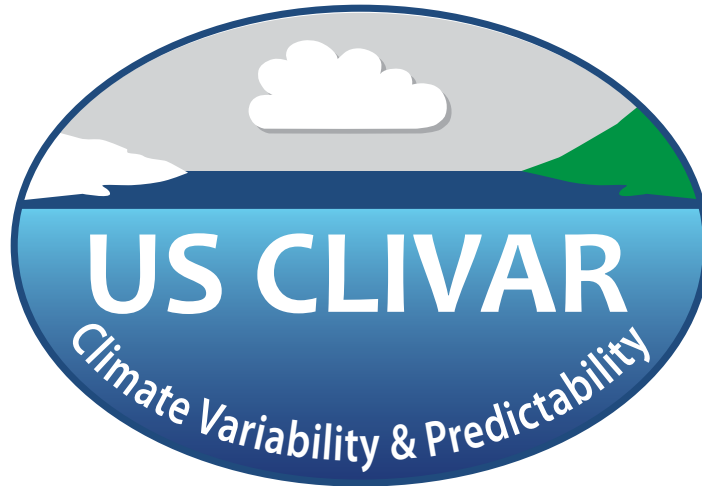


## 2013 US CLIVAR SUMMIT REPORT

July 9-11, 2013

Annapolis, Maryland



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View of the capitol building and Annapolis Harbor in Annapolis, Maryland.

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## Introduction

The 2013 US CLIVAR Summit was held in Annapolis, MD on July 9 – 11 and brought together over 60 participants from the science community and federal agencies. The Summit provided the opportunity to review progress, identify opportunities, and develop strategies to advance US CLIVAR goals. During the three days of meetings, Panels had the opportunity to meet and identify action items in addition to cross-panel collaboration, Science Teams and Working Groups provided brief reports, agency managers highlighted recent support and ways to engage, and participants received an update on the National Climate Assessment.

The 2013 Summit had four main objectives.

- Context: Provide update on US and International CLIVAR programs and plans
- Cross-Panel Interaction: Foster dialogue among panels on common or joint topics
- Panel Business: Review progress and identify gaps and opportunities
- Implementation Planning: Identify action items to progress on new Science Plan goals and research challenges

This abbreviated report summarizes presentations and discussion during each of the three Panel breakout sessions and the resulting action items to be addressed during fall 2013 through spring 2014. Plenary and breakout presentations can be found online at <https://usclivar.org/usclivar-2013-summit-agenda>.



## 2

## Action Items

### *POS Panel will:*

1. Review and revise the POS Terms of Reference (ToR) for consistency with the new Science Plan.
2. Review POS membership.
3. Review the NOAA Center for Weather and Climate Prediction GODAE Symposium, which was held in November 2013, at next year's Summit.
4. Revisit extremes issues following the upcoming working group workshop in September 2013 and review the Obs4MIPS.
5. Continue discussions on future working groups and request broader input.

### *PSMI Panel will:*

1. Review and revise the PSMI ToR for consistency with the new Science Plan.
2. Future process study reviews might request a "Nature Figure" rather than a long list of slides, that could be used in future publications and serve as a focal point for PSMI discussions.
3. The next best practices document should cover metrics and demonstration of impact of particular processes.

### *PPAI Panel will:*

1. Review and revise PPAI ToR for consistency with the new Science Plan.
2. Lay groundwork for a US CLIVAR Workshop on "Connecting Predictions and Applications":
  - Liaising with appropriate boundary organizations (e.g., USGS, NOAA, DOE, etc.);
  - Developing a thematic paper on current challenges facing "Pathways to Operations" for inclusion in US CLIVAR Variations;
  - Hosting a plenary session on "Communication and Decision Support" at 2014 Summit; and
  - Schedule gathering of US CLIVAR and application community to discuss and better understand future research requirements.
3. Promote to funding agencies the concept of CMEP like activity for assessment of seasonal predictability & predictions using NMME data sets.
4. Promote to funding agencies a Science Team on "Natural and Societal Impacts of Decadal Climate Variability: Predictability and Predictions," including:
  - Development of a concept paper based upon AGU session talks on this topic;
  - Presentation of a concept paper to US CLIVAR SSC for feedback;
  - Schedule a workshop with funded researchers and funding agency heads; and
  - Propose a Science Team at 2015 Summit.

5. Scope the concept for the Application Process Teams (APT) before the 2014 Summit, including:
  - Development of a white paper based upon Garfin and Ray presentation;
  - Presentation of white paper to US CLIVAR SSC for feedback; and
  - Propose an APT framework at 2014 Summit.
6. Develop additional thematic papers on current challenges for inclusion in US CLIVAR Variations such as communication and utilization of uncertainty in decision-making or predictability of high latitude climate variability.

# 3

## Breakout Summaries

US CLIVAR implementation is organized by three Panels, each with specific responsibilities reflecting the way in which the community works.

**Phenomena, Observations and Synthesis (POS) Panel** – to improve understanding of climate variations in the past, present and future, and to develop syntheses of critical climate parameters while sustaining and improving the global climate observing system.

**Process Study and Model Improvement (PSMI) Panel** – to reduce uncertainties in the general circulation models used for climate variability prediction and climate change projections through an improved understanding and representation of the physical processes governing climate and its variation.

**Predictability, Predictions, and Applications Interface (PPAI) Panel** – to foster improved practices in the provision, validation, and uses of climate information and forecasts through coordinated participation within the US and international climate science and applications communities.

Terms of Reference for each Panel are provided in breakout session summaries.

### *Charge to the Panel Breakouts*

Each Panel was charged to address in breakout their specific Terms of Reference as well as the following common responsibilities:

- Advise US CLIVAR on research priorities, identify research gaps, and develop suitable milestones to promote funding opportunities.
- Develop and encourage mechanisms (e.g., community workshops, commissioned studies, Working Groups) to further develop and implement US CLIVAR goals and research challenges.
- Advise on the adequacy and effectiveness of Working Group plans and implementation.
- Consider necessary coordination with other national and international activities to develop integrated, efficient, and effective plans.
- Liase with other US CLIVAR Panels to ensure relevant needs are considered in their efforts.
- Generate a list of accomplishments and progress over the past year, action items for the Panel, and set of recommendations for SSC and funding agency consideration.

## *Inter-Panel Interaction*

The Summit emphasized how to further strengthen the work of US CLIVAR by stimulating interactions between Panels. An initial set of questions were posed for consideration during Panel breakouts.

- Do POS and PPAI see that work by PSMI has supported or guided their own efforts?
- Does PSMI ask POS and PPAI for inputs on what processes need to be researched and improved in models?
- Does PPAI identify processes and parameterizations that are poorly understood and/or sources of model error and inform PSMI?
- Does POS ever interact with PSMI to indicate which observing resources should be left in place after a process study to gain from what is learned?
- Should the Panel, Working Group, and CPT structure and approach be changed or refined to promote such interactions.

The Panels were encouraged to explore these questions and identify priority topics requiring future engagement with the other Panels.



## 3.1 POS Panel Breakout

### *Summary of action items from previous Summit and update on progress*

1. Prepare an announcement of the May 2012 reanalysis conference for posting on US CLIVAR website.  
*Status: Done.*
2. Encourage comments on “A Framework for Ocean Observing” approach, and how it would dovetail with the activities of one’s own organization.  
*Status: The framework approach is now referenced in US CLIVAR Science Plan.*
3. Review the TRACE workshop summary, available at [www.trace-rhp.org](http://www.trace-rhp.org), aiming to refine the broad goals and objectives of TRACE to encourage complementary activities and collaborations where appropriate.  
*Status: Done.*
4. The metrics used to characterize the nature of ENSO events may deserve additional consideration by the proposed working group. The POS panel recommends that a proposal to support this working group be submitted to US CLIVAR.  
*Status: This action item led to formation of ENSO Diversity Working Group.*
5. It was recommended that Simon deSzoke contact potential participants and determine how much community interest there is in going forward with a working group proposal on Synthesis of Upper-Ocean Heat Budgets in Eastern Ocean Basins.  
*Status: This action item led to formation of Eastern Tropical Ocean Synthesis Working Group.*
6. A letter of support from the POS Panel (or US CLIVAR as a whole) to CLIVAR towards improving the availability of ocean reanalyzes in real-time.  
*Status: The US CLIVAR GSOP is conducting an intercomparison project of all ocean synthesis led by Magdalena. One of the action items is to explore how to make some ocean fields such as ocean heat content available to the public. They had a workshop last summer (see summary by Jim Carton below). More results from the project will be presented at the coming GODAE Symposium in November at NCWCP.*

### *Objectives for the panel breakout*

#### **POS Panel Terms of Reference:**

- Review, prioritize, and coordinate US plans for relevant studies needed to identify and elucidate observable physical coupled ocean-atmosphere-land mechanisms, processes, and phenomena in the global climate system. It is envisioned to address studies such as diagnostics and evaluation of observations and model results, characterization of the coupled system, and others.

- In consultation with other groups, assess elements of, identify needs of, and coordinate plans for the sustained climate observation system especially for the ocean (including the development, assemblage, and curatorship of climate records), to improve monitoring, prediction, and simulation of the coupled ocean-atmosphere-land system.
- Guide and assess efforts to extend the record of past climate variability through assembly of quality-controlled instrumental data sets & paleoclimatic data.
- Identify, review, and prioritize regional observational efforts that should be pursued through limited deployments (aka enhanced monitoring) to advance our understanding of climate-relevant processes and phenomena.
- In consultation with other groups, assess and prioritize plans, and coordinate activities that lead to syntheses of observations and models in order to develop consistent four dimensional climate products (i.e., climate reanalyses).

### ***POS Motivating Questions:***

We now have about a decade of ARGO and some other elements of the sustained ocean observing system along with different ocean reanalyses and synthesis products.

- How does this context guide us/encourage us/concern us going forward?
- For example, how does one combine decadal repeat hydrography with ARGO?
- One lesson from the present observations is that they are not obviously affordable and are under duress, so how does this influence how we consider going forward from Ocean Obs 09?
- What is US CLIVAR's role – e.g., to wisely guide what to sustain, what to sunset, what priorities should be addressed when it is clear that not all we wish to do is affordable?

### ***Inter-Panel Interaction:***

- Do POS and PPAI see that work by PSMI has supported or guided their own efforts?
- Does PSMI ask POS and PPAI for inputs on what processes need to be researched and improved upon in models?
- Does POS ever interact with PSMI in the sense of saying, let's leave some of those observing resources in place after the process study to gain from what you learned?
- Would you change/refine the Panel, Working Group, and CPT structure and approach?

### ***Summary of each panel session (in order of the agenda) summarizing key points of presentations, discussion, and any suggested action items***

#### ***Building forward from OceanObs'09: Integrated Ocean Observing System (IOOS) and Framework on Ocean Observing (FOO) (Eric Lindstrom):***

While golden age of observations should continue through 2020, requirements are plateaued at 62% of planned capacity for essential climate variables (ECVs). Intended to address plateau, economy pushes back. For long term planning, variable based approach (e.g., ECVs) provides some permanency in that core variables will be as important tomorrow as today.

#### ***Status of understanding observable modes of climate variability: What's missing? (Art Miller):***

The preferred spatial patterns of atmospheric variability exert a forcing on the ocean that can excite a concomitant response, in some cases exhibiting the potential to interact with the atmosphere and

result in a coupled mode of variability. The mechanisms that control those coupled feedbacks are still unclear. The most critical observations needed to sort out these interactions require measuring the fluxes between the two systems, including surface heat fluxes, wind stresses and freshwater fluxes, especially in critically important locations where the atmosphere is able to sense the effects of the ocean. In addition, coupled model simulations of these modes are needed both at high resolution and for long time intervals to pick apart the interplay of the ocean and atmosphere.

***Status of understanding and modeling extremes in temperature and precipitation (Matt Barlow):***

Connecting heat/cold wave occurrence in climate change, we need to consider non-stationary in climate extremes. While US CLIVAR focus is understanding and data, more work is needed to foster connections with users (explore societal needs with PPAI). Complexities will require a sustained effort to make significant progress; however, enhanced coordination among existing national and international efforts that have overlapping interests could likely speed things up a great deal.

A working group on the large-scale meteorological patterns associated with short-term temperature and precipitation extremes is underway, with primary deliverables being two survey papers and a workshop. Extreme events have a high societal cost and evoke much public interest. Additionally, in terms of heat waves, they are likely to be one of the earliest and most obvious ways that the public experiences climate change, so this is recognized as an important problem to focus on. Recommended future efforts include: 1) identifying a small number of extreme indices to focus on, that align best with physical processes and with important societal impacts; 2) collaborating with other national and international programs working on similar efforts, to pool expertise, share tools and techniques, and identify and prioritize research questions; 3) assessing the degree of confidence in model projections of extremes based on the ability to correctly reproduce the underlying dynamics; and 4) investigating the ability of potentially-predictable modes of oceanic variability to modulate the large-scale meteorology that produces extremes. These efforts would address the US CLIVAR extremes research challenge and contribute to the National Climate Assessment.

This is a complex issue that will require a sustained effort to make significant progress on; however, enhanced coordination among existing national and international efforts that have overlapping interests could likely speed things up a great deal.

Suggested action: Revisit extremes issues following the upcoming working group workshop (September 2013).

***Summary of November 2012 Ocean Synthesis and Air-Sea Flux Evaluation Workshop (Arun Kumar):***

With surface fluxes, there are many (15-20) observationally based data products with substantial variance, which calls for algorithm and measurement improvements. It is suggested that a field experiment needs to come first to close the budget, including fluxes, transports though, and uncertainty. There is also a need to improve data collection for evaluation (should consider Obs4MIPS, discussed below).

***Summary of July CLIVAR GSOP/GODAE Ocean Reanalysis Intercomparison Workshop (Jim Carton):***

There are many ocean reanalysis products, is it time to consolidate? The ensemble shows good agreement. There has been progress in representing AMOC, but significant scatter is still present. Should RAPID be assimilated? Ice analyses have comparable variability, despite a range of total value.

***Links with land surface (Alexander Gershunov):***

Land feedback and processes provide a vital connection between climate and society. Drought feedback is a prime example, but cold season snow cover is not insignificant. WCRP Grand Challenges provide an opportunity to include some interdisciplinary topics that are related to US CLIVAR goals (e.g., collaboration with GEWEX Data Assessment Panel). The land surface is an important reservoir of climate memory and source of predictability for seasonal climate and extreme weather. Improvement in process understanding and predictability requires consideration of land surface processes in observations and modeling. In global water and energy balance, all land precipitation comes (in some time scale) from the ocean. So, land sensible heat and evaporation provide a key balance check on ocean water cycle. GEWEX is land, but there is no US GEWEX. US CLIVAR should include land regions and processes that can help it address its goals.

***Toward budget conserving coupled ocean-atmosphere-ice reanalyses (Dimitris Menemenlis):***

Because of numerical weather prediction pedigrees, most modern-day atmospheric and oceanic reanalyses are based on optimal interpolation or Kalman filter methodologies, or their derivatives, e.g., 3D-Var and 4D-Var, which are not properly conserving in their time evolution. For example, 24% of the NCEP/NCAR's atmospheric reanalysis mass change during "assimilation" updates is physically unaccounted for. Although these non-budget conserving reanalyses have proved useful for addressing a wide variety of practical and scientific questions, there is a certain class of science questions that would be better addressed by property-conserving, time evolving state estimates. Examples of such problems include the advection of tracers, e.g., oxygen and carbon by the ocean for biogeochemistry and ecology applications; a fuller exploitation of formally future data, e.g., as is made possible by the application of optimal smoothers; heat and freshwater budget computations to determine the origin and destination of source waters; model evaluation and improvement; and establishing the scientific basis for decadal climate predictability.

Suggested action: For above reasons the POS Panel advocates that steps be taken towards exploring and enabling coupled ocean-atmosphere estimates with closed property budgets. A very early example of such effort is the work of the group lead by Nozomi Sugiura at Frontier Research Center for Global Change at the Japan Agency for Marine-Earth Science and Technology.

***Initialization of seasonal predictions (Yan Xue):***

The ocean reanalysis intercomparison workshop held at European Centre for Medium Range Weather Forecasts on July 1-3, 2013 suggested that the ensemble mean of 15-20 ocean reanalyses can be used to describe climate signal and the ensemble spread is a measure of uncertainties in ocean reanalyses. The ensemble mean and spread of each variable in the comparison (i.e., ocean heat content, sea level, steric height, D20, surface fluxes, etc.) could be made available to the general public. The data could be potentially useful for model validation projects such as Obs4MIPs. Such intercomparison activity should be encouraged since it has the following potential benefits:

1. Provide variables for validation of climate models
2. Provide variables for real time climate monitoring
3. Provide supports for sustaining ocean observing systems
4. Provide needs for data assimilation system development

There are coupled analyses going on at several centers. SST assimilation yields forecast improvements. Many questions remain on the sensitivity of forecasts to the observing system, uncertainties, and model biases.

***What does US CLIVAR need from reanalyses and next steps for US CLIVAR engagement (Michael Bosilovich):***

In recent years, US CLIVAR has been a proponent of the reanalysis method and data products through supporting workshops on the need and development of integrated Earth systems analyses (Baltimore 2010). Indeed, most if not all atmospheric reanalysis centers now have the capability to perform offline land and ocean reanalyses and have development plans leading toward integration of the Earth system beyond atmosphere, ocean, and land (e.g., aerosols, chemistry and cryosphere).

The US CLIVAR Science Plan emphasizes several research directions that reanalyses will play a significant role in making progress, such as decadal variability, extreme climate and events, the polar climate, and marine biogeochemistry. Reanalyses provide a globally continuous observationally based diagnostic tool for the Earth's climate. Yet a fundamental limitation remains in the assimilated observations, and how they change as technology advances, replacing obsolete observing platforms. Reanalyses can provide weather data that describe extreme events and their connections to the large-scale circulation including regular global coverage and teleconnections. Strength in reanalyses is providing continuous data even when observations are minimal, for example, in high latitude regions. Yet, in all the potential for reanalyses, one underlying deficiency is the lack of quantitative uncertainty estimates in reanalyses data products.

A potential role for US CLIVAR is to utilize the sponsored CPT's, Working Groups, and Science Teams to develop a list of fundamental metrics and diagnostic methods to test and compare reanalyses. These could be based on well known ECV's that are observed, or they may be more related to fundamental processes in the climate system. A potential platform to improve the understanding of reanalysis uncertainty and also to test these proposed metrics might be the Obs4MIPS project, initially developed by NASA and DOE for verifying CMIP present day climate projections. However, a greater reanalysis intercomparison would require international collaboration. One possibility may exist in the GEWEX Data Assessment Panel, which works with the intercomparison of global observed data products.

***Polar Climate (Xiangdong Zhang):***

There is a need for long consistent records of sea ice and snow thickness, better coverage of vertical atmospheric and oceanic profiles, improved description of polar climate through high-resolution, data-assimilating models with closed energy and water budgets, and an observationally-based, physical process oriented matrix for evaluating climate models.

***Sea level and review of WCRP/International CLIVAR Grand Challenge white paper (Don Chambers):***

Sea level information should be used to decipher uncertainties in surface forcing fields by comparing resulting sea level changes against observations and thereby learn more about accuracy of forcing. This is a strategy that is being pursued in ocean syntheses efforts. Regional trends in sea level related to changes in wind forcing, emphasizes a need for long term, consistent wind observations.

***Satellite observations, subsurface sensing, and continuity issues (Xiao-Hai Yan):***

Ocean remote sensing challenges for CLIVAR research include measurement continuity, intercalibration of satellite retrievals (e.g., vector winds), and inferences about subsurface (e.g., mixed layer and deep ocean). Maintaining ocean wind observations and utilizing international collaborations for data access are critically important. Models are not representing sea level well over long time periods. Uncertainty in reanalyses, for ocean model forcing, remains a major issue.

***Water cycle missions and decadal survey (Jared Entin):***

Instruments need to be designed to more directly respond to multiple science and application needs and use multiple data products to extract consistent ECVs e.g., through data assimilation. In preparation for the next decadal survey, what do we need to think about now to get the most out of the satellite observing platforms? Connections to the instrument engineers should begin early and more workshops should be expected. Level 4 data processing (incorporation of models) plans need to be laid out well in advance.

***DOE Integrated Water Cycle Workshop (Ruby Leung):***

This workshop aimed to advance scientific understanding and predictive modeling and uncertainty quantification of the integrated human-earth system, multiscale atmospheric and terrestrial processes, and their links with water resources. Human processes are being implemented in modeling, yet resolution and scaling behavior of models is very sensitive. For example, cloud parameterization does not scale to higher resolution without significant revision. Water cycle extremes have gained attention at many, if not all of the funding agencies, owing to their importance in societal and economic matters.

***Obs4MIPS (Duane Waliser):***

Obs4MIPS is being developed as a satellite observation capability for the climate modeling community to support model-to-data intercomparison (especially CMIP). Collaboration with the satellite data community has been key in growing beyond the initial pilot project. Yet, more opportunities exist, and other observational groups are encouraged to contribute to Obs4MIPS, especially international collaborations. Modeling groups are encouraged to produce output diagnostics comparable to the observed data. A workshop is being planned next year to bring together modelers, observation experts, and CMIP architects to enhanced Obs4MIPs for CMIP6.

***Measurements needed in Tropical and Equatorial Pacific for understanding ENSO diversity (Antonietta Capotondi):***

Differences in amplitude and longitudinal location of ENSO events can result in important differences in impacts. Continuation of TAO/TRITON observations of surface and subsurface temperature, upper-ocean velocities, surface winds, and surface heat fluxes is fundamental for understanding characteristics, dynamics, and origin of different ENSO flavors, assessing predictability, and evaluations and adjustment of climate models.

***Upper ocean processes with focus on GDP and tropical moored arrays (PIRATA, TAO, RAMA) (Rick Lumpkin):***

Degradation since mid-2012 of TAO array is symptomatic of ship time underfunding, which has also impacted other observing system components. Need to maintain existing *in situ* ocean observing system



for uninterrupted climate time series in all ocean basins. This requires continued assessment of various components of observing system, while recognizing interdependencies, e.g., ship time used to deploy both TAO and Argo floats. In the current funding environment, choices need to be made. A new workshop is planned on the tropical Pacific Ocean observing system, intended to inform decisions on best observations to maintain.

***TAO array and NCEP-GFDL project on TAO observing system experiments (Yan Xue):***

The TAO/TRITON array is the cornerstone of the ENSO observing system since it systematically measures upper ocean temperature, salinity, velocity, and air-sea fluxes that contribute to the dynamics of ENSO, and are essential for ENSO monitoring and prediction. One tool to assess the value of the TAO data in the presence of the Argo data is to conduct observing system experiments (OSEs) using multiple ocean data assimilation systems (ODAS) and seasonal forecast models. The relative role of the TAO and Argo data towards constraining the upper ocean thermal structure and ocean currents in ocean reanalysis can be assessed. Hindcast experiments initialized from the OSEs can be used to show if the seasonal forecast skill of the current generation seasonal forecast models are able to show the benefits of enhanced ocean observing systems. This activity is resource demanding, but it is critical for the mission of CLIVAR to monitor, understand, and predict climate variability, and to sustain and expand global ocean observing systems for the societal benefits. We recommend US CLIVAR/CLIVAR to support a national and international coordination of such activity.

***Potential topics for inter-panel coordination***

Reanalyses, being a blend of model forecasts and observations provide an important tool for understanding weather and climate processes, but also the observations and models. The observed data assimilated in a reanalyses is rarely evaluated after the reanalysis production, and much less outside of the developing center. Providing these observations alongside the forecast departure will provide reanalysis users with much needed information about the quality and uncertainty of the resulting analysis. This is a potential opportunity for collaboration with PSMI panel on (re) analyses innovation, increments, and residuals.

***Review of panel terms of reference***

There was general agreement that the POS Panel ToR needs to be more “active”. One possibility to achieve that may be to narrow the ToR. This needs to be taken up after the summit in teleconferences.

***Summary and conclusions***

***Noted Gaps:***

The POS is extremely concerned by the degradation since mid-2012 of the TAO array and symptomatic of underfunding for ship time that has also impacted other observing system components. We emphasize the need to maintain the existing *in situ* ocean observing system to provide uninterrupted (or at least minimally interrupted) climate time series in all ocean basins. Ameliorating this will require continued assessment of various components of the observing system, while recognizing interdependencies, e.g., ship time used to deploy both TAO and Argo floats.

Sea level could use more attention in US CLIVAR, agencies are already moving on it. What unique role can US CLIVAR play? Perhaps focus on storm surge and extremes? Or Panel collaborations?

Ocean remote sensing challenges for CLIVAR science include continuity and intercalibration of satellite retrievals, surface wind and flux observations, high latitude observations, and inferences about subsurface, e.g., mixed layer and deep ocean.

Because climate change is a global issue, filling the gaps of data need international cooperation. Involvement of other countries, especially Chinese scientists and satellite data, should be encouraged in the US CLIVAR community.

***Some recommendations:***

- Re-emphasize climate and ocean ecosystem connections, fisheries, and economic aspects.
- Understand old synoptic measurements in light of new observations of ocean variability.
- How do you evaluate/assess best practices? What has been successful?
- Since the AMOC is a part of global thermohaline conveyor, extending the AMOC study to global thermohaline circulation response to climate variability and change is timely.
- Since deep ocean convection cell is about one kilometer in size and cloudy conditions are very often in higher latitude, there is a need high resolution, all weather remote sensing data, such as SAR, in climate research.

***Possible future working groups:***

1. Storm surges and other sea level extremes
2. Air sea fluxes, mixed layer, and balancing budgets
3. Deep ocean response to climate variability and change
4. Coupled ocean-atmosphere (re) analyses development, evaluation, and intercomparison, including the development of property-conserving climate-quality reanalyses
  - a. The objectives of this working group would be to (1) develop coupled ocean-atmosphere data assimilation systems, (2) evaluate and intercompare reanalysis fluxes and their ability to assimilate climate modes, and (3) explore predictability in ocean variables that are linked to ecosystem and fisheries applications.
5. Ana4MIPs (analyses for model intercomparisons)
6. Coastal observations
7. Ecosystems

***List of action items***

1. Review and revise the POS ToR for consistency with the new Science Plan.
2. Review POS membership.
3. Review NCWCP GODAE Symposium, which was held in November 2013, at next year's Summit.
4. Revisit extremes issues following the upcoming working group workshop in September 2013 and review the Obs4MIPS.
5. Continue discussions on future working groups and request broader input.

## 3.2 PSMI Panel Breakout

### *Summary of action items from previous Summit and update on progress*

1. PSMI Panel to assess metrics for CPT success.
2. PSMI Panel to discuss the extent to whether best practices for process studies have been followed by the process studies.
3. PSMI Panel to discuss possible strategies for maintaining data/publications archive for process studies.

### *Objectives for the panel breakout*

#### ***PSMI Panel Terms of Reference:***

- Review, prioritize, and coordinate US scientific plans for, and programmatic support of, relevant process studies, CPTs and other investigations that lead to improved parameterizations of critical climate processes, better quantification of climate model uncertainties, improved climate model fidelity, and validation of observing systems aimed at increasing their global utility, as necessary to achieve the goals of CLIVAR. Through its review process, US CLIVAR encouragement of nascent process studies does not imply a formal endorsement.
- Develop and encourage mechanisms (e.g., community workshops, commissioned studies, Working Groups) to further the development and implementation of timely and relevant process studies and a research strategy, including filling gaps.
- Guide, assess, and coordinate efforts to improve utilization of process-oriented research and limited observation campaigns in parameterization and model development (especially in national and community model activities) through the use of CPT and similar frameworks.

#### ***PSMI Motivating Questions:***

US CLIVAR has a strong history of implementing regional process studies that “bubble-up” from the community.

- How well are we doing at diagnosing the potential sources of uncertainty in predictions and projections and then listing these together with establishing a sense of both the feasibility of addressing them and the likelihood of making real progress in addressing them?
- Of course another reason for a process study might be to identify and better describe a mode of variability that could be a new source of predictive skill. Is this a suitable stand-alone rationale?
- A pragmatic question is whether or not the agencies are funding the analysis tail to follow these process studies that allows a comprehensive even if not complete mining of the good results that would have impact on model improvement.
- Is U.S. CLIVAR going into the field too often, with too little time between field studies and not having time and support to derive maximum benefit from the process studies?
- What are the measures of success for a CPT? What lessons learned/best practices have emerged from the series of CPTs supported to inform future CPT formulation?
- Are there recommended changes to the PSMI Panel terms of reference to reflect the goals and cross-cutting strategies of the new Science Plan?

### ***Inter-Panel Interaction:***

- Does PSMI ask POS and PPAI for inputs on what processes need to be researched and improved in models?
- Does PPAI identify processes and parameterizations that are poorly understood and/or sources of model error and inform PSMI?
- Does POS ever interact with PSMI to indicate which observing resources should be left in place after a process study to gain from what is learned?
- Should the Panel, Working Group, and CPT structure and approach be changed or refined to promote such interactions?

### ***Summary of each panel session (in order of the agenda) summarizing key points of presentations, discussion, and any suggested action items***

#### ***KESS ([Kuroshio Extension System Study](#)) (Meghan Cronin):***

A key point made in the document is the long-term archiving of datasets and websites. It is unclear from where the funding and support for these activities will come, but the panel agreed that it is within the interests of US CLIVAR to aid in making these connections.

#### ***CLIMODE ([CLIVAR MObile Water Dynamic Experiment](#)) (Terry Joyce):***

The short written report was a recast version of an earlier message sent to Mike Patterson for a request in developing the science plan. It was agreed that perhaps a request for such a document would have been more fruitful earlier after the conclusion of the project.

#### ***VOCALS ([VAMOS Ocean-Cloud-Atmosphere-Land Study](#)) (Roberto Mechoso):***

The report from VOCALS consisted of a combination of a short email and a BAMS article. The panel agreed that the latter was an ideal way to report a sunset of a project, and suggests that any future requests for sunset reports can be handled in this way. VOCALS was a very successful process study, and is a model for future air-sea interaction projects.

#### ***GO Amazon ([Green Ocean Amazon](#)) (Martin & Schumacher):***

The report from GO Amazon was sufficiently more detailed than the presentation that was given at the 2012 summit. There was general agreement that the topic was important and timely and that it the project is likely to result in improvements in cloud and aerosol understanding and modeling. However, the panel was hard pressed to see how US CLIVAR could be useful in supporting this project, given that the primary interaction is human-environment and land-atmosphere without much connection to the oceans. So, the consensus was that PSMIP and US CLIVAR efforts would continue to be supportive of this project, although there was not a clear path for doing so.

#### ***ASIRI ([Air-Sea Interactions in the Northern Indian Ocean Research Initiative](#))/Bay of Bengal Observations (Bob Weller):***

The ASIRI project and the upcoming Bay of Bengal project were both of great interest to the panel, falling precisely into the improved understanding of air-sea interaction with a clear intraseasonal to seasonal climate and societal impact. At this stage, most of the questions were clarifications of the goals and instrumentation to be used. These projects should continue to be reviewed and assessed to see that understanding and improved predictions are being put together. It would be reasonable

to have a joint session with POS or PPAI or a plenary to discuss operational and forecasting outcomes of this work.

***DYNAMO (Dynamics of the Madden-Julian Oscillation) (Augustin Vintzileos):***

The presentation by Vintzileos was well appreciated by the panel, and an appreciation was gained of the scope and significance of the work carried out and just how fortunate the timing of the observations were. The project is well on its way into the reporting of results and sharing of data, and some assets used during the campaign have been demonstrated to improve operational skill. As in the ASIRI/BoB case, it would be reasonable to have joint or plenary discussions to further the transition of this work toward operational use.

***CalWater2/ACAPEX (Ruby Leung):***

The presentation demonstrated the primary results of the preceding observations and the motivation for the newest set in CalWater 2. The importance of atmospheric rivers in dominating the precipitation of the near-coastal region is clear after these campaigns. Dynamical aspects, such as the barrier jet, are becoming more clearly understood, with consequences for better monitoring and prediction. Long-range impact of aerosols has clear local consequences and international regulatory implications. The set of observations planned for next winter seems ready to improve the understanding further. Some key assets are only in the request or design phase, and it was the general opinion of the panel that these resources would be a valuable addition to the project.

***Stratocumulus to cumulus transition Climate Process Team (Ruiyun Sun):***

This presentation, plus the short write-up by the Donner GFDL group on their contributions to the CPT, was not a satisfying representation of the sum of the efforts. As a panel, we were unable to connect the dots between the different groups' efforts, and the work in GFS seemed to be stuck in "reinventing the wheel already in use in CAM5." However, rather than an actual technology transfer, the CFS work seems oriented toward retuning that model's clouds to make it climate-worthy rather than fundamentally reassessing its value in this role. Rather than validating the seamless prediction approach, this assessment left the panel wondering about the capability of the weather models to do climate and vice versa.

It was quite clear that panel is presently lacking expertise in this area after the departure of Teixeira and Wood (unable to attend the summit this year), and so it will be important to recruit for the panel in this regard.

***SPURS (Salinity Processes in the Upper Ocean Regional Study) (Ray Schmitt):***

This presentation covered the SPURS project in substantially more detail than in previous presentations—not surprising due to the deployment of many of the key observations between the 2012 summit and the 2013 summit. PI groups assessing their own data has provided some of the early progress already achieved. Data sharing among the groups is now beginning in earnest, and two upcoming meetings in December and at Ocean Sciences 2014 are likely to be productive. Some of the key connections still to be made are between rates of mixing and stratification changes, as well as plateau behavior in the salinity time series.

***DIMES (Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean) (Lou St. Laurent):***

Recent presentations on DIMES have focused on other aspects of the project rather than the microstructure measurements, but due to the presenter's role, this year was focused on this topic. The argument was made for highly spatially variable dissipation, giving special importance to the observations above Phoenix Ridge as compared to the mid-Pacific sites. This spatial variability is consistent with the changes observed in the rate of diapycnal spreading from the tracer release experiment. A few more microstructure cruises are planned for the near future, which will enhance this picture.

***LatMIX (Scalable Lateral Mixing and Coherent Turbulence DRI) and Related Studies (Tamay M. Özgökmen):***

The Özgökmen presentation covered both of the ONR LatMix DRI experiments, as well as touching on the industry-funded Grand Lagrangian Deployment (GLAD) experiment. These process studies focus on dispersion, spreading, and processes in the 1-100 km range of the oceanic submesoscale. It is becoming clear that these scales are nontrivially connected to the mesoscale and may substantially impact the dispersion of Lagrangian tracers and particles on these scales. Implications of these results for air-sea interaction and global scales are still in progress.

***OSNAP (Overturning in the Subpolar North Atlantic Program) & North Atlantic Bloom 2 (Baylor Fox-Kemper):***

The slides from this presentation were provided by Mary Jane Perry and mainly focused on the results of the 2008 North Atlantic Bloom project and a proposed follow-up (present status pending). Like the LatMix experiments the NABloom08 experiment showed a profound effect of the submesoscale, this time on the biophysical process (spring bloom). A coordinated effort involving meteorological conditions, ocean Lagrangian physical and biological measurements, as well as matched biophysical modeling, was able to connect the early occurrence of the spring bloom to submesoscale processes. Follow-up questions that remained were primary around the carbon and other biogeochemical export due to the bloom. Monitoring these processes would require a more ambitious set of biological observations.

OSNAP was briefly discussed, without accompanying slides. The question was raised as to what role PSMIP has in monitoring process projects so closely related to the AMOC Science Team. It was decided that such projects should be evaluated by PSMIP in the future, under request, or in consultation with the science team.

At a certain point in the discussion of NABloom 2, program managers suggested that it was not within the PSMIP terms of reference to extensively discuss particular projects that were not yet funded.

***Mixing Climate Process Team (Improving representations of internal-wave driven mixing in global ocean models) (Lou St. Laurent)***

This CPT involves the parameterization of various mixing processes in a way that is consistent with energy sources and microstructure observations. Key emphasis was placed on geographic variability of mixing depending on the intermediary process transmitting the energy (high-mode, low-mode, near field, far field, abyssal, surface, topographic). Some of the present parameterizations



and parameterizations in development were schematized. The CPT team is meeting regularly and planned meetings in January and at Ocean Sciences. This will further the cooperation among the PI groups.

***Ocean under Ice Climate Process Team ([Ocean mixing processes associated with high spatial heterogeneity in sea ice and the implications for climate models](#)) (Meibing Jin):***

This CPT presentation emphasized the CPT efforts in two categories: GCM sensitivity to parameterization changes and simulations of ice-tethered profiler observations. The approach to parameterization revolves around subdividing climate model grid cells into assorted ice and open-ocean categories, and then separately simulates each of these subgrid classes. Some parameters remain not optimized, and the work presented centered around comparing runs with different optimizations. Generally, the results in the climate models were very modest perturbations of the ice properties, while the comparisons to the ITP data showed substantial promise of the new tools—although the observations still lie far from any of the model simulations.

The project is moving to study the downstream and coupled-model changes that result from these changes to the ice model dynamics. It is unclear at this stage whether these changes are likely to be incorporated into future standard model versions.

***SAMOC ([South Atlantic Meridional Overturning Circulation](#)) (Igor Kamenkovich):***

The presentation discussed some dynamical reasons why the SAMOC differs from other parts of the AMOC observing system. The Southern Ocean overturning is quite different from the Northern Hemisphere overturning in forcing and consequences, so it was agreed that this is a rather different dataset. The observational array is quite similar to the present RAPID AMOC one in principle, and is expected to have interestingly different results.

Again, the question of the role for PSMIP in AMOC science projects was raised.

***Department of Energy Enterprise for Earth System Modeling (Dorothy Koch):***

This invited webcast was a very informative review of a newly planned DOE project to develop a new, coupled modeling system, distinct from present DOE efforts and the DOE/LANL participation in the CESM in particular. Dorothy Koch reviewed the principal scientists and the goals of the project, and the panel had many questions.

Overall, the panel agreed that the project would be an exciting new development if successful, and it is clear that there were DOE needs that are not being met by the present suite of coupled models (e.g., wind farm and hydropower forecasts). However, there were considerable concerns that 1) the project would take away resources from the present DOE commitment to climate modeling, such as the Los Alamos COSIM group's participation in the CESM model, 2) that the project goals do not feature the ocean or ocean-related variability (of particular concern to US CLIVAR), and 3) that the participation of non-DOE scientists is not intended during the early stages of development. It was agreed that DOE labs certainly have expertise, particularly in the computational side of science, which rivals or exceeds other groups. However, the scale and complexity of a coupled model requires a diversity of skills and expertise, and it was unconvincing to the panel that DOE would be successful without early and frequent input from the community.

US CLIVAR, and the PSMIP in particular, are eager to help in locating collaborators and facilitating the interaction to help this project succeed.

### *Summary of process study reviews*

Overall, the PSMI Panel agreed that the level and quality of process studies reporting has significantly improved, in terms of compliance with our best practices recommendations. It is our opinion that this compliance has improved both the science and the utility of these studies. Additionally, this regular compliance makes PSMI reviews easier.

Particular areas of past underperformance that are now routinely functional are:

- Data management & openness
- Collaboration between observationalists & modelers
- Attempt at model improvement, or propose future projects to do so

However, PSMIP believes that even higher standards may one day also become routine. No obvious patterns of repeated issues were observed across the projects this year, but future panels will remain vigilant.

Programmatically, some issues reduced the success of this year's presentations. Directives about the intent of the review and time limits were ignored or underappreciated—continued emphasis on clear directives to presenters is key. Time for next year's summit may be better, but a minimum of 30 minutes per reviewed project plus a few hours for general discussion and panel business is recommended. To this end, four projects are suggested to be removed from further review (CLIMODE, VOCALS, GOAMAZON, KESS), some projects may not need revisiting unless their funding status changes (NAbloom), and some projects should be taken on in consultation or joint session with either other panels (ASIRI/BoB & DYNAMO) or with the AMOC Science Team (SAMOC & OSNAP). It may be necessary to add more time to the summit for these joint reviews to occur, or for PSMIP to cede review to other entities (i.e., should AMOC Science Team review AMOC-related process studies?). The four page format for sunseting of projects, where KESS summary was a model, was deemed successful, as was the BAMS article plus email format of the VOCALS sunset. However, a written format for ongoing projects was less successful, due to the lessened interactivity—for these projects a teleconference is still preferred.

### *General emergent themes: Continuing process study improvements*

Can PSMI push process studies to next level of efficiency/model improvement/impact? Can US CLIVAR help process studies to next level of efficiency/model improvement/impact? To answer these questions some key follow-up issues were raised in the general discussion.

The first question was how projects should obtain funding for the "analysis tail" following a process study. It is agreed by the panel that often data is left unanalyzed or unformatted, or both, during the initial funding cycle. Is this the failure of the short timescale of funding or the PIs? Our discussion indicated that both are sometimes to blame. Sometimes, the PIs fall short of their promised deliverables, despite a reasonable window of time and resources to deliver. However, sometimes

the timing of a project, especially with regulatory or logistical delays, ends up with collected data unanalyzed at the end of the funding cycle. The funding agency representatives present suggested that in this case, additional proposals should be sent to follow-up and get this data in a usable form. However, these “analysis tail” projects should include goals beyond those of the original project and perhaps a new team of investigators, bringing new skills (e.g., statistics or modeling) to the specific problems in data analysis already identified in the initial project.

Through this discussion the sequencing of blue-sky process studies, followed by analysis, theory, and modeling becomes clearer from proposal and management perspectives. After this process, follow-up process studies are appropriate and hypotheses of sufficient clarity and achievable goals may be posed. Thus, there is a process in place to determine how often we should be going to sea and toward fostering active periods of collaboration between cruises. The PSMIP can be a helpful review body in clarifying these timescales and identifying when failures occur.

Some other repeated themes of the discussions should be summarized. Many of the successful projects that were noted by the panel involved the modeling centers—even for non-CPT projects—at an early stage in application of new understanding toward model improvement. Many of the projects had concluded with a key result—improved forecasts when the observations from the process study were assimilated into forecast models. Repeatedly, when this occurred, the PSMIP wished for joint discussion with the POS/PPAI portions of US CLIVAR to help speed the operational implementation of these results. PSMIP has repeatedly delivered in improving climate models, but a mechanism for improving operational forecast models and observational monitoring as suggested by the results of process studies is presently suboptimal within the structure of US CLIVAR. Finally, many projects in the sunset phase were concerned about continued data management and website upkeep after sunset of studies and retirement of the PIs. While no obvious solutions were found by the panel, it should remain a future effort.

### *Model improvement concerns*

Model improvement continues, but the panel did identify some areas of present concern that should be noted. The first area of concern is the present funding climate and its impact on personnel. Modeling centers presently do not have spare personnel to receive/distill/validate most process study results. The elimination of the CESM liaisons due to funding is a key sign of problems. What does this mean for community engagement? A brief email from Marika Holland to the CESM users nicely summarizes:

Dear CESM Community,

We would like to inform you of ongoing issues regarding community liaison resources for the CESM project. Due to several years of funding reductions at NCAR, including sizable base funding decreases for FY2014, liaison resources for the project have been cut substantially. Steps have been taken to minimize the impact of this on the scientific community, such as the launch of a new CESM bulletin board that facilitates user support. However, with continuing reductions in liaison resources, user support for CESM development and application activities have been reduced. We appreciate your understanding with the reduced level of support that we are now able to provide.

Note that adequately funding the community liaison resources is a high priority for NCAR and discussions are underway on how to address and further mitigate the current issues.

For more information on the current community liaison resources, please see:

<http://www2.cesm.ucar.edu/working-groups>

Note that many of the resources listed here only work in a liaison capacity on a part-time basis.

Sincerely,  
Marika Holland  
CESM Chief Scientist

Another cause of enthusiasm and concern is the Department of Energy transformation of coupled modeling efforts. It is an exciting prospect to have a new-coupled model effort in the US. However, the fact that no additional funds are being drawn into the effort raises concerns that there will be an inevitable drawdown of ongoing DOE efforts in climate modeling, in particular their participation in community efforts such as the CESM. The development model DOE is planning is also more isolated from the community than other US coupled modeling efforts. How will the scientific community/process studies/parameterization developers be engaged? Where will the funds for this engagement be found? Finally, it is obviously the business of DOE to develop the model it needs for its purposes if the community modeling effort is not addressing these issues. However, one would hope that synergy would arise where the scientific goals of the DOE effort might also provide a tool that could be adapted beyond the needs of DOE. At present, there was concern that the oceans were not a significant concern for the DOE effort, which puts this model outside of the interests of US CLIVAR. The PSMIP would have been much happier if some of the science goals of the project had mentioned air-sea interaction or simulations over sufficiently long timescale to address interannual and decadal variability.

### *Summary and conclusions*

Overall, it is increasingly clear that the PSMI community appreciates the role of US CLIVAR and the PSMI Panel in increasing skill and the likelihood of process studies leading to model improvements. But, PSMIP can do better! Big challenges lie ahead, such as the continued funding difficulties, DOE coupled modeling transformation, transition to higher resolution at modeling centers and the new

parameterizations this requires, and the growing appreciation and demonstration through process studies of important smaller scales that will challenge future observations and models.

### *List of action items*

1. Review and revise the PSMI ToR for consistency with the new Science Plan.
2. Future process study reviews might request a “Nature Figure” rather than a long list of slides, that could be used in future publications and serve as a focal point for PSMI discussions.
3. The next best practices document should cover metrics and demonstration of impact of particular processes.

### 3.3 PPAI Panel Breakout

#### *Summary of action items from 2012 Summit and update on progress*

1. Develop a special session on the National Climate Assessment (NCA) to investigate common synergies (during next year's summit).  
*Status: Complete. Had a special session related to NCA during 2013 CLIVAR Summit in Annapolis.*
2. Recommend existing Working Groups to explore contributions to NCA Topical reports on: state of knowledge of interest to NCA; observational needs for NCA; etc.  
*Status: This recommendation was not followed up on.*
3. Review recommendations that will be in the NCA final report and their connection with CLIVAR science foci.  
*Status: Complete. Many members of the PPAI (and members from other panels) participated in the NCA process, and review of various NCA reports and documents.*
4. Possible application workshop (action from the last year) with NCAR/CESM "Social Dimension" group, RISAs, etc.  
*Status: This recommendation was not followed up on. The idea was brought up during the 2012 summit when a panel member provided the information about the formation of a CESM (Community Earth System Model) "Social Dimension" working group.*
5. Explore CLIVAR connection with the climate service organizations and centers, e.g., DOI Climate Services Centers, RISAs, etc.  
*Status: Complete. Had an invited presentation by Robin O'Malley from USGS/DOI on activities at "Climate Services Centers".*
6. Recommend a science team on "decadal predictions and predictability."  
*Status: Complete. The concept of "Decadal Predictions and Predictability" was discussed after 2012 summit but a formal request to agencies was not made. With encouraging signs from the funding agencies about formation of science teams during 2013 summit, we may follow up on this.*
7. Recommendation to the WGCM or US Modeling Centers on better practices for data availability.  
*Status: Complete. Issues about data availability of CMIP5 archive was communicated to the WGCM and US modeling centers.*
8. CLIVAR Webinars in between two summits.  
*Status: Although PPAI panel has business conference calls between 2012 and 2013 summits, no formal webinars were held. The proposed concept was to follow the format of MAPP webinars.*
9. CLIVAR to provide reviews to various US science plans .  
*Status: Complete. Panel members were either involved in the completion of the CLIVAR Science Plan or provided reviews for the draft version.*



10. NMME – A overview paper in US CLIVAR *Variations*.

*Status: Complete. Instand in "CLIVAR Variations" an overview paper on NMME will appear in BAMS.*  
<http://dx.doi.org/10.1175/BAMS-D-12-00050.1>

11. Develop metrics of success for US CLIVAR output and accomplishments.

*Status: This was not followed up. The idea came in 2012 summit to develop "metrics of success" for US CLIVAR output and accomplishments. It would be good to revisit for US CLIVAR as a whole.*

12. Update ToR.

*Status: Discussed updating ToR during the 2013 panel breakout panel, and will follow up via emails or conference calls.*

### **Objectives for the panel meeting**

The breakout panel agenda was divided into one introductory session and two special sessions. The introductory session focused on summarizing PPAI activities since the 2012 summit and the focus of 2013 breakout session.

One of the focused sessions was a joint session with the POS panel on reanalyses and focused on the 'State Estimation and Prediction.' The aim of this session was to identify and prioritize strategies that aid in the use of reanalyses in "Quantifying improvements in predictions" [Cross Cutting Strategy 4 (CCS4)]. The main goals of these strategies are the following:

- Better quantify uncertainty in the underlying observations and underlying models within the reanalyses [CLIVAR Strategic Plan (CSP) Goal 3]
- Better quantify uncertainty in simulations and predictions initialized from reanalyses (CSP Goal 3)
- Improve the evaluation of climate simulations using the reanalyses (CSP Goal 4)
- Collaborate with research and operational communities that develop observations and models used within reanalyses to improve model evaluation, simulation, and prediction (CSP Goal 5)

The second session focused on "Communication and Decision Support" and was to identify and prioritize strategies that aid in the development of appropriate "Communication of Climate Research" (CCS5). The main goals of discussed strategies are the following:

- Better quantify uncertainty in predictions and projections of climate processes, patterns and parameters to which social, natural, and/or economic system are most sensitive (CSP Goal 3)
- Identify, evaluate, and develop improved climate-prediction metrics for applications-based use (CSP Goal 4)
- Collaborate with research and operational communities that develop climate and use climate model information to i) raise awareness and understanding of vulnerability and sensitivity of human systems to climate variability and change; and ii) to improve dissemination and adoption of climate predictions and accompanying uncertainties (CSP Goal 5).

***PPAI Panel Terms of Reference:***

- Review, prioritize, and coordinate US plans to characterize predictability, and demonstrate improved prediction capabilities, on sub-seasonal, seasonal, interannual, decadal, and century and longer time scales as necessary to achieve the goals of CLIVAR.
- Interface with agency and CCSP activities and groups (e.g., NOAA-NMFS, IRI, and RISAs; NASA-RESACs, RACs, and ESIPs) to identify user requirements for useful climate information, improve the communication of these requirements, and encourage development of appropriate tools and approaches for improved decision support capabilities.
- Coordinate US efforts to insure advances in prediction research have appropriate connections and pathways into operational forecast system development.

***PPAI Motivating Questions:***

- How are improvements to prediction capability measured? What other useful measures could be employed? How well are metrics identified through US CLIVAR efforts used for predictive model evaluation?
- How should uncertainty in predictive information be quantified to be of use?
- How well do research advances in model development and predictive capability transfer to operational forecast system development. What are the impediments, if any, to such transfer? How can the transfer be improved?
- What are effective and useful ways to interface with applications? How do we determine which application topics to engage? What outcomes are desired through such interaction?
- How does the panel encourage development of appropriate tools and approaches for improved decision support capabilities?
- Are there recommended changes to the PPAI Panel terms of reference to reflect the goals and cross-cutting strategies of the new Science Plan?

***Inter-Panel Interaction:***

- Do POS and PPAI see that work by PSMI has supported or guided their own efforts?
- Does PSMI ask POS and PPAI for inputs on what processes need to be researched and improved in models?
- Does PPAI identify processes and parameterizations that are poorly understood and/or sources of model error and inform PSMI?
- Should the Panel, Working Group, and CPT structure and approach be changed or refined to promote such interactions?

***Summary of each panel session (in order of the agenda) summarizing key points of presentations, discussion, and any suggested action items***

***MAPP activities and Task Force summary (Annarita Mariott):***

The mission of the MAPP program aligns well with the PPAI ToR to “characterize predictability, and demonstrate improved prediction capabilities, on sub-seasonal, seasonal, S-I, decadal, and century and longer time scales.”

The highlight of the presentation was the concept of a Task Force (TF) organized by the MAPP program whereby PIs working on a common thematic area participate in an organized activity to share results, and

also advance summary papers. Three TFs that are currently active are related to drought; climate predictions, and climate variability over North America in CMIP5 simulations. The concept of a TF is similar to the concept of Science Teams but only within NOAA Climate Program Office funded proposals.

#### ***Joint session with POS on reanalysis***

Summary should be available as part of the POS panel breakout summary. During this session Arun Kumar provided a summary of the “GSOP Ocean fluxes workshop.”

#### ***Status of NMME (Jin Huang):***

NMME is an interagency supported program that brings in seasonal forecasts run at different centers to the Climate Prediction Center (CPC) to advance operational seasonal forecasting capability. The seasonal forecast data archives from different forecasts systems are publicly available for prediction and predictability research, and should enable advancement in our understanding. Future plans of NMME include extending to sub-seasonal prediction time scale.

#### ***Role of CLIVAR science and decision making (Lisa Goddard):***

Dr. Lisa Goddard, the outgoing Chair of US CLIVAR SSC gave a presentation highlighting the gap between the CLIVAR science and decision making process. The talk stressed that (a) advances in science are outpacing their use in decisions making, and (b) the challenge of developing adequate pathways from forecast providers (CLIVAR) to decision makers (users).

#### ***Role of CLIVAR science and service (Robin O’Malley):***

This talk focused on the status of Climate Science Centers (CSCs) that have been initiated by the Department of Interior/USGS. The presentation stressed that the research and developmental work at CSCs is driven by the premise of addressing management challenges for specific questions, and the research agenda is shaped as such. The focus of CSCs is on actionable science required in the context of providing support for management decisions. The surprising point of the talk was CSC’s focus on climate science information in support of management decisions with a 30-40 year time horizon. However, predictive information on shorter time scale (1-20 years) would also be welcome. In hindsight, this presentation would have been very appropriate as part of a plenary session.

#### ***Applications Process Teams (APTs) – Are they the right tool for improved decision support capabilities? (Gregg Garfin):***

The last talk in the breakout session discussed the concept of APTs along the lines of the concept of Climate Process Teams (CPTs). The purpose of the APTs will be to enhance collaboration between US CLIVAR science community and the application communities, and to help facilitate and organize communication between the two.

#### ***Potential topics for inter-panel coordination***

Following the charge given to the panels, potential topics for inter-panel coordination were discussed and noted. These include:

- Seek input from other panels while revising PPAI ToR
- Coordinate with POS on reanalysis strategy and foci
- In consultation with other panels, inform on observing systems requirements necessary to maintain, and enhance, prediction skill (e.g., tropical Pacific)

## *Review of panel terms of reference*

There was a short discussion on the reviewing the current ToR for the PPAI panel. However, the panel felt that the time available was not enough for a comprehensive review, and suggestion for changes. There was a consensus to complete this task via email, and if needed, via a teleconference.

## *Summary and conclusions*

Overall, PPAI breakout panel was successful in reaching its goals of summarizing and reviewing activities since the last summit and focusing on some high priority areas that will be part of the upcoming US CLIVAR Science Plan. Action items for the coming year are listed below.

## *List of action items*

1. Review and revise PPAI ToR for consistency with the new Science Plan.
2. Lay groundwork for a US CLIVAR Workshop on “Connecting Predictions and Applications,” including:
  - Liaising with appropriate boundary organizations (e.g., USGS, NOAA, DOE, etc.);
  - Developing a thematic paper on current challenges facing “Pathways to Operations” for inclusion in US CLIVAR Variations;
  - Hosting a plenary session on “Communication and Decision Support” at 2014 Summit; and
  - Schedule gathering of US CLIVAR and application community to discuss and better understand future research requirements.
3. Promote to funding agencies the concept of CMEP like activity for assessment of seasonal predictability & predictions using NMME data sets.
4. Promote to funding agencies a Science Team on “Natural and Societal Impacts of Decadal Climate Variability: Predictability and Predictions,” including:
  - Development of a concept paper based upon AGU session talks on this topic;
  - Presentation of a concept paper to US CLIVAR SSC for feedback;
  - Schedule a workshop with funded researchers and funding agency heads; and
  - Propose a Science Team at 2015 Summit.
5. Scope the concept for the Application Process Teams (APT) before the 2014 Summit, including:
  - Development of a white paper based upon Garfin and Ray presentation;
  - Presentation of white paper to US CLIVAR SSC for feedback; and
  - Propose an APT framework at 2014 Summit.
6. Develop additional thematic papers on current challenges for inclusion in US CLIVAR Variations such as communication and utilization of uncertainty in decision-making or predictability of high latitude climate variability.

# Appendix A: Organizers

## SCIENTIFIC STEERING COMMITTEE

**Bob Weller, Chair**

Woods Hole Oceanographic Institution

**Arun Kumar, Co-Chair**

NOAA National Centers for Environmental Prediction

**Janet Sprintall, Co-Chair**

University of California San Diego/Scripps Institution of Oceanography

**Bruce Anderson**

Boston University

**Mike Bosilovich**

NASA Goddard Space Flight Center

**J. Tom Farrar**

Woods Hole Oceanographic Institution

**Baylor Fox-Kemper**

Brown University

**Dimitris Menemenlis**

NASA Jet Propulsion Laboratory

## PROJECT OFFICE

**Mike Patterson**

**Jennifer Mays**

**Jill Reisdorf**

## Appendix B: Agenda

Tuesday, July 9		
Time	Agenda	Location
0730 – 0800	Check-in	Atrium
0800 – 0815	Welcome, Introductions, Meeting Objectives & Outcomes (Bob Weller)	Ballroom C
0815 – 0830	US CLIVAR Overview (Mike Patterson)	Ballroom C
0830 – 0930	US CLIVAR Science Plan (Lisa Goddard)	Ballroom C
0930 – 1000	International CLIVAR Program Update (Lisa Goddard & Anna Pirani)	Ballroom C
1000 – 1030	Coffee break	Atrium
1030 – 1130	US Agency Engagement (Eric Lindstrom, Eric Itsweire, Rick Rosen, & Dan Eleuterio)	Ballroom C
1130 – 1200	Research Challenges (Jay McCreary & Janet Sprintall)	Ballroom C
1200 – 1315	Working lunch	Loews (TBD)
1315 – 1500	<u>Science Team and Working Group Reports</u> (20 min each) US AMOC Science Team (Jim Carton) Decadal Predictability WG (Lisa Goddard) High Latitude Surface Flux WG (Mark Bourassa) Greenland Ice Sheet/Ocean Interactions WG (Olga Sergienko) Southern Ocean Heat & Carbon Uptake WG (Joellen Russell)	Ballroom C
1500 – 1520	Coffee break	Atrium
1520 – 1700	Ocean Carbon Uptake in CMIP5 Models WG (Annalisa Bracco by phone) Hurricanes WG (Suzana Camargo) Extremes WG (Matt Barlow) ENSO Diversity WG (Antonietta Capotondi) Eastern Tropical Ocean Synthesis WG (Simon de Szoeke)	Ballroom C
1700 – 1730	Inter-Panel Interaction (Bob Weller & Panel Co-chairs)	Ballroom C

Wednesday, July 10		
Time	Agenda	Location
0730 – 0800	Refreshments	Atrium
0800 – 0830	Charge to the Panel Breakouts (Bob Weller)	Ballroom C



0830 – 1200	Panel Breakouts (break at 1000) Phenomena, Observations & Synthesis (POS) Process Study Model Improvement (PSMI) Predictability, Predictions & Applications Interface (PPAI)	Powerhouse Breakout Rooms
1200 – 1330	Lunch on your own	
1330 – 1730	Breakouts Resume (break at 1500)	Powerhouse Breakout Rooms
1730	Break for day; Dinner on your own	

### Thursday, July 11

Time	Agenda	Location
0730 – 0815	Refreshments	Atrium
0815 – 0830	DoE Funding Agency Engagement (Renu Joseph)	Ballroom C
0830 – 0930	Panel Breakout Summaries & Action Items (Panel Co-chairs, 15 min each plus 5 min Q&A)	Ballroom C
0930 – 1000	Cross-Panel Interaction (Bob Weller & Panel Co-chairs)	Ballroom C
1000 – 1030	Coffee break	Atrium
1030 – 1130	National Climate Assessment (Fred Lipschultz & Yan Xue)	Ballroom C
1130 – 1200	Conclusions and Wrap-up (Bob Weller)	Ballroom C
1200	Summit Adjourns	
1230 – 1700	US CLIVAR SSC Meeting (Thursday PM & Friday AM)	Mainsail

### POS Panel Breakout Powerhouse Breakout Rooms Wednesday, July 10

Time	Agenda
0830 – 0845	Welcome and introductions (Michael Bosilovich)
0845 – 0900	Summary of last year's POS activities and POS panel breakout aims (Dimitris Menemenlis)
0900 – 1000	Session 1: Observations, science, and society (Michael Bosilovich)
0900 – 0920	Building forward from OceanObs'09: Integrated Ocean Observing System (IOOS) and Framework on Ocean Observing (FOO) (Eric Lindstrom)
0920 – 0940	Status of understanding observable modes of climate variability. What's missing? (Art Miller)
0940 – 1000	Status of understanding and modeling extremes in temperature and precipitation (Matt Barlow)

1000 – 1030	Coffee break
1030 – 1200	Session 2: Joint session with PPAI on reanalysis and surface fluxes (Bruce Anderson)
1030 – 1045	Summary of November 2012 Ocean Synthesis and Air-Sea Flux Evaluation Workshop (Arun Kumar)
1045 – 1100	Summary of July CLIVAR GSOP/GODAE Ocean Reanalysis Intercomparison Workshop (Jim Carton)
1100 – 1115	Links with land surface (Alexander Gershunov)
1115 – 1130	Toward budget conserving coupled ocean-atmosphere-ice reanalyses (Dimitris Menemenlis)
1130 – 1145	Initialization of seasonal predictions (Yan Xue)
1145 – 1200	What does US CLIVAR need from reanalyses and next steps for US CLIVAR engagement (Michael Bosilovich)
1200 – 1330	Lunch on your own
1330 – 1600	Session 3: Role of satellite data in the climate observing system (Dimitris Menemenlis)
1330 – 1345	Polar Climate (Xiangdong Zhang)
1345 – 1400	Sea level and review of WCRP/International CLIVAR Grand Challenge white paper (Don Chambers)
1400 – 1420	Satellite observations and continuity issues (Xiao-Hai Yan)
1420 – 1440	Water cycle missions and decadal survey (Jared Entin)
1440 – 1500	DoE Integrated Water Cycle Workshop (Ruby Leung)
1500 – 1520	Coffee break
1520 – 1600	Obs4MIPS (Duane Waliser)
1600 – 1700	Session 4: Tropical variability and observations (Michael Bosilovich)
1600 – 1620	Measurements needed in Tropical and Equatorial Pacific for understanding ENSO diversity (Antonietta Capotondi)
1620 – 1640	Upper ocean processes with focus on GDP and tropical moored arrays (PIRATA, TAO, RAMA) (Rick Lumpkin)
1640 – 1700	TAO array and NCEP-GFDL project on TAO Observing System Experiments (Yan Xue)
1700 – 1730	Wrap up (Mike Bosilovich & Dimitris Menemenlis)
1730	Break for day; Dinner on your own

**PSMI Panel Breakout  
Powerhouse Breakout Rooms  
Wednesday, July 10**

<u>Time</u>	<u>Agenda</u>
0830 – 0845	Introductions, orientation, breakout aims (Baylor Fox-Kemper)
0845 – 0900	KESS Discussion, written
0900 – 0915	CLIMODE Discussion, written
0915 – 0930	VOCALS, written
0930 – 0945	GO Amazon, written
0945 – 1000	Discussion – Goals & Fundamental Science Questions (Baylor Fox-Kemper)
1000 – 1020	Coffee break
1020 – 1040	ASIRI/Bay of Bengal (Bob Weller)
1040 – 1100	DYNAMO (Augustin Vintzileos)
1100 – 1120	CalWater2/ACAPEX (Ruby Leung)
1120 – 1145	Stratocumulus to cumulus transition CPT (Ruiyun Sun)
1145 – 1200	Discussion
1200 – 1315	Lunch on your own
1315 – 1340	SPURS (Ray Schmitt)
1340 – 1405	DIMES (Lou St. Laurent)
1405 – 1430	LatMIX (& related, e.g., GLAD) (Tamay Ozgokmen)
1430 – 1445	OSNAP & NA Bloom2 (Baylor Fox-Kemper)
1445 – 1500	Discussion
1500 – 1520	Coffee break
1520 – 1545	Mixing CPT (Lou St. Laurent)
1545 – 1610	Ocean under Ice CPT (Meibing Jin)
1610 – 1625	SAMOC (Igor Kamenkovich)
1625 – 1640	DoE Enterprise for Earth System Modeling (Dorothy Koch & Bill Collins by phone)
1640 – 1730	Discussion
1730	Break for day; Dinner on your own

**PPAI Panel Breakout  
Powerhouse Breakout Rooms  
Wednesday, July 10**

<u>Time</u>	<u>Agenda</u>
0830 – 0845	Welcome to new members, go around
0845 – 0900	Summary of last year’s PPAI activities (Arun Kumar)
0900 – 0915	Summary of this year’s Agenda: “A return to basics” (Bruce Anderson & Arun Kumar)
0915 – 0930	Goals of Session 1- “State estimation and Prediction” (Bruce Anderson & Arun Kumar)
0930 – 1000	MAPP activities and Task Force Summary (Annarita Mariotti by phone)
1000 – 1030	Coffee break
1030 – 1200	Joint session with POS on reanalysis and surface fluxes
1030 – 1045	Summary of November 2012 Ocean Synthesis and Air-Sea Flux Evaluation Workshop (Arun Kumar)
1045 – 1100	Summary of July CLIVAR GSOP/GODAE Ocean Reanalysis Intercomparison Workshop (Jim Carton)
1100 – 1115	Links with land surface (Alexander Gershunov)
1115 – 1130	Toward budget conserving coupled ocean-atmosphere-ice reanalyses (Dimitris Menemenlis)
1130 – 1145	Initialization of seasonal predictions (Yan Xue)
1145 – 1200	What does US CLIVAR need from reanalyses and next steps for US CLIVAR engagement (Michael Bosilovich)
1200 – 1330	Lunch on your own
1330 – 1400	Goals of Session 2- “Communication and Decision Support” (Bruce Anderson & Arun Kumar)
1400 – 1430	Status of NMME (Jin Huang)
1430 – 1500	Role of CLIVAR Science and Decision-making (Lisa Goddard)
1500 – 1530	Coffee break
1530 – 1600	Role of CLIVAR Science and Service (Robin O’Malley)
1600 – 1700	Applications Process Teams (APTs) – Are they the right tool for improved decision support capabilities? (Gregg Garfin)
1700 – 1730	Wrap up

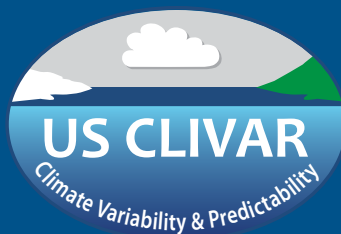
## Appendix C: Participants

First Name	Last Name	Affiliation
Bruce	Anderson	Boston University
Anjali	Bamzai	National Science Foundation
Matt	Barlow	University of Massachusetts-Lowell
Anthony	Barnston	Columbia University/International Research Institute for Climate and Society
Daniel	Barrie	NOAA Climate Program Office
Michael	Bosilovich	NASA Goddard Space Flight Center
Mark	Bourassa	Florida State University
Suzana	Camargo	Columbia University/Lamont-Doherty Earth Observatory
Antonietta	Capotondi	University of Colorado/NOAA Earth System Research Laboratory
James	Carton	University of Maryland
Don	Chambers	University of South Florida
Judah	Cohen	Atmospheric and Environmental Research, Inc.
William	Collins	Lawrence Berkeley National Laboratory
Simon	de Szoeki	Oregon State University
Eric	DeWeaver	National Science Foundation
Jared	Entin	National Aeronautics and Space Administration
Baylor	Fox-Kemper	Brown University
Gregg	Garfin	University of Arizona
Alexander	Gershunov	University of California-San Diego/Scripps Institution of Oceanography
Alessandra	Giannini	Columbia University
Lisa	Goddard	Columbia University/International Research Institute for Climate and Society
Wayne	Higgins	NOAA Climate Program Office
Jin	Huang	NOAA National Centers for Environmental Prediction
Eric	Itsweire	National Science Foundation
Meibing	Jin	University of Alaska, Fairbanks
Renu	Joseph	US Department of Energy
Igor	Kamenkovich	University of Miami
Jennifer	Kay	National Center for Atmospheric Research
Hyemi	Kim	Stony Brook University
Dorothy	Koch	Columbia University

Arun	Kumar	NOAA National Centers for Environmental Prediction
Ruby	Leung	Pacific Northwest National Laboratory
Gad	Levy	NorthWest Research Associates
Ron	Lindsay	University of Washington
Eric	Lindstrom	National Aeronautics and Space Administration
Fredric	Lipschultz	US Global Change Research Program
Sandy	Lucas	NOAA Climate Program Office
Richard (Rick)	Lumpkin	NOAA Atlantic Oceanic and Meteorological Laboratory
Annarita	Mariotti	NOAA Climate Program Office
Jennifer	Mays	US CLIVAR Project Office
Julian	McCreary, Jr.	University of Hawaii
Dimitris	Menemenlis	NASA Jet Propulsion Laboratory
Arthur	Miller	University of California-San Diego/Scripps Institution of Oceanography
Robin	O'Malley	US Geological Survey
Tamay	Ozgokmen	University of Miami
Michael	Patterson	US CLIVAR Project Office
Kathleen	Pegion	University of Colorado/NOAA Earth System Research Laboratory
Anna	Pirani	International CLIVAR Project Office
Andrea	Ray	NOAA Earth System Research Laboratory
Jill	Reisdorf	University Corporation for Atmospheric Research
Joellen	Russell	University of Arizona
Raymond	Schmitt	Woods Hole Oceanographic Institution
Olga	Sergienko	Princeton University
Janet	Sprintall	University of California-San Diego/Scripps Institution of Oceanography
Louis	St. Laurent	Woods Hole Oceanographic Institution
Cristiana	Stan	George Mason University
Aneesh	Subramanian	University of California-San Diego/Scripps Institution of Oceanography
Liqiang	Sun	North Carolina State University/NOAA National Climatic Data Center
Petrus (Peter)	van Oevelen	International GEWEX Project Office
Augustin	Vintzileos	NOAA Climate Prediction Center
Duane	Waliser	NASA Jet Propulsion Laboratory
Robert	Weller	Woods Hole Oceanographic Institution
Yan	Xue	NOAA National Centers for Environmental Prediction
Xiao-Hai	Yan	University of Delaware
Xiangdong	Zhang	International Arctic Research Center



**For more information visit  
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