



CLIMATE VARIABILITY AND PREDICTABILITY

Workshop on Tropical Atlantic Variability 3-6 September 2001, Paris, France

The CLIVAR workshop on Tropical Atlantic Variability (TAV) took place at UNESCO, Paris, September 3 through 6, 2001. The workshop originated as a follow up of the COSTA meeting held in Miami during May 1999 (<http://www.aoml.noaa.gov/phod/COSTA/>).

The main objectives of the Paris workshop were to review advances in science since the last workshop, and to coordinate international efforts toward a sustained observing system in support of understanding, modelling and predicting TAV. The workshop was sponsored by the International CLIVAR Project Office. At its conclusion detailed recommendations were presented to the CLIVAR Atlantic Implementation Panel on an implementation plan for tropical Atlantic (TA) research. The workshop was attended by 120 scientists from 10 different countries.

This article briefly summarizes the workshop. A report containing the complete program, the list of participants, abstracts of the presentations, as well as the reports from the working groups can be found at: <http://www.clivar.org/organization/atlantic/TAV/>.

During the first three days of the workshop, keynote presentations were made during the morning, and interactive poster sessions were held in the afternoon. At the end of the day, the attendants met in a plenary session, in which rapporteurs lead a discussion of the oral and poster presentations that took place during that day.

The first day was dedicated to a discussion of the role of local air-sea interaction in TAV (presented by S. P. Xie), the coupling between TAV and other regions (R. Sutton), and the local air-sea flux exchanges with the ocean (S. Planton).

On the second day, the first part of the morning session was dedicated to a discussion of the influence of the tropical Atlantic atmosphere/ocean circulation on climate variability over the Americas (J. Paegle and P. Nobre), and the interactions between tropical Atlantic and African climate (C. Thorncroft). The second part of the morning was dedicated to the interaction between TAV and the large-scale atmosphere/ocean circulation. A discussion of its relation to the North Atlantic oscillation (NAO) and the meridional overturning circulation (MOC), (by B. Blake), was followed by a discussion on the shallow overturning cells and cross-gyre exchange in the region (by W. Johns), and by a presentation of potential links to decadal variability, secular variability and climate change (R. Fine).

The third day was dedicated to the observing system. A summary of the present observing system in the tropical Atlantic (by J. Servain) was followed by a discussion of the role of GODAE in the future observing and prediction systems (N. Smith). Finally, representatives of NCEP and ECMWF (P. Arkin, and T. Stockdale) discussed observational needs for prediction, what we have learned from model assimilation of data from the current observing system and whether the existing data streams satisfy the assimilation and prediction needs.

Following the oral and poster presentations, three working groups (WG) were created:

- WG1: Coupled Ocean Atmospheric Systems (Chair: P. Delecluse)
- WG2: Climate Impact and Predictability (Chair: Y. Kushnir)
- WG3: Links between the upper Tropical Atlantic, the Deeper Ocean and the other Basins (Chair: F. Schott)

The charge to the Working Groups was to summarize the science and the observational needs based on the workshop discussions, and to make recommendations towards an implementation plan. The following is a summary of these recommendations.

Report from WG1: Coupled Ocean-Atmospheric Systems. Recent analyses and modeling studies concerning TAV indicate several critical issues, such as the emerging consensus on the existence of a local ocean-atmosphere coupling in the equatorial region and the importance of external forcing (i.e., by atmospheric or oceanic teleconnections) in affecting regional variability. Also of significance is the fact that TAV displays a large range of variability from interannual to decadal scales and that these time scales seem to be interdependent. Moreover, the specific meridional configuration of the tropical Atlantic basin, bordered by two large landmasses with complex boundaries (South America and Africa), confers a strong predominance to the seasonal cycle, which consequently interacts with lower frequency variability. The variability in the tropical Atlantic thus remains difficult to understand, model, and predict. With this in mind, it is proposed that progress in understanding and predicting TAV can be achieved by emphasizing two key scientific themes:

- The regional three-way coupling between atmosphere, ocean and land-surface interactions.
- The regional links between the seasonal mean evolution of the background state and its variation on all time scales.

These should be emphasized in both analysis and modeling studies. In the modeling approach to these topics, perturbation experiments are recommended to clarify the role of the different interactions between atmosphere, ocean, and land-surface patterns. Perturbation experiments are also needed to clarify the slower oceanic teleconnections between the tropical region and the mid-latitudes. In addition, regional coupled modeling studies are recommended to explore the local effects of atmospheric teleconnections from other regions (e.g., the tropical Pacific and North and South Atlantic) and how they interact with local processes. It is also recommended to conduct studies that will help understand and correct the discrepancies in present coupled model simulations of the local amplitude and phase of the annual cycle in the atmosphere, land, and ocean. Continued modeling and analysis towards an improved understanding of the processes that control the SST variability is also recommended.

Report from WG 2: Climate Impacts and Prediction. The goal of WG2 was to facilitate communication between ongoing prediction efforts related to the tropical Atlantic region and the science and ocean observing community in order to improve prediction. Such communication will help identify needs in the areas of ocean observations, development of models and data assimilation methodologies, and the identification and design of crucial process studies. In addition, the group aimed to facilitate through this communication the fertilization of ideas leading to improve forecasting methods and forecast applications. In its discussions, WG2 identified three areas that need attention: data gaps, climate impacts and predictability.

There are obvious gaps in surface ocean data due to the nature of VOS tracks and the location of permanent platforms. Lagrangian tracers also display patterns of convergence that leave some areas unsampled. These gaps result in the loss of necessary information not only where climate variability is concerned but also, in some regions, in fundamental aspects of the mean seasonal cycle. Other less obvious gaps are linked to failures to constrain regional data assimilation products with observations (these are partially related to model discrepancies, see above discussion of WG1). It is recommended that these issues be continually monitored with help from operational centers and the observational programs of GCOS and GOOS.

On the problem of impacts, it is clear that while much is known on the links between fluctuations of climate variables important to society and tropical Atlantic sea surface temperature (SST), there is much more that needs to be done in terms of identifying the actual societal effects of this variability, the composition of the end user community, and the implied priorities. It is therefore recommended that continued emphasis be given to the need for impact related research (if possible end-to-end) and that increased attention be given to year-round variability and the southern tropical Atlantic (STA) region.

There is need to better define the predictability limits of TAV and related phenomena through diagnostics of data and model experiments. This also requires an improved definition of model (numerical and statistical) limitations.

Finally, this working group addressed the link to operational centers and Climate Outlook Fora. It was recommended to plan an international workshop meant to facilitate discussion between prediction centers/climate fora and the research community. Such workshop should be preceded by establishing contact with the climate centers involved in operational prediction for the tropical Atlantic and the identification of key topics and issues for discussion.

Report from WG 3: Links between the upper Tropical Atlantic, the deeper ocean and the other basins. The overarching question discussed in WG3 was the role of four-dimension advection in affecting tropical Atlantic (SST), and specifically, the role of subsurface to deep circulation in determining TAV, the inter-tropical convergence zone (ITCZ) position and (SST).

Sub-tropical Cells (STCs) and the role of the meridional overturning circulation were largely discussed. In particular, the need to understand the mean STCs and their

variability, the mean pathways relating subduction areas with upwelling, and the relative roles of the interior meridional exchange versus western boundary undercurrents was emphasized. Also discussed was the relative role of equatorial and off-equatorial upwelling, the transformation of thermocline waters into surface waters, and the role of North Brazil Current (NBC) rings in inter-hemispheric water mass exchange. On the topic of STC variability, the relation between the North Brazil Undercurrent equatorial upwelling, and SST was discussed as well as the role of planetary waves.

On the relation between TAV and larger scale circulation, the discussion was centered on the need to determine mean cross-equatorial exchanges, water mass transformations, and their variability. Also discussed, in general terms, was the effect of decadal and inter-decadal variability of Meridional Overturning Circulation (MOC) structure on the North Atlantic Deepwater (NADW), and on the warm water return flow through different South Atlantic source waters. The need to understand the role of MOC/NADW pulses in TAV at different time scales was addressed as well as how TAV affects NAO and MOC.

On implementation issues, process studies are proposed for three of the science objectives: STCs, MOC transformation study, and NADW pulse effects on the TAV. Of the three, the STC process study is judged the one most ready for implementation because of the work done during the 2000 Venice CLIVAR Workshop on the STC (for more information see:

http://www.clivar.ucar.edu/organization/atlantic/STC/STC_rep0801.pdf).

It is therefore recommended that an Implementation Workshop be organized for a basin wide STC international process study. Recommendations are also made on sustained observations. These include MOC transport time series and STC transports. It was also recommended to improve the VOS fleet by adding the capability of measuring currents (ADCP) and thermosalinograph for tracks crossing the tropical Atlantic.

The Workshop was co-chaired by Silvia L. Garzoli (NOAA/AOML, US) and Jacques Servain (IRD/FR). Chantal Andrie (LODYC,FR) was the local organizer. Members of the organizing committee were: Edmo Campos (USP/BR), Jim Carton (UMd/US), Ping Chang (TAMU, US), Pascale Delecluse (LODYC/CNRS/FR), James Hurrell (NCAR/US), Mike McPhaden (NOAA/US), Paolo Nobre (INPE/CPTec/BR), and Serge Planton (Meteo/FR). CLIVAR Atlantic Implementation Panel Representatives to the committee: Yochanan Kushnir (LDEO/US), and Rowan Sutton (Reading/UK).