Dynamical reconstruction of AMOC variability at the mouth of the South Atlantic

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Abstract

The two main dedicated Atlantic meridional overturning circulation (AMOC) observing systems (RAPID and OSNAP) are located in the Northern hemisphere. Insights from these systems have motivated a recent focus on the South Atlantic basin, where water masses are exchanged with neighboring ocean basins. In a numerical study, we compute linear sensitivities of the South Atlantic MOC (SAMOC) at 34°S to surface wind, thermal, and freshwater forcing, highlighting the important dynamical pathways for carrying perturbations into and around the South Atlantic ocean basin. We use the adjoint of the MIT general circulation model (MITgcm), configured based on the data assimilation procedure of the consortium for Estimating the Circulation and Climate of the Ocean (ECCO) version 4 release 2. Boundary forcing is given as the near surface atmospheric state from 1992-2011 ERA-Interim reanalysis fields. We quantitatively attribute the influence of each forcing component on the monthly mean AMOC at 34°S and find that wind (particularly the zonal component) dominates variability on monthly and interannual timescales. Freshwater forcing contributes less to SAMOC variability during this twenty year time frame, adding little beyond a seasonal cycle. For all components, perturbations in the atmospheric forcing over the Pacific, Southern, and Indian ocean basins have a notable influence over the AMOC at 34°S even at lead times of one month. This behavior is in contrast to the AMOC in the Northern hemisphere (e.g. 26°N), where the domain of influence is largely confined to the North Atlantic and Subpolar gyre. These results emphasize the importance of continuous widespread observations of the global atmospheric state for (eventually) forecasting SAMOC variability. Further in-depth analyses of sensitivity pathways and time scales are afforded by the availability of the full adjoint state (the dual) of the model.

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