

**Discussion of a
Position Paper on Climate Change Scenarios and Impact Analysis in the
Southeast**

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Climate Change

Concerns about CO₂ climate change by the general public and public officials have increased around the world as more and more attention to the issue has been provided in the popular media.

The Obama Administration is making climate change a priority.

In Florida, Governor Crist has taken climate change, its impacts and mitigation, a major emphasis of his administration.

Surveys of the general public in Florida indicate concerns about the local impact of climate change (Broad 2008).

How should the SECC respond to this environment?

Leaders in the SECC have been skeptical of engaging in climate change impacts analyses.

Substantial resources may be available for climate impact assessments.

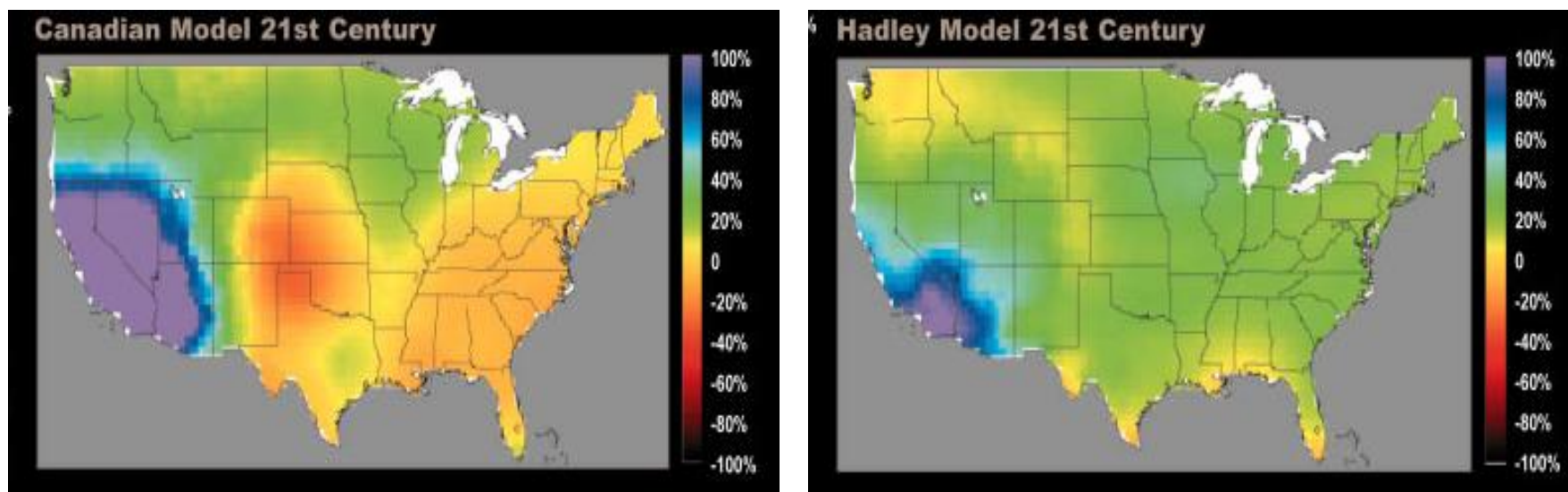
Is it in the best interest of the SECC and its stakeholders for the SECC not to be involved in climate change impact analyses?

Basis of Skepticism on Climate Change Analyses

- The last major attempt at assessing the impact of climate change in the SE as part of the National Assessment (National Assessment 1999) undertaken as part of the Climate Change Act of 1990 was decidedly ambiguous.
- The climate scenarios used in this assessment which were based on single run of two Global Circulation Models (GCMs) for one economic/emissions scenario gave strongly divergent views on the future state of the climate in the 21st century.
- Additionally, neither model replicated key aspects of the 20th century climate.
- Members of the SECC had key roles in this SE Assessment.

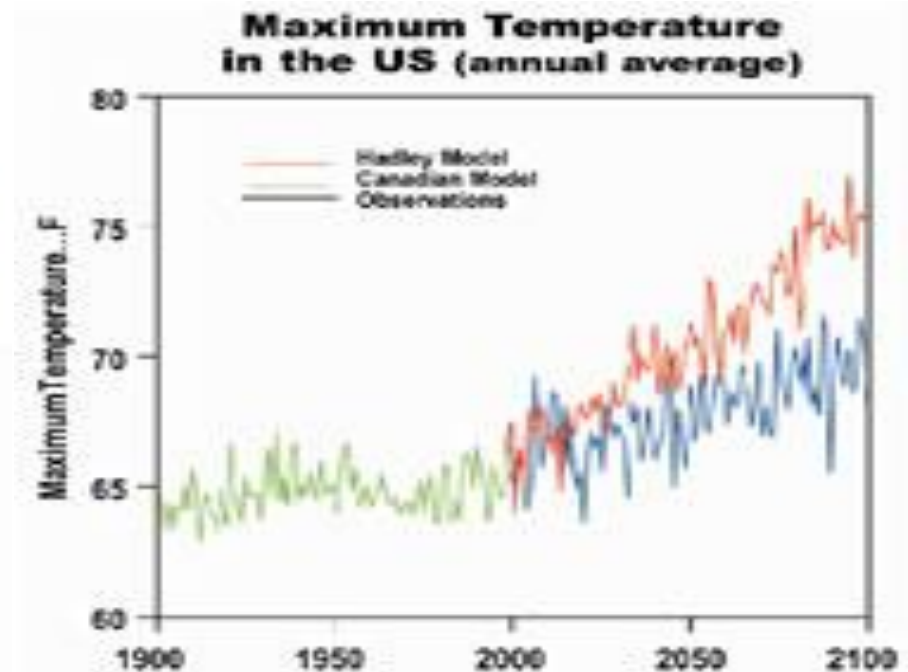
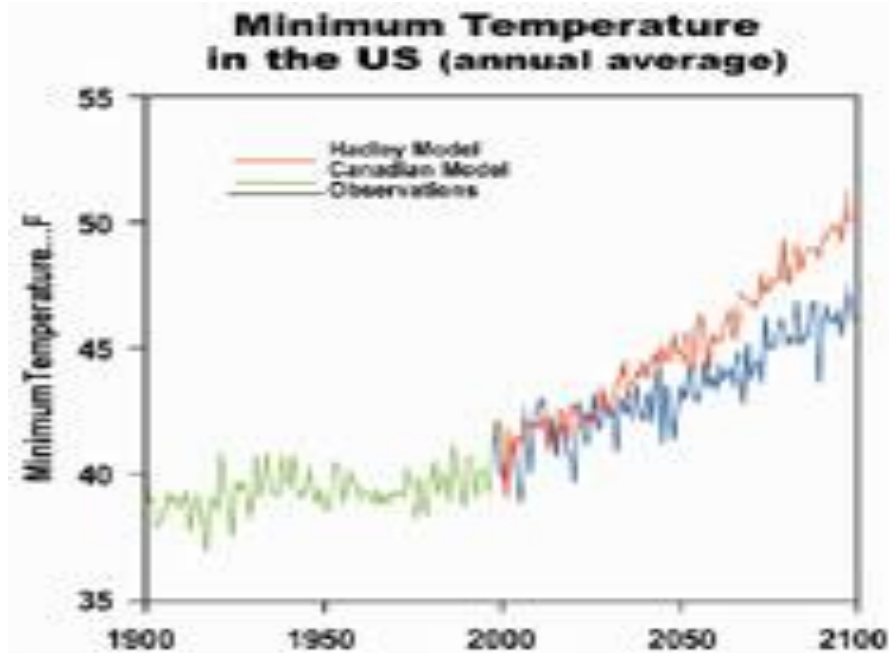
The results of this process were largely unsatisfying to those involved in the SE Assessment.

First the range of results from the climate models of a near desert future scenario in the Canadian Climate Model to a wetter future scenario in the Hadley Center Model were not the type information that would be useful to policy makers since the range of future climates would not support any particular adaptation strategy.



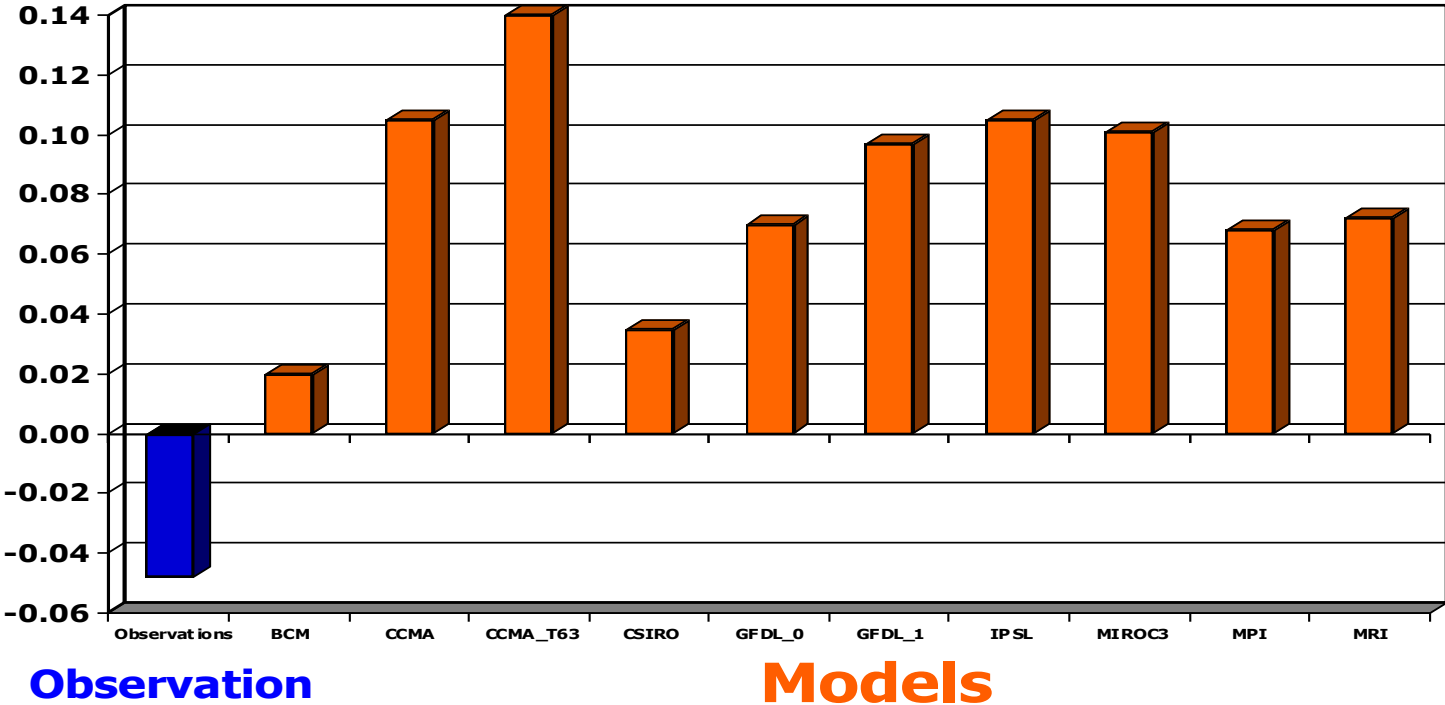
One reading of the divergent scenarios from a stakeholder perspective is that climate scientists don't have any information that I (a policy maker) can count on – so I am going to give my attention to other problems.

Many prominent members of the SE Climate Consortium have been skeptical of climate change projections due to concerns about the ability of current models to capture key signals of the past climate.

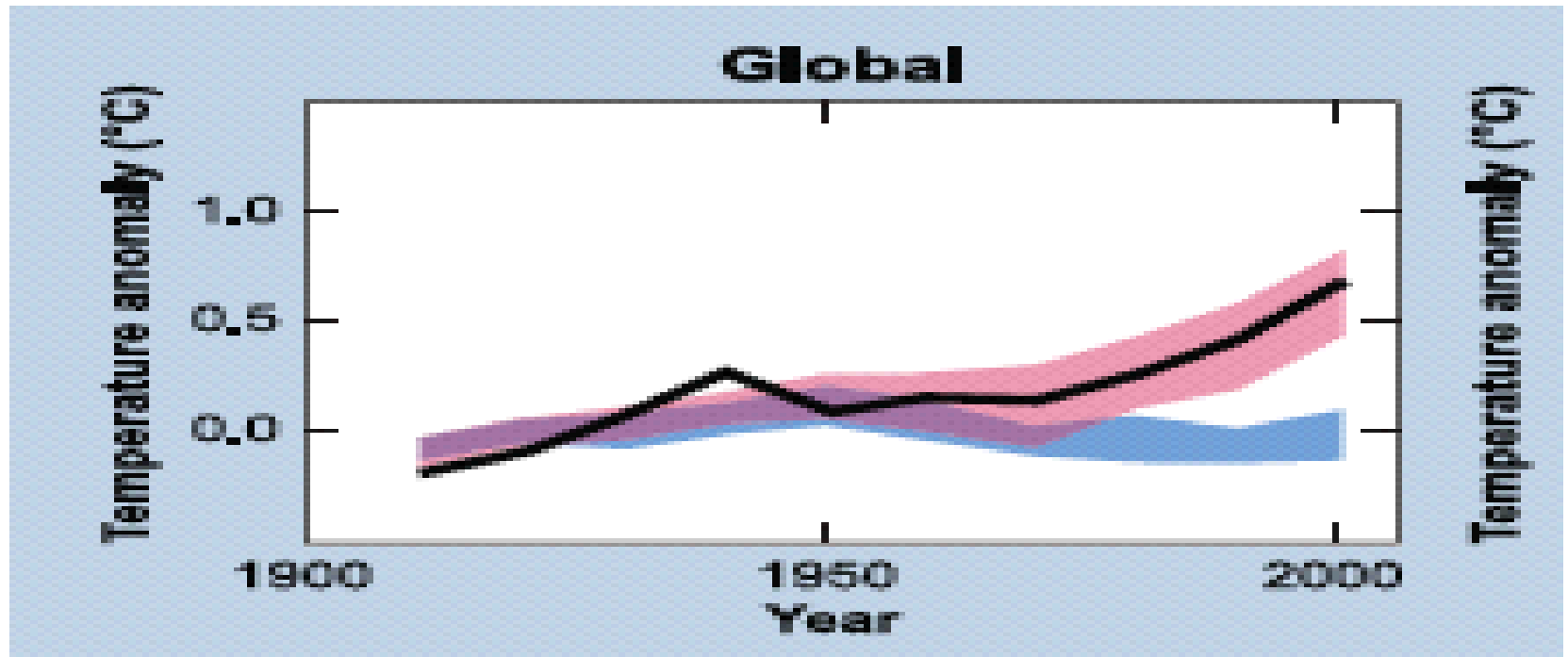


Even new generations of models don't reflect the reality of observations

Mean Surface Temperature Southeast USA 1899-2003



While Global Scale Models often look good at the global scale when one starts looking at the details especially at the regional scale, the model performance is often very poor.



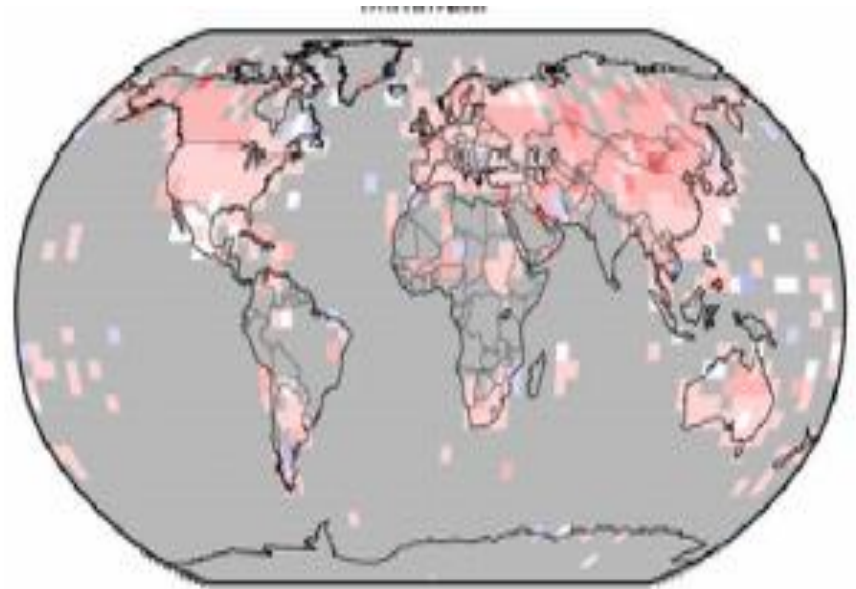
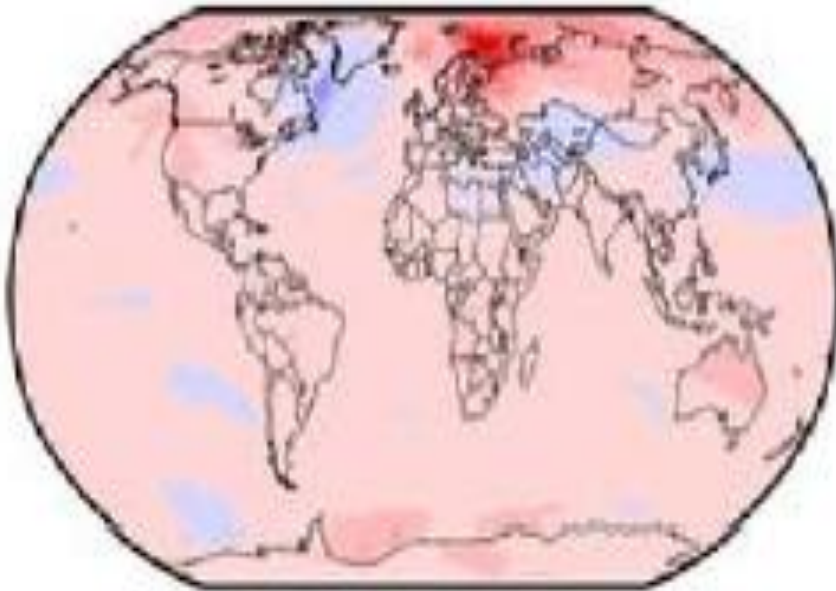
models using only natural forcings



models using both natural and anthr

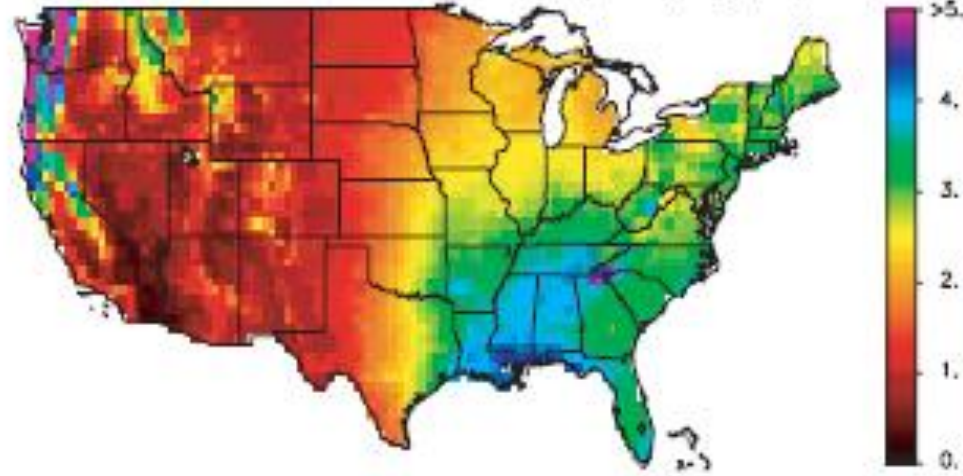
GFDL 1950-2000

Observed 1950-2004

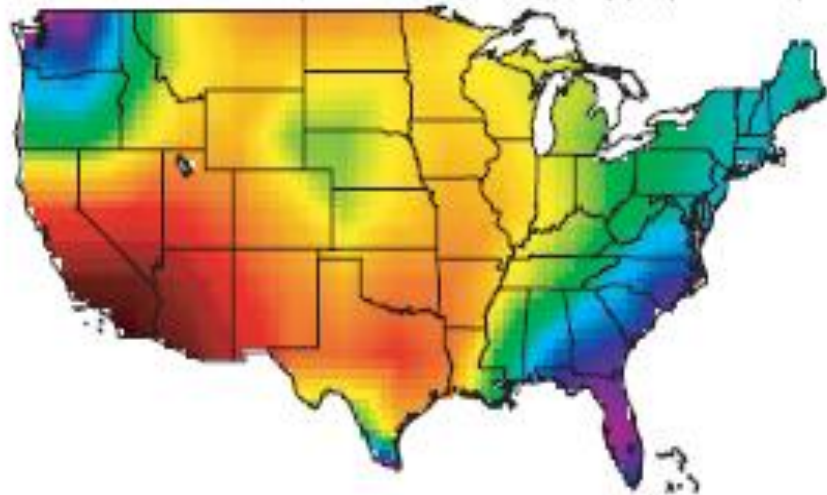


From Easterling et al 2006

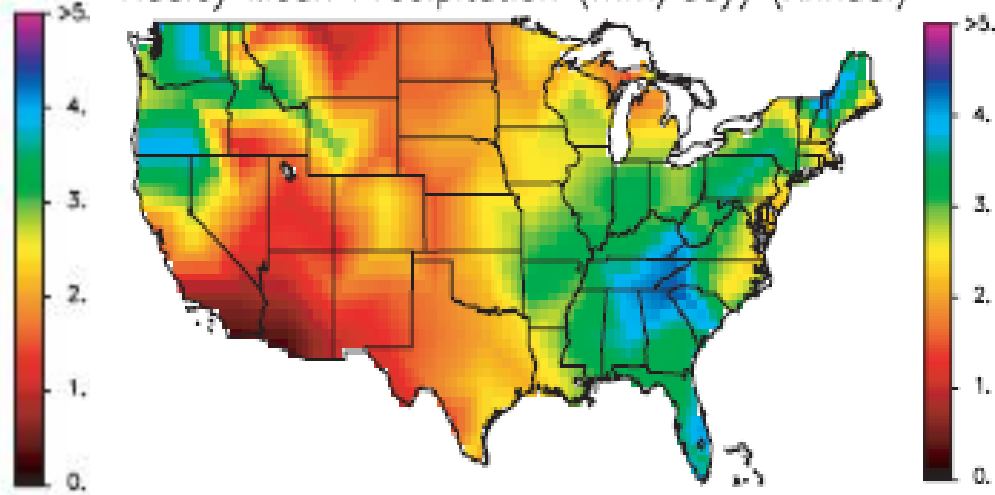
VEMAP Observed Precipitation (mm/day) (Annual)



CCC Mean Precipitation (mm/day) (Annual)



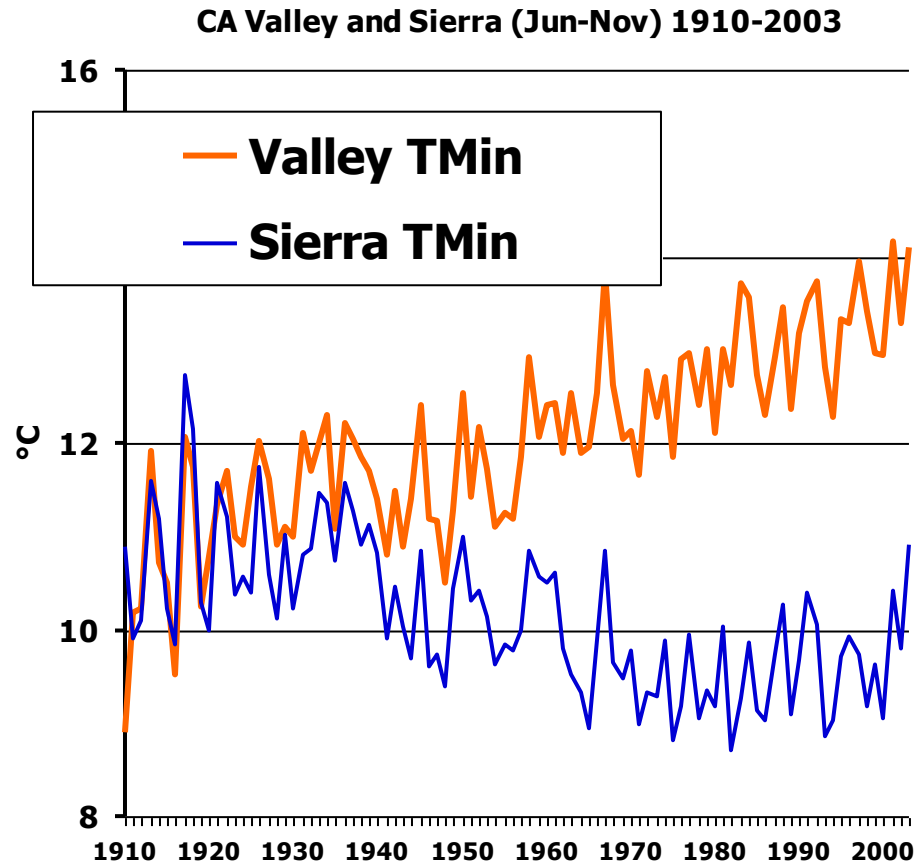
Hadley Mean Precipitation (mm/day) (Annual)

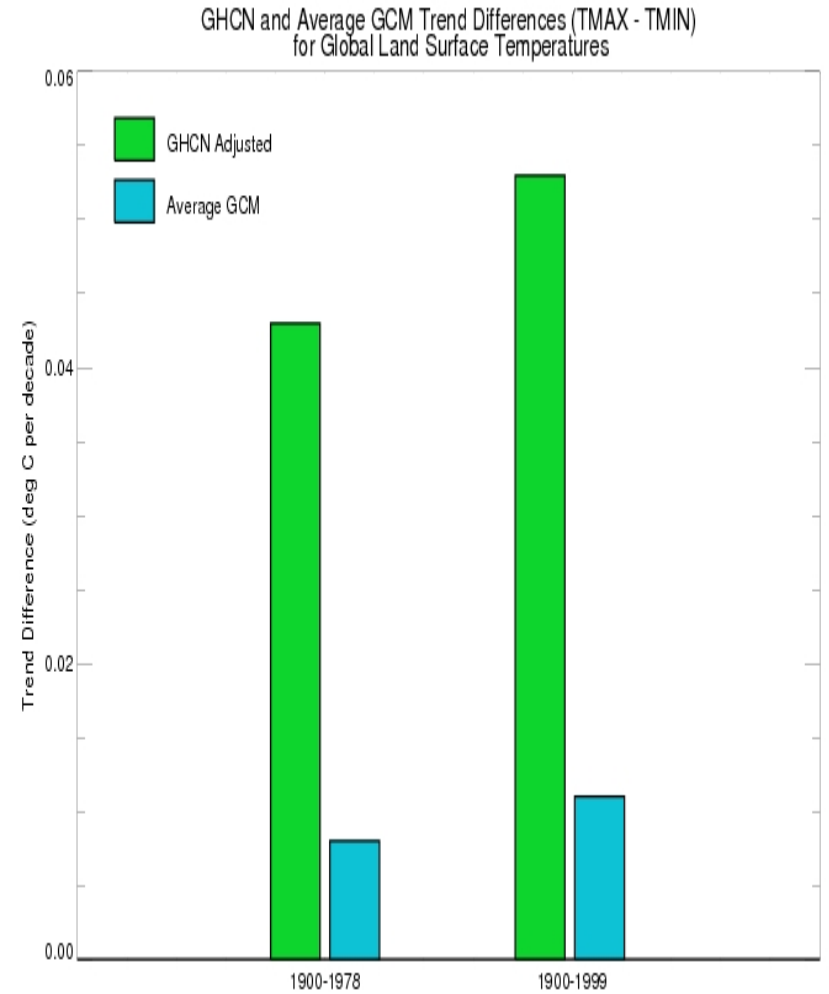
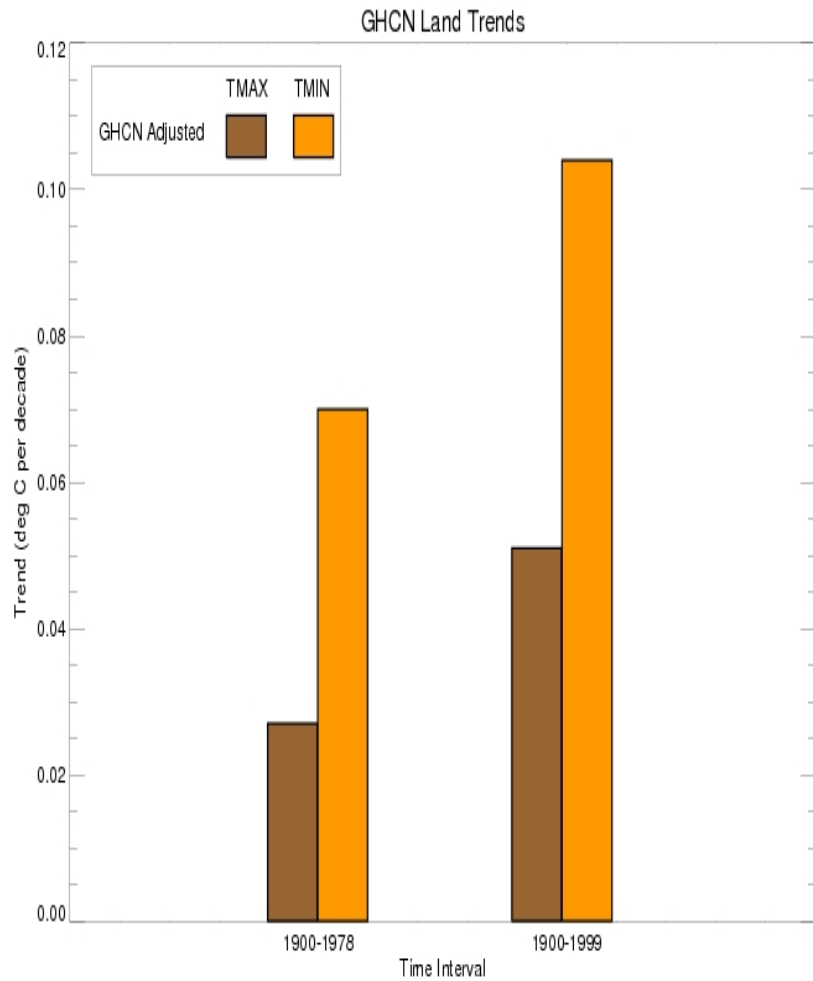


Regional climate change model scenarios are highly suspect

1. *Lack of Skill in Regional Details of the Current Climate* - In general, GCMs have done a poor job of replicating regional climates (see Castro et al 2008). For the SE, this inability of models to represent the past climate is a clearly troublesome factor since all future scenarios immediately depart from current trends
2. *Lack of natural variability* - GCMs have in general not replicated internal climate variability due to major global phenomena such as El Nino/La Nina, Pacific Decadal Oscillations and the North Atlantic Oscillation (McCracken et al 2003). Such features are well known to impact regional climates. Additionally, critical features such as hurricanes and severe weather, which are modulated by these global variability modes are not represented in GCMs. Thus, scenarios based only on large scale models remove much of the variability which drives societal impact.
3. *Lack of Regional Forcing* - Many aspects of the current climate related to regional scale topography, coastlines and land use are not carried forward into the future climates.
4. *Boundary Layer Resolution* - The coarse vertical resolution in GCMs make their representation of boundary layer processes, especially nocturnal boundary layer processes, highly suspect (Walters et al., 2007, Pielke et al 2007, Steeneveld et al. 2008).

Even current generation regional climate models don't capture land use changes accurately





Because of these problems with climate change scenarios and the past bad experience of the SECC in the last regional assessment, leaders have been reluctant to engage in “make work” but practically useless employment of model scenarios for climate impact analyses.

CO₂ climate change scenarios are in fact not draconian in the SE. Thus, CO₂ scenarios may in fact understate our real vulnerability to climate variability.

However, the SECC might be remiss and let down our stakeholders if we don't address the vulnerability of our states to climate impacts.

If we don't engage in climate change impact analysis the SECC may give up substantial resources that could make our climate impact assessment tools such as DSSAT or hydrologic models better.

Also, other groups with less expertise and experience may take the climate change resources and not do work that is important to our states and stakeholders.

How can we be intellectually honest and still play in the climate change arena?

While the SECC leaders were critical of the National Assessment there have also been published critiques of the National climate impact assessment process, which are in line with SECC concerns.

One of these (*Morgan et al., 2005*) was based on surveys of participants in the regional assessments. The *Morgan et al.* paper is not just a skeptic's retrospective since many of the authors were architects of the National Assessment.

In the introduction, *Morgan et al.* stated - “*Officially, the National Assessment adopted three strategies for characterizing possible future climates: (1) historical records of past climate variability and change, (2) scenario analysis using large-scale general circulation models (GCMs), (3) and sensitivity analysis that asked “what degree of climate change would cause significant impacts to natural and human systems” of interest... However, in our view, two GCM runs, based on a single emissions scenario (the IPCC scenario IS92a), predominated as the vehicle used to explore possible future climate in the National Assessment.*”

Thus, a reasonable path that circumvents the use of climate model scenarios was actually contained in the last National Assessment guidance

Instead of CO2 Climate Model Scenarios use

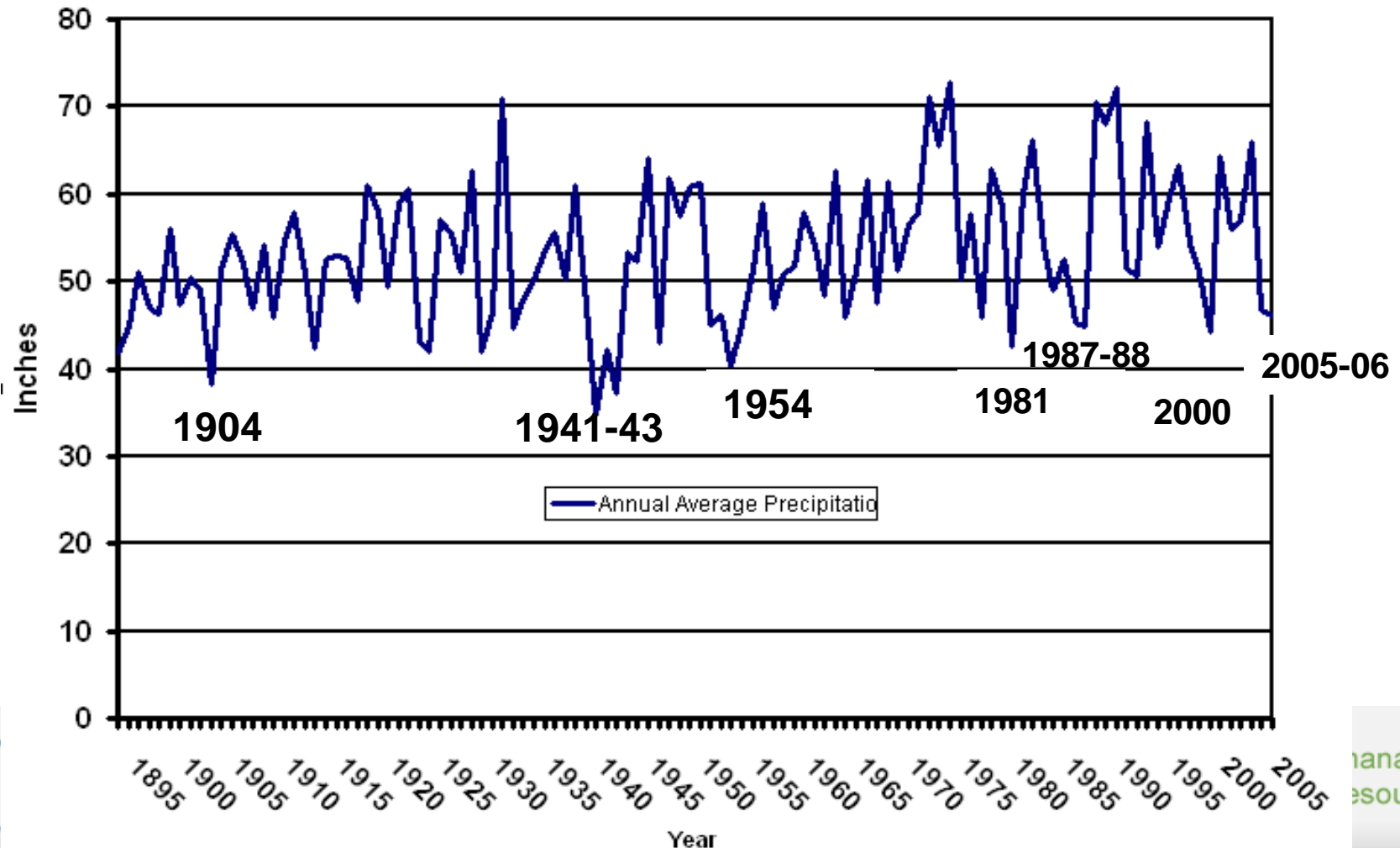
- 1. *Historical records of past climate variability and change***
- 2. *Sensitivity analysis that asks “what degree of climate change would cause significant impacts to natural and human systems” of interest***

The following outlines some alternative climate scenarios that are in keeping with this guidance.

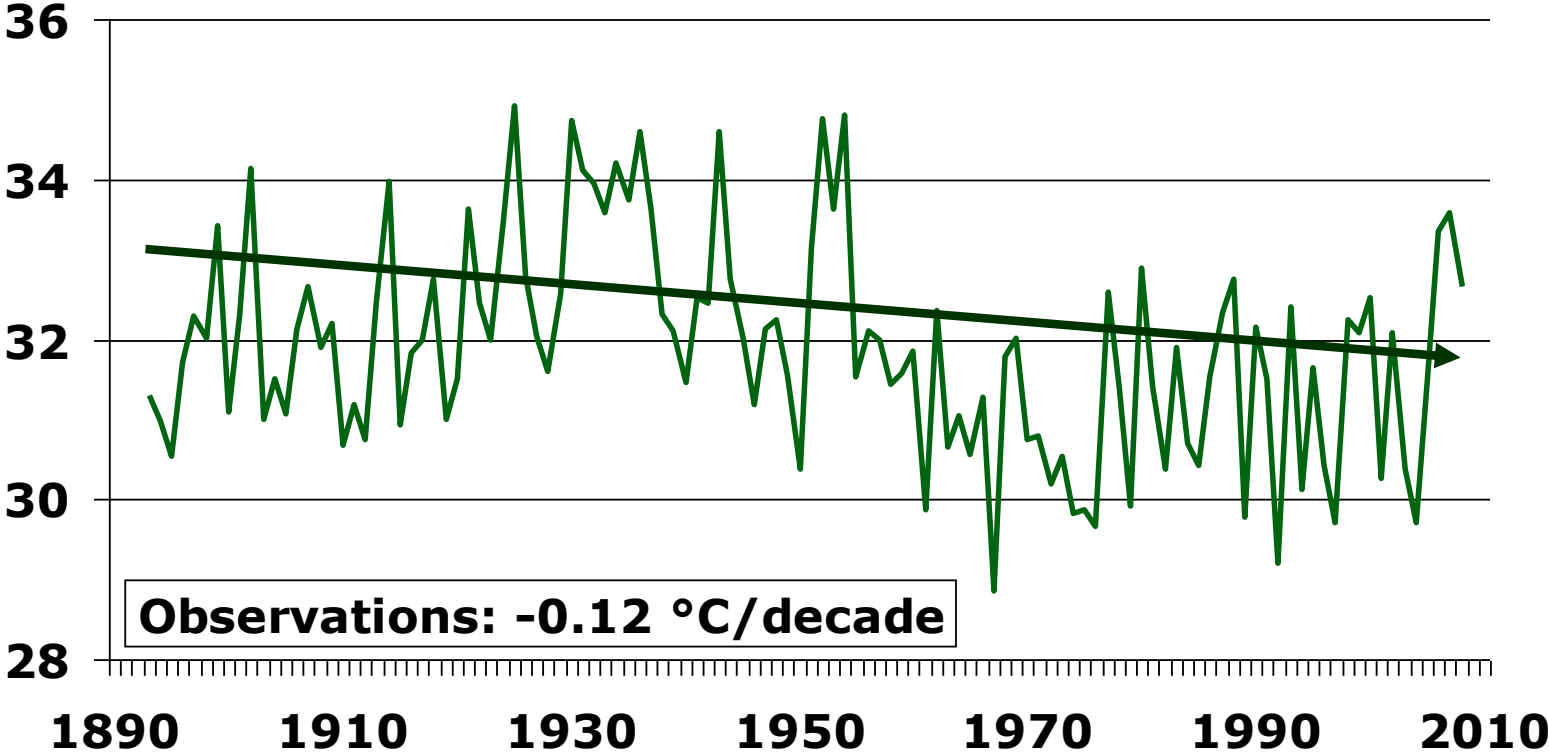
4.2 Development of Relevant Climate Scenarios for Impact Analyses

The instrumental observed climate of the SE since the late 1800s provides a rich source of data to use in constructing future climate scenarios. Additionally, tree rings, bore holes and marsh cores provide opportunities for extending data on climate extremes over the past several hundred years.

Statewide Annual Average Precipitation



Alabama Statewide Temperatures



1930s and 1950s are equivalent to 50-100 years of greenhouse gas warming!

Impact of past climates on current and projected society and infrastructure

Some might argue that past observed climates have already been seen and thus within our experience to cope.

However, society and its infrastructure have evolved significantly since many of the historic climate extremes occurred.

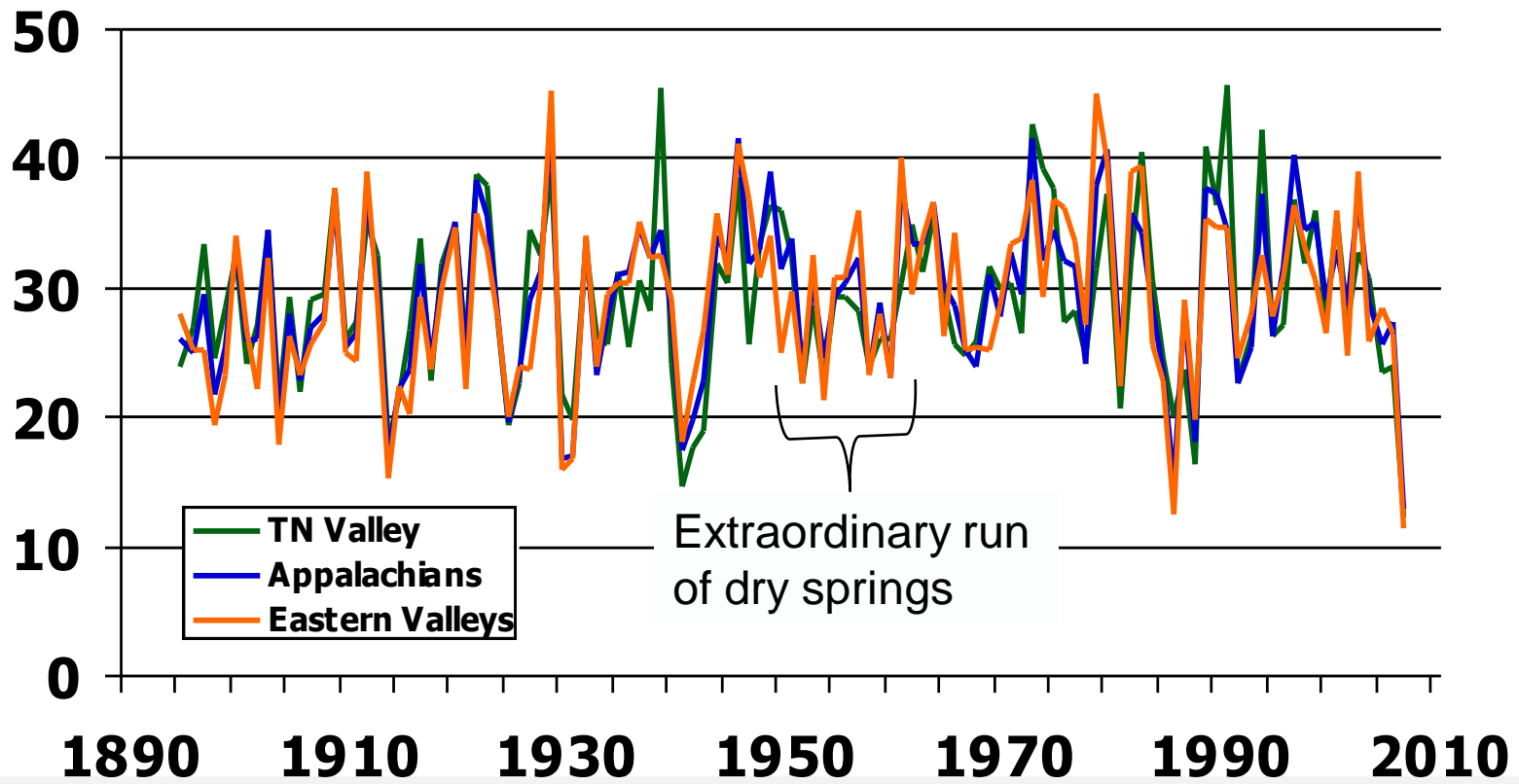
Most of our reservoirs for navigation and flood in the SE were built since the 1930s and we have been in an era of increasing precipitation since then.

How would they respond to the droughts of the 1920s and 1930s?

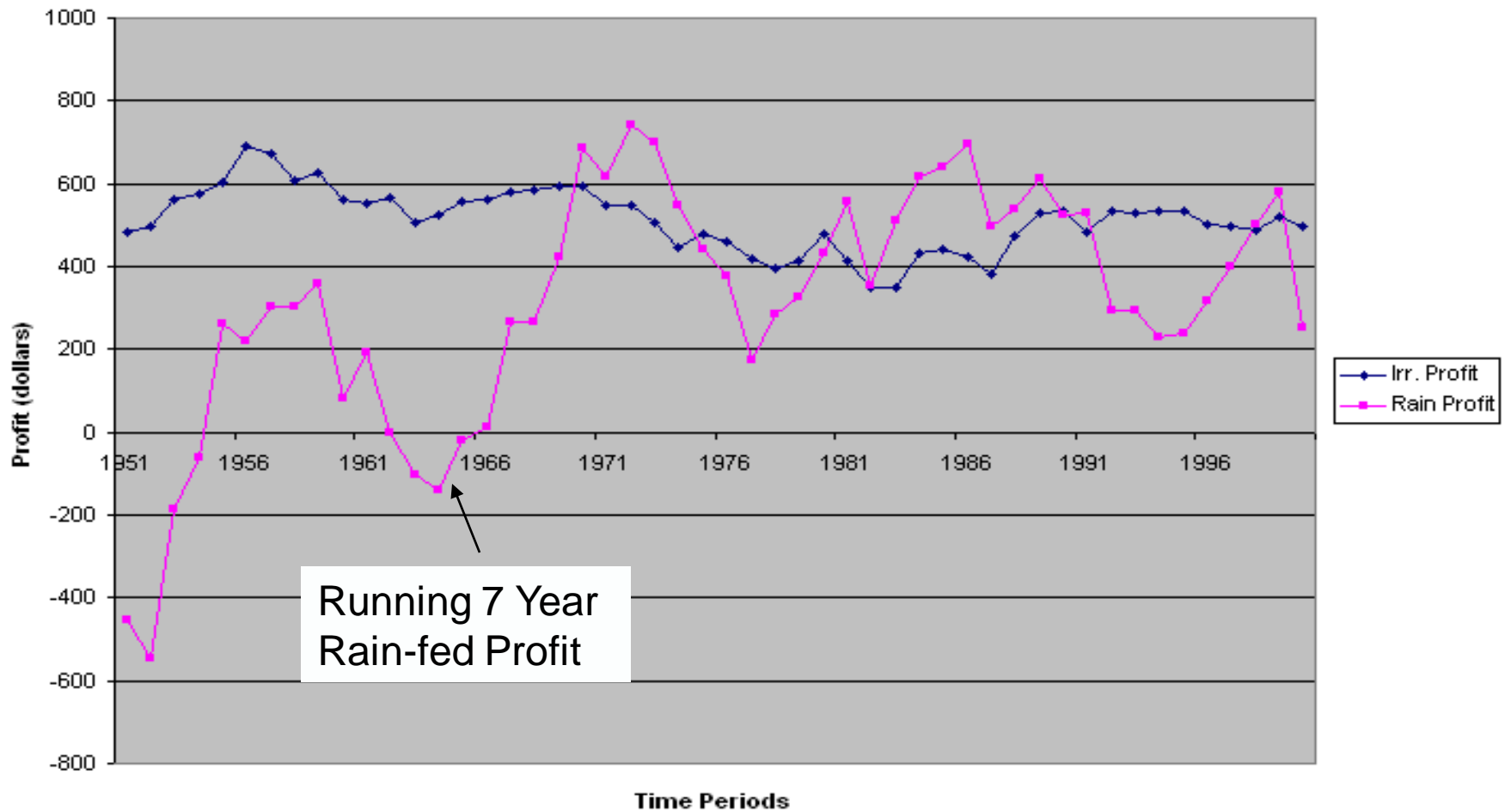
How would they respond to the great Flood of 1927? Would land use change to greater urban and suburban land use types with larger run-off have exacerbated flood events in the past?

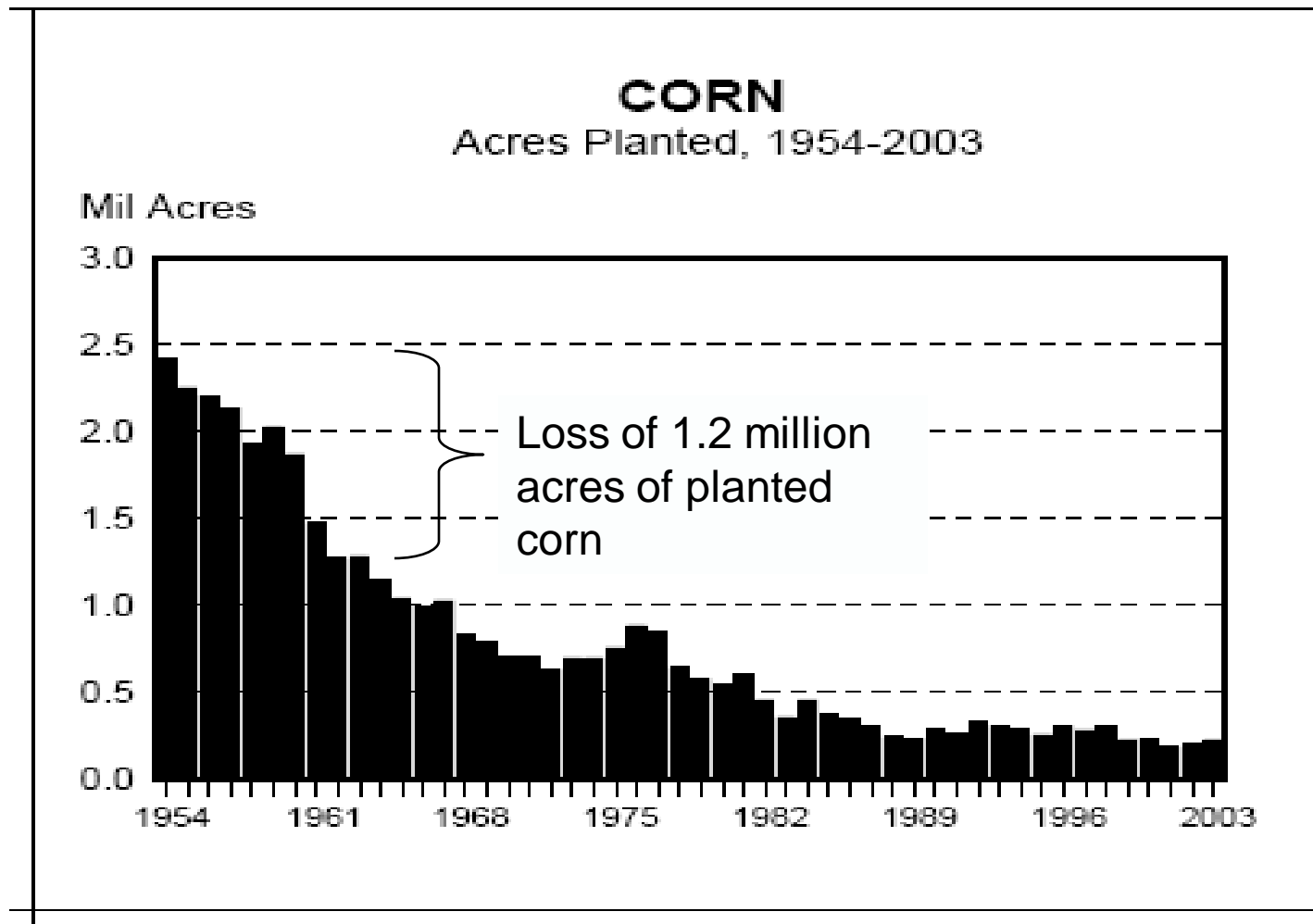
Water supply infrastructure for population and irrigation in the SE has grown by several magnitudes since 1950. How would water systems and agriculture now deal with the extraordinary and extended droughts of the 1950s.

Jan-Jun Alabama Rainfall 1895-2007



Cumulative 7 year Irr. Profit v. Rain Profit While Paying for Irrigation System





No wonder Alabama lost over 1.2 million acres of corn in this period.

Precipitation:

CO₂ climate change impacts are relatively benign for SE. Precipitation changes are not considered reliable. IPCC consensus says wet areas likely to become wetter. Thus, past events would be a better test of vulnerability.

Sea Level Rise:

There are other impacts that may be under-stated in CO₂ scenarios that will occur in the real climate. One example is sea level rise.

While climate activists and the popular media have greatly exaggerated the sea level rise (with maps on coffee cups showing a disappearing Florida), the fact is even the IPCC predicts only a modest increase in sea level (20-30cm) in the next century, which is not much different than the rate change during the past century.

Yet, it could be argued that what should be included for Florida for an impact analysis is a sea level rise scenario of **8-12 ft!** This is the level of rise that almost any point of the coast in the next century would experience for a short time period with a direct hurricane hit.

Climate extremes beyond those observed

While the observed climate record provides a pragmatic approach for developing climate impact scenarios, those in the catastrophic CO2 climate change camp might argue that the real danger to society is seeing events or long-term climate that are outside the observed climate record.

It is also just as possible that the future climate will be outside the range of these CO2 – based scenarios. The medieval warm period and Little Ice Age are probably out of the CO2 based scenarios.

The actual climate is modulated sharply by internal modes such as El Niño/La Niña, NAO, and PDO. Since these are not included or poorly represented in GCMs, CO2 model scenarios may greatly underestimate the extreme events in climate.

Extending the Existing Climate Record

It is true that the directly observed climate record is relatively short, and extremes in the extended proxy record might be exceeded. However, the observed climate coupled with well known statistical methods may allow for developing scenarios that have a basis in statistical fact, but, which reach beyond the climate of our recent experience. Quoting a well known climatologist in the SECC about climate – “ If it happened before it can happen again only worse.”

Using bootstrapping in which individual years are considered independent might allow us to look at runs of dry or wet years that would threaten society’s ability to cope. For example we might find that the extraordinary runs of dry years in the 1950s in a statistical sense might likely be extended.

Additionally, Markov Bootstrapping techniques that contain time correlations can be used to modify the existing record to deliberately add runs of extreme events beyond those actually observed.

Sensitivity Analyses:

As noted by *Morgan et al. (2005)*, qualitative projections of climate for impact assessments can be also be useful. Simple sensitivity techniques such as raising or lowering temperatures or precipitation in a season or year within one-standard deviation can provide an assessment of the vulnerability of society using, and in a statistical sense, a possible occurrence.

Such a sensitivity study to determine at what level society might be impacted was an original goal of National Assessment (see above).

Spatial adjustments and magnitude adjustments to specific climate events can also be useful. For example, what if the large scale precipitation anomaly in 1926-1927 over the Upper Mississippi Basin that culminated in the Great Flood of 1927 had been centered over the Tennessee River Basin and was 10% greater. How, would the infrastructure created in the Tennessee Valley respond to this catastrophic event.

Non-CO₂ Climate Change

CO₂ is not the only anthropogenic impact that may take climate beyond the historic observations. Land use change, especially the new urban megalopolis areas in the SE, where heat island effects are growing, might take temperature extremes and distributions well beyond those observed in the past. As noted by Pielke (2008), land use change has been understated or ignored in many climate change scenarios and assessments yet its impact may rival that of CO₂.

Urban run-off and flash flooding can be exacerbated with urban climate change.

Other Societal Changes

There is a danger in examining the future and only allowing the climate to change (*Morgan et al 2005*). As an example, in the last SE assessment, there was a conclusion that there might be a slight shift in forest species even under the Hadley Center modest change scenario. However, this slight shift pales in comparison to the anthropogenic expansions in pine plantations and forests that occurred in the SE in the last half of the last century as row crop acreage was reduced.

The last agricultural assessment was also made without the inclusion of what we now see as a significant agricultural event – the expansion of agriculture for biofuels.

Should a new SE agricultural climate assessment consider the role of a reduction (adaptation) in western agriculture due to climate change producing an expansion in SE agriculture?

Summary and Conclusions

The SECC has developed impressive sets of climate data that characterize the variability and trends of SE climate. It has also developed an array of tools, such as DSSAT and hydrologic models, to examine the impacts of climate variability.

Uncertainties in developing CO₂ scenarios and the results of the last National Assessment have made the leadership of the SECC reluctant to embrace climate change impact assessments. However, determining the SE's vulnerability to climate is a legitimate undertaking and in fact much of the SECC current activities fall within the realm of assessing vulnerability to climate variability.

It is also possible that exactly the experience gained by the SECC in the last Assessment is what is needed to develop other and better techniques for carrying out climate impact assessments besides GCM CO₂ scenarios. The SECC may not be alone in its concern about using GCM CO₂ scenarios as the sole method for assessing climate vulnerability *Morgan et al. 2005* offer similar concerns to that of the SECC.

The SECC should be judicious in embracing climate change assessments, but, involvement especially by some of the younger investigators may be useful.

SECC investigators should take a proactive role in writing proposals to NSF's Societal Impacts Programs and other such programs to develop alternative scenario tools. It also should not easily give up its place at the table in the next round of Assessments since good work (though it may not show up in the politicized overview documents) may be important to our States and stakeholders.

In a pragmatic sense, it is very likely that if the SECC does not take an active role in regional climate change assessments they will be carried out by others who have less understanding of climate and poorer tools to address impacts.