Geophysical Research Abstracts
Vol. 14, EGU2012-5993, 2012
EGU General Assembly 2012

Basin-wide response of the North Atlantic Meridional Overturning Circulation to wind stress forcing

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The dynamics and response to wind stress forcing of the North Atlantic Meridional Overturning Circulation (AMOC) are investigated from an observational standpoint, 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 basin: the RAPID WAVE array (42.5°N), the Woods Hole Oceanographic Institution Line W array (39°N), the RAPID MOC array (26.5°N), and the MOVE array (16°N). Mode decomposition of the analytic cross-covariance between these transport time series and scaterrometer wind stress over the North Atlantic suggests that basin-scale changes in the 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 between overturning transports and wind stress 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 strength of the horizontal gyre circulations, and to reinforce and weaken at times a basin-wide overturning cell.