

Ocean Heat Fluxes And Rapid Sea Ice Decline

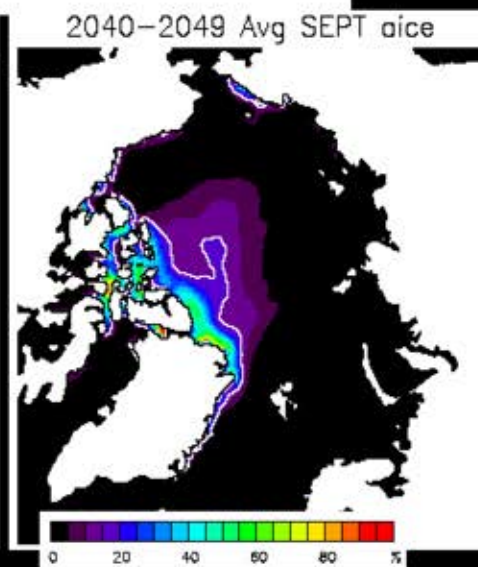
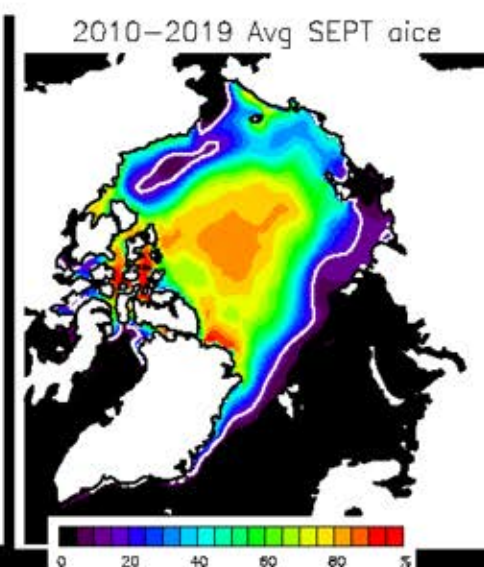
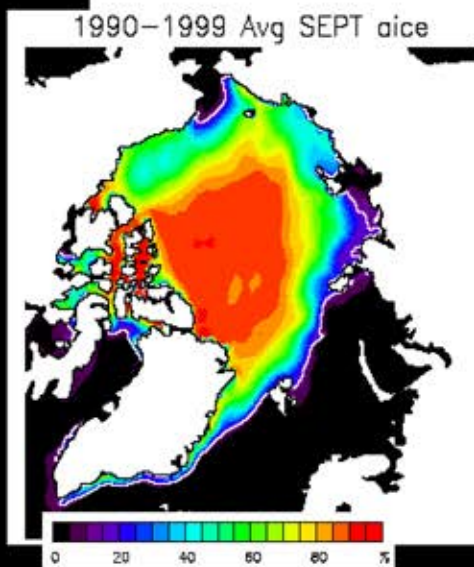
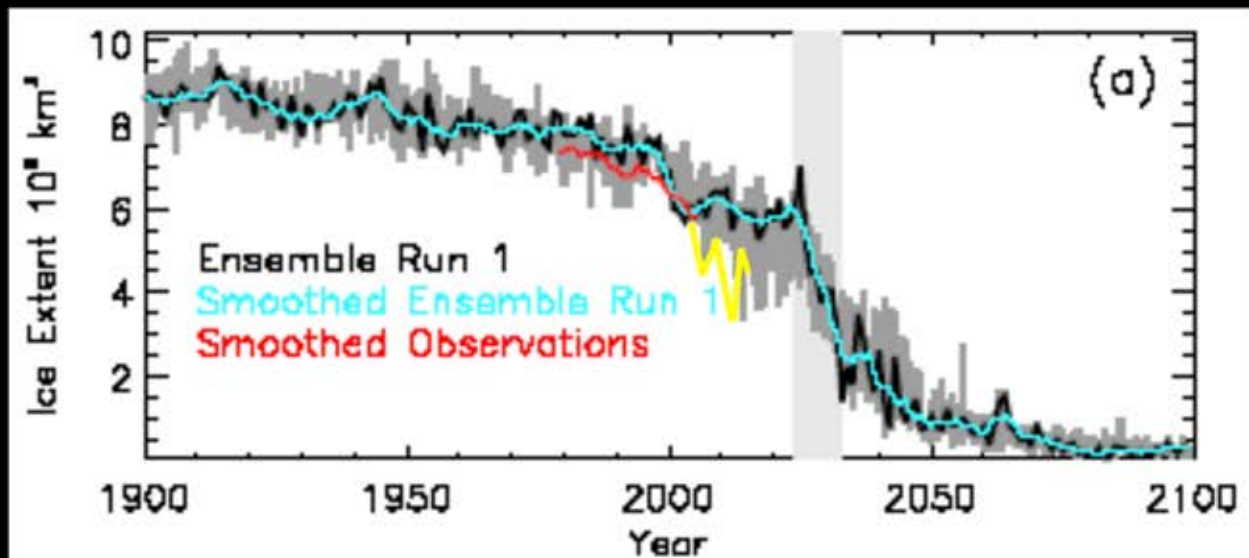
Gabriel Auclair and Bruno Tremblay
McGill University

Arctic System Change Workshop
April 9-12, 2018

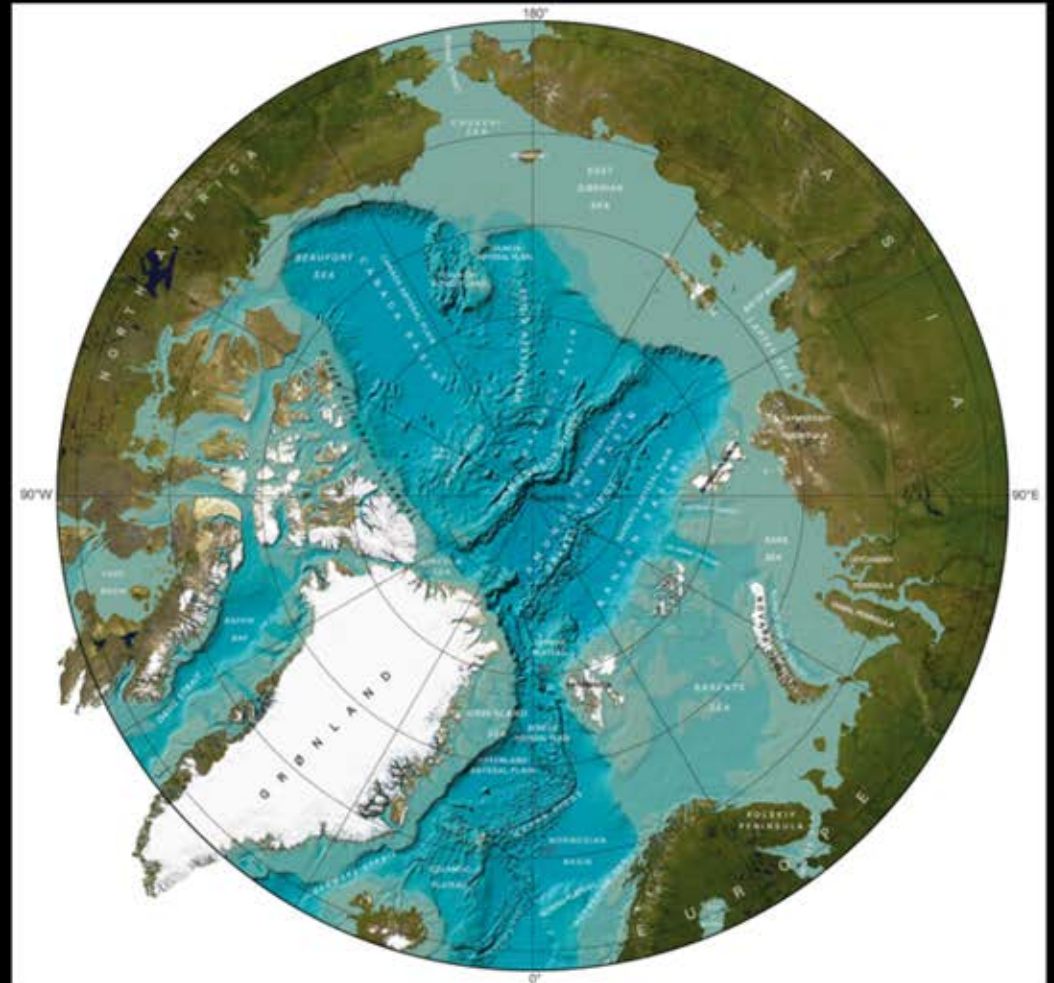
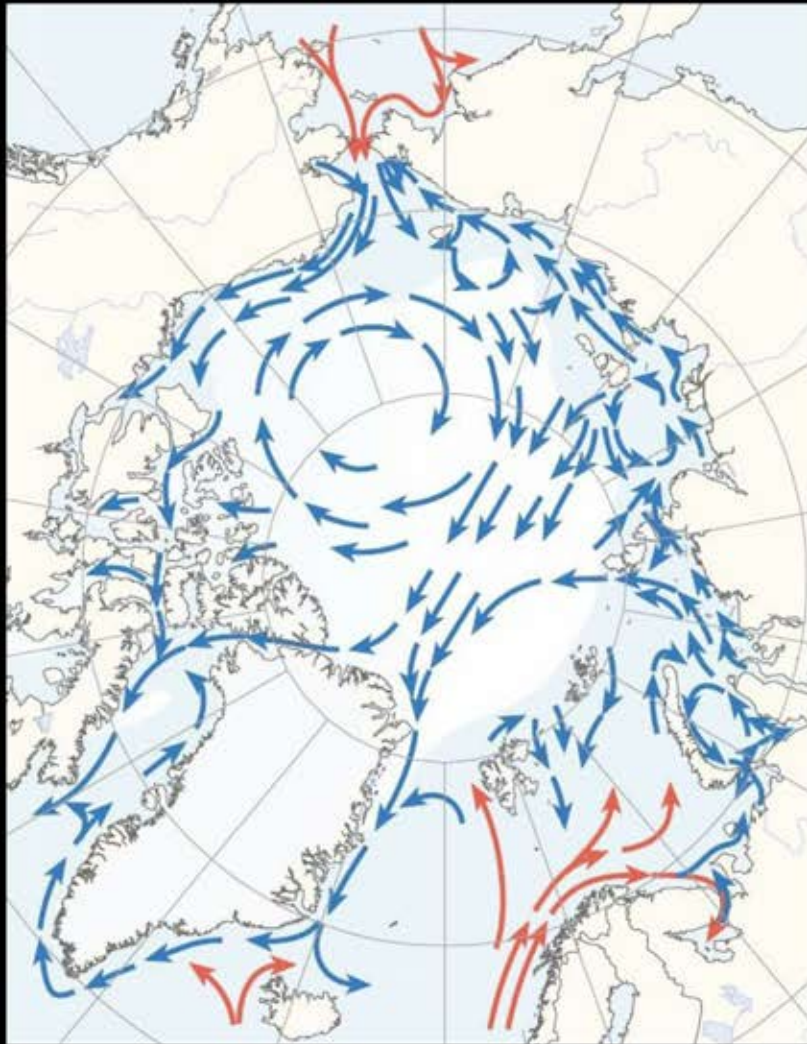
National Center for Atmospheric Research, Mesa Lab Boulder, CO



Minimum Sea Ice Extent CCSM3



Ocean Heat Transport Pathways

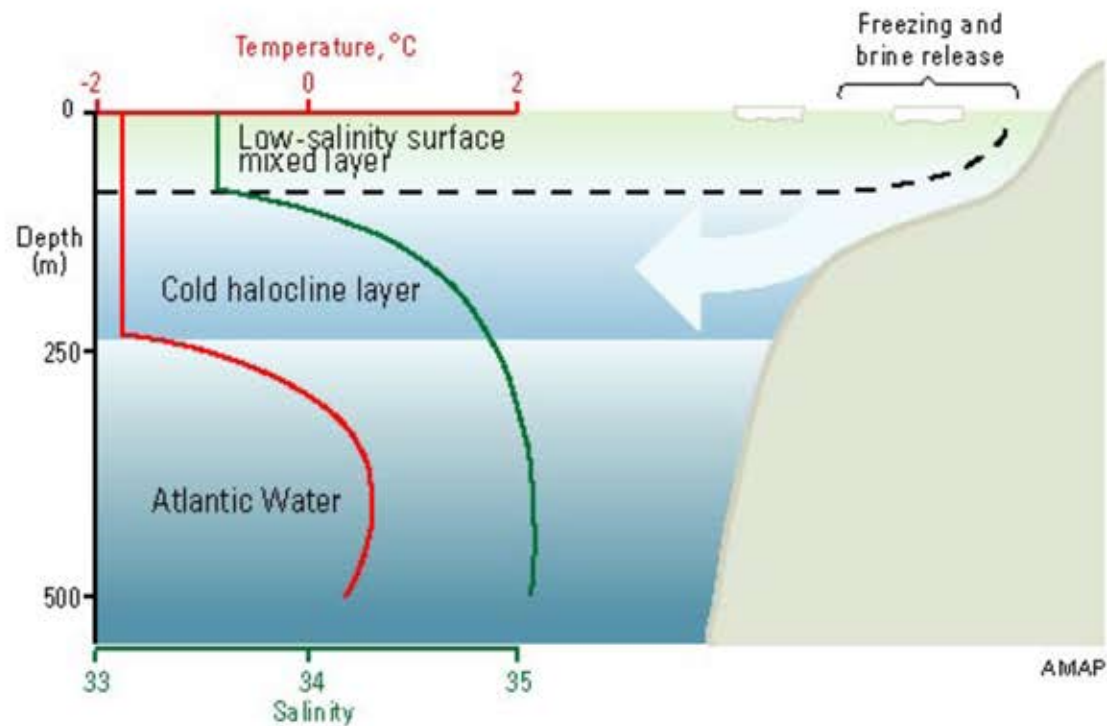


Cold Halocline Layer

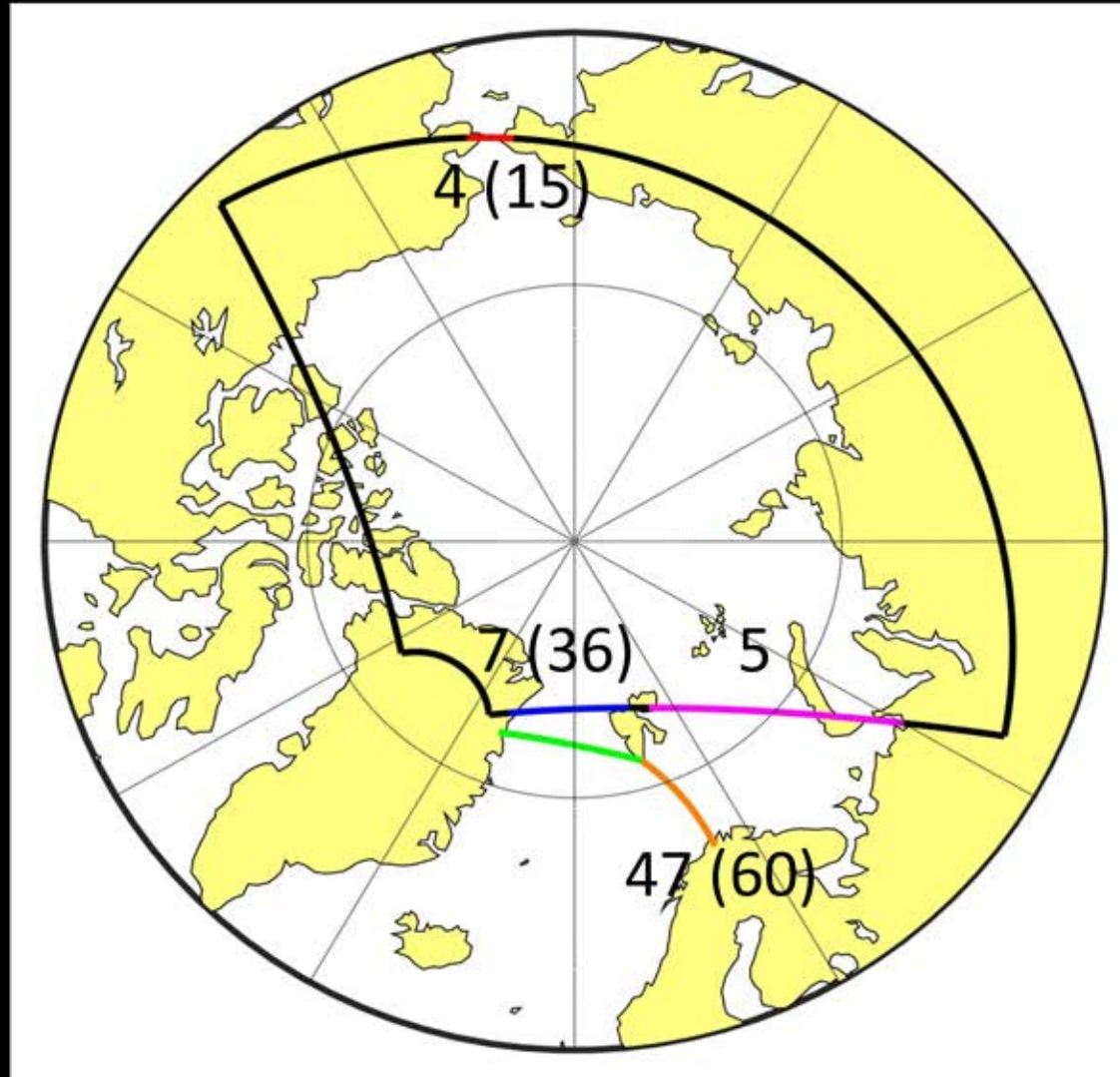


Arctic Monitoring and Assessment Programme

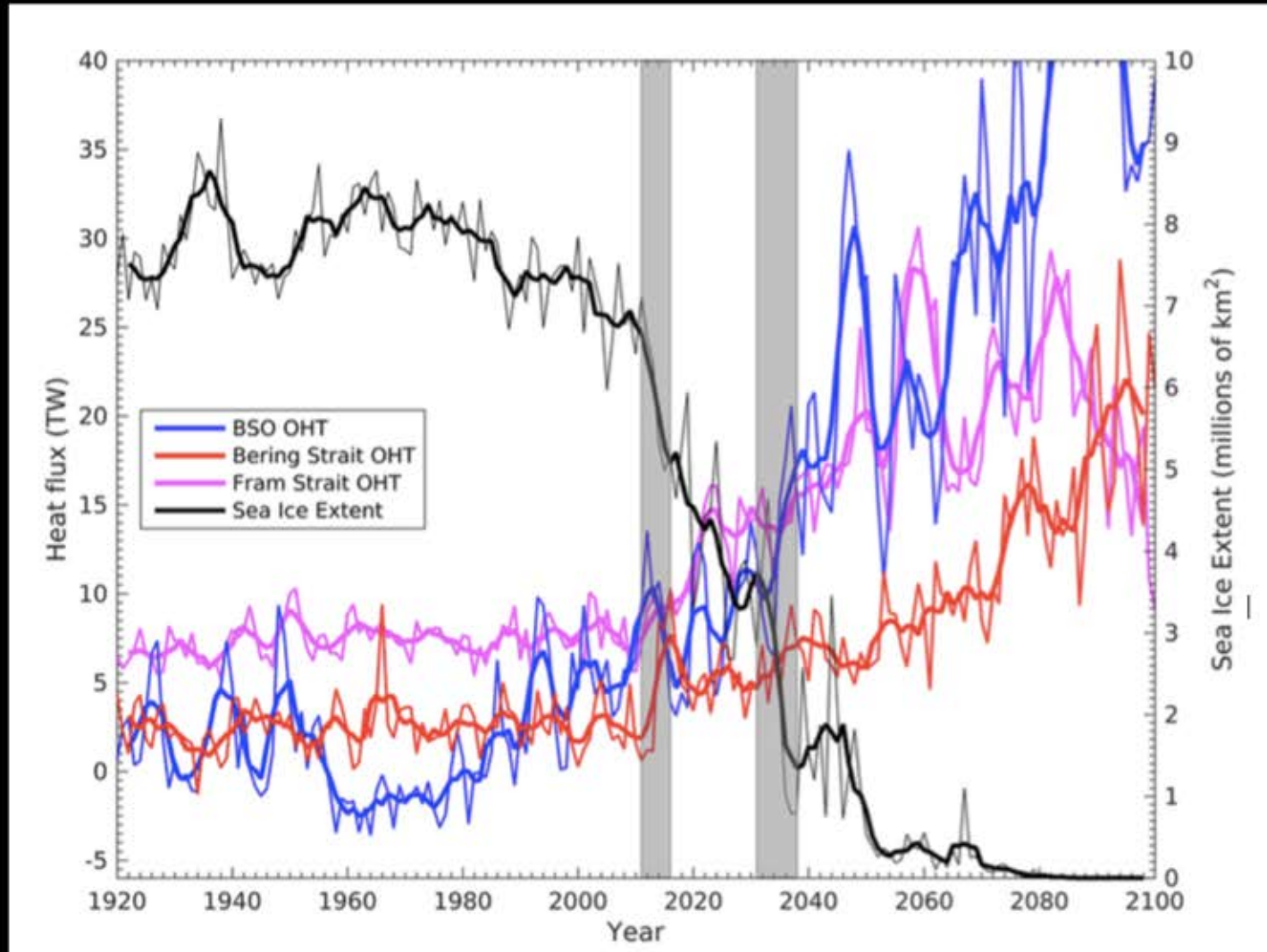
AMAP Assessment Report: Arctic Pollution Issues, Figure 3-40



Ocean Heat Transport Simulated - Observed

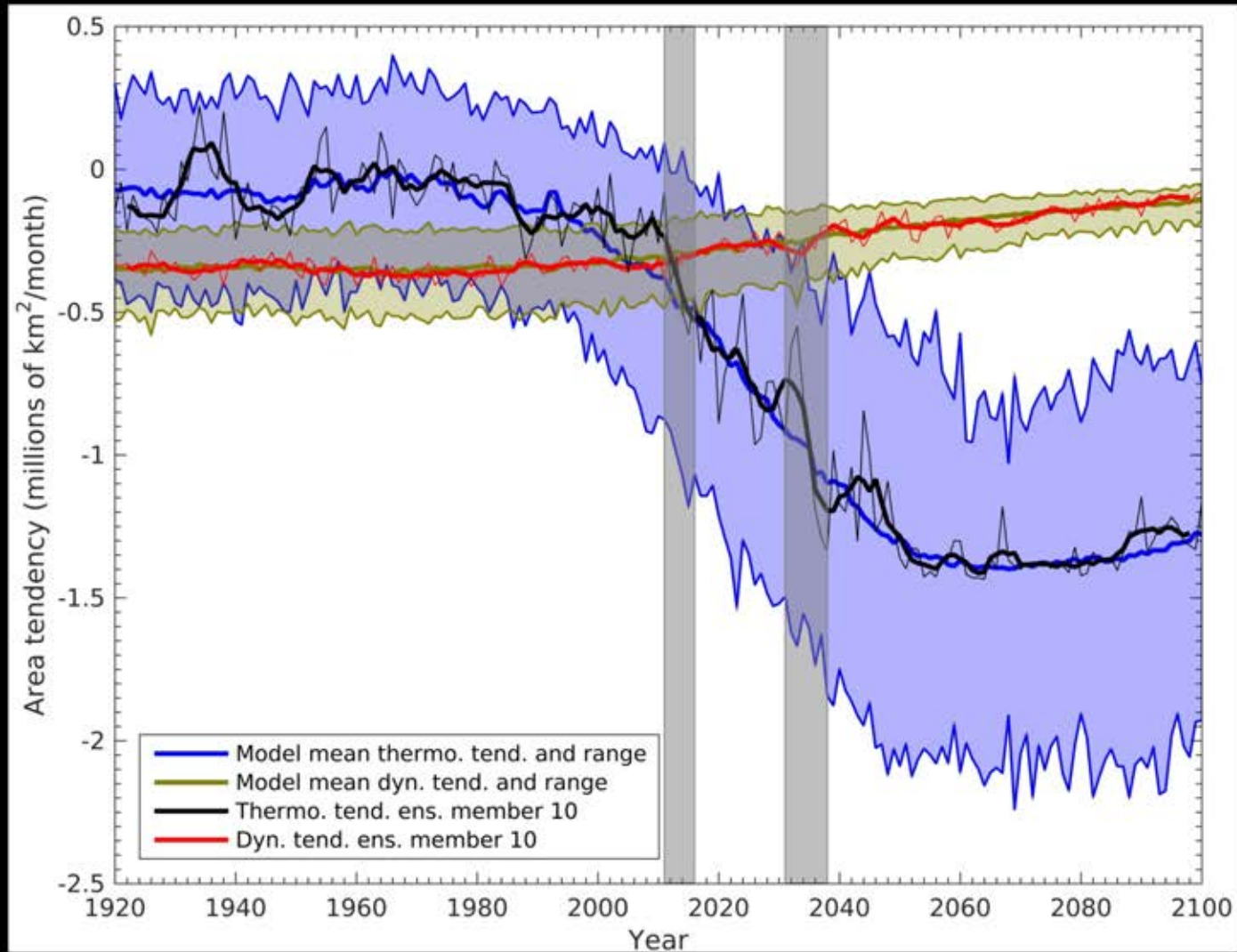


OHT and Rapid Sea Ice Declines



Area Tendencies

Dynamic and Thermodynamic



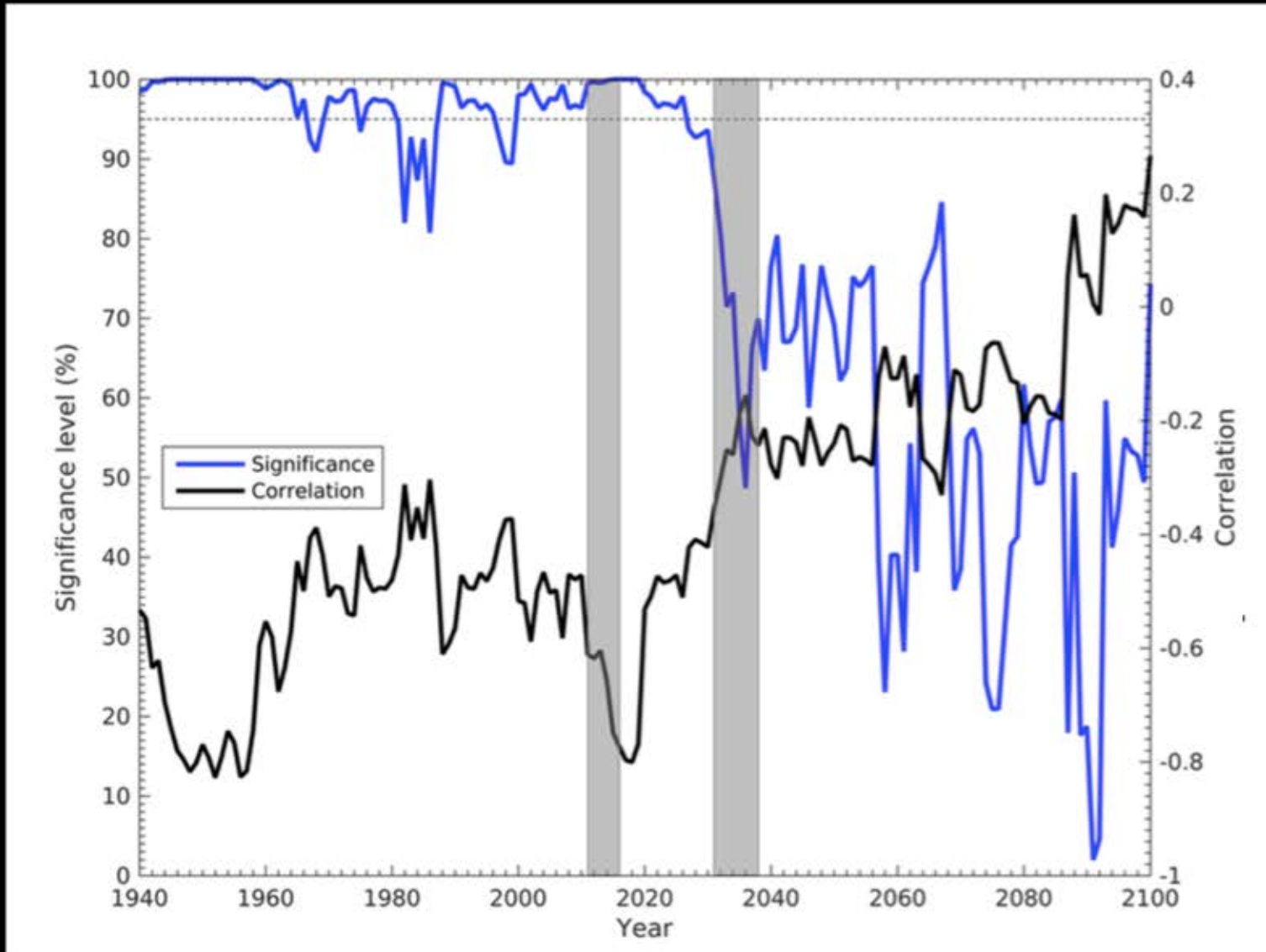
Rapid Declines

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

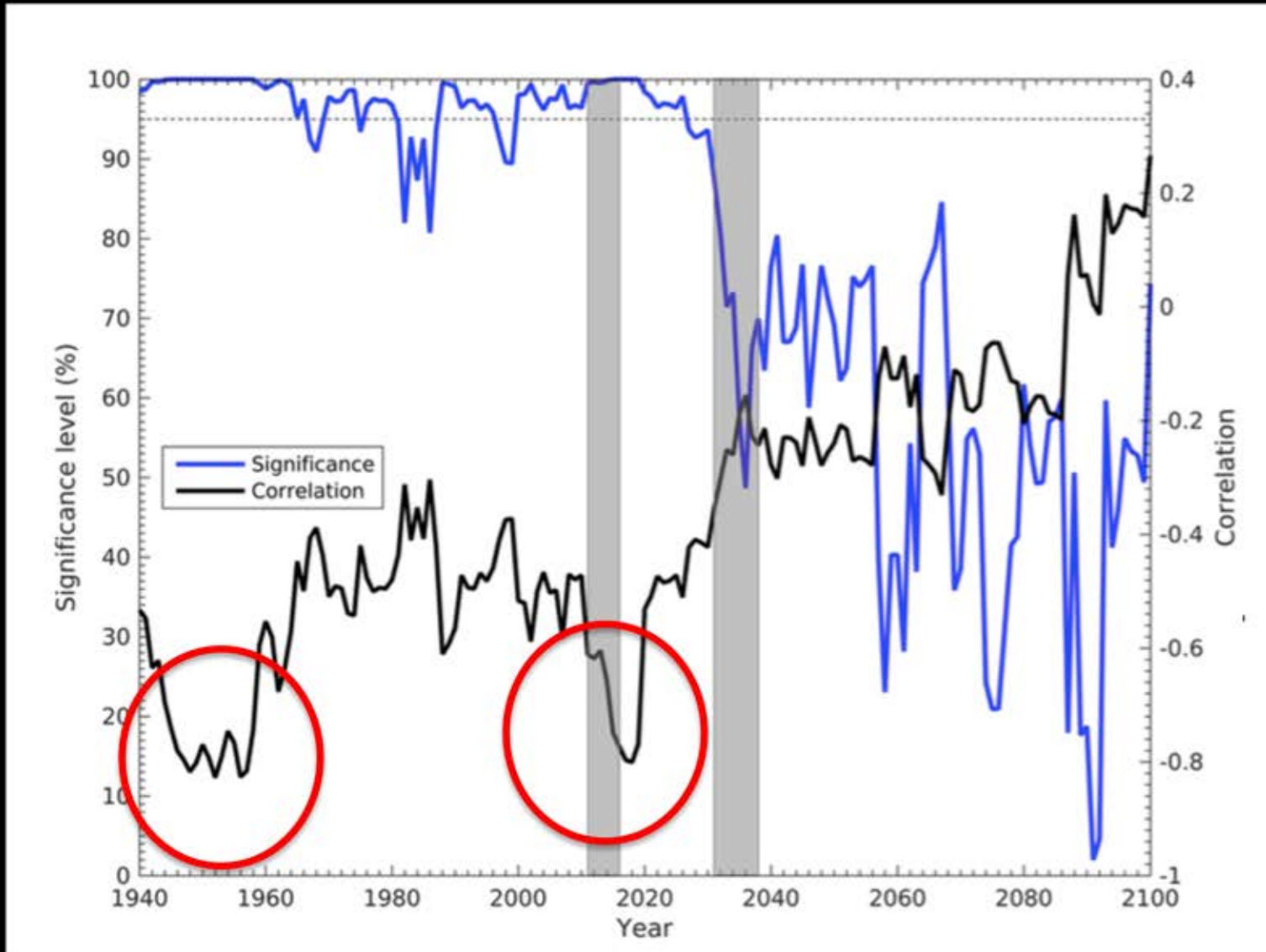
OHT and Min SIE

Ensemble Member #10



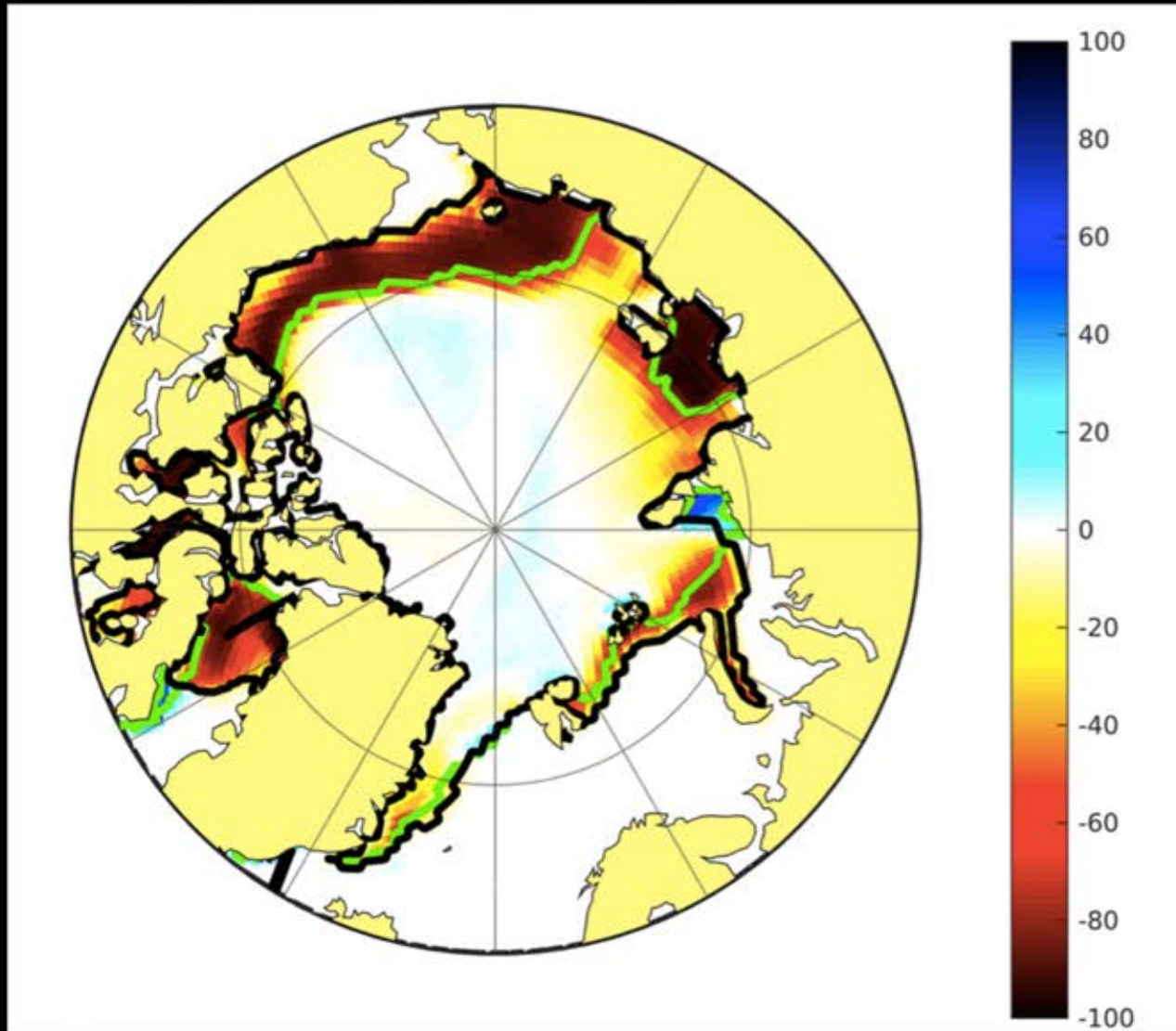
Bering OHT and Min SIE

Ensemble Member #10



Change in SIC

Earlier Decline

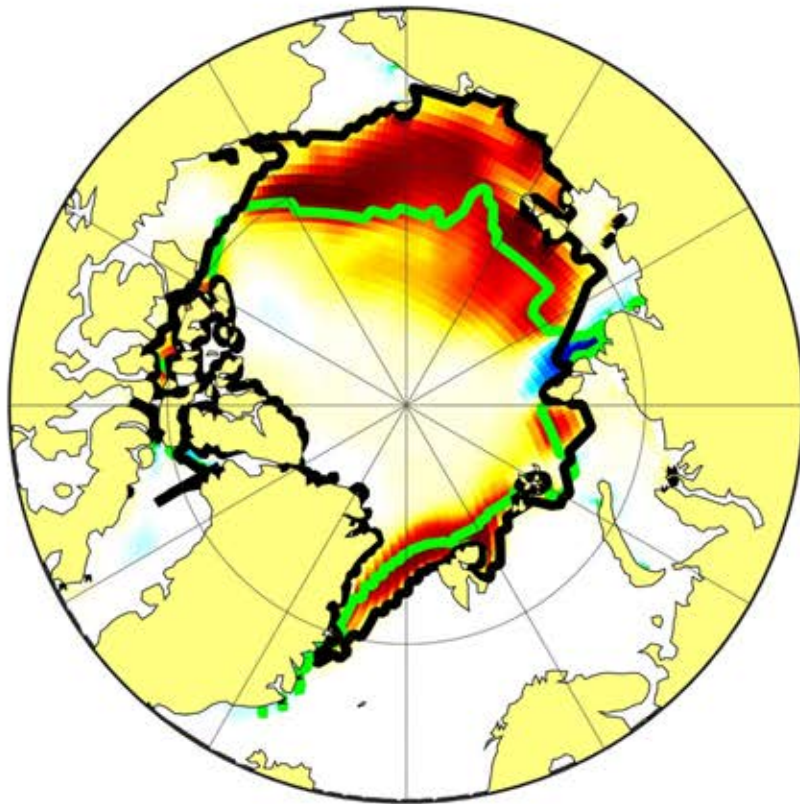


1938-1948

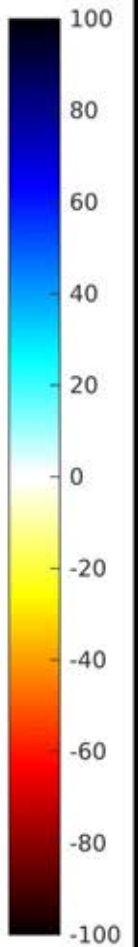
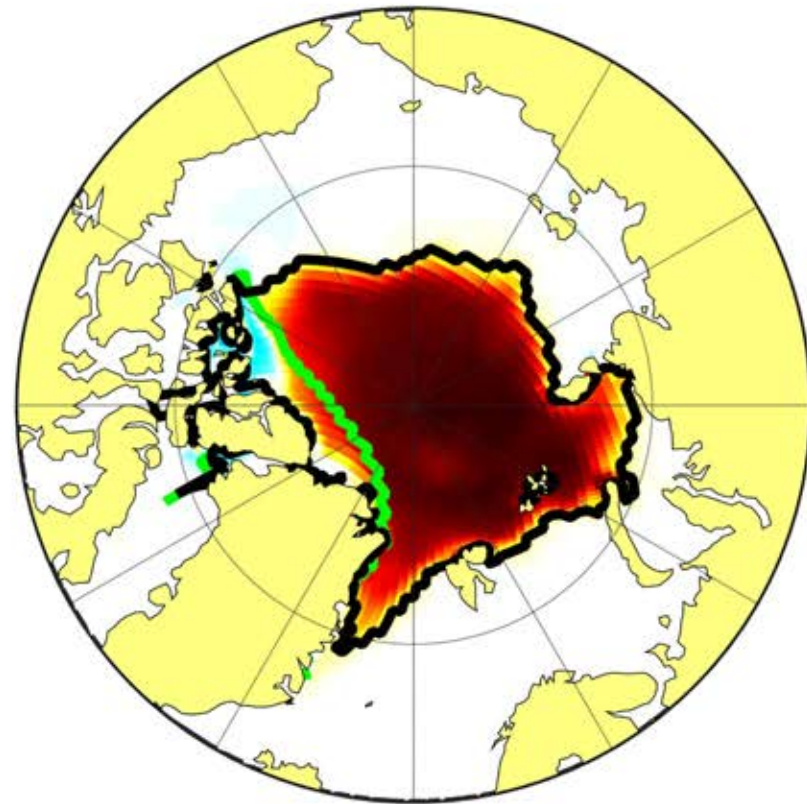
Change in SIC During Rapid Declines

EM-10

1st Rapid Decline



2nd Rapid Decline



79 rapid declines in total over the 40 ensemble members

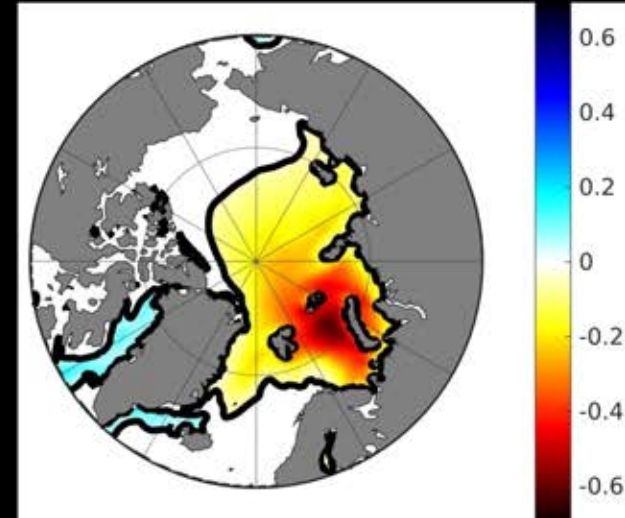
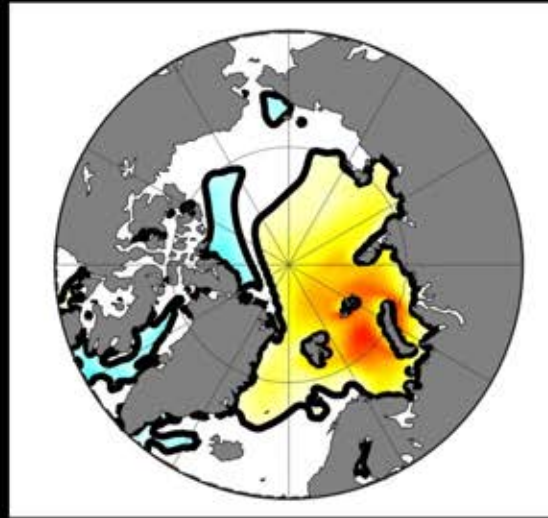
Mechanisms

Bering Sea Opening

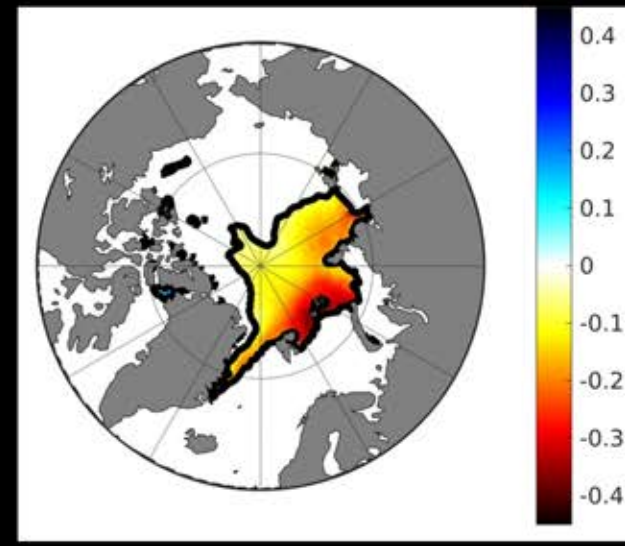
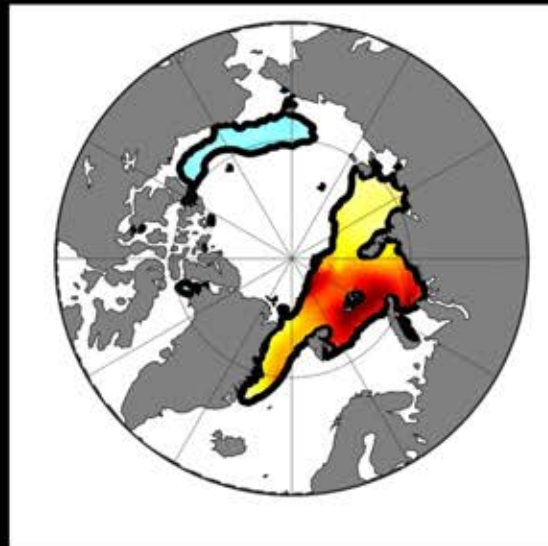
BSO OHT – Ice Conditions

Regression Analysis

March
Thick



Sept
SIC

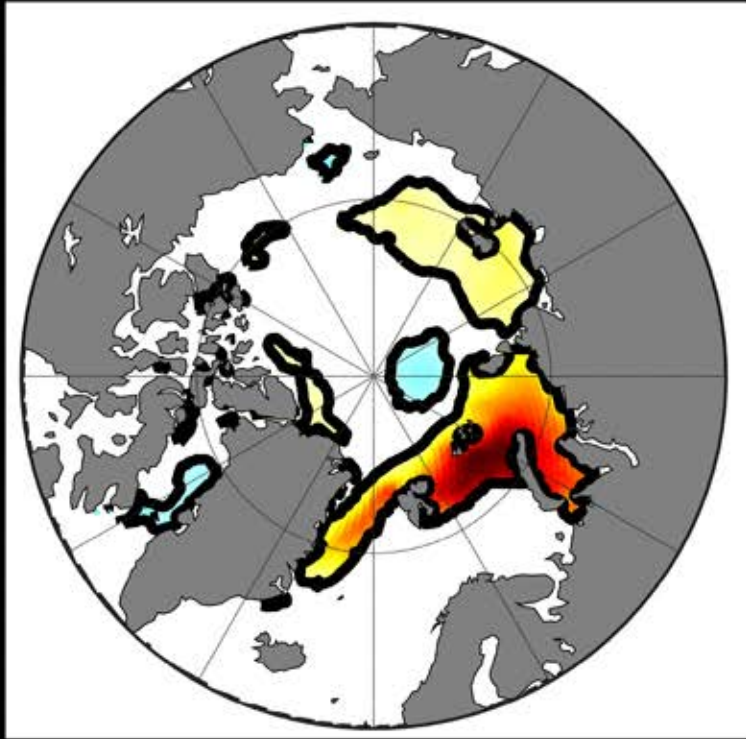


1921-1999

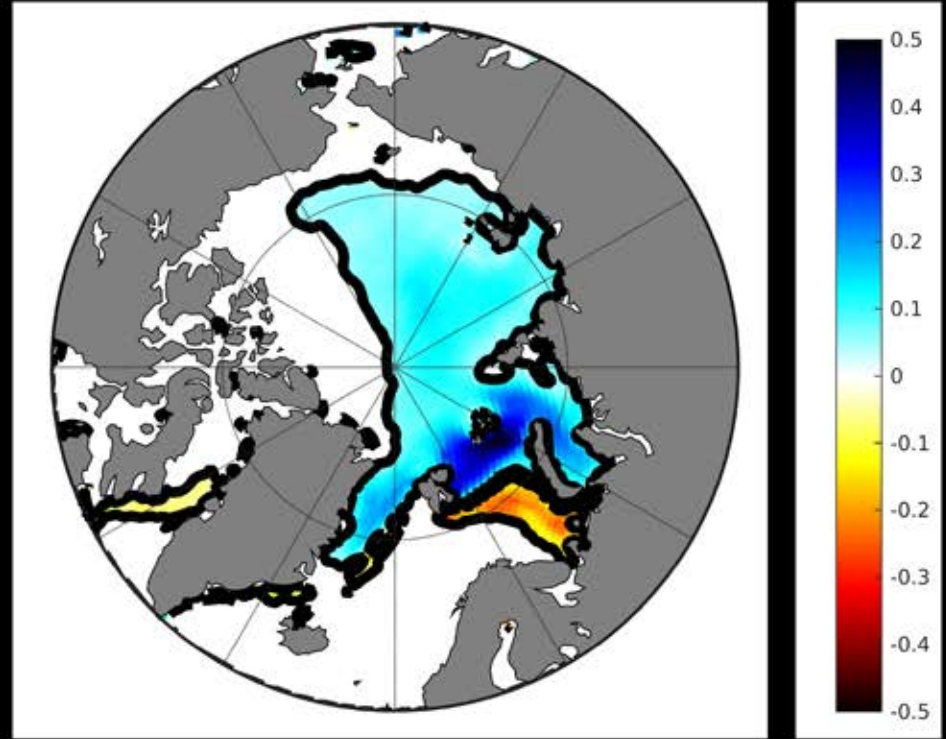
2000-2049

BSO OHT

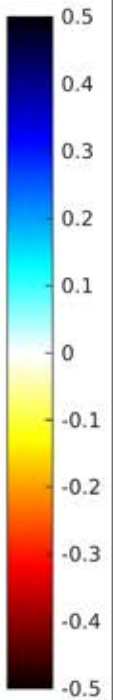
Turbulent Fluxes



OHT - Winter Ice Growth



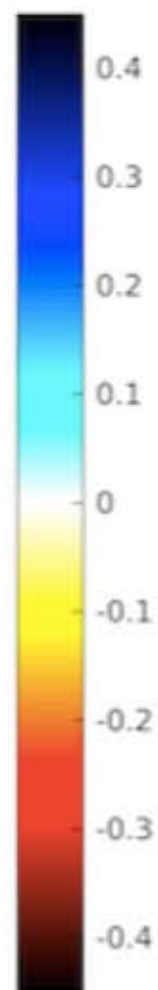
OHT - Summer melt



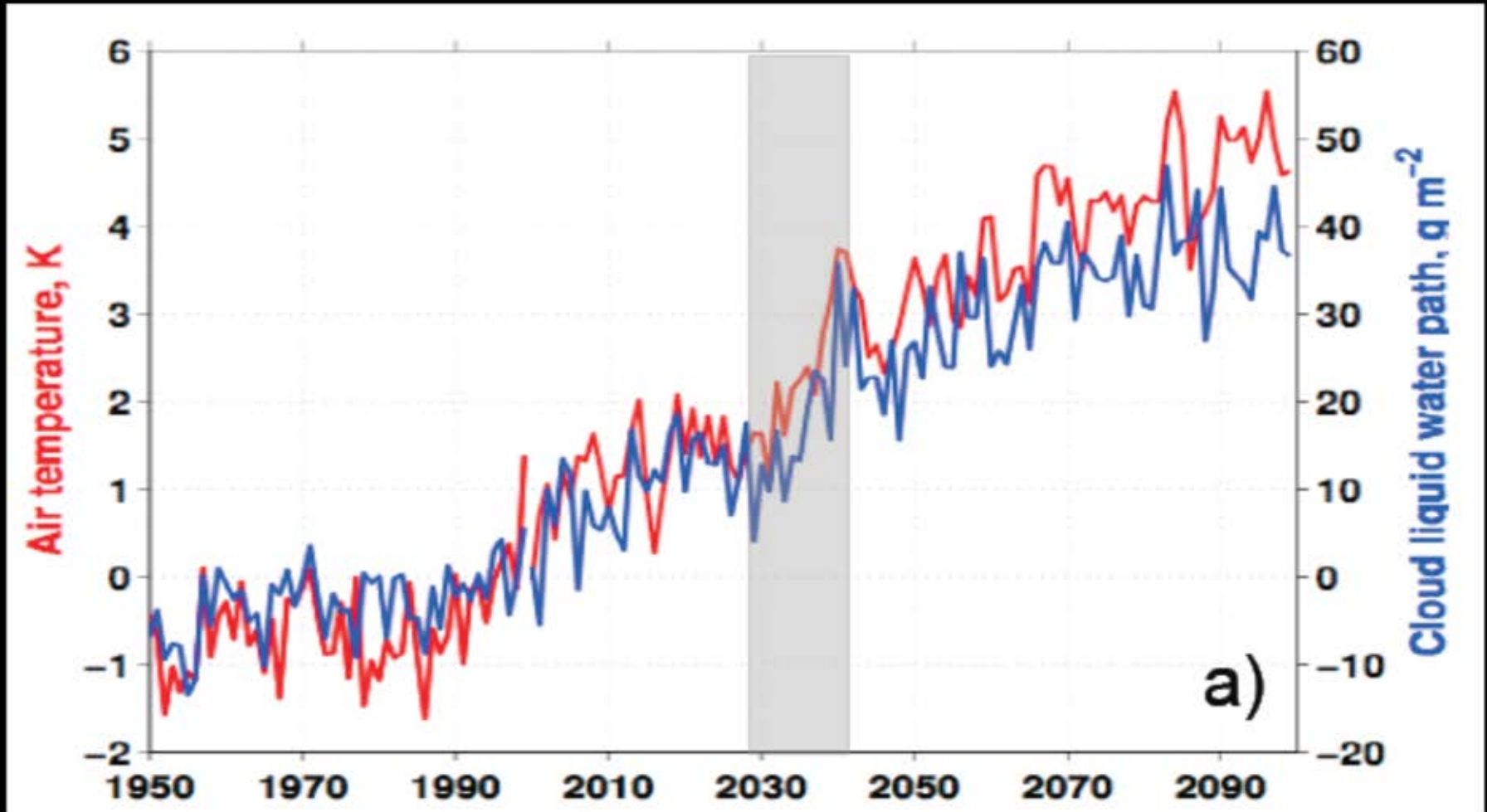
BSO OHT

Solar Flux

BSO OHT and July absorbed SW



Atmosphere Feedback

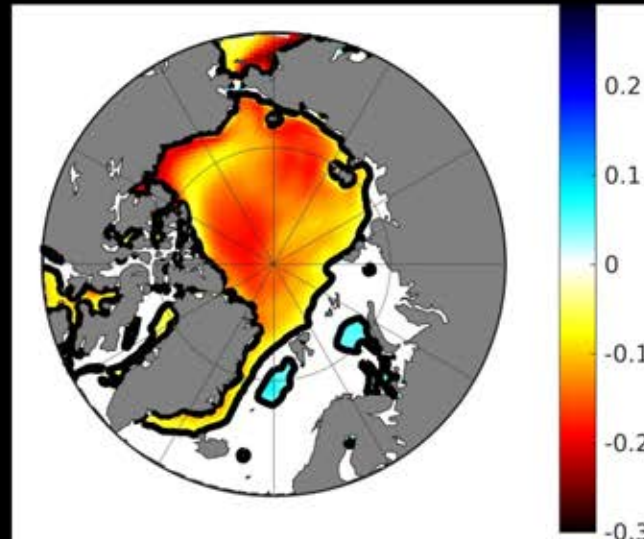
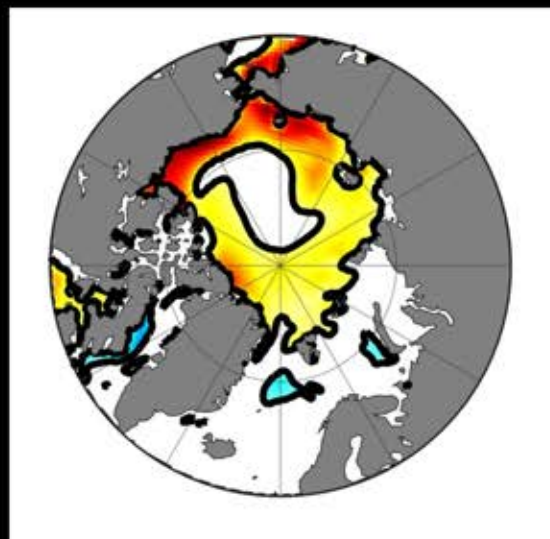


Bering Strait

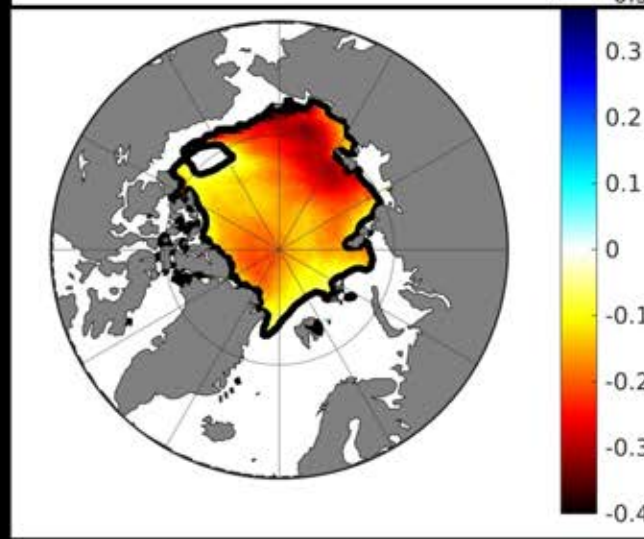
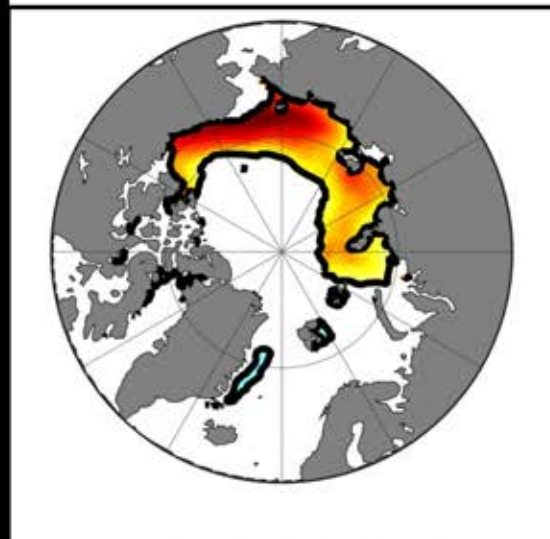
Bering Strait OHT – Ice Condition

Regression Analysis

March
Thick



Sept
SIC



1921-1999

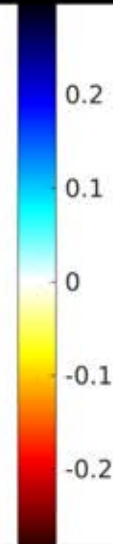
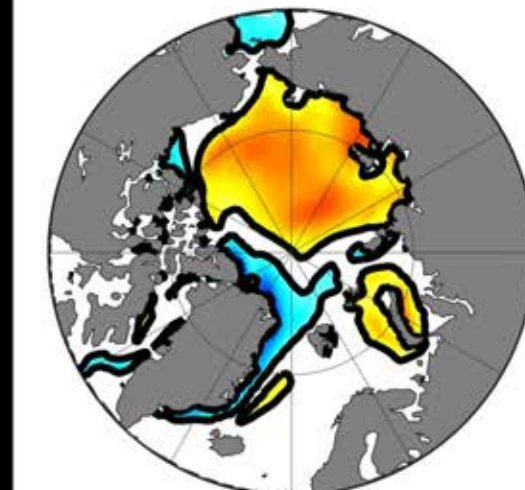
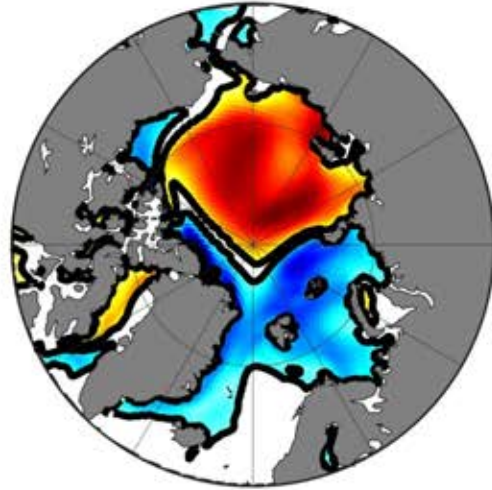
2000-2049

Fram Strait

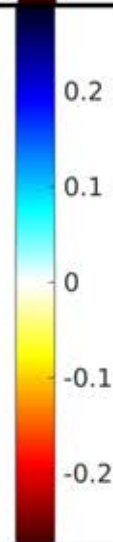
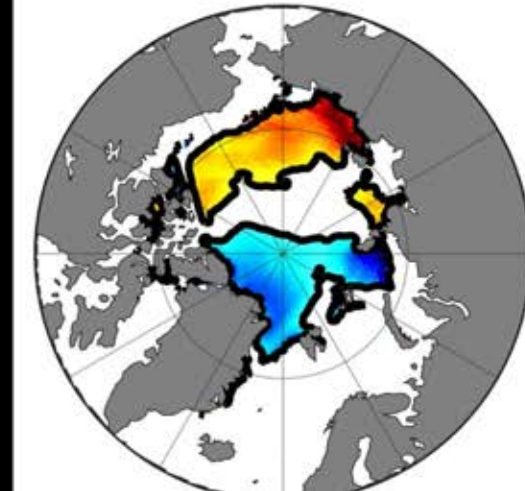
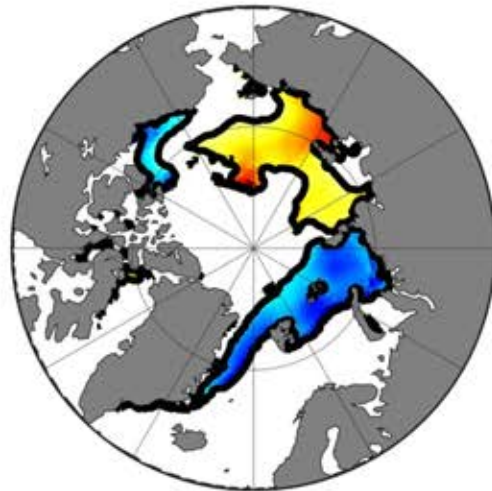
Fram Strait OHT – Ice Condition

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*]