Predicting an acceleration of Arctic sea ice loss

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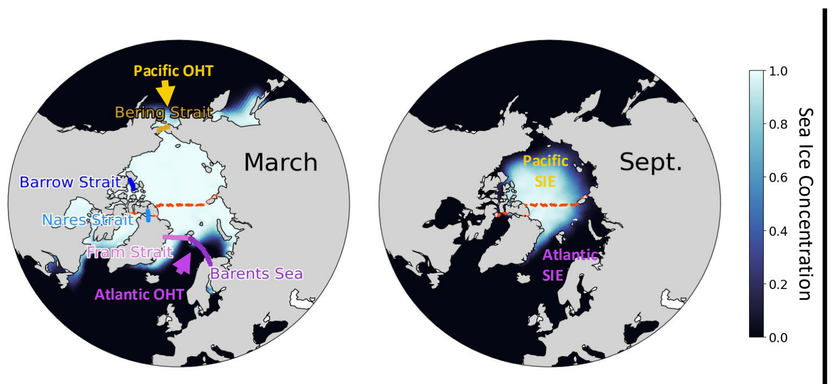
1. Introduction

Arctic sea ice extent (SIE) has declined over the past several decades, but a slowdown in sea ice loss has occurred since 2007. We show that predictions of SIE and short-term SIE trends are skillful, effectively capturing past periods of sea ice loss and the recent pause in sea ice loss. Recent initialized predictions suggest that Arctic sea ice loss may accelerate in the next decade.



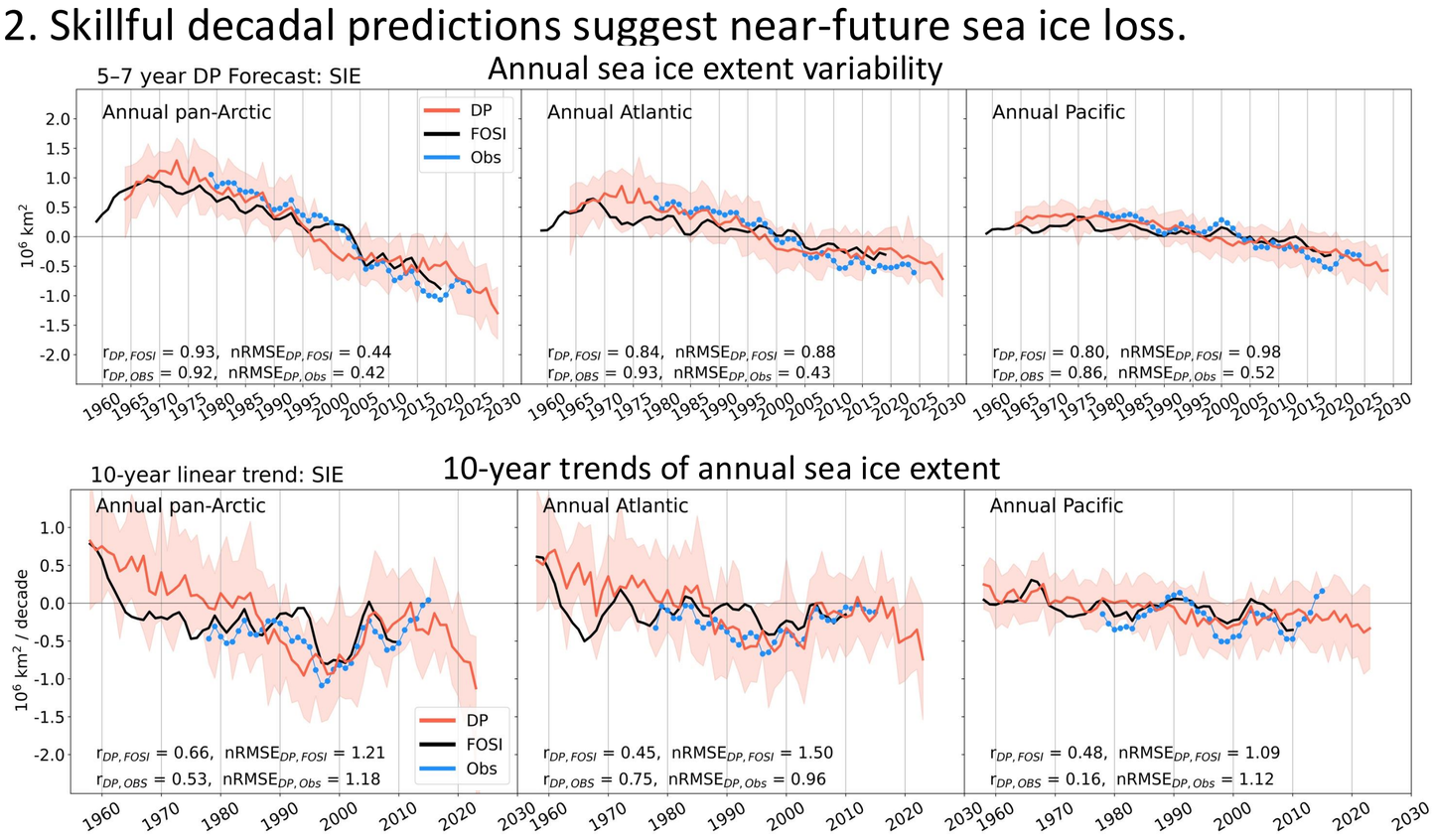
Data

We evaluate prediction skill in the Community Earth System Model Decadal Prediction System (CESM2-DP) against observations and against the initial conditions from FOSI.

CESM2 DP
Initial conditions: Forced Ocean–Sea-Ice (FOSI) simulation
Initialization years: 1958–2023
1 initialization / year (Nov. 1)
122-month forecast (10 years)

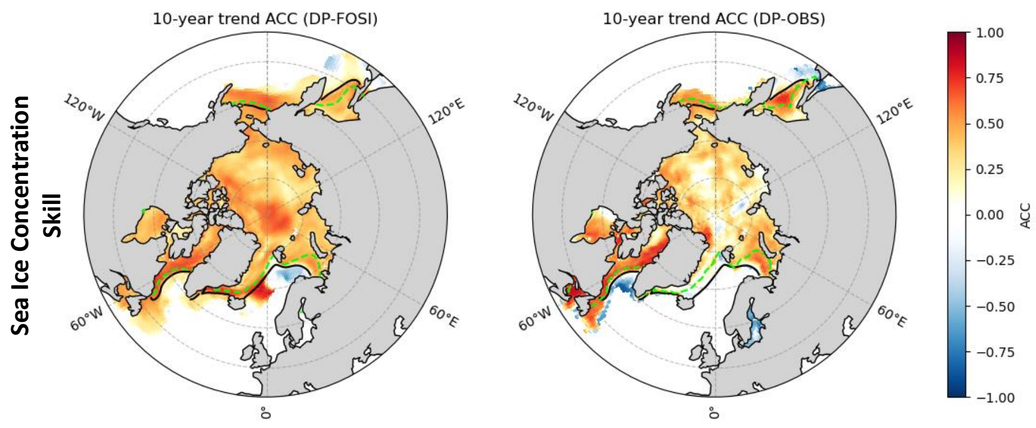
Observations	
Sea ice	NSIDC
SST	OISST
SLP	JRA55
OHT	FOSI only

2. Skillful decadal predictions suggest near-future sea ice loss.



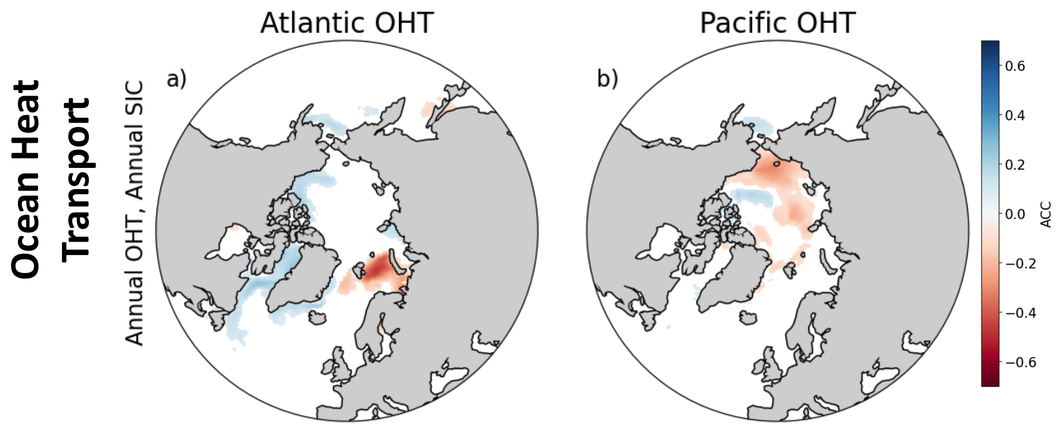
CESM2 predicts decadal variability and trends of sea ice. We compare the observed and modeled SIE and 10-year linear trends in SIC and SIE to predictions in CESM2-DP (left). CESM2-DP successfully predicts annual SIE and decadal trends in SIE across Arctic regions. SIC prediction skill is high across most of the Arctic, despite differences in the climatological sea ice edge in observations, FOSI, and CESM2-DP.

The predicted SIE correctly reproduces the sea ice decline from 1980–2007 and the minimal sea ice loss since 2007. Recent initialized predictions suggest that sea ice decline may resume soon.

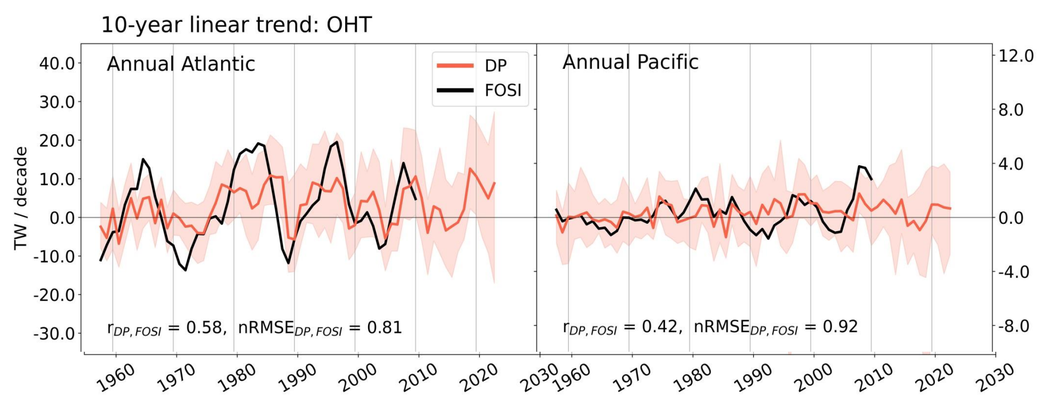


3. Drivers: ocean heat transport (OHT), sea surface temperature (SST), sea level pressure (PSL)

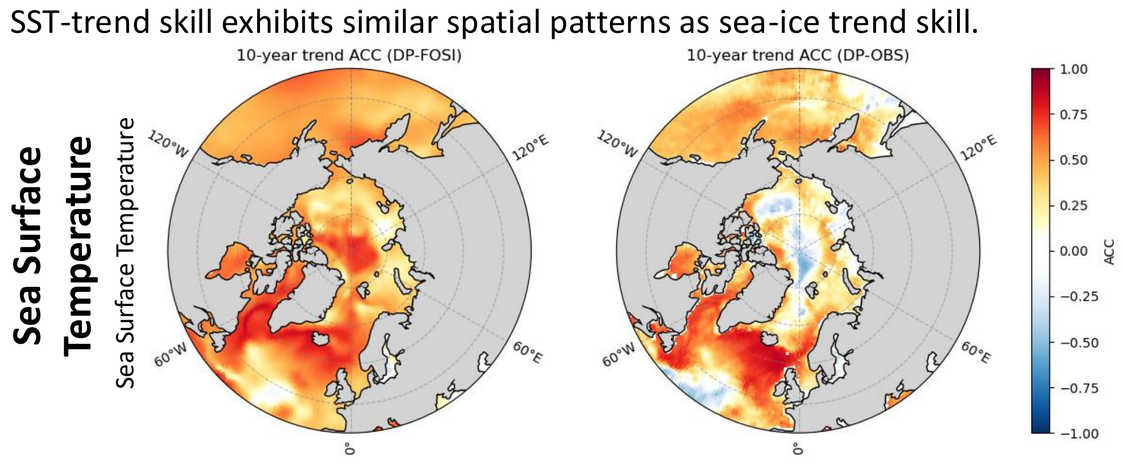
In FOSI, SIC anomalies are related to OHT anomalies. Atlantic OHT anomalies are associated with sea ice loss in the Barents Sea, while Pacific OHT anomalies are associated with sea ice loss in the Chukchi Sea and the East Siberian Sea.



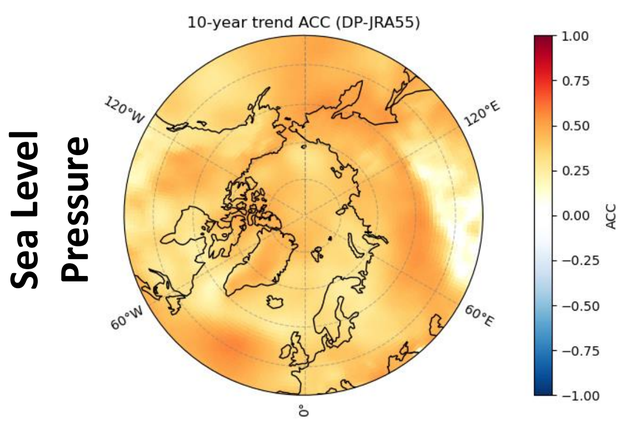
CESM2-DP demonstrates skill in predicting decadal trends of both Atlantic and Pacific OHT. Decadal trends in Atlantic OHT are increasing in unison with Atlantic SIE trends.



Ocean temperatures drive the variability of OHT into the Arctic. CESM2-DP skillfully predicts decadal trends of SST as well, especially in the Atlantic sector. SST-trend skill exhibits similar spatial patterns as sea-ice trend skill.



Sea level pressure patterns (i.e., North Atlantic Oscillation, Arctic Oscillation, Dipole Anomaly) drive winds and sea ice growth/decay in the Arctic. Predictive skill for PSL is weak.

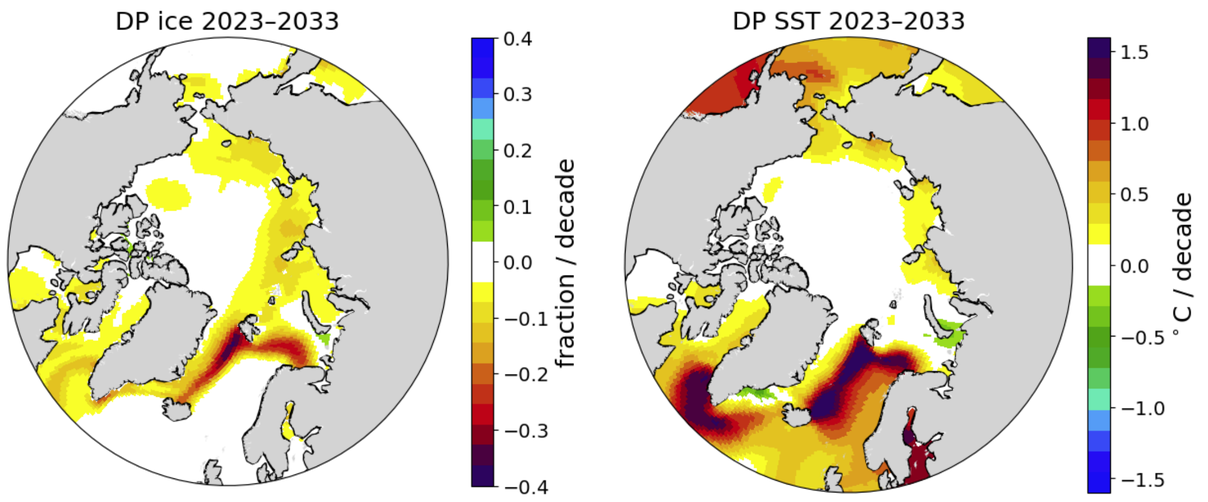


4. Near-future Arctic conditions: decreasing SIC, increasing SST

Predictions initialized on November 1, 2023 show strongly declining Arctic sea ice and warming sea surface temperatures in the Bering Sea, the Barents Sea, and the Labrador Sea.

Arctic SIE is predicted to decline at the fastest rate predicted in CESM2-DP, driven mostly by declining sea ice in the Atlantic region (Sec. 2). Warm ocean temperatures (right) and increasing Atlantic OHT (Sec. 2) drive the predicted SIE decline.

Ongoing work explores predictions of atmospheric modes of variability for the next decade.



Conclusions

- CESM2 demonstrates significant predictive skill for sea ice, ocean heat transport, and sea surface temperature on decadal timescales.
- Forecasts initialized in 2023 predict sea ice decline coinciding with warming SSTs and increasing ocean heat transport.
- Atmospheric drivers (i.e., Dipole Anomaly) may play a role in upcoming sea ice loss, but SLP exhibits weak predictive skill.

Acknowledgements

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