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Effects of tides, vertical discretization schemes and runoff variability on a pan-Arctic Ocean simulation.

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The results of a recently developed NEMO-shelf pan-Arctic Ocean model coupled with LIM2 ice model are presented. This pan Arctic model has a hybrid s-z vertical discretization with terrain following coordinates on the shelf, condensing towards the bottom and surface boundary layer, and partial step z-coordinates in the abyss. This allows (a) processes near the surface to be resolved (b) Cascading (shelf convection), which contributes to the formation of halocline and deep dense water, to be well reproduced; and (c) minimize pressure gradient errors peculiar to terrain following coordinates. Horizontal grid and topography corresponds to global NEMO –ORCA 0.25 model (which uses a tripolar grid) with seamed slit between the western and eastern parts. In the Arctic basin this horizontal resolution corresponds to 15-10km with 5-7 km in the Canadian Archipelago.
The model uses the General Length Scale vertical turbulent mixing scheme with (K- ε) closure and Kantha and Clayson type structural functions. Smagorinsky type Laplacian diffusivity and viscosity are employed for the description of a horizontal mixing. Vertical Piecewise Parabolic Method has been implemented with the aim to reduce an artificial vertical mixing.
Boundary conditions are taken from the 5-days mean output of NOCS version of the global ORCA-025 model and OTPS/tpxo7 for 9 tidal harmonics . For freshwater runoff we employed two different forcings: a climatic one, used in global ORCA-0.25 model, and a recently available data base from Dai and Trenberth (Feb2011) 1948-2007, which takes in account inter-annual variability and includes 1200 river guages for the Arctic ocean coast.
The simulations have been performed for two intervals: 1978-1988 and 1997-2007. The model adequately reproduces the main features of dynamics, tides and ice volume/concentration. The analysis shows that the main effects of tides occur at the ice-water interface and bottom boundary layers due to mesoscale Ekman pumping , generated by nonlinear shear tidal stresses, acting as a ‘tidal winds’ on the surfaces. Harmonic analysis shows, that at least five harmonics should be taken in account: three semidiurnal M2, S2, N2 and two diurnal K1 and O1.
We present results from the following experiments: (a) with tidal forcing and without tidal forcing; (b) with climatic runoff and with Dai and Trenberth database. To examine the effects of summer ice openings on the formation of brine rejection and dense water cascades, additional idealised experiments have been performed: (c) for initial conditions of hydrographic fields and fluxes for 1978 with initial summer ice concentration of 2000; (d) opposite case of initial ocean conditions for 2000 and ice concentration of 1978.
The comparisons with global ORCA-025 simulations and available data are discussed.