EGU21-1310, updated on 09 Aug 2022
https://doi.org/10.5194/egusphere-egu21-1310
EGU General Assembly 2021

North Atlantic Ocean Circulation Response to Stochastic Mesoscale Weather Systems

Shenjie Zhou[1], Xiaoming Zhai[2], and Ian Renfrew[2]
[1]British Antarctic Survey, Polar Ocean, Cambridge, UK (shezhou@bas.ac.uk)
[2]Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich, UK

The ocean is forced by the atmosphere on a range of spatial and temporal scales. In ocean and climate models the resolution of the atmospheric forcing sets a limit on the scales that are represented. For typical climate models this means mesoscale (< 400 km) atmospheric forcing is absent. Previous studies have demonstrated that mesoscale forcing significantly affects key ocean circulation systems such as the North Atlantic Subpolar gyre and the Atlantic Meridional Overturning Circulation (AMOC). However, the approach of these studies has either been ad hoc or limited in resolution. Here we present ocean model simulations with and without realistic mesoscale atmospheric forcing that represents scales down to 10 km. We use a novel stochastic parameterization – based on a cellular automaton algorithm that is common in weather forecasting ensemble prediction systems – to represent spatially coherent weather systems over a range of scales, including down to the smallest resolvable by the ocean grid. The parameterization is calibrated spatially and temporally using marine wind observations. The addition of mesoscale atmospheric forcing leads to coherent patterns of change in the sea surface temperature and mixed-layer depth. It also leads to non-negligible changes in the volume transport in the North Atlantic subtropical gyre (STG) and subpolar gyre (SPG) and in the AMOC. A non-systematic basin-scale circulation response to the mesoscale wind perturbation emerges – an in-phase oscillation in northward heat transport across the gyre boundary, partly driven by the constantly enhanced STG, correspoding to an oscillatory behaviour in SPG and AMOC indices with a typical time scale of 5-year, revealing the importance of ocean dynamics in generating non-local ocean response to the stochastic mesoscale atmospheric forcing. Atmospheric convection-permitting regional climate simulations predict changes in the intensity and frequency of mesoscale weather systems this century, so representing these systems in coupled climate models could bring higher fidelity in future climate projections.