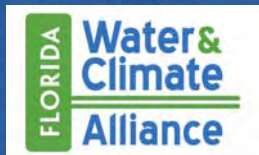


# Regional Climate Impacts

Chris Martinez  
Associate Professor  
Agricultural and Biological Engineering  
University of Florida



# The Florida Water and Climate Alliance

- Partnership of:
  - Water utilities
  - State agencies
  - Researchers
  - Local governments
- Formed in 2010



# The Florida Water and Climate Alliance

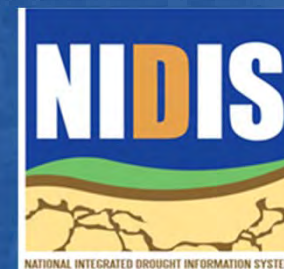
## Goal:

To increase the regional relevance and usability of climate and sea level rise models for the specific needs of water suppliers and resources managers in Florida.





# National Integrated Drought Information System (NIDIS)



- Research
- Outreach

**SOUTHEAST CLIMATE CONSORTIUM**

## What does the 2010-2011 La Niña mean for the Southeastern USA?

**An Apalachicola-Chattahoochee-Flint River Basin Drought Early Warning System Fact Sheet**

Prepared by Christopher J. Martinez<sup>1</sup> for the Southeast Climate Consortium (SECC) and the National Integrated Drought Information System (NIDIS), January 2011.

<sup>1</sup> Department of Agricultural and Biological Engineering, University of Florida, P.O. Box 110570, Gainesville, FL 32611, (352) 392-1864, cjm@ufl.edu

La Niña typically brings warmer and drier conditions to the Southeastern USA during winter, resulting in reduced streamflow, lower reservoir and lake levels, and greater risk of wildfire. La Niña events can last one or more years. In multi-year La Niña events, there is a greater likelihood for successive winters to be warmer and drier than normal. The winter of 2010-2011 has been colder than would be expected during a La Niña, with some locations in the Southeastern USA recording the coldest December on record. This unusually cold weather has been caused by the North Atlantic Oscillation (NAO), which has effectively overpowered La Niña for much of this winter. However, the condition of the NAO can change in a manner of a week or two, while La Niña conditions are expected to continue through the spring.

The purpose of this document is to describe the 2010-2011 La Niña, the impact the NAO has had this winter, and the potential impacts of La Niña for the remainder of the winter and through the spring.

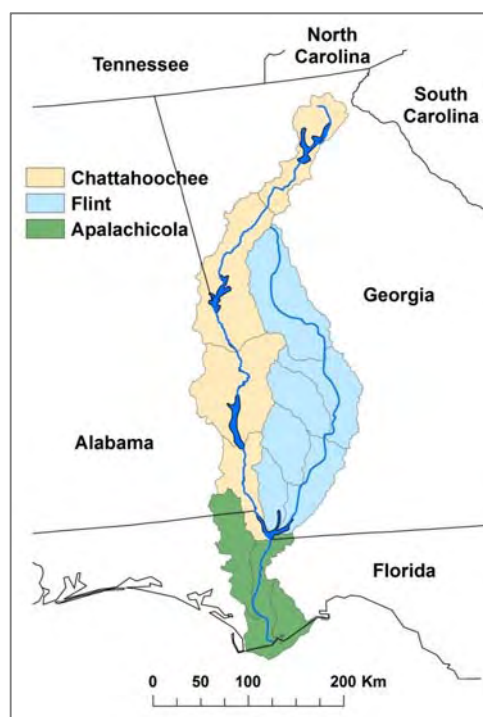
### What Is La Niña?

La Niña is a cooling of the surface of the eastern and central Pacific Ocean along the equator and is part of the climate phenomenon known as the El Niño-Southern Oscillation (ENSO). Periods of warming of the eastern and central Pacific are known as El Niño. The change in heating and cooling of the ocean caused by El Niño or La Niña cause changes in the atmosphere in the tropical Pacific, which in turn impacts atmospheric circulation in many regions of the world.

El Niño and La Niña events tend to occur every 3-7 years. Periods where the tropical Pacific Ocean is neither warmer nor cooler than usual are called Neutral. El Niño events may last for a period of a few months up to one year (though multi-year events have occurred in the past), while La Niña events have a greater tendency to continue for multiple years (Figure 1). The La Niña events in 1954-1957, 1973-1976, and 1998-2000 are examples of past multi-year events.

Figure 1. The Multivariate ENSO Index (MEI). La Niña events are indicated by large, negative values of the index and El Niño events as large, positive values. The MEI is essentially a weighted average of the significant features related to ENSO over the tropical Pacific and includes the following six variables: sea-level pressure, the east-west and north-south components of the surface wind, sea surface temperature, surface air temperature, and total amount of cloudiness. Details of the MEI can be found at: <http://www.cgd.noaa.gov/mex/multivariate/multivariate.html>

**SECC**  
Southeast Climate Consortium  
SECC.org



**FAS**  
of FLORIDA



Florida Climate Institute

**ACF Water**

A product of the National Integrated Drought Information System (NIDIS) and the Southeast Climate Consortium (SECC). Providing water resource related information for the Apalachicola-Chattahoochee-Flint River Basin and the Southeast USA.

July 2011

**Much of ACF basin in drought**

**U.S. ACF Water**

Constant Contact; Emails; Manage Archive

August 2011

A product of the National Integrated Drought Information System (NIDIS) and the Southeast Climate Consortium (SECC). Providing water resource related information for the Apalachicola-Chattahoochee-Flint River Basin and the Southeast USA.

**La Niña Watch Issued by NOAA Climate Prediction Center**

**ACF Water**

A product of the National Integrated Drought Information System (NIDIS) and the Southeast Climate Consortium (SECC). Providing water resource related information for the Apalachicola-Chattahoochee-Flint River Basin and the Southeast USA.

September 2011

**La Niña returns**

La Niña conditions are expected to continue through the remainder of 2011 and into the start of 2012. View the forecast for the next 3-9 months in the **ENSO Quick Look** issued by the International Research Institute for Climate and Society (IRI).

**ACF Water**

A product of the National Integrated Drought Information System (NIDIS) and the Southeast Climate Consortium (SECC). Providing water resource related information for the Apalachicola-Chattahoochee-Flint River Basin and the Southeast USA.

November 2011

**La Niña continues**

La Niña conditions are expected to continue through the remainder of 2011 and into the start of 2012. View the forecast for the next 3-9 months in the **ENSO Quick Look** issued by the International Research Institute for Climate and Society (IRI).

**How does the current drought in the southeast compare to previous droughts?**

Source: IRI.

**Links**

- National Integrated Drought Information System (NIDIS)
- ACF Regional Drought Early Warning System
- ACF Reservoir Levels and Forecasts
- USGS WaterWatch
- ACFStakeholders.org
- Southeast River Forecast Center
- Southeast Regional

# NIDIS SE Pilot Motivation

- 2007-2008 and 2011-2012 droughts linked, in part, to La Niña events.
- Both drought events were forecasted many months in advance.

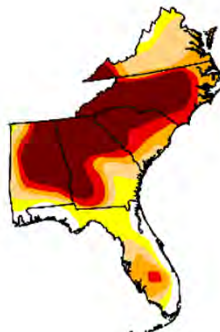
## U.S. Drought Monitor Southeast

December 11, 2007  
Valid 7 a.m. EST

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	8.6	91.4	79.3	63.2	47.9	36.2
Last Week (12/04/2007 map)	12.3	87.7	77.9	59.7	45.2	31.5
3 Months Ago (09/18/2007 map)	8.2	91.8	76.7	58.1	41.7	15.9
Start of Calendar Year (01/01/2007 map)	52.2	47.8	10.2	1.5	0.0	0.0
Start of Water Year (10/01/2007 map)	10.1	89.9	77.9	63.8	45.2	24.0
One Year Ago (12/12/2006 map)	63.6	36.4	10.1	1.7	0.0	0.0

### Intensity

D0 Abnormally Dry  
D1 Drought - Moderate  
D2 Drought - Severe  
D3 Drought - Extreme  
D4 Drought - Exceptional



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

<http://drought.unl.edu/dm>



Released Thursday, December 13, 2007  
Author: Brian Fuchs, National Drought Mitigation Center

## New to Being Dry, the South Struggles to Adapt



Erik S. Lesser for The New York Times

Val Perry of the Lake Lanier Association walking from his dock last week. The governor of Georgia wants the Army Corps of Engineers to reduce the amount of water it releases from the lake.

By SHAILA DEWAN and BRENDA GOODMAN  
Published: October 23, 2007

TWITTER



Give Our Georgia Friends a Drink Day

nsortium

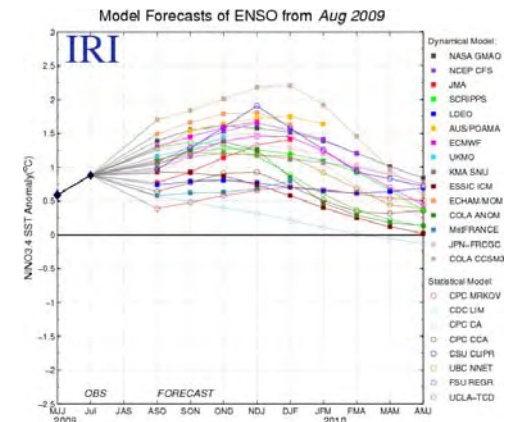
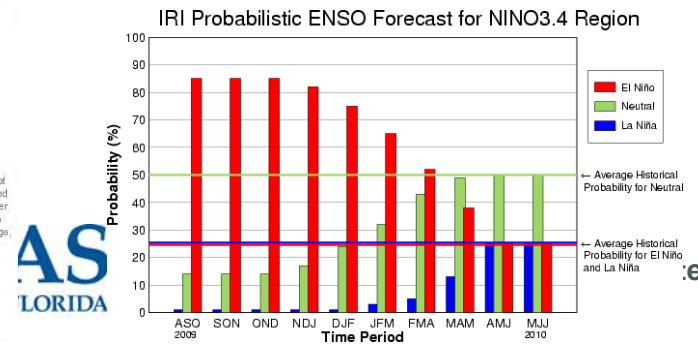
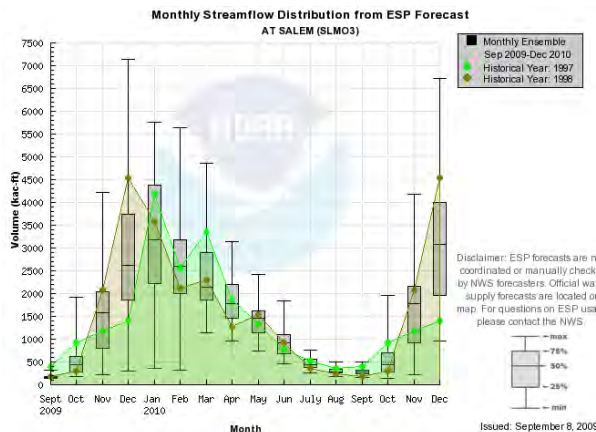
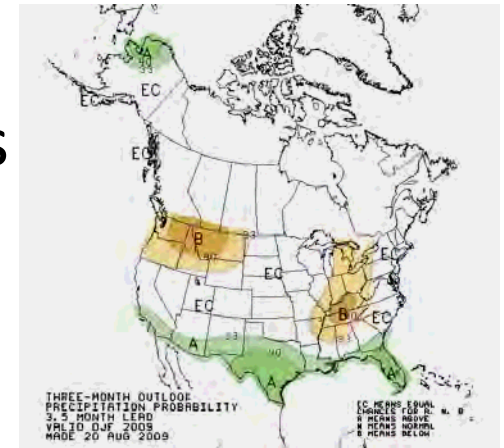
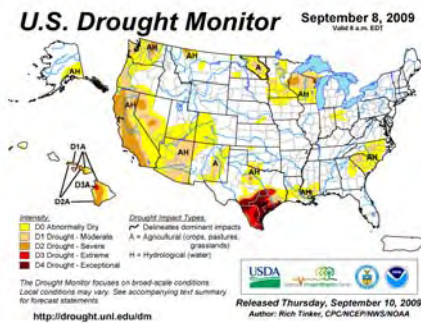


Florida Climate In



# Issues in the Application of Climate Science for Decisions

1. Mismatches of scales
2. Awareness and easy access
3. Misinterpretations
4. Perceptions of poor skill
5. Institutional conservatism
6. Regulatory constraints



# Hydrologists are from Venus and Climatologists are from Mars

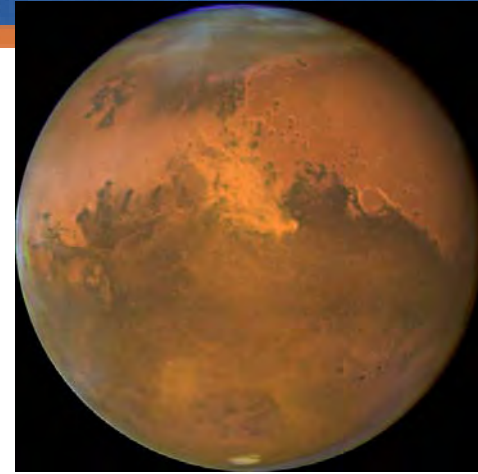


## Hydrologists

**Watershed to Local Scale**

**Deterministic Models**

**'High' Model Skill ( $R^2 \sim 0.9$ )**



## Climatologists

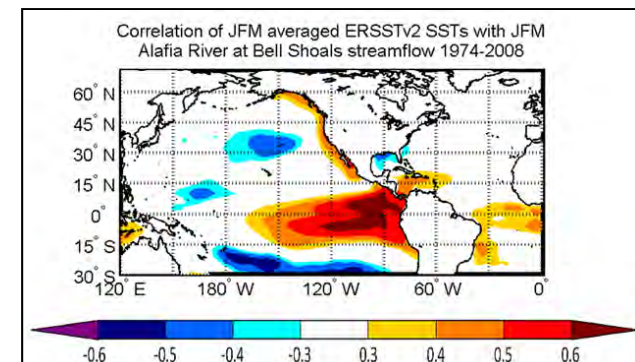
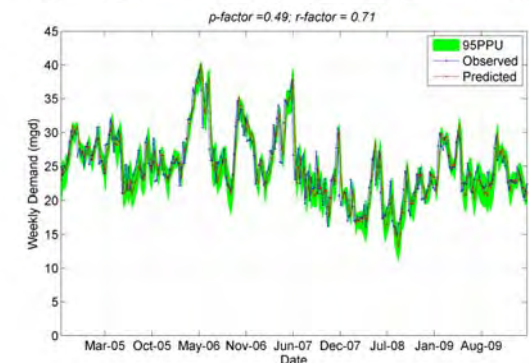
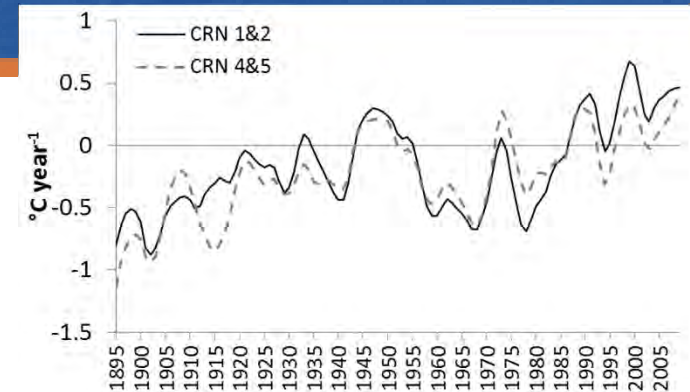
**Continental to Global Scale**

**Probabilistic Models**

**'Low' Model Skill ( $R^2 \sim 0.2?$ )**

# Products at Multiple Scales

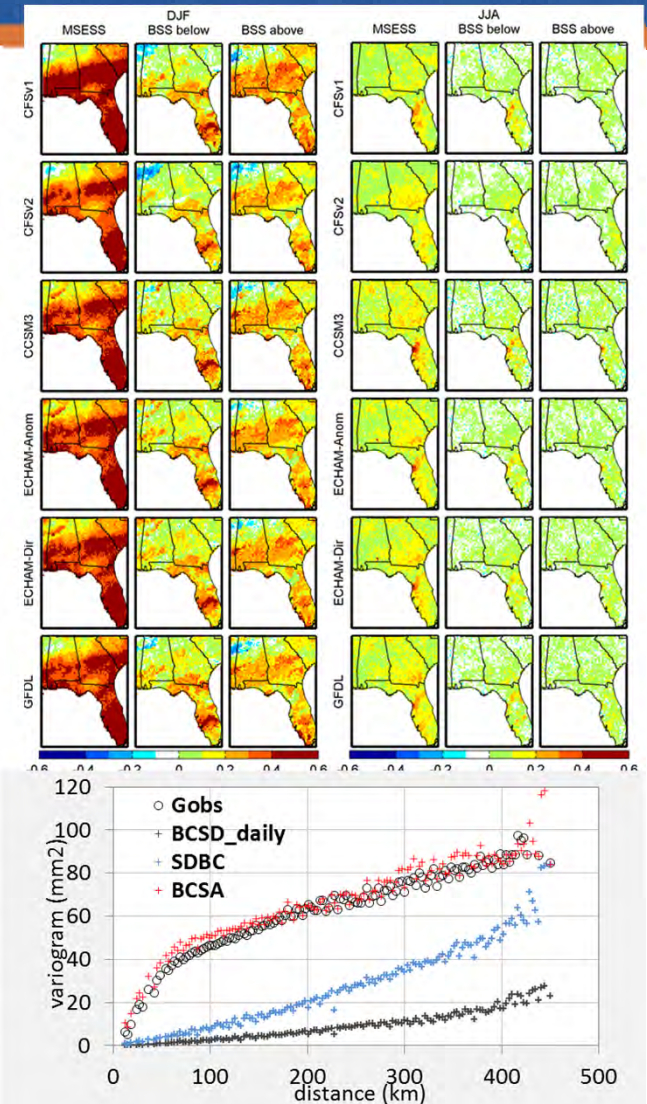
- Historical Trends
  - Florida IS warming!
- Weekly Urban Demand Forecasts
  - Global Ensemble Forecast System (GEFS)
  - Reduced uncertainty
- Seasonal Streamflow Forecasts
  - El Niño/Southern Oscillation
  - Probability of Exceedance





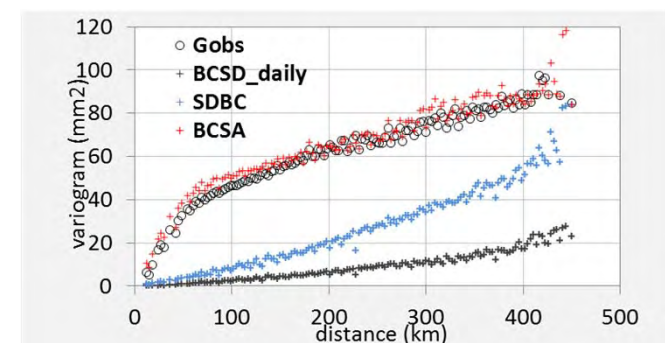
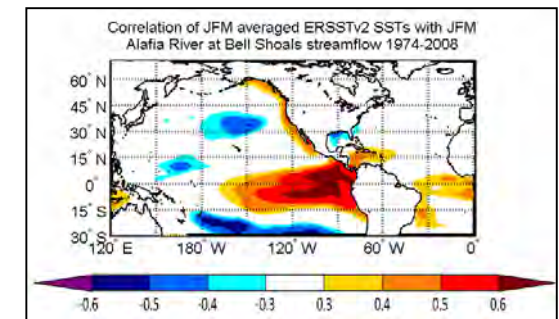
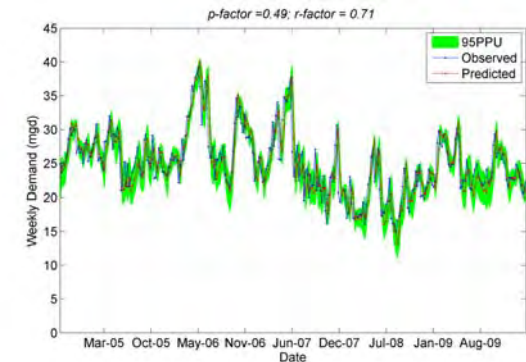
# Products at Multiple Scales

- Downscaled Seasonal Forecasts
  - North American Multi-Model Ensemble (NMME)
  - 6 GCMs
  - 12 km grid
- Downscaled Projections
  - CMIP3
  - CMIP5
  - Multiple GCMs and downscaling methods
  - Hydrologic applications



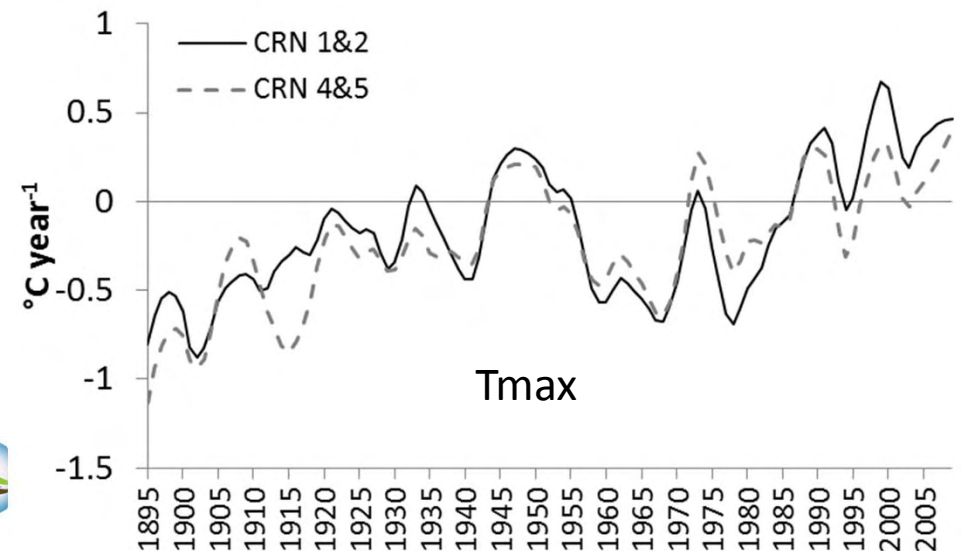
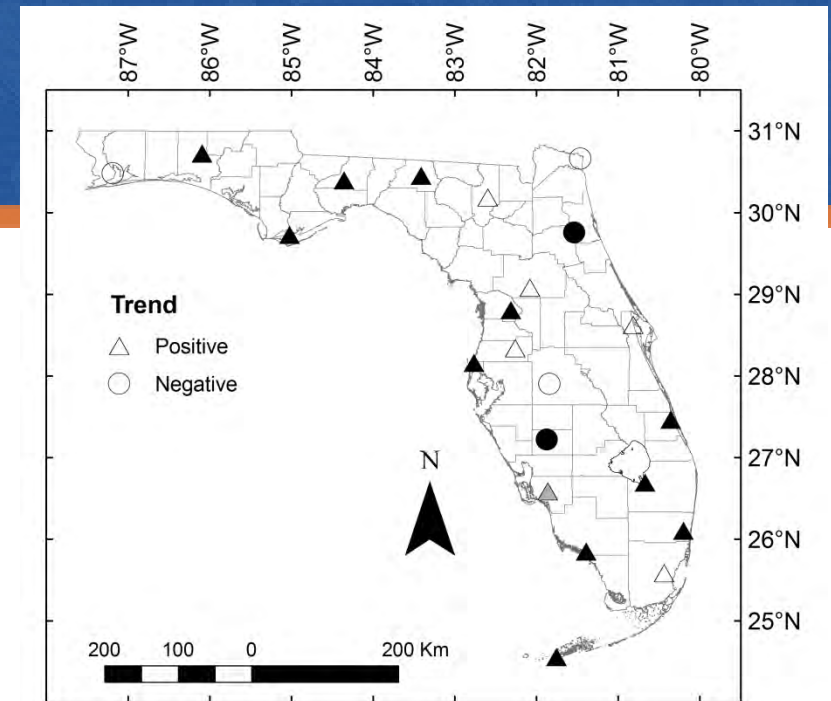
# Products at Multiple Scales

- Weekly Urban Demand Forecasts
  - Global Ensemble Forecast System (GEFS)
  - Reduced uncertainty
- Seasonal Streamflow Forecasts
  - El Niño/Southern Oscillation
  - Probability of Exceedance
- Downscaling Future Climate
  - Multiple GCMs
  - Hydrologic Applications



# Historical Trends

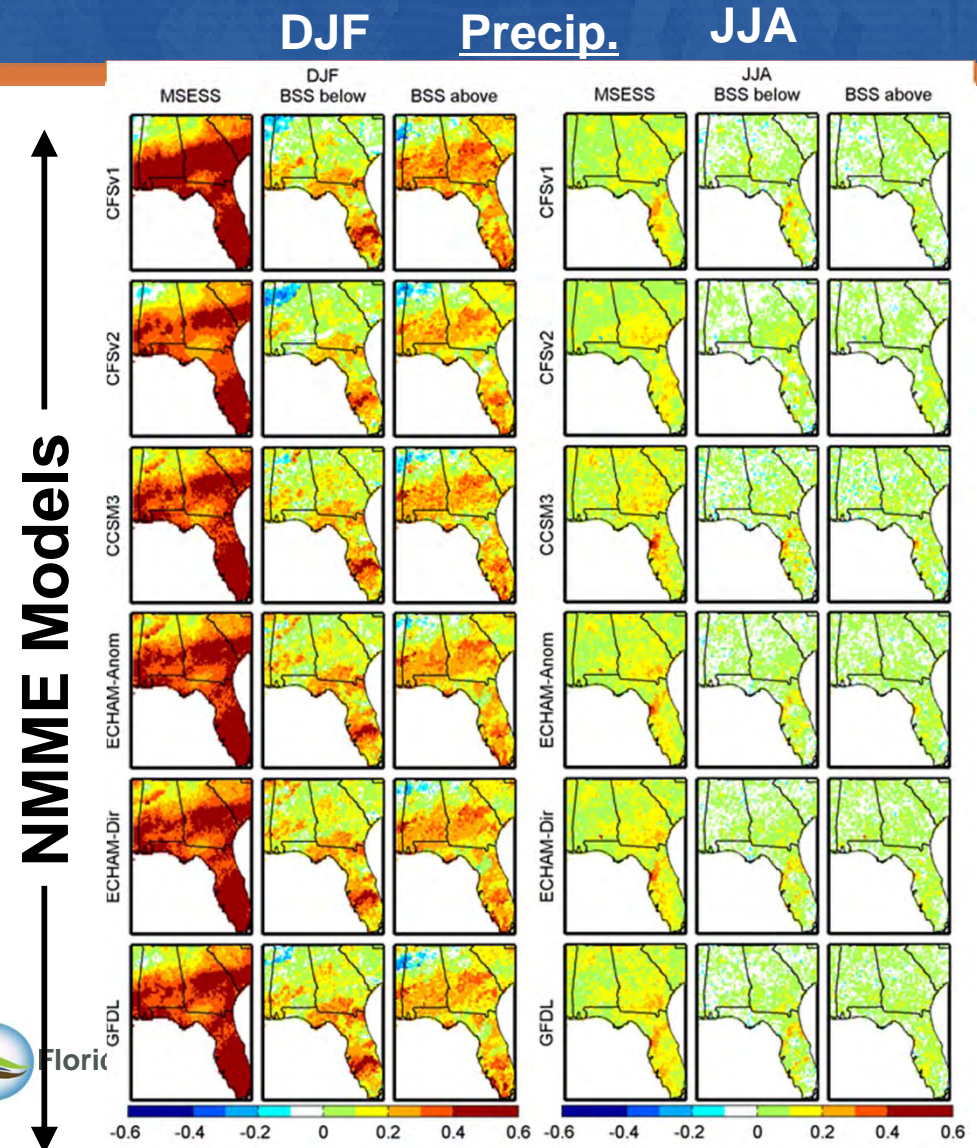
- Negative trends in May rain (1970-2009)
- Trends in Mean, Max, Min monthly T
- T trends impacted by station siting quality and land use



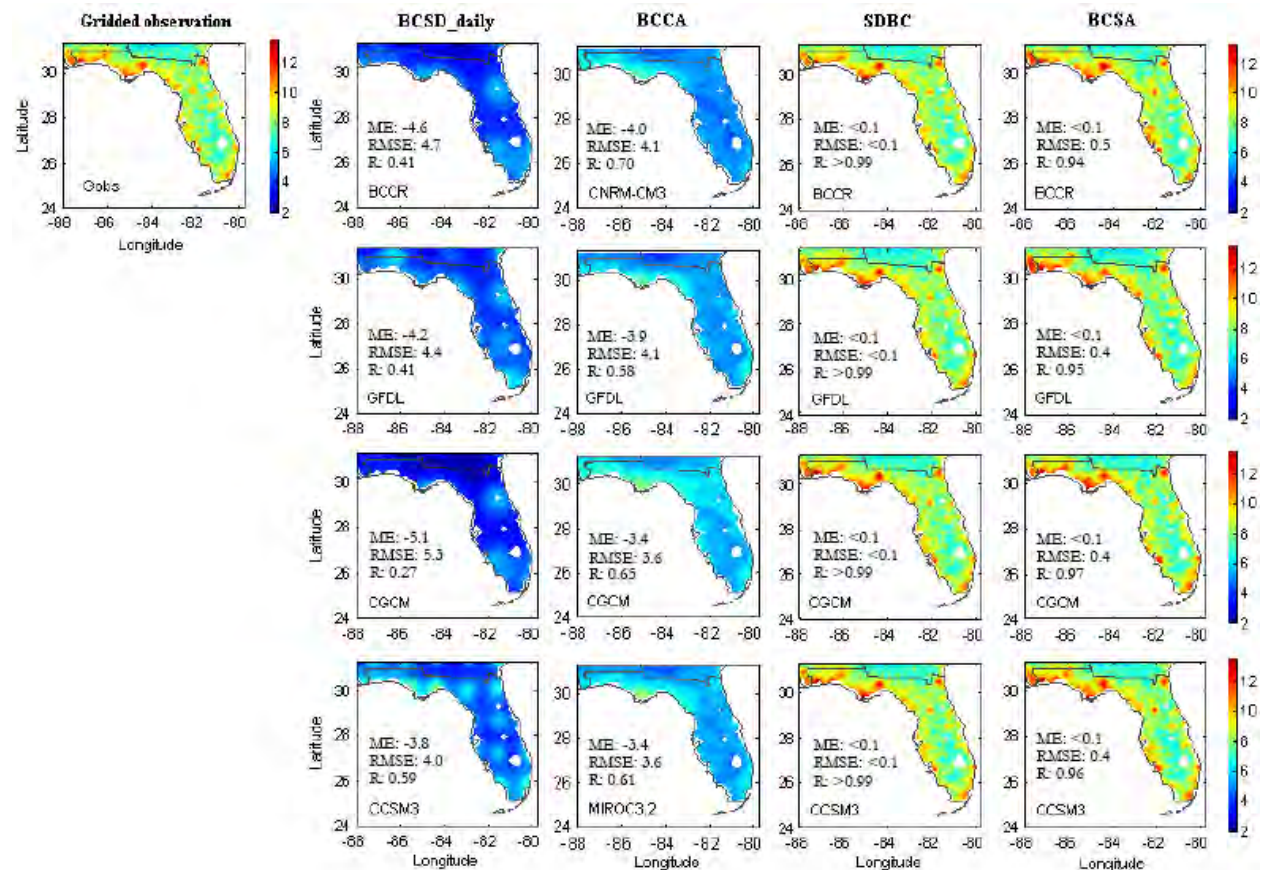
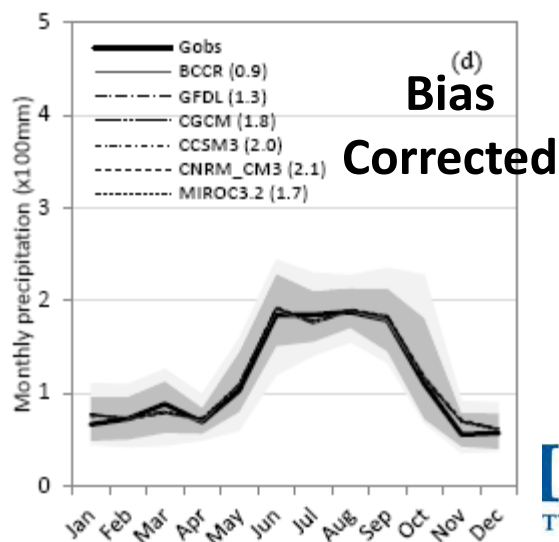
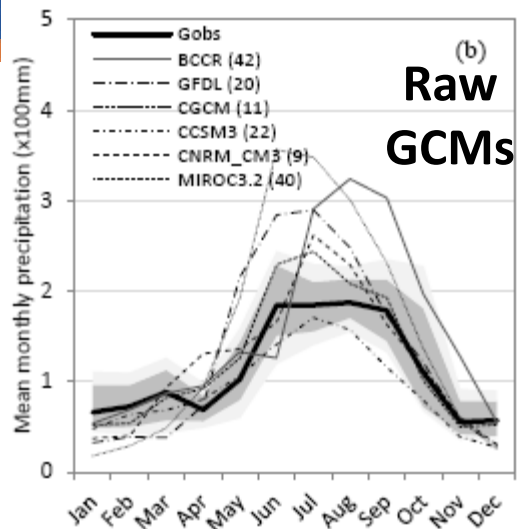


# Seasonal Scale Forecasts using the North American Multi-Model Ensemble (NMME)

- 6 GCMs downscaled to 12 km
- Multiple downscaling methods



# Downscaled and Bias-Corrected Climate Change Projections



But do they capture the day to day variability needed for hydrological modeling??



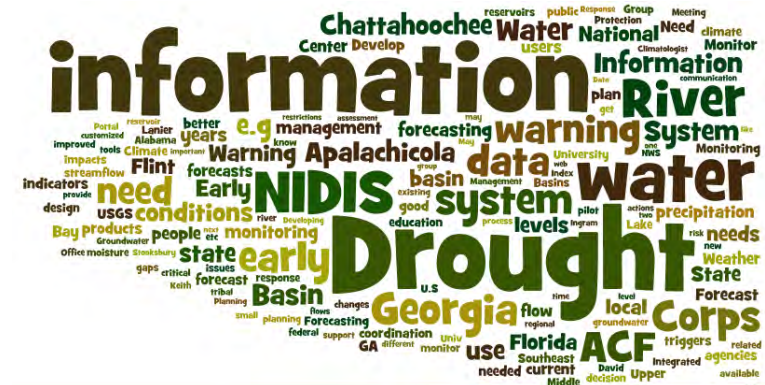
# What do stakeholders think about?

# Florida WCA



**[www.FloridaWCA.org](http://www.FloridaWCA.org)**

# NIDIS in the ACF

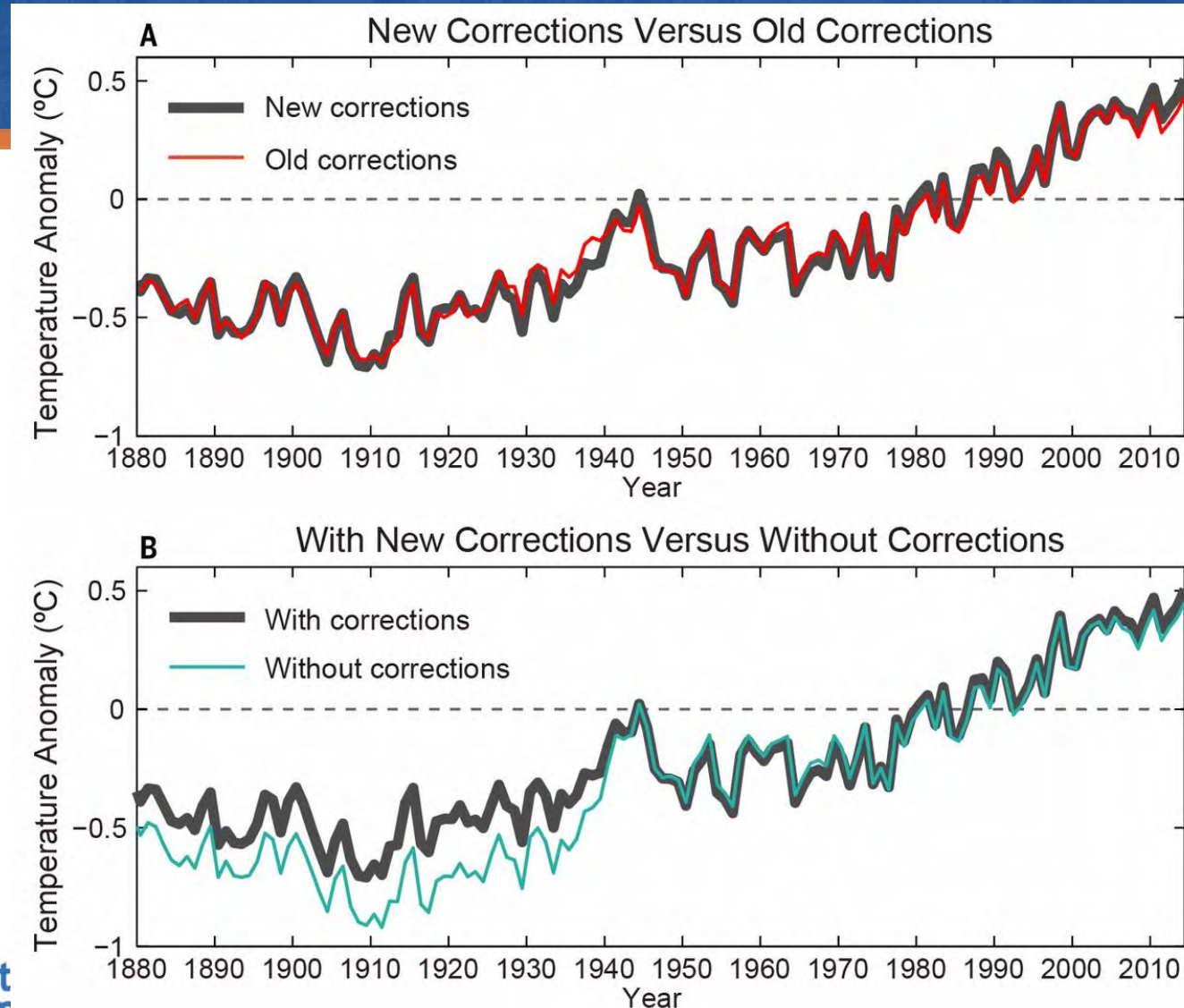


**www.Drought.gov**

(Created using wordle.net)



# Global Temperature Rise Hiatus?



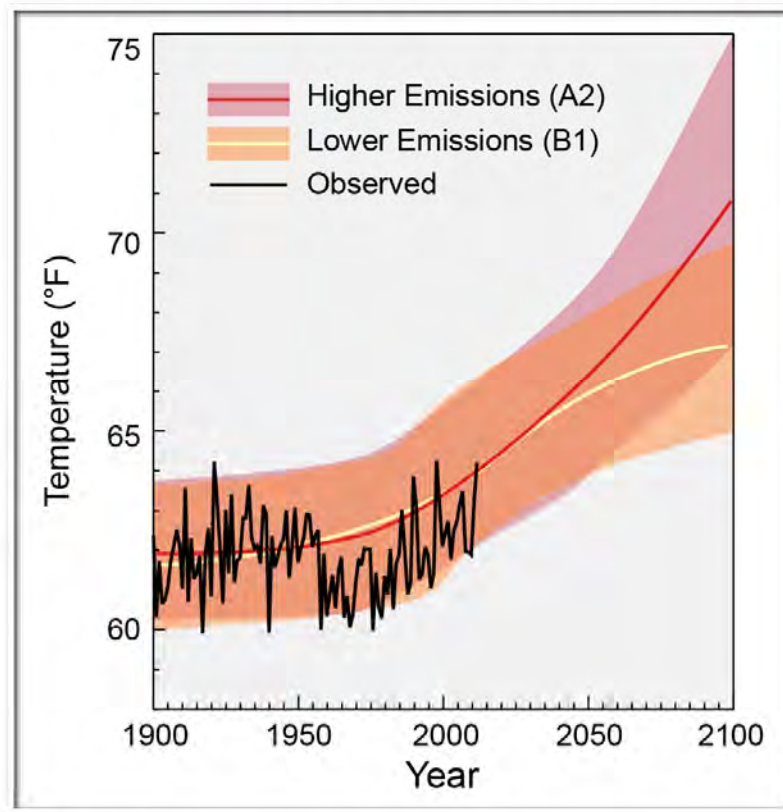
Karl et al.  
2015 Science



**Fig. 2 Global (land and ocean) surface temperature anomaly time series with new analysis, old analysis, and with and without time-dependent bias corrections.**

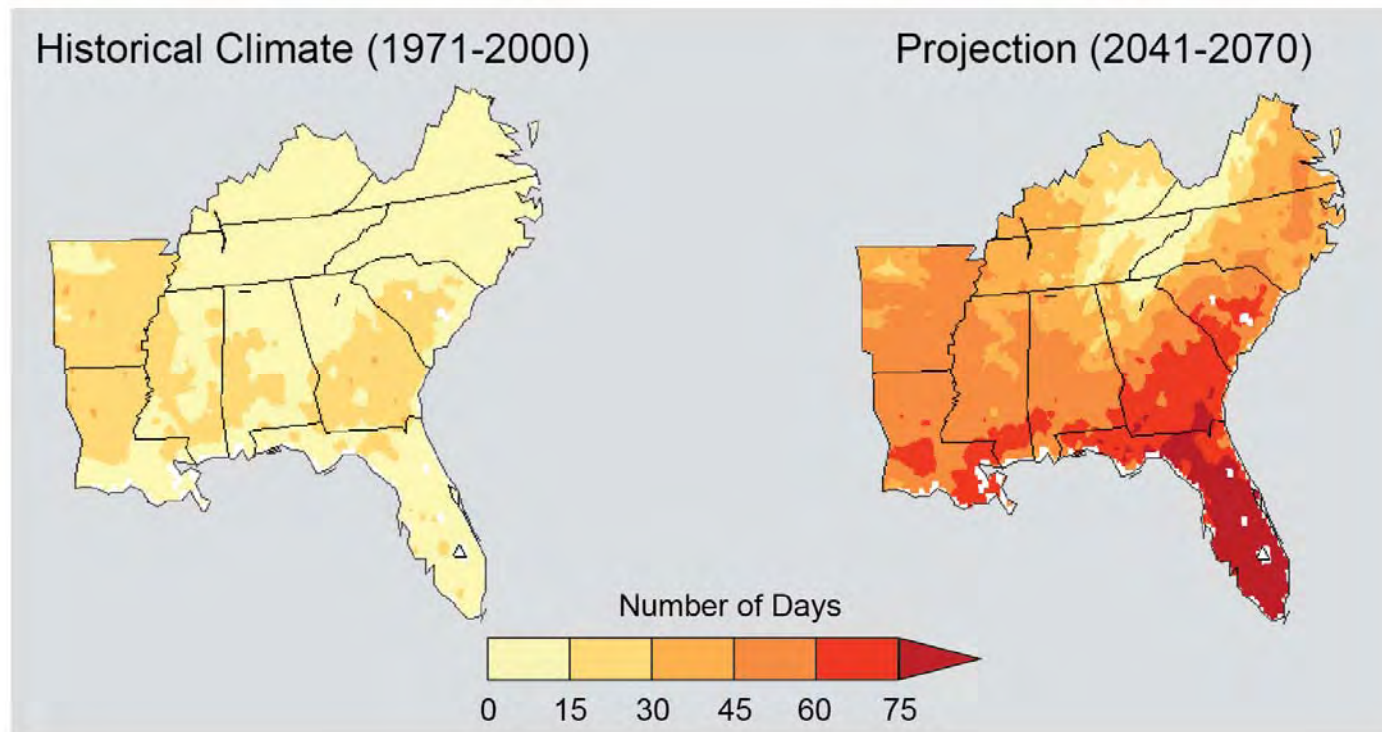
# Southeast Temperature

Southeast Temperature: Observed and Projected



Carter et al. 2014. Ch. 17: Southeast and the Caribbean. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 17-3. (Figure adapted from Kunkel et al. 2013)

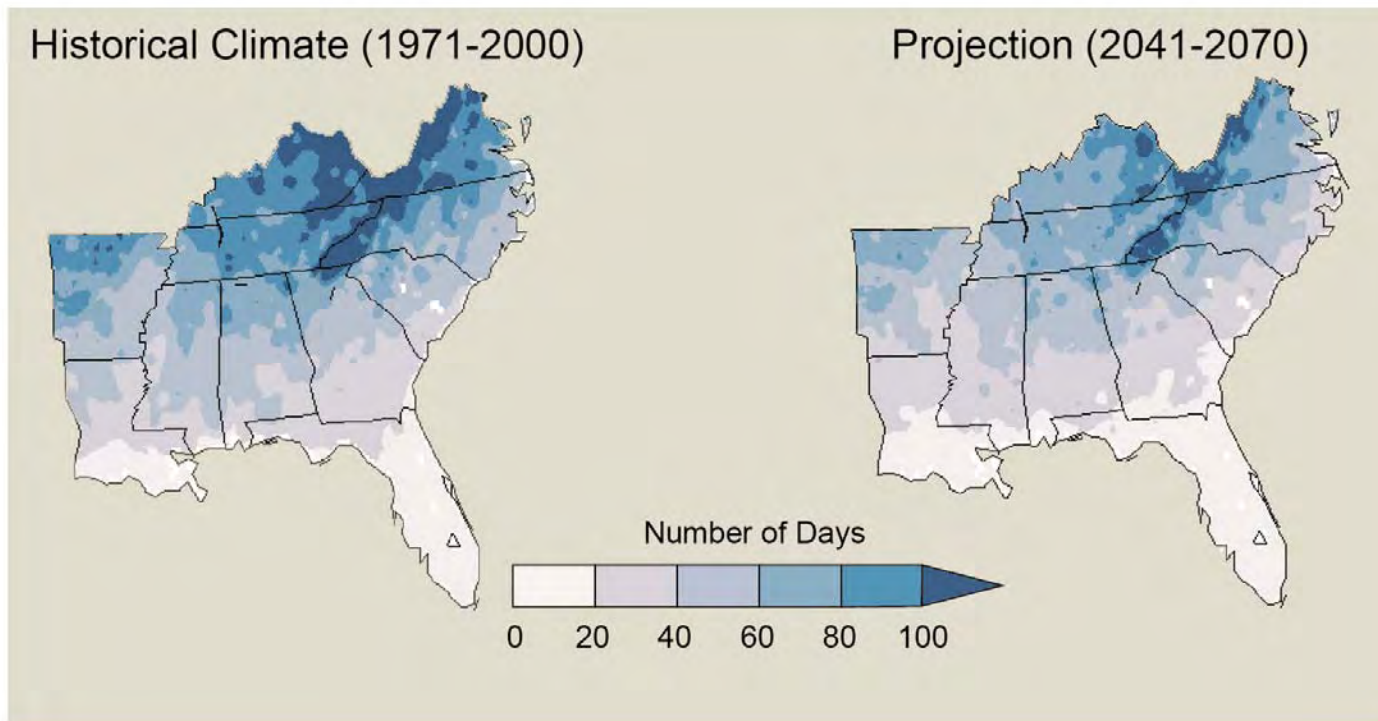
# Projected Change in Number of Days Over 95° F (2041-2070)



Carter et al. 2014. Ch. 17: Southeast and the Caribbean. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 17-4. (Figure source: NOAA NCDC / CICS-NC)



# Projected Change in Number of Nights below 32° F (2041-2070)

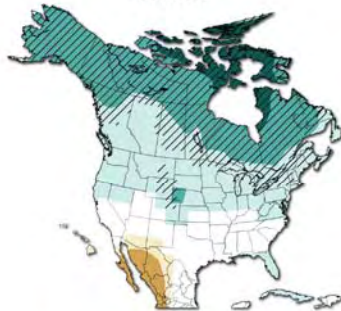


Carter et al. 2014. Ch. 17: Southeast and the Caribbean. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 17-5. (Figure source: NOAA NCDC / CICS-NC)

# Seasonal precipitation 2071-2099 vs 1970-1999 (Rapid Emission Reductions)

Rapid Emissions Reductions (RCP 2.6)

Winter



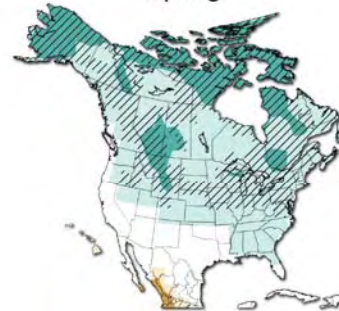
Precipitation Change (%)

-30 -20 -10 0 10 20 30

Rapid Emissions Reductions (RCP 2.6)

Rapid Emissions Reductions (RCP 2.6)

Spring



Precipitation Change (%)

-30 -20 -10 0 10 20 30

Rapid Emissions Reductions (RCP 2.6)

Summer

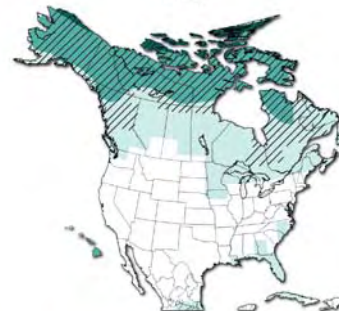


Precipitation Change (%)

-30 -20 -10 0 10 20 30

S  
IDA

Fall



Precipitation Change (%)

-30 -20 -10 0 10 20 30

Walsh et al. 2014. Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 2-15. (Figure source: NOAA NCDC / CICS-NC)

Hatched areas show significant and consistent changes among models

# Seasonal precipitation 2071-2099 vs 1970-1999 (Continued Emission Increases)

Continued Emissions Increases (RCP 8.5)

Winter



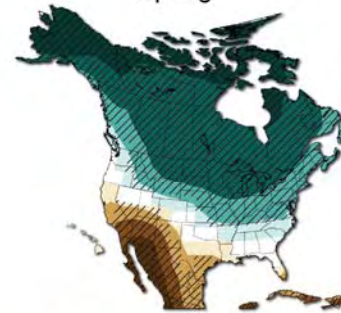
Precipitation Change (%)

-30 -20 -10 0 10 20 30

Continued Emissions Increases (RCP 8.5)

Continued Emissions Increases (RCP 8.5)

Spring

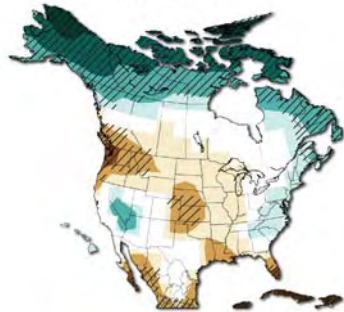


Precipitation Change (%)

-30 -20 -10 0 10 20 30

Continued Emissions Increases (RCP 8.5)

Summer

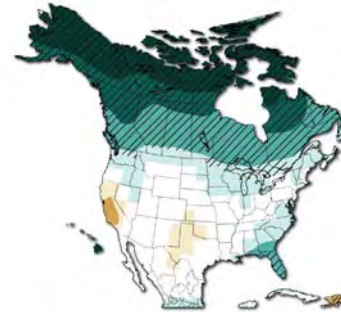


Precipitation Change (%)

-30 -20 -10 0 10 20 30

S  
IDA

Fall



Precipitation Change (%)

-30 -20 -10 0 10 20 30

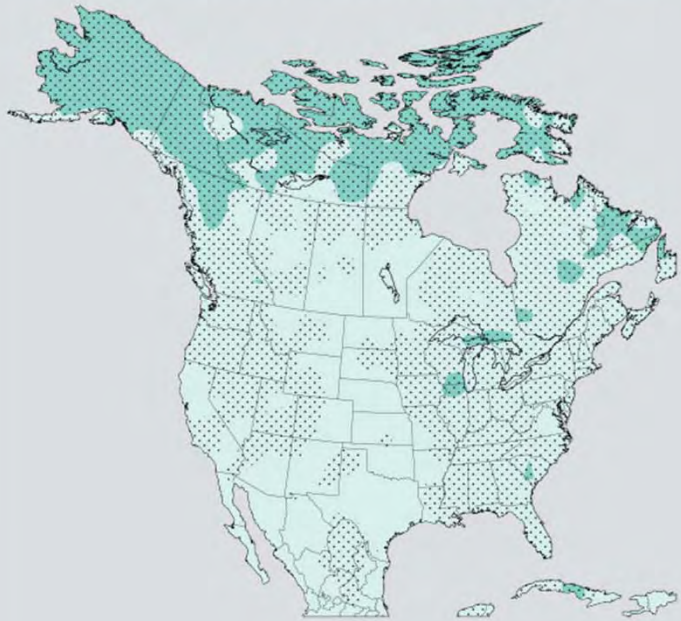
Walsh et al. 2014. Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 2-15. (Figure source: NOAA NCDC / CICS-NC)

Hatched areas show significant and consistent changes among models

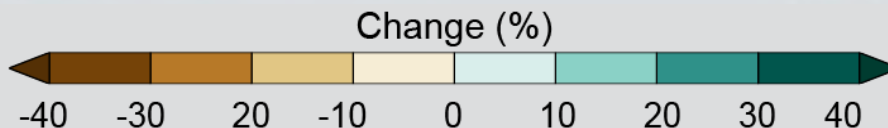
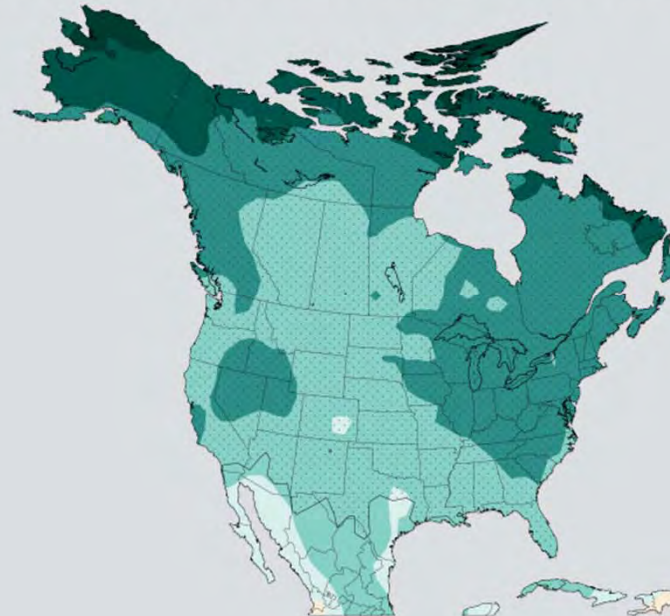


# Annual Maximum Daily Precipitation 2070-2099 compared to 1971-2000

Rapid Emissions Reductions (RCP 2.6)



Continued Emissions Increases (RCP 8.5)



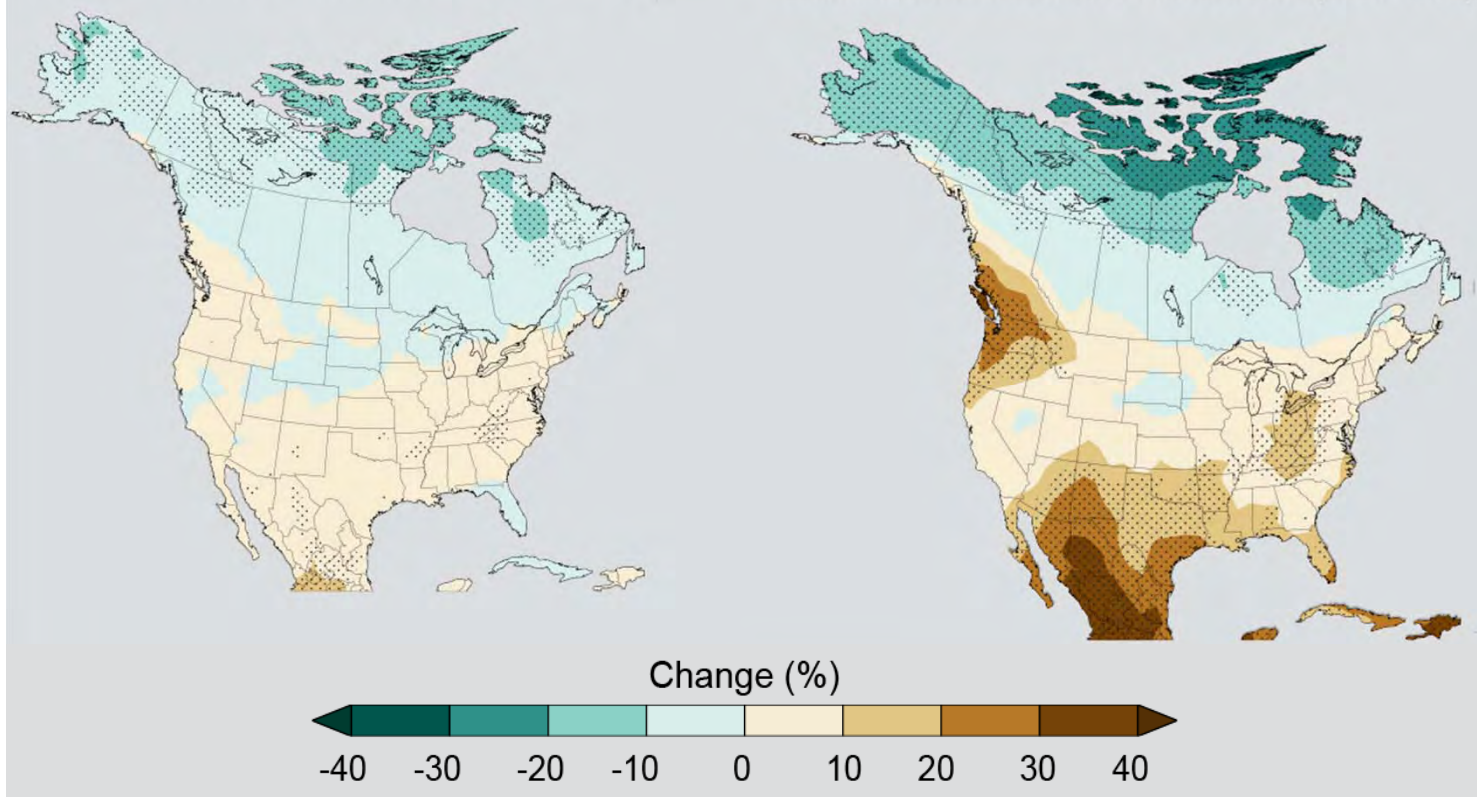
Walsh et al. 2014. Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 2-13. (Figure source: NOAA NCDC / CICS-NC)

Stippling shows where at least 80% of models agree

# Number of Consecutive Dry Days 2070-2099 compared to 1971-2000

Rapid Emissions Reductions (RCP 2.6)

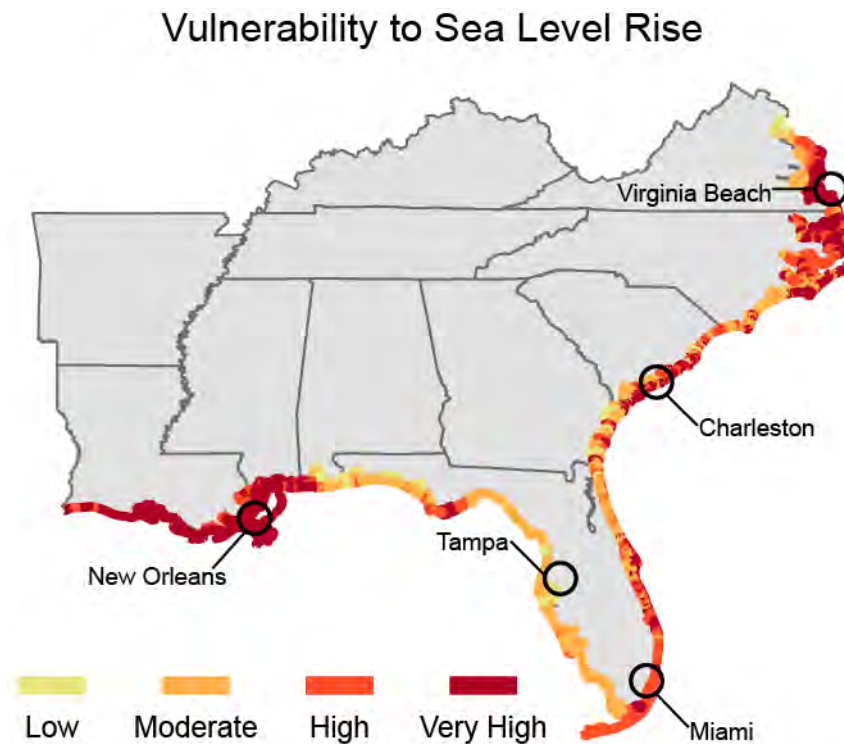
Continued Emissions Increases (RCP 8.5)



Walsh et al. 2014. Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 2-13. (Figure source: NOAA NCDC / CICS-NC)

Stippling shows where at least 80% of models agree

# Vulnerability to Sea Level Rise

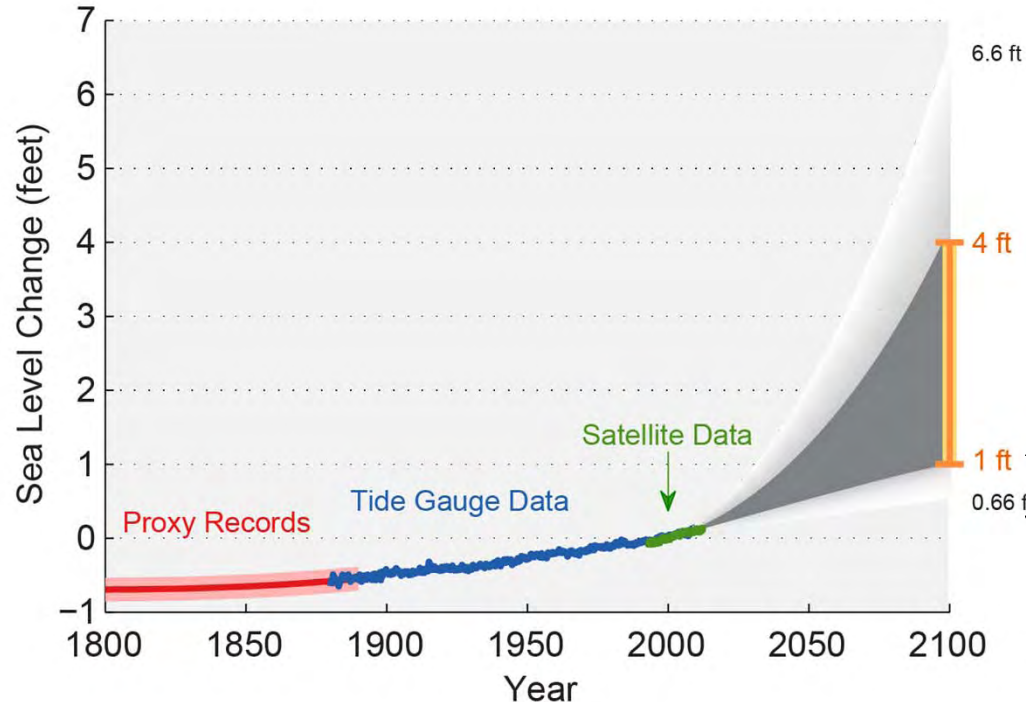


Carter et al. 2014. Ch. 17: Southeast and the Caribbean. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 17-6. (Data from Hammar-Klose and Thieler 2001)



# Projected Sea Level Rise

Past and Projected Changes in Global Sea Level



Walsh et al. 2014. Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 2-26. ((Figure source: Adapted from Parris et al. 2012 with contributions from NASA Jet Propulsion Laboratory))

**No contribution from Greenland or Antarctica**

**Extrapolation of historical**

# Tropical Storms

- No clear trend in occurrence
- Increase in strongest hurricanes – category 4 & 5



# South Florida

## South Florida: Uniquely Vulnerable to Sea Level Rise



Carter et al. 2014. Ch. 17: Southeast and the Caribbean. Climate Change Impacts in the United States: The Third National Climate Assessment. USGCRP. Figure 17-8. (Maps: SFWMD, Photo: Luis Espinoza)

**Well field protection – Pink**  
**Salt/Fresh water Interface – Red**  
**Coastal Water Control Structures - Yellow**



# Questions?

[chrisjm@ufl.edu](mailto:chrisjm@ufl.edu)

<http://FloridaWCA.org>