Annual Report to NOAA Regional Integrated Sciences and Assessments Program

1. **SECC-RISA: Science and partnerships for adaptation and resilience to climate change and climate variability**

2. **Performance Period – May 2013 through June 2014**

3. **SECC Executive Committee**

University of Florida:	S Asseng, CW Fraisse, KT Ingram
Florida State University:	V Mishra, JJ O'Brien
University of Miami:	D Letson
Auburn University:	P Srivastava
University of AL, Huntsville:	J Christy
University of Georgia:	G Vellidis

Full list of team members for each institution are included with institutional reports and posted on the SECC website at: http://www.seclimate.org/programs.php

4. **New Focus Areas and Partnerships**

4.1. Expanding the use of seasonal statistical rainfall forecasts for crop management into seasonal temperature forecasts for managing winter and summer crops in SE US. We also started to explore the use of dynamic seasonal forecast using Global Circulation Models (GCM) and the potential of using multi-model seasonal forecast ensembles in partnership with FSU and AU.

4.2. Explore model uncertainty and to separate this from natural variability in using crop models in climate change impact assessments. The separation and quantification of model uncertainty and natural variability is important for the understanding of climate change impacts and preparing for adaption options in the SE and elsewhere. This activity is in partnership with AgMIP and several international institutions.

4.3. Evaluating the Impact of Climate Change on Rainfall Erosivity in the Southeast. Climate change is expected to change the intensity of precipitation events in the Southeast. This change in intensity would change the energy in the storm events and would result in increased rainfall erosivity. The best management practices designed to control erosion from urban and agricultural areas would not be sufficient in future. To adapt to climate change, natural resource managers should use new rainfall erosivity values that are derived from climate projections.

4.4. Climate variability impacts nitrogen use efficiency in corn production. Increasing environmental stewardship aided by adapting management practices, nitrogen management, based on climate information could be important.

4.5. Adding drought adaptation strategies to irrigation scheduling tools. An example is primed acclimation which reduces irrigation levels early during the growing season to 60% of normal. This strategy promotes the development of deeper root systems and allows crops access to soil moisture at depth thus reducing the need for irrigation. These adaptation strategies are being incorporated into sensor-based and ET-based scheduling tools.

4.6. Evaluating precipitation forecasting information to eventually be included in sensor-based and ET-based irrigation scheduling tools. Forecasts are being provided by new partners – IBM's Deep Thunder Project and Georgia Tech School of Earth and Atmospheric Science.
4.7. Assessment of the economic impact of the Alabama Irrigation Tax Credit to farmers on the budget of the State of Alabama.
4.8. Development of a real-time hydrologic model for water resource planning.

5. Research Findings

- High resolution downscaling of global climate change projects more drying over southeast US because of a significant reduction in diurnal variation of convection.
- While GCM-based ensemble seasonal forecasts might help to improve the forecast skill for managing crops by quantifying forecast uncertainty, there are large regional differences in forecast skills for seasonal rainfall and seasonal temperature with implications for farmers decision support
- A smartphone app for irrigation scheduling on cotton was calibrated and validated during the 2013 growing season. The app outperformed other scheduling methods in both irrigation water used and yield produced. The app was released to the public during April 2014. www.smartirrigationapps.org (See figures below)
- A multi-output/input stochastic distance frontier model was used to analyze the effect of interannual climatic variability on agricultural production and to assess the impact of climate forecasts on the economic performance of this sector in the Southeastern United States. Seasonal rainfall and temperature forecasts have a positive effect on economic performance of agriculture. However, the effectiveness of climate forecasts on improving technical efficiency is sensitive to the type of climate index used. These findings have strong potential for designing new policy.
- The first year of the irrigation tax credit in Alabama, which was enacted based on SECC analyses of climate and crop water needs, was utilized by 156 farming operations costing the state tax revenues of $719K. The total increase in tax revenues from the use of irrigation were calculated by two teams and indicated the total return in 20 years would be $9-15M.
- A study on how climate variability and nitrogen rate interactions affect corn nitrogen use efficiency in Alabama showed that years with a forecast for dry May and June months only 50 lb N/acre should be applied to corn in Central Alabama with contrast with 100 lb N/acre should be applied if the forecast calls for wet May and June months.

6. Accomplishments

6.1. Needs, uses, perceptions, and attitudes towards weather and climate forecast information by water resource managers in the Southeast USA

Despite nearly 20 years of work on understanding the climate information needs of stakeholders and simultaneous development of decision support tools, a relatively low level of awareness of specific climate information products exists among many water managers in the southeastern

United States. Through an online survey, we collected data from 141 water managers across the region. Our findings reveal that:

- Water managers surveyed, for the most part, are unaware of most sources of seasonal climate forecasts as well as specific sources of long-term climate change information.
- The use of seasonal climate forecast products remains mostly in the realm of water managers with high levels of expertise and training generally employed at large water management agencies.
- In addition to limited awareness, some reasons for nonuse are a lack of understanding of forecasts and limitations in temporal and spatial scales of available climate information.

These findings can be used to align goals of climate science research by ensuring that it is relevant to decision-makers' needs and decisions and by identifying opportunities for improvements in forecast dissemination and climate risk management. For example, the need for more interactions among scientists and decision-makers, and the identification of opportunities within the decision-making frameworks where climate information can be input are manifest throughout the study.

6.2. Impact of climate change on agriculture in the Southeast USA, including key climate vulnerabilities, uncertainties, adaptation, assessment and research needs.

The challenge of communicating about climate change with more skeptical audiences is being addressed within the SE Climate Consortium (SECC) by focusing initial discussions on climate-related issues that are of more urgent concern to growers. Findings include:

- Farmers in central and northern Florida, who have more diversified and smaller operations, tend to place more importance on seasonal climate variability and are better positioned to respond to climate predictions.
- Similarly, dry land farmers face very different adaptation challenges than do farmers who have irrigation systems.
- When viewing agriculture as a complex system of practices, climate information should be integrated gradually and experimented with over time. In this way, farmers will learn to employ these new technologies and adapt them to their own particular circumstances.

6.3. Climate impacts on aflatoxin contamination of corn

The fungus *Aspergilus flavus* produces one of the most highly carcinogenic natural mycotoxins known, aflatoxin. *A. flavus* is particularly prone to attack crops and produce aflatoxin under conditions of drought. During 2013, the risk for aflatoxin contamination of corn that is associated with changes of management practices (planting date and planting density) was studied at two locations, Fairhope in the South and Pratville in Central Alabama. The frequent rainfall observed during the 2013 corn growing season at both locations was not conducive of high aflatoxin contamination. Significant differences in aflatoxin levels between the two planting date treatments (standard planting date and month later) were observed at the Fairhope location. At Fairhope, AL, delaying planting one month with respect to the standard planting date resulted on lower aflatoxin contamination. However; it resulted in 24 bu/acre less corn yield. At Pratville, AL, there were neither differences in aflatoxin among planting dates nor in plant densities. In contrast, significant differences in corn yield were observed with planting date 2 (one month later) exhibiting higher yield - 24 bu/acre - than the standard planting date.

In addition to these field experiments, data from 10 years aflatoxin study conducted in Mississippi were analyzed to test whether we can predict risk of corn aflatoxin contamination based on a drought index and to identify the growing windows when the afltoxin risk increase. Results from showed that a drought index, specifically ARID index, can be used to predict aflatoxin risk. Data also showed that aflatoxin risk is higher during the week after silking and four weeks before silking with increased drought conditions. Results also showed that the risk for aflatoxin changes with soil type, and corn growing on light texture soils is at higher risk for aflatoxin contamination.

6.4. Climate outreach to underserved farmer groups

Analysis of data collected with small-scale organic farmers revealed the presence of adaptive capacity in cases where a strong social network exists. Analysis of data collected with African American farmers revealed the need to incorporate climate information into risk management strategies- as a way of better engaging this community. We also identified the need to incorporate climate information into mentoring programs that encourage cross-generational exchange of knowledge for African American Farmers. This knowledge exchange builds stronger relationships within the community and, therefore, greater adaptive capacity. (see figure below)

6.5. The changing climate of the Little River Watershed

The Little River in southern Georgia, has experienced lengthening droughts since monitoring began in 1972. We evaluated the impacts of drought on riverine carbon cycling using a 9 year dataset for dissolved organic carbon (DOC) coupled with laboratory experiments in the Little River, as well as long-term data sets in three additional rivers within the Suwannee River basin. Longer drought periods reduced downstream DOC export but also led to higher DOC concentrations in the following hydroperiod. If the current climatic trend of intensifying droughts, elevated temperatures and decreased discharge continue, our results suggest the net effect may be for a more localized riverine carbon cycle with reduced downstream transport of DOC, but higher local mineralization rates due to elevated DOC concentrations.

7. Outreach Activities

7.1. On-line decision support

The centerpiece for SECC outreach is AgroClimate [http://AgroClimate.org], an on-line decision support system for agriculture. AgroClimate is managed by Florida Cooperative Extension, with support from the SECC to update databases and develop new products for the site. In 2013 we introduced a new version of AgroClimate, with a new look and layout, while retaining all of the popular features from previous versions of AgroClimate.

The SECC is also developing a new decision support system for water resources managers. The prototype for the site has added several new features during the past year, including an evapotranspiration (ET) tool that allows users to view recent and historic levels for ET at a local level. We anticipate that this site will be operational by early 2015.

7.2. Tri-State Agricultural Working Group

The aim of this Tri-state climate group is to encourage on-going interactions among row crop stakeholders for knowledge exchange and learning. Participants explore management options for adapting production systems in the face of a changing and variable climate. Semiannual workshops build and strengthen relationships and communication among participants involved in research, outreach, and practice. We emphasize hands-on, peer-to-peer learning through on-farm field visits, experimentation, and in-depth discussions. We strive to facilitate a two-way flow of information and ideas within this climate learning network so that local experiences can influence research directions (and vice versa).

7.3. Florida Water Climate Alliance

With initial funding from SARP in 2010 for the Public Water Supply Utilities Climate Impacts Working Group, this group has evolved in 2013 into the Florida Water Climate Alliance [http://floridawca.org]. The Florida Water and Climate Alliance is a stakeholder-scientist partnership committed to increasing the relevance of climate science data and tools at relevant time and space scales to support decision-making in water resource management, planning and supply operations in Florida. The collaborative Learning network is engaged in co-exploration and co-development of actionable climate science. FloridaWCA Projects contribute to assessing and developing relevant climate data and tools and ensuring their usefulness to water supply and resource planning.

7.4. Apalachicola-Chattahoochee-Flint River Drought Early Warning System

With partial sponsorship from the National Integrated Drought Information System (NIDIS), we helped establish a series of webinars to help stakeholders of the Apalachicola-Chattahoochee-Flint River Basin to prepare for and manage drought. This webinar series has evolved to become an operational drought early warning system (DEWS), with regular webinars continuing even during periods when drought is neither present nor forecast for the basin.

7.5. Meetings, conferences, workshops, and symposia

In addition, SECC members organize and present information to multiple meetings, conferences, workshops, and symposia each year. Lists of these activities are included with the institutional annual reports on the SECC website.

8. Key Publications

Asseng, S., Ewert, F., Rosenzweig, C., Jones, J. W., Hatfield, J. L., Ruane, A. C., Boote, K. J., Thorburn, P. J., Rotter, R. P., Cammarano, D., Brisson, N., Basso, B., Martre, P., Aggarwal, P. K., Angulo, C., Bertuzzi, P., Biernath, C., Challinor, A. J., Doltra, J., Gayler, S., Goldberg, R., Grant, R., Heng, L., Hooker, J., Hunt, L. A., Ingwersen, J., Izaurralde, R. C., Kersebaum, K. C., Mueller, C., Kumar, S. N., Nendel, C., O'Leary, G., Olesen, J. E., Osborne, T. M., Palosuo, T., Priesack, E., Ripoche, D., Semenov, M. A., Shcherbak, I., Steduto, P., Stoeckle, C., Stratonovitch, P., Streck, T., Supit, I., Tao, F., Travasso, M., Waha, K., Wallach, D., White, J. W., Williams, J. R. & Wolf, J. 2013. Uncertainty in simulating wheat yields under climate change. Nature Climate Change 3(9): 827-832.

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9. Key Outputs and Impacts

9.1. Climate forecasts for water managers

As a result of our interaction with the Florida Water and Climate Alliance (FloridaWCA) and demonstration of the usefulness of seasonal climate forecast the Peace River Manasota Regional Water Supply Authority (Peace River Authority) developed Aquifer Storage and Recovery (ASR) initiation index. This index employs ten variables: four operational variables, two hydrologic condition variables and four climate forecast products (Table 1). Each variable is given a weight based upon its typical range in context of the risk posed to water supply. The variables differ in importance and the respective weights factors reflect this. The index is recalculated weekly by Authority staff as a guide in making the decision on when to initiate ASR recovery operations.

Table 1. Variables employed in the ASR Recovery Initiation Index

Operational Variables	Frequency of Updates and Origin
Raw Water Reserves	Daily, Self-Provided
Month	Monthly, NA
ASR Reserves	Daily, Self-Provided
Customer Demand	Daily, Self-Provided
Hydrologic Variables	
River Flow	Daily, United States Geological Survey
Keetch-Byram Drought Index	Daily, Florida Forest Service
Climate Forecast Products	
3-Month Precipitation Probability Outlook	Monthly, Climate Prediction Center
1-Month Precipitation Probability Outlook	Monthly, Climate Prediction Center
3-Month Temperature Probability Outlook	Monthly, Climate Prediction Center
1-Month Temperature Probability Outlook	Monthly, Climate Prediction Center

9.2. Climate information for organic farmers

As a result of the SECC-funded talk by Knox and Furman at the Georgia Organics annual meeting in February 2014, they were invited to provide a regular column to the Georgia Organics newsletter on impacts of changing climate on Georgia agriculture.

9.3. Climate and water use efficiency in agriculture

The University of Georgia Smart Sensor Array (UGA SSA) soil moisture sensing system coupled with variable rate irrigation (VRI) enabled center pivots was adopted by the Flint River Soil & Water Conservation District as the technological solution for automated irrigation scheduling in the Lower Flint River Basin.

9.4. Irrigation tax credit

IN 2013, 156 farming operations took advantage of the Alabama Irrigation Tax Credit that the UAH team of the SECC was responsible for promoting. More detail is given above.

9.5. Metrics and indicators of success

- Participation in our sponsored workshops and online courses.
- Web-based traffic on blogs and project-related web sites.
- Administer and analyze post-workshop assessment surveys.
- Provide copies of any written material and workshop reports and ask for feedback.
- Research published in international peer-review journals, cited by others and being relevant to farm decisions. For example, the Cotton Smartirrigation App was one of four in a suite of apps which received a 2014 Educational Aids Blue Ribbon Award from the American Society of Biological and Agricultural Engineers.

- New stakeholder-needed knowledge generated by the project.
- Number of invited presentations to discuss topics related to climate variability and its relation to agriculture and water resources.
- Number of outreach interactions with stakeholders, including phone calls or emails from farmers, extension agents, crop consultants, and water.
- Number of farmers or extension agents using or considering using climate information as part of agronomic management of row crops in the Southeast US.
- Number of farming operations which took advantage of the Alabama Irrigation Tax Credit for which the UAH – SECC team was responsible.

Dr. Carrie Furman (left) discusses climate-related educational materials with members of the Federation of Southern Cooperatives during a farmers meeting in Albany, Georgia.

SmartIrrigation Cotton App released by the University of Georgia and University of Florida SECC team in early 2014. The app is included in a suite of four apps which received a 2014 Educational Aids Blue Ribbon Award from the American Society of Biological and Agricultural Engineers (ASABE).

Method	Conservation Tillage		Conventional Tillage	
	Lint Yield (lb/ac)	Water Use (in)	Lint Yield (lb/ac)	Water Use (in)
Checkbook	1350	12.7	1150	12.2
Cotton App	1485	3.0	1259	3.0
CWSI	1430	5.0	1305	2.3
Irrigator Pro	1455	2.8	1200	4.3

10. All SECC Publications

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