Seasonal-to-Decadal Prediction of Regional Arctic Sea Ice and Ocean Heat Transport

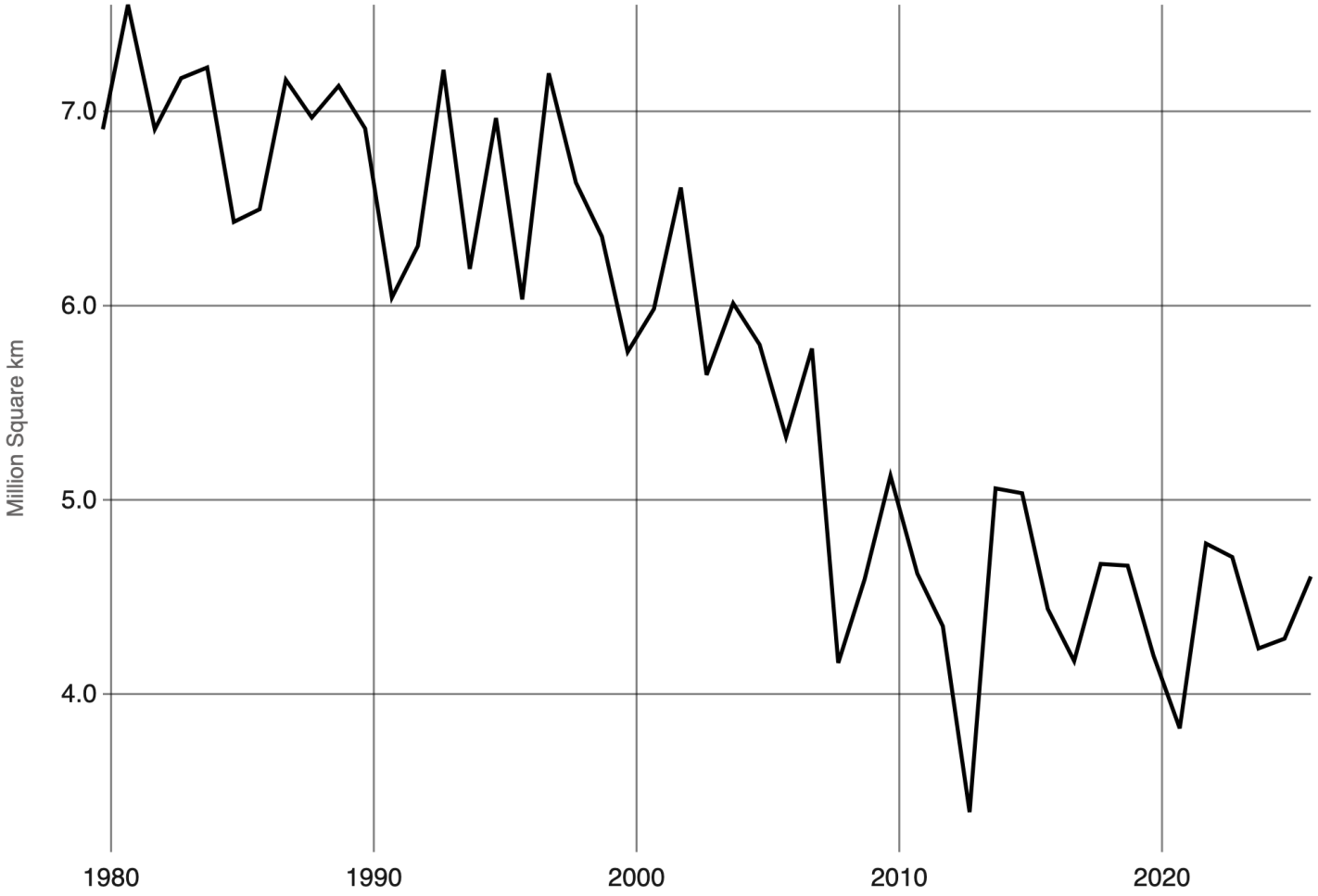
Jacob T. Cohen[1,2], Stephen Yeager[3], Wei Cheng[1,2], LuAnne Thompson[1]

CESM Polar Climate Working Group Meeting

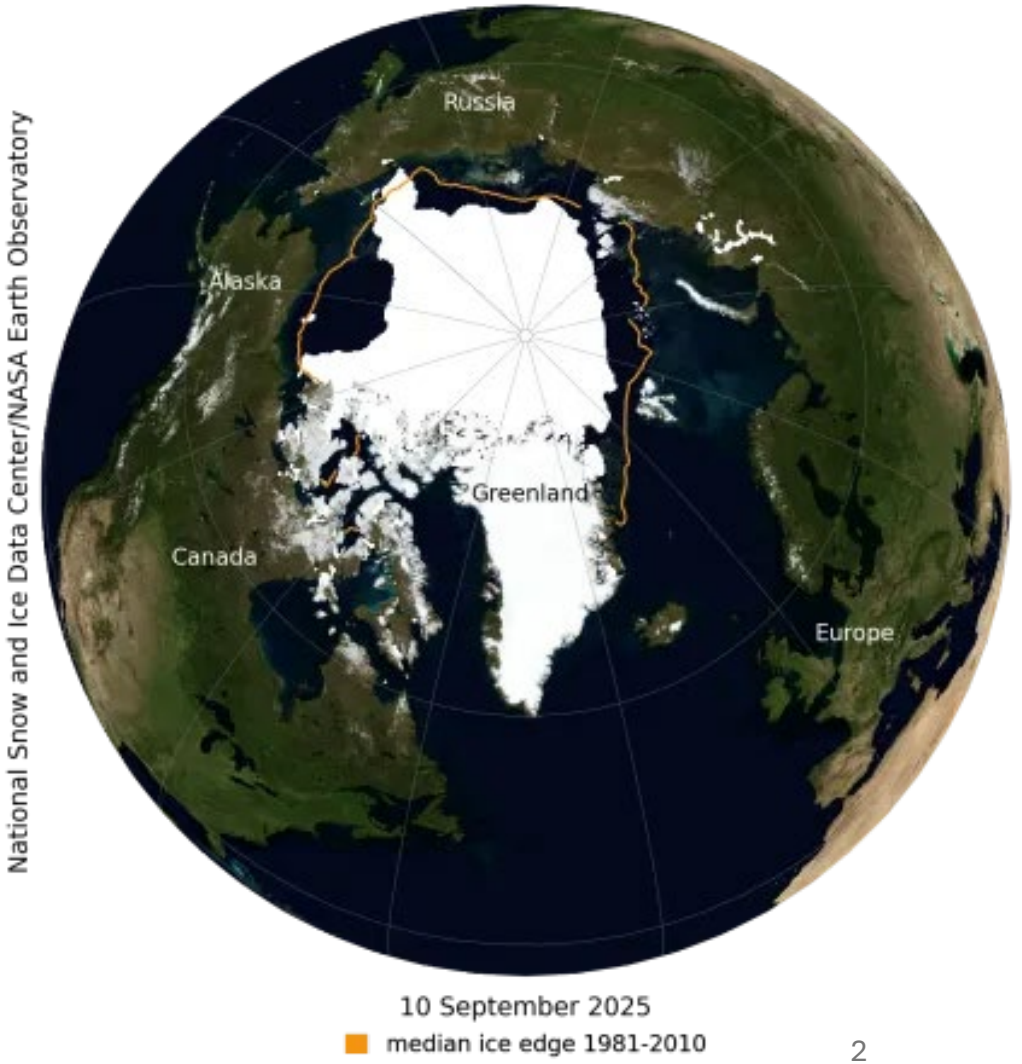
February 6, 2026

1. School of Oceanography, University of Washington
2. Cooperative Institute for Climate, Ocean, and Ecosystem Studies
3. NSF NCAR

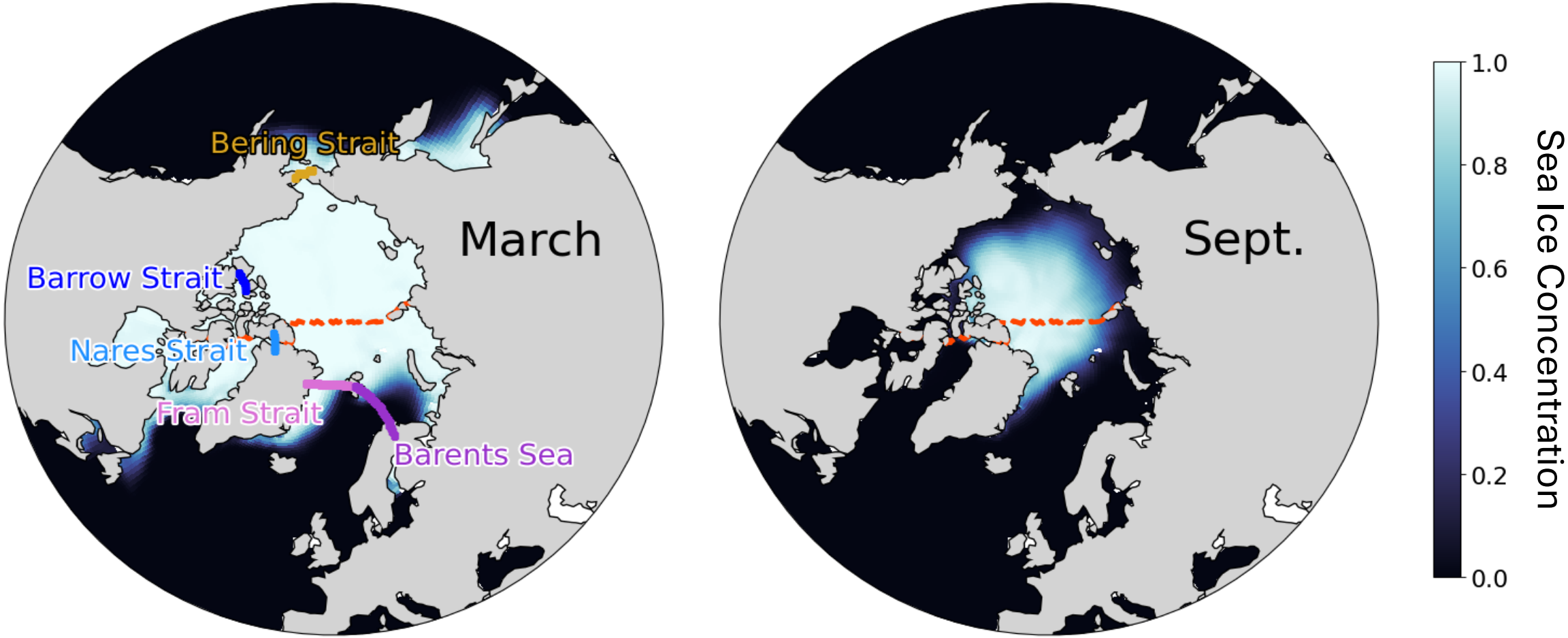
Arctic sea ice decline highlights the need for accurate predictions.



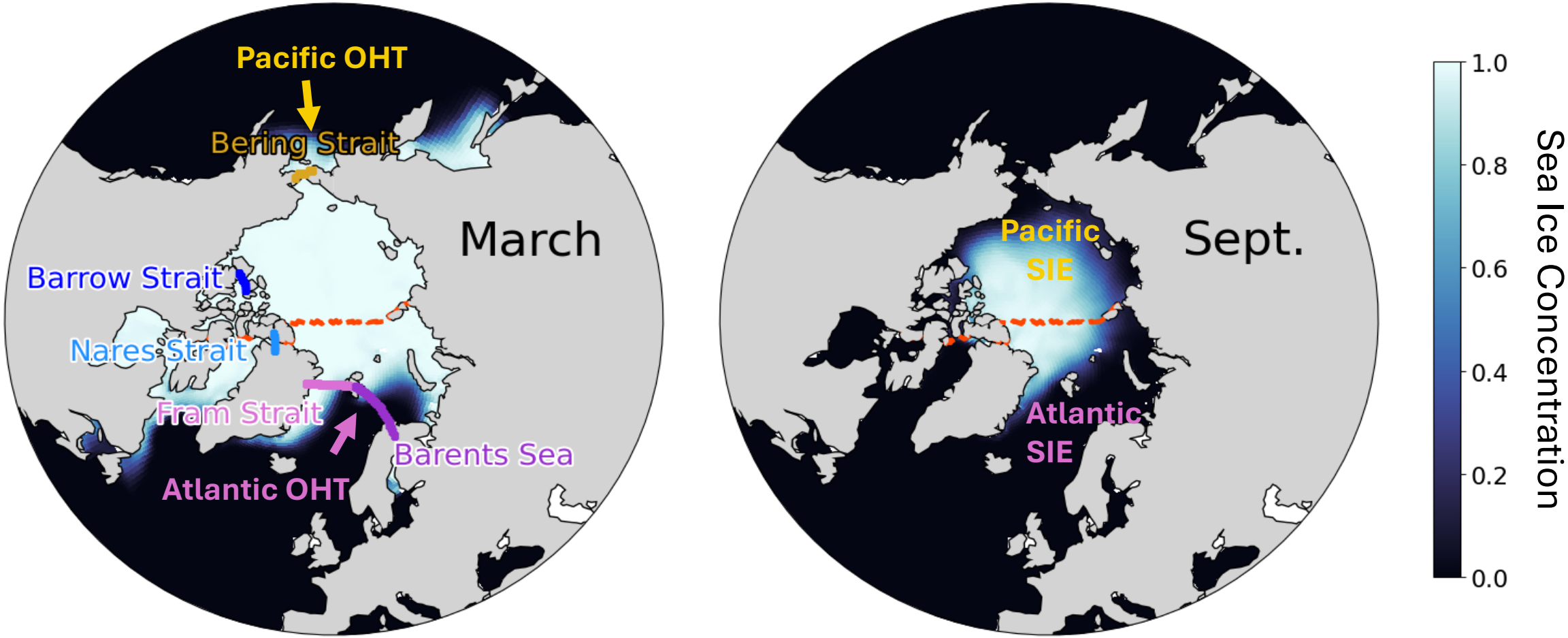
Source: climate.nasa.gov



Arctic Sea Ice and Ocean Gateways

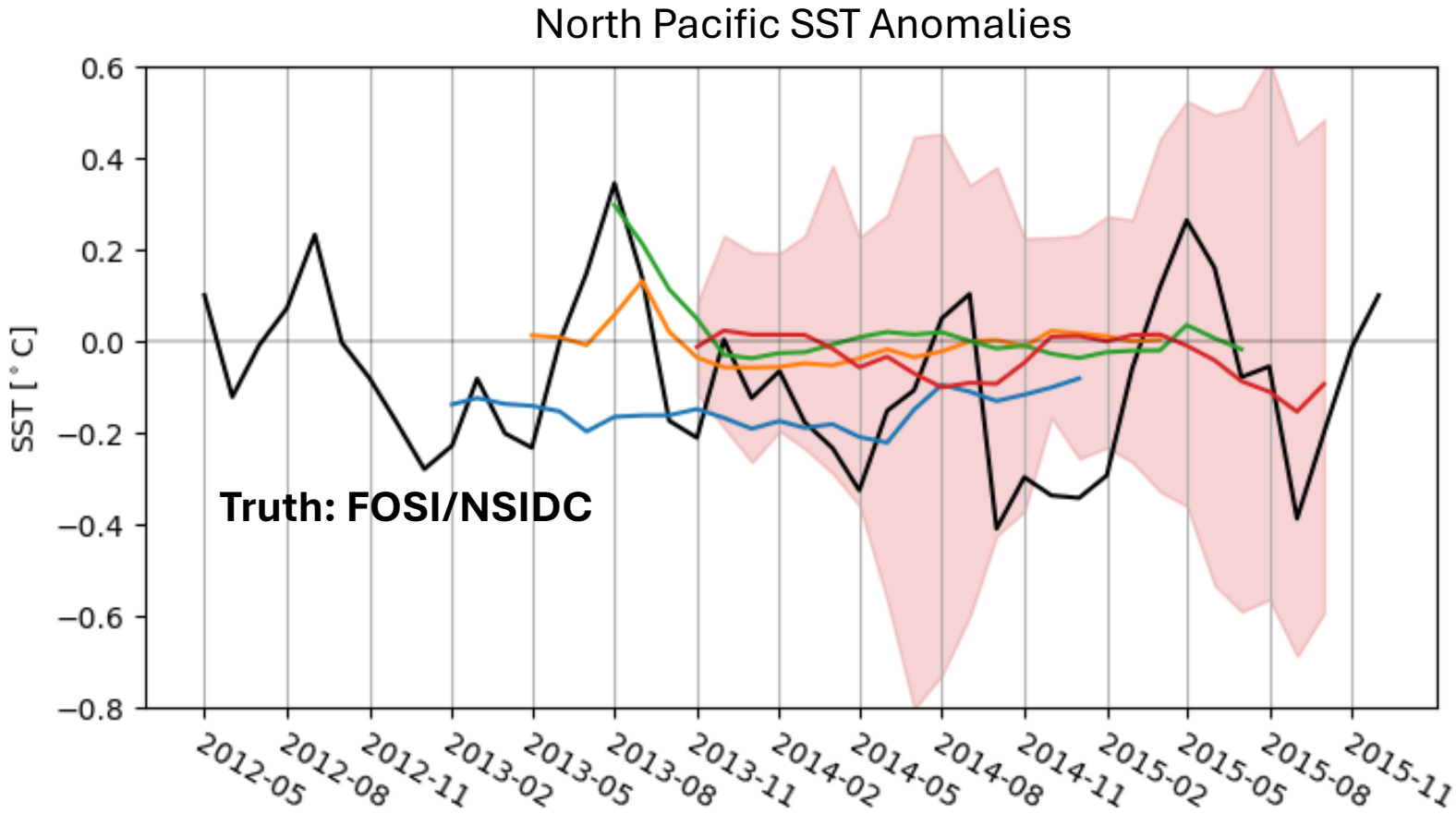


Arctic Sea Ice and Ocean Gateways



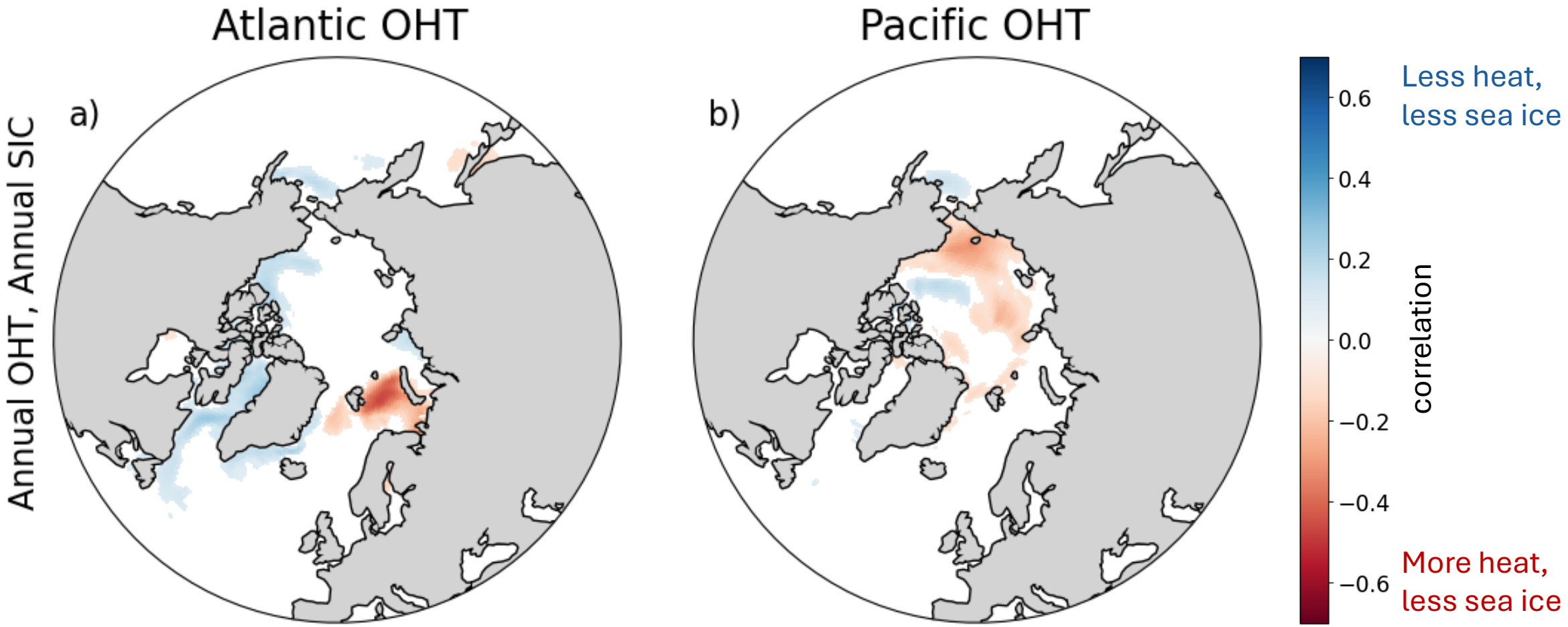
The Seasonal-to-Multiyear Large Ensemble (SMYLE)

- Verification data:
  - OHT from FOSI
  - Sea ice from FOSI and the National Snow and Ice Data Center (NSIDC)
- We use the full record of all forecasts and observations.
- We evaluate detrended anomalies.



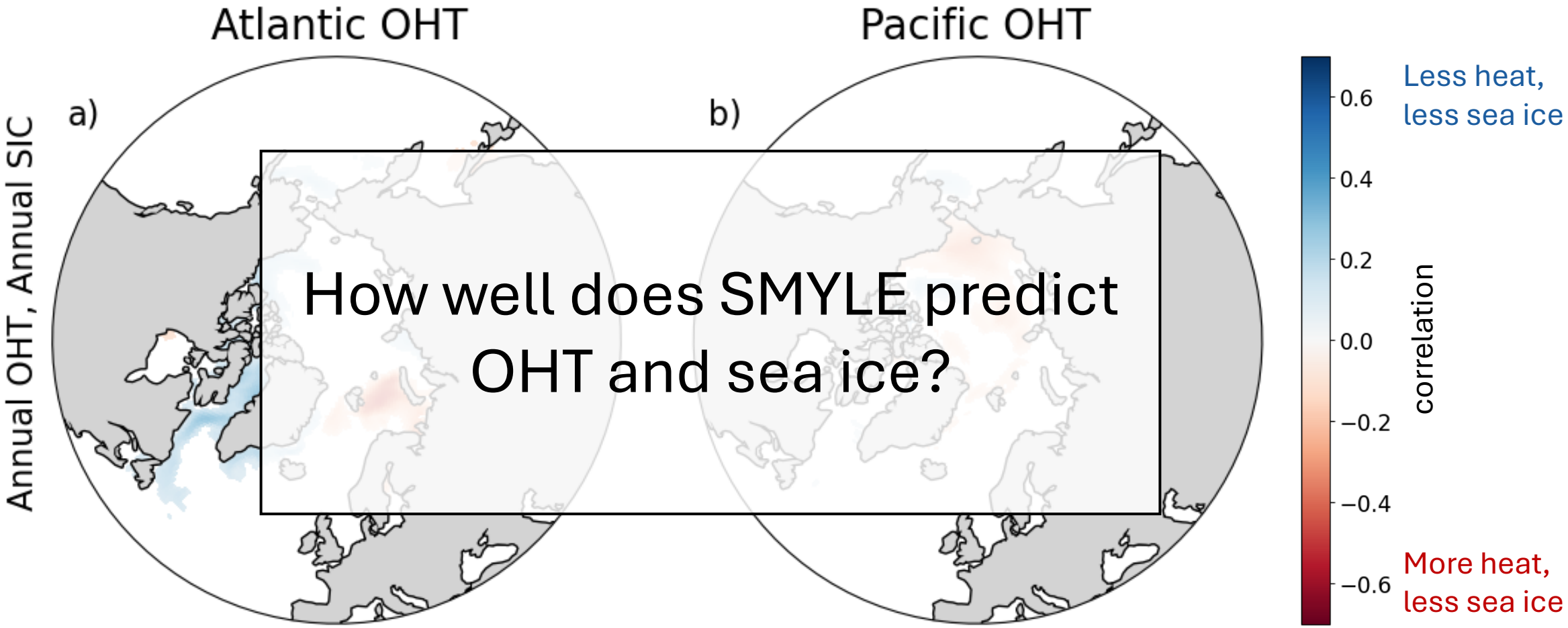
OHT influences regional sea ice.

FOSI correlation: annual sea ice concentration (SIC) and annual OHT

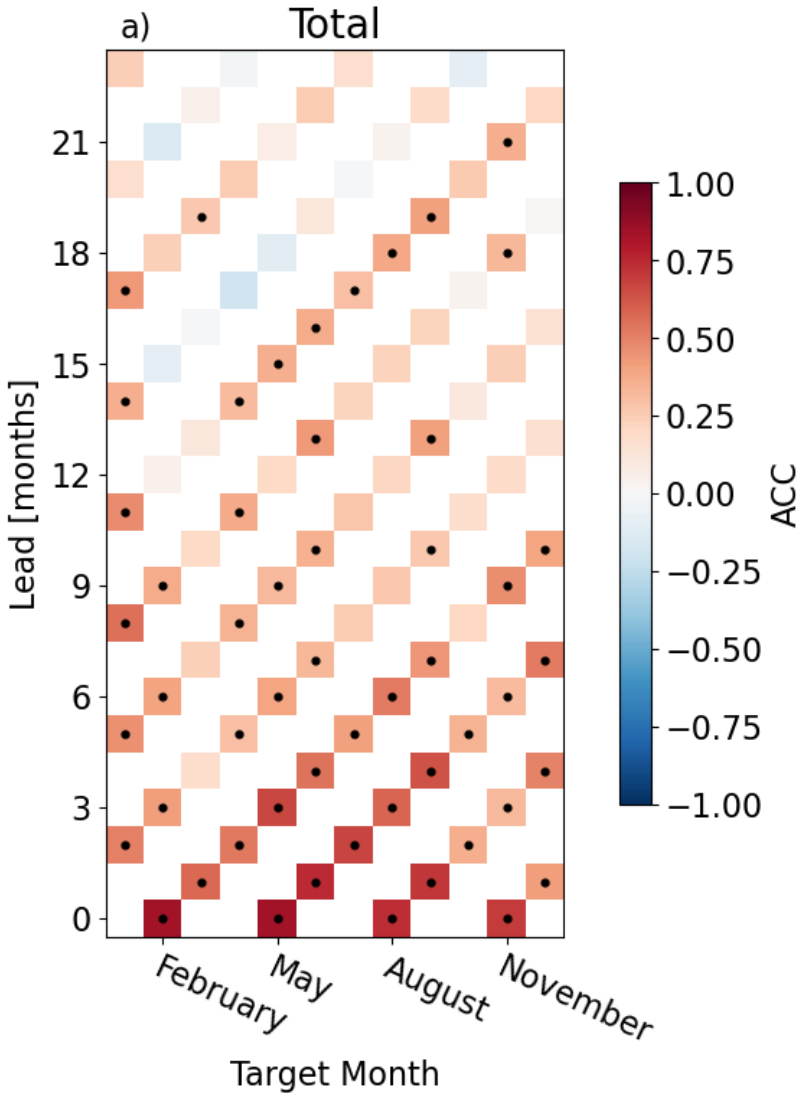


OHT influences regional sea ice.

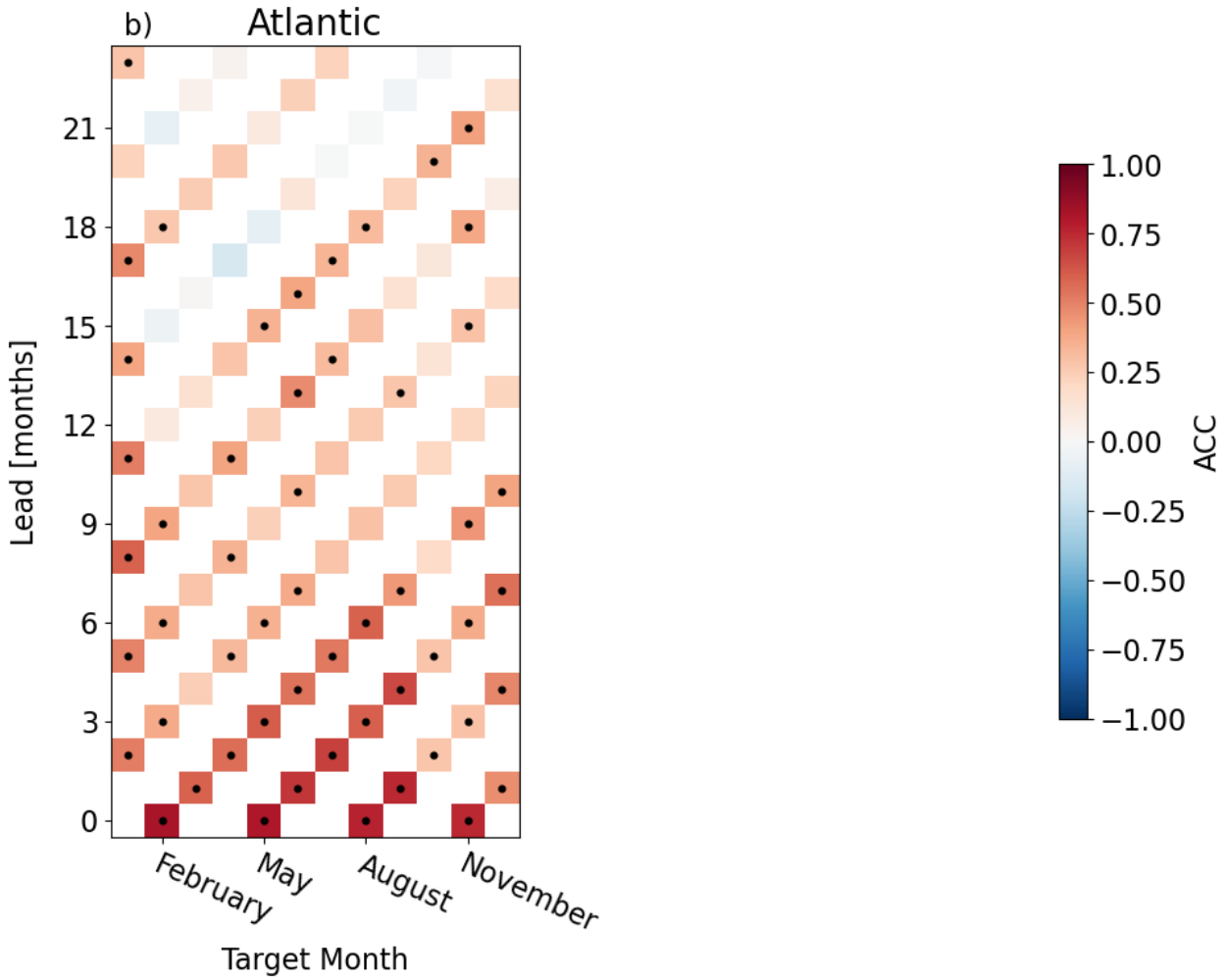
FOSI correlation: annual sea ice concentration (SIC) and annual OHT



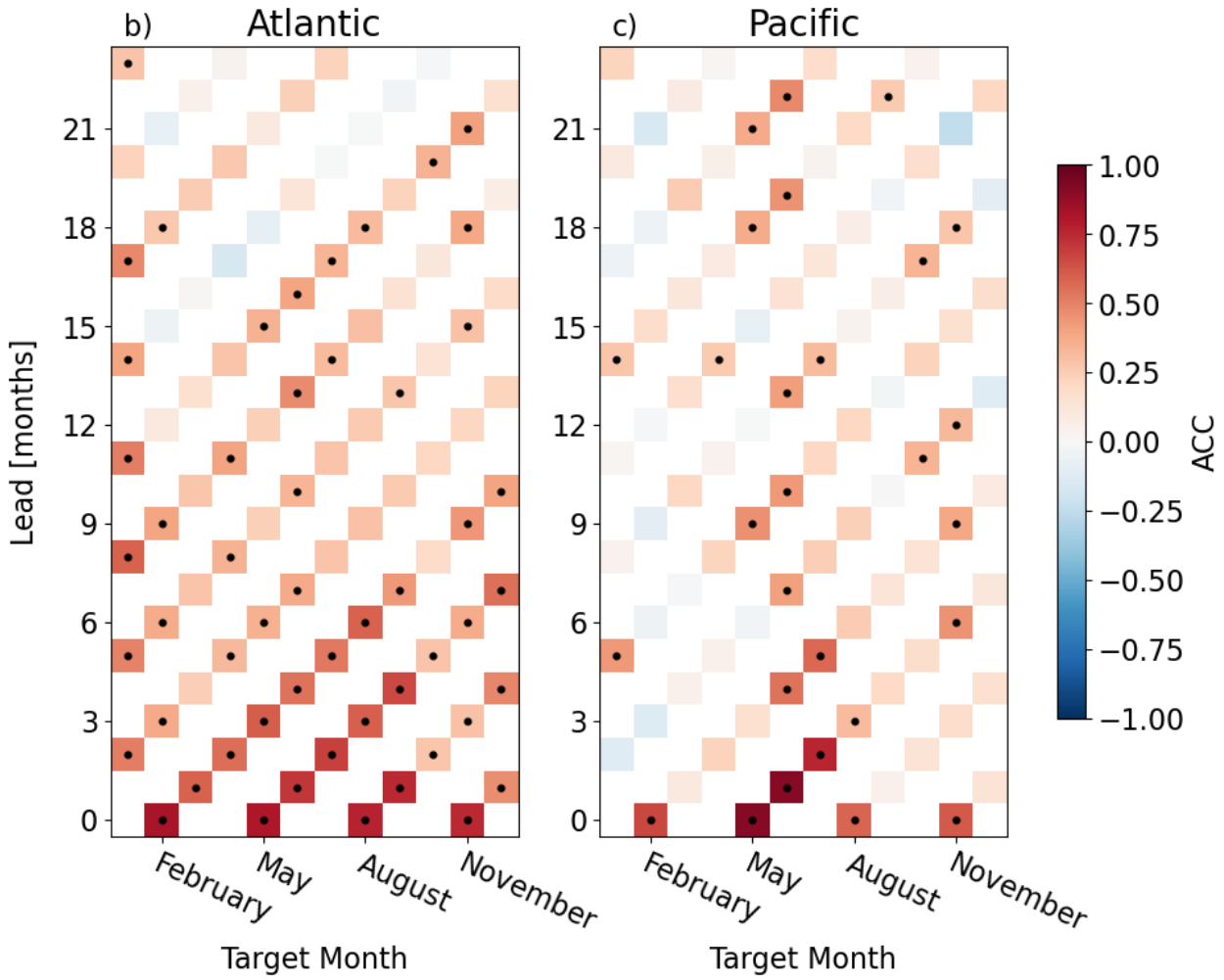
OHT prediction skill: target month vs lead month



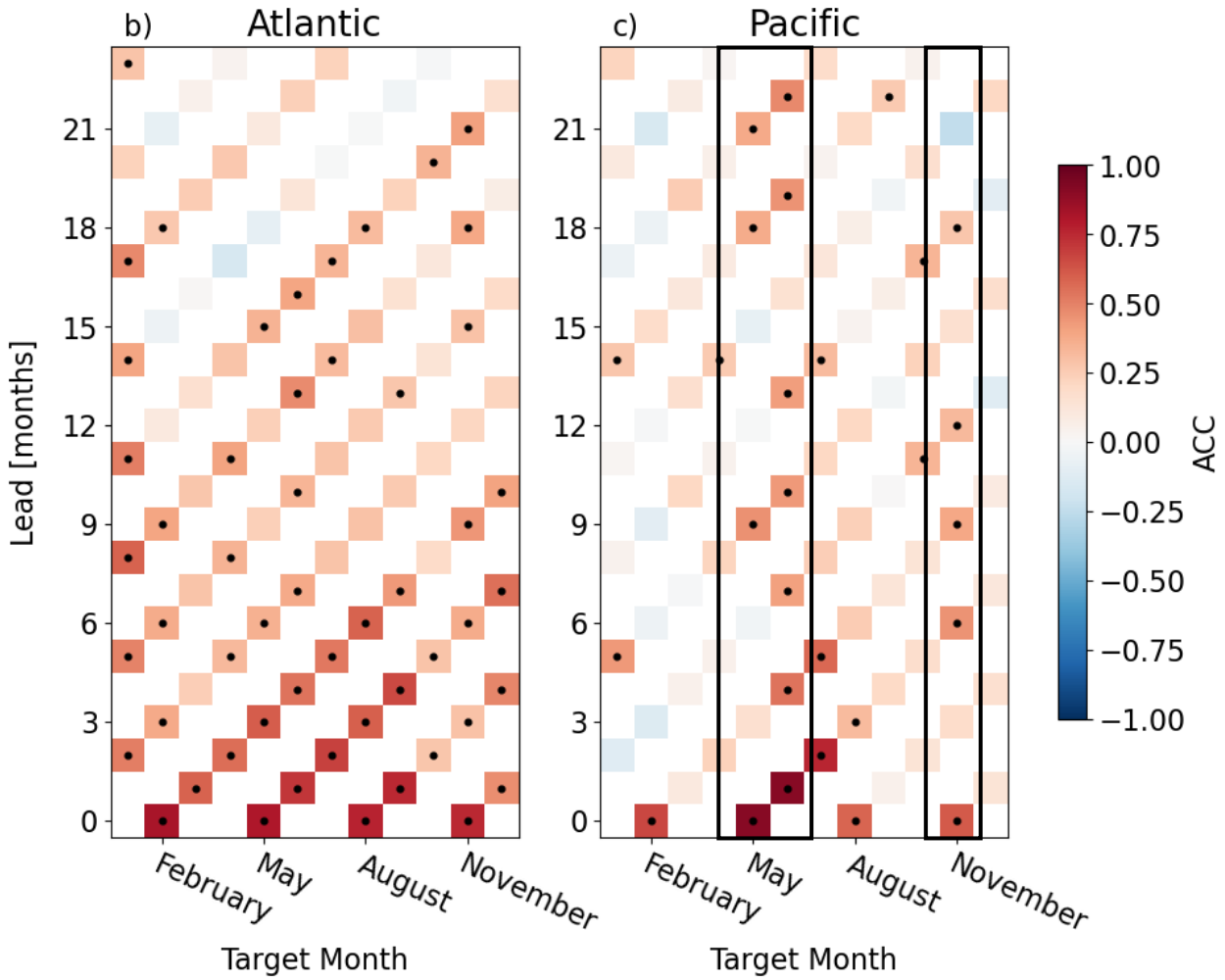
Unlike Atlantic OHT, Pacific OHT is well predicted only in May, June, and November.



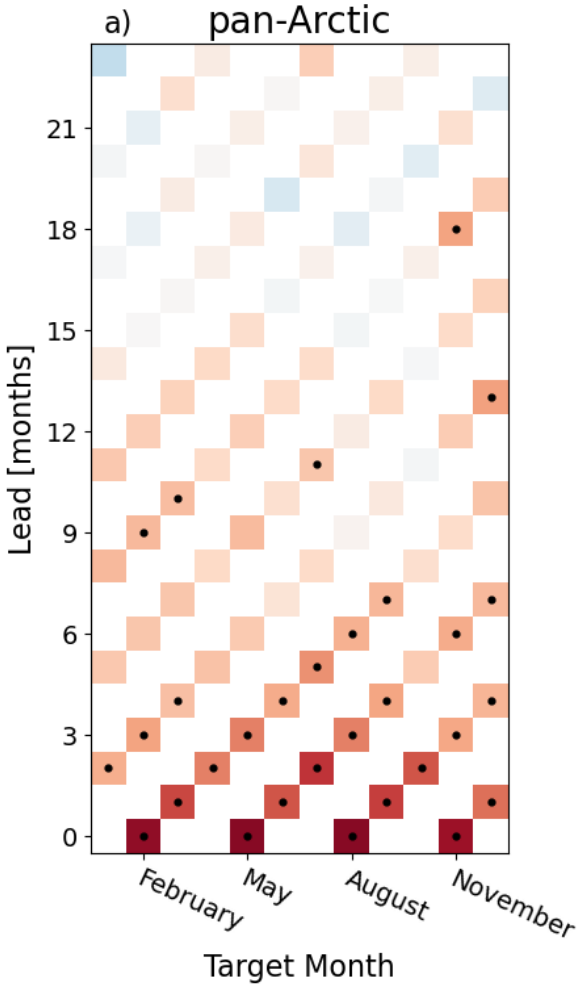
Unlike Atlantic OHT, Pacific OHT is well predicted only in May, June, and November.

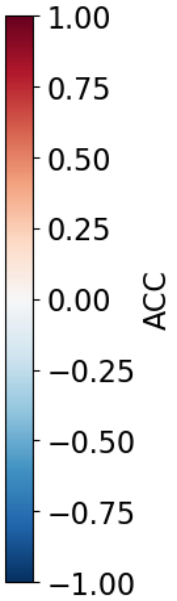


Unlike Atlantic OHT, Pacific OHT is well predicted only in May, June, and November.

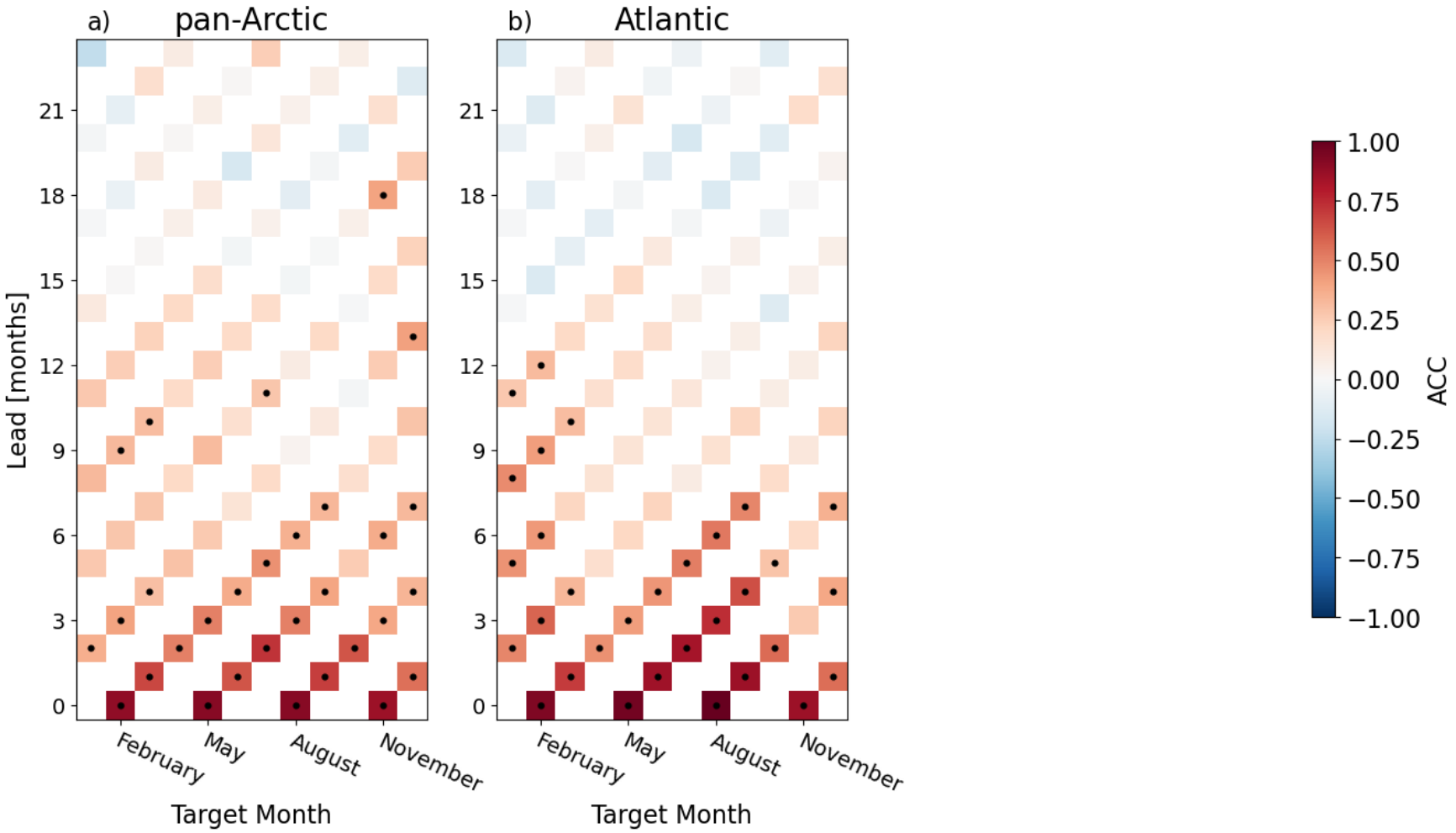


Pacific SIE is predictable for longer lead times when OHT is predictable.

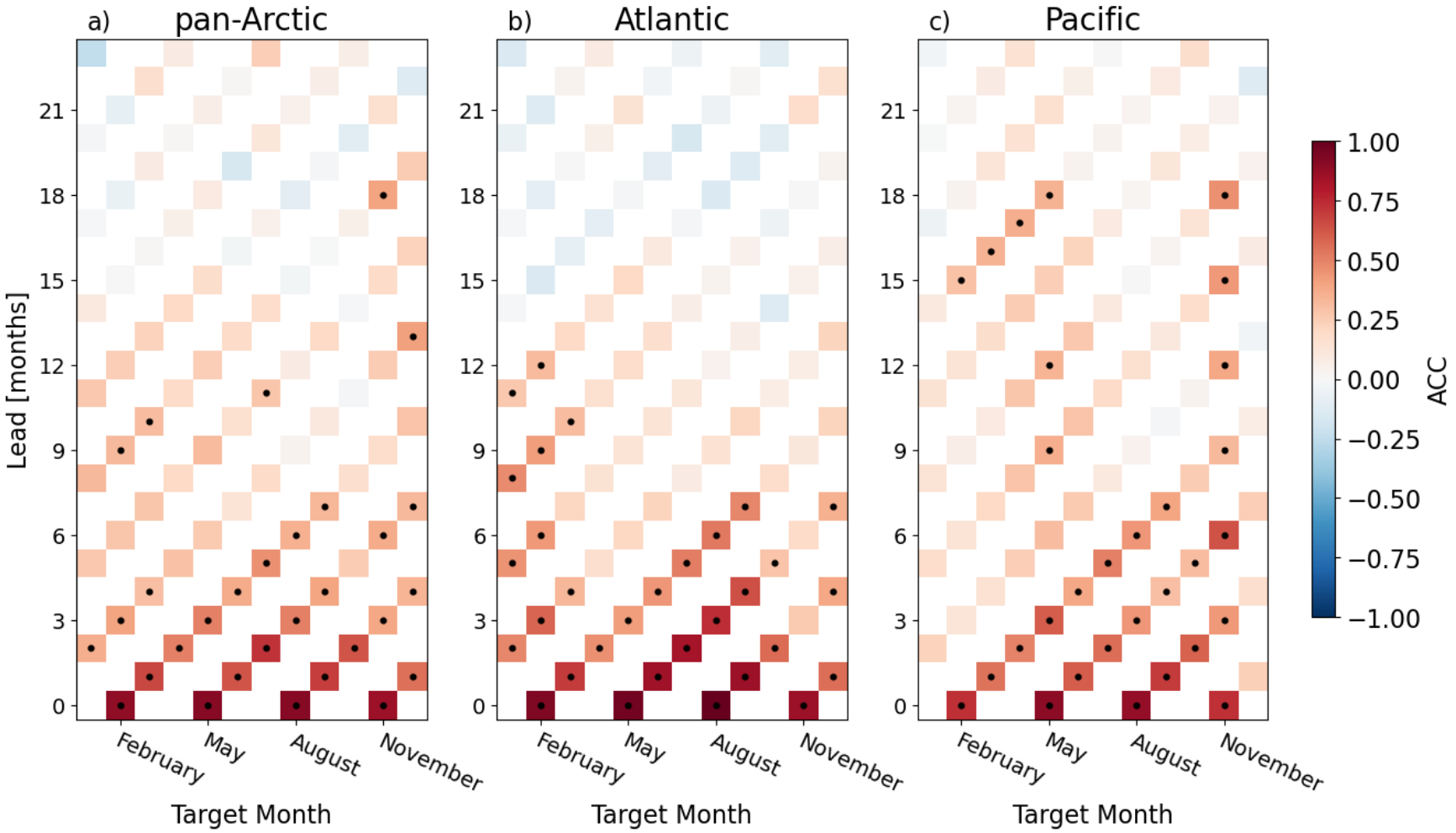




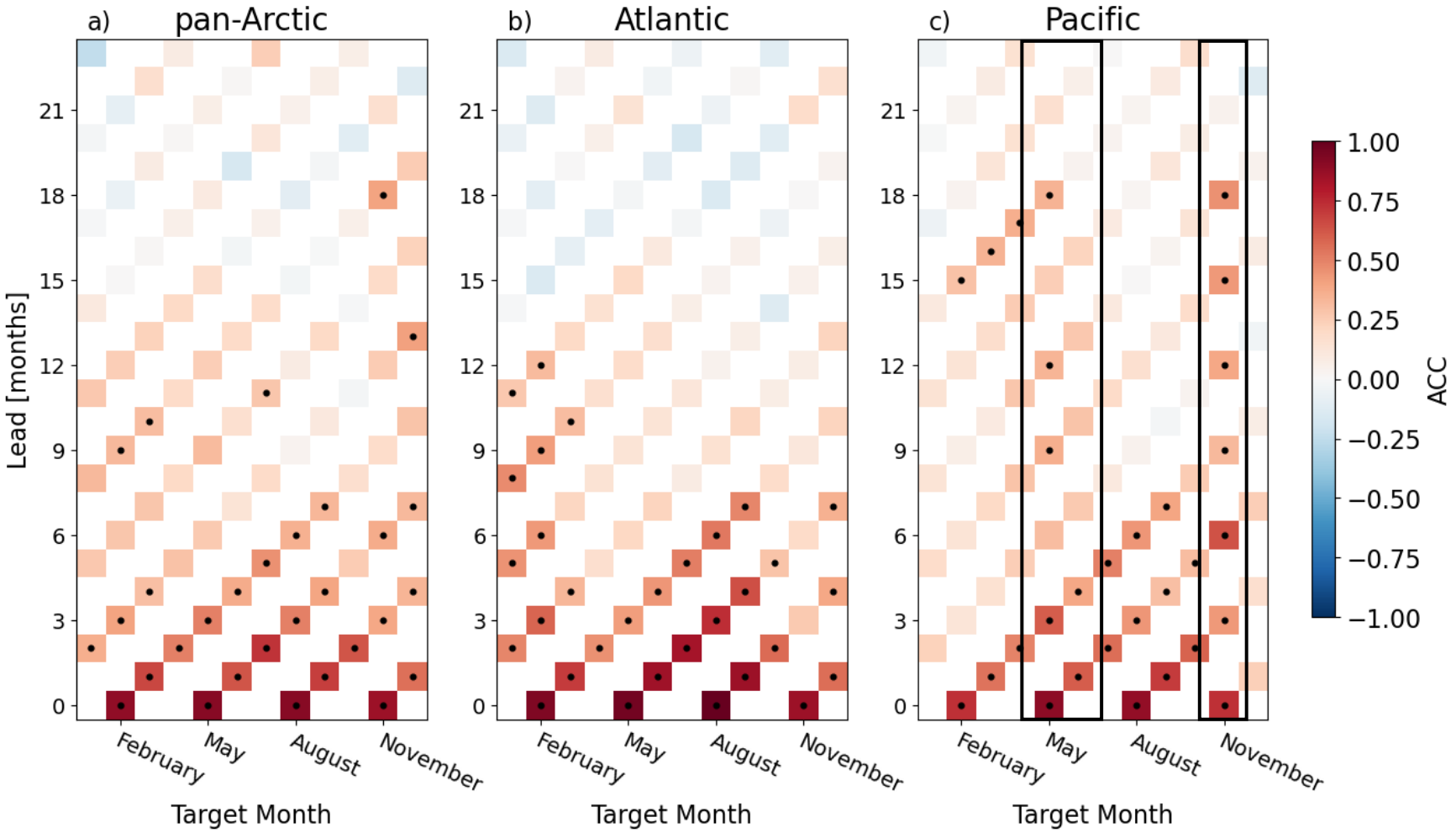
Pacific SIE is predictable for longer lead times when OHT is predictable.



Pacific SIE is predictable for longer lead times when OHT is predictable.

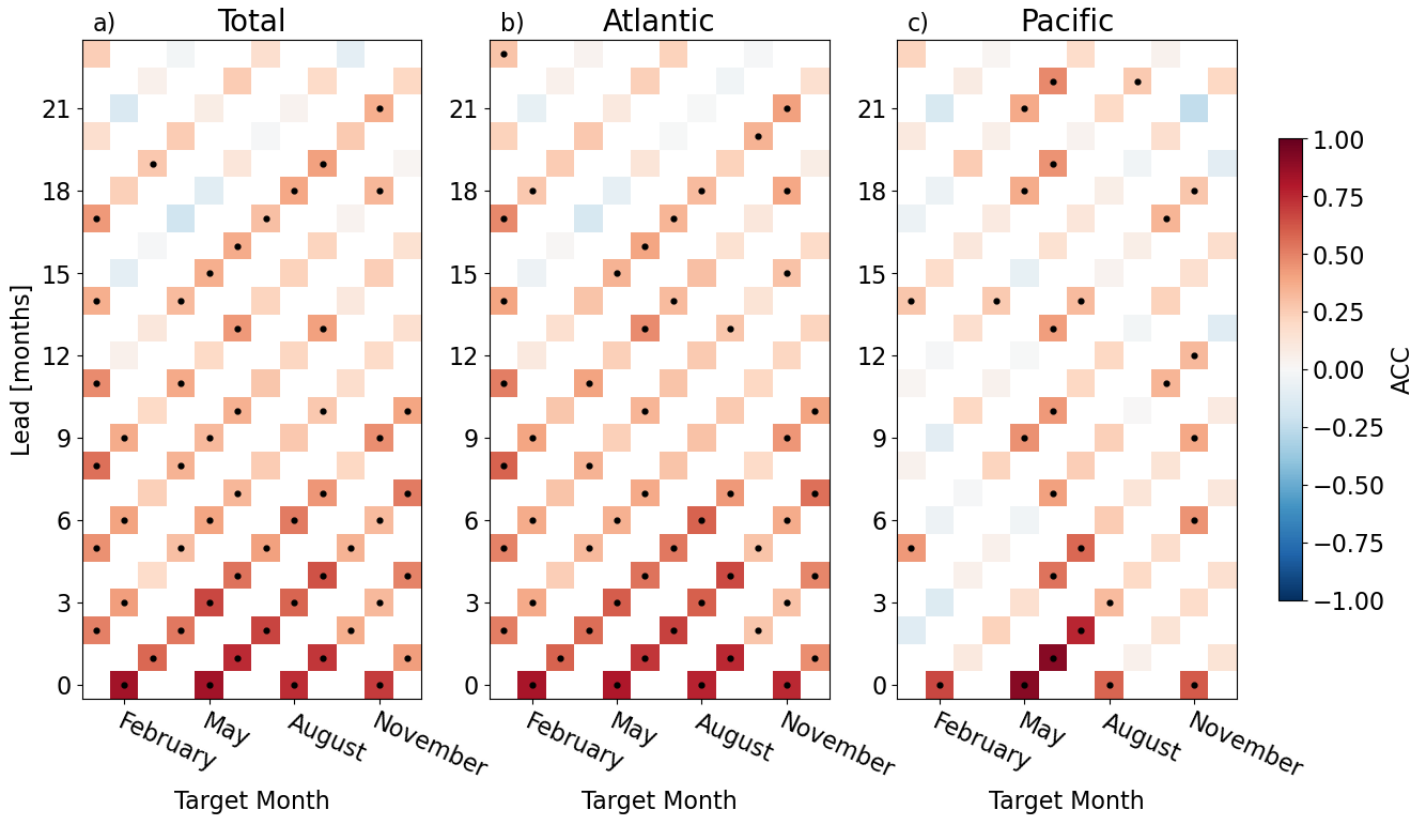


Pacific SIE is predictable for longer lead times when OHT is predictable.



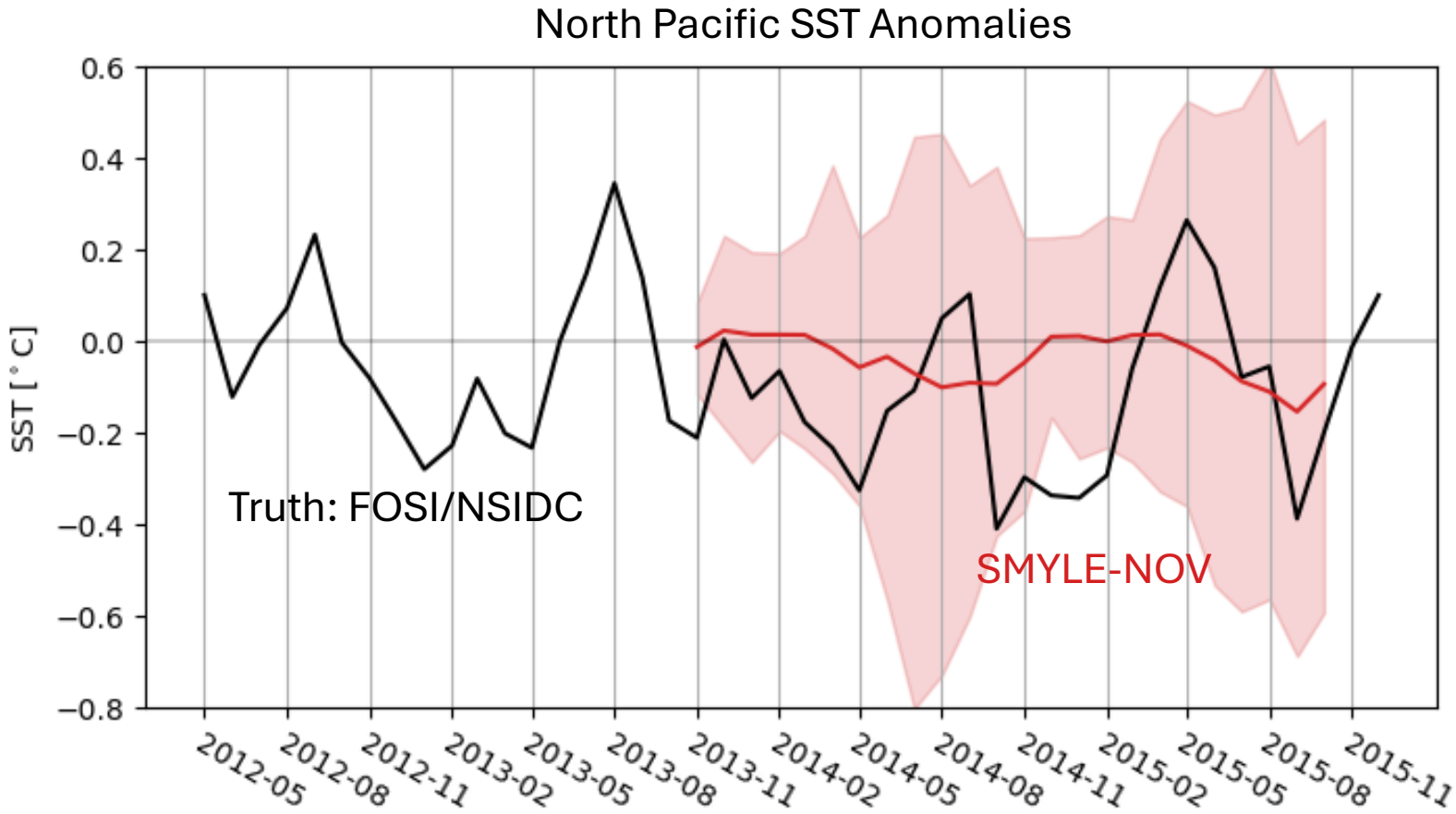
Seasonal Prediction Recap:

Atlantic-Arctic and Pacific-Arctic ocean heat transport (OHT) affect sea ice variability and predictability.



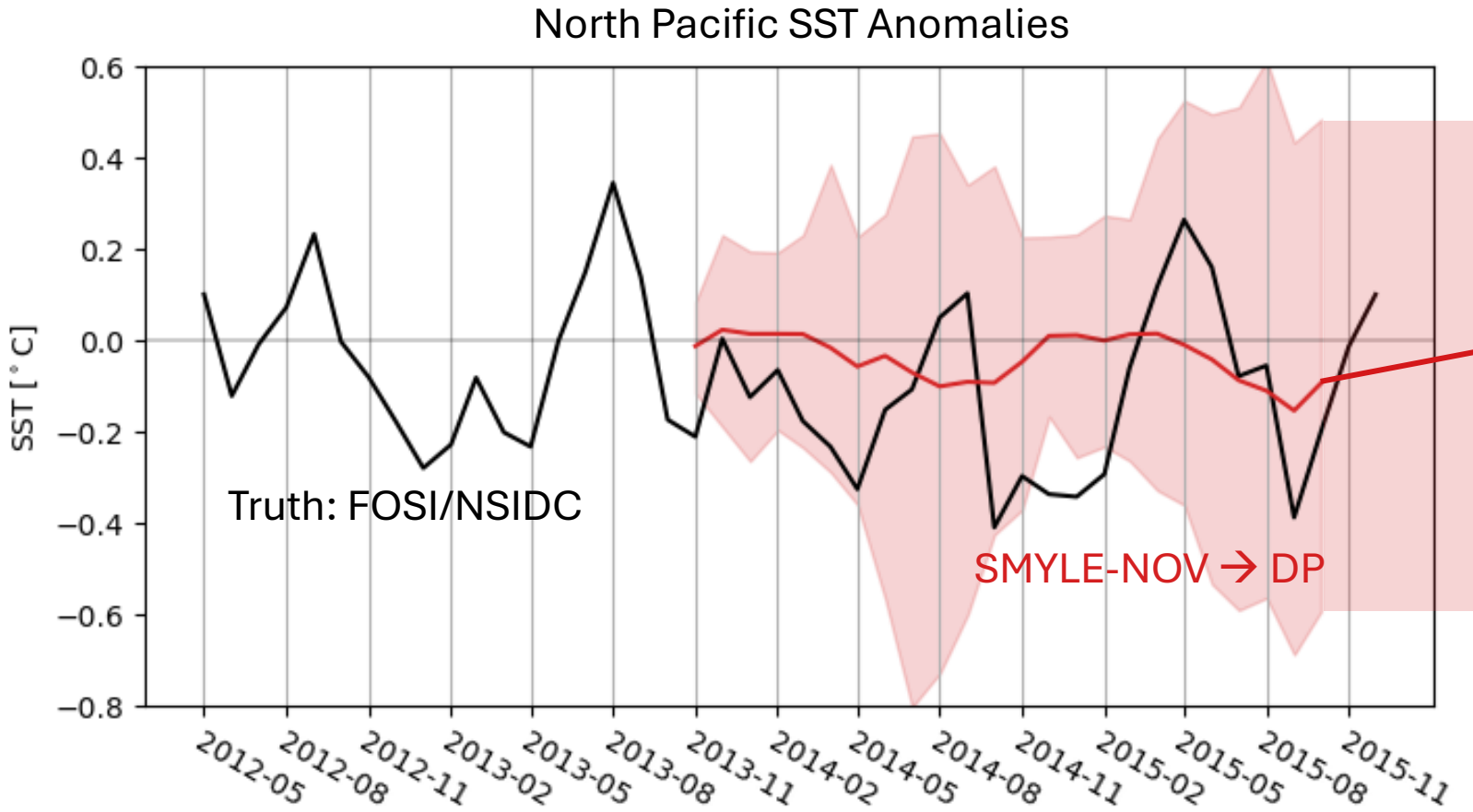
CESM2 Decadal Prediction System (DP)

- Extend SMYLE-NOV from 24 months to 122 months.
- Average January–December predictions to create 10-year predictions.
- Evaluate OHT and SIE anomalies without removing the long-term linear trend.

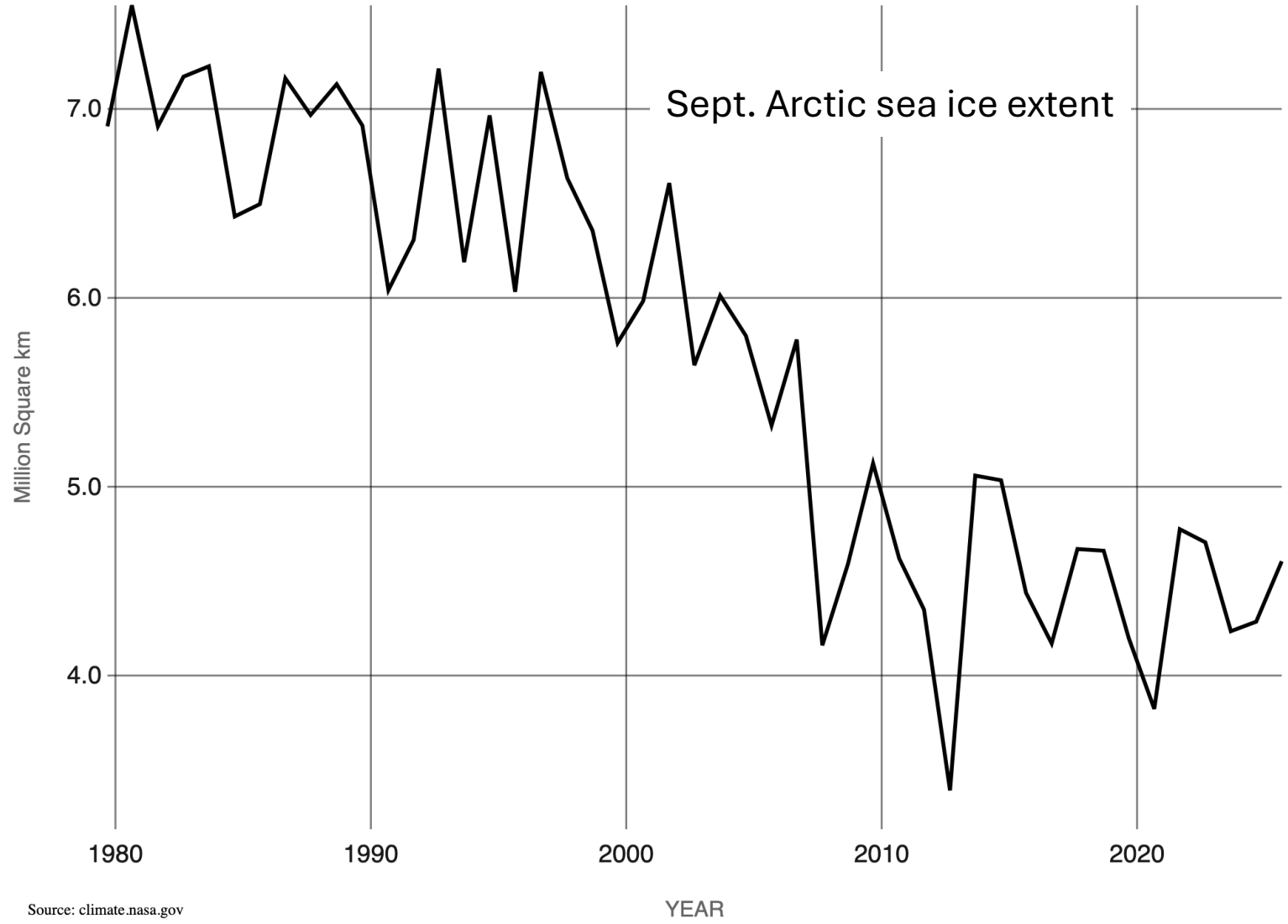


CESM2 Decadal Prediction System (DP)

- Extend SMYLE-NOV from 24 months to 122 months.
- Average January–December predictions to create 10-year predictions.
- Evaluate OHT and SIE anomalies without removing the long-term linear trend.

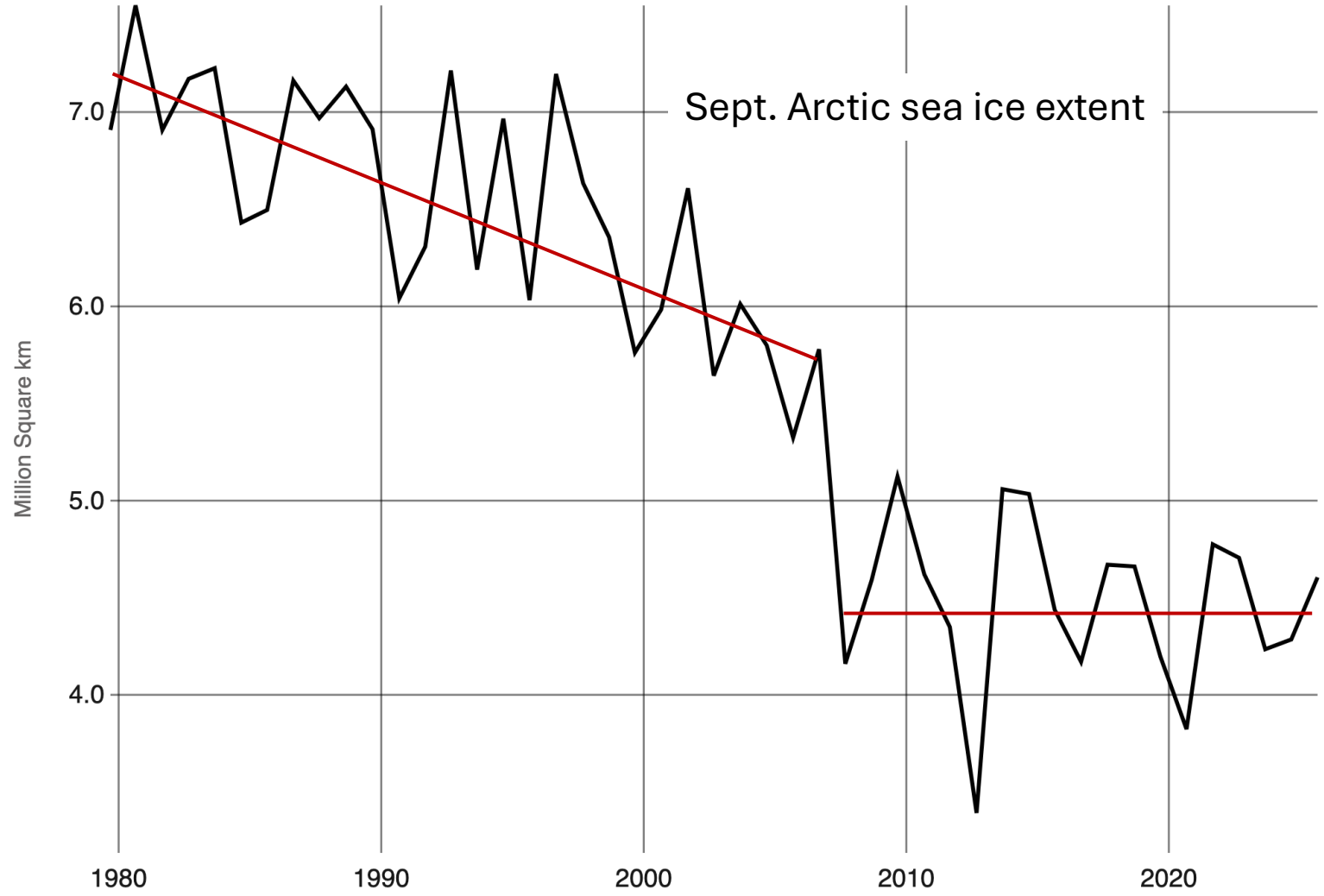


Since 2007, a slowdown in Arctic sea ice decline has occurred.



Source: climate.nasa.gov

Since 2007, a slowdown in Arctic sea ice decline has occurred.



Source: climate.nasa.gov

Since 2007, a slowdown in Arctic sea ice decline has occurred.

Geophysical Research Letters

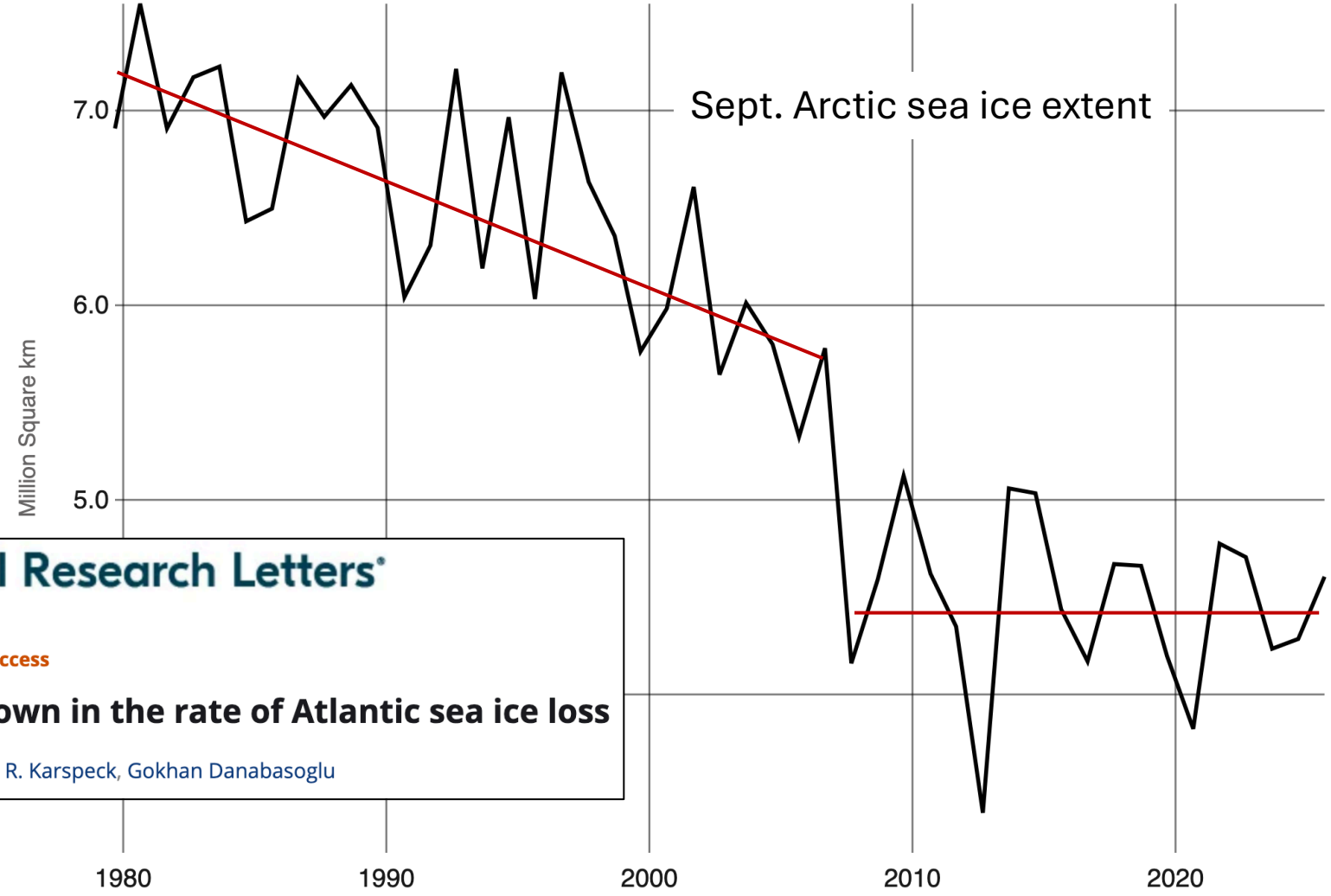
Research Letter | Open Access

Minimal Arctic Sea Ice Loss in the Last 20 Years, Consistent With Internal Climate Variability

M. R. England, L. M. Polvani, J. Screen, A. C. Chan

Source: climate.nasa.gov

The slowdown in Arctic sea ice decline was predictable.



Geophysical Research Letters

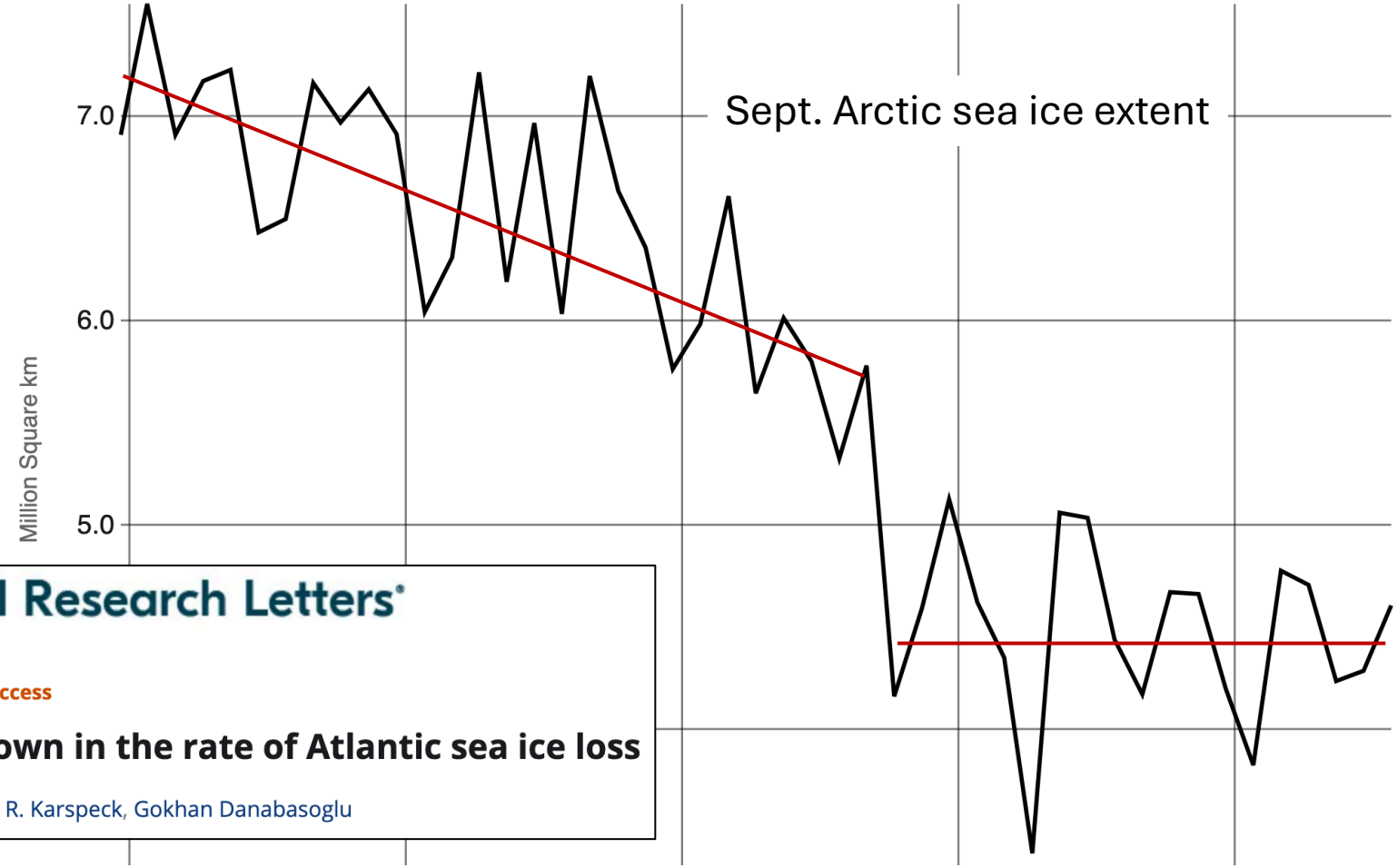
Research Letter | Free Access

Predicted slowdown in the rate of Atlantic sea ice loss

Stephen G. Yeager, Alicia R. Karspeck, Gokhan Danabasoglu

Source: climate.nasa.gov

The slowdown in Arctic sea ice decline was predictable.



Geophysical Research Letters

Research Letter | Free Access

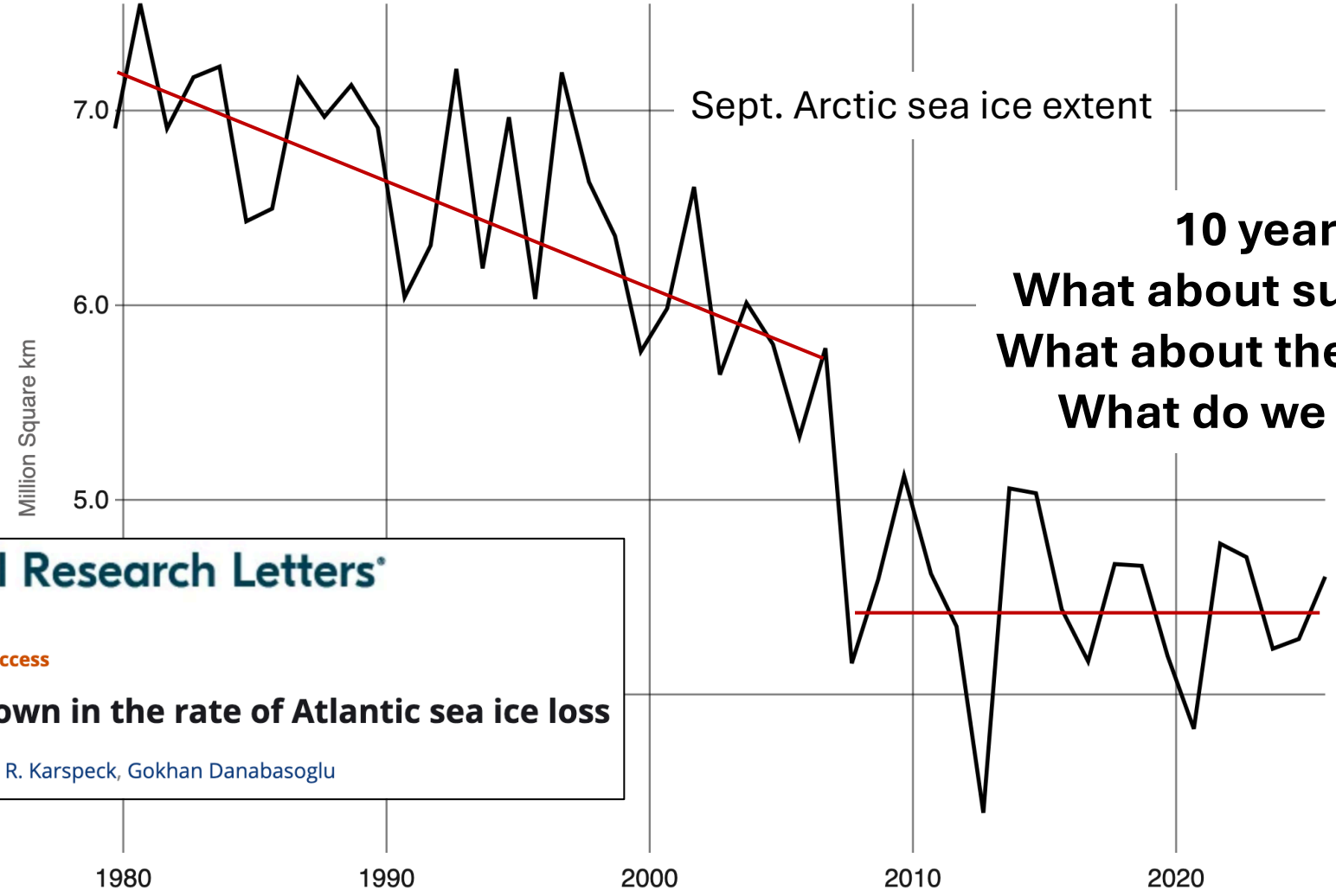
Predicted slowdown in the rate of Atlantic sea ice loss

Stephen G. Yeager, Alicia R. Karspeck, Gokhan Danabasoglu

Changes in atmospheric circulation → Changes in ocean circulation → Changes in sea ice

Source: climate.nasa.gov

The slowdown in Arctic sea ice decline was predictable.



10 years later…
What about summer sea ice?
What about the Pacific-Arctic?
What do we predict now?

Geophysical Research Letters

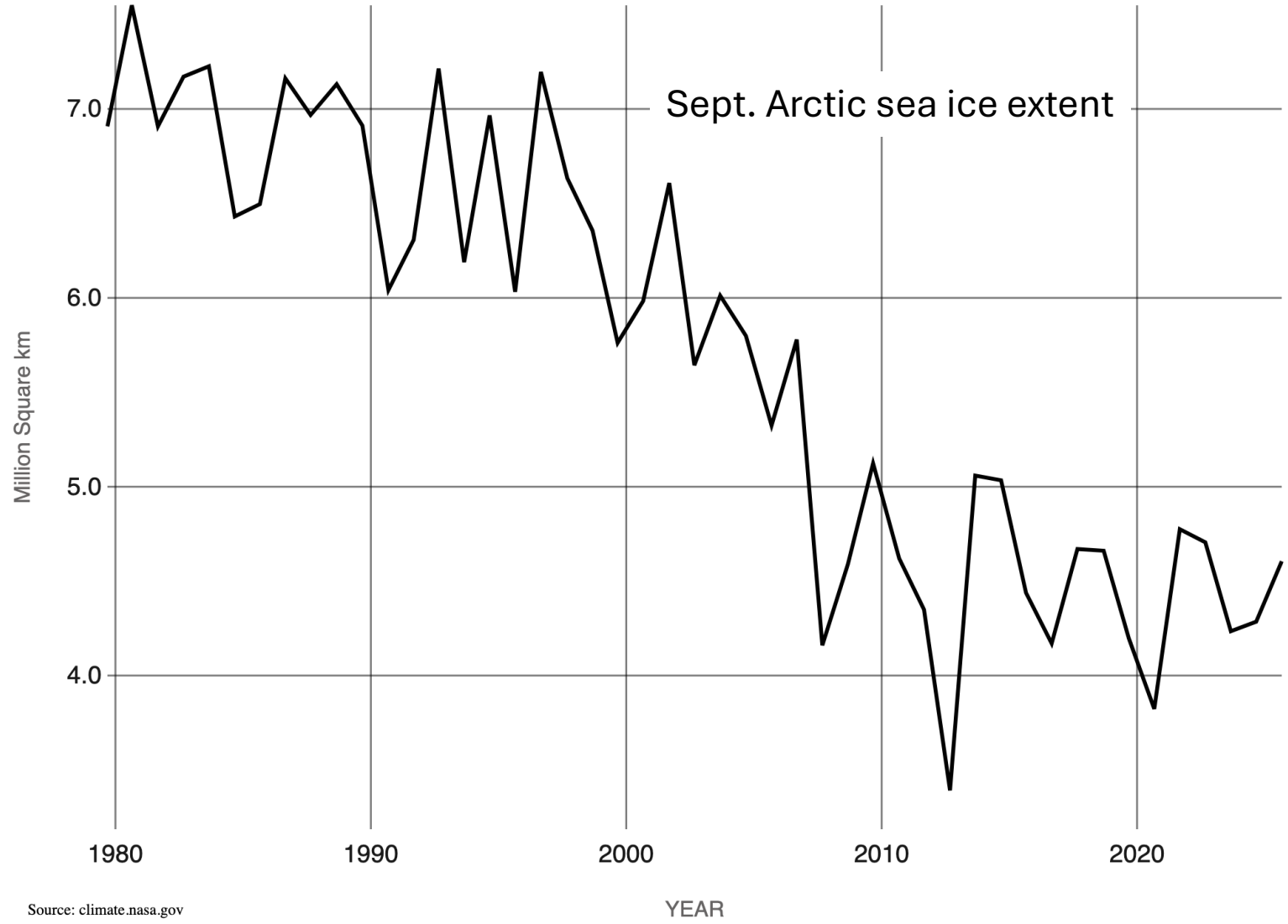
Research Letter | Free Access

Predicted slowdown in the rate of Atlantic sea ice loss

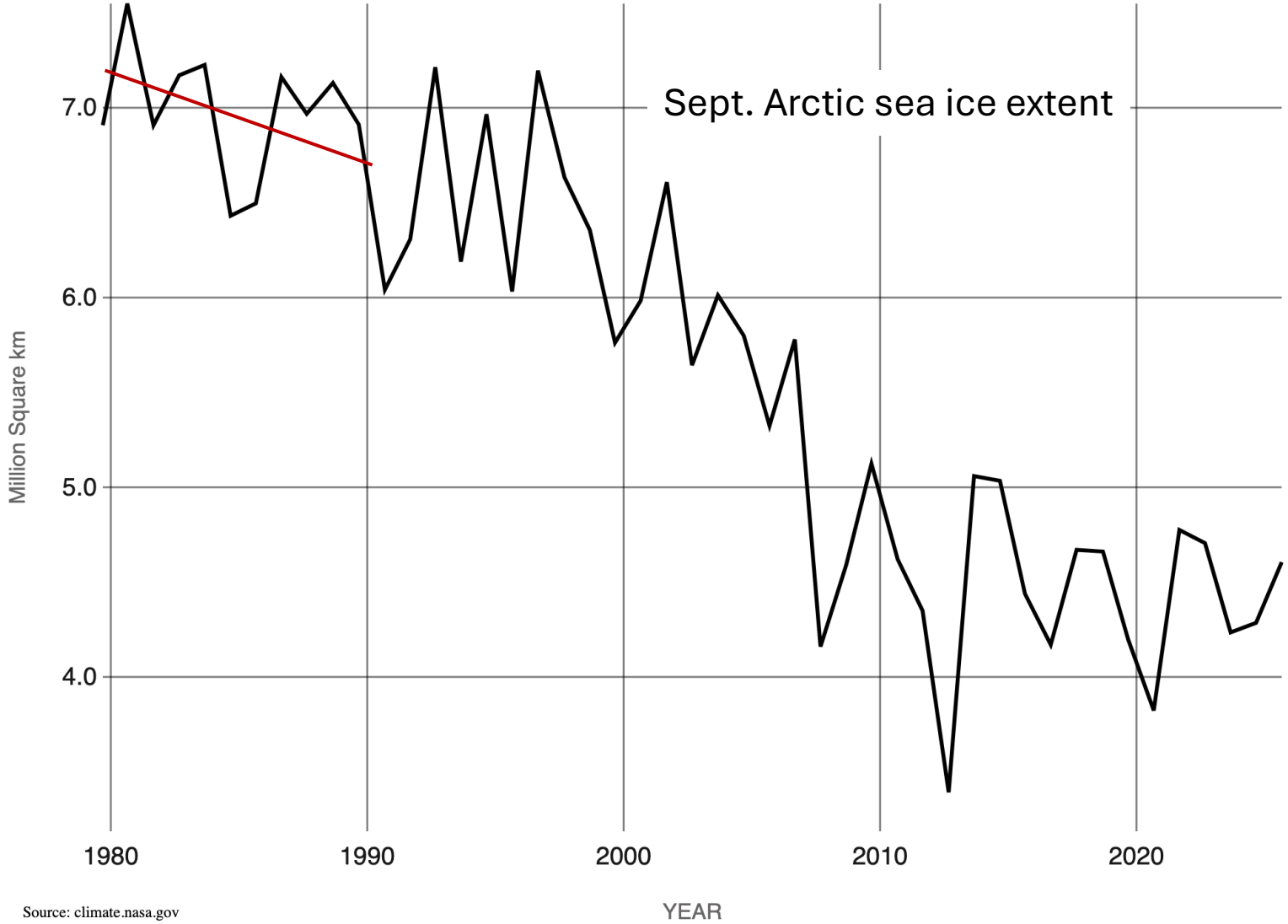
Stephen G. Yeager, Alicia R. Karspeck, Gokhan Danabasoglu

Source: climate.nasa.gov

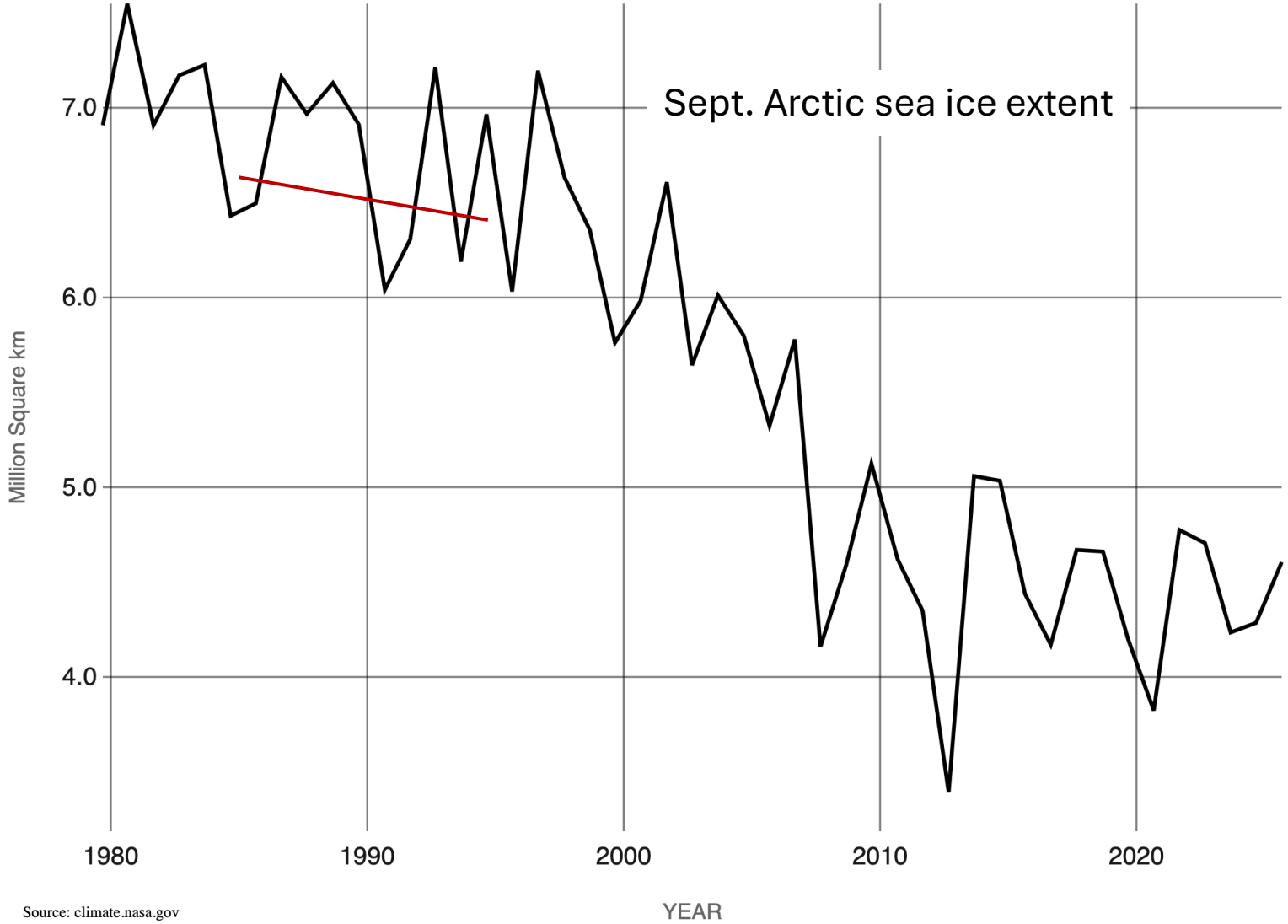
We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.



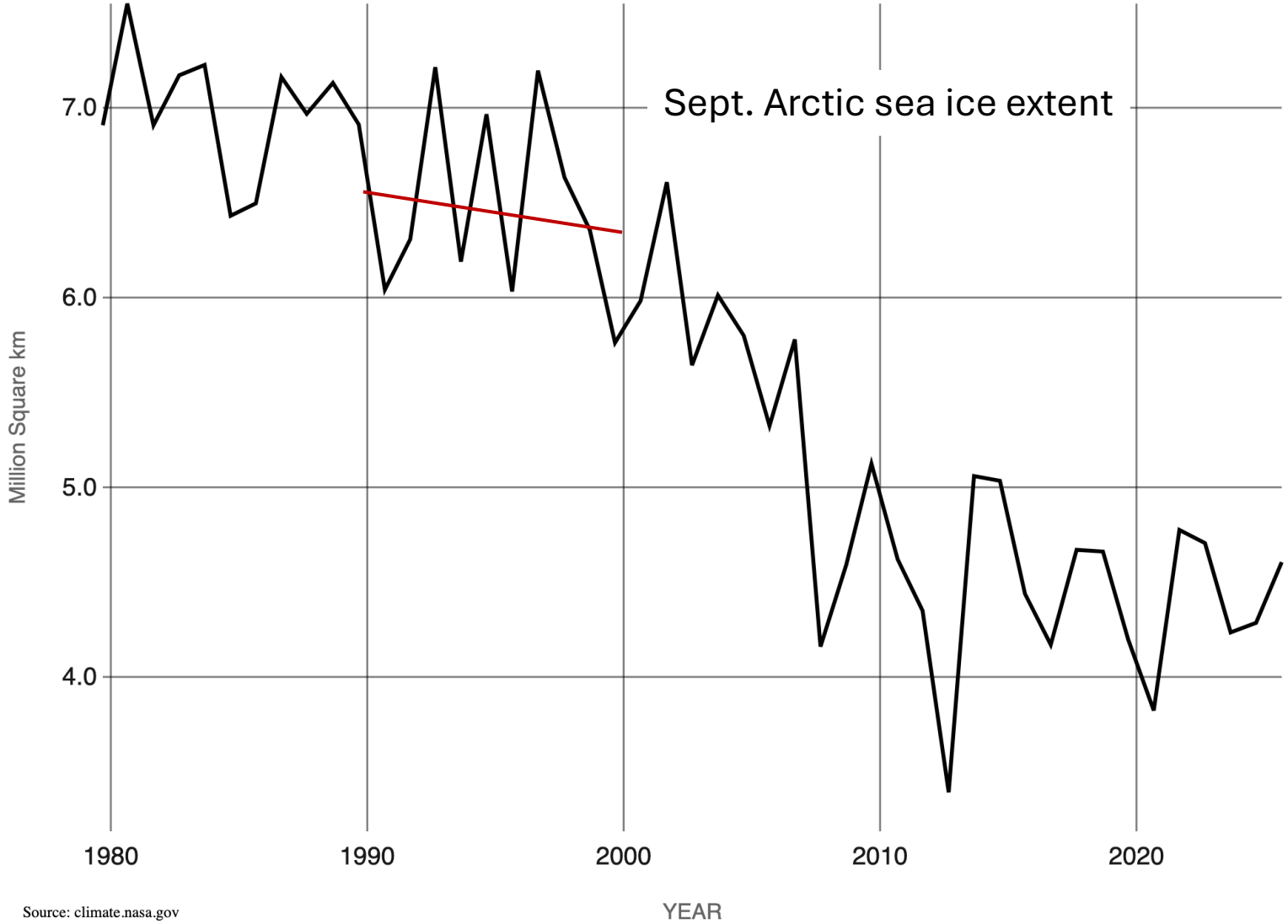
We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.



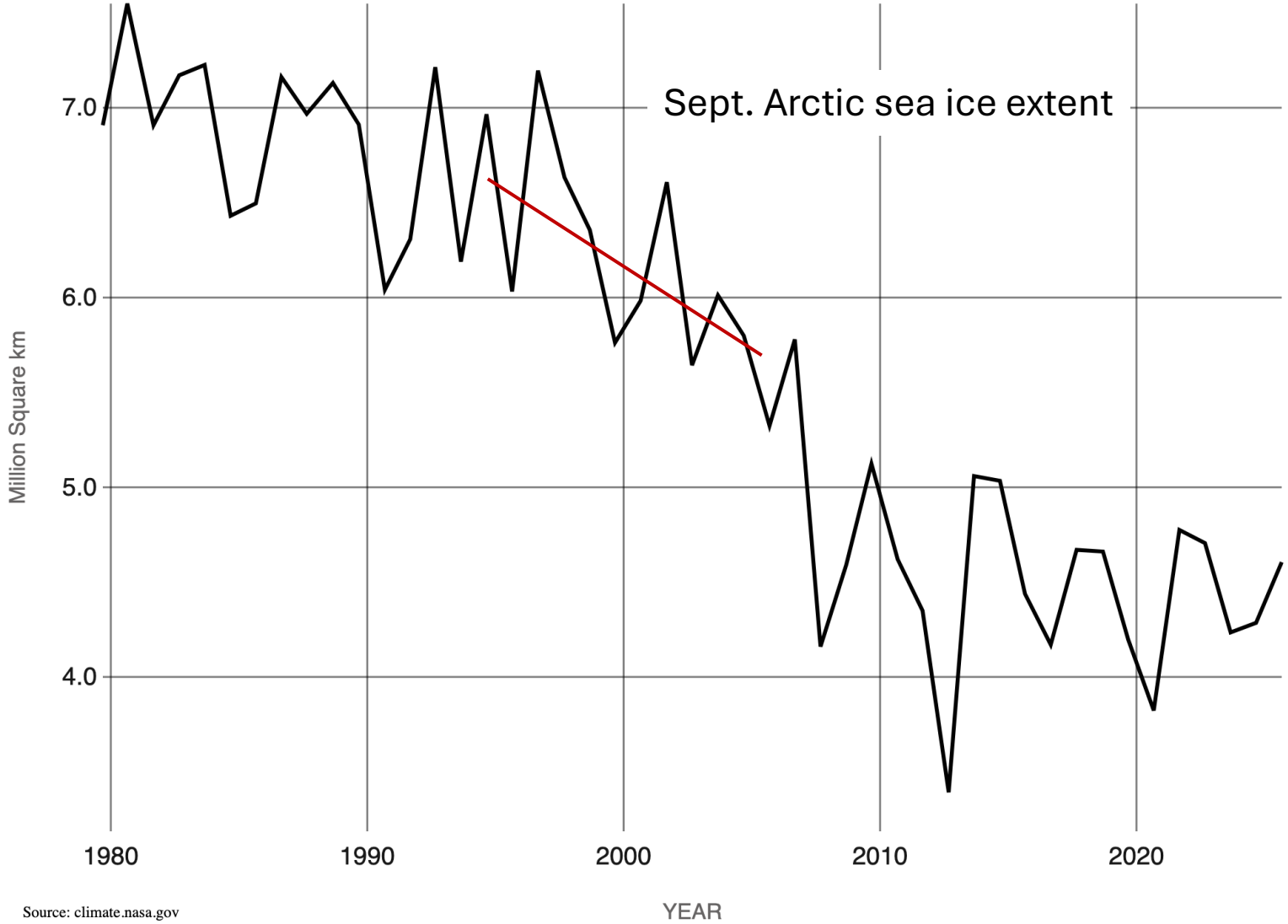
We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.



We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.

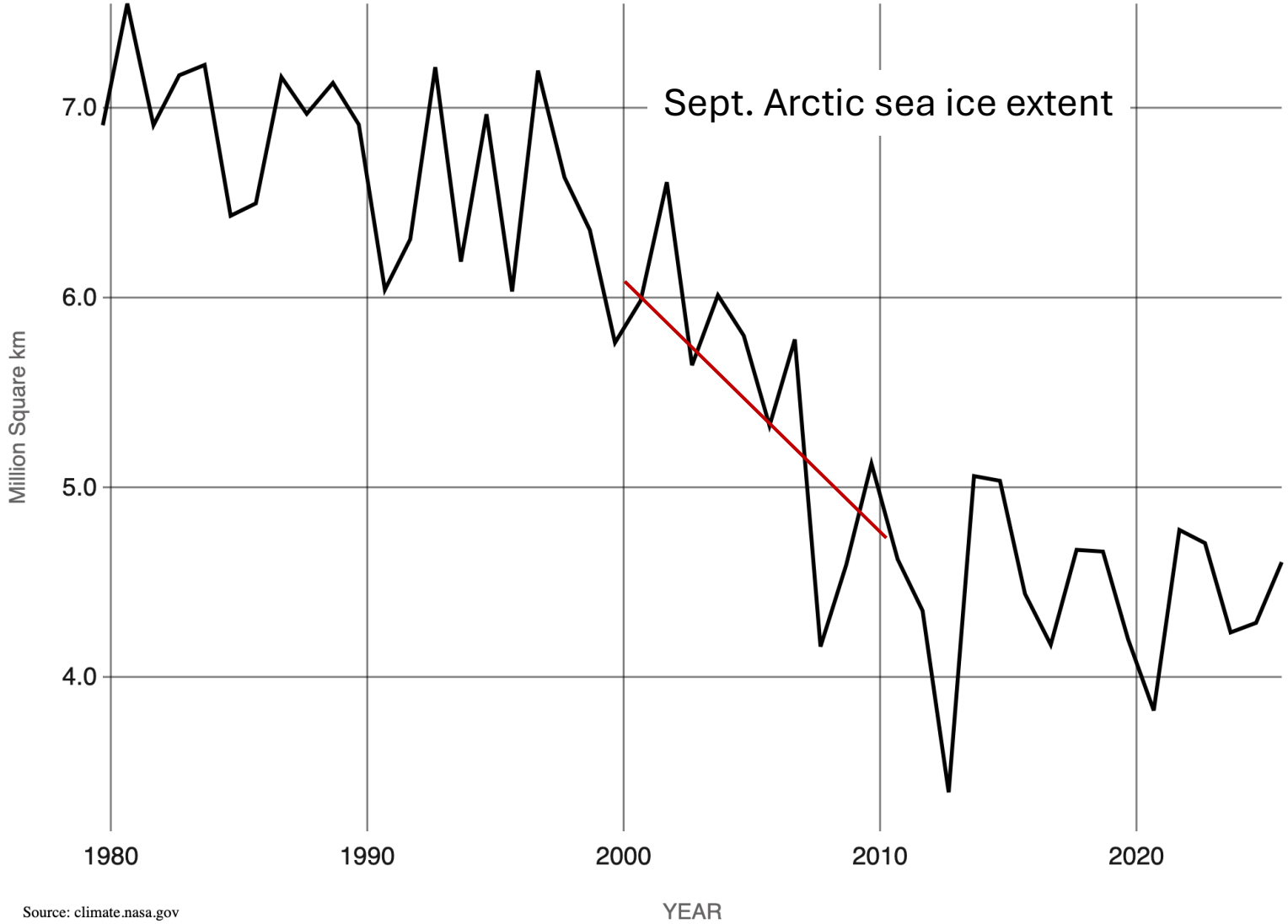


We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.

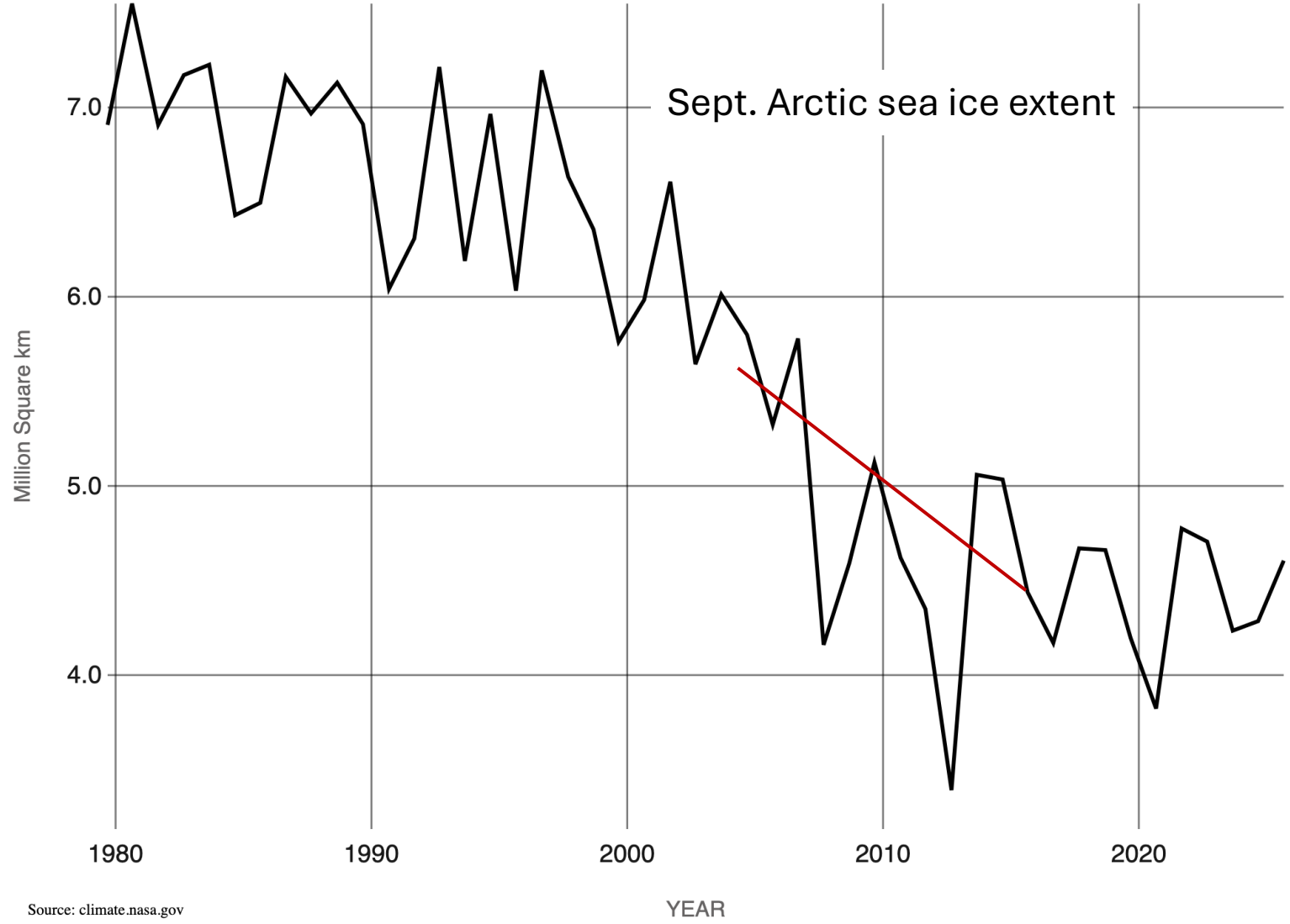


Source: climate.nasa.gov

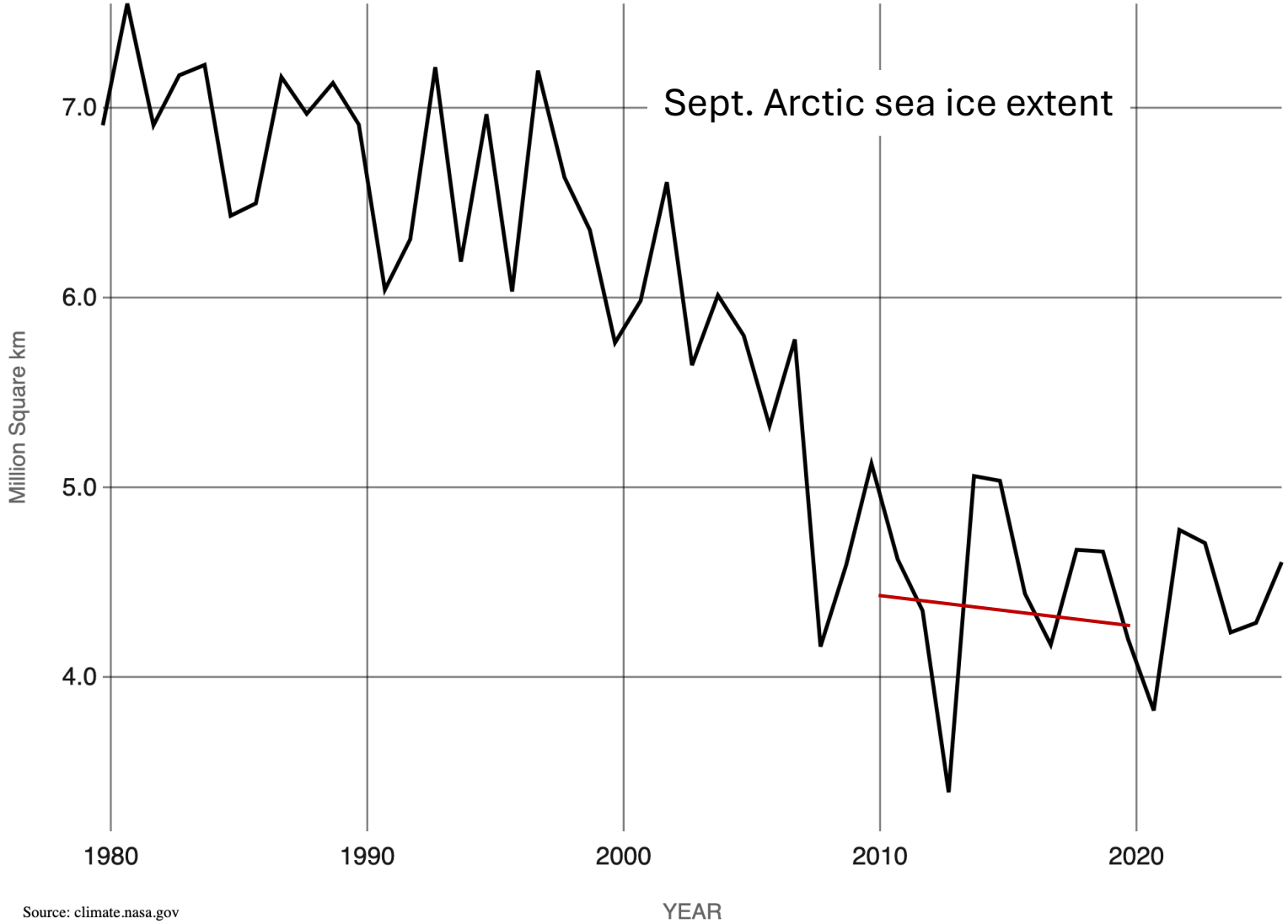
We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.



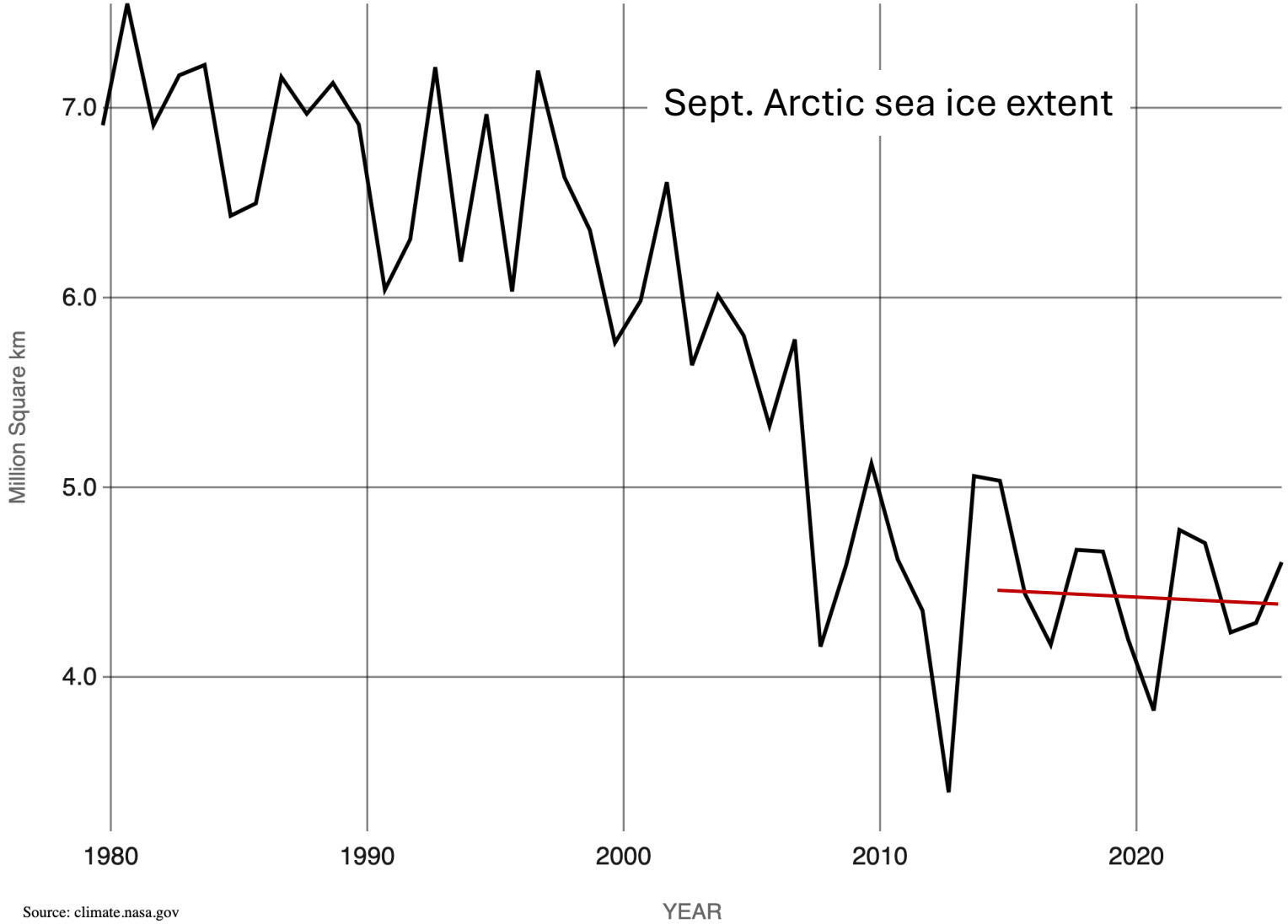
We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.



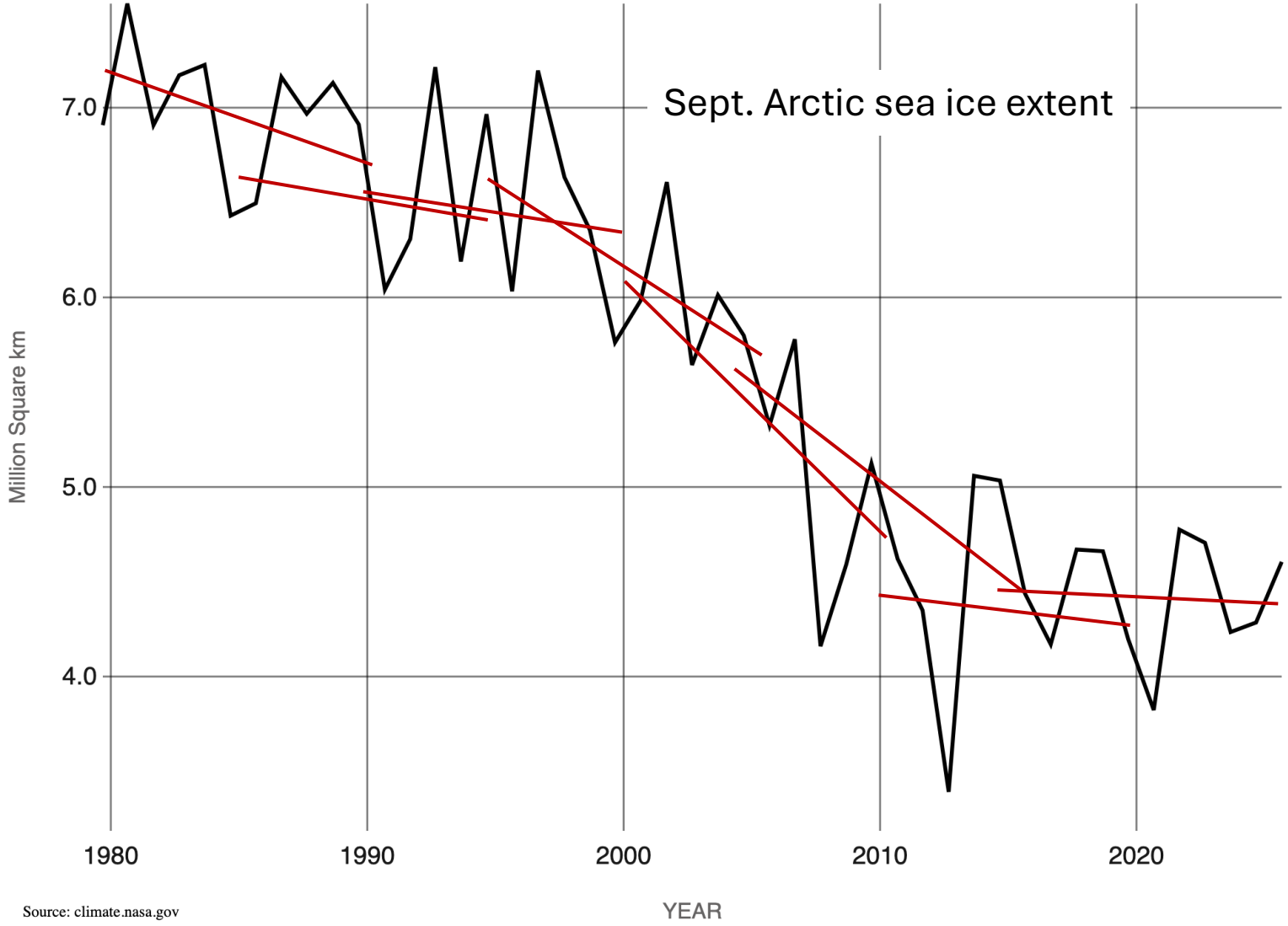
We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.



We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.



We calculate the 10-year linear trend in FOSI, observations, and CESM2-DP.

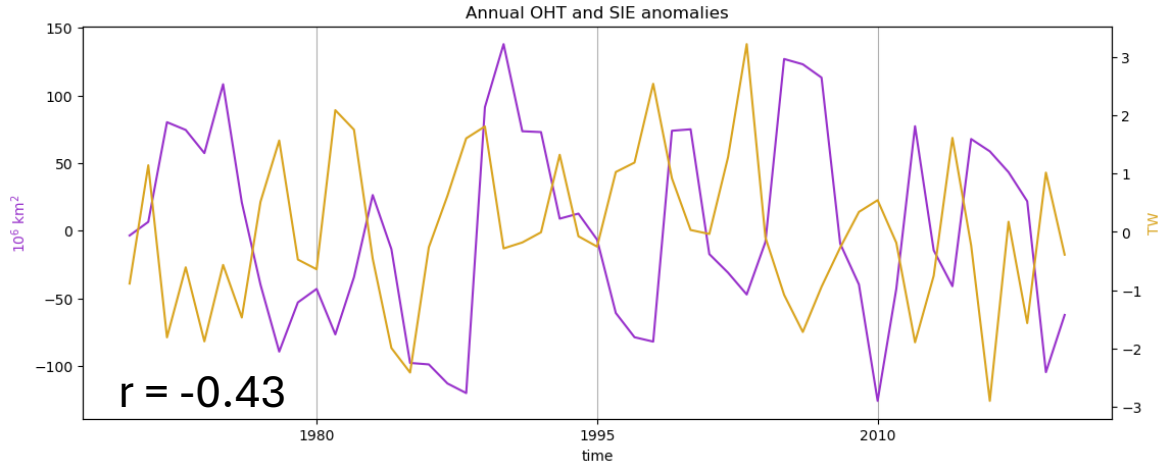


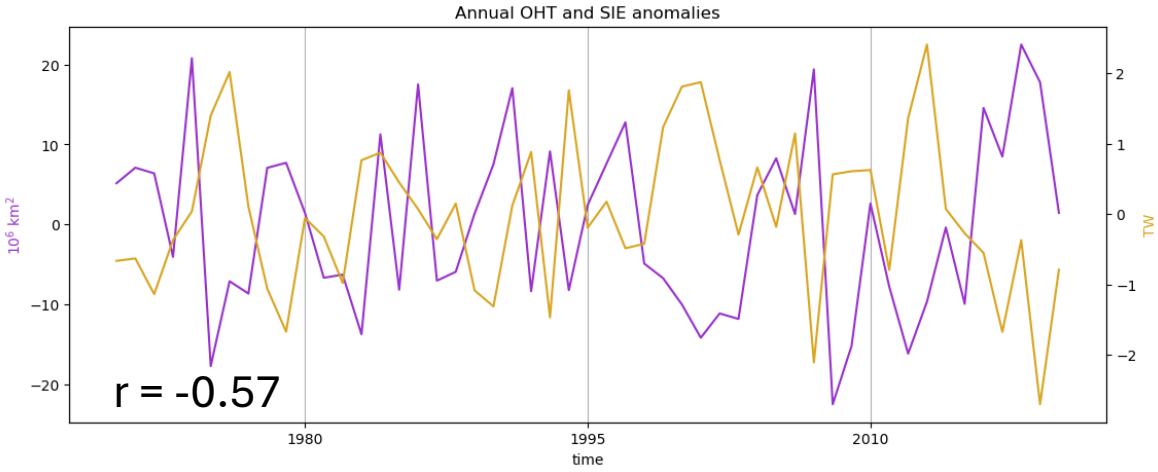
OHT and SIE anomalies and decadal trends are related.

Atlantic

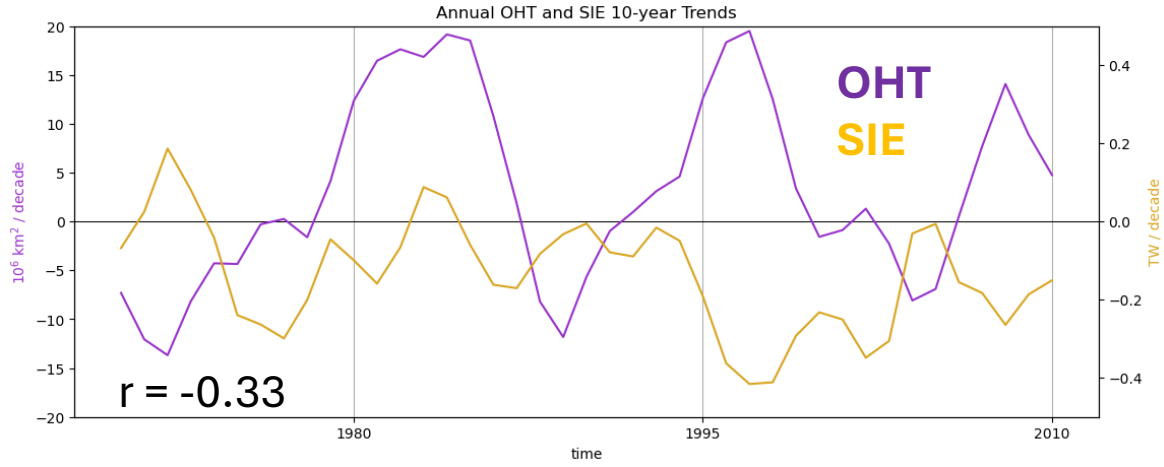
Pacific

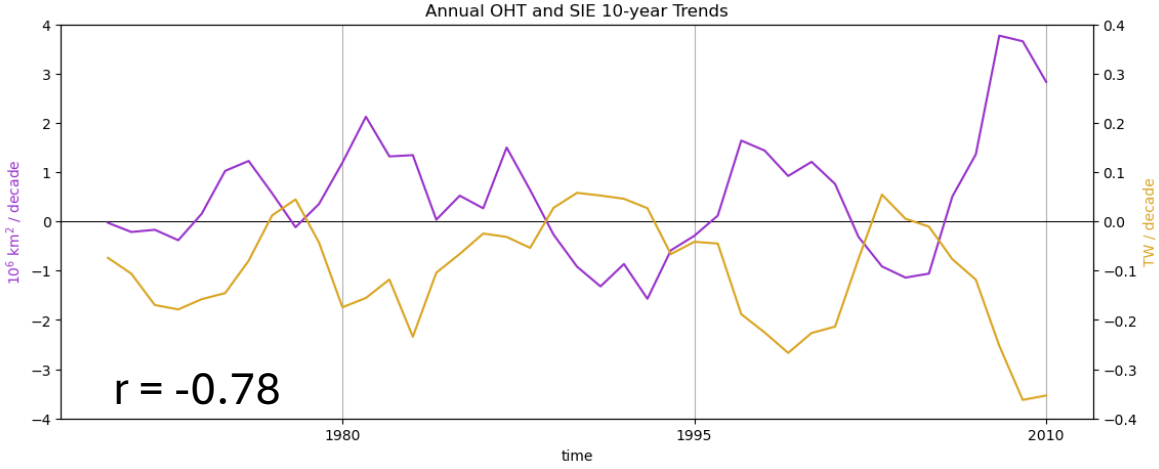
Anomalies



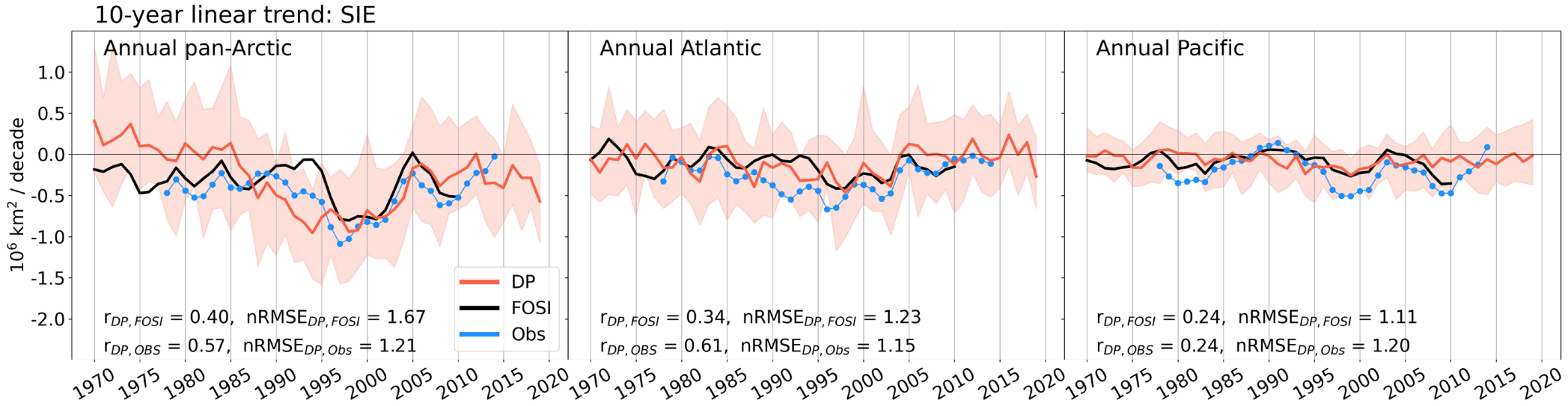


10-year trends



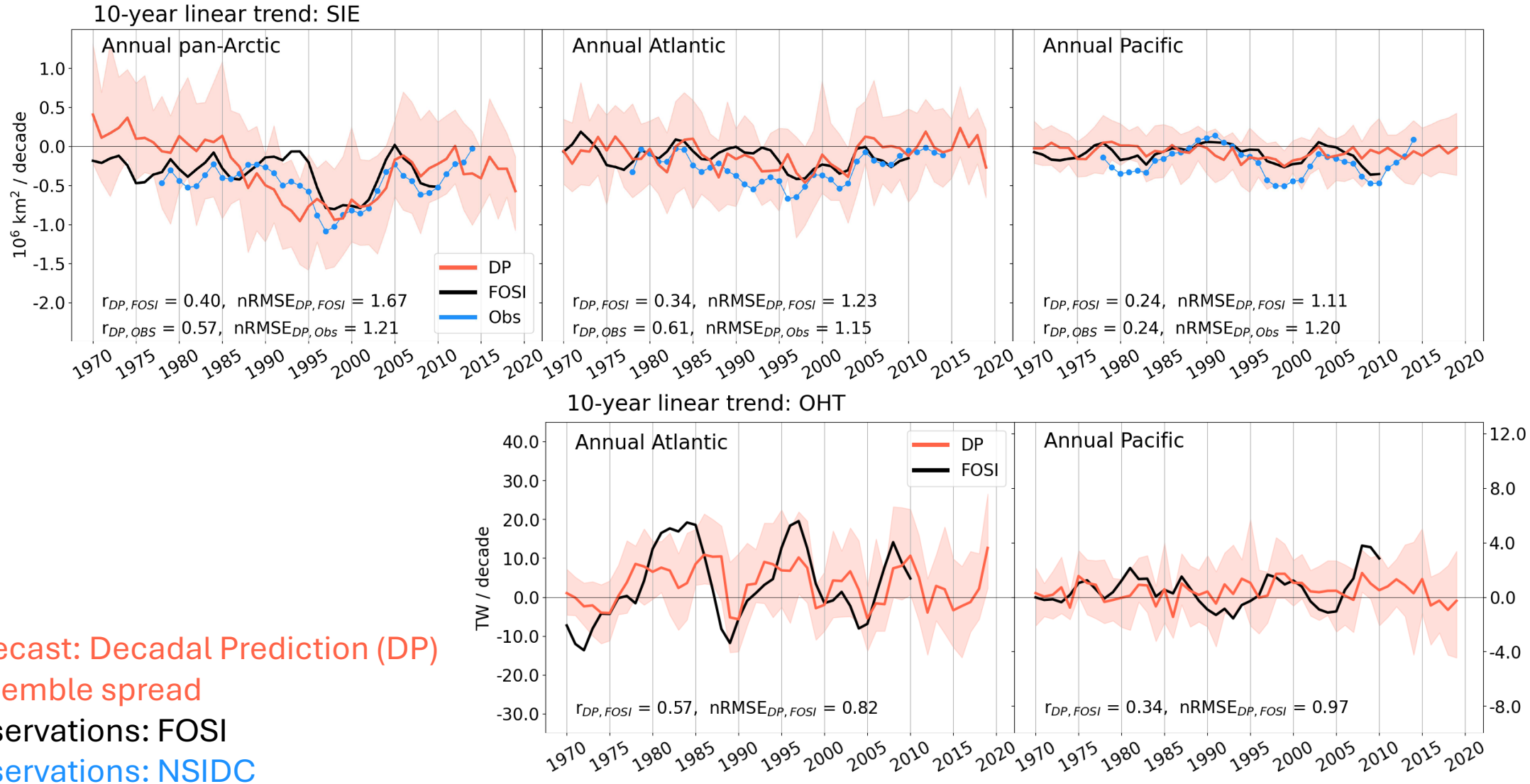


DP skillfully predicts the 10-year linear trend of **annual SIE and OHT**.



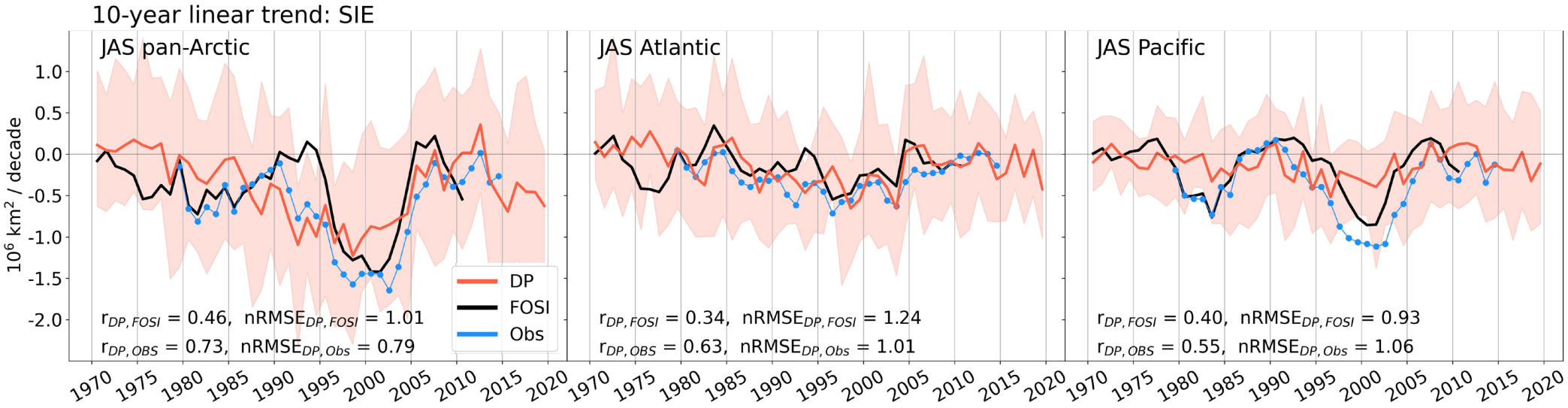
— Forecast: Decadal Prediction (DP)
Ensemble spread
— Observations: FOSI
— Observations: NSIDC

DP skillfully predicts the 10-year linear trend of **annual SIE and OHT**.



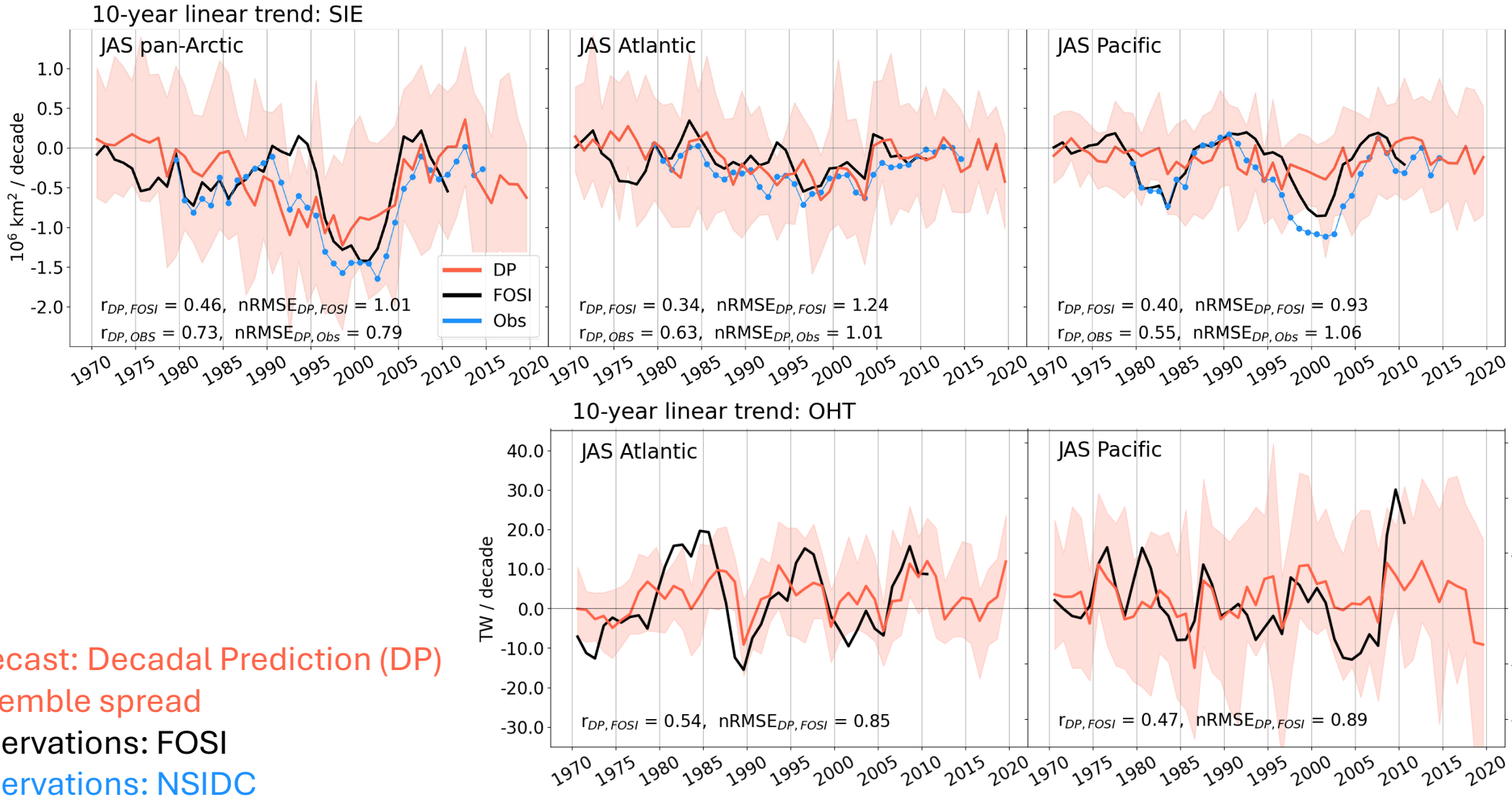
— Forecast: Decadal Prediction (DP)
Ensemble spread
— Observations: FOSI
— Observations: NSIDC

DP skillfully predicts the 10-year linear trend of **JAS SIE and OHT**.



— Forecast: Decadal Prediction (DP)
Ensemble spread
— Observations: FOSI
— Observations: NSIDC

DP skillfully predicts the 10-year linear trend of **JAS SIE and OHT**.



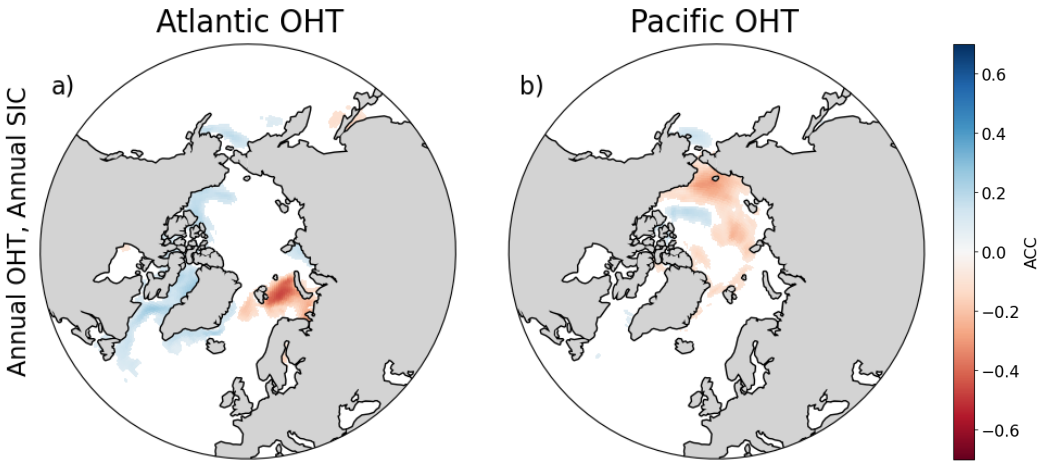
— Forecast: Decadal Prediction (DP)
Ensemble spread
— Observations: FOSI
— Observations: NSIDC

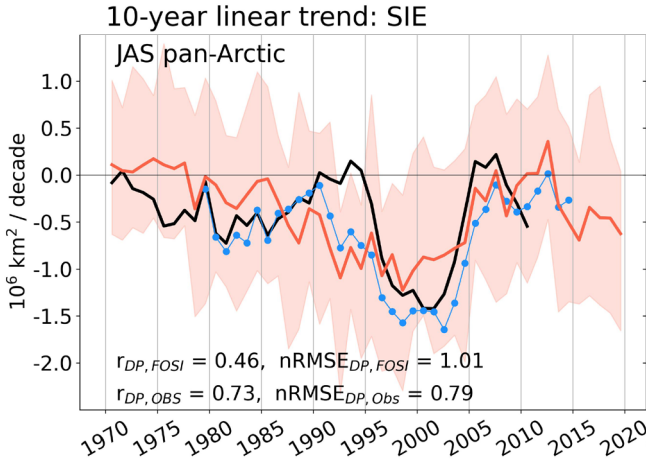
Key Points

1. Atlantic-Arctic and Pacific-Arctic ocean heat transport (OHT) affect sea ice variability and predictability.

2. CESM2-DP skillfully predicts decadal trends of OHT and SIE across regions and seasons.

3. CESM2-DP potentially predicts near-future SIE decline driven by Atlantic OHT.





Manuscript in preparation

Contact: jtcohen@uw.edu