A Prospectus for a US-CLIVAR Working Group On Decadal Climate Predictability

I. Motivation

There is increasing interest among user communities for information on possible climate trajectories for the next decade. For example, the CIRES/NOAA Western Water Assessment is working with water managers in the Rocky Mountain West to include information from decadal climate forecasts in their long-term planning process.

Research efforts of numerous scientists and working groups, such as the CLIVAR AMOC WG, indicate that significant dynamical connections exist between the tropics/extratropics, Pacific/Atlantic basins, ocean/land (among others) on decadal time scale. Regarding the sources of decadal variability, the results of previous studies and working groups have also suggested the importance of distinguishing between natural and forced decadal variability in order to identify predictability of decadal variations due to an increase in greenhouse gases and due to internal variability of the coupled system.

Recognizing the importance of decadal variability and its societal impacts, international and national efforts are now underway to provide decadal predictions based on climate models (for example, ENSEMBLES, the US-CLIVAR Atlantic Meridional Overturning Circulation Planning Team, and design considerations for the initialized decadal predictions and hindcasts as part of the IPCC Fifth Assessment) to complement projections of expected changes in climate over the next 10-30 years based solely on the climate forcing information. Given the considerable interest in decadal climate predictability and the number of parallel modeling efforts that will be carried out in the next few years, a U.S. CLIVAR working group is proposed that will provide guidance to the modeling and research communities by quantifying predictable aspects of decadal variability through assessment of observational and model simulation data.

Developing a perspective and an approach to assessing decadal climate predictability is the primary focus of the proposed U.S. CLIVAR working group. In our context, the phrase “decadal prediction” refers to providing some information on relative changes in the climate system over the next 10-30 years. What complicates predictability over this time horizon is that it lies at the intersection between externally forced variability due to changing atmospheric composition, and low frequency natural variability of the coupled climate system. The IPCC assessments have established that continuing increases in greenhouse gasses, and the committed time-delayed warming from the slow response of the oceans, implies decadal predictability in the climate system. On the other hand, decadal-scale climate variability inherent in the climate system is also present due largely to slow variations in the oceans’ circulation. The premise of initialized prediction efforts is that a proper initialization of the ocean state can provide “additional” predictability on decadal timescales that is associated with certain modes of climate variability, e.g., the Pacific Decadal or the Atlantic Multi-Decadal Oscillation (PDO and AMO) .

The purpose of this document is to outline objectives for a U.S. CLIVAR Working Group

on Decadal Climate Predictability (DPWG). This Working Group seeks to advance assessment of decadal predictability by *(i)* defining a framework to quantify decadal variations from anthropogenically forced variability on decadal timescales, thereby building on the successes of previous working groups that were focused on investigating the predictability of specific phenomena such as drought and the AMO, and *(ii)* developing a framework, and associated metrics, for understanding decadal variability and predictability that can be used to validate climate simulations and predictions.

The null hypothesis of this group will be that all predictability on decadal timescales is entirely due to the external forcing from greenhouse gases. Starting with this premise the working group will identify appropriate metrics that can be used to quantify additional predictability arising from the natural variability of the coupled climate system, and determine to what extent this predictability could be realized in initialized coupled predictions. These metrics will be used as benchmarks for the assessment of upcoming IPCC AR5 decadal prediction simulations.

II. Objectives

***Objective 1*:** The first objective of the working group will be *to define a framework to distinguish natural decadal variability from anthropogenically forced variability and to quantify their relative magnitude*. This objective involves the following task:

1.1. Define a framework to distinguish natural variability from anthropogenically forced variability on decadal time scale for the purpose of assessing predictability of decadal-scale climate variations

Empirical statistical model studies suggest that natural and anthropogenically-forced decadal variability have distinct spatial structures and timescales. This finding indicates that different physical processes control these two types of variability. However, anthropogenic climate change could also project on natural decadal variability. In order to assess how models simulate decadal variability, and what initialized predictions could offer over uninitialized radiatively-forced projections, it is necessary to untangle decadal variability from these two sources. In this working group we seek to identify approaches to separate natural decadal variability from anthropogenically forced decadal variability, shed light on their relative magnitudes, and examine of what processes dominate natural decadal variability.

To achieve this objective, we will start from the analysis of simple averages of the IPCC models to extract the anthropogenically forced decadal signal and also utilize more sophisticated analysis techniques such as optimal "fingerprinting" favored by the detection and attribution community. The work will use observational data together with the IPCC AR4 coupled model simulations for 20th century and preliminary initialized decadal climate simulations completed by modeling groups in advance of the AR5 for separating anthropogenically-forced and naturally occurring decadal variability. Progress in this area will greatly benefit the climate community's ability to estimate the predictability of natural decadal variability, as well as the ability to estimate the impact of

future increases in greenhouse gases.

What is the role for U.S. CLIVAR in achieving this objective? Through the DPWG, U.S. CLIVAR will play a central role in coordinating existing and emerging decadal climate prediction assessment efforts. The DPWG will assess the extent to which analysis of decadal variability and predictability depends on the method of separation, as well as the pros and cons of different methodologies. Guidance on separating natural and forced decadal variability will contribute directly to the analysis of decadal climate prediction efforts planned for the IPCC AR5.

Expected Deliverables: The task outlined above will be written up into a white paper entitled "Isolating natural decadal variability in the climate record" to be submitted to *BAMS*. Deliverables from this objective will include a special session on "Isolating Natural Decadal Variability in the Climate Record" at the Eighth Decadal Variability Workshop.

Objective 2: The second objective of the working group will be *to develop a framework for understanding decadal variability through metrics that can be used as a strategy to assess and validate decadal climate predictions simulations.* This involves the following tasks:

2.1. *Identify common metrics to assess the simulation of decadal variability in climate models*

As with any prediction, quality, which refers to how well the forecast works, is not necessarily synonymous with value, which refers to the ability to extract societal benefit. While both quality and value are important elements of decadal predictability, the DPWG will focus on metrics of the quality of decadal variability that are guided, at least in part, by their societal impact and potential for value to user communities.

The DPWG will initially focus on metrics associated with large-scale modes of variability to assess the simulation of decadal variability in climate models. We will mine the CMIP3 (IPCC AR4) database to identify strategies for defining these metrics. The goal of this task is to provide a framework that can be later used to assess and compare coupled climate model simulations of decadal variability and to serve as a standard for comparing model performance in the upcoming IPCC AR5 report.

2.2. For the metrics identified, investigate mechanisms that cause predictability on decadal time scales

For the metrics identified in 2.1 the DPWG will investigate the mechanisms that cause predictability on decadal time scales. The investigation will cover precursors to oceanic variability as well as teleconnected variability of terrestrial climate. This will involve an assessment of observational and empirical statistical model studies of current and past climate variations, as well as, coupled and atmospheric model simulations. This task will focus on advancing our understanding of how representations of large-scale modes of

variability in climate models contribute to the skill of the decadal forecasts. The findings based on the currently existing models will be applied to the AR5 decadal predictions as they become available.

What is the role for U.S. CLIVAR in achieving this objective? Through defining relevant metrics for decadal prediction, as well as their assessment in the available climate model simulations, this task will facilitate communication between very different efforts at decadal prediction now ongoing in the scientific community. The findings of the DPWG will contribute to the upcoming IPCC AR5 report by providing a framework for assessing model simulations, and predictions, of decadal variability in coupled climate models.

Expected deliverables:
A workshop on "Defining Metrics to Assess Decadal Predictions in Climate Models" will be held concurrently with the Ninth Decadal Variability Workshop. In 2011 when the AR5 decadal prediction database becomes available we will recommend a call by funding agencies for numerous small projects (similar to DRICOMP) to investigate decadal predictability in the AR5 initialized decadal climate projections.

Timeline/Activities

- January 2009 – finalize membership and prospectus, first telecom to begin planning experiments, discuss roles and activities.
- Monthly telecons: progress on analysis, workshop planning, etc.
- May 2009 – Session on 'Isolating Natural Decadal Variability in the Climate Record' at the 8th Decadal Variability Workshop.
- September 2009 – submit white paper, summarizing key results from WG and May '09 workshop session on isolating natural decadal variability.
- Spring 2011 – Session on 'Defining Metrics to Assess Decadal Predictions in Climate Models' at the 9th Decadal Variability Workshop
- Summer 2011 – Write workshop report and WG wrap-up focused on decadal prediction metrics

III. Membership

The table below summarizes the panel membership and the communities each member would be drawn from. Each member will have expertise in theory, modeling, or observations.

Theory	Models/Initialization Strategies	Observations
Signal Detection	Climate Models	Pacific Climate
Quantifying Uncertainty	Intermediate Process Models	North American Land Surface Processes
Probabilistic Climate Projections	Statistical/Stochastic Models	Atlantic Climate

US Membership:
Jim Carton (Atlantic climate variability, University of Maryland)
Tom Delworth (Climate models, GFDL/NOAA)
Clara Deser (Pacific climate variability, NCAR)
Lisa Goddard – co-chair (Prediction methodologies, IRI/Columbia University)
Ben Kirtman (Climate models, University of Miami)
Randy Koster (Land surface processes, NASA)
Arun Kumar – co-chair (Attribution of climate variability, NOAA/CPC)
Jerry Meehl (Climate models, NCAR)
Matt Newman (Statistical models, NOAA/University of Colorado)
Ben Santer (Detection & attribution, LLNL/PCMDI)
Amy Solomon – co-chair (Climate dynamics, NOAA/University of Colorado)
Lowell Stott (Paleoclimate, USC)
Joe Tribbia (Climate dynamics and predictability, NCAR)
Dan Vimont (Pacific climate, University of Wisconsin)
Yan Xue (Ocean analysis, NOAA/CPC)

US Membership: Ex Officio
2009 NOAA CVP PIs

International Membership: Ex Officio
Ed Hawkins (Regional climate change, University of Reading, UK)
Gabi Hegerl (Regional climate change, Edinburgh University, UK)
Noel Keenlyside (Initialized decadal predictions, IFM-GEOMAR, Germany)
Doug Smith (Initialized decadal predictions, Hadley Centre)

IV. Resources Requested

Teleconference support
2 WG meetings (coincident with US CLIVAR Summit)
2 special sessions at DecVar Workshops
1 article/workshop report
1 article/WG wrap-up report