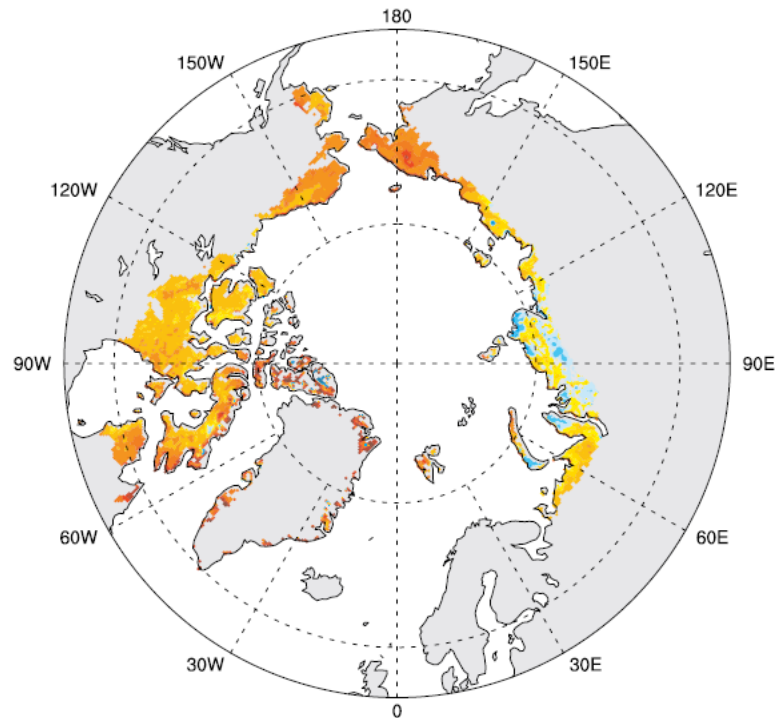


XKCD Alt Text:

Correlation doesn't imply causation, but it does waggle its eyebrows suggestively and gesture furtively while mouthing "look over there"

Observed Summer Warmth Index (SWI)

Summer Warmth Index (SWI)
(percentage change, 1982-2008)



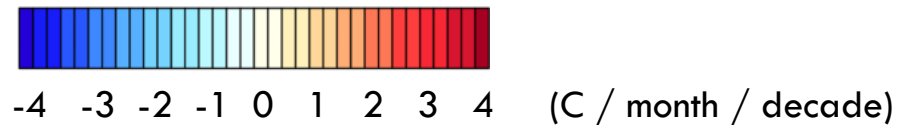
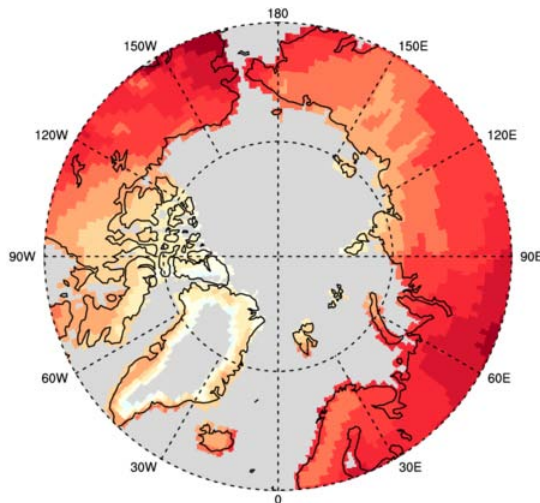
Bhatt 2010

Summer Warmth Index model trends

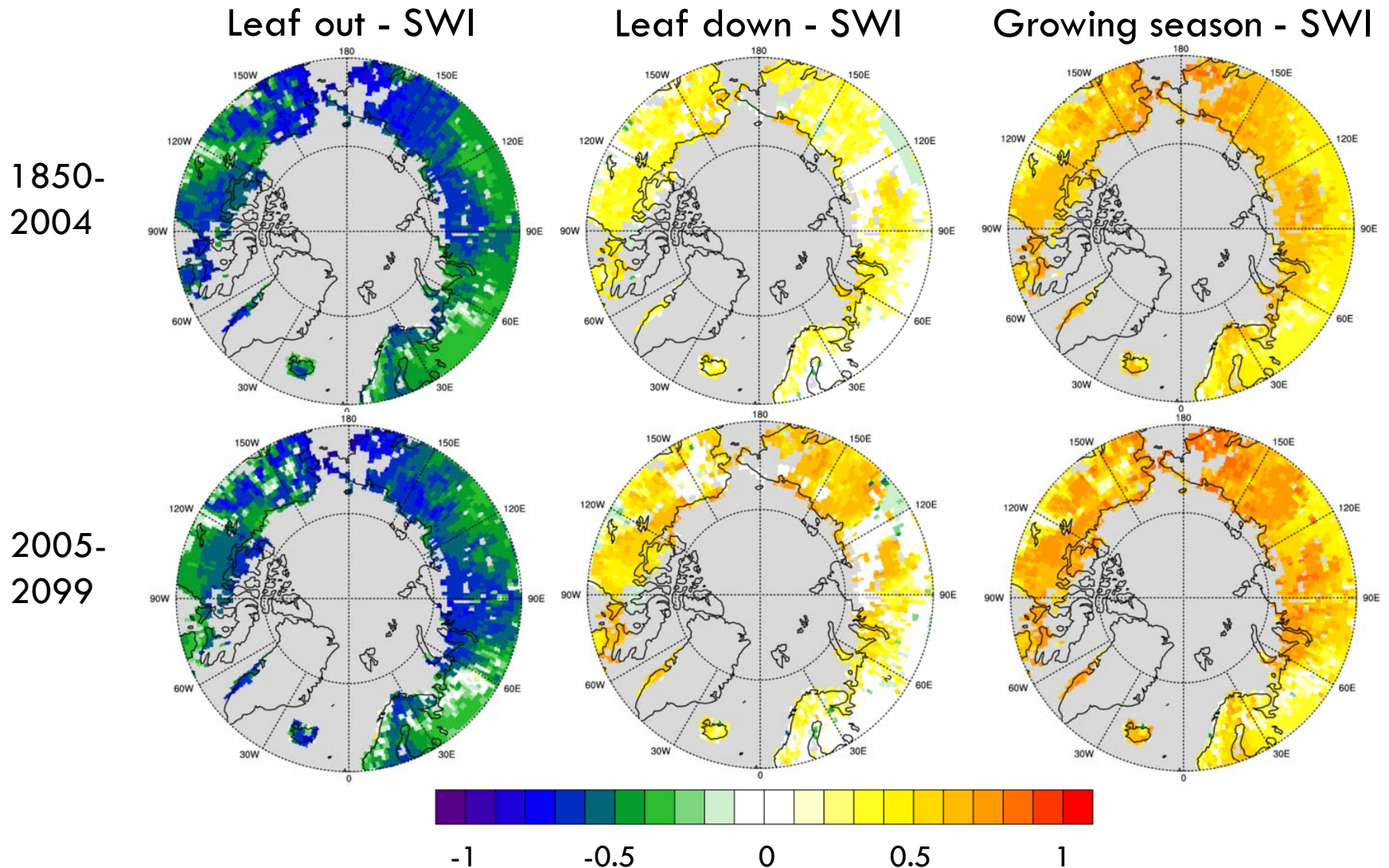
1850-
2004



2005-
2099

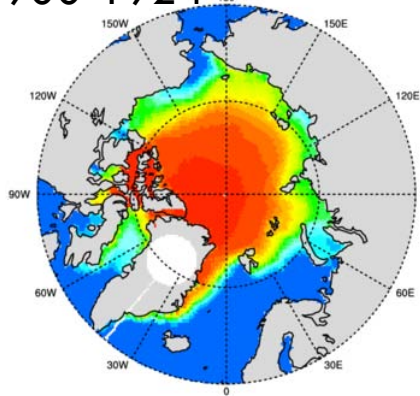


Summer Warmth Index correlations

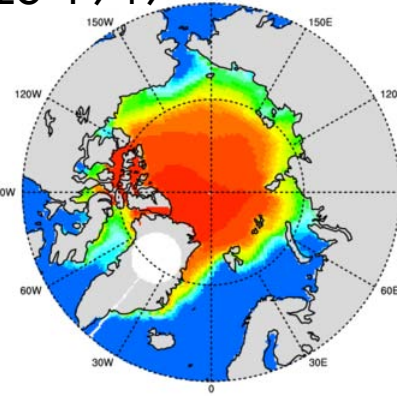


September sea ice extent model trends

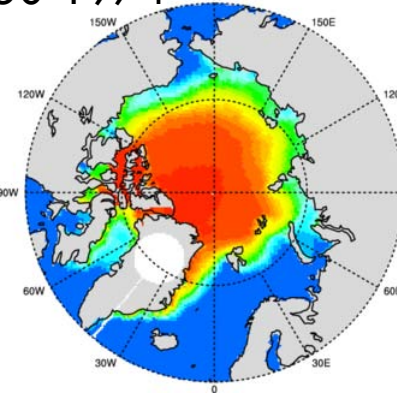
1900-1924



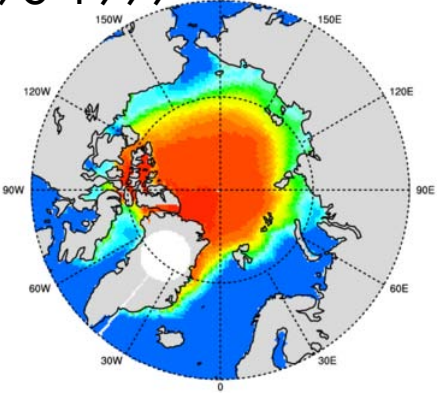
1925-1949



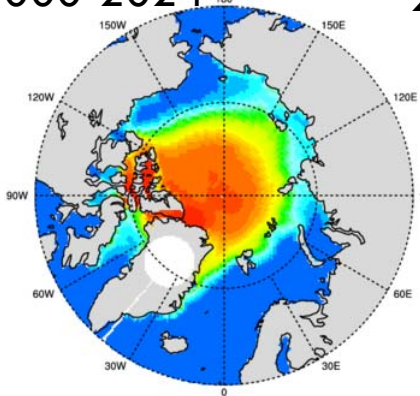
1950-1974



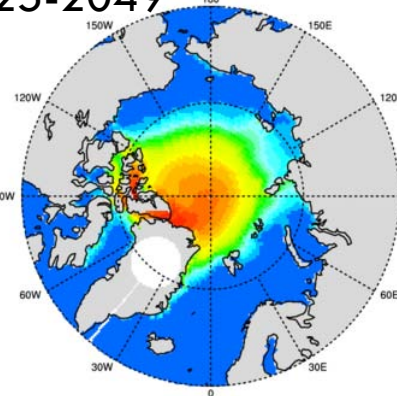
1975-1999



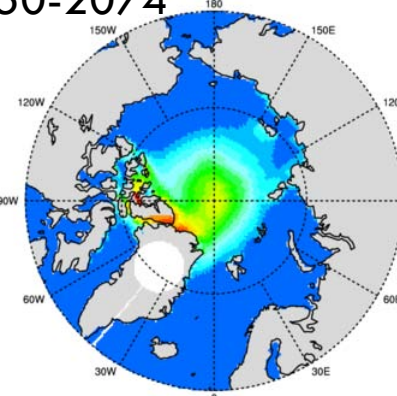
2000-2024



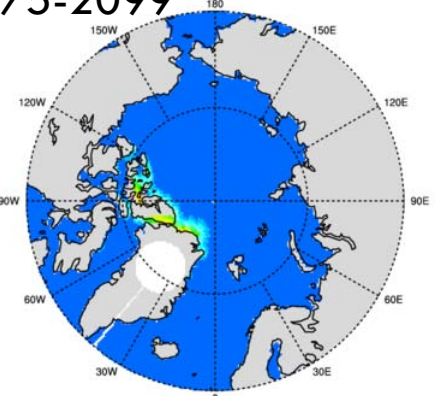
2025-2049



2050-2074

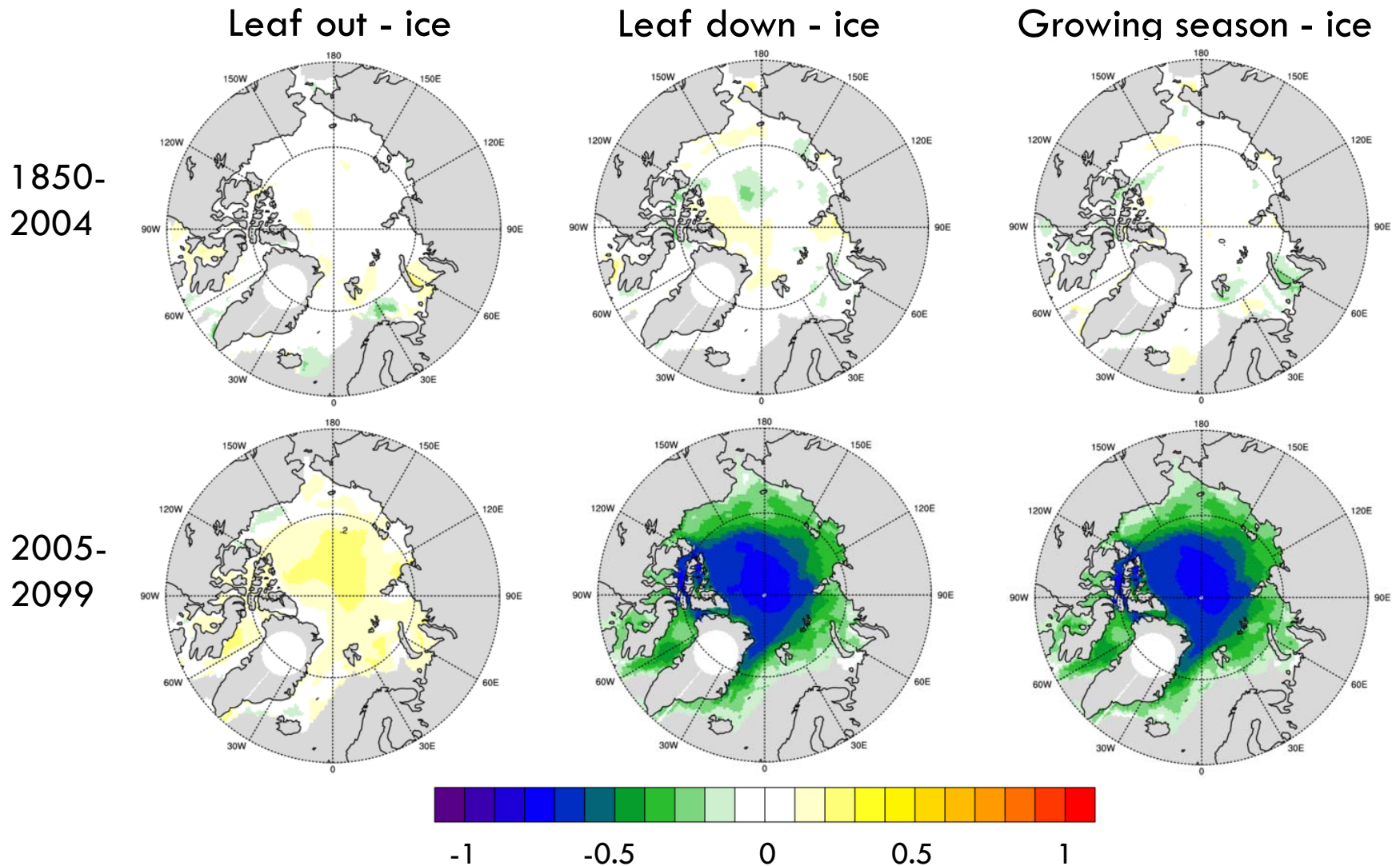


2075-2099

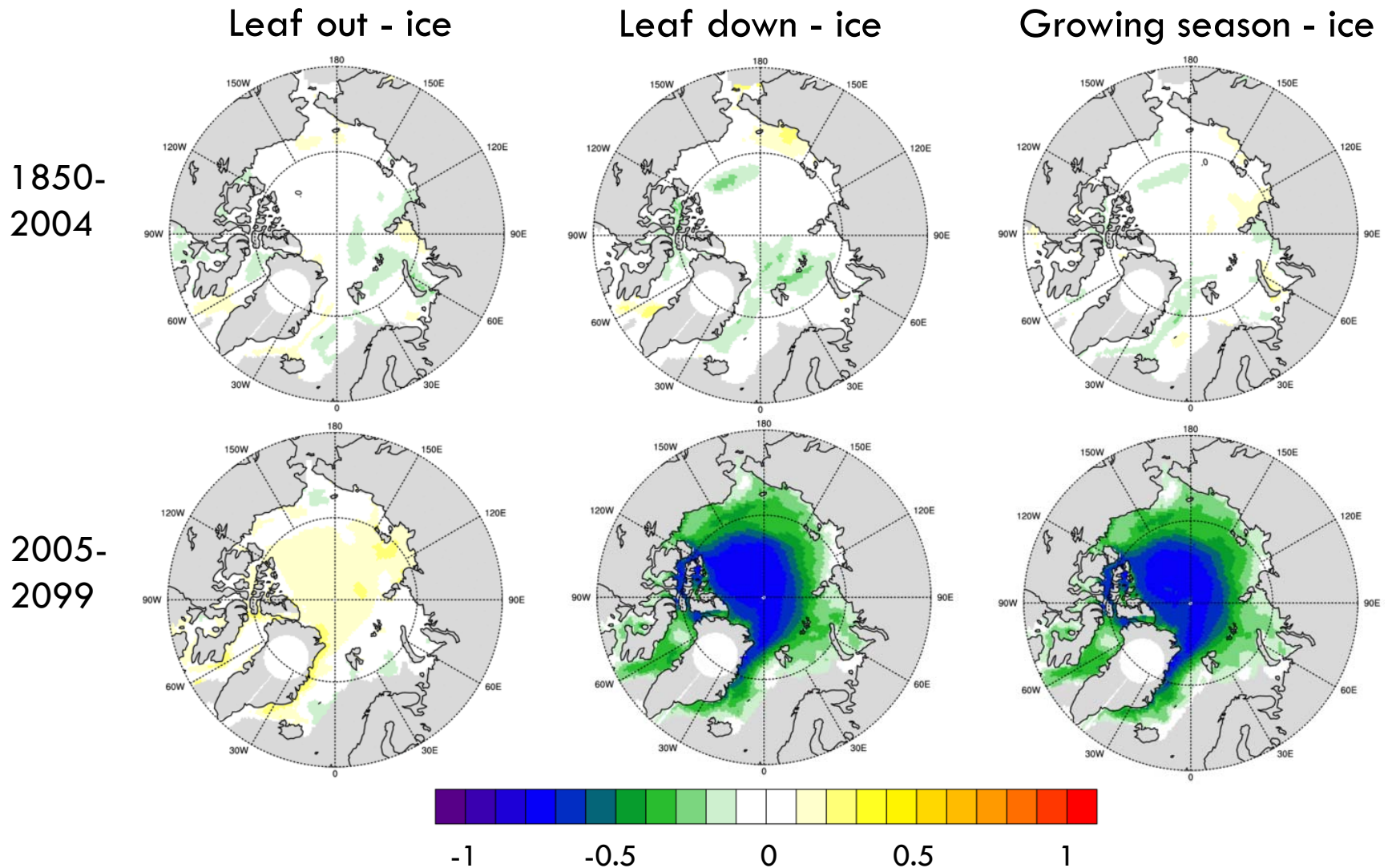


0 10 20 30 40 50 60 70 80 90 100 (%)

September sea ice extent correlations



September sea ice correlations, one year lag



Conclusions

- Leaf area index can be used to estimate phenological dates in CLM
- Significant shift in phenological dates in RCP 8.5:
 - ▣ ~1-2 days / decade advance of leaf out date
 - ▣ ~1-5 days / decade delay of leaf down date
 - ▣ ~1-6 days / decade increase in growing season
- Strong correlation between SWI and phenological dates
- Strong correlation between leaf down date and sea ice loss in both current year and prior year