PROJECT FINAL REPORT
TIME PERIOD ADDRESSED BY REPORT: 09/01/2011 - 08/31/2014
SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP)

PROJECT TITLE: Collaborative Development of Public Water Supply Utility Relevant Climate Information for Improved Operations and Planning

INVESTIGATORS:

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FINAL REPORT: 09/01/2011 - 08/31/2014 (**time period addressed)**

I. PRELIMINARY MATERIALS

A. Research project objective.

The goal of this project was to increase the regional relevance and usability of climate and sea level rise data and tools for the specific needs of water suppliers and resources managers in Florida. Specific project objectives included (1) developing a collaborative Working Group comprised of public water suppliers, water resource managers, climate scientists, and hydrologic scientists focused on understanding how climate variability/change and sea level rise may impact planning and operations of Florida's public water supply utilities, (2) Identifying the appropriate spatio-temporal scales, climatic indices, and events that drive utilities' decisions, and evaluating the practical applicability of current climate tools at these scales through synthesis of nationally available General Circulation Model (GCM) simulations and statistically and dynamically downscaled GCM data products for the region, and (3) Identifying appropriate entry points for climate data and model predictions in Working Group members' models and decision making processes and evaluating the usefulness of these data for minimizing current and future risks associated with climate variability/climate change and sea level rise.

B. Stakeholders, decision makers and partners

Florida Public Water Supply Utilities

- Alison Adams, Tampa Bay Water
- Maurice Tobon, Palm Beach County, Water Utilities Department
- Kevin Morris, Peace River Manasota Regional Water Supply Authority
- David Richardson, Gainesville Regional Utilities
- Robert Teegarden, Orlando Utilities Commission
- Douglas Yoder and Bertha Goldenberg, Miami-Dade Water and Sewer Department
- Barbara Powell, Broward County

Florida Water Management Districts

- Jayantha Obeysekera, South Florida Water Management District
- Michael Cullum, St Johns River Water Management District
- John Ferguson, Southwest Florida Water Management District

Florida State Climatologist

- David Zierden, SouthEast Climate Consortium

C. Approach

Our basic approach centered on developing a Working Group that operates as a social learning and collaboration platform and promotes shared knowledge, data, models and decision-making tools relevant to climate impacts and water supply planning. The working group and key beneficiaries are public water suppliers, local governments, water resource managers, climate scientists and hydrologic scientists engaged with planning and operations of Florida's public water supply utilities. While the immediate focus of the Working Group is on Florida public water supply utilities, the Working Group process and the Working Group products are transferable and useful nationwide.

The working group collaboratively defined and explored the most important issues faced by water utilities at a range of planning and management timescales, possible impacts of climate variability/change and sea level rise on these issues; the relevant spatio-temporal scales at which climate-related information is needed to assess risks of potential impacts; identified sources of climate data to provide the desired information, and processed the data into a format consistent with Working Group needs. We evaluated the ability of nationally available reanalysis products and GCM retrospective simulations to reproduce historic climatology in Florida at utility-relevant space-time scales using both dynamic and statistical downscaling techniques. We also evaluated alternative methods for generating future downscaled regional climate scenarios for use in water resource applications. We evaluated the potential for incorporation this climate information into two cooperating utilities planning processes, models and decisions support systems to enable risk assessment and adaptation/mitigation planning. All Working Group members participated in these assessments in order to gain experience and build capacity for their own future applications. Finally, the project provided feedback to the climate science community on additional research needed to improve the utility of local- to regional-scale climate simulations/predictions for water resource based on applications.

D. Matching funds/activities

Throughout the project, network members from the Public Water Supply Utilities, Water Management Districts and local governments provided in-kind support through paying their own travel costs and staff time to attend quarterly project meetings and conduct project specific activities between quarterly meetings. During 2013-2014 funds from Tampa Bay Water were used to fund an additional Ph.D. student who worked on this project (stipend and tuition approximately $33,700 per year). Funds from the South East Climate

Consortium base grant (approximately $23,500 per year) were used also to co-fund a post-doctoral associate who worked on the project. A proposal is currently being prepared to allow participating agencies to sustain the network beyond the NOAA grant funding.

E. Partners *(included in section B)*

II. ACCOMPLISHMENTS

A. Project timeline and tasks accomplished

This report presents project accomplishments in the context of the (**1) Working Group process** – collaborative learning network, **(2) Research** - evaluation of existing climate data and models, and **(3) Science to Action** - the application of this information within the Utility and Water Resource community. These accomplishments include both those specific to the stated project objectives outlined in the original proposal (and reported in detail in annual reports) as well as additional accomplishments such as value added impact, lessons learned, and resulting personal, professional and institutional change as a result of the engagement in a collaborative learning process that are often harder to capture. In order to effectively convey the specific and broad project accomplishments we will tell the story of the Florida Water and Climate Alliance and its group development, research outputs and learning. Key points for success are highlighted along the way.

1. Working Group Process - Objective 1: Develop a collaborative Working Group

Prompted by the interest of Florida utility companies and organizations interested in anticipating climate-related impact to water resources, the Florida Water and Climate Alliance (FloridaWCA) working group was initiated in 2010. The idea of a Working Group was stakeholder driven. Dr. Alison Adams of Tampa Bay Water, as a result of recent experience engaging with the Water Utilities Climate Alliance, saw value in linking together Florida Utilities and brought the idea to the directors of University of Florida (UF) Water Institute and the Florida Climate Institute. The UF Water Institute identified and interviewed major public water supply utilities and found broad interest in such an effort. During initial interviews utilities emphasized a need for the Water Management Districts (WMDs, the resource managers and permitting authority) to be at the table, so UF Water Institute contacted WMDs and carried out similar interviews. "Buy-in" by the utilities and WMDs to participate in an initial workshop were clear and initial efforts were moving forward simultaneously with the submission of a proposal to NOAA for this project. Our goal was to get a project funded that would support not only the research, but the group building itself.

Key point for success: The working group was stakeholder initiated, built on strong interest, pre-existing relationships and recognized the importance of having both resource users (Utilities) and resource managers (Water Management Districts) included from outset.

Key point for success: NOAA funding provided an external mandate and recognition of the importance of the working group that was critical to agency and institutional buy-in.

Often the "coordination" and group building aspects, that we believe are critical to collaborative research, are the most difficult aspects to fund. Although we got started without external funding, the funding of the project by NOAA was pivotal to the FloridaWCA development in that it provided an external mandate as well as external

recognition of the importance of the working group that was critical for both agency and academic institution administrative buy-in.

After the UF Water Institute had obtained stakeholder buy-in and project funding to build a working group we asked ourselves several questions, "How do we create a space for collaborative learning so that we (a diverse group of public water suppliers, water resource managers, climate, hydrologic and social scientists) can work together toward developing and using relevant climate data and tools? How do we make differences and similarities among members explicit and work toward a common vision? How do we ensure the continued engagement of all participants over time? How do we build ownership over the process and provide space for reflection and growth? How do we structure, provide and nurture such ongoing interactions?"

Purposeful Process:

We developed a "purposeful process" for our working group interactions guided by key social learning and educational foundations. Iterative processes and more interactions provided scientists better understanding of types of information that are most relevant to user needs, and provided users better insight into scientific processes, networks, and ideas for how to use available information. Our deliberate approach was based on a "Communities of Practice" framework (Wenger, E. 1998) and the "Experiential Learning Process" (Kolb, D. 1984) where the key is iterative and continued focus on experience to reflection to generalization, to application. According to Wenger, Communities of Practice have three key elements. The domain is the thing that brings people together and defines the identity of the community. Our Working Group domain is useful climate science tools at relevant spatial and time scales that are ultimately used in decision making for water supply. The community is the group of people that interact together, share commitment, identity, ownership, and belonging, and build relationships. The practice is how the group works, what they do, and the shared ways of doing things together.

Key point for success: Bringing together multiple stakeholders with different perspectives and organizational contexts is rich, but requires engagement, program and logistical coordination, and mechanisms for feedback. (It does not just happen!)

We designed a set of workshops and activities to create learning opportunities to understand the stakeholders; assess climate data, models and tools; evaluate the applicability of tools; and use the information. The project proposal included 4 workshops over 2 years, but to date, we have had 12 workshops, including those before and following the active dates of the project. This has not been just a series of meetings, each workshop was carefully designed as part of the process. We employed several feedback mechanisms for building dialog, ownership and trust and to incorporate lessons learned along the way. These included participatory activities to increase interaction, dialogue and share experience, and build continuity by looking back and looking forward; presentations sharing new knowledge and state of the art science; and on-going evaluation and reporting.

The workshops and the progression of topics are noted in table 1 on the following page. Complete documentation of all workshops including agenda, presentations and reports is available at Floridawca.org.

Table.1 Chronology of workshops (workshop information including agenda, presentations and reports can be accessed by clicking on the highlighted workshop number. To access each workshop report click on REPORT)

DATE	WORK SHOPS	KEY EMPHASIS
Sept 22 2010 **January 20, 2011**	**1 and** **2**	Early emphasis was on understanding stakeholder groups, their needs and potential contributions to the co-development of relevant climate models & tools. REPORT 1; REPORT 2
May 4, 2011 **October 7, 2011** **February 28, 2012**	**3,** **4 and** **5**	Science presentations began drawing on expertise from within our group, followed by invited outside speakers. Main topics included existing climate data and tools for Florida including evaluating the reliability of retrospective predictions, seasonal forecasts, long term climate projections, and sea level rise projections. NOAA project was funded and collaborative planning began. REPORT 3; REPORT 4; REPORT 5
May 10, 2012	**6**	Climate science from the user perspective - Focused on hearing from the users– water resource and supply operations managers and planners --- about their specific needs and how the information shared thus far might be most helpful to them. REPORT 6
October 5, 2012 **February 27, 2013**	**7 and** **8**	Sharing NOAA project research results – Science teams presented their research and evaluation results for dynamically and statistically downscaled GCM reanalysis data, retrospective predictions and long-term projections. Following each presentation, we asked participants to lead and engage in discussions - "So what does this mean to me? REPORT 7; REPORT 8
June 6, 2013	**9**	Understanding different thinking, learning and communication styles and exploring practical application of seasonal climate forecast results. Decided to focus application of project findings on two water utilities. REPORT 9
October 30-31, 2013	**10**	Focus on sea level rise this workshop addressed current plans and responses of several cities and counties to sea level change. Held in Miami with field trip. REPORT 10
April 10, 2014	**11**	Focused on tools of communication useful to convey science to decision makers and exploring sustainable partnerships. REPORT 11
November 5, 2014	**12**	Strategic planning --Sustaining the FloridaWCA Where do we go from here? In addition to several presentations by groups working with sea level rise.

Participation: FloridaWCA has maintained a steady level of participation throughout the four years and 12 workshops, with a consistent participation of over 22 people at each workshop. There was a core set of about 10 individuals from different institutions that attended all workshops; however for several institutions engagement varied from individual to individual along the way. Over 125 individuals participated in at least 1 workshop, 10 attending between 4 and 7 workshops, and 13 attending over 8 of 12 the workshops. It was important to have a strong core group of champions and early promoters of the group who set the domain, as these members took on stewardship roles. By the second workshop a suggestion was made to "bring a friend" in order to broaden participation. This is an important point in the evolution of the learning network.

One of the great challenges for sustaining collaborative processes is helping participants to recognize diverse perspectives and manage that diversity. It was during workshop t3 that government planners first participated and began to show a strong interest in the group. This brought a new set of interests and issues to the table. Activities helped to identify some differences including goals. Researchers wanted to do innovative research, managers of larger water utilities wanted to refine tools already being used, and smaller scale utilities wanted to understand information and develop ways to use the information. As new participants joined (such as local county and city planners/managers) they brought new interests and expectations, challenging the established domain. In addition, the constant in flow of new people required re-introducing and re-visiting the group's goals continually throughout the process. Key questions emerge in such multi-stakeholder groups regarding how to manage the different interests and goals. We employed several interactive activities to set goals, reflect on progress, nurture identity and build ownership of the process.

Key point for success: Participatory activities are an important part of developing a working group by helping participants to recognize the range of expectations, perspectives, and learning styles and encourage dialogue, share visions and discuss differences.

Planning and Evaluation: Given the iterative nature of the process, we employed several mechanisms to contribute to adaptive planning efforts of the facilitation and project teams. These included facilitation team planning and debriefing meetings, workshop planning teams to build ownership of the process design, technical task forces and an executive advisory board. Documenting and sharing progress, and incorporating suggestions of the group into each workshop agenda, helped participants to be cognizant of the working group process it takes to effectively achieve group learning. Formative evaluation of the stakeholder engagement/facilitation process has informed each working group meeting and each workshop was followed up by the collection of post-workshop evaluation reflection questions and workshop visioning and reflection exercises.

Data for each workshop were collected using a post-workshop survey questionnaire. Participants in 10 of the 12 workshops conducted as part of this project had the opportunity to provide written feedback on a standard form. This questionnaire asked participants to identify the stakeholder group to which they belonged, rate the quality and effectiveness of the workshop using a five-point Likert-type scale, and to provide feedback responding to three or four open-ended questions. The quality and effectiveness of the workshop was measured using the same five questions each time: 1) Output – How well did we achieve what we needed to? 2) Organization – How effective was the meeting structure? 3) Use of time – How well did we use our time? 4) Participation – How well did we do on making sure everyone was involved? And 5) Next steps – How clear and doable are our next steps? The open-ended questions varied from one workshop to the other and were aligned to specific and timely information needs of the project. Responses were available by different stakeholder groups (i.e. Academia/Research, Water Utility group, Water Management Districts, Government, and Other. Each evaluation was summarized in detail in the workshop reports, and used by the facilitation team for planning subsequent workshops.

The consolidated responses are shown in Table 2 on the following page. Responses to the five questions of quality and effectiveness remained pretty constant throughout the 10 workshops for which data were collected. The only dimension in which significant differences were observed between workshops was the one related to 5) Next steps - *How clear and doable are our next steps are*, particularly, respondents rated this dimension lower during the first workshops.

Table 2. Consolidated Survey responses

Feedback Survey Question	RESPONSES n=175 feedback forms over 10 workshops					
	Excellent/ and Good	**Excellent**	**Good**	**Satisfactory**	**Fair**	**Poor**
1) Output – How well did we achieve what we needed to?	94%	45.9%	48.3%	5.8% (n=10)		
2) Organization – How effective was the meeting structure?	95%	59.3%	36%)	4.1% (n=7)	(n=1)	
3) Use of time – How well did we use our time?	90%	52.9%	37.8%	8.7% (n=15)	(n=1)	
4) Participation – How well did we do on making sure everyone was involved?	95%	57.6%	37.2%	4.1% (n=7)	1.2% (n=2)	
5) Next steps – How clear and doable are our next steps?	85%	33.7%	52.3%	12.8%) (n=22)	1.2% (n=2)	

Framing analysis was conducted on the information available via qualitative data collection from group member interviews and workshop activities. Resulting data was categorized into three major themes: a) Purpose of group, b) Communication differences, and c) Using climate information at work. Overall, there was agreement among the group that 1) the purpose of the group was to share and develop research tools to be used for planning and decision-making, 2) it was important to listen to others when communicating and 3) it was important to prepare and stick to your point when communicating in front of an audience, and 4) the main challenge and opportunity for group members was the potential for using data for practical planning purposes. However, there was a difference in opinion over whether part of the group's purpose was to communicate with policy makers outside the group vs. focusing on sharing information just to group members. Also, communication challenges (e.g. feeling too nervous or shy to speak in the group or confusing others with overly technical communication) and communication style differences (e.g. engaging friendly style preferred by non-academics vs. technical style about individual research expertise preferred by the university community) were points of divergence among group members.

Based on this framing analysis, it was recommended that working groups such as FloridaWCA continue to devote time during workshops to discussing communication strategies and how to strategically achieve goals. Based on this project, future diverse stakeholder working groups could benefit from incorporating discussion of communication strategies at the beginning stages of group formation. It was also suggested that learning about diverse learning styles and communication preferences within the group can help a group to function more cohesively.

Learning Styles: Our group building and evaluation strategies initially proposed the use of social network analysis, the Kirton Adaption-Innovation Inventory (KAI), and focus groups. As the group progressed, we chose to focus on Kolb's Learning Styles, as a parsimonious approach to experiential learning theory that resonated with group participants (Kolb, 1999a). Experiential learning theory differs from other theories and inventories of individual cognitive differences in its comprehensive approach to learning and human development. Experiential learning theory is the "process whereby knowledge is

created through the transformation of experience. Knowledge results from the combination of grasping and transformational experience" Kolb, 1984, p. 41).

Learning style is a measurement of individual differences in how learners prefer to learn and process information. Kolb's Learning Style Inventory (LSI) is used to categorize learners according to four distinct learning styles (Accommodators, Divergers, Assimilators, and Convergers), These constructs were introduced during the workshops as a way of recognizing individual differences and preferences that could help group members understand how information exchange and decision making processes are influenced by cognitive and experiential factors. During Workshop 9 participants took and self-scored the LSI, then grouped themselves according to which of the four style preference categories they scored into. Group members found this helpful and discussed how this could relate to challenges group members feel when trying to communicate complex science to other group members of different learning styles.

In addition to the in-workshop activity focused on Learning Styles, an online survey was distributed before workshop 10 to all past and present workshop attendees. This survey was designed to capture all respondents' learning styles in a way that could be easily analyzed. This was done to follow up with the high level of interest exhibited by workshop participants in workshop 9, where they self-scored their responses. By understanding the composition of the group in terms of diversity of learning styles, and the strengths and weaknesses associated with each type, the group may develop more effective ways of collaboration.

Knowledge management:

Key point for success: The recognized need for an information portal surfaced early and is currently mentioned by participants as a tangible representation of the group remaining a high priority for FloridaWCA sustainability.

Early in the working group process participants expressed a strong interest in having a central place to go to for relevant information – i.e. a clearinghouse of some sort for easy access to information. They anticipated an on-line Knowledge Management System (KMS) that would include vetted information, data, model assessments and scenarios, reports, quarterly newsletter, webinars, seminars, workshops and other information of relevance to climate and water. To establish this KMS the following activities were conducted 1) preparing a needs assessment and analyzing results, 2) assembling a sub-committee to oversee the development process, 3) reviewing and testing the functionality of multiple platforms for construction, 4) drafting documents to guide the design of the website, 5) identifying hosting platform and domain name (Floridawca.org), 6) implementing a participatory activity in Workshop 7 for refining relevant information categories, and 7) establishing a site management and review committee to focus on usability, and sustainability of the KMS. The full design and soft roll out of the KMS was completed in year 2 of the project with a new website http://floridawca.org. Currently, the website is mentioned by the participants as a key outcome of the working group, and remains a high priority in discussions for the continuation of the FloridaWCA.

2. **Research - Objective 2: Identify the appropriate spatio-temporal scales, climatic indices, and events that drive utilities' decisions, and evaluate the practical applicability of current climate tools at these scales**

The FloridaWCA participants' "shared passion" was learning about, accessing and developing relevant tools and information at industry relevant space/time scales to plan for climate impacts on the business of water supply. By workshop 4, when funding from NOAA project became available, science presentations and sharing new knowledge had become a key element of each of the workshops. Topics had included presentation of climate data and tools for Florida, evaluation of seasonal forecasts, seasonal-decadal projections, long term climate scenarios, sea level projections, and exploration of levels of trust in the current models. Participating scientists were interested in working on methods to refine predictions and evaluating the technical integrity and fidelity of data and models for use in water management operations. At this point we began to incorporate collaborative planning for the NOAA project into the workshop process. This was really the first time for all participants to have key input to the technical and science aspects of the project. This was important to ensure that their interests, group interests, and those of their institutions are reflected in project implementation. Previous discussions had identified that climate predictions (rainfall, temperatures, and extreme events) are needed at space, time and event scales relevant to operations (3-12 months), permitting (20 years) and capital planning (20-50 years).

During a participatory group activity in workshop 4 various stakeholder groups contributed ideas for each of the key outputs planned for the project at the above scales. Three technical teams were established during that workshop and initiated activities to develop research roadmaps in the following areas 1) **Seasonal Scale Forecasts** (to robustly diagnose seasonal climate predictability and skill for all 4 seasons), 2) **Long-term Climate Scenarios** (focused on developing common climate scenarios for use in Florida that include precipitation, temperature and other climate variables (relative humidity, wind speed, solar radiation etc.), and 3) **Sea-level Rise/Change** (initially focused on improving access to existing information). The research roadmaps were presented and refined at the following workshop (workshop 5). Each of the technical/science teams met in small groups with participants who self-selected to participate in a specific team. The technical teams shared their roadmaps, got reaction, input, suggestions, and fielded questions. Results of the activity were refined roadmaps and revised approaches if possible. "At the core of the technical committees was "the nitty-gritty stuff, such as using computer programs to turn global climate predictions into city-size predictions. That's being done by meshing global models with long-term local temperature and rainfall data — and by using newer types of climate analysis…." *(Kevin Spear, Orlando Sentinel).*

Key point for success: Recognize the challenges of achieving shared understanding of both "toolmakers" and "tool users" and the need for better ways of communicating the science.

Given the diverse range of people in the growing community of learning there were different reactions to the technical nature of some presentations and discussion. Some participants expressed that there was not enough time for the technical details they wanted to talk about. Other participants reflected some level of confusion in comments such as, "What…. this is alphabet soup…." "I know this is important and good stuff….. " "I trust the scientists…. I just am not getting it right now…", "Not sure how I can use it…. " After having spent significant time talking about the "nitty gritty science," several of the participants pushed to know "How do we take science into the planning process?" Some participants emphasized the need for "talking points" to communicate climate science to policy and decision makers. Discussion moved into the framing the climate science for various audiences (governing boards, comprehensive planning boards, operations managers, etc.), influencing the next workshop design. In workshop 6 we focused on hearing from the users – operations managers and planners. Issues emerged

from discussion, including the importance of considering communication, regulations, costs, the political process, uncertainty of info & risk - confidence in science, and context.

Technical Group Accomplishments -Seasonal Scale Forecasts and Long Term Climate Projections

Rigorous research had been underway in the technical groups and new results were available. Researchers were excited about sharing these results with the group, and in Workshops 7 and 8 both the Seasonal Scale Forecasts team and the Long Term Climate team presented their results. The researchers spent about 30-40 minutes during each of the workshops presenting what they did, how they did it, and the results. They shared details, graphs, insights and their conclusions.

In additional to presentations made to the working group (during workshops 7, 8, and 9) and posted on the working group website project research resulted in the following peer reviewed publications:

Seasonal Scale Forecasts:

- Bastola,S., V. Misra, and H. Li, 2013: Seasonal hydrological forecasts for watersheds over the Southeastern United States for the boreal summer and fall seasons Earth Interactions, 17(25), 1-22, doi:10.1175/2013EI000519.1.
- Bastola, S and V Misra, 2013: Sensitivity of Hydrological Simulations of Southeastern United States Watersheds to Temporal Aggregation of Rainfall. *J. Hydrometeor*, **14**, 1334–1344. doi: http://dx.doi.org/10.1175/JHM-D-12-096.1
- Bolson, J., C. Martinez, N. Breuer, P. Srivastava, P. Knox, 2013, Climate information use among southeast US water managers: beyond barriers and toward opportunities, Reg. Environ Change, Springer-Verdag Berlin Heidelberg, DOI 10.1007/s10113-013-0463-1
- Misra, V. and H. Li, 2014: The seasonal climate predictability of the Atlantic Warm Pool and its Teleconnections, Geophys. Res. Lett., 41(2), 661-666, doi:10.1002/2013GL058740.
- Nag, B., V. Misra, and S. Bastola, 2014, Validating ENSO teleconnections on Southeastern United States Winter Hydrology Earth Interactions. *Earth Interact.*, **18**, 1–23. DOI: EID-14-0007.1.
- Risko, SL and CJ Martinez, 2014, Forecasts of seasonal streamflow in West-Central Florida using multiple climate predictors, Journal of Hydrology, Volume 519, Part A, 27, Pages 1130–1140.
- Tian, D., C. Martinez, and W. Graham, 2014 Seasonal predictions of regional reference evapotranspiration (ETo) based on Climate Forecast System version 2 (CFSv2), Journal of Hydrometeorology,15, 1166–1188. doi: http://dx.doi.org/10.1175/JHM-D-13-087.1.
- Tian, D., C. Martinez, W. Graham, and S. Hwang, 2014: Statistical Downscaling Multimodel Forecasts for Seasonal Precipitation and Surface Temperature over the Southeastern United States. *J. Climate*, **27**, 8384–8411. doi: http://dx.doi.org/10.1175/JCLI-D-13-00481.1
- Tian, D. and **C.J. Martinez**. 2014. The GEFS-based daily reference evapotranspiration (ETo) forecast and its implication for water management in the southeastern United States. Journal of Hydrometeorology, 15(3): 1152-1165. doi: 10.1175/JHM-D-13-0119.1

Long-term Projections:

- Asefa, T. and A. Adams, 2013, Reducing bias corrected precipitation projections uncertainties: A Bayesian based indicator weighting approach, Journal of Regional Environmental Change (2013) 13:111-120 DOI 10.1007/s10113-013-0431-9
- Bastola, S., 2013, Hydrologic impacts of future climate change on Southeast US watersheds, Reg. Environ Change, Springer-Verdag Berlin Heidelberg (doi:10.1007/s10113-013-0454-2

- Bastola, S. and V. Misra, 2014, Evaluation of dynamically downscaled reanalysis precipitation data for hydrological application Hydrological Processes, 28(4), 1989-2002, doi:10.1002/hyp.9734.
- Hwang, S., and W. Graham, 2013, Development and comparative evaluation of a stochastic analog method to downscale daily GCM precipitation, Hydrol. Earth Syst. Sci., 17, 4481-4502, doi:10.5194/hess-17-4481-2013.
- Hwang, Syewoon *and* Wendy D. Graham, 2014. Assessment of Alternative Methods for Statistically Downscaling Daily GCM Precipitation Outputs to Simulate Regional Streamflow. Journal of the American Water Resources Association (JAWRA) 50*(4):* 1010-1032. *DOI:* 10.1111/jawr.12154
- Hwang, S., W. Graham, J. Guerink, and A. Adams, 2014, Hydrologic implications of errors in bias-corrected regional reanalysis data for west-central Florida, Journal of Hydrology, 510:513–529, http://dx.doi.org/10.1016/j.jhydrol.2013.11.042.
- Hwang, S., W. Graham, J. Hernández, C. Martinez, J. Jones, and A. Adams, Quantitative Spatiotemporal evaluation of dynamically downscaled MM5 precipitation predictions over the Tampa Bay region, 2011, Florida, Journal of Hydrometeorology, 12, 1447–1464, doi: 10.1175/2011JHM1309.1.
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- Misra,V. (Summer, 2013) The NOAA MAPP Climate Prediction Task Force, U.S. CLIVAR VARIATIONS, Summer 2013, Vol. 11, No. 2
- Obeysekera, J., Validating climate models for computing evapotranspiration in hydrologic studies: how relevant are climate model simulations over Florida?, Reg. Environ Change, Springer-Verdag Berlin Heidelberg, (doi:10.1007/s10113-013-0411-0)

Technical Group Accomplishments: Sea-level Rise/Change

This technical group focused on improving access to information rather than carrying out specific research. The group established four goals and a list of activities in order of priority. Although the group agreed that all four goals were important, they also agreed that it would be best to wait until the first two were well underway before addressing the third and fourth.

- Improved access to information already available
- Catalog current projects on sea level change – As efforts for the National Climate Assessment are already undertaking a similar task, we decided to build on that effort when it becomes available rather than to repeat work that other are doing.
- Develop and implement plan on how best to move from science to policy and action
- Investigate the role of governance structures related to responses to sea level change

During the NOAA project we accomplished the first two priorities noted by the Sea level Rise/Change contributing important information. Recent publications with regionally relevant information on sea level change were cataloged and made available through the FloridaWCA website.

It was clear by the later workshops that the group had a strong and growing interest in sea level rise and impacts for planning. We focused workshop 10 in South Florida on exploring current plans and responses of several cities and counties to sea level change, and conducted a field trip to the City of Miami Beach. In addition FloridaWCA participants used growing statewide interest in Sea Level Rise to reach out to groups not currently involved in the FloridaWCA. Both Tampa Bay Water and Peace River Manasota are participating a nascent group in South west Florida that is bringing local counties together around the issue of sea level rise. They shared information on these efforts at the FloridaWCA meetings and informed the new organization about the existence and activities of FloridaWCA. These groups were invited to the most recent workshop (Workshop 12) held at Tampa Bay Water. In addition, the Florida Department of Environmental Protection, in partnership with the five Florida Water Management Districts, formed a task group that has met over the last year to discuss issues of Sea Level Rise. Discussions of potential synergies between this group and the FloridaWCA have recently taken place.

3. **Science to Action - Objective 3: Identify appropriate entry points for climate data and model predictions in Working Group members' models and decision making processes**

While research results were being presented during the workshops we asked that the participants listening to the presentations consider "What does what I am hearing mean to me?" How might I use this in my work?" Each utility is unique and the role of climate information in their decision making processes varies. Although concerns emerged about forecast skill discussions emerged regarding the risks of not using information vs. risks of using wrong information. "The forecast has to be wrong only once to cause major issues," said one participant in workshop 8. This led to a return to concerns that went beyond the evaluation of the tools. How we communicate climate science (both to decision makers and among working group participants) remains a top concern. Some participants emphasized the need for "talking points" to communicate climate science to policy and decision makers without overwhelming them. In moving science to action framing the message for the audience and being true to the science is critical. The group continues to desire ways to determine how much technical information do they need or want to know? When do we know how much information is too much? When do we know how much is too little? During Workshop 10 a presentation focused on "Moving Science to Action – what does change management mean to us?" helped to begin to unfold these issues. In workshop 11 participants discussed an example of one member's presentation to the board to explore tools of communication useful to convey science to decision makers.

Key point for success: Regional actionable information is difficult given the various sources of uncertainty. We cannot provide ONE best answer… rather the realization that we need to prepare for a range of possibilities.

Key point for success: Understanding what the science is telling us is important but there remains a strong desire among participants to learn about ways to convey science to decision makers.

B. Application of findings to inform decision making: During Workshop 9 it was decided to focus applications of project findings to two utilities, Tampa Bay Water and Peace River Manasota Water Authority. Although we focused on only 2 specific applications, other Utilities were encouraged to consider entry points for climate data and model predictions in their own models and decision processes during workshop discussions and activities.

1. **Tampa Bay Water**

Tampa Bay Water's physically-based Integrated Hydrologic Model (IHM) that they use for long-term planning purposes was identified as appropriate for incorporating downscaled reanalysis data, retrospective climate predictions and future climate projections for water resource planning and decision making.

Hydrologic predictions generated by forcing IHM with reanalysis data, retrospective predictions and future climate projections were shared at workshops. Hydrologic model predictions using non-bias-corrected reanalysis data and non-bias-corrected retrospective predictions were not able to reproduce historic observed hydrologic behavior. Hydrologic model predictions using bias-corrected dynamically-downscaled reanalysis data, and bias-corrected dynamically- and statistically -downscaled retrospective data, were found to adequately predict historic streamflow and groundwater levels. Hydrologic model predictions using bias-corrected dynamically-downscaled future climate forecasts showed that differences in GCM projections propagate into significant differences in future streamflow and groundwater level projections. Discussions during the workshop focused on the importance of selecting appropriate downscaling and bias-correction methods for Florida (a new statistical downscaling method, Hwang and Graham 2013, was developed as a part of this project) and emphasized the importance of using a large ensemble of GCM projections for bracketing the range of possible hydrologic futures.

In workshop 9, Tirusew Asefa (Tampa Bay Water) provided a presentation entitled, "Use of Climate Information in Tampa Bay Water Decision Support Tools" sharing current use of seasonal forecast data by Tampa Bay Water in operational decision making. Discussion followed on how new seasonal forecast data developed in this project might be used to further improve operations in Tampa Bay Water and other utilities. Discussions during workshop focused on the value of decision tools, the development of the decision tool in different contexts, and the criteria for choosing variables depending on context and need.

2. **Peace River Manasota Water Authority**

As a result of participation in FloridaWCA workshops and proposal writing efforts, Kevin Morris from Peace River Manasota Water Authority decided to find a more reliable way to determine when to start pumping water from the authority's Aquifer Storage and Recovery (ASR) wells that takes into account climate data. Through knowledge gained at FloridaWCA working group meetings, Morris and his co-workers blended measures of current water supply and hydrologic conditions with NOAA Climate Prediction Center monthly and seasonal outlook products and water demand projection scenarios in order to reduce subjectivity in deciding when to initiate ASR recovery. Morris presented his new decision support tool for Peace River Manasota Regional Water Supply Authority at workshop 9. In his presentation "Decision Tool Development Exercise: "When to Start ASR Recovery?," he explored managing risk of starting Aquifer Storage and Recovery operations too early or too late within the Peace River Manasota Regional Water Authority. The document he developed, Peace River Decision Model, was distributed at the workshop and is available at the Florida WCA website. Morris has also made presentations and published an article in Florida Water Resources Journal in September of this year.

C. Planned methods to transfer the information and lessons learned from this project

The website, journal publications, as well as poster and oral presentations at working group and professional meetings have provided numerous opportunities to share project information. In addition, participants actively sought collaborative opportunities to build on lessons learned and submitted 8 proposals over the duration of the project. One of these proposals was funded by NOAA, and has contributed additional knowledge and practical applications of seasonal climate forecasts to the working group.

Participants reported sharing information in their own organizations, as well as making presentations to other professional contacts. Several new members of the group mentioned that they joined the group based on presentations that they have heard in various venues.

Importantly Workshop 12 focused on strategic planning for the future of the FloridaWCA. At the end of the workshop, it was agreed to submit a proposal to the agency stakeholders for funding to continue the functions of the learning network. The successful continuation of the FloridaWCA will contribute to the continued transfer of information and lessons learned from this project, as well as contributing to new research.

D. Significant deviations from proposed activities

We requested and were granted a no cost extension. We carried out significantly more workshops than originally proposed.

E. Completed publications, white papers, or reports (with internet links if possible).

Publications (alphabetic listing)

- Asefa, T. and A. Adams, 2013, Reducing bias corrected precipitation projections uncertainties: A Bayesian based indicator weighting approach, Journal of Regional Environmental Change (2013) 13:111-120 DOI 10.1007/s10113-013-0431-9
- Bastola, S., 2013, Hydrologic impacts of future climate change on Southeast US watersheds, Reg. Environ Change, Springer-Verdag Berlin Heidelberg (doi:10.1007/s10113-013-0454-2
- Bastola, S. and V. Misra, 2014, Evaluation of dynamically downscaled reanalysis precipitation data for hydrological application Hydrological Processes, 28(4), 1989-2002, doi:10.1002/hyp.9734.
- Bastola,S., V. Misra, and H. Li, 2013: Seasonal hydrological forecasts for watersheds over the Southeastern United States for the boreal summer and fall seasons Earth Interactions, 17(25), 1-22, doi:10.1175/2013EI000519.1.
- Bastola, S and V Misra, 2013: Sensitivity of Hydrological Simulations of Southeastern United States Watersheds to Temporal Aggregation of Rainfall. *J. Hydrometeor*, **14**, 1334–1344. doi: http://dx.doi.org/10.1175/JHM-D-12-096.1
- Bolson, J., C. Martinez, N. Breuer, P. Srivastava, P. Knox, 2013, Climate information use among southeast US water managers: beyond barriers and toward opportunities, Reg. Environ Change, Springer-Verdag Berlin Heidelberg, DOI 10.1007/s10113-013-0463-1

- Hwang, S., and W. Graham, 2013, Development and comparative evaluation of a stochastic analog method to downscale daily GCM precipitation, Hydrol. Earth Syst. Sci., 17, 4481-4502, doi:10.5194/hess-17-4481-2013.
- Hwang, Syewoon *and* Wendy D. Graham, 2014. Assessment of Alternative Methods for Statistically Downscaling Daily GCM Precipitation Outputs to Simulate Regional Streamflow. Journal of the American Water Resources Association (JAWRA) 50*(4):* 1010-1032. *DOI:* 10.1111/jawr.12154
- Hwang, S., W. Graham, J. Guerink, and A. Adams, 2014, Hydrologic implications of errors in bias-corrected regional reanalysis data for west-central Florida, Journal of Hydrology, 510:513–529, http://dx.doi.org/10.1016/j.jhydrol.2013.11.042.
- Hwang, S., W. Graham, J. Hernández, C. Martinez, J. Jones, and A. Adams, Quantitative Spatiotemporal evaluation of dynamically downscaled MM5 precipitation predictions over the Tampa Bay region, 2011, Florida, Journal of Hydrometeorology, 12, 1447–1464, doi: 10.1175/2011JHM1309.1.
- Hwang, S., W. Graham, A. Adams, and J. Guerink, 2013, Assessment of the utility of dynamically-downscaled regional reanalysis data to predict streamflow in west central Florida using an integrated hydrologic model, Regional Environmental Change, doi: 10.1007/s10113-013-0406-x.
- Li, Haiquin and V. Misra, 2014, Thirty-two-year ocean-atmosphere coupled downscaling of global reanalysis over the Intra-American Seas, Springer-Verlag Berlin Heidelberg 2014
- Misra, V. and H. Li, 2014**:** The seasonal climate predictability of the Atlantic Warm Pool and its Teleconnections, Geophys. Res. Lett., 41(2), 661-666, doi:10.1002/2013GL058740.
- Misra, V., 2013: A multi-disciplinary assessment of the southeastern United States climate Reg. Environ. Change, 13, S1-3. doi:10.1007/s10113-013-0507-6.
- Misra, V.; S.M. DiNapoli, S. Bastola, 2013, Dynamic downscaling of the twentieth-century reanalysis over the southeastern United States, Reg. Environ Change, Springer-Verdag Berlin Heidelberg, doi:10.1007/s10113-012-0372-8
- Misra,V. (Summer, 2013) The NOAA MAPP Climate Prediction Task Force, U.S. CLIVAR VARIATIONS, Summer 2013, Vol. 11, No. 2
- Morris, K. M. Coates, and M. Heyl, 2014, Developing a surface water resiliency model for the 21st century, Florida Water Resources Journal, September 2014.
- Nag, B., V. Misra, and S. Bastola, 2014, Validating ENSO teleconnections on Southeastern United States Winter Hydrology Earth Interactions. *Earth Interact.*, **18**, 1–23. DOI: EID-14-0007.1.
- Obeysekera, J., Validating climate models for computing evapotranspiration in hydrologic studies: how relevant are climate model simulations over Florida?, Reg. Environ Change, Springer-Verdag Berlin Heidelberg, (doi:10.1007/s10113-013-0411-0)
- Risko, SL and CJ Martinez, 2014, Forecasts of seasonal streamflow in West-Central Florida using multiple climate predictors, Journal of Hydrology, Volume 519, Part A, 27, Pages 1130–1140.
- Tian, D., C. Martinez, and W. Graham, 2014 Seasonal predictions of regional reference evapotranspiration (ETo) based on Climate Forecast System version 2 (CFSv2), Journal of Hydrometeorology,15, 1166–1188. doi: http://dx.doi.org/10.1175/JHM-D-13-087.1.
- Tian, D., C. Martinez, W. Graham, and S. Hwang, 2014: Statistical Downscaling Multimodel Forecasts for Seasonal Precipitation and Surface Temperature over the Southeastern United States. *J. Climate*, **27**, 8384–8411. doi: http://dx.doi.org/10.1175/JCLI-D-13-00481.1
- Tian, D. and **C.J. Martinez**. 2014. The GEFS-based daily reference evapotranspiration (ETo) forecast and its implication for water management in the southeastern United States. Journal of Hydrometeorology, 15(3): 1152-1165. doi: 10.1175/JHM-D-13-0119.1

FloridaWCA group building, process related documents

- A Review of Regional and Global Water Utilities Use of Climate Information Victoria Keener, PhD. University of Florida, Southeast Climate Consortium (Handout Workshop 1)
- Bibliography of resources related to Climate and Water Utilities Victoria Keener, PhD, University of Florida, Southeast Climate Consortium (Handout Workshop 1)
- Working Group Monitoring and Feedback – Research Summary of Report 1 Wendylin Bartels, PhD, University of Florida, Florida Climate Institute (Handout Workshop 2)
- "What Can We Learn from other Groups" Includes participant summaries of groups focused on impacts of climate change, climate variability and sea level rise on public water utilities, compiled by Lisette Staal, UF Water Institute (Pre-workshop document Workshop 2)
- Participants' PROJECT Summaries Brief descriptions of participants' projects focused on Evaluation of potential climate impacts to Water Utilities — updated May 2011

- Development of Public Water Supply Utility Relevant Climate Information for Improved Operations and Planning: Implementing a collaborative working group process in Florida, Staal, L. et. al., November 2010 (Poster presented at Florida Climate Institute, Tallahassee Florida)
- Development of Public Water Supply Utility Relevant Climate Information for Improved Operations and Planning, Staal, L. et. al., November 2011 (Poster presented at Southeast Climate Consortium, Tallahassee Florida)
- Two Sides of the Same Coin: Communicating Climate Change Science to Stakeholders in Florida and Hawai'i. Keener, V. W., Staal, L., & Finucane, M. L. Poster presented at the Annual Meeting of the American Geophysical Union, "Scientist Participation in Science Communication" Session, San Francisco, CA, December 5-9, 2011.
- FloridaWCA Workshop Reports - There were 12 workshops with 8 being during this reporting periods of this project. The related information including agenda, summary report, and presentations are available on the Floridawca.org website. In addition, information on all other workshop and working group documents are available at the Floridawca.org website

Websites

- http://floridawca.org
- http://waterinstitute.ufl.edu/WorkingGroups/PWSU-CIWG.html
- http://waterinstitute.ufl.edu/research/projects_detail.asp?TA=Water+and+Climate&Contract=79361

Outreach – Presentations, Media, Information

Participants have reported sharing information in their own organizations, as well as making presentations to their contacts in various professional venues (2014 Water Institute Symposium, SECC meetings, RISA meetings, PUMA meetings, WUCA meetings, AGU meetings and other professional society meetings).

- Kevin Morris, Sea Level Rise Compels Florida Coastal Surface Water Supply to Develop Sustainability Model presented at the American Water Resource Association, Integrated Water Resource Management-from theory to application Conference, June 30-July 2, 2014, in Reno, Nevada
- Kevin Morris and Jessica Bolson, "Synthesis of Diverse Data in Developing a Decision Tool for Initiating ASR Recovery," presentation at , AWRA, July 2014
- Kevin Morris, presentation at the FSAWWA Region IV Summer Luncheon- July 30, 2014
- Lisette Staal, Climate Prediction Applications Workshop, Utah 2013.

- Wendy Graham, Seminar, Civil Engineering Department, University of South Florida, April 2012.
- Wendy Graham, Invited Presentation, Florida Atlantic University Climate Change Workshop, March 2012.
- Wendy Graham, Invited Presentation, Everglades Climate Change Webinar, August 2012.
- Wendy Graham, Seminar, Agricultural Education and Communications Department, University of Florida, March 2013.
- Wendy Graham, Invited Presentation to the Tampa Bay Water Governing Board, October 2013
- Wendy Graham, Invited Presentation, American Geophysical Union Annual Meeting, December 2013.
- Syewoon Hwang, Presentation, American Geophysical Union Annual Meeting, December 2010.
- Kevin Spear, Reporter, Orlando Sentinel newspaper article
- NOAA - Featured project in NOAA CPO Fact Sheet
- NOAA- Article/Video - Tampa Bay Water's innovative use of climate science in utility operations decision-making is highlighted in the feature article of NOAA's ClimateWatch magazine: Florida's Fragile Oasis. http://www.climatewatch.noaa.gov/article/2012/floridas-fragile-oasis
- Wendy Graham, UF Center Public Issues Education, Blog
- Wendy Graham, Presentation about project to Rotary Club & USF & Everglades climate meeting"
- Tirusew Asefa, Tampa Bay Water, Coping with uncertainties in CMIP5 precipitation projections: A case study from west central Florida
- Jessica Bolson, Wharton Risk Management and Decision Processes Center, Early lessons learned from the Florida Water Climate Alliance on the integration of climate information into water resource decision-making
- Kathryn I Frank, Department of Urban and Regional Planning, UF, Coastal Utilities' Response To Saltwater Intrusion
- Tracy Irani, Odera, E., & Staal, L. Center for Public Issues Education, Water Institute, UF/IFAS, Creating Stakeholder Collaborations for Water Use Planning in an Uncertain Future: The Case of the Florida Water and Climate Alliance
- Kevin Morris, Peace River Manasota Regional Water Supply Authority, Synthesis of Diverse Data in Developing a Decision Tool for Initiating Recovery from an Aquifer Storage and Recovery System
- Jayantha Obeysekera, South Florida Water Management District, Scenario-based, Integrate Assessment of the Greater Everglades System to Climate Change
- Di Tian, University of Florida, Forecasting short-term urban water demands based on the Global Ensemble Forecast System
- Galen Treuer, Leonard and Jayne Abess Center for Ecosystem Science and Policy, University of Miami, Using behavioral science to support south Florida water management
- Alison Adams, Tampa Bay Water, asked the panel members (leaders of Florida's agencies responsible for water planning and management) about their support for climate change research for use in hydrologic modeling to help understand climate change impact on water resources as it relates to Florida and the Southeast during the final plenary session. Click here for the video stream of the question and response.

III. GRAPHICS: PLEASE INCLUDE THE FOLLOWING GRAPHICS AS SEPARATE ATTACHMENTS TO YOUR REPORT

- ☐ Photo /Slide 1: Introduction to the Florida Water and Climate Alliance
- ☐ Photo/ Slide 2: FloridaWCA timeline reflecting workshops and activities.

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION

http://floridawca.org/
http://waterinstitute.ufl.edu/WorkingGroups/PWSU-CIWG.html
http://waterinstitute.ufl.edu/research/projects_detail.asp?TA=Water+and+Climate&Contract=79361

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES – none

VI. REFERENCES

Kolb, D. A. (1984), *Experiential learning: Experience as the source of learning and development*, Prentice Hall, Englewood Cliffs, NJ.

Kolb, D. A. (1999a). *Learning Style Inventory, Version 3*. Boston, MA: Hay Group, Hay Resources Direct. 116 Huntington Avenue, Boston, MA 02116, haytrg@haygroup.com.

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Wenger, E. (1998) *Communities of Practice: Learning, Meaning, and Identity*, Cambridge University Press, NY