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Meridional coherence and divergence of the Atlantic Meridional Overturning Circulation (AMOC)

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The AMOC is responsible for the meridional transport of heat on climate relevant timescales. Numerical model studies suggest, that the AMOC varies on broad range of periods: Wind forcing dominates local and intraseasonal variability; Buoyancy forcing is important at longer periods and sets – at least the mean strength – of a meridionally coherent AMOC. We shall present contemporaneous observations targeting AMOC fluctuations for the period 2000 to 2010. Three continuous data sets from 16°N, 26°N and 40°N are available.

Continuous mooring-based density observations of the deep southward transport of North Atlantic Deep Water in the western basin are available since the year 2000 at 16°N in the framework of the MOVE experiment (operated by SIO, San Diego, USA). From 2006 the western basin transports are extended to the eastern basin using data from the TENATSO mooring near Cape Verde. This enables us to compute NADW transports integrated across almost the entire zonal width of the Atlantic at 16°N. From 2004 the RAPID / MOCHA (NOC, UK / RSMAS & AOML, USA) a purposefully designed monitoring array has been monitoring the strength of the AMOC (both the northward transport of warm water and cold NADW return flow) at 26°N To put the decade-long observations at 16°N and 26°N into a long-term perspective, we construct a 146 year-long index of changes of the AMOC near 40°N based on tide gauge records along the US east coast (which goes back in time with interruptions to the year 1856).

We present evidence for the occurrence of coherent changes of the AMOC between 16°N and 26°N, suggesting that AMOC anomalies with meridional scales larger than 1000 km are observed. We find evidence for periods of pronounced divergence in NADW transports between 16°N and 26°N. Isolating different transport contributions of the AMOC signal at both latitudes we trace the origin of coherent and divergent events.

Extreme low AMOC values (observation period 2004 to 2010) were observed at 26°N in the winter of 2009/10, associated with the extreme negative state of the North Atlantic Oscillation. The tide-gauge AMOC index at 40°N, (since 1868) also has its lowest value at this time. This might indicate that occurrences of low-AMOC events like the winter 2009/10 anomaly are extremely rare.