Climate Means, Trends And Extremes In The Everglades: Historical Data And Future Projections

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Everglades' Climate

How does it vary and how might it change?

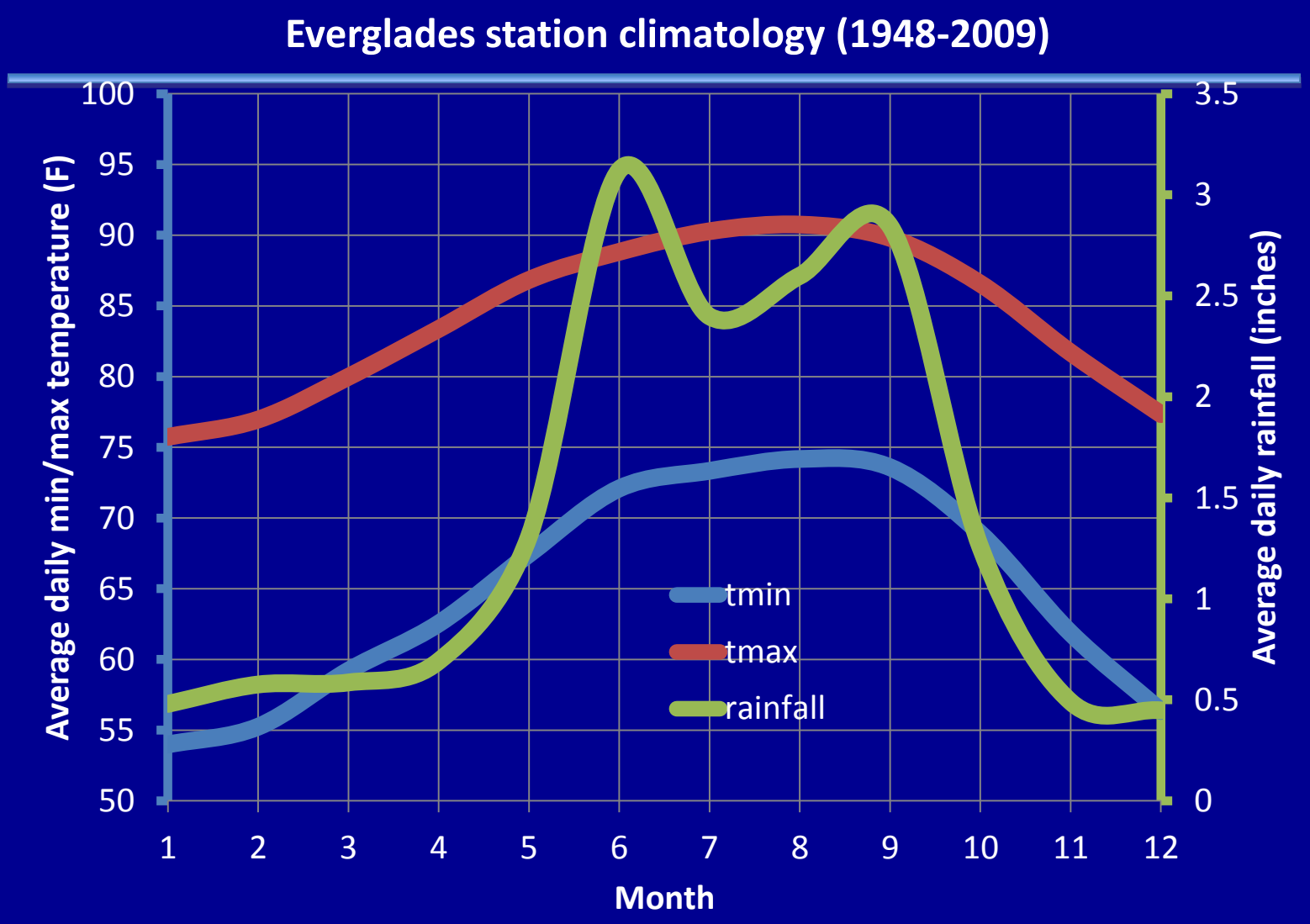
Part 1: Climate variations in recent history

Part 2: Climate Projections and downscaling: A brief overview

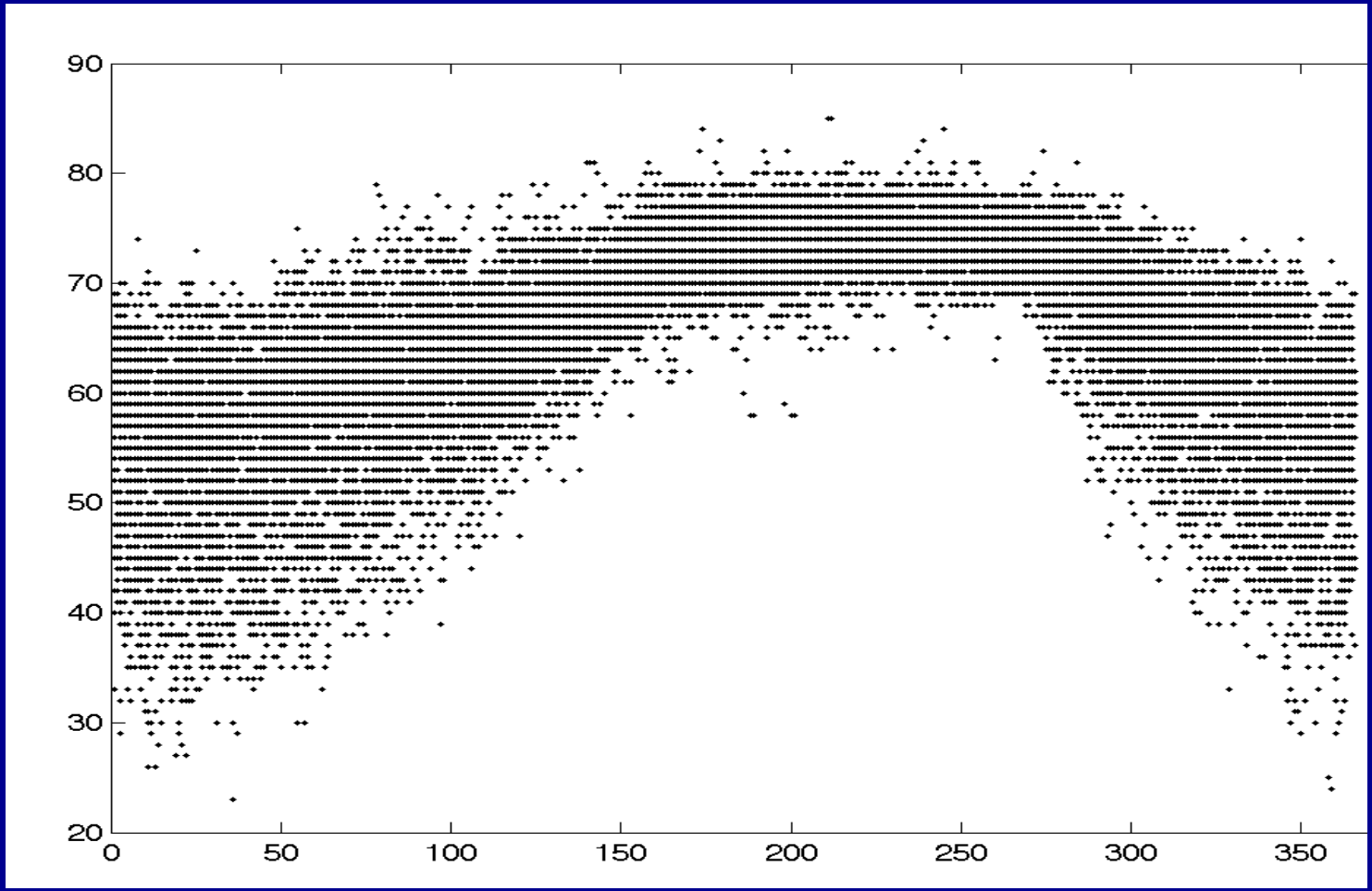
Part 3: "La Florida" climate downscaling: Interpreting the model projections

Part 1
Historical Climate Variability

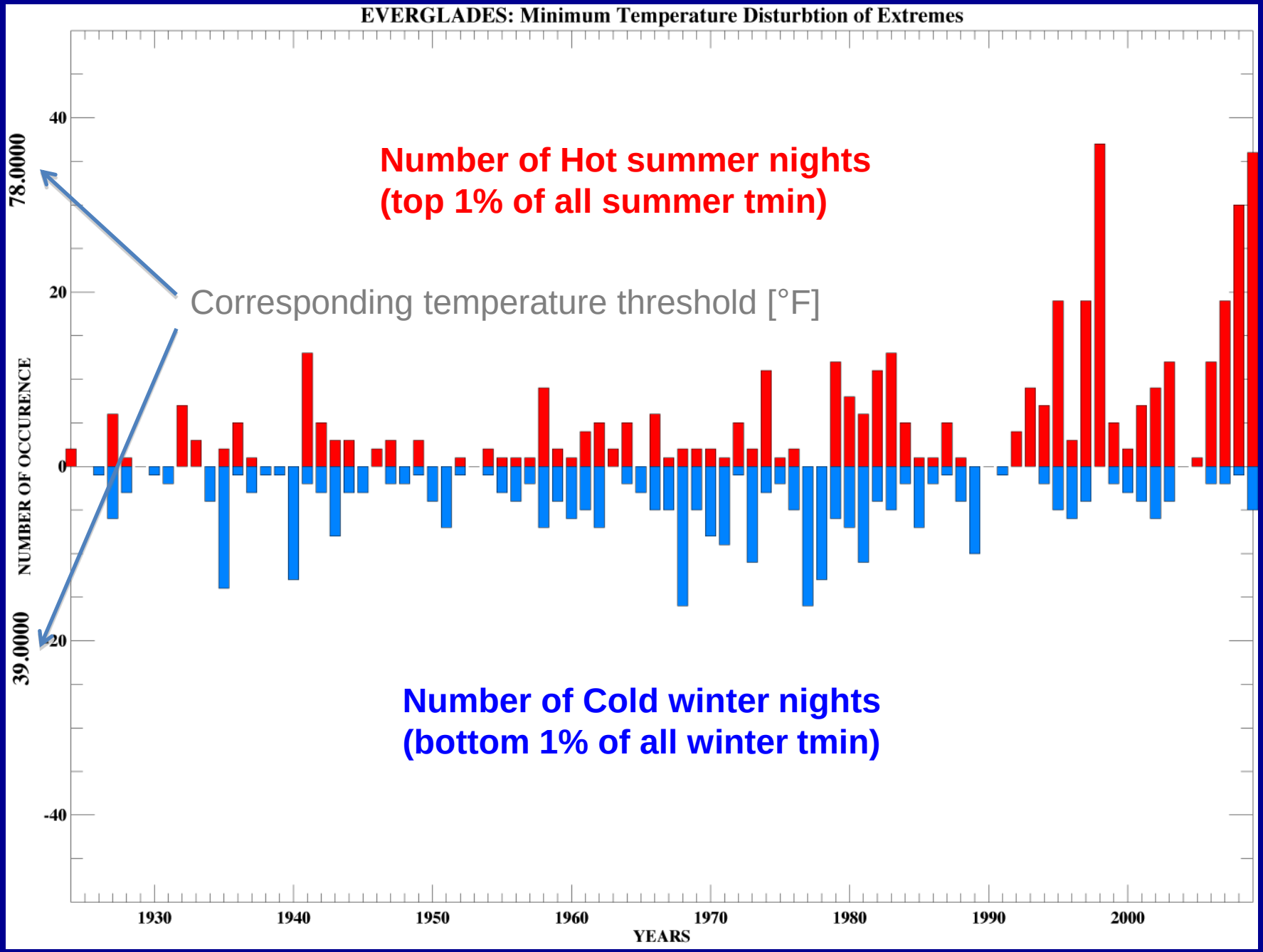

Mapping Everglades Ecosystems
color key
Marine and Estuarine (all blue tones)
Mangrove
Cypress
Coastal Prairie
Fresh Water Slough
Pinelands
Fresh Water Marl Prairie
Hardwood Hammocks
Everglades City
Flamingo
Tavernier
BIG CYPRESS NATIONAL PRESERVE
EVERGLADES NATIONAL PARK
GULF OF MEXICO
ATLANTIC OCEAN
FLORIDA BAY
Message to Boaters
South Florida National Parks
Wilderness Waterway
Main Visitor Center to Areas in the Park
Royal Palm Visitor Center 4mi/6km
Long Pine Key 6mi/10km
Pinelands 7mi/11km
Pa-Hay-Okee Overlook 13mi/21km
Mahogany Hammock 20mi/32km
Paurotis Pond 24mi/39km
Nine Mile Pond 37mi/43km
West Lake 31mi/50km
Flamingo Visitor Center 38mi/61km
Key Largo Ranger Station 38mi/61km
Shark Valley 50mi/80km
Gulf Coast Visitor Center 92mi/148km
Main Visitor Center to Other Areas
Homestead 11mi/18km
Miami International Airport 45mi/72km
Key West 135mi/217km
Water Depths
0–3 feet (0–1 meter)
3–6 feet (1–2 meters)
More than 6 feet (more than 2 meters)
Hiking trail
Canal
Wilderness waterway and canoe trail
Buoy
Canal gates
Crocodile sanctuary (restrictions apply)
Picnic area
Interpretive trail
Campground
Primitive campsite
Private Campground
Marina
Swimming
Boat ramp
Lodging and meals
Gasoline
North
0 1 5 10 Kilometers
0 1 5 10 Miles

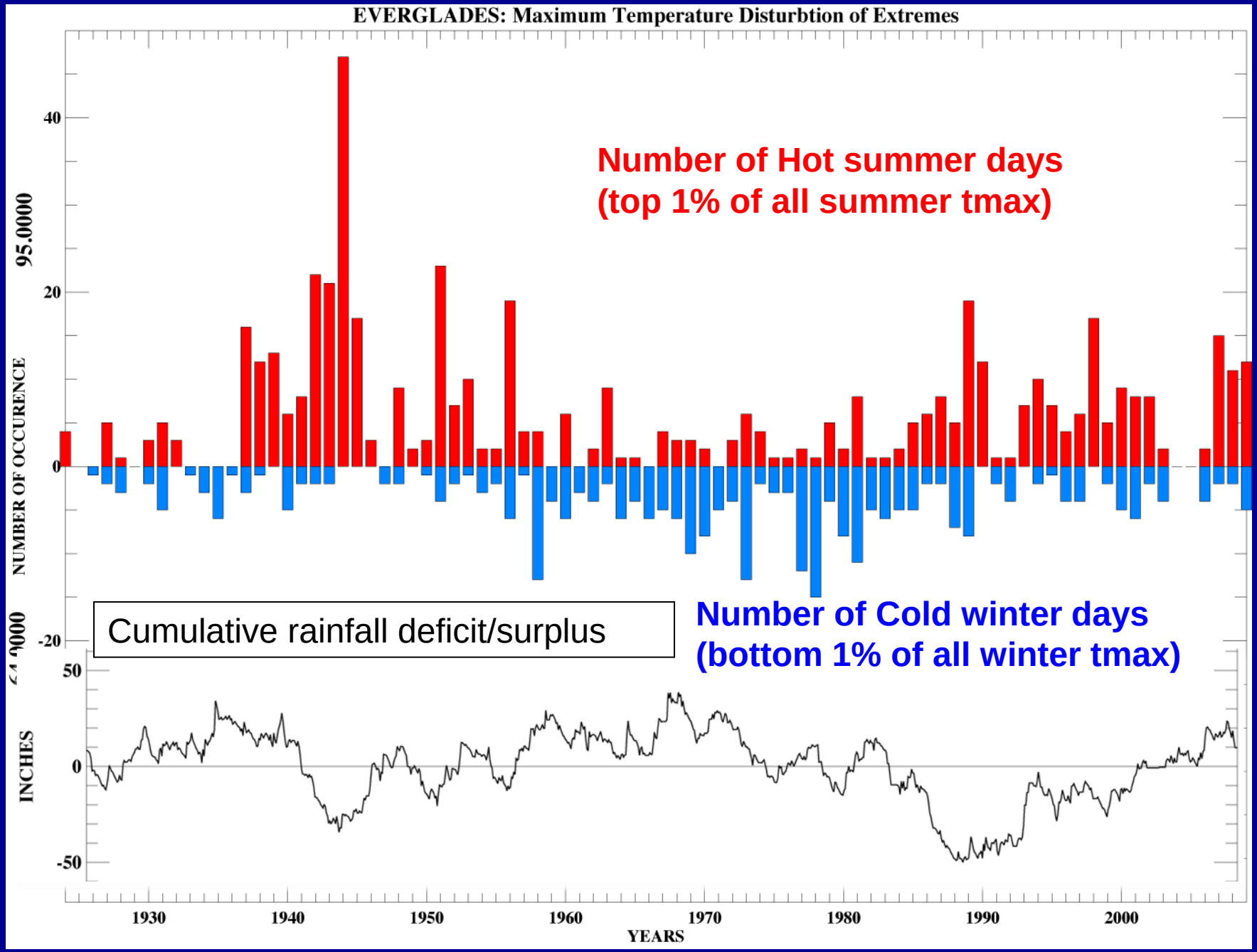

Everglades station climatology (1948-2009)
Average daily min/max temperature (F)
100
95
90
85
80
75
70
65
60
55
50
Average daily rainfall (inches)
3.5
3
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
tmin
tmax
rainfall

Seasonality of temperature variability



Tmin as a function of calendar day at Everglades station – all years from 1948-2009, in deg. F; note winter variability


EVERGLADES: Minimum Temperature Disturbtion of Extremes
Number of Hot summer nights
(top 1% of all summer tmin)
Corresponding temperature threshold [°F]
78.0000
39.0000
NUMBER OF OCCURENCE
40
20
0
-20
-40
1930
1940
1950
1960
1970
1980
1990
2000
YEARS
Number of Cold winter nights
(bottom 1% of all winter tmin)


EVERGLADES: Maximum Temperature Disturbtion of Extremes
95.0000
NUMBER OF OCCURENCE
40
20
0
-20
Number of Hot summer days
(top 1% of all summer tmax)
Number of Cold winter days
(bottom 1% of all winter tmax)
Cumulative rainfall deficit/surplus
INCHES
50
0
-50
1930
1940
1950
1960
1970
1980
1990
2000
YEARS

Part 2
Climate Projections and Downscaling: brief background

Climate Scenarios for the Future

Analog scenarios

- Draw from historical record of observations e.g. during warm regimes
- Computationally cheap, fully consistent, realistic
- Limited historical records, assuming qualitatively similar future

Modeling projections

- Socio-economic & emission scenarios → physics-based numerical models
- Computationally expensive, limited by model deficiencies
- Multiple realizations, can analyze physical processes, can address "what if"

Downscaling Climate: How?

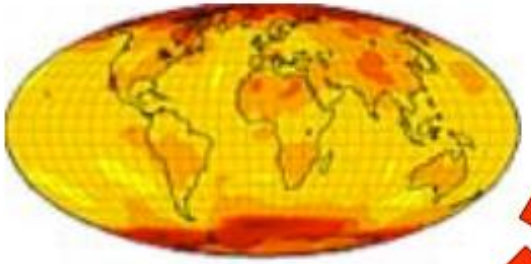
Statistical downscaling

- Develop statistical relationship between large and small scales using model and observed histories; apply to future.
- Computationally cheap → can have many realizations
- Not necessarily physically consistent, limited variables, assumption of stationary statistics, limited by statistical model deficiencies

"Dynamical" downsclaing

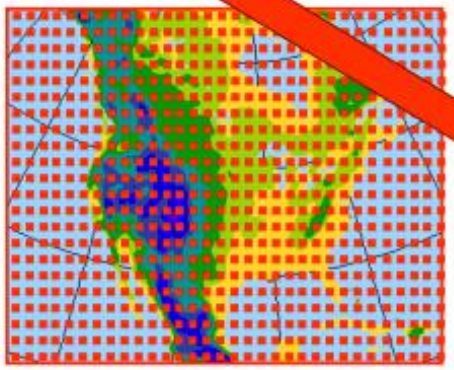
- Run regional physical-based models forced by the large-scale model projections for the future
- Computationally expensive → limited realizations; limited by global and regional model deficiencies
- Physically consistent, many variables, no assumption of stationary statistics, can trace processes

Dynamical Downscaling

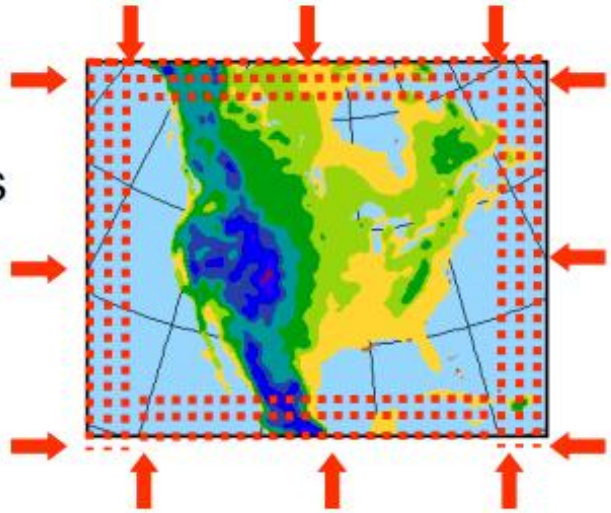


Run the global model, storing output several times per day.

Interpolate global model results to initialize the regional model grid.



Continually update the regional model around its lateral boundaries using later results from the global model.



Part 3
The “La Florida” Downscaled Projections

La Florida Downscaling Project

- 20 century: 1979-2000 for reanalyses (R2 and ERA-40), 1969-2000 for models (CCSM, GFDL, HadCM3)
- 21 century: A2 scenario 2039-2070 (as in NARCCAP)
- Blue (reanalyses) and Green (climate scenarios): completed
- Yellow: underway

	20 century			21 century (A2)		
	Historic veg	Current veg	Future veg	Historic veg	Current veg	Future veg
R2						
ERA-40						
CCSM						
GFDL						
HadCM3						

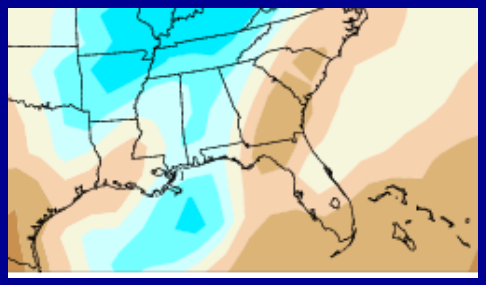
CLAREnCE10: COAPS Land-Atmosphere Regional Ensemble Climate Change Experiment, 10km resolution

Global models: NCAR CCSM, Hadley Centre HadCM3

Regional model: National Centers for Environmental (NCEP)/Experimental Climate Prediction Center (ECPC) Regional Spectral Model (RSM)

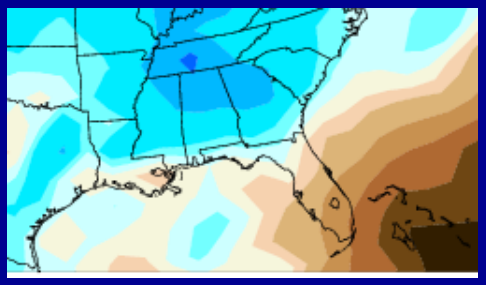
Scenario: Historical (1969-2000)
A2 (high emission scenario), (2039-2070)

Global model projections:

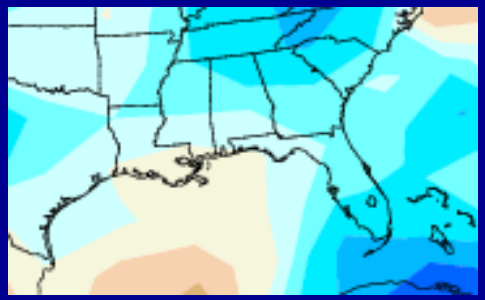


CCSM global model

← Winter Summer→

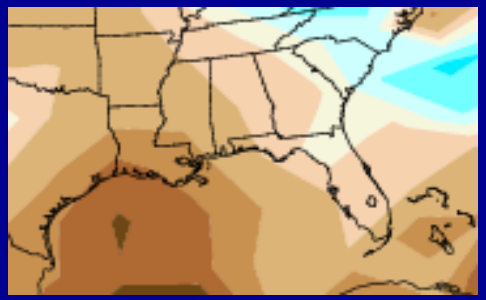


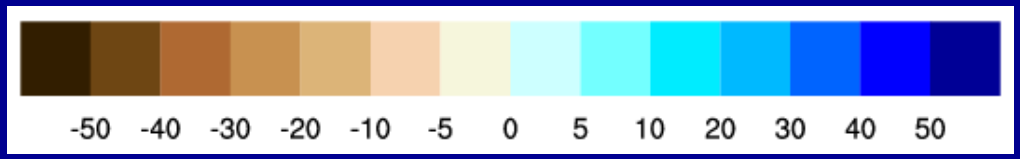
Seasonal mean precipitation in the global models: lack of agreement for the Southeast



HadCM3 global model

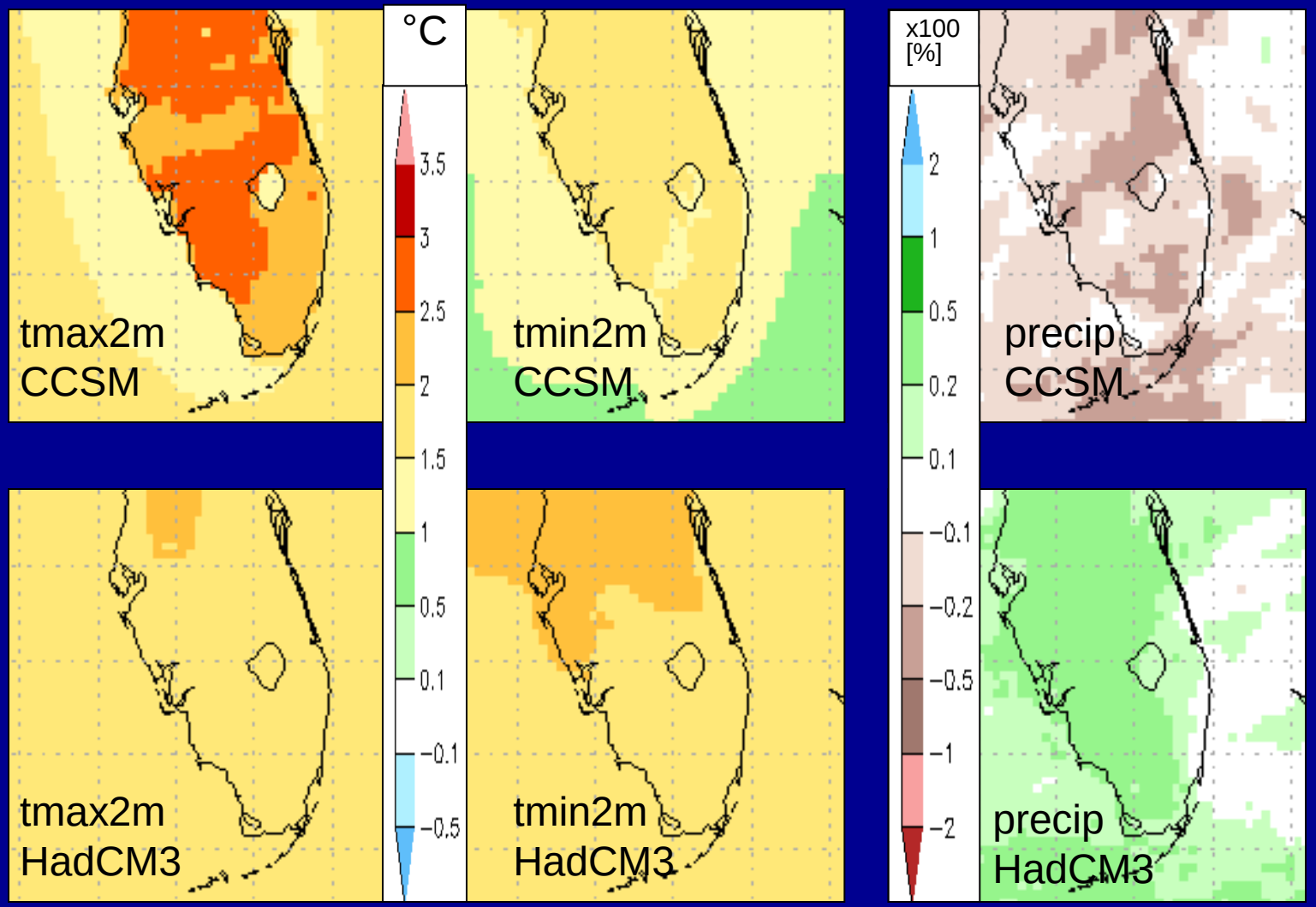
← Winter Summer→



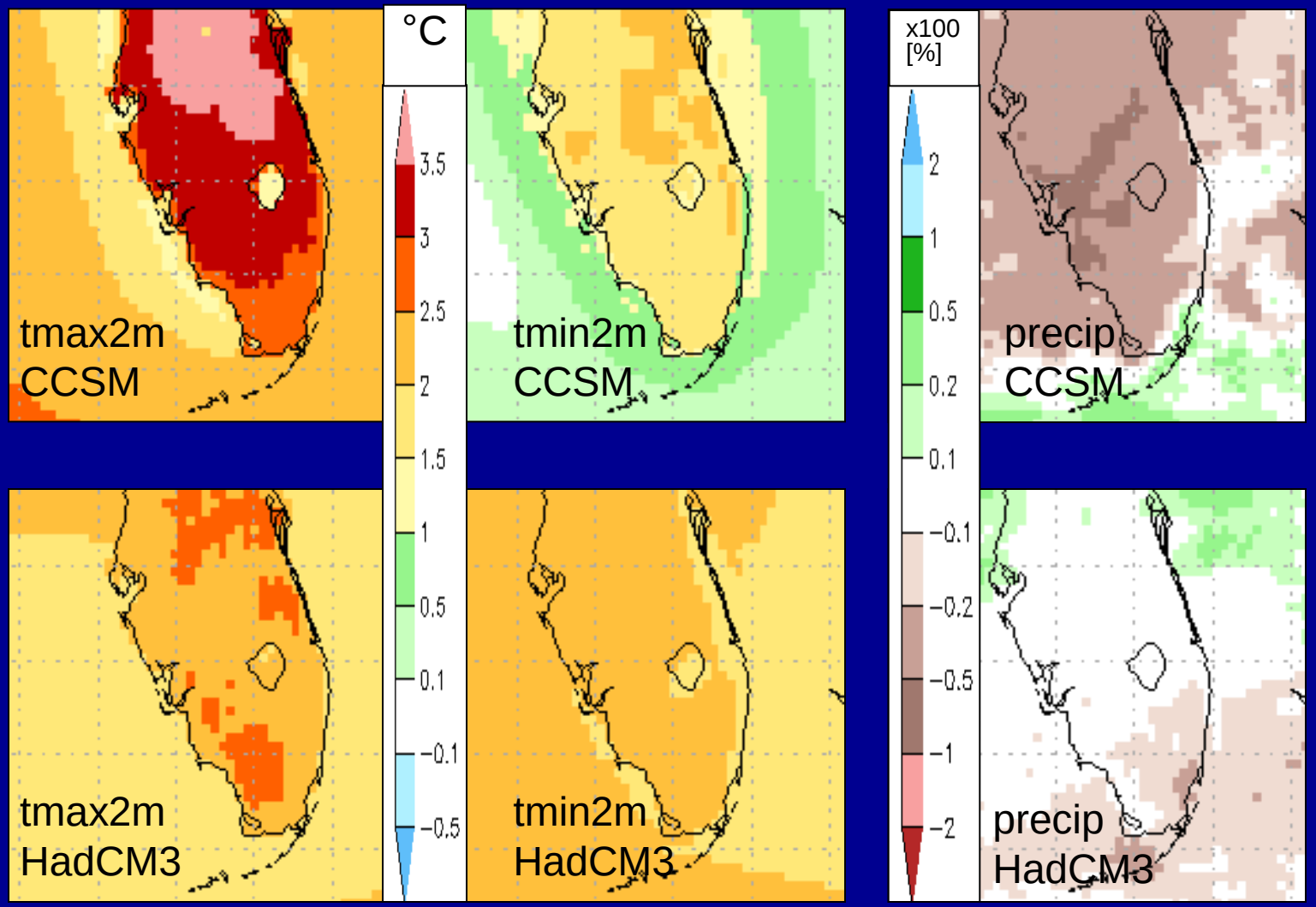


(CMIP3 models from NARCCAP website)

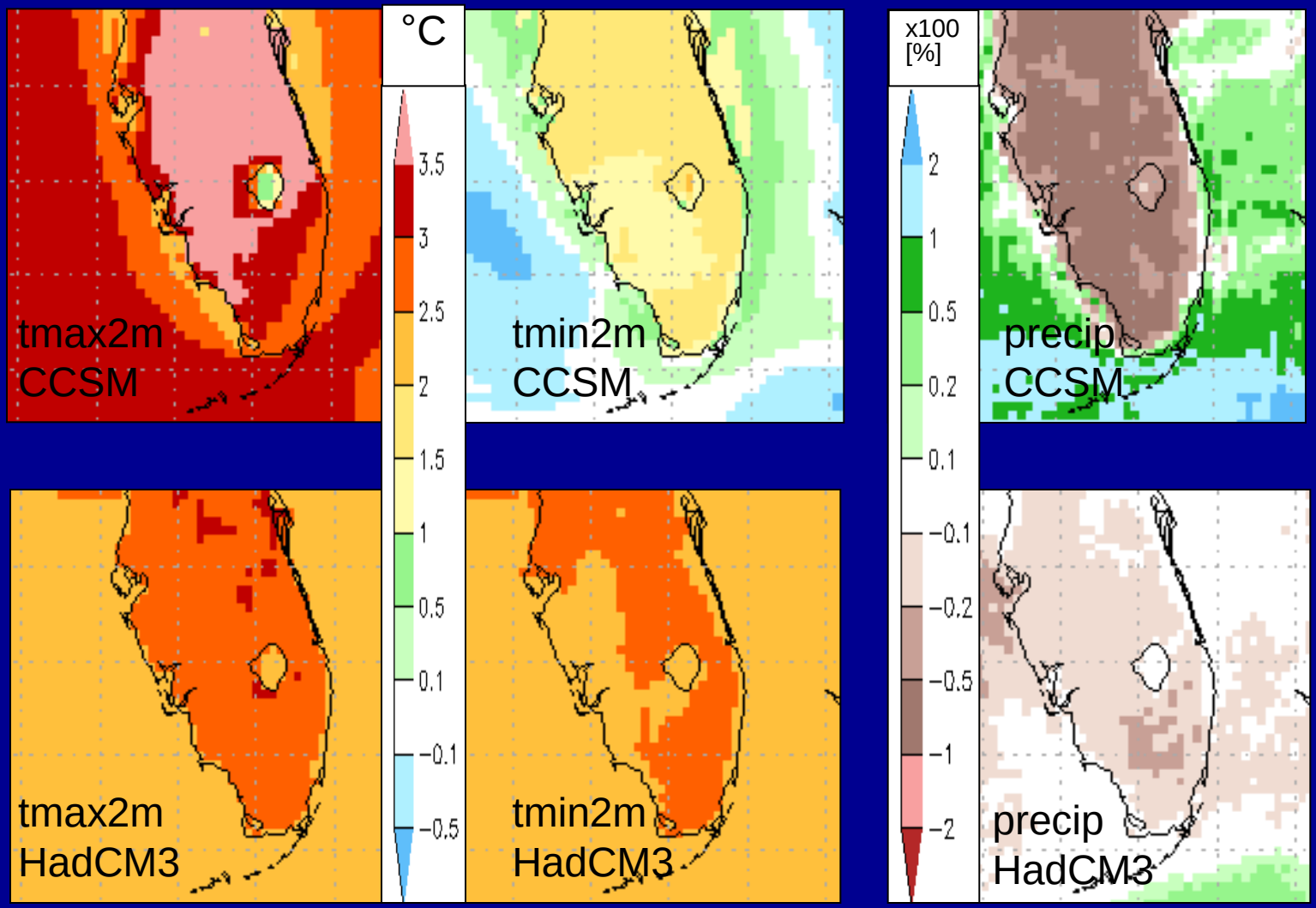
Downscaled winter (DJF) changes



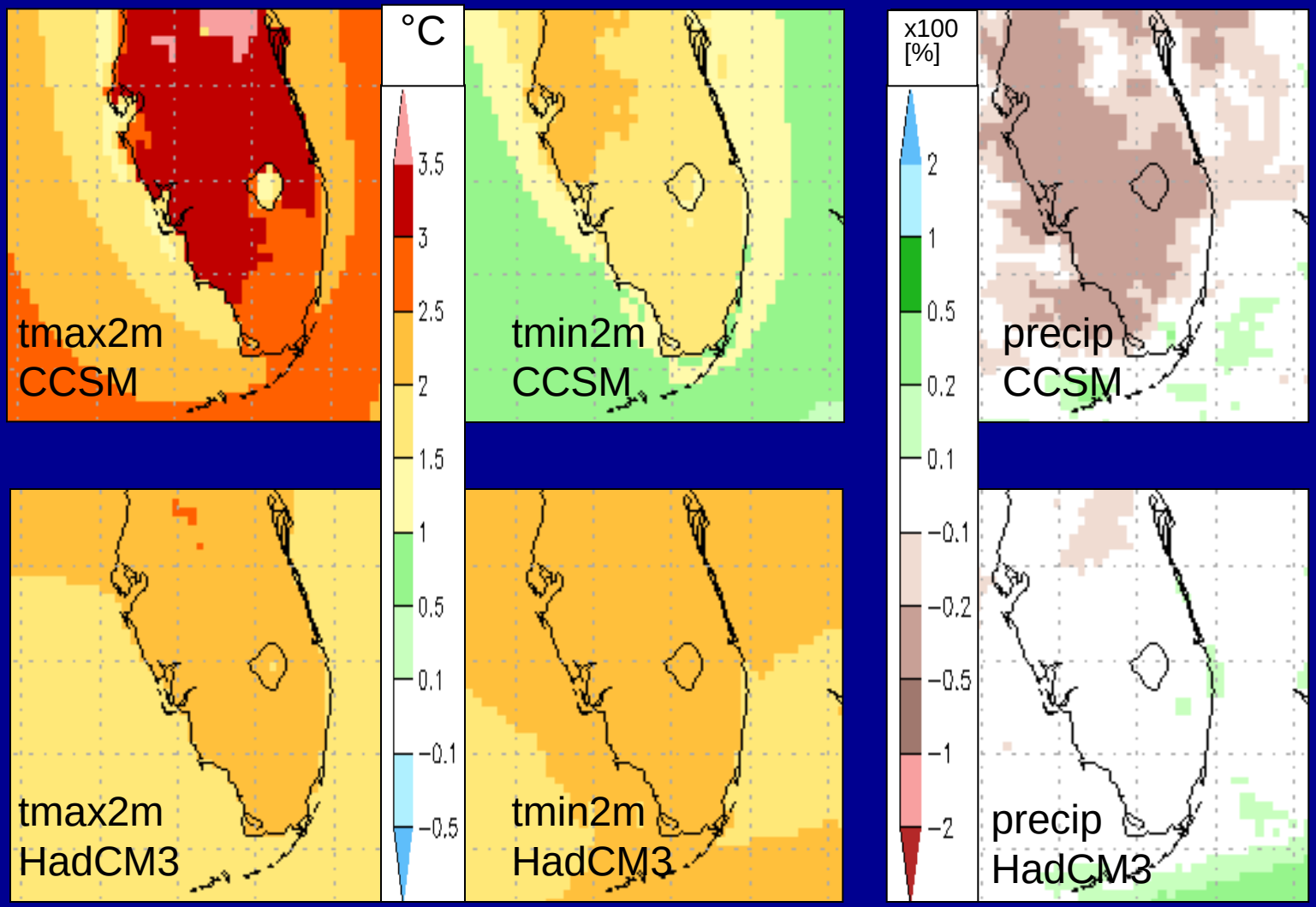
Downscaled spring (MAM) changes



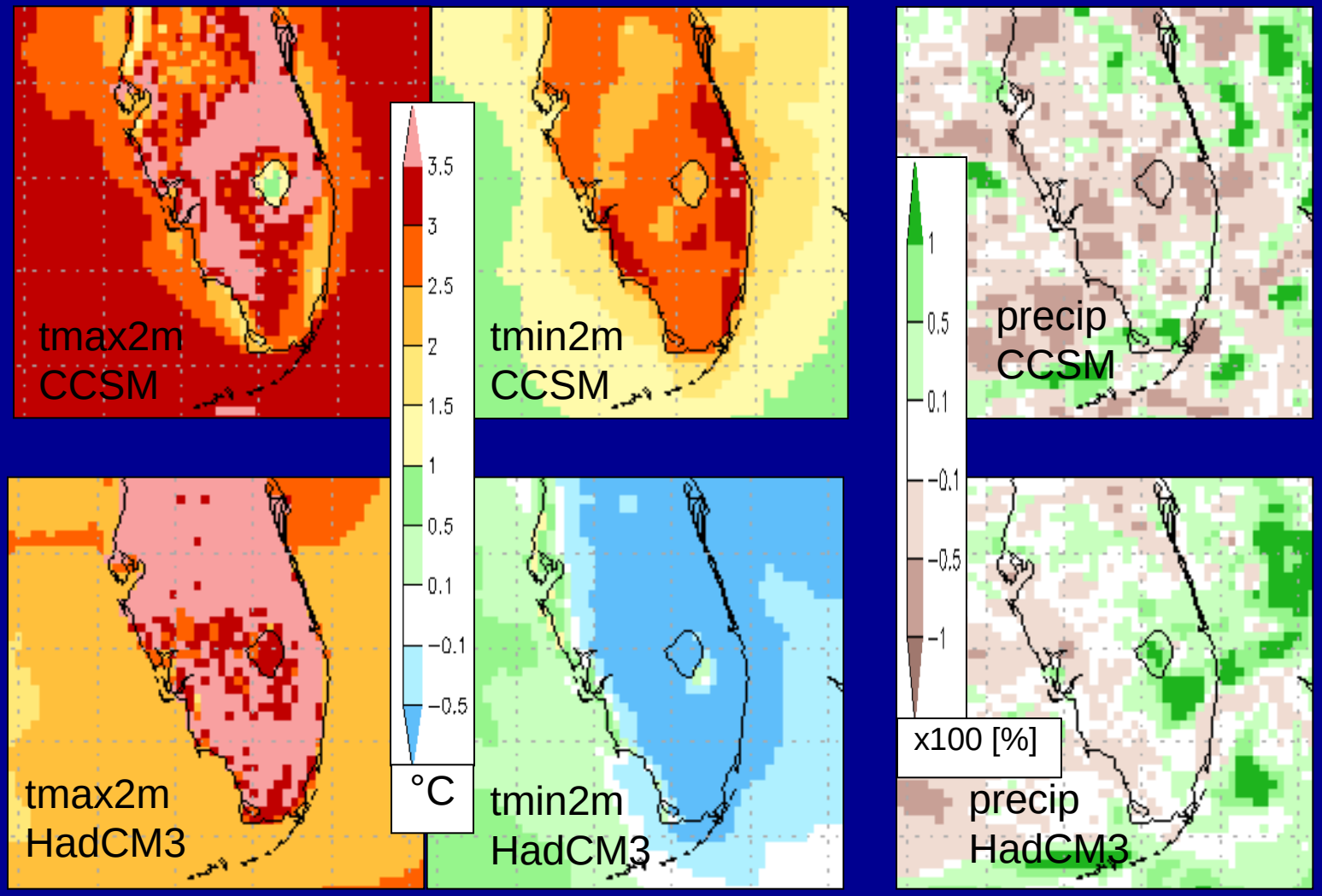
Downscaled summer (JJA) changes



Downscaled fall (SON) changes



Change in the record warmest/coldest/wettest monthly values



Regional Downscaling: Summary

In the downscaled CCSM and HadCM3 projections, the mid-to-late 21st century the Everglades under the A2 emissions scenario are ***warmer; summers are drier***.

- Downscaled CCSM projections: Monthly mean Tmax increased by ~3-3.5+^{o}C in summer, 2-3^{o}C in winter, ~3^{o}C the rest of the year; Tmin increases by 1.5-2.5^{o}C
- Downscaled HadCM3 projections: Monthly mean Tmax and Tmin increases are similar to each other, ~2.5^{o}C in summer, ~2^{o}C the rest of the year
- Precipitation is reduced in the downscaled HadCM3 projections, seasonally dependent sign of change in CCSM; In spring and summer, both models project drier Everglades

…continued

- The record warmest month in the future period is warmer than that in the historical period in both models.
- The record coldest month in the future period is not necessarily warmer than that in the historical period.
- A preliminary look at the data suggests that the above may be related to an increased variance around the mean in the future compared to the historical period.

What do these results imply for potential users:

1. Modeling uncertainties are large; downscaling is unlikely to reduce these uncertainties.
2. Both outcomes represent 'feasible' scenarios for the future, to the extent that the global models can be relied upon.
3. The two downscaled models exhibit consensus on the sign of the temperature changes and summer precipitation changes.
4. Rather than going with the average of available realizations, applications should explore the consequences of each available scenario; should more weight may be assigned to models that are better at simulating historical climate?

Thank You

Data from the La Florida regional downscaling available at

http://floridaclimateinstitute.org/resources/data-sets/regional-downscaling/

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