U.S. CLIVAR
VARIATIONS
Winter 2002, Vol. 1, No. 1

FROM THE U.S. CLIVAR OFFICE

Moving Ahead

by David M. Legler, director

Welcome to the inaugural issue of the U.S. CLIVAR Newsletter. Since I started in the office, I felt there has been an unmet need for communicating timely and informative information as well as highlighting program achievements to those with interest in CLIVAR. I hope you agree that this first issue is a step forward.

U.S. CLIVAR has made significant progress during the past two years. The Scientific Steering Committee (SSC), with the assistance of the regional panels and working groups, developed our implementation strategy. We owe a particular debt of gratitude to Russ Davis and David Battisti for steering the SSC during this most difficult developmental period. But the role of the SSC is not complete. A roadmap that fleshes out important details of the implementation remains a high priority.

The Climate Process Team (CPT) concept, first introduced to the SSC over a year ago, has garnered a tremendous amount of attention in both the scientific and programmatic communities. This new approach (described in more detail elsewhere) aims to hasten advancement of climate research through formations of

Continued on Page Two

ITCZ Structure and Variability in EPIC2001

By David J. Raymond, New Mexico Tech., Socorro, NM, and Steven K. Esbensen, Oregon State University, Corvalis, OR

In September and October 2001 scientists from the United States, Mexico, Ecuador, and Chile converged on the tropical east Pacific in order to make intensive observations of the coupled ocean-atmosphere system in this region. Known as EPIC2001 (Eastern Pacific Investigation of Climate processes in the coupled ocean atmosphere system 2001), the purpose of this project was to investigate processes in the atmosphere and the ocean that are known to be poorly represented in climate models. These intensive observations, plus a program of enhanced monitoring over a longer period, have the ultimate goal of improving the parameterizations of these processes in climate models, and therefore hopefully leading to better model predictions.

The east Pacific is somewhat mysterious in that the warmest surface water almost always occurs north of the equator, in spite of the seasonal migration of solar heating between the northern and southern hemispheres. This peculiar seasonal cycle is not well represented by most coupled ocean-atmosphere models.

Possible sources of error are poor representations of:

- deep atmospheric convective processes in the inter-tropical convergence zone (ITCZ) over the warm water north of the equator;
- the low-level cross-equatorial atmos-

Continued on Page Two

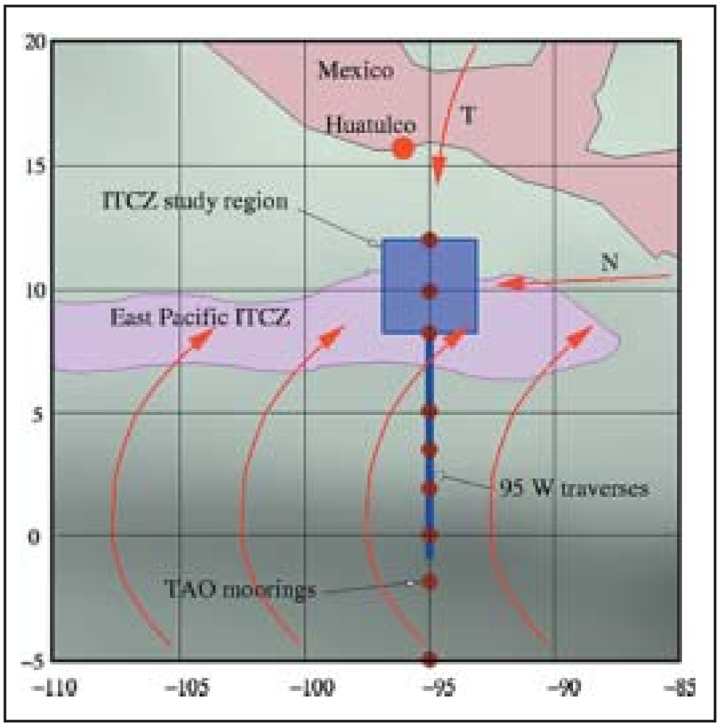

FIGURE 1.1. **Map of the eastern tropical Pacific showing the ITCZ, general surface flows, locations of TAO moorings and the ITCZ study region, and the aircraft base in Huatulco, Mexico. The arrows labeled T and N represent sporadic gap flows through the Isthmus of Tehuantepec and the lowlands of Nicaragua. The sea surface temperature is represented qualitatively by the shading, with cooler temperatures being darker.**

Continued from Page One

teams comprised of climate model developers, observationalists, and those focusing on parameterizing critical processes. This approach has been highlighted not only in U.S. CLIVAR, but also in the just-released Climate Change Science Program (CCSP) Strategic Plan. The U.S. federal research agencies are constructively engaged in a process leading perhaps very soon to opportunities for this concept to be demonstrated.

The first intensive field campaign falling under the auspices of U.S. CLIVAR, EPIC (Eastern Pacific Investigation of Climate Processes) took place in the fall of 2001. The analyses of the initial data (see examples in this newsletter) highlight the importance of continued efforts in this region to more fully characterize the climate and the myriad of climate-relevant processes that must be observed and correctly modeled in this region. The next anticipated process study, North American Monsoon Experiment (NAME), is ramping up for deployment during summer 2004. It aims to sharpen our understanding and improve predictions of the continental-scale North American monsoon.

The climate observation system continues to grow and evolve. As of early November,

Continued on Page Six

Variations

Published two to three times per year by
U.S. CLIVAR Office
1717 Pennsylvania Ave., NW,
Suite 250, Washington, DC 20006
(202) 419-3471

Staff: **Dr. David M. Legler**, *Editor*
Richard M. Todaro,
Assistant Editor and Staff Writer

This newsletter is supported through contributions to the U.S. CLIVAR Office by NASA, NOAA—Office of Global Programs, and NSF.

ITCZ Structure and Variability in EPIC2001

Continued from Page One

pheric flow into the ITCZ;

- mixing, transport, and energy balance in the thin layer of warm surface water north of the equator;
- the energy balance in the stratocumulus-topped region of cold water south of the equator.

The field program was divided into two pieces, consisting of (1) a study of the ITCZ, the cross-equatorial inflow, and ocean mixing processes north of the equator, and (2) measurements in the stratocumulus region south of the equator. This article briefly describes some of the studies on and north of the equator. Other articles in this issue address the observations south of the equator and the enhanced monitoring program.

FIGURE 1.1 shows a map of the study region for EPIC2001. Research platforms in the field that supplemented the TAO array observing system included two ships, the NOAA research vessel *Ron Brown* and the NSF research vessel *New Horizon*, and two aircraft, the NSF/NCAR C-130 and a NOAA P-3.

Our two major concerns in this project have been the air mass transformations in the cross-equatorial flow and the space and time variability in the ITCZ convection. Both of these issues are important to the energy balance in the mixed layer of the underlying ocean in the vicinity of the ITCZ.

FIGURE 1.2 shows a cross-section of the flow and thermodynamic fields along

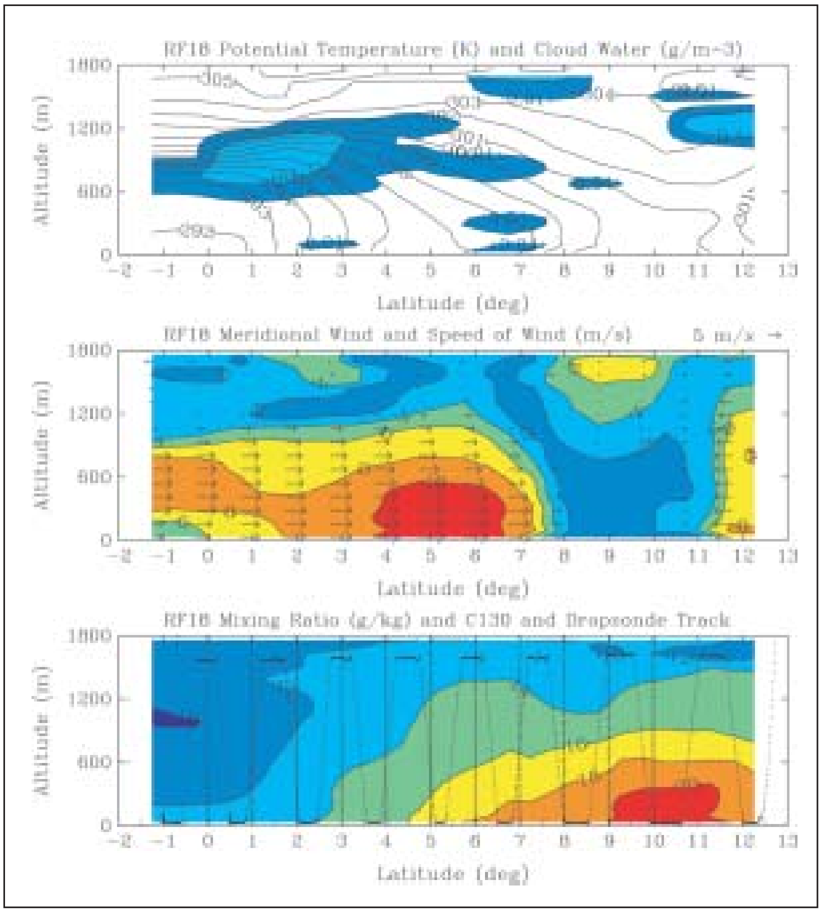

FIGURE 1.2. Cross section along 95W of potential temperature, cloud water, meridional wind, and mixing ratio, as measured by the C-130 aircraft on 9 October 2001.

95W on 9 October 2001. It is interesting that the low-level flow maintains its integrity and doesn't deepen until it terminates in ITCZ convection near 8N. Also evident in is the decoupling of the flow from the surface layer near the equator, where it crosses the region of cold water known as the equatorial cold tongue. The boundary between cold equatorial surface water and warmer water further north is very sharp, and it meanders north and south with periods of 20 to 40 days due to the westward passage of oceanic tropical instability waves along the temperature interface. Detailed atmospheric observations show that the northward flow reacts

We suspect that convective variability in the east Pacific rectifies onto climatological time scales, and is therefore important for climate modeling.

very strongly to its passage across this sea surface temperature front.

The flow south of about 5N is relatively steady. In contrast, the flow and convection north of this latitude are highly variable, as is illustrated by the variability in the GOES infrared brightness temperature seen in FIGURE 1.3. This variability is at least partly associated with the passage of African easterly waves that have survived the long trip across the Atlantic and the Caribbean. These waves are evident in the time series of radar and sounding observations from the Ron Brown as well as from aircraft observations.

We suspect that convective variability in the east Pacific rectifies onto climatological time scales, and is therefore important for climate modeling. This rectification can happen when the coupling between various model components is highly nonlinear.

Surface winds over the warm water near 10N are often light and variable, because the cross-equatorial flow terminates farther south. Furthermore, the easterly trade winds are generally blocked at low levels by the topography of Mexico and Central America. However, significant convective outbreaks are invariably accompanied by strong surface winds, either from the northward extension of the cross-equatorial southerlies or as the result of episodic gap flows through passes in the mountains to the north and east. These winds are thought to stimulate convection as a result of the strong surface energy fluxes that they produce. Under these conditions climatological average winds will not produce climatological average surface fluxes and convection, since the variance in the wind is much more important than the mean value in determining the mean energy fluxes.

Similar considerations apply to the entrainment of cool sub-surface water into the surface ocean mixed layer. This entrainment is an important component in the energy balance of the especially thin

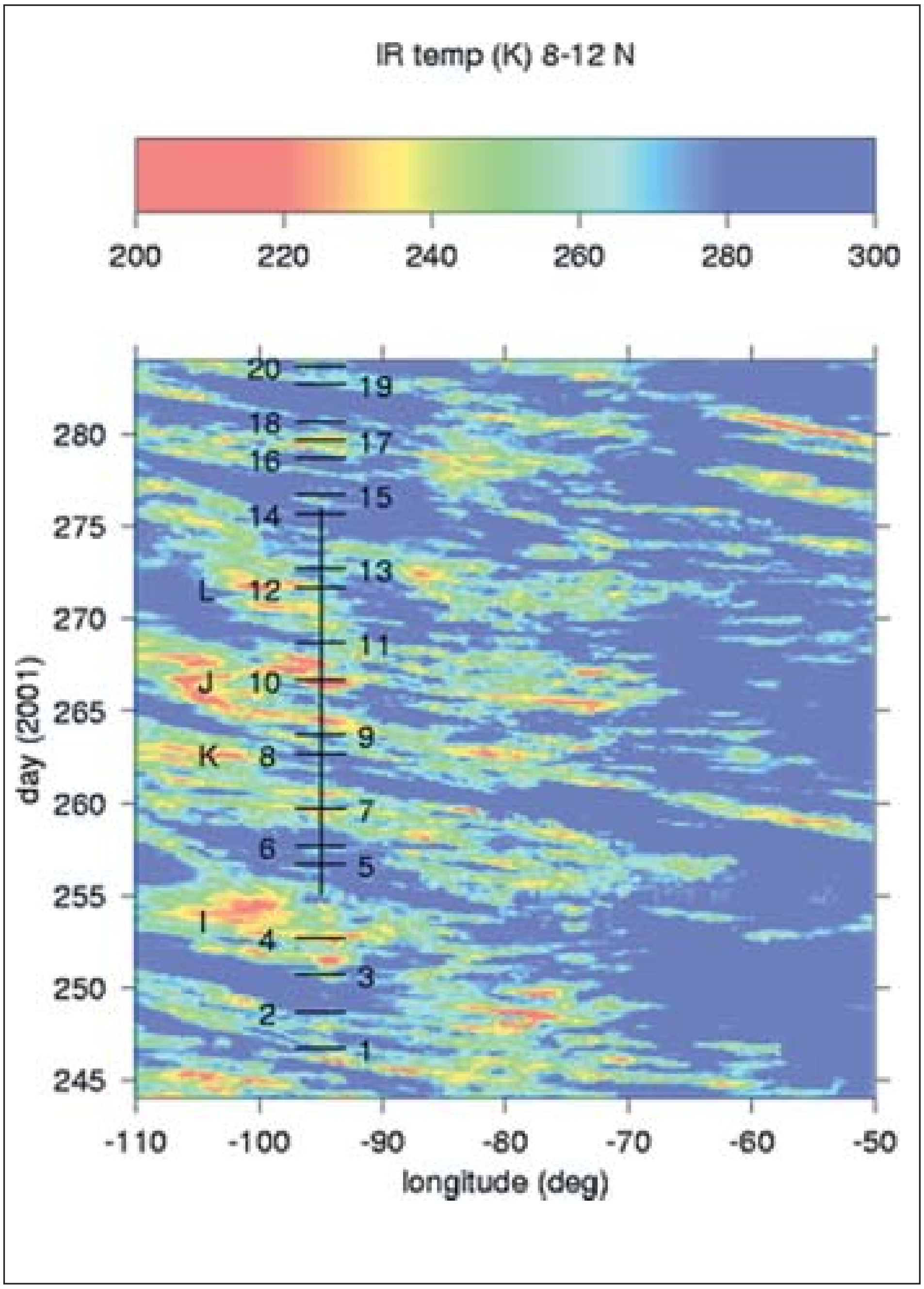

FIGURE 1.3. **Longitude-time section of infrared brightness temperature from the GOES satellite, average over 8N to12N during the EPIC2001 field phase (September - October 2001). The horizontal lines and numbers show the timing of EPIC aircraft missions and the vertical line shows the time during which the ship *Ron Brown* was present at 95W, 10N. The letters indicate the eastern Pacific tropical storms Ivo, Juliette, Kiko, and Lorena or their precursors which developed during EPIC2001. (Kiko appears before Juliette because it wasn't named until it had reached a point much farther west.)**

mixed layer (see FIGURE 1.4) and it is driven in a nonlinear fashion by strong surface winds. Observations of diapycnal mixing from the Ron Brown support this picture.

The analysis of data from EPIC2001 is still in its early stages. However, it is already clear that the results of this project will provide a useful observational basis for validating and improving the representations of a number of physical processes that are problematic for the current generation of coupled ocean-atmosphere climate models. EPIC investigators are looking forward to closer collaboration with climate modelers to improve the understanding and simulation of the climate system over the eastern Pacific Ocean the Pan American region. ■

Acknowledgments

We thank Walt Peterson and Rob Cifelli for their input regarding Ron Brown radar and sounding observations, Mike Gregg for information on ocean mixing measurements on the *Ron Brown*, and Meghan Cronin for the CTD cross- section from the *Ron Brown*. The NSF and NOAA ship and aircraft crews, the UCAR JOSS team, and the staff of the Centro de Ciencias de la Atmósfera of the Universidad Nacional Autónoma de México were indispensable to the successful completion of this project. This work was supported by the Consejo Nacional de Ciencia y Tecnología of Mexico, the National Science Foundation, and the National Oceanic and Atmospheric Administration under the auspices of the U.S. CLIVAR program.

David J. Raymond
Email: raymond@kestrel.nmt.edu

Steven K. Esbensen
Email: esbensen@coas.oregonstate.edu

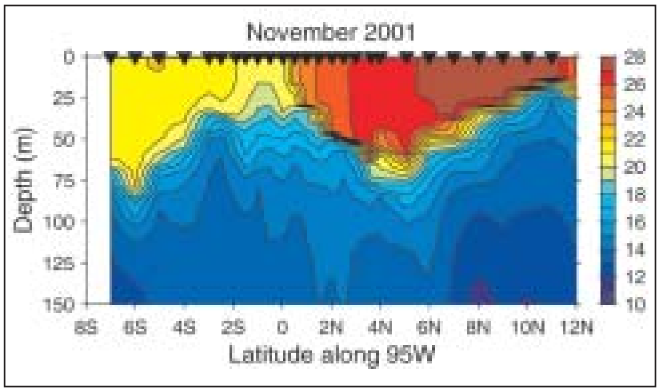

FIGURE 1.4 — Ocean temperatures along 95W for November 2001 from CTD measurements by the *Ron Brown.*

The EPIC 2001 Stratocumulus Study: Is Drizzle a Swizzle?

By Christopher S. Bretherton, Department of Atmospheric Sciences, University of Washington, Seattle

Subtropical stratocumulus cloud layers cover vast areas of the relatively cooler oceans, acting as "climate refrigerators" by reflecting back to space sunlight that would otherwise reaching the ocean surface. They are typically low (cloud tops below 1500 meters), thin (less than 500 meters thick), and topped by a sharp inversion above which the air is 5-10 K warmer, rather dry, and persistently subsiding. They are maintained by turbulent circulations in the planetary boundary layer (PBL) that are in substantial part driven by radiative cooling at the tops of the clouds. Persistent marine stratocumulus layers tend to form over regions where the SST is relatively cold compared to the air temperatures above the atmospheric boundary layer (ABL) at 2-3 km (Klein and Hartmann 1993). The thin clouds, sharp vertical gradients, and interplay of physical processes have vexed climate modelers attempting to realistically simulate these clouds and their sizeable impact on climate.

Fundamentally, the thickness of these clouds (which determines their albedo) is limited by two processes, whose relative importance is poorly understood. The first is turbulent entrainment of dry air, which evaporates the cloud, and the second is drizzle, which removes water from thicker cloud layers. Because stratocumulus derive all their moisture from local evaporation of 2-4 millimeters per day of water from the sea-surface, drizzle rates of as little as 1 millimeter per day, which are almost impossible to measure using a rain gauge, can be very important to the water budget of the cloud and the ABL.

The southeast Pacific stratocumulus region is the biggest and most persistent region of subtropical stratocumulus in the world. This is likely due to the favorable geography of South America, whose coastline is aligned with the prevailing south and southeast trade winds, promoting coastal upwelling of cold water that promotes marine low cloud formation (Philander et al. 1996). The Andes mountain range also isolates the cool marine layer from the more sultry conditions of the Brazilian jungles. Low-cloud feedbacks in the southeast Pacific affect the seasonal cycle of SST over the entire eastern Pacific Ocean and may significantly amplify the intensity of ENSO.

EPIC2001 included an exploratory cruise through the southeast Pacific stratocumulus region to help us better understand the physics of stratocumulus-capped boundary layers in this region and how to improve their representation in climate models. One of its goals was to gather the first detailed set of in-situ observations of this region. A second goal was to understand if drizzle helps to regulate stratocumulus thickness. After a stop at the Galapagos Islands, the *Ron Brown* steamed west on 8 October to 95W, then south along the remainder of the TAO buoy line into the southeast Pacific stratocumulus-capped boundary layer. It stopped for six days to maintain a buoy maintained by Robert Weller of Woods Hole Oceanographic Institution at 20S, 85W (this is an important part of EPIC longer-term monitoring; see Cronin et al. 2002), then on 24 October reached the port of Arica in northern Chile.

Some key measurements are shown in Table 1. Three-hourly soundings complemented a suite of NOAA/ETL vertically pointing remote sensing measurements, including a ceilometer for measuring cloud base, 8 millimeter wavelength radar for sensing of clouds and drizzle, and a microwave radiometer for measuring vertically integrated cloud liquid water. The 5-centimeter scanning radar mounted on the *Ron Brown* was used to survey the morphology and mean amplitude of drizzle within 30 kilometers of the ship. Surface meteorology, turbulent and radiative flux measurements, occasional samples of drizzle drop size distribution, and limited measurements of aerosol concen-

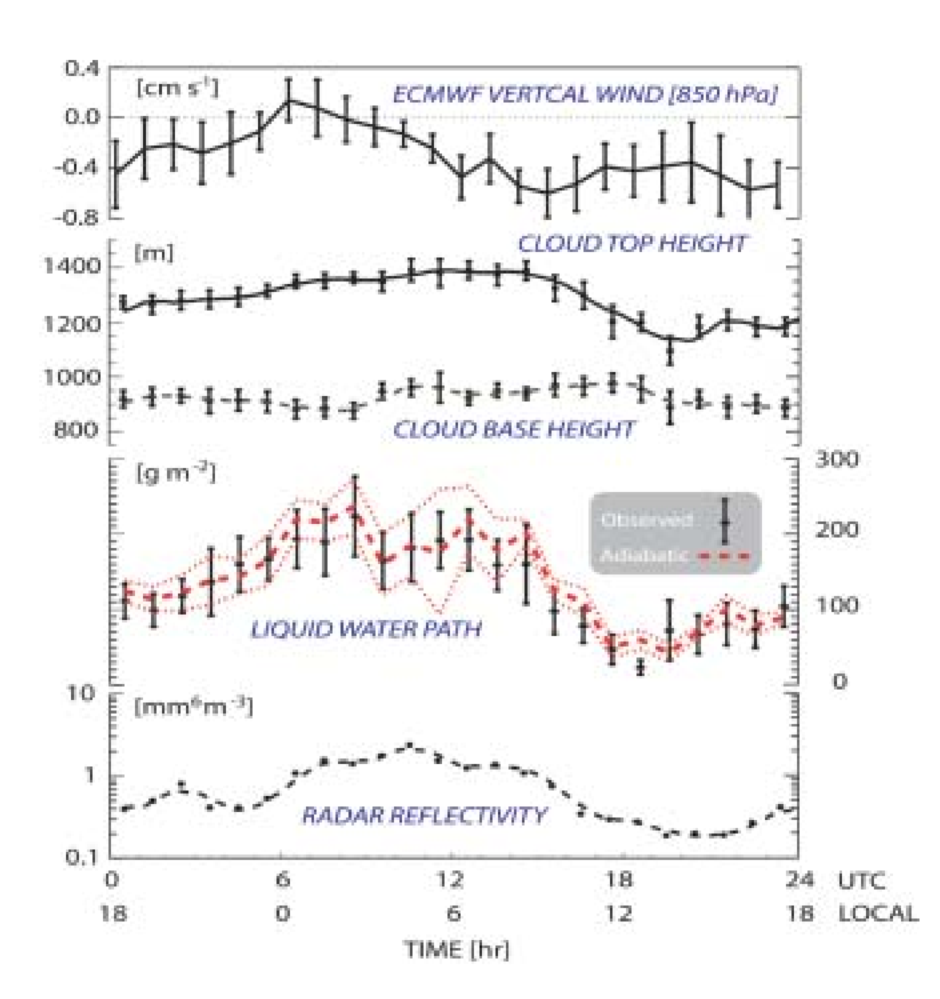

FIGURE 2.1. **Six-day composite diurnal cycle of selected variables for 16 - 21 October 2001 measured aboard the NOAA research vessel *Ron Brown* at the WHOI buoy site, 20S, 85W. Cloud top and radar reflectivity were obtained using a vertically pointing millimeter-wavelength radar, cloud height was obtained using a laser ceilometer, and liquid water path was obtained using a microwave radiometer. Large-scale vertical velocity is from 12-36 hour forecasts of the ECMWF operational weather forecast model.**

Table 1

Lead EPIC2001 Southeast Pacific stratocumulus ABL Principal Investigators

PI	Institution	Key measurements
Yuter / Bretherton	U. Washington	Sondes, 5 cm scanning radar
Raga / Baumgardner	UNAM (Mexico)	Aerosol concentration, sulfate fraction
Fairall / Uttal	NOAA / ETL	Cloud remote sensing, surface fluxes.
Weller	WHOI	IMET buoy

tration and composition provided a comprehensive near-surface view of the PBL.

The six-day period spent at the WHOI buoy provided a particularly clean snapshot of the heart of the stratocumulus regime. The ABL was capped by a sharp 10 K inversion at approximately 1300 meter elevation and had a surprisingly 'well mixed' structure with weak stratification of equivalent potential temperature below this, suggesting efficient turbulent mixing was occurring much of the time. The cloud thickness and precipitation was strongly modulated on the 10 to 50-kilometer scale, visible as "mesoscale cellular convection" on satellite images. As seen in FIGURE 2.1 (courtesy Rob Wood) the ABL exhibited a strong and quite regular diurnal cycle with nighttime maxima of inversion height (which was also the cloud top) and mean cloud thickness. Part of this cycle seems to be due to local processes–solar absorption within the clouds weakens turbulent entrainment and hence ABL deepening during the day. However, roughly half of the cloud-top and thickness variations appear driven by a strong and unexpected diurnal cycle in subsidence rate (as derived from ECMWF short-range forecasts sampled hourly). Based on other analysis, we believe this strengthening to be associated with an internal gravity wave generated by the daily cycle of heating over South America.

FIGURE 2.2 (courtesy Rob Wood) shows retrievals of precipitation rate at cloud base and the surface over the six-day buoy period based on the ship radar observations. There are considerable uncertainties (at least a factor of two) associated with radar calibration and the assumptions needed to go from vertical profiles and horizontal sections of radar reflectivity to precipitation rate. However, the basic conclusion is clear.

During the night, the cloud thickens and considerable drizzle starts to fall from the cloud base. However, almost all of it evaporates in the deep unsaturated layer below cloud base. We conclude that in this region, very little water is actually removed from the ABL by surface precipitation. Instead, the role of drizzle is indirect. Latent heat is released in the cloud when drizzle droplets are condensed and removed by evaporation in the few hundred meters just below cloud base. This heating over cooling couplet diminishes the intensity of convection and probably reduces turbulent entrainment into the ABL. Conceivably the effect of drizzle

Continued from Page Two

the Argo ocean-profiling float array has grown to nearly 600 floats from 14 countries. Continued U.S. and international commitments will increase the number of deployed floats for the foreseeable future. Several components of CLIVAR are dependent on *full* deployment of the Argo array, thus CLIVAR should be looking for opportunities to insure Argo data are utilized and their value demonstrated. While CLIVAR and others in the scientific community convinced NASA to continue crucial ocean altimeter and vector wind satellite missions in order to overlap future missions, CLIVAR must also be mindful of other proposed changes such as the transition of ocean observing systems (e.g. TAO buoys) from research to operations.

The national climate research programs have benefited from the ongoing attention and encouragement by the administration, which continues to signal that climate research is a priority. As evidence of this interest, in early December, the Climate Change Science Program (CCSP), incorporating the U.S. Global Change Research Program (USGCRP) and the Climate Change Research Initiative (CCRI), held a workshop to receive comments on its new draft strategic plan. It is important that CLIVAR scientists voice their reaction/review of the plan (see article, page 11).

Looking towards the not too distant future, the First International CLIVAR Open Science Conference (June 21-25, 2004 in Baltimore, MD) is a high-profile target for showcasing the scientific advancements of CLIVAR and exploring how CLIVAR can more efficiently interact with the users and ultimate beneficiaries of climate research information and products. ■

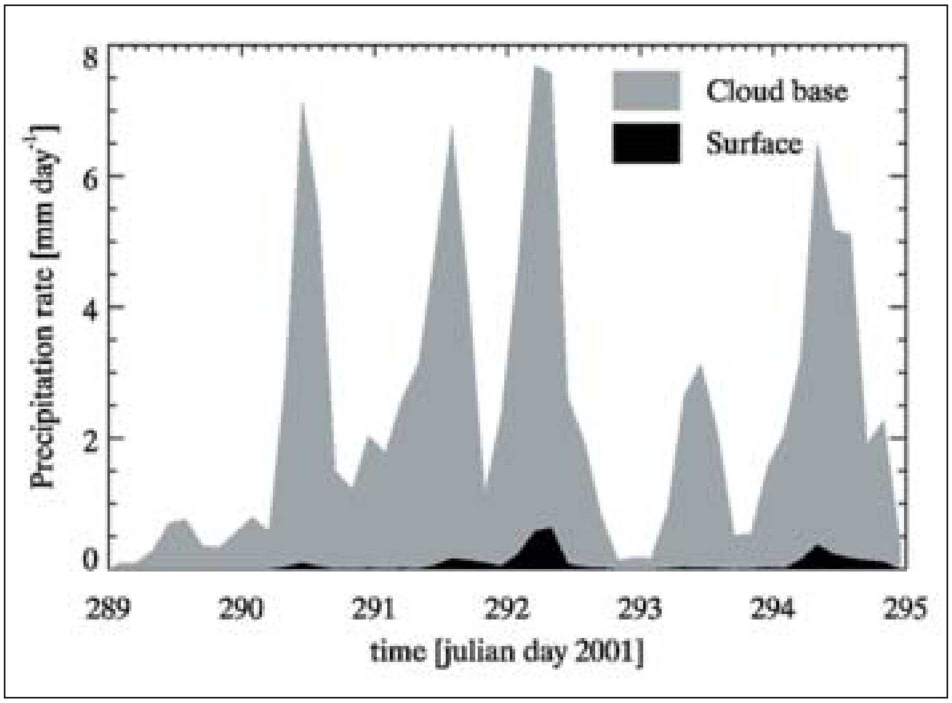

FIGURE 2.2. Radar-derived precipitation rate at the WHOI buoy for 16 - 21 October 2001. Julian day 289.0 corresponds to 00 UTC 16 October 2001.

could be to *thicken* the cloud by reducing the drying of the ABL by entrainment of dry air.

We are using various types of ABL models, ranging from mixed-layer models to single-column models that mimic what GCMs might simulate to large-eddy simulation models, to obtain a better understanding of the drizzle-turbulence-cloud thickness feedbacks hinted at by the EPIC observations. Our measurements are also nicely complemented by another field experiment called DYCOMS-II in July 2001 performing comprehensive airborne measurements of nocturnal stratocumulus in the northeast Pacific (Stevens et al. 2002). The GCSS (GEWEX Cloud System Study) Boundary Layer Cloud Working Group hopes to conduct a series of LES and single-column model intercomparison studies based on both of these field experiments to improve our understanding of what we think are large model-to-model differences in the simulation of drizzle microphysics in stratocumulus and its feedbacks on stratocumulus cloud thickness and albedo. Under the auspices of the CLIVAR VAMOS (Variability of the American Monsoons) program, the VEPIC (VAMOS-EPIC) program (http://www.atmos.washington.edu/~breth/VEPIC/VEPIC_Science_Plan.pdf) is being developed to coordinate continued enhanced measurements, diagnostic and modeling studies of this region. ■

Acknowledgement.
EPIC2001 was a cooperative effort between many students, other scientific staff and principal investigators staff of the aircraft and ships, and the UCAR Joint Office of Science Support. Jay Fein of NSF and Mike Patterson of NOAA were instrumental in putting together the resources that made it possible. The author acknowledges support from NSF grants ATM-0082384 and ATM-0082391.

Selected background readings

• Cronin, M. F., N. Bond, C. Fairall, J. Hare, M. J. McPhaden, and R. A. Weller, 2002: Enhanced oceanic and atmospheric monitoring underway in eastern Pacific. *EOS Transactions*, 83, 205, 210-211.

• Klein, S. A., and D. L. Hartmann, 1993: The seasonal cycle of low stratiform clouds. *J. Climate*, 6, 1587-1606.

• Philander, S.G.H., D. Gu, D. Halpern, G. Lambert, N-C. Lau, T.Li, and R.C. Pacanowski, 1996: Why the ITCZ is mostly north of the equator. *J. Climate*, 9(12) Part 1, 2958-2972.

• Stevens, B., et al., 2002: Dynamics and Chemistry of Marine Stratocumulus — DYCOMS-II. *Bull. Amer. Meteor. Soc.*, in press.

Christopher S. Bretherton,
E-mail: breth@atmos.washington.edu

Seasonal and year-to-year variations in the cold-tongue / ITCZ complex

By Meghan F. Cronin, NOAA Pacific Marine Environmental Laboratory, Seattle, WA,
Nicholas Bond, NOAA / University of Washington, JISAO, Seattle, WA, and
Chris Fairall, NOAA Environmental Technology Laboratory, Boulder, CO

Introduction

EPIC is a five-year experiment designed to improve understanding of the inter-tropical convergence zone (ITCZ), its interactions with the cold tongue of water that extends along the equator, and the physics of the stratus cloud deck that forms over the cool waters off South America. The acronym EPIC stands for "Eastern Pacific Investigation of Climate processes in the coupled ocean atmosphere system." As discussed in the previous articles, EPIC fieldwork began in 1999 and involves a 2-month process study (EPIC2001), embedded within a longer term (3-4 year) enhanced monitoring, built on the El Niño-Southern Oscillation (ENSO) observing system. As part of EPIC monitoring (Cronin et al., 2002), the easternmost (95ºW) Tropical Atmosphere and Ocean (TAO) line of moorings was enhanced with additional moorings and sensors (FIGURE 3.1) to provide a picket fence time series of surface heat, moisture, and momentum fluxes, and upper ocean temperature, salinity and horizontal currents. In addition, NOAA ships servicing the 95W and 110W TAO lines have supported radiosonde launches and have been instrumented to measure surface fluxes and cloud properties. In this article, we use these EPIC-enhanced monitoring data to highlight some seasonal and year-to-year variations in the far eastern Pacific cold tongue / ITCZ complex.

Seasonal variations in the cold tongue / ITCZ complex

TAO moorings are typically recovered and re-deployed on a yearly basis, and a NOAA ship visits each TAO line twice a year to perform repairs, and carry out planned recoveries and deployments. During EPIC, the biannual TAO cruises servicing the 95W and 110W lines have been aboard the NOAA research vessel *Ron Brown* in the fall and aboard the NOAA research vessel *Ka'imimoana* in the spring. For brevity, we show data from the first three EPIC sections, which occurred in fall 1999 (23 November-2 December), spring 2000 (21-30 April), and fall 2000 (2-11 November).

Differences between the fall and spring sections were much more striking than between the two fall sections (FIGURE 3.2). Most notably, both fall sections show low level southerlies extending from the cool southern region to the warm ITCZ region near 7N to 8N. Also, during both fall sections, the atmospheric boundary layer (ABL) in the southern region was weakly unstable, with small air-sea temperature differences and prominent capping inversion layers (not shown). In contrast, the spring 2000 section shows a double ITCZ, with sea surface temperatures above 26ºC at all latitudes, no equatorial cold tongue, relatively large air-sea temperature differences (particularly near 4S), and an ABL that lacked a well-defined stable layer as a cap.

Time series from buoys in the southern region (8S, 95W and 5S, 95W) also show a strong annual cycle (FIGURE 3.3), with warm surface temperatures from February through May, and cool temperatures from July through December. Consistent with formation of a southern hemispheric ITCZ, air-sea temperature differences at 5S, 95W were largest during March. Rainfall (not shown) occurred only during the warm season and preliminary (no post-calibrations applied) upper ocean salinity at 5S, 95W (FIGURE 3.3) shows an annual cycle with strong surface freshening from January through April.

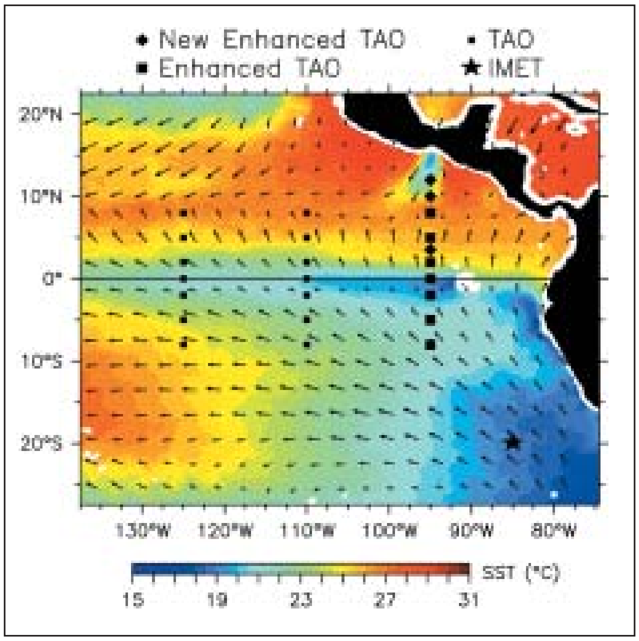

FIGURE 3.1. EPIC mooring array, shown in relation to the November 1999 averaged TRMM Microwave Imager sea surface temperature and QuikSCAT wind stress fields.

Year-to-year variations

While there were dramatic seasonal variations in the cold tongue/ITCZ complex, FIGURE 3.2 and FIGURE 3.3 also show large year-to-year variations. In particular, the inversion layer was stronger during fall 2000 than during the previous fall. Likewise during fall 2000, northerly winds aloft extended from the ITCZ region only to about 1N to 2N, while during the previous fall (fall 1999), northerly winds aloft extended across the entire section. Because these northerly winds carry moisture southward, southern hemispheric air above the ABL was relatively moist during fall 1999 and dry during fall 2000. Further work is needed to determine whether these variations aloft influence ABL structure through radiative effects. In particular, it is expected that drier air aloft should tend to reduce downwelling longwave radiation at the top of the ABL, which in turn would tend to result in a

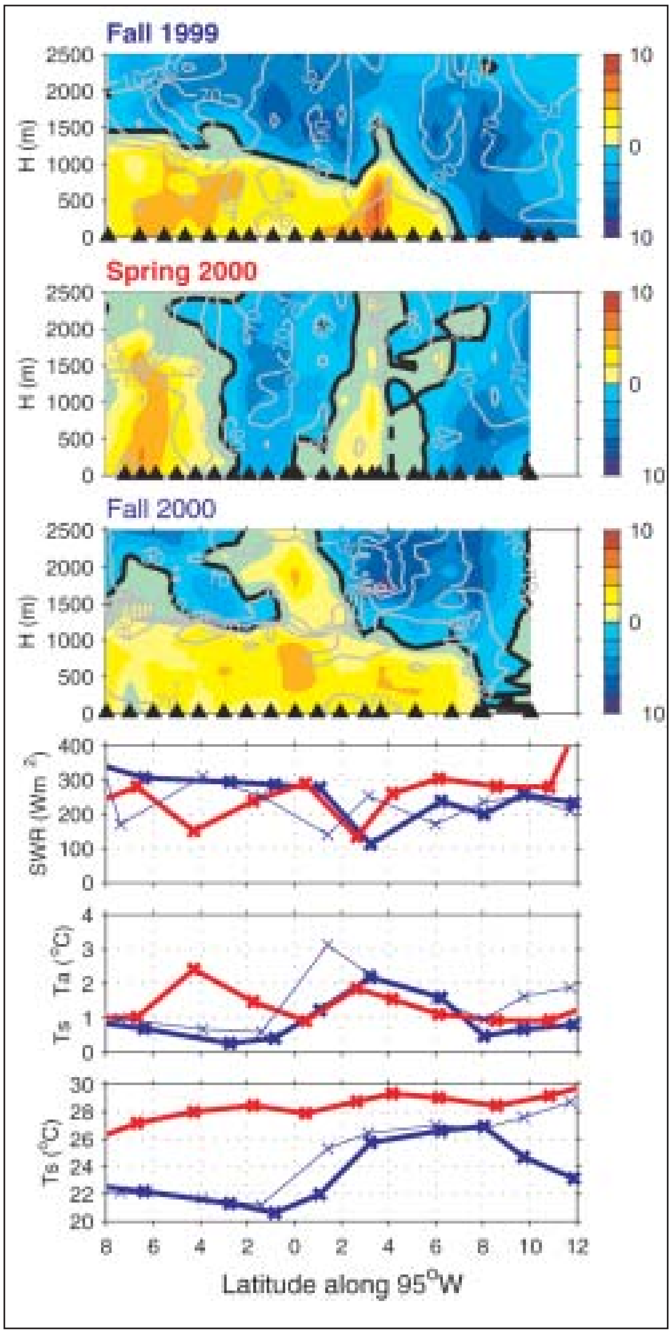

FIGURE 3.2. **Boundary layer measurements along 95W from NOAA ships Ron Brown (fall 1999, fall 2000) and *Ka'imimoana* (spring 2000). Top three panels show surface to 2500 m height meridional winds (in units ms^{-1}, positive from south, shaded in intervals of 2 ms^{-1}) and relative humidity (in units percent, contour intervals of 20 percent). Bottom three panels show downwelling solar radiation in Wm^{-2}, sea minus air temperature difference and sea surface temperature in units ºC. Surface data from fall 1999 and fall 2000 sections are shown respectively as bold and thin blue lines. Surface data from spring 2000 section are shown as bold red lines.**

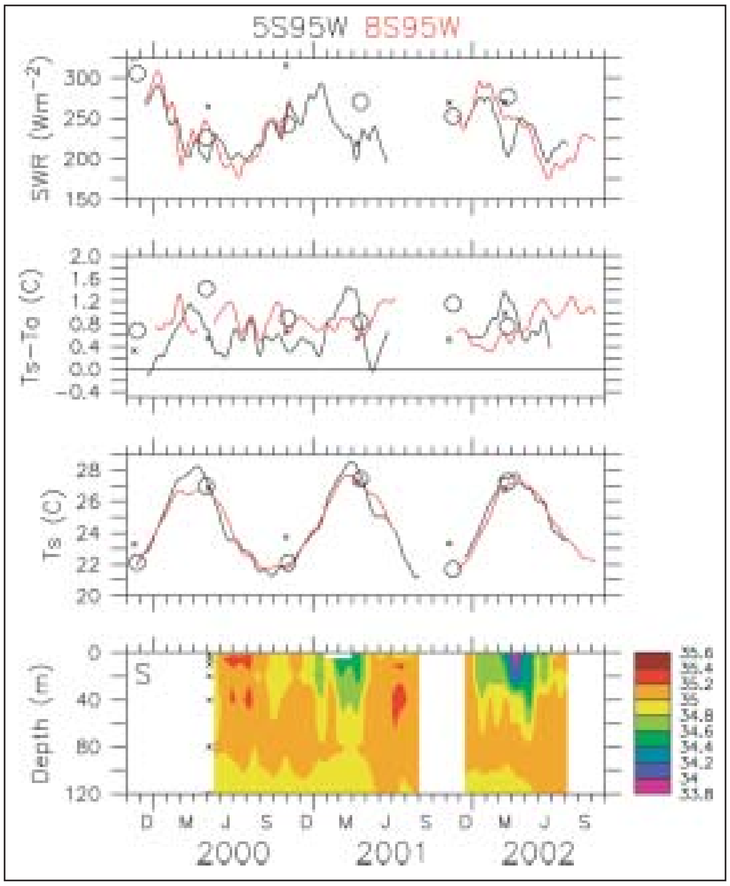

FIGURE 3.3. **Time series from southern region. Top three panels show downwelling solar radiation (Wm^{-2}), sea minus air temperature (ºC), and sea surface temperature (ºC). Data are from 5S, 95W buoy (black line) and 8S, 95W buoy (red line), and from ship sections averaged along 3.5S to 8S, 95W (circle) and 3.5S to 8S, 110W ('x'). Bottom panel shows upper ocean salinity at 5S, 95W, with sensor depths indicated ('x') at start of time series. All buoy time series are low-passed with a 29-day triangular filter.**

cooler ABL, and ultimately, enhanced ABL cloudiness. Both ship and buoy measurements indicate that the southern region had more clouds during fall 2000 than during fall 1999.

Because there is little or no temporal averaging performed on the ship data, the sections show influence from synoptic events as well as seasonal and interannual variations. For example, during November 1999 strong winds through the Isthmus of Tehuantepec caused large cooling from the Gulf of Tehuantepec to 10N, 95W (FIGURE 3.1 and FIGURE 3.2). Tehuantepec wind events are episodic, lasting only a couple of days, and occurring most frequently during November through February (Chelton et al., 2000). Thus, although these winds can cause seasonal and interannual variability in the northeastern Pacific warm pool region, the 6-monthly ship sections cannot be used to distinguish these types of variability.

Conclusion

Monitoring for EPIC has produced an invaluable data set for analyzing the structure and variability of the far eastern Pacific cold tongue / ITCZ complex. By combining buoy time series with more comprehensive ship-based observations collected during mooring operations we hope to distinguish effects of episodic and synoptic-to-intraseasonal variations on fall versus spring and year-to-year variations, and the effects of these variations on the coupled ocean-atmosphere system. These longer-term EPIC data sets also provide context for interpreting the intensive observations collected during the EPIC2001 process study. For more information on this project and these data, see: http://www.pmel. noaa.gov/tao/epic/. ■

Acknowledgment.

We thank the TAO project office and the officers and crews of the NOAA ships *Ron Brown* and *Ka'imimoana* for their efforts in collecting these data. QuikSCAT winds were courtesy D. Chelton and M. Schlax; TMI SST were from Remote Sensing Systems. This work was supported by NOAA Office of Global Programs and Office of Oceanic and Atmosphere Research.

References

- Chelton, D. B., M. H. Freilich, and S. K. Esbensen, 2000: Satellite observations of the wind jets off the Pacific coast of Central America. Part I. Case study and statistical characteristics. *Mon. Wea. Rev*., 128, 1993-2018.
- Cronin, M. F., N. Bond, C. Fairall, J. Hare, M. J. McPhaden, R. A. Weller, 2002: Enhanced oceanic and atmospheric monitoring underway in eastern Pacific. *EOS*, Transactions, American Geophysical Union, 83(19), 205, 210-211.

Additional EPIC and EPIC2001 information is available at the following web sites:

- http://www.pmel.noaa.gov/tao/epic/
- http://kestrel.nmt.edu/~raymond/epic2001/epic2001.html
- http://www.joss.ucar.edu/epic/
- http://www.atmos.washington.edu/gcg/EPIC/

Corresponding author: Meghan F. Cronin
Email: cronin@pmel.noaa.gov

Climate Process Modeling and Science Teams (CPTs)

By Richard M. Todaro, U.S. CLIVAR Office

As global climate and the overall Earth system continue to change, the need for scientists and policy-makers to accurately simulate and predict climate variability and change will become more acute. One of the ways the CLIVAR program is seeking to improve the climate models that serve as the foundation for prediction forecasts and projection scenarios is through a novel approach called a climate process modeling and science team (abbreviated CPT).

It is a fundamental aim of the CLIVAR program to enhance the understanding of and ability to predict seasonal-to-interannual climate variations and to project with ever-greater certainty climate variations and change of the global climate system. The vehicle by which this is done is the coupled climate model system. These model systems provide products — like predictions and scenarios — that are useful for scientists, decision-makers, and policy-makers at local, regional, and national levels.

But these climate model systems contain inherent uncertainties that make application and utilization of the products problematic. Characterizing, quantifying, and ultimately reducing these uncertainties and deficiencies is thus essential to model improvements.

While the nature of certain model uncertainties and deficiencies are known, the issue of how to address them is subtle and complex.

To begin with, there is a long history of process studies and other field campaigns that have left legacies of valuable data and knowledge products that have not been effectively incorporated into climate models.

In addition, there are limited resources at the major modeling centers devoted to the development of new parameterizations, better numerical efficiencies, software engineering, and other testing activities. While there have been some voluntary efforts under the auspices of the WCRP-CLIVAR Working Group on Coupled Models (WGCM) — efforts that have identified areas of model agreement and disagreement—these efforts have lacked the necessary focus resources to assess the quality of physical parameterizations and to consider and test new parameterizations. It is true that some model-specific working groups meet regularly. However, there has been insufficient focus on systematically assessing, diagnosing, and improving the fidelity of physical parameterizations. Such parameterizations are the foundation for state of the art climate models, including coupled models and their ocean and atmospheric circulation components.

The Scientific Steering Committee of U.S. CLIVAR is looking for ways to address these challenges. The climate process modeling and science team (CPT) approach seeks to link more effectively the process-oriented research to coupled climate model development. The three main objectives of the CPT approach are to:

- speed the transfer of theoretical and practical process understanding into improved treatment of processes in climate model systems (e.g. coupled models and their component models, assimilation and prediction systems), and demonstrate, through testing and diagnostics, the impact of these improvements;
- identify process study activities necessary to further refine climate model fidelity; and
- develop sustained observational requirements for climate model systems.

Under the CPT approach, we envision the formation of teams of process-oriented observationalists, theoreticians, and individual process and parameterization modelers working collaboratively with climate model developers. Teams would organize around specific issues, model deficiencies, and/or parameterization issues. Among the topics identified as particularly important during the past year are climate model sensitivity, with emphasis on important tropical processes such as tropical deep convection, and ocean mixing.

Continued on Page Twelve

Calendar of CLIVAR and CLIVAR-related meetings

African Monsoon Multidisciplinary Analysis (AMMA) Workshop
14 - 15 November 2002
Catonsville, Maryland
Attendance: Open
Sponsor:
AMMA project principal investigators
Contact: Chris Thorncroft,
chris@atmos.albany.edu

World Ocean Circulation Experiment (WOCE) Final Conference
18 - 22 November 2002
San Antonio, Texas
Attendance: Open
Sponsor: WOCE International Project Office
Contact: U.S. WOCE Office,
woce2002@tamu.edu
http://www.woce2002.tamu.edu

U.S. CLIVAR Atlantic Implementation Panel Meeting
25 - 26 November 2002
Chicago, Illinois
Attendance: Limited
Sponsor: U.S. CLIVAR (Atlantic Implementation Panel)
Contact: Martin Visbeck,
visbeck@ldeo.columbia.edu

3rd GODAE High resolution SST pilot project (GHRSST-PP) Workshop
02 - 04 December 2002
Frascati, Italy
Attendance: Open
Sponsor: The ESA European Space Research Institute (ESA/ESRIN)
Contact: Craig Donlon, craig.donlon@jrc.it
http://www.ghrsst-pp.org/3rd-workshop-announcement.html

Planning Workshop for Scientists & Stakeholders
03 - 05 December 2002
Washington, DC
Sponsor: U.S. Climate Change Science Program (CCSP) - U.S. Global Change Research Program (USGCRP) Office
Contact: CCSP - USGCRP, Office of James R. Mahoney, workshop@climatescience.gov
http://www.climatescience.gov/events/workshop2002/default.htm

U.S. CLIVAR Southern Ocean Working Group
03 - 05 December 2002
San Diego, California
Attendance: Limited
Sponsor: U.S. CLIVAR (Southern Ocean Working Group)
Contact: Arnold Gordon,
agordon@ldeo.columbia.edu

AGU 2002 Fall Meeting
06 - 10 December 2002
San Francisco, California
Attendance: Open
Sponsor: American Geophysical Union
Contact: AGU Meetings Department,
meetinginfo@agu.org
http://www.agu.org/meetings/fm02/

U.S. CLIVAR Pan American Implementation Panel
Date: 15 - 17 December 2002
Location: Albuquerque, New Mexico, USA
Attendance: Limited
Sponsor: U.S. CLIVAR (Pan American Implementation Panel)
Contact: Dave Gutzler, gutzler@unm.edu

U.S. CLIVAR 10th Scientific Steering Committee (SSC - 10)
07 - 09 January 2003
San Diego, California
Attendance: Limited
Sponsor: U.S. CLIVAR
Contact: David Legler, legler@usclivar.org

International Open Science Conference OCEANS: Ocean Bio-geochemistry and Ecosystems Analysis
07 - 10 January 2003
Paris, France
Attendance: Open
Sponsor: International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR)
Contact: scor@dmv.com
http://www.igbp.kva.se/obe/

North American Monsoon Experiment Science Working Group Meeting
9 - 10 January 2003
Boulder, Colorado
Attendance: Limited
Contact: Wayne Higgins,
Wayne.Higgins@noaa.gov

International Ocean Carbon Coordination Workshop
13 - 15 January 2003
Paris, France
Attendance: Limited
Sponsor: Scientific Committee on Oceanic Research (SCOR) -Intergovernmental Oceanographic Commission (IOC) Advisory Panel on Ocean CO2 and the IGBP-IHDP-WCRP Global Carbon Project
Contact: Maria Hood, m.hood@unesco.org
http://ioc.unesco.org/iocweb/co2panel/OCCPws.html

Variability of the African Climate System Panel meeting
15 - 17 January 2003
Cape Town, South Africa
Attendance: By invitation
Sponsor: International CLIVAR (Variability of the African Climate System [VACS] Panel)
Contact: Chris Thorncroft, email:
chris@atmos.albany.edu

PIRATA - 9
03 - 05 February 2003
Angra dos Reis, RJ, Brazil
Attendance: Limited
Sponsor: IAI (Inter-American Institute for Global Change Research), CPTEC/INPE, and IOC/GOOS
Contact: João Antonio Lorenzzetti,
loren@ltid.inpe.br
http://tucupi.cptec.inpe.br/pirata/

Abrupt climate change: evidence, mechanisms, and implications
04 - 05 February 2003
London, England, UK
Attendance: Open
Sponsor: The Royal Society
Contact: info@royalsoc.ac.uk
http://www.royalsoc. ac.uk/events/index1.html

CLIVAR/OOPC South Atlantic Workshop
06 - 08 February 2003
Angra dos Reis, RJ, Brazil
Attendance: Limited
Sponsor: International CLIVAR (CLIVAR Atlantic Panel and the OOPC)
Contact: Edmo Campos, edmo@usp.br

83rd Annual Meeting of the American Meteorological Society
09 - 13 February 2003
Long Beach, California
Attendance: Open
Sponsor: American Meteorological Society
Contact: AMS Meetings Inquiries,
amsmtgs@ametsoc.org; http://www.ametsoc.org/AMS/meet/83rdannual/index.html

Asian-Australian Monsoon Panel (AAMP), 5th Session
24 - 27 February 2003
Atlanta, Georgia
Attendance: Invitation
Sponsor: International CLIVAR (CLIVAR Asian-Australian Monsoon Panel)
Contact: Dr. Zhongwei Yan, zxy@soc.soton.ac.uk

Pacific Decadal Variability Workshop
25 - 27 February 2003
Alexandria, Virginia
Sponsor: U.S. CLIVAR
Contact: Ed Sarachik, sarachik@atmos.washington.edu

4th Gordon Research Conference on Polar Marine Science
16 - 21 March 2003
Location: Ventura, California, USA
Attendance: Open
Sponsor: Gordon Research Conferences
Contact: Robin Muench, rmuench@esr.org
http://www.grc.uri.edu/programs/2003/polar.htm

PROMISE/ICTP Conference on Monsoon Environments: Agricultural and Hydrological Impacts of Seasonal Variability and Climate Change
24 - 28 March 2003
Trieste, Italy
Attendance: Open
Sponsor: International Centre for Theoretical Physics (ICTP)
Contact: Emily Black, emily@met.rdg.ac.uk

7th International Conference on Southern Hemisphere Meteorology and Oceanography
24 - 28 March 2003
Wellington, New Zealand
Attendance: Open
Sponsors: National Institute of Water and Atmospheric Research (NIWA), Meteorological Society of New Zealand, American Meteorological Society
Contact: Jim Renwick, j.renwick@niwa.cri.nz
http://metsoc.rsnz.org/7icshmo/7icshmo.html

International Symposium on Climate Change (ISCC)
31 March - 03 April 2003
Beijing, People's Republic of China
Attendance: Open
Sponsor: China National Climate Committee
Contact: Ren Guoyu, ISCC@cma.gov.cn

EGS - AGU - EUG Joint Assembly
07 - 11 April 2003
Nice, France
Attendance: Open
Sponsors: European Geophysical Society (EGS), American Geophysical Union (AGU), and the European Union of Geosciences (EUG)
Contact: EGS Office, egs@copernicus.org

Variability of the American Monsoon System (VAMOS), 6th Session
23 - 26 April 2003
Miami, Florida
Attendance: Limited
Sponsor: International CLIVAR (Variability of the American Monsoon Systems [VAMOS] panel)
Contact: Carlos Ereño, ereno@fibertel.com.ar
http://www.clivar.org/organization/vamos/index.htm

Role of Stratosphere in Tropospheric Climate
29 April - 2 May 2003
Attendance: Open
Whistler, British Columbia, Canada
Contact: Mark Baldwin, mark@nwra.com
http://www.atm.amtp.cam.ac.uk/shuckburgh/whistler/

Seventh Conference on Polar Meteorology and Oceanography and Joint Symposium on High-Latitude Climate Variations
12 - 16 May 2003
Hyannis, Massachusetts
Attendance: Open
Sponsor: American Meteorological Society
Contact: amsinfo@ametsoc.org
http://www.ametsoc.org/AMS

CCSM Annual Workshop
24 - 26 June 2003
Breckinridge, Colorado
Attendance: Open
Sponsor: Community Climate System Model (CCSM)
http://www.ccsm.ucar.edu/

XXIII General Assembly of the International Union of Geodesy and Geophysics
30 June - 11 July 2003
Sapporo, Japan
Attendance: Open
Sponsor: International Union of Geodesy and Geophysics (IUGG)
Contact: IUGG Service, iugg_service@jamstec.go.jp
http://www.jamstec.go.jp/jamstec-e/iugg/index.html

CCSP Draft Plan Available for Comment

By Richard M. Todaro
U.S. CLIVAR Office

The reorganization initiative of the federal government's global climate change research efforts has resulted in a new program structure and a new draft strategic plan outlining the goals and overall direction of the administration wants to go in the area of climate change.

Originally announced in June 2001, President George W. Bush's Climate Change Research Initiative (CCRI) resulted in the restructuring of the U.S. Global Change Research Program (USGCRP). The new Climate Change Science Program (CCSP) focuses and coordinates the climate research activities of 13 agencies of the U.S. Government. The CCSP includes both CCRI and USGCRP activities.

A new strategic plan describing CCSP goals and the CCRI and USGCRP components is now in draft form. According to the draft plan, the CCRI will pursue accelerated development of answers to key scientific questions in the near term (two to four year time frame), while the USGCRP will be the broad program seeking advances in knowledge of the processes that influence the Earth system.

The draft of this strategic document is now available on-line in both PDF and HTML formats for public comment through 18 January 2003. A final version of the strategic plan is scheduled for release during the spring of 2003.

Individuals and organizations interested in making their views on the draft plan known can visit the new CCSP web site at http://www.climatescience.gov and click on the "strategic plan" link.

This draft plan was the subject of considerable discussion at a large workshop being held in Washington, DC on 3 - 5 December 2002. Among the participants were a wide range of scientists, stakeholders, environmentalists, and industry representatives. ■

CPTs Transcend Boundaries

Continued from Page Nine

By organizing teams, a CPT should transcend the traditional boundaries between process-oriented research and climate model development. CLIVAR and the federal research agencies believe this would encourage the team to collectively focus on and demonstrably improve the fidelity of coupled climate model systems through evaluations against diverse data sets, as well as develop and test improved parameterizations. Such teams would therefore provide a responsive two-way link between process-oriented research (including short-duration observation campaigns) and climate modeling development. Such a linkage has not been previously effectively demonstrated in climate modeling research.

Ultimately CPTs are expected to contribute directly to the betterment of the state-of-the-art class of coupled climate models and their components (e.g. ocean general circulation models and atmospheric general circulation models), as well as data assimilation and prediction systems.
Based on numerous inputs, the CLIVAR Scientific Steering Committee (SSC) believes that the climate research community is ready to proceed with CPT implementation as a pilot-phase activity. It believes such a pilot phase should allow the community to target problems of narrow scope and high priority and where progress can be expected within two to four years. The SSC further believes that a pilot-phase approach will allow the community to demonstrate the effectiveness of the CPT strategy and generate additional community interest in order to continue refining the CPT framework concept vis-à-vis planning and execution of process studies.

CPTs would therefore provide a responsive two-way link between process-oriented research and climate model development.

The U.S. CLIVAR Office is in the final stages of preparing white papers that motivate and describe CPTs. Because the scientific issues that CPTs may address are at different stages of research maturity, a range of CPT activities is envisioned. Some CPTs may focus more on model, process, and data diagnostics and identification/attribution of model deficiencies. Others—reflecting a more mature research status—may test and qualify new parameterizations, identify additional process studies, or address observational requirements.

In addition, for maximum impact CPTs should explicitly consider more than one climate model. CLIVAR believes such a multi-model approach further reduces the likelihood of tuning results to a single model and renders the resulting gains more applicable to a wider array of models, many of which share common parameterizations and approaches.

Lastly, the approach recognizes that success of the CPTs will be measured not only by advances in knowledge (perhaps leading to research manuscripts), but more importantly, by its practical productivity as evidenced by development of new capabilities and products.

The CPT white papers will soon be available on-line at the U.S. CLIVAR web site at http://www.usclivar.org. They provide more salient details on CPT approach issues, including team composition, team activities, and capabilities and products. Also addressed are management issues.

It is exciting to see the interest and excitement in CPTs from both the programmatic and scientific communities. Because of this keen interest of the CLIVAR research agencies, we anticipate CPT research opportunities from the federal agencies may soon be available to the climate research community. The SSC and the U.S. CLIVAR Office will continue to develop the CPT program and work to build support for implementation ■

Richard M. Todaro
Email: rtodaro@usclivar.org

U.S. CLIVAR OFFICE
1717 Pennsylvania Avenue, NW
Suite 250
Washington, DC 20006

Subscription requests, and changes of address should be sent to the attention of the U.S. CLIVAR Office (usco@usclivar.org)