Variability and Forcing Mechanisms of the Atlantic Meridional Overturning Circulation

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LONG-TERM GOALS

To understand processes associated with intra-seasonal to decadal variability of the Atlantic Meridional Overturning Circulation (AMOC) and the relation to surface forcing.

OBJECTIVES

(1) To analyze the consistency and fidelity of existing global ocean data assimilation (ODA) products for their estimates of AMOC state and the associated meridional transports of heat and freshwater, (2) to anatomize AMOC variability by decomposing it into different components that are associated with different dynamics and observations, (3) to examine the meridional coherence and connectivity of the AMOC, and (4) to study the sensitivities of AMOC to surface forcing and lateral sources of buoyancy forcing from the high-latitude North Atlantic as well as the Southern and Indian Oceans.

APPROACH AND WORK PLAN

To achieve the objectives, we will (1) analyze the consistency among available ODA products and compare them with the RAPID observations, (2) decompose AMOC variability inferred from ODA products into various dynamical components and examine their relations to different forcing and observations; (3) examine the meridional coherence and connectivity of the AMOC using ODA products, and (4) use the adjoint of an OGCM to study the sensitivity of AMOC to different forcings and the relative contribution of local and remote forcings.

The PI, Dr. Tong Lee of JPL, is working closely with Co-I, Dr. Geoffrey Gebbie of Harvard University, and collaborator Dr. Detlef Stammer of University of Hamburg to conduct the proposed investigation. Drs. Lee, Gebbie, and Stammer will collaborate on the analysis for the consistency of ODA products and the meridional connectivity of AMOC. Drs. Gebbie and Stammer will focus more on the North Atlantic while Dr. Lee will focus more on the South Atlantic while having a broad scope of investigation of the AMOC over the entire Atlantic basin as a whole.

In the coming year, we plan to complete and submit a manuscript describing the consistency of over a dozen ODA products in terms of the variability of AMOC in different time scales, latitudes, and depths. We will embark on the investigation of meridional connectivity of AMOC.

WORK COMPLETED

We have analyzed 14 ODA products for their consistency in the estimated state of the AMOC. We evaluated the consistency of these ODA products as a function of time scales (intra-seasonal, seasonal, interannual, and decadal), latitude, and depth.

RESULTS

We found that the strengths of the AMOC estimated by ODA products are the most consistent for seasonal time scales, followed by interannual time scales. Most of the inconsistency is for the intra-seasonal time scales. The differences among ODA estimates are the largest near the equator, indicating the need to improve data assimilation methods in regions where geostrophy is not a good approximation. Overall speaking, the spread among the estimates of ODA products is smaller than the magnitude of variability represented by these products. In other words, the “signal-to-noise” ratio is larger than 1.