Measuring Interannual Variability of the AMOC and Meridional Ocean Heat Transport at 26.5°N: The RAPID-MOCHA Array

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The objective of this program is to continuously monitor the strength and structure of the Atlantic meridional overturning circulation and meridional ocean heat transport at 26.5°N using a basin-wide observing system. As of March 2014, we have completed a decade of observations. Funding for the array was renewed in 2014 and will continue through at least 2020.

Recent results

The mean values for the AMOC strength and northward heat transport from the 10-year time series (2004-2014) are 17.0 Sv and 1.24 PW, respectively. Both the AMOC strength and the heat transport have decreased in recent years compared to values observed prior to 2009; the five-year means for the pentad 2009-2013 were 15.6 Sv (1.34 PW) compared to values of 18.7 Sv (1.14 PW) for the pentad 2004-2008. The decline in the heat transport of 0.2 PW between these periods is significant. It is equivalent to a net decrease in surface heat flux of ~7 W/m^2 over the whole North Atlantic, north of 26.5N, and represents a net deficit in heat delivery to the North Atlantic of 1.0 PW during the last five years, nearly equivalent to one year's worth of the typical heat transport. Observations of ocean heat content (OHC) from Argo data show that the North Atlantic OHC reached a decadal peak in about 2007 and has since declined, consistent with the lower recent heat transport values recorded by the 26.5°N array.

More than 90% of the interannual variability that has occurred in the meridional heat transport is contained in the overturning component of the heat transport, while the gyre component has maintained a stable mean value. Both Ekman and Gulf Stream variability contribute to large, short-term changes in the AMOC and heat transport, including occasional heat transport reversals. However, the interannual variability of the heat transport is dominated by the geostrophic circulation and mostly by the mid-ocean heat transport. Analysis of global climate models and simpler forced dynamical models suggest that most of the interannual variability can be explained by wind-forced changes in mid-ocean circulation associated with first baroclinic mode Rossby waves that are excited by interannual wind stress curl anomalies in the central and western part of the basin.

Several improvements in the methodology for the MOC and heat transport calculations have been implemented since 2009, which have been applied retrospectively to the entire time series. These include improvements in the surface extrapolation of interior geostrophic velocities, adoption of the TEOS-10 equation of state, updated Gulf Stream temperature transport calibration, and weekly optimal interpolation of Argo and RAPID mooring data to estimate the interior temperature transport.

Online data

MOC data: http://www.noc.soton.ac.uk/rapidmoc/
Heat transport data: http://www.rsmas.miami.edu/users/mocha/