The wind stress drives the coherence of the North Atlantic Meridional Overturning Circulation on seasonal and annual time scales.

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The response to wind stress forcing of the Atlantic Meridional Overturning Circulation (AMOC) is investigated using four time series of overturning transports below 1000 m spanning 3.7 years. These time series are derived from four moored arrays located on the western boundary of the North Atlantic: the RAPID WAVE array (42N), the Woods Hole Oceanographic Institution Line W array (39N), the RAPID MOC array (26N), and the MOVE array (16N). Mode decomposition of the cross-covariance between these time series and scatterrometer wind stress over the North Atlantic suggests that basin-scale changes in atmospheric forcing significantly affect the AMOC on relatively short time scales. First, the phasing of the transport time series at semi-annual and annual time scales is shown to be statistically linked to basin-wide seasonal patterns of wind stress and wind stress curl. This predominant mode of covariability is interpreted in terms of rapid basin-scale adjustments in the form of two counter-rotating meridional overturning Ekman cells centered on the tropics and the subtropical gyre. A second mode of co-variability is found which is associated with anomalous patterns of wind stress and wind stress curl correlated with the North Atlantic Oscillation. This mode acts to modulate the horizontal gyre circulations, and to reinforce and at times weaken an overturning cell at the inter-gyre boundary.