

Coupled impacts of sea ice thermodynamics due to Antarctic coastal ice production

Polar Climate Working Group Meeting – Winter 2021

Photo by M.E. Rhodes

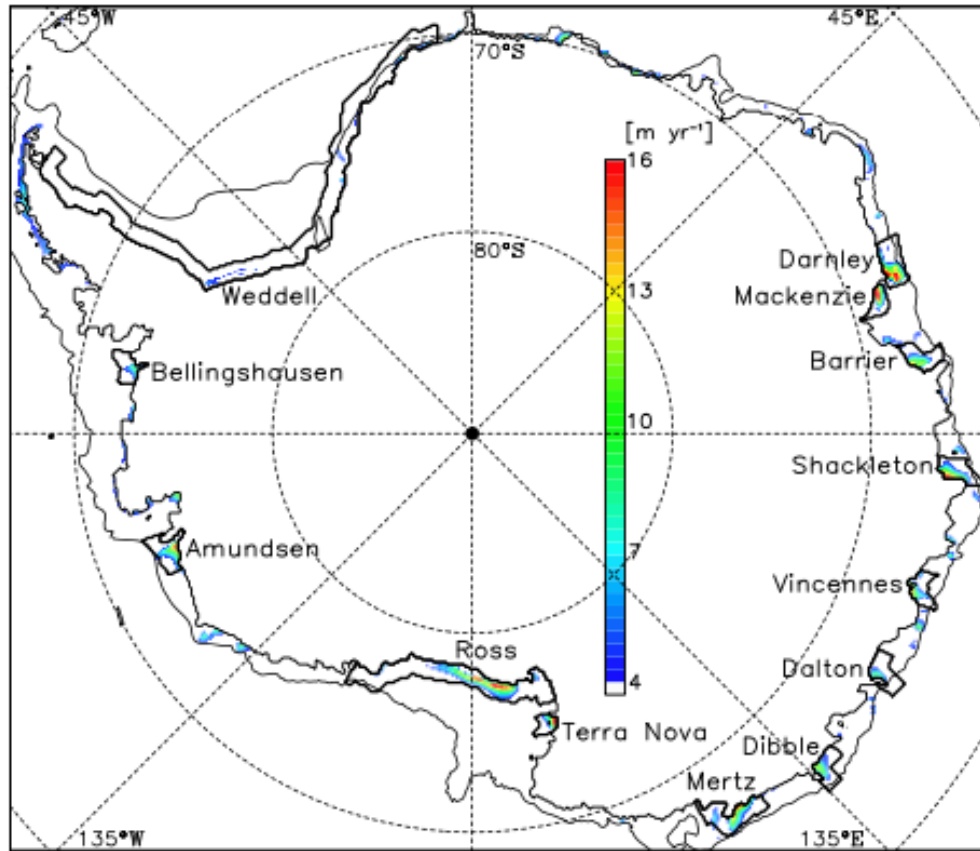


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Antarctic polynyas are important for both the physical system and the ecosystem.

- Polynyas are “sea ice factories” and location of Antarctic Bottom Water Formation.
- Polynyas are habitat for marine animals and phytoplankton.



Tamura et al. 2016

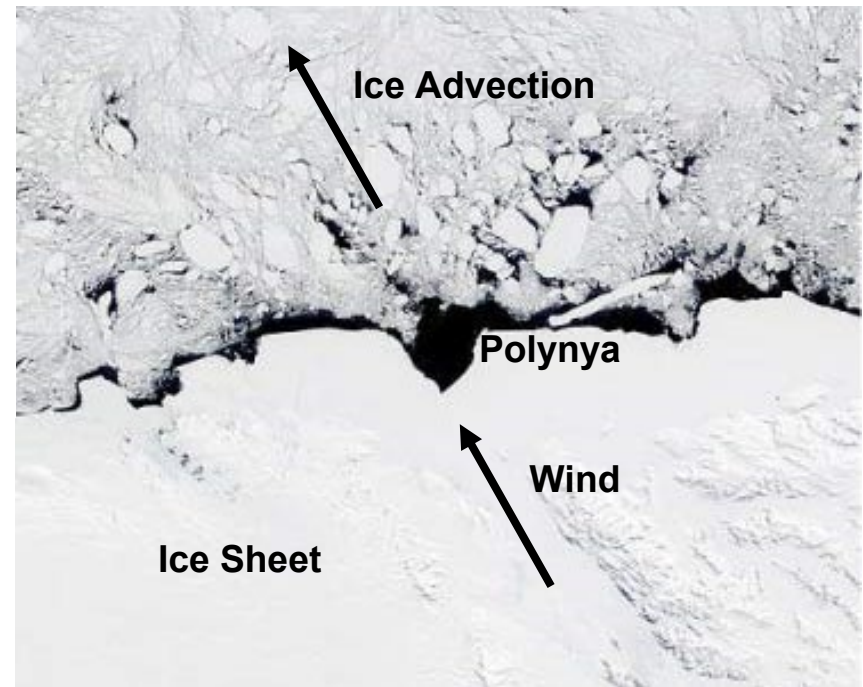


Image from NSIDC:
<https://nsidc.org/cryosphere/seaice/characteristics/polynyas.html>

CESM2 has significantly more frazil ice formation than CESM1, likely related to the change in thermodynamics to MUSHY.

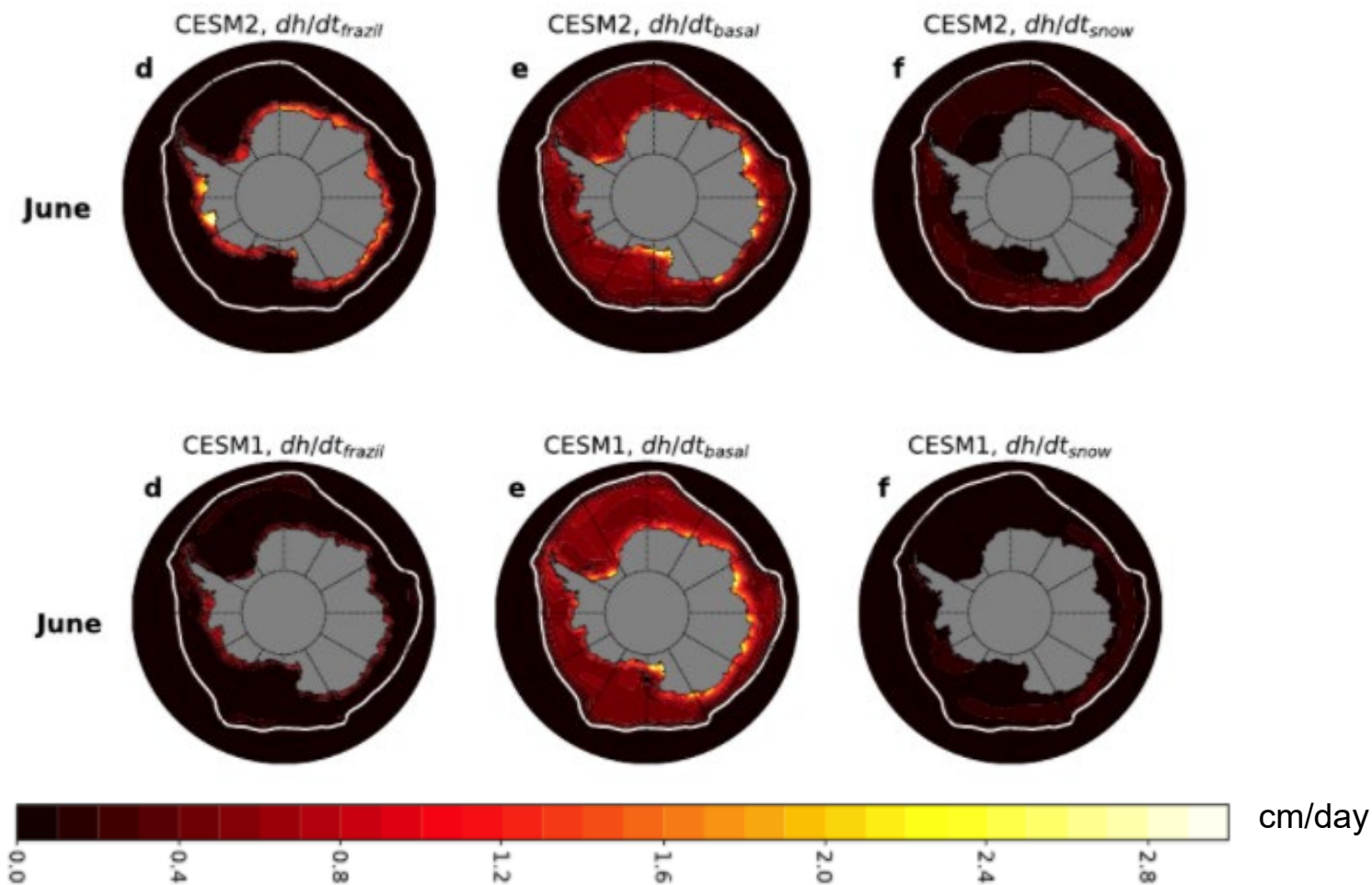


Image from Singh et al. 2020. An Overview of Antarctic Sea Ice in the CESM2: Analysis of the Seasonal Cycle, Predictability, and Atmosphere-Ocean-Ice Interactions. DOI: 10.1029/2020MS002143

Apples -to -apples comparison shows there are other differences in Antarctic coastal ice.

Difference: MUSHY – BL99

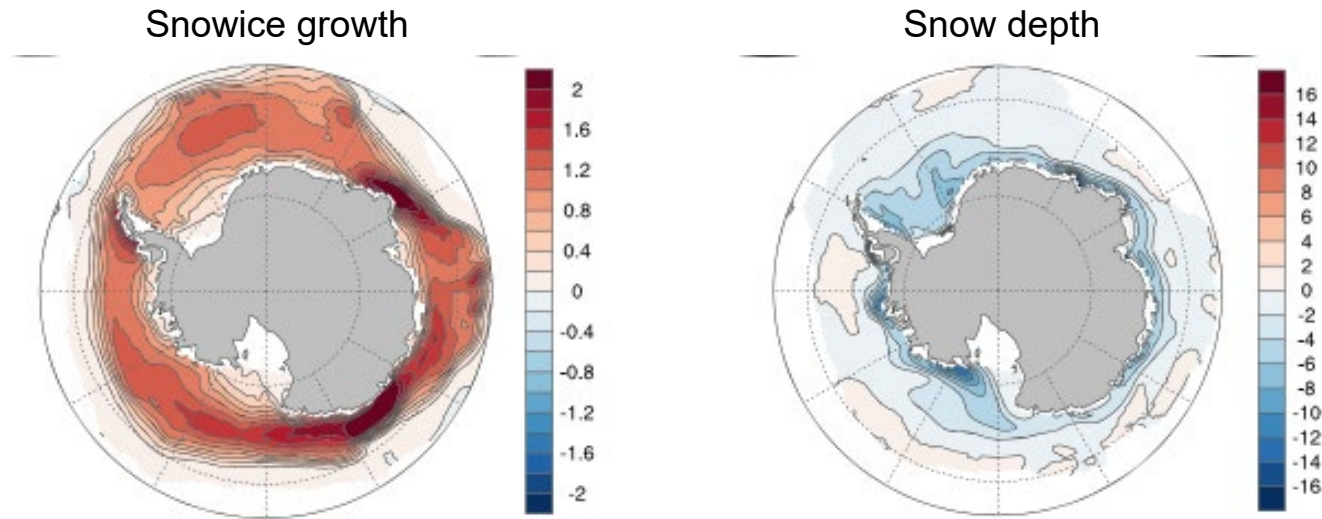


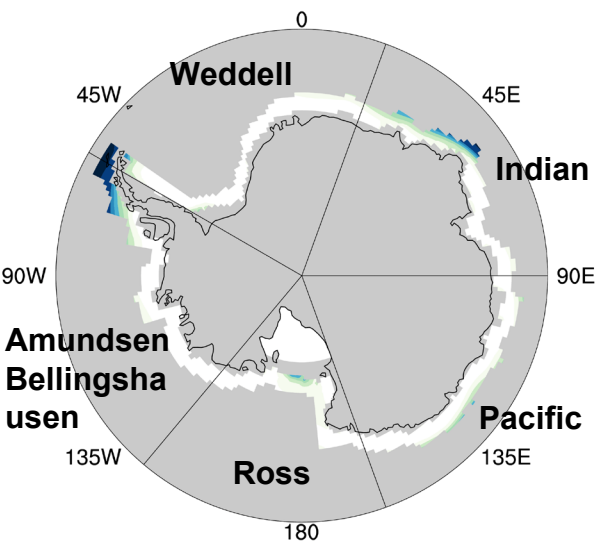
Image from Bailey et al. 2020. *Impact of Sea Ice Thermodynamics in the CESM2 sea ice component*. DOI: 10.1029/2020MS002154

Purpose of this study: to understand regional, seasonal, and coastal impacts of sea ice thermodynamics on the coupled system.

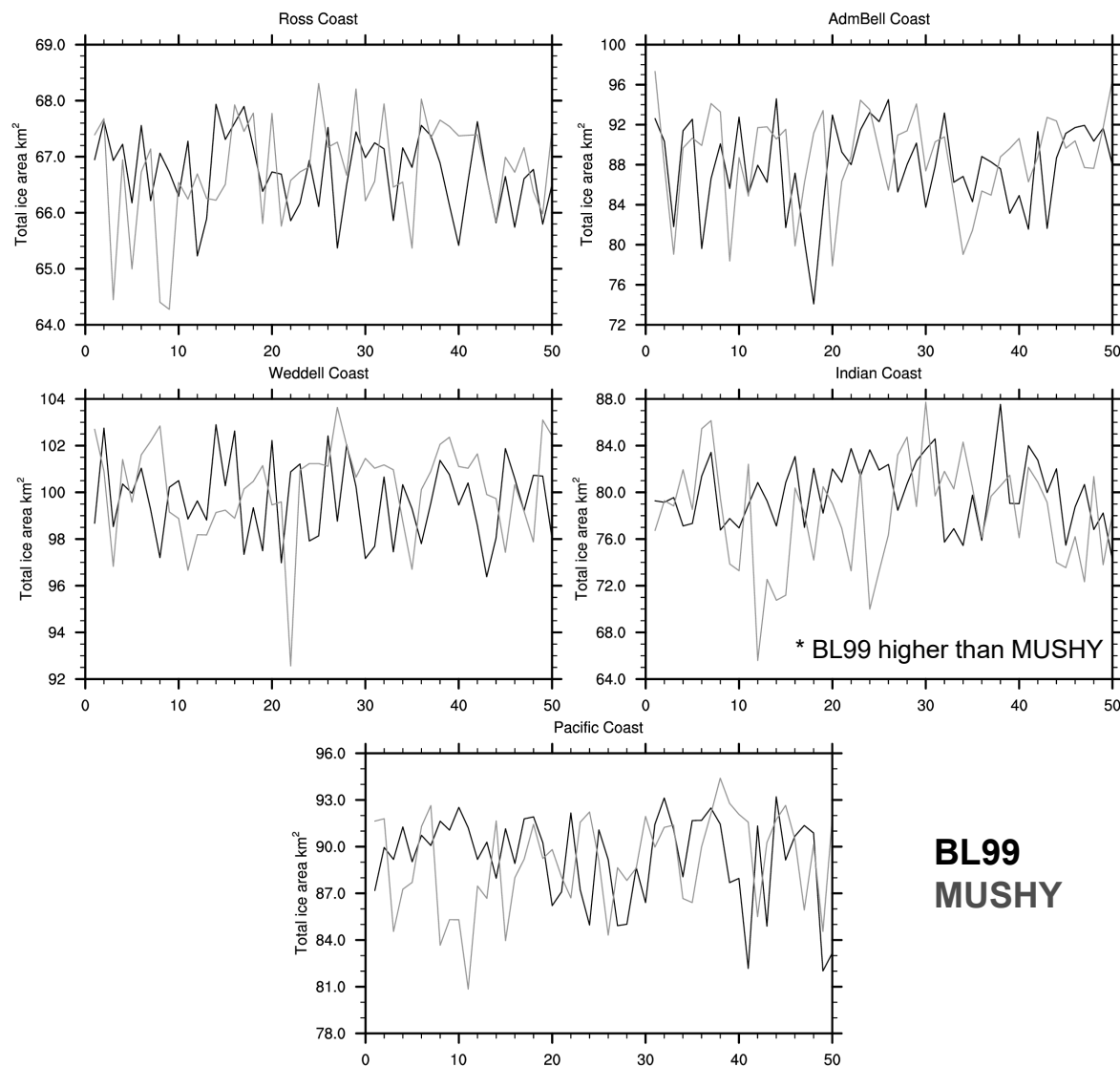
→ Use 50-year PI BL99 and MUSHY experiments Dave ran

Winter regional ice area and volumes are similar with both thermodynamics.

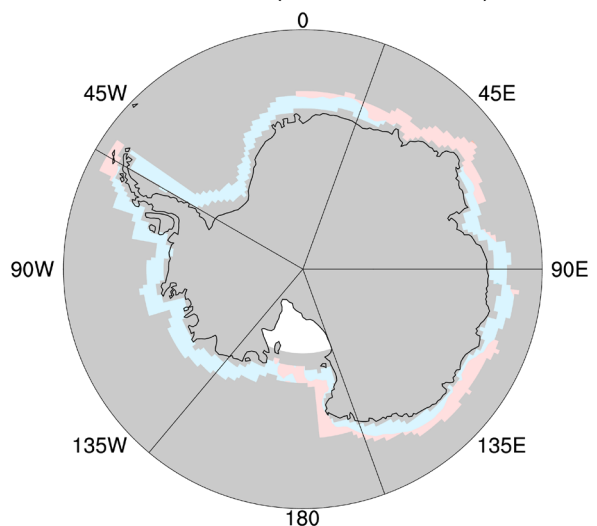
BL99 Winter - AMJJAS



Regional ice area AMJ



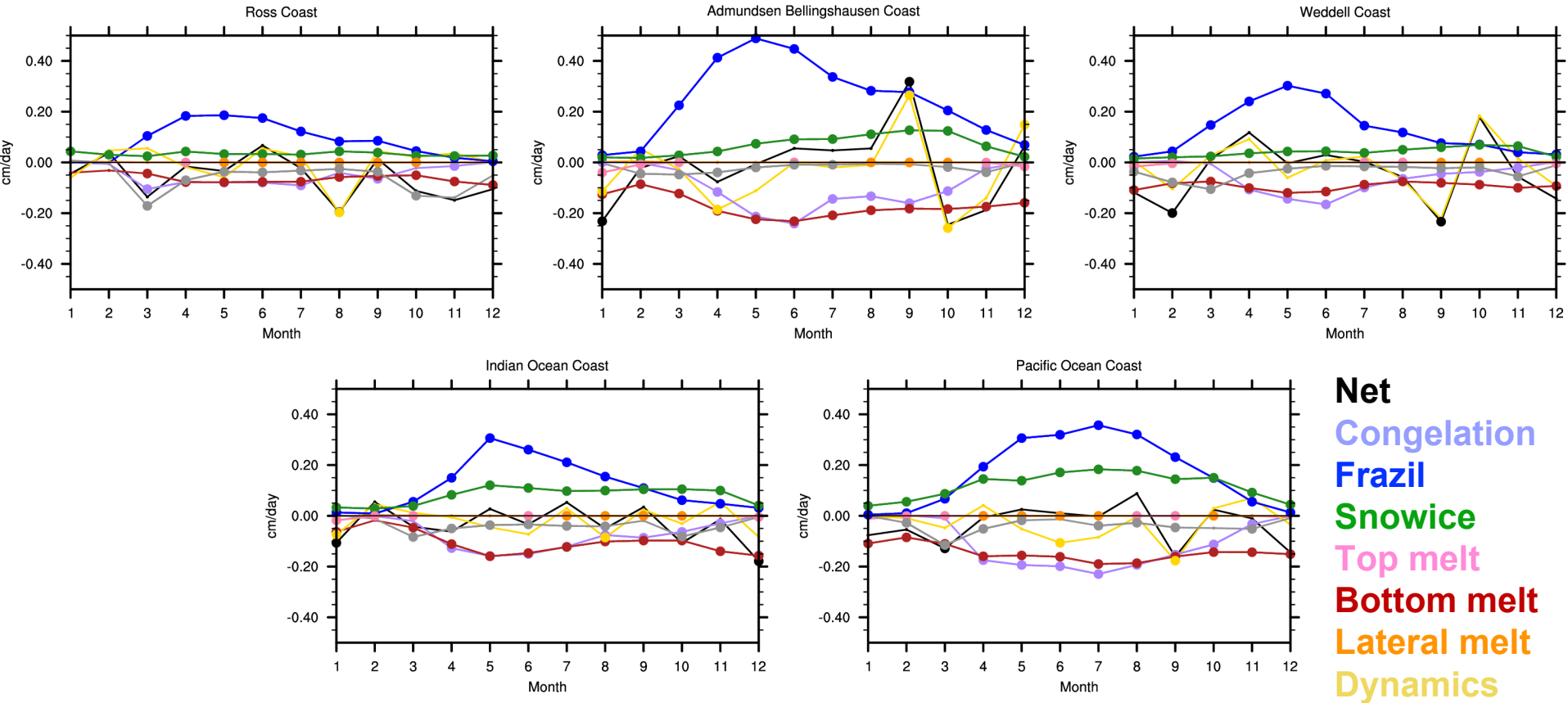
Winter Diff (MUSHY-BL99)



BL99
MUSHY

All regions have significant differences in ice growth terms, but net budget is not significantly different.

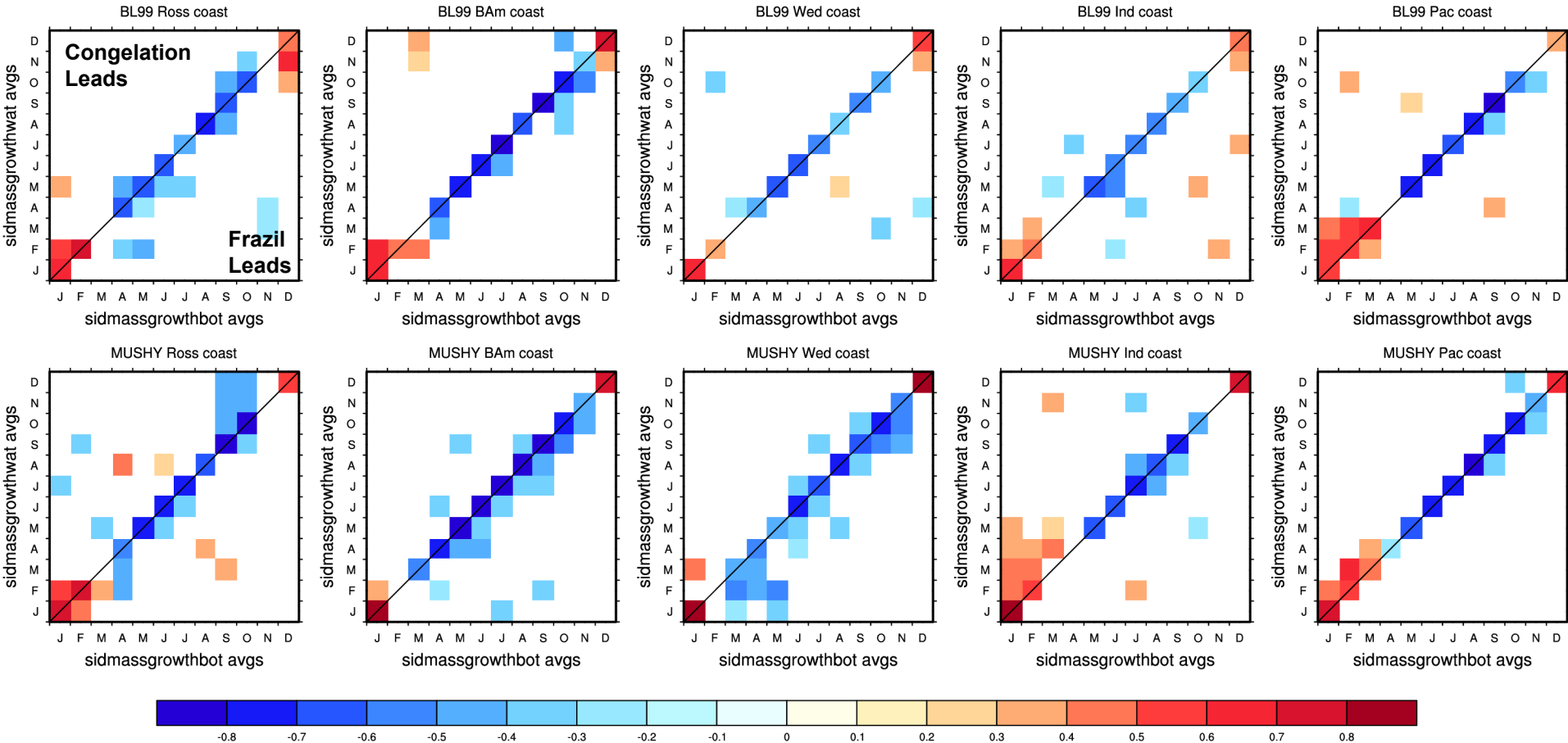
Mass Budget Differences (MUSHY-BL99)



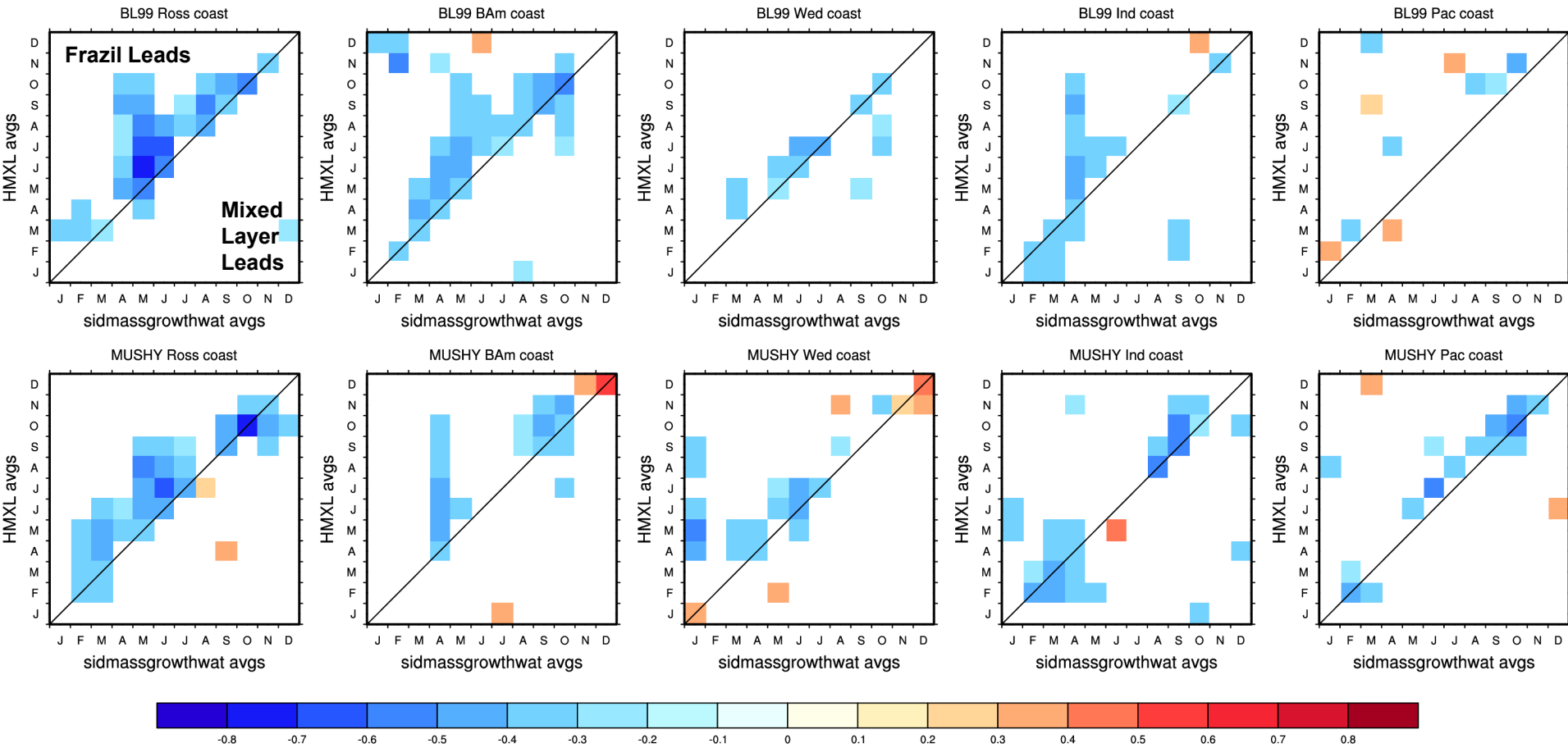
- MUSHY has an increase in frazil and snowice growth, and a decrease in congelation. MUSHY also has increase in bottom melt year round.

Frazil and Congelation growth are anticorrelated

→ we don't understand why yet.



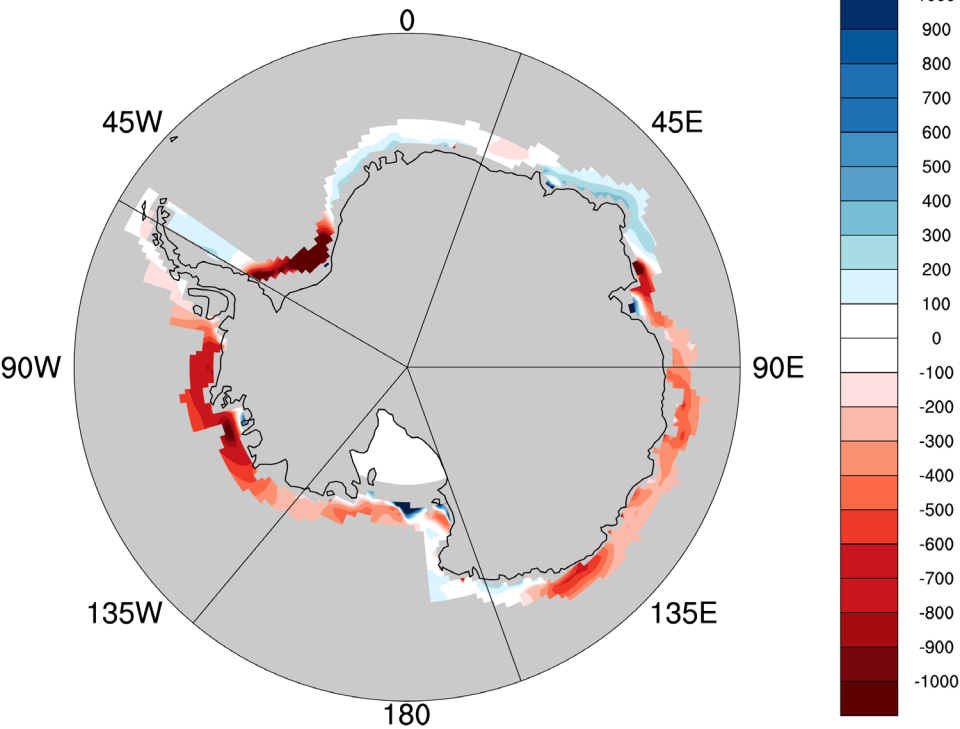
More frazil growth is associated with shallower ocean mixed layers in the same region.



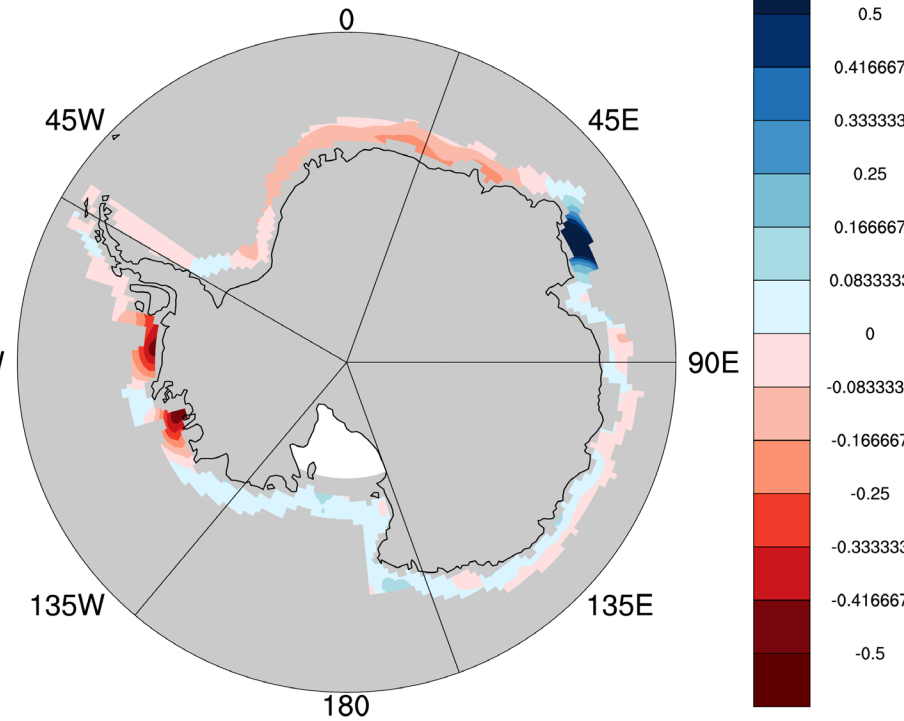
Correlations between congelation growth and ocean mixed layer depth is opposite.

Mixed layer depths winter mean and distributions

**Difference (MUSHY - BL99)
Mixed Layer Depth (m)**



**Difference (MUSHY - BL99)
200m Ocean Temperature (C)**



Atmospheric impact of thermodynamics



Oops! Something went wrong.

Atmospheric data were not kept!

We are re-running the PI experiments for 50 (100?) years with daily atmosphere, ocean, BGC, and sea ice data.

Arctic and Antarctic output will be available.



Outstanding questions

- Look over a range of timescales – weekly, monthly, seasonal
 - What are the important processes before/during/after a polynya event?
- Use LENS2 to investigate changes in time:
 - Coupled impacts on the atmosphere and ocean?
 - Do the mechanisms change over time?
 - How do different methods of polynya identification (e.g. ice production vs. concentration) affect categorization of the regions?
 - What are the implications on the biology in the region?

Arctic Shifts: An ArtScience project by Anna Lindemann



Anna is a Professor of Fine Arts at UConn who specializes in ArtScience work.

If you're interested in being a scientific subject matter expert and interested in consulting with the Artists, please contact Anna or Alice:

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Arctic Shifts is an animated short with music that focuses on complex changes in ecosystems and physical landscapes occurring in the Arctic, the region of our planet most affected by climate change. Through animation that ranges from phytoplankton life cycles to Arctic sea ice shifts over centuries, *Arctic Shifts* illuminates interconnected microscopic and macroscopic processes resulting from climate change. It will use NCAR climate data and will be displayed at the NCAR Mesa Lab for public viewing.



Thank you!

Questions?

The CESM project is supported primarily by the National Science Foundation (NSF). This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the NSF under Cooperative Agreement No. 1852977. Computing and data storage resources, including the Cheyenne supercomputer (doi:10.5065/D6RX99HX), were provided by the Computational and Information Systems Laboratory (CISL) at NCAR.



Photo by A. DuVivier