

U.S. CLIVAR: CLIMATE VARIABILITY AND PREDICTABILITY

U.S. CLIVAR 2009 SUMMIT REPORT

March 2010

**U.S. CLIVAR Report
No. 2010-1**

March 2010

**U.S. CLIVAR Office
Washington, DC**

BIBLIOGRAPHIC CITATION:

U.S. CLIVAR Office, 2010: U.S. CLIVAR 2009 Summit Report. U.S. CLIVAR Report 2010-1,
U.S. CLIVAR Office, Washington, DC, 20006, 43pp.

2009 U.S. CLIVAR Summit Executive Summary

U.S. CLIVAR held its annual Summit during the second week of July 2009 in Annapolis, Maryland (USA). During the Summit the three U.S. CLIVAR Panels met to review program progress as well as identify and recommend future activities. This year discussion focused on new *Themes*, or areas of scientific research that should become a focus of new U.S. CLIVAR activities in the future.

The Drought and Western Boundary Current Working Groups described the terrific synergy and activities stimulated. Their findings have been submitted for publication, including a Journal of Climate special issue on drought. The High-Latitude Fluxes Working Group is planning a workshop in March 2010 and a review paper. The Decadal Predictability Working Group has organized monthly teleconferences and held their first meeting in June 2009. The Atlantic Meridional Overturning Circulation (AMOC) Project (now involving nearly 2 dozen US PI's) recently organized its first international workshop (May 2009), and coordinating activities in several areas, including prospects for additional AMOC observations, AMOC analyses, and ocean syntheses. In addition to these US efforts, reports on the new International CLIVAR Imperatives (Anna Pirani), and VAMOS (Hugo Berbery) provided valuable information on new directions and specific activities (i.e., within VAMOS) that should be considered by U.S. CLIVAR.

The Phenomena Observations and Synthesis Panel (POSP) discussed a wide range of activities and challenges, including a special focus on reanalyses and Integrated Earth System Analyses (IESA). They are considering a workshop on these issues sometime in 2010. The Process Study Model Improvement Panel (PSMIP) met and celebrated the successful issuance of a joint-agency Announcement of Opportunity for new Climate Process Teams (CPTs). They spent considerable time reviewing DYNAMO, a potential US field campaign targeting coupled ocean-atmosphere dynamics important for MJO initiation. They reviewed the state of current US-lead process studies (like CLIMODE and DIMES) and prospects for additional future studies (e.g. VAMOS IASCLIP). The Predictability, Predictions and Applications Interface Panel (PSMIP) addressed follow-on activities to the Drought Working Group; scoping of a new Tropical Biases Working Group (to be proposed later this year); and how to take advantage of upcoming Decadal Predictability/Prediction workshops. PPAI also celebrated the successful second year of another flagship activity: the Post-Docs Applying Climate Expertise (PACE), that supports climate scientists working the decision support arena.

Because of the effectiveness and synergy generated in response to current U.S. CLIVAR "Themes" (i.e., "Drought" and "Decadal Predictability/Variability"), U.S. CLIVAR wished to identify a few additional Themes, or scientific challenges for which U.S. CLIVAR should be encouraging activities for the next 3-5 years. Two candidate themes were selected: Extremes (which will likely replace the Drought theme) and High-Latitude Climate Changes. Additionally, there was a strong push for U.S. CLIVAR to develop Themes addressing a) climate and carbon cycle, b) ecosystems, and c) coastal interactions and feedbacks in a changing climate. Some of these new themes may already be the focus of other programs (e.g. within WCRP or IGBP); however, Summit discussions suggested that there is an opportunity and need for CLIVAR to more urgently and concretely develop partnerships with these other programs in order to address important scientific challenges that transcend disciplinary boundaries.

The Summit concluded anticipating that U.S. CLIVAR would spend much time discussing over the next year these new Themes in order to identify new activities (e.g., workshops, Working Groups, agency meetings) that would hasten scientific progress.

U.S. CLIVAR 2009 Summit Report

1	ACTION ITEMS.....	2
2	WELCOME AND INTRODUCTIONS	4
3	U.S. CLIVAR REPORT.....	4
4	WORKING GROUP REPORTS.....	6
4.1	HIGH LATITUDE SURFACE FLUXES WG SCIENCE REPORT	6
4.2	DROUGHT WG SCIENCE REPORT.....	7
4.3	DECADAL PREDICTABILITY WG SCIENCE REPORT	7
4.4	WESTERN BOUNDARY CURRENT WG SCIENCE REPORT	8
4.5	U.S. ATLANTIC MERIDIONAL OVERTURNING CIRCULATION (AMOC) REPORT	9
5	INTERNATIONAL CLIVAR REPORT	9
6	VARIABILITY OF THE AMERICAN MONSOONS REPORT (VAMOS)	10
7	DYNAMICS OF THE MJO (DYNAMO).....	11
8	INTRA AMERICAS STUDY OF CLIMATE PROCESSES (IASCLIP).....	13
9	STRATEGIC THEME DISCUSSION	14
10	CHARGE TO THE PANELS	17
11	PREDICTIONS, PREDICTABILITY & APPLICATIONS INTERFACE PANEL REPORT ..	18
11.1	DECADAL PREDICTION AND PREDICTABILITY	18
11.2	DROUGHT.....	19
11.3	CLIMATE PREDICTION APPLICATIONS POSTDOC PROGRAM (CPAPP)	19
11.4	BEST PRACTICES IN PREDICTION	20
11.5	TROPICAL BIASES WORKING GROUP.....	20
11.6	DISCUSSION OF NEW THEMES.....	ERROR! BOOKMARK NOT DEFINED.
12	PROCESS STUDIES AND MODEL IMPROVEMENT PANEL REPORT.....	21
12.1	ONGOING PROCESS STUDIES.....	21
12.2	POSSIBLE FUTURE PROCESS STUDIES	22
12.3	PSMIP'S RELATIONSHIP WITH PROCESS STUDIES	23
12.4	BEST PRACTICES FOR PROCESS STUDIES	24
12.5	BEST PRACTICES FOR PARAMETERIZATION DEVELOPMENT	24
12.6	SATELLITE DATA FOR PARAMETERIZATION DEVELOPMENT	24
12.7	CONNECTIONS WITH NASA	24
12.8	DATA STEWARDSHIP.....	25
12.9	TURBULENCE DATA ARCHIVAL	25
12.10	CLIMATE PROCESS TEAMS.....	26
12.11	POSTDOCTORAL TRAINEE FELLOWSHIP SCHEME.....	26
12.12	WORKING GROUPS	26
12.13	PANEL MEMBERSHIP.....	27
13	PHENOMENA, OBSERVATIONS AND SYNTHESIS PANEL REPORT.....	27
13.1	WORKSHOPS AND WORKING GROUPS.....	27
13.2	INTEGRATED EARTH SYSTEM ANALYSIS	30
13.3	DISCUSSION OF NEW THEMES.....	30
13.4	DATA STEWARDSHIP.....	31
13.5	HOUSEKEEPING ITEMS (MEMBERSHIP, ETC.).....	32

14	EMERGING THEMES	32
14.1	ECOSYSTEMS, CARBON AND COASTAL THEME BREAKOUT GROUP REPORT	33
14.2	EXTREMES THEME BREAKOUT GROUP REPORT	33
14.3	HIGH LATITUDE AND POLAR THEME BREAKOUT GROUP REPORT	34
15	CLOSING REMARKS	34
16	U.S. CLIVAR SUMMIT AGENDA	36
17	U.S. CLIVAR SUMMIT PARTICIPANT LIST.....	38

1 ACTION ITEMS

- Action Item 1.** PPAI members (Goddard, Kumar and Kirtman) continue to contribute to the Decadal Predictability WG white paper.
- Action Item 2.** The PPAI Panel and the Decadal Predictability WG should ensure coordination across all three decadal climate workshops: Earth System Initialization for Decadal Prediction, Decadal Climate Variability and Predicting the Climate of the Coming Decades (Goddard, Kirtman, Kumar, Meehl)
- Action Item 3.** Kumar and Kirtman to discuss with U.S. CLIVAR executive committee whether to establish a Scoping Group to build on the success of the Drought Working Group.
- Action Item 4.** PPAI will continue working with Meg Austin, Director of the UCAR visiting scientist program, to further the Climate Prediction Applications Postdoc Program. (Lisa Goddard, Ben Kirtman)
- Action Item 5.** PPAI members (Goddard, Kirtman and Koster) will continue to participate in the National Academies assessment of climate predictability.
- Action Item 6.** PPAI will submit a revised Working Group prospectus on Tropical Biases to the U.S. CLIVAR Executive Committee (Ben Kirtman, Paquita Zuidema, Ed Schneider)
- Action Item 7.** PSMIP will communicate feedback to each of the U.S. CLIVAR process studies by the end of summer [process study liaisons].
- Action Item 8.** PSMIP to include a short statement in their terms of reference on the webpage regarding their relationship with process studies. [Zuidema]
- Action Item 9.** PSMIP to continue to solicit information from and provide feedback to process studies concerning their progress toward best practices goals. [process study liaisons]
- Action Item 10.** PSMIP to write an opinion piece on best practices in parameterization development [Donner (lead), Zuidema, Bryan]
- Action Item 11.** PSMIP to develop ideas for promoting the use of satellite data for model evaluation and parameterization development, including: a workshop to build community consensus; a short paper for *Eos* or NASA Earth Observer to emphasize that satellite data can be used in global model evaluation and process studies. [Teixeira and Zeng]
- Action Item 12.** PSMIP to continue to communicate with NASA program managers and explore ways in which PSMIP can contribute to planning stages of new missions. [Zeng and Teixeira]
- Action item 13.** PSMIP to write an extremely short document for *EOS* with a focus on what is new in the NODC data policy. We anticipate that Margarita Gregg, NOAA, would collaborate on this document. A potentially new aspect of the policy would be a recommendation that PIs follow up on the availability of previously submitted data. [Gille, POS lead, with Donohue, PSMIP lead]

- Action item 14.** Archival of LADCP data: PSMIP to recommend to NOAA/NODC that U.S. CLIVAR sees the LADCP archive as a priority -- Pat Caldwell is willing to archive LADCP data but needs more resources, and a LADCP processing expert needs to join any effort Pat Caldwell undertakes to archive LADCP data. [Donohue and members of POS]
- Action item 15.** PSMIP to assess the status of unusual data sets (e.g. RAFOS floats, pressure, current, inverted echo sounder) within the NODC archive. For example: Are they readily available? Are PIs submitting contemporary data sets? [Donohue]
- Action Item 16.** PSMIP to monitor the efforts of the DIMES process study to archive their microstructure data at Scripps (contact, Steve Diggs), so that lessons learned from this experiment can be transferred to other process studies. [Legg]
- Action item 17.** PSMIP to compile a list of all existing climate-related turbulence data sets we would like to see archived, drawing on efforts of Lou St. Laurent and Kurt Polzin. [Legg]
- Action item 18.** PSMIP to work with NSF program managers to encourage current and future turbulence data sets to be archived following the DIMES example. [Legg]
- Action Item 19.** Ensure that PSMIP CPT Review and Recommendations document is publicized to potential CPT participants, and work with community to facilitate a competitive field of proposals for this next round. [Legg]
- Action Item 20.** PSMIP to initiate a meeting between advocates from the climate modeling centers and agency representatives to gauge interest in a climate modeling postdoctoral trainee fellowship scheme, and discuss how this could be coordinated between centers [Donner]
- Action Item 21.** PSMIP to recommend the tropical biases Working Group proposal be submitted for consideration by U.S. CLIVAR. [Schneider, PSMIP lead]
- Action Item 22.** PSMIP to contact potential new Panel members to encourage them to apply to PSMIP. [Legg, Zuidema]
- Action Item 23.** POS will provide feedback on Western Boundary Current CPT proposal (as requested) and individual members should comment on the WBC OceanObs'09 white paper.
- Action Item 24.** In order to address concerns about dearth of data (particularly for soil moisture), POS will make inquiries to determine whether data can be part of climate reference network, or whether a drought data workshop will be needed to help coordinate needed observations. (Mike Alexander)
- Action Item 25.** POS to identify AMOC (and SAMOC) participants who might participate in the high latitude surface flux Working Group workshop in March, 2010. (Chris Meinen to follow up.)
- Action Item 26.** Mike Alexander will brief POS on relevant issues in the Climate and Ecosystem community that might arise.
- Action Item 27.** POS encouraged Rong to formulate more detailed workshop plan on abrupt change and energy security before deciding on the level of formal U.S. CLIVAR involvement. A steering committee could draw on CLIVAR scientists.
- Action Item 28.** PSMIP will take the lead in commenting on IASCLIP. POS will provide additional comments as needed.
- Action Item 29:** POS to ask David Legler to convey to NOAA Program Managers the need for an increase in funds to the global surface drifter system.
- Action Item 30:** Sarah Gille to follow up with the Argo Steering Team and make sure they are taking Aquarius concerns into account and she will report back to U.S. CLIVAR on the status.
- Action Item 31.** POS members were strongly encouraged to read and provide comments for OceanObs community white papers that fell within their own areas of expertise.

- Action Item 32.** POS to recommend U.S. CLIVAR jointly sponsor a workshop on air-sea fluxes from IESA/reanalysis. Workshop aims: (a) Assimilators talk to users, (b) Users show findings/applications, (c) Identify metrics for future IESA efforts. (Tentative steering committee: David Legler (lead), Mike Alexander, Mike Bosilovich, Sarah, Tony, Ben, Randy Dole.)
- Action Item 33.** POS to contact EOS and Margarita Gregg, NODC, and draft a statement of data archiving strategy (Sarah with help)
- Action item 34.** POS to support efforts to archive turbulence data, both past and present (Sonya Legg, PSMI lead)
- Action item 35.** POS to provide recommendation to NOAA that LADCP data archiving should be made a priority. (Chris, Sarah to ask Margarita how to proceed)
- Action item 36.** POS to recommend to NODC that other unusual data sets need to be assessed within the NODC archive and a consensus reached about how to proceed (Kathy Donohue)

2 Welcome and Introductions

Marty Hoerling welcomed everyone to the 5th U.S. CLIVAR Summit. He gave an overview for new Panel members on how CLIVAR Summits usually proceed. He noted that the fidelity of the science is important to CLIVAR and that U.S. CLIVAR provides a visible face and audible voice for our science enterprise as a group. Through U.S. CLIVAR, scientists are able to express a community vision of the science (i.e., process of how science is conducted, and setting priorities) and to articulate the standards of excellence in the science. Marty stated that CLIVAR has an important role in representing climate science and providing a vision for its future – it provides a home in which scientists can incubate ideas and coordinate shared activities of common interest with a prospect for focused, critical mass capabilities through multiagency support. During the Summit, Panelists will be analyzing the climate system in different ways. He encouraged everyone to consider program legacies and where CLIVAR needs to go. Marty proposed that part of U.S. CLIVAR’s legacy is integrity of the science and the scientific process, and improving the manner in which the community articulates climate science to a community of other scientists and non-scientist interests such as decision makers and the public. . He also noted that during the Summit, the Panels would be looking for an additional theme to take on in the coming years. Marty closed by saying that it is an honor to be selected by peers to serve on CLIVAR Panels, and that it was a great opportunity to interact with agency representatives.

3 U.S. CLIVAR Report

Marty Hoerling reviewed the Panels and their accomplishments this past year. The Process Studies and Model Improvement (PSMI) Panel’s mission is to reduce uncertainties in general circulation models used for climate variability prediction and climate change projections. This is accomplished through an improved understanding and representation of the physical processes governing climate and its variation. Their past year accomplishments include: changing the manner in which field studies are done and how they integrate into model improvement; and Climate Process Teams (CPTs) which are now accepted as an effective framework in the U.S. Global Climate Research Program (USGCRP) and the World Climate Research Programme (WCRP). The PSMIP review of previous CPTs was a critical component to the new announcement of opportunity. An article on “best practices” in process studies is appearing in the Bulletin of the American Meteorological Society (BAMS), July 2009, noting ways field studies can improve modeling and prediction. Marty also listed the ongoing field campaigns listed such as VAMOS Ocean Cloud Atmosphere Land Study (VOCALS), Diapycnal and Isopycnal Mixing

Experiment in the Southern Ocean (DIMES), and the proposed Dynamics of the Madden-Julian Oscillation (DYNAMO) which will be discussed at the Summit by PSMI.

The Phenomena, Observation and Synthesis (POS) Panel's mission is to improve understanding of climate variations in the past, present, and future. It also seeks to develop syntheses of critical climate parameters while sustaining and improving the global climate observing systems, with particular attention on how to sustain and improve the global monitoring system. Data stewardship has been a major focus in the past year. The Panel is working hard on identifying best practices for data stewardship and strategies for orphaned data with no archival home. The Panel also shepherded an Ecosystems and Climate Colloquium at NCAR which could provide potential new themes for U.S. CLIVAR. Marty also noted that there are now 5 years of ARGO data, which could be a major tool in future climate research.

The Predictability, Predictions and Applications Interface (PPAI) Panel's mission is to foster improved practices in the provision, validation and uses of climate information and forecasts through coordinated participation within the U.S. and international climate science and applications communities. The Panel is as much about predictability as predictions and a broader application to the community. The Panel is engaged in the World Climate Conference and Ocean Obs'09. The Panel also just initiated the U.S. CLIVAR Decadal Predictability Working Group. The Panel has led the way toward developing a predictive understanding of climate. Results include advancing the understanding of natural variability and warming trends and the oceans role in terrestrial temperature trends. Marty noted that 1998 was the warmest year, and yet 10 years later the earth is cooler. How do we reconcile cold periods, or cooling trends, with global warming he asked? What is the predictability of the fluctuations around the trend pattern---for instance, how long will the recent cooling cycle last? Analysis shows a cooling period within a warming trend due to natural variability of the cycle. Greenhouse gas warming of the earth is shown to be the result of heating in the ocean and not just the radiative impact on terrestrial temperature. Marty stated that there are emerging issues of the oceans role in temperature and the extent of natural low frequency variability, ENSO variability and variation in forecast skill, the 2008 North America cooling, initialized decadal prediction including understanding the 1970s climate shift, forced vs. internal variability, and the extent to which such modes of natural variability mask the effect of greenhouse gases.

This past year, each Panel put together a two-page analysis on their role in the current U.S. CLIVAR themes - Drought and Decadal Variability. Marty explained the integrated approach of U.S. CLIVAR to Drought through: the physics of drought-relevant processes (field campaigns such as NAME, DYNAMO and CPTs and the Drought in Coupled Models Project); attributing the causes for drought variability; and through the predictability of drought in model intercomparisons such as AMIP, DEMETER and CMIP4. A special issue of the Journal of Climate on drought as a result of the U.S. CLIVAR Drought Working Group and DRICOMP results is due out soon. Marty noted that attribution of drought is important for the warning and observation system which in turn is important to predictability and modeling of system.

U.S. CLIVAR's integrated approach to Decadal Variability focused on: processes contributing to decadal variability; and attributing the causes for decadal variability and decadal variability strategies. Relevant field campaigns such as those in the Western Boundary Current (WBC) region, the Indian Ocean region, and the Atlantic Meridional Overturning Circulation (AMOC) can provide insight on physics that lead to predictability and to determine how much of the system is predictable. Strategies for prediction include looking at whether or not there is predictability beyond just the greenhouse gas forcing; and what can be tied to natural modes of variability. The question is which approach is best - empirical vs. numerical, coupled vs.

uncoupled. The U.S. CLIVAR Decadal Predictability Working Group will be looking at some of this. Marty then thanked everyone for contributing and looks forward to the future of U.S. CLIVAR.

4 Working Group Reports

4.1 High Latitude Surface Fluxes WG Science Report

Sarah Gille provided an overview of the High Latitude Surface Fluxes Working Group activities. The group's motivation comes from the enormous discrepancies in the climatology of heat flux products. The PDFs of the fluxes (NCEP, JRA, ERA40, IFREMER) vary widely. Currently there is no "truth", and there has been no field campaign to validate these products. Thus the Working Group has two objectives: to document the present state of high-latitude fluxes, considering momentum, heat, freshwater, and CO₂; and to organize a community workshop to coordinate efforts to improve flux estimates at high latitudes. Their membership has a broad range of scientists from different backgrounds. They have spent most of their time educating each other and have contributed to several publications, including U.S. CLIVAR *Variations*, *FluxNews*, and *OceanObs'09*, and workshops. Flux measurements are challenging at high latitudes (e.g. because of icing of instrumentation). In the late 1990s, the Surface Heat Budget of the Arctic (SHEBA) deployed for 12 months and was arguable the best regional sampling of surface fluxes in high latitude environments, but they occurred at an ice camp. These measurements may not be helpful in future years with the recent disappearance of ice. Sarah discussed some of the group's findings including that radiative fluxes vary quite a lot and need an accuracy of 10 W/m² or better. The Working Group has 5 strategies for improving the fluxes: analyzing existing data and ensure the quality of the data to make it more readily accessible; expand field observations by targeting direct flux observations and high-quality, high-temporal resolution data for satellite calibration/validation; expand the use of ships of opportunity and autonomous instruments; make better use of satellite data and expand the satellite observing system; and improve the understanding of the physics underlying air-sea fluxes thus helping to improve model parameterizations.

The group is organizing an open workshop, jointly with SeaFlux, in Colorado, 17-19 March 2010. The agenda will focus on the entire range of concerns including in-situ observation issues, process studies, satellite data, and gridded products.

During discussion, Leo Donner noted that NCAR and GFDL have just finished Atmospheric General Circulation Model (AGCM) runs and that sea ice is a big concern. They don't have a reference for what the fluxes should be and one of the modeling center's big goals is to put in land ice in the models. He noted that fluxes will be very important to get correct. His suggestion was that the centers could use a best estimate of fluxes with error bars in regional areas. Sarah replied that the length scales of variability are quite small and that fluxes could vary greatly over 1 km and be uncorrelated with satellite data. Xubin Zeng noted that different centers are considering doing a new intercomparison. Marty Hoerling then asked about the understanding of how much reduction of sea ice was observed in comparison to what was predicted? Nick Bond replied that a few colleagues were looking into it and a couple of predictions actually indicated some reduction in sea ice as had been observed.

4.2 Drought WG Science Report

Siegfried Schubert gave a summary of the Drought Working Group activities. Many results will be coming out shortly in a Journal of Climate special issue. Siegfried said the Working Group is in its golden years at the moment and there are a lot of interested outside participants. One key accomplishment includes coordinated model experiments. The group examined the sensitivity of models to SST, land surface or global warming forcings leading to drought. He noted that a subset of model results is available to outside researchers, and their website (http://gmao.gsfc.nasa.gov/research/clivar_drought_wg/index.html) provides details of experimentation. In addition, the Working Group held a workshop in conjunction with NOAA's Climate Diagnostic and Predictions Workshop (CDPW). From the workshop, a special issue of the Journal of Climate will be published with articles from DRICOMP and from the Drought Working Group.

Siegfried then reviewed the results of the model intercomparison. The models were forced with 3 sea surface temperature (SST) patterns from an EOF analysis: a linear warming trend, a Pacific SST pattern, and an Atlantic SST pattern – both positive and negative versions of each pattern were used. Surface height forcing showed similar response amongst all models. Small details of regionally significant importance were observed. The March-April-May (MAM) response was most widespread and largest over the U.S. Siegfried was not sure why all models produce a typical response in December-January-February (DJF), but open up in MAM, but this has important implications for drought over U.S. The correlation was the strongest for 200 mb height and the response better in Pacific than Atlantic. The response to U.S. precipitation forcing was much more coherent across all the models compared to the SST response. Meanwhile, soil moisture feedback has a huge impact from land. Siegfried reviewed the group's findings. He again noted the importance of SST in droughts and pluvials stating that the Atlantic has a lot less agreement, but is playing a role in drought. It is critical to understand the seasonality as results show a lot of seasonality. Storm track changes are important as well. The models agree that a cold Pacific and warm Atlantic lead to drought while the reverse leads to pluvial conditions. The models however disagree on the regional details and are sensitive to the strength of the land-atmosphere coupling and the low level response in the Caribbean.

Siegfried noted that there is much more to be learned from the simulations and that they are a tremendous resource for the community. The group will continue to focus on: drought dependence on various time scales; coupled model responses, resolution issues (diurnal cycle, mesoscale); the role of land (soil moisture, vegetation, aerosols); observations such as satellite measurements and other quantities such as snow, run-off, etc.

During the discussion, Marty Hoerling note that a related activity is NIDIS (www.drought.gov), and it is interested in the reconciliation of causes of US drought in 20th century. He asked Siegfried for his thoughts on our understanding of principal droughts of 20th century. Siegfried said there is still a lot of uncertainty, especially in the 30s drought. SSTs don't support what researchers know about responses, but the SSTs are suspect during that time. There is still a lot to learn about SST and land interactions.

4.3 Decadal Predictability WG Science Report

Lisa Goddard gave an update on the Decadal Predictability Working Group (DPWG). Her initial graph showed three different forecasts and a range of uncertainty for the ensemble mean and observations. She noted that the Intergovernmental Panel on Climate Change (IPCC) 5th

assessments and the amount of decadal information that can be captured in these assessments helps to motivate the group. The Working Group has 2 objectives: to define a framework to distinguish natural variability from anthropogenically forced variability on decadal time scales for the purpose of assessing predictability of decadal-scale climate variations; and to work towards better understanding of decadal variability and predictability through metrics that can be used as a strategy to assess and validate decadal climate predictions and simulations. The group was formally approved in January 2009 and has a diverse membership. The monthly teleconferences thus far have focused on how to separate natural decadal variability from anthropogenically forced decadal variations. The group has turned to the IPCC models to try and isolate climate change signal. One member, Jerry Meehl is looking at the 20th century runs. He notes that the 2nd EOF of the IPCC models projects strongly on the Pacific Decadal Variability (PDV) pattern; and the results suggest a forced component of variability with a delayed reaction by 10 years. But, there is also strong interaction between anthropogenic and natural variability. The DPWG plans to meet in early 2010 at a Decadal Workshop in Miami. In addition they are hoping for a small grants opportunity in the spring of 2010 to investigate decadal predictability in the AR5 projections. A workshop in the fall of 2010 would showcase results from these small grants. And finally, the group hopes to host a meeting in the spring of 2011 on “Defining Metrics Relevant to Dynamical Decadal Predictions”. They are coordinating with other WGs in U.S. CLIVAR AMOC group and International CLIVAR Working Group on Ocean Model Development (WGOMD) on the separation of forced and natural components. Jointly, the groups will participate in a meeting in October 2010. The NCAR Climate Change and Climate Variability Working Groups are partnering with the DPWG to do ensemble runs for the metrics study. Lisa noted that although the January meeting will be focused on Florida and Southeastern US regions, broad aspects of decadal predictability will be discussed. The group is starting to assemble data sets to be used in metrics study. In addition, there is a white paper in preparation, which will summarize and critique methodologies to distinguish natural decadal variations from anthropogenically-forced variations in order to assess the potential contribution of initialization for decadal predictions.

4.4 Western Boundary Current WG Science Report

Mike Alexander discussed the outcomes from the Western Boundary Current Working Group (WBCWG). The Panel finished their two years of work and individuals are moving forward in several new directions. Mike listed the Panel members and noted that the WG began in January 2007 and culminated with a workshop in January 2009. He noted that the group was initially formed to discuss the similarities and differences in KESS and CLIMODE programs, but that air-sea interaction became important component of the WG. Several review articles on frontal and large-scale air-sea interactions were the result. Several other notable accomplishments from the WG include a web page: <http://www.cdc.noaa.gov/WBC> that displays the western boundary current analysis from several data sets; new analyses that were conducted for the review papers, the workshop in January 2009, and a special issue of the *Journal of Climate*. The review papers looked at SST and latent heat flux (LHF) for 2003 and 2007 – periods with good satellite resolution. There were substantial differences in the two time periods, indicating that south of front had larger LHF. The meridional gradient of Kuoshi and Oyashi fronts for two separate time periods (1984-88 and 1968-72) were also examined. Their differences showed that the frontal structure could be resolved and there were actually two fronts. The fronts are shifted further south in the later period and the impacts of SST fronts on atmosphere, i.e. eddy kinetic energy (storm track variability) were tracked. The group was interested in the remote effects on the boundary currents and noted that the ENSO signal was tied to the cold front in North Atlantic and Gulf Stream.

Mike noted that the workshop in Phoenix, Arizona overlapped with the annual AMS meeting, and the group sponsored a joint session at the AMS meeting on air-sea interaction. Over 60 people, including a large international contingency, participated in the WBC Workshop. The agenda and workshop presentations can be found online at:

<http://www.usclivar.org/org/WBCWorkshop2009.php>. A special issue of the *Journal of Climate* will be issued in August 2009. There are 25 papers submitted for this special issue and the Working Group has authored several other papers/publications. The WBC leaves as a legacy continued cooperation between scientists investigating the two western boundary regions. There is a shift to focus more on air-sea interaction, and the group hopes to concentrate more on the overall coupling issue. They are looking at requirements for an ocean and atmospheric observing systems in WBC regions, and a paper on such requirements was submitted to OceanObs'09. A CPT is also being developed on metrics and observations needed for the modeling community. During discussion, Marty Hoerling noted that Working Groups like WBC is where U.S. CLIVAR can get real work done, and that these WGs are producing great work and publications. He encouraged the Panels to be thinking about new Working Groups in addition to new themes.

4.5 U.S. Atlantic Meridional Overturning Circulation (AMOC) report

Jim Carton reviewed U.S. Atlantic Meridional Overturning Circulation (AMOC) activities. He noted that it is an inter-agency program with a focus on AMOC monitoring and prediction capability. The history of AMOC began with the Joint Subcommittee on Ocean Science and Technology (JSOST) Ocean Research Priorities Plan in October 2007. Jim noted that there are several unanswered questions AMOC is investigating including: What is the current state of the AMOC?; How has the AMOC varied in the past on interannual to centennial time scales?; What governs AMOC changes?; Is the AMOC predictable on 10-100 year time scales?; and What are the impacts of AMOC variability and change on climate? The group has three scientific/implementation objectives: to design and implement an AMOC monitoring system (in conjunction with U.S. CLIVAR POS Panel); assess the AMOC role in global climate; and assess AMOC predictability (with the aid of the U.S. CLIVAR DPWG). Jim listed several recommended activities from AMOC that attempt to put together whole picture of the circulation in the Atlantic. He noted key components of the observation program are currently focused in the North Atlantic, but are developing plans for the South Atlantic. There is an international effort RAPID/MOCHA array at 26N. The array is funded for 2004 – 2014 with the evaluation phase to begin in 2011. Additional observations include Line W, a sustained measurement program in the North Atlantic Deep Western Boundary Current at 39N, and the Western Boundary Time Series, along the Florida Straits. Jim then listed some of the ongoing AMOC funded projects, which are listed on the website at: <http://www.atlanticmoc.org/fundedresearch.php>. AMOC links to CLIVAR include an AMOC presentation to DPWG at their June meeting. In addition, AMOC is requesting feedback from the DPWG on distinguishing forced and natural components for AMOC, and requested input on metrics for evaluating the AMOC in model simulations. They will have joint meeting on predictability with CLIVAR WGOMD in September 2010. Finally, Jim pointed out that the only way to have an effective monitoring system is through international cooperation and coordination.

5 International CLIVAR Report

David Legler introduced Anna Pirani from the International CLIVAR Project office. Anna reviewed CLIVAR's activities and imperatives, which include climate modeling, observations and process studies, climate extremes, monsoons and African climate variability, and decadal

variability and prediction. Anna stated that CLIVAR will continue through 2013 and has been asked by WCRP to reflect on where CLIVAR is headed in the next 5 years and beyond. Anna discussed the current membership of the CLIVAR SSC and the overall CLIVAR organization and structure. Since the U.S. CLIVAR reorganization, International CLIVAR no longer mirrors the US component, although the activities are similar. Anna showed CLIVAR's Panel structure and discussed their foci. Currently the basin Panels look at phenomena, observations, modeling, and process studies. Within climate modeling, the highlights from the previous year include coordinated development of ocean synthesis products and regional climate modeling, looking at best practices in regional downscaling. Key activities in process studies and observations include the Global Ocean Observing System (GOOS) and improving the prediction of key tropical modes such as ENSO and Tropical Atlantic Variability (TAV). Under the monsoons and African climate variability activity, CLIVAR is participating in the Year of Tropical Convection (YOTC), the U.S. CLIVAR MJO Working Group and AMMA, and helping implement the Variability of the African Monsoon System (VAMOS) modeling plan. The Working Group on Ocean Model Development (WGOMD) is hosting a workshop on the role of ocean variability in decadal prediction in October 2010.

WCRP is working under the Coordinated Observation and Prediction of the Earth System (COPEs) and tasked CLIVAR to formulate a series of imperatives for WCRP. An imperative is defined by WCRP as an activity that must continue and has high chance of success. The imperatives are organized around the WCRP cross cutting themes. Anna stated that CLIVAR has the lead on Anthropogenic Climate Change (ACC), Decadal Variability Predictability and Prediction, and Intraseasonal and Seasonal Predictability and Prediction. Other imperatives for CLIVAR include improved atmosphere and ocean components of Earth System Models, data synthesis and analysis, an ocean observing system and capacity building, as a means of making modeling and other data sets more easily available to the community.

Anna requested feedback on a survey for the WCRP community-wide consultation on model evaluation and improvement. The survey will be sent to many forecasting centers, CLIVAR Panels, and WCRP projects. Anna noted that this is a bottom-up survey to assess the need for improving CLIVAR integration. It will also serve as input for the Working Group on Coupled Modeling (WGCM) and the Working Group on Numerical Experimentation (WGNE), and as a community resource website and a white paper. The survey will hopefully help define priorities and new opportunities and develop the next generation of models.

During the discussion Marty Hoerling noted that caution labels should be applied to certain model data sets, as models continue to have imperfections, but that the community should be utilizing the existing suites of model runs. He stated that too often scientists are discouraged from using models that are deficient, but they still need to still use older model runs. He hoped the survey would not prevent scientists from using these older model runs.

6 Variability of the American Monsoons Report (VAMOS)

Hugo Berbery, chair of the CLIVAR VAMOS Panel, gave background information on the establishment of VAMOS. The Panel grew out of two internationally coordinated monsoon experiments: the Monsoon Experiment of South America (MESA) and the North American Monsoon Experiment (NAME). A monsoon system encompasses not only the summer monsoon rainfall, but also the perturbations in the planetary, synoptic and mesoscale flow patterns that occur in association with it. The region covers both the tropical and extra-tropical Americas and surrounding oceans. One of motivations for the Panel was that MESA and NAME were linked by

the annual cycle of precipitation. A new process study, Intra Americas Study of Climate Processes (IASCLIP) will be a new science component of VAMOS. VAMOS participates in several of CLIVAR's cross cuts that Anna previously mentioned, most notably modeling and extremes. VAMOS is trying to align with WCRP COPES, but on a more regional scale. As NAME ends, many challenges remain, including the clear lack of predictability; the need for improved downscaling methods, and the failure of coupled models to realistically represent key features of the North American Monsoon hydroclimate.

Hugo also presented the goals of the VAMOS Ocean Cloud Atmosphere Land Study (VOCALS) field experiment. The field campaign has ended, and he noted that now is the time to take advantage and do data analysis and modeling (which continuing at several centers, universities and research institutes). Information on VOCALS can be found at:

www.eol.ucar.edu/projects/vocals/ .

IASCLIP is the next field campaign that VAMOS is sponsoring. The main science issues include sources and predictability of summertime anomalies in the Western Hemisphere Warm Pool (WHWP) and the structure and dynamics of the regional atmospheric circulation in the low level jets. IASCLIP can provide links and collaboration with NAME through Great Plains precipitation and with VOCALS through the boreal summer circulation. Hugo also mentioned the La Plata Basin research success through cooperative research networks.

With regards to the WCRP cross cuts on climate modeling, the VAMOS Modeling Plan is working to improve the prediction of warm season precipitation over the Americas for societal benefit and to assess implication of climate change. For the extremes cross cut, VAMOS has created a VAMOS Extremes Task Force. Siegfried Schubert has agreed to chair the group. They will be identifying extremes that are inherent to VAMOS Panel. The third cross cut addressed through VAMOS is the Anthropogenic Climate Change (ACC) task force which will look at regional climate downscaling important to VAMOS through the North American Regional climate Change Assessment Program (NARCCAP). Hugo summarized by noting that VAMOS contributes regional expertise to advance CLIVAR's imperatives and promotes communication between science components and research networks, and VAMOS is interested in strengthening its collaboration with U.S. CLIVAR.

During the discussion, Arun Kumar asked what is the best way to quantify model improvement in the process studies. Hugo indicated that NAME had sub-areas of importance and orography data, but was NCEP been able to take advantage of this? Arun thought the data could be used for validation possibly, but not improvement. Jin Huang stated that model improvement was not major focus in NAME, but that NAMAP followed on NAME, and did analyze the shortcomings of models in this region. NAME was the first time modelers were able to use process study information in their model development. Eric DeWeaver then asked what downscaling actually mean in VAMOS. The reply was that VAMOS wants to take advantage of regional models in an appropriate manner. CLARIS-LPB has several regional climate model scenarios and a set of metrics that will be employed in assessing model performance. The uncertainties in simulations from those metrics will be examined and reported.

7 Dynamics of the MJO (DYNAMO)

Dynamics of the MJO (DYNAMO) is the U.S. contribution to the Cooperative Indian Ocean Experiment on Intraseasonal Variability in year 2011 (CINDY2011). Chidong Zhang (University of Miami) presented an overview on the proposed process study. Also representing DYNAMO at the Summit were Steve Rutlege (Colorado State U), Jim Moum (Oregon State U), and Wayne

Higgins (NOAA-NCEP). Chidong explained that CINDY will study the initiation of MJO in Indian Ocean.

Wayne Higgins led the discussion on operational prediction of the MJO prediction. The lack of understanding of the initiation process makes prediction difficult, and although dynamical models are improving, they currently offer limited skill. NOAA-NCEP views DYNAMO as a way forward in prediction, as daily monitoring of the MJO is the most reliable approach for the anticipation of the MJO development. DYNAMO can help through field observations by improving documentation of MJO initiation. Currently operational MJO prediction uses zonal wind and outgoing longwave radiation (OLR). A dynamical model framework is proposed for DYNAMO using a suite of models (e.g. ECMWF, NCEP, UKMet, CMC). A DYNAMO CPT would be very useful as well. Currently, the NOAA Global Tropics Hazard/Benefits Assessment relies heavily on MJO prediction and provides lead-time on extreme events to many aid agencies (Red Cross, USAID, weather agencies). Thus, DYNAMO could provide very important information to improve operational prediction. The prediction skill is limited at the moment, particularly in the initiation phase of MJO in the Indian Ocean. The NOAA Climate Prediction Center (CPC) can provide strong operational support for DYNAMO, relying on their previous experience with NAME and AMMA. CPC can also provide expert assessment of the CLIVAR MJO index forecast tools and archive information.

Chidong then presented the scientific importance of the MJO and its challenges. He stated that the initiation of MJO is important to many weather/climate events such as monsoons, ENSO, extreme events, teleconnections (NAO, AO, etc...). The problem is the inability to consistently reproduce MJO in global climate models. He stated that models, some of which can predict the MJO, still have problems in the Indian Ocean region. There is a systematic eastward propagation of precipitation, and in between MJO events there is no convection present in the models. Two types of initiation mechanisms are proposed for DYNAMO investigation: 1) Internal, with no preexisting conditions and 2) External, with perturbations from upstream or the extratropics. Chidong then noted recent theoretical and modeling studies on MJO, and then outlined DYNAMO and the guidelines and criteria for proposed hypotheses. The proposed hypotheses must be field tested, must lead to specific information for model improvement and will concentrate on 4 components: the role of moisture; the role of diabatic heating; the role of multi-scale interaction and the role of the upper ocean. Four hypotheses were listed under scenario A (internal initiation) and are currently under development. The DYNAMO program structure was then explained. A proposed CPT is forming to make close connection between DYNAMO and modeling centers. PSMIP is curious to know how DYNAMO will involve modeling centers during its planning. Chidong said that the field campaign will be the main source of data for testing hypotheses using models. DYNAMO will leverage existing modeling activities, and the CPT will develop diagnostic metrics for processes of convection-circulation coupling.

The 2011 field campaign will include a sounding-radar array (with Japan, Australia, India and maybe the U.S., France and China). The field campaign is designed to study moisture, convection and upper-ocean mixing. IndoOS and RAMA will continue long-term monitoring. The enhanced observing period (EOP) will run from September 2011 through February 2012. In 2011 there are already a suite of observations occurring, (AMIE-DOE AMMA; HARIMAU-Japan and Indian; and PAC3E-SA – NASA field campaign). Chidong said that DYNAMO must leverage these other campaigns. Unfortunately, ship time is still questionable, as is getting permission from the Naval Base site at Diego Garcia. He also noted that with all the international programs occurring, this is a great chance to monitor MJO from a very early initiation phase. He noted that the MJO is a rare event and doesn't always occur. DYNAMO will target 70E to 80E based on probability and a four-month observing period is needed in order to capture MJO events. PSMI asked if

DYNAMO is necessary after TOGA COARE. Chidong says the MJO is a unique climate modeling challenge, there is new observing technology, and the MJO has a unique life evolution. Outcomes will also include a unique in-situ data set. The data collected will be available to all climate-modeling centers. In addition, there will be advancement in the understanding of the MJO dynamics and initiation processes.

During the discussion, Eric Itsweire (NSF) asked how CINDY2011 would contribute to DYNAMO. The answer is that no single country can support a four-month EOP, but if four ships were present in the area a longer observation period could occur. Discussion is ongoing with France as to whether they will bring a ship, but nothing is definite yet. Eric DeWeaver (NSF) asked if there were plans for remote sensing. Chidong doesn't know if current satellites will last that long so there is not a current plan for remote sensing. If satellite data were available, it would definitely be useful. Sonya Legg mentioned that new CPTs would begin this year and would be almost over before the DYNAMO field campaign took place. Chidong replied that DYNAMO could not directly contribute to a CPT in first phase, but it could do sensitivity studies before the field campaign. Further discussion centered on the models not being able to simulate an MJO, but maybe through the use of CLOUDSAT data or cloud resolving models, the hypotheses could be tested. Leo Donner mentioned that the MJO Working Group has developed diagnostics and metrics for the MJO, which have been used on many models. He also noted that several GCMs do have good MJO and could be used to test the hypotheses. Siegfried Schubert reemphasized the importance of data assimilation and it should not be overlooked as a way to make assessments of models and then apply the outcomes to new data.

8 Intra Americas Study of Climate Processes (IASCLIP)

David Enfield presented an overview of IASCLIP - a CLIVAR VAMOS program aimed to better understand the role of the Western Hemisphere warm pool (WHWP) in climate and to assess and improve the performance of models in predicting warm pool variations. IASCLIP will identify and quantify sources of predictability such as the remote forcing that is responsible for developing warm pool. There will also be a focus on linkages between the WHWP and tropical cyclone activity, mid-summer Caribbean drought, and Midwest floods and tornados. IASCLIP encompasses multiple space and time scales (e.g. ENSO, NAO, role of Amazon). SST and warm pool anomalies also have a strong impact on the land climates of the surrounding regions including west Africa, northern South American, the Caribbean, Central and southern North America. Associated with changes of the WHWP are changes of the low level jet (LLJ) over the Caribbean and in vertical wind shear, which alters cyclogenesis. Because of intersecting and multiple climate processes central to the region, it is difficult to develop a *single* study that would address its many components. However, the Atlantic warm pool will be the central focus of IASCLIP.

Enfield noted there are many challenges to IASCLIP, which will be addressed in three Working Groups. The first Working Group, Predictability and Prediction, will assess multiple GCMs to determine how well the WHWP is reproduced and what is needed for forecast initialization. The Diagnostics and Observations Working Group will look at the specific needs for a long term observing system and provide data for downscaling studies. The last Working Group, IAS Alliance, is focused on entraining countries in the region to help in monitoring, developing statistical prediction tools, and capacity building.

David noted that IPCC AR4 models have SST biases (models are weaker than actual values) as well as rain biases over the region. The LLJ is too strong as is wind shear in the models. 2005 was a big year for WHWP and cyclogenesis, but the NOAA CFS model was unable to predict it. Few

observations exist in the Gulf Mexico or Caribbean (WHWP region) compared to Atlantic. To address this, the Predictability and Prediction WG has 2 goals: to improve the understanding of the physical processes and mechanisms association with the IAS climate variability on seasonal to interannual time scales through numerical experimentation and model diagnostics; and to quantify the limit of predictability through numerical experimentation and experimental prediction. Strategies for goal one include diagnosing the role of local processes versus remote influences; diagnosing the roles of oceanic, atmospheric and land process on IAS variability; and understanding the interaction between warm pool variability and mesoscale phenomena such as tropical cyclogenesis. For goal two, the WG plans to evaluate and identify deficiencies in model forecasts; coordinate a comprehensive analysis of seasonal to interannual prediction skill based on available hindcast data; and entrain statisticians and modelers in assessing the best predictive capability for the IAS region.

David then discussed the needs of the observing network. Surface in situ data on the small islands and the isthmus of Central America are critical. Adding TAO like temperature sensors to National Data Buoy Center (NDBC) buoys in Caribbean and four XBT routes across the warm pool region on VOS ships would be ideal. Finally, profiling gliders, which were noted as costly, would also be tremendously useful. The Applications and Outreach Working Group, by building up the alliance with other countries, particularly those countries affected climatically, could aid in securing additional observations. Short-term goals of IASCLIP include streamlining the original proposal by incorporating the implementation strategy into three Working Groups; broadening the participation in modeling; increasing the awareness of IASCLIP (e.g. at meetings such as the U.S. CLIVAR Summit); and implementing the Working Group strategies.

During the discussion, Leo Donner acknowledged the work by Knutsen on hurricane research using a high-resolution global model. Given historical SST, it is possible to predict cyclones in the eastern Pacific and Western Pacific. There is a strong suggestion that if the SST is correct, there may be substantial ability to predict tropical cyclones, but getting SST right is absolutely essential. The subtle details of SST are crucial and it is an important issue that IASCLIP could possibly address. He also noted that hurricane forecasting improvement money was coming to GFDL. Siegfried Schubert stated that a high-resolution tropical cyclone modeling approach could provide IASCLIP more focus. It was also suggested that other countries such as Puerto Rico (which is beginning to understand how the island modifies large-scale environment) could engage in the research as well.

9 Strategic Theme Discussion

David Legler led the discussion on developing new themes within U.S. CLIVAR. He noted that these themes would help prioritize scientific challenges within U.S. CLIVAR, stimulate strategic multi-year planning, and encourage integration across the Panels. These themes would also aid in agency strategic planning, and through U.S. CLIVAR's public acknowledgement of their importance, encourage other scientists to get involved in U.S. CLIVAR. Finally, additional themes would allow coordination of activities among other programs within WCRP, USGCRP, and elsewhere. U.S. CLIVAR currently has two major themes, Drought and Decadal Variability/Predictions, which are motivated in part by the service and decision making communities. Legler presented U.S. CLIVAR's drought activities, the strategy forward on drought, and future activities on drought. He highlighted the Drought Working Group's model experiments and the linkages to international modeling efforts as well as the DRICOMP small grants program. The U.S. CLIVAR Panels were charged with determining how U.S. CLIVAR can build on these successes within the drought activities and to formulate a way forward. Legler then listed highlights within U.S. CLIVAR on Decadal Variability/Predictions, which included

the establishment of a Decadal Predictability Working Group, field campaigns such as KESS and CLIMODE, and interaction with the AMOC program. Though Decadal Variability is a relatively new theme within U.S. CLIVAR, and not as developed as drought, there is significant interest and many ongoing activities.

Legler then attempted to define what constitutes a theme, though he acknowledged this could be developed further during the Summit. He suggested that themes need to: exist in a compelling area of coupled climate science research, intersect two or more U.S. CLIVAR Panels, and address the missions of the U.S. CLIVAR agencies. Themes should also reflect a state of readiness of the scientific community to engage and provide rapid payoff. Themes should be guided by a set of research questions reflecting strategic direction. Implementation of these themes should leverage existing funded activities and utilize current U.S. CLIVAR Working Groups and Panels.

Legler charged the Panels with developing and discussing potential themes in their individual Panel discussions, and in particular to focus on future activities within U.S. CLIVAR with respect to Drought. Legler went on to review the agenda for the Summit noting that each Panel would present proposed foci in the concluding plenary session. The Executive Committee would then confer on the proposed themes and establish a list of three they deemed ready to go forward. The last day of the Summit, each theme would be discussed in small groups. Following the Summit, a prospectus will be developed for new Working Groups related to the new theme(s), and U.S. CLIVAR would begin to identify partnerships and linkages to be formed and nurtured. The Summit 2010 will focus on some of the new theme(s).

During the ensuing open discussion, Siegfried Schubert noted that he sees the future of drought research connecting to the Decadal Working Group. By narrowing the focus of the DPWG and by working with AMOC, questions such as patterns linked to regional drought, and how predictable they are relative to changes in the ocean could be examined. In other words, does AMOC predictability really affect drought? Siegfried suggested that decadal prediction runs in CMIP5 could be more detailed than previous AMIP runs. Adding to this, Marty stated that U.S. CLIVAR has yet to touch the issue of climate change and drought, and is still wrestling with a definition of drought. He stated that drought simply refers to a departure from normal. A way forward might include a task force on climate change and drought to determine whether or not we are in a new climatic state. Kelly Redmond sees the necessity of getting drought down to a regional scale, and noted that there are different types of drought. The Drought WG was mainly focused on SST, but some sort of land modeling (e.g. such as looking at snow pack, as its differentiation is very important and necessary to drought) could also focus further drought efforts. Marty noted that a current RISA program on the Colorado River flow is looking at the Colorado River response to climate change. Nick Bond asked if the Drought WG had looked at flooding as a mirror to drought. Siegfried confirmed the idea of flooding, stating that the group examined both drought and pluvials. Vimont agreed the flooding idea is good and brought up the importance of land processes. Vegetation was also deemed important to the study of drought. Arun Kumar reminded the Summit attendees that the initial focus of the Drought WG was predictive understanding of drought.

In discussing the actual procedure for developing new themes, several questions were raised. Xubin Zeng expressed concern about the lack of expertise in the room to really push new themes forward. Involving others in fleshing out themes might be prudent. Dan Vimont asked if the new themes would expand U.S. CLIVAR or if it would come from within the existing framework of U.S. CLIVAR Panel members. The answer is both, but David advised a cautious approach to expanding CLIVAR. Emerging topics within the agencies include carbon and ecosystems, and while U.S. CLIVAR does not do actual research in these areas, it can reach out and partner with

these other communities and bring them to the CLIVAR table. Currently, biological communities are really interested in climate. However, there is a huge scaling difference as the biological communities are still focused on much smaller regions.

Leo Donner noted that extremes, as a focus, have the potential for growth as a theme. GFDL has had some success in predicting past tropical cyclones and it may be possible for big modeling breakthroughs in this area, which would relate to societal impacts as well. Rick Rosen noted that climate and health were also being pushed forward within the agencies and so societal relevance was a key. Marty thought it would help to hear from operational centers as to their current problems and how U.S. CLIVAR could assist them. Coupled data assimilation and global and regional sea level change were brought forth as well.

After discussion within each Panel, the group reconvened to present the Panels' ideas on possible future themes. David Legler moderated the discussion. PPAI proposed themes included: 1) climate, carbon and ecosystems, 2) storms, sea level and coasts, 3) pathways for reducing model biases. The Panel initially thought they would stick within the physical system, but after listening to NOAA program managers, the group decided a cross-disciplinary theme essential. A cross-disciplinary theme could leverage upcoming opportunities and ongoing efforts within the US. Theme 2 was partially motivated by bringing extreme events to CLIVAR in a more concrete way. Looking at sea level ties into longer time scales such as decadal, while the coastal portion provides a connection to NOAA's new focus on coastal zones. They noted that storms could imply hurricanes, mid-latitude storms, eastern seaboard storms etc. Finally, theme 3 came from two directions: seasonal-interannual (SI) predictions and a prior tropical biases Working Group prospectus that has recently refocused itself. The idea morphed into an overarching view of model biases which brings in a lot more diversity to the problem such as diagnosing sources of model biases; documenting how we treat them; the implications of these errors; and prognoses – a process oriented or CPT like approach for using model biases which would bring together all Panels.

The PSMI Panel presented also three potential new themes: 1) High latitude climate change, including sea ice, land ice, sea level rise, and the entire Arctic/Antarctic climate change system; 2) Coastal zone and ecosystems in a changing climate which included upwelling, river runoff; impact on ecosystems and societal importance and would bring in a downscaling component; and 3) Extreme events which could overlap with drought, should the scope of drought be broadened.

The POS Panel potential themes included: 1) Extremes, which would cover ocean influences, wind events, frequency, ecosystem impacts; simulation of observed distribution by models and physical explanation; and initiation of tipping points; 2) Regional Climate Change to cover coastal (land and ocean); downscaling methodology; applications including ecosystem impacts as a way to examine unresolved problems in climate models; and observing systems on a regional scale and potential predictability.

David noted that coastal, extremes and ecosystems appeared to have overlapping ideas among the three Panels, and asked how the members felt about these three themes. Some discussion on ecosystems followed. Would the theme focus on the coastal or global ecosystem? Would it cover terrestrial or marine ecosystems, or both? POS stated that they dismissed carbon and ecosystems as a potential theme because they did not have enough expertise in their Panel. PPAI initially felt the same, but after NOAA program managers repeatedly noted future funding was aimed in this direction, PPAI decided to step out of their comfort zone. Ecosystems would provide an excellent opportunity to bring CLIVAR expertise to other communities. Mike Alexander noted that the marine ecosystem community is very interested in climate. The theme could be organized around

getting information to those communities that need climate data. The theme would have to be restructured a bit different from current CLIVAR themes. To focus the theme, PSMI offered that coastal zones in ecosystems could be examined otherwise the theme seemed too broad. Alexey Kaplan says U.S. CLIVAR is about physical science and thus an ecosystem theme should focus on climate feedbacks. The group was reminded that CLIVAR needed to look for linkages to other communities, would be a partner with these other communities, and not do all the research. Lisa Goddard believes CLIVAR should examine local/regional climate processes and their predictability while partnering with other communities. She noted that the terrestrial ecosystem community is quite different from the marine ecosystem community, and communication would be more difficult with the terrestrial community.

Next, questions regarding carbon cycle aspects arose. PPAI noted that it has shared activities in modeling the vegetation cycle, which is where earth system modeling is headed. CMIP5 runs are targeting ways to predict carbon system. Therefore, the Integrated Earth System Analysis is where U.S. CLIVAR and the carbon system could interact and where funding is becoming available.

PSMI felt drought should expand to include extreme events, as extremes seem to be included in all of the Panels' theme discussions. The group agreed there has been little progress in what is meant by extremes, so a concrete list must be developed if this were to go forward as a theme. A number of research topics could fall under extremes including: tipping points, statistics, and downscaling.

Discussion then centered on Arctic and high latitude climate change. It was unclear to PSMI if some engagement by U.S. CLIVAR would help the activities. The Panel also noted there was limited expertise on all the current U.S. CLIVAR Panels with respect to high latitude climate change. PPAI felt polar climate could be embedded under sea level and coastal issues. PSMI stated that the southern ocean region is relatively unexplored. The Arctic has a lot of activity through the International Polar Year (IPY), although not much activity within the US. However, a lot of questions remain in the Southern Ocean region including whether or not the Antarctic ice sheet is actually growing or shrinking.

Finally David brought up model biases. PSMI did not consider the topic a scientific theme, more of a technical topic, as the current strategy is unscientific. PSMI stated the model bias is not a "science question"; it's a mandate of the PSMI Panel. However, PPAI would like to connect with field studies and develop some methodology on how to deal with biases. There is growing concern that model tuning is done without relating to physical processes. There is also concern that process studies do not translate into model improvements fast enough. PSMI stated that model improvements lie within their mandate and should not be considered a theme.

The common themes that emerged were:

- 1) Climate and ecosystems
- 2) Extremes
- 3) Climate changes on regional and local scales
- 4) High latitude climate change

10 Charge to the Panels

David Legler provided a template to each of the Panels for reporting at the end of the Summit. In addition to discussing the Panel's previous year's activities, he asked each Panel to consider their progress on its two foci: Drought and Decadal Variability/Predictability. He noted that discussion

of these foci should center on synthesizing existing knowledge of the foci and capabilities within the Panel, assessing opportunities and articulating Panel goals related to the foci, while devising a plan to achieve these goals.

11 Predictions, Predictability & Applications Interface Panel Report

11.1 Decadal Prediction and Predictability

The Panel had extensive discussion of U.S. CLIVAR contributions to decadal prediction and predictability. The Panel was briefed on the progress of the Decadal Predictability Working Group (DPWG), and the three upcoming decadal workshops.

Decadal Predictability Working Group:

The DPWG is finalizing a white paper to be submitted to BAMS. The paper summarizes and critique methodologies that have been used to distinguish the role of natural variations from anthropogenically-forced variations on decadal time-scales. The paper also discusses the present understanding of physical mechanisms, or modes of variability, that might lead to skillful predictions on decadal time-scale and could be useful for evaluation of model simulations. The white paper addresses the following questions:

- Can we estimate the relative amplitude, and spatial structure, of natural and forced variability on decadal timescales?
- What approaches can be used to separate natural decadal variability from anthropogenically forced decadal variations?
- How does the analysis depend on the chosen method?

In addressing these questions, the white paper describes how the “fingerprint” of forced variability may interact with the natural variability, and what robust estimates of observed decadal variations could be used to validate the models. The white paper will be submitted to BAMS this fall.

Action Item 1: PPAI members (Goddard, Kumar and Kirtman) continue to contribute to the Decadal Predictability WG white paper.

Decadal Workshops:

The Panel was briefed on the status of three upcoming decadal workshops. PPAI members are represented on the organizing/science committees for all three workshops. Some expressed concern regarding the need for three workshops with similar themes in rapid succession. The Panel noted that the foci of the workshops were complementary, but that some coordination will be encouraged.

The three workshops are:

- a) Earth-System Initialization for Decadal Prediction; 4-6 November, Utrecht, the Netherlands
- b) The 8th Workshop on Decadal Climate Variability; 12-15 October, St. Michaels Island, Maryland USA
- c) Predicting the Climate of the Coming Decades; 11-15 January, Miami, Florida USA

Action Item 2: The PPAI Panel and the Decadal Predictability WG should ensure coordination across all three decadal climate workshops: Earth System Initialization for Decadal Prediction, Decadal Climate Variability and Predicting the Climate of the Coming Decades (Goddard, Kirtman, Kumar, Meehl)

Ocean Obs09 White Papers:

The Panel was briefed on a number of Ocean Obs09 white papers. These white papers include:

- Initialization for Seasonal and Decadal Forecasts: Balmaseda et al.
 - Argo Capable of Constraining Deep Ocean Variables Responsible for Decadal Variability
- Ocean Observing System Evaluation: Oke et al.
 - Propose various techniques to evaluate ocean observing systems
- Dynamics of Decadal Climate Variability and Implications for its Prediction: Latif et al.
 - Focuses on the internal mechanisms relevant to the Atlantic Multidecadal Oscillation/Variability (AMO/V) and the Pacific Decadal Oscillation/Variability (PDO/V)
- Decadal Climate Prediction: Opportunities and Challenges: Hurrell et al.
 - Identify sources of predictability: forcing and natural and challenges: Initial conditions and verification
- Ocean State Estimation for Global Ocean Monitoring: ENSO and Beyond ENSO
 - Ocean Reanalysis for S-I prediction and climate monitoring

11.2 Drought

The Panel had extensive discussion on how to capitalize on the momentum established by the Drought Working Group. Siegfried Schubert co-Chair of the Drought Working Group participated in the discussions. The Panel recommends that there be a *Scoping Group* to identify priorities in terms of analysis of existing data sets, possible follow-on experiments, reaching out to NIDIS, and a possible AO.

Action Item 3: Kumar and Kirtman to discuss with U.S. CLIVAR executive committee whether to establish a Scoping Group to build on the success of the Drought Working Group.

11.3 Climate Prediction Applications Postdoc Program (CPAPP).

The CPAPP program has been renamed to Post-Docs Applying Climate Expertise (PACE). Lisa Goddard provided an update of the program. The goal remains to grow the pool of scientists qualified to transfer advances in climate science and climate prediction into climate-related decision framework(s) and decision tools. Year one of the program funded one post-doctoral scientist (*Galina Guentchev*) with host partners Joe Barsugli (NOAA Western Water Assessment) and Terry Fulp (Bureau of Reclamation, Lower Colorado Region). Year two of the program is funding two post-doctoral scientists (Kelly Mahoney, Imtiaz Rangwala). The host partners for Mahoney are David Raff (US Bureau of Reclamation) and Michael Alexander (NOAA/ESRL) and the host partners for Rengwala are Jim Prairie (Center for Advanced Decision Support for Water & Environmental Systems) and Joe Barsugli (NOAA/ESRL).

Action Item 4: PPAI will continue working with Meg Austin, Director of the UCAR visiting scientist program, to further the Climate Prediction Applications Postdoc Program. (Lisa Goddard, Ben Kirtman)

11.4 Best Practices in Prediction

There is a National Academies assessment of climate predictability on intraseasonal-to-interannual time scales. This study will review the current state of knowledge about estimates of predictability of the climate system on intraseasonal-to-interannual timescales, assess in what ways current estimates are deficient, and recommend ways to improve upon the current predictability estimates. The study will also recommend research and model development foci and efforts that will be most beneficial in narrowing the gap between the current skill of predictions and estimated predictability limits. The review of predictability estimates to be addressed will include oceanic and atmospheric variables such as sea surface temperature, surface temperature, precipitation, and soil moisture, as well as indices like Nino 3.4 sea surface temperatures or the phases of the Madden-Julian Oscillation.

Action Item 5: PPAI members (Goddard, Kirtman and Koster) will continue to participate in the National Academies assessment of climate predictability.

11.5 Tropical Biases Working Group

The PPAI Panel led discussions on the need for a Working Group focused on tropical biases in coupled general circulations models. The discussion concluded that systematic biases in the tropics are unacceptably large in terms of prediction and associated teleconnections limiting use and that this is severely limiting the usefulness. Some examples include the double ITCZ, excessively strong cold-tongue, eastern Ocean biases. Past efforts, which have had notable success include three focused workshops (GFDL'03, COLA'05, NCAR'06) and the WGNE-WGSIP meeting San Francisco 2007. The discussion group also concluded that despite these successes there is need for reinvigoration. This is particularly timely since there is going to be a new set of models participating in CMIP5, and we need to assess where our efforts have succeeded and where there is still much need for improvement. Moreover, there are new data sets from various field campaigns (e.g., YOTC, VOCALS, ARGOS, IASCLIP) that will be particularly useful in assessing the fidelity of the models.

The discussion group recommended that the Tropical Biases Working Group prospectus be revised to build on previous activities by providing an unbiased assessment of the current state of the models with an evaluation of what strategies have and have not worked. The discussion group also recommended that the prospectus and WG membership clearly reflect the need to have observationalists, process models and large-scale modelers work together to reduce biases. The expected outcomes of the WG include a review of current status and outcomes from workshops (BAMS or EOS paper outlining best practices in model improvement strategies).

The WG would reevaluate tropical biases in datasets from recent model intercomparisons with a focus on attacking the models with existing observational datasets from recent field campaigns and observing programs. This is an excellent opportunity to interface with the VOCALS program, YOTC and the emerging IASCLIP program. The WG would focus on developing new process

oriented diagnostics and would develop a paper in *Climate Dynamics* or *J. Climate* demonstrating the use of these diagnostics.

Action item 6: PPAI will submit a revised Working Group prospectus on Tropical Biases to the U.S. CLIVAR Executive Committee (Ben Kirtman, Paquita Zuidema, Ed Schneider)

11.6 Discussion of New Themes

PPAI participated in extensive discussion of a new U.S. CLIVAR theme. The discussion included:

- Climate, Carbon and Ecosystems
- Storms, Sea Level and Coasts
- Pathways for Reducing Model Biases

No clear consensus was reached.

12 Process Studies and Model Improvement Panel Report

12.1 Ongoing Process Studies

In advance of the Summit, process study liaisons solicited information from process study PIs, which was shared with the full Panel at the Summit. The Panel discussed the process study progress with regard to the best practices, summarized below for each process study.

Action item 7: PSMIP will communicate feedback to each of the U.S. CLIVAR process studies by the end of summer [process study liaisons].

12.1.1 CLIMODE [Liaison: Kathy Donohue and Paquita Zuidema]

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. In this CLIMODE was working with CPT Emilie. A website is being maintained (<http://www.climode.org/>) as well as one at NCAR/EOL, but these appear to be out of date. No level-3 datasets or diagnostics are available.

Recommendation to CLIMODE: encourage PIs to update their website, and develop and make higher-level datasets available.

12.1.2 DIMES [Liaison: Lisa Beal and Kathy Donohue]

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. A total of eight field campaigns will be carried out by early 2012, of which the first was completed in February 2009.

Recommendation to DIMES: establish a precedent for archiving microstructure data in a universal format that can be subsequently adopted at NODC.

12.1.3 KESS [Liaison: Kathy Donohue and Lisa Beal].

The field phase of the Kuroshio Extension System Study ended in 2006. The Panel was encouraged by the website (uskess.org) serving as a centralized information and data portal, but noticed a lack of gridded datasets and the diagnostics used in publications on the website. Recommendation: Create synthesis datasets to use as benchmarks for assessing models, make more 'level 3' products available through uskess.org

12.1.4 NAME [Liaison: Wanqiu Wang and Xubin Zeng]

The North American Monsoon Experiment field phase ended in 2005, a data archive is maintained at EOL and synthesis datasets have been created. Current activities include a NAME Forecast Forum and 'legacy coordination'; the latter includes continued development of a regional observing system design. An AGU special session will be held during the 2009 fall meeting.

Recommendation to NAME: NAME is also valuable as a guide to the future of IASCLIP. The AGU special session is one opportunity to develop scientific and programmatic links between the 2 process studies; we encourage the seeking of other opportunities. This can include developing explicit applications of the Regional Climate Observing System Design for the proposed IASCLIP study. A helpful legacy activity also is to develop science questions based on the NAME experience that could potentially be addressed by IASCLIP.

12.1.5 VOCALS [Liaison: Paquita Zuidema and Piotr Flatau]

The VAMOS Ocean-Coupled-Land-Atmosphere Study completed its Regional Experiment during Oct-Nov 2008. A pre-experiment modeling assessment of 2006 conditions along 20S is nearing completion, and a modeling assessment of 2008 conditions is underway. Data are being archived at EOL. A special session will be held at the 2009 AGU fall meeting, and a JGR Special Issue is under discussion.

Recommendation to VOCALS: None at this point in time

12.2 Possible future process studies

12.2.1 IASCLIP [Liaison: Xubin Zeng and Paquita Zuidema]

David Enfield provided an overview talk of IASCLIP activities during the plenary meeting, with Mike Douglas providing more detail to the PSMI Panel and jointly to the PSMI and POS Panels. NOAA CPPA has selected several IASCLIP-related projects for funding in FY2009. Mike Douglas has been funded by NOAA CPPA to do a site survey, but scientific hypotheses driving an atmospheric observational program are not yet well articulated. The cost versus benefit of a vertical profiling capability attached to existing NODC buoys also needs to be articulated better, perhaps through an OSSE exercise.

Recommendation to IASCLIP: A shorter, more focused, white paper needs to be developed. Ideas for an extended monitoring program seem to be in place, but a strong scientific justification and cost-benefit analysis are lacking. NAME legacy science questions could be examined in this quest. In keeping with the discussion at the plenary meeting, we also recommend more of a

connection be made with the hurricane community. PSMIP does not expect to request another presentation next year.

12.2.2 Salinity Process Study [Liaison: Frank Bryan and Paquita Zuidema]

While this concept has not been significantly developed since last year, interest remains, motivated by the availability of new sensors. A community white paper describing a more detailed science plan is currently in preparation by members of the former U.S. CLIVAR Salinity Working Group. Further formulation of a prospectus for a field experiment is expected in the coming months as part of the formation of the NASA Salinity Science Team. PSMIP encourages any potential experiment to be designed so as to provide insight at a process level.

Recommendation: Inquire if the team developing the science plan wishes for continued engagement with the PSMIP.

12.2.3 PUMP2 [Liaison: Ed Schneider and Sonya Legg]

Interest remains in a Pacific Upwelling and Mixing Physics study, with activity occurring by individual funded investigators. Desire for coordination is reflected in a Google group “pump2”. The process and modeling studies described address very important model biases and are relevant to PSMIP. Expanding the domain of interest to encompass regions farther off the equator would be of great interest also.

Recommendation to PUMP2: PSMIP would like to be informed if PUMP2 investigators begin work on designing and/or coordinating a coordinated project.

12.2.4 DYNAMO [Liaison: Piotr Flatau and Ed Schneider]

DYNAMO PI Chidong Zhang gave a plenary presentation followed by presentations to the PSMI Panel on the radar and ocean observing systems (Steve Rutledge and Jim Moum, respectively). An open data policy, with data archiving anticipated to take place at EOL, was stated. The PSMIP requested that modelers and observationalists work together as early as the funding timeline will allow. This collaboration will need to be separate from any CPT considerations, as the CPT timeline does not allow for a Dynamo-focused CPT. PSMIP also requested that outreach to the international community and satellite community continue.

Recommendation to DYNAMO: begin early discussions on synthesis datasets and on diagnostic activities, for example, an MJO forecast activity for DYNAMO based on existing datasets. Continue outreach to the international and satellite community; the MJO is particularly suitable for space-based observation.

12.3 PSMIP's relationship with process studies

PSMIP discussed its “non-endorsement” charge for process studies. PSMIP can provide a forum and feedback for process studies interested in engaging with U.S. CLIVAR. The Panel cannot officially endorse, however, as this implies a funding preference be granted to ‘endorsed’ process studies, when in fact the process studies are still subject to normal programmatic review procedures. This charge contrasts with International CLIVAR, where Panels do endorse process studies furthering its goals.

Action Item 8: PSMIP to include a short statement in their terms of reference on the webpage regarding their relationship with process studies. [Zuidema]

12.4 Best practices for Process Studies

PSMIP discussed the best practices for process studies, which have been developed over the course of several years in consultation with process study PIs. A recent article in BAMS aims to publicize these best practices.

Action item 9: PSMIP to continue to solicit information from and provide feedback to process studies concerning their progress toward best practices goals. [process study liaisons]

12.5 Best practices for parameterization development

Following a presentation by Leo Donner last year, and ensuing discussion, an opinion piece on best practices in parameterization development has been proposed. Due to other commitments, this has not been completed, but it is still considered an important task.

Action item 10: PSMIP to write an opinion piece on best practices in parameterization development [Donner (lead), Zuidema, Bryan]

12.6 Satellite data for parameterization development

Joao Teixeira briefly discussed the use of various satellite data (e.g., AIRS, CloudSat, MISR, GPS RO, GOES) in model evaluation and process studies. He emphasized that the traditional way of field experiments, followed by large-eddy simulation (LES) and cloud-resolvable modeling (CRM), and subsequently followed by global model evaluation has proved valuable in identifying critical processes and formulating parameterizations, but produces results of uncertain generality, because limited areas can be studied for limited periods. In contrast, satellite data has the potential for model evaluation and parameterization development over the globe for longer periods of time. Satellite observations are an important means of generalizing the results from field and process studies, and synergies between the three are important.

PSMIP agreed to advocate the use of satellite data (particularly their pdfs) in model evaluation and process studies. This could also open a new door for cooperation between PSMIP and NASA.

Action item 11: PSMIP to develop ideas for promoting the use of satellite data for model evaluation and parameterization development, including: a workshop to build community consensus; a short paper for *Eos* or NASA Earth Observer to emphasize that satellite data can be used in global model evaluation and process studies. [Teixeira and Zeng]

12.7 Connections with NASA

Several of the new NASA missions, e.g. Aquarius, were discussed in some detail. The new NRC decadal survey NASA missions associated with specific physical processes were summarized (e.g. SMAP, CLARREO). In addition the GPM precipitation mission and possible new GPS Radio Occultation missions were also mentioned. The possibility of using current high-resolution NASA observations to directly obtain information on Probability Density Functions (PDFs) for

parameterization development was presented. A final suggestion was that the Panel should try to get more involved in the planning stages of new missions.

Action item 12: PSMIP to continue to communicate with NASA program managers and explore ways in which PSMIP can contribute to planning stages of new missions. [Zeng and Teixeira]

12.8 Data stewardship

Discussion, jointly between members of PSMIP and POS, focused on a goal of preparing a best practices document for publication and/or for web distribution.

A new development over the past year is that Margarita Gregg has led a data stewardship OceanObs'09 Community White Paper. We discussed whether this white paper sufficed as a best practices document. We discussed that NSF does have a clear and straightforward data sharing policy and that any future best practices publications should stress what's new.

Action item 13: PSMIP to write an extremely short document for EOS with a focus on what is new in the NODC data policy. We anticipate that Margarita Gregg, NOAA, would collaborate on this document. A potentially new aspect of the policy would be a recommendation that PIs follow up on the availability of previously submitted data. [Gille, POS lead, with Donohue, PSMIP lead]

Action item 14: Archival of LADCP data: PSMIP to recommend to NOAA/NODC that U.S. CLIVAR sees the LADCP archive as a priority -- Pat Caldwell is willing to archive LADCP data but needs more resources, and a LADCP processing expert needs to join any effort Pat Caldwell undertakes to archive LADCP data. [Donohue and members of POS]

Action item 15: PSMIP to assess the status of unusual data sets (e.g. RAFOS floats, pressure, current, inverted echo sounder) within the NODC archive. For example: Are they readily available? Are PIs submitting contemporary data sets? [Donohue]

12.9 Turbulence data archival

PSMIP and POS had a joint discussion regarding ocean turbulence/microstructure data sets. Currently such data sets are not archived at any centralized data repositories (e.g. NODC) and archival is managed by each individual PI. A discussion with turbulence observationalists over the past year highlighted some of the difficulties: spotty archival practices when the responsibility rests with individuals; the inflexibility of current centralized archives; and the need for lots of meta-data to record the context of the measurement and the algorithms used to obtain dissipation from raw measurements. The Summit discussion focused on the steps that need to be taken to try to correct the current situation and ensure that data is not lost.

Action item 16: PSMIP to monitor the efforts of the DIMES process study to archive their microstructure data at Scripps (contact, Steve Diggs), so that lessons learned from this experiment can be transferred to other process studies. [Legg]

Action item 17: PSMIP to compile a list of all existing climate-related turbulence data sets we would like to see archived, drawing on efforts of Lou St. Laurent and Kurt Polzin. [Legg]

Action item 18: PSMIP to work with NSF program managers to encourage current and future turbulence data sets to be archived following the DIMES example. [Legg]

12.10 Climate Process Teams

Following efforts of PSMIP in the past couple of years, NSF and other agencies announced a new round of climate process teams, for which proposals are due in September. These encompass both oceanic and atmospheric endeavors.

Action item 19: Ensure that PSMIP CPT Review and Recommendations document is publicized to potential CPT participants, and work with community to facilitate a competitive field of proposals for this next round. [Legg]

12.11 Postdoctoral trainee fellowship scheme

There is a clear challenge at US climate modeling centers in recruiting staff for model development positions. While fundamentals of climate modeling should be taught at the graduate level, model development (as opposed to model experimentation or diagnostics) may be too specialized for graduate students to take on as a research topic. One possible mechanism to address this shortage would be to establish a traineeship, spread across and coordinated among major centers, ideally international in scope. This apprenticeship program would be sized and structured to meet the staffing needs of the centers themselves, offering long term career opportunities following the traineeship period.

Action item 20: PSMIP to initiate a meeting between advocates from the climate modeling centers and agency representatives to gauge interest in a climate modeling postdoctoral trainee fellowship scheme, and discuss how this could be coordinated between centers [Donner]

12.12 Working Groups

12.12.1 Tropical biases Working Group proposal

Ben Kirtman presented an overview of an updated proposal for a Tropical Biases Working Group (TBWG; authors Kirtman, Schneider, Mechoso, and Zuidema) to members of the Panels. The proposal builds on two earlier proposals declined by CLIVAR. Based on feedback from the earlier submissions, the new version places a strong emphasis on encouraging large-scale modelers, process modelers, and observationalists to work together in a CPT-like framework, thus cutting across the CLIVAR Panel activities. The TBWG will enhance international collaboration and partnerships.

A comprehensive assessment is needed for the new generation of models, especially in light of new data and process studies. The TBWG will build on earlier efforts in the past decade, which led to or were associated with significant successes in the reduction of tropical biases. The proposed Working Group activities include a review of the both the methods and outcomes from earlier attempts to correct the tropical biases (e.g. from publications and workshop reports) with a view to suggesting best practices, a reevaluation of the biases in datasets from recent model intercomparisons, and development of new process oriented diagnostics.

Action item 21: PSMIP to recommend the tropical biases Working Group proposal be submitted for consideration by U.S. CLIVAR. [Schneider, PSMIP lead]

12.13 Panel membership

Several members of PSMIP will be rotating off the Panel: Legg, Flatau, Zeng, and Donner. To replace these Panel members, we would like to see new membership including people with expertise in atmospheric GCMs, land surface processes, the cryosphere, regional climate processes and coastal downscaling, and the southern ocean (the latter three topics reflecting the proposed new themes of USCLIVAR).

Action Item 22: PSMIP to contact potential new Panel members to encourage them to apply to PSMIP. [Legg, Zuidema]

13 Phenomena, Observations and Synthesis Panel Report

13.1 Workshops and Working Groups

13.1.1 Western Boundary Current Working Group

We briefly reviewed the status of the Western Boundary Current Working Group, which wrapped up early in 2009. The Working Group submitted a community white paper for the OceanObs meeting. The CWP notes that the momentum balance differs on either side of a temperature front and highlighted the importance of enhanced winds over warm eddies. Panel members were encouraged to review and provide feedback for the white paper.

One follow-on to the Working Group is expected to be a proposal led by LuAnne Thompson for a climate process team (CPT), built on the premise that some of the Pacific-Decadal Oscillation variability in the Pacific is too large in models because of problems with western boundary currents.

Action Item 23: POS will provide feedback on Western Boundary Current CPT proposal (as requested) and individual members should comment on the WBC OceanObs'09 white paper.

13.1.2 High Latitude Flux Working Group

The Working Group has put forth a number of fledgling recommendations for improving flux estimates at high latitudes. POS reviewed a number of observing system issues, including considering the potential for deploying multiple flux moorings in close proximity. There was some discussion of the “Explorer of the Seas” model of using a cruise ship to obtain oceanographic observations. Regional a were also discussed. Weller and Cronin have been working on identifying appropriate flux mooring sites in the Southern Ocean, and they are seeking community consensus for these choices.

13.1.3 Drought Working Group

Rong Fu highlighted several follow on points for the drought Working Group:

- It's important to monitor soil moisture, and we don't currently have the observations.

- The response of models to realistic (Atlantic) SST forcing needs to be validated and compared with actual observations.
- AMIP runs with and without soil moisture are important.
- Historical data are important for better understanding droughts, such as the one that took place in the 1930s.

A number of issues were discussed. Should there be a Working Group or task force for drought? How should observations required to model land-atmosphere moisture transfer be obtained? Should there be a community workshop or a small committee?

Action Item 24: In order to address concerns about dearth of data (particularly for soil moisture), POS will make inquiries to determine whether data can be part of climate reference network, or whether a drought data workshop will be needed to help coordinate needed observations. (Mike Alexander)

13.1.4 Decadal Predictability Working Group.

The Working Group started in early 2009 and is working to identify differences between forced and intrinsic variability. The Panel identified no action items.

13.1.5 AMOC

AMOC encompasses 20+ projects funded by NASA, NOAA, NSF, and DOE. See listing on <http://www.atlanticmoc.org>. Four task groups (observations, climate impacts, predictability, and assimilation/modeling) are coordinating research efforts.

Action Item 25: POS to identify AMOC (and SAMOC) participants who might participate in the high latitude surface flux Working Group workshop in March 2010. (Chris Meinen to follow up.)

13.1.6 Climate-Ecosystems

Following last year's informal discussion on climate and ecosystems, an NCAR student colloquium was organized on the topic and took place during the summer of 2009. The colloquium will feature tutorials on using models. We identified no action items, pending the follow up to the colloquium.

Action Item 26: Mike Alexander will brief POS on relevant issues in the Climate and Ecosystem community that might arise.

13.1.7 Tipping Points and Extreme Events

Rong Fu has been in discussion with the Jackson School at the University of Texas Austin about a possible workshop on abrupt climate change and its applications to the energy security. POS discussed the workshop possibilities in considerable detail. Although we are generally favorable disposed to workshops on climate issues, we felt we were not in a position to evaluate whether

CLIVAR should be involved in this workshop until the objectives and the workshop audience is more fully identified.

Action Item 27: POS encouraged Rong to formulate more detailed workshop plan on abrupt change and energy security before deciding on the level of formal U.S. CLIVAR involvement. A steering committee could draw on CLIVAR scientists.

13.1.8 IASCLIP

POS met jointly with PSMIP to learn about the proposed IASCLIP program. IASCLIP proposes to improve measurements of the intra-Americas region by augmenting the current observing network in order to assess the impact of the Atlantic warm pool.

Action Item 28: PSMIP will take the lead in commenting on IASCLIP. POS will provide additional comments as needed.

13.1.9 OceanObs'09

POS was asked in 2008 to provide input for the OceanObs'09 meeting to be held in Venice in September 2009. At the time we generated some suggestions and agreed that we were willing to provide input as meeting planning progressed. The OceanObs'09 meeting garnered substantial community support leading to a series of community white papers describing requirements for the different aspects of the global ocean observing system. Community white papers were posted to the web starting in early summer in order to solicit community and reviewer comments prior to the meeting. During this year's meeting we took a bit of time to preview highlights from the white papers, with an eye to identifying large themes that emerge. Among the broad themes that we identified were: (i) remote sensing has emerged as being critical to a broad range of applications, (ii) ocean synthesis are sensitive to data gaps, and thus data continuity is extremely important, (iii) although atmospheric reanalyses are commonly used for oceanographic research, they are potentially unreliable, (iv) there is a clear need for continuity of satellite and in situ observations.

Two critical issues emerged in our discussion. First, we noted that the global surface drifter system has proved itself to be a valuable component of the observing system, but that the program has suffered from a flat budget. We strongly recommend that the budget be increased.

Action Item 29: POS to ask David Legler to convey to NOAA Program Managers the need for an increase in funds to the global surface drifter system.

Second, we noted that calibration and validation of the Aquarius satellite would require surface salinity measurements. Argo floats are potentially a desirable tool for obtaining surface (or near surface salinities), but some design changes may be needed in order to keep salinity sensors functioning near the surface. In our assessment this is a useful goal and should be pursued.

Action Item 30: Sarah Gille to follow up with the Argo Steering Team and make sure they are taking Aquarius concerns into account and she will report back to U.S. CLIVAR on the status.

Action Item 31: POS members were strongly encouraged to read and provide comments for OceanObs community white papers that fell within their own areas of expertise.

13.2 Integrated Earth System Analysis

A major focus of our discussion on Thursday was Integrated Earth System Analysis (IESA). Randy Dole of NOAA, Boulder, presented a summary of IESA objectives and current science questions. IESA is proposed as an interagency priority for the US Global Change Climate Research Program. Minimal criteria for advancing IESA are first to do a better job with current efforts to assimilate observations, second to prioritize new observations, and third to improve coordination in observations, modeling and data assimilation. IESA (and the related topic of reanalysis) are perceived to be important activities, and our discussion focused on identifying ways that U.S. CLIVAR could facilitate research advances in this area.

One topic of concern is making sure that IESA/reanalysis products are widely disseminated and exploited within the science user communities, and that a healthy exchange exists between the originators of IESA/reanalysis products and the users. To facilitate this, we agreed that U.S. CLIVAR could effectively help in coordinating a workshop. We also agreed that the workshop might be most effective if it focused on a specific theme, and we suggested air-sea fluxes as a possible focal point to draw in the atmospheric and oceanographic communities as well as representatives of ocean state estimates and atmospheric reanalysis projects.

Action Item 32: POS to recommend U.S. CLIVAR jointly sponsor a workshop on air-sea fluxes from IESA/reanalysis. Workshop aims: (a) Assimilators talk to users, (b) Users show findings/applications, (c) Identify metrics for future IESA efforts. (Tentative steering committee: David Legler (lead), Mike Alexander, Mike Bosilovich, Sarah, Tony, Ben, Randy Dole.)

13.3 Discussion of new themes

The POS discussion of new possible themes began with a broad list, including extremes and risk assessment, climate and ecosystems, seasonal to interannual prediction, climate analysis data of the Earth System, carbon cycle diagnostics, drought, decadal variability, downscaling/regional processes, fluxes and ocean/atmosphere boundary layers. In our discussions, we ruled out climate and ecosystems (subject of large efforts elsewhere), carbon cycle issues (greater expertise outside CLIVAR), and seasonal to interannual prediction.

The POS discussion ultimately focused on extremes and regional climate.

In regional climate, we were interested in a broad range of topics including the role of ecosystems in regional climate and on best practices (i.e. those that can be applied globally) for studying regional climate.

We viewed extremes as a continuation and broadening of the existing drought theme. Our discussion focused on a number of issues including the existence of non-Gaussian data distributions of physical variables and the link between non-Gaussian and extreme events, and

also the challenges in identifying a correct pdf from a coarse climate model. We thought that downscaling and tipping points had clear links to a possible extremes theme.

13.4 Data stewardship

An ocean data stewardship discussion was carried out Thursday evening by a sub-group of people. We were concerned about the issue of assisting NODC in their efforts to gather data, and we were specifically concerned about the fate of non-traditional data that are not readily included within the NODC archiving structure and that are not being collected elsewhere at present within discipline specific archives.

Margarita Gregg led an OceanObs community white paper on data stewardship that articulates many of the concerns that we expressed. We considered the possibility of preparing a BAMS “inbox” article, in parallel with the PSMIP “best practices” for process studies document, but concluded that BAMS was probably not the best venue for a strictly oceanographic audience. Moreover, we noted there is not strictly a need for a “best practices” document, as NOAA and NSF currently have well-articulated policies.

Instead, we felt that it would be appropriate to write a short EOS article articulating NODC’s current data archiving policies, which endeavor to ensure that non-conventional data are archived. We expect to entrain Margarita into this effort. We also suggested a recommendation that after submitting data, PI's should follow up 6 months later to make sure that the data they submitted are accessible in a way that makes sense.

We also suggested taking action on several data types that are not currently being archived.

For ocean turbulence data, the DIMES field program will be used as a test bed (see comments in the PSMI Panel report), and Sonya Legg agreed to follow up more closely on this issue. Information was conveyed to DIMES investigators at their meeting held 3 days after the Summit. A more serious concern is how best to recover historic turbulence data. Through SCOR (<http://www.scor-int.org/>) some effort is underway to encourage the turbulence/microstructure community to self-organize and create a usable archive.

For lowered ADCP data, Patrick Caldwell is positioned to archive data, but would require additional funding and some agreement from the community about formatting standards.

Other data sets not actively archived in a systematic way include IES/PIES/C-PIES and dropsondes.

Action item 33: POS to contact EOS and Margarita Gregg, NODC, and draft a statement of data archiving strategy (Sarah with help)

Action item 34: POS to support efforts to archive turbulence data, both past and present (Sonya Legg, PSMI lead)

Action item 35: POS to provide recommendation to NOAA that LADCP data archiving should be made a priority. (Chris, Sarah to ask Margarita how to proceed)

Action item 36: POS to recommend to NODC that other unusual data sets need to be assessed within the NODC archive and a consensus reached about how to proceed (Kathy Donohue)

13.5 Housekeeping items (membership, etc.)

We had a brief discussion of membership. A large number of Panel members are scheduled to rotate off. Dan Vimont, Chris Meinen, and Gudrun Magnúsdóttir said that they would stay until 2010. We also suggested that Tony Lee, who was unable to attend, might be able to continue an additional year.

In discussions of new members a broad number of names were suggested. We considered the importance of maintaining the geographic diversity of the Panel and covering a broad range of research interests.

14 Emerging Themes

On the final day of the Summit, David Legler presented the goals for the day, and (based on the executive committee meeting in the morning) narrowed the list of potential new U.S. CLIVAR themes to two topics:

- Extremes – which could include depiction and analysis of regional climate variability and would be replacing the current drought theme and expand U.S. CLIVAR’s mandate
- Polar climate, and its impact on the physical system

David noted that the executive committee decided further discussion was needed over the next year on coastal, ecosystems, and the carbon cycle. Currently, these topics are not sufficiently fleshed out, nor are the predictability of the system or climate models ready to handle these themes. The agency program managers were seriously concerned about the lack of ecosystems on the table. They argued that the RISAs will be using information on coastal vulnerability, and U.S. CLIVAR is in a great position to provide this information. Marty indicated that the executive committee will be scoping these areas, but U.S. CLIVAR is not ready to make these areas a focus. He suggested it would be prudent to first assess CLIVAR’s capability and see which areas of carbon, coastal, and ecosystems were ready for CLIVAR engagement. NSF stated that now is the time to engage these other communities as partners. Panel chairs noted that extremes and polar climate themes are more tractable as they have a narrower focus and the CLIVAR Panels currently have some expertise in these areas. However, agency program managers remained adamant and pushed for marine ecosystems to be discussed as a potential U.S. CLIVAR theme. Rick Rosen, NOAA, said one way to compromise on ecosystems and carbon is to realize that under extremes and polar climate, coastal zones and ecosystems are actually involved. He added that the NOAA science committee has established a new Working Group on this topic, noting therefore that carbon and ecosystems will be in the forefront at NOAA. All Panels agreed to add more expertise in these areas with the next call for membership. Lisa Goddard noted that U.S. CLIVAR should link with the ecosystem community now and bring the communities on as partners, not just as individuals sitting on Panels. CLIVAR itself cannot solve alone some of the research challenges in these new theme areas, but needs to find its niche within the problem. Dan Vimont reminded everyone that there are a series of physical scientific questions in the ecosystem realm that can be answered - these are gaps that CLIVAR *can* fill. Most agreed that a Working Group in this area is needed to interact with global and regional modeling centers focusing on downscaling. Sonya agreed to discuss with modelers and modeling centers the parameters that are needed for modeling carbon and ecosystems within climate models.

Three breakout groups were thus initiated: carbon and ecosystems, extremes, and polar climate. David provided questions for the breakout groups to respond to. He challenged each group to

consider the scientific questions that would emerge in these new themes. Each group should note also the potential payoffs and contributions to CLIVAR science as well as the focused activities that could take place under these themes in the next 2-3 years. And finally, each group should identify the programs and partners that CLIVAR needs to engage in order to be effective.

14.1 Ecosystems, Carbon and Coastal Theme Breakout Group Report

Annalisa Bracco led the discussion on the Ecosystems, Carbon and Coastal theme. Two key scientific questions arose that could motivate U.S. CLIVAR's engagement in the ecosystem/carbon community.

- How can U.S. CLIVAR help the ecosystem and carbon cycle communities to better understand/interpret the variability and changes they observe?
- Can the information collected and provided by the ecosystem/carbon communities be used to drive an advancement of climate science?

The key is how information is transferred between the communities. Can the climate community gain further knowledge from time-series of chlorophyll, nutrients or fish? Thus far, GLOBEC has been successful at bringing the two communities together. The processes and issues that should be tackled within this theme include the physics and the interface of ocean and land; turbulence mixing in the ocean; the predictability in coastal upwelling regions and downscaling and regional modeling.

For this to become a theme, a small workshop of about 30 people was proposed. The suggested title was: "What can CLIVAR learn from biological sciences?" In order to bring together the most appropriate people, CLIVAR would need to review the previous NOAA workshop and the NSF GLOBEC efforts. The potential payoffs from this theme would be an introduction of new data and information relative to understanding and predicting the climate system; promoting interdisciplinary science; and promoting CLIVAR science within other communities.

14.2 Extremes Theme Breakout Group Report

Mike Alexander presented the outcomes of the discussion on Extremes. The group first attempted to define what is meant by extremes and to make sure issues relative to ecosystems and other applications were included in the discussion. Three key scientific questions emerged within this theme.

- How are return periods of societal relevant events changing over time?
- How does large-scale climate variability influence behavior of extremes?
- How do climate models simulate the behavior of extremes?

In order to answer these questions, the role of the ocean must be understood. Likewise, the dynamical and physical tipping points that lead to abrupt changes in extreme events must be determined. A Working Group would need to examine extreme event probability and its dependence on climate variation as well as look at what statistical advances exist that could be brought to the climate community. A Working Group that brings together climate scientists, statisticians, and application scientists was proposed. The group could therefore develop an effective mechanism for climate scientists to exchange information with applications, and other scientific communities.

14.3 High Latitude and Polar Theme Breakout Group Report

Mike Spall led the discussion on High Latitudes and Polar Climate as a theme. The Panel suggested a number of specific polar issues relevant to CLIVAR. Questions included:

- Why is sea level rising in reality faster than predicted by current IPCC-type coupled models?
- How does sea ice impact (interact with) global climate? What other aspects of ice-sheet dynamics impact climate?
- How does the ocean interact with ice shelves?
- How can we separate natural from anthropogenic variability in Polar Regions?
- How do the Polar Regions impact lower-latitude circulations?
- What are the large-scale polar/subpolar/subtropical interactions that impact climate?

Within the group there were two broad categories of discussion: land/sea ice and the overturning circulation. The discussion was dominated by oceanographers, merely a reflection on the composition of the discussion group. The group agreed input from meteorologists was essential. In order to engage the polar community, it was suggested that polar program managers from NOAA and NSF regularly attend the U.S. CLIVAR IAG meetings. In addition, a joint AGU, AMS, or other session could be organized on a topic of direct interest to *both* CLIVAR and polar scientists. The topic should be one that facilitates “crosstalk” between the two groups. And finally, a Working Group on polar science/traditional CLIVAR issues should be proposed within the next year. WG possibilities are: polar/subpolar/subtropical interactions, which also involve ocean mixing (WG1), and sea ice (WG2). WG2 could tackle such questions as: How can the climate community improve implementation of sea ice in climate models? How does polar/midlatitude exchange influence sea ice? How do variations in the overturning circulations impact sea ice? How do surface forcing, winds and freshwater fluxes as well as heating, impact sea ice extent and thickness?

The participants of the polar/high latitude group agreed the sea-ice community needed to be involved. This issue would be a good topic for consideration at a U.S. CLIVAR inter-agency meeting. There was not a lot of discussion about predictability, as predictability is limited by sea ice and fluxes to some extent. The group agreed CLIVAR could/should:

- Engage the ice community (through program managers at an IAG meeting; bring in polar managers, facilitate exchange of information)
- Host a joint session at AGU or some other venue to appeal to ice and climate community
- Develop a Working Group to address overturning – exchanges between polar regions and lower latitudes

15 Closing remarks

David thanked the breakout groups for considering these themes in great detail. One way to move forward on these themes is through the Working Groups. David noted that there would be a call for new Working Groups this fall and encouraged the Panels to consider writing prospectuses on these themes. U.S. CLIVAR will address one or more of the themes at the 2010 Summit. New members will be solicited in December. Summaries were requested from the Panels with their action items. David thanked the Panel chairs and encouraged the support of those that are rotating off (Mike, Sarah, and Sonya). Marty thanked the U.S. CLIVAR Office for their central role in organizing the Summit and many of the discussions. Marty Hoerling closed the Summit by thanking all the participants for their time and energy. Next year’s Summit will possibly be held in Colorado.

16 U.S. CLIVAR Summit Agenda

Wednesday, 15 July 2009				
Time	Agenda		Speaker	Room
0730 – 0815	Refreshments			Atrium
0815 – 0830	Welcome and introductions	15 min		Ballroom
0830 - 0845	U.S. CLIVAR Report	15 min	Marty Hoerling	Ballroom
0845 - 1015	<u>WG Reports</u> Western Boundary Current High-latitude Fluxes Drought Decadal Predictability AMOC	15 min talks, 15 mins disc	Mike Alexander, Sarah Gille, Siegfried Schubert, Lisa Goddard, Jim Carton	Ballroom
1015 - 1030	Morning Break			Atrium
1030 - 1115	International CLIVAR update: Brief overview of CLIVAR and new imperatives; VAMOS	45 min	Anna Pirani, Hugo Berbery	Ballroom
1115 – 1215	Strategic Themes for U.S. CLIVAR	60 min		Ballroom
1220 - 1230	Charge to the Panels	10 min	David Legler	Ballroom
1230 - 1400	Lunch (on your own)			
1400 - 1730	Panel Breakouts (break from 1545-1600)	195 min		
1730 – 1830	U.S. CLIVAR SSC Meets with Program Managers			
1830 - 2000	Reception			

Thursday, 16 July 2009				
0800 - 0830	Refreshments			Atrium
0815 - 0915	DYNAMO – a proposed MJO field campaign	30 min presentation, 30 min discussion	Chidong Zhang	Ballroom
0915 – 0945	IASCLIP (20 min talk / 10 min discuss)	30 min	Dave Enfield	Ballroom
0945 – 1015	Morning Break			Atrium
1015 – 1230	Panel Breakouts	120 min		
1230 – 1400	Lunch (on your own) • DYNAMO Meeting (program managers + DYNAMO leads ONLY) - Thomas Point East Room Climate and Ecosystems Meeting (open to all) – Room to be announced			
1400 - 1530	Panel Breakouts	90 min		

1530 - 1600	Afternoon break			
1600 - 1730	Panel Breakouts	90 min		
1730 - 1830	Plenary discussion on new themes	60 min		Ballroom
1830 – 2030	Joint breakouts as needed			

Friday, 17 July 2009				
0730 – 0815	Exec Committee breakfast			Restaurant
0800 – 0815	Refreshments			Atrium
0815 - 0900	Panel reporting – 15 min per Panel	45 min		Ballroom
0900 - 1030	Breakouts to discuss themes	90 min		
1030 - 1100	Theme Reporting	30 min		Ballroom
1100 - 1130	Wrapup, review action items	30 min		Ballroom
1130	END of SUMMIT			
1130-1230	Executive Session	60 min		Ballroom

17 U.S. CLIVAR Summit Participant List

Michael A. Alexander
NOAA Earth System Research Laboratory
Mail code: R/CDC1
325 Broadway
Boulder, CO 80305-3328
Tel: (1) 303-497-6030
Fax: (1) 303-497-7013
E-mail: michael.alexander@noaa.gov

Lisa Beal
RSMAS/MPO
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149
E-mail: lbeal@rsmas.miami.edu

E. Hugo Berbery
Department of Atmospheric and Oceanic
Science/ESSIC
The University of Maryland
Computer and Space Science Building
Rm. 3427
College Park, MD 20742-2425
Tel: (1) 301-405-5351
Fax: (1) 301-314-9482
E-mail: berbery@atmos.umd.edu

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

Michael G. Bosilovich
Global Modeling and Assimilation Office
NASA Goddard Space Flight Center
8800 Greenbelt Rd., Building 33, Code
610.1
Greenbelt, MD 20771
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
Tel: (1) 404-894-1749
Fax: (1) 404-894-5638
E-mail: abbracco@gatech.edu

Frank Bryan
Climate and Global Dynamics Division
National Center for Atmospheric Research
P.O. Box 3000 - ML
Boulder, CO 80307-3000
Tel: (1) 303-497-1394
E-mail: bryan@ucar.edu

James A. Carton
Department of Meteorology
University of Maryland
2417 Computer & Space Science Bldg.
College Park, MD 20742-2425
Tel: (1) 301-405-5365
Fax: (1) 301-314-9482
E-mail: carton@atmos.umd.edu

Eric DeWeaver
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230
E-mail: edeweave@nsf.gov

Randall M. Dole
Deputy Director for Research
Physical Sciences Division
NOAA Earth System Research Laboratory
325 Broadway, R/E/CD, Rm. 1D116
Boulder, CO 80305-3328
Tel: (1) 303-497-5812
Fax: (1) 303-497-7013
E-mail: randall.m.dole@noaa.gov

Leo J. Donner
NOAA Geophysical Fluids Dynamics
Laboratory
201 Forrestal Rd.

Princeton, NJ 08540-6649
Tel: (1) 609-452-6562
Fax: (1) 609-987-5063
E-mail: leo.j.donner@noaa.gov

Kathleen Donohue
Graduate School of Oceanography
University of Rhode Island
215 South Ferry Road
Narragansett, RI 02882-119
Tel: (1) 401-874-6615
Fax: (1) 401-874-6728
E-mail: kdonohue@gso.uri.edu

Michael W. Douglas
NOAA NSSL
120 David L. Boren Blvd.
Norman, OK 73072
Tel: (1) 405-325-6098
E-mail: michael.douglas@noaa.gov

Daniel P Eleuterio, USN, Ph.D.
Ocean, Atmosphere & Space Research
Office of Naval Research
875 N. Randolph Street, Suite 1425
Code 322MM, Room 1071
Arlington, VA 22203-1995
Tel: (703) 696-4303
E-mail: Daniel.Eleuterio@navy.mil

David B. Enfield
Scientist
University of Miami/CIMAS
4301 Rickenbacker Causeway
Miami, FL 33149
Tel: (1) 305-361-4351
Fax: (1) 305-361-4392
E-mail: david.enfield@noaa.gov

Piotr J. Flatau
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Dr.
La Jolla, CA 92093-0221
Tel: (1) 858-534-1025
Fax: (1) 858-534-7452
E-mail: pflatau@ucsd.edu

Rong Fu
Dept. of Geological Sciences
University of Texas at Austin

1 University Station C1100
Austin, TX 78712-0254
E-mail: rongfu@jsg.utexas.edu

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

Dr. Sarah T. Gille
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Dr., Mail Code 0230
La Jolla, CA 92093-0230
Tel: (1) 858-822-4425
Fax: (1) 858-534-9820
E-mail: sgille@ucsd.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
Tel: (1) 845-680-4430
Fax: (1) 845-680-4865
E-mail: goddard@iri.columbia.edu

Sirpa Hakkinen
NASA Goddard Space Flight Center
Code 971
Greenbelt, MD 20777
E-mail: hakkinen@gssc.nasa.gov

Michael Halpert
NOAA/NCEP/CPC
5200 Auth Rd.
Camp Springs, MD 20746
Tel: (1) 301-763-8227
Fax: (1) 301-763-8125 or 8395
E-mail: Mike.Halpert@noaa.gov

Scott Harper
Office of Naval Research

Code 322, Physical Oceanography
Arlington, VA
E-mail: harpers@onr.navy.mil

Wayne Higgins
Director, Climate Prediction Center
NOAA, NWS, NCEP
5200 Auth Rd., WWB, Rm. 605, W/NP52
Camp Springs, MD 20746-4304
Tel: (1) 301-763-8000 x7547
Fax: (1) 301-763-8395
E-mail: wayne.higgins@noaa.gov

Martin P. Hoerling
Meteorologist
NOAA/CIRES Climate Diagnostics Center
325 Broadway (R/E/CD)
Boulder, CO 80305-3328
Tel: (1) 303-497-6165
Fax: (1) 303-497-6449
E-mail: martin.hoerling@noaa.gov

Jin Huang
Program Manager for Climate Prediction
Program for the Americas (CPPA)
NOAA Climate Program Office
1315 East-West Hwy., SSMC3, Rm. 12106
South
Silver Spring, MD 20910
Tel: (1) 301-734-1226
Fax: (1) 301-713-0515
E-mail: jin.huang@noaa.gov

Eric Itsweire
Physical Oceanography Program
Division of Ocean Sciences
National Science Foundation
4201 Wilson Blvd., Rm. 726 N
Arlington, VA 22230
Tel: (1) 703-292-8582
Fax: (1) 703-292-9085
E-mail: eitsweir@nsf.gov

Dr. Alexey Kaplan
Climate Modeling Group
Lamont-Doherty Earth Observatory
Columbia University
P. O. Box 1000
61 Route 9W
Palisades, NY 10964
Tel: (1) 845-365-8689

Fax: (1) 845-365-8736
E-mail: alexeyk@ldeo.columbia.edu

Ben Kirtman
Division of Meteorology and Physical
Oceanography
University of Miami-RSMAS
4600 Rickenbacker Causeway
Miami, FL 33149
Tel: (1) 305-421-4046
E-mail: bkirtman@rsmas.miami.edu

Randal D. Koster
NASA Goddard Space Flight Center
8800 Greenbelt Rd., MC 974
Greenbelt, MD 20771-0002
Tel: (1) 301-614-5781
Fax: (1) 301-286-1758
E-mail: randal.d.koster@gsfc.nasa.gov

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

Sonya A. Legg
NOAA Geophysical Fluid Dynamics
Laboratory
201 Forrestal Rd.
Princeton, NJ 08540-6649
Tel: (1) 609-452-6582
Fax: (1) 609-987-5063
E-mail: sonya.legg@noaa.gov

David M. Legler
Director
U.S. CLIVAR Project Office
1717 Pennsylvania Ave., NW, Ste. 250
Washington, DC 20006
Tel: (1) 202-419-3471
Fax: (1) 202-223-3064
E-mail: legler@usclivar.org

Eric Lindstrom
Program Manager - Physical Oceanography
NASA Headquarters

300 E. Street SW, Code YS
Washington, DC 20546
Tel: (1) 202-358-4540
Fax: (1) 202-358-2770
E-mail: eric.j.lindstrom@nasa.gov

Gudrun Magnusdottir
Dept. of Earth System Science
University of California Irvine
Irvine, CA 92697-3100
Tel: (1) 949 824 3520
Fax: (1) 949 824 3256
E-mail: gudrun@uci.edu

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

Christopher Meinen
Cooperative Institute for Marine and
Atmospheric Studies
University of Miami
NOAA/AOML/PHOD
4301 Rickenbacker Causeway
Miami, FL 33149
Tel: (1) 305-361-4355
Fax: (1) 305-361-4412
E-mail: Christopher.meinen@noaa.gov

James N. Moum
College of Oceanography
Oregon State University
COAS Admin. Bldg. 104
Corvallis, OR 97331-5503
Tel: (1) 541-737-2553
Fax: (1) 541-737-2064
E-mail: moum@coas.oregonstate.edu

Anna Pirani
International CLIVAR AOS Program
Princeton University
Forrestal Campus
Princeton, NJ 08544
Tel: (1) 609-258-4183
Fax: (1) 609-258-2850
E-mail: anna.pirani@noc.soton.ac.uk

Balaji Rajagopalan
Assistant Professor and Fellow, Cooperative
Institute for Research in Environmental
Science (CIRES)
Dept. of Civil, Environmental and Arch.
Eng.
University of Colorado at Boulder
Campus Box 428, ECOT-541
Boulder, CO 80309-0428
Tel: (1) 303-492-5968
Fax: (1) 303-492-7319
E-mail: balajir@spot.colorado.edu

Kelly T. Redmond
Regional Climatologist
Deputy Director
Western Regional Climate Center
Desert Research Institute
2215 Raggio Pkwy.
Reno, NV 89512-1095
Tel: (1) 775-674-7011
Fax: (1) 775-674-7016
E-mail: krwrcc@dri.edu

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

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

Steven A. Rutledge
Scientific Director, CSU-CHILL Radar
Facility
Department of Atmospheric Sciences
Colorado State University

Fort Collins, CO 80523-1371
Tel: (1) 970-491-8283
Fax: (1) 970-491-8449
E-mail: rutledge@atmos.colostate.edu

Edwin K. Schneider
School of Computational Sciences, Climate
Dynamics Program
George Mason University
Center for Ocean-Land-Atmosphere Studies
(COSA)
4041 Powder Mill Rd., Ste. 302
Calverton, MD 20705
Tel: (1) 301-902-1250
Fax: (1) 301-595-9793
E-mail: schneide@cola.iges.org

Siegfried Schubert
Global Modeling and Assimilation Office
NASA Goddard Space Flight Center
8800 Greenbelt Rd., Code 900.3
Greenbelt, MD 20771
Tel: (1) 301-614-6145
Fax: (1) 301-614-5644
E-mail: siegfried.d.schubert@nasa.gov

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

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

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

James F. Todd
Program Manager, Climate Variability and
Predictability (CVP) Program
NOAA Climate Program Office
1315 East-West Hwy., SSMC3, Rm. 12114
South
Silver Spring, MD 20910
Tel: (1) 301-734-1258
Fax: (1) 301-713-0518
E-mail: james.todd@noaa.gov

Dan Vimont
Department of Atmospheric & Oceanic
Sciences
University of Wisconsin - Madison
1225 W. Dayton Street
Madison, WI USA
Tel: (1) 608-263-3420
Fax: (1) 608-262-0166
E-mail: dvimont@wisc.edu

Wanqiu Wang
CPC/NCEP/NOAA
5200 Auth Road
Camp Springs, MD 20746
Wanqiu.wang@noaa.gov

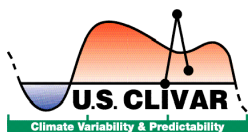
Xubin Zeng
Department of Atmospheric Sciences
University of Arizona
PAS Bldg., #81 P.O. Box 210081
Tucson, AZ 85721
Tel: (1) 520-621-4782
Fax: (1) 520-621-6833
E-mail: xubin@atmo.arizona.edu

Chidong Zhang
Meteorology & Physical Oceanography
Division
University of Miami, RSMAS
4600 Rickenbacker Causeway, MPO
Miami, FL 33149-1096
Tel: (1) 305-361-4042
Fax: (1) 305-361-4696
E-mail: czhang@rsmas.miami.edu

Paquita Zuidema
Rosenstiel School of Marine and
Atmospheric Science

Department of Meteorology and Physical
Oceanography
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149
Tel: (1) 305-421-4276
Fax: (1) 305-421-4696

E-mail: pzuidema@rsmas.miami.edu



U.S. CLIVAR Office
1717 Pennsylvania Ave NW
Suite 250
Washington DC 20006
(202) 419-3471
(202) 223-3064 - Fax
<http://www.usclivar.org>
info@usclivar.org

U.S. CLIVAR is a contributor to the U.S. Climate Change Science Program (CCSP; <http://www.climatechange.gov>). International coordination of CLIVAR is organized through the International CLIVAR Project Office (<http://www.clivar.org>). CLIVAR is a project of the World Climate Research Programme (WCRP).

U.S. CLIVAR acknowledges support from these agencies:

