Seasonal prediction of Arctic sea ice

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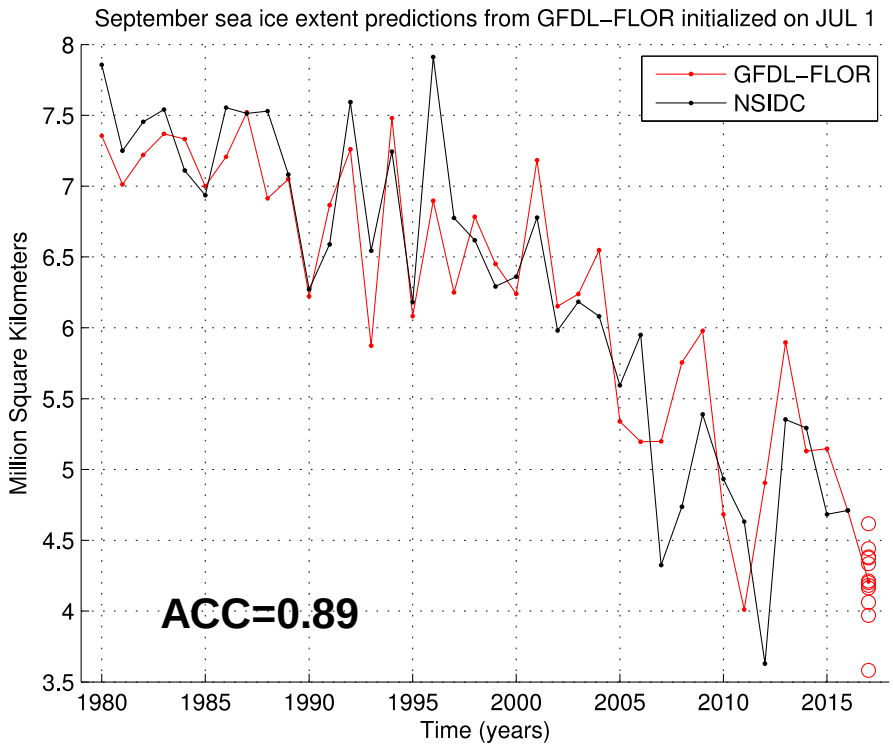
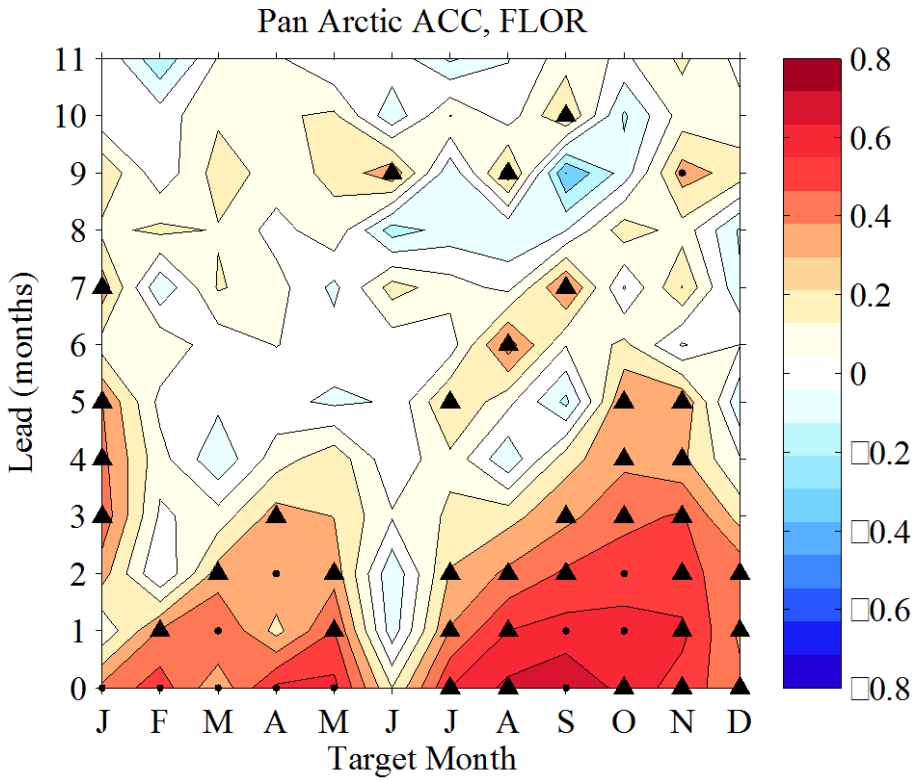
Current Seasonal Predictions of Arctic Sea Ice

- Retrospective seasonal forecasts made with GFDL-FLOR[1,2] spanning 1980-2017
- Initialized via **E**nsemble Kalman Filter **C**oupled **D**ata **A**ssimilation (ECDA[3,4])

Target: September; Lead: 2



All target months, leads 0-11 months

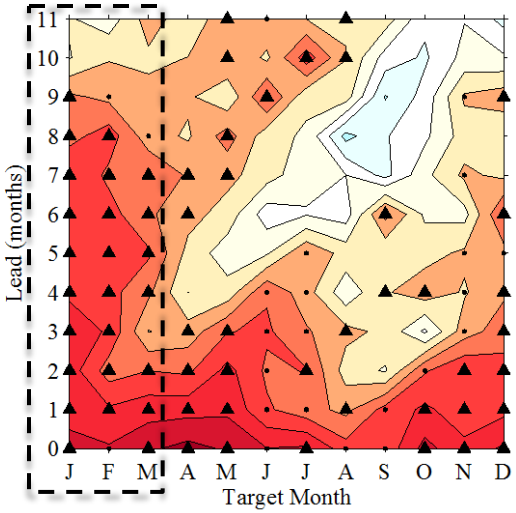


- *Msadek et al. (2014)* showed this system can skillfully predict detrended pan-Arctic SIE

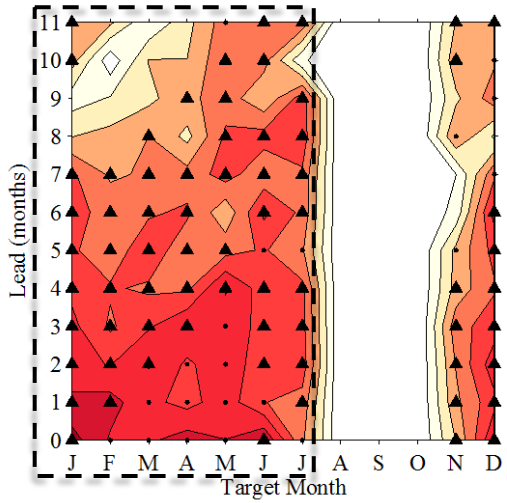
1: Vecchi et al. 2014, *J. Clim.*; 2: Delworth et al. 2012, *J. Clim.*; 3: Zhang et al. 2007 *MWR.;* 4. Zhang and Rosati (2010), *MWR*

Regional Prediction Skill For Winter Sea Ice

Barents Sea

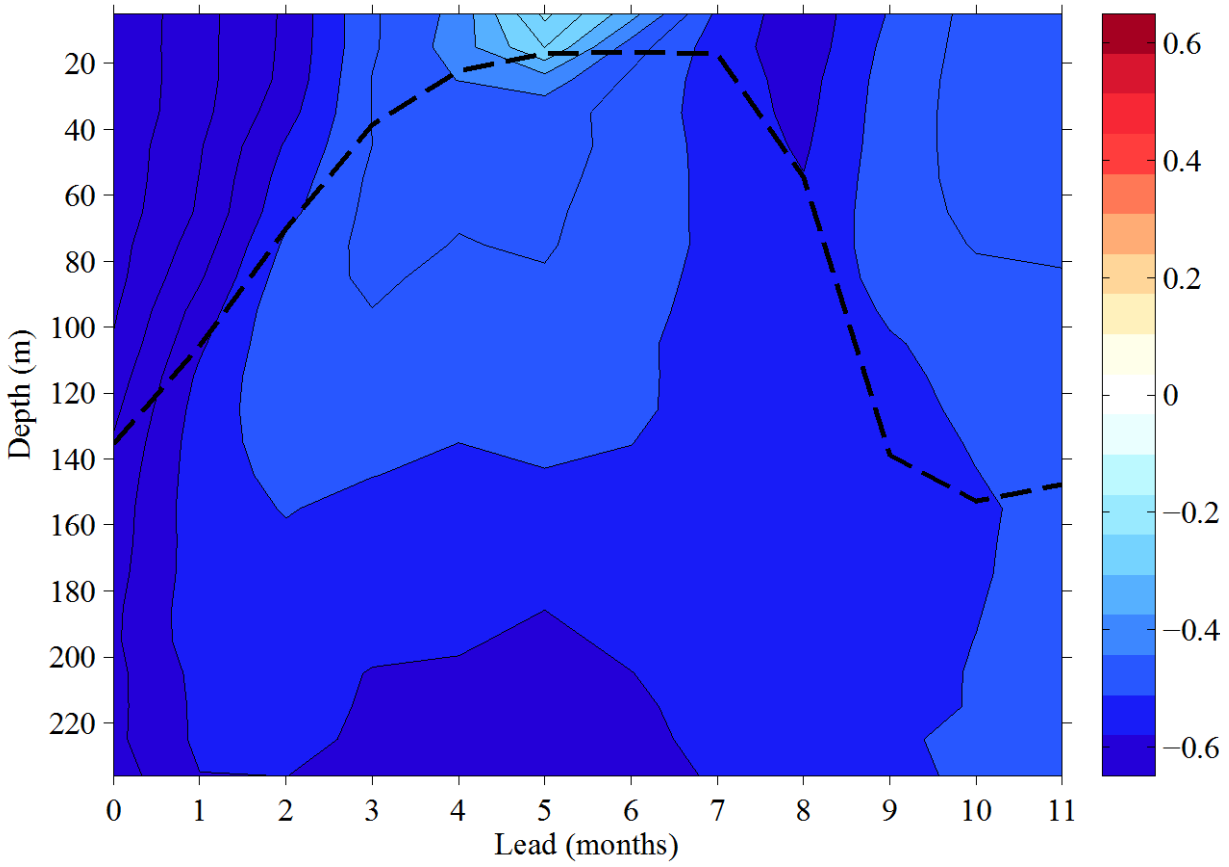


Labrador Sea



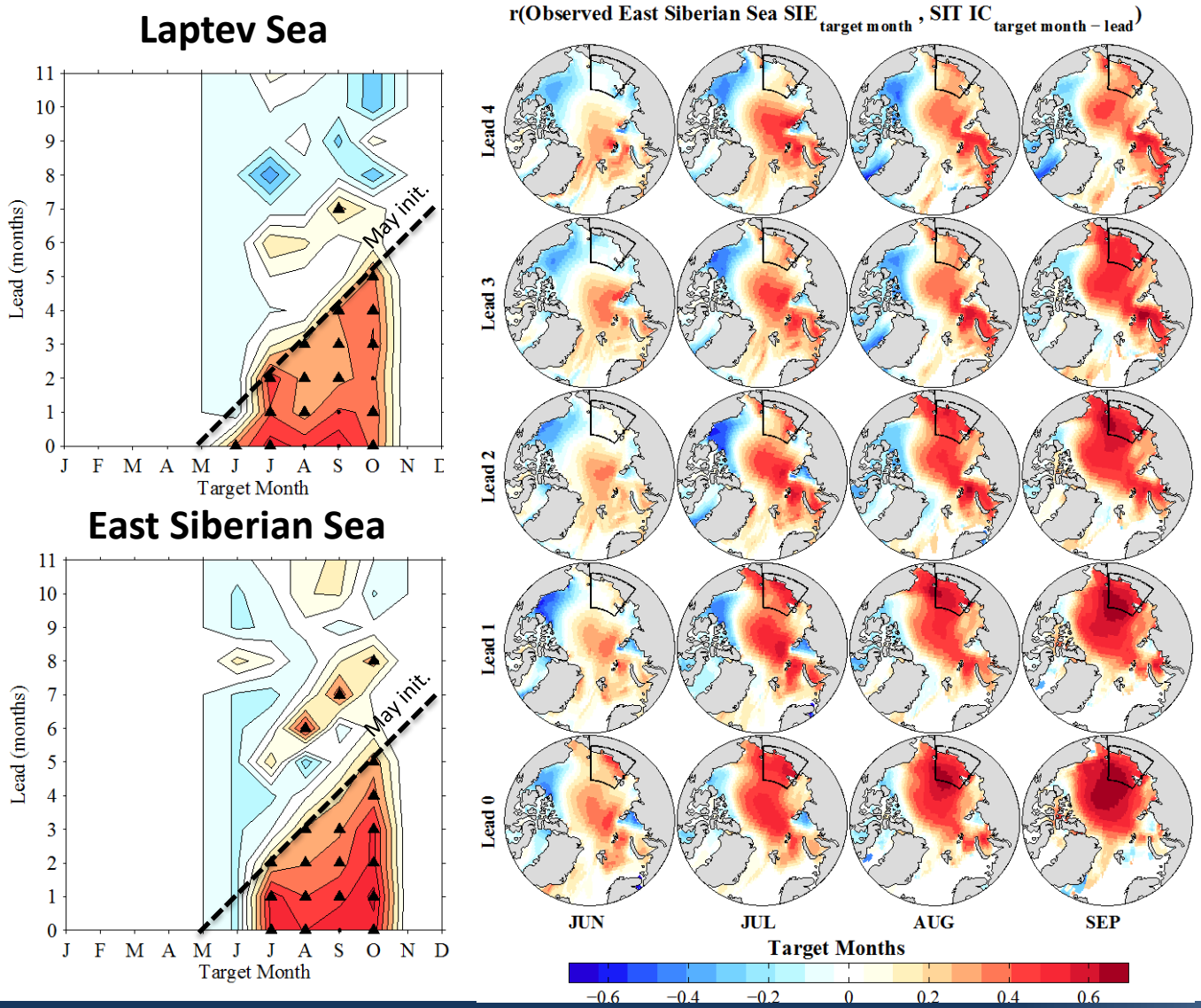
- Subsurface ocean temperature initialization provides key source of winter prediction skill

r(Observed Barents SIE_{Jan}, Ocean Temperature $IC_{Jan\ —\ lead}$)



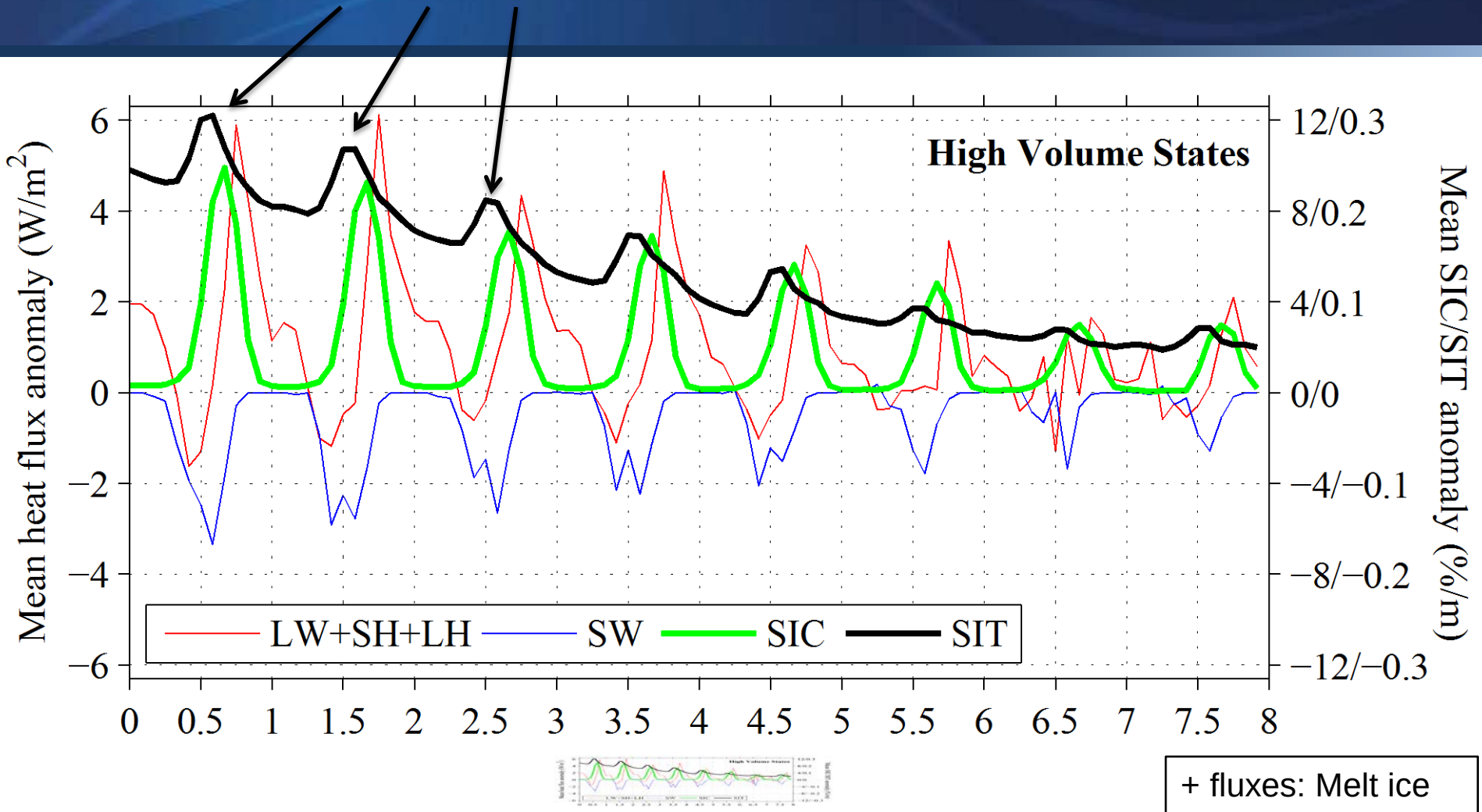
Bushuk et al (2017b), *GRL*

Regional Prediction Skill For Summer Sea Ice



- Laptev and East Siberian Seas have spring prediction skill barrier: Predictions initialized May 1 and later are skillful; those initialized prior to May 1 are not
- Sea ice thickness initialization provides key source of summer prediction skill

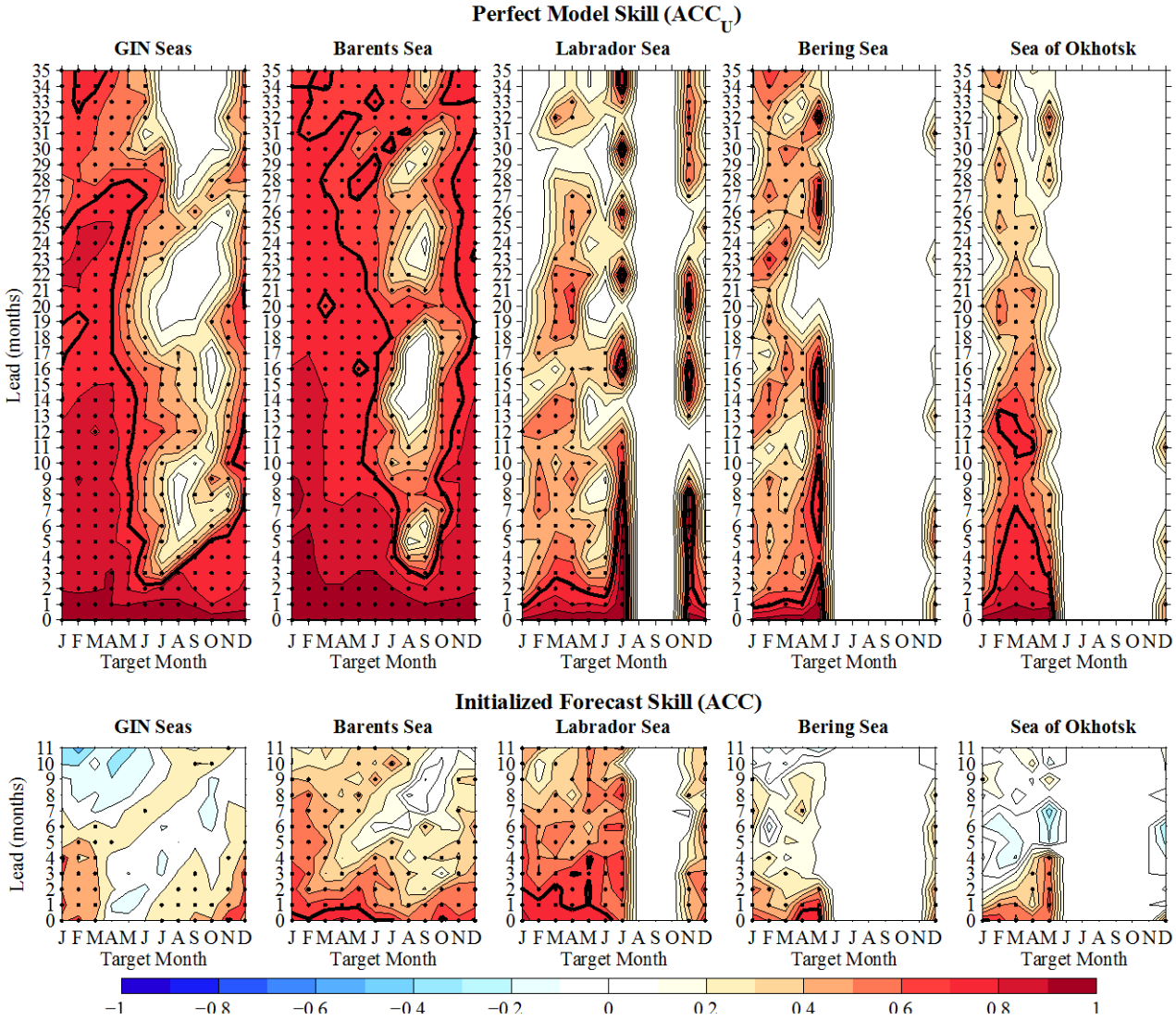
Summer Enhancement of Arctic Sea-Ice Volume Anomalies



+ fluxes: Melt ice
- fluxes: Freeze ice

- Thickness anomalies persist for 4-5 years
- Anomalies enhanced over summer via albedo feedbacks

The Sea-Ice Prediction Gap: Comparison of Perfect Model and Operational Skill



- Suite of perfect model experiments run with GFDL-FLOR provide direct comparison with initialized predictions
- Large skill gap between perfect model and initialized prediction skill
- Similar regional skill structure
- Identify key gaps in current prediction system (initial conditions, model physics, etc.)

Summary and Future Outlook

- GFDL-FLOR seasonal predictions skillfully predict pan-Arctic and regional sea-ice extent at lead times of 0-11 months depending on region and target month
- Prediction skill is notably high for (3-11 months) for North Atlantic winter SIE
- Winter SIE skill partially attributable to subsurface ocean temperature initialization and summer skill partially attributable to sea ice thickness initialization
- Perfect model experiments suggest substantial skill improvements are possible

Future Outlook

- Improved Arctic sea-ice predictions depend on:
  1. Improved observational data
  2. Better data assimilation and initialization
  3. Improved model physics and reduced model bias
  4. Fundamental work on sea-ice predictability
- Where do we focus our efforts? What are the crucial mechanisms? Our work suggests: subsurface ocean and sea-ice thickness