A Prospectus for a US-CLIVAR Working Group On Predictability of Pacific Decadal Variability

Daniel J. Vimont and Co-Chair TBD

I. Motivation

Pacific decadal climate variability and predictability are attracting increasing attention in research and user communities not only because of their direct social relevance, but also due to their potential to modulate interannual decadal variations as well as interact with anthropogenic climate change projections. On one side, user communities are recognizing that decadal-scale fluctuations in the Pacific strongly affect socially relevant impacts such as hydrological processes (including snow pack), forest fire regimes, tropical cyclone activity, and marine ecosystems. These communities have expressed strong interest in obtaining decadal climate information and predictions (including now-casts of the current state of decadal variations) for long-term planning purposes. On the other side, scientific communities recognize that Pacific decadal variability limits our understanding of, and ability to predict, interannual ENSO variability as well as anthropogenic climate change. Studies of decadal predictability, though few, have largely focused on prediction of large-scale climatic processes [e.g. the sea-surface temperature (SST) signature of the Pacific Decadal Oscillation (PDO)], or specific climatic features (e.g. thermocline variations in the northwestern Pacific). It is not immediately apparent that these variables are useful for user communities. Indeed, based on current understanding, it is not even clear that a now-cast of the decadal state of the system would imply any useful predictability, despite the implied long time scale associated with "decadal" variability. A coordinated effort is needed in the scientific community to *(i)* identify what aspects of decadal variability may be *predictable*; *(ii)* determine the extent to which this predictability is associated with *socially relevant climate variables*; and *(iii)* outline a strategy for developing and undertaking coordinated decadal *predictions*.

Existing efforts at understanding decadal predictability have largely focused on Atlantic variability. The PREDICATE program (through International CLIVAR) focused on understanding mechanisms and predictability of Atlantic decadal variability. Current efforts are also underway within to understand the longer-term predictability of the North Atlantic overturning circulation [CLIVAR Variations, **4**(3)]. While these efforts do have connections with the current proposed working group, there is a clear distinction (both in physical processes and in observational constraints) between decadal prediction efforts in either basin. In particular, the longer-term variations associated with the Atlantic overturning circulation involve surface and deep-ocean processes, and as such require understanding of physical processes and detailed oceanic measurements that span both the surface and deep ocean. In contrast, mechanisms of Pacific decadal variability are thought to involve upper-ocean processes, and as such requirements for sampling may be better met by current observing networks in the Pacific (e.g. the TAO and ARGO arrays, though it is not clear whether either observational network is sufficient for characterizing the decadal state of the system) than in the Atlantic. The impacts of decadal variations in

the Atlantic and Pacific are quite different as well, especially when considering "remote" (see Section II below) impacts over land where variations in the tropical Pacific play a clearer role in affecting a number of climatic conditions over North America. It is clear that a focused effort in the Pacific will involve a very different set of physical and practical considerations, though strong communication between prediction efforts in either basin is essential for avoiding an artificial separation between the two groups.

II. Definitions

Decadal variations encompass natural and anthropogenic-forced variations between interannual and multi-decadal time scales. For practical purposes, this leads to the following working definition of *predictable* decadal variability:

- *predictable decadal variability* includes any climate information (natural or anthropogenically forced, observed or modeled) that can be inferred with a lead time that extends beyond our current ability to forecast interannual climate variations (i.e. about a year).

Note that this definition recognizes that, despite short lead times, decadal predictions may provide useful information beyond what is currently available from ongoing seasonal to interannual prediction efforts. It is also sufficiently broad to include variations in climatic variables that may not be directly useful to user communities. As such, additional effort is needed to understand the links between predicable climate variations and the predictability of:

- *socially relevant climate variables.* These include "local" impacts that are collocated with the (possible) source of decadal predictability (e.g. SST or thermocline variations in the mid-latitudes, or characteristics of upwelled water in the tropical Pacific) as well as "remote" impacts (e.g. snow pack or hydrological variations over North America that are remotely related to decadal SST variations in the tropical Pacific).

This sub-classification provides a regional and phenomenological focus for predictability studies that narrows the scope of the proposed activities and provides guidance for future efforts at decadal *prediction*. In this case, we define:

- *prediction* as the act of using existing information about the observed current (and past) state of the climate system to infer something about the future state of the system.

This last definition seems obvious, but we include it to provide an important distinction with *predictability* studies, which, for example, may include model hindcast experiments aimed at identifying what aspects of modeled climate variability may be predictable.

III. Objectives and Implementation

The primary objectives of the proposed working group are to accelerate progress in:

- *the identification, quantification, and attribution of decadal predictability in the Pacific;*
- *identifying relevant objectives for Pacific decadal prediction;* and
- *developing a framework for carrying out decadal predictions.*

The working group (WG) will seek to leverage *(i)* existing activities in the scientific community, and between scientific and user communities; and *(ii)* existing research efforts in developing and analyzing models and observational datasets for predicting and understanding decadal climate variations. These objectives motivate a series of specific proposed activities, described below.

Multiple research activities spanning multiple agencies will be necessary to implement recommendations of this WG; these connections are sought largely through the proposed membership. In particular, we recognize the importance of strong links between this WG and ongoing efforts within the US CLIVAR community in understanding hydrological processes, western boundary currents, and decadal predictability in the Atlantic. Also, we expect that the objectives and activities of this WG will provide mutual benefits to other predictability and prediction activities in other parts of the U.S. and international research enterprise. The US CLIVAR project enjoys strong links to the international CLIVAR community, and works directly with the U.S. research community and with multiple agencies and programs. Therefore it is appropriate that such a WG should be formed under US CLIVAR that can provide national and international co-ordination.

IV. Proposed Activities

This WG will aim to achieve the above objectives by the following activities during its two year term:

A1. Quantify potential decadal predictability in the Pacific in existing climate models and in the observed record

This task includes: *(i)* identifying and prioritizing mechanisms of decadal variability based on their potential to produce decadal predictability (this task lends direction to subsequent tasks); *(ii)* determining a null hypothesis for expected decadal predictability by evaluating the decadal skill of existing intearnnual forecast schemes (both statistical and model-based); *(iii)* identifying current model capabilities (e.g. those models contributing to the IPCC AR4, archived at LLNL – DOE) in simulating decadal variability, including decadal modulation of ENSO (the latter may also include analysis of a hierarchy of models); *(iv)* determine potential predictability using existing "perfect model" predictability studies at GFDL (NOAA) and NCAR (NSF), as well as decadal-scale initialized experiments currently being conducted under the ENSEMBLES project; and *(v)* survey anthropogenically forced climate model simulations to determine the relative signals of anthropogencally forced climate predictability vs. natural climate variability. These tasks will primarily involve assessment of existing research and model simulations, though some additional research within the scope of the existing WG may be conducted.

A2. Determine relationships between predictable climate variations and relevant climate information

An important step in predicting relevant climate information is the attribution of existing impacts to specific processes in the climate system. The second major task that will be undertaken by the WG is an assessment of existing theories of decadal variability to

determine the extent to which relevant decadal impacts are related to specific climatic processes, which, in turn, may be predictable. This task involves: *(i)* an identification of a set of relevant variables highlighted by user communities, and *(ii)* an evaluation of proposed physical processes that generate variations in these relevant processes. This activity is important in that it provides guidance for future decadal forecast efforts, and contributes to communication of decadal climate information to user communities. This task will involve a synthesis report of key variables that have been identified by user communities, and a description of how these variables are likely to be affected by decadal climate processes.

A3. Identify the degree to which existing observing systems are capable of resolving the current state of the system with enough fidelity to undertake decadal predictions

The third task to be undertaken by the working group will be to *(i)* determine our current ability to define the current decadal state of the Pacific this includes identifying what we need to observe, as well as how well current observation systems work; *(ii)* identify shortcomings in our current observational networks that hinder progress in understanding decadal variability and prediction. This task includes identifying what we need to observe [the focus on mechanisms in A1*(i)* and the model synthesis in A1*(iii)* contribute to this task] as well as determining how well we observe it (e.g. using the current ARGO and TAO arrays, as well as assessing the skill of current assimilation systems).

A4. Synthesize our currentability to undertake decadal predictions in the Pacific, and provide suggestions for future improvements in our ability

The WG will synthesize results from the first three activities, and evaluate our current prospects for providing decadal forecasts in the Pacific. This synthesis will result in a publication in BAMS or in the US CLIVAR Variations newsletter.

Working group activities will be coordinated and discussed through continued meetings of the WG at existing conferences and coordinated communication through teleconferences and the CLIVAR web site. We anticipate approximately two meetings of the WG per year (at existing conferences), as well as monthly communication through teleconferences and/or the WG's website.

V. Publication and Outreach

Website – mirrored on decvar.org and usclivar.org
White paper on current understanding and predictive capacity of Pacific decadal variability
Synthesis report of key variables that have been identified by user communities, and a description of how these variables are likely to be affected by decadal climate processes?
One article to US CLIVAR Variations newsletter
Workshop reports (2007, 2009)

VI. Resources

(Details TBD)
3 WG meetings – 2 coincident with US CLIVAR Summit

1 newsletter article
Partial support of concluding workshop (coincident with Eighth Decadal Variability Workshop)
1 workshop report

VII. Proposed Period of WG

September 2007 – August 2009

VIII. Proposed Working Group Membership

(TBD)