

Ocean Heat Fluxes And Rapid Sea Ice Decline

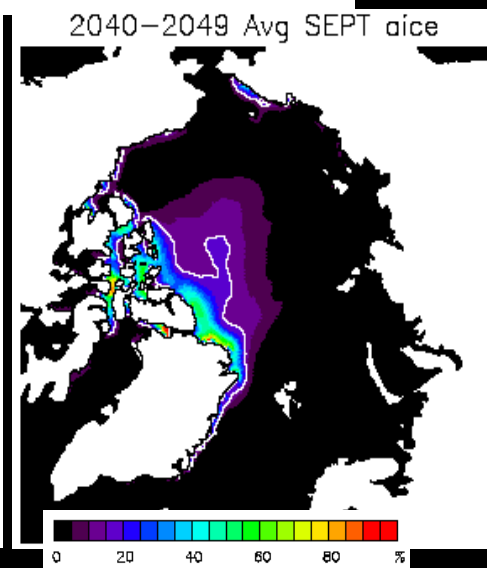
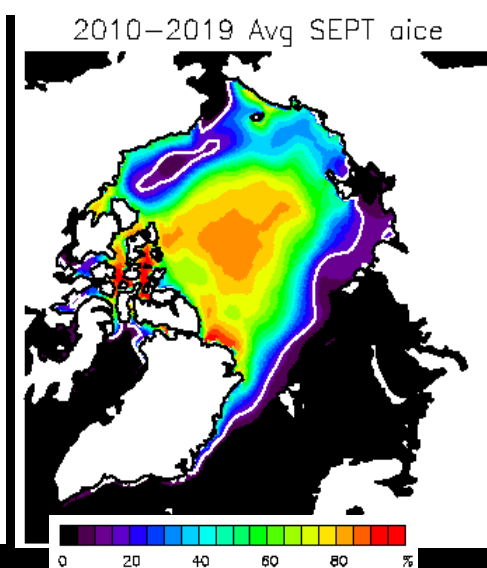
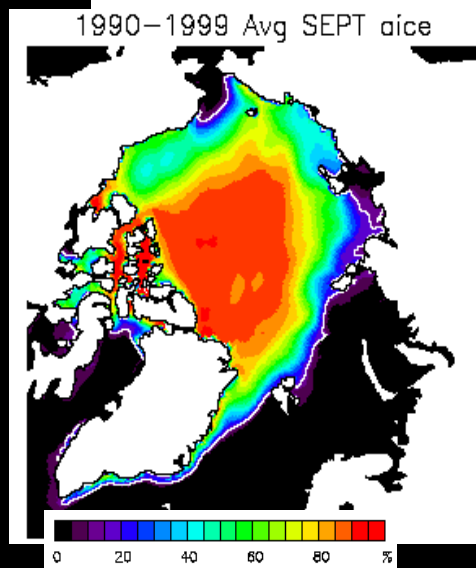
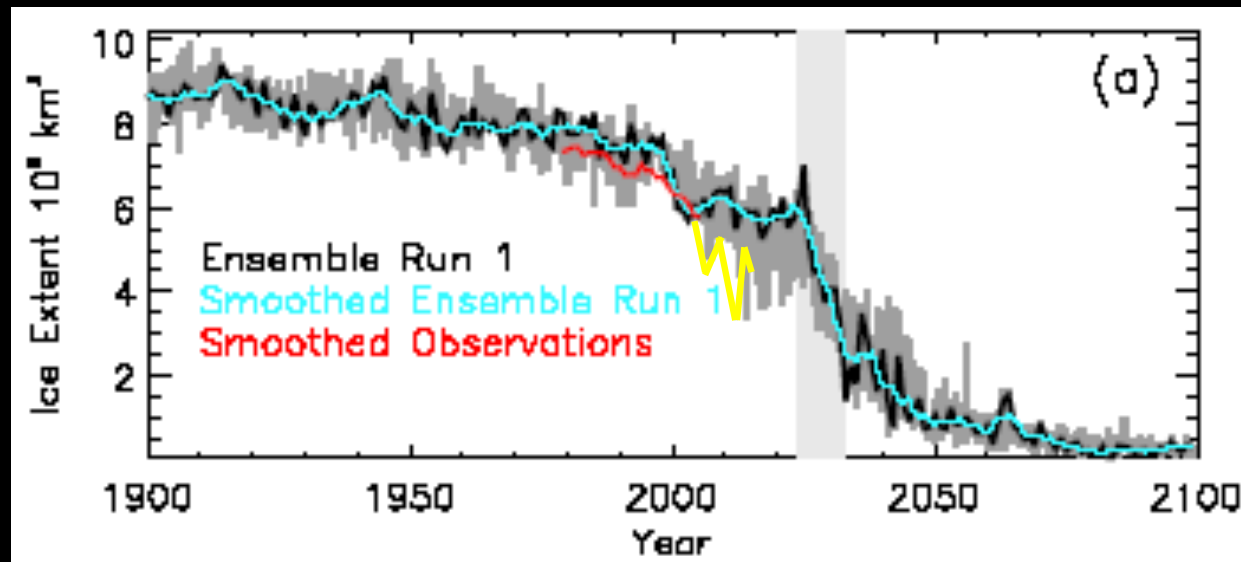
Gabriel Auclair and Bruno Tremblay
McGill University

Arctic System Change Workshop
April 9-12, 2018

National Center for Atmospheric Research, Mesa Lab Boulder, CO



Minimum Sea Ice Extent CCSM3

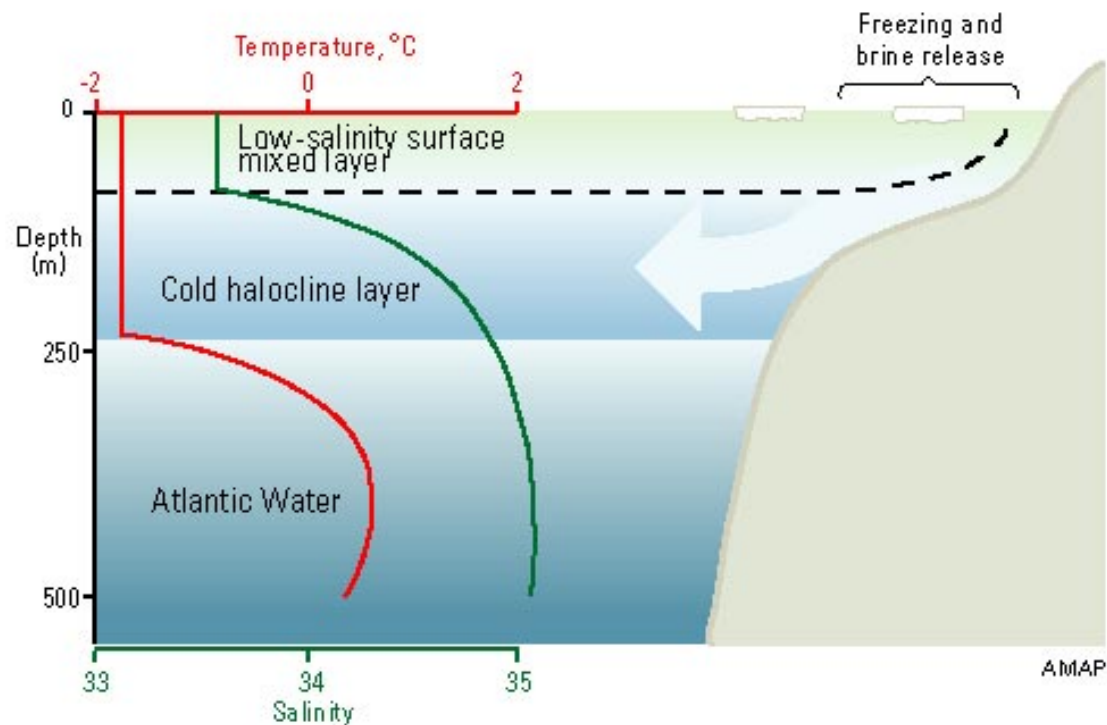


Cold Halocline Layer

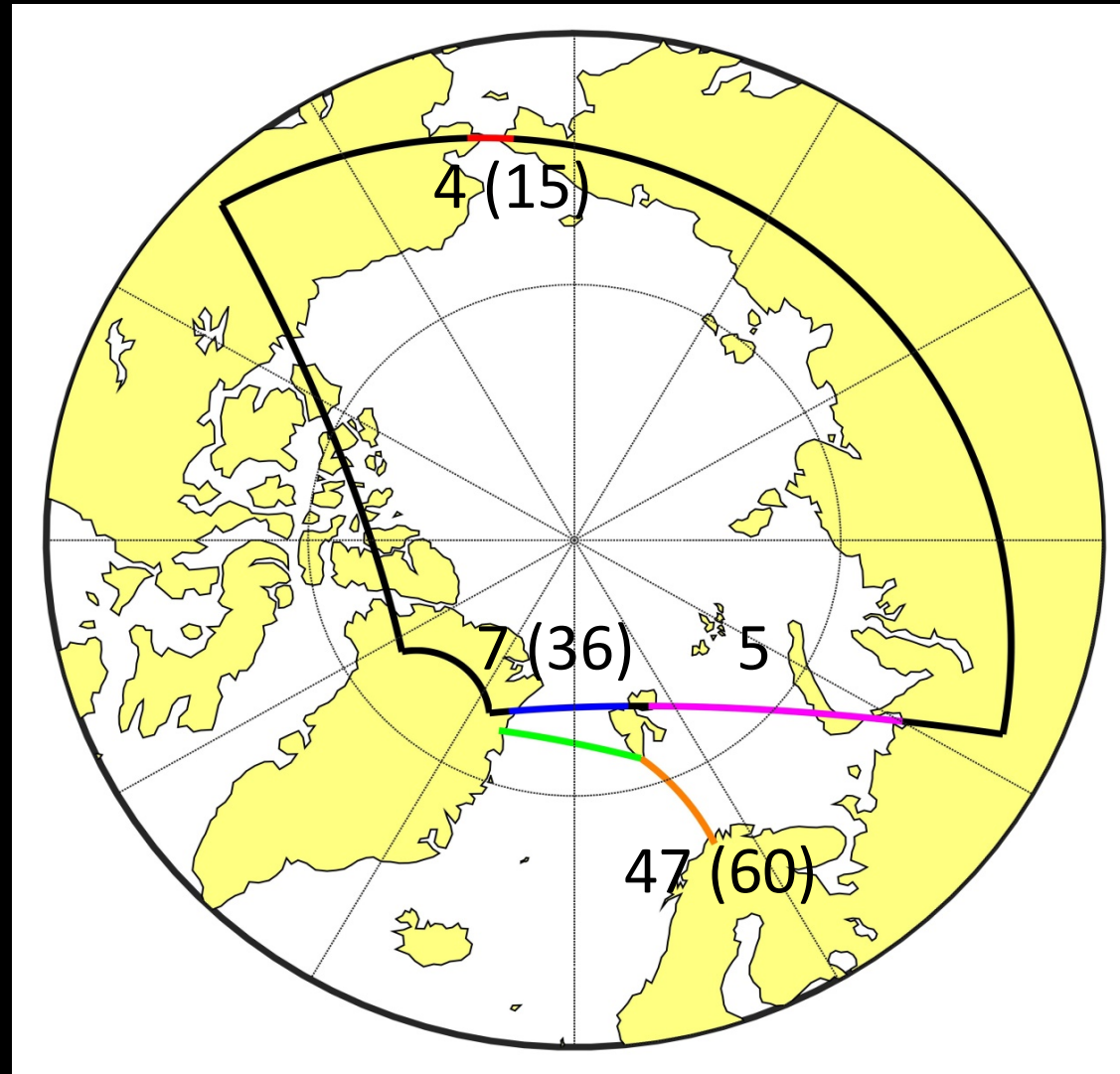


Arctic Monitoring and Assessment Programme

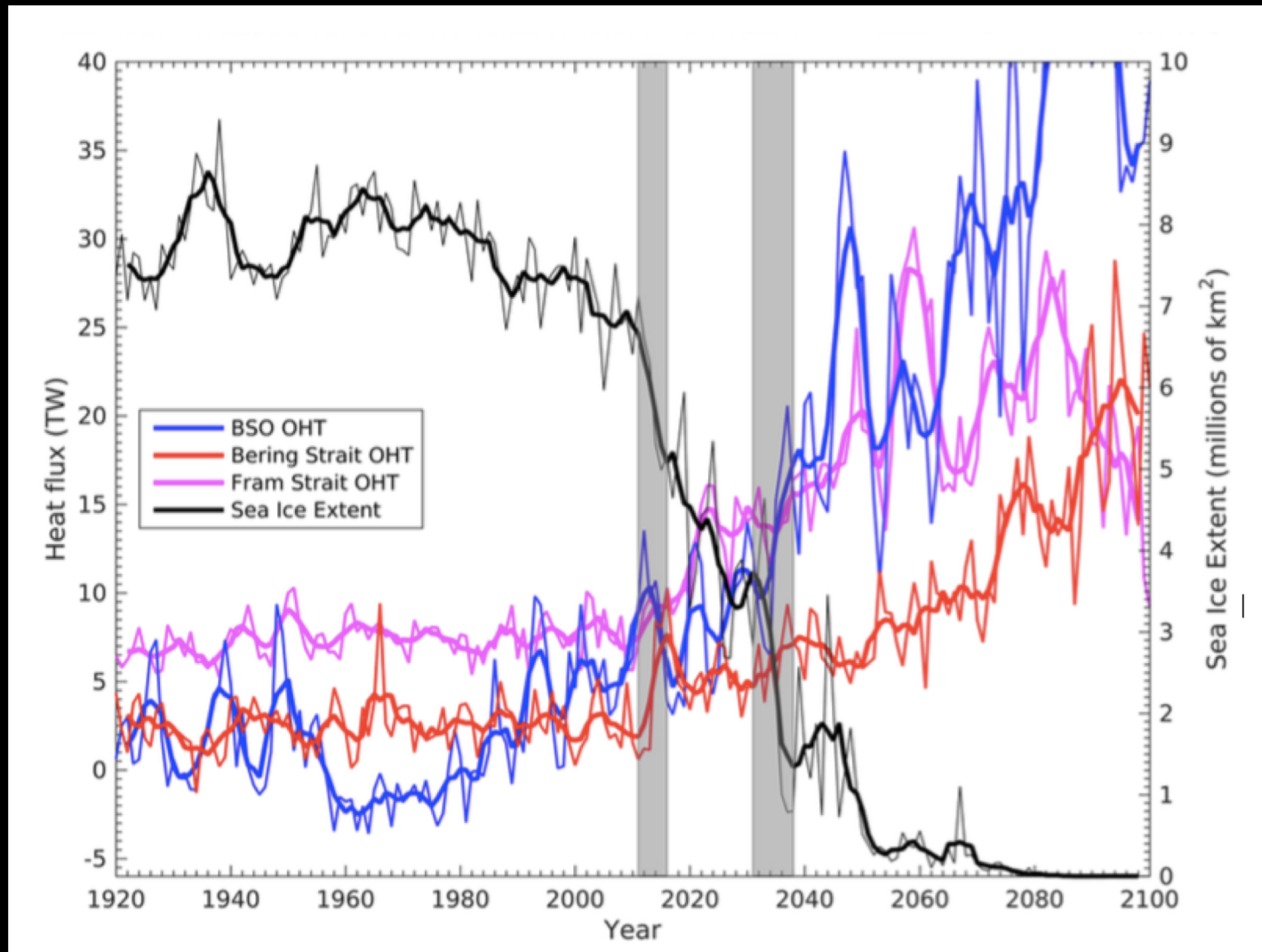
AMAP Assessment Report: Arctic Pollution Issues, Figure 3-40



Ocean Heat Transport Simulated - Observed

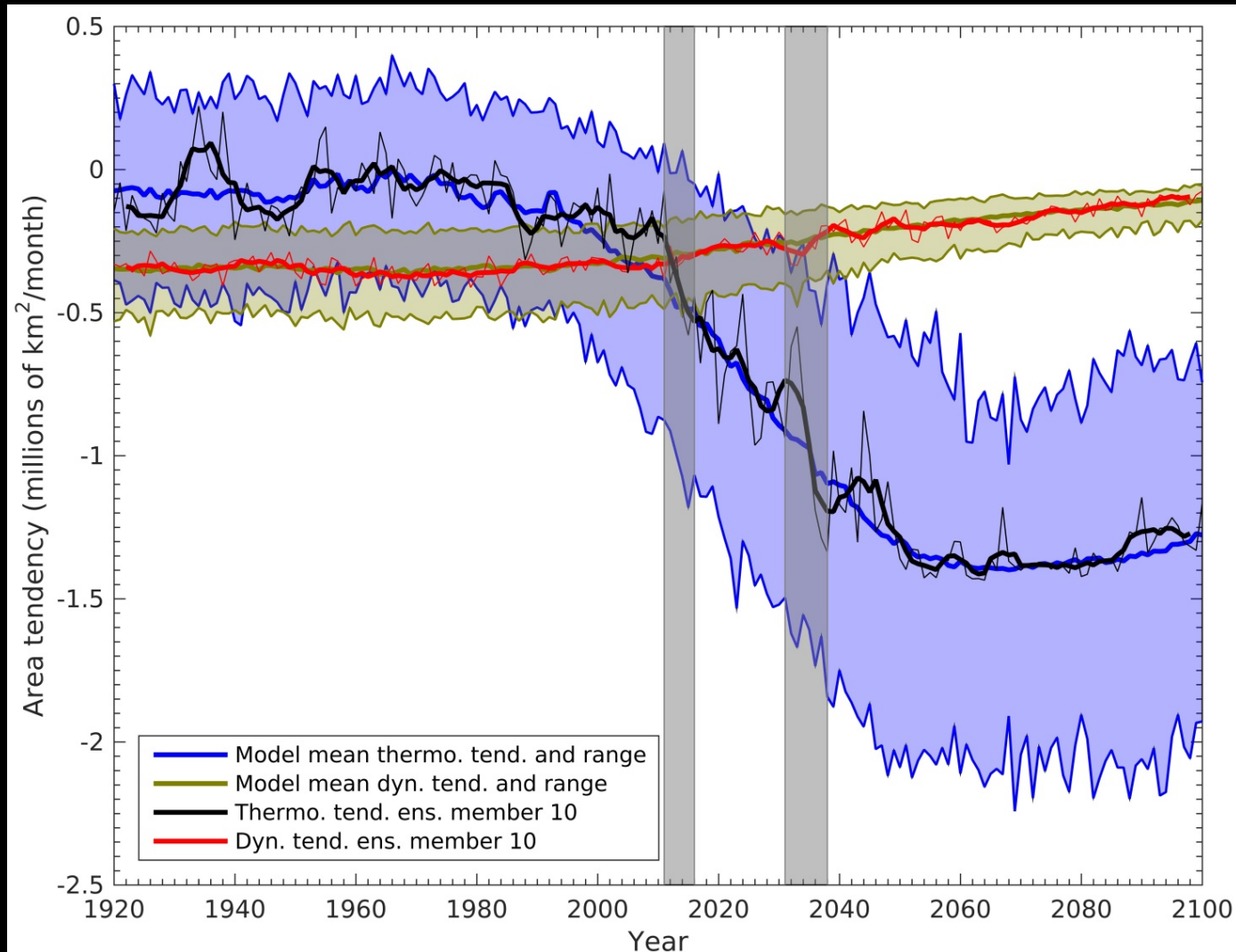


OHT and Rapid Sea Ice Declines



Area Tendencies

Dynamic and Thermodynamic



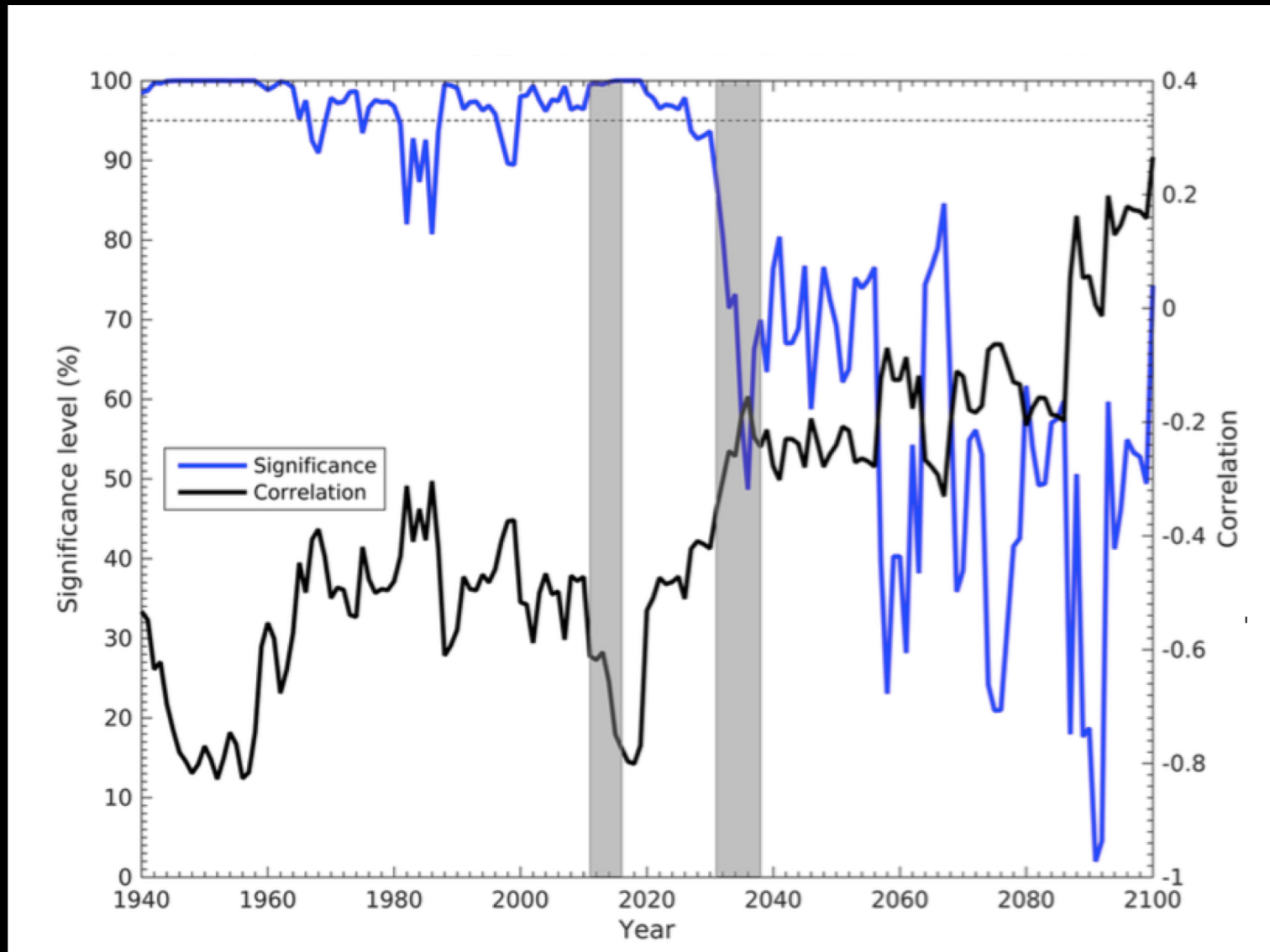
Rapid Declines

Correlation over 20-year moving window

Rapid declines linked to OHT in ...	64/79
... Bering Strait	44 (23)
... BSO	37 (14)
... Fram Strait	12 (1)
... both BSO and Bering Strait	15

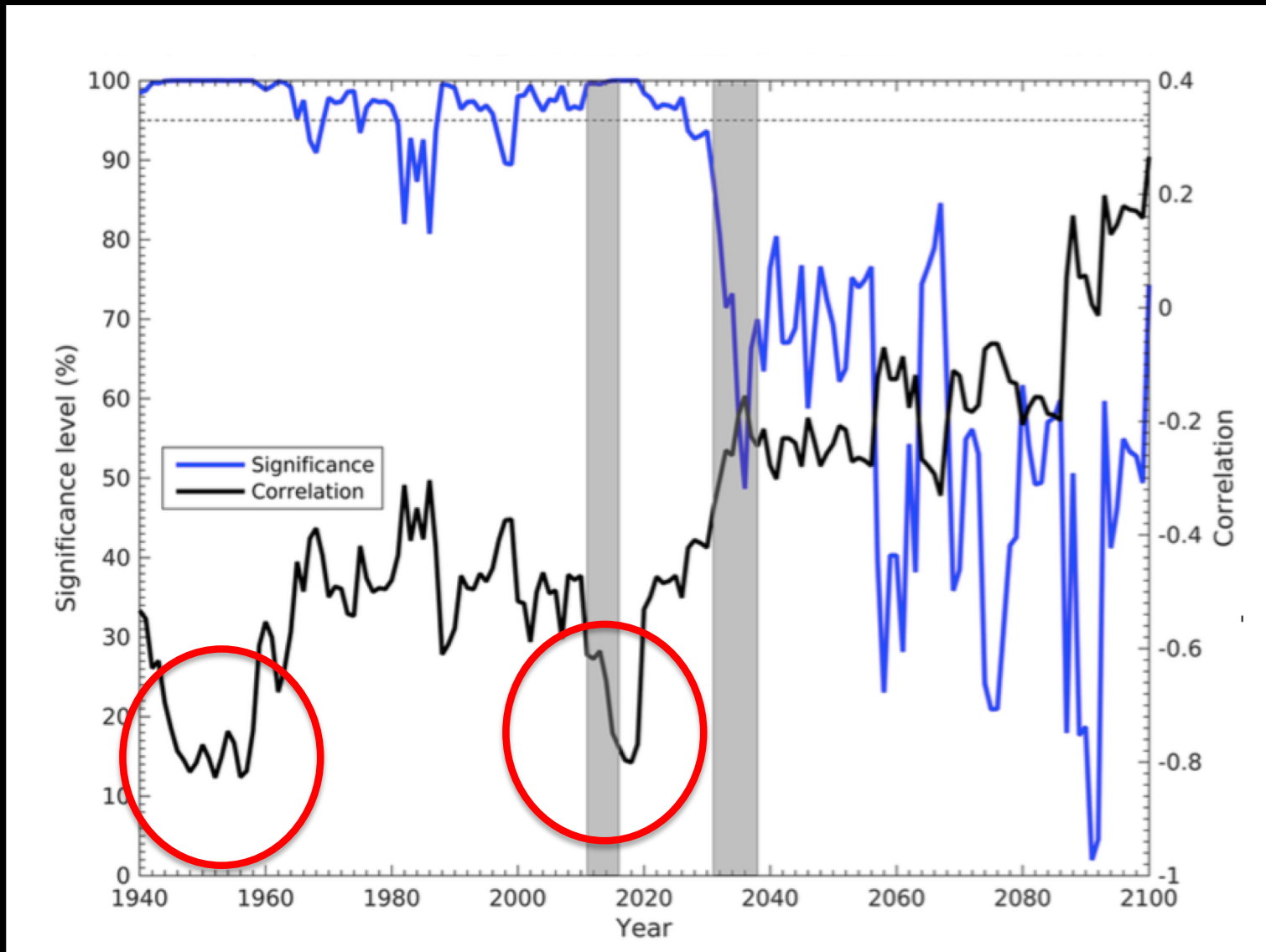
OHT and Min SIE

Ensemble Member #10



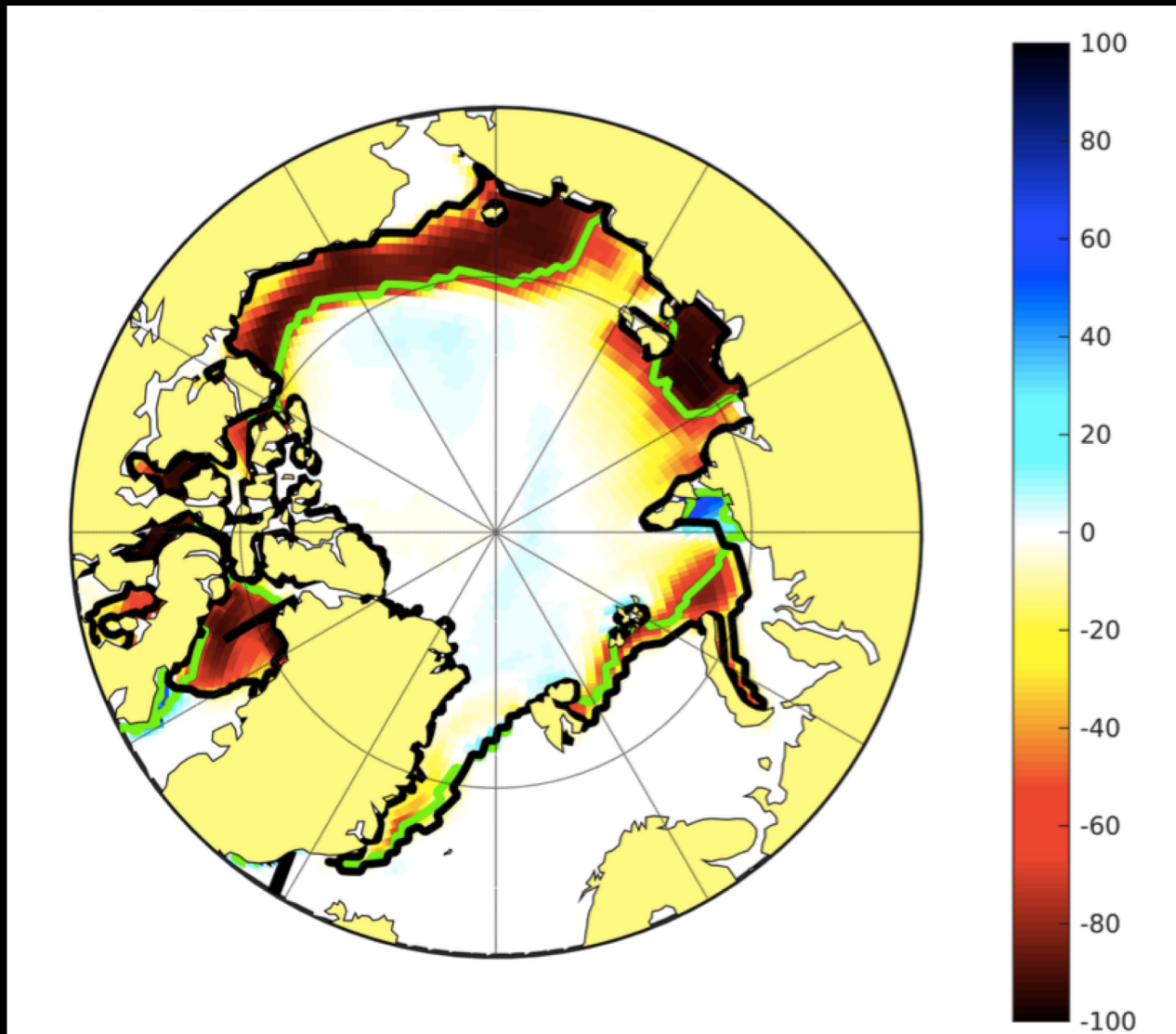
Bering OHT and Min SIE

Ensemble Member #10



Change in SIC

Earlier Decline



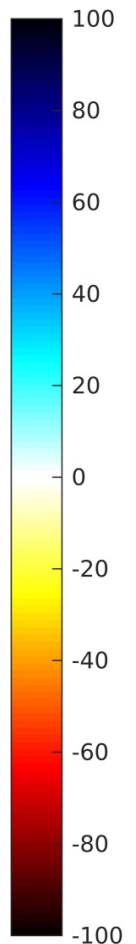
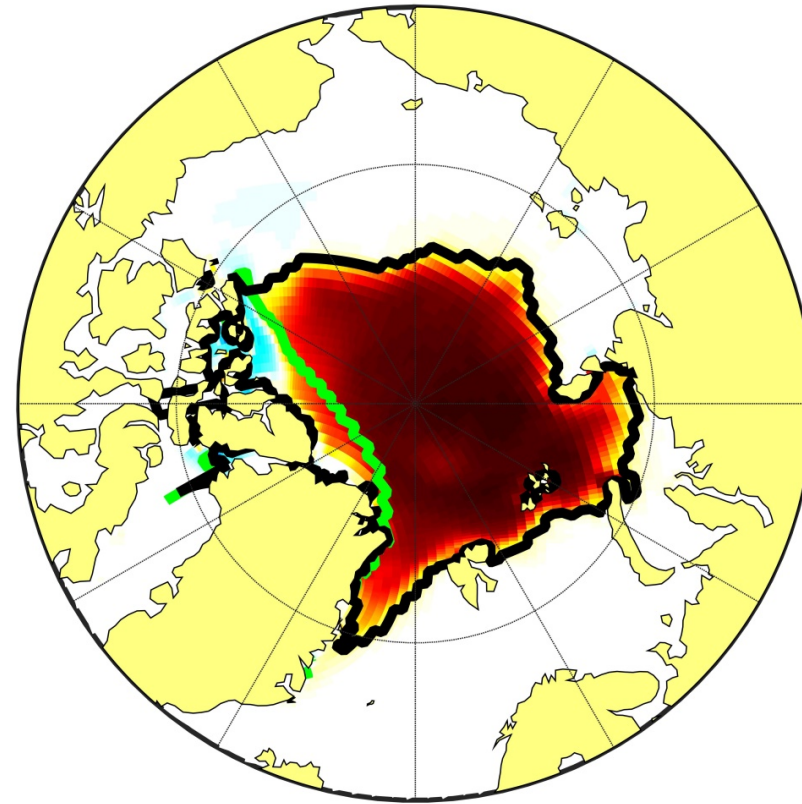
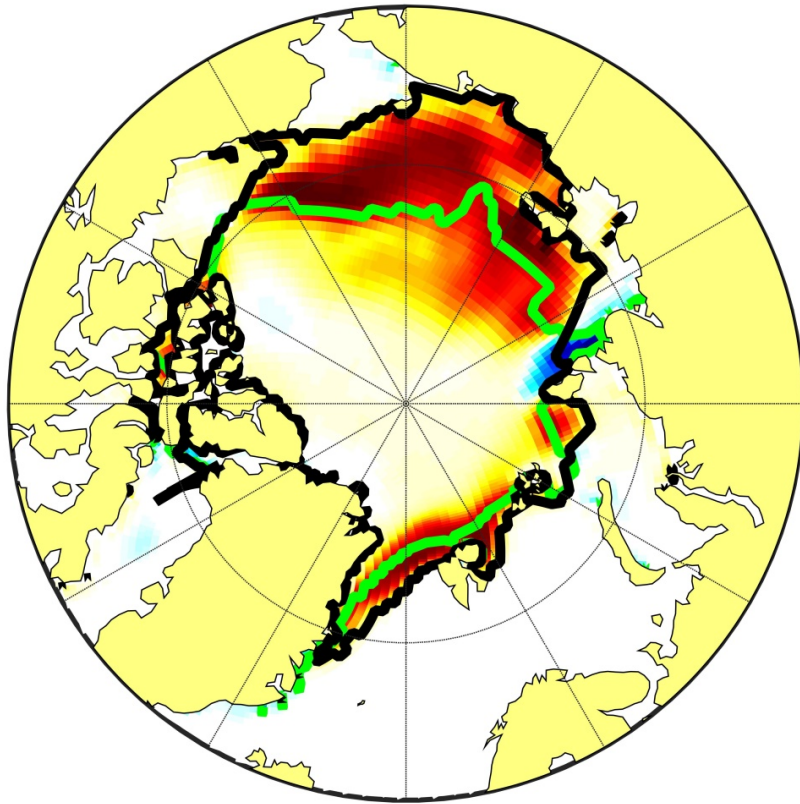
1938-1948

Change in SIC During Rapid Declines

EM-10

1st Rapid Decline

2nd Rapid Decline



79 rapid declines in total over the 40 ensemble members

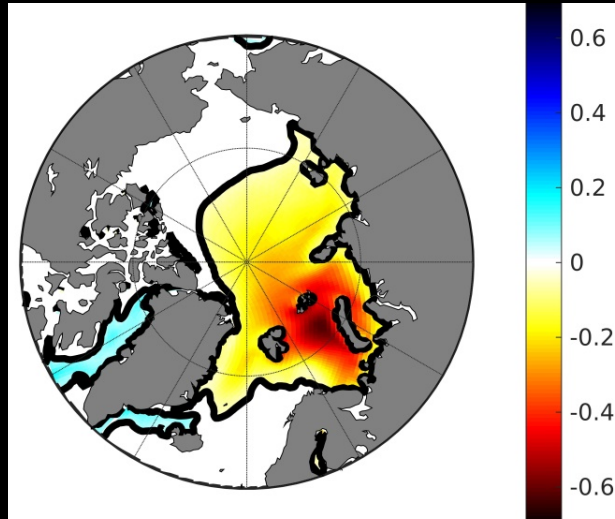
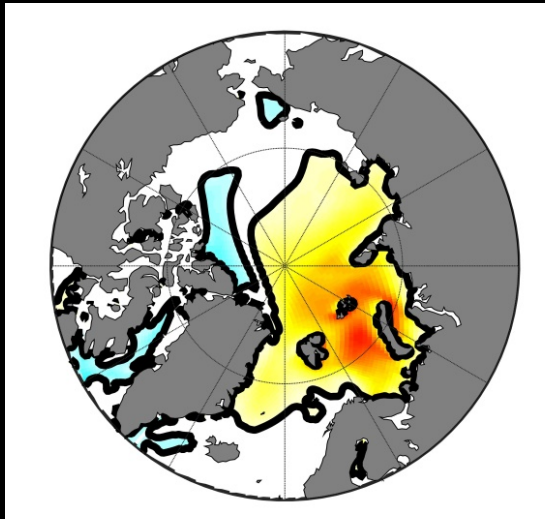
Mechanisms

Bering Sea Opening

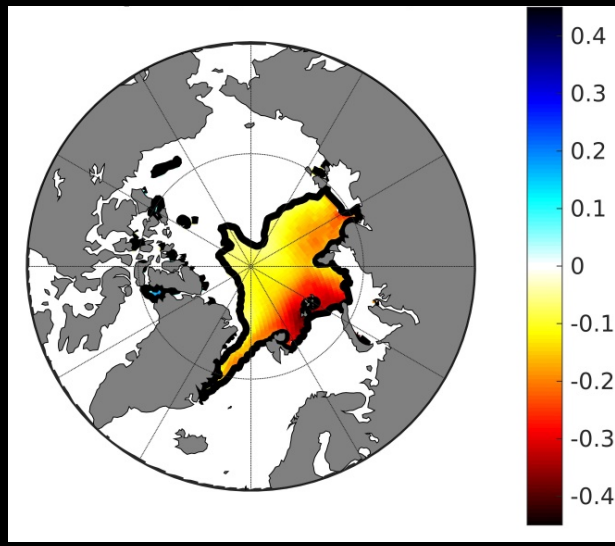
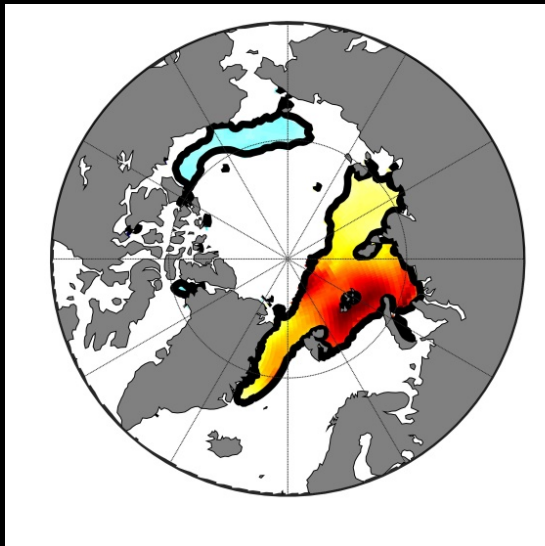
BSO OHT – Ice Conditions

Regression Analysis

March
Thick



Sept
SIC

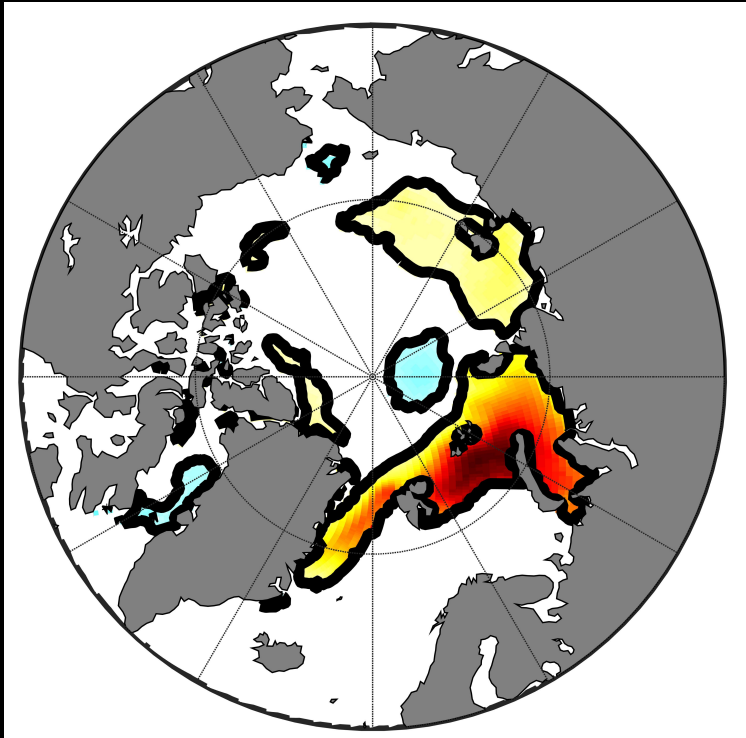


1921-1999

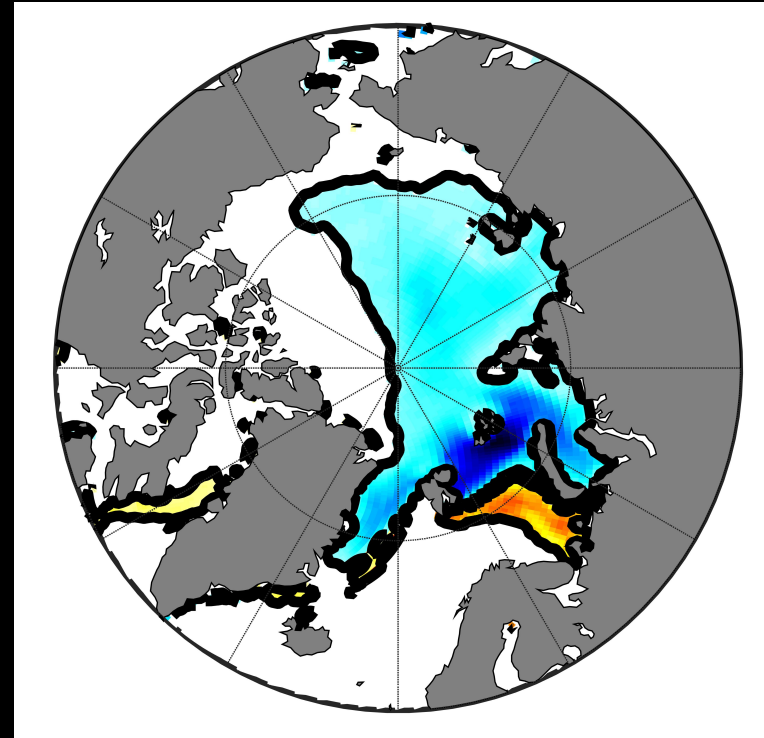
2000-2049

BSO OHT

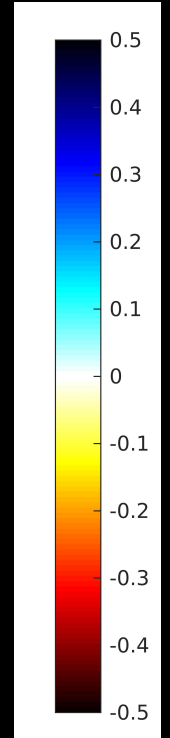
Turbulent Fluxes



OHT - Winter Ice Growth

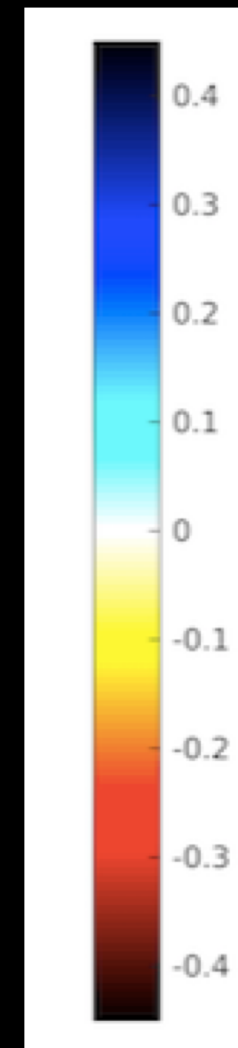
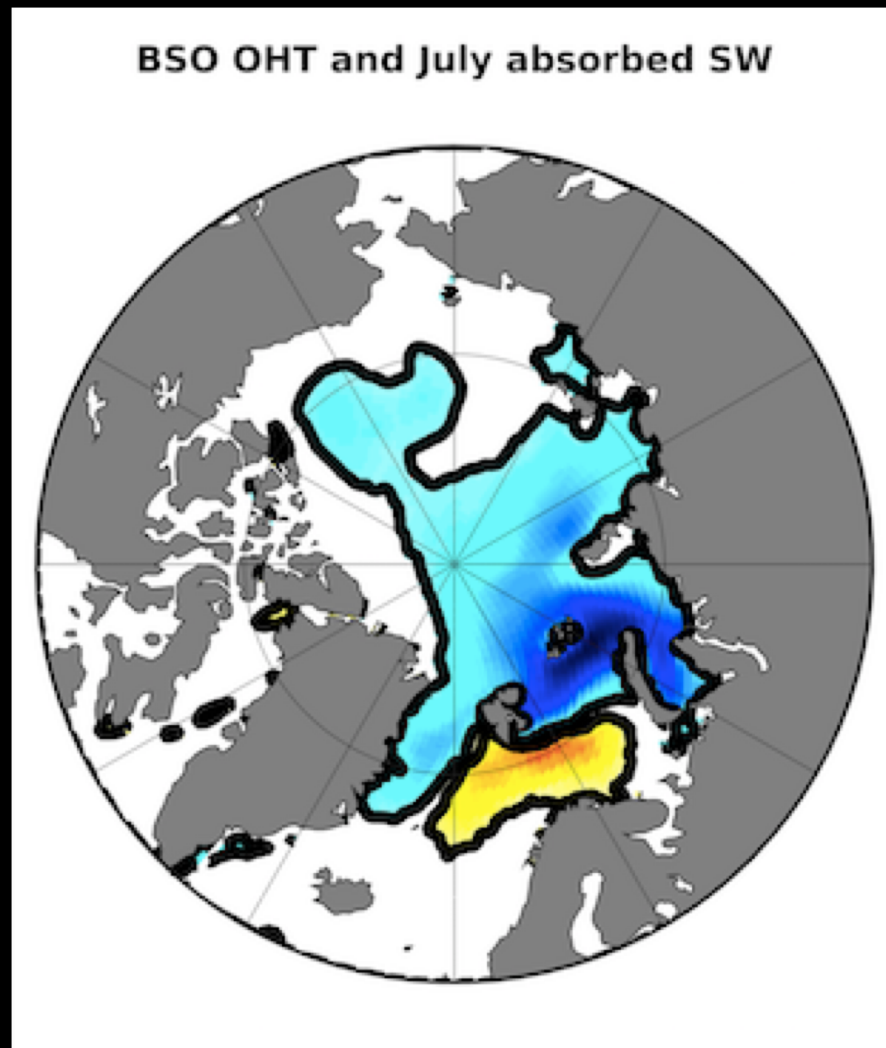


OHT - Summer melt

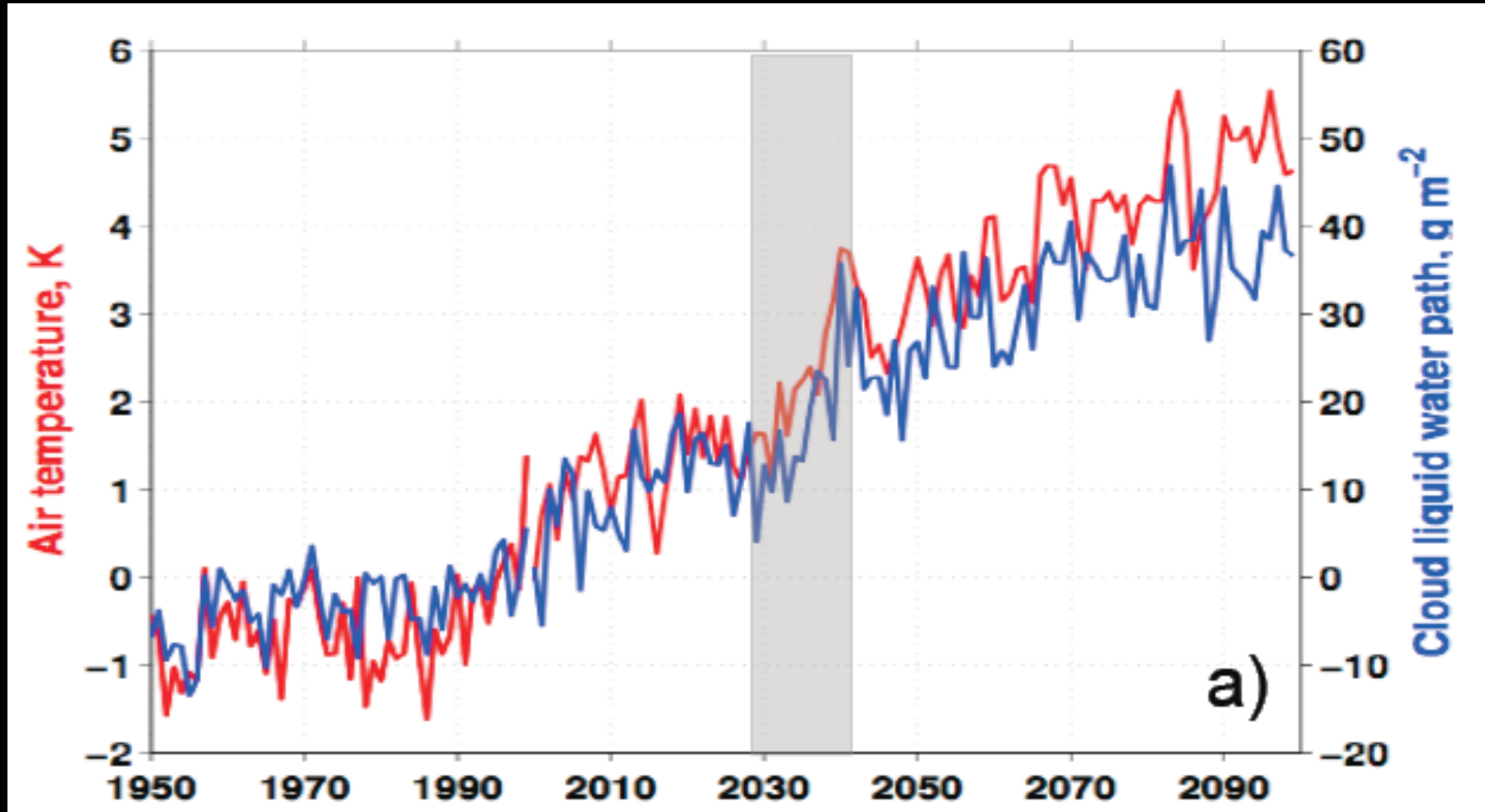


BSO OHT

Solar Flux



Atmosphere Feedback



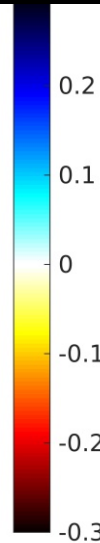
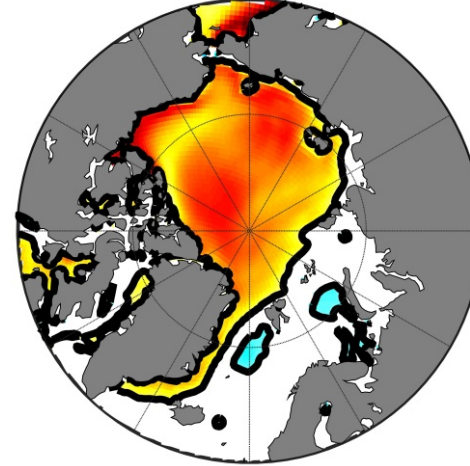
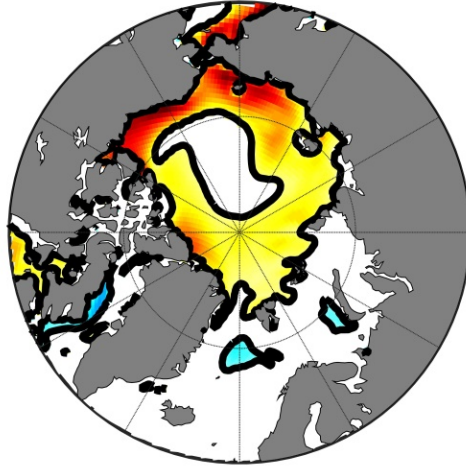
CCSM3

Bering Strait

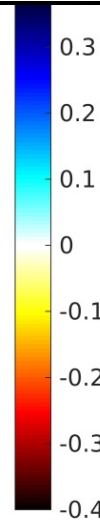
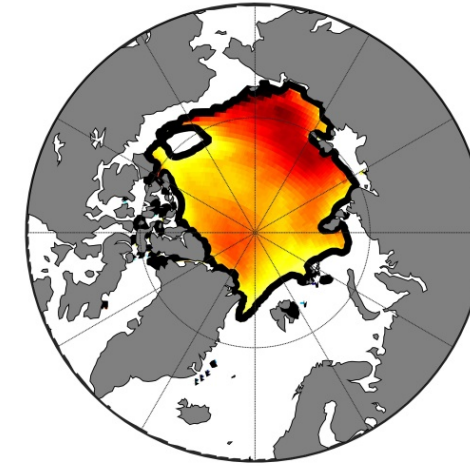
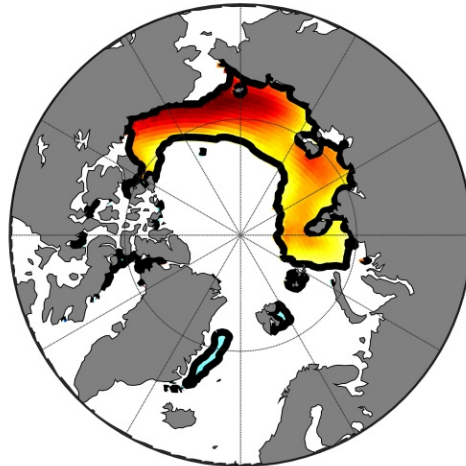
Bering Strait OHT – Ice Condition

Regression Analysis

March
Thick



Sept
SIC



1921-1999

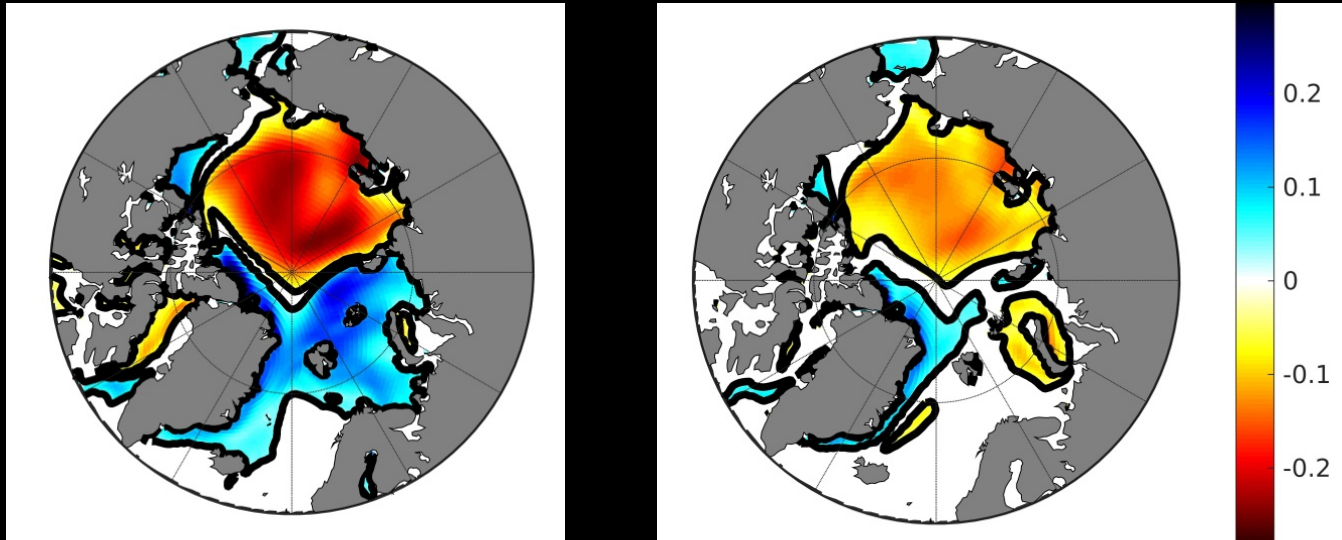
2000-2049

Fram Strait

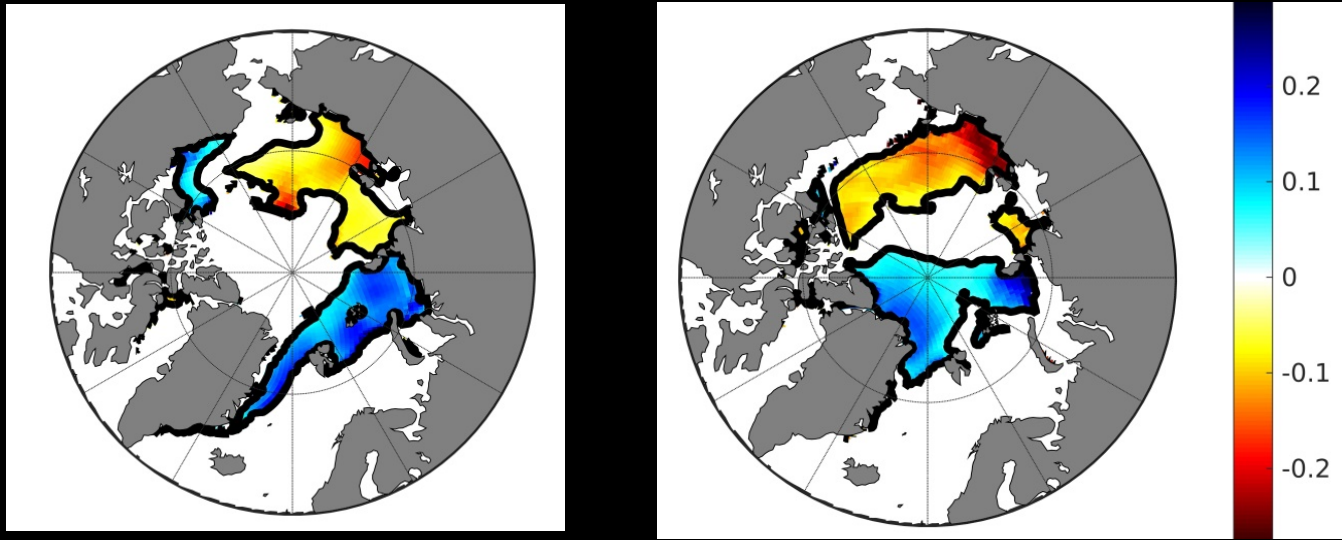
Fram Strait OHT – Ice Condition

Regression Analysis

March
Thick



Sept
SIC



1921-1999

2000-2049

Conclusions

- 83% of of the rapid declines in CESM-LE are linked to anomalous ocean heat transport through Bering Strait and Barents Sea Opening.
- The sea ice loss is amplified by anomalies in surface heat fluxes.
- OHT entering the Arctic Ocean over shallow shelves have the largest impact on Rapid Sea Ice Declines.

Future Work

- Impacts of melt onset date [*Stroeve et al.*, 2013], spring melt-pond fraction [*Schröder et al.*, 2014] and spring longwave cloud forcing [*Gorodetskaya et al.*, 2008]