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10-years of Atlantic Overturning observations: variability revealed on sub-annual, seasonal, annual and multi-annual timescales

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The RAPID/MOCHA/WBTS project has been measuring the Atlantic Overturning circulation (AMOC) at 26.5 N in the North Atlantic since 2004. The joint UK-US project has recently reached the 10 year milestone. Here we present some of the key results from the first 10 years of the program.

The first year's measurements revealed a sub-annual variability that encompassed all previous ship-based, hydrographic estimates of the AMOC, thus showing that a perceived decline could be encompassed in short-term variability. Seasonal variability in the AMOC was larger than expected with a 6 Sv range, with the largest single component derived from wind-stress curl induced density fluctuations at the eastern boundary.

Interannual variability, far larger than that present in state of the art climate models, was seen in 2009/10. A 30% reduction lasted 18 months and cooled the subtropical North Atlantic significantly. The existence of continuous heat transport measurements enabled us to show that the main cause of the cooling was a reduction in ocean heat convergence rather than air-sea fluxes.

The winter of 2010/11 revealed a second consecutive winter of low AMOC: a double dip. Whether ocean re-emergence or the change in AMOC circulation was the cause of the SST tripole pattern pattern that emerged in the winter of 2010/11 is a topic of ongoing research. Nonetheless, this SST pattern was shown to be sufficient to push the atmosphere into a second consecutive negative wintertime North Atlantic Oscillation (NAO) and increased predictability of this negative NAO.

Most recently a multi-year decline in the AMOC has been observed. This 0.5 Sv/year decline is much larger than the long-term decline predicted due to anthropogenic climate change. The decline first reported on the 8.5-year timeseries has continued in the 10-year timeseries. The magnitude of the decline is so large as to suggest it may be decadal variability. A decline in the AMOC is consistent with a declining phase of the Atlantic Multi-decadal oscillation of sea-surface temperatures that is predicted by a number of authors.