The sensitivity of the MOC and MHT seasonal cycle to wind forcing

Renellys C. Perez[1,2], Rym Msadek[3], Shenfu Dong[1,2]
[1]Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Miami, Florida
[2]Atlantic Oceanographic and Meteorological Laboratory, Miami, Florida
[3]Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey

Abstract:

Using observations and simulations by the GFDL CM2.5 high-resolution, eddy-permitting, coupled climate model and an ocean-only (CORE forced) version of the same model, we analyze the sensitivity of the seasonal cycle of the volume and heat transport by the meridional overturning circulation (MOC) to wind forcing at the latitudes of the RAPID/MOCHA array (nominally 26.5ºN) and the developing SAMBA array (nominally 34.5ºS). Observation-based estimates of the annual cycle of volume and heat transport by the MOC suggest that both geostrophic and directly wind-driven Ekman 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 cycles. In contrast, none of the model simulations are able to reproduce the observed geostrophic seasonal variations. Rather the simulated MOC annual cycles are dominated by the Ekman component, yielding a total annual cycle in phase with observations at 26.5ºN but too weak in magnitude, and with a strong annual cycle at 34.5ºS contrary to the weak annual variations from observations. 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 coupled model and ocean-only simulations. We determine whether these deficiencies are basin-wide or arise on the western boundary, interior, or eastern boundary. 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.