U.S. Atlantic Meridional Overturning Circulation (AMOC) Update
July 2012

Recent U.S. AMOC Activity

Under the guidance and support of four federal agencies (NASA, NOAA, NSF, and DoE), the U.S. AMOC Program is coordinating research focused on the 4th near-term priority of the Ocean Research Priorities Plan, the Atlantic Meridional Overturning Circulation (AMOC). The AMOC Science Team, composed of PIs leading 50 research projects, continues the development of the AMOC Program with annual meetings, program reports and international collaboration.

The U.S. Department of Energy (DoE) has joined U.S. AMOC as a participating funding agency with 13 DoE projects now identified as contributing to the goals of the U.S. AMOC research program. The DoE projects principally focus on understanding and modeling the mechanisms of AMOC variability and its predictability, its role in abrupt climate change, extreme climate events, and ecosystem changes.

The 2012 U.S. AMOC PI Meeting will be held August 15-17 at the UCAR/NCAR Center Green Campus in Boulder, Colorado. This is an open meeting for U.S. AMOC Principal Investigators and all interested parties to review current research and examine near-term priorities in four topical areas: The AMOC Observing System, AMOC fingerprinting from historical and proxy data, AMOC mechanisms and predictability, and AMOC's impact on the carbon cycle. The meeting will consist of plenary, mini-workshop and poster sessions. The full agenda with presentation abstracts can be found online.

The U.S. CLIVAR Project Office released the Fourth Annual Progress Report for a SOST Near-Term Priority Assessing Meridional Overturning Circulation Variability: Implications for Rapid Climate Change. This 100-page report, authored by the U.S. AMOC Executive Science Team members and edited by the U.S. CLIVAR Project Office, includes a review on the progress of program objectives and near-term research priorities with recommended activities to sustain observation and analyses. Also included in the report are summaries of currently-funded AMOC projects and recent AMOC publications.

U.S. AMOC funding agency managers have called for a review in the fifth year of the U.S. AMOC Program. An external review committee of three scientists knowledgeable in the science, methods and challenges of studying the Earth's meridional overturning circulation and its global impacts has been assembled to evaluate the Program's science planning, implementation and synthesis of results beyond individual research projects. The review committee members include Galen McKinley (University of Wisconsin), Lynn Talley (Scripps Institution of Oceanography), and Noel Keenlyside (University of Bergen, Norway). The committee will survey background materials outlining initial plans and annual progress of the program, engage the Program's research during the U.S. AMOC PI Meeting in August, and conduct follow-up with the Program's Executive Committee as necessary. A written report of findings and recommendations will be provided to the U.S. CLIVAR Interagency Group of managers supporting the Program by the end of 2012.

New U.S. AMOC webpages are currently under development by staff at the U.S. CLIVAR Project Office. These updates, to be completed by August, include a comprehensive list of all identified U.S. AMOC PIs and associated research projects, as well as related resources including presentations, reports, and recent journal articles.

New Science Results

These results will appear in a forthcoming issue of the Journal of Climate:
Yeager, S., A. Karspeck, G. Danabasoglu, J. Tribbia, and H. Teng, 2012: A Decadal Prediction Case Study: Late 20th Century North Atlantic Ocean Heat Content. *J. Climate*, early online release, doi:10.1175/JCLI-D-11-00595.1.

Decadal Prediction using CCSM4

Stephen Yeager, Alicia Karspeck, Gokhan Danabasoglu, Joseph Tribbia, and Haiyan Teng
National Center for Atmospheric Research, Boulder, CO

We have found that an ensemble of initialized decadal prediction (DP) experiments using the Community Climate System Model, version 4 (CCSM4), run under the auspices of CMIP5, shows considerable skill at forecasting changes in North Atlantic upper ocean heat content and surface temperature up to a decade in advance. We ran coupled model ensembles forward from each of 10 different start dates spanning 1961 to 2006 (at 5 year intervals) with ocean and sea-ice initial conditions obtained from a forced historical experiment. The latter entailed integrating a coupled ocean--sea-ice model from 1948-2007 using Coordinated Ocean-ice Reference Experiment (CORE) atmospheric surface fluxes. The resulting ocean state reanalysis (referred to as CORE-IA) exhibits a good correspondence with late 20*th* century ocean observations from the North Atlantic subpolar gyre (SPG) region.

North Atlantic heat content anomalies from the DP ensemble correlate highly with those from the CORE-IA simulation after correcting for a drift bias. In all prediction experiments, model drift is the dominant decadal signal, but techniques for bias correction appear to work quite well in the decadal prediction context, so that meaningful climate signals can be detected after such data processing. In particular, the observed large, rapid rise in subpolar gyre heat content in the mid 1990s is successfully predicted in the ensemble initialized in January of 1991 (Fig. 1), and heat content tendency is generally well-captured for all initialization dates. As a result, the correlation of SST in the subpolar gyre region between the DP experiments and observation in the second pentad of prediction is 0.89, which is significant at the 95% confidence level.

A budget of SPG heat content from the CORE-IA experiment sheds light on the origins of the 1990s regime shift, and it demonstrates the extent to which low-frequency changes in ocean heat advection related to the Atlantic meridional overturning circulation (AMOC) dominate temperature tendencies in this region. Similar budgets from the DP ensembles reveal varying degrees of predictive skill in the individual heat budget terms, with large advective heat flux anomalies from the south exhibiting the highest correlation with CORE-IA. The skill of the DP in this region is thus tied to correct initialization of ocean circulation anomalies, which are related to slow AMOC variations, while external forcing is found to contribute negligibly (and for incorrect reasons) to predictive skill in this region and over this time period.

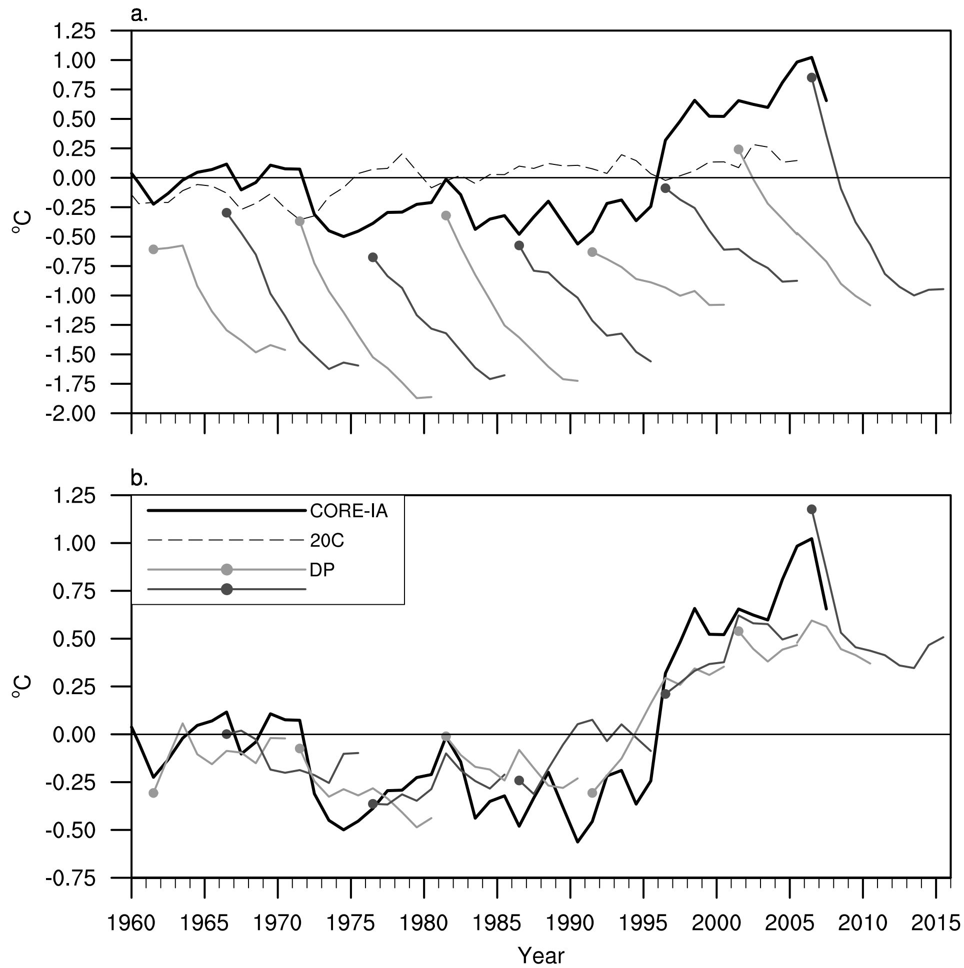

Figure 1 Annual mean 275-m heat content anomaly in the subpolar gyre region (50°-10°W; 50°-60°N; in °C). Panel (a) shows CORE-IA (thick solid black), a 6-member ensemble average of uninitialized 20th century integrations (thin dashed black), and the raw DP 10-member ensemble means (grey curves, alternating shades for clarity). Panel (b) shows CORE-IA and the bias-corrected DP ensemble means (note the change in scale). Large circles indicate the first-year average of each DP ensemble. The CORE-IA and DP anomalies are computed relative to the CORE-IA climatology over the reference period 1961-2007.