



**Final Technical Report for DOE
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"DOE Contribution to the 2015 US
CLIVAR Project Office Budget"
PI: Michael Patterson**

US CLIVAR Project Office
July 15, 2015-July 14, 2016

Accomplishments

What are the major goals of the project?

The primary goal of the US Climate Variability and Predictability (CLIVAR) Project Office is to enable science community planning and implementation of research to understand and predict climate variability and change on intraseasonal-to-centennial timescales, through observations and modeling with emphasis on the role of the ocean and its interaction with other elements of the Earth system, and to serve the climate community and society through the coordination and facilitation of research on outstanding climate questions.

What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Major Activities:

Planned and Promoted US CLIVAR Implementation

The US CLIVAR Project Office (USCPO) and Scientific Steering Committee (SSC) focused in 2015 on initial implementation of science outlined in the US CLIVAR Science Plan. The USCPO assisted the SSC and Panels to organize the 2015 US CLIVAR Summit and its review of near-term implementation priorities and action items to make progress toward goals and address research challenges. The outcomes were reported to the agency sponsors at Interagency Group meetings in the summer and fall, and to the broader community at the CLIVAR Town Hall at the 2015 fall American Geophysical Union (AGU) meeting.

Enabled the US CLIVAR Interagency Group (IAG)

The USCPO organized eight meetings of the IAG to foster dialogue and joint planning among participating agency program managers from the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the US Department of Energy (DoE), and the Office of Naval Research (ONR). The Project Office developed and distributed the agendas, generated materials for consideration, drafted and disseminated summaries, identified action items, and ensured their timely completion. The Office provided updates and organized briefings on progress of the International CLIVAR and World Climate Research Program (WCRP) Programs, the US SSC and Panel activities, the US Atlantic Meridional Overturning Circulation (AMOC) Science Team, and US CLIVAR Working Groups, workshop planning, and developments of the US Global Change Research Program (USGCRP). The IAG meeting agendas were designed to facilitate exchange of information among agency managers on developments in their respective agencies including solicitations and awards, budget developments, meetings and webinars, and evolving plans for observing system deployment, new

data sets and synthesis products, field campaigns, analysis and modeling projects, and prediction studies.

Coordinated US CLIVAR Scientific Steering Committee and Panels

The USCPO provided secretariat functions for the SSC and its three Panels, coordinating teleconferences and webinars, assisting with agendas, providing program updates, and preparing summaries. The USCPO engaged Panel co-chairs to organize teleconferences aimed at supporting continuity of work throughout the year, including updating the progress on action items, refining the panel responsibilities to reflect the strategies of the new Science Plan, discussing potential future cross-panel collaborative activities, and identifying expertise needs for new panel membership.

The USCPO supported the planning and execution of the 2015 US CLIVAR Summit Meeting held August 4-6 in Tucson. The Office worked closely with the SSC to develop and finalize the Summit agenda, collect abstracts, coordinate the plenary session, prepare presentations for SSC Executive members, organize agendas for the Panel business breakout sessions, and organize webinars on implementation activities, cross-panel collaboration, and International CLIVAR plans and linkages. The Office also organized logistics, arranged travel, and posted the agenda, abstracts, and presentations to the US CLIVAR website to inform the broader community.

Supported the US Atlantic Meridional Overturning Circulation Science Team

The USCPO provided ongoing planning, implementation, and reporting for the US AMOC program. The Office organized teleconferences of the four US AMOC task teams during the fall and spring and an in-person meeting of the Executive Committee at the Fall AGU meeting, to develop and implement a set of action items to advance data sharing, establish metrics, and design coordinated model experiments. The USCPO assisted with agenda setting, provided updates and reports, and drafted meeting summaries.

The USCPO cosponsored the 2015 International AMOC Science Meeting, hosted by the UK National Environmental Research Council (NERC) in Bristol, UK, during July 21-24, which showcased research on characterizing and predicting the AMOC and its impacts on the atmosphere, cryosphere, and land. The USCPO participated on the local organizing committee, supporting logistics and promotion. The USCPO organized a meeting of the US AMOC Executive Committee and the UK RAPID Advisory Group immediately following the Science Meeting to discuss inter-program collaborations in modeling, observations, engagement of other communities, and drafting synthesis papers. A set of joint modeling experiments were identified and are being pursued through funding calls of agencies within the two countries.

Enabled US CLIVAR Working Groups

The USCPO supported the completion of five Working Groups (WGs), a newly established WG on Arctic-midlatitude interactions, and the selection of an additional new WG on the

expanding width of the tropical belt to begin in 2016. During the past year the USCPO has financed journal publications for the completing WGs, published a report for the workshop on ocean's carbon and heat uptake, and convened telecons, webinars, and an in-person meeting of the new Arctic-midlatitude WG.

Organized and Sponsored Science Meetings and Workshops

The USCPO arranged travel and logistics for US CLIVAR-sponsored meetings and workshops:

- US CLIVAR Summit, August 4-6, Tucson, AZ
- US CLIVAR Virtual Workshop on Observing and Modeling Climate Variability in the Intra-Americas Seas and Impacts on the Continental Americas and the Caribbean, September 9-11
- US CLIVAR Workshop on Translating Process Understanding to Improve Climate Models, October 15-16, Princeton, NJ
- US CLIVAR Arctic-Midlatitude Working Group Meeting, December 17, San Francisco, CA
- US CLIVAR Workshop on Connecting Paleo and Modern Oceanographic Data to Understand Atlantic Meridional Overturning Circulation over Decades to Centuries, May 23-25, Boulder, CO

For each meeting, staff supported the organizing committee planning, meeting promotion and webpage information, registration, abstract collection and publication, event meals, breaks and receptions, local transportation, the production of summary notes, and editing and publication of meeting reports. Web-conferencing was arranged when possible to enable remote participation.

Enabled International Coordination

Support of International CLIVAR staff, meetings, and workshops has facilitated US participation in planning and implementation of research activities with the international community toward shared science interests.

International CLIVAR Panel, Working Group, and Research Foci meetings:

- Climate Dynamic Panel Meeting, July 2-4, Exeter, UK
- ENSO in a Changing Climate Research Foci Meeting, July 8-10, Paris, France
- International AMOC Science Meeting, July 21-24, Bristol, UK
- Southern Ocean Region Panel Meeting, September 24-25, Frascati, Italy
- Global Synthesis and Observations Panel, September 28, Exeter, UK
- Planetary Heat Balance and Ocean Storage Research Foci Meeting, September 29-October 2, Exeter, UK
- Marine Biophysical Interactions and Dynamics of Upwelling Systems Research Foci Meeting, October 2-3, Ankara, Turkey

- Pacific Ocean Region Panel, October 10-11, Santiago, Chile
- Monsoons Panel, November 17-18, Paris, France
- Decadal Climate Variability and Predictability Research Foci Meeting, November 20-21, Trieste, Italy
- Indian Ocean Region Panel, December 7-9, Goa, India
- Ocean Model Development Panel, January 14-15, Yokohama, Japan

For each international meeting and workshop, staff arranged and supported the travel of approved participants, engaged participants on US interests for reporting at the meetings, and collected brief meeting updates for the US CLIVAR SSC, Panels, and IAG.

In April, the USCPO organized a joint briefing with International CLIVAR of the National Academy of Sciences Board on Atmospheric Sciences to update the program oversight body on the US CLIVAR science goals, research challenges, and connections to the international program.

Significant Results:

US CLIVAR Interagency Group

Key 2015-2016 IAG meeting actions included:

- Updating on components of the observing system – including (a) the Tropical Pacific Observing System 2020 Project, sponsored in the US by NOAA and NASA, to evaluate and evolve the elements of the observing system in the tropical Pacific, (b) the end of the Aquarius satellite transmissions in June and continuity of salinity measurements via SMAP and SMOS and (c) the US CLIVAR collected input on climate research-based requirements for the ocean observing system survey by the Ocean Observations Panel for Climate
- Coordinating agency-sponsored activities in process studies, including the Dynamics of the Madden-Julian Oscillation (DYNAMO), Salinity Processes in the Upper Ocean Regional Study (SPURS-2), and briefings on possible future process study opportunities (Year of the Maritime Continent)
- Updating on the plans for and outcomes from the workshop to review lessons learned and future opportunities for applying process understanding to improve climate models (e.g., Climate Process Teams)
- Updating on international plans for CMIP6 and decisions on set of endorsed MIPs and the modeling centers participating in each
- Sharing interagency plans to support evaluation of North American Multi-Model Ensemble (NMME) predictions and explore applications of the NMME data to develop new subseasonal-to-seasonal prediction products
- Deciding to complete the US AMOC Science Team in 2020 (in line with current commitments to RAPID and OSNAP observation projects), to change the frequency of

- US AMOC meetings and reports from annual to 18 months, and reviewing the progress of AMOC science (through the 2014 report and briefing by the Science Team chair)
- Feeding back to the SSC and panels on future research directions, including prioritized input for planning of observing system components (examining scientific problems that drive observing system needs), engagement of process studies (to not be unduly prescriptive and allowing for formal agency reviews), expanding research challenge to understand predictability of coastal/shelf systems (with leadership by marine ecosystem science and fisheries programs), developing a white-paper on ENSO forecasting challenges (to motivate the community and agency programs), building on the hiatus science sessions to hone US CLIVAR messages on sources of confusion and updating on scientific understanding
 - Considering prospectuses for new WGs and selecting to start the new 2016 WG on widening of the tropical belt, with instructions to balance membership to include scientists
 - Deciding agency support of workshops and conferences (e.g., CLIVAR 2016 Open Science Conference, and US West Coast Ecosystems and ENSO Workshop)
 - Coordinating agency participation in and presentations for meetings (e.g., Summit, Workshop on Applying Process Understanding to Improve Climate Models, International AMOC Meeting)
 - Approving USCPO participation in writing the USGCRP Strategic Plan update, contributing to discussion of 2015-2016 USGCRP priorities, briefing of Interagency Working Groups on CPTs/enlisting their help in identifying contributions to the observations and process studies survey, and planning to implement a US GEWEX program and project office
 - Keeping abreast of National Academy of Sciences (NAS) studies/reports and discussing relative roles for NAS and US CLIVAR on climate-related topics, including those on the decadal survey of ocean sciences, decadal survey of satellite observations, ocean observations, subseasonal-to-seasonal forecasting, decadal climate variability, extreme event attribution, Antarctic and Southern Ocean research, and Arctic climate change
 - Connecting to International CLIVAR with briefings by the International Project Office on future program directions and plans for the 2016 Open Science Conference, briefing on plans for decadal variability and predictability research foci, supporting US scientist participation in research foci teams and workshops in 2015, and timely reports from international panel and team members to the IAG

2015 US CLIVAR Summit

The Summit, held August 4-6, 2015, in Tucson, Arizona, and attended by nearly 70 scientists and program managers, generated the following set of key action items for the SSC and Panels to address over the subsequent year:

- Contribute to the straw man for TPOS-2020, identifying observation needs for ENSO

- precursors (e.g., velocity and observation in the off-equatorial region), facilitating engagement of modeling centers, and recommending data assimilation experiments
- Evaluate sustainability of Ocean Observing systems by developing a mechanism to help promote them (e.g., ongoing evaluations, strategic plans), with initial focus on US GO-SHIP
 - Form partnerships between physical and ecosystem scientists to study coastal shelf ecosystems in partnership with US ecosystem and fisheries programs and the international CLIVAR research focus on biophysics and upwelling systems
 - Provide feedback to process study investigators who briefed the PSMI Panel in spring-summer 2015, including DYNAMO, YMC, and SPURS process studies
 - Finalize guidelines for presentations on process studies and set schedule for webinar presentations on 8-10 process studies during fall 2015-spring 2016
 - Facilitate interaction of process studies and modeling centers by (a) sharing summaries of modeling/process study surveys and workshop recommendations with community and agency sponsors; (b) getting feedback from previous process studies on what was beneficial for modeling/observation integration; and (c) sharing process study reports with operational/modeling centers and asking about interest in process study topics
 - Organize US CLIVAR workshops for scientists to address gaps in process understanding (e.g., for coastal oceans/marginal seas)
 - Develop appropriate metrics for defining and communicating uncertainty/biases in predictions
 - Address challenges of subseasonal-to-seasonal (S2S) prediction identified in the upcoming S2S review report of the National Research Council; develop trainings on the next generation of S2S forecasting and in the use of new subseasonal forecast information
 - Examine the sensitivity of natural and human systems to decadal variability and identifying climate prediction metrics for applications-based use
 - Assess the state of readiness for applications of various components of CLIVAR science, drawing upon the sessions organized at annual conferences and opportunities identified through assessment projects (e.g., Regional Integrated Science Assessments)
 - Solicit, through questionnaire, expert guidance for improvements in ENSO predictions and applications
 - Provide concise summary of hiatus discussion for scientists; connect with communications programs of other organizations (e.g., Climate Central) to disseminate information on the hiatus, including FAQ site and fact sheet

US AMOC Science Team

The four task teams convened telecons during the spring and fall to determine actions to make tangible progress on the near-term priorities, incorporating suggestions from the engagement of UK RAPID Advisory Group at the International AMOC Science Meeting in July. Members of the Science Team are co-organizing with the paleoceanography and paleoclimate communities a May 2016 workshop to combine modern records and paleo reconstructions to better characterize

and model multidecadal AMOC variability and its influences on climate, carbon cycle, and ecosystems over decades to centuries.

Key outcomes or other achievements:

US CLIVAR Working Groups

- *El Niño Southern Oscillation (ENSO) Diversity WG*
The WG published the cover article entitled “Understanding ENSO Diversity” in the June edition of the Bulletin of the American Meteorological Society (BAMS), surveying the state of understanding of ENSO diversity and concluding that ENSO can be described as a continuum, rather than a bimodal system. Open questions included understanding of precursors and the predictability of different ENSO types. The WG also organized a special collection of Climate Dynamics to include papers on the definition of metrics for examining diversity in climate models. Completed in 2015, the WG informed international planning for the Tropical Pacific Observing System (TPOS-2020), the ENSO MIP endorsed experiment for CMIP6, and the CLIVAR research focus on ENSO in a warming world. During the past year, the USCPO financed the publication charges for the BAMS journal article.
- *Eastern Tropical Ocean Synthesis WG*
The WG drafted a white paper and submitted an article to BAMS on the challenges and future prospects for reducing coupled climate model SST biases in the Eastern Tropical Atlantic and Pacific Oceans. The papers assess current understanding of SST biases, the processes that drive them, and promising avenues for future work. The WG found that globally the most pronounced SST model biases occur in the Southeast Atlantic, with larger global impacts than for the biases in the Southeast Pacific. Oceanic processes play a more significant role in the biases occurring in the Southeast Atlantic than the Pacific. The stratocumulus cloud fractions are underestimated in most CMIP5 models, even when the SST field is unbiased, indicating that the atmospheric model component is the likely origin of cloud error. Higher resolution atmospheric models should improve topography and better capture coastal atmospheric jets and the equatorial cold tongue. The USCPO is financing the publication charges for the BAMS article.
- *Extremes WG*
The WG published a survey paper on “North American Extreme Temperature Events and Related Large Scale Meteorological Patterns (LSMPs)” in the February 2016 edition of Climate Dynamics. A second paper on precipitation extremes will be submitted to Climate Dynamics in 2016. The papers address data issues, methodologies for identifying LSMPs, synoptics/dynamics, model simulations of LSMPs and temperature/precipitation extremes, and trends in extremes. With its wrap-up in 2015, the WG recommends increased investments in (a) big data infrastructure to manage and process large quantities of model data and to catalog extremes; (b) development of simple, effective, and concise metrics related to LSMPs; (c) atmospheric dynamics studies of physical mechanisms for LSMPs; (d)

analysis of model output for LSMP biases, frequency, duration, and trends; (e) follow-on workshops on predictability of extremes and application sector needs. The USCPO financed the open access publication charges for the Climate Dynamics paper.

- *Ocean Carbon Uptake WG*

The WG, co-sponsored by OCB, focused on processes responsible for oceanic carbon uptake and their representation in climate models. It published an August 2015 BAMS meeting summary on the 2013 NCAR Summer Colloquium organized by the WG for 25 graduate students and a related workshop with an additional 60 scientists working on terrestrial and ocean aspects of the carbon cycle and its interactions with the physical climate system. A student project produced an article entitled “Assessing the Ability of CMIP5 Models to Represent the Seasonal Cycle of Surface Ocean pCO₂” in the July 2015 edition of *Journal of Geophysical Research-Oceans* (Pilcher et al. 2015). The WG co-chairs guest edited the spring 2015 edition of a joint US CLIVAR-OCB Variations newsletter, presenting findings and challenges in modeling and understanding mechanisms, sensitivities, and feedbacks of ocean carbon uptake. WG members also published an article on “Sustained Growth of the Southern Ocean Carbon Storage in a Warmer Climate” in the June 2015 edition of *Geophysical Research Letters* (Ito et al. 2015).

- *Southern Ocean WG*

The WG, also joint with OCB, sought improved understanding of the response of the Southern Ocean stratification, circulation, and heat and carbon uptake to a changing climate. The WG co-chairs guest edited the fall 2015 edition of a joint US CLIVAR-OCB Variations newsletter, presenting 5 invited articles highlighting recent progress and scientific gaps in knowledge of the Southern Ocean’s role in climate and the ocean’s response to climate forcings. The WG prepared a manuscript, “Metrics for the Evaluation of the Southern Ocean in Coupled Climate Models and Earth System Models” for submission in 2016 to the *Journal of Climate*, summarizing the evaluation of Southern Ocean biases in CMIP5 model simulations, assessing the role of eddies, and identifying critical observational gaps. The set of observationally based metrics for consistent evaluation of model output, developed by the WG, will soon be available via the University of Arizona-hosted Southern Ocean Climate Model Atlas website.

The two joint OCB WGs completed drafting and published a report of findings and recommendations from the December 2014 workshop on “Ocean’s Carbon and Heat Uptake: Uncertainties and Metrics.” Key recommendations were to (a) address significant model biases in ocean convection, eddy mixing, large-scale advection, and interactions between large and subgrid scale dynamics; (b) expand critical observations including deep Argo and biogeochemistry-Argo, high-latitude winter hydrography, higher resolution measurement of atmospheric gases, and additional measurements at and under the ice edge; (c) study key processes such as eddy transport and mixing, carbon exchanges and storage in coastal

regions, convection and water mass overflows at high latitudes, and seasonal cycle of exchanges of pCO₂ with the atmosphere, and (d) address Southern Ocean biases across models, with rigorous assessment using metrics. The USCPO helped set the agenda and summarize discussion, draft summary notes for each of the workshop sessions, edit the workshop report draft, and publish the report online in October.

- *Arctic-Midlatitude WG*

The WG, which launched in May 2015, is undertaking work to further the understanding of the coupling between Arctic variability and mid-latitude climate and weather by synthesizing ongoing efforts, coordinating research to fill out key gaps, and providing specific recommendations for accelerating scientific progress. Initial telecons and scoping webinars were held during the summer to begin examining (a) the observational challenges to better understand Arctic variability and surface-atmosphere coupling and (b) the ability of models to capture relationships between Arctic and mid-latitude climate/weather. The WG met in person at 2015 fall AGU meeting to further discuss these challenges and develop next steps, including the establishment of task teams to identify the critical scientific questions and hypotheses, the observational needs and opportunities, and the coordination of model experiments. An Organizing Committee initiated planning an open, international community workshop for February 2017 to capture wider community input and finalize a white paper synthesizing the state of the scientific understanding and future research needs.

- *Widening of the Tropical Belt WG*

A new WG, initiated in spring 2016 aims to quantify impacts of observed expansion in width of tropics over recent decades, identify how anthropogenic forcing and natural ocean-atmosphere variability contribute, and examine how global-scale widening of the tropics is manifested through regional-scale impacts. Confirmation of WG members and an initial telecon to plan the work for the first year will occur in April-May 2016.

What opportunities for training and professional development has the project provided?

Enabled Early Career Scientist and Student Participation in Conferences and Workshops

The USCPO offered reduced registration for early career scientists and students to encourage participation in the Workshop on Transferring Process Understanding to Improve Climate Models. To recognize outstanding presentation and participation by an early career scientist/student in the Virtual Workshop on the Intra-Americas Seas, the Organizing Committee advertised and selected a recipient of a travel award to enable her to present research findings at a future scientific conference of his choice. Invitations for oral presentations by early career scientists were emphasized for these workshops.

How have the results been disseminated to communities of interest?

The USCPO communicates research results and program developments to the climate science community through a variety of mechanisms, including oral presentations at meetings, journal articles, program reports, quarterly newsletters, monthly news-grams, website updates, and twitter feeds.

The Office conducted a community survey of current and potential US CLIVAR communication products and received 76 responses. The survey results indicate that, overall, the current set of information products are timely, relevant, and useful – suggesting that they should be continued with their current format and on their current schedule. A concerted effort to promote the newsletter and news-gram has increased the number of subscribers from near 800 to over 1,000 during the past year. Future expansion will include a webinar series on programmatic and scientific topics. The survey feedback helped inform a communications strategy plan, being completed in January, to guide updates and targets for the next year.

What do you plan to do during the next reporting period to accomplish the goals?

- Nothing to report.

Products

Journals:

US CLIVAR-Sponsored Journal Publications

- Barlow, M., M. Bosilovich, T. Cavazos, A. Gershunov, W. J. Gutowski, J. R. Gyakum, R. W. Katz, R. Leung, Y.-K. Lim, R. Schumacher, and M. F. Wehner, 2016: North American extreme precipitation events and related large scale meteorological patterns: a review of statistical methods, dynamics, modeling, and trends. *Climate Dyn.*, in preparation.
- Bracco, A., M. Long, N. Levine, Q. Thomas, C. Deutsch, and G. McKinley, 2015: NCAR's Summer Colloquium: Capacity building in cross-disciplinary research of Earth system carbon-climate connections. *Bull. Amer. Meteor. Soc.*, **96**, 1381-1384, doi:10.1175/BAMS-D-13-00246.1.
- Capotondi, A., A. Wittenberg, M. Newman, E. Di Lorenzo, J.-Y. Yu, P. Braconnot, J. Cole, B. Dewitte, B. Giese, E. Guilyardi, F.-F. Jin, K. Karnauskas, B. Kirtman, T. Lee, N. Schneider, Y. Xue, and S.-W. Yeh, 2015: Understanding ENSO diversity. *Bull. Amer. Meteor. Soc.*, **96**, 921-938, doi:10.1175/BAMS-D-13-00117.1.
- Grotjahn, R., R. Black, R. Leung, M. F. Wehner, M. Barlow, M. Bosilovich, A. Gershunov, W. J. Gutowski, J. R. Gyakum, R. W. Katz, Y.-Y. Lee, Y.-K. Lim, and Prabhat, 2016: North American extreme temperature events and related large scale meteorological patterns:

- Statistical methods, dynamics, modeling, and trends. *Climate Dyn.*, **45**, 1-35, doi:10.1007/s00382-015-2638-6.
- Ito, T., A. Bracco, C. Deutsch, J. Frenzel, M. Long, and Y. Takano, 2015: Sustained growth of the Southern Ocean carbon storage in a warming climate. *Geophys. Res. Lett.*, **42**, 1-7, doi:10.1002/2015GL064320.
- Russell, J. L., I. Kamenkovich, C. Bitz, R. Ferrari, S. T. Gille, R. Hallberg, K. Johnson, I. Marinov., M. Mazloff, J. Sarmiento, K. Speer, L. D. Talley, and R. Wanninkhof, 2016: Metrics for the Evaluation of the Southern Ocean in Coupled Climate Models and Earth System Models. *J. Climate*, submitted.
- Walsh, K. J. E., S. J. Camargo, G. A. Vecchi, A. S. Daloz, J. Elsner, K. Emanuel, M. Horn, Y.-K. Lim, M. Roberts, C. Patricola, E. Scoccimarro, A. H. Sobel, S. Strazzo, G. Villarini, M. Wehner, M. Zhao, J. Kossin, T. LaRow, K. Oouchi, S. Schubert, H. Wang, J. Bacmeister, P. Chang, F. Chauvin, C. Jablonowski, H. Murakami, T. Ose, K. A. Reed, R. Saravanan, Y. Yamada, C. M. Zarzycki, P. L. Vidale, J. A. Jonas, and N. Henderson, 2015: Hurricanes and climate. *Bull. Amer. Meteor. Soc.*, **96**, 997-1017, doi:10.1175/BAMS-D-13-00242.1.
- Zuidema, P., P. Chang, B. Medeiros, B. Kirtman, R. Mechoso, E. Schneider, T. Toniazzo, J. Small, I. Richter, K. Bellomo, P. Brandt, S. de Szoeko, T. Farrar, E. Jung, S. Kato, C. Patricola, M. Li, Z. Wang, R. Wood, and Z. Xu, 2016: Challenges and Future Prospects for Reducing Coupled Climate Model SST Biases in the Eastern Tropical Atlantic and Pacific Oceans. *Bull. Amer. Meteor. Soc.*, submitted.

Conference Papers and Presentations:

US CLIVAR Presentations

- Weller, R., US CLIVAR: Ocean Observations for Climate, 9th NOAA Climate Observations Division Community Workshop, June 15, 2015, College Park, MD
- Patterson, M., Updates on Research Challenges, 2015 US CLIVAR Summit, August 4, 2015, Tucson, AZ
- Weller, R., Meeting Objectives and Outcomes, 2015 US CLIVAR Summit, August 4, 2015, Tucson, AZ
- Legg, S., Wrap-Up and Next Steps, 2015 US CLIVAR Summit, August 6, 2015, Tucson, AZ
- Patterson, M., US CLIVAR Overview, Briefing for the American Meteorological Society Policy Program, August 10, 2015, Washington, DC
- Weller, R., US CLIVAR Plans and Activities, CLIVAR Town Hall at Fall 2015 AGU Meeting, December 16, 2015, San Francisco, CA
- Goddard, L., The Impact of CLIVAR Science on Society, Fall 2015 AGU Meeting, December 18, 2015, San Francisco, CA
- Weller, R., and M. Patterson, The Pathway Forward for US CLIVAR, Fall 2015 AGU Meeting, December 18, 2015, San Francisco, CA

Other Publications:

US CLIVAR Reports

US CLIVAR Project Office, 2015: 2014 US CLIVAR Summit Report, Report 2015-2, US CLIVAR Project Office, 43pp.

Russell, J., H. Benway, A. Bracco, C. Deutsch, T. Ito, I. Kamenkovich, and M. Patterson, 2015: Ocean's Carbon and Heat Uptake: Uncertainties and Metrics. Report 2015-3, US CLIVAR Project Office, 33pp.

US CLIVAR Project Office, 2016: 2015 US CLIVAR Summit Report, Report 2016-1, US CLIVAR Project Office, in preparation.

Misra, V., G. Poveda, E. R. Fernandez, Y. Serra, and C. Wang, 2016: Observing and Modeling Climate Variability in the Intra-Americas Seas and Impacts on the Continental Americas and the Caribbean, Report 2016-2, US CLIVAR Project Office, in preparation.

Zuidema, P., P. Chang, B. Medeiros, B. Kirtman, R. Mechoso, E. Schneider, T. Toniazzi, J. Small, I. Richter, K. Bellomo, P. Brandt, S. de Szoek, T. Farrar, E. Jung, S. Kato, C. Patricola, M. Li, Z. Wang, R. Wood, and Z. Xu, 2016: Challenges and Future Prospects for Reducing Coupled Climate Model SST Biases in the Eastern Tropical Atlantic and Pacific Oceans. Report 2016-3, US CLIVAR Project Office, in preparation.

Giannini, A., M. Holland, S. Legg, A. Mahadevan, A. Subramanian, J. Teixeira, and C. Ummenhofer, 2016: Translating Process Understanding to Improve Climate Models. Report 2016-4, US CLIVAR Project Office, in preparation.

US and International CLIVAR Newsletters

US CLIVAR Project Office, 2015: Understanding the Earth's Climate Warming Hiatus: Putting the pieces together. *US CLIVAR Variations*, Summer 2015, Vol. 13, No. 3, Washington, DC, 20005, 30 pp.

US CLIVAR Project Office, 2015: The Southern Ocean's Role in Climate. *US CLIVAR Variations*, Fall 2014, Vol. 13, No. 4, Washington, DC, 20005, 32 pp.

US CLIVAR Project Office, 2016: The Intra-Americas Seas: Vital to regional climate & extreme events, Winter 2016, Vol. 14, No. 1, Washington, DC, 20005, 35 pp.

US CLIVAR Project Office, 2016: A Tale of Two Blobs. *US CLIVAR Variations*, Spring 2016, Vol. 14, No. 2, Washington, DC, 20005, in preparation.

International CLIVAR Project Office, 2015: Sustained Ocean Observing and Information in Support of Ocean and Climate Research. *CLIVAR Exchanges*, No. 67, Vol. 19, No. 2, 54pp.

International CLIVAR Project Office, 2015: Celebrating 50 Years of Indian Ocean Research. *CLIVAR Exchanges*, No. 68, Vol. 19, No. 3, 46pp.

Websites:

The USCPO maintains and regularly updates the US CLIVAR web site (www.usclivar.org), providing information on US CLIVAR mission, goals, science activities, meetings and workshop presentations, reports and publications, organizational structure, and a calendar of events. The communications survey results reveal that the website meets the needs of the community (based on 49 respondents; with 75% rating very well or better) and is organized to

easily find information (with 65% rating very easy or better). An update of the website, providing improved visibility and content on US CLIVAR science, is to be completed in January 2016.

The USCPO also maintains and updates a twitter account page (www.twitter.com/USCLIVAR) providing links to scientific and programmatic developments of interest to the climate research community.

Participants

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Karyn Sawyer	Principal Investigator	Less than 1 month
Michael Patterson	USCPO Director	12 months
Kristan Uhlenbrock	USCPO Program Specialist II	12 months
Jill Reisdorf	Project Coordinator	10 months

Impacts

What is the impact on the development of the principal discipline(s) of the project?

With a primary focus on the role of the ocean and coupled ocean-atmosphere interactions, US CLIVAR engages the broad participation of the oceanographic and atmospheric scientists to plan and implement targeted and collaborative research efforts. The program promotes and facilitates the assessment and development of advances in observations and models needed to monitor, understand, and predict climate variability and change with quantified uncertainty.

What is the impact on other disciplines?

To address its mission to foster understanding and prediction of climate variability and change across timescales, US CLIVAR actively develops collaborations with other Earth science communities. Links with land surface, cryosphere, ocean carbon/biogeochemistry, marine ecosystem, and paleoclimate sciences have been established for many of the research activities supported by the program, e.g., drought, temperature and precipitation extremes, ice-ocean interaction, ocean carbon uptake, marine ecosystem impacts of climate variability, and extended multidecadal time series for understanding AMOC variability. US CLIVAR engages other disciplinary programs to jointly scope and undertake research activities and develop integrated cross-disciplinary teams.

What is the impact on the development of human resources?

US CLIVAR's contributions to graduate student training and enabling young scientist participation in workshops and meetings are motivated by interest in developing the next generation of scientists. The USCPO encourages Panels, working groups, and workshop organizing committees to promote membership opportunities for young scientists to gain experience in science planning and leadership.

What is the impact on society beyond science and technology?

While US CLIVAR's principal focus is to advance understanding and prediction of climate, the development of information on past, present, and future state of the climate system with estimates of uncertainty are of value to a range of societal and resource application sectors. The Predictability, Predictions, and Applications Interface Panel convened a session during the 2015 Summit to explore opportunities for connecting to climate applications. The Panel identified specific action items to make progress, including: (a) developing trainings in the use of new subseasonal forecast information being provided by NOAA; (b) examining the sensitivity of natural and human systems to decadal variability, identifying climate prediction metrics for applications-based use; and (c) crafting a white paper assessment of the state of readiness for applications of various components of CLIVAR science, informed by Panel-organized sessions at the 2015 fall AGU and 2016 AMS meetings. Although still nascent, the intent of such US CLIVAR activities is to enhance the communication and exchange of information from those who work to produce climate information and those who use it.