Overturning in the Subpolar North Atlantic: Insights from Observing System Simulation Experiments

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Abstract

Currently, there is no direct measurement of the Atlantic Meridional Overturning Circulation (AMOC) or its associated fluxes of heat and freshwater at subpolar latitudes. Quantifying the overturning in the subpolar North Atlantic is challenging because of vigorous currents along the boundaries, strong barotropic flow in the basin interior, and the smaller spatial scales of the flow at high latitudes. Here we present the results of several Observing System Simulation Experiments (OSSE) in which an eddy-resolving circulation model of the North Atlantic is subsampled with simulated observations mimicking data collected by Argo floats, gliders, moorings, and satellites. To assess the degree to which combinations of instruments are able to reconstruct basin-integrated volume, heat, and freshwater fluxes, fluxes calculated from the subsampled model output are compared to those computed from the full resolution model output. Depending on the type of flux (volume, heat, or freshwater) and the vertical coordinate system (z-level or density), several OSSEs recover more than 70% of the subpolar Atlantic meridional overturning flux variability with feasible numbers of simulated moorings, gliders, and Argo floats. We find that direct velocity observations by moored current meters are a critical component of any subpolar gyre overturning observing system due to strong currents along the boundaries and the Reykjanes Ridge. Furthermore, attempts to reconstruct a barotropic reference velocity for the subpolar gyre from the displacements of Argo floats are thwarted by aliasing of the mesoscale velocity field with the current spatial coverage of Argo floats. Several subpolar North Atlantic meridional overturning observing system configurations are presented, as are the relative advantages and disadvantages of each system.