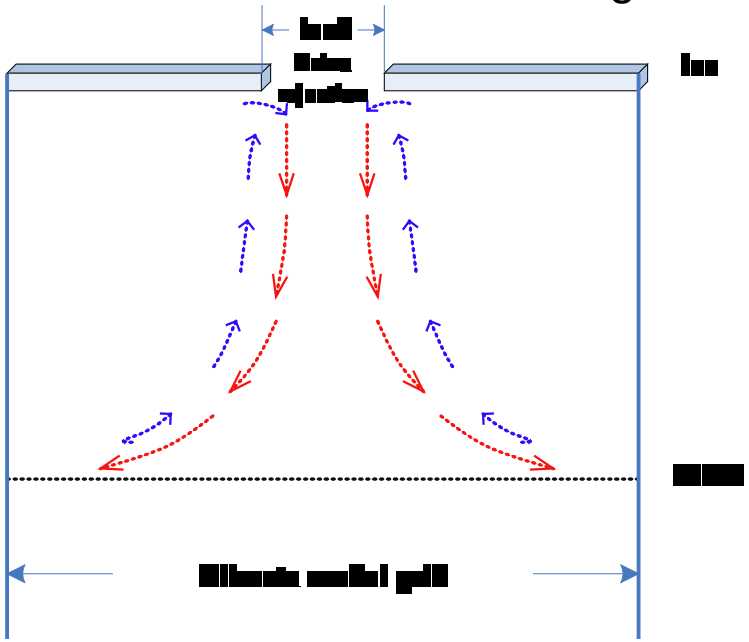
Sensitivity study of ocean mixing under sea ice using a 2-column ocean grid in coupled POP-CICE

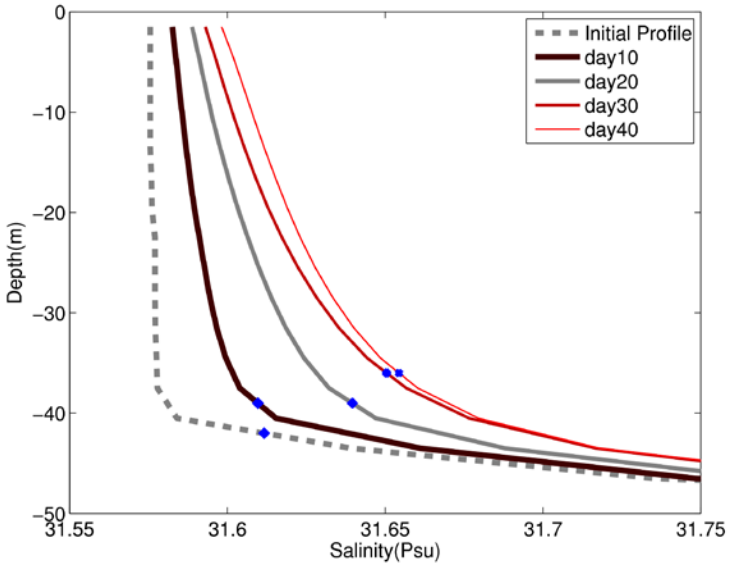
CPT team:
Meibing Jin, Jennifer Hutchings, Igor Polyakov (IARC)
Marika Holland, Gokhan Danabasoglu (NCAR)
Robert Hallberg, Michael Winton, and Alistair Adcroft (GFDL)

Other collaborators
Yusuke Kawaguchi and Takashi Kikuchi (JAMSTEC, Japan)

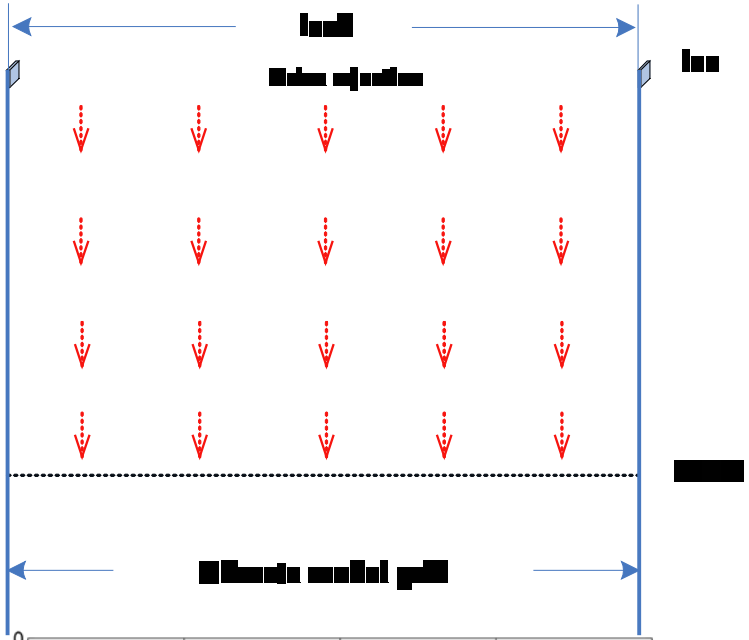
Science questions

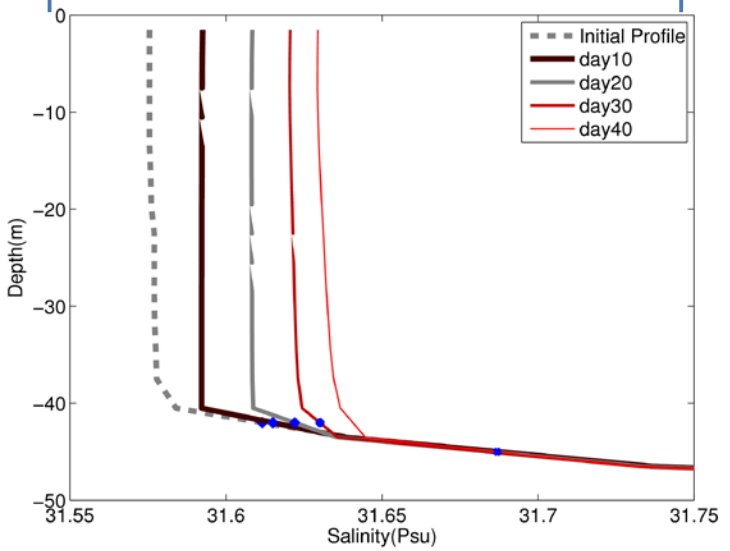
When lead << climate model grid





When lead ~ climate model grid

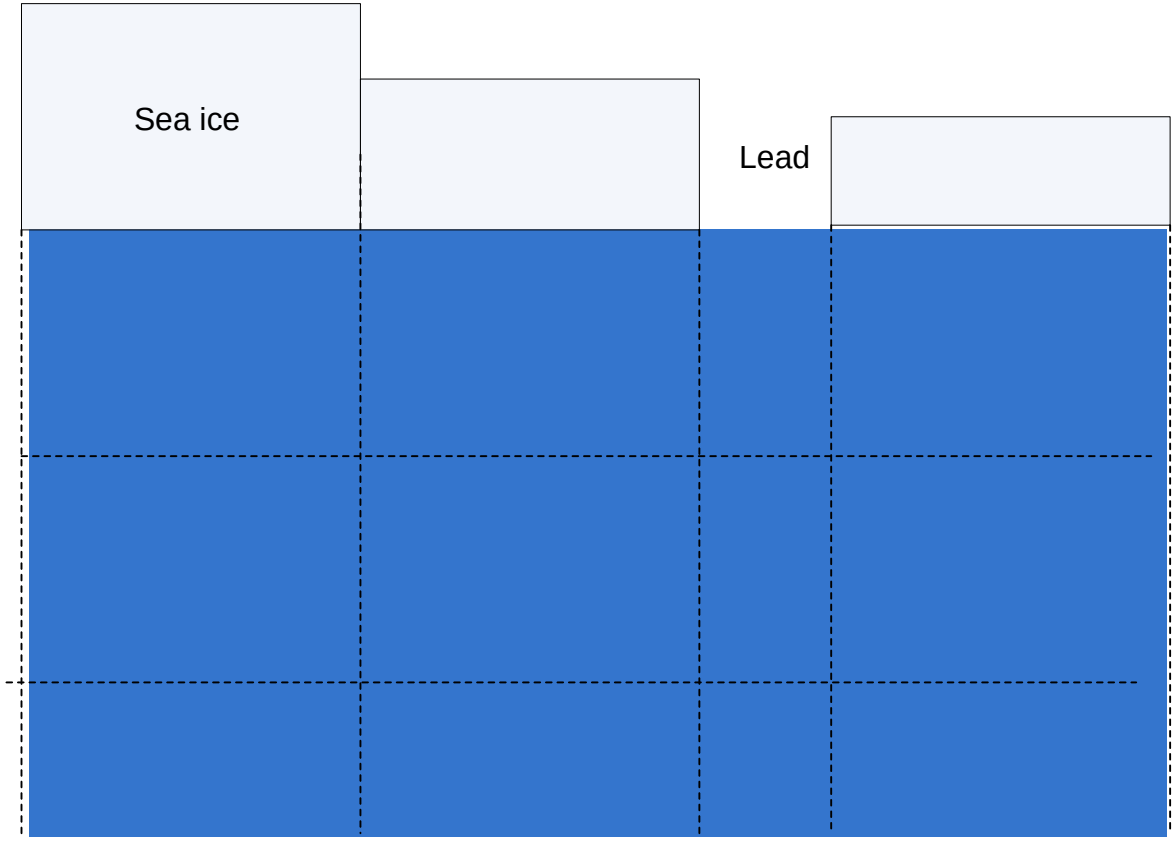




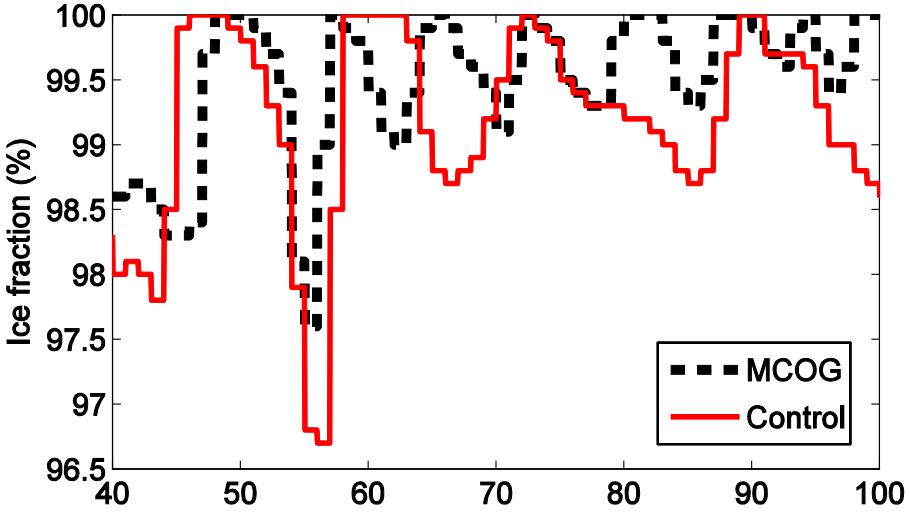
Forced POP-CICE and fully coupled CESM runs for MCOG

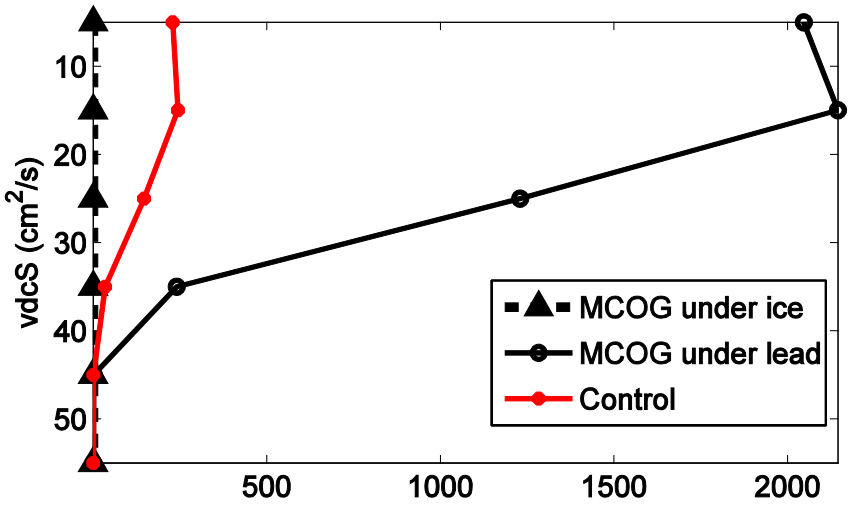
Control run and MCOG run

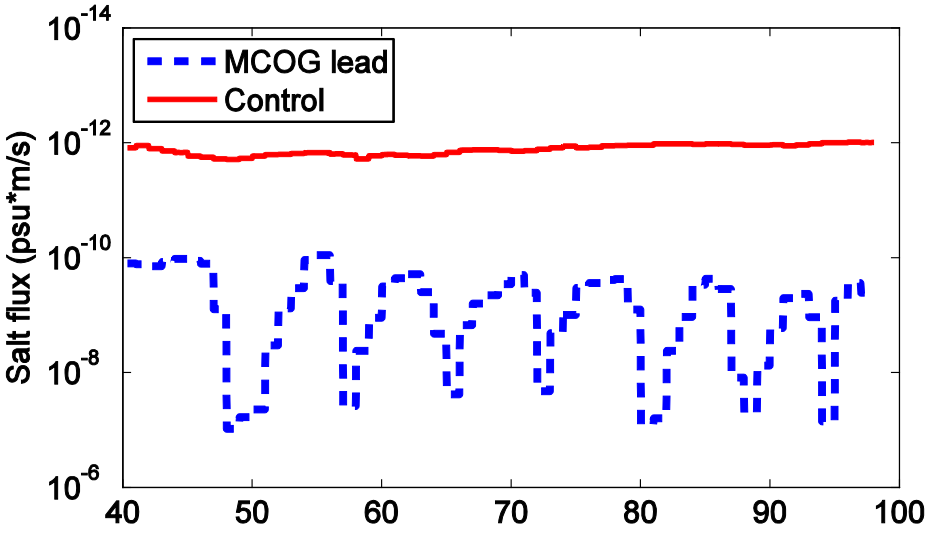
MCOG is multi-column ocean grid associated with sea ice thickness categories from CICE. To reduce computational cost, here, we used only two columns: lead and ice. The separate computation of ocean mixing in each column are merged every time step due to consideration of computational cost (memory) and limited changes to POP code structure.

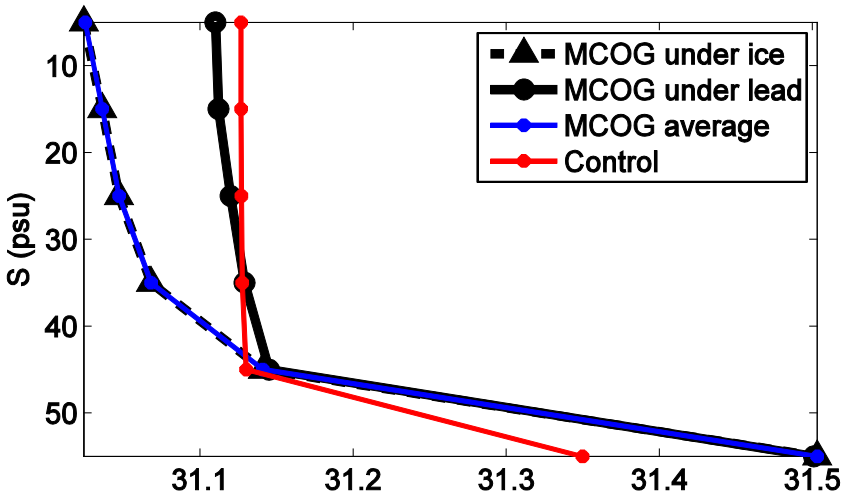


Forced POP-CICE and fully coupled CESM runs for MCOG:
--- Results of the two columns from one grid point output

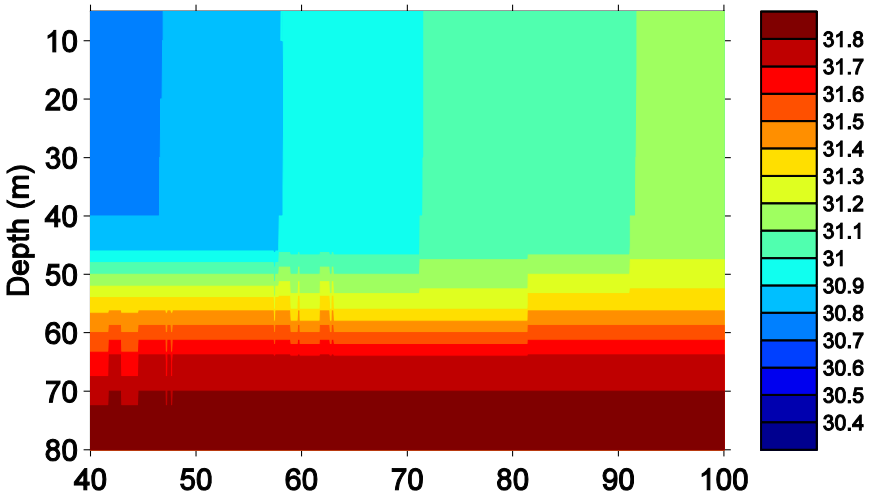


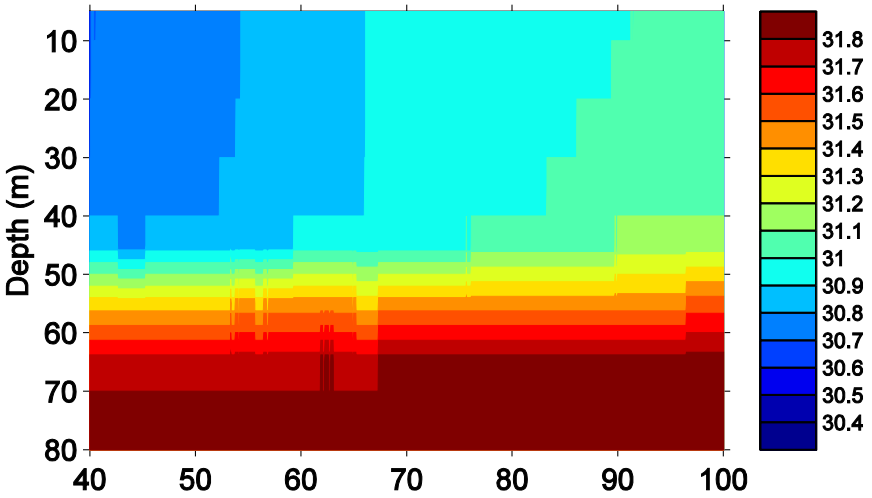


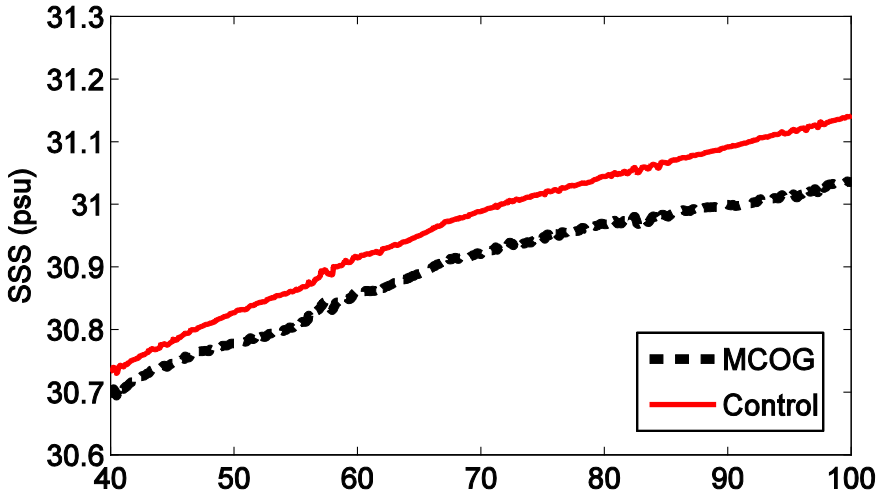


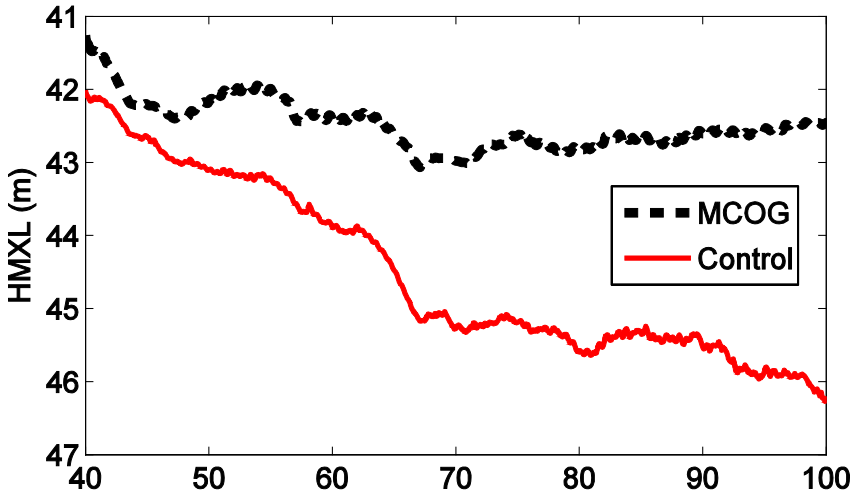


Forced POP-CICE and fully coupled CESM runs for MCOG:
--- Results of the two columns from one grid point output

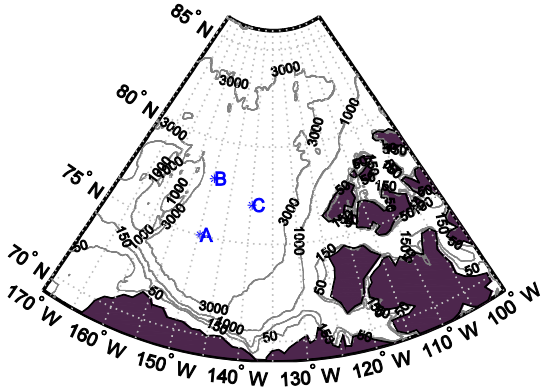


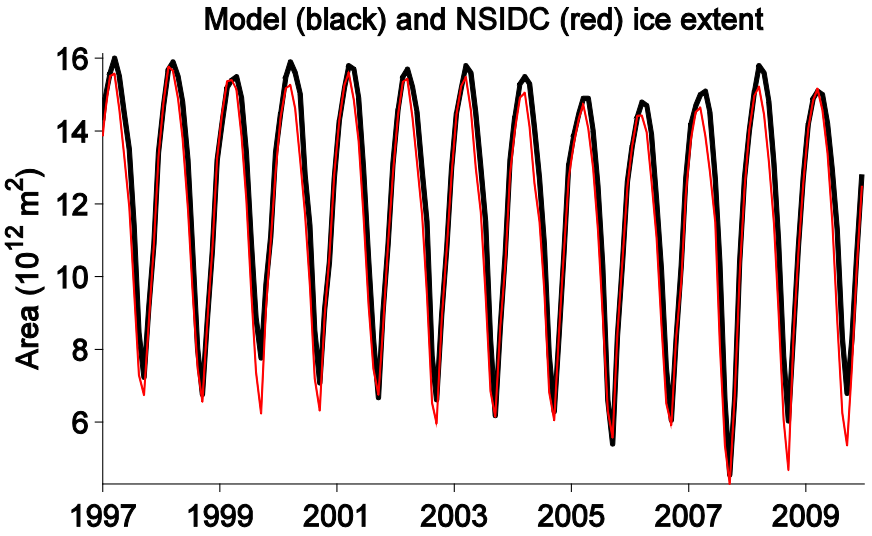


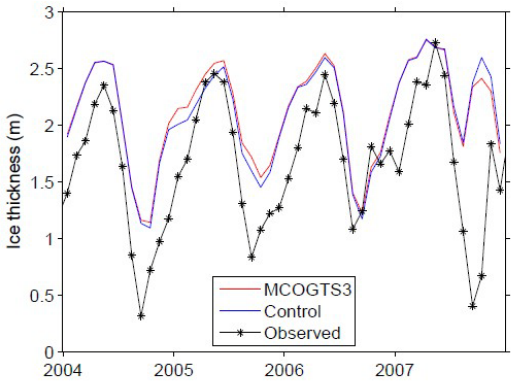


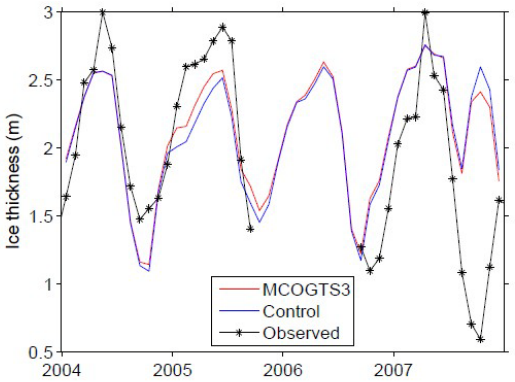


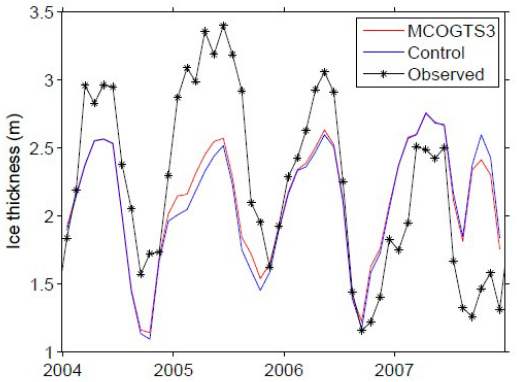
CESM runs with MCOG:
--- Sea ice area and ice thickness

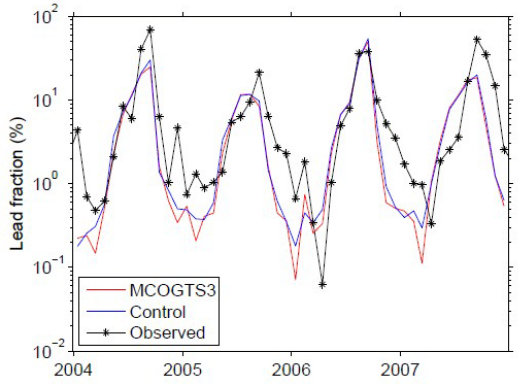


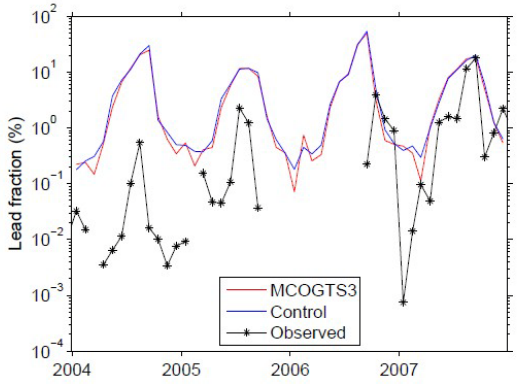


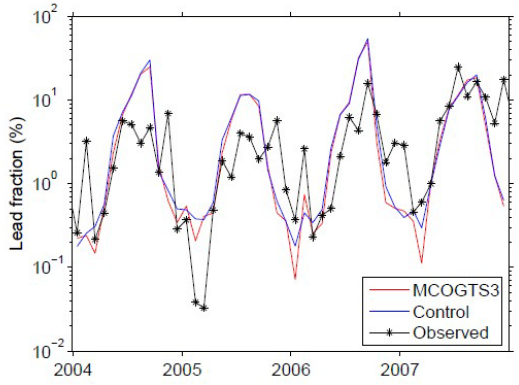




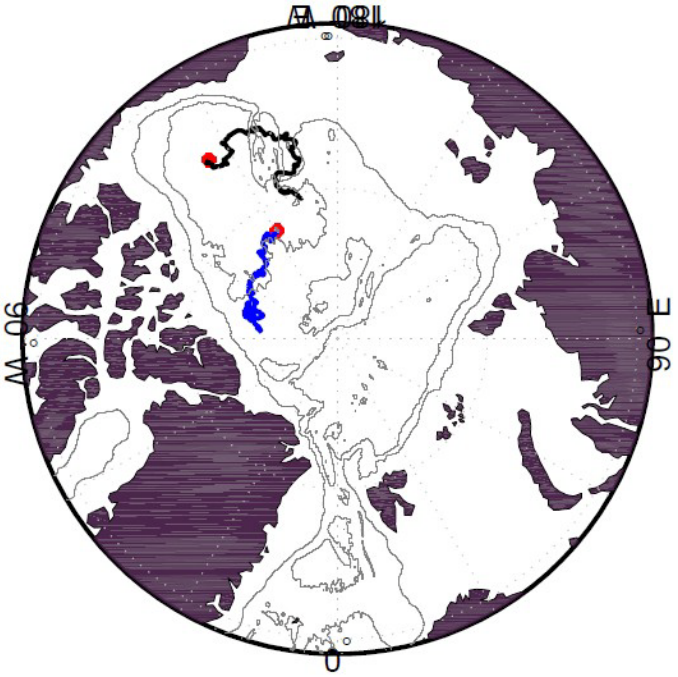




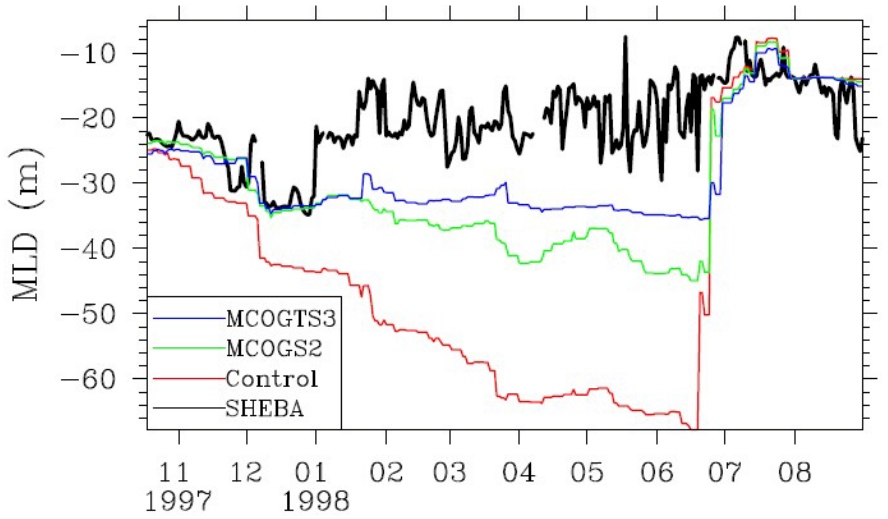




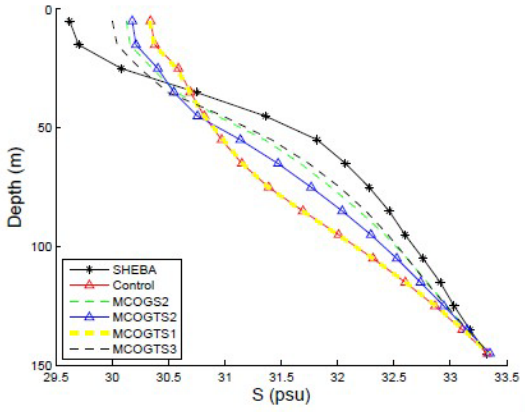
CESM runs with MCOG: SHEBA profile 1997.10 to 1998.09 --- Ocean mixed-layer depth (MLD), T, S and VDC profiles.



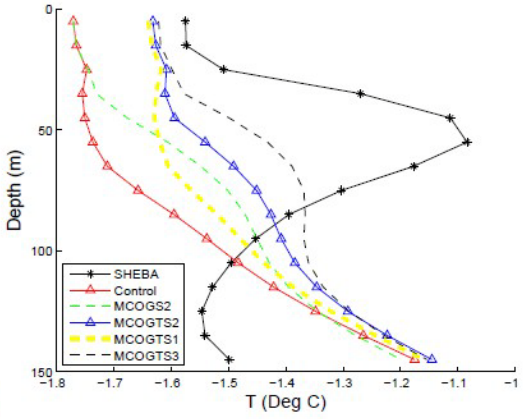
a)



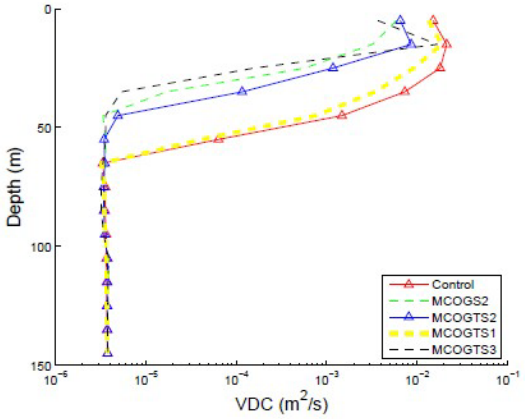
b)



c)

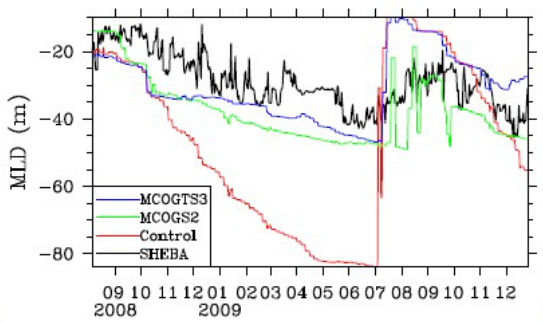


d)

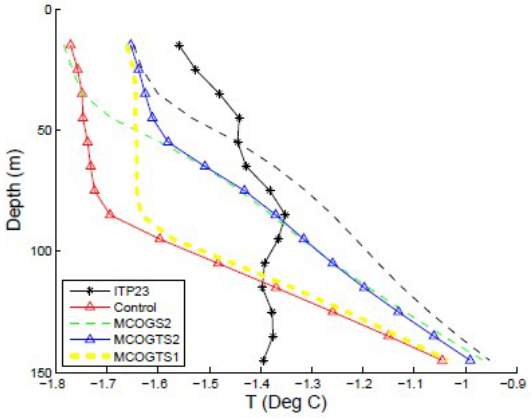


e)

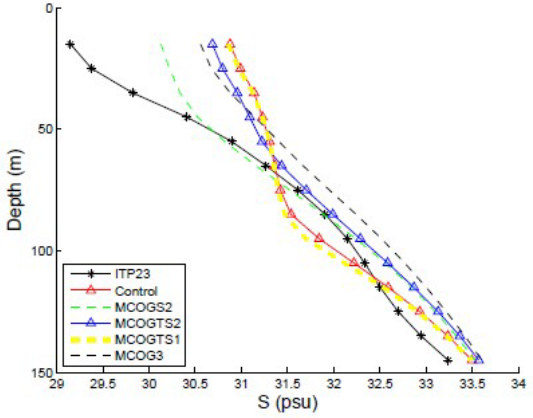
CESM runs with MCOG: ITP23 2008.09 to 2009.12
--- Ocean mixed-layer depth (MLD), T, S profiles.



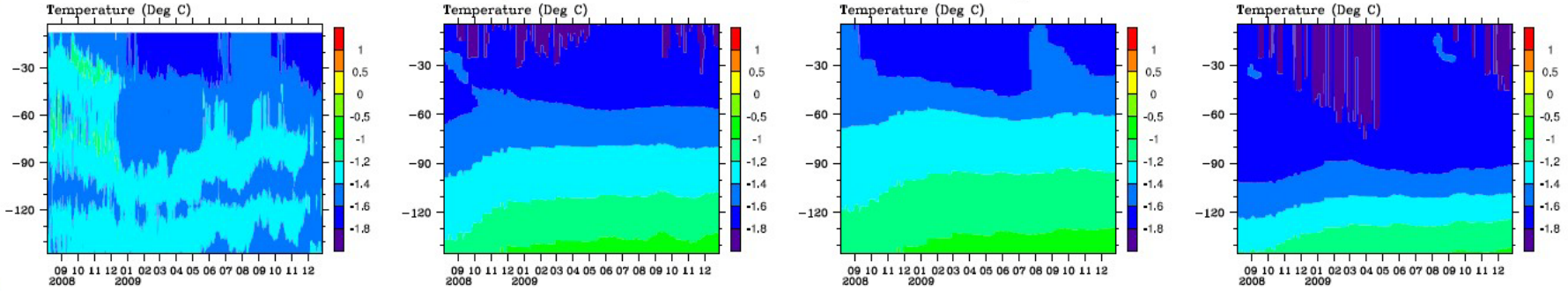
a)



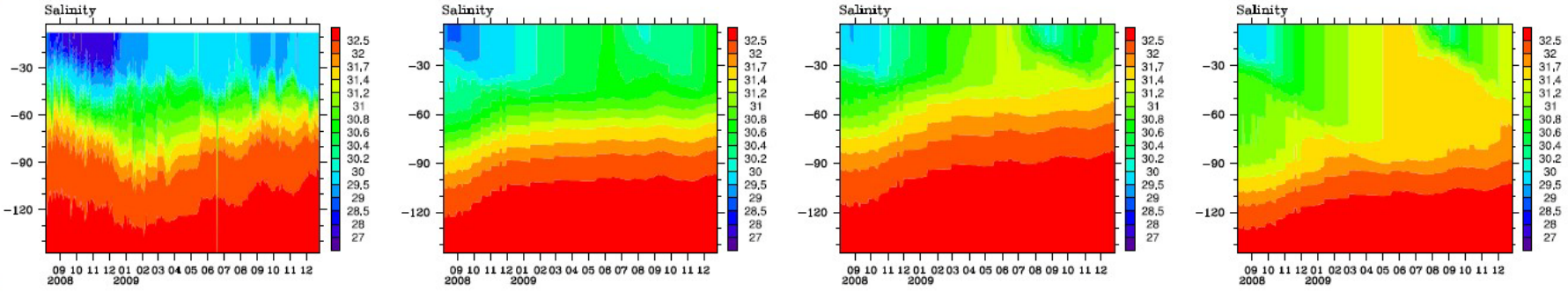
b)



c)



d)

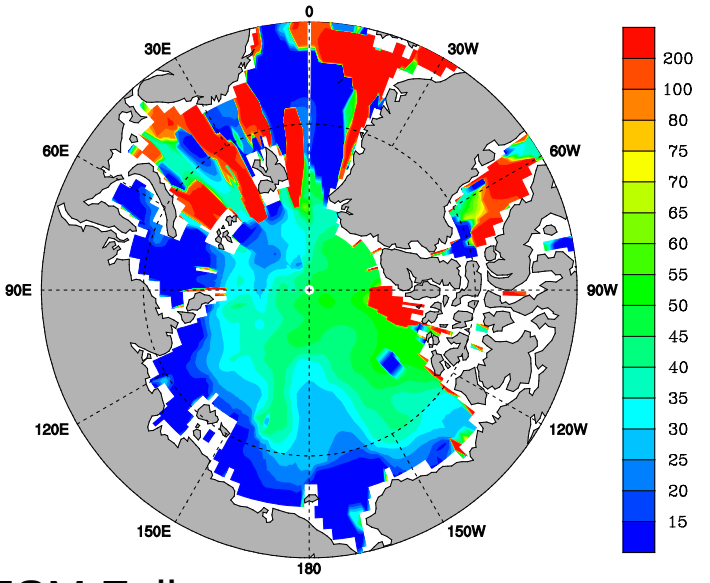


e)

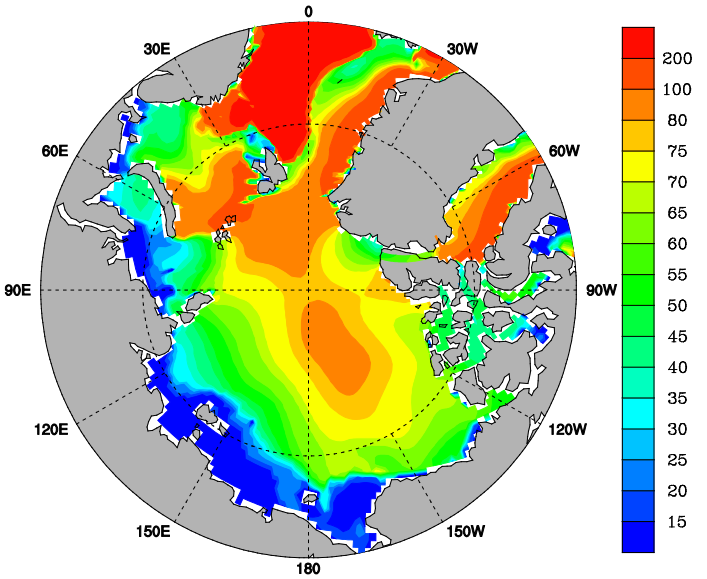
Observation MCOGS2 MCOGTS3 Control

Mixed-layer depth (MLD) in March

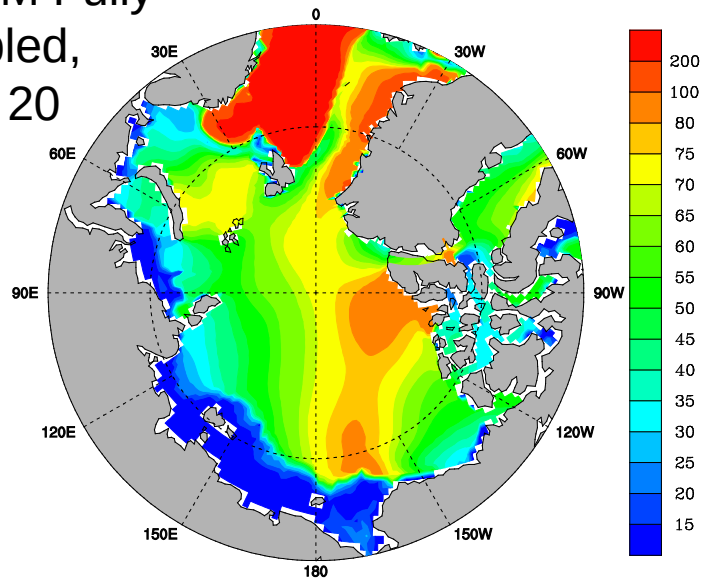
PHC 3.0



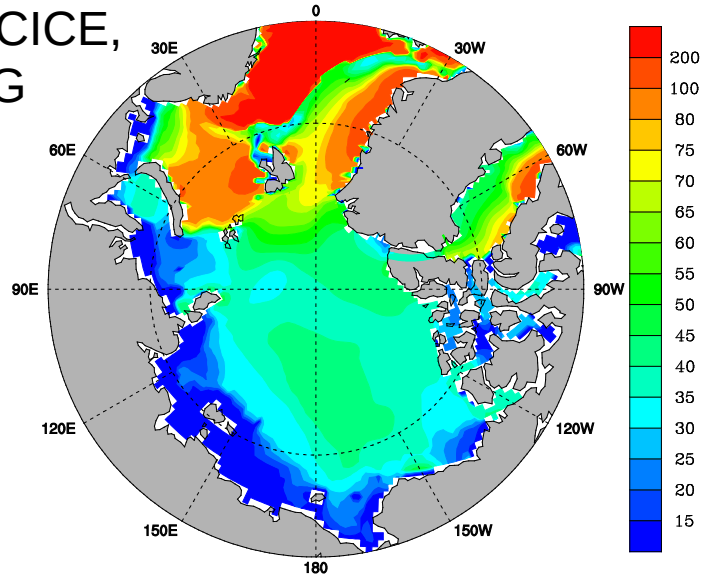
POP-CICE, Control



CESM Fully coupled, year 20



POP-CICE, MCOG



Summary

- A multi-column ocean grid (MCOG) scheme (2-column here) is tested in a global coupled POP_CICE setting in CESM.
- Sensitivity studies showed significant model improvements of simulated MLD, T, and S when salt flux is separately applied to MCOG, but only improvement in T when heat flux is separately applied to MCOG.
- The model improvements are seen in the broad arctic basin and consistent over two decades of integration.

Acknowledgments.
NSF Climate Process Team (CPT) project ARC-0968676**,** NSF ARC-0652838
Funding support from IARC-JAMSTEC Agreement