

The Los Alamos Sea Ice Model (CICE5)

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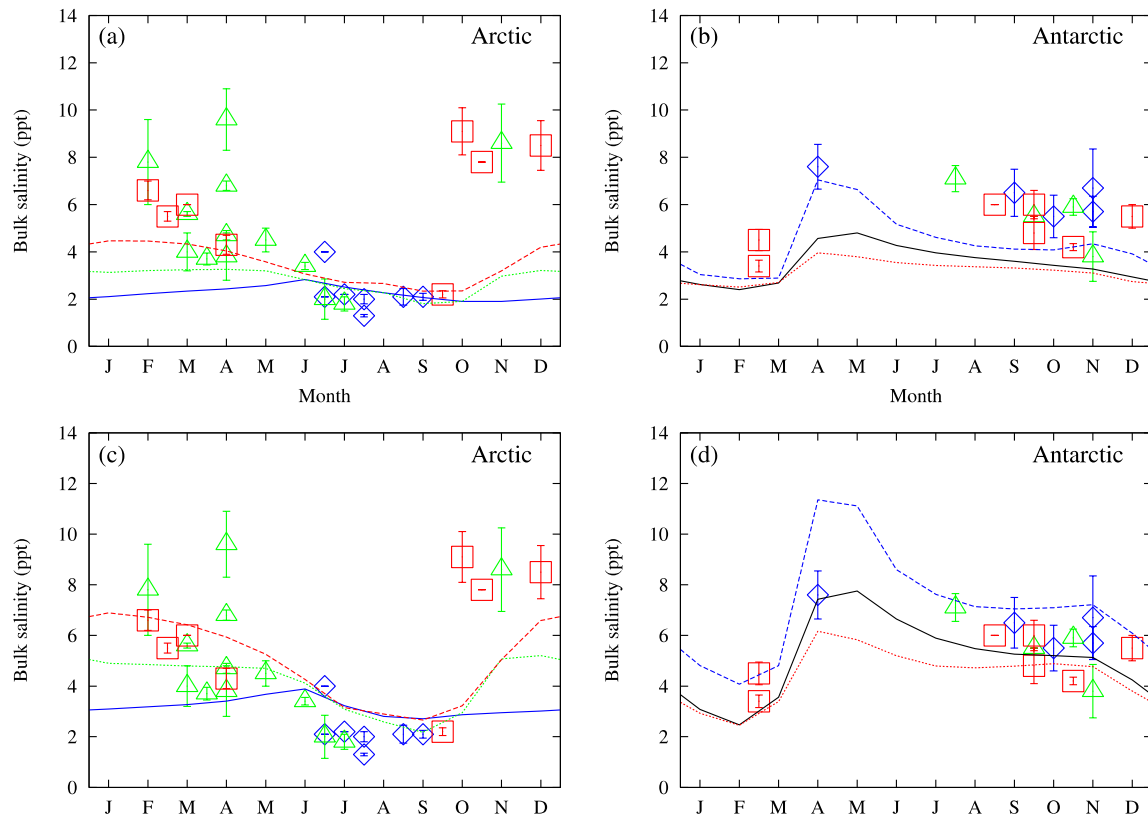
Anthony Craig, FA

CICE₅

- Same infrastructure as CICE₄
- New thermodynamics, dynamics, melt pond, and BGC options.
- Initial configuration will be same as CICE₄ and will be in cesm1_3_beta21. Many thanks to Tony Craig!
- Not bfb, but same climate as CICE₄.

PCWG Priorities

- New mushy-layer (ML) thermodynamics (Turner and Hunke, submitted)
- Elastic-Anisotropic (EAP) dynamics (Tsamados et al. 2012)
- Form drag at atmosphere-ice interface (Hunke et al.)
- Snow on sea ice processes
- Ponds
- Vertical levels and subgridscale categories.



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$$\rho c \frac{\partial T}{\partial t} = \frac{\partial}{\partial z} \left(K \frac{\partial T}{\partial z} \right) + F, \quad (1)$$

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where z is the vertical coordinate, defined to be positive downward with $z = 0$ at the

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top surface, ρ is a fixed sea-ice density, c is the specific heat of sea ice, K is the thermal

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conductivity of sea ice, F is the absorbed shortwave radiation. The specific heat, c , is

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given by the approximation of *Ono* [1967]

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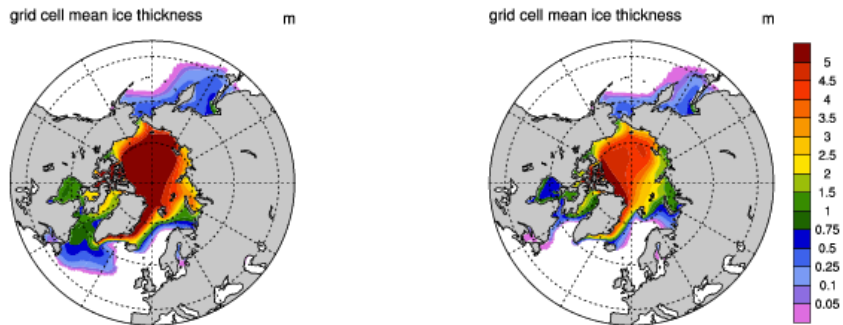
$$c(T, S) = c_0 + \frac{L_0 \mu S}{T^2}, \quad (2)$$

where L_0 is the specific latent heat of fusion at 0°C, μ is the latent heat of fusion of fresh ice,

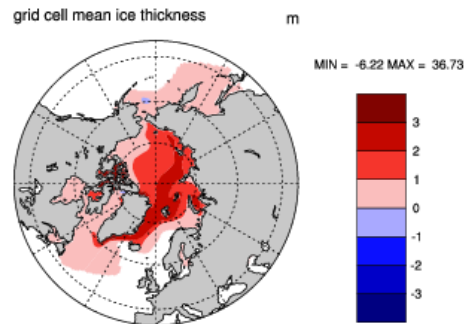
ML Thermo

ANN Mean

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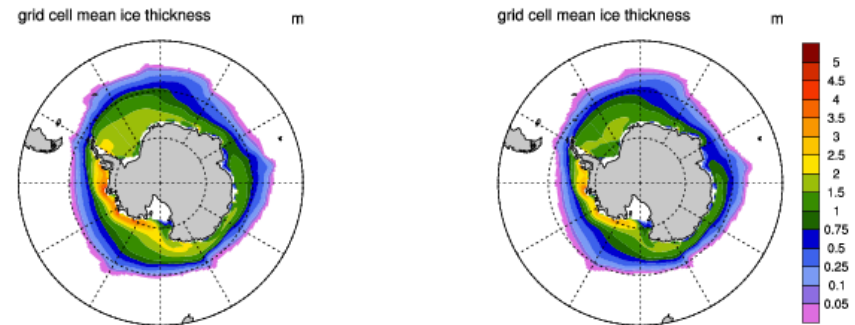


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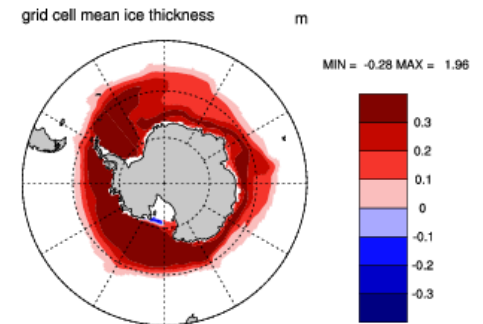


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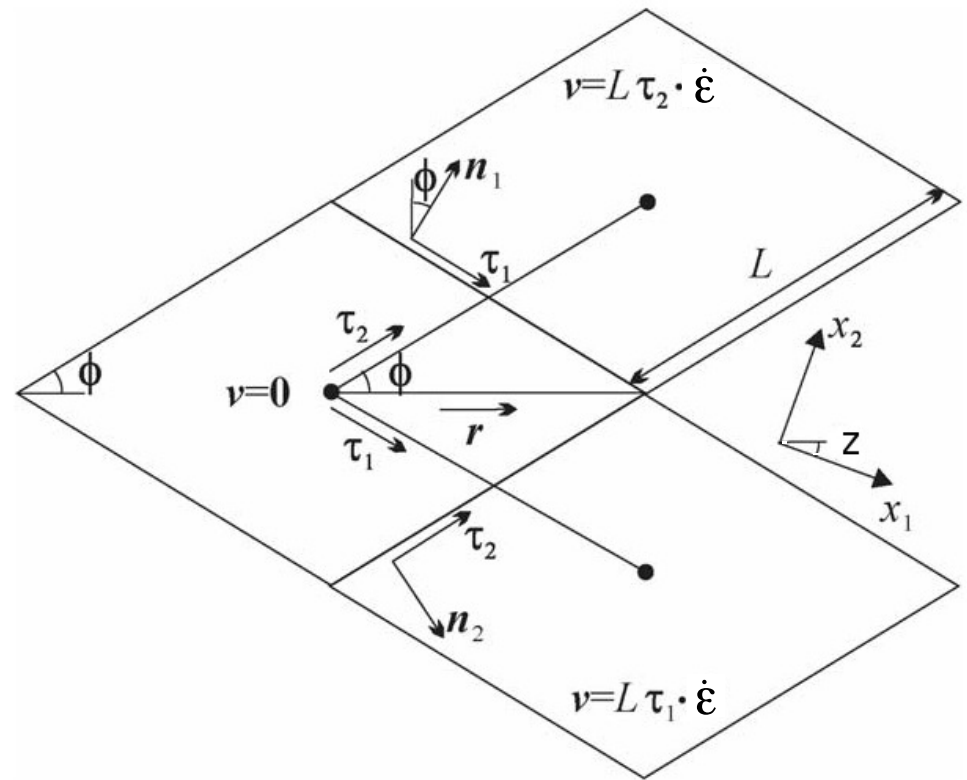
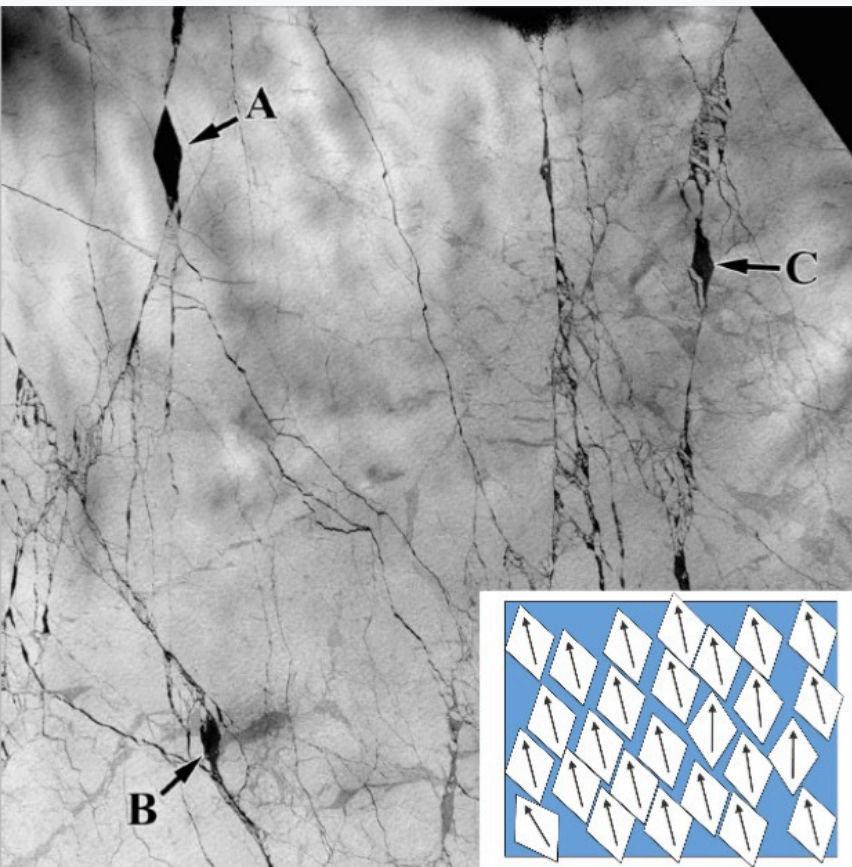
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b.e13.B1850C5CN.f09_g16.cice5.004 - b.e13.B1850C5CN.f09_g16.cice5.001



Elastic-Anisotropic Sea Ice



EAP Dynamics

ANN Mean

ANN Mean

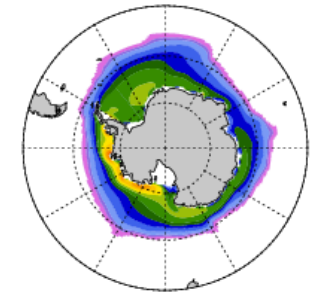
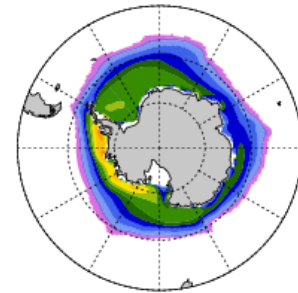
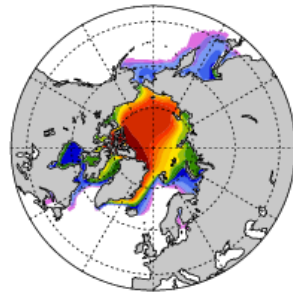
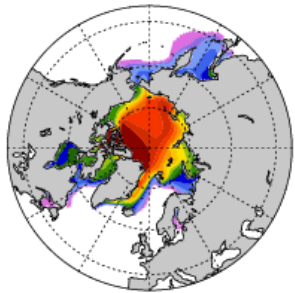
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grid cell mean ice thickness m

grid cell mean ice thickness m

grid cell mean ice thickness m

grid cell mean ice thickness m

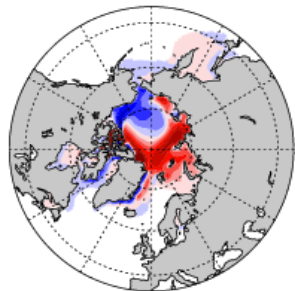


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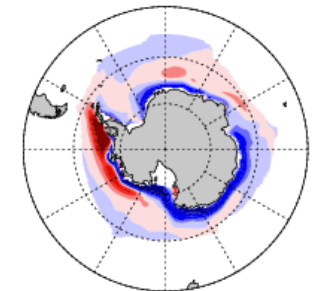
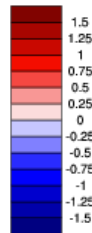
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grid cell mean ice thickness m

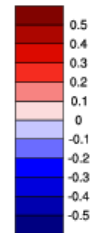
grid cell mean ice thickness m



MIN = -11.33 MAX = 10.23



MIN = -1.55 MAX = 5.78

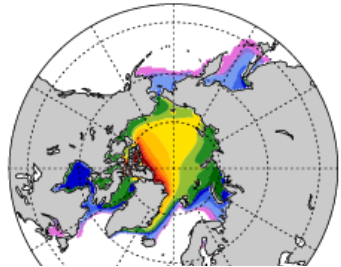


Snow patchiness

NH
ANN Mean

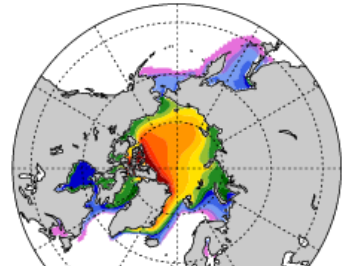
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grid cell mean ice thickness m

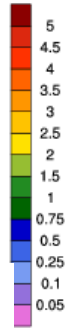


hs0 = 0.1

grid cell mean ice thickness m



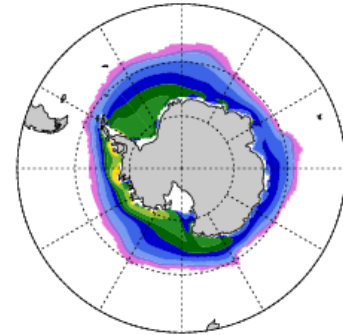
hs0 = 0.03



SH
ANN Mean

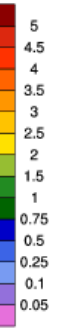
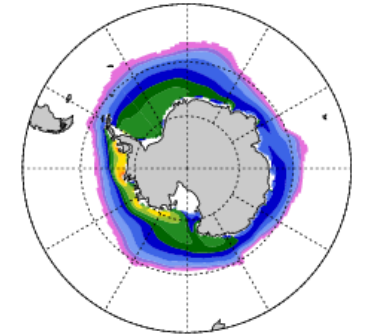
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grid cell mean ice thickness m

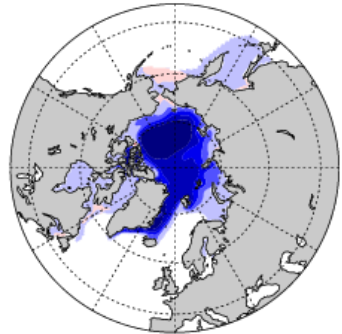


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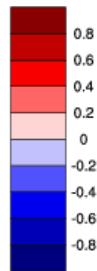
grid cell mean ice thickness m



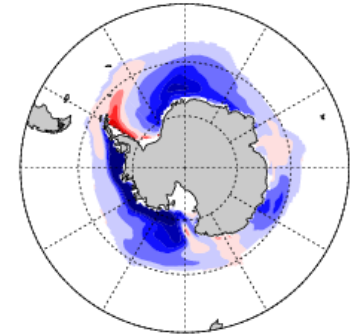
grid cell mean ice thickness m



MIN = -4.38 MAX = 0.27



grid cell mean ice thickness m



MIN = -0.77 MAX = 0.68



$$\text{snow_fraction} = \min(\text{hs}/\text{hs0}, 1.0)$$

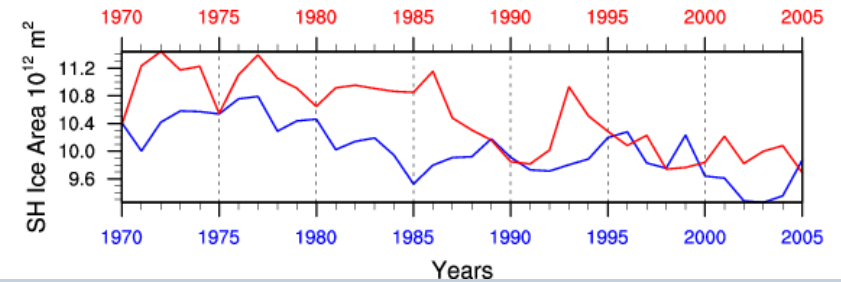
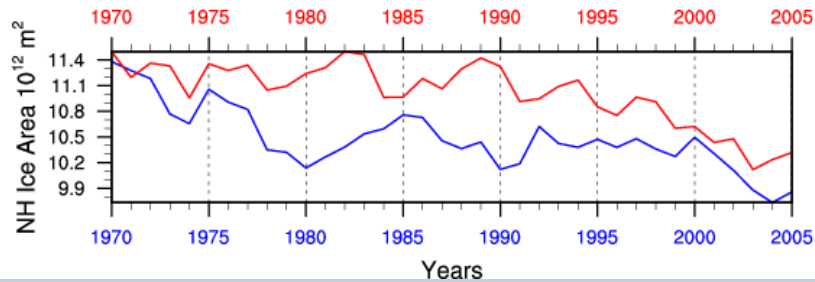
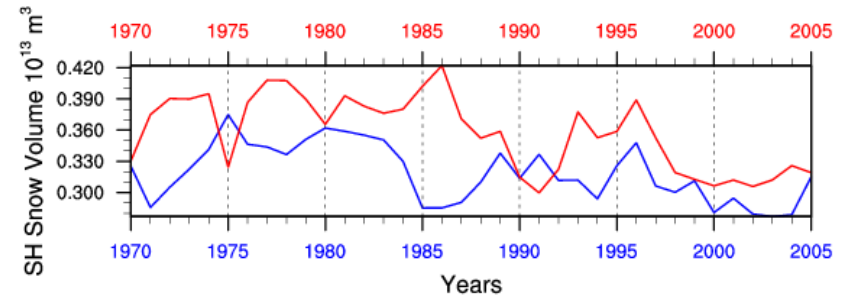
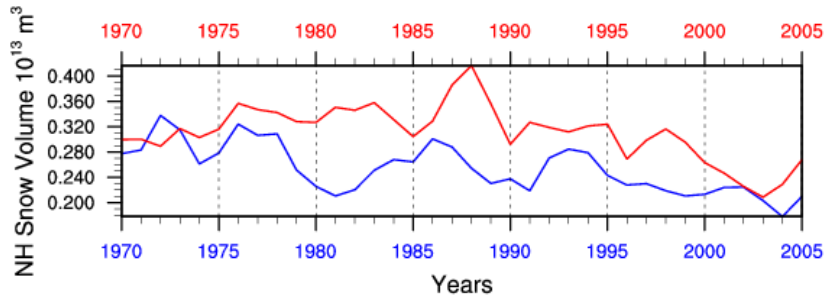
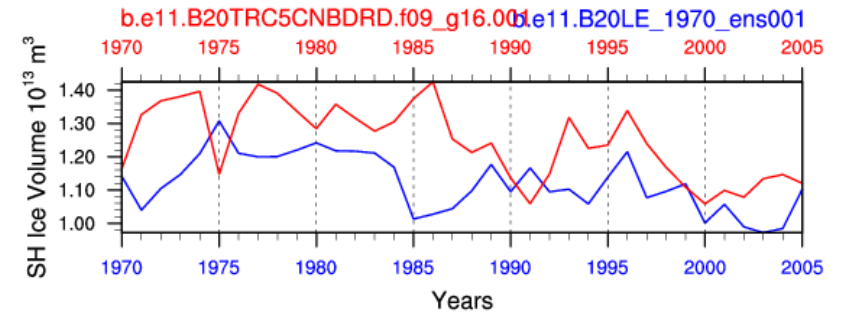
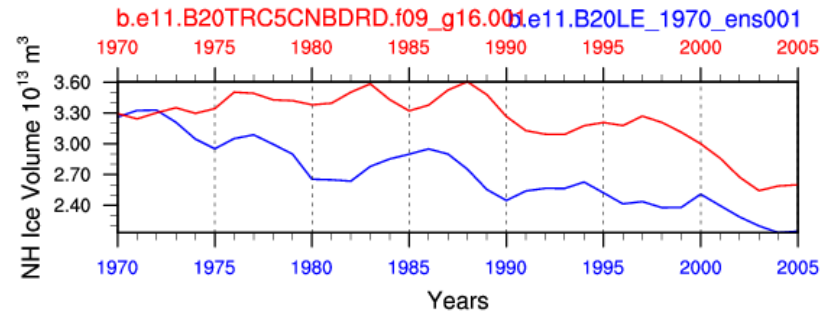
Snow patchiness

NH

SH

ANN Mean b.e11.B20LE_1970_ens001-b.e11.B20TRC5CNBDRD.f09_g16.001

ANN Mean b.e11.B20LE_1970_ens001-b.e11.B20TRC5CNBDRD.f09_g16.001



hs0 = 0.1

hs0 = 0.03

Summary

- Sensitivity with CAM5.1 in 1850 controls. What about CAM5.4/6? Transient?
- EAP tends to thicken the thicker ice by slowing it down. Better for higher resolution simulations.
- CESM1.3 will have CICE5 configured the same as CICE4, but with the optional physics.
- While ML tends to thicken ice, it is better physics. More stable solution and needed for BGC.
- Pond Drainage

CICE₅ versus CICE₄

Other issues/Tuning:

- Snow Infiltration
- Pond drainage
- Snow grain radius/melt temperature