OSM 2016-02-22:26, poster HE44A-1486. Thursday 4:6pm

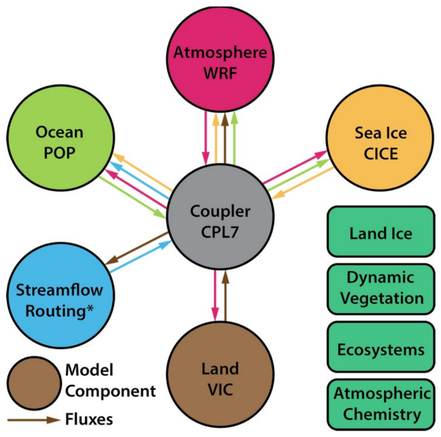
Arctic Ecosystem Changes from Gloal Community Earthc System Model (CESM) and Regional Arctic System Model (RASM)

Meibing Jin (International Arctic Research Center, University of Alaska Fairbanks)
RASM Collaborators: Clara Deal (IARC), Wieslaw Maslowski, Andrew Roberts and Frants Marina (NPS), Osinski Robert (Poland), and Anthony Craig

Introduction: The Arctic Ocean is currently experiencing rapid and large environmental changes related to global warming. Many small scale physical processes, such as mesoscale eddies, mixed layer dynamics, ocean boundary and coastal currents, varying sea ice edges, upwelling can influence nutrient transport, light availability and ocean stratification, thus are critical for understanding marine primary production and carbon cycling in the Arctic Ocean. A high-resolution pan-Arctic regional earth system model (RASM) was developed to investigate the ecosystem response to climate changes in seasonal to decadal scales. Here we show some initial results from the high resolution ecosystem model and comparison with results from coarse resolution global community earth system model. Both models include coupled ice algal submodel at the bottom of sea ice and intermediate NPZD pelagic ecosystem submodel in water column.

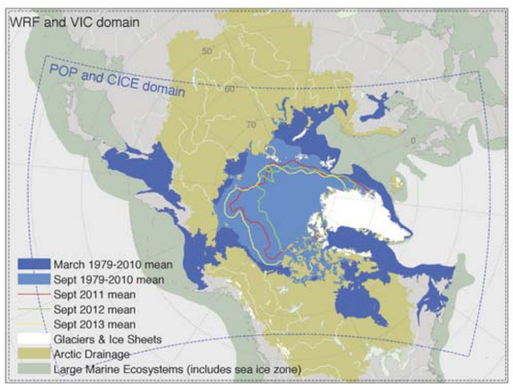
1 Introduction

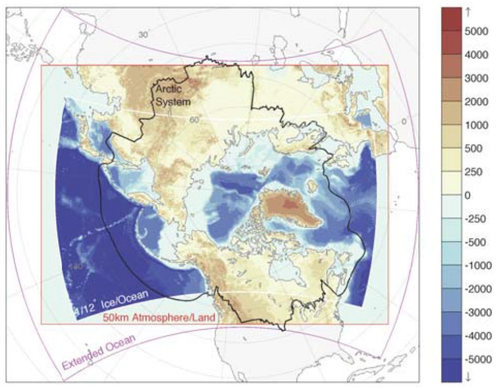
Ecologically significant changes due to declining sea ice cover have been observed in the Arctic Ocean in last decades, and it is critical to develop high resolution ecosystem models to investigate the mechanisms behind the primary production variations in all temporal and spatial scales in response to climate change. The NCAR global earth system model CESM framework are used in this development of high-resolution regional arctic earth system model (RASM). Here we compare the results from global 1-degree CESM (around 40-50km grid in the Arctic Ocean) and 9km-RASM (preliminary) in the Arctic Ocean. Both of them include the same ice and ocean ecosystem modules .



2 Model setting:

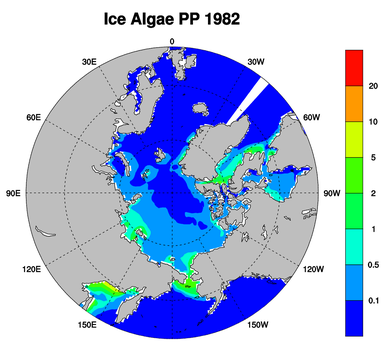
- Ocean-sea ice coupled model (POP2 and CICE 5) run with forcing of CORE 2 data. The sea ice ecosystem model components (ice algae and nutrients) at the ice bottom (Jin et al., 2006 and 2012, Deal at al., 2011) were calculated and coupled with pelagic ecosystem model components (Moore et al., 2004, Jin et al. 2016).
- There are 5 ice thickness categories and one snow layer. The model output at point of interest are analyzed.

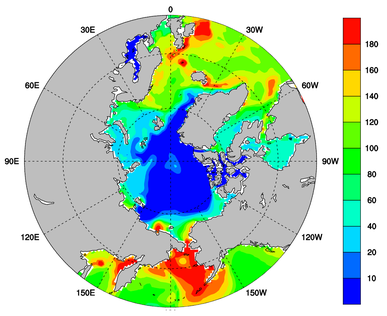




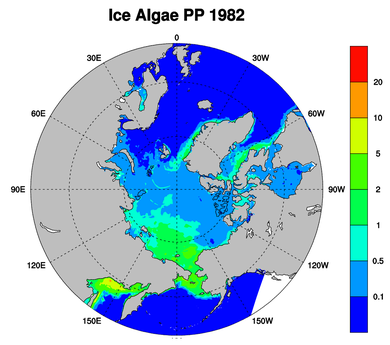
3 Modeled ice and ocean primary production

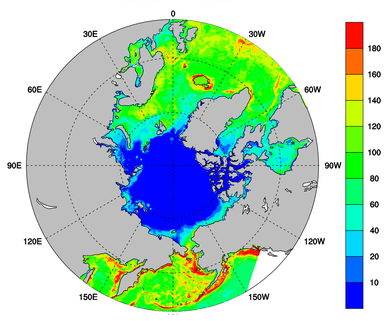
Global CESM





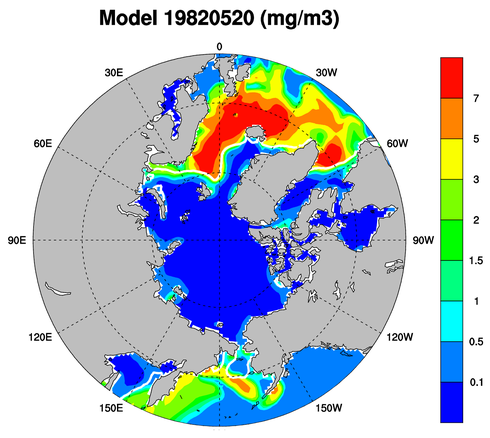
9km-RASM



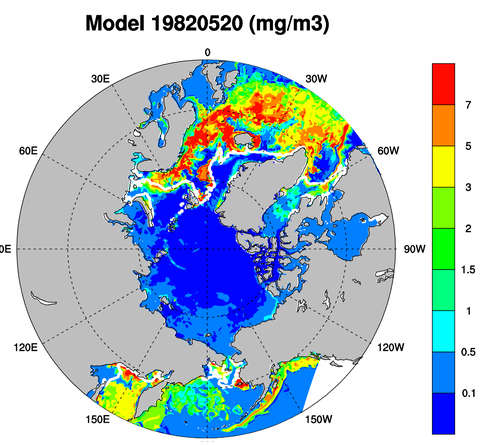


4 Snapshot of modeled sea surface Chl-a overlaid by ice edge

Global CESM



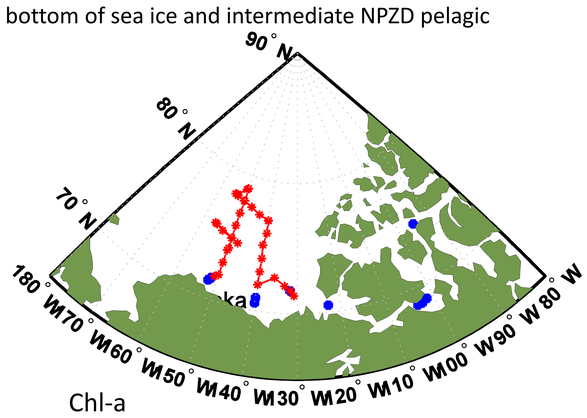
9km-RASM



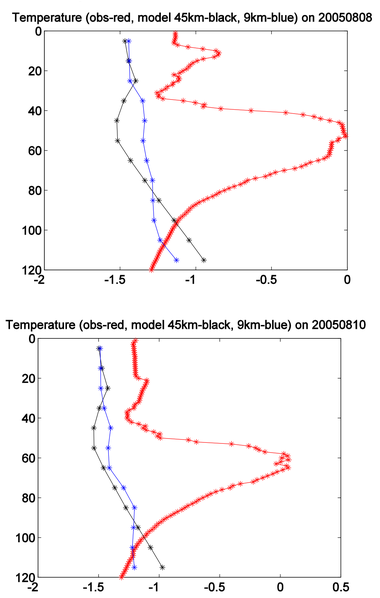
5. Model results of comparison with one cruise data

(data courtesy of Dr. Steiner of Canada, see the reference below, where a previous version of POP-CICE was used in the validation)

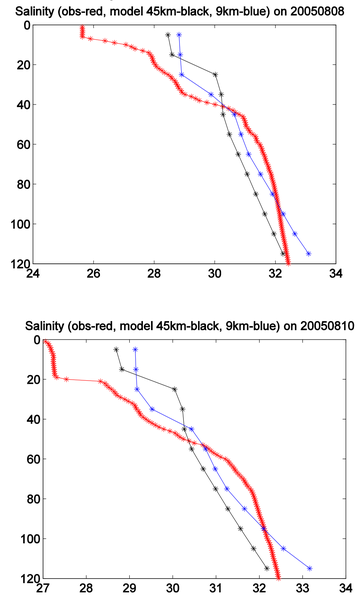
Steiner, N. S., T. Sou, C. Deal, J. M. Jackson, M. Jin, E. Popova, W. Williams, and A. Yool (2015), The future of the subsurface chlorophyll-a maximum in the Canada Basin - A model intercomparison, *J. Geophys. Res. Oceans*, 120, doi:10.1002/2015JC011232.



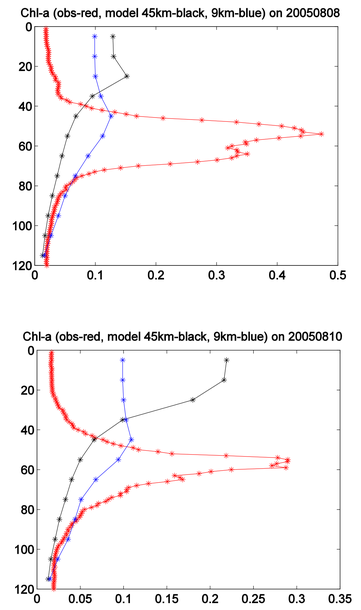
Temperature



Salinity



Chl-a



Summary

- The high-resolution 9km-RASM reproduced consistent results with global CESM model in terms of annual primary production.
- The 9km-RASM sharper gradients at shelf breaks and better eddy and fine T, S Chl-a structures.
- More model validation and comparison is in the processes.

References

- Jin M., C. Deal, S.H. Lee, S. Elliott, E. Hunke, M. Maltrud and N. jeffery (2012), Investigation of Arctic sea ice and ocean primary production for the period 1992 to 2007 using a 3-D global ice-ocean ecosystem model. *Deep-Sea Research* II, 81-84: 28-35, doi: 10.1016/j.dsr2.2011.06.003.
- Deal C., M., Jin, S., Elliott, E., Hunke, M., Maltrud, and N., Jeffery, 2011. Large-scale modeling of primary production and ice algal biomass within arctic sea ice resulted from the 1992 model simulation. Journal of Geophysical Research-Ocean, Vol. 16, C07004, doi: 10.1029/2010JC006409.
- Jin M., C.J. Deal, J. Wang, K.H. Shin, N. Tanaka, T.E. Whitledge, S.H. Lee, and R.R. Gradinger, 2006. Controls of the landfast ice-ocean ecosystem offshore Barrow, Alaska. *Annals of Glaciology*, Vol. 44, 63-72.
- Jin, M., E. E. Popova, J. Zhang, R. Ji, D. Pendleton, Ø. Varpe, A. Yool, and Y. J. Lee (2016), Ecosystem model intercomparison of under-ice and total primary production in the Arctic Ocean, *J. Geophys. Res. Oceans*, 120, doi:10.1002/2015JC011183.
- Moore J.K., Doney S.C., and K. Lindsay (2004). Upper ocean ecosystem dynamics and iron cycling in a global three-dimensional model. Global Biogeochem Cycles 18:GB4028.