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Continuous observations of the variability of the Atlantic meridional overturning circulation at 26.5°N: Major results and present challenges

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The RAPID-WATCH/MOCHA array for monitoring the Atlantic meridional overturning circulation (AMOC) at 26.5°N has been in continuous operation since April 2004. Here we present a 4 year timeseries of its strength and variability. The 26.5°N section is separated into a Florida Strait section west of the Bahamas where the Gulf Stream transport is monitored from cable voltage measurements and a mid-ocean section from the Bahamas to Africa. Variability in the wind-driven surface-layer Ekman transport is derived from QuikScat satellite-based observations. The zonally integrated geostrophic profile of northward velocity of the mid-ocean flow is estimated from time-series measurements of temperature and salinity throughout the water column at the eastern and western boundaries and on either side of the mid-Atlantic Ridge, complemented by direct velocity measurements. Here we focus on two aspects, (i) the interactions of the different branches of the AMOC, and (ii) the observed AMOC variability.
i. We show that the addition of bottom pressure as an independent indicator of the ocean circulation adds to provide the experimental proof that the upper-ocean northward transport fluctuations are compensated for by fluctuations of the deep-ocean southward transport. In particular fluctuations in either Gulf Stream or deep western boundary current transports are compensated in a barotropic manner very close to the continental slope off the Bahamas. Bottom pressure further reveals that the abyssal, zonally integrated transport variations at 5000 m exceed that at any other level below the thermocline. The presence of the large-amplitude abyssal transport variability is puzzling, as it clearly exceeds the level of variability required for a compensation of upper-ocean transports We also document how wave dynamics within 100 km of the western boundary provides an efficient mechanism to suppress an imprint of the offshore eddy field on the AMOC.

ii. The mean AMOC strength is 18.5 and it fluctuates over time by ±4.9 Sv. The sub-seasonal variance (periods between 10 and 90 days) of the Ekman transport exceeds that of the Gulf Stream and mid-ocean, dominating fluctuations of the AMOC. However, the seasonal variance of both the Gulf Stream and mid-ocean transports dominate seasonal fluctuations of the AMOC. The strength of the AMOC displays a seasonal cycle of 7 Sv peak-to-peak, with maxima in early Autumn and minima in early Spring. A strong seasonal cycle in eastern boundary densities from the surface to 1400 dbar dominates the upper mid-ocean seasonal cycle and appears to be driven by seasonal variations of the eastern boundary wind stress curl. Our results further show that the inferred meridional heat transport at 26.5° N is closely correlated with the strength of the AMOC, and that the gyre contribution to fluctuations in the heat transport is likely to be an order of magnitude smaller than the overturning component.