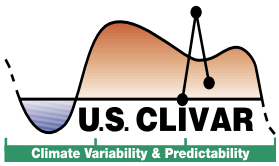

U.S. CLIVAR: Climate Variability and Predictability

Climate Process Modeling & Science Teams (CPTs)

Motivation and Concept

Recommendations by the U.S. CLIVAR Scientific Steering Committee

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U.S. CLIVAR Office
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Motivation

A fundamental aim of the CLIVAR program is enhancing our understanding and ability to predict climate variations and change of the global climate system through the use of improved coupled climate model systems. These model systems provide products useful not only for scientists, but also decision-makers and policy-makers at local, regional, and national levels. The inherent uncertainties associated with these model products provide the contextual guidance for their application and utilization. Consequently, characterizing, attributing, and reducing the deficiencies and uncertainties of coupled climate models is an important priority. These deficiencies are related, in part, to limits in understanding the physics of the climate system and non-optimal parameterizations (or numerical representations) of critical physical processes. Addressing these deficiencies has proven challenging under current programmatic and scientific division of activities.

CLIVAR envisions coordinating and supporting several process studies that can provide critical observations and process-oriented knowledge to address these deficiencies. Many such process studies have been organized over the past 10-20 years, leaving a legacy of valuable data and knowledge products. However, transferring knowledge acquired in such process experiments to climate models has been less successful than the advances in scientific understanding which have arisen from the field programs. The large gap that exists between process oriented research and coupled climate model development has traditionally been bridged only through the customary mechanism of scientific papers, field reports and conference proceedings – a relatively slow and inefficient process.

The limited resources at major modeling centers devoted to development of new numerics, parameterizations, software engineering, and testing activities further impedes advancement. While voluntary efforts within the modeling community such as model inter-comparisons established under the WGCM (for example, CMIP) have been helpful in identifying areas of model agreement and disagreement, they lack the necessary focus and resources to assess the quality of the physical parameterizations, and consider and test new parameterizations. Some model-specific working groups (e.g. NCAR CCSM) meet on a regular basis; but, to date, there is limited participation by process scientists, little time and resources for effective interaction between modelers and process scientists, and insufficient focus on the difficult task of systematically assessing, diagnosing and improving the fidelity of physical parameterizations that serve as the foundation for this class of models.

This document describes the motivation and concept for a new research paradigm that more effectively links process-oriented research to coupled climate model development. Other documents will suggest an implementation strategy and identify scientific areas/issues of high-priority within the climate community where CPTs would most likely be effective.

The new approach, developed by the U.S. CLIVAR program, recommends formation of teams of process-oriented observationalists, theoreticians and process and parameterization modelers working collaboratively with climate model developers. By organizing around an issue, model deficiency, and/or parameterization(s), these Climate Process modeling and science Teams (CPTs) can transcend boundaries between process-oriented research and climate model development. Through their collective focus CPTs can demonstrably improve the fidelity of coupled climate model systems through evaluations against diverse data sets, as well as develop and test improved model physical parameterizations. CPTs will also quantify, and ultimately reduce uncertainties of climate model systems (and their component models). Additionally, CPTs can identify needed process studies and observational requirements necessary to correctly capture and parameterize important climate processes. Such teams would in essence provide an effective two-way link between process-oriented research (such as short duration observation campaigns, process parameterizations, etc.) and climate modeling development.

Objective

The overall objectives of CPTs 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.

Approach

Collectives of process-oriented observationalists, researchers, and individual process and parameterization modelers, working collaboratively with climate model developers, will form Climate Process modeling and science Teams (CPTs). These teams will organize around an issue, model deficiency, and/or parameterization(s) to hasten the exchange of knowledge and information. Through evaluations against diverse data sets and development and evaluation of new parameterizations, CPTs aim to improve the fidelity of coupled climate model systems (and their component models). **Because the 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/data diagnostics and identification (and attribution) of model deficiencies, while others, reflecting a more mature research status, may test and qualify new parameterizations, identify further process study activities, or address observational requirements.

CPTs will be expected to contribute directly to the betterment of the state-of-the-art class of coupled climate model systems and their component (e.g. OGCM, AGCM) models, as well as data assimilation and prediction systems. CPTs that contribute to the improvement of IPCC-class models are especially critical. **For maximal impact, CPTs should explicitly consider more than one climate model.** This 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. The number of models considered should not be so large as to result in only an intercomparison project. Additionally, it is highly desirable that model components, diagnostic toolsets, and validation data sets be developed as to conform to developing (e.g. ESMF) community standards for interoperability and reuse in climate, numerical weather prediction, data assimilation, and other Earth science applications.

An important distinction between CPTs and more routine research activities is the emphasis on teamwork, *demonstrated* progress, and development of useful products. **Success of the CPTs will be measured not only by advances in knowledge (leading to research manuscripts), but more importantly by its practical productivity as evidenced by development of new capabilities and products.**

Several distinguishing characteristics will mark potentially successful CPTs:

Team Composition	The success of CPTs depends critically on the commitment of individual team members and their ability to work together constructively to demonstrate the effectiveness of their collaboration. CPT composition will vary depending on needs, but be composed of a combination of observation-oriented experimentalists, process modelers, process diagnosticians, and developers of climate models. The emphasis on demonstrable progress necessitates that CPTs may wish to include participation of a mix of climate scientists, analysts, and/or software engineers, particularly a staff scientist from each modeling center who would complete diagnostics and test code improvements.

Team Activities	CPTs are encouraged to pursue activities that foster sustained and constructive interaction. These activities should emphasize the importance of open, regular, and interactive pathways of communication (e.g. web-based forums, teleconferencing, visitation by key scientific and supporting personnel). The scope of scientific activities will be team dependent, and may fall into one or more of categories, including: • Assessing modeling capabilities (e.g. process diagnostics; assessing consistency of parameterizations with existing observations, detailed process models, and other implementations; preparation of documented observation set for testing); • Model sensitivity to process uncertainties (e.g. single and multiple-model sensitivities/ intercomparisons; diagnosis/attribution of model errors to parameterization errors; determining accuracy requirements for simulating climate feedbacks); • Best use of observations (e.g. upscaling of local process measurements to needed space/time scales); and • Parameterization improvements (e.g. testing and documentation of parameterizations).
Capabilities and Products	CPTs will emphasize advancement by demonstrating new capabilities and delivering new products (not necessarily manuscripts). Depending on the maturity of research on the issue in question, as well as current abilities and readiness, CPTs may produce a variety of capabilities and products, including: • Documented set of observables suitable for process/model diagnostics; • Descriptions of uncertainties associated with key models/processes; • Assessments/diagnostics of how particular physical processes impact the climate system; • Refinements of parameterizations already in climate model systems; • Parameterizations of important processes not included explicitly in climate model systems; • Evaluations demonstrating the impact (positive and negative) of a parameterization; • Plans and rationale for additional process studies necessary to reduce uncertainties associated with important climate model processes/parameterizations; and • Requirements for observables necessary to enable a new parameterization.

Management Issues

CPT Work Plan: The CPT program is fundamentally different from other research programs. The emphasis on demonstrating advancement should be central to all CPT members. To insure success, teams will develop a suitable work plan specifying activities, a schedule of milestones, and anticipated products. Such a plan will clearly indicate how the team will operate and areas of responsibility (who will be responsible for completing the various tasks). Teams will be expected to provide routine and specific updates on progress towards milestones as well as the motivation for revisions to the work plan. A yearly meeting of CPTs will highlight advances of the program. Pilot CPTs are expected to have a 3-5 year duration. Continuation beyond the initial duration as well as annual renewal of CPT funding will be contingent on demonstration of meeting expected milestones.

Costs: The CPT program is envisioned to establish a new mechanism for linking process-oriented research and model development. Financial support will likely be required over the course of several years and for multiple investigators and support personnel. Additionally, provisions must be made for identifying and insuring the availability and dedication of critical institutional compute (e.g. computer cycles, storage, transport, and support) and staff resources for development, testing, and diagnostic/validation purposes.

U.S. CLIVAR Reports

U.S. CLIVAR Scientific Steering Committee, 2002: Climate Process Modeling and Science Teams (CPTs): Motivation and Concept. Report 2002-1, U.S. CLIVAR Office, Washington, DC 20006, 4pp.

U.S. CLIVAR Scientific Steering Committee, 2002: Climate Process Modeling and Science Teams (CPTs): Implementation and Initial Foci. Report 2002-2, U.S. CLIVAR Office, Washington, DC 20006, 8pp.

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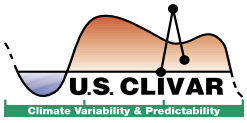

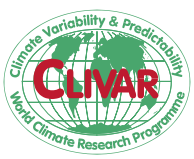

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