TOPAZ5: Upgraded the Arctic coupled ocean and sea-ice forecasting system with Ensemble Kalman Filter

With the increased changes in the Arctic Ocean, more human activities and industries require a high-resolution forecast of the ocean and sea ice, and more relevant variables are expected as a knowledge base for sustainable management of resources. The upgraded version of the coupled Arctic ocean and sea-ice data assimilation system, TOPAZ5, uses version 2.2.98 of the Hybrid Coordinate Ocean Model (HYCOM), which is coupled with the sea ice model (CICE, the Los Alamos National Laboratory Community Ice CodE). To enhance the eddy dynamic changes in the Pan-Arctic region, the model grids have been refined both horizontally to ~6 km and vertically from 28 to 50 hybrid layers. Instead of climatological boundary conditions, TOPAZ5 uses the nesting boundary from the global NEMO model system by the Copernicus Marine Service. The sea ice model has been upgraded to CICE v5.1, with five categories of sea ice thickness and complex thermodynamics. The TOPAZ5 system has been tested under two assimilation experiments in 2021, using an Ensemble Kalman filter with 100 model members, whose ensemble runs are driven by randomly perturbed atmospheric forcing centered on the ECMWF reanalysis (ERA5). The results show that multiple types of ocean physical and sea ice observations can be successfully assimilated, preventing the model forecast bias from increasing. The forecasting based on this system improves upon the previous TOPAZ4 version of the system, and the relevant products are released daily on the Copernicus Marine Services. We will discuss different avenues for the further development of this system.

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