Southwest Atlantic Meridional Overturning Circulation (SAM)

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Project Summary

Variations in the Atlantic Meridional Overturning Circulation (MOC) have been shown to have connections to changes in precipitation and air temperatures over large segments of the northern hemisphere. The 2007 US interagency Ocean Research Priorities Plan designated the study of the MOC as a key near-term priority, and the US AMOC implementation panel has identified improving the observations of the MOC in the South Atlantic as one of the critical needs to better understand MOC variability. In the subtropical South Atlantic the MOC cell has a number of characteristics that distinguish it from the MOC circulation in the subtropical North Atlantic. Unlike in the north, where the MOC consists primarily of two western boundary components, in the South Atlantic the MOC circulation is more widely spread across the basin. Near 34-35°S the warm northward flowing upper limb is carried in the basin interior (via Agulhas Rings) and along the eastern boundary (in the Benguela Current), while the cold southward limb flows in the Deep Western Boundary Current (DWBC), which is primarily located under the southward flowing Brazil Current. This longitudinal spread is indicative of the role that the South Atlantic plays as both the 'gateway' and the 'mixing pot' of waters exchanged simultaneously with the Indian and Pacific Oceans. Deep waters that are formed in the northern North Atlantic must pass through the South Atlantic on their way to the Southern Ocean, where they are spread throughout the global ocean. Warm waters returning to the northern North Atlantic from the Indian and Pacific must pass through the South Atlantic and mix with those waters on their way northward across the equator. The NOAA Southwest Atlantic MOC ('SAM') observing project began in March 2009 as a collaboration between the US, Argentina and Brazil; the goal is to measure key MOC flows near the western boundary of the ocean in the South Atlantic. A parallel effort is underway in the Southeast Atlantic operated by France and South Africa. Locations of the four NOAA-funded moored instruments deployed as part of SAM are shown in Figure 1.

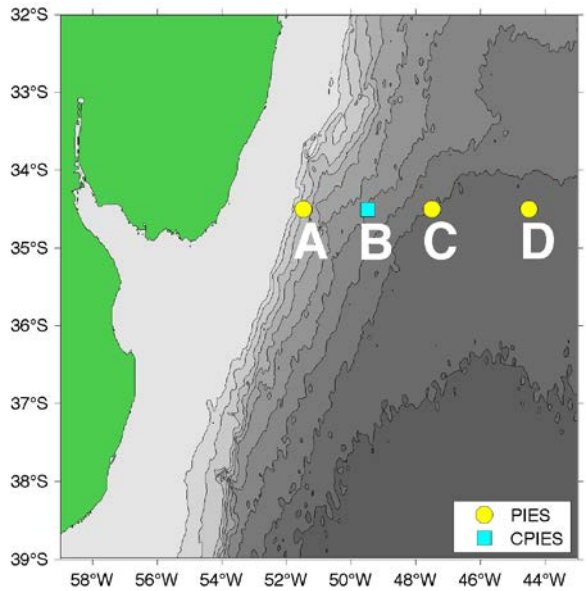

***Figure 1**: Locations of the four pressure-equipped inverted echo sounders (PIES) and current-and-pressure-equipped inverted echo sounders (CPIES) deployed as part of the NOAA funded SAM project. Note in July 2011 the CPIES at Site B was replaced with a PIES.*

The SAM project is designed to parallel and complement NOAA's well-established project monitoring the MOC in the North Atlantic, the Western Boundary Time Series (WBTS) project. The WBTS project has formed the cornerstone for an international trans-basin MOC measurement array at 26.5°N; the SAM project represents the first step to initiate a similar array at 34.5°S. The SAM

array is based on two different types of moored instruments: inverted echo sounders equipped with pressure sensors (PIES), and inverted echo sounders equipped with both a pressure sensor and a single-depth acoustic current meter (CPIES). Work in the WBTS project has demonstrated that this combination of instruments is capable of quantifying the upper and deep layer transports. The initial SAM pilot array involving four PIES/CPIES represents a test of the array locations and the start of a long-term monitoring project for the MOC in the South Atlantic.
The time series observations in SAM are seen as serving three main purposes for climate variability studies:

- Monitoring of the DWBC for water mass and transport signatures related to changes in the strengths and formation regions of high latitude water masses in the North Atlantic for the ultimate purpose of assessing rapid climate change.
- Serving as a western boundary endpoint of a nascent international MOC monitoring system designed to measure the basin-wide meridional flows across the South Atlantic Ocean near 35°S.
- Quantifying how variations in the MOC propagate meridionally between the North and South Atlantic through comparison with the WBTS results.

The SAM project is a component of the NOAA "Ocean Reference Station" system in the Atlantic Ocean, and is one of the few time series observing sites in the Global Ocean Observing System (GOOS). SAM seeks to specifically address the NOAA climate goals by providing long-term, integrated, measures of the global thermohaline (overturning) circulation. This project is designed to deliver yearly estimates of the state of the thermohaline circulation, i.e. its intensity, properties, and heat transport. Heat and carbon generally are released to the atmosphere in regions of the ocean far distant from where they enter. Monitoring the transport within the ocean is a central element of documenting the overturning circulation of fresh water, heat and carbon uptake and release. Long-term monitoring of key locations will provide a measurement of the primary routes of ocean heat, carbon, and fresh water transport and hence include the bulk of the Meridional Overturning Circulation. Measurements from the SAM project will provide critical records for use in validation and evaluation of the numerical climate models that are and will be used in the future for informing governments and agencies on climate change and planning.