The effects of tides on the water mass mixing and sea ice in the NEMO-shelf Arctic Ocean model.

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In this study we use a novel pan-Arctic sea ice-ocean coupled NEMO-shelf model to examine the effects of tides on sea ice and the mixing of water masses. We use s-z hybrid coordinates with terrain-following coordinates on the shelf and z –partial steps below to reduce baroclinic pressure gradients errors and piecewise parabolic vertical advection scheme guaranteed low numerical diapycnal mixing. Two 30-year simulations were performed: one with explicitly resolved tides and the other without any tidal dynamics. We find that the tides are responsible for a ~15% sea ice volume reduction during the last decade and also for changes in the salinity distribution, with surface salinity in the case with tides being on average ~ 1.-1.8 practical salinity units (PSU) higher than without tides. The ice volume trend in the two simulations also differs: -2.09 $x10^3$ km^3/decade without tides to -2.49 $x10^3$ km^3/decade with tides, the latter being closer to a trend of -2.8 $x10^3$ km^3 /decade in the PIOMASS model, which assimilates SST and ice concentration. The three following mechanisms of tidal interaction appear to be significant: (a) strong shear stresses generated by the baroclinic clockwise rotating component of tidal currents in the interior waters; (b) thicker subsurface ice-ocean and bottom boundary layers; and (c) intensification of quasi-steady vertical motions of isopycnals (by ~50%) through enhanced bottom Ekman pumping and stretching of relative vorticity over rough bottom topography. The combination of these effects leads to the entrainment of warm Atlantic Waters into the colder and fresher surface waters, supporting the melting of the overlying ice.