Sources of Predictability in Seasonal Forecasts of September Arctic Sea Ice

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

1. University of Washington School of Oceanography
2. National Center for Atmospheric Research

CAMAS Workshop

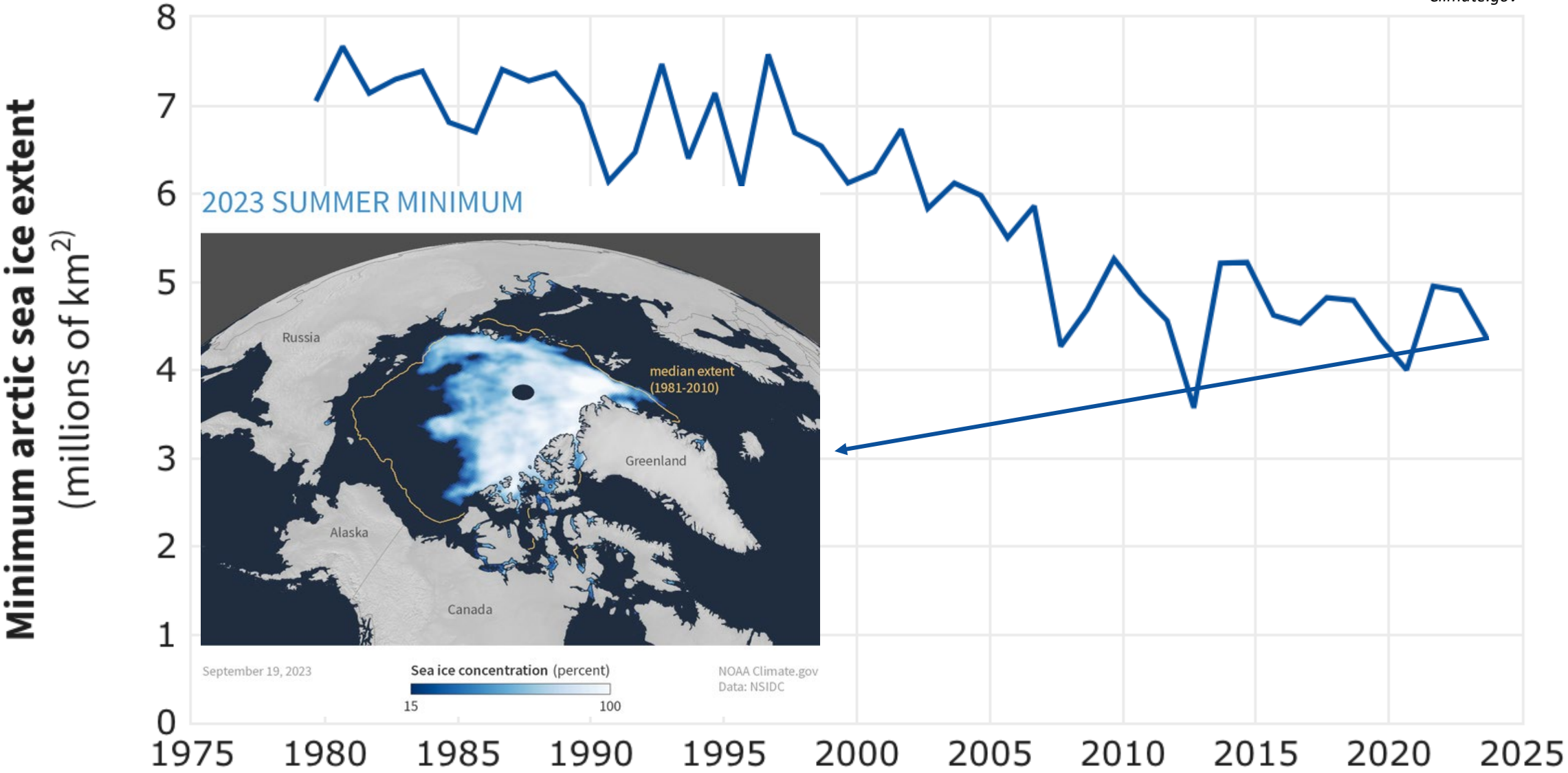
April 17, 2025

CAMAS

Consortium for the Advancement of Marine Arctic Science

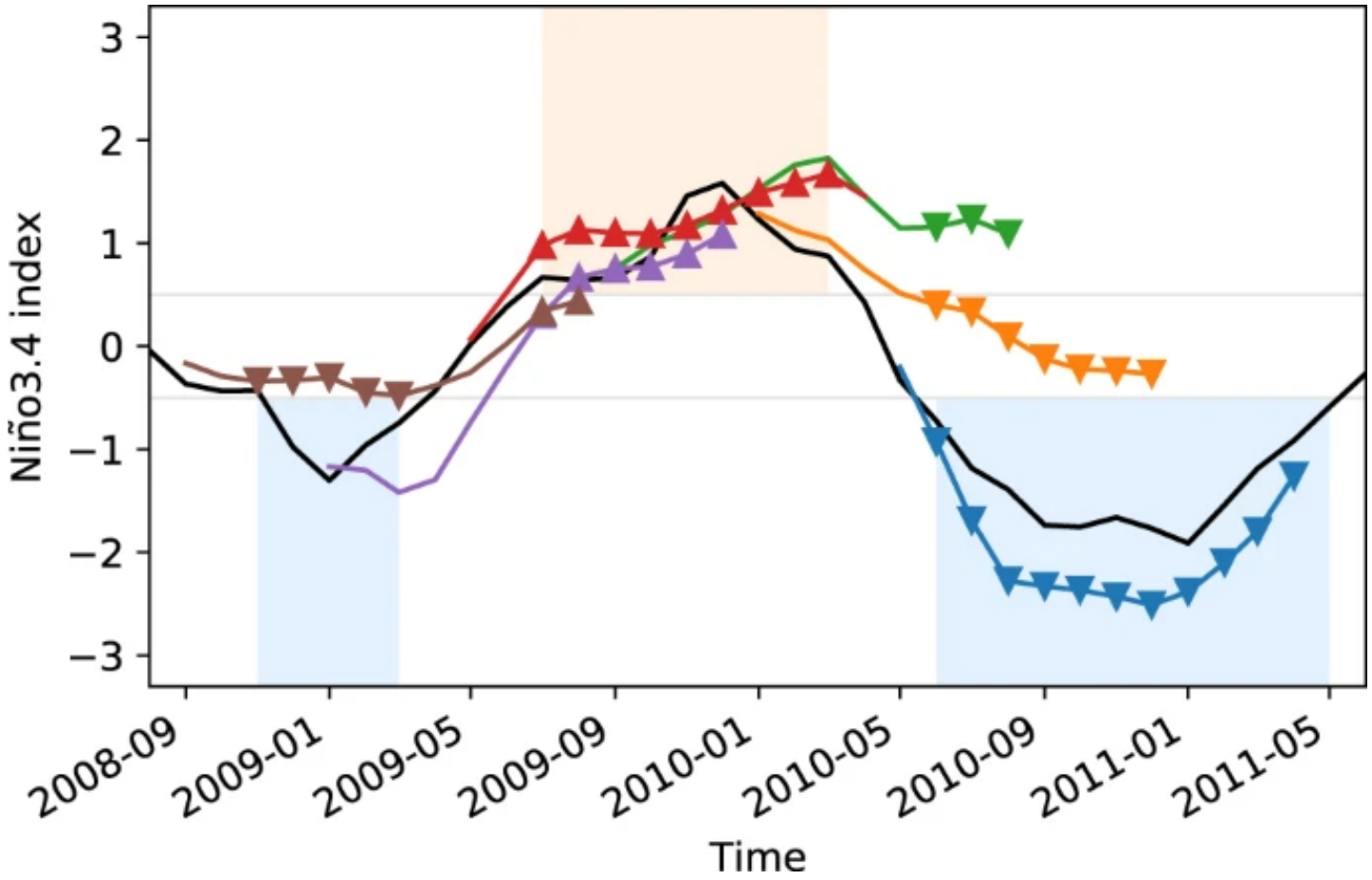
Arctic sea ice decline highlights the need for accurate seasonal predictions.

Climate.gov



The CESM2 Seasonal-to-Multiyear Large Ensemble (SMYLE)

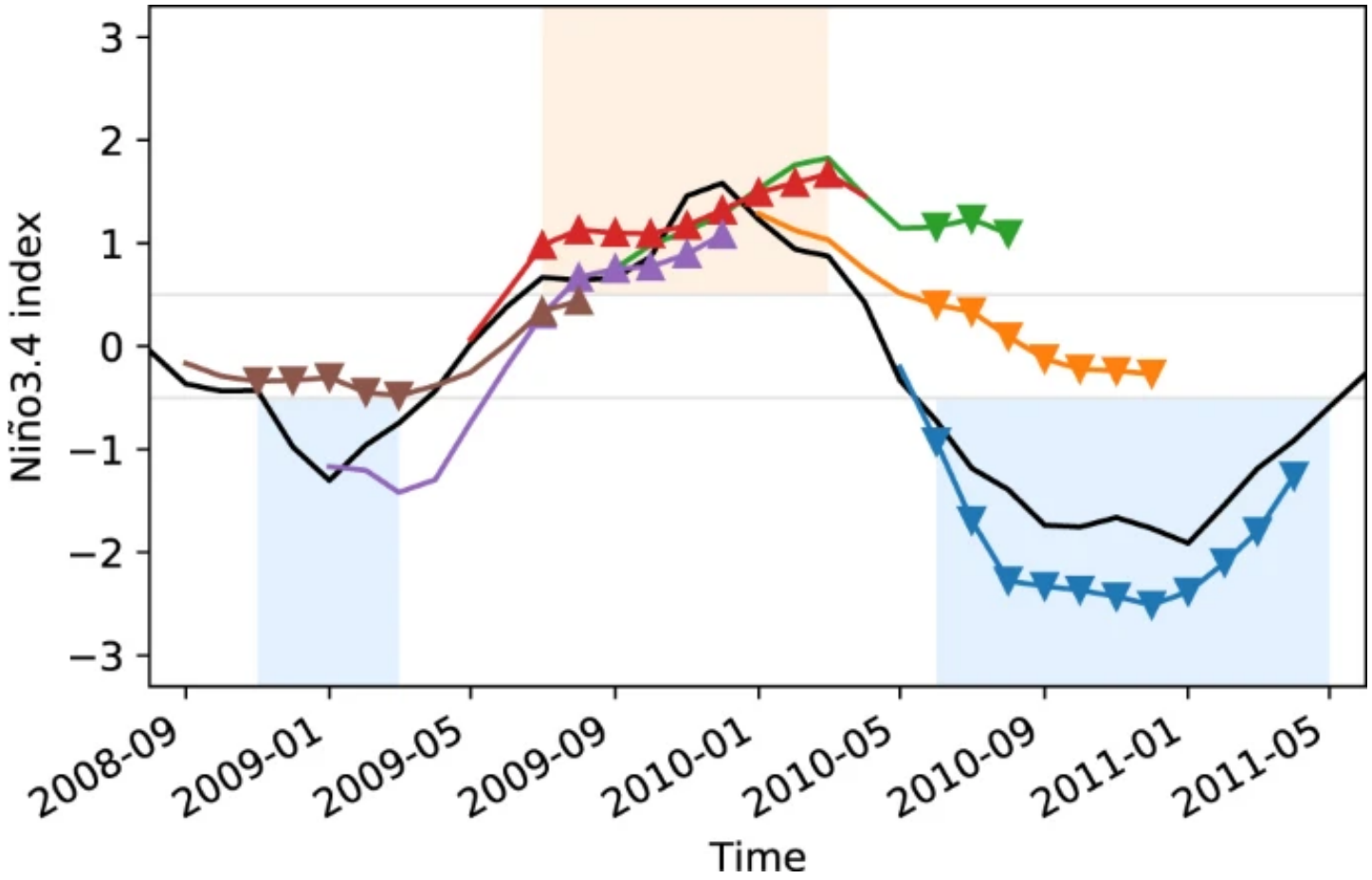
- Initial conditions: forced ocean – sea-ice (FOSI) model



Risbey et al., 2021

The CESM2 Seasonal-to-Multiyear Large Ensemble (SMYLE)

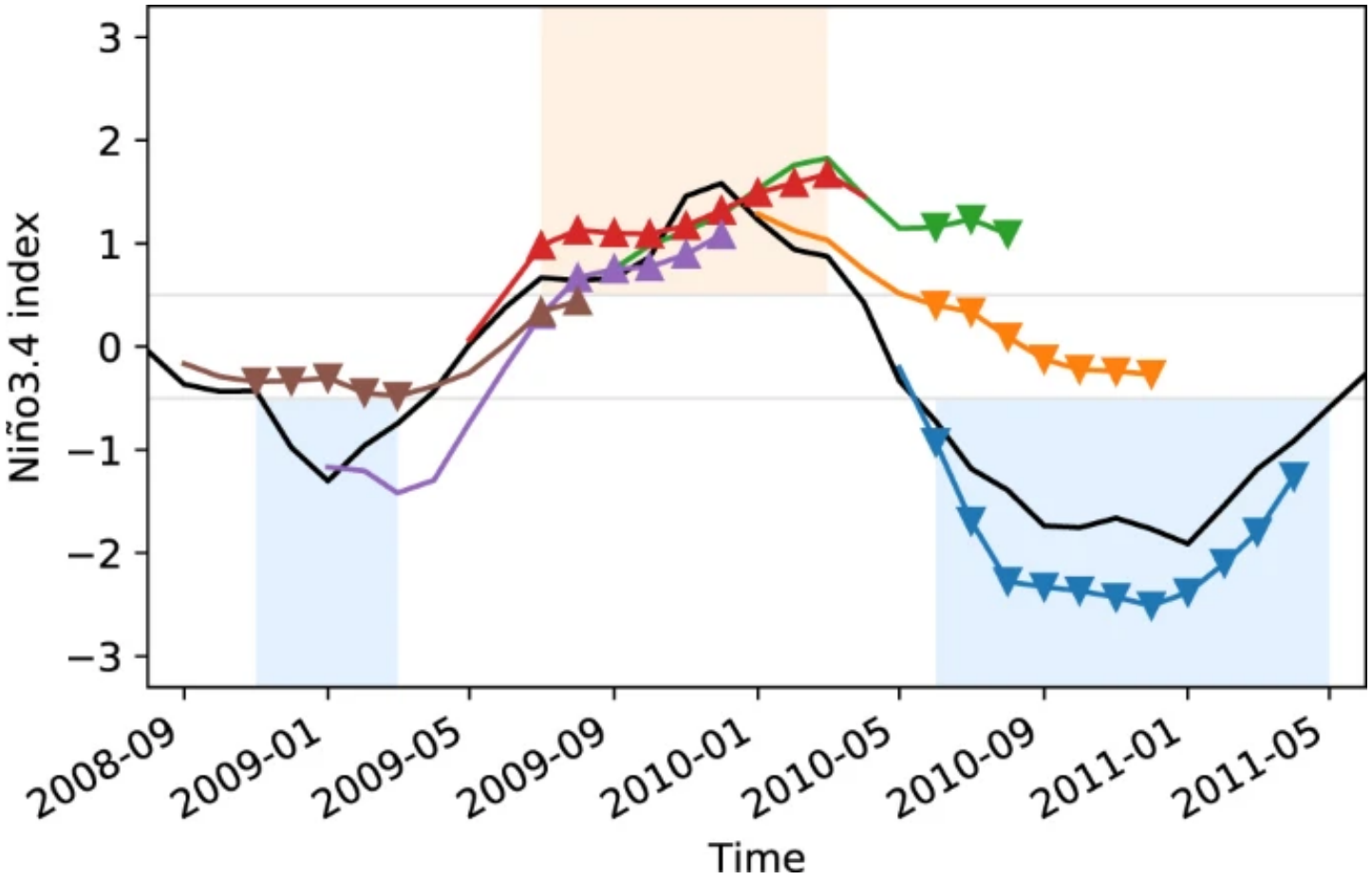
- Initial conditions: forced ocean – sea-ice (FOSI) model
- Climate model: Community Earth Systems Model (CESM2)



Risbey et al., 2021

The CESM2 Seasonal-to-Multiyear Large Ensemble (SMYLE)

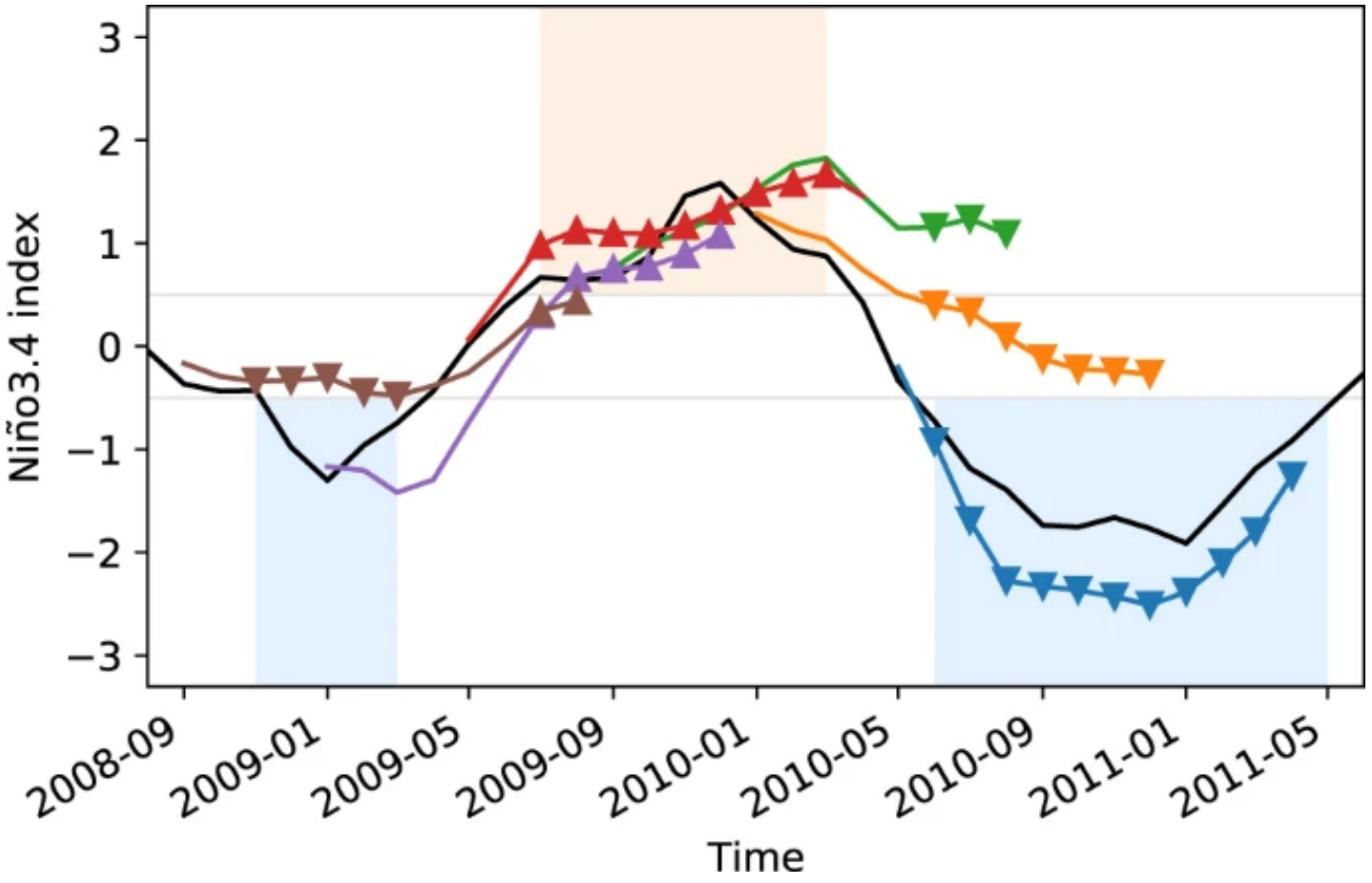
- Initial conditions: forced ocean – sea-ice (FOSI) model
- Climate model: Community Earth Systems Model (CESM2)
- **24-month forecasts** initialized quarterly with **20 ensemble members**



Risbey et al., 2021

The CESM2 Seasonal-to-Multiyear Large Ensemble (SMYLE)

- Initial conditions: forced ocean – sea-ice (FOSI) model
- Climate model: Community Earth Systems Model (CESM2)
- **24-month forecasts** initialized quarterly with **20 ensemble members**
- I compare sea ice concentration to FOSI and observations from NSIDC.



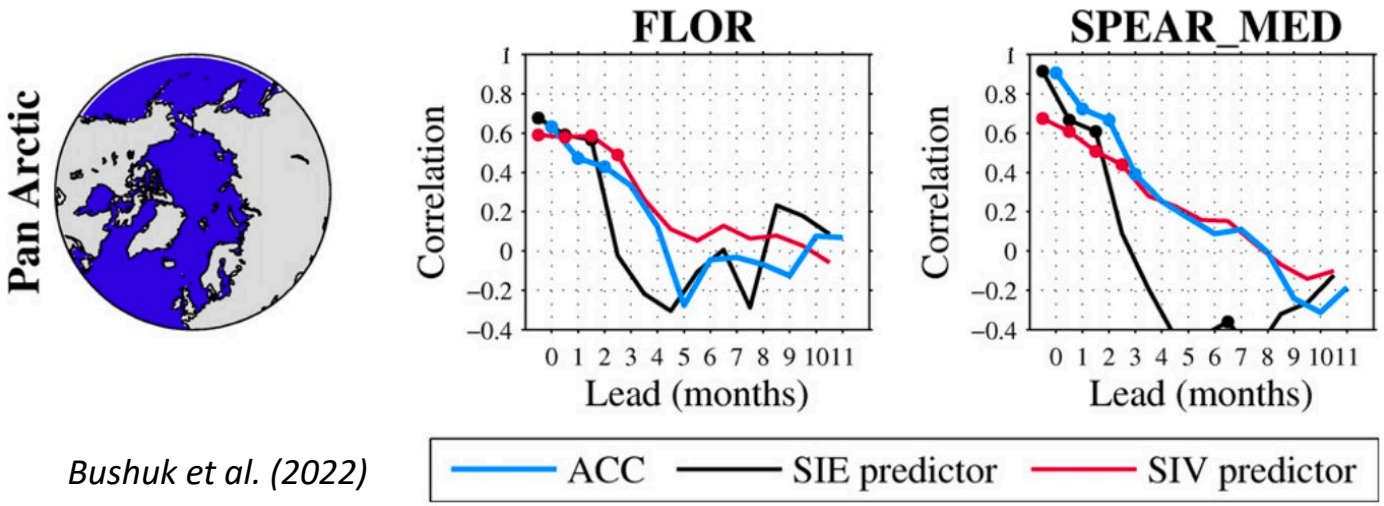
Risbey et al., 2021

Key Questions

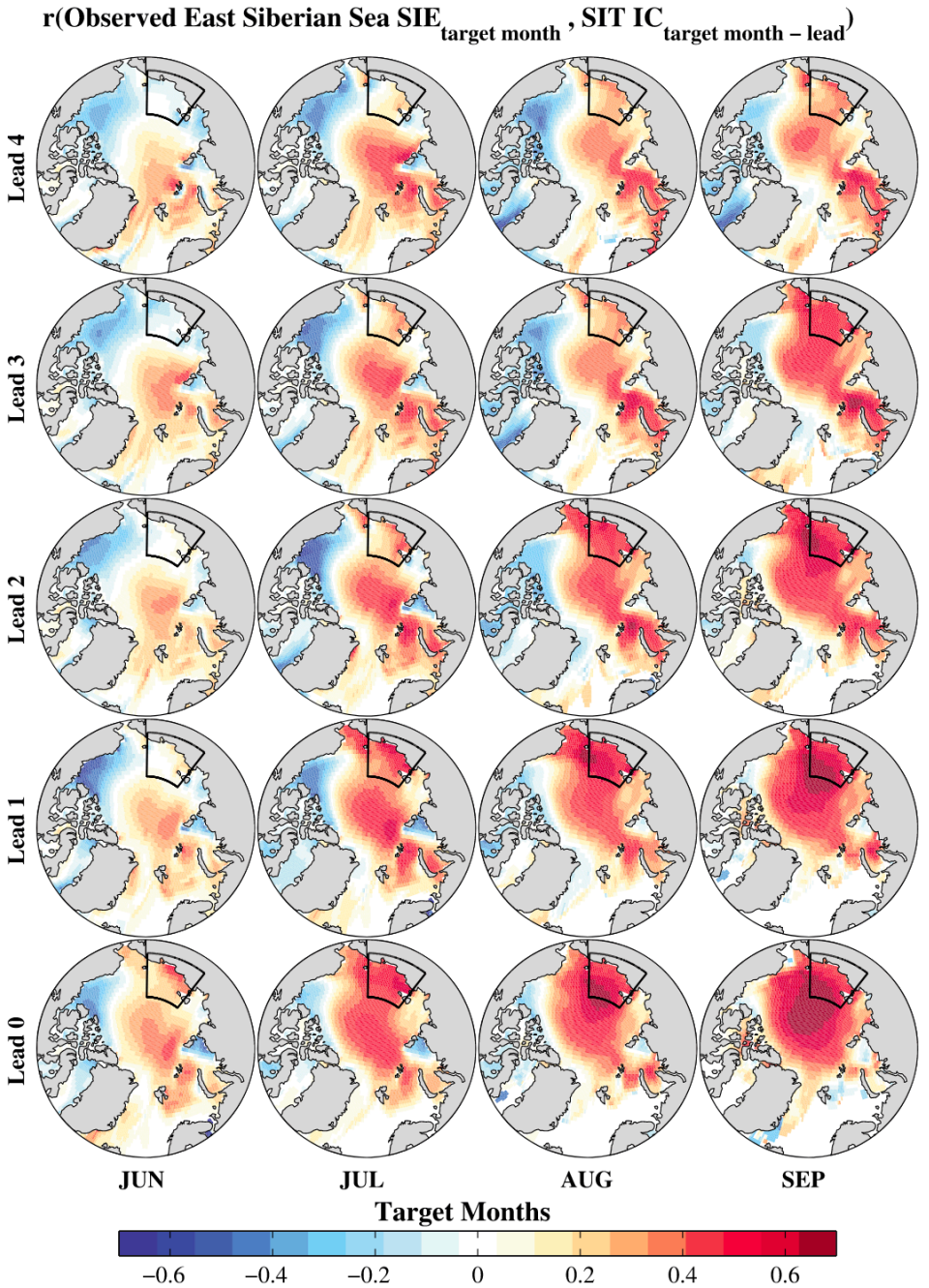
1. What are skillful predictors of regional and pan-Arctic sea ice extent?
2. How do predictions of Atlantic and Pacific sea ice extent differ?
3. Can we use skillful predictors to improve seasonal predictions?

Previously identified sources of predictability:

sea ice thickness and sea ice volume



Bushuk et al. (2022)



Bushuk et al. (2017)

Pan-Arctic vs. Atlantic vs. Pacific

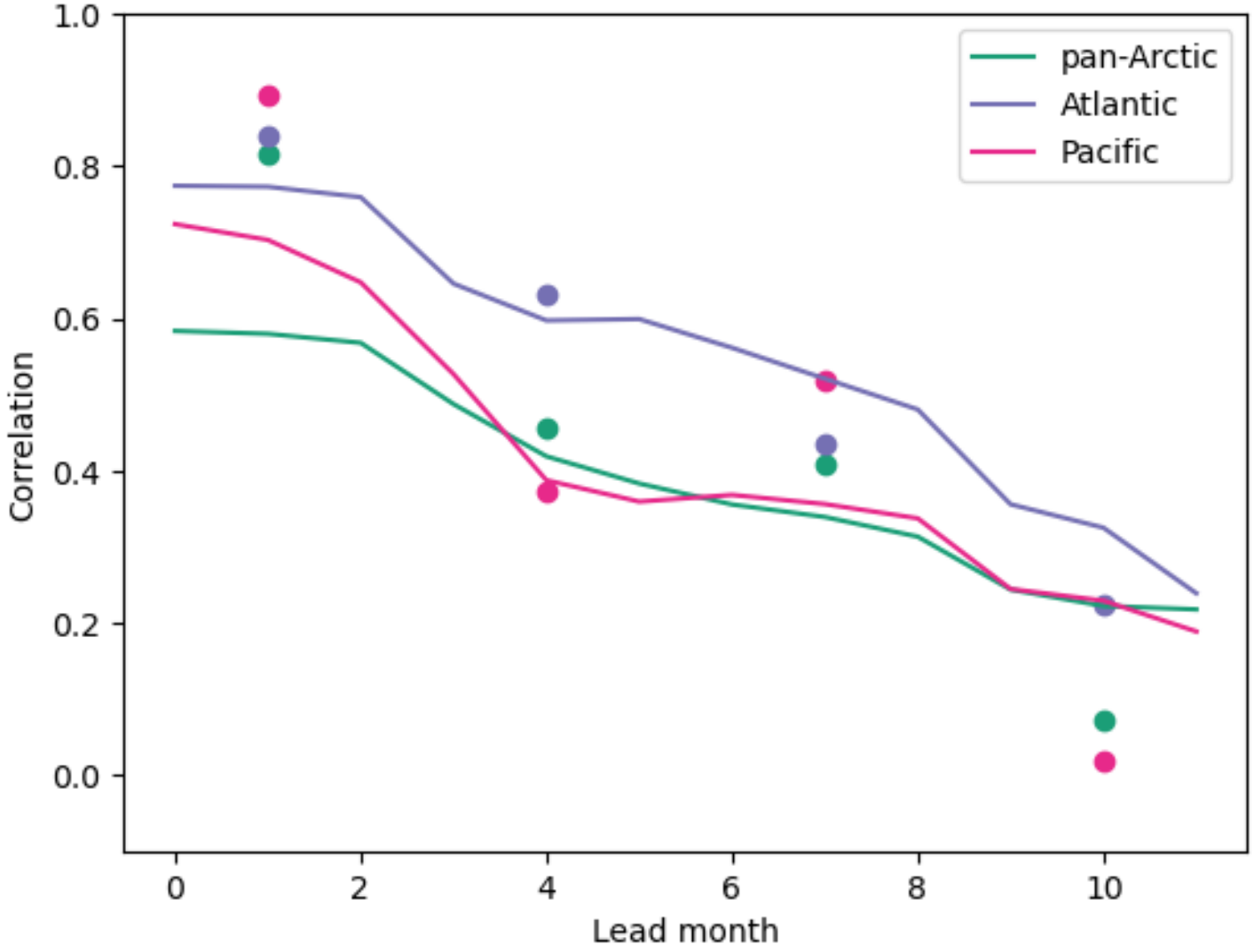
- Pacific and Atlantic regions represent about 1/4 of the pan-Arctic SIE each

- SIE/SIV anomalies are calculated relative to a 10-year rolling mean

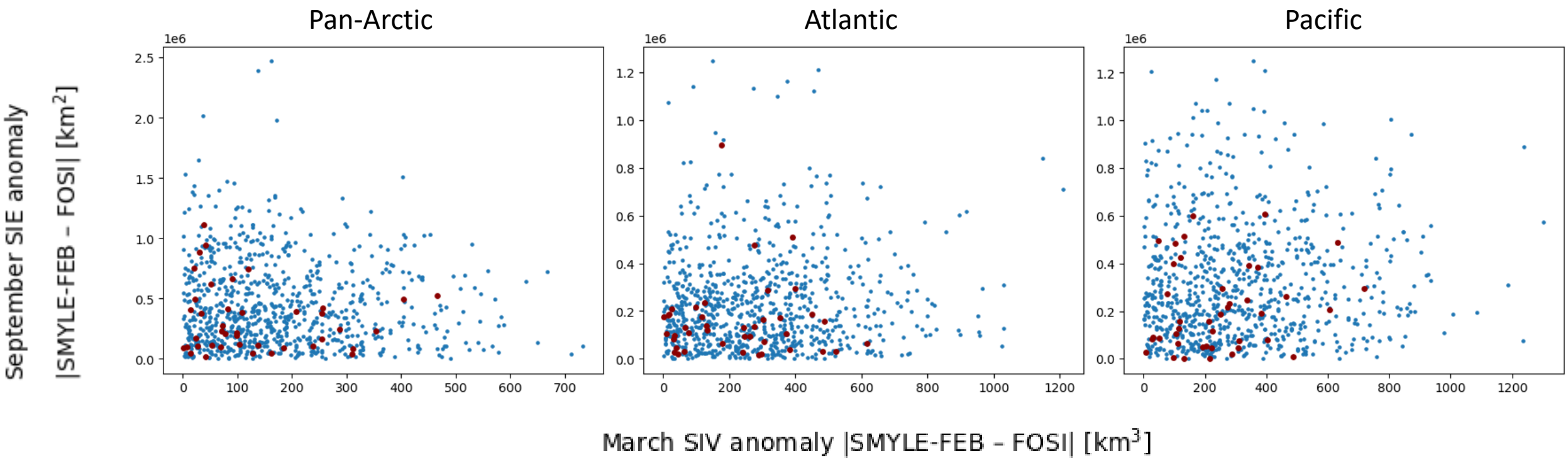
Sea ice volume serves as the main source of predictability.

Lines: SIV predictor

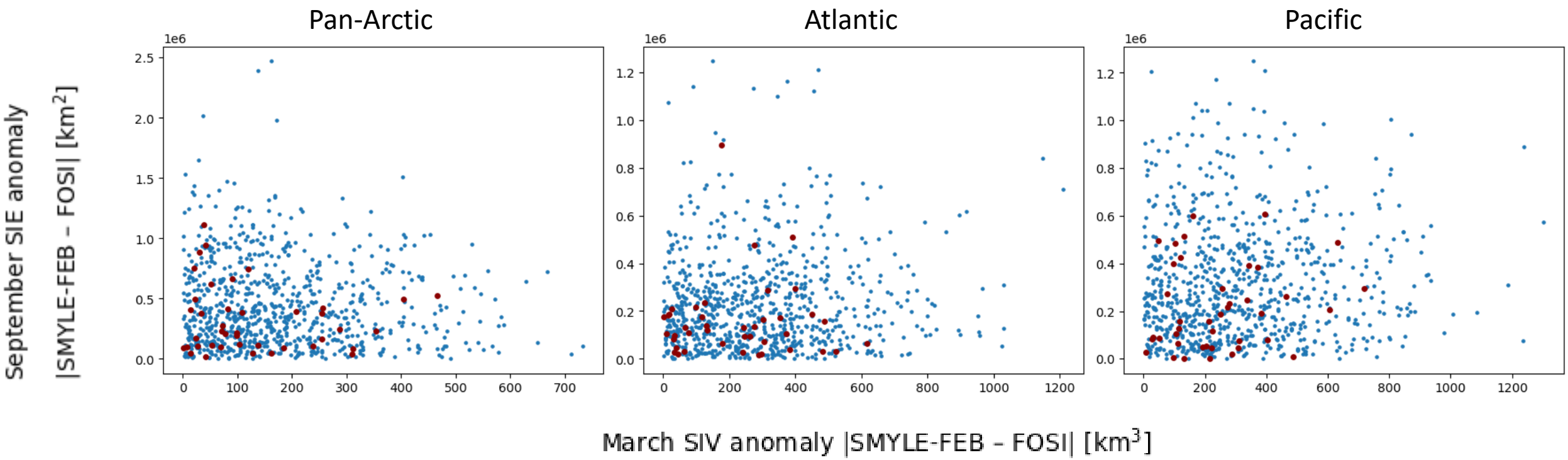
Points: SMYLE correlation



SMYLE exhibits large variability of 1-month SIV and 7-month SIE prediction accuracy.



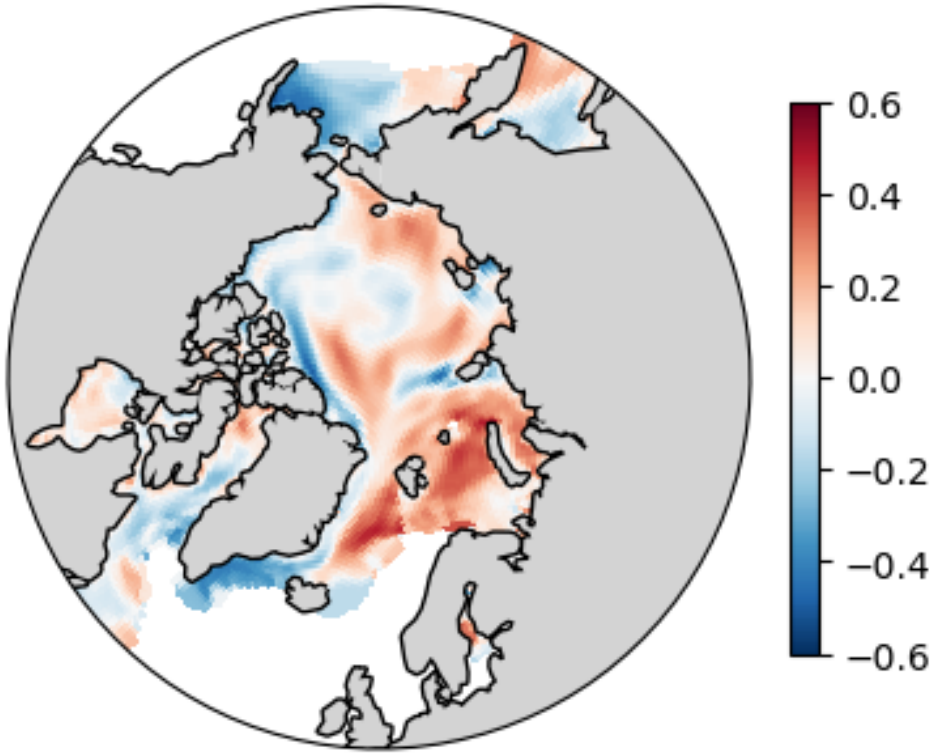
SMYLE exhibits large variability of 1-month SIV and 7-month SIE prediction accuracy.



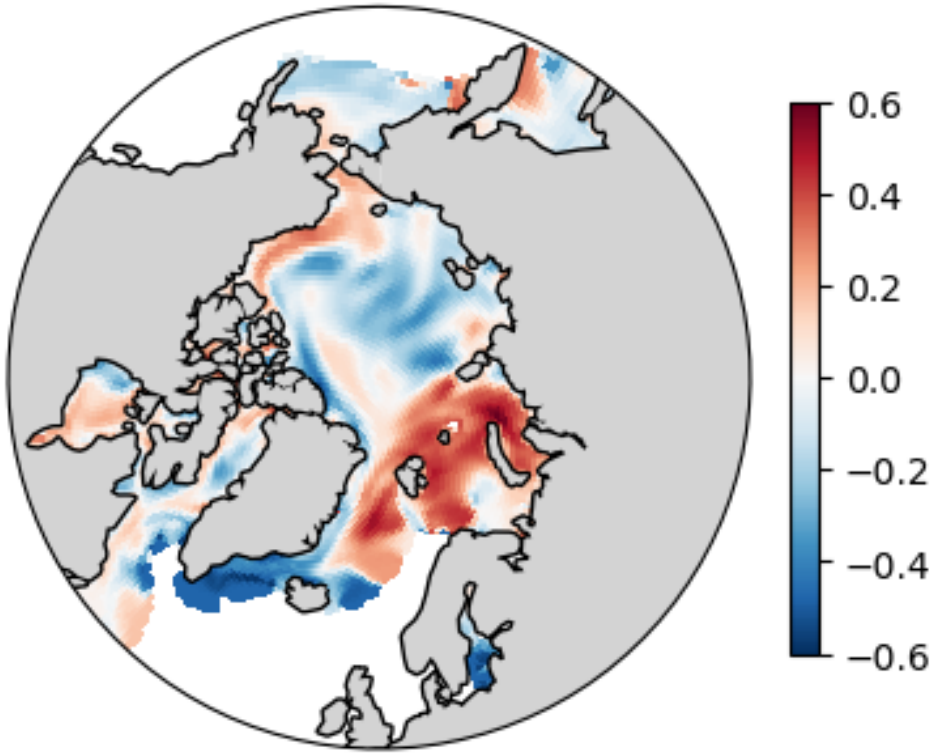
Can we use the ensemble members with good 1-month lead predictions of SIV to improve predictions of September SIE?

Pan-Arctic SIV to SIE skill likely comes from the Atlantic region.

Correlation between local March SIT and pan-Arctic Sept. SIE

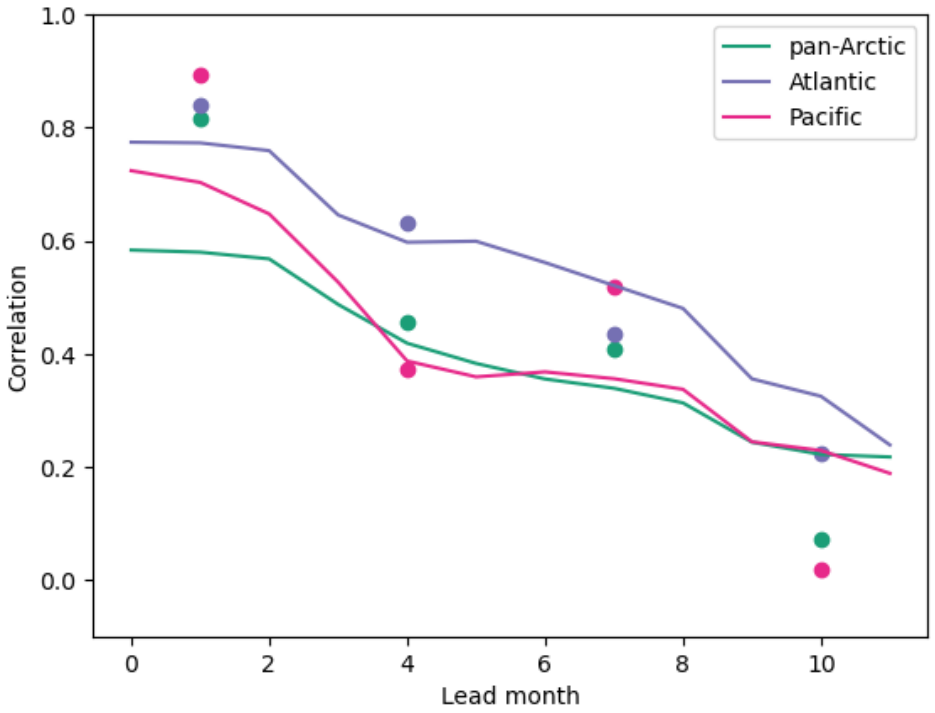


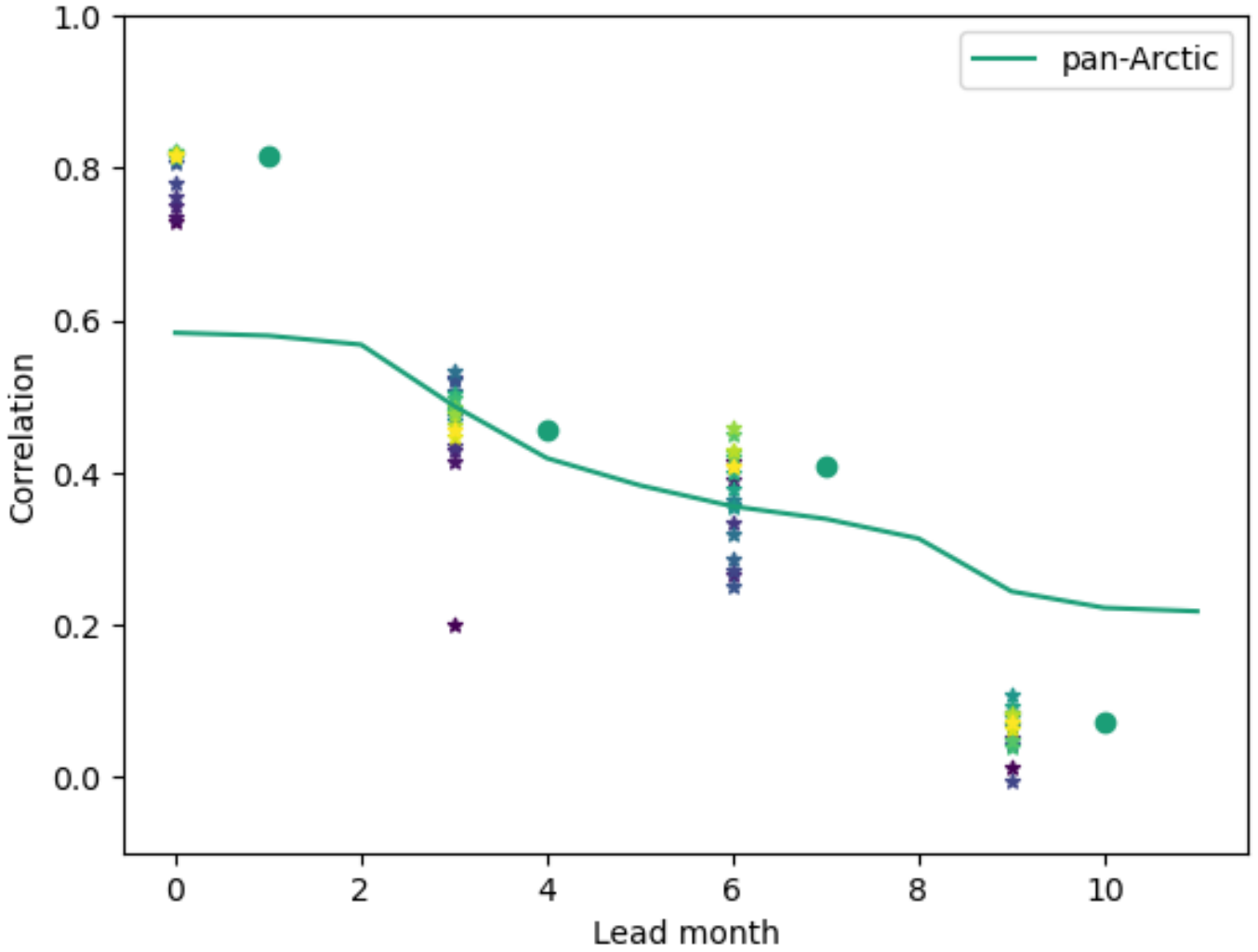
FOSI: March thickness and Sept. SIE



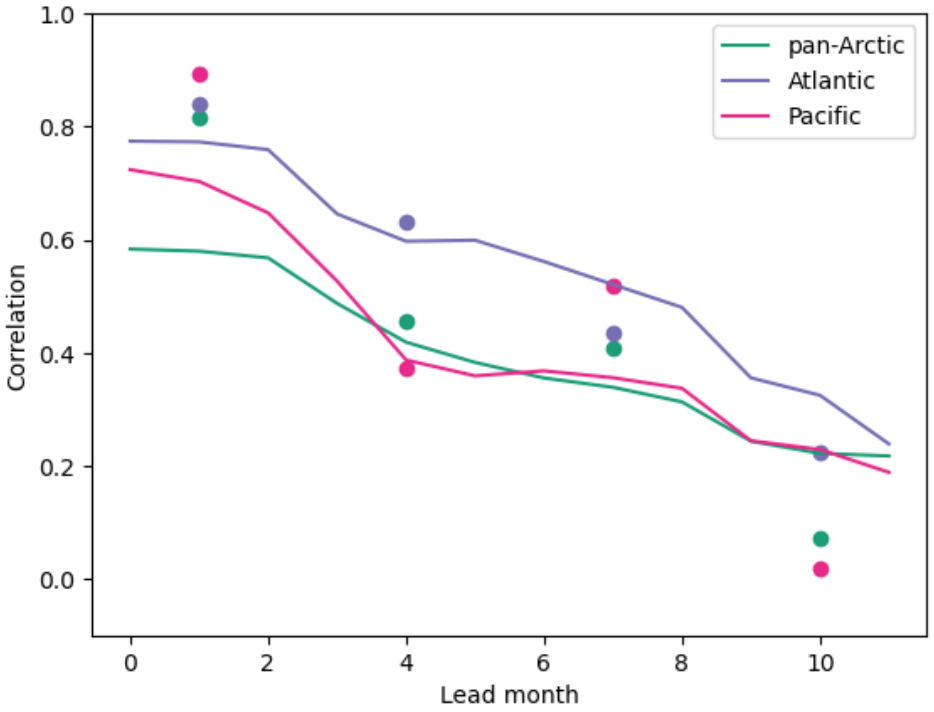
SMYLE-Feb: March thickness and Sept. SIE

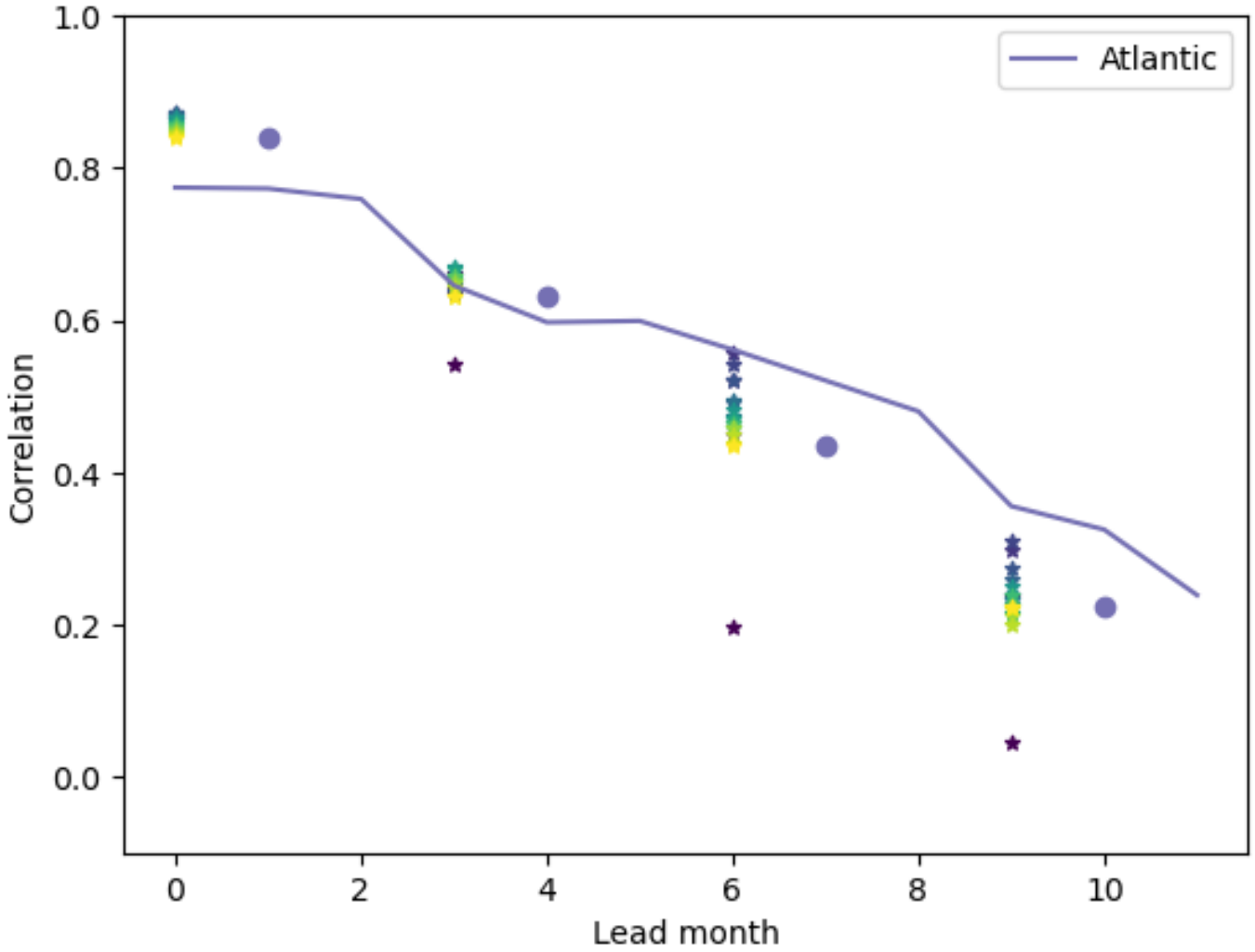
Pan-Arctic: unclear if SIV predictions can improve SIE predictions



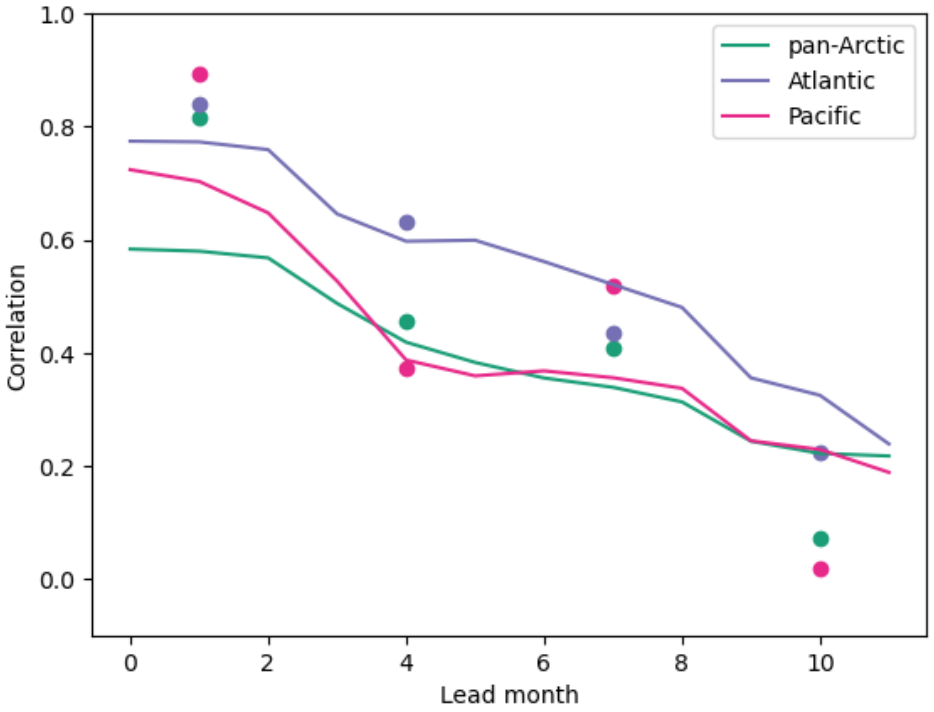


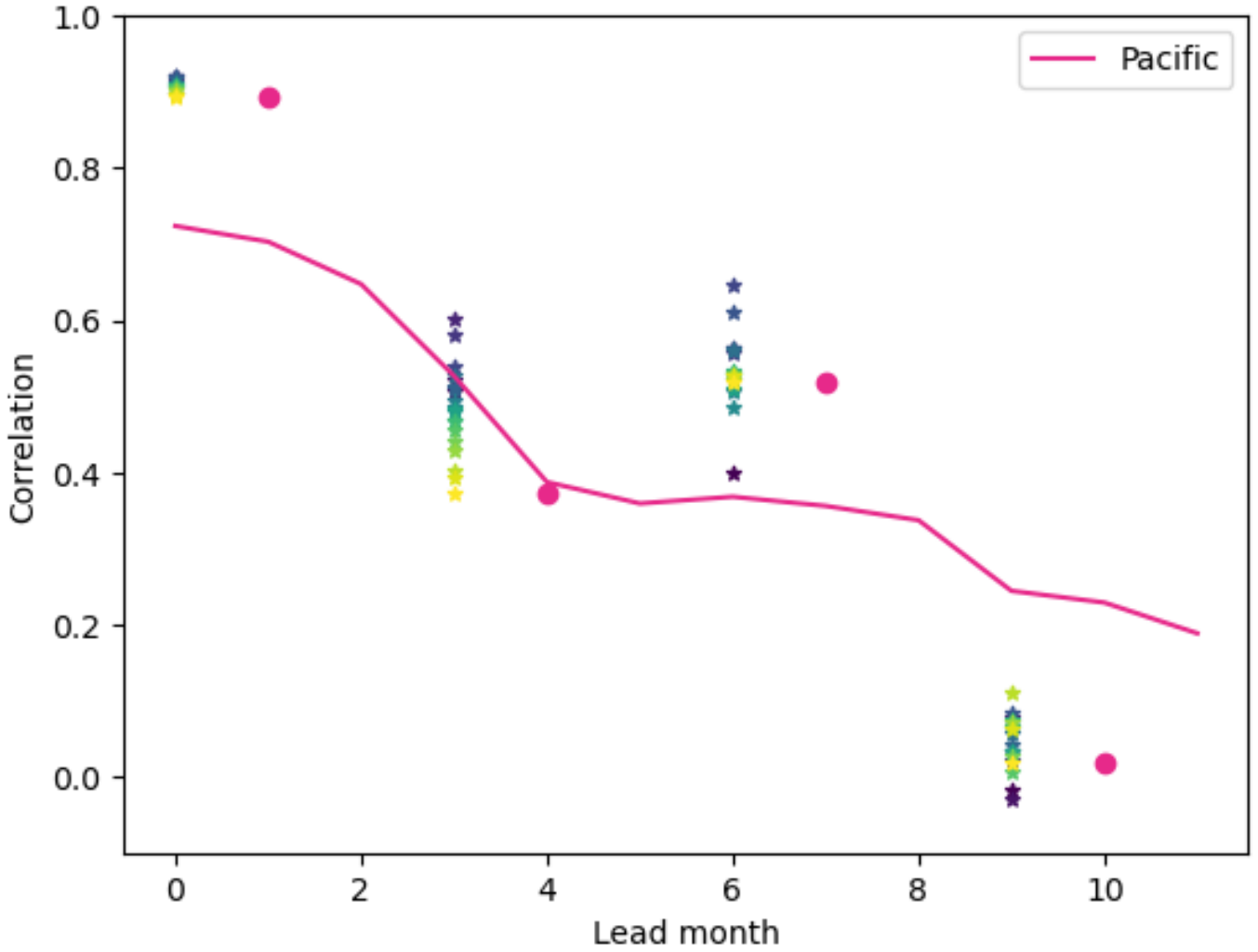
Atlantic: early SIV predictions lead to improved skill for later SIE predictions





Pacific: June SIV from May prediction may improve September SIE prediction





Ongoing work!

- How does SIE prediction skill depend on ensemble size?
- How does ocean heat content influence prediction skill?

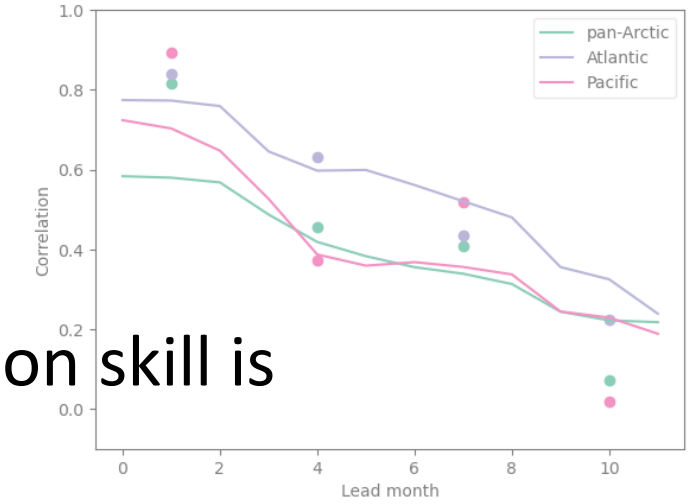
- How well does SMYLE predict Arctic heat and freshwater transport in the Pacific vs. Atlantic?

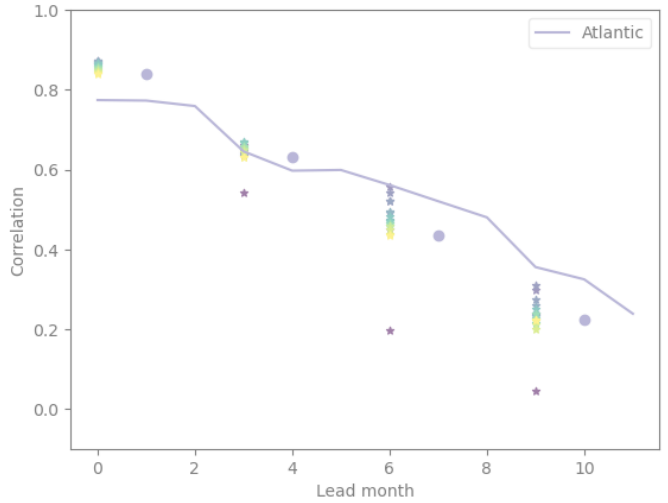
- Model comparison: E3SM-SMYLE

- Other ideas/suggestions welcome!

Takeaways:

- Regional and Pan-Arctic September Arctic SIE prediction skill is related to sea ice thickness/volume initial conditions.
- This may enable early selection of better predictions.
- Other sources of predictability exist as well.





email: jtcohen@uw.edu