U.S. CLIVAR
VARIATIONS

Winter 2005, Vol. 3, No. 1

FROM THE DIRECTOR

Towards a New U.S. CLIVAR

by David M. Legler

The year 2004 was a year of celebration and assessment for CLIVAR. Our first International Science Conference in Baltimore was a rousing success, drawing over 600 people from 50+ nations. It showcased CLIVAR science achievements and raised the visibility of the CLIVAR program within the U.S. and internationally. It was also an opportunity to review CLIVAR's initial implementation and identify future challenges. Following the Conference, an assessment of international CLIVAR supplied detailed insight as to the successes.

In the U.S, a review of the U.S. CLIVAR Office (see related article) offered several recommendations on how U.S. CLIVAR could more effectively inform and engage the scientific community and CLIVAR's supporting research agencies. Lastly, an informal assessment of the U.S. program emphasized that a primary legacy of U.S. CLIVAR should be improved predictive capability. Achieving this goal requires U.S. CLIVAR to continue its great strength in basic research; however, at the same time it must also focus on the need to facilitate the transition of that knowledge towards improved prediction. Additional feedback indicated that our present panel structure places too much emphasis on implementation in geographic regions, weakening our efforts to address global implementation challenges.

Based on these various assessments and consideration of whether or not the way in which U.S. CLIVAR is organized and functions is well-suited to meeting its objectives over the next decade, the Scientific Steering Committee of U.S. CLIVAR will consider several proposed changes to the U.S. CLIVAR program

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Seeking Progress in El Niño Prediction

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1. Introduction

The primary goal of predicting El Niño is to better anticipate the relative likelihood of regional climate anomalies. Much progress has been made in the last several decades to better understand El Niño and its global consequences (McPhaden et al. 1998, Trenberth et al. 1998). This knowledge has motivated more complex and sophisticated prediction models, but it's not clear whether these advances have translated into increased prediction skill of El Niño.

By the standard verification measures of NINO indices, complex dynamical models do not outperform simpler statistical models. Comparison of skill and event evolution suggests that dynamical and statistical models are approximately equivalent (Barnston et al. 1999, Kirtman et al. 2000). Ultimately what is communicated by these verification measures is whether or not a forecast system can indicate an imminent El Niño or La Niña event. However, the impact of a particular El Niño on the seasonal climate depends on more than the value of a static box average.

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Knowledge of the event's evolution, in terms of timing, amplitude and structure are important characteristics of the event. Studies are beginning to show that the atmosphere may be sensitive to the relative placement of warm SST anomalies in the equatorial Pacific (e.g. Barsulgi and Sardeshmukh, 2002); however, the limited observational record and relative infrequency of El Niño events makes such distinctions difficult to verify in nature. Still, an event focused in the central Pacific will carry a different precipitation forecast for certain parts of the world than one focused farther in the eastern Pacific.

The ability to predict seasonal climate anomalies increases significantly during El Niño and La Niña events (Shukla 2000; Goddard and Dilley 2005); skill over land (world-wide) increases linearly with the strength of the event. The opportunity of obtaining better climate forecast information during El Niño events is to some degree conditional upon the accuracy of information about the particular El Niño event. Therefore, the more reliably ENSO prediction systems can capture the characteristics of amplitude, timing and structure of El Niño events, the more reliably the associated regional climate anomalies can be forecast.

2. Pattern Correlation – Predicting El Niño Structure

It is not obvious whether it is dynamical or statistical models that should exhibit more accurate patterns of SST anomalies in the equatorial Pacific during El Niño

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infrastructure. These changes include a new organizational framework and greater emphasis on communications and transparency. The proposed new organizational framework and its functions will be fleshed-out at the upcoming Scientific Steering Committee meeting (SSC-12); but, in brief, U.S. CLIVAR's regionally-based panels would morph into a smaller number of committees organized around research capabilities that contribute towards improved predictions. The spectrum of approaches addressed by these committees includes observing, and simulating important processes and phenomena; model improvement; monitoring; hypothesis testing; empirical analyses and diagnostics; predictability studies; assimilation systems; as well as interface to applications (end users). Ties to the International CLIVAR program remain critical for our success. These proposed changes will increase visibility of the program, entrain new scientists, and improve agency involvement. They will also help U.S. CLIVAR argue for maintaining current funding levels and potentially leverage additional resources.

The details of the new organizational framework will appear on the U.S. CLIVAR web site by the time this newsletter hits the streets. We welcome your input.

2005 will be a time of change and revitalization for U.S. CLIVAR. The momentum of the CLIVAR Conference, the reorganization; and, as always, new and exciting scientific findings, portend a period of increased excitement and greater recognition of the U.S. CLIVAR program. ■

Variations

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Seeking Progress in El Niño Prediction

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events. Statistical models are designed to represent the observed patterns of variability, but statistical models can only predict characteristics that are consistent with previously sampled events, and to some degree, each El Niño event is unique. Dynamical models (i.e. coupled ocean-atmosphere general circulation models, or CGCMs) are free to evolve according to the equations of motion and the currently observed state of the ocean; however, the majority of CGCMs still have substantial errors or biases in the spatial signature of ENSO. El Niño events are often centered too far west, which means that the associated convective anomalies are also too far west. Thus for both statistical and dynamical models, one could expect that the spatial structure of El Niño in the prediction models may be somewhat constant – that the prediction models cannot discern between eastern Pacific focused events and central Pacific focused events, for example. Figures 1 & 2, comparing two statistical ENSO prediction methods and one CGCM, suggest that this is not necessarily the case. The pattern correlation over the eastern equatorial Pacific (180-90W; 5S-5N), which largely indicates whether the prediction can distinguish between central Pacific and eastern Pacific events, shows instances where the CGCM captured the peak SST anomalies in the eastern Pacific (1997) and the central Pacific (1994) very well, and instances where the CGCM did not do as well. Similar cases can be found for both of the statistical models.

Incremental progress is being made. For example, improved parameterization of convective momentum transfer (GFDL, 2005) improves the longitudinal placement of the westerly wind anomalies associated with El Niño, which improves both the spatial structure of their CGCM's SST variability and the timescale (Wittenberg 2004, personal communication). Still, a diffuse equatorial thermocline in the eastern Pacific is a chronic problem that has not yet been overcome.

3. Improved use of the information

a) **Multi-model predictions**

Predictions benefit from multi-model combination when a group of models shows similar skill levels and each contains errors or biases that are somewhat unique to the model or technique. Such a situation applies to ENSO prediction as well as climate prediction. A combination of ENSO predictions yields a better forecast than any individual model, even using equal weights for each model, as is appropriate when the hindcast record is limited as it often is for CGCMs (Kirtman et al. 2000). Maps of anomaly correlation indicate that unweighted averaging of five CGCMs (Fig 3b) improves over the skill from a single CGCM (Fig 3a) especially in the eastern equatorial Pacific, in the vicinity of the NINO3 and NINO3.4 regions.

The results shown in Figure 3 are based on the ARCS (Applied Research Centers) multi-model ensemble, which consists of five coupled models. Each CGCM uses the same ocean component model (MOM3, Pacanowski and Griffies 1998) and ocean state from an ocean data assimilation system (Derber and Rosati 1989). All of the models are directly coupled; no corrective terms are added to either the atmosphere or the ocean to keep the climate from drifting. The five coupled models utilize one of the ECHAM4.5 (Roeckner et al. 1996), COLA (Schneider 2002), or CCM3 (Kiehl et al. 1996) AGCMs coupled to two different resolutions of the MOM3 OGCM. The multi-model combination is made using an equal weighting for each model. Full details of this multi-model ensemble data can be found in Schneider et al. (2003).

b) **MOS Correction**

Further improvements can often be made to dynamical predictions by means of model output statistics (MOS). Systematic biases can be addressed effectively by such methods. However, it often takes careful investigation to identify the

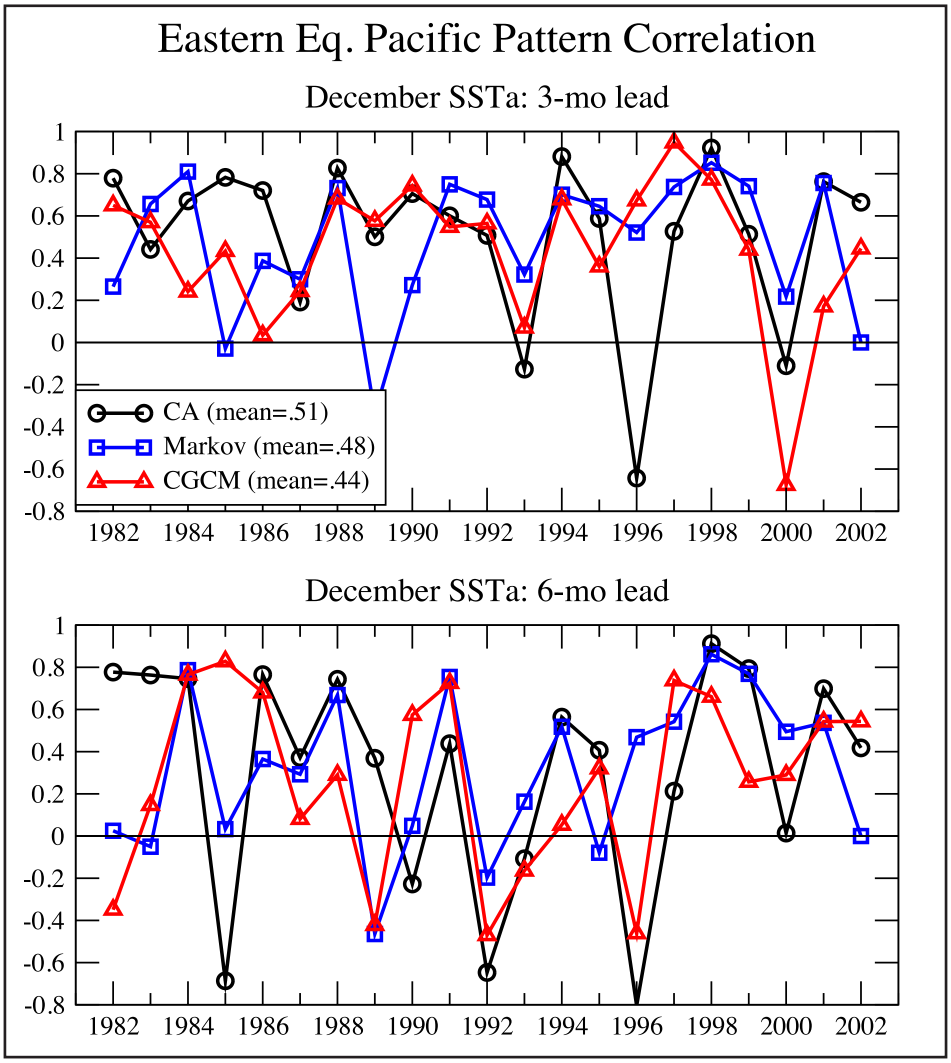

FIGURE 1. Pattern correlation of SSTa between ENSO prediction models and observations (OIv2; Reynolds et al. 2002) over the eastern equatorial Pacific (180-90W; 5S-5N). Two statistical models are shown: Constructed Analog (CA; van den Dool and Barnston 1995) and Markov (Xue et al. 2000), and one CGCM (ECHAM4.5+MOM3; DeWitt 2005). The time mean pattern correlation coefficient is listed in the legend for the 3-month lead forecasts; that value is approximately 0.3 for all 3 models at 6-month lead. Note, the area mean has been removed.

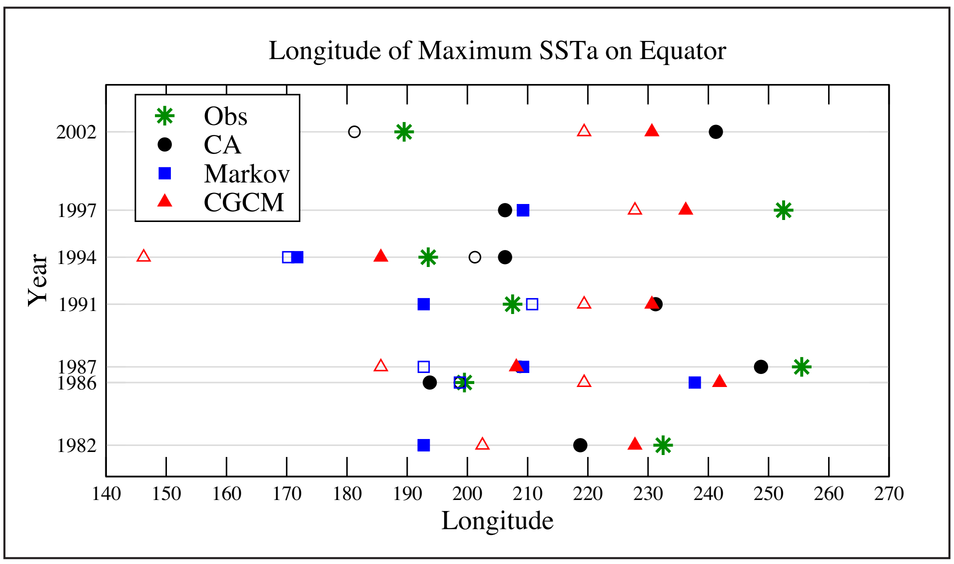

FIGURE 2. Location of maximum SST anomaly along the equator for 3-month lead (solid symbols) and 6-month lead (open symbols) prediction of El Niño events from the same set of models shown in Fig. 1. All models, including the statistical ones, appear to be incapable of producing a peak SST anomaly in the far eastern equatorial Pacific.

accurate information provided by the prediction model(s) that is physically connected to the biased information provided by the model(s). The CGCMs have errors and biases in their SST anomalies, but the biases are not systematic enough to benefit from using the CGCM-predicted SST anomalies as the predictor (Fig 3c). On the other hand, CGCMs predict well the evolution of heat content anomalies. The problems in getting those heat content anomalies to the surface are related to model biases such as a too diffuse thermocline and imperfect mixing parameterizations. Thus statistically correcting SST anomalies based on heat content anomalies leads to dramatic increases in skill (Fig 3d). For the results presented, both the heat content and SST correction are done in cross-validated (leave one out) EOF regression space. For the predictor and predictand, 6 EOFs each are kept. The regression is performed between the principal components of the predictor modes with each of the predictand modes.

4. Conclusion

The current state-of the-art dynamical models perform on par with the best statistical models. The best statistical models are about as good as they will ever get. However, dynamical models remain far from perfect, which means that improvements are possible. Meaningful improvements to CGCMs will involve considerable human, observational, and computing resources. In the short term, better use can be made of the tools at hand. Multi-model ensembling and MOS techniques yield predictions that outperform the raw individual models, and thus probably outperform the best statistical tools as well. In the end, the best forecasts should draw on the best information available, which means including information from both statistical and dynamical predictions. Performance analyses of such systems are

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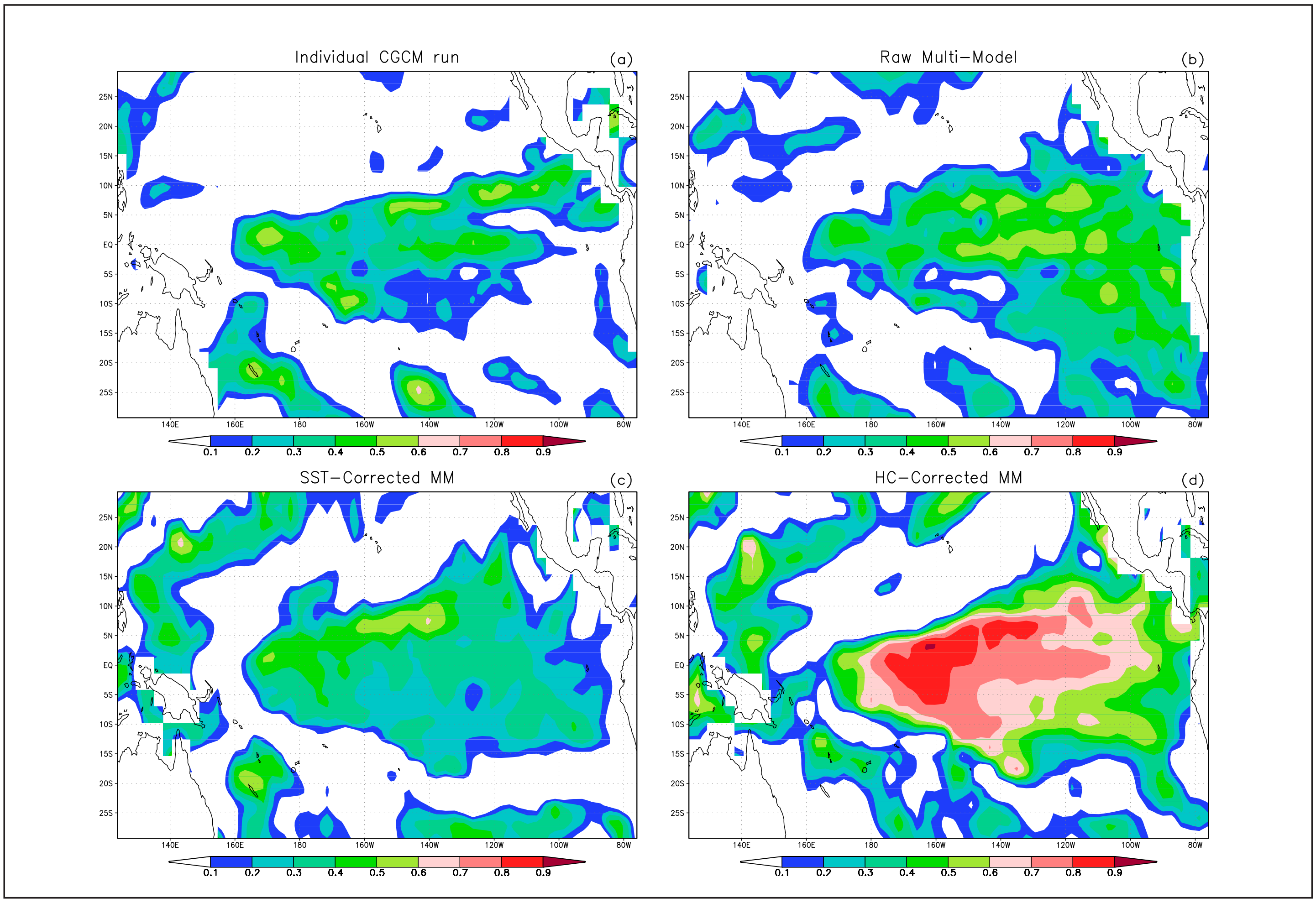

FIGURE 3. Anomaly correlation maps for 12-month lead forecasts initiated in January for the years 1980-1999. (a) Individual CGCM; (b) Raw (uncorrected) ensemble average of 5 CGCMs; (c) Corrected ensemble-average CGCM SSTa using the raw SSTa for the predictor (as described in text); (d) Corrected ensemble-average CGCM SSTa using ensemble-average heat content for the predictor.

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likely to reveal the next notable increase in ENSO prediction skill.

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The NOAA Climate Test Bed

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1. Introduction

The operational Seasonal-to-Interannual (S/I) forecast is a challenging scientific problem that has primarily been the province of sophisticated statistical forecast algorithms, with a lesser role given to fully dynamical forecast systems. The relative lack of skill in dynamical forecast systems has dissuaded efforts at extending operational forecasts past the traditional predictability limit of two weeks. Despite many important applications, not the least of which is the prediction of tropical intraseasonal variability (e.g. the Madden-Julian Oscillation), and despite considerable research aimed at improving prediction on 2 week to 12 month time scales, progress has been slow.

Recent developments in coupled atmosphere-ocean-land surface forecast systems for S/I climate prediction, however, have reinvigorated attention on this critical NOAA product area. For example, in the past year NOAA has implemented a coupled Climate Forecast System (CFS), composed of the NCEP Global atmospheric Forecast System (GFS) model and the GFDL Modular Ocean Model (MOM3), that is a significant step forward in forecasting ENSO related SST variability in the Tropical Pacific and, shows skill at least equal to that of current statistical algorithms (Fig. 1). Moreover, recent tests with fully coupled climate forecast systems have demonstrated that atmospheric forecasts extending beyond 10-14 days also show increased skill. This advancement provides a major motivation to extend current "Week 2" forecasts into monthly, and longer, time domains.

It is now clear that, having achieved at least parity with statistical algorithms, coupled numerical forecast systems have the greatest potential for improving climate forecasts. Moreover, they now appear mature enough to be used as realistic vehicles for basic research on predictability of the "Earth" (atmosphere-ocean-land surface-cryosphere) system. Supporting the NOAA climate forecast systems for use by climate researchers is an optimal way to leverage the expertise of the external scientific community as well as that of NOAA researchers in order to accelerate the necessary improvements.

The "Predictions and Projections" component of the FY05 NOAA Climate Program Plan has identified support for a systematic research to operations transition program as a key deficiency. The plan emphasizes that there is a lack of support to transition research and operational climate models to a community-based infrastructure to accelerate model advances from the external and internal research communities to operations. In order to achieve this synergistic blend of internal and external research and development efforts required to accelerate improvements in NOAA operational climate forecast systems, a Climate Test Bed (CTB) facility has been organized.

2. CTB Mission and Operations Concept

The mission of the NOAA Climate Test Bed (CTB) is to accelerate the transition of research and development into improved NOAA operational climate forecasts, products, and applications.

The CTB mission is intended to provide more traction and visibility to intraseason-

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al-to-decadal research and development efforts by accelerating the transition of this research into NOAA climate forecast operations. The CTB will provide an operational testing environment to support projects that result in a direct influence on NOAA climate forecast operations and provide infrastructure and resources for (long term, competitive, community-wide) projects on broader research issues affecting NOAA climate forecast operations.

In order to accomplish its mission, the CTB has the following objectives;

It is now clear that, having achieved at least parity with statistical algorithms, coupled numerical forecast systems have the greatest potential for improving climate forecasts.

• to assess scientific advances (models, tools, data sets, observing systems) that have potential for a direct influence on NOAA operations;

• to accelerate the synthesis and implementation of these advances for NOAA operational climate forecasts;

• to develop new tools and applications in a quasi-operational environment subject to metrics that mandate good scientific performance while meeting ease-of use criteria and time constraints;

• to utilize advanced statistical and numerical model output, and stimulate model improvements in climate analysis and forecasting applications;

• to facilitate the transfer of tested software into the NCEP development cluster while incorporating adjustments necessary to generate climate forecast products that are forecaster-friendly and time-efficient;

• to prepare documentation, training materials, and evaluations of performance characteristics of successful products to facilitate their use by NOAA climate forecast operations staff.

The CTB framework includes both "infrastructure" and "transition projects". CTB infrastructure includes computing support (e.g. the NCEP Research Supercomputer), software support (e.g., models, data, diagnostics), contractors, technical assistants, system administrators, management and administrative staff. CTB infrastructure will support the exchange of climate forecast system software (e.g. models, data assimilation, codes, testing data sets, etc.). This software will be donated by NCEP and others who wish to participate in the CTB. The CTB infrastructure will also support a capability for generating and producing multi-model ensembles (subject to CTB implementation guidelines). The CTB will maintain Earth System Modeling Framework (ESMF) compatible software when it becomes capable of supporting a full S/I forecast system and the software has been converted to ESMF-compatible structures. The bulk of the computing resources will be supplied by the NOAA "Research computer" resource, although augmentation funding will be required for some infrastructure.

Scientific work in the CTB will be accomplished via transition projects, that include both base funded activities and Announcements of Opportunity. Base funded activities will generally be *near-term* activities, funded by NOAA organizations, that are likely to influence NOAA climate forecast operations within 1 year. These projects have definite outcomes and lifecycles. They will be selected by CTB management in consultation with the Oversight Board (see below). Announcements of Opportunity (AO's) will support *long-term, competitive, reviewed* community wide activities that are likely to influence NOAA climate forecast operations in 2-3 years. These activities will be funded by NOAA and potentially other U.S. agencies, proposed and selected through a formal review process. Proposal selection and peer review will be managed and coordinated by the NOAA Climate Program Office.

Science priorities for base funded activities include climate forecast system assessments (e.g. model diagnostics and testing), and climate products and applications (e.g. consolidation of forecast tools, skill masks, objective verification, product development for climate monitoring and assessment). AO's will support community-wide participation in the CTB on broader science issues such as

• Multi-model ensemble system development; climate forecasts and applications; Attribution

• Model development through Climate Process and modeling Teams (CPTs);

• Climate product and applications development (e.g. predictability studies, drought monitoring and prediction, extreme events);

• Climate reanalysis and data impact;

• Advanced forecast capabilities (e.g. ecosystems; air chemistry; carbon cycle; fisheries)

Collaboration, via AO-driven proposals, with organizations maintaining climate-relevant software will be encouraged. In the more distant future, expansion to international climate forecasting by adding ECMWF, Canadian, Met Office, and Meteo France products is a major goal.

The CTB will maintain strong linkages to CLIVAR, GEWEX, and joint CLIVAR-GEWEX programs such as the Climate Prediction Program for the Americas (CPPA), the GEWEX Americas Prediction Project (GAPP), Pan American Climate Studies (PACS), CLIVAR Atlantic and Pacific, Variability of the American Monsoons (VAMOS), the Climate Dynamics and Experimental Prediction (CDEP) program and others. Some specific examples include:

a) CLIVAR/Climate Process and Modeling Teams (CPT's)

The CTB is closely related in concept to the CLIVAR Climate Process and modeling Teams (CPTs). The CTB priority of improving physical parameterizations in NOAA climate forecast models can be considered as the NOAA implementation of the CPT concept by providing computing resources and an operational testing environment to address high priority science issues that are common among operational climate prediction models. The NOAA Climate Test Bed emphasizes S/I time scales and is uniquely oriented

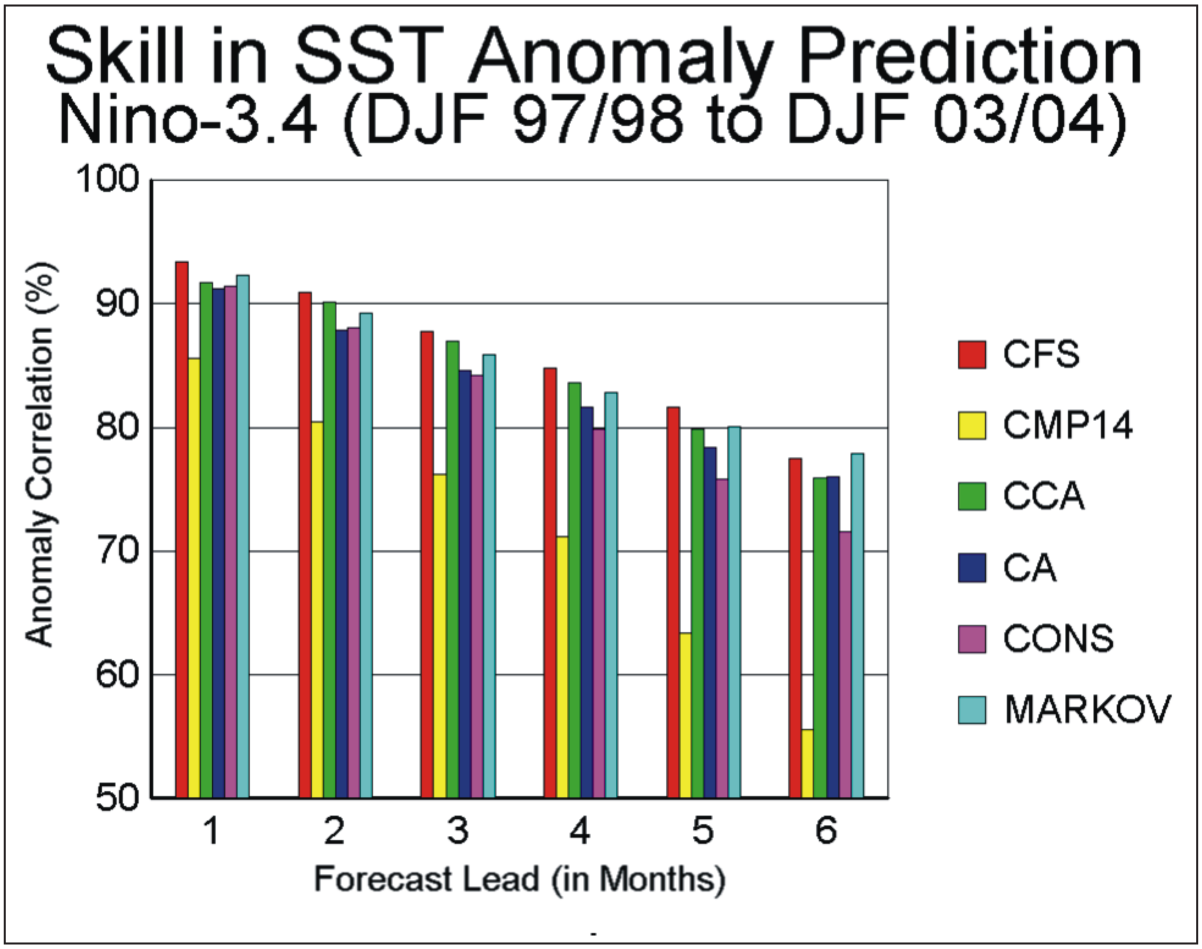

Figure 1. Forecast anomaly correlation for NINO3.4 SST for all months (25 seasons) over the period DJF 1997-1998 to DJF 2003-2004. CFS: new NCEP coupled Climate Forecast System; CMP14: old NCEP coupled system; CCA: Canonical Correlation Analysis (statistical); CA: Constructed Analog (statistical); CONS: official CPC consolidation forecast; MARKOV: Markov (statistical) technique (Courtesy Huug VandenDool, CPC).

towards applications that can be transitioned to operational implementation at NOAA. The NOAA CTB will support competitive, peer-reviewed proposals oriented toward contributions to NOAA operational missions.

b) ESMF

The recent emergence of the Earth System Modeling Framework (ESMF) provides an excellent opportunity for the CTB to investigate new model components and to improve operational climate forecast systems using ESMF compatible software. GFDL's climate forecast codes are becoming ESMF compatible. NASA is building an ESMF compatible model and NCEP is constructing ESMF-compatible versions of its next-generation global model.

c) JCSDA

The NASA-NOAA-DOD Joint Center for Satellite Data Assimilation provides a leveraged resource for addressing climate data assimilation and modeling issues. The JCSDA supports observations and data assimilation (ocean, land-surface, atmosphere) software and proposals in this arena can be executed more efficiently due to the supported infrastructure.

4) NOMADS

Dissemination and archiving of CTB data sets will be done through the NOAA Operational Model Archive and Distribution System (NOMADS). GFDL and NCEP scientists have been part of a larger consortium that has been developing NOMADS capabilities for broad data set availability.

It is important to emphasize that the CTB will not take the lead on the following activities under the purview of NOAA climate forecast operations or the participating NFCs:

- Operational forecasting;
- Real-time monitoring or integrated climate assessments;
- NCEP operational climate forecast system development, integration, and calibration;
- Model development for participating NFC's.

3. Management Structure

The CTB management structure includes the following areas: oversight and scientific direction, programmatic and scientific management and computing. The CTB staff will include a Director and other associated personnel (e.g. Staff, Visiting Scientists and Students). Complete Terms of Reference (ToR) and responsibilities for CTB staff are found on the CTB web page at: http://www.cpc.ncep.noaa.gov/products/ctb.

The CTB also includes an Oversight Board (OB), a Climate Science Team (CST) and an external Science Advisory Board (SAB). These groups have unique responsibilities and charges that are briefly summarized as follows:

- **Oversight Board (OB):** to make recommendations to the Directors of the NOAA

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U.S. CLIVAR Climate Model Evaluation Project (CMEP)

by Cathy Stephens, U.S. CLIVAR Office

Currently, modeling groups in the U.S. and internationally are conducting late 19th - 20th century simulation experiments and 21st - 23rd century projection experiments for assessment in the IPCC Fourth Assessment Report (AR4). To support diagnostic analyses leading to the evaluation of U.S. coupled climate model simulations of the late 19th - 20th century, NSF, NOAA, NASA and DOE agreed to award 15-20 small grants to PIs for such efforts. The objective of these grants is to increase community-wide diagnostic research into the quality of model simulations, leading to more robust evaluations of model predictions and a better quantification of uncertainty in projections of future climate. The results of this research will be used for the subsequent evaluations of the quality of U.S. model global and regional climate projections of the 21st century and beyond in the context of an international multi-model dataset.

An announcement of opportunity was issued on behalf of the agencies by the U.S. CLIVAR in May 2004. As the climate models will project 21st – 23rd century climate, it is anticipated that the results of the diagnostic studies of their late 19th - 20th century simulations, funded under this opportunity, will aid in understanding and assessing the uncertainty of the future climate change projections for the IPCC AR4 at global and regional scales. Over sixty proposals were submitted to the U.S. CLIVAR Project Office with topics ranging from tropical variability, inter-annual decadal variability, monsoons, fluxes, heat budgets, detection and attribution, and weather. In the end, 17 proposals were selected for funding by the agencies.

These selected Principal Investigators are expected to participate and discuss their results in a workshop to be convened by U.S. CLIVAR and hosted by the International Pacific Research Center (IPRC) at the University of Hawaii from 1-4 March 2005. Scientific papers describing the results of the multi-model analyses for IPCC will be presented at the workshop. There will be a workshop report summarizing the presentations that will be furnished to the lead authors of the relevant chapters for the AR4. Results from the analysis projects must then be written up by the respective investigators, and submitted to peer-reviewed journals by the time of the Second Lead Author Meeting in May 2005, in order to be fully included and assessed in the AR4 as specified by the guidelines of IPCC.

The workshop organizing committee consists of members of the U.S. CLIVAR Scientific Steering Committee: Gerald Meehl (NCAR), James Hurrell (NCAR), Lisa Goddard (IRI), and Dave Gutzler (University of New Mexico). Additional information, including abstracts of the grants awarded, can be found at www.usclivar.org/science.html. For information regarding model output and access, visit http://www pcmdi.llnl.gov/ipcc/about_ipcc.php.■

CLIVAR/CMEP Grants Awarded

Author	Title	Affiliation
A. Capotondi	Interannual and Decadal Variability in the Topical Pacific Ocean: Description and Mechanisms	NOAA CIRES/CDC
D. Chelton and E. Maloney	An Investigation of SST Influence on Surface Wind Stress in Climate Models	Oregon State University
K. Cook	Sensitivity of the West African Monsoon to Gulf of Guinea SSTs	Dept of Earth and Atmospheric Sciences, Cornell University
R. Curran and W. Lau	Hydrological Cycles in the Tropics	University of Maryland, Baltimore Campus
K.Hamilton and H. Annamalai	South Asian Summer Monsoon Climatology and Variability in the Control and 20th Century IPCC AR4 Simulations	IPRC, University of Hawaii
I. Kamenkovich	Subantarctic Mode Water and Antarctic Intermediate Water: How well are they represented in climate models?	University of Washington
D. Karoly	Simple Indices of Climate Variability and Change	University of Oklahoma
B. Leipert	Evaluation of Surface Solar Irradiance in Coupled Climate Models	Lamont Doherty Earth Observatory - Columbia University
J. Lin, B. Mapes and K. Weickmann	Intraseasonal Variabilities: Structure and Feedback Analysis	NOAA CIRES/CDC
M. McPhaden	Assessing Tropical Pacific Decadal Variability in Climate Models	NOAA – PMEL
S. Nigam and R. Joseph	Teleconnection Structure and Evolution in the coupled Model Simulations	University of Maryland
J. Overland and M. Wang	Evaluation of the coupled Climate Model Simulations over the Arctic - Contrasting the Warming in the 1990s versus 1930-50s	NOAA – PMEL
M. Raphael and M. Holland	Model Simulation of the Southern Hemisphere Atmospheric Circulation, Antarctic Sea Ice, and their Interaction: An Evaluation	UCLA
A. Ruiz-Barradas and S. Nigam	Diagnosis of North American Hydroclimate Variability in Coupled Model Simulations	University of Maryland
A. Solomon	Pacific Subtropical Cells in coupled climate model simulations of the late 19th-20th century	NOAA CIRES/CDC
S. Sun	Model Intercomparison: Thermohaline Circulation and Its Relation to Surface Fluxes	Massachusetts Institute of Technology
G. Tselioudis and M. Chandler	Evaluation of Midlatitude Storm Characteristics and Variability in IPCC Coupled Models	Columbia University
M. Wehner	Multivariate Climate Change Detections	Lawrence Berkeley National Laboratory

NOAA Climate Test Bed

Continued from Page Seven

Climate Office and NCEP concerning the CTB on an annual basis;

• **Climate Science Team (CST):** to guide CTB activities at the working level, including evaluation of CTB activities and recommendations to CTB management on computing resource usage and access;

• **Science Advisory Board (SAB):** to coordinate with the broader science community and with other programs, and to provide "independent" advice on high-priority scientific challenges.

Complete ToR and responsibilities for the OB, CST and SAB are also found on the CTB web page.

The CTB will maintain strong linkages to CLIVAR, GEWEX, and joint CLIVAR-GEWEX programs such as the Prediction Project (GAPP), Pan American Climate Studies (PACS), CLIVAR Atlantic and Pacific, Variability of the American Monsoons (VAMOS), and the Climate Dynamics and Experimental Prediction Program (CDEP).

4. Supported Software

NCEP's next generation model will be on the development path for upgrades to NCEP's operational climate forecast system. The large amount of testing necessary for putting any new system upgrade into operations, which includes lengthy calibration runs, ensures that these upgrades will occur every 3-4 years, rather than several times annually as in weather applications. Thus, the next upgrade to NCEP's system will probably occur in 2007. Therefore, there is now an excellent opportunity for the community to work with NCEP on its next operational upgrade. All components of NCEP's system are now in a position to be upgraded, including the atmospheric, ocean, land-surface and sea ice forecast models, standardized (formatted) observations, data assimilation systems (ocean, atmosphere, land-surface), post-processing and archive capability.

In order to improve NCEP forecasts from Week 2 to S/I, a multi-model ensemble strategy will be pursued in the CTB. The CTB will host an ESMF-compatible software framework that will promote the experimentation and development of multi-model ensemble products.

The CTB will collaborate with the JCSDA to develop improved data assimilation techniques for the CTB applications. Common software will be maintained jointly between the JCSDA and CTB, with the JCSDA focusing on the data assimilation modules (primarily ocean and land surface) and the CTB focusing on specialized data sets and output products. Any Reanalysis capability will draw upon JCSDA software but be executed within CTB resources.

5. Resources

A three-year ramp up of CTB resources is planned. CPC and EMC FTEs have been reallocated to the CTB. As mentioned above, the bulk of the computing resources will be supplied by the NOAA "Research Supercomputer". Augmentation funding will be needed to transfer and enhance CTB software and datasets, and to maintain computing infrastructure. The CTB management will establish an overall policy on allocation of computing resources.

Base funded activities will be funded by NOAA organizations to accelerate the transition of R&D to improved NOAA operational climate forecasts, products and applications. These activities are expected to directly influence NOAA climate forecast operations within 1 year, with definite outcomes and lifecycles. Participating NOAA organizations will support visiting scientists, including reassigned personnel from other centers. Annual Announcements of Opportunity (AO's) issued through NOAA OGP will be funded by NOAA and other agencies to support community-wide participation on broader research issues.

NOAA Climate Office funding will provide a venue for scientists in the external research community to work on NCEP models and products through the CTB. NCEP has limited manpower to work with external PI's on AO-driven CTB projects and complete its own base funded projects. Thus, the CTB will require a few "bridge" scientists, to help infuse AO-driven research into operations.

CLIVAR 2004 Presentations Available

A DVD of the CLIVAR 2004 Conference in Baltimore is currently in production. All conference attendees will receive a copy by early January 2005. This DVD contains all posters and oral presentations delivered at the Conference. The presentations and posters are currently viewable on the web (www.clivar2004.org/Poster_guide.html or www.clivar2004.org/Program.html). Note that the oral presentations which contain video clips are best viewed with Adobe 6.0 Reader which can be freely downloaded at: http://www.adobe.com/products/acrobat/readermain.html.

Calendar of CLIVAR and CLIVAR-related meetings

Further details are available on the U.S. CLIVAR and International CLIVAR web sites: www.usclivar.org and www.clivar.org

85th AMS Annual Meeting
9-13 January 2005
San Diego, CA
Attendance: Open
Contact: http://www.ametsoc.org

U.S. CLIVAR Scientific Steering Committee (SSC-12)
26 January – 28 January 2005
Miami, FL
Attendance: Invited
Contact: David Legler (legler@usclivar.org)

Layered Ocean Modeling Workshop
26 January – 28 January 2005
Miami, FL
Attendance: Open
Contact: http://oceanmodeling.rsmas.miami.edu/lom/

U.S. CLIVAR Atlantic Science Conference
31 January – 2 February 2005
Miami, FL
Attendance: Open
Contact: Walter Robinson (robinson@atmos.uiuc.edu), Andrew Robertson (awr@iri.columbia.edu)

TACE Implementation Meeting
3 February 2005
Miami, FL
Attendance: Open
Contact: Bill Johns (wjohns@rsmas.miami.edu) , Walter Robinson (robinson@atmos.uiuc.edu)

NOAA/GCOS Workshop to Define Climate Requirements for Upper Air Observations
8-11 February 2005
Boulder, CO
Attendance: Open
Contact: www.oco.noaa.gov

International Workshop on Analyses of Climate Model Simulations for IPCC AR4
1-4 March 2005
Honolulu, HI
Attendance: Open
Contact: Jerry Meehl (meehl@ucar.edu), Jim Hurrell (jhurrell@cgd.ucar.edu)

NAME Data Analysis Meeting
9-11 March 2005
Mexico City, Mexico
Attendance: Open
Contact: Wayne Higgins (Wayne.Higgins@noaa.gov)

5th Gordon Research Conference on Polar Marine Science "Climate Feedbacks and Trophic Shifts in Polar Seas"
13-18 March 2005
Ventura, California
Attendance: Open
Contact: http://www.grc.org/programs/2005/polar.htm

ARM Science Meeting
14-18 March 2005
Daytona Beach, FL
Attendance: Open
Contact: www.arm.gov/science/stmeeting/index.stm

SCOR/IMAGES Workshop on Paleocean Circulation
20-23 March 2005
Atlanta, GA
Attendance: Open
Contact: Jean Lynch-Stieglitz (jean@eas.gatech.edu)

16th Global Warming International Conference
19-21 April
New York City, NY
Attendance: Open
Contact: http://www.globalwarming.net/

NOAA Climate Observation Workshop
26-28 April 2005
Silver Spring, MD
Attendance: Open
Contact: Mike Johnson (Michael.Johnson@noaa.gov)

Drought Prediction Workshop
17-19 May 2005
College Park, MD
Attendance: Open
Contact: Siegfried Schubert (schubert@gsfc.nasa.gov)

Seasonal to Interannual Climate Variability: its Prediction and Impact on Society - NATO Advanced Study Institute (ASI)
23 May – 3 June 2005
Gallipoli, Italy
Attendance: Open
Contact: Alberto Troccoli

AMS joint conference on Atmospheric and Ocean Fluid Dynamics, Middle Atmospheres and Climate Variability
13-17 June 2005
Boston, MA
Attendance: Open
Contact: www.ametsoc.org

International GEWEX Workshop
20-24 June 2005
Orange County, CA
Attendance: Open
Contact: www.gewex.org/5thconf.html

10th Annual CCSM Meeting
21-23 June 2005
Breckenridge, CO
Attendance: Limited
Contact: http://www.ccsm.ucar.edu

The International Association of Meteorology and Atmospheric Sciences (IAMAS) Biennial Scientific Assembly
2-11 August 2005
Beijing, China
Attendance: Open
Contact:
http://web.lasg.ac.cn/IAMAS2005

PAGES 2nd Open Science Meeting
10-12 August 2005
Beijing, China
Attendance: Open
Contact: http://www.pages2005.org

CRCES Workshop on Decadal Variability
17-20 October 2005
West virginia, USA
Attendance: Open
Contact: http://wwww.crces.org

AGU Fall Meeting
5-8 December 2005
San Francisco, CA
Attendance: Open
Contact: http://www.agu.org/meetings/

U.S. CLIVAR Project Office Review

In early 2004, the National Research Council (NRC) was commissioned to review the U.S. CLIVAR Project Office (USCPO), not a review of CLIVAR-related scientific research in the United State or a review of agency funding for CLIVAR and related climate research. This study was conducted from June to October 2004. Based on the input received, the committee found that the USCPO is "vital for coordinating U.S. CLIVAR activities and that it should be continued." Several opportunities for enhancing the communication and visibility of U.S. CLIVAR were also recommended. Full documentation of this report can be found at: http://www.nap.edu/books/0309095018/html/R1.html

Based on the NRC recommendations, the U.S. CLIVAR web pages are continually being updated. Several new sections now exist including a CLIVAR Science page (www.usclivar.org/science.html), describing CLIVAR ongoing research efforts, as well as an updated publications page (www.usclivar.org/publications). If you wish to have information added to the U.S. CLIVAR web pages, please send suggestions or preferable content to Cathy Stephens in the U.S. CLIVAR Project Office (cstephens@usclivar.org).■

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