Chaotic vs externally forced variability of the Atlantic Meridional overturning circulation on intra and inter-annual timescales.

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Abstract

The ocean, like the atmosphere, is chaotic, which means that even under the same external forcing (atmospheric conditions), a small difference in the oceanic initial state can result in a different oceanic state beyond a decorrelation time. In this analysis, we use the ORCA12 configuration of NEMO forced by DFS5.2 atmospheric forcing to investigate the fraction of chaotic variability of the Atlantic meridional overturning circulation (AMOC). The variability of the AMOC in ORCA12 shows good agreement with the RAPID-MOCHA array observations of the AMOC for the 2004-2012 period. To estimate the amplitude of the chaotic AMOC variability two 4-member ensembles, starting in 2007 and 2009 respectively and integrated over 4 years, have been performed. The structure of the chaotic variability of the AMOC, assessed from the ensemble spreads, shows similarities with the finding of Hirschi et al. (2013) and Gregorio et al. (2015) with a peak of chaotic variability around 35∘N. To gain some insight into the physical processes behind the chaotic variability we decompose the AMOC into its geostrophic, barotropic and Ekman components. Particular emphasis is on a case study of the minimum event observed at 26∘N in 2009-2010. The results show that this pronounced event does not stand out in terms of the relative contributions of chaotic vs externally forced variability. In both ensembles the geostrophic contribution accounts for the largest fraction of the chaotic variability.

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