

Towards CESM3: Snow physics, waves, and fast ice, oh my.

Plans for CESM3 and beyond
CICE consortium updates

Working Group Meeting
March 2023

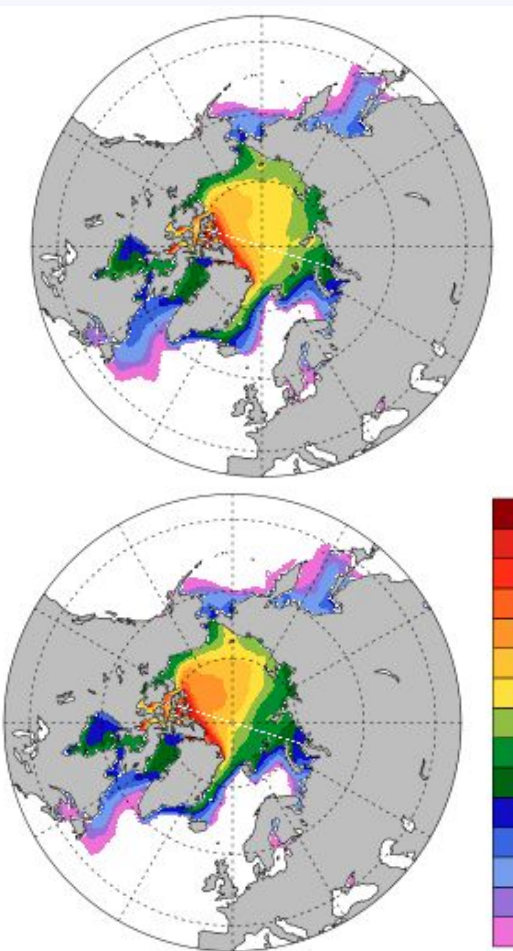
Plans for CESM3 and beyond

- Component models to be (nearly) ready by summer 2023
- Plan for sea ice within CESM3:
 - using new CICE6 model physics including: improved snow physics, landfast ice, floe-size distribution (improved wave-ice interactions)
 - Adding better ice-ocean freshwater / salt coupling (done!)
 - Adding C-grid capability
 - Inclusion of sea ice biogeochemistry and coupling to ocean
- Plans for CESM3+
 - Parameterizations of subgridscale snow heterogeneity
 - Improvements to albedo (optical properties of ponds, spectral resolution, etc.)
 - Improvements to pond parameterization (water retention on ice, etc.)
 - Others?
- DART Data assimilation capabilities and CICE.
 - A working interface between CICE and DART is available
 - The DART group is interested in whether there are additional cryospheric datasets that would be useful to support (ICESat-2, CryoSat-2???)

* Plan to return to these topics during discussion sessions

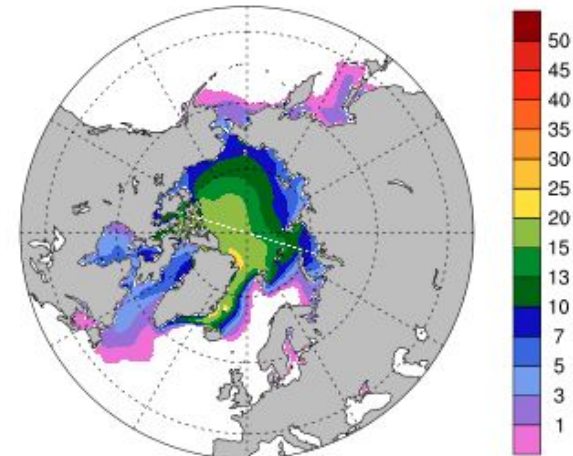
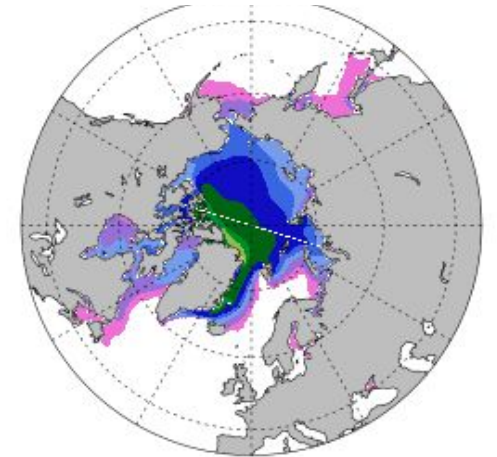
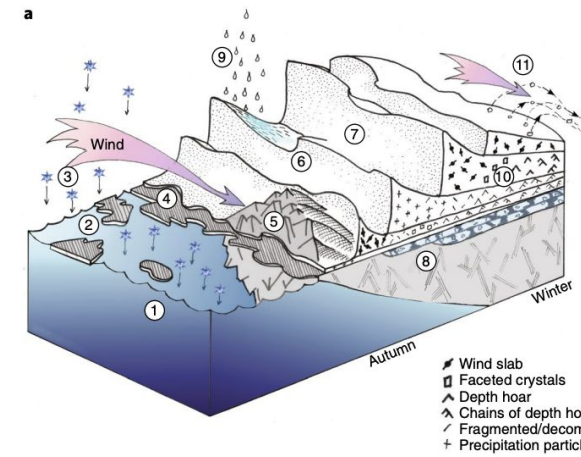
Coupled model (CESM3) validation.

- Run 100+ year fully-coupled 1850 control integration with base configuration in all component models.
- Perform sensitivity runs with each of the new physics options to assess the coupled model impacts.
- Labrador Sea problem: At the nominal one-degree resolution, the Labrador Sea is on the cusp of freezing over. Small perturbations allow it to stay ice free or freeze over.
- We have two 200+ year runs where the Labrador Sea is not frozen.



Advanced Snow Physics

- Snow redistribution (“bulk” or “ITD”): Snow loss to leads and movement from level to ridged ice. Compaction by wind.
- Ice and liquid mass in snow: Meltwater is still “virtual”.
- Metamorphosis of snow grains: Changes to snow grain radii used in dEdd shortwave scheme.
- Generally leads to thinner snow and thinner ice.
- One CESM3* simulation with advanced snow physics. Bug found in bulk redistribution where heat and water from snow lost to leads was not passed to the ocean.

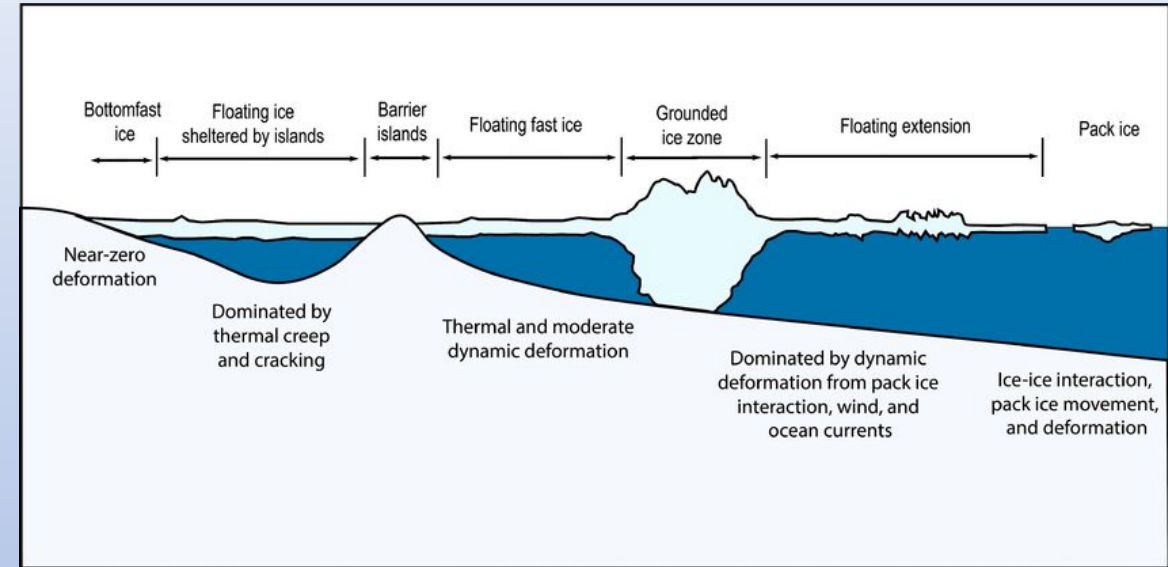


Landfast Ice / Seabed Stress Formulation

- Following Lemieux et al. 2016.
- ‘LKD’ or ‘probabilistic’ formulations.

$$h_c = a_i * h_w / k1$$

where k1 is a tuning parameter.



- POP minimum depth was 30m. MOM6 minimum depth is 10m.
- Need subgridscale min/max depth with variance for the ‘probabilistic’ formulation.

Floe-Size Distribution (FSD) – Wave Interaction

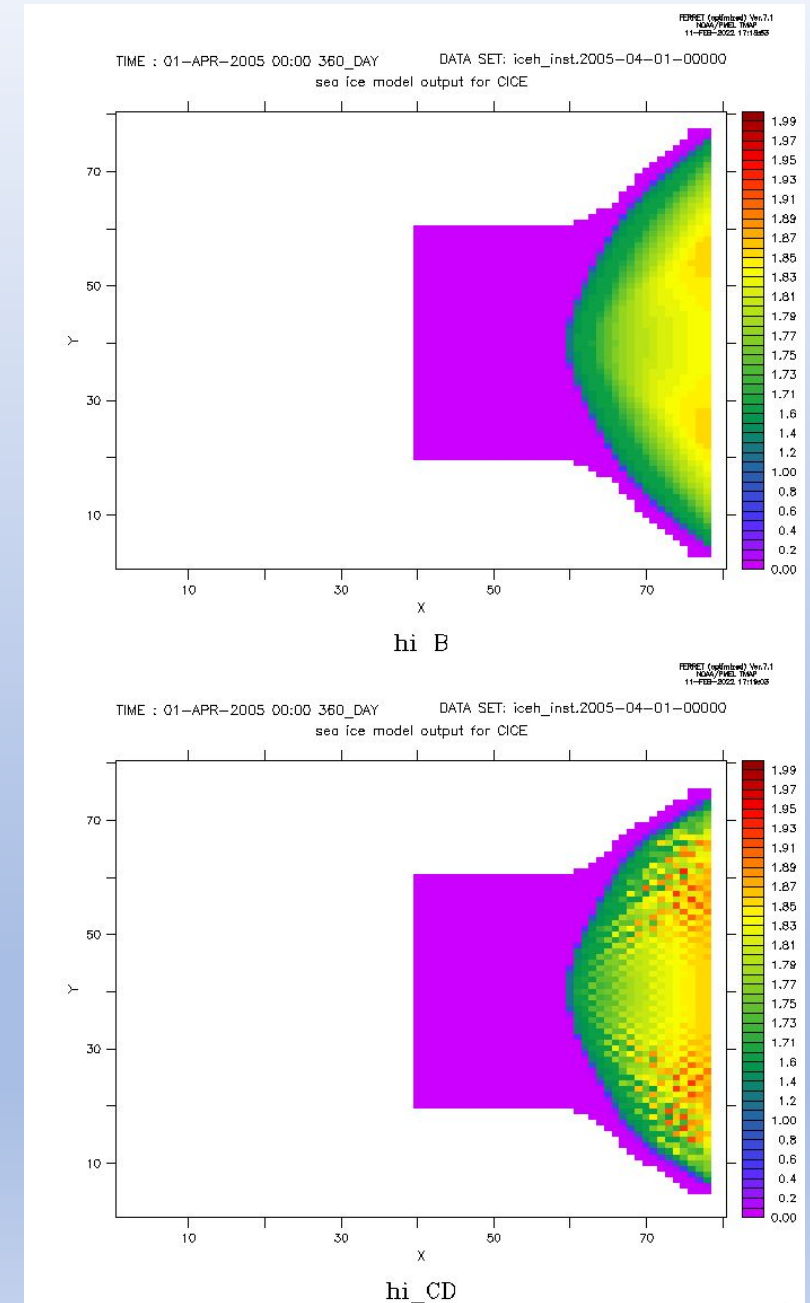
- Joint FSD / Ice Thickness Distribution (ITD)
- 12 FSD categories and 5 ITD categories
- Lettie Roach and Cecilia Bitz have a version running with CESM2 (CICE5).
- Need coupling of wave-energy spectrum from wave model.
- Remaining issues: Significant wave height; Resolution / Cost of WAVEWATCH3.



CICE Consortium updates.

CICE6.4.1 and Icepack 1.3.3 recently released.

- C-grid officially released*
- Some features deprecated (CESM ponds, Z-salinity)
- Prognostic salt flux option
- SNICAR based radiation options in dEdd
- Idealized domain test cases
- CICE User's Group Meeting in Fall 2023



Next Steps

- New CESM3* coupled run.
- Redesigned 2/3 degree tripole grid: More points in latitude direction; closing off some bays.
- BGCWG doing some exploration into coupling of ocean / sea ice BGC.
- CICE / Icepack in a container!