The Los Alamos Sea Ice Model (CICE5)

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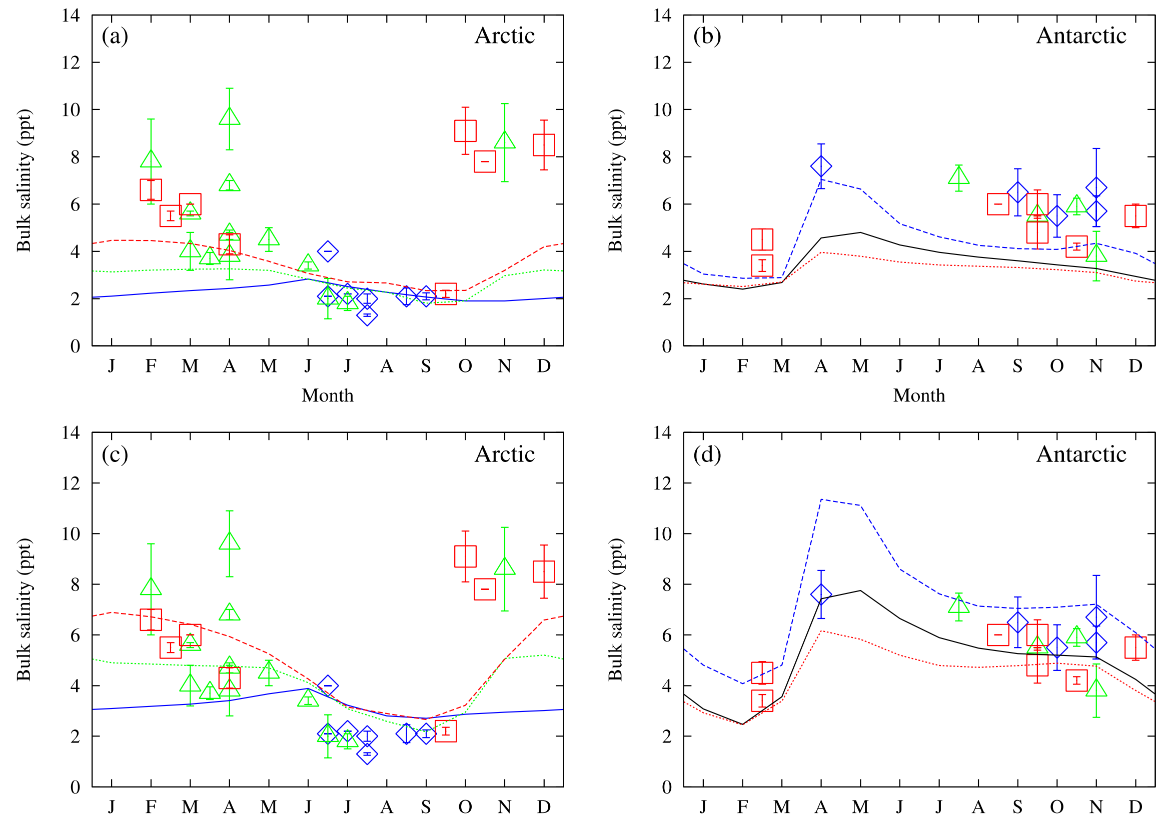
NCAR is sponsored by the National Science Foundation.
D. Bailey is funded by OPP.

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_beta16. 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.

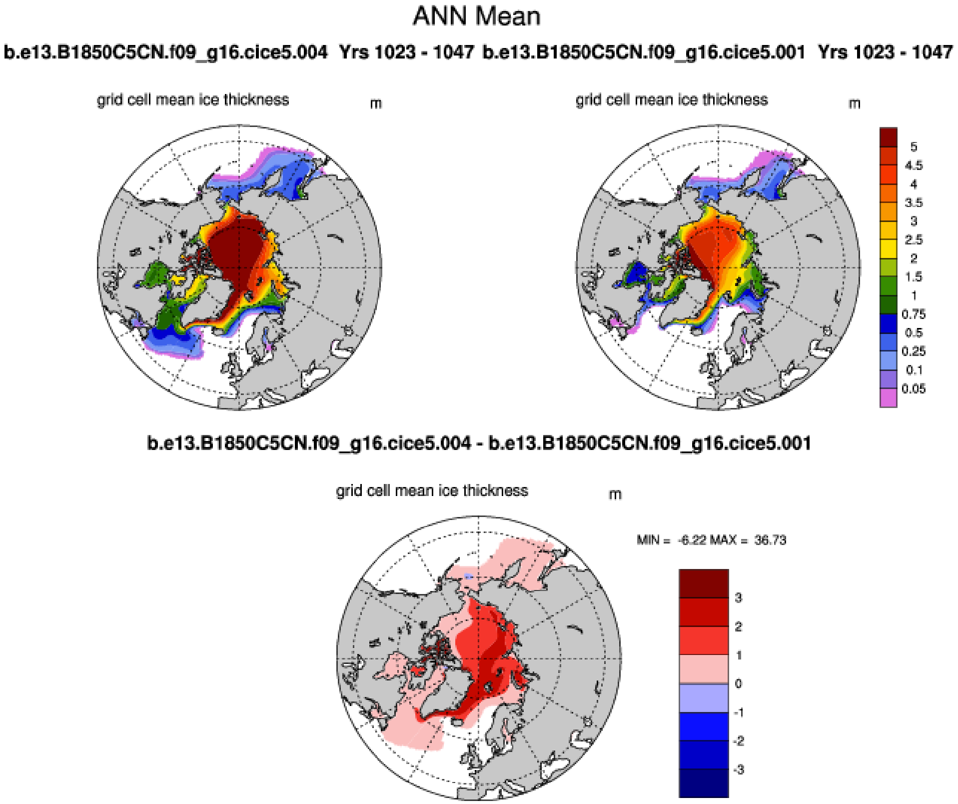


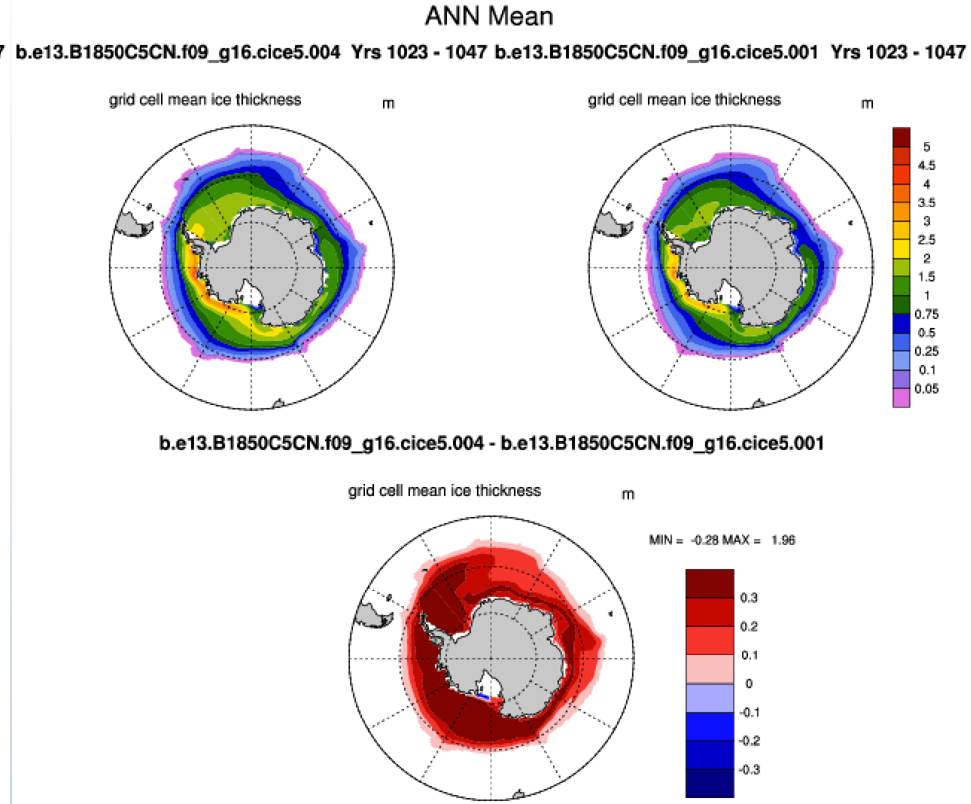
$$\rho c \frac{\partial T}{\partial t} = \frac{\partial}{\partial z}\left(K \frac{\partial T}{\partial z}\right) + F, \tag{1}$$

where z is the vertical coordinate, defined to be positive downward with $z = 0$ at the top surface, ρ is a fixed sea-ice density, c is the specific heat of sea ice, K is the thermal conductivity of sea ice, F is the absorbed shortwave radiation. The specific heat, c, is given by the approximation of *Ono* [1967]

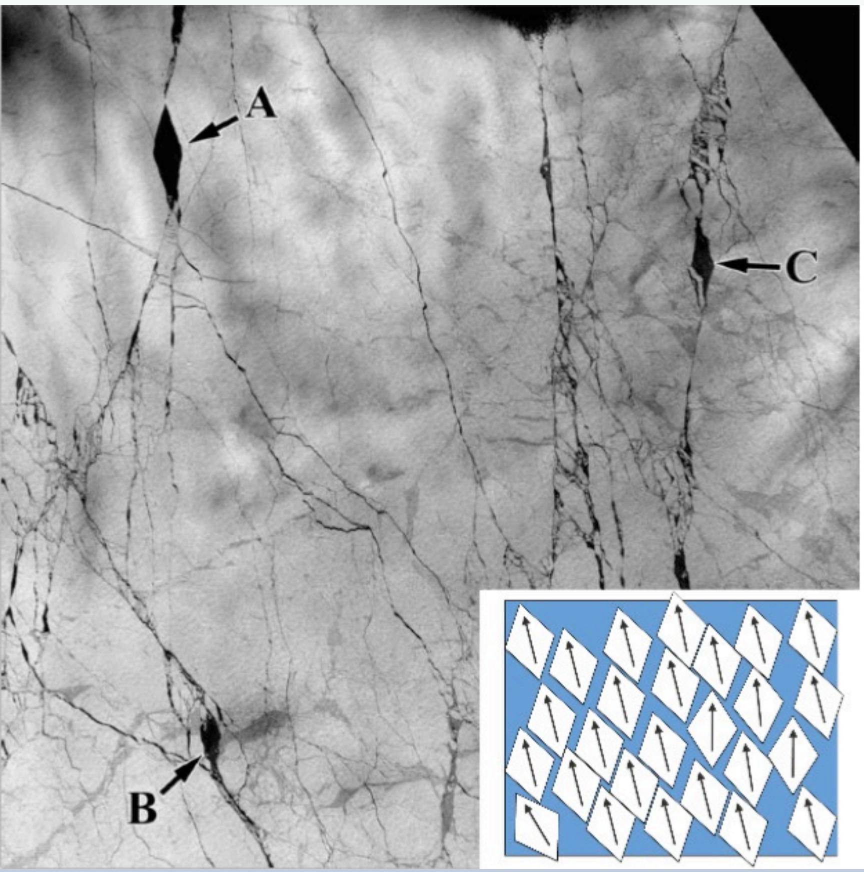
$$c(T, S) = c_0 + \frac{L_0 \mu S}{T^2}, \tag{2}$$

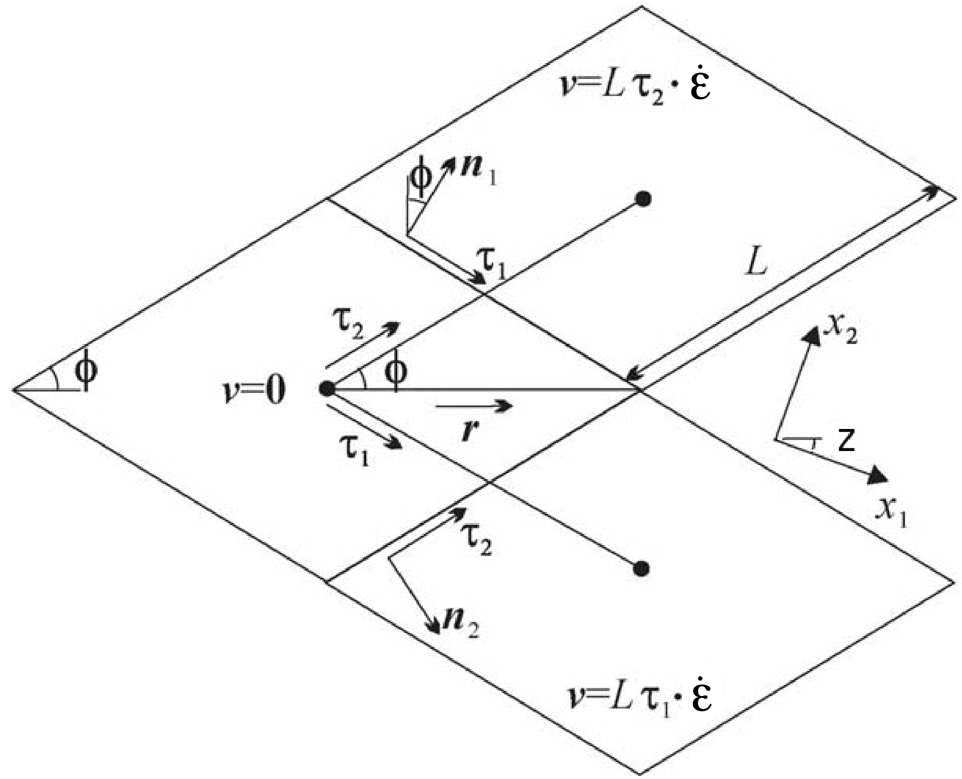
ML Thermo


ANN Mean
b.e13.B1850C5CN.f09_g16.cice5.004 Yrs 1023 - 1047 b.e13.B1850C5CN.f09_g16.cice5.001 Yrs 1023 - 1047
grid cell mean ice thickness
m
grid cell mean ice thickness
m
5
4.5
4
3.5
3
2.5
2
1.5
1
0.75
0.5
0.25
0.1
0.05
b.e13.B1850C5CN.f09_g16.cice5.004 - b.e13.B1850C5CN.f09_g16.cice5.001
grid cell mean ice thickness
m
MIN = -6.22 MAX = 36.73
3
2
1
0
-1
-2
-3

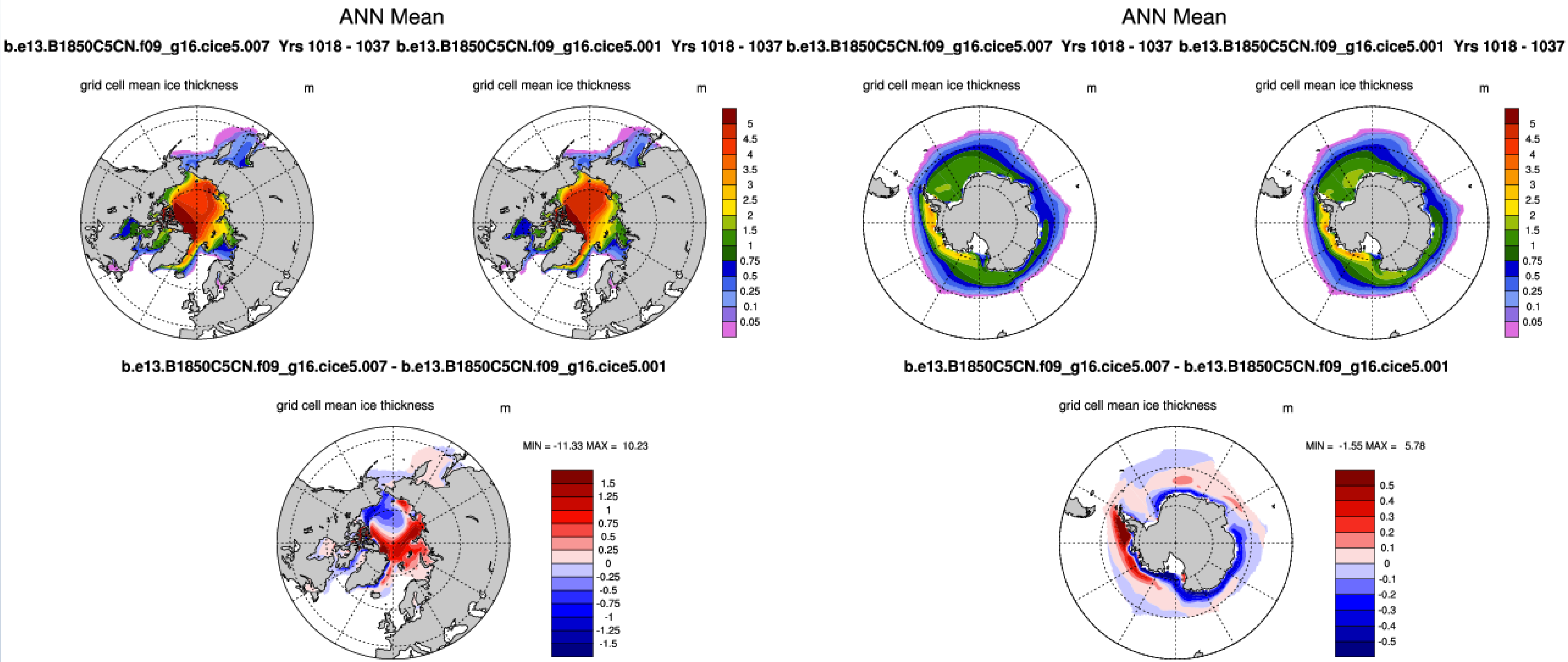

ANN Mean
b.e13.B1850C5CN.f09_g16.cice5.004 Yrs 1023 - 1047 b.e13.B1850C5CN.f09_g16.cice5.001 Yrs 1023 - 1047
grid cell mean ice thickness
m
grid cell mean ice thickness
m
5
4.5
4
3.5
3
2.5
2
1.5
1
0.75
0.5
0.25
0.1
0.05
b.e13.B1850C5CN.f09_g16.cice5.004 - b.e13.B1850C5CN.f09_g16.cice5.001
grid cell mean ice thickness
m
MIN = -0.28 MAX = 1.96
0.3
0.2
0.1
0
-0.1
-0.2
-0.3

Elastic-Anisotropic Sea Ice



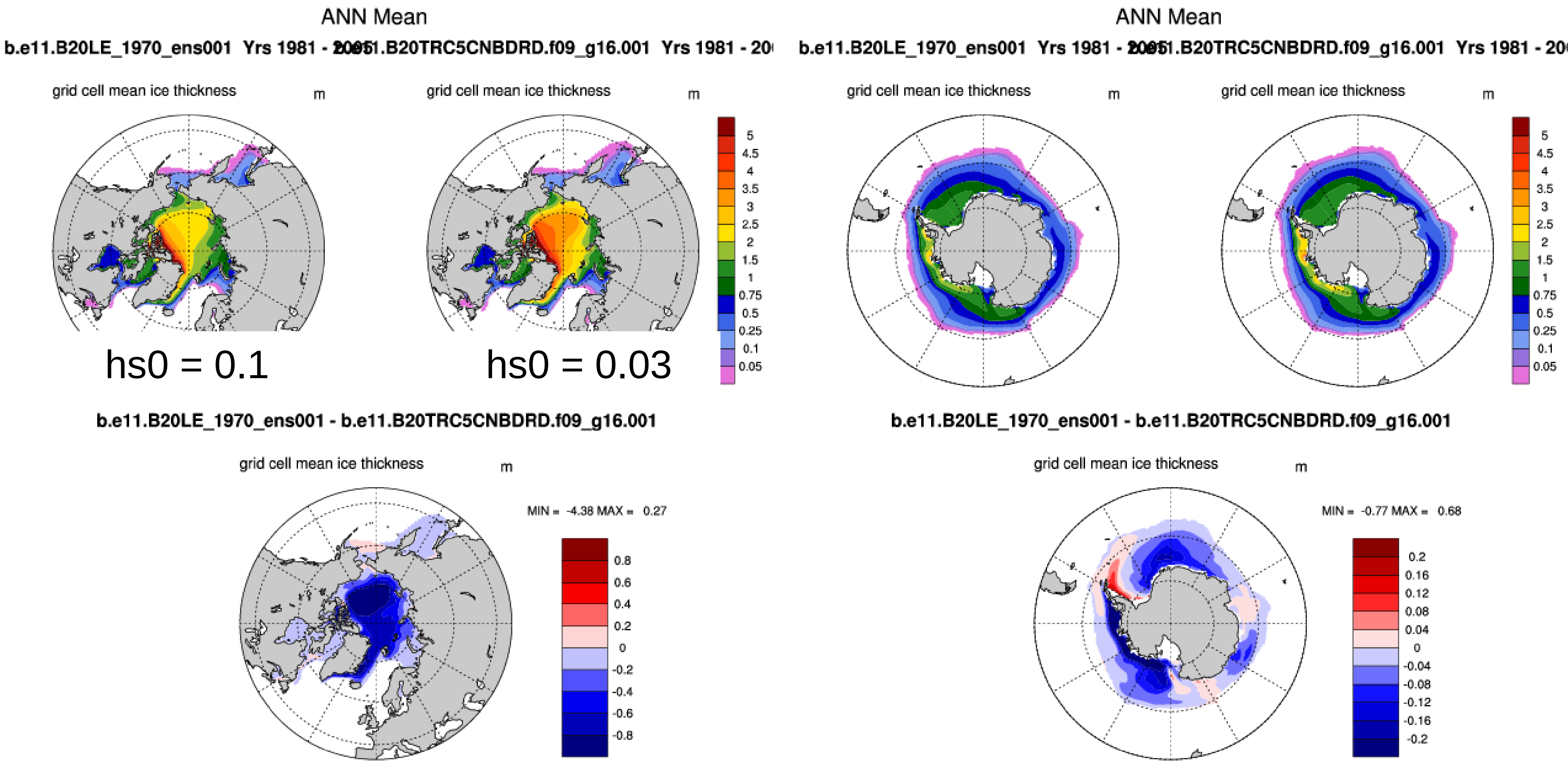


EAP Dynamics



Snow patchiness

NH | SH

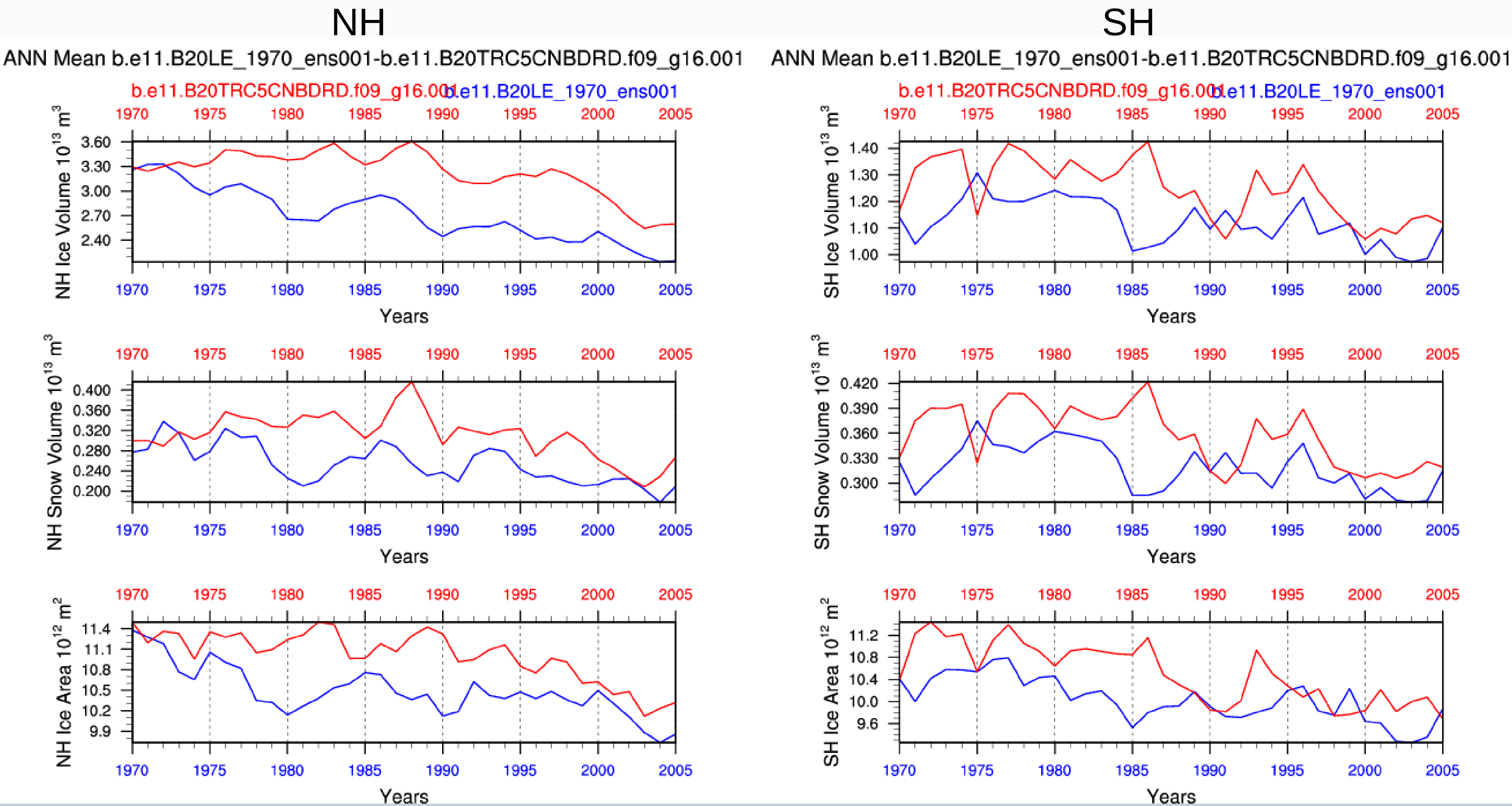


hs0 = 0.1

hs0 = 0.03

snow_fraction = min(hs/hs0,1.0)

Snow patchiness



hs0 = 0.1

hs0 = 0.03

Summary

- Sensitivity with CAM5.1 in 1850 controls. What about CAM6? 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.
- Salinity dependent freezing point, salt exchange
- Natural boundary conditions; Z*