WHAT DO WE KNOW ABOUT FUTURE CLIMATE IN COASTAL SOUTH CAROLINA?

Amanda Brennan & Kirsten Lackstrom
Carolinas Integrated Sciences & Assessments
November 13, 2013

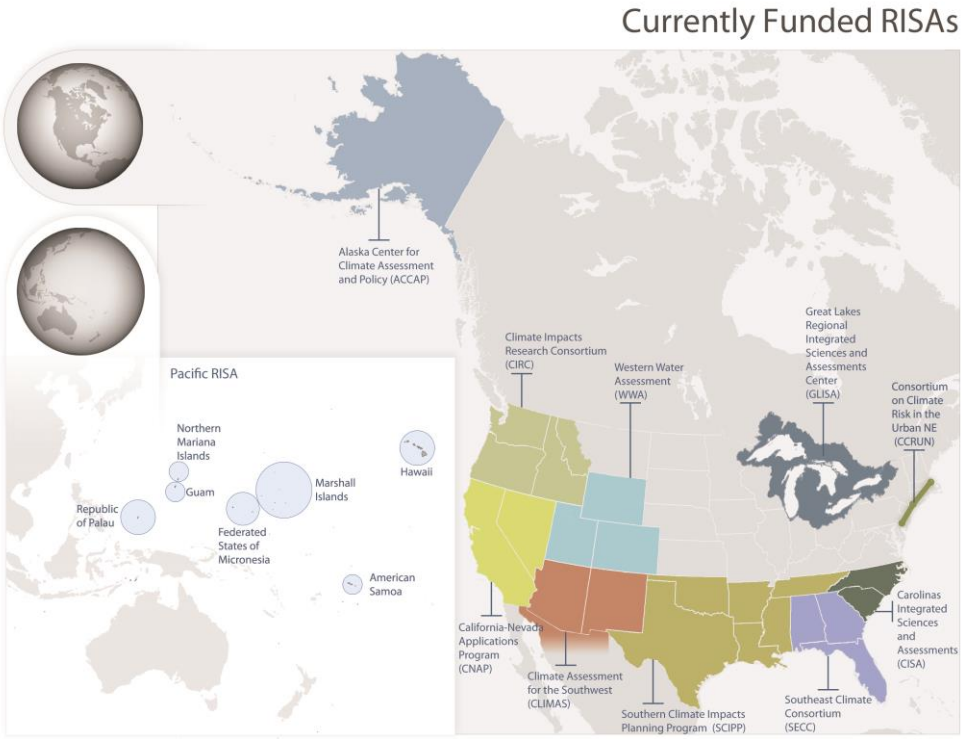
Content Development Support: Greg Carbone

Regional Integrated Sciences & Assessments

NOAA's RISA programs support research teams that help build the nation's capacity to prepare for and adapt to climate variability and change.

RISA teams work with public and private user communities to:

- Understand decision contexts
- Develop actionable knowledge
- Maintain diverse, flexible networks
- Innovate services to enhance the use of science in decision making



cisa
carolinas integrated sciences & assessments

CISA works to be a regional resource for a variety of stakeholders to incorporate climate information into water and coastal management, public health, and related decision making processes.

CISA's Core Focus Areas:

- Drought
- Climate & Watershed Modeling
- Coastal Management
- Public Health
- Adaptation

Partner Organizations:

- Southeast Regional Climate Center
- NC Sea Grant
- SC Sea Grant Consortium
- NC & SC State Climate Offices
- Federal, State & Local Agencies
- Private Sector
- NGOs

What can climate models tell us?

Some responses are clearer, especially in the latter portion of the century

- **Response:**
  - **Exploit those variables (Temperature, Sea Level)**
  - **Look at the range of future projections for other variables (Precipitation)**

Model choice matters most, especially for precipitation

- Response:
  - Use Climate Wizard to get a range of model output OR
  - Use an ensemble mean of many models

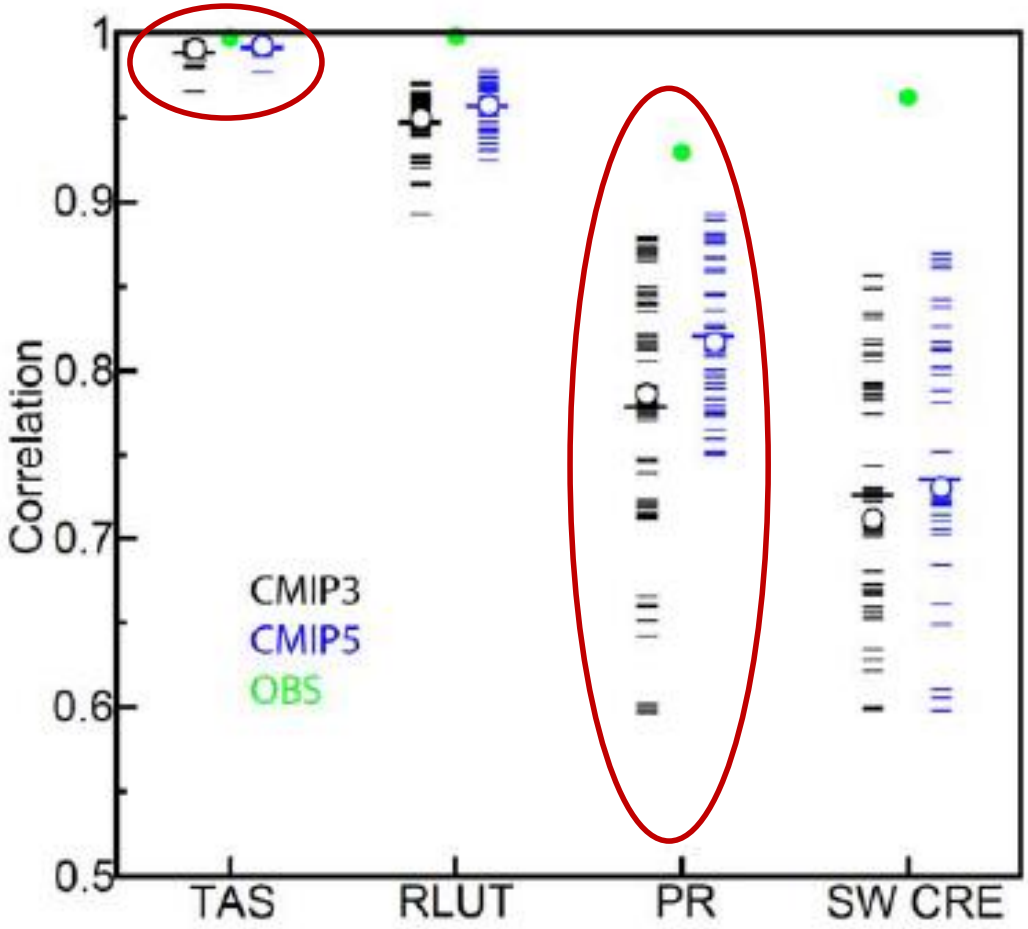
Emissions scenario choice matters a lot at the end of the Century

- Response:
  - Be realistic, choose a high-end emissions scenario

For harder variables (precipitation, tropical storms), precise high-resolution climate scenarios are plentiful, accurate ones are not (and are not ‘around the corner’).

- Response:
  - Figure out why you want the crystal ball (i.e. what would you do with perfect information?)
  - Consider a bottoms-up approach and think about what variables matter

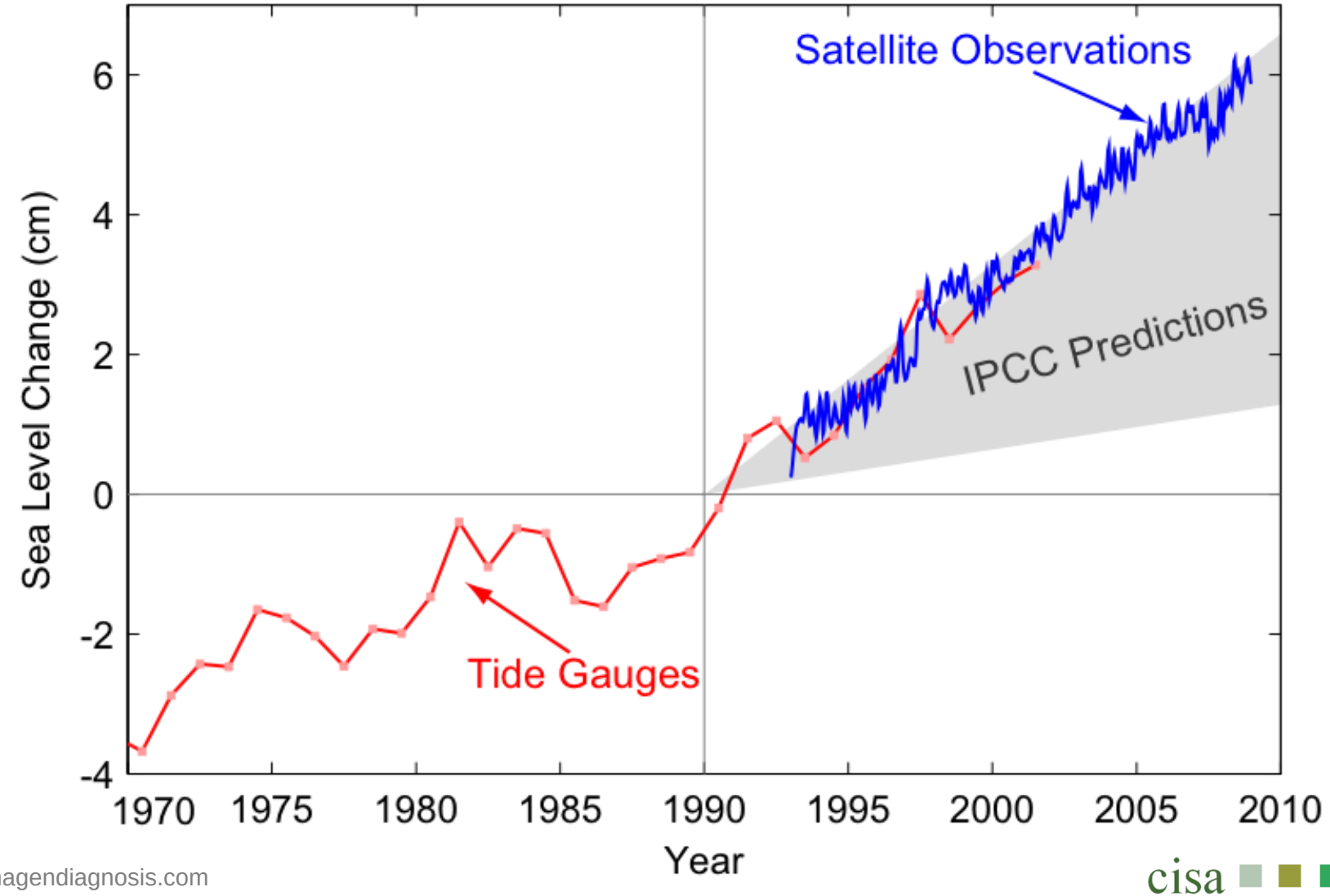
Observations vs. Model Output



IPCC, AR5

cisa

Global Sea Level Change 1970-2010

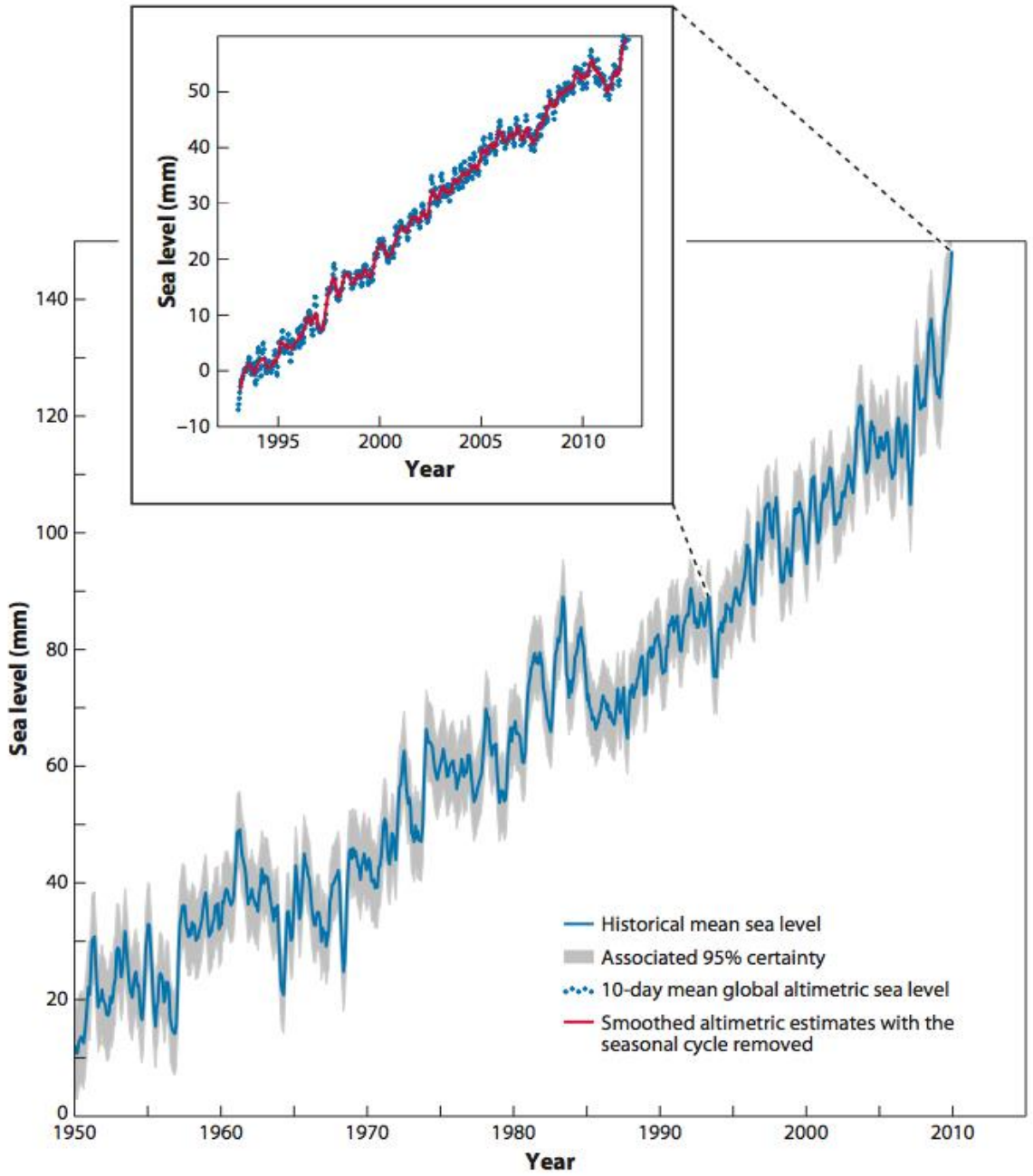


cisa

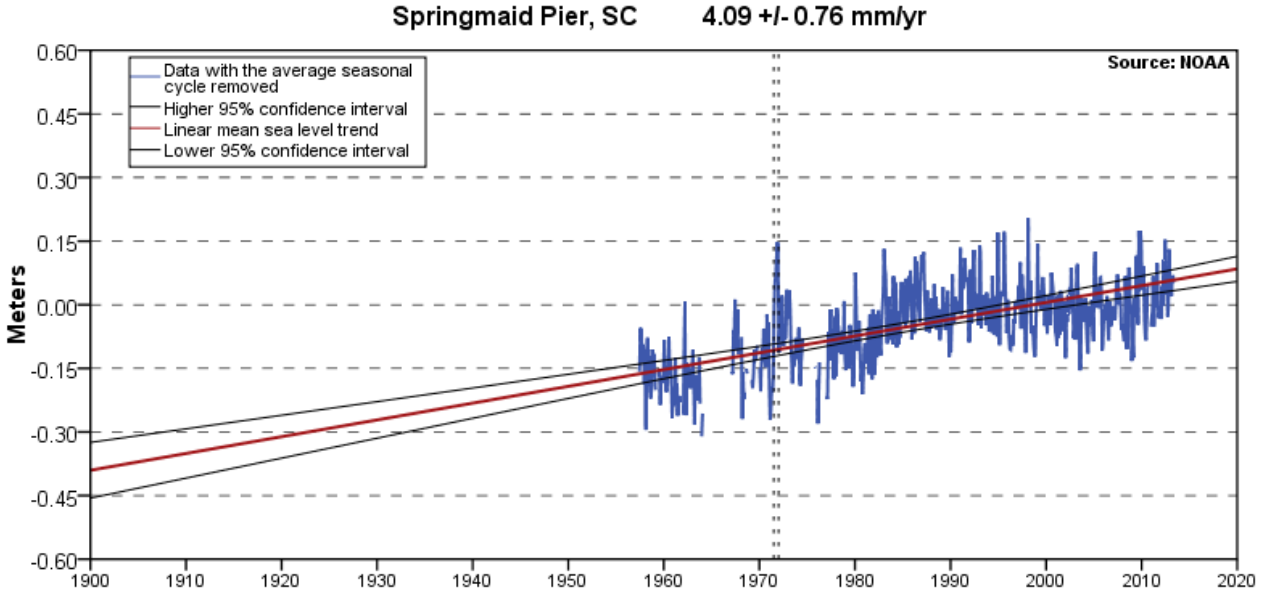
Historical Mean Sea Level Since 1950

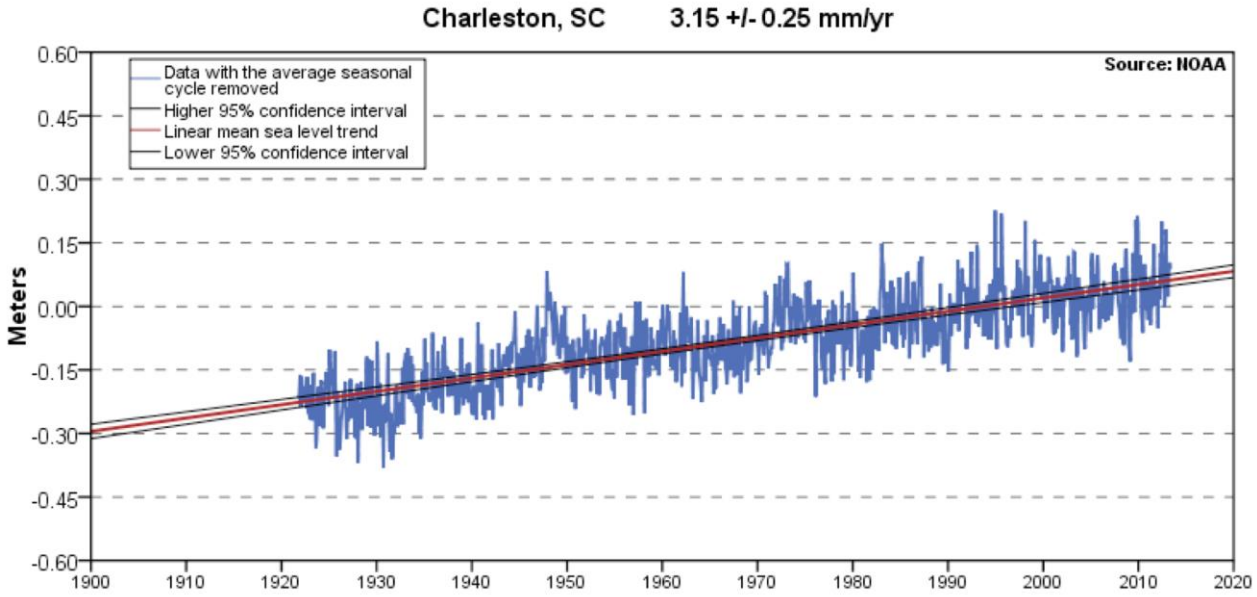
20th Century 1.7-1.8 mm/yr
(±0.3 mm/yr)

Since 1993: ~3.2 mm/yr
(±0.4 mm/yr)



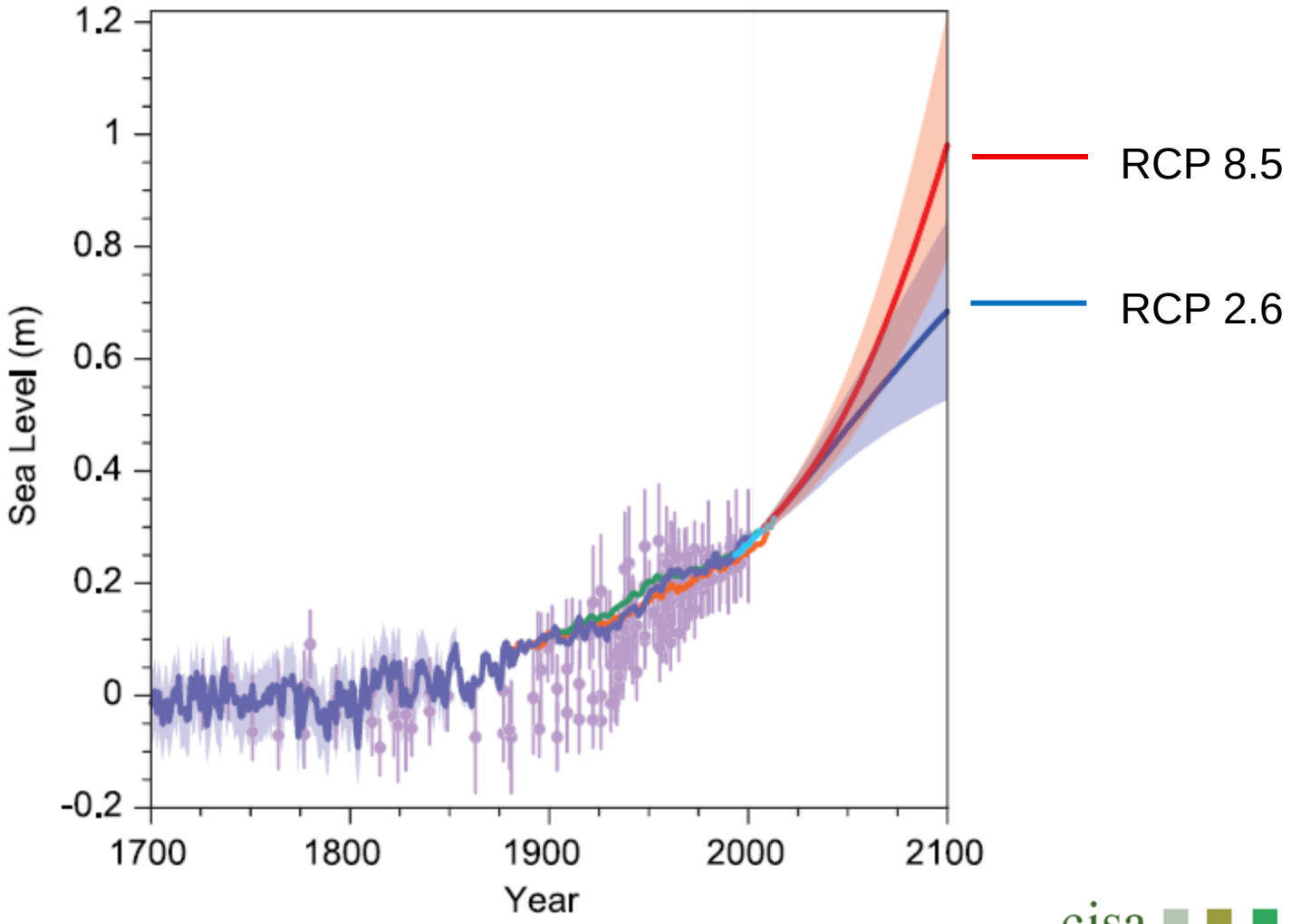
Local Observations & Trends





cisa

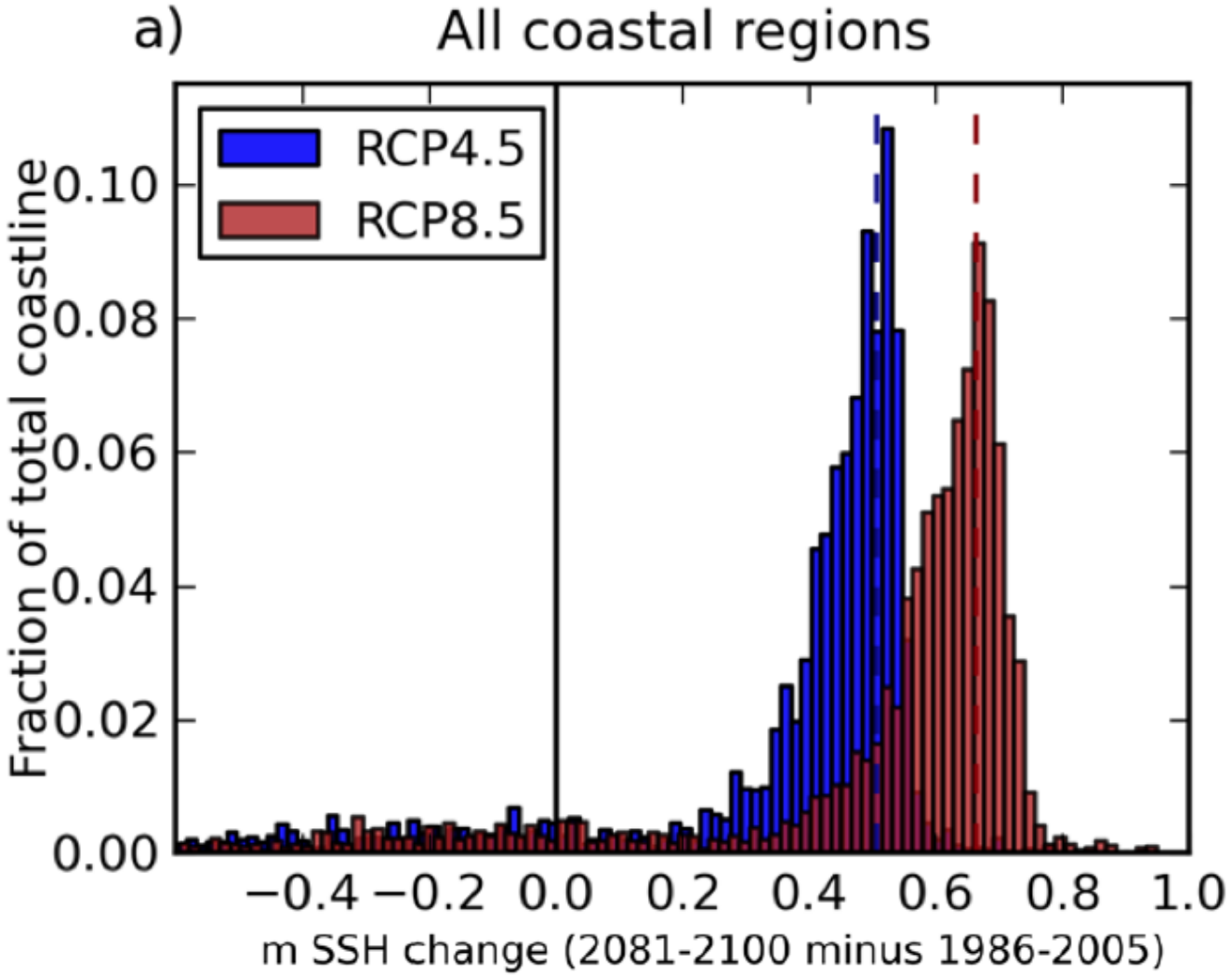
Global Sea Level Rise Projections



IPCC, AR5, Fig. 13.27

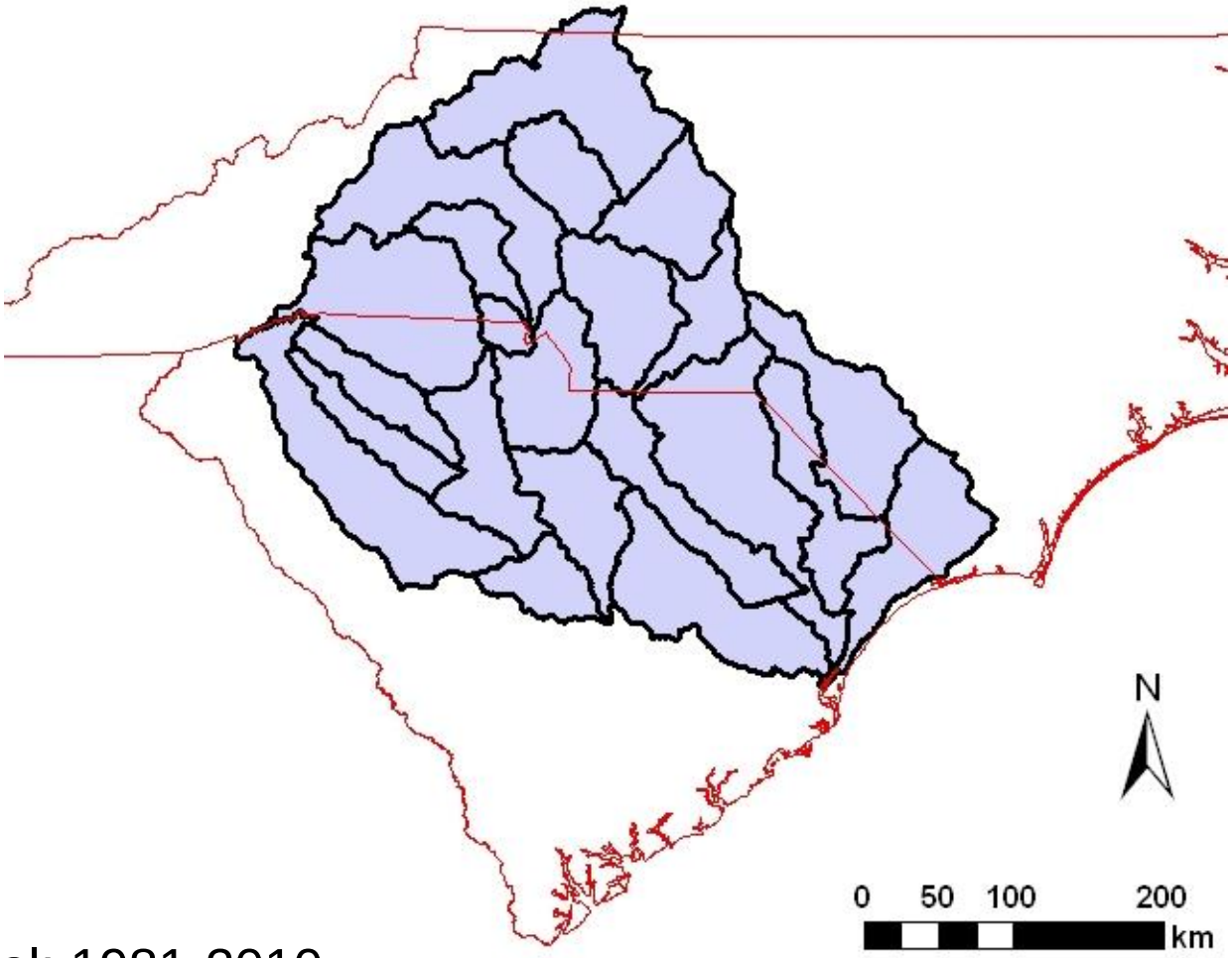
Global Sea Level Rise Projections

2081-2100 relative to 1986-2005



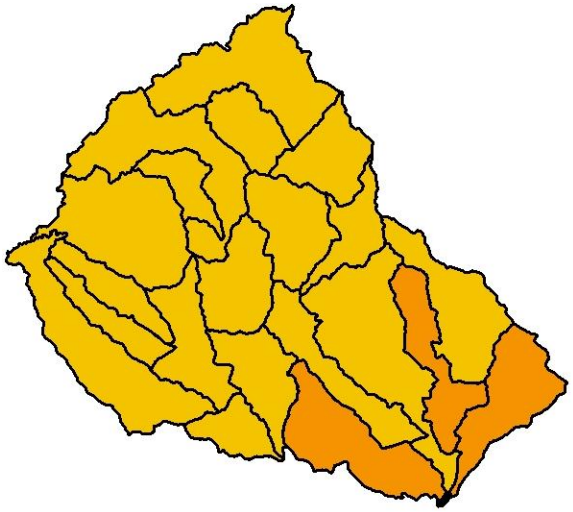
IPCC, AR5, Fig. 13.22

CISA's Climate Modeling Work

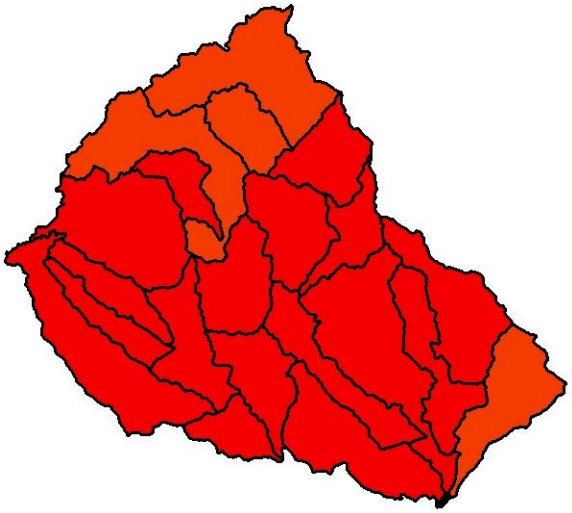


- Historical: 1981-2010
- Future: 2041-2070
- Models: CCSM, CNRM, ECHO, GFDL, and PCM

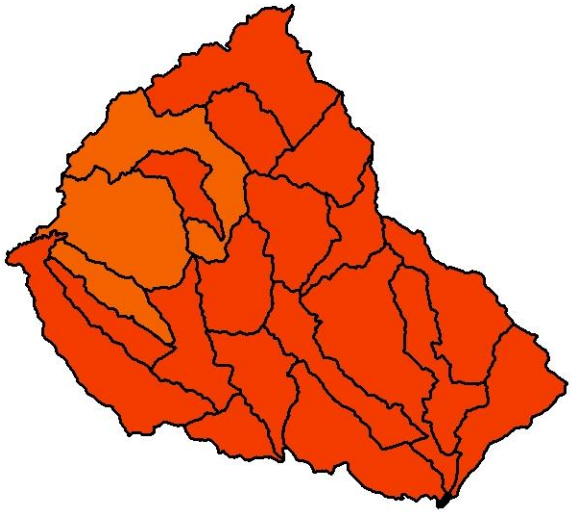
Change in Summer Maximum Temperature



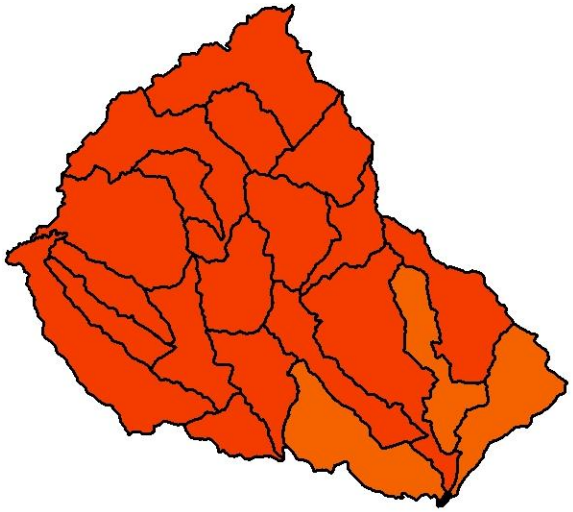
CCSM



CNRM



ECHO



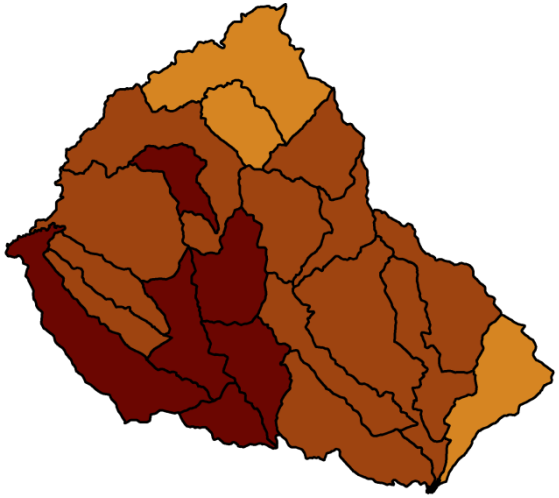
GFDL

PCM

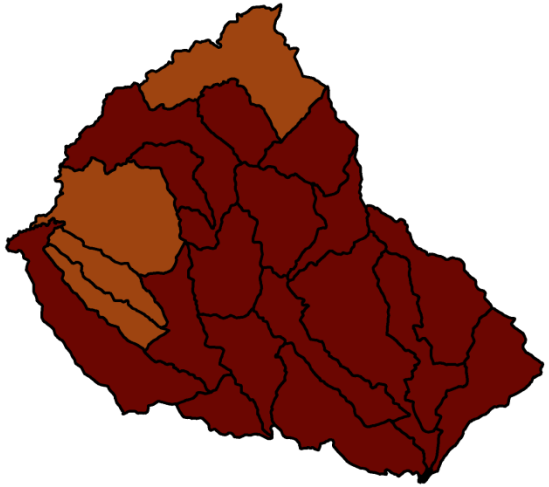
cisa

Potential Evapotranspiration Change in Summer

CCSM



CNRM



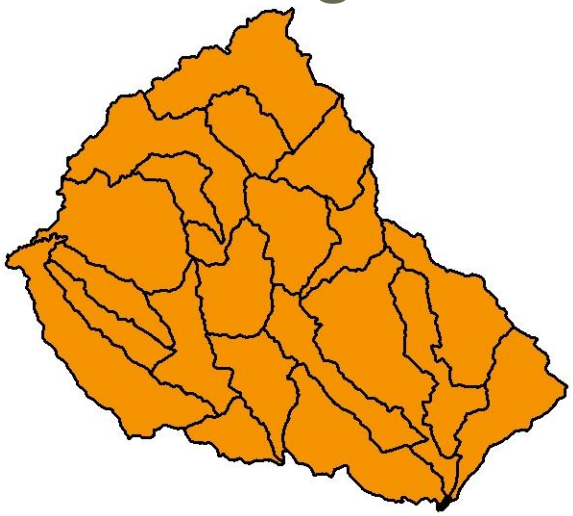
ECHO

GFDL

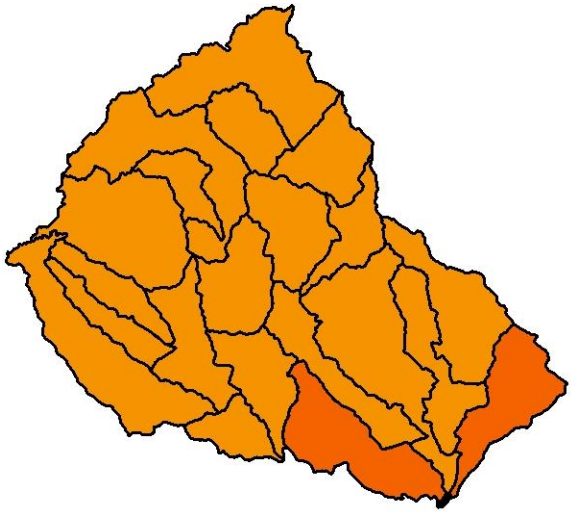
PCM

cisa

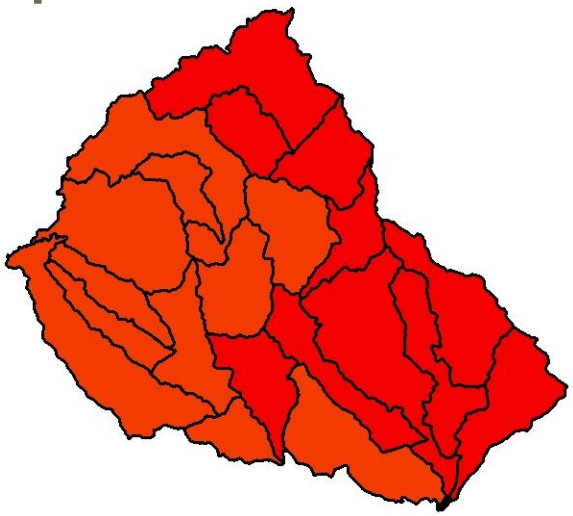
Change in Winter Maximum Temperature



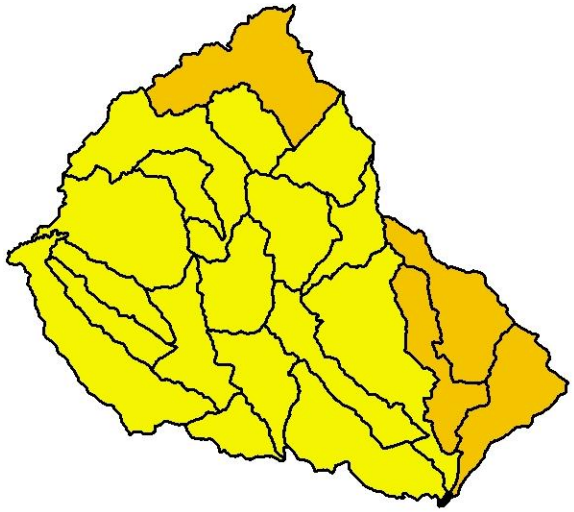
CCSM



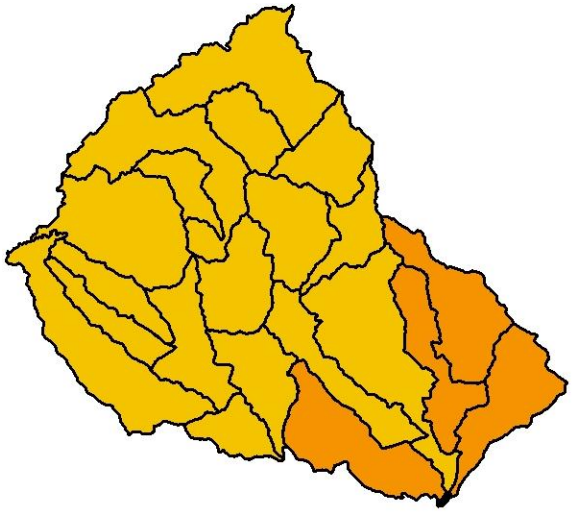
CNRM



ECHO



GFDL

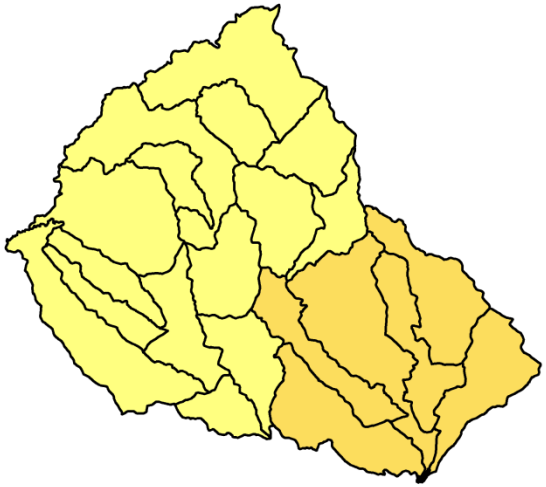


PCM

cisa

Potential Evapotranspiration Change in Winter

CCSM



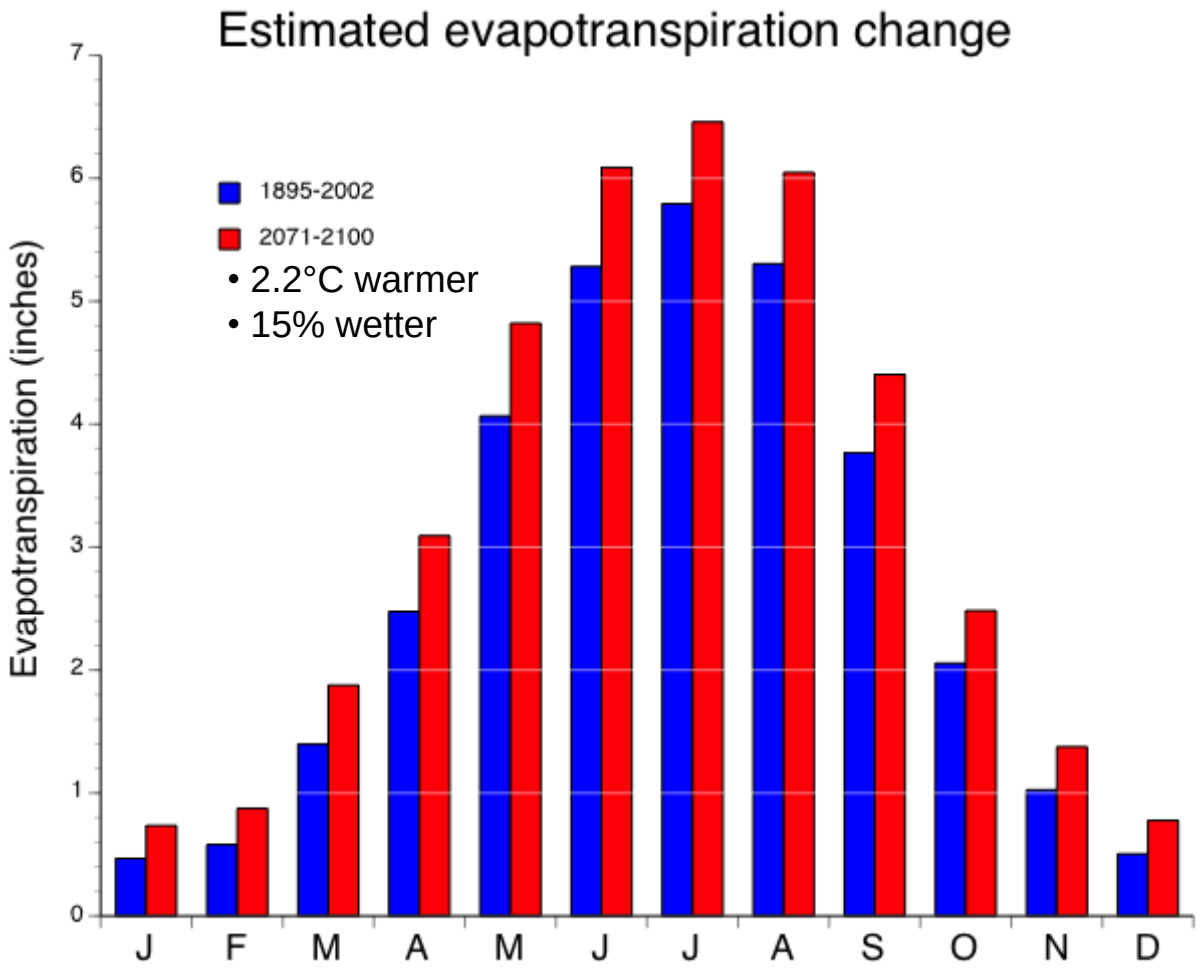
CNRM

ECHO

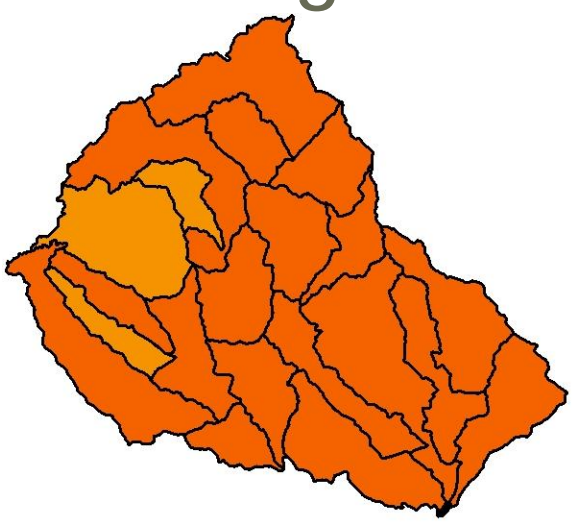
GFDL

PCM

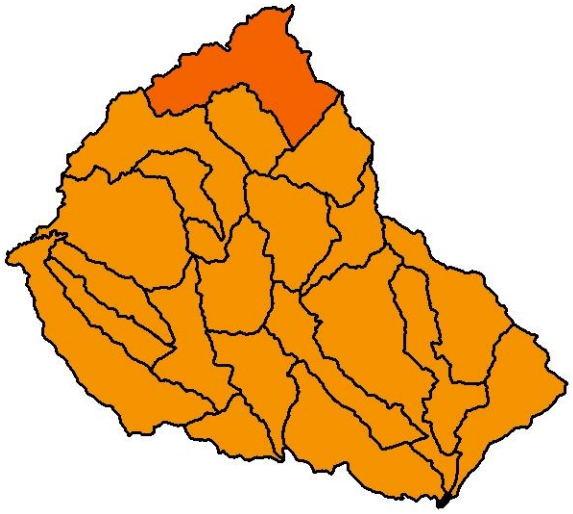
Evapotranspiration Change



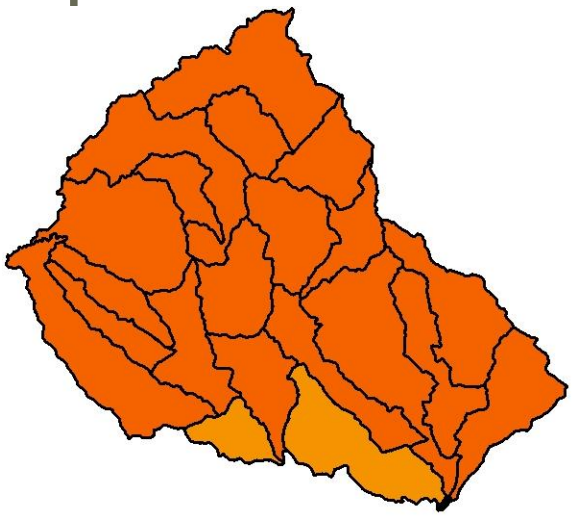
Change in Summer Minimum Temperature



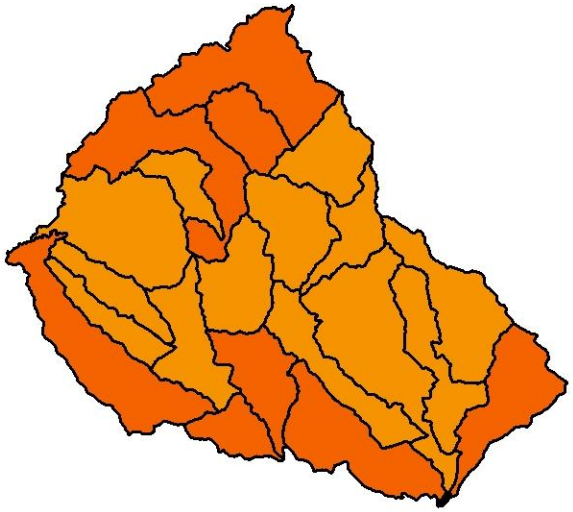
CCSM



CNRM



ECHO

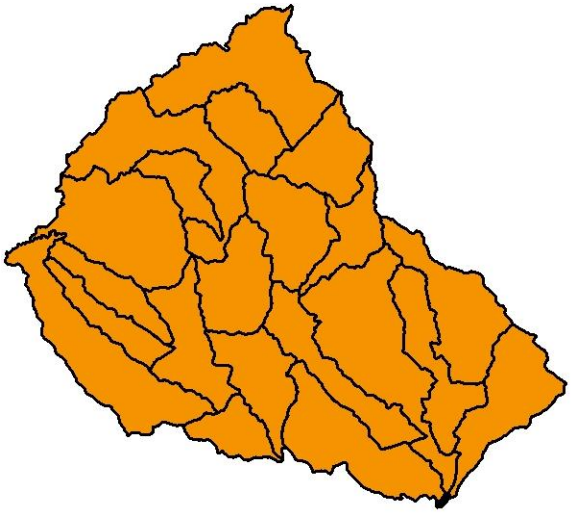


GFDL

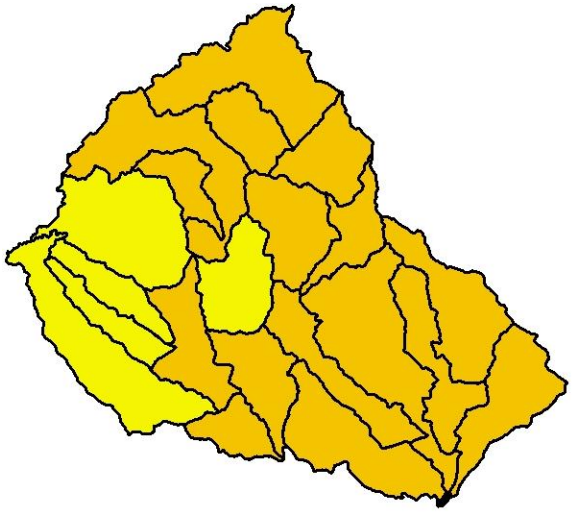
PCM

cisa

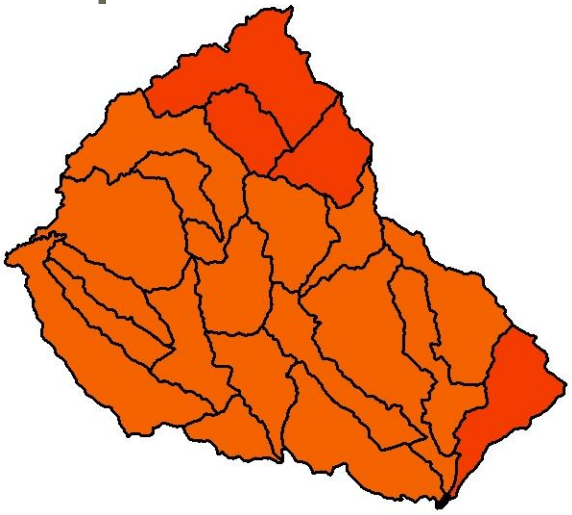
Change in Winter Minimum Temperature



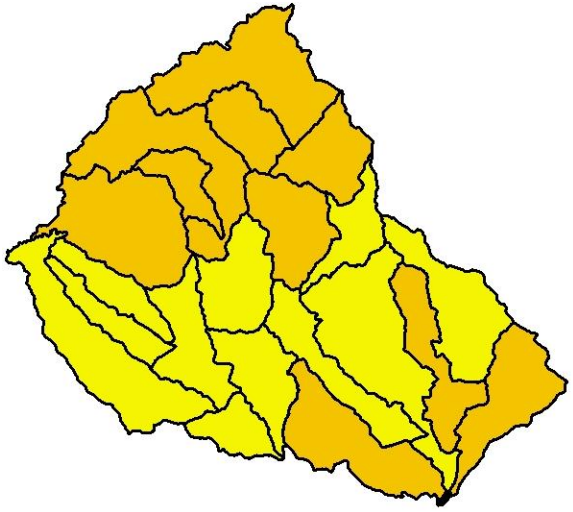
CCSM



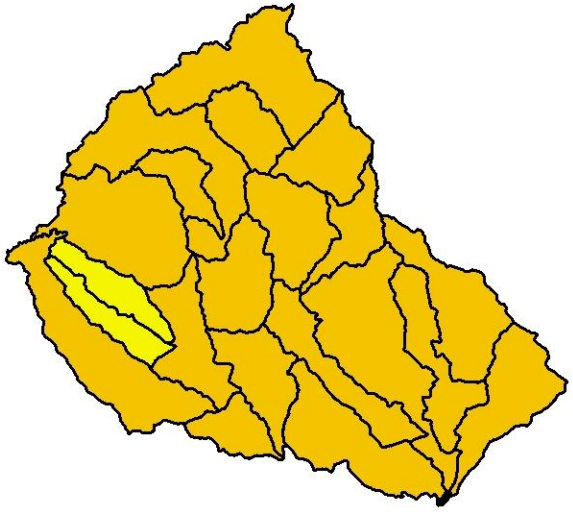
CNRM



ECHO



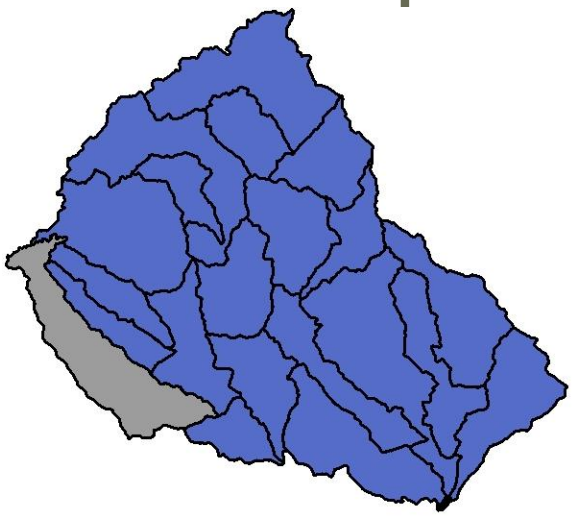
GFDL



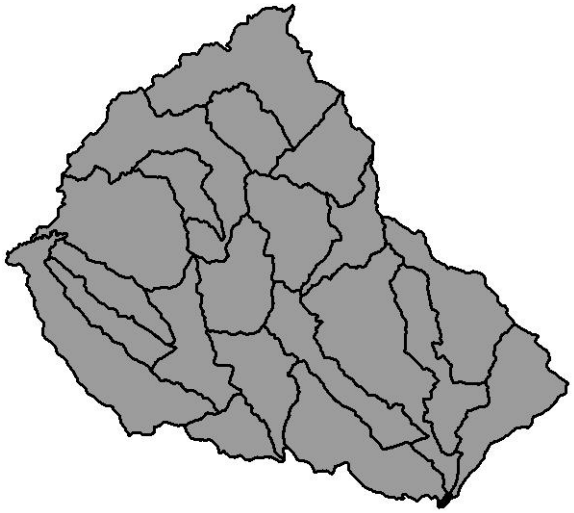
PCM

cisa

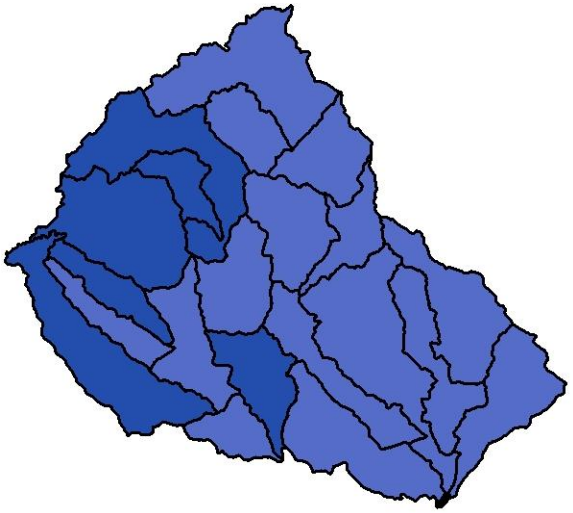
Precipitation Change in Summer



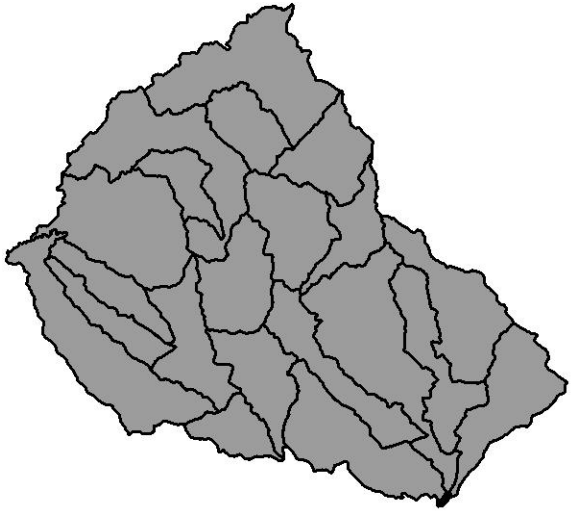
CCSM



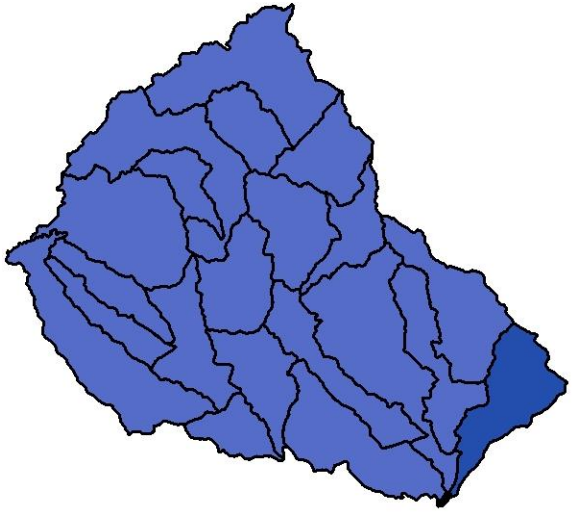
CNRM



ECHO



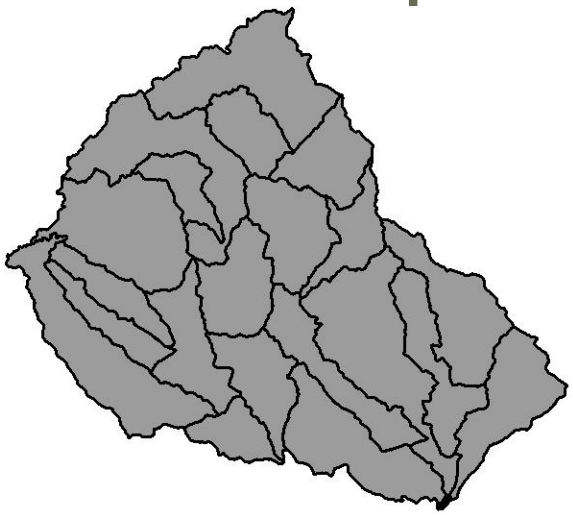
GFDL



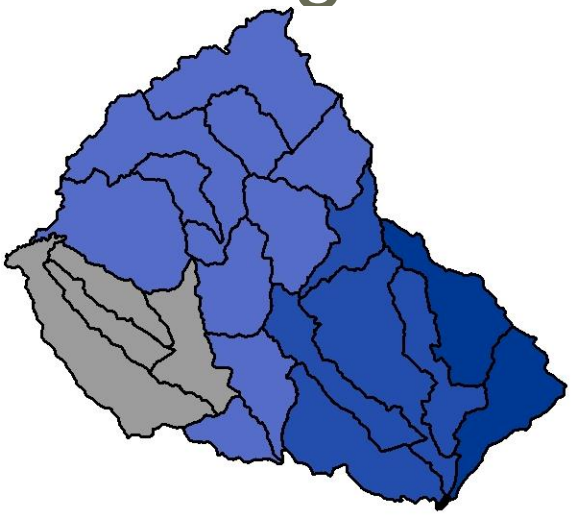
PCM

cisa

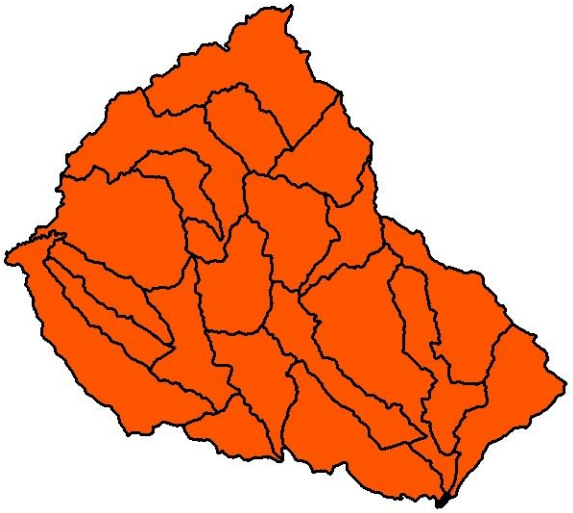
Precipitation Change in Winter



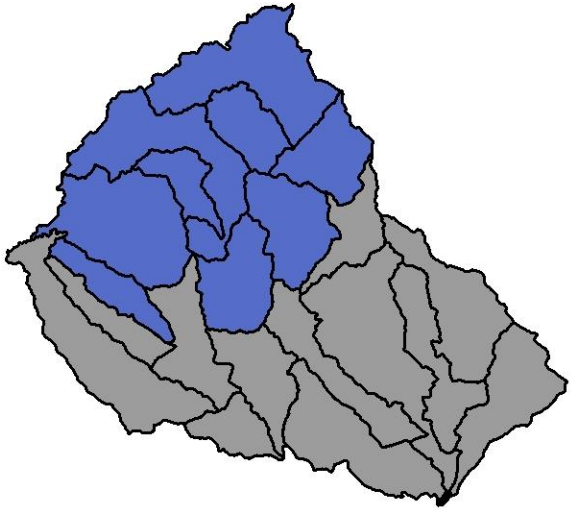
CCSM



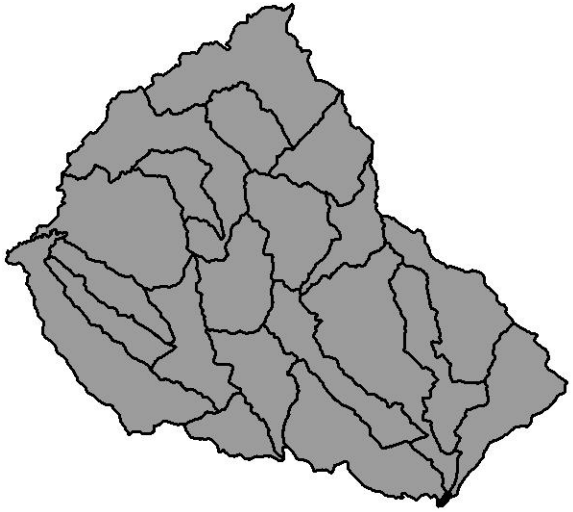
CNRM



ECHO



GFDL



PCM

cisa

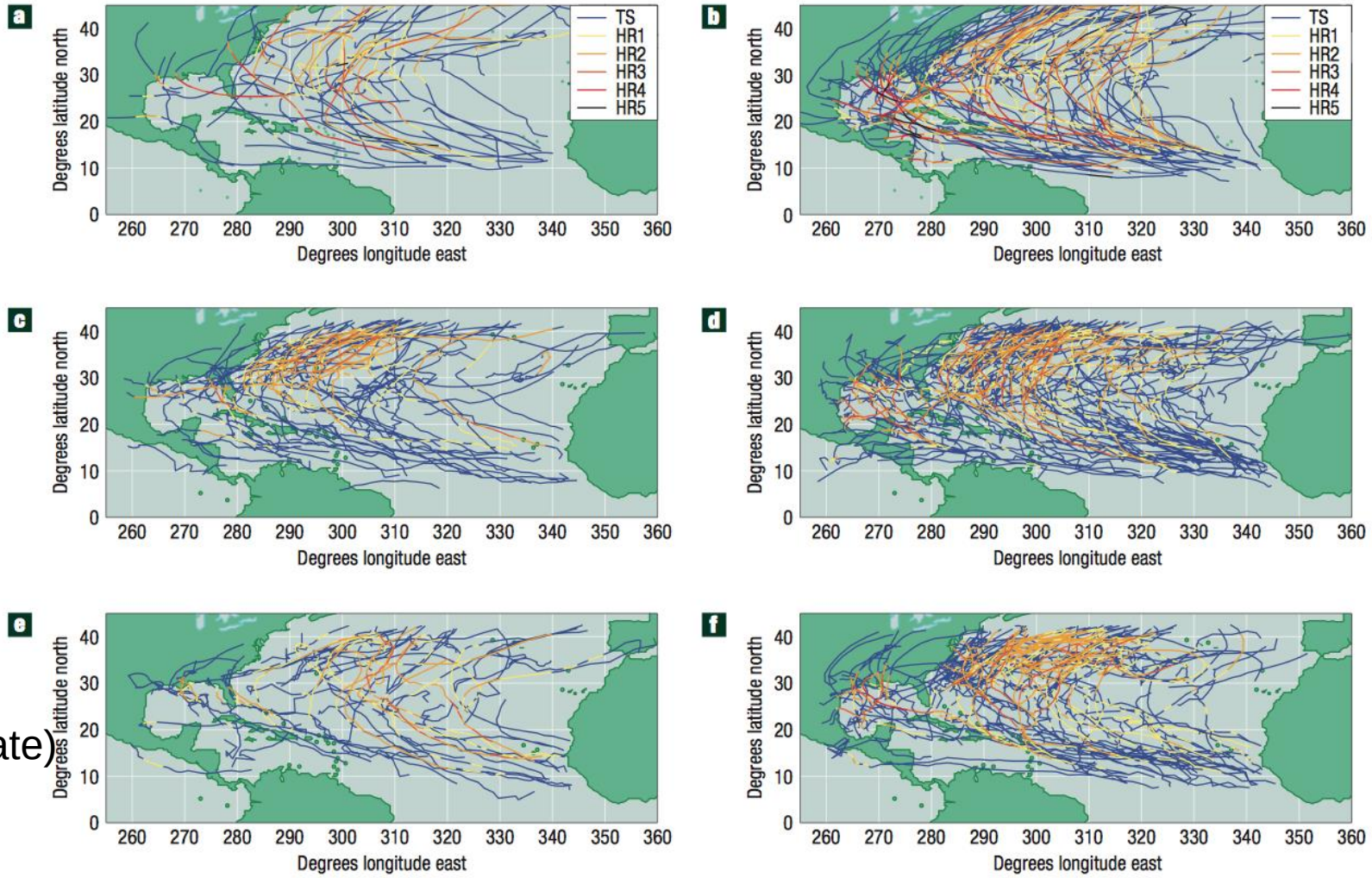
10 least-active years, 1980-2006

10 most-active years, 1980-2006

Observed

Simulated (control)

Simulated (warm climate)



(Knutson et al., 2008)

What can climate models tell us?

Some responses are clearer, especially in the latter portion of the century

- Response:
  - Exploit those variables (Temperature, Sea Level)
  - Look at the range of future projections for other variables (Precipitation)

Model choice matters most, especially for precipitation

- **Response:**
  - **Use Climate Wizard to get a range of model output OR**
  - **Use an ensemble mean of many models**

Emissions scenario choice matters a lot at the end of the Century

- Response:
  - Be realistic, choose a high-end emissions scenario

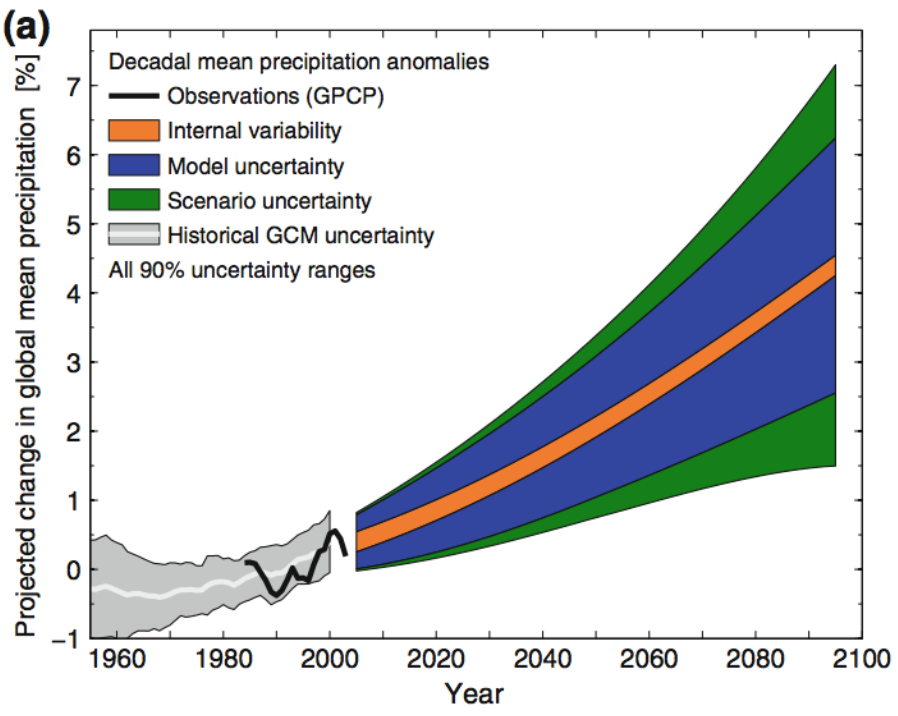
For harder variables (precipitation, tropical storms), precise high-resolution climate scenarios are plentiful, accurate ones are not (and are not ‘around the corner’).

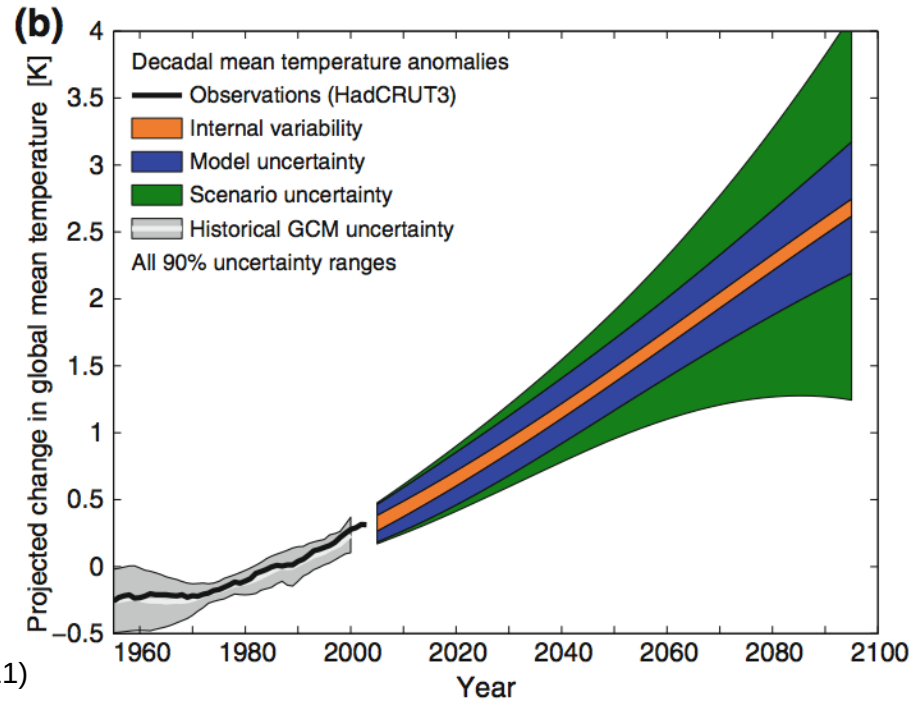
- Response:
  - Figure out why you want the crystal ball (i.e. what would you do with perfect information?)
  - Consider a bottoms-up approach and think about what variables matter

Variability and Uncertainty

For precipitation, *model uncertainty* plays a larger part in the total range of projections.

For temperature, *scenario uncertainty* is the larger determining factor.

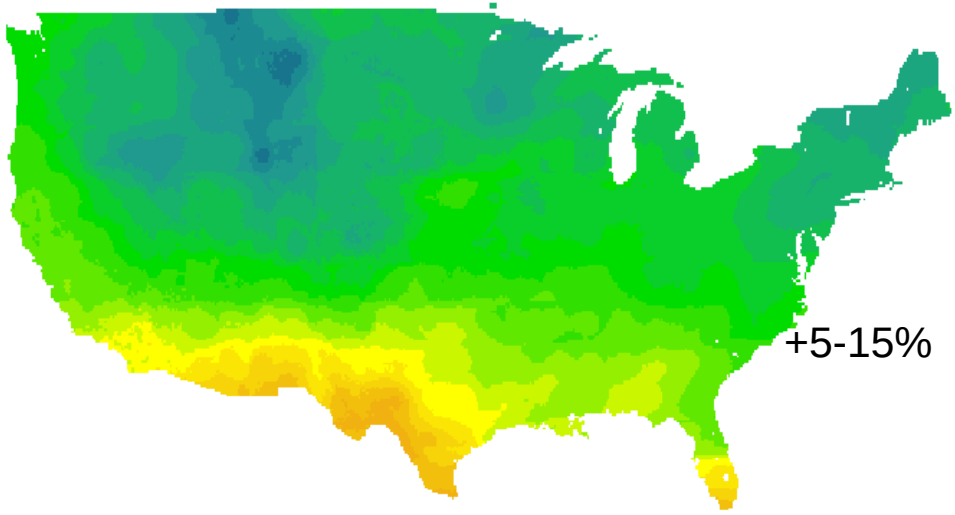


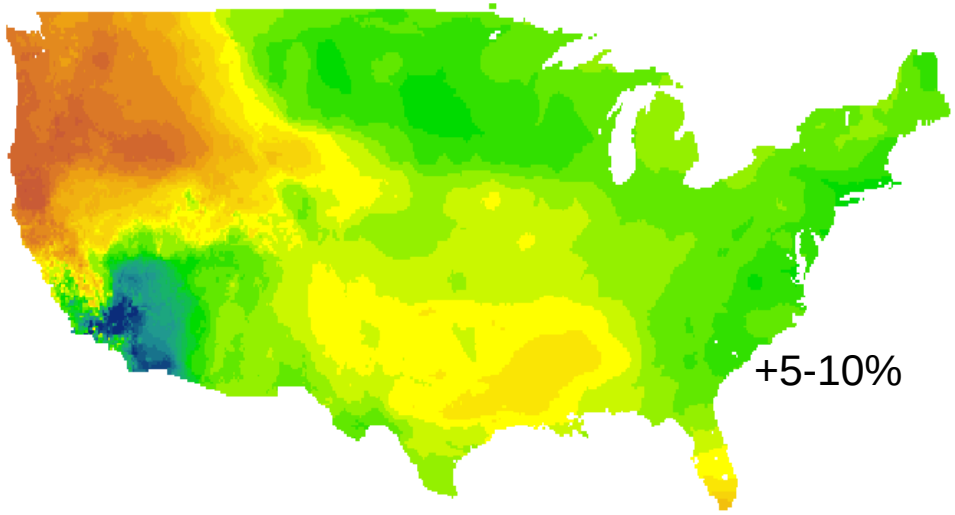


(Hawkins & Sutton, 2011)

cisa

Precipitation Ensemble Average vs. Single Model

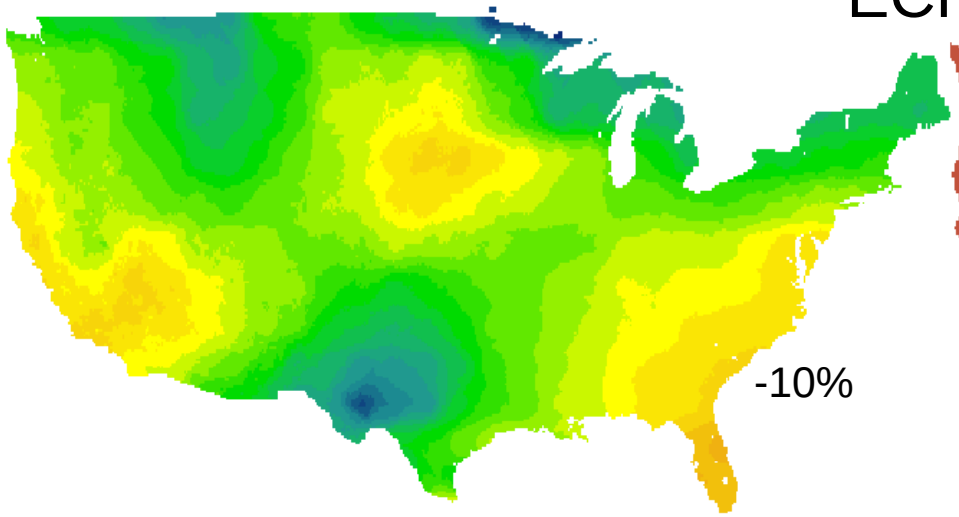


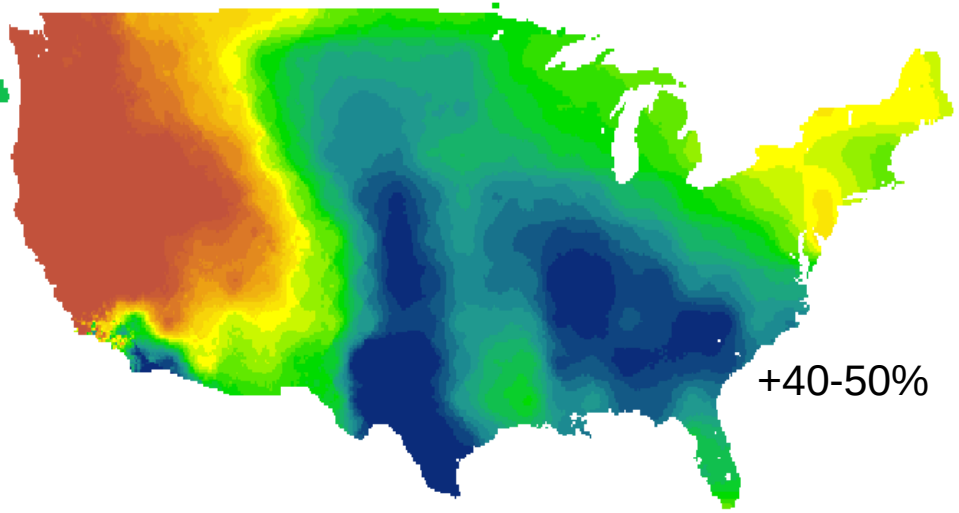


WINTER

SUMMER

ECHO





What can climate models tell us?

Some responses are clearer, especially in the latter portion of the century

- Response:
  - Exploit those variables (Temperature, Sea Level)

Model choice matters most, especially for precipitation

- Response:
  - Use Climate Wizard to get a range of model output OR
  - Use an ensemble mean of many models

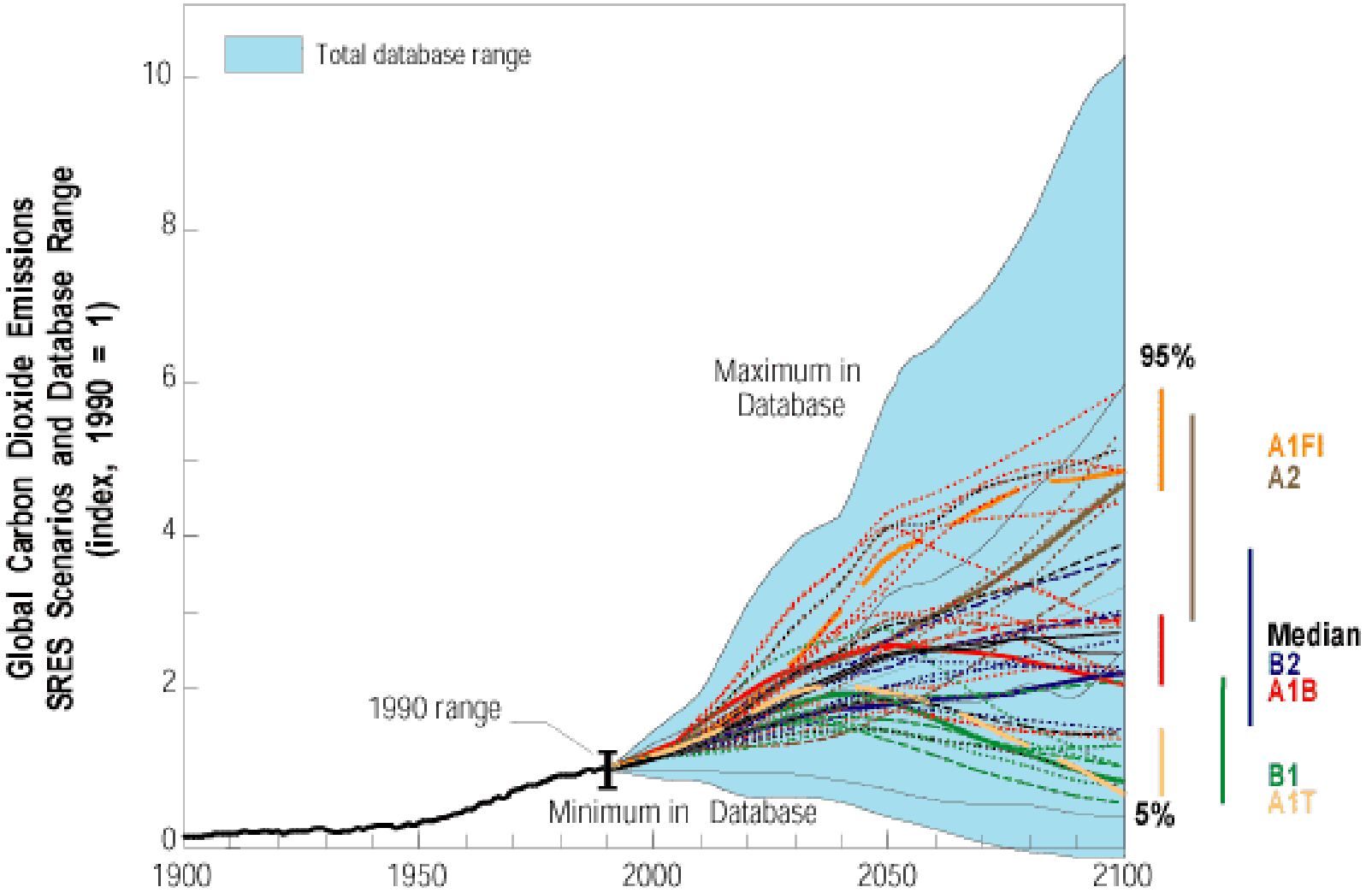
Emissions scenario choice matters a lot at the end of the Century

- **Response:**
  - **Be realistic, choose a high-end emissions scenario**

For harder variables (precipitation, tropical storms), precise high-resolution climate scenarios are plentiful, accurate ones are not (and are not ‘around the corner).

- Response:
  - Figure out why you want the crystal ball (i.e. what would you do with perfect information?)
  - Consider a bottoms-up approach and think about what variables matter

Range of Future GHG Emissions



IPCC Emissions Scenarios Special Report, 2000

What can climate models tell us?

Some responses are clearer, especially in the latter portion of the century

- Response:
  - Exploit those variables (Temperature, Sea Level)

Model choice matters most, especially for precipitation

- Response:
  - Use Climate Wizard to get a range of model output OR
  - Use an ensemble mean of many models

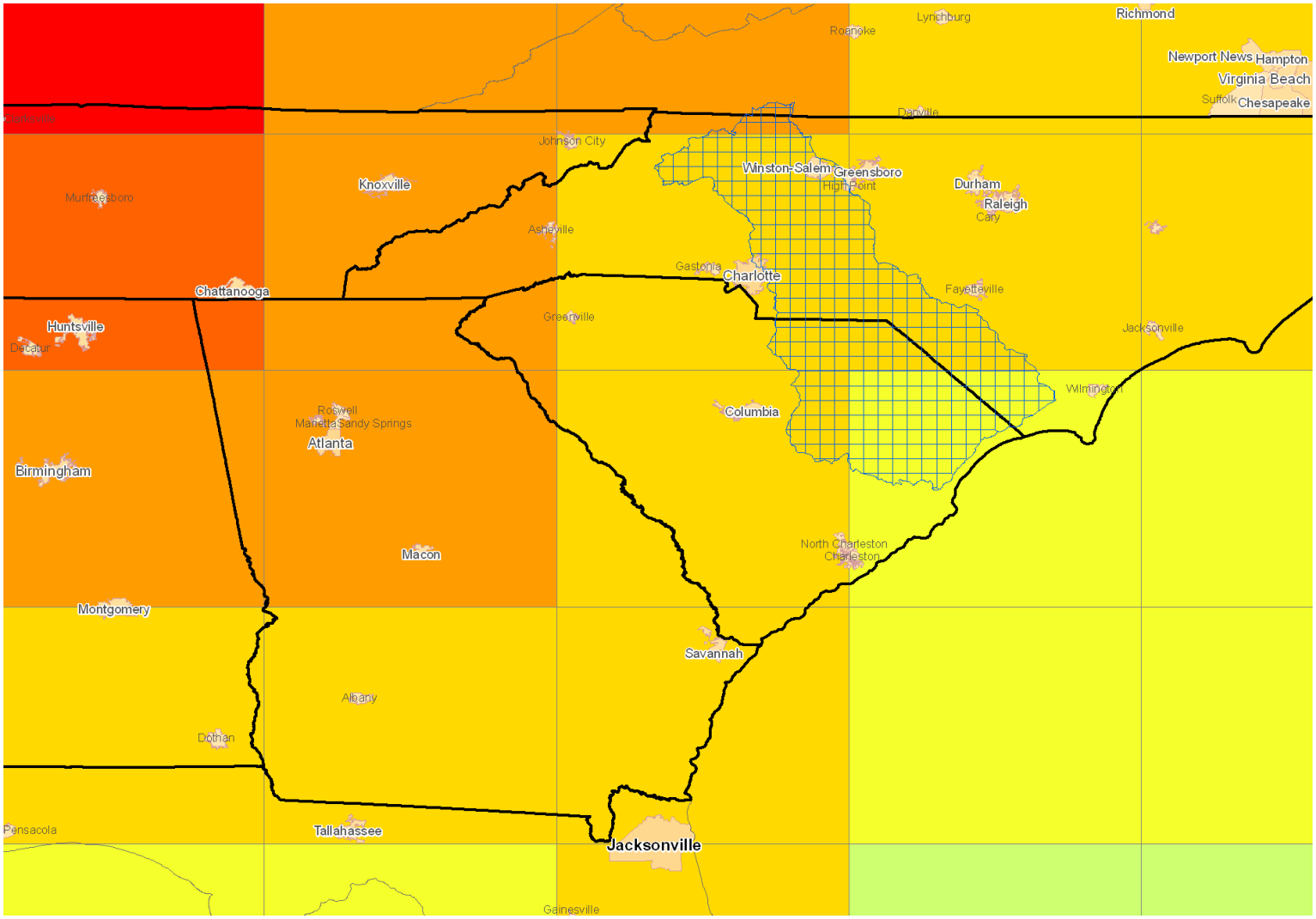
Emissions scenario choice matters a lot at the end of the Century

- Response:
  - Be realistic, choose a high-end emissions scenario

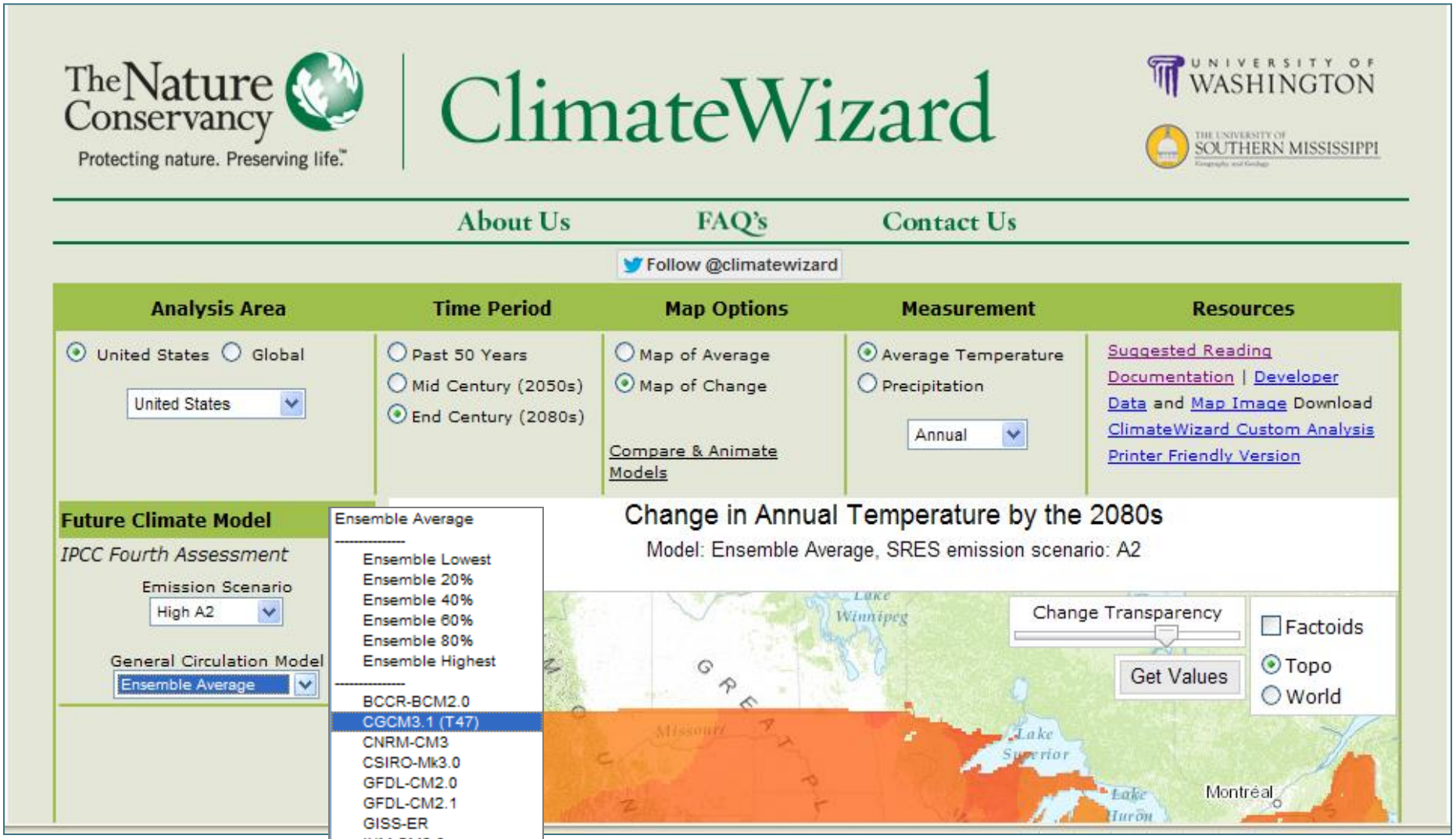
For harder variables (precipitation, tropical storms), precise high-resolution climate scenarios are plentiful, accurate ones are not (and are not 'around the corner).

- **Response:**
  - **Figure out why you want the crystal ball (i.e. what would you do with perfect information?)**
  - **Consider a bottoms-up approach and think about what variables matter**

Downscaling Climate Change Information



cisa


The Nature Conservancy
Protecting nature. Preserving life.
ClimateWizard
University of Washington
The University of Southern Mississippi
About Us
FAQ's
Contact Us
Follow @climatewizard
Analysis Area
United States
Global
United States
Time Period
Past 50 Years
Mid Century (2050s)
End Century (2080s)
Map Options
Map of Average
Map of Change
Compare & Animate Models
Measurement
Average Temperature
Precipitation
Annual
Resources
Suggested Reading
Documentation | Developer
Data and Map Image Download
ClimateWizard Custom Analysis
Printer Friendly Version
Future Climate Model
IPCC Fourth Assessment
Emission Scenario
High A2
General Circulation Model
Ensemble Average
Ensemble Average
Ensemble Lowest
Ensemble 20%
Ensemble 40%
Ensemble 60%
Ensemble 80%
Ensemble Highest
BCCR-BCM2.0
CGCM3.1 (T47)
CNRM-CM3
CSIRO-Mk3.0
GFDL-CM2.0
GFDL-CM2.1
GISS-ER
INM-CM3.0
IPSL-CM4
MIROC3.2 (medres)
ECHO-G
ECHAM5/ MPI-OM
MRI-CGCM2.3.2
CCSM3
PCM
UKMO-HadCM3
Change in Annual Temperature by the 2080s
Model: Ensemble Average, SRES emission scenario: A2
Change Transparency
Get Values
Factoids
Topo
World
Lake Winnipeg
Missouri
Lake Superior
Lake Huron
Montréal

cisa

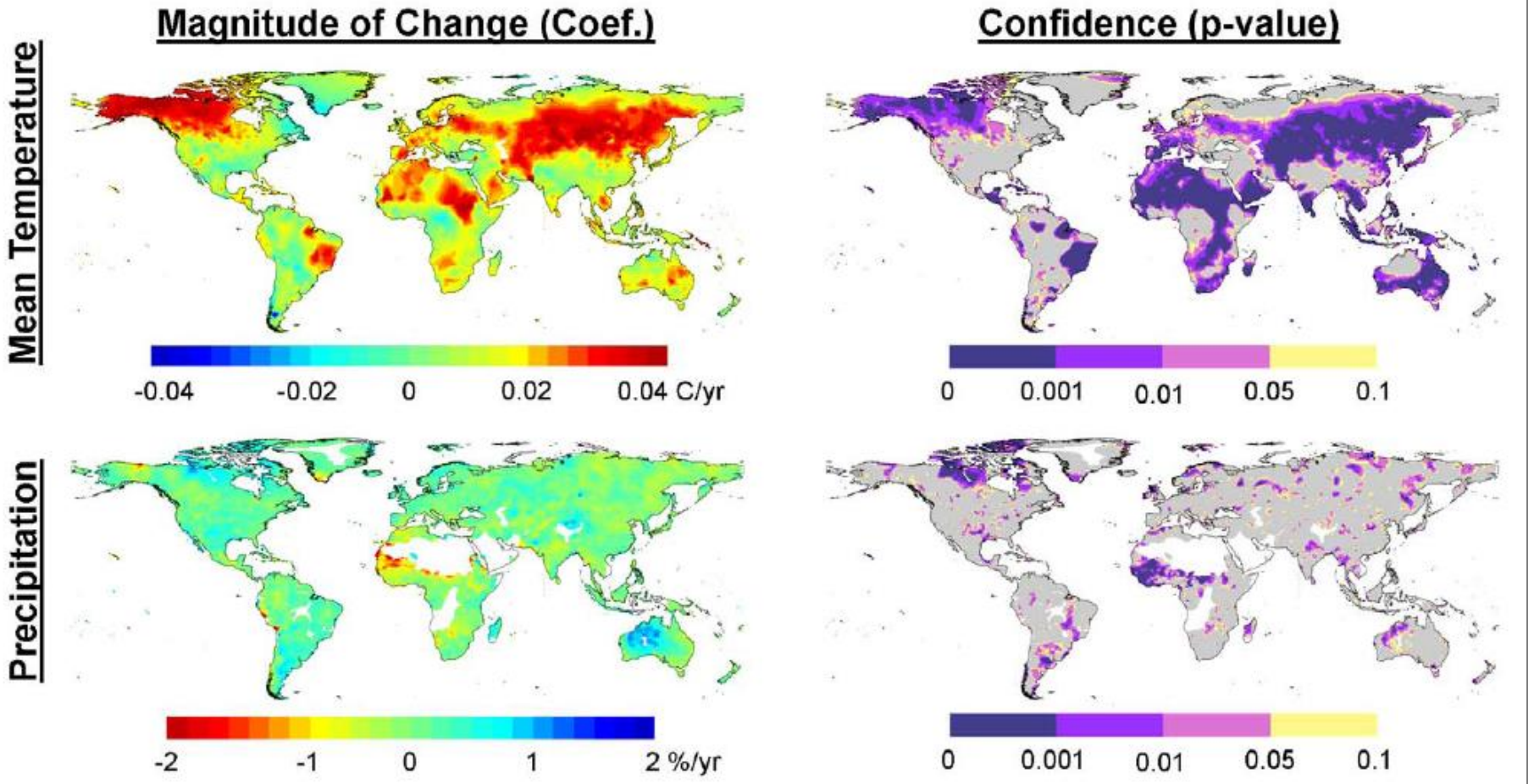
Climate Wizard (advantages)

- Provides statistically downscaled climate projections, 0.5 degree or ~50 km resolution
- Includes many variables and options
  - Temperature (T), precipitation (P)
  - Mean T and P, trend analysis (how has climate changed over time)
  - Annual, seasonal, monthly climate change statistics
  - 3 emissions scenarios, 16 GCMs
  - 3 time periods

Climate Wizard (caveats)

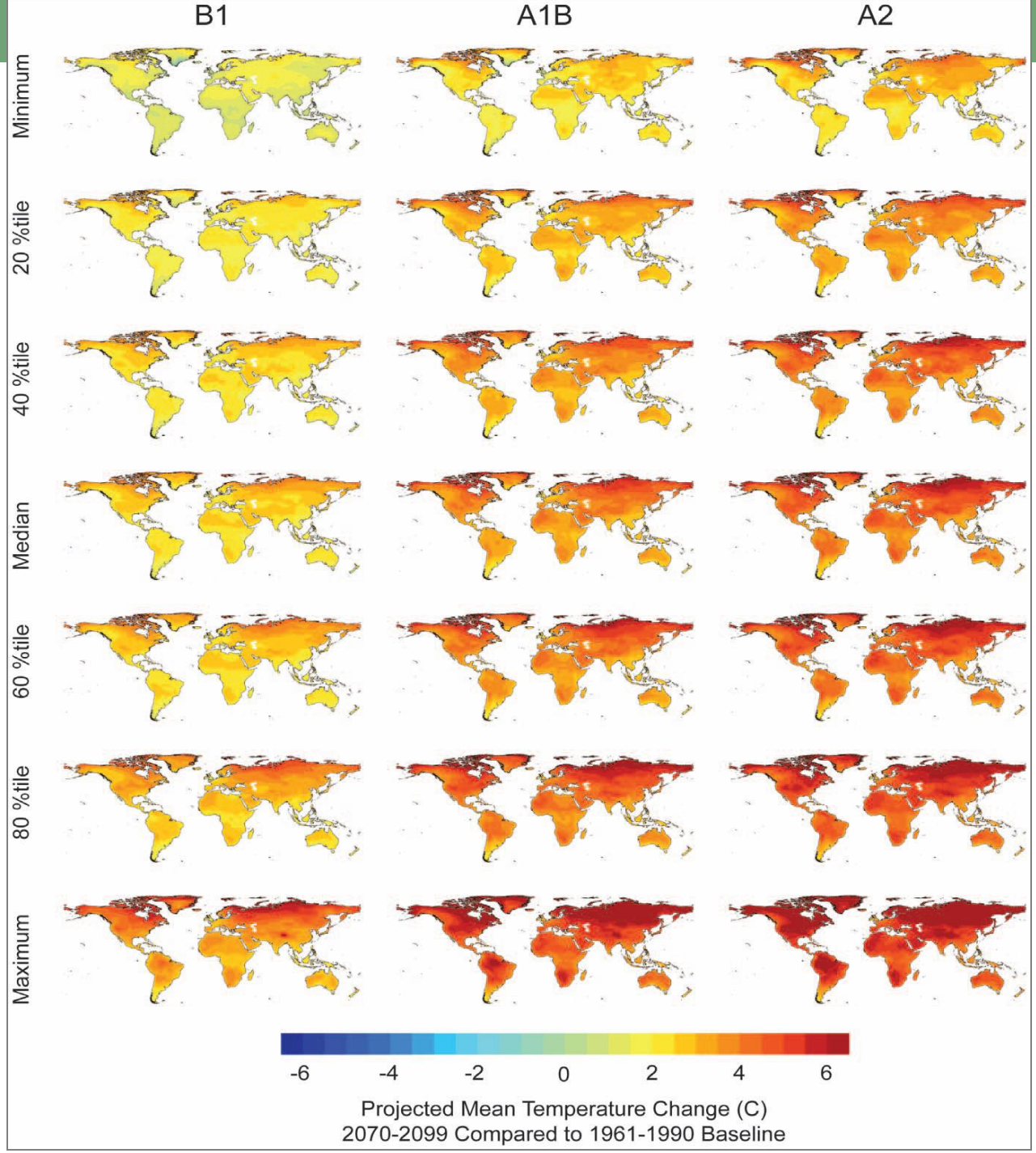
- Statistical confidence in linear trends
  - Gray areas have low statistical confidence, not recommended for decisions

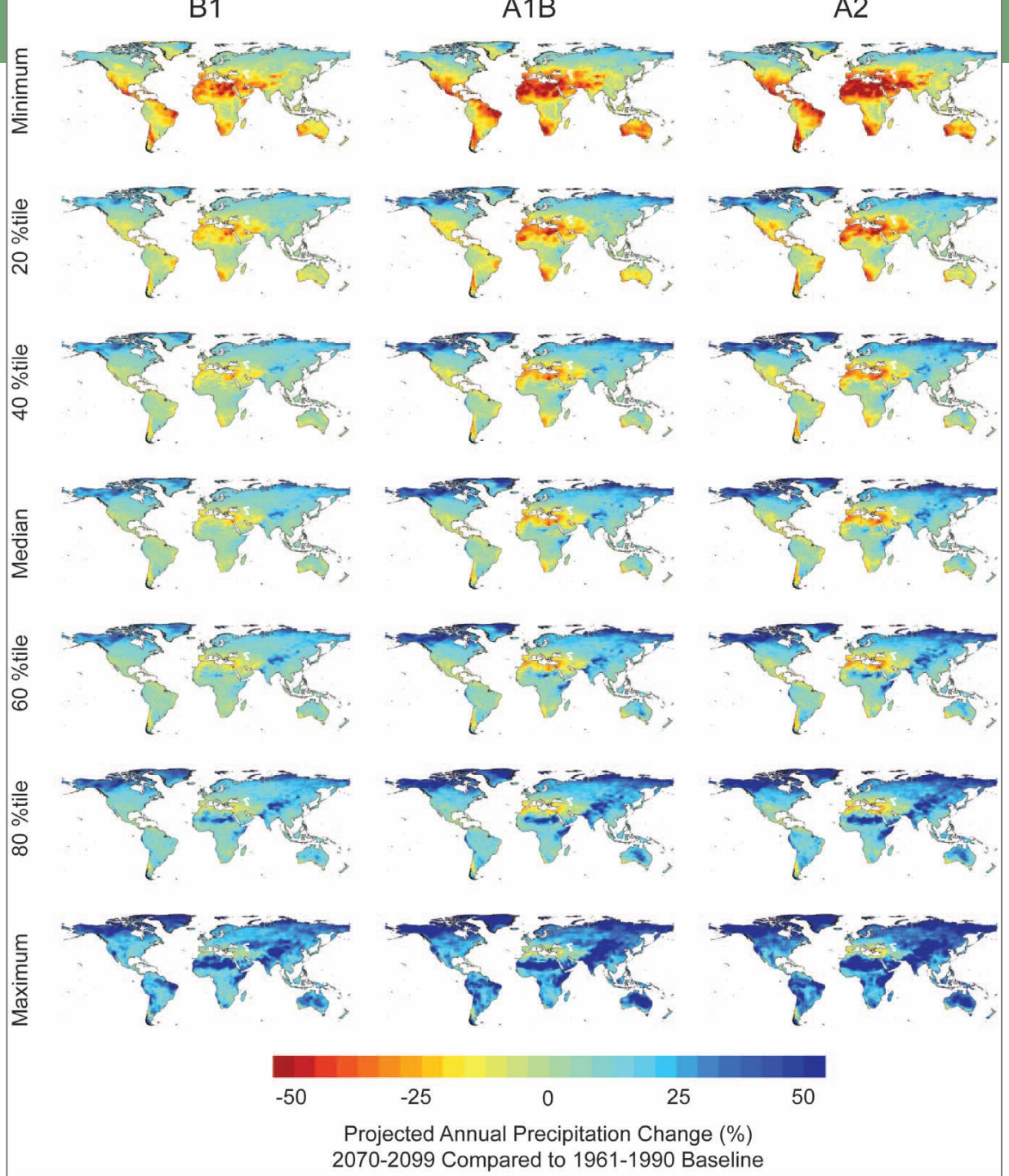
Temperature and precipitation change, 1951–2002

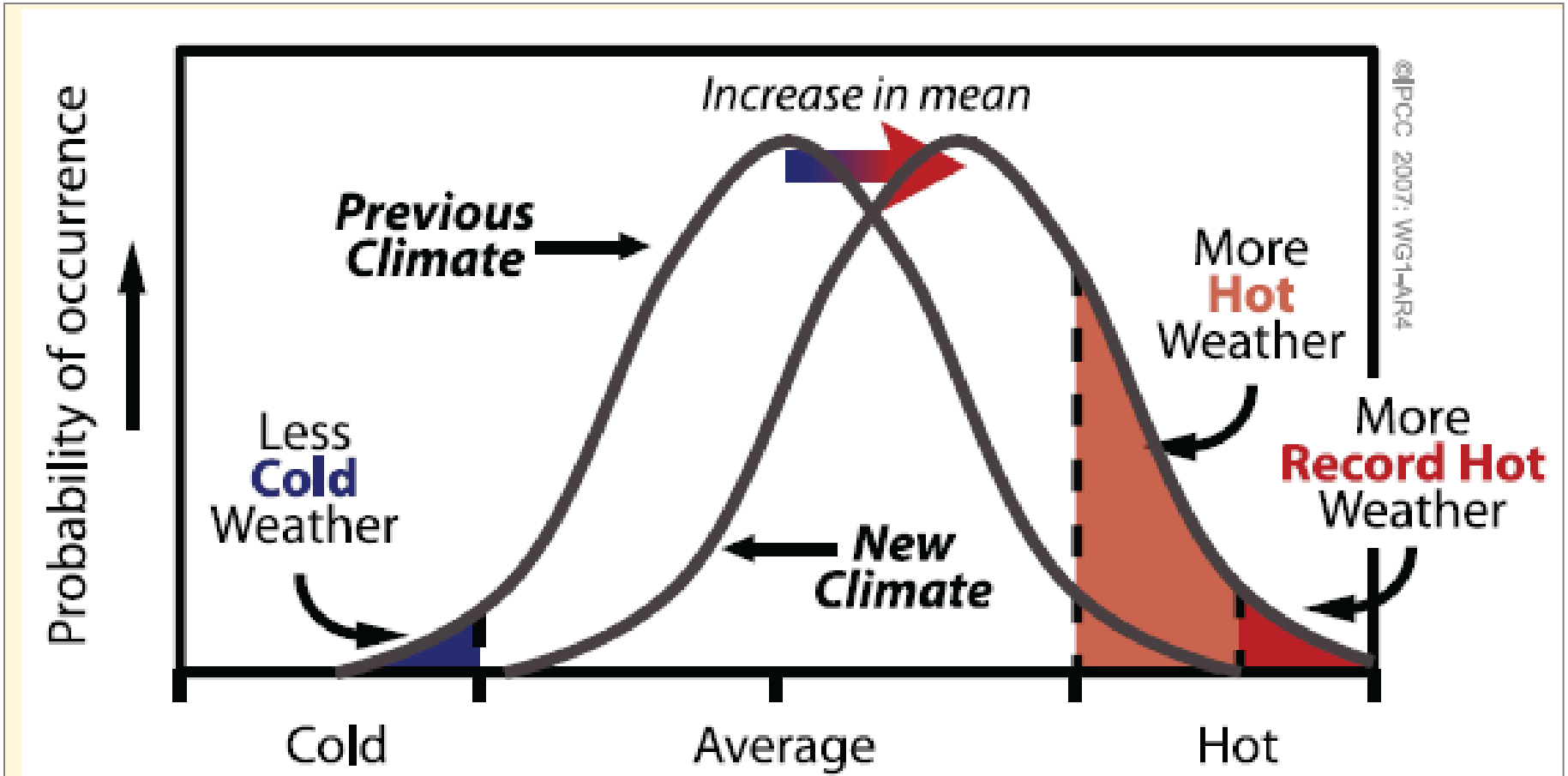


Climate Wizard (caveats & suggestions)

- Different GCMs often disagree in their projections of future climate
  - Use ensembles to identify where models agree, and disagree
- Spatial resolution of downscaling techniques are still too coarse for many decisions
  - Consider many grid cells and regional patterns of change
- Understand how a selected time period and spatial scale influences the degree of climate change
  - Do climate trends relate to the spatial and temporal scales at which the processes of interest are operating?

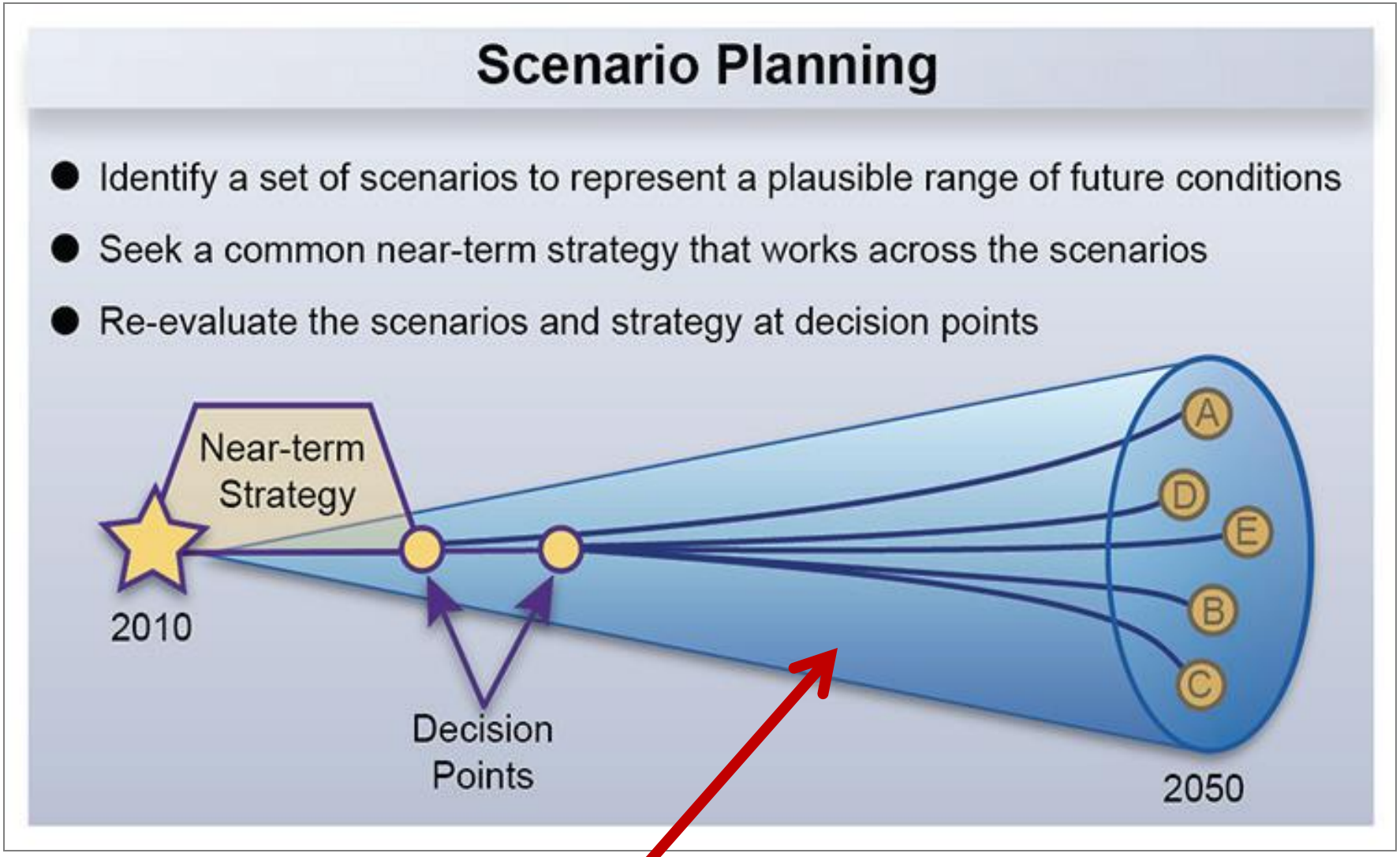

B1
A1B
A2
Minimum
20 %tile
40 %tile
Median
60 %tile
80 %tile
Maximum
-6
-4
-2
0
2
4
6
Projected Mean Temperature Change (C)
2070-2099 Compared to 1961-1990 Baseline


B1
A1B
A2
Minimum
20 %tile
40 %tile
Median
60 %tile
80 %tile
Maximum
-50
-25
0
25
50
Projected Annual Precipitation Change (%)
2070-2099 Compared to 1961-1990 Baseline

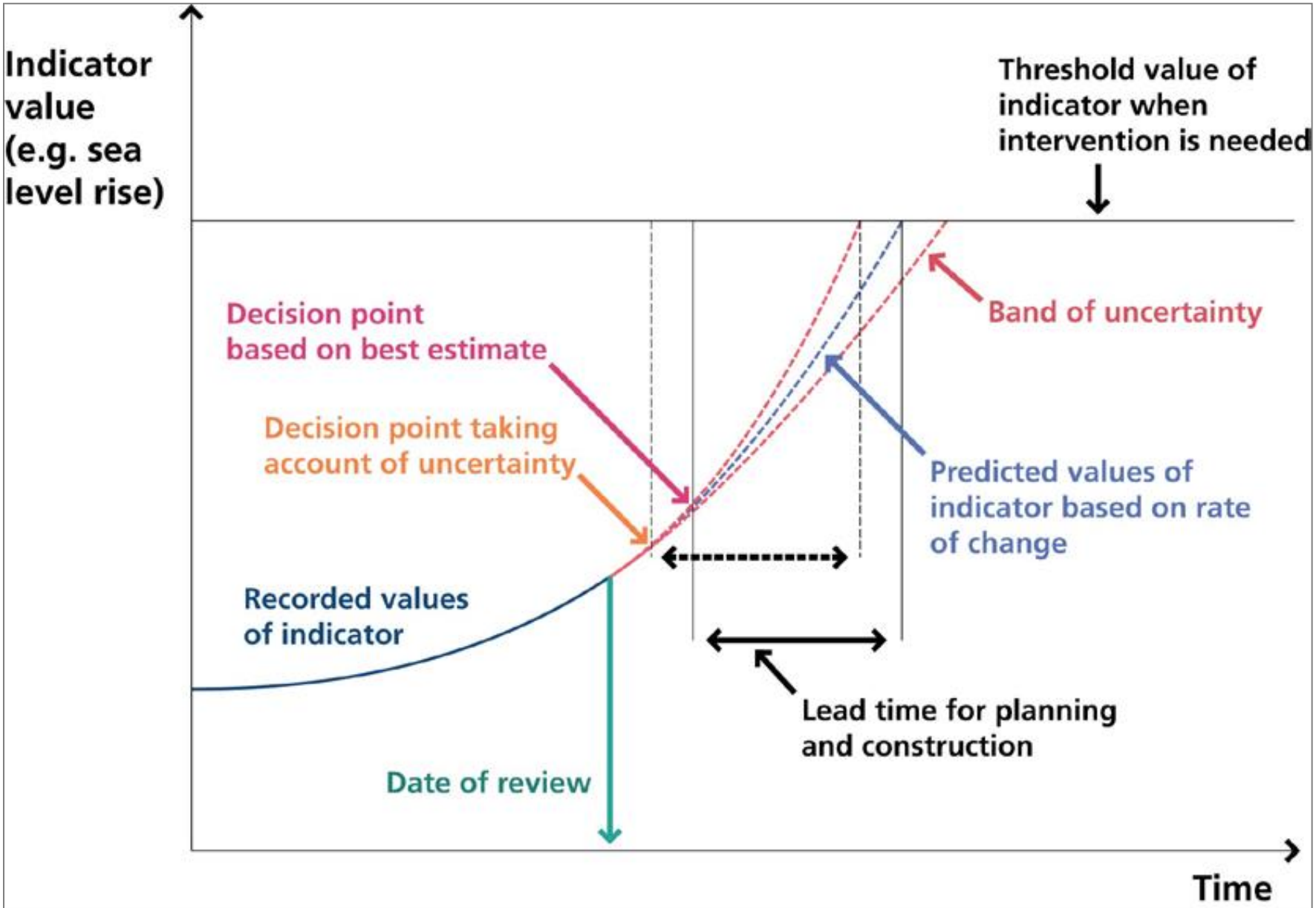


Box TS.5, Figure 1. *Schematic showing the effect on extreme temperatures when the mean temperature increases, for a normal temperature distribution.*

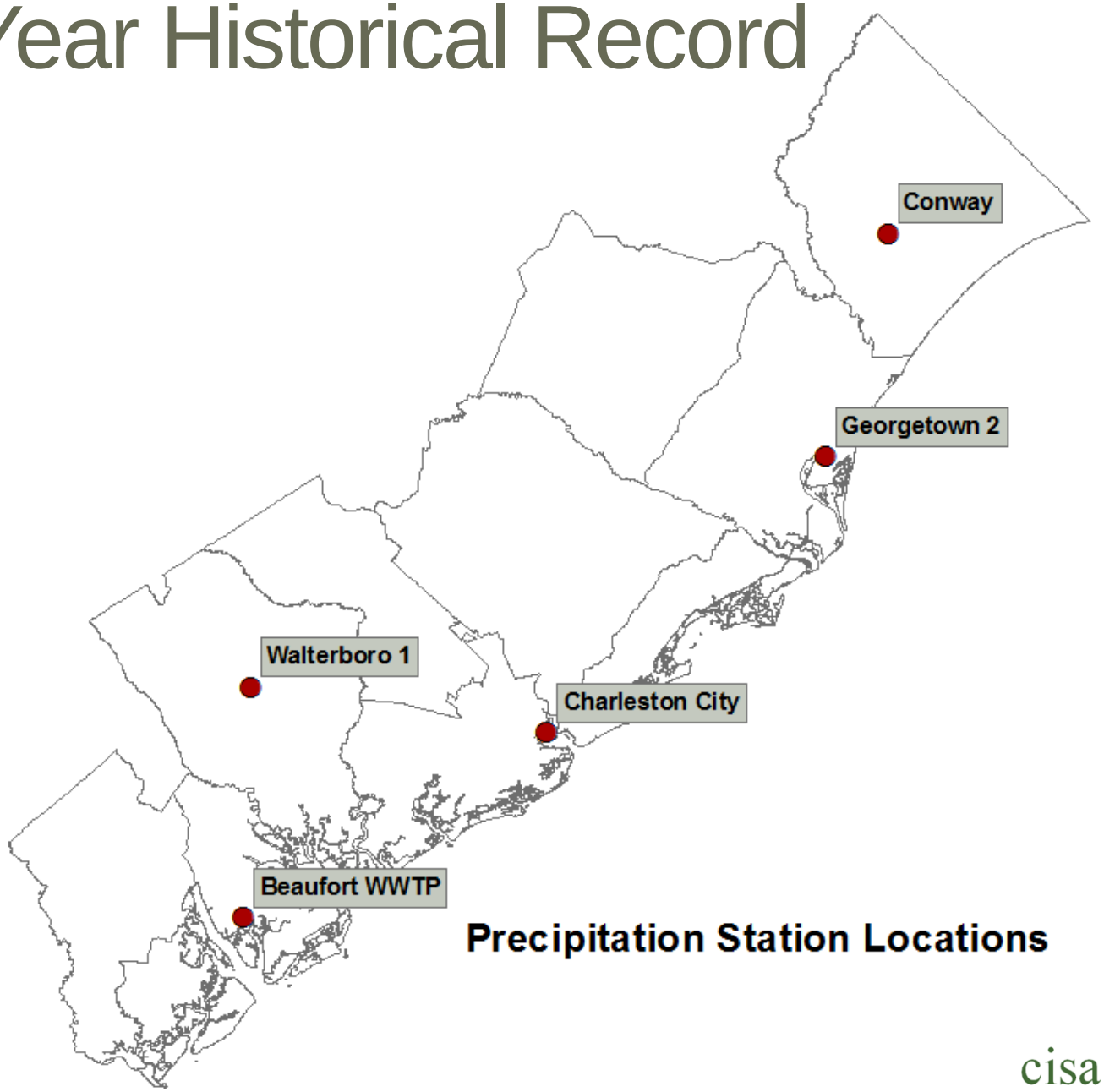
What can we do?



How to adapt in an uncertain world?

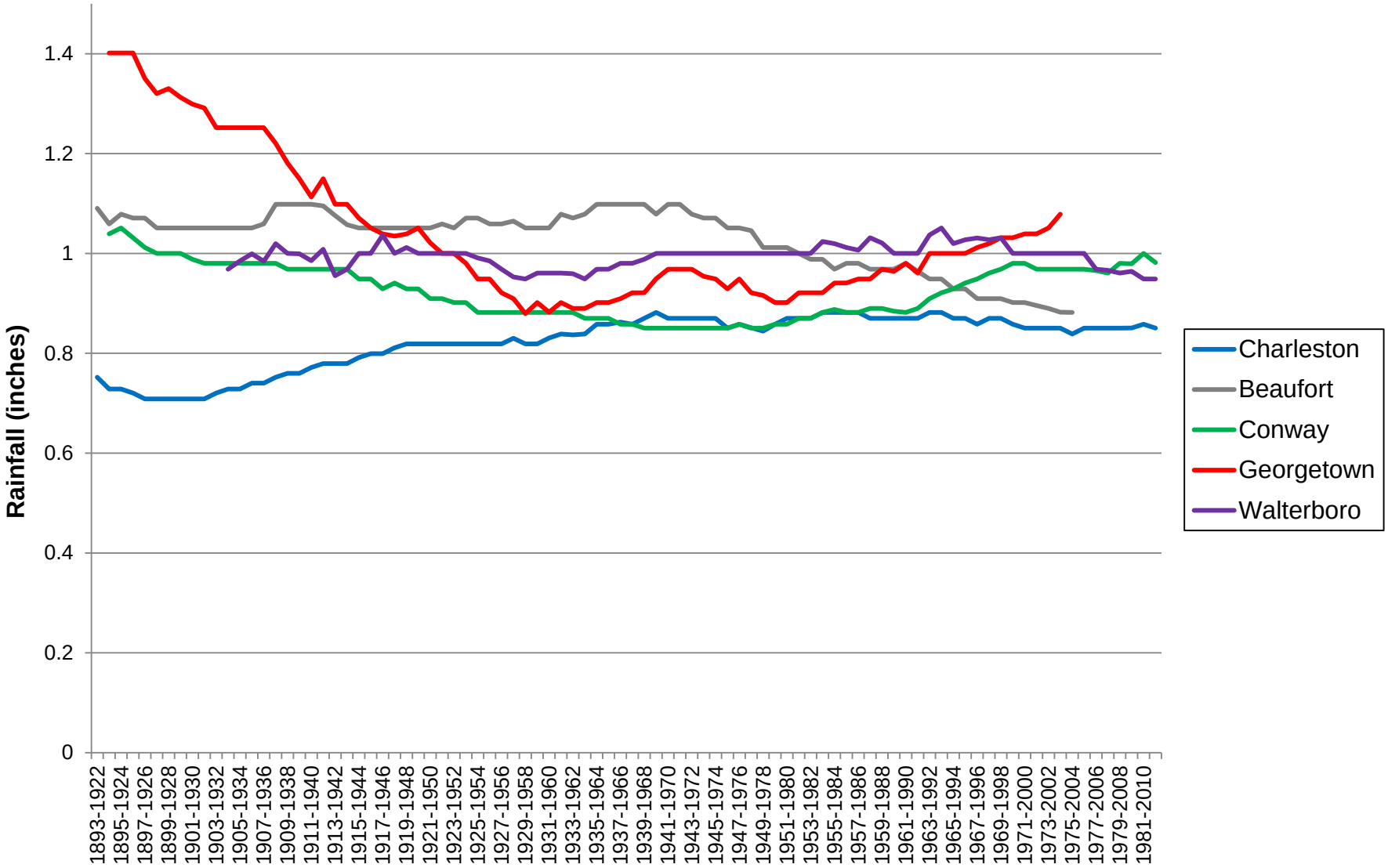


100+ Year Historical Record



Precipitation Station Locations

85th Percentile Rainfall (inches)



One final note…

April 28-29, 2014
Charlotte, NC
www.cisa.sc.edu/ccrc

An interactive conference geared towards networking and information exchange.

Conference topics will include:

- climate science, research and information
- climate communications
- sector-specific projects and activities

THANK YOU!

Questions or Comments?

Amanda Brennan ~ abrennan@sc.edu
Kirsten Lackstrom ~ lackstro@mailbox.sc.edu
www.cisa.sc.edu

References

- IPCC, 2013. Working Group I Contribution To The IPCC Fifth Assessment Report (AR5), Climate Change 2013: The Physical Science Basis. Draft Report
- IPCC, 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.
- Knutson, T. et al. 2010. Tropical cyclones and Climate Change. Nature Geoscience. 3:157-163
- Swanson, K. 2008. Nonlocality of Atlantic tropical cyclone intensities. Geochemistry Geophysics Geosystems. 9
- Vecchi, G., Knutson,T. 2008. On estimates of historical North Atlantic tropical cyclone activity. Journal of Climate. 21:3580-3600
- Vecchi, G., Swanson, K.,Soden, B. 2008. Whither hurricane activity. Science. 322:687-689
- Villarini, G. and Vecchi, G. 2012. Projected increases in North Atlantic tropical cyclone intensity from CMIP5 Models.