Polynyas and Antarctic Slope Current in Long-Term CESM-iHESP Simulation (preliminary)

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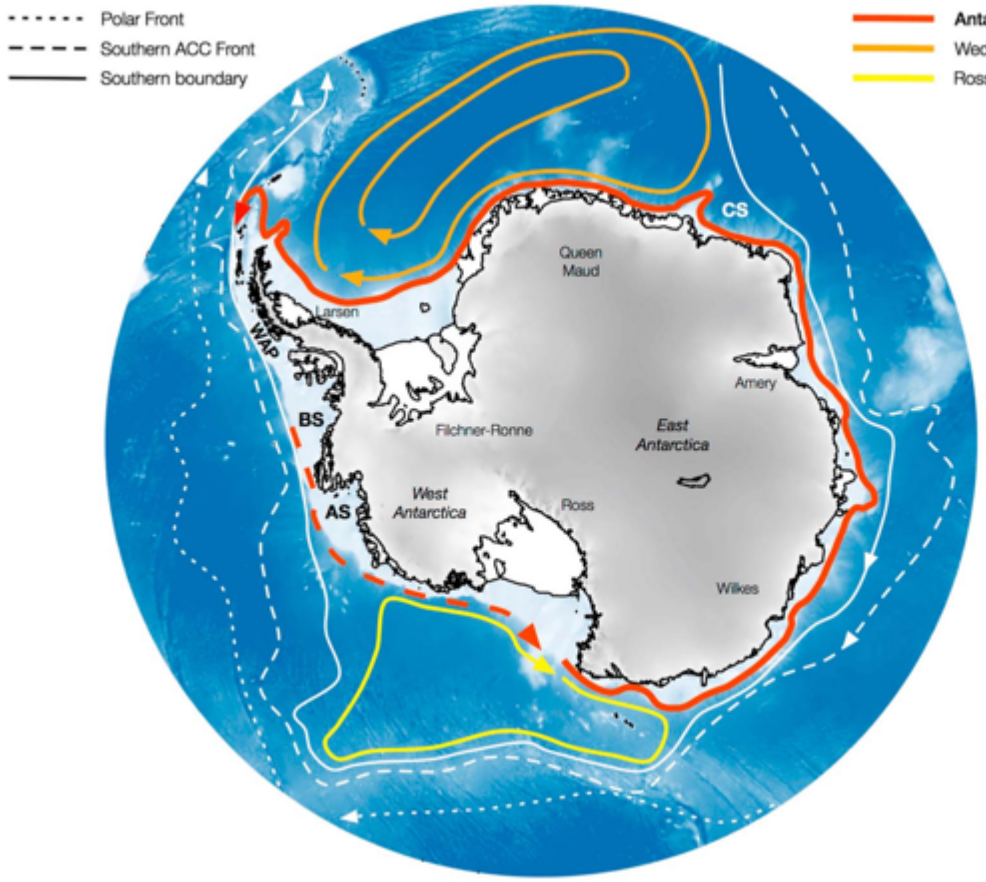
2020 CESM WORKSHOP

CESM-iHESP Simulation

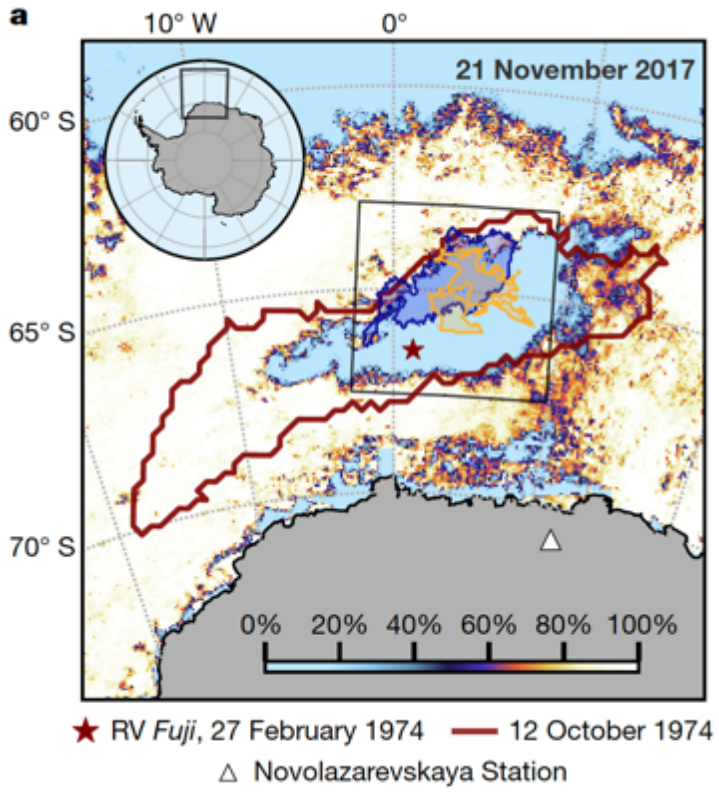
- Community Earth System Model (CESM1.3)
  - CAM5-SE (0.25°, 30 levels), CLM4 (0.25°)
  - POP2 (tri-polar grid, 0.1°, 62 layers), CICE4 (tri-polar grid, 0.1°)
  - Preindustrial greenhouse gas forcing
  - High-resolution, fully-coupled, long-term (up to 500 years)
  - Currently full output available for first 320 years

- Scientific goals:
  - Investigate reasons for intermittent occurrence of Maud Rise Polynyas (MRPs), and Weddell Sea Polynyas (WSPs); builds on the works of Kurtakoti et al. (2018), Campbell et al. (2019), and Cheon and Gordon (2019)
  - Investigate model representation of Antarctic Slope Current (ASC), and its impact on polynya and Antarctic Bottom Water (AABW) formation

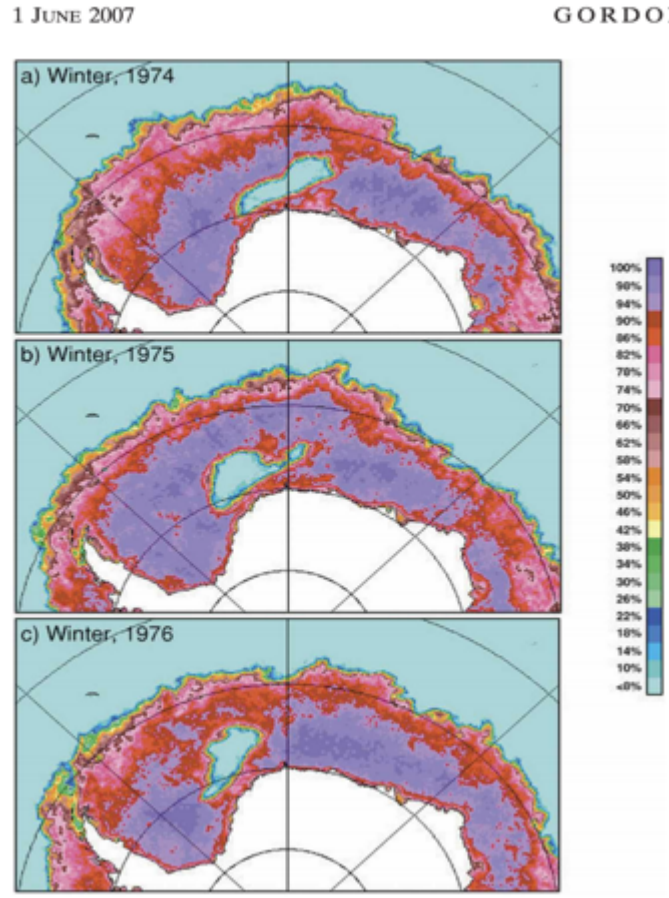
Background



Main Currents in Antarctic
(from Thompson et al. 2018)

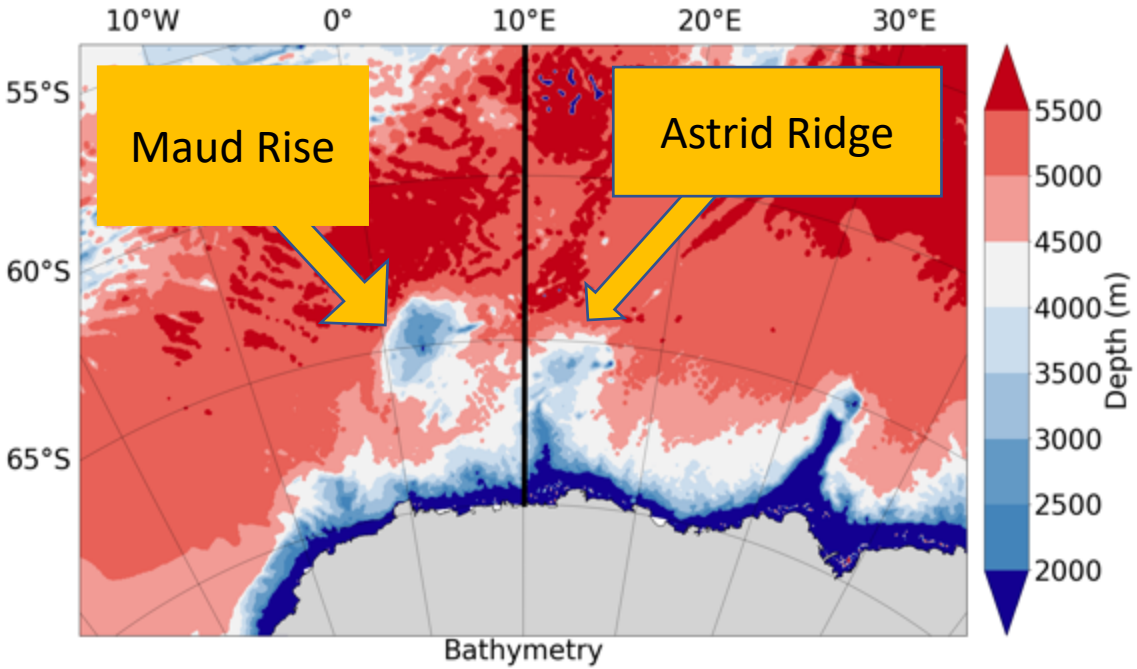


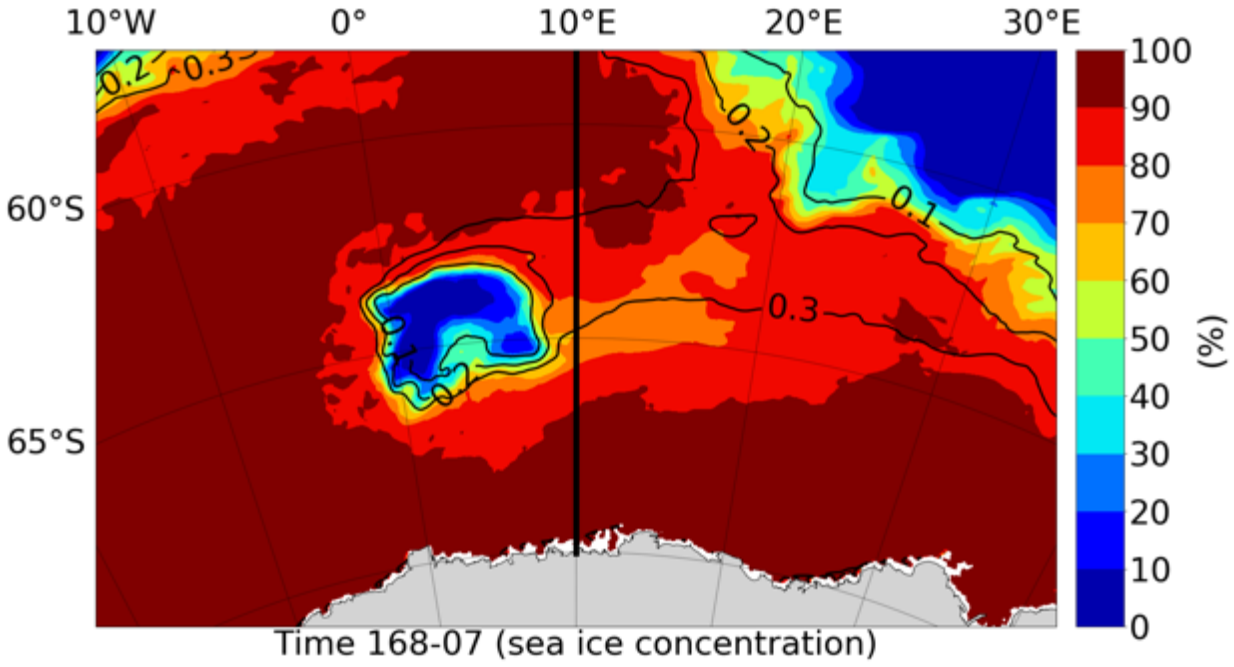
Satellite Observation of MRPs
(from Campbell et al. 2019)

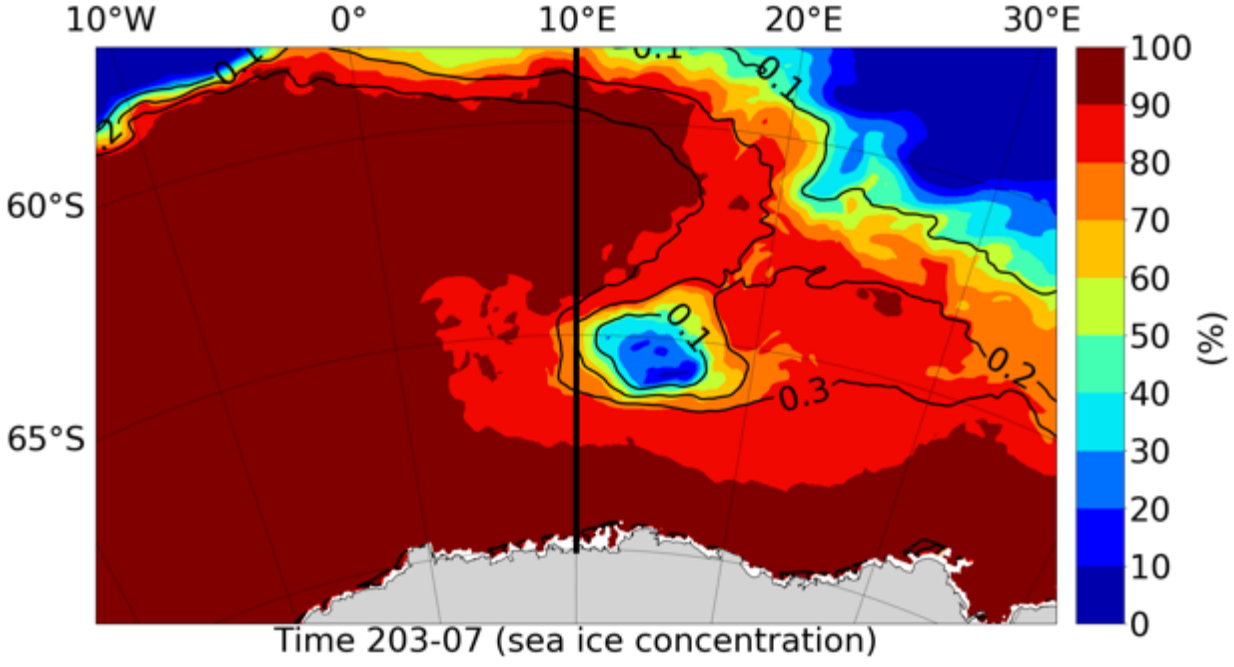


Satellite Observation of WSPs
(from Gordon et al., 2007)

Simulated Maud Rise (and Astrid Ridge) Polynyas

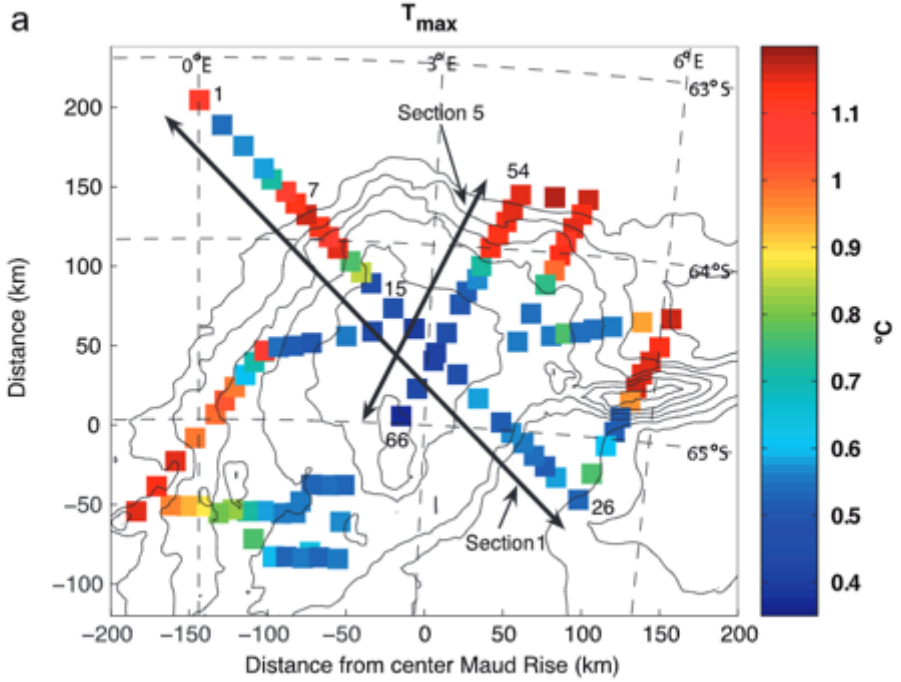






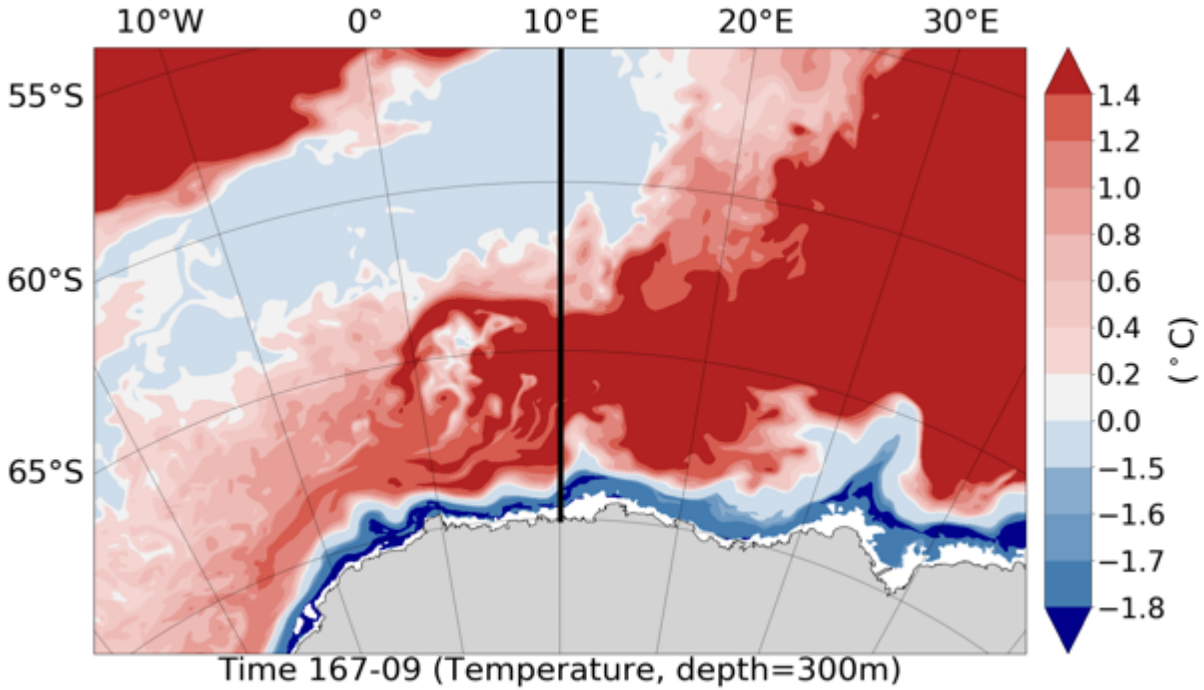
Temperature

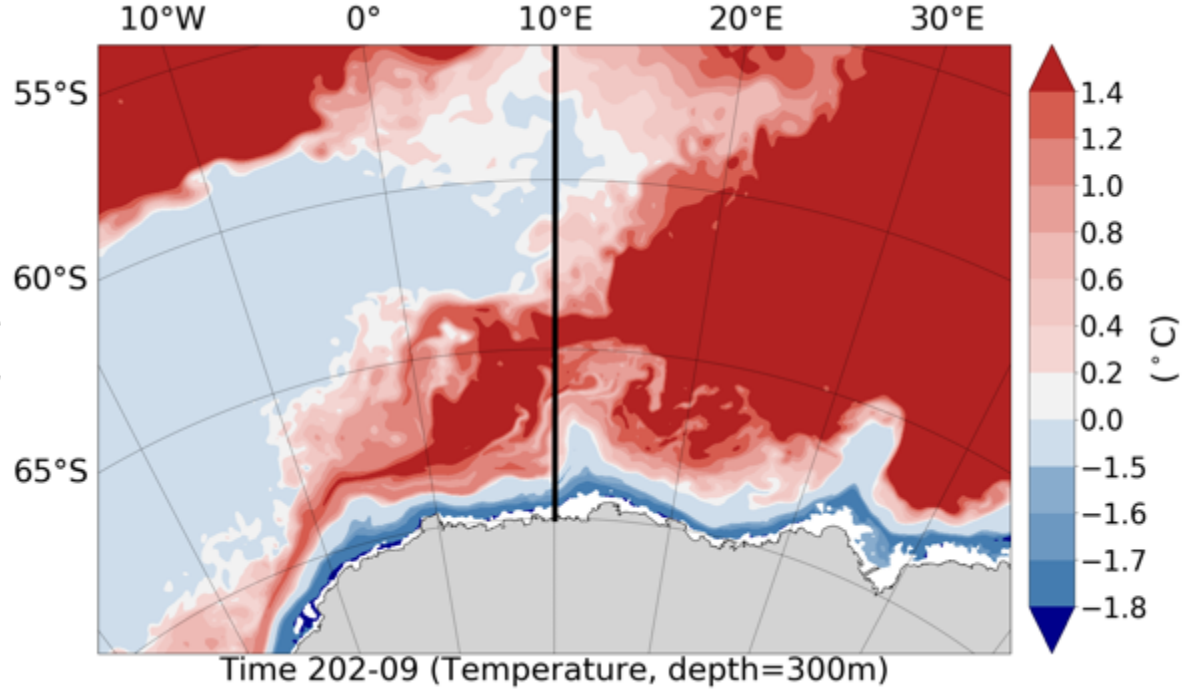
at 300 m depth 1 year before occurrence of polynya



Observation

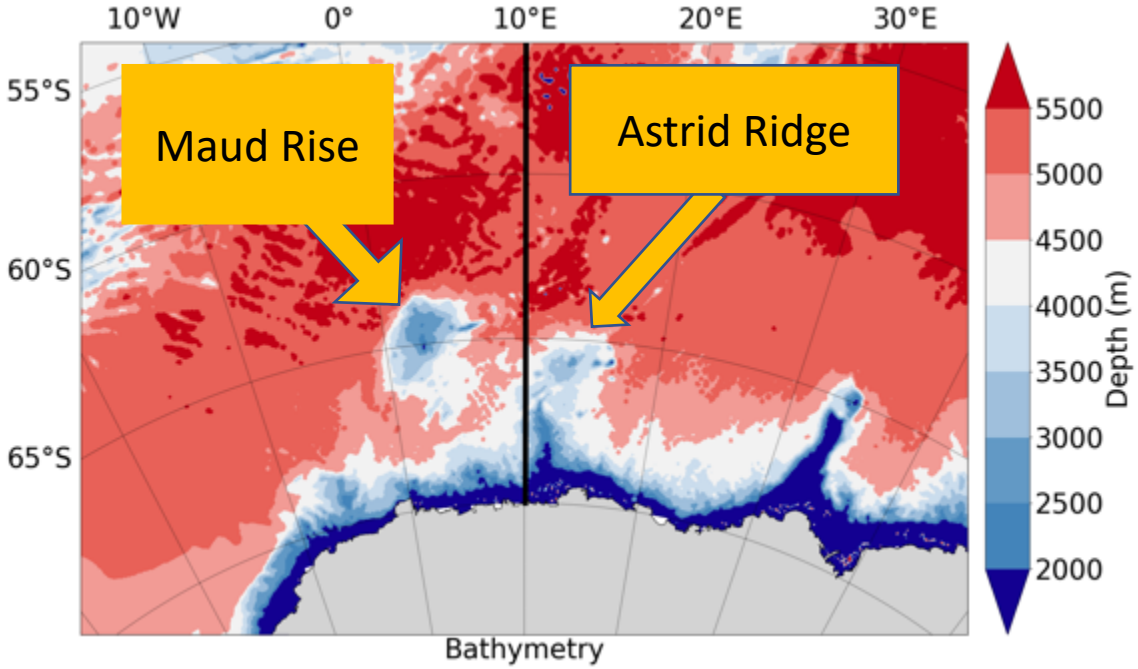
de Steur et al.(2007)



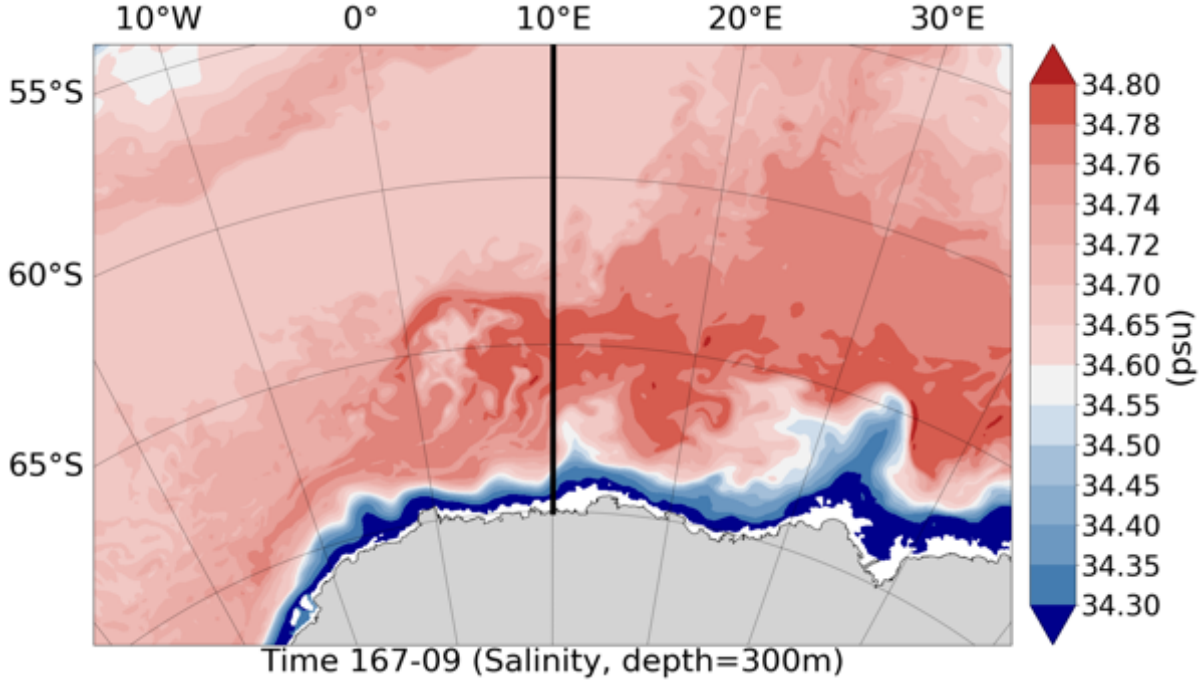


CESM-iHESP Simulation

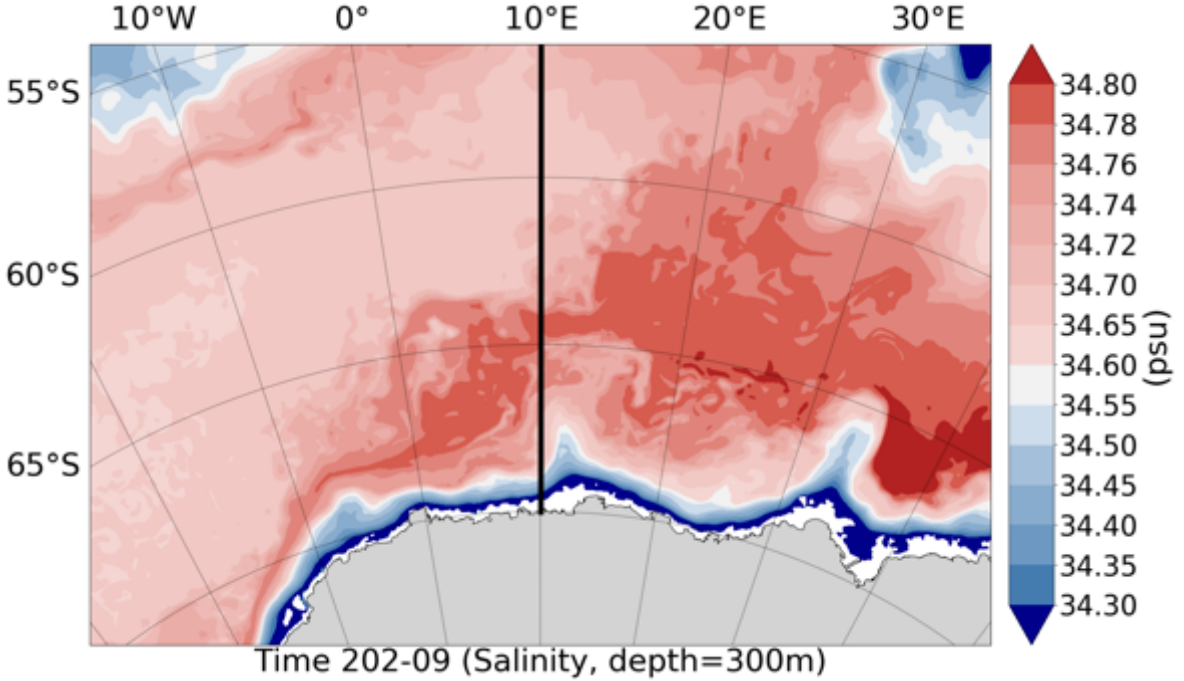
Salinity (300m)



Bathymetry

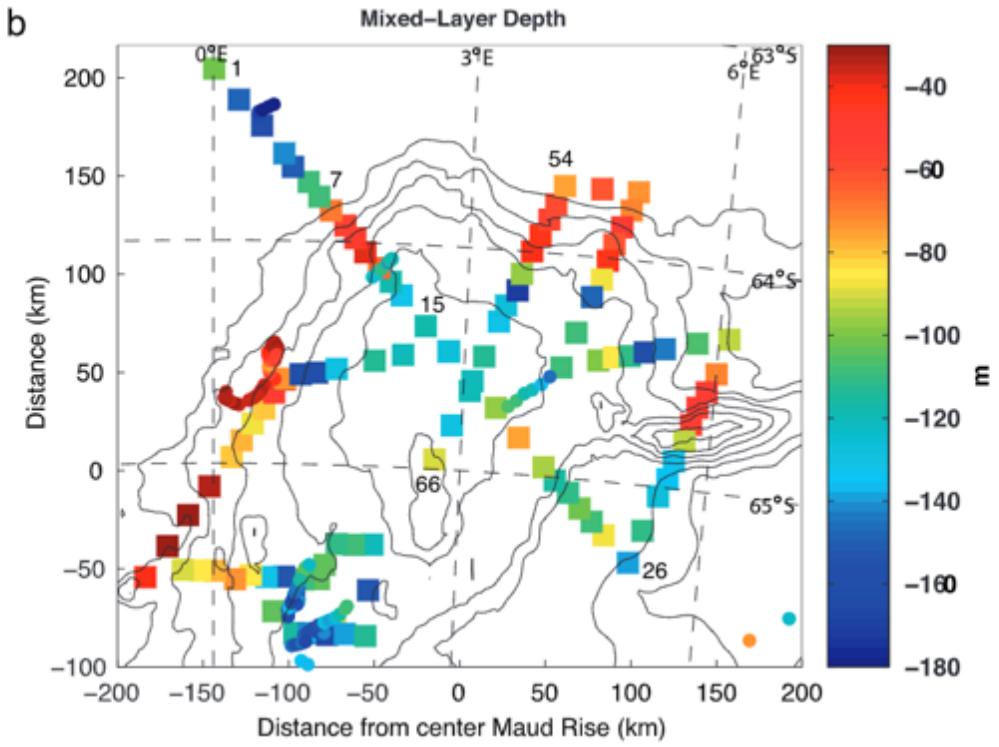


Time 167-09 (Salinity, depth=300m)



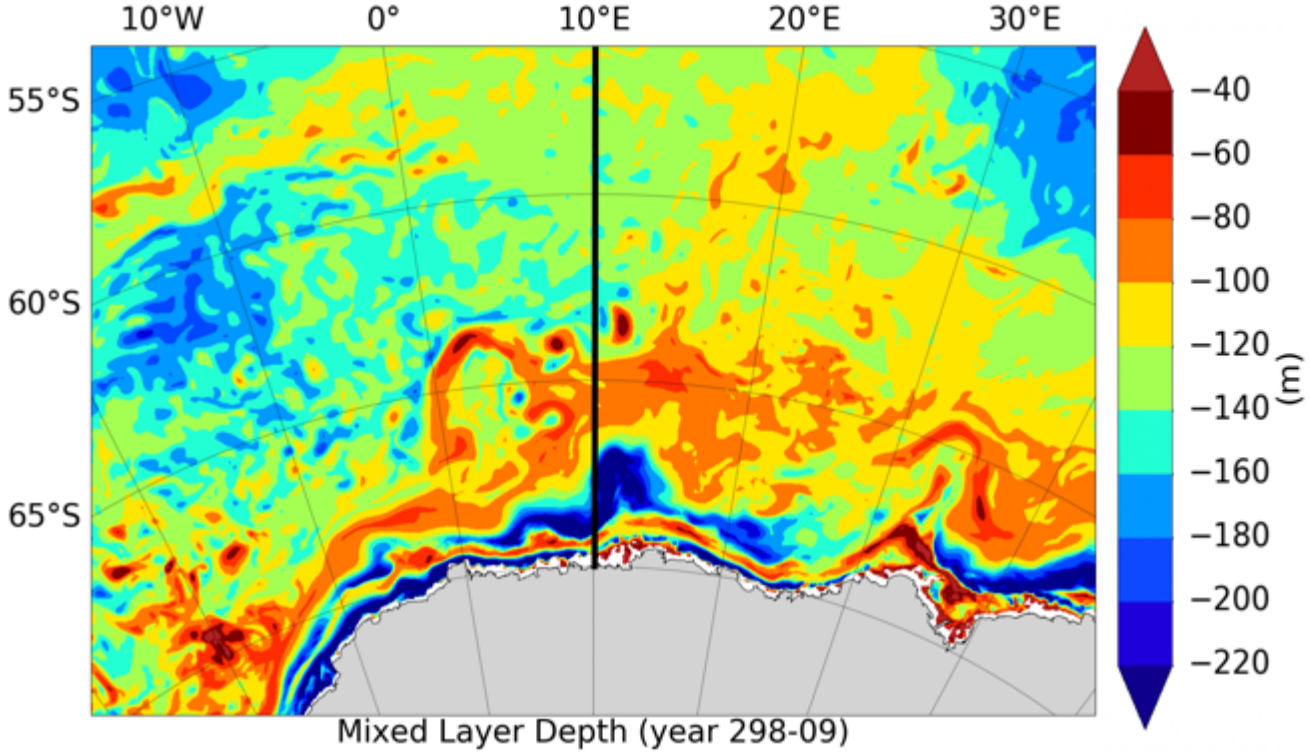
Time 202-09 (Salinity, depth=300m)

Mixed layer Depth



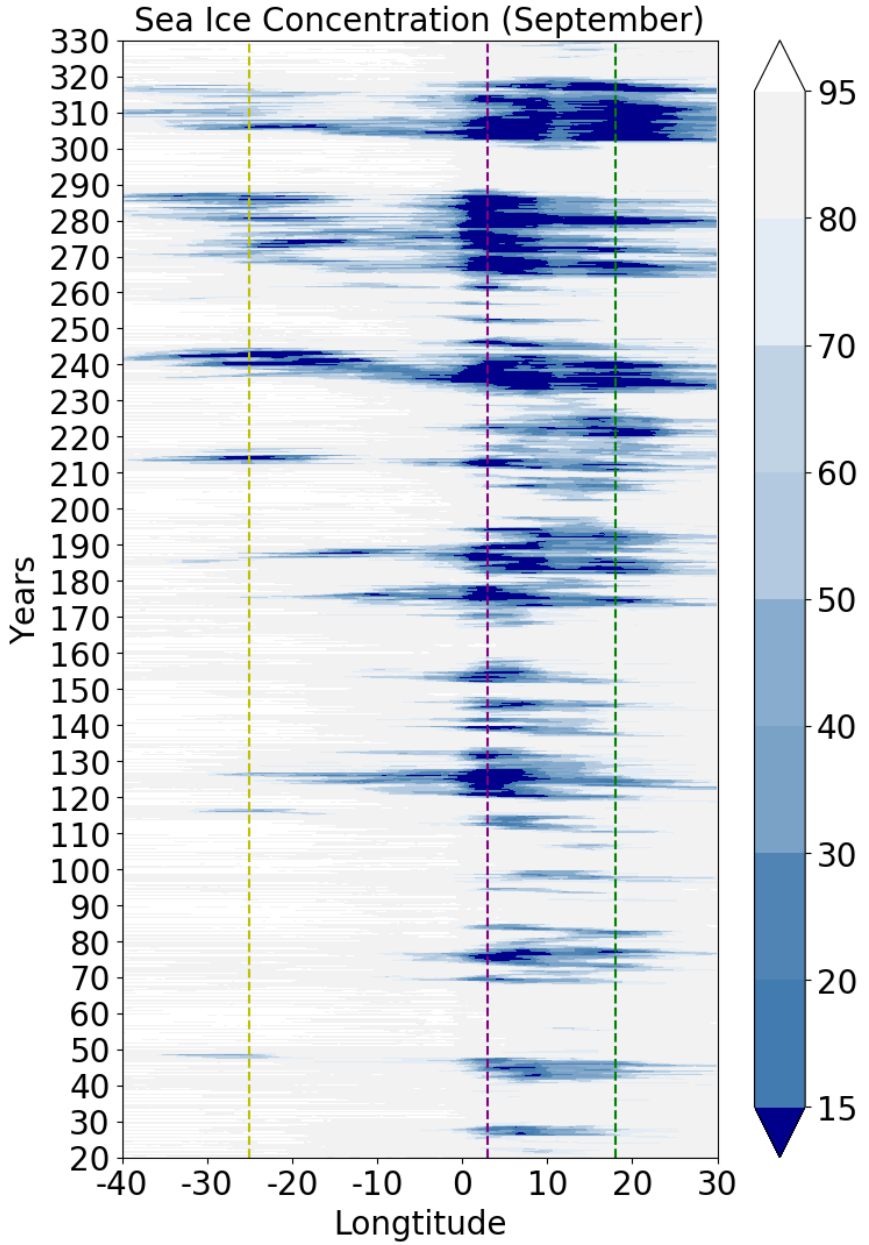
Observation

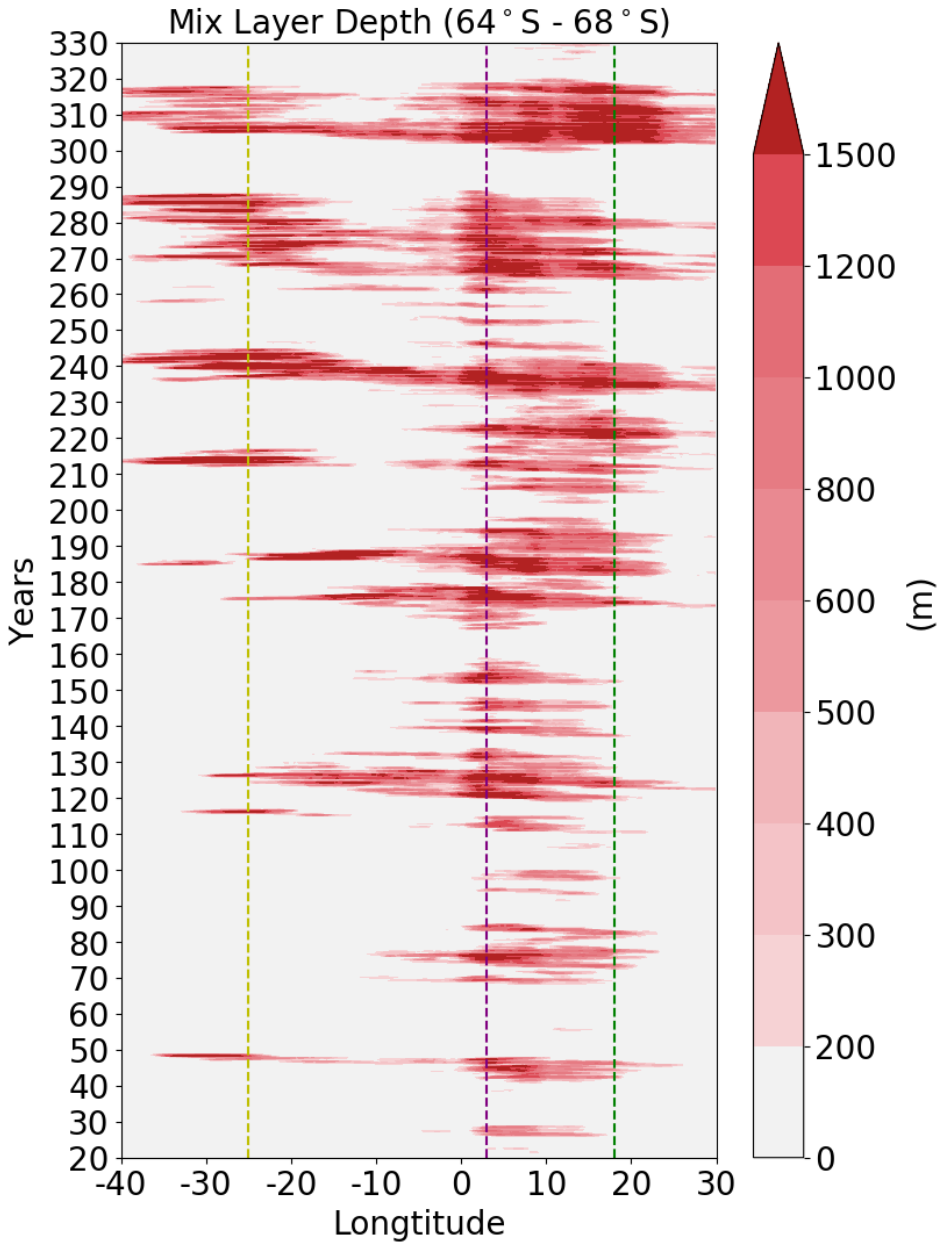
de Steur et al.(2007)



CESM-iHESP
Simulation

Evolution of Polynyas in CESM-iHESP



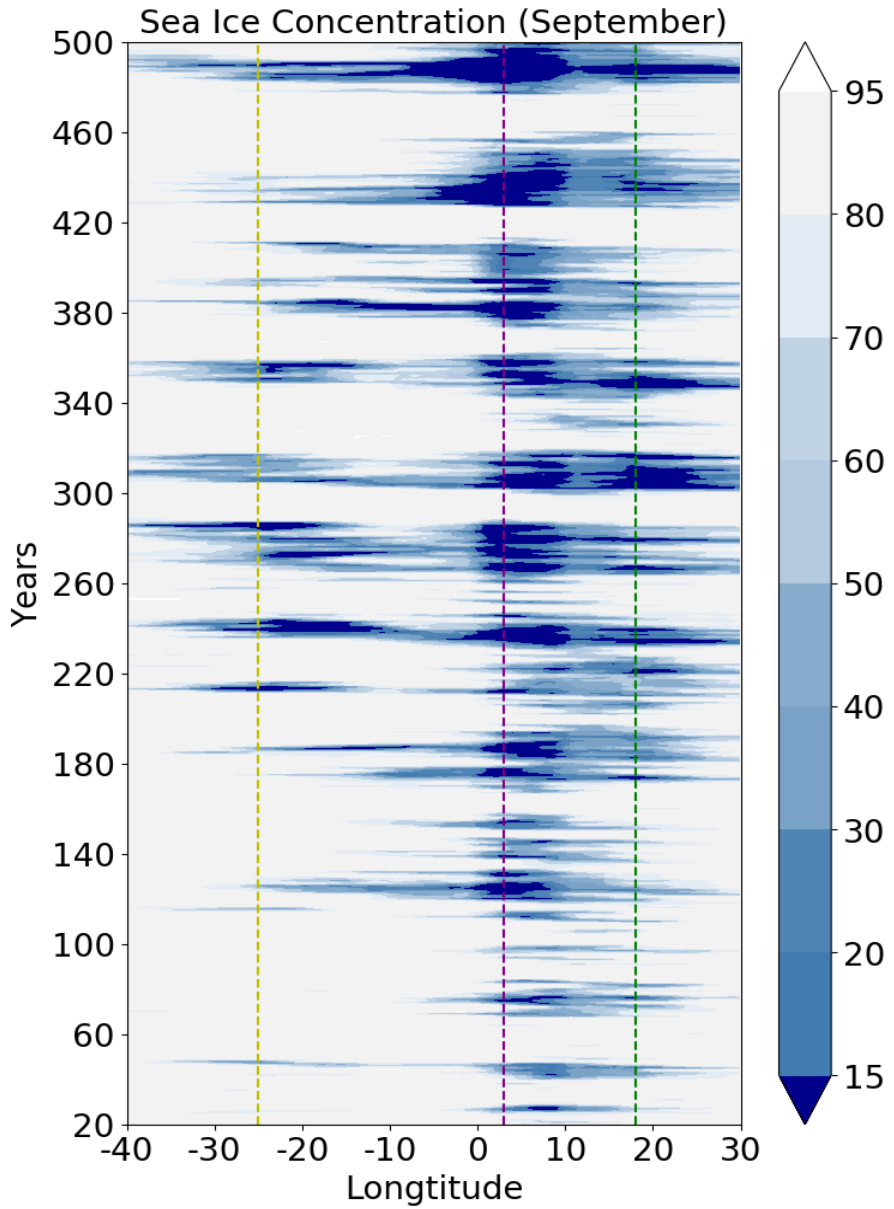


Astrid Ridge

Maud Rise

Central Weddell Sea

Evolution of Polynyas in CESM-iHESP (500 years)

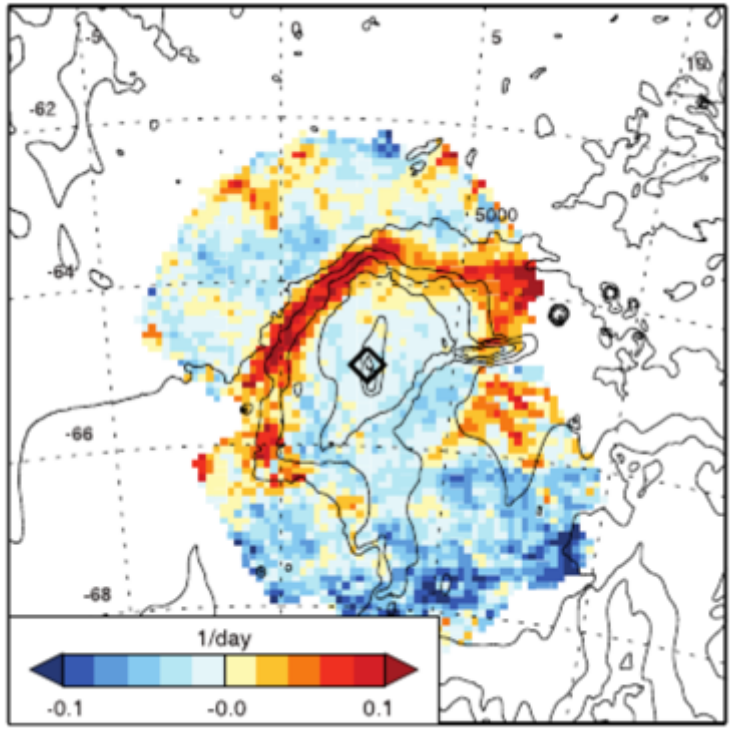


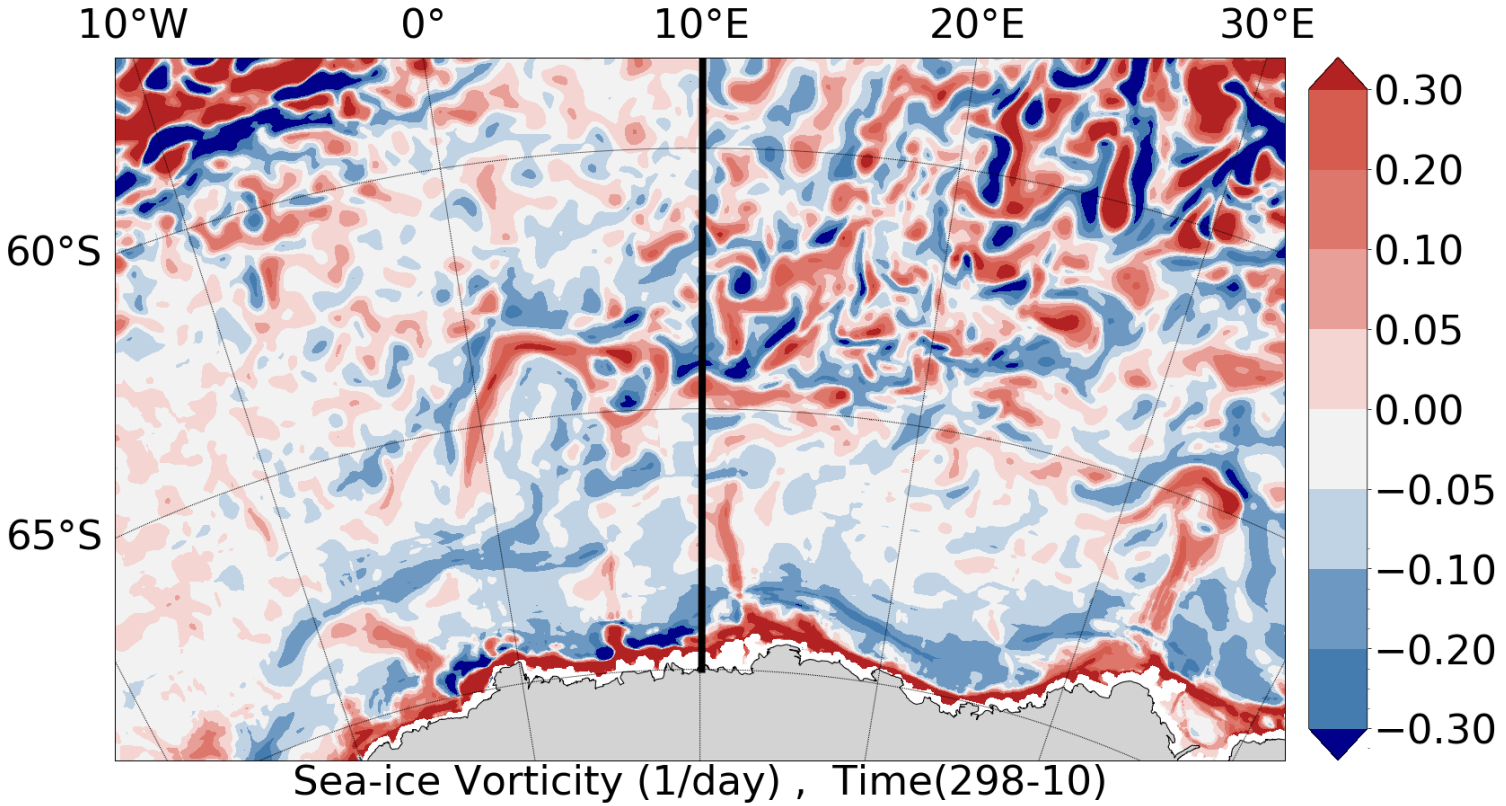
Astrid Ridge

Maud Rise

Central Weddell Sea

Sea ice vorticity



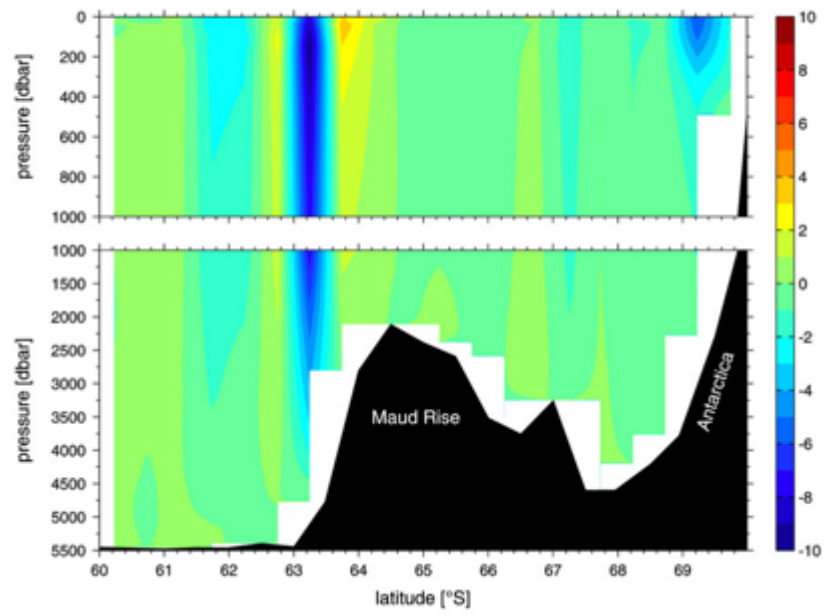


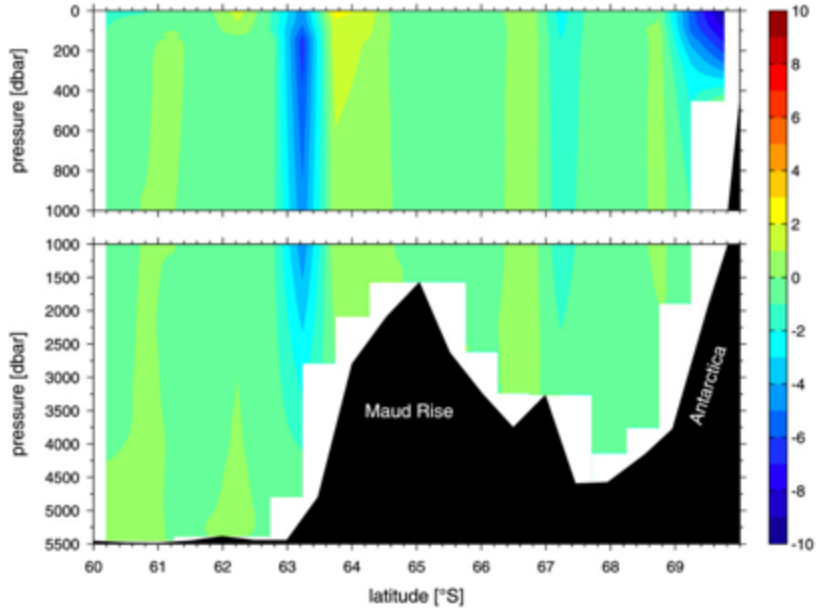
Observation

Lindsay et al. (2008)

CESM-iHESP
Simulation

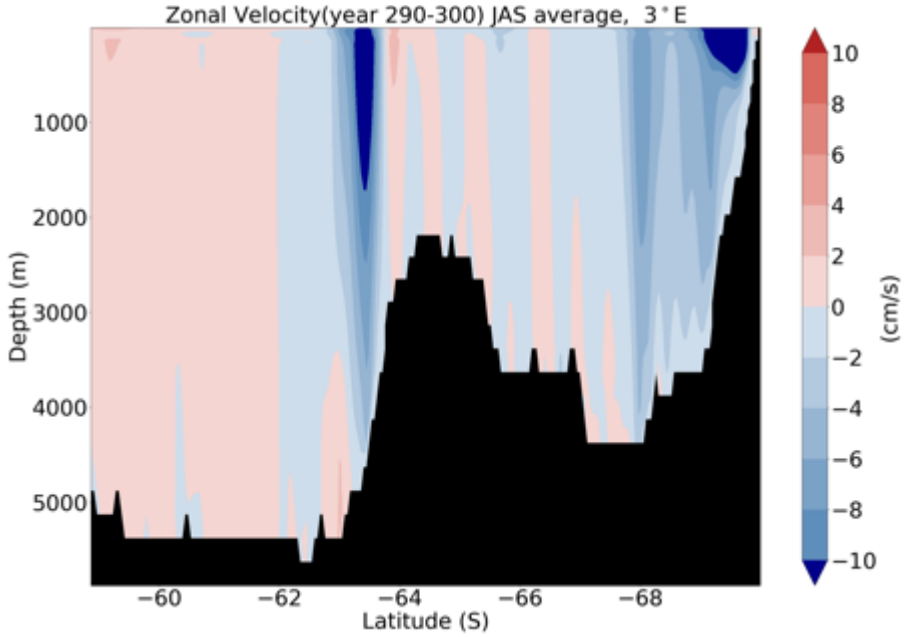
Seasonal change of zonal velocity along Maud Rise section

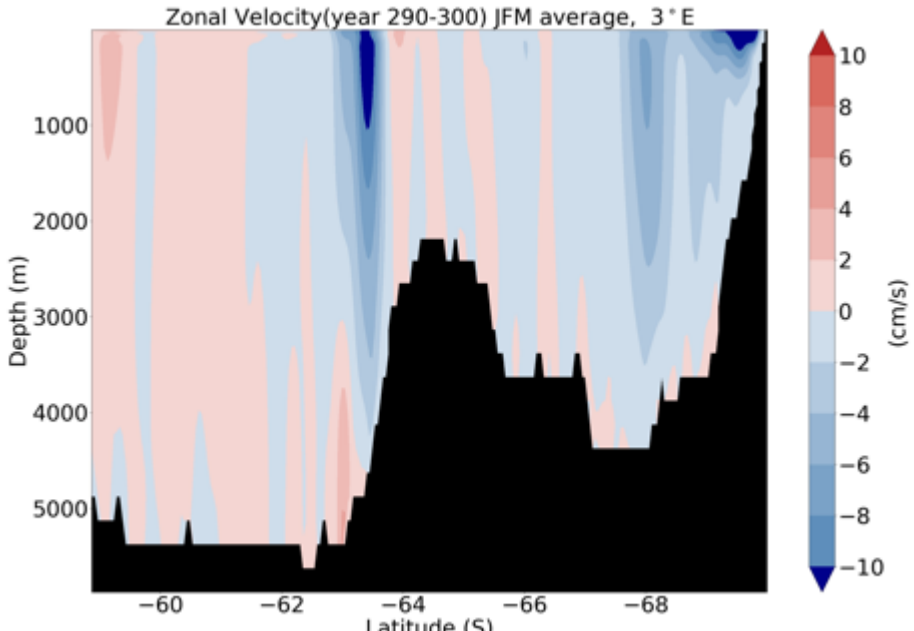




Observation

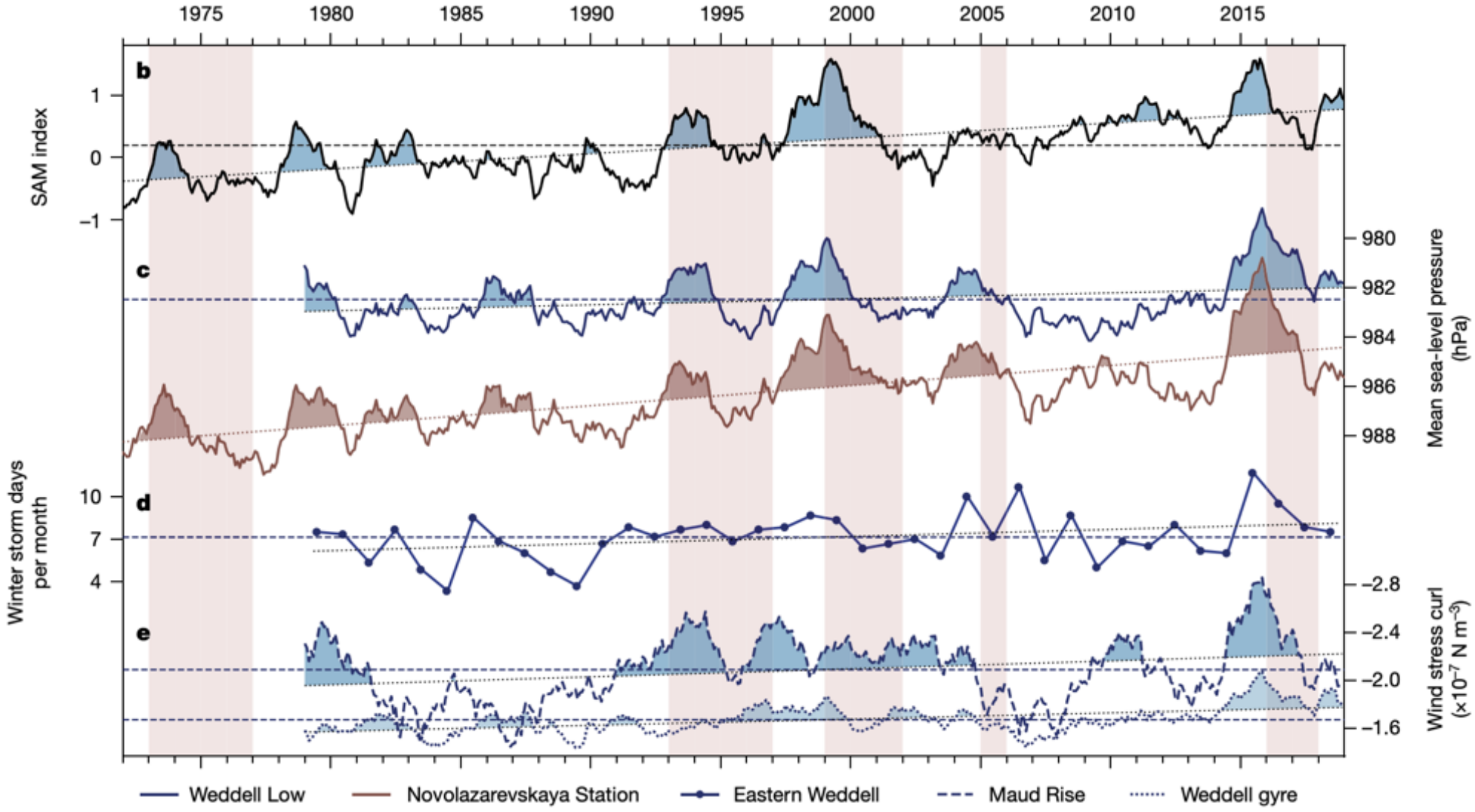
Cisewski.et.al (2011)





CESM-iHESP Simulation

Observed relationships between past open-ocean polynyas and wind-related variables

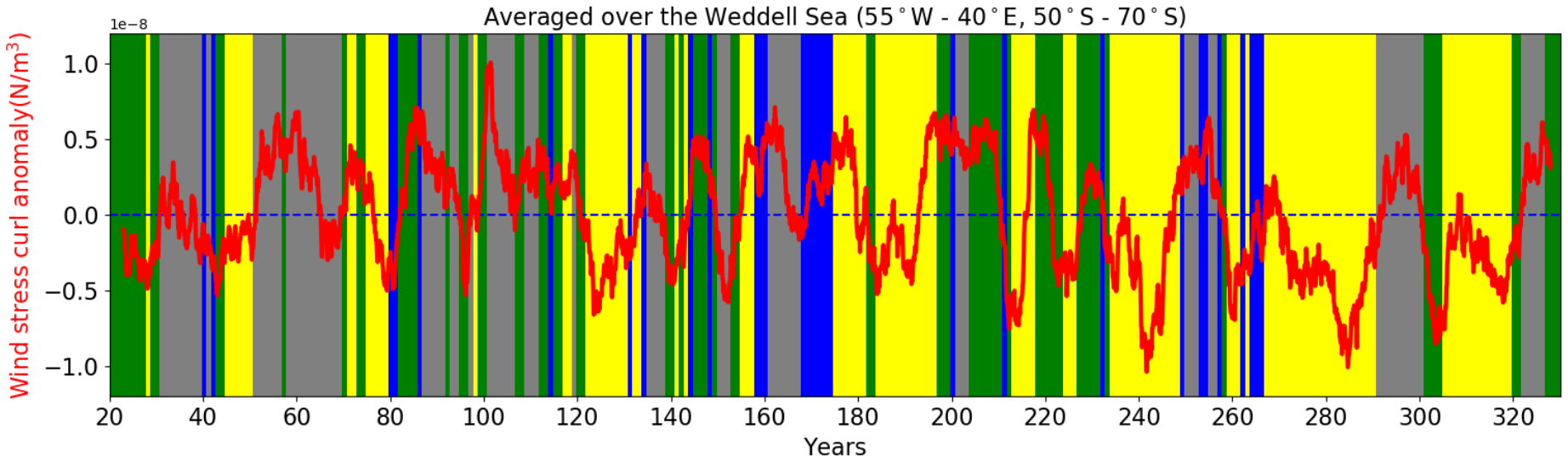


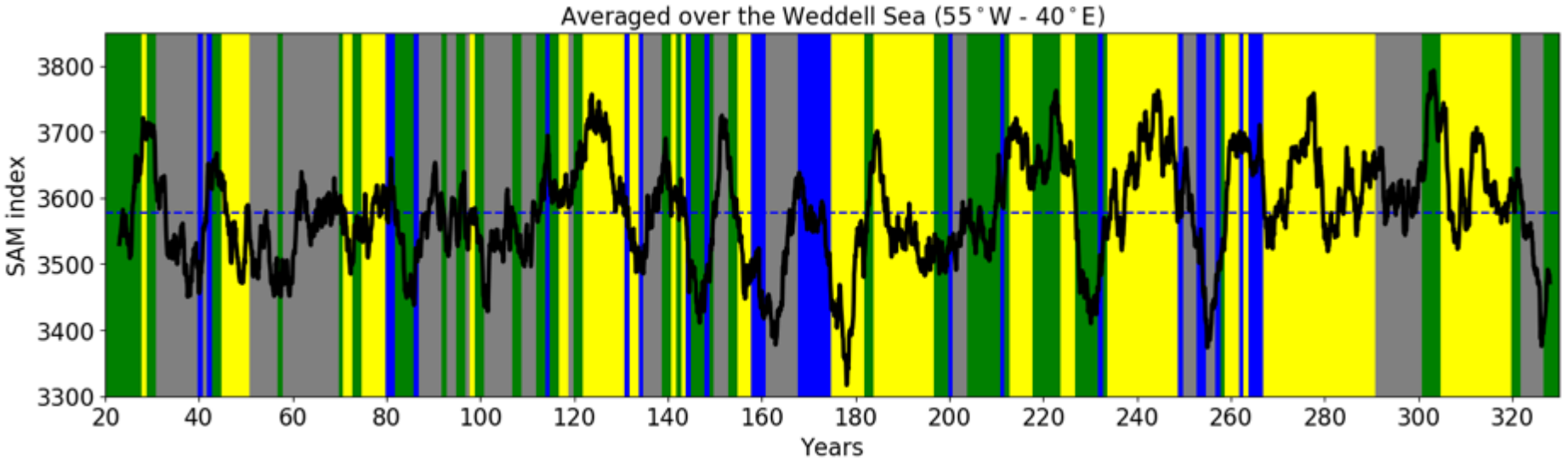
Observation

Campbell et al.(2019)

Simulated relationships between open-ocean polynyas and wind-related variables

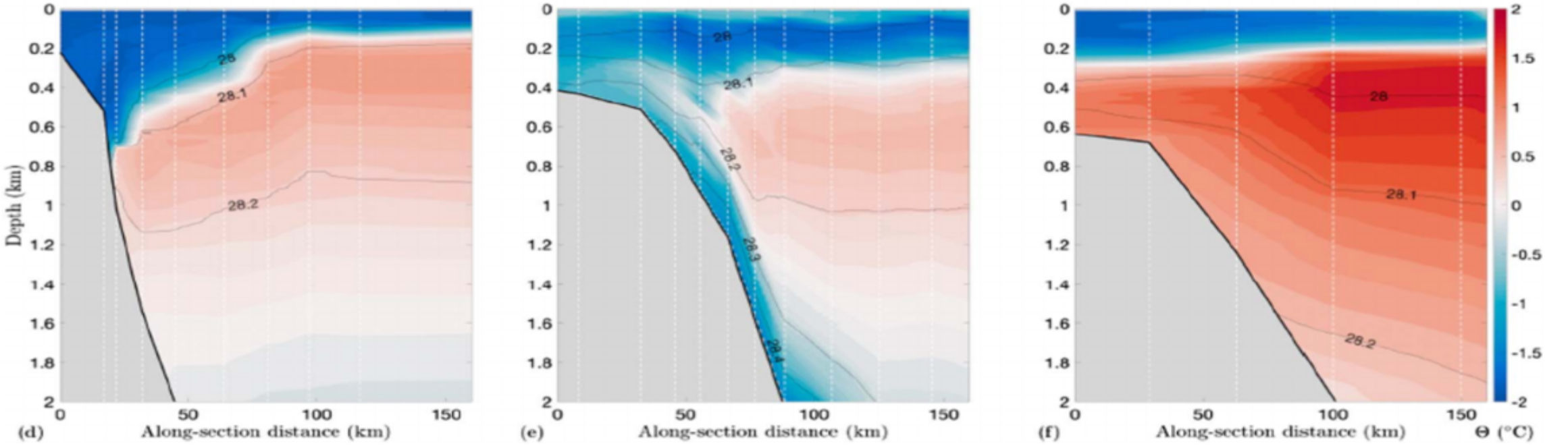
Weddell Sea Polynyas
No Polynyas
Maud Rise Polynyas
Astrid Ridge Polynyas





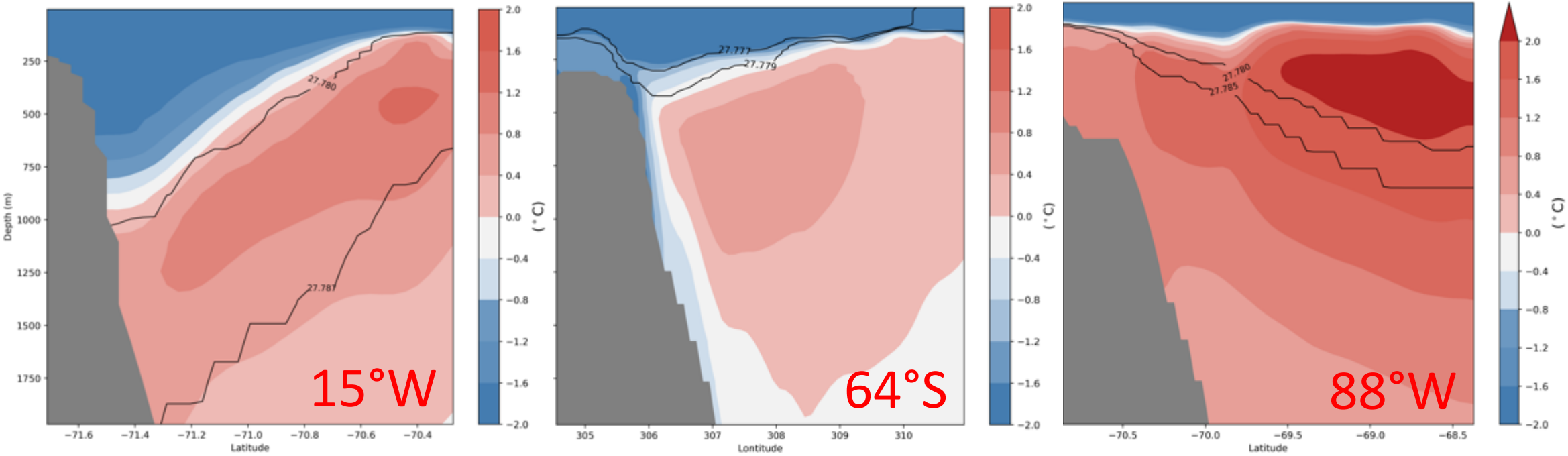
CESM-iHESP Simulation

Antarctic Slope Current



Observation

Thompson et al.(2018)



CESM-iHESP Simulation

Conclusions and future work

- CESM-iHESP simulation resolves processes that are critical for AABW formation, such as
  - Taylor cap effect over Maud Rise and Astrid Ridge
  - Intermittent expansion of MRPs into WSPs
  - Characteristic ASC regimes
- Wind stress curl anomaly and SAM index are correlated with occurrence of WSPs
  - This will systematically be analyzed when the whole 500 year model output becomes available
  - Explore the structure and variability of ASC and its possible effect on polynya and AABW formation (shelf-slope convection)
  - Investigate effect of intermittent occurrence of WSPs on AABW formation (open-ocean convection)

Thank you!

Any questions?