Attribution of midlatitude AMOC variations to surface wind, heat and freshwater forcing

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A key challenge in AMOC research is to attribute observed AMOC variations to past wind and buoyancy forcing. Here we present such results obtained using a non-eddying ocean circulation model (the MITgcm) and its adjoint.

First we compute the sensitivity of the monthly AMOC at 25N to global patterns of wind, heat and freshwater forcing over the preceding 15 years (beyond which the assumption of linearity required for the adjoint calculation becomes tenuous). Consistent with previous studies, the AMOC exhibits sensitivity to wind forcing for only a few months, but multidecadal sensitivity to buoyancy forcing that oscillates with time. The sensitivities vary seasonally, the midlatitude AMOC being most sensitive to wind anomalies over the Eastern US Seaboard in autumn and to high-latitude buoyancy anomalies in winter and spring. The role of barotropic and baroclinic Rossby waves (including the mid-Atlantic ridge), Kelvin waves, and advective pathways in setting the teleconnection pathways will be discussed.

Subsequently we project observed seasonal climatologies of wind, thermal and freshwater forcing onto the computed monthly sensitivities over the period 1995-2010 to determine the time scales over which the midlatitude AMOC has memory of past forcing. We find that wind-driven AMOC variations are dominated by wind forcing over the previous year, whereas the buoyancy-driven AMOC responds to heat flux anomalies over the entire 15 year window (and only modestly to freshwater anomalies). There is no convergence in the AMOC response as the memory of the AMOC is increased.