A High-Resolution Ice-Ocean Model of the Arctic Ocean

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Objectives

The model is being developed for applications in operational forecast/analysis and region climate research. The time scale of interest span hours to multi decades. For realistic simulations of changes in sea-ice and ocean conditions in the Arctic basin and the Canadian Arctic coasts, we designed nested grids, with fine-resolution (~18 km) in the pan-Arctic domain and high-resolution (~6 km) in the Canadian Arctic Archipelago (CAA).

The model is based on NEMO which is adopted by the DFO-EC-DND inter-departmental program CONCEPTS as the ocean component of the global coupled atmosphere-ocean forecasting system. NEMO is widely used by government research labs and universities in Canada. Collaborations with inter-national partners, e.g., the Mercator-Ocean of France, has been well developed.

Model Description

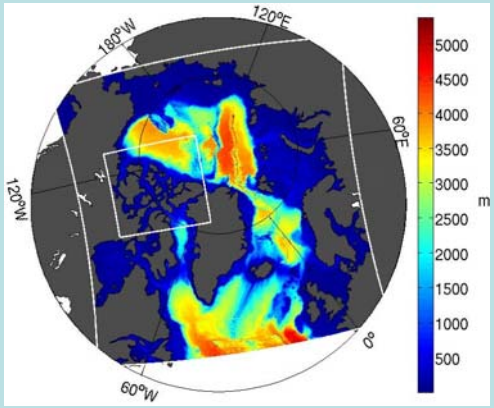
The model is based on version 2.3 of NEMO, which includes an ocean component OPA and a sea-ice component LIM2. LIM2 includes thermodynamic two category (frazil or open water, ice) representation of sea-ice and a viscous-plastic rheology for the dynamics. Future updating to LIM3 will allow more complicated sea-ice physics to be resolved.

The model grid is created by shifting poled to the equator. There are 348x364 horizontal grids in the pan-Arctic model, and 349x328 grids in the nested domain. Vertical quantization uses "z-levels" and "partial cells" near the bottom with a maximum of 46 levels. Level thickness increases from 6 m at the surface to 250 m at the bottom of the deep basins.

Spin-up simulation: Initialization and Forcing

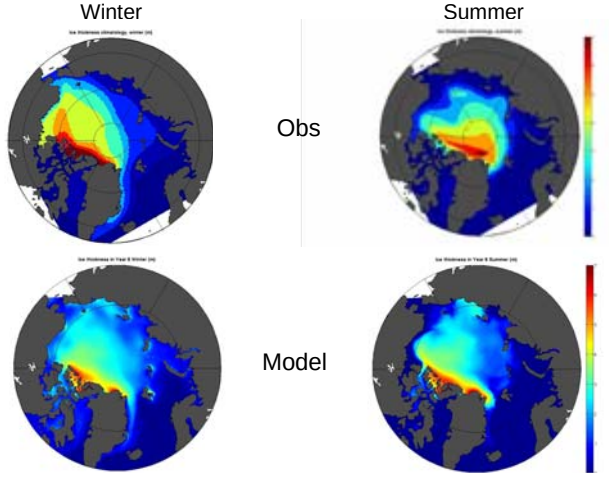
The model is initialized with the January climatology of temperature and salinity, and sea-ice conditions. Temperature, salinity and velocities at the open boundaries, and the initial sea-ice conditions are set according to a monthly climatology derived from the solution of a global model. Sea surface salinity (SSS) is restored to the climatology. Runoff is specified according to climatology. Surface forcing is the "Normal Year Forcing" of the Common Ocean-ice Reference Experiments (CORE). The spin up simulation is run for 8 years.

Model Domain and Bathymetry

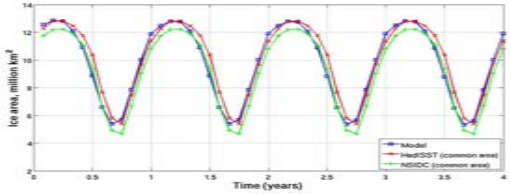


Results: Pan-Arctic Model

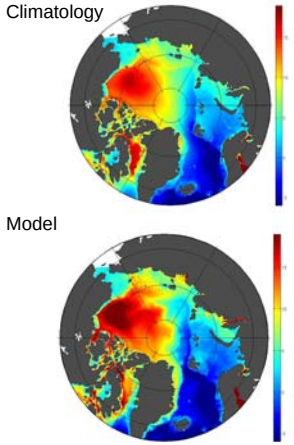
Seasonal Sea-Ice Thickness (m)



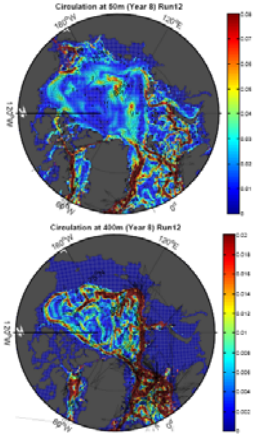
Total Ice Area



Freshwater Content (upper 1000 m)

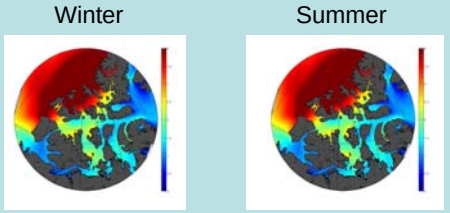


Time-mean Circulation (colour axis in m/s)

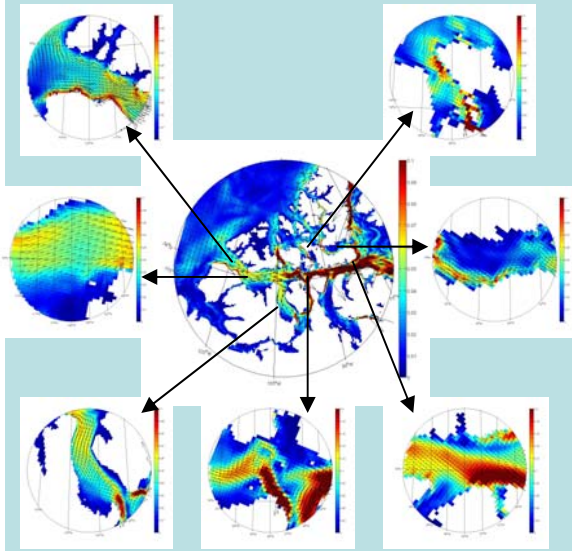


Results: High-Resolution Embedding

Sea-Ice Thickness (m)



Annual Mean Circulation, 30 m
(colour axis m/s)



Summary

The new Arctic ice-ocean model includes a fine-resolution pan-Arctic component and a high-resolution nested sub-model for the Canadian Arctic coast. Spin-up simulation obtains seasonal variations of sea-ice and hydrography consistent with the observed climatology. Within the domain of the nested grid, the model depicts detailed spatial structure of sea-ice and circulation in the CAA. The next steps are to continue simulations with inter-annually varying forcing, to validate model results with observations, and to develop forecast capacity.

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