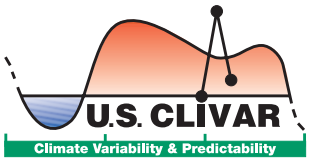


U.S. CLIVAR: Climate Variability and Predictability

U.S. CLIVAR 2011 Summit Report
Woods Hole, MA
18-21 July, 2011

July 2012

U.S. CLIVAR Report
No. 2012-3

July 2012

U.S. CLIVAR
Project Office
Washington, DC

BIBLIOGRAPHIC CITATION: U.S. CLIVAR Project Office, 2012: 2011 U.S. CLIVAR Summit Report, Report 2012-3, U.S. CLIVAR Project Office, Washington, DC 20006, 32 pp.

U.S. CLIVAR 2011 Summit Report

U.S. CLIVAR 2011 Summit Report

1 Action Items

Action item 1: POS to prepare an announcement of the May 2012 Reanalysis conference for posting on U.S. CLIVAR website.

Action Item 2: POS was encouraged to comment on the framework approach, and how it would dovetail with the activities of one's own organization.

Action Item 3: The TRACE workshop summary is available at www.trace-rhp.org. POS will review the report, aiming to refine the broad goals and objectives of TRACE to encourage complementary activities and collaborations where appropriate (POS and PPAI co-chairs, and other interested U.S. CLIVAR panelists)

Action Item 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 U.S. CLIVAR in fall 2011.

Action Item 5: POS recommended that Simon deSzoke contact potential participants and determine how much community interest there is in going forward with a Working Group proposal.

Action Item 6: POS Panel proposes writing a letter of support to International CLIVAR towards improving the availability of ocean reanalyses in real-time.

Action Item 7: POS to develop a prospectus for a working group in collaboration with PPAI (with possibly also some links to the ENSO Diversity working group).

Action Item 8: Nick Bond was encouraged to draft an outline for a prospectus to be circulated amongst the POS Panel in fall 2011, focusing on the specific issues/activities that would be undertaken.

Action Item 9: PSMI Panel will propose a Southern Ocean U.S. CLIVAR working group in the Fall.

Action Item 10: The workshop on 'Physics of Weather and Climate Models' will produce a report with recommendations that will be submitted for publication in BAMS, which will discuss the issue of 'Best Practices for Parameterization.'

Action Item 11: PSMI Panel will get in touch with DIMES PIs to clarify situation regarding archiving of microstructure observations.

Action Item 12: PPAI to propose a Working Group on the "Large-scale climate patterns responsible for climate extremes"

Action Item 10: PPAI members Annalisa Bracco and Curtis Deutsch to propose a joint Working Group on the "Climate and Carbon"

Action Item 11: PPAI members to resubmit a Working Group prospectus on "Sea-ice variability"

Action Item 12: PPAI encourages Stan to propose a Working Group on "Decadal Variability in the North Pacific"

Action Item 13: PPAI to explore the possibility to organize a Summer Colloquium in conjunction with the ASP on 'Climate and Carbon"

Action Item 14: PPAI to propose organizing a workshop focused on interfacing U.S. CLIVAR with Applications.

2 Welcome and Introductions

Lisa Goddard welcomed the Panelists, SSC members, agency managers and project office staff to the 2011 U.S. CLIVAR Summit in Woods Hole, Massachusetts. She provided an overview of the U.S. CLIVAR Program, orienting new members and updating on recent activities and accomplishments.

Mike Patterson briefed on the objectives and agenda for the joint science session with the Ocean Carbon Biogeochemistry (OCB) Program focused on Climate and Ocean Carbon. The session is designed to explore what U.S. CLIVAR can contribute to OCB research objectives and what OCB can contribute to advance U.S. CLIVAR's. Seven invited talks present science issues of common interest addressing the following motivating questions:

- How do changes in the physical ocean circulation and heat content affect the magnitudes and distributions of ocean carbon sources and sinks on seasonal to centennial time scales?
- What are the coupled physical/biogeochemical processes and feedbacks that contribute to determining the future state of heat and carbon sources and sinks and ecosystem structure?
- What will be the future atmospheric concentrations of carbon dioxide, methane, and other carbon-containing greenhouse gases, and how will marine carbon sources and sinks change in response to anthropogenic forcing in the future?

The session is intended to generate potential collaborative research topics, identifying near and long-term objectives; recommend potential focused meetings or workshops; and encourage PI groups to form and generate working group prospectus proposals for submission in Fall for joint consideration by U.S. CLIVAR and OCB.

The Panels convened for an hour to identify priority ideas of common interests between OCB and their Panel that would be important to address during the joint Scientific Session. The POS Panel identified ocean heat transport in eastern tropical basins (tracers would help resolve), coastal upwelling (importance of local forcing and processes of water transport), and the need for more sophisticated biogeochemical model requirements for verification as priorities. PSMI's interests lay in improved process understanding of air-sea interactions, mesoscale ocean mixing, and Southern Ocean atmospheric dynamics/ocean mixing/carbon uptake. PPAI focused on global general circulation and carbon uptake, air-sea exchange and ocean mixing, and the use of biological system indicators.

3 Update of current U.S. CLIVAR Themes

3.1 *Extremes Theme*

Mike Spall moderated the plenary discussion on U.S. CLIVAR's progress in extremes and polar climate, two themes from last year's Summit. Each Panel was asked to comment on activities this past year related to these themes. Arun Kumar, PPAI co-chair, mentioned PPAI's involvement with NCAR and their joint Advanced Study Program (ASP) held on the Statistical Assessment of Extreme Weather Phenomena Under Climate Change. During the ASP, U.S. CLIVAR members held a one-week workshop on extremes for 25-30 students together with expert speakers from diverse backgrounds including climate modelers, statisticians, and applications scientists involved in water management, energy, agriculture and infrastructure. A key focus that emerged during the

week was the importance of multivariate extremes. A summary report is in progress for publication in the Bulletin of the American Meteorological Society (BAMS) or the American Geophysical Union (AGU) newsletter, EOS. As a follow on activity, PPAI is exploring the possibility of an extremes working group.

Molinari, International CLIVAR Project Office (ICPO) Director, stated that a focus on extremes provides a great intersection and collaboration for International and U.S. CLIVAR. However, both groups need to do a better job of managing and defining extremes. Following on the ASP Colloquium, one definition could focus on users and what the users need for forecasting such as extreme rainfall, temperature, and surface winds in terms of energy. Kumar noted that during the ASP Colloquium drought was not a key point of the discussion. Spall inquired whether or not a specific time scale emerged from the application side during the workshop. A few time scales came into play during the workshop, but mostly the weather scale. However, some discussion associated with large-scale variations did occur.

Richard Grotjahn reminded everyone of the conference next year in China on Extreme Climate Events and High Impact Weather, sponsored by IUGG. One action item from the Summit could be a discussion with International CLIVAR about co-sponsorship of this meeting.

Further discussion ensued on how to focus extremes as a theme. The Drought Interest Group has an existing structure and will continue. But a new extremes group could focus on heavy precipitation events and/or heat waves. There are potentially other dynamic pieces that are ready to exploit. Matt Barlow stated that often scientists try to predict the mean value. Climate models provide the mean value, but there is no reason that scientists cannot predict what the variance of the prediction is. This would be especially relevant for extremes as there is interest in the distribution of variance and skewness, not just the mean state. Models could provide this output at a course resolution over the ocean though higher resolution may be needed at the coastal regions.

Balaji is currently working on drought conditions and linkage to the Western Water Assessment. In particular he is focused on the result of extreme waves on coastal erosion and change in frequency of rogue waves as result of climate change. In both cases, climate model outputs are inadequate.

3.2 *Polar Climate Theme*

With respect to the theme of polar climate, PPAI members reminded the group of the proposed Sea Ice Working Group which is currently being revamped after receiving suggestions and recommendations from the U.S. CLIVAR Scientific Steering Committee. PPAI was asked if there are enough resources and Panel members to focus on polar climate in their Panel. Kumar replied that sea ice expertise was not as important as finding the intersection between sea-ice and PPAI. The Working Group would be focused on predictability and application interface as there are multiple issues with predictability of sea ice on all time scales.

Lindsay reminded everyone of the Study of Environmental Arctic Change (SEARCH) outlook, which makes predictions of mean sea ice estimates. A NOAA workshop will be held in September regarding the prediction of sea ice at all time scales. A recommendation was made that U.S. CLIVAR interact with the workshop organizers and SEARCH as well.

Spall questioned why the Panels have not made more progress in these themes. The previous Summit yielded much discussion on these themes, but there was very little action following the Summit. Panel members disagreed with the statement of little action. Joellen Russell, PSMI Panel, pushed forward with her research community on ideas regarding subtropical cells that stemmed from last year's Summit. While the progress in research did not stem directly from the Panel, the ideas were definitely generated as a result of the Summit. Most agreed that the organization of U.S. CLIVAR should generate momentum on research topics that resonate well with the agencies. The Panels do not have to carry out the work on these topics. This is the innate difference between the Panels and the Working Groups.

Spall concluded the discussion by encouraging the Panels in their breakouts to consider the current U.S. CLIVAR themes, whether or not they need redefining, if they are necessary to the program, and/or if new themes are needed.

4 Working Group Reports

4.1 *Decadal Predictability Working Group*

Arun Kumar, co-chair of the Decadal Predictability Working Group (DPWG), provided a summary of the group's activities for the previous year as well as background information on the formation of the Working Group. He noted the climate system has internal, natural variability, which exhibits considerable influence over the decadal climate signal. Because of this, the WG set out to define a framework to distinguish natural variability from anthropogenically forced variability on a decadal time scale for the purpose of assessing the predictability of decadal-scale climate variations. The WG also aimed to develop a set of metrics that can be used to assess and validate initialized decadal climate predictions and simulations. The WG holds regular teleconferences and has met three times over the past two years in pursuit of their goals. The first WG paper was published in the Bulletin of American Meteorological Society (BAMS) in July 2011 entitled "Distinguishing the Roles of Natural and Anthropogenically Forced Decadal Climate Variability".

Currently, there is a huge effort under CMIP5 and IPCC AR5 initiatives to perform initialized decadal runs, and thus the WG will be working on developing a set of metrics from these runs. The 2nd WG paper will focus on the development of metrics for the assessment of these initialized decadal prediction efforts. Several WG members will also participate in writing the AR5 chapter on short-term prediction of climate. Towards the framework for assessing initialized hindcasts, the WG will be looking at several questions including:

- Do the initial conditions in the hindcasts lead to more accurate predictions of the climate?
- Is the model's ensemble spread an appropriate representation of forecast uncertainty on average?
- In the case that the forecast ensemble does offer information on overall forecast uncertainty, does the forecast-to-forecast variability of the ensemble spread carry meaningful information?

The remainder of the WG lifetime will be focused on initiating work on the third and final paper which will assess the modes of climate variability (that provide basis for decadal prediction) in climate models. Towards this effort, U.S. CLIVAR through the DPWG, and with the support of U.S. agencies, initiated a call for Proposals for Analysis of Climate Model Simulations for the

IPCC Fifth Assessment Report (CMEP 2011). These small grants were awarded the summer of 2011 to promote diagnostic analysis of decadal simulations and for studies of late 19th - 20th century simulations through intercomparisons and comparisons with observations. The call encouraged analysis of initialized decadal hindcasts and predictions for predictability studies of the climate system on interannual to decadal time scales. Results will be presented at the CMIP 5 workshop to be held in Hawaii, March 2012. Many DPWG members will attend.

During discussion a question was raised about the existence of a compilation of observational data that are available and which data the WG used. The WG did not compile a new data set to use, merely used what currently exists. As the group gets more into the validation, they will start to look more at observations and which observations are better. A comment was made regarding the benefits of medium range forecasting that exists in Europe. This has the advantage of focusing on one specific goal such as ENSO prediction or frontal systems. Often choosing a specific phenomenon helps choose the metrics. The DPWG was asked if they would focus on a specific phenomenon. The answer was either AMOC or PDO. There is much ocean variability in AMOC and PDO, and the WG hopes to improve decadal prediction based on the initialized state. The usual idea of decadal prediction is based on regional climate change or the ability to predict temperature changes over specific time period say 4-8 years. However, the application demand for this information is greatly desired, but prediction data is somewhat disconnected to application requirements on space/time scales. As observations of AMOC do not really exist, the WG was questioned on how they can actually go about making predictions of AMOC. Is this one possible outcome from the WG, identifying specific data that is needed? The response was that different kind of initialization processes are being identified as well as different techniques when no data exist. Another possible outcome for the WG is to identify shortcomings in these decadal prediction systems rather than actual predictions.

4.2 *Greenland Ice Sheet Working Group*

Patrick Heimbach, co-chair of the Greenland Ice Sheet Working Group, provided the motivation and background for the newly formed WG. Polar ice sheets store an enormous amount of water, but for climate purposes ice sheets were not of significant interest to climate scientists or the IPCC until recently. In 2007, ice dynamics was identified as a major uncertainty in the climate system. Recent satellite data around Greenland show an increase in flow speed, mass loss and thinning near marine margins. The WG decided to focus on the Greenland Ice Sheet as Antarctica is already the subject of much examination. There are a limited number of outlet glaciers in Greenland, which could make the study more tractable. Large-scale coupled atmosphere/ocean variability is a key driver. The WG encompasses diverse membership from glaciologists, oceanographers and meteorologists involved in modeling and observational studies. The WG has a strong link with International and U.S. CLIVAR groups such as Working Group on Model Development (WGOMD) and AMOC as well as the WCRP CliC project.

The WG overarching goals are:

- to foster interaction between the diverse communities (oceanographic, glaciological, atmospheric and climate), interested in glacier/ocean interactions around Greenland;
- to include modelers, field and data scientist within each community;
- to promote exchange of data and model products;
- to coordinate field programs; and

- to advance understanding of the dominant processes and improve their representation or parameterization within climate models.

The WG is viewed as a major community building activity in climate science. Serious challenges exist regarding data including the harsh weather environment. In the coming years, the WG will be writing a paper to summarize the state of knowledge and provide open science questions that still exist. The WG meet for the first time at the International Glaciology meeting in San Diego, CA, in June 2011. At the end of the WG lifetime, a community wide, open workshop will occur.

The group was asked if there would be consortium development of a model with a single focus, or would there be multiple independent models involved. Many models currently exist and are so vastly different, that for now, the group is allowing independent models to develop and experiment. Another question concerned sufficient satellite measurements from GRACE, ICESAT and other follow on missions. NASA admitted there are gaps in the satellite observing system, but this is addressed through aircraft missions over Greenland. The Panels encouraged the WG to push NASA on these satellite data gaps and to bring these observational issues forward to the agencies.

4.3 *Hurricane Working Group*

Suzanna Camargo, co-chair of the Hurricane Working Group, provided an overview of the newly formed WG. The group has many international contributing members participating. The goals of the WG are:

- to define common experiments for model simulations by participating model groups;
- to supply common data sets and tropical cyclone metrics for those experiments;
- to coordinate the evaluation and reporting of common experiments and the storage of model output; and
- to organize a series of workshops to present and discuss the results.

Dynamical models exhibit skill in seasonal basin-wide hurricane frequency. However, problems still exist in the models. In climate change runs, the models diverge due to different forcing for future scenarios and different model sensitivities exist as a result of these forcings. There are also different definitions of tropical cyclones (TC) and their genesis. In addition, TC data is of poor quality outside the Atlantic region. With the multi-model simulations from the WG, the group hopes to establish an improved understanding of interannual variability, and trends, in TC activity from the beginning of the 20th century to the present. They will also examine the potential predictability of TCs. The second scientific objective is to quantify changes in the characteristics of tropical cyclones under a warming climate. Fourteen models from various U.S. and international institutions will provide model simulations for the set of experiments. The WG is negotiating with NCDC to archive and host the data, first for the WG participants, and ultimately to all who are interested. Camargo listed the present set of experiments involved. The WG will focus initially on North Atlantic cyclones.

The first set of experiments run include:

- Interannual – 20 years (1981-1990) forced with observed SST.
- Climatology – Climatological SST
- Global 2K : Climotological SST+ Global 2K
- Double CO2: Climotological SST + Double CO2

- Global 2K & Double CO2: Climotological SST+ Global 2K + Double CO2
- Global Warming: Climotological SST + Specified SST anomalies

The second set of experiments include:

- Atlantic 1K: Climo SST + 1K Atlantic
- Pacific 1K: Climo SST + 1K Pacific
- Slab Ocean
- High Resoluton snapshots
- Varying horizontal resolutions

The WG is currently discussing model diagnostics. They will be meeting for two days in January 2012 following the AMS Meeting in New Orleans to examine their progress thus far.

4.4 *Atlantic Meridional Overturning Circulation Science Team*

Rong Zhang updated U.S. CLIVAR on the progress of the U.S. AMOC program, an interagency program designed to focus on AMOC monitoring and predictability. This past year the group underwent reorganization into four task teams charged with accomplishing the seven near-term priorities of the program. The four task teams are: 1) AMOC Observing System Implementation and Evaluation Team; 2) AMOC State, Variability, and Change Team; 3) AMOC Mechanisms and Predictability Team; and 4) Climate Sensitivity to AMOC: Climate/Ecosystem Impacts Team. The co-chairs of each task team comprise the Executive Science Team along with Bill Johns, University of Miami, who chairs the Executive Team.

Rong provided some scientific highlights from the joint UK RAPID / U.S. AMOC meeting held in Bristol, England the week prior to the U.S. CLIVAR Summit. With respect to observations, the RAPID/MOCHA array at 26.5N has shown a strong reduction in AMOC transport since 2009. This array is providing continuous ocean heat transport estimates of unprecedented accuracy and also provides a precise definition of the relationship between MOC and heat transport variability, an important benchmark for climate model evaluation. Meanwhile, ARGO data and altimetry can be combined to monitor AMOC variability at latitudes where the boundary circulations are weak. ARGO-altimetry correlations provide an extended record back to 1993, suggesting a weak increasing trend of AMOC for the last two decades.

New observing systems for AMOC include the proposed South Atlantic line (SAMOC) and the Subpolar North Atlantic Program (OSNAP). OSNAP would capture the net transport of the overflow waters from the Nordic and Labrador Seas. OSNAP would also provide a strong linkage with the biogeochemistry, ocean biology and cryosphere communities. The program will be examining the mechanisms controlling CO^2 uptake in the North Atlantic and how the physics of the AMOC constrain this uptake. The group also intends to examine primary productivity in this region and how AMOC constrains this productivity. OSNAP will leverage existing monitoring systems and has garnered much international support and collaboration.

From the modeling side, NCAR has developed a new overflow parameterization for their model, which shows a change in deep-sea convection in their model (CCSM4). This overflow parameterization will be implemented in the GFDL model soon. CCSM4 results yielded dramatically reduced variance of the AMOC on decadal and longer timescales compared to a controlled CCSM4 simulation without this parameterization.

The U.S. AMOC program has seven near-term priorities that the four task teams are tackling. They are:

- Assessing the meridional coherence of AMOC changes should be a continued focus of prognostic models, state estimation models, and enhancement of the AMOC observing system.
- Assimilation modeling efforts focused on reaching a consensus on the variability of the AMOC over the past few decades, and on placing realistic uncertainty bounds on these estimates.
- Developing fingerprinting techniques to better characterize AMOC variability by combining model simulations with observations should be further encouraged and supported. Particular focus should be on understanding the linkage between AMOC variability and SST variability, both from a diagnostic and mechanistic viewpoint.
- Understanding the teleconnections between AMOC/North Atlantic SST and climate variability elsewhere, and the physical mechanisms of these teleconnections. Targeted studies of the impact of AMOC variability on sea ice, ocean ecosystems, sea level changes around the Atlantic Basin, and the exchange of carbon between the atmosphere and ocean are also needed.
- Understanding AMOC variability mechanisms and the model dependencies of these variability mechanisms.
- Exploring AMOC and meridional heat transport (MHT) relationships in various models (forward, assimilation, non-eddy-resolving, eddy-resolving) in comparison with observational data being generated by the program, to understand the reasons for differences, or biases, in the relationship between model AMOC intensity and MHT in available models.
- Coordinating with the near-term prediction experiments being conducted by modeling centers for the IPCC AR5 an inter-comparison study should be performed to investigate the robustness of AMOC predictions among simulations using various models.

The next U.S. AMOC Science Team meeting will be held in Boulder, Colorado in August 2012. The meeting will focus on mechanisms and fingerprinting. In 2013, another joint AMOC meeting will be held with the international community. Further information on AMOC can be found on the program website: http://www.atlanticmoc.org, including annual and bi-monthly reports to the agencies.

5 Integrated Earth System Analysis Report

Mike Bosilovich, NASA Goddard, provided a brief report on the Integrated Earth System Analysis (IESA) Workshop held in Baltimore, MD, November 2010 and sponsored by U.S. CLIVAR. The motivation for the workshop was to bring together the entire community that is currently analyzing reanalysis products. The first day focused on assessing the strengths and limitations of the new U.S. reanalyses and discussing potential improvements. The second day of the workshop identified goals for the forthcoming generation of integrated Earth system analyses and development of diagnostics to quantitatively assess the needed improvements in IESA products. Finally, day three focused on applications of reanalyses in climate and weather and highlighted needed improvements to the products.

In assessing the strengths and weaknesses of the reanalyses, the changing observation system still greatly influences the output data products. Model biases are still apparent as well due to a lack of closure in the budgets. Observation data corrections and recovery are ongoing, but the challenge is making assimilated observations available in user-friendly formats. The next generation of

reanalyses will be challenging. Diagnostics and definitions were discussed. As additional components are included in reanalyses, the degrees of freedom and coupling become very important in the system.

With regards to the application community, there was much discussion on how the products are actually used. One example provided was an evaluation of hurricane tracks. All agreed that multiple reanalyses are more beneficial and can lead to improved understanding of uncertainties. The multiple reanalyses products could be used to develop a benchmark from which to evaluate new integrated reanalyses and to better understand the physics of the system. Currently, NOAA's CFSR has coupled components to the reanalyses while NASA Goddard's coupled analysis is still under development. However, many data limitations still exist.

The 4th WCRP International Conference on Reanalyses will be held in Silver Spring, MD from 7-11 May 2012. The conference will focus on IESA and components of the Earth system, the impact of the changing observing system, validation and metrics, observations and data assimilation, and applications and international collaborative efforts.

Several questioned whether or not there was any discussion of property conserving during the workshop. Bosilovich noted that the budgets are closed, but have an extra term on one side. The models also have internal biases and the model forecasts are corrected to observations. At any given time step, change in the fields is possible. The best assimilations occur when the model is averaged up from zero. There were also questions regarding how much uncertainty comes from a particular assimilation method. The answer is uncertain. Wood asked if reanalyses might be put on a common grid. Bosilovich was unaware of this occurring at the moment. However, one possibility would be for PCMDI to compare back to the AR5 analyses by putting the reanalyses back into the Earth system grid, but not changing the original data.

6 International CLIVAR Report

Bob Molinari briefed the Summit participants on International CLIVAR's activities and it's relationship with the World Climate Research Programme (WCRP). The WCRP objectives are to determine the predictability and the effects of human activities on climate. WCRP is in the process of expanding its mandate to include multi-disciplinary studies such as ecosystems, biodiversity and climate services. CLIVAR, as a result, will be transitioning to a new phase in the coming years with more focus on societal needs. The CLIVAR Panel structure and Terms of Reference are likely to change during this transition and focus heavily on ocean-atmosphere interactions only.

Bob provided information on CLIVAR's imperatives over the next five years. These are areas where considerable progress can occur and help shape the evolution of the restructured WCRP. CLIVAR imperatives include:

- Anthropogenic Climate Change
- Decadal Variability, Predictability and Prediction
- Intraseasonal and Seasonal Predictability and Prediction
- Improved Atmosphere and Ocean Components of Earth System Models
- Data Synthesis and Analysis
- Ocean Observing System
- Capacity Building

Molinari reminded everyone that embedded in each theme are not only the physical aspects of each issue but the requirements to include multidisciplinary topics such as ecosystems and biodiversity, as well as cross cuts such as extremes, and climate services.

The Joint Scientific Committee (JSC) meeting this year focused largely on the restructuring of the WCRP. A major outcome was the decision of all three WCRP sponsoring agencies, the World Meteorological Organization (WMO), the International Council for Science (ICSU) and the Intergovernmental Oceanographic Commission (IOC) to increase activities towards climate services. The four core projects of WCRP will remain in tact even with the restructuring of the WCRP. In addition, a coordination office is still needed for each core project. The four core projects were asked to consider how they would provide support under the new WCRP structure to the key themes of observations and analysis, model development, evaluation and experiments, processes and understanding, and applications and services. The JSC will also be forming, within WCRP, a Modeling Council as well as a Data Council.

The Modeling Council will promote model development, evaluation and applications in a way that makes the whole Programme activities greater than the sum of individual Working Groups and Panels through a "grass roots" effort and not a "top-down" approach. The Modeling Council will also build on the strengths of the existing modeling activities rather than duplicate or re-create new ones, unless it is found absolutely essential. New activities would be directed at biogeochemistry issues and shorter time scales.

The new Data Council is seen as a focal point for WCRP interactions with other observational groups and programs. It was established to identify and promote cross-cutting activities of WCRP and GCOS related to observations and data assimilation. The Council will facilitate communication both within the research community and between data developers and researchers.

CLIVAR's current mandate is considered too vast by the JSC. The program was asked to reexamine its substructure and determine whether elements of CLIVAR may have a better home elsewhere in WCRP. The program is also to address the issue of a name change via consultation with early career scientists in CLIVAR. All core projects will present their ideas to the JSC following the Open Science Conference in October 2011.

As a result of the JSC meeting, CLIVAR's Scientific Steering Group (SSG) meeting in May focused on defining grand challenges for the future and the role of CLIVAR in the new WCRP structure. A CLIVAR grand challenge in one sense is an activity that extends beyond the 'ocean-atmosphere' box. For example, the CLIVAR imperatives could also be considered grand challenges. However, grand challenges should also have definable metrics and the possibility of significant progress over the next 5 years. Famine early warning was considered a possibility.

Finally, Molinari identified some specific areas of intersection in which CLIVAR and U.S. CLIVAR could engage. Both sides agreed that better communication and more frequent updates were needed between the two project offices, especially concerning recent awards, potential WGs and other activities. Molinari's ideas for intersection include:

- developing a way to synthesize data resulting from CLIVAR projects and field campaigns;
- coordinating efforts to sustain ocean observations; and

- forming a consortium of national CLIVAR programs and the ICPO to identify critical problems, improve coordination, identify climate services needed, and to serve as a resource forum for the community.

7 U.S. Agency Briefing

NOAA, NASA and NSF provided representation to the Summit. Jim Todd (NOAA) was optimistic about the FY12 budget, though it has yet to be approved. The NOAA Climate Project Office (CPO) Federal Funding Opportunity for FY12 was released on July 2, 2011. Letters of Intent are due July 26. The full proposals are due October 3. Start dates of August 1 are tied to NOAA's next generation strategic plan. The particular focus of solicitation was on climate extreme. He stressed the importance of U.S. CLIVAR engaging NOAA mission directions.

Eric Lindstrom (NASA) noted that his program has U.S. CLIVAR as the leading element. He looks to the Summit and Panels each year to help set his scientific agenda. He is also using the outcomes from OceanObs '09 to help establish his agenda. He suggested that the Panels all consider their Terms of Reference (TOR) during the breakouts instead of looking for new scientific directions each year. He encouraged U.S. CLIVAR to consider programs that could lead to future satellite missions.

Eric DeWeaver (NSF) noted that NSF focuses on long-term investments in basic research that may not follow U.S. CLIVAR directly. He indicated it was too early to know the FY12 budget details. NSF has a new solicitation on the horizon. The acronym is "Science Engineering and Education for Sustainability (SEES)." Another emphasis for NSF is Sustainable Energy Pathways to support basic research on renewable energies. One solicitation is returning to NSF, the Earth System Prediction on Decadal and Regional Scales, which was co-funded last time by NSF, DOE, USDA. NSF and CLIVAR intersect through the solicitation of small grants such as the recent Couple Model Experiment Project (CMEP), using the AR5 model runs, and through the field campaign DYNAMO.

8 Charge to Breakout Panels

At the completion of the plenary session on Wednesday, Mike Patterson identified the two primary Summit goals: 1) to support an annual review of U.S. CLIVAR research activities, and 2) to plan and recommend approaches to advance new research thrusts.
During the panel breakouts, discussions should:

- engage the Summit Theme (CLIVAR and Ocean Carbon/Biogeochemistry), considering current efforts and identifying gaps that could be addressed by coordinated research efforts (e.g. possible working groups);
- review and provide feedback to researchers and funding agencies on recent and ongoing U.S. CLIVAR research foci;
- Identify priority emerging research opportunities to advance U.S. CLIVAR science objectives, including recommendations for workshops, working groups, and coordinated research projects; and
- consider the progress made on polar climate and extremes Themes, and whether or not a new Theme within U.S. CLIVAR is ready to emerge.

9 Phenomena, Observation and Synthesis (POS) Panel Discussion

9.1 *Communicating/Interacting with OCB*

POS considered how best to interact with the OCB community. There was general agreement that the POS Panel did not have the expertise to initiate a Working Group focused on OCB issues at the present time. There was recognition of the importance of these issues, and that perhaps the Panel was best suited for a supporting role. POS might best contribute expertise on sub-surface physical ocean properties. The 4th WCRP International Conference on Reanalyses is scheduled for May 2012 in Silver Spring, Maryland. This meeting may result in exploration of activities related to tracer-conserving analyses that could involve the OCB community.

9.2 *Review of "Evaluation of Reanalyses – Developing an Integrated Earth System Analysis (IESA) Capability" workshop and recommendations for the future*

Mike Bosilovich provided a summary of the Reanalysis workshop that occurred in November 2010. The primary outcomes from the workshop included results on the degree to which reanalyses are improving, the impacts of observation system changes, and the merit of coupled atmosphere-ocean versus uncoupled reanalyses. Discussion ensued on how the increments/residuals from reanalyses can be useful in diagnosis, and how consideration of multiple reanalyses provides measures of uncertainty. As mentioned directly above, conceivably a Working Group or some other activity may be appropriate down the line (after the upcoming WCRP conference).

Action Item: **POS to prepare an announcement of the May 2012 Reanalysis conference for posting on U.S. CLIVAR website**

9.3 *Briefing on "A Framework for Ocean Observing"*

Eric Lindstrom's presentation focused on the recommendations of a task team/working group formed to follow-up on OceanObs09. Details on the framework for ocean observing are available at the following website: www.oceanobs09.net/wg/outputs.php. The development of such a framework has benefits for scientists, sponsoring agencies and society. A near-term priority is establishing which ocean variables are essential. It was recognized that is not a trivial matter to actually implement a framework within existing programs.

Action Item: **POS was encouraged to comment on the framework approach, and how it would dovetail with the activities of one's own organization.**

9.4 *Joint meeting with the "Predictability, Predictions and Applications Interface (PPAI)" Panel on Terrestrial Regional North American Hydroclimate Experiment (TRACE)*

Mike Bosilovich briefed the POS and PPAI Panels on TRACE. The TRACE activity (www.trace-rhp.org) represents a natural continuation of prior GEWEX U.S. continental scale experiments.

Its objectives, which are still evolving and being refined, are to provide climate projections on the regional scale with special attention to factors related to water supply and its management. The specific work envisioned includes developing the observational resources and hydrological models required to make progress. Predictions of large-scale climate features are needed for forecasts on the scale of hydrological units; there are overlaps with a variety of topics that are being considered by U.S. CLIVAR. Rick Rosen of NOAA indicated that the research undertaken by TRACE would receive favorable agency support. Because the project is still being defined, U.S. CLIVAR input to TRACE, at this time, is both appropriate and important to encourage collaborations and complementary activities.

Action Item: **The TRACE workshop summary is available at www.trace-rhp.org. POS will review the report, aiming to refine the broad goals and objectives of TRACE to encourage complementary activities and collaborations where appropriate (POS and PPAI co-chairs, and other interested U.S. CLIVAR panelists)**

9.5 *Discussion of proposed working group "ENSO Diversity"*

The planning for the ENSO Diversity Working Group began in earnest after the 2010 U.S. CLIVAR Summit. The WG co-chairs are Antonietta Capotondi and Ben Kirtman. A strong slate of interested participants has been assembled. The motivation for this WG relies upon the recognition that the location of warming along the equatorial Pacific strongly affects the nature of tropical-extratropical teleconnections, thus altering the influence of ENSO upon aspects of climate (e.g. precipitation, storminess, hurricane activity) that are of fundamental importance to society. Central Pacific equatorial warming may also force modes of variability (e.g. NPGO) that are strongly connected to physical quantities relevant for biology. Understanding the nature of the different flavors of ENSO, and examining the existence of possible precursors to them can provide guidance for predictability. Thus, the activities of this WG would dovetail with other U.S. CLIVAR WGs and activity, including decadal predictions, TRACE, hurricane studies, and ocean biogeochemistry. The proposed working group would take on the following tasks: (1) document the spectrum of ENSO flavors in observations, ocean reanalyses, and climate models, and identify underlying mechanisms leading to the different flavors (recognizing limits in the extent to which the observations and models are capable of discerning these differences), and (2) Examine the performance of the CMIP5 archive in reproducing the full spectrum of ENSO diversity, since these models are going to be used for predictions and projections. In particular, the models can help assess whether the frequency of "unconventional" ENSO events is increasing with global warming. Proposed analyses techniques will include the statistical approach introduced by Giese and Ray (2010), as well as analyses based on linear inverse modeling (LIM). Planned deliverables include a white paper to the Bulletin of the American Meteorological Society, a website to share analysis of the CMIP5 archive, and a final workshop to synthesize the WG findings. The panel recognized the usefulness of the proposed website, based on the experience of the reanalyses website.

Action Item: **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 U.S. CLIVAR in fall 2011.**

9.6 *Discussion of potential working group "Synthesis of Upper-Ocean Heat Budgets in Eastern Ocean Basins"*

Simon deSzoeke led a discussion of the systematic errors that current models exhibit in eastern ocean basins, with a focus on the sub-tropical southeastern Pacific. Through evaluation of modeled SSTs and surface heat fluxes, it appears that these models do not handle correctly the horizontal advection of heat above the thermocline. It was suggested that a U.S. CLIVAR Working Group would be a means for making headway on this issue. One approach would be to investigate how high-resolution ocean models account for the effects of eddies, and to use those results to guide the parameterization(s) used in coarse global models. The POS Panel agreed that the topic merited attention but that the plan for a proposal needed to be fleshed out.

Action Item: **POS recommended that Simon deSzoke contact potential participants and determine how much community interest there is in going forward with a Working Group proposal.**

9.7 *Review of "Monitoring Climate Indices Derived from Operational Ocean Reanalyses"*

This activity represents an outgrowth of the recommendations of a group assembled to write a paper for OceanObs'09 (Xue et al. 2010). Yan Xue spoke about the benefits of a real-time ensemble of ocean analyses. It would help indicate gaps in the observing system, and provide assessments of uncertainty in oceanic initial conditions for ensemble numerical ocean model predictions, as well as measures of the uncertainties in the state of the ocean, and ocean climate indices in real-time. The POS Panel felt that such an effort should be nurtured but it was unclear exactly how to best proceed. For example, perhaps this is a topic that is best pursued via a workshop rather than a working group.

Action Item: **POS Panel proposes writing a letter of support to International CLIVAR towards improving the availability of ocean reanalyses in real-time.**

9.8 *Discussion of additional potential Working Groups*

9.8.1 Extremes

Extremes have garnered considerable interest from the PPAI (namely Richard Grotjahn) as well as the POS Panel. Among the other specific issues of special interest are the interactions between extremes in temperature and precipitation, i.e., "compound analyses". It was pointed out that current global models do not properly simulate the observed nature of extreme precipitation events and hence our ability to forecast these kinds of events is seriously compromised. It was also noted that atmospheric reanalyses do not fully characterize these types of events, which may indicate limitations in the models on which the reanalyses are based. It was agreed that the topic of extremes is squarely in line with the interests of U.S. CLIVAR, and it should be feasible to develop a community effort, which ideally would include participants with expertise on societal impacts.

Action Item: **POS to develop a prospectus for a working group in collaboration with PPAI (with possibly also some links to the ENSO Diversity working group).**

9.8.2 Coastal Upwelling

Nick Bond shared some brief comments were made on coastal upwelling. It may represent a viable subject on which to collaborate with the OCB community. The Panel felt that the Working Group proposals that were further along were sufficient in quality and quantity but that the topic merited future consideration.

Action Item: **Nick Bond was encouraged to draft an outline for a prospectus to be circulated amongst the POS Panel in fall 2011, focusing on the specific issues/activities that would be undertaken.**

9.9 *Membership*

The discussion of membership was brief. It was pointed out that the terms of Nick Bond and Ben Giese nominally end in December 2011. It was unclear whether rotations will necessarily proceed as they have in the past in light of the upcoming end of U.S. CLIVAR in 2014. If Nick Bond rotates off the committee, a new co-chair would need to be appointed. None of the Panel members present were eager to take on this position. The present make-up of the Panel will continue for the foreseeable future with the expectation that some of the newer members of the Panel will take on leadership roles in the not-too-distant future.

10 Process Study Model Improvement Panel Discussion

10.1 *Climate model Process Teams (CPTs)*

10.1.1 CPT on Internal-Wave Driven Mixing in Global Ocean Models

Harper Simmons, University of Alaska, Fairbanks, presented the strategy and latest results concerning this CPT. A key point presented was that most vertical mixing in the ocean interior is due to breaking internal gravity waves. This mixing is patchy in space and time but the patchiness is particularly important. The goal of the CPT is to develop mixing parameterizations due to internal waves. To develop these parameterizations there is a need to know in some detail the tidal and wind forcing (it was noted that for wind forcing information every 1 hour is necessary – a 6 hour interval is not good enough). In addition, details about wave propagation and dissipation are crucial. There was some discussion regarding validation of the parameterizations and models.

10.1.2 CPT on Ocean mixing processes associated with high spatial heterogeneity in sea ice and the implications for climate models

Meibing Jin, University of Alaska Fairbanks, presented and discussed this particular CPT. The essential motivation of this CPT is the reduction of the uncertainty of ice-ocean components in

climate models. The representation of subgrid scale leads is a key parameterization problem the CPT is currently focusing on. In particular, high-resolution models are being used to investigate the physics and dynamics of subgrid-scale leads. During the discussion it was not clear if the manner in which the high-resolution experiments are being framed is the ideal one, and how this methodology could be brought together to develop a specific GCM parameterization.

10.1.3 CPT on Cloud Parameterization and Aerosol Indirect Effects

Rob Wood, University of Washington, presented the work plan for the new atmospheric CPT on cloud parameterization. The motivation for this CPT is to improve the representation in climate models of subgrid-scale cloud and aerosol physics. In particular, this CPT proposes to implement in the GFDL and NCAR climate models a sophisticated higher-order closure for cloudy boundary layers based on assumed double-Gaussian PDFs for the conserved thermodynamic variables and vertical velocity, and will investigate its impact in the context of cloud-aerosol interaction. In addition, the project will make significant use of Large-Eddy Simulation (LES) and Single-Colum Models (SCMs). No significant discussion ensued.

10.1.4 CPT on Stratocumulus to Cumulus Transition

Joao Teixeira, NASA JPL/Caltech, presented and discussed this particular CPT. The key goal is to improve the representation of the cloudy boundary layer in global weather and climate models with a focus on the subtropical stratocumulus-to-cumulus (Sc-Cu) transition in the NCEP and NCAR global models. Although significant positive developments have recently occurred, both the NCAR and NCEP still struggle with major problems in realistically representing the transition from stratocumulus to cumulus clouds. This transition is likely to play a key role in the way the climate system will respond to an increase in greenhouse gases. The main tasks for this CPT include the development and testing of a Gaussian PDF cloud scheme in the NCAR model; the development of long-run and SCM diagnostics for the NCEP model and the development and testing of the Eddy-Diffusivity/Mass-Flux approach in the NCEP model. No significant discussion occurred.

10.2 *Southern Ocean*

Jorge Sarmiento, Princeton University, discussed a proposal for an NSF 'Science and Technology Center for Southern Ocean biogeochemical observations & modeling'. The grand challenge of understanding the essential role that the Southern Ocean plays in the Earth's climate system was presented in detail. This proposal was extremely well received given the role that Southern Ocean plays, and its strong connection to ocean biogeochemistry. His team was recently invited to propose to NSF.

Action Item: **PSMI Panel will propose a Southern Ocean U.S. CLIVAR working group in the Fall.**

10.3 *Discussion on the CPTs and on 'Best Practices for Parameterization'*

These two topics were discussed together since there was a feeling that the CPTs' science strategies could help focus the 'Best Practices' discussion. Some key common issues were found

to be present in most, if not all, CPTs: i) Identification of key climate prediction problem; ii) Utilization of high-resolution modeling; iii) Operational implementation of parameterizations; and iv) Detailed evaluation of improved models. The crucial question debated was: Are these issues common (universal) enough for parameterization development and implementation that lead to clear and concise 'best practices' recommendations? A WCRP/WWRP workshop on the 'Physics of Weather and Climate Models' will be organized in Pasadena, California, in March 2012, to discuss many of these issues.

Action Item: **The workshop on 'Physics of Weather and Climate Models' will produce a report with recommendations that will be submitted for publication in BAMS, which will discuss the issue of 'Best Practices for Parameterization.'**

10.4 VOCALS

The key goals of VOCALS were (1) the elimination of coupled GCM systematic errors in the South-East Pacific (SEP), and improved model simulations of the coupled system in the region and global impacts of its variability; and (2) improved understanding and regional/global model representation of aerosol indirect effects over the SEP. The experiment took place in the Fall of 2008 and many directly related science activities are still taking place. A key topic of discussion was the issue of not enough funding to analyze the data carefully. Another topic was the possibility for some of the field experiments to also provide model-useful datasets.

10.5 SPURS

The Salinity Processes Upper-ocean Regional Study (SPURS) field experiment will take place between the NH summers of 2012 and 2013 in the subtropical North Atlantic. SPURS' science is aligned with the recent launch of the Aquarius mission to study the oceans salinity. The central question guiding SPURS is: Can we constrain the upper-ocean salinity (and thus water) budget with new salinity sampling tools?

10.6 DIMES

The Diapycnal and Isopycnal Mixing Experiment is a joint US-UK field experiment, investigating mixing in both quiescent and turbulent regimes of the Antarctic Circumpolar Current. Five cruises have been completed. There are three UK cruises remaining, scheduled in Dec/ Jan for next 3 years. One more US cruise will be proposed. A data archiving system for US DIMES is being setup. Some preliminary CTD data are currently available to PIs (password protected) through the DIMES website. Archiving of microstructure data will be challenging and no advancements have been made thus far. Data will be made publicly available three years after gathering.

Action Item: **PSMI Panel will get in touch with DIMES PIs to clarify situation regarding archiving of microstructure observations.**

10.7 KESS

The field phase of the Kuroshio Extension System Study ended in 2006. The panel was

encouraged that some of the essential 'Best Practices' have been followed, namely: i) Modelers and observationalists were integrated in the study from the planning stage onward; and that ii) the broad use of the data was encouraged through open data policies, centralized access to all components of experiment and archiving data in format intended for broad use. The panel recommends that synthesis data sets should be created that can be used as benchmarks for assessing and validating models.

10.8 CLIMODE

The CLIvar MOde water Dynamic Experiment studies the dynamics of eighteen-degree water, the subtropical mode water of the North Atlantic, created just south of the Gulf Stream during winter. The observational component is nearing conclusion. A mix of in situ and satellite-based observations, and high-resolution modeling, will lead to improved air-sea flux parameterizations. Modelers and observationalists were integrated in the study from the planning stage onward. However, the broad use of the data is not apparently encouraged. The data availability is confusing and the observations are apparently not publicly available. As fr other experiments, the panel recommends that synthesis data sets should be created that can be used as benchmarks for assessing and validating models.

10.9 DYNAMO

The Dynamics of the Madden-Julian Oscillation (DYNAMO) will follow the data management plan of previous field experiments such as NAME and VOCALS. The data should be fully available 12 months after the end of the experiment.

10.10 SABLE

Rob Wood from the University of Washington discussed a proposal to make spaceborne estimates of cloud top entrainment. Cloud top entrainment is one of the most challenging processes to understand and accurately represent in climate models. Entrainment is a fundamentally small-scale process that has not been adequately estimated using satellite observations. The Spaceborne Atmospheric Boundary Layer Experiment (SABLE) is a proposed NASA Ventures mission to provide the observations needed to constrain cloud top entrainment rates on a regional and monthly timescale. These measurements will be used collectively to better understand the key factors controlling the geographical and temporal variability of cloud top entrainment rate. Mission selection for the NASA Ventures proposals will be made in April 2012.

10.11 IASCLIP

Lisa Goddard presented an update on the Intra-Americas Study of Climate Processes (IASCLIP) study, designed by the IASCLIP Science Working Group under the auspices of the CLIVAR VAMOS Panel. Responding to feedback and recommendations from the PSMI Panel at the 2010 Summit, the IASCLIP science working group provided further implementation details beyond

those given in the IASCLIP Science Plan through two new white papers: An IASCLIP Modeling Plan (published in December 2010) and a Monitoring Plan (published in January 2011).

10.12 Workshop on Coupled Ocean-Atmosphere-Land Processes in the Tropical Atlantic

In March 23-24, 2011, a workshop was held at the University of Miami in Miami, Florida to specifically focus on the bias problem in the tropical Atlantic. A goal of the workshop was to bring together disparate communities working on research relevant to the hypotheses for the model biases, and to identify a network of interested researchers. The workshop received support from both US funding agencies and from WCRP. Participation in the workshop was international and at a high level of expertise. Approximately 85 people participated; the agenda and presentations are available through clivar.org/organization/atlantic/meetings/tropical_bias/miami.php. Interest in this problem is clearly high. A major workshop objective was to develop a coherent synthesis of the state-of-the-art knowledge on the Atlantic SST model biases and their causes for the southeast and eastern tropical Atlantic, as well as a set of sharpened hypotheses. Formal and informal task teams will further articulate, rank, and address approaches to causes for the coupled model SST biases, and develop a pathway forward for future research.

10.13 General discussion on observational process study reviews (All)

A few general issues were highlighted during this discussion. There are still problems with the availability of field experiment data. 'Best practices' are relatively well established (e.g. BAMS paper). Field experiment data policy should follow what is done by satellite observational community. Atmospheric community follows better data availability 'best practices.'

Key questions at the U.S. CLIVAR level that require an answer in this context are: 1) should agencies establish a way of enforcing/facilitating field experiment data availability? and 2) should U.S. CLIVAR / PSMIP go beyond encouraging best practices to facilitating?

11 Prediction, Predictability and Applications Interface (PPAI) Panel Discussion

11.1 Climate Extremes

After a brief review of the PPAI activities during 2011, Richard Grotjahn and Liqiang Sun led a discussion on the linkage of large-scale circulation patterns and the occurrence of extreme events, addressing the role of their predictability. Difficulties in developing a viable framework to validate climate model simulations (that have a coarse resolution) in their representation of extreme events were noted.

11.2 Polar Climate

Ron Lindsey moderated an extensive discussion on the opportunity to resubmit the sea-ice Working Group prospectus. Strong agreement emerged on the need to submit a revised proposal. Following the comments received from U.S. CLIVAR, the Panel decided to narrow the focus of

the prospectus to the influence of Arctic sea-ice variability and trends on the high latitude climate variability on seasonal time scale.

11.3 Seasonal and intra-seasonal predictability

Arun Kumar brought to the attention of the panel the recently released NRC report on the assessment of seasonal and intra-seasonal prediction. A discussion moderated by Joshua Fu on the influence of intraseasonal variability on the modes of climate variability (and consequently, on extremes) followed.

The joint meeting with the POS Panel on TRACE (Terrestrial Regional North American Hydroclimate Experiment) concluded the breakout session on Wednesday.

11.4 Decadal Predictability

Cristina Stan led the discussion on decadal variability and predictability of the North Pacific. Her presentation focused on potential mechanisms responsible for the Pacific decadal variability (PDV) and on possibility of intercomparison among different model simulations of the processes at play. The presentation also noted the current gaps in understanding of decadal predictability in the North Pacific, and it was felt that a U.S. CLIVAR Working Group might be the right avenue to advance the current state of knowledge related to the PDV.

11.5 ASP-CLIVAR workshop

Arun Kumar and Richard Grotjahn summarized the outcomes of the workshop on "Statistical Assessment of Extreme Weather Phenomenon under Climate Change" held at NCAR in Boulder. The panel agreed that similar activities centered on current knowledge and understanding of topics of interest to U.S. CLIVAR, and focusing both on the scientific understanding and on the application interface should be planned in the future to engage graduate and post-graduate students.

11.6 Applications Interface

For the "application" component of the PPAI panel, Gregg Garfin led a discussion on outstanding problems related to the use of climate simulations in decision making. The focus of the presentation was on how to explain and communicate to the user community differences between CMIP3 and CMIP5 model outputs (i.e. how to describe a plausible range of future scenarios based on reasonable assessments of model performances between those two modeling efforts). To this end the Panel agreed that an intercomparison of CMIP3 and CMIP5 performances and future predictions for the sub-continental USA would be particularly useful and would provide some guidance on the best available projections to the user community. Thoughts were given on asking support from the agencies on either a small grants program or a more substantive collaborative program supporting the inter-comparison of CMIP3 and CMIP5 simulations in the context of regional climate over the USA.

11.7 Potential Working Groups

The last session of the breakout on Thursday primarily focused on possible Working Groups, and workshops, that could be proposed as part of the U.S. CLIVAR.

11.7.1 Large-scale climate patterns

The focus of this Working Group, possibly led by Richard Grotjahn, should be the identification of climate extremes of relevance and the investigation of their connection with large-scale circulation patterns. The simulation of those large-scale patterns would then be assessed in climate simulations, with the final goal of understanding the reasons for model biases. The proposed working structure of the group would be set of coordinated analysis of available datasets and model experiments and would represent an extension of the Drought Working Group. This Working Group would be of relevance for the U.S. CLIVAR theme on extremes.

Action Item: **PPAI to propose a Working Group on the "Large-scale climate patterns responsible for climate extremes"**

11.7.2 Climate and Carbon

This Working Group, proposed by Curtis Deutsch and Annalisa Bracco, will connect U.S. CLIVAR with the Ocean Carbon Biogeochemistry (OCB) group. It will focus on quantifying the relative role of ocean stratification and winds on air-sea CO2 fluxes, which is relevant for attributions and for reducing uncertainties in future projections. The Working Group will develop and perform a coordinated multi-model analysis of carbon-climate interactions in CMIP5 model outputs. Metrics of physical variation (upper ocean density gradient, pCO2 or CO2 flux, wind strength, carbon export), common regions for flux analysis, and time scales (long-term trends, decadal/interannual variability) will be identified prior to the model analysis.

Action Item: **PPAI members Annalisa Bracco and Curtis Deutsch to propose a joint Working Group on the "Climate and Carbon"**

11.7.3 Sea-ice variability

Following the recommendation from U.S. CLIVAR and the discussion during the breakout, the Working Group prospectus on sea-ice variability will be submitted again, with a narrower focus on the influence of sea-ice changes on high latitude climate variability at seasonal time scale. This Working Group would be of relevance for the U.S. CLIVAR theme on polar climate.

Action Item: **PPAI members to resubmit a Working Group prospectus on "Sea-ice variability"**

11.7.4 Decadal Variability in the North Pacific

Cristina Stan proposed to lead the submission of a Working Group to investigate mechanisms of decadal variability in the North Pacific and their representation in coupled climate models. The goal of this effort would be to identify how coupled models reproduced the mechanisms of decadal variability, common biases within models and sources of uncertainty in future climate projections.

Action: **PPAI encourages Stan to propose a Working Group on "Decadal Variability in the North Pacific"**

After further discussion on the intersection and collaboration between U.S. CLIVAR and OCB, the Panel felt a workshop would help better define the potential for collaboration. Gregg Garfin proposed two options: a workshop on predictability of the sequence of climate events of interest to the water management service and/or one session on U.S. CLIVAR activities of interest to the management of forestry and natural resources at one of their main conferences.

Action: **PPAI to explore the possibility to organize a Summer Colloquium in conjunction with the ASP on 'Climate and Carbon"**

Action: **PPAI to propose organizing a workshop focused on interfacing U.S. CLIVAR with Applications.**

Overall, the PPAI breakout session had a vigorous and lively discussion and resulted in some concrete ideas about proposing Working Groups and a workshop during the coming year. The PPAI Co-Chairs, Annalisa Bracco and Arun Kumar, presented a summary of this breakout session in the subsequent plenary session.

12 Closing

Each Panel provided a brief summary from their Panel discussions, listing ideas for potential U.S. CLIVAR Working Groups as well as joint Working Groups with OCB. PSMIP would like the U.S. CLIVAR Working Group proposal process to be more competitive and open.

During the wrap up, Annalisa commented that the whole oceanographic community, especially the biological community, has a problem sharing and receiving data. She questioned whether or not the agencies could help release the data, or what other solutions were possible. Lisa Goddard noted that data management and data sharing are important and agencies should view this as an element of climate services and could somehow get data flowing if it was part of the climate services mandate. Currently, CLIVAR has no data management strategy or a Panel focused on data. The question is how to appropriately police the flow of data. Lisa Beal suggested this could be taken on by PSMI as they are encouraging the release of data from the field campaigns. A suggestion was made to create another Panel within U.S. CLIVAR.

Eric Lindstrom mentioned that the 2011 Summit did not address the full suite of issues related to the Panels' terms of reference. He suggested that the Panels have become too focused on themes

and new WG ideas rather than reviewing their initial charges. The USCO and SSC will take this under advisement in planning the Summit next year.

The next Summit will be held July 2012, on the West Coast of the U.S., date and location to be determined. Mike Patterson and Lisa Goddard thanked everyone for their participation throughout the week.

13 U.S. CLIVAR Summit Agenda

U.S. CLIVAR Summit Agenda: 18-21 July 2011 Woods Hole, MA

Monday 18 July

Time	Agenda	Room
1900 - 1930	Welcome and introductions to US CLIVAR – Lisa Goddard	Inn on the Square
1930 – 2000	General overview and suggested outcomes of the joint meeting with OCB on Tuesday (Mike Patterson)	Inn on the Square
2000 – 2100	Panels to suggest ideas of common interests between OCB and their Panel (each Panel has 20 minutes)	Inn on the Square
2100 - 2130	Discussion of Potential ideas	Inn on the Square

Tuesday 19 July – Joint with Ocean Carbon Biogeochemistry Group

Time	Agenda	Room
0730 - 0800	Continental Breakfast and Hang Posters	
0800 – 0820	Meeting introduction, objectives, outcomes (*Annalisa Bracco, Georgia Tech*)	
0820 – 0900	OCB and US CLIVAR: Scientific questions and global observing capabilities (*Scott Doney, WHOI*)	
0900 - 0945	Joint OCB and US CLIVAR science and observing objectives (community discussion)	
0945 - 1015	Break (posters)	
1015 - 1115	Global modeling challenges (30 mins. talk, 30 mins. community discussion) (*Mick Follows, MIT*)	
1115 - 1215	Overturning circulation impacts on heat and carbon transport, ecosystem processes and anthropogenic carbon uptake in the ocean (30 mins. talk, 30 mins. community discussion, Alison McDonald, WHOI)	
1215 - 1345	Lunch (provided)	
1345 – 1445	The interaction of climate, wind and sea ice on vertical mixing, ecosystem structure and carbon uptake (e.g., Southern Ocean) (30 mins. talk, 30 mins. community discussion) (*Nicole Lovenduski, Univ. Colorado*)	
1445 - 1545	Coupled air-sea interaction, heat and gas exchange contributing to variability and trends in ocean biogeochemistry (e.g. carbon sources and oxygen minimum zones) (30 mins. talk, 30 mins. community discussion) (*Curtis Deutsch, UCLA*)	
1545 – 1615	Break (posters)	

1615 – 1715	Sub-daily to seasonal and sub-mesoscale to mesoscale processes and interaction with ocean biology (30 mins. talk, 30 mins. community discussion, Amala Mahadevan, WHOI)	
1715 – 1730	Wrap up remarks	
1730 – 1830	Poster session	
1830	Workshop Dinner	Fenno lawn

Wednesday 20 July		
0730 - 0800	Refreshments	
0800 – 0830	Recap from Tuesday's meeting	Mike Spall, moderator
0830 - 0915	Discussion and updates on themes of Extremes and Polar Climate (panels report on progress)	
0915 - 1030	<u>Working Group Reports</u> Decadal Predictability (Arun Kumar)– 20 min AMOC (Rong Zhang) – 20 min Greenland Ice Sheet (Patrick Heimbach) – 20 min Hurricanes WG (Suzana Camargo) – 20 min	
1030 - 1045	**Morning Break**	
1045 - 1100	IESA Recap – (Bosilovich) – 15 min	Jay McCreary, moderator
1100 - 1115	International CLIVAR – Bob Molinari	
1115 - 1215	Agency briefing; goals of the Summit; charge to the panels (Mike Patterson)	
1215 - 1330	**Lunch** (on your own)	
1330 - 1800	Panel Breakouts (break at 1545)	

Thursday 21 July		
0800 - 0830	Refreshments	
0830 – 1230	Panel Breakouts (break at 1015)	
1230 - 1330	Lunch (on your own)	
1330 - 1500	Panel reporting in plenary	
1500 - 1530	Wrap up and adjournment	

14 U.S. CLIVAR Summit Participant List

Dr. Donald E. Anderson
Environmental Modeling Program Manager,
Modeling, Analysis, Predictions
and Projections (MAPP) Cluster Lead
NOAA Climate Program Office
1315 East-West Hwy, SSMC3, Rm. 12-108
Silver Spring, MD 20910
USA
Tel: (1) 301-734-1222
Fax: (1) 713-0518
E-mail: don.anderson@noaa.gov

Dr. Matt Barlow
Assistant Professor
Environment, Earth, & Atmospheric Science
University of Massachusetts- Lowell
One University Avenue
Lowell, MA 01854
USA
Tel: (1) 978-934-3908
Fax: (1)
E-mail: mathew_barlow@uml.edu

Lisa Beal
Department of Meteorology & Physical
Oceanography
RSMAS/MPO
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098
USA
Tel: (1) 305-421-4093
Fax: (1) 305-421-4696
E-mail: lbeal@rsmas.miami.edu

Dr. Nicholas A. Bond
JISAO
NOAA, Pacific Marine Environmental
Laboratory
7600 Sand Point Way, NE
Seattle, WA 98115-6349
USA
Tel: (1) 206-526-6459
Fax: (1) 206-526-6485
E-mail: nicholas.bond@noaa.gov
USA

Dr. Michael G. Bosilovich
Global Modeling and Assimilation Office
NASA Goddard Space Flight Center
8800 Greenbelt Rd., Building 33, Code 610.1
Greenbelt, MD 20771
USA
Tel: (1) 301-614-6147
Fax: (1) 301-614-6297
E-mail: michael.g.bosilovich@nasa.gov

Annalisa Bracco
Assistant Professor
School of Earth and Atmospheric Sciences
Georgia Institute of Technology
311 Ferst Dr.
Atlanta, GA 30332
USA
Tel: (1) 404-894-1749
Fax: (1) 404-894-5638
E-mail: abracco@gatech.edu

Suzana J. Camargo
Lamont-Doherty Earth Observatory
Columbia University
61 Rt. 9W
PO Box 1000
204A Oceanography
Palisades, NY USA
Tel: (1) 845-365-8640
Fax:
E-mail: suzana@ldeo.columbia.edu

Dr. Antonietta Capotondi
CIRES/NOAA Earth System Research
Laboratory
R/CDC1, 325 Broadway
Boulder, CO 80303-3328
USA
Tel: (1) 303-497-6105
Fax: (1) 303-444-4009
E-mail: antonietta.capotondi@noaa.gov

Simon de Szoeke
Oregon State University
104 COAS Admin. Building
Corvalis, OR 97331-5503
USA
Tel: (1) 541-737-8391
Fax:
E-mail: sdeszoek@coas.oregonstate.edu

Curtis Deutsch
Department of Atmospheric & Oceanic
Sciences
University of California, Los Angeles

405 Hilgard Ave
7125 mat Science Building
Los Angeles, CA 90095-1565
USA
Tel: (1) 310-206-5219
Fax: (1) 310-825-0088
E-mail: cdeutsch@atmos.ucla.edu

Eric DeWeaver
Climate & Large-scale Dynamics Program
National Science Foundation
4201 Wilson Blvd., Suite 775 S
Arlington, VA 22230
USA
Tel: (1) 703-292-8527
Fax:
E-mail: edeweave@nsf.gov

Baylor Fox-Kemper
CIRES
University of Colorado at Boulder
Ekeley Room S250B
216 UCB
Boulder, CO USA
Tel: (1) 303-492-0532
Fax: (1) 303-492-1149
E-mail: bfk@colorado.edu

Dr. Xiouhua (Joshua) Fu
Associate Researcher
International Pacific Research Center
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa
1680 East-West Rd., POST Bldg., Rm 401
Honolulu, HI 96822
USA
Tel: (1) 808 956-2629
Fax: (1) 808 956-9425
E-mail: xfu@hawaii.edu

Dr. Gregg Marc Garfin
Deputy Director for Science Translation & Outreach
Institute for the Study of Planet Earth (CLIMAS RISA)
University of Arizona
845 N. Park Avenue, Suite 532
Tucson, AZ 85721
USA
Tel: (1) 520-626-4372
Fax: (1) 520-792-8795
E-mail: gmgarfin@email.arizona.edu

Dr. Alexander Gershunov
Climate, Atmospheric Science and Physical Oceanography
(CASPO)
Scripps Institution of Oceanography
University of California
9500 Gilman Dr. #0224
La Jolla, CA 92093-0224
USA
Tel: (1) 858-534-8418
Fax: (1) 858-534-8561
E-mail: sasha@ucsd.edu

Dr. Benjamin S. Giese
Associate Professor
Deptartment of Oceanography
Texas A&M University
O&M Building
College Station, TX 77843-3146
USA
Tel: (1) 409-845-2306
Fax: (1) 409-845-6331
E-mail: b-giese@tamu.edu

Lisa Goddard
International Research Institute for Climate and Society
Lamont-Doherty Earth Observatory
Columbia University
228 Monell Bldg.
61 Route 9W
Palisades, NY 10964-8000
USA
Tel: (1) 845-680-4430
Fax: (1) 845-680-4865
E-mail: goddard@iri.columbia.edu

Prof. Richard Grotjahn
Atmospheric Science Program
Dept. of L.A.W.R.
University of California
One Shields Avenue
Davis, CA 95616-8627
USA
Tel: (1) 530-752-2246
Fax: (1) 530-752-1793
E-mail: grotjahn@ucdavis.edu

Patrick Heimbach
MIT
EAPS 54-1518
77 Massachusetts Ave
Cambridge, MA 02139
USA
Tel: (1) 617-253-5259
Fax: (1) 617-253-4464

E-mail: heimbach@mit.edu

Meibing Jin
International Arctic Research Center
University of Alaska Fairbanks
930 Koyukuk Dr.
Fairbanks, AK 99775
USA
Tel: (1) 907-474-2442
Fax: (1) 907-474-2643
E-mail: mbj@iarc.uaf.edu, mjin@alaska.edu

Dr. Igor V. Kamenkovich
Division of Meteorology & Physical Oceanography
RSMAS/University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149
USA
Tel: (1) 305-421-4108
Fax: (1)
E-mail: ikamenkovich@rsmas.miami.edu

Dr. Arun Kumar
Chief, Development Branch
Climate Prediction Center
NOAA, NWS, NCEP
5200 Auth Road, Rm 807
Camp Springs, MD 20746
USA
Tel: (1) 301-763-8000 x7579
Fax: (1) 301-763-8125
E-mail: arun.kumar@noaa.gov

Dr. David Lawrence
Project Scientist
CGD
National Center for Atmospheric Science
PO Box 3000
Boulder, CO 80307
USA
Tel: (1) 303-497-1384
Fax:
E-mail: dlawren@ucar.edu

Sukyoung Lee
Department of Meteorology
Pennsylvania State University
503 Walker Building
University Park, PA 16802
USA
Tel:
Fax:
E-mail: sl@meteo.psu.edu

Ron Lindsay
Polar Science Center
Applied Physics Laboratory
University of Washington
1013 NE 40th Street
Seattle, WA 98195
USA
Tel: (1) 206-543-5409
Fax: (1) 206-616-3142
E-mail: lindsay@apl.washington.edu

Dr. Eric Lindstrom
Program Manager - Physical Oceanography
NASA Headquarters
300 E. Street SW, Code YS
Washington, DC 20546
USA
Tel: (1) 202-358-4540
Fax: (1) 202-358-2770
E-mail: eric.j.lindstrom@nasa.gov

Dr. Julian P. McCreary, Jr.
IPRC/SOEST
University of Hawaii
2525 Correa Rd.
Honolulu, HI 96822
USA
Tel: (1) 808-956-2216
Fax: (1) 808-956-9425
E-mail: jay@soest.hawaii.edu

Dr. Dimitris Menemenlis
Research Scientist
Jet Propulsion Laboratory
Mail Stop 3000-323
4800 Oak Grove Drive
Pasedena, CA 911009
USA
Tel: (1) 818-354-1656
Fax: (1) 818-393-6720
E-mail: menemenlis@jpl.nasa.gov

Dr. Robert Molinari
Director, International CLIVAR Project Office
National Oceanography Centre Southampton
European Way
Southampton SO14 3ZH
United Kingdom
Tel:
Fax:
E-mail: Robert.Molinari@noc.soton.ac.uk

Mr. Mike Patterson
Director
US Clivar Project Office (USCPO)

1717 Pennsylvania Ave NW
Ste 250
Washington, DC 20006
USA
Tel: (1) 202 419-3471
Fax:
E-mail: mpatterson@usclivar.org
;mikencomo@hotmail.com

Ms. Jill M. Reisdorf
Project Coordinator
Joint Office for Science Support
University Corporation for Atmospheric Research
P.O. Box 3000 - FL4, Rm. 2344
Boulder, CO 80307-3000
USA
Tel: (1) 303-497-8636
Fax: (1) 303-497-8633
E-mail: reisdorf@ucar.edu

Dr. Richard D. Rosen
Senior Advisor for Climate Research
NOAA Climate Program Office
1315 East-West Hwy., SSMC3, Rm. 12872
North
Silver Spring, MD 20910
USA
Tel: (1) 301-734-1250
Fax: (1) 301-713-0515
E-mail: rick.rosen@noaa.gov

Joellen Russell
Assistant Professor
Department of Geosciences
University of Arizona
1040 E Fourth St.
Gould-Simpson, Room #309
Tucson, AZ 85721
USA
Tel: (1) 520-626-2194
Fax: (1) 520-621-2672
E-mail: jrussell@email.arizona.edu

Dr. Raymond Schmitt
Physical Oceanography Dept.
Woods Hole Oceanographic Institute
Woods Hole, MA 02543
USA
Tel: (1) 508-548-1400 x2426
Fax:
E-mail: rschmitt@whoi.edu

Dr. Harper Simmons
School of Fisheries and Ocean Sciences
University of Alaska Fairbanks
905 N. Koyukuk Drive
129 O'Neill Building
Fairbanks, AK 99775
USA
Tel: (1) 907-474-5729
Fax: (1) 907-474-7204
E-mail: hsimmons@sfos.uaf.edu

Dr. Michael Spall
Physical Oceanography Dept.
Woods Hole Oceanographic Institute
MS #21
Woods Hole, MA 02543
USA
Tel: (1) 508-548-1400 x3342
Fax: (1) 508-457-2181
E-mail: mspall@whoi.edu

Dr. Cristiana Stan
COLA
4041 Powder Mill Road, Suite 302
Calverton, MD 20705-3106
USA
Tel: (1) 301-902-1261
Fax: (1) 301-595-9793
E-mail: stan@cola.iges.org

Dr. Diane M Stanitski
Climate Observation Division
NOAA Climate Program Office
1100 Wayne Avenue, Suite 1202
Silver Spring, MD 20910
USA
Tel: (1) 301-427-2465
Fax: (1) 302-427=0033
E-mail: Diane.Stanitski@noaa.gov

Ms. Catherine O. Stephens
Program Specialist III
U.S. CLIVAR Project Office
1717 Pennsylvania Ave., NW, Ste. 250
Washington, DC 20006
USA
Tel: (1) 202-419-3482
Fax: (1) 202-223-3064
E-mail: cstephens@usclivar.org

Dr. Liqiang Sun
IRI
231 Monell Building
61 Route 9W
Palisades, NY 10964
USA
Tel: (1) 845-680-4433

Fax: (1) 845-680-4865
E-mail: sun@iri.columbia.edu

Dr. Joao Teixeira
JPL
4800 Oak Grove Dr.
MS 169-237
Pasadena, CA 91109
USA
Tel: (1) 831-656-4790
Fax:
E-mail: teixeira@jpl.nasa.gov

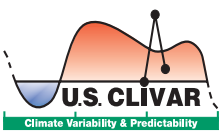
James F. Todd
Earth System Science Cluster Lead
NOAA Climate Program Office
1315 East-West Hwy., SSMC3, Rm. 12114
South
Silver Spring, MD 20910
USA
Tel: (1) 301-734-1258
Fax: (1) 301-713-0518
E-mail: james.todd@noaa.gov

B. Mete Uz
Directorate for Geosciences
Division of Ocean Sciences
National Science Foundataion
4201 Wilson Boulevard
Arlington, VA USA
Tel: (1) 703-292-4557
Fax: (1) 703-292-9085
E-mail: bmuz@nsf.gov

Dr. Robert Wood
Research Assistant Professor
Department of Atmospheric Sciences
University of Washington
Box 351640
Seattle, WA 98195
USA
Tel: (1) 206-543-1203
Fax: (1) 206-685-9302
E-mail: robwood2@u.washington.edu

Dr. Yan Xue
Climate Prediction Center
NCEP/NWS/NOAA
Room 605-A, WWB
5200 Auth Road
Camp Springs, MD 20746
USA
Tel: (1) 301-763-8000 x7574
Fax:
E-mail: yan.xue@noaa.gov

Dr. Rong Zhang
NOAA/GFDL
Forrestal Campus
Route 1
Princeton, NJ 08540
USA
Tel:
Fax:
E-mail: rong.zhang@noaa.gov



U.S. CLIVAR Project Office

1717 PENNSYLVANIA AVE NW

Suite 850
Washington DC 20006
(202) 419-1800
(202) 419-1889 - Fax

U.S. CLIVAR is a multi-agency sponsored contribution to the U.S. Global Change Research Program (USGCRP; www.globalchange.gov) and the U.S. contribution to the International CLIVAR Programme (www.clivar.org) of the World Climate Research Programme (WCRP; wcrp-climate.org).

The U.S. CLIVAR Program acknowledges support from three U.S. agencies:

This material was developed with federal support of NASA (AGS-093735), NOAA (NA06OAR4310119) and NSF (AGS-0926904). Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the sponsoring agencies.