Cooperative Institute for
Climate Applications and Research
EARTH INSTITUTE | COLUMBIA UNIVERSITY

# CICAR

## NOAA SPONSORED PROJECT SUMMARIES

July 1, 2003 – June 30, 2004

# THEME I: Earth System Modeling

**Project title**: *CLIVAR: South Atlantic Ocean-Atmosphere Interaction*

Seasonal climate forecasts over tropical Africa and South America are hampered by the lack of skillful predictions of sea surface temperatures in the tropical Atlantic. The aim of this CLIVAR South Atlantic Ocean-Atmosphere Interaction research is to make advances in two areas in order to improve seasonal prediction over the tropical Atlantic. With funding from NOAA's Office of Global Programs, Dr. Andrew W. Robertson of the International Research Institute for Climate Prediction (IRI) and the Earth Institute at Columbia University, in collaboration with researchers C.R. Mechoso and A. Hall, professors in the Department of Atmospheric Sciences at UCLA, is conducting a general circulation modeling (GCM) and diagnosis study to address issues of:

1. The physical understanding of ocean-atmosphere interactions in the South Atlantic and their interactions with El Niño / Southern Oscillation (ENSO) and tropical Atlantic Climate Variability (TAV).
2. Simulation of the mean climate and seasonal cycle by coupled ocean-atmosphere general circulation models over the South Atlantic, as a prerequisite to successful dynamical seasonal prediction over the Atlantic sector.

Both parts of this research should yield results that directly address the goals of CLIVAR-Atlantic. Looking forward, the work should also contribute toward improved seasonal prediction through being able to better predict Atlantic SST anomalies with coupled models and through an improved understanding of the interannual dynamics that could be utilized in simplified dynamical or empirical prediction models.

Read more:
Seasonal Climate Prediction over the Americas (PDF), by Andrew W. Robertson, International Research Institute for Climate Prediction (IRI)

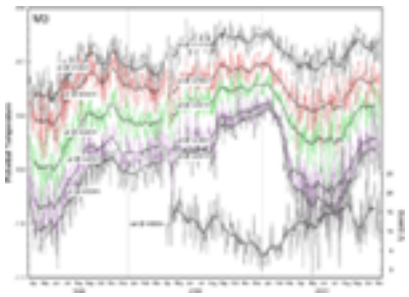
**Project title**: *Consortium on Ocean's Role in Climate (CORC) – AbRupt climate CHangE Studies (ARCHES)*

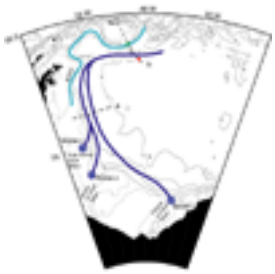
(Research addressing the CICAR Themes Earth system modeling and Modern and paleoclimate observations.)

CORC-ARCHES is a partnership between the National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs (OGP) and the Lamont-Doherty Earth Observatory (LDEO) and includes researchers from other academic institutions. CORC emphasizes the study of longer-term climate variability, where the ocean is perceived to be important. The ARCHES element is

dedicated to the study of mechanisms that lead to abrupt and significant shifts in the state of the climate system in the past and evaluate the likelihood of abrupt changes in the future.

ARCHES has three components: Paleo Observations, Modern Observations, and Modeling. Dr. Peter Schlosser and Dr. Wallace S. Broecker of LDEO are the lead project investigators of CORC-ARCHES. They coordinate the research within LDEO and between LDEO and the sub-awardees from Woods Hole Oceanographic Institute and the University of Maine consortium.





1. The M3 temp [4141 to 4567 m] and vel [4592 m] time series
2. The map view [as used on the CLIVAR poster]
3. The temperature section showing position of the moorings [as used on the CLIVAR poster]

The ARCHES moorings, installed in April 1999, provide a time series of the combined outflow (currents and temperature/salinity) of a variety of Antarctic bottom water types drawn from various sites along the continental margins of the Weddell Sea. Analysis of the near-bottom potential temperature, salinity and current time series at the deepest of the moorings, M3, reveals significant variability. The coldest outbreak of bottom water from April to July 2001 is associated with higher bottom speeds towards the east and higher salinity. This suggests an impulse of the saline bottom water type derived from the southwest corner of the Weddell Sea. The observations imply significant changes in the production rate of the Weddell Sea bottom types, presumably brought about by changes in the wind and sea ice features that produce and export dense shelf water.

To read more about this subject:

Field Report #1
Field Report #2
Field Report #3
Field Report #4

**Project title**: *Dynamical Forecasting of ENSO: A Contribution to the IRI Network*

The International Research Institute for Climate Prediction (IRI) uses LDEO ENSO predictions in its ensemble forecasting procedures and in its forecasts. Additionally, these predictions are published monthly in the Climate Prediction Center's (CPC) Climate Diagnostic Bulletin. The goals of this research are to improve our ability to predict ENSO and to make that prediction as usable as possible to the forecasters at application centers.

To accomplish these goals, Lamont-Doherty Earth Observatory researchers Mark A. Cane, Dake Chen, and Alexey Kaplan focused their attention on forecast system improvement, quantitative forecast error estimates, and ENSO predictability. LDEO researchers utilized past progress with emphasis on participating in the ocean data assimilation consortium, an activity of NOAA's Climate Dynamics and Experimental Prediction (CDEP) Applied Research Centers (ARCS), and on making the results usable to other participants of the IRI Network.

**Project title**: *ENSO Prediction in the Western Tropical Pacific: The Roles of Surface Heat and Freshwater Fluxes*

ENSO research conducted by Dake Chen and Mark A. Cane of the Lamont-Doherty Earth Observatory focused on analyzing observational data of surface fluxes, configuring the LDEO global tropical ocean model, and performing a series of preliminary model experiments. Drs. Chen and Cane improved the predictive skill of the current LDEO ENSO forecast model by introducing a bias correction method that statistically corrects for model deficiencies in parameterizing subsurface temperature and surface heat fluxes. The new model, known as LDEO5, was able to predict most of the warm and cold events of the last one and a half centuries, especially the relatively large El Niño and La Niña. In addition, their results suggest that ENSO is largely driven by internal relationships between ocean temperature and tropical winds rather than by more unpredictable factors such as externally driven wind bursts, thus making the future of long-term climate prediction much more optimistic.
Read more:
LDEO News release

**Project title**: *Understanding Climate Change From the Medieval Warm Period to the Greenhouse Future*

(Research addressing the CICAR Themes Earth system modeling and Modern and paleoclimate observations.)

Scientists from the Lamont-Doherty Earth Observatory and the Geophysical Fluid Dynamics Laboratory propose to model and understand the changes in global climate and climate variability over the period from 1000AD to 2200AD. The primary purpose of this collaborative research effort is to understand and simulate future climate change.
The period of study covers the Medieval Warm Period (MWP) until about 1300AD, the Little Ice Age (LIA) until the end of the Nineteenth Century, the modern period, and the future. It incorporates a range of external forcing including changes in solar irradiance, volcanism, atmospheric aerosols, and greenhouse gas concentrations that are rising to levels unprecedented over the period of human evolution.

Lamont's Principal Investigator Richard Seager leads a team of researchers attempting to explain how changes in atmospheric and ocean circulation were involved in past climate changes and how these influence past and future global and regional climate change. The scientists are using an integrated research program that examines current and future climate change in the context of change that has occurred over the last 1000 years. The research program involves model simulations

of the last 1000 and next 200 years, diagnosis of data from the modern period, and rigorous validation of simulations against paleoclimate proxy records of past climate.
Throughout the project, researchers will highlight model deficiencies and gaps in understanding in order to improve model predictions of future climate and our understanding of future climate.

## THEME II: Modern and Paleoclimate Observations

**Project title**: *Collaborative Research: Development of a Blended, Living Gridded Network of Drought Reconstructions for North America*

Principal Investigator Edward R. Cook of the Lamont-Doherty Earth Observatory and scientists from NOAA's National Climatic Data Center are engaged in a collaborative research effort to develop a living blended North American drought reconstruction grid that can be continuously updated as new instrumental data become available. The grid is calibrated against single-station monthly precipitation and temperature records for the United States, Canada, and Mexico.

The gridded precipitation and temperature data will be used to generate Palmer Drought Severity Indices (PDSI) and Standardized Precipitation Indices (SPI), two widely used measures of relative drought and wetness. These gridded drought/wetness metrics will be used with centuries-long annual tree-ring chronologies to generate well-calibrated and verified drought reconstructions covering the past 500-1000 years in most areas of North America. Because the tree-ring chronologies typically end in the 1980-90's, the researchers are developing methods for blending the tree-ring reconstructions with the gridded instrumental drought indices in such a way that the tree-ring reconstructions can be continuously updated with the most current gridded estimates of PDSI and SPI. This living blended drought reconstruction grid will greatly increase the usefulness of the paleo-reconstruction grid by guaranteeing that it is never out of date.

Related links:
Tree Ring Laboratory of Lamont-Doherty Earth Observatory
National Drought Mitigation Center

**Project title**: *Multivariate Approach to Ensemble Reconstruction of Historical Marine Surface Winds From Ships and Satellites*

Scientists at the Lamont-Doherty Earth Observatory are analyzing historical winds on the basis of ship data, with statistical parameters helped by scatterometry data, to investigate epochal changes in Indian monsoon connections with ENSO and global warming and sources of the Pacific Decadal Oscillation.

Researchers Alexey Kaplan, Mark Cane, and Yochanan Kushnir identified four key scientific objectives for this NOAA OGP funded project:

- Developing adequate techniques for multivariate analyses of winds and related variables
- Use of objective multivariate analysis approach for removing spurious long-term trends in wind data
- Developing and utilizing the procedure for representing the analysis uncertainty by an ensemble of possible realizations
- Applying newly developed products for addressing relevant questions about Indian monsoon – global warming connections and genesis of the PDO

Analyzed data sets produced in this project will be made publicly available and will respond to a great need of ocean modeling in the studies of long-term climate variability and climate change.

**Project title**: *Atmospheric and Coastal Ocean $CO_2$ Measurement Platform – SABSOON*

The coastal ocean is the primary pathway that delivers inorganic, dissolved organic, and particulate organic carbon from estuaries, rivers, and terrestrial sources to the open ocean. In Coastal systems, $CO_2$ concentrations are also strongly affected by physical processes and it is therefore important to identify the mechanisms that regulate coastal ocean $CO_2$.

Click on image for larger view and expanded caption.

Lamont-Doherty Earth Observatory scientist Wade McGillis, in concert with fellow researchers from Princeton University and the NOAA / Climate Modeling & Diagnostics Lab will study measurements of $CO_2$ in the ocean and atmosphere from an ocean tower on the southeastern continental shelf of the United States. The research will address the relative importance of different drivers such as gross primary production, net ecosystem metabolism, air-sea exchange, and temperature solubility effects on annual and spatial scales.

The complex interplay between mixing water masses, atmospheric forcing, and spatial heterogeneity in bottom topography and roughness make $CO_2$ studies in the coastal ocean move challenging. This work represents a unique study to map the variability in $CO_2$ concentrations and air-sea $CO_2$ exchange at a coastal site. The researchers hope to determine the processes most important to controlling and predicting the influence of coastal carbon cycling in North American terrestrial carbon cycling.

Related links:

The North American Carbon Program Plan

The South Atlantic Bight Synoptic Offshore Observational Network (SABSOON)