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Mechanisms of Interannual Variations of the Meridional Overturning Circulation of the North Atlantic Ocean

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The nature of the interannual variability of the meridional overturning circulation (MOC) of the North Atlantic Ocean is studied using an ECCO (http://www.ecco-group.org) assimilation product for the period of 1993-2003. The time series of the 1st Empirical Orthogonal Function (EOF) of the MOC is found to be correlated with the North Atlantic Oscillation (NAO) index while the associated circulation anomalies correspond to cells extending over the full ocean depth. Model sensitivity experiments suggest that the wind is responsible for most of this interannual variability at least south of 40N. A dynamical decomposition of the meridional stream function allows us to look further into the mechanisms. In particular, we examine the contributions associated with (1) the Ekman flow and its depth-independent compensation, (2) the vertical shear flow, (3) the barotropic gyre flowing over zonally varying topography. The Ekman dominates shorter time scales (1.5 - 3yr) while vertical shear is important for longer time scales (3-10yr). In the subtropics, the latter is primarily caused by the heaving of the pycnocline at the western boundary due to strong Ekman pumping in the western part of the basin. The western intensification of interannual Ekman pumping is found to be a ubiquitous feature among various scatterometer and reanalysis wind products. Implications of the findings to monitoring the Atlantic MOC using in-situ and satellite observations are discussed.