Inter-hemispheric comparison of meridional overturning circulation and meridional heat transport using high-resolution coupled climate and ocean-only simulations

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Abstract:
We conduct an inter-hemispheric comparison of the meridional overturning circulation (MOC) and meridional heat transport (MHT) in a suite of GFDL high-resolution coupled climate and ocean-only simulations, with an emphasis on examining the similarities and differences between the MOC and MHT at the latitudes of the RAPID/MOCHA array (nominally 26.5ºN) and the developing array in the South Atlantic (nominally 34.5ºS). Estimates of the annual cycle of the MOC and MHT suggest that both geostrophic and wind-driven components contribute to the annual cycle in observations, and are in (out of) phase at 26.5ºN (34.5ºS), leading to a strong (weak) seasonal cycle in the MOC and associated MHT. In contrast, none of the model simulations are able to reproduce the observed geostrophic seasonal variations. The simulated MOC and MHT annual cycles are dominated by the Ekman component, yielding a total annual cycle in phase with observations at 26.5ºN, but in disagreement with observations at 34.5ºS. We explore the possible causes for this discrepancy between models and observations and investigate whether there is a similar mechanism responsible for these inter-hemispheric differences and for the weak geostrophic seasonal cycle in the model simulations. We show that these differences cannot be explained only by deficiencies in the simulated wind stress curl over the Atlantic basin. Our analysis highlights that a thorough comparison between models and observations at key latitudes across the whole Atlantic basin is needed to advance our understanding of MOC variability and improve the realism of model simulations.