

Decomposing the Variability in the North Atlantic Meridional Overturning Circulation

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Models show that Atlantic Meridional Overturning Circulation (AMOC) anomalies, linked to buoyancy forcing in the subpolar region, progress rapidly to tropical latitudes. This signal, however, is masked by high frequency, wind-driven AMOC variability at subtropical latitudes, leading to latitudinal incoherency in AMOC variability between the subpolar and the subtropical gyres. Despite a focus of the AMOC community in recent years, the extent to which AMOC signals are connected between gyres remains an open question. In this study, we decompose the latitudinal AMOC (calculated in density space) variability using an Empirical Orthogonal Function (EOF) analysis in two ocean circulation models (FLAME and ORCA025) and two ocean reanalysis datasets (SODA3 and ECCO4). With the trend removed, EOF1 (50%) in all datasets detects a meridionally coherent mode of AMOC variability. This mode maximizes in the subpolar gyre and decreases towards low latitudes. EOF2 (20-30%) reveals a gyre-specific mode with AMOC strength in the subpolar gyre out-of-phase with that in the subtropical gyre. The time series of this mode is linked to an NAO-like wind stress pattern. At the gyre-gyre boundary, where EOF2 reverses signs (i.e. EOF2=0), AMOC variability can be reconstructed from the first mode only, suggesting this location as the key region to detect the meridionally coherent mode of AMOC variability. We also discuss the dominant frequency of the time series for EOF1/EOF2, as well as the vertical structure of the overturning streamfunction for the two modes.