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Sensitivity of northwestern North Atlantic shelf circulation to surface and boundary forcing: A regional model assessment

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The northwestern North Atlantic shelf circulation, influenced by both North Atlantic subpolar and subtropical gyres, is one of the hydrographically most variable regions in the North Atlantic Ocean and hosts biologically rich and productive fishing grounds. With the goal of simulating conditions in this productive and complex region, we implemented a nested regional ocean model for the northwest North Atlantic shelves including the Gulf of Maine, the Scotian Shelf, the Gulf of St. Lawrence, the Grand Banks, and the adjacent deep ocean. Configuring such a model requires choosing external data to supply surface forcing and initial and boundary conditions, as well as the consideration of nesting options. Although these selections can greatly affect model performance and results, often they are not systematically investigated. Here we assessed the sensitivity of our regional model to a suite of atmospheric forcing datasets, to sets of initial and boundary conditions constructed from multiple global ocean models and a larger scale regional ocean model, and to two variants of the model grid – one extending further off-shelf and resolving Flemish Cap topography. We conducted model simulations for a 6-year period and assessed model performance relative to a regional climatological dataset of temperature and salinity, observations collected from multiple monitoring stations and cruise transect lines, satellite sea surface temperature (SST) data, and descriptions of regional currents from literature. Based on this model assessment, we determined the model configuration that best reproduces observations. We find that while all surface forcing datasets are capable of producing model SST close to observed, the different datasets result in significant differences in model sea surface salinity (SSS). We find that initial and boundary conditions based on global ocean models do not necessary produce realistic circulation, and climatological initial and boundary conditions can improve model performance over those from global ocean models. Beyond optimizing model performance, we gained mechanistic understanding of model responses to variable nesting, surface forcing and domain choices.