Using climate projections for local impact assessments

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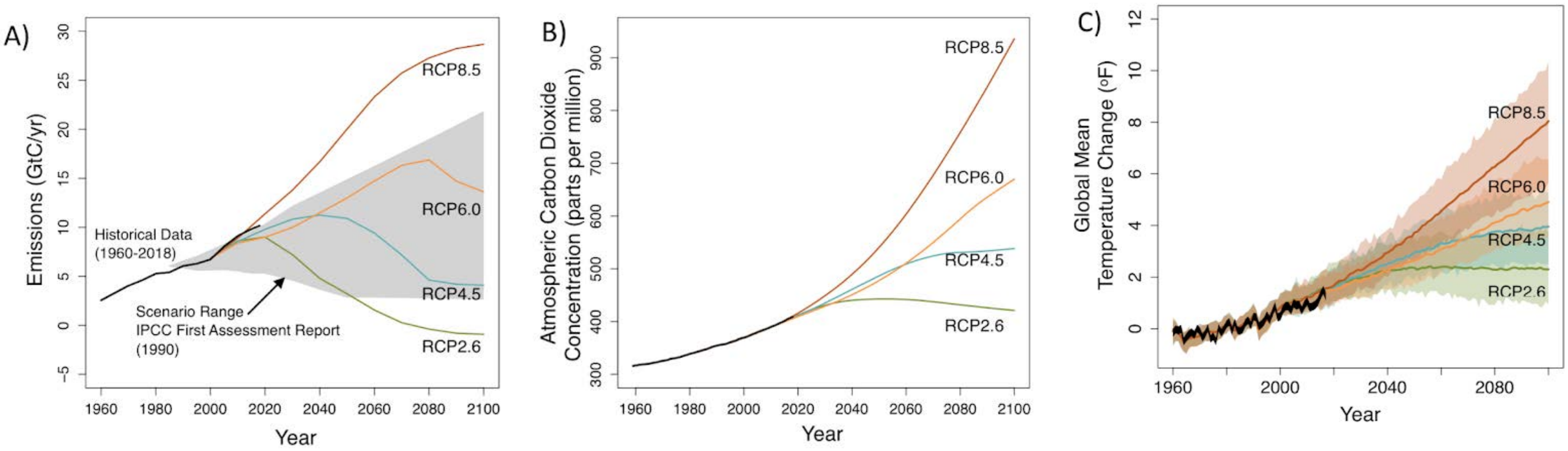
How do we use climate models to assess risk?

Climate scenarios (and climate models) can help to better characterize and manage risk



Greenhouse Gas Emissions (Scenarios) → Atmospheric Concentrations → Modeled Climate Response (Projections)

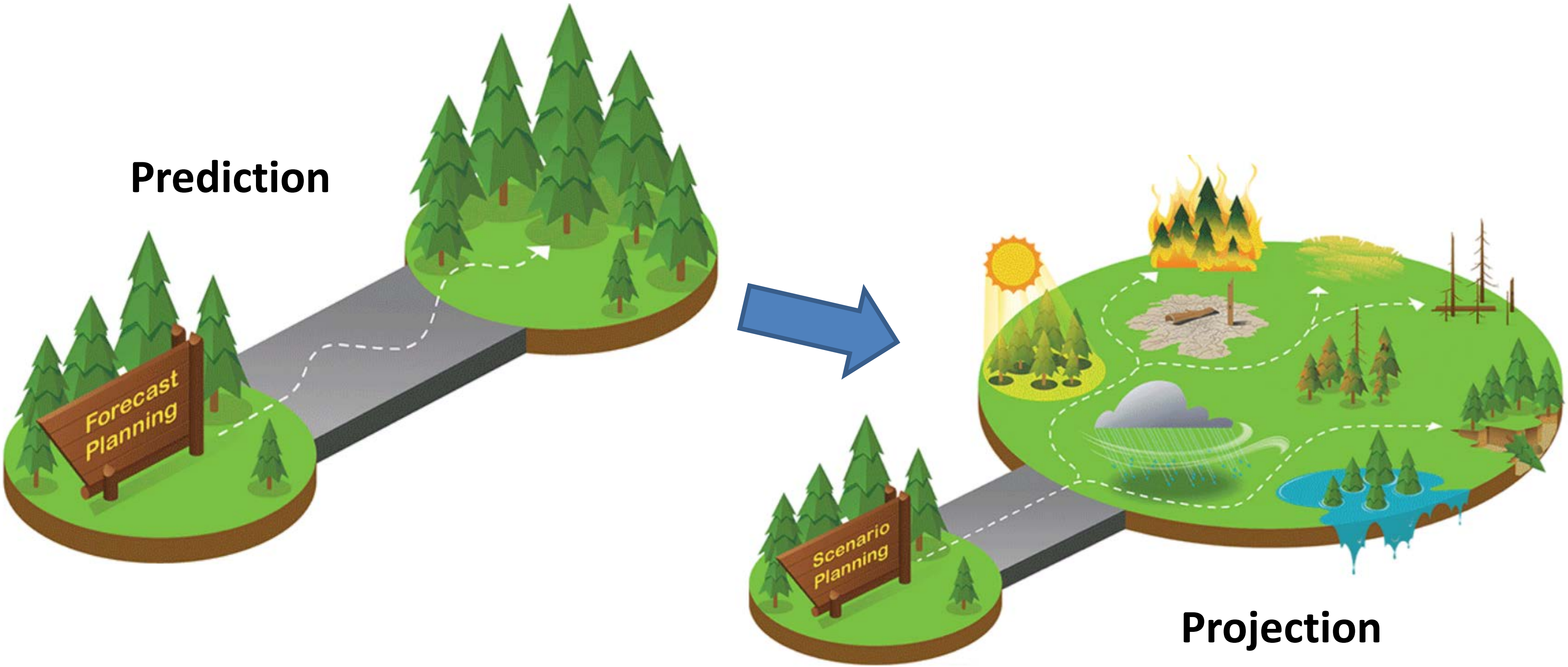
A few definitions…….

Scenario – A sequence of events that defines a plausible future (*What if* the future unfolded like this?)

Projection – A predicted outcome for a given scenario of the future (What do we *expect* to happen *if* the future unfolded in this way?)

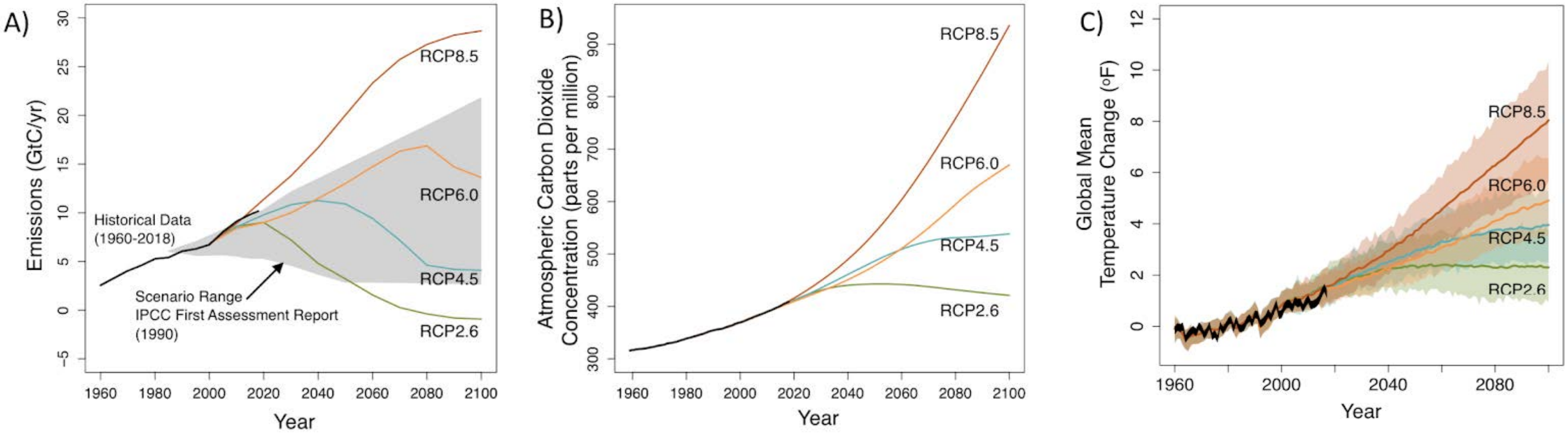
Prediction – A statement about the future expressed with some degree of certainty or likelihood (What do we *expect* the high temperature *will be* tomorrow?)

Scenario Planning



Credit: NPS Climate Change Response Program

Climate Scenarios



Greenhouse Gas Emissions (Scenarios) → Atmospheric Concentrations → Modeled Climate Response (Projections)

Data from:
CMIP5; DOE-LLNL, (2008)
Houghton et al. (1990)
Meinshausen et al. (2011)
Morice et al. (2012)
Hansen et al. (2013)
Cowtan and Way (2014)

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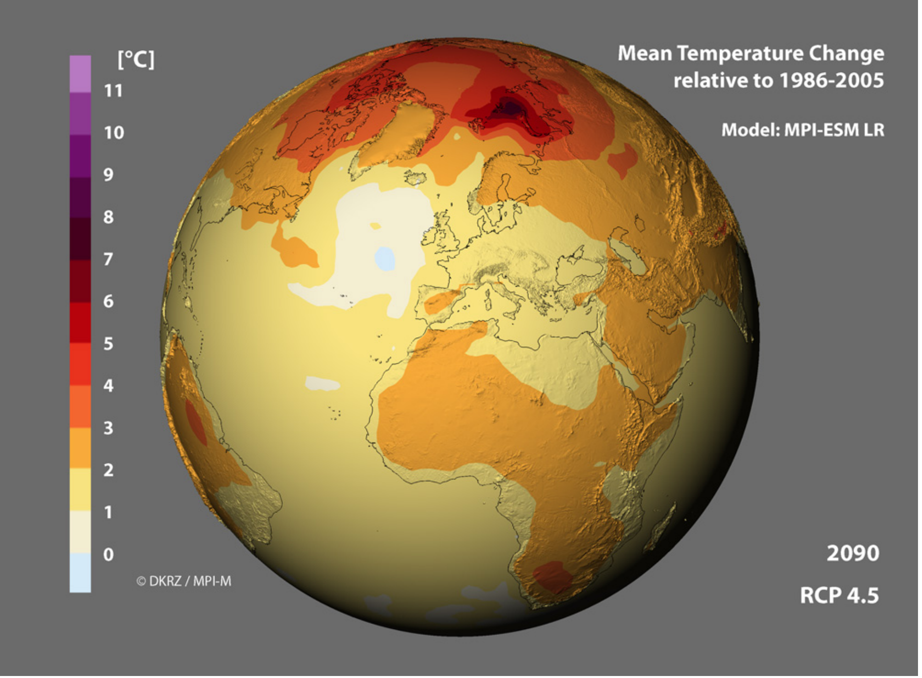

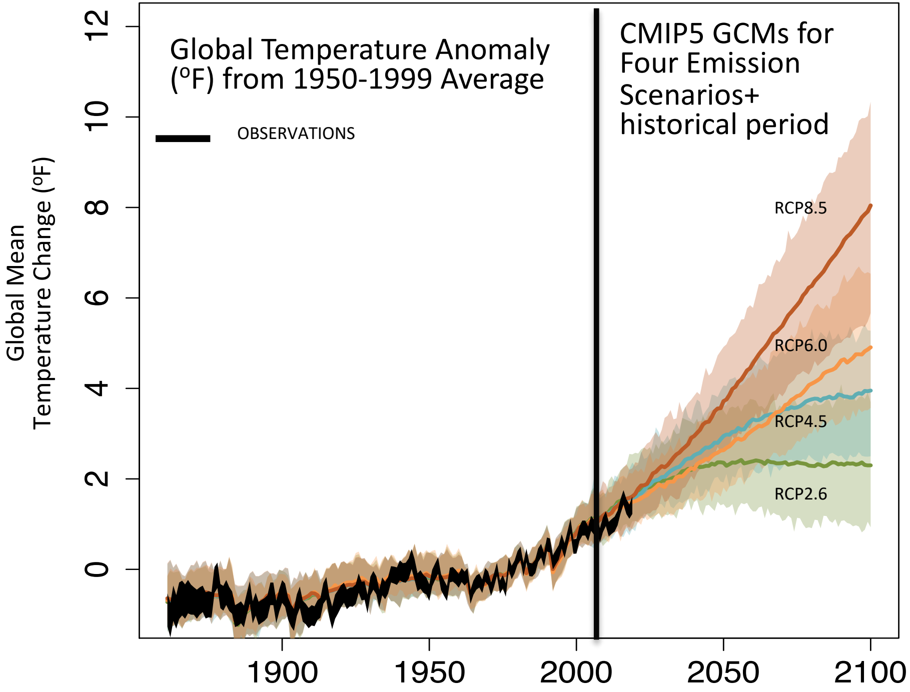

GCMs are used to *project* how the climate could respond to *perturbations* of the system as defined for different *scenarios*

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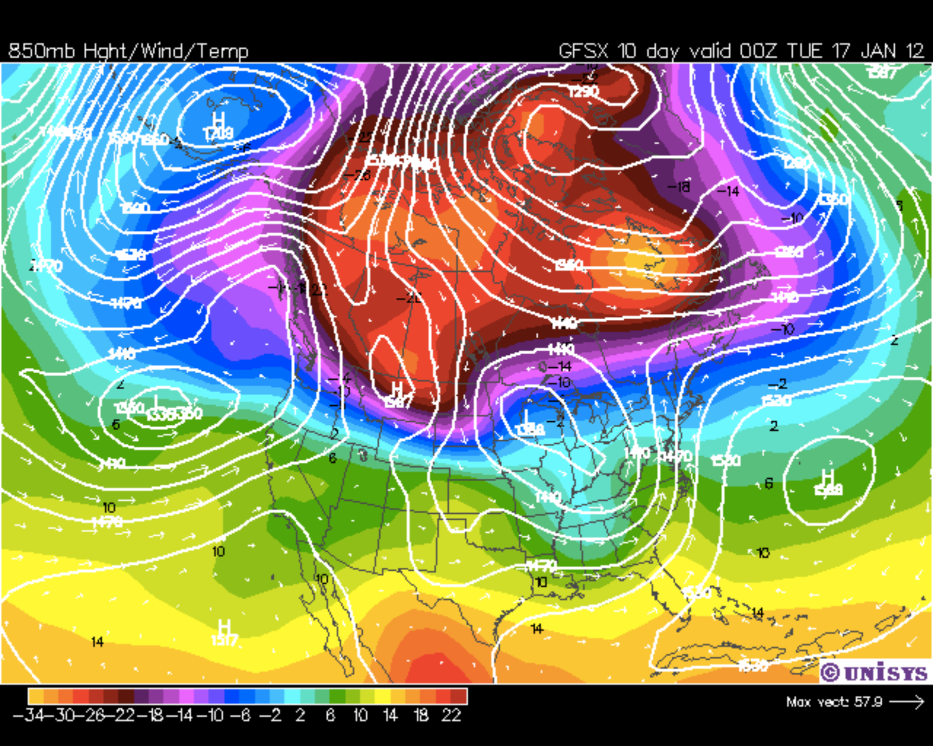

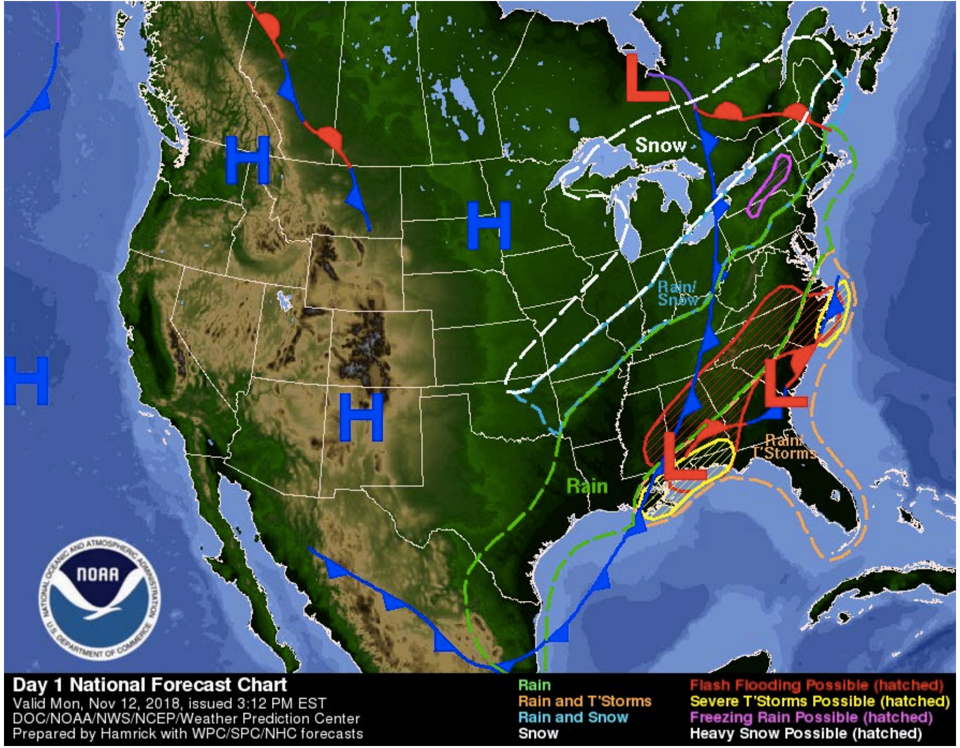

Important distinction from weather models where the goal is to predict the actual observed weather (i.e. the exact condition of the atmosphere) in the future

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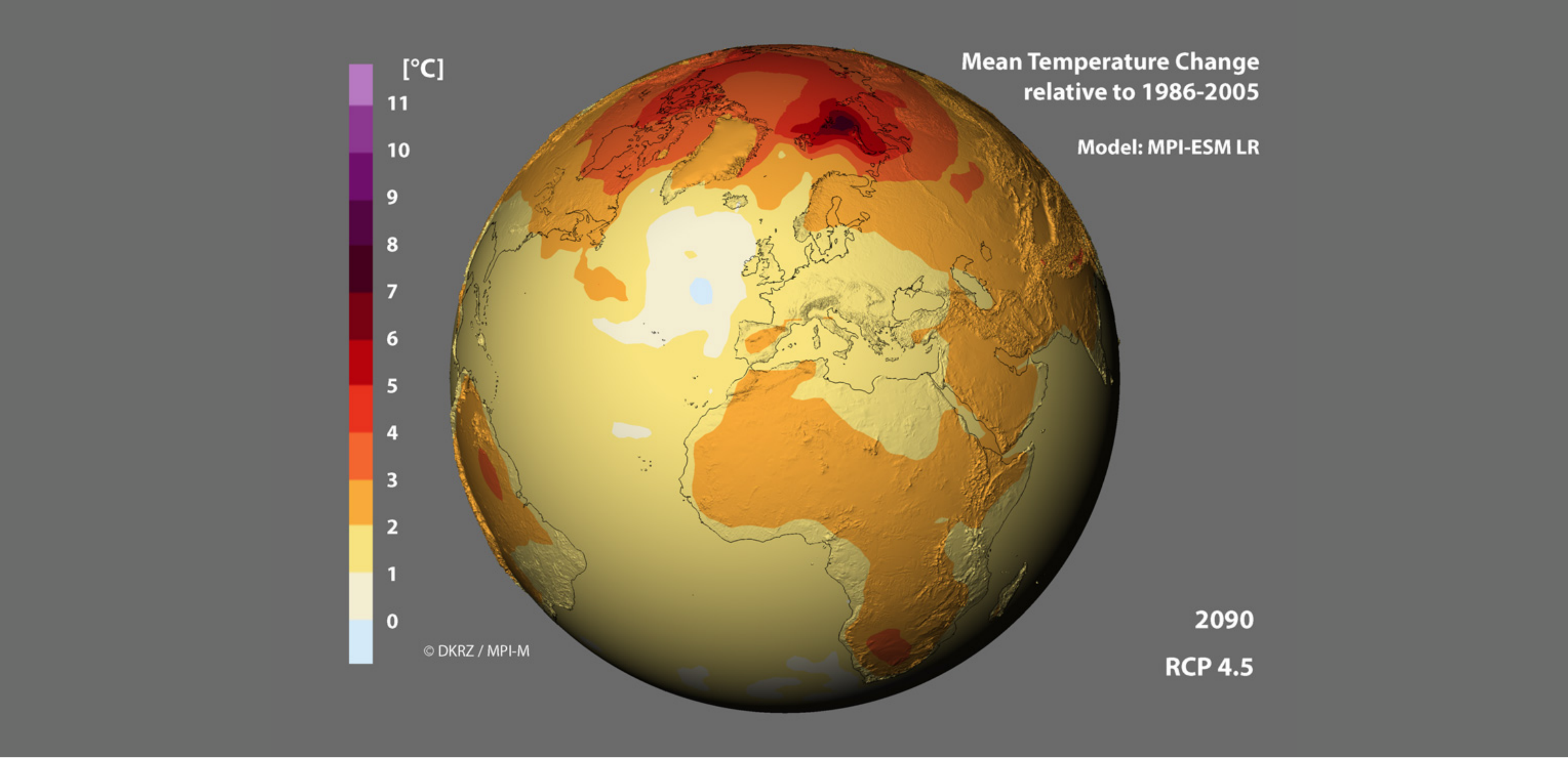
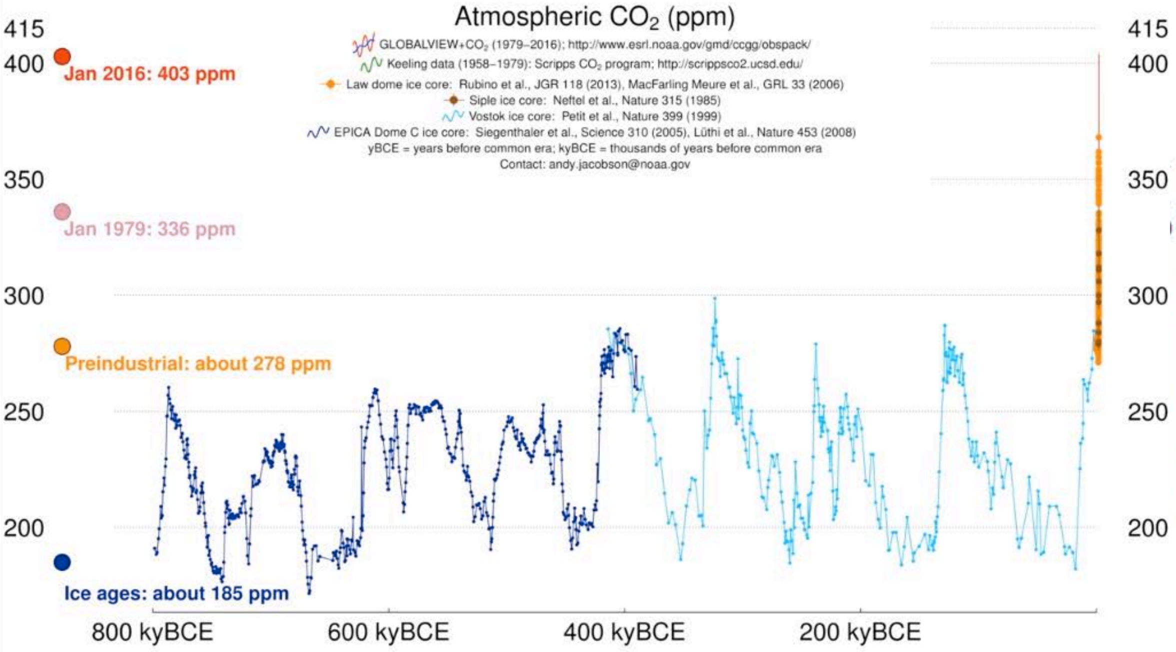
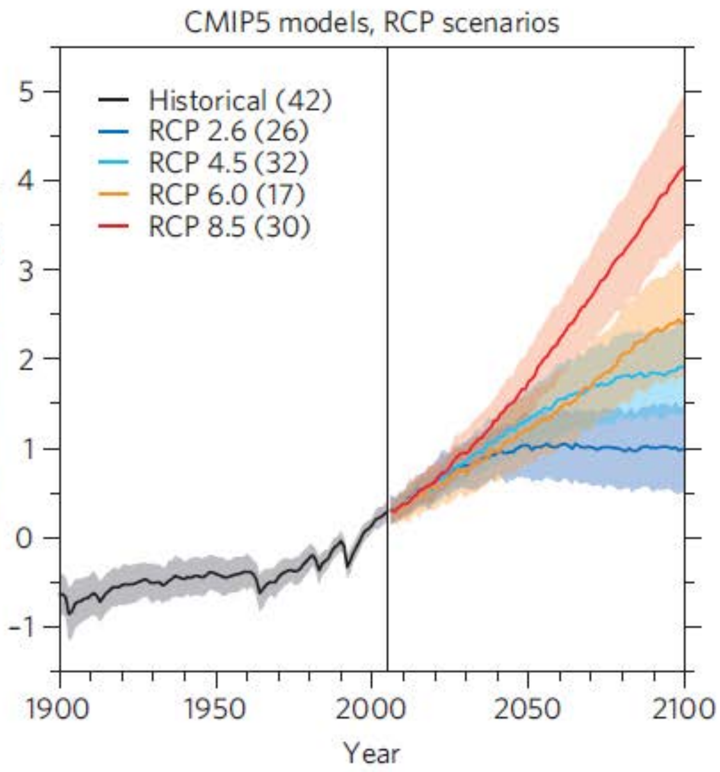


GCMs are ***not*** trying to do this.





Instead, we construct experiments to simulate how the climate would respond to some change in the system

THE WCRP CMIP3 MULTIMODEL DATASET

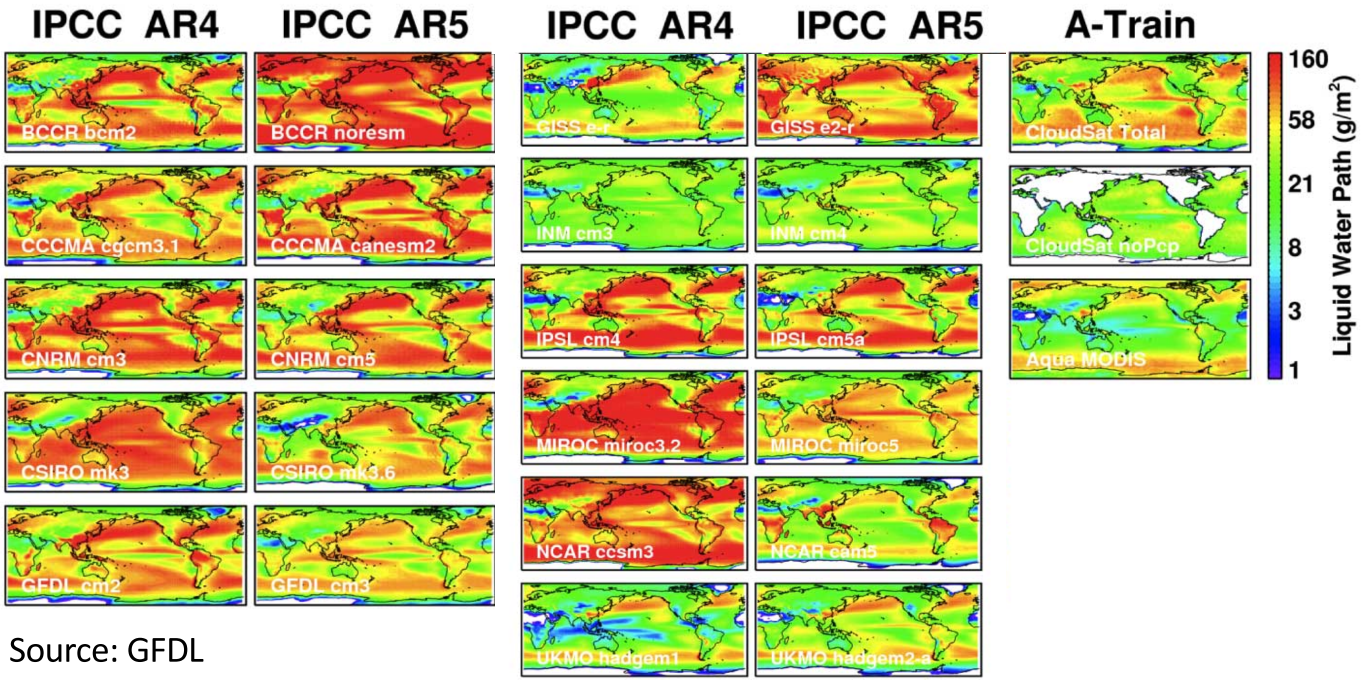
A New Era in Climate Change Research

BY GERALD A. MEEHL, CURT COVEY, THOMAS DELWORTH, MOJIB LATIF, BRYANT MCAVANEY, JOHN F. B. MITCHELL, RONALD J. STOUFFER, AND KARL E. TAYLOR

Open access to an unprecedented, comprehensive coordinated set of global coupled climate model experiments for twentieth and twenty-first century climate and other experiments is changing the way researchers and students analyze and learn about climate.

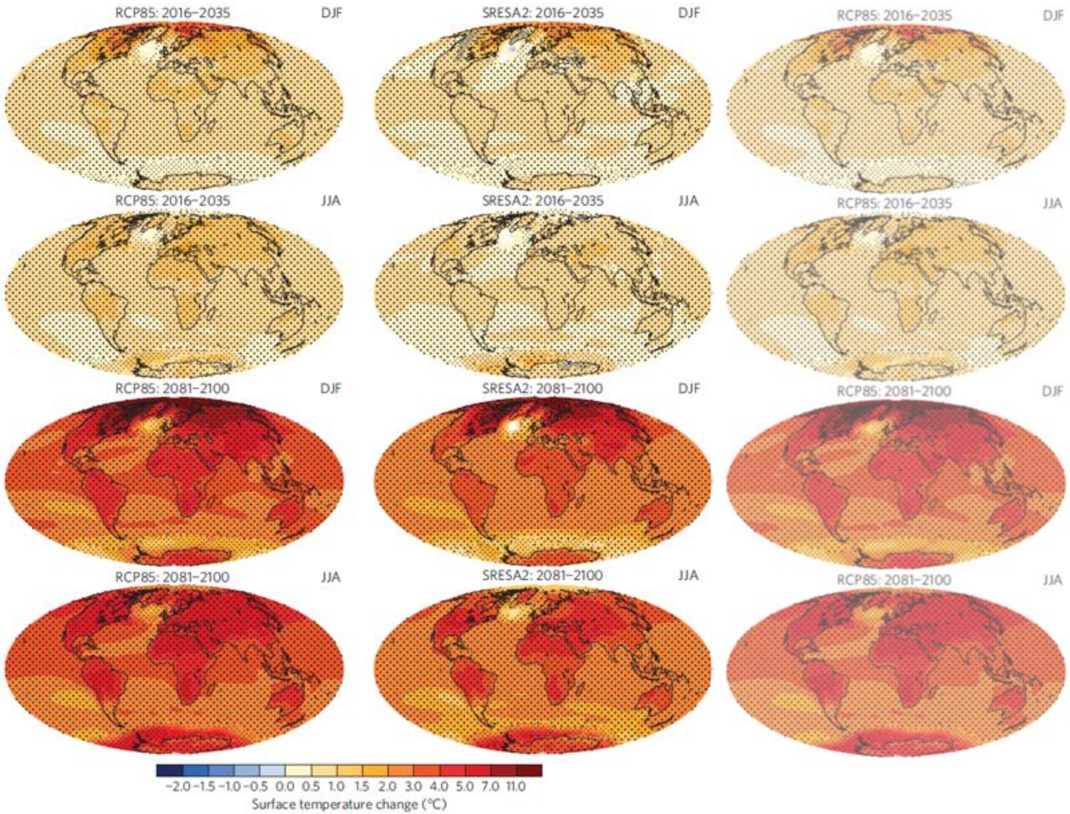
The history of climate change modeling was first characterized in the 1980s by a number of distinct groups developing, running, and analyzing model output from their own models with little opportunity for anyone outside of those groups to have access to the model data. This was partly a consequence of relatively primitive computer networking and data transfer capabilities, along with the daunting task of collecting and storing such large amounts ▶

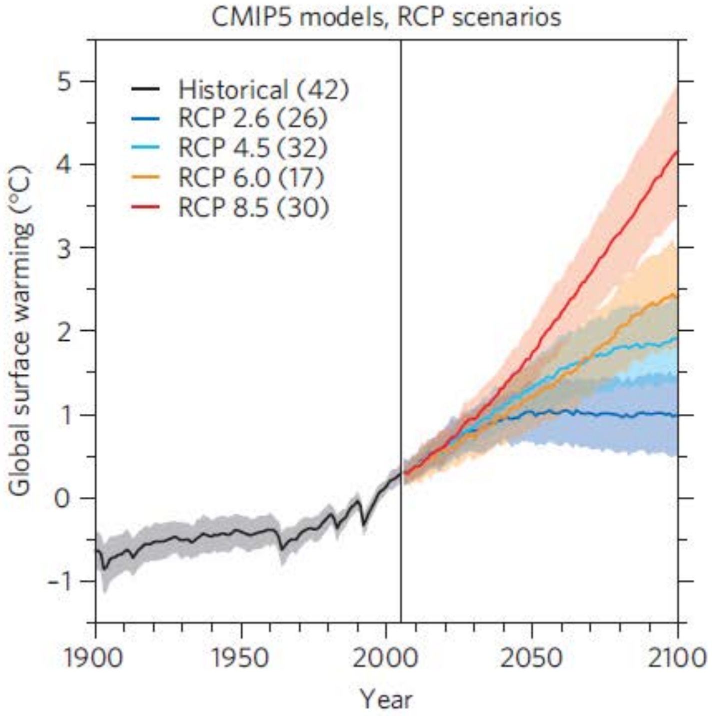
Big advance for climate impacts research came with the advent of the 'CMIPs' or Coupled Model Intercomparison Project



Source: GFDL

Participating modeling groups agree to perform a pre-determined set of experiments





Many global models for each emissions scenario creates an ***ensemble***

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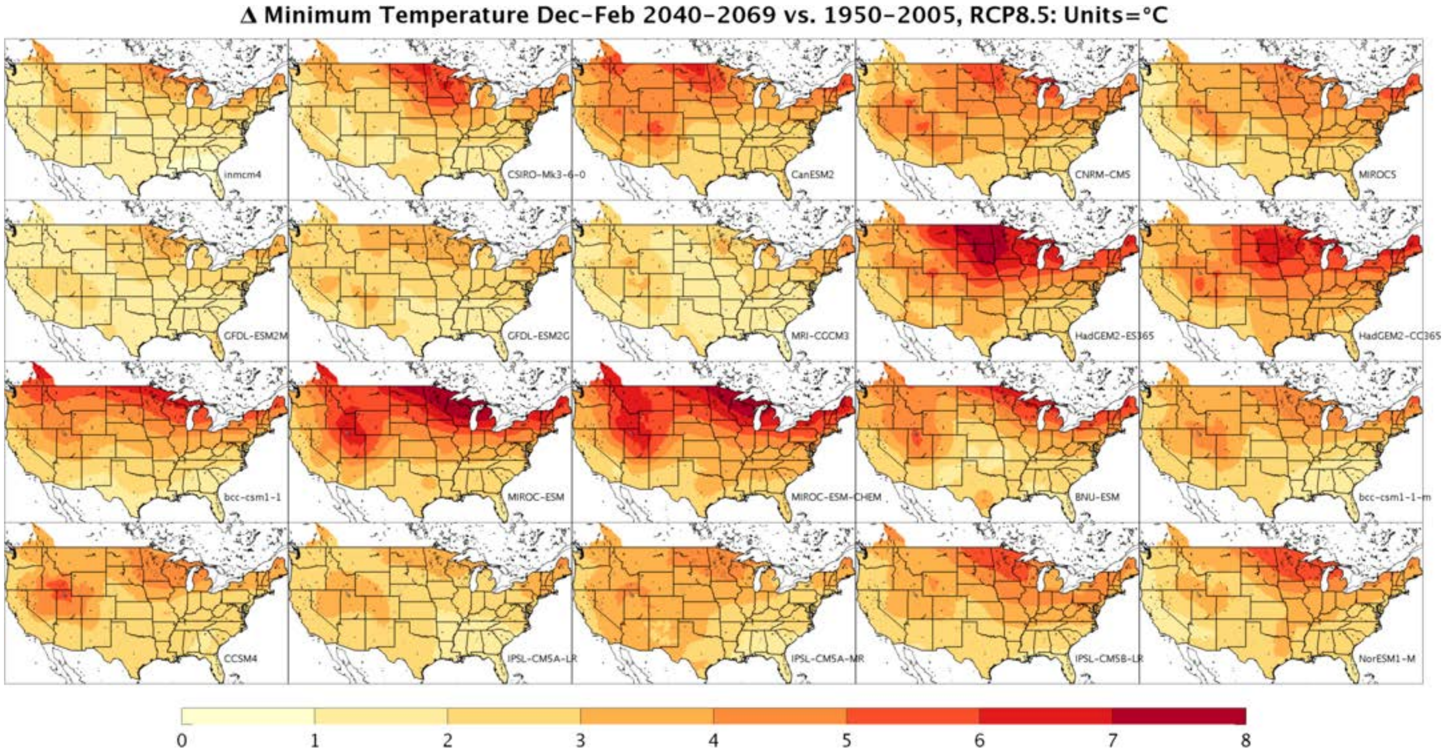


Ensemble of models permits *much* better characterization of uncertainty about future change since models performing same experiment (or multiple simulations from the SAME GCM) can be analyzed together.

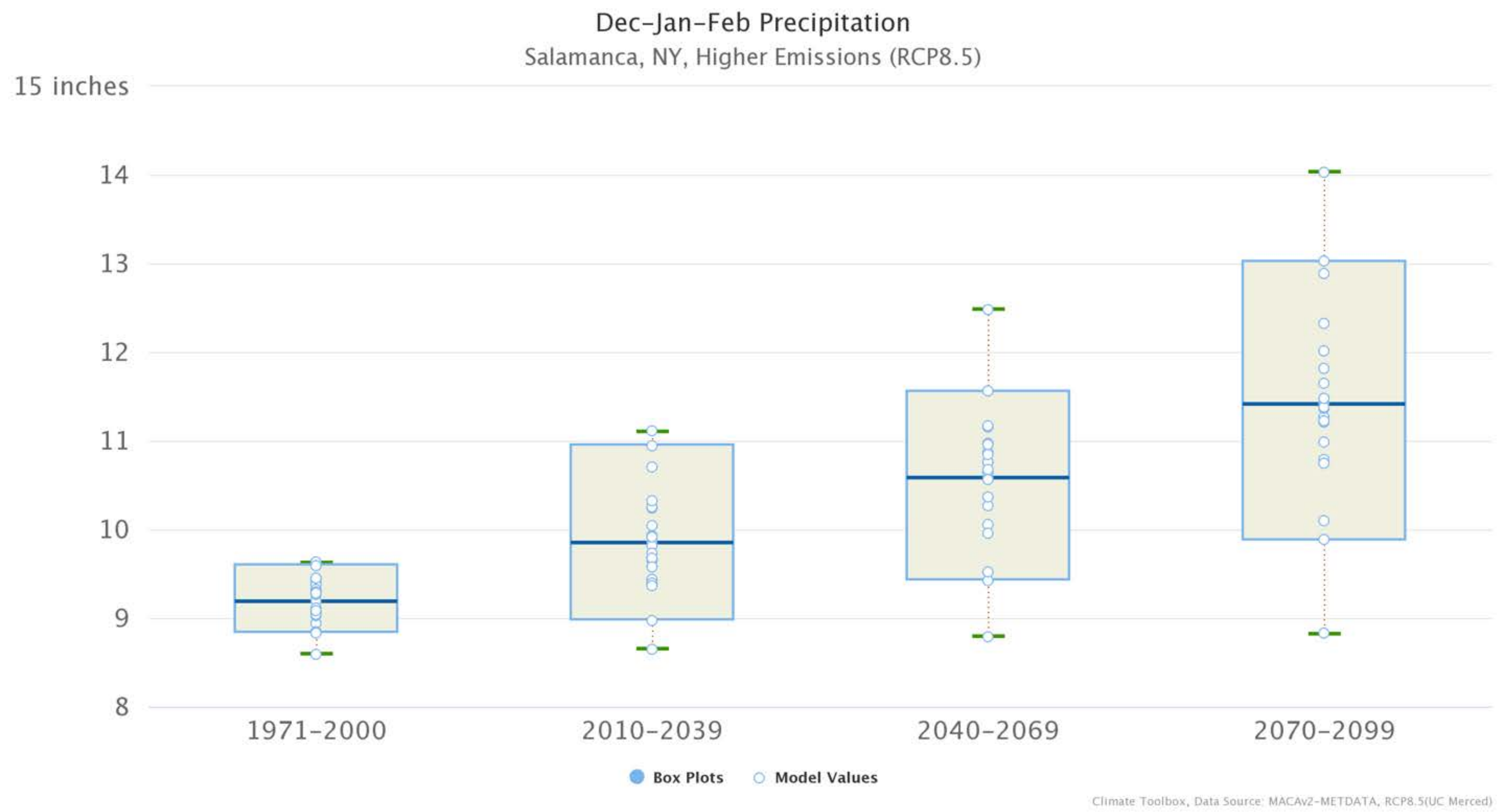
How to use climate model projections

- Establish the connection between climate and impacts
  - projections **are more useful** when link between climate and your system is well-understood

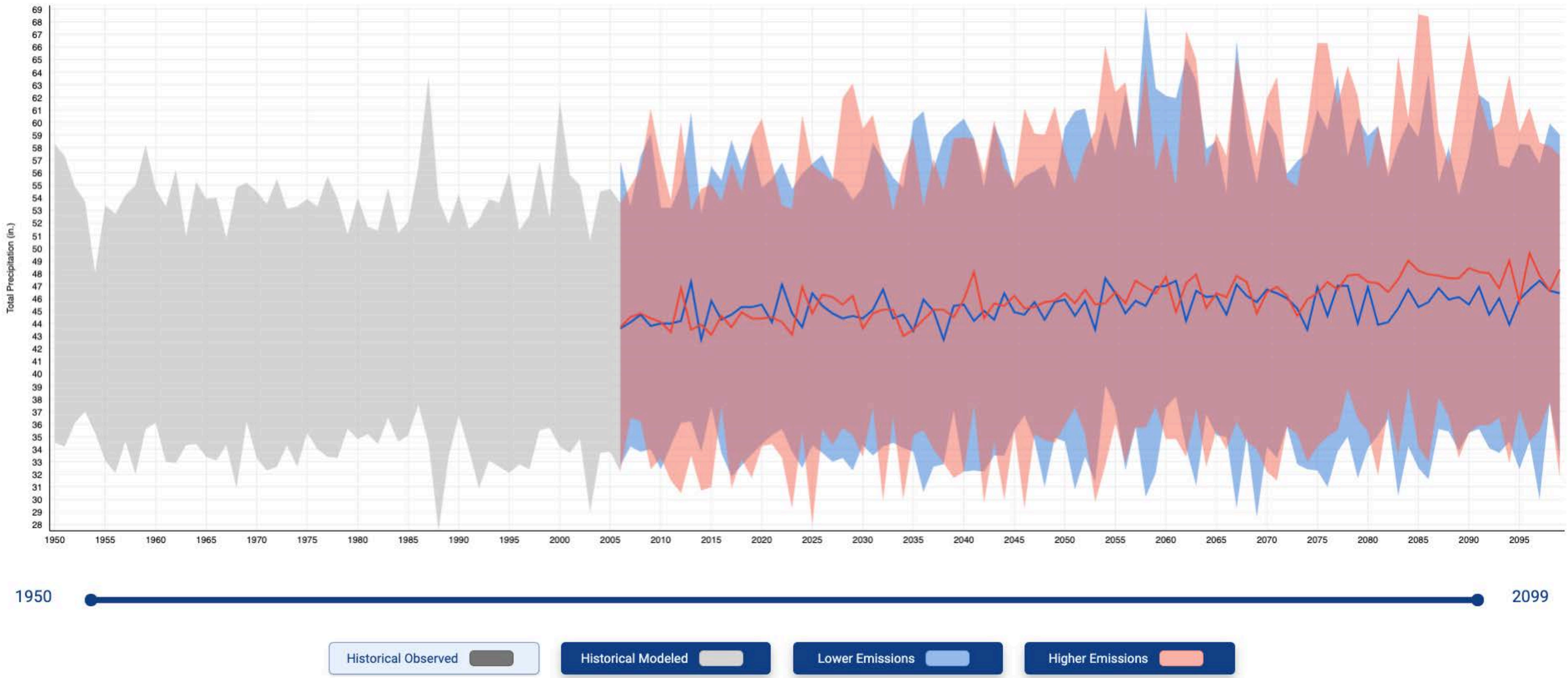
- Consider direct and indirect impacts

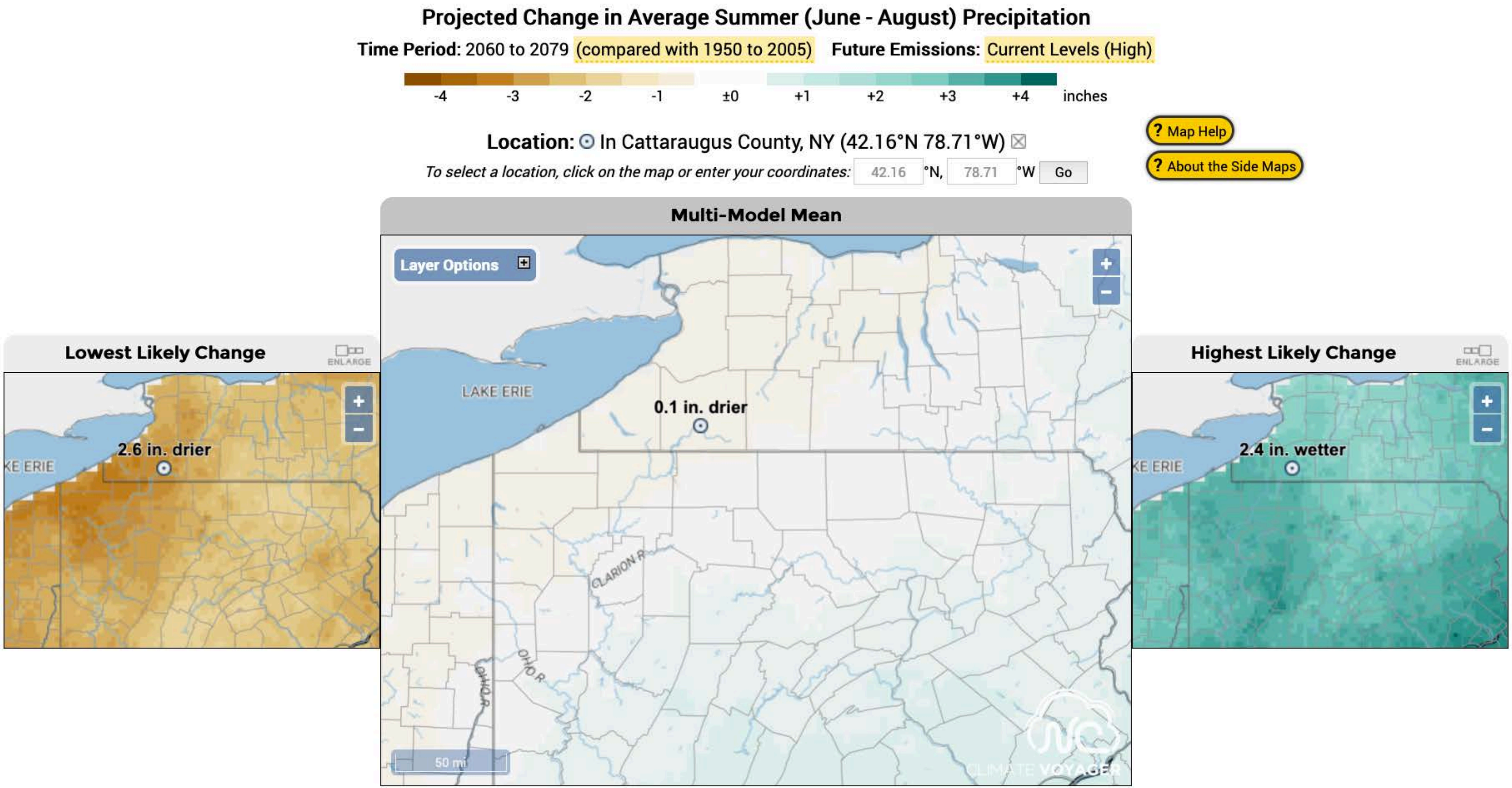
Examples

- Precipitation changes in Northeast
- Temperature Changes in mid-Atlantic
- Sea Level Rise in south Florida

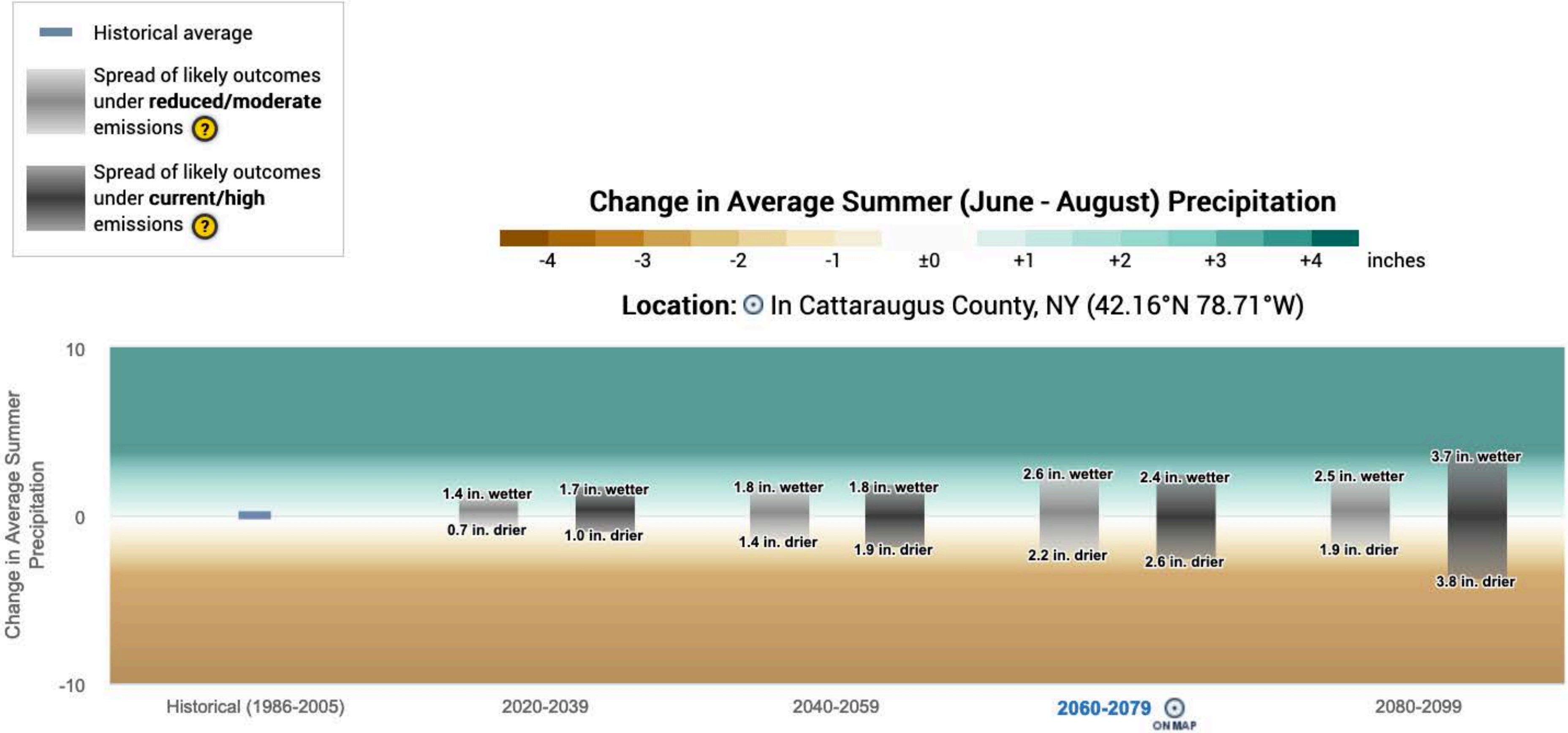

Dec-Jan-Feb Precipitation
Salamanca, NY, Higher Emissions (RCP8.5)
15 inches
14
13
12
11
10
9
8
1971-2000
2010-2039
2040-2069
2070-2099
Box Plots
Model Values
Climate Toolbox, Data Source: MACAv2-METDATA, RCP8.5(UC Merced)

Salamanca, NY in Cattaraugus County - Total precipitation

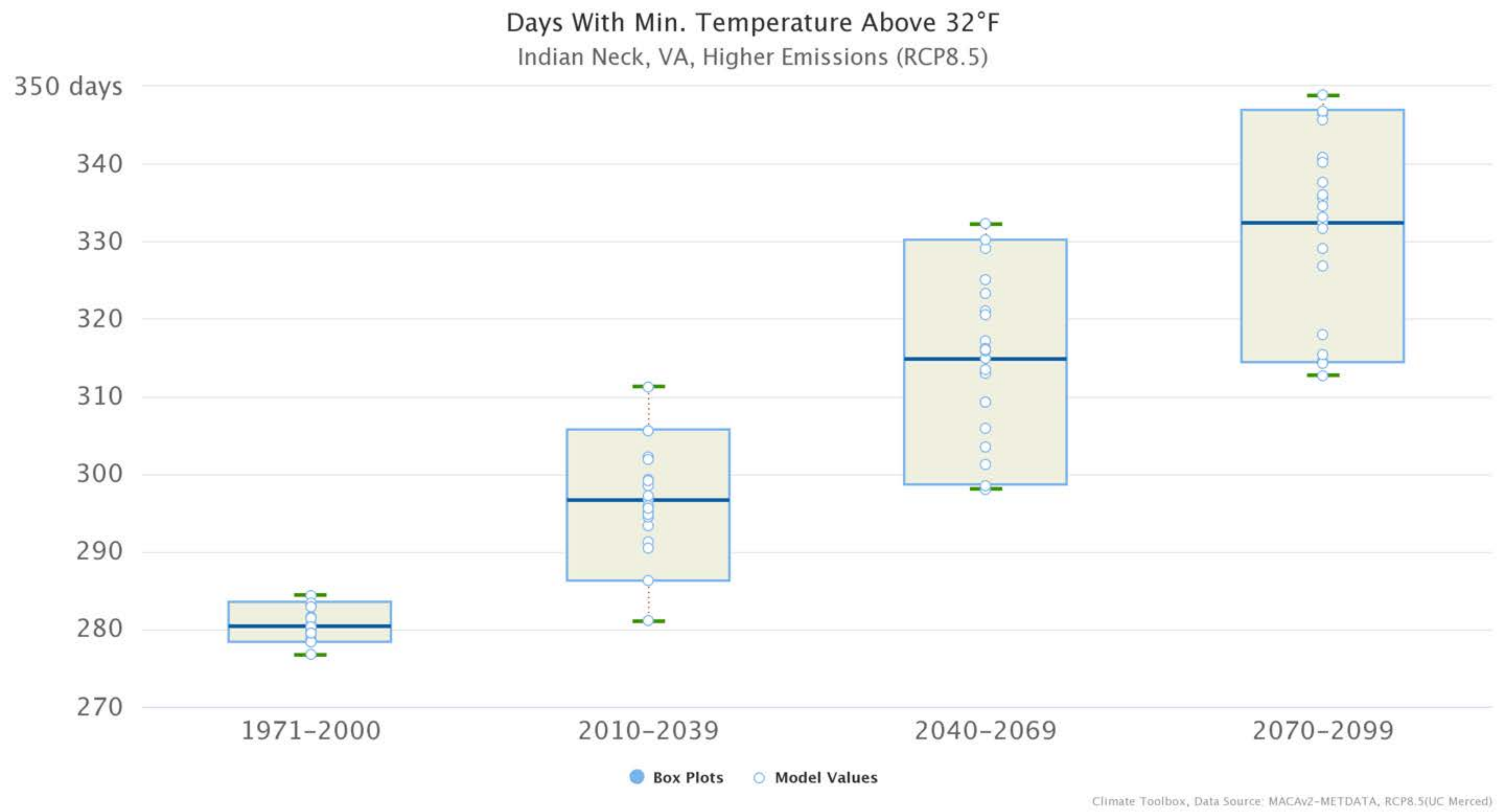




Projected Change in Average Summer (June - August) Precipitation
Time Period: 2060 to 2079 (compared with 1950 to 2005) Future Emissions: Current Levels (High)
-4 -3 -2 -1 ±0 +1 +2 +3 +4 inches
Location: In Cattaraugus County, NY (42.16°N 78.71°W)
To select a location, click on the map or enter your coordinates: 42.16 °N, 78.71 °W Go
Map Help
About the Side Maps
Multi-Model Mean
Layer Options
LAKE ERIE
0.1 in. drier
CLARION R
OHIO R
50 mi
CLIMATE VOYAGER
Lowest Likely Change
ENLARGE
2.6 in. drier
KE ERIE
Highest Likely Change
ENLARGE
2.4 in. wetter
KE ERIE

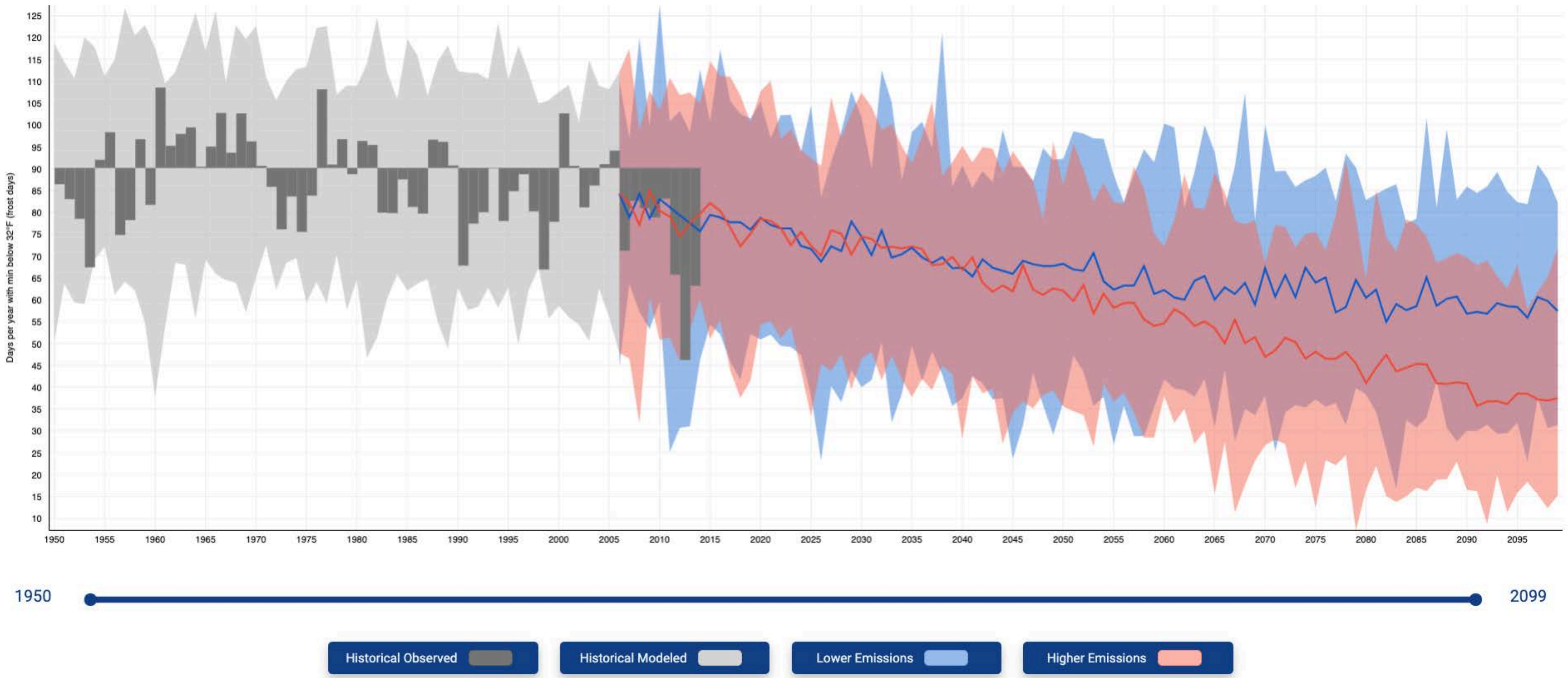


Historical average
Spread of likely outcomes under reduced/moderate emissions
Spread of likely outcomes under current/high emissions
Change in Average Summer (June - August) Precipitation
-4
-3
-2
-1
±0
+1
+2
+3
+4
inches
Location: In Cattaraugus County, NY (42.16°N 78.71°W)
Change in Average Summer Precipitation
10
0
-10
1.4 in. wetter
0.7 in. drier
1.7 in. wetter
1.0 in. drier
1.8 in. wetter
1.4 in. drier
1.8 in. wetter
1.9 in. drier
2.6 in. wetter
2.2 in. drier
2.4 in. wetter
2.6 in. drier
2.5 in. wetter
1.9 in. drier
3.7 in. wetter
3.8 in. drier
Historical (1986-2005)
2020-2039
2040-2059
2060-2079
ON MAP
2080-2099



Days With Min. Temperature Above 32°F
Indian Neck, VA, Higher Emissions (RCP8.5)
350 days
340
330
320
310
300
290
280
270
1971-2000
2010-2039
2040-2069
2070-2099
Box Plots
Model Values
Climate Toolbox, Data Source: MACAv2-METDATA, RCP8.5(UC Merced)

Indian Neck, VA in King and Queen County - Days w/ min < 32°F



Projected Change in the Average Number of Days Per Year with Minimum Temperatures < 32°F

Time Period: 2060 to 2079 (compared with 1950 to 2005) **Future Emissions:** Current Levels (High)

+8 ±0 -8 -16 -24 -32 -40 -48 -56 -64 -72 -80 -88 -96 days

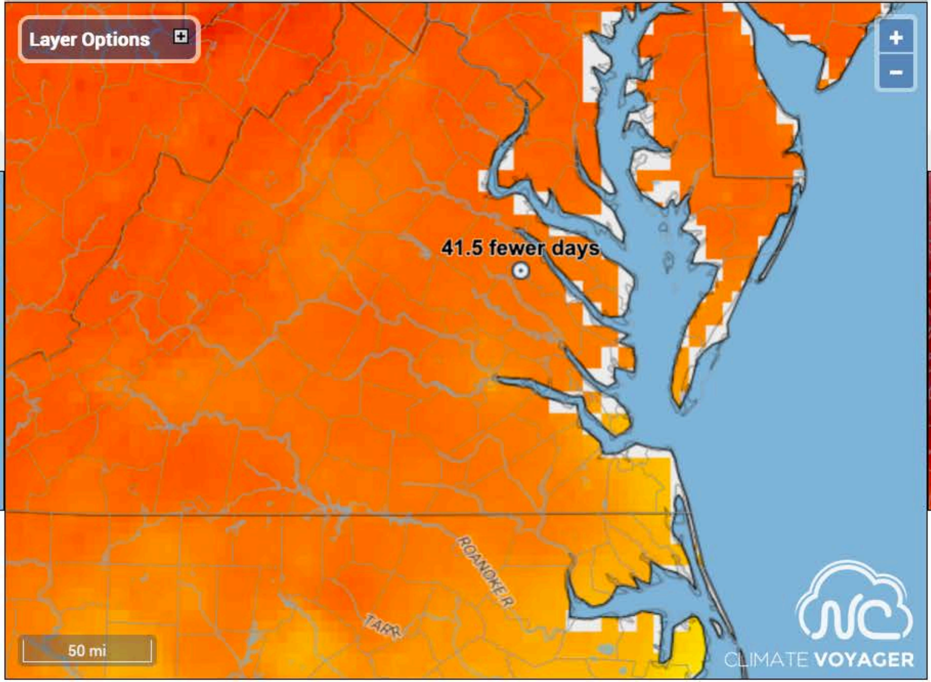
Location: In King and Queen County, VA (37.93°N 77.09°W)

To select a location, click on the map or enter your coordinates: 37.93 °N, 77.09 °W Go

? Map Help

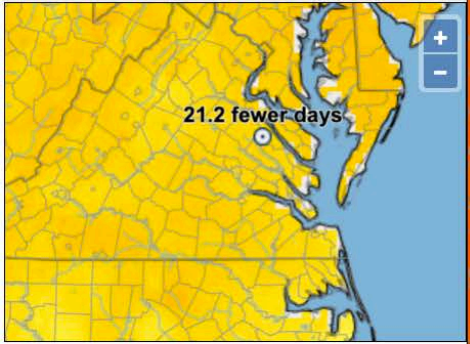
? About the Side Maps

Multi-Model Mean



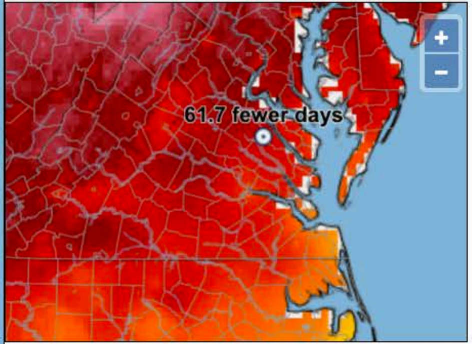
Lowest Likely Change

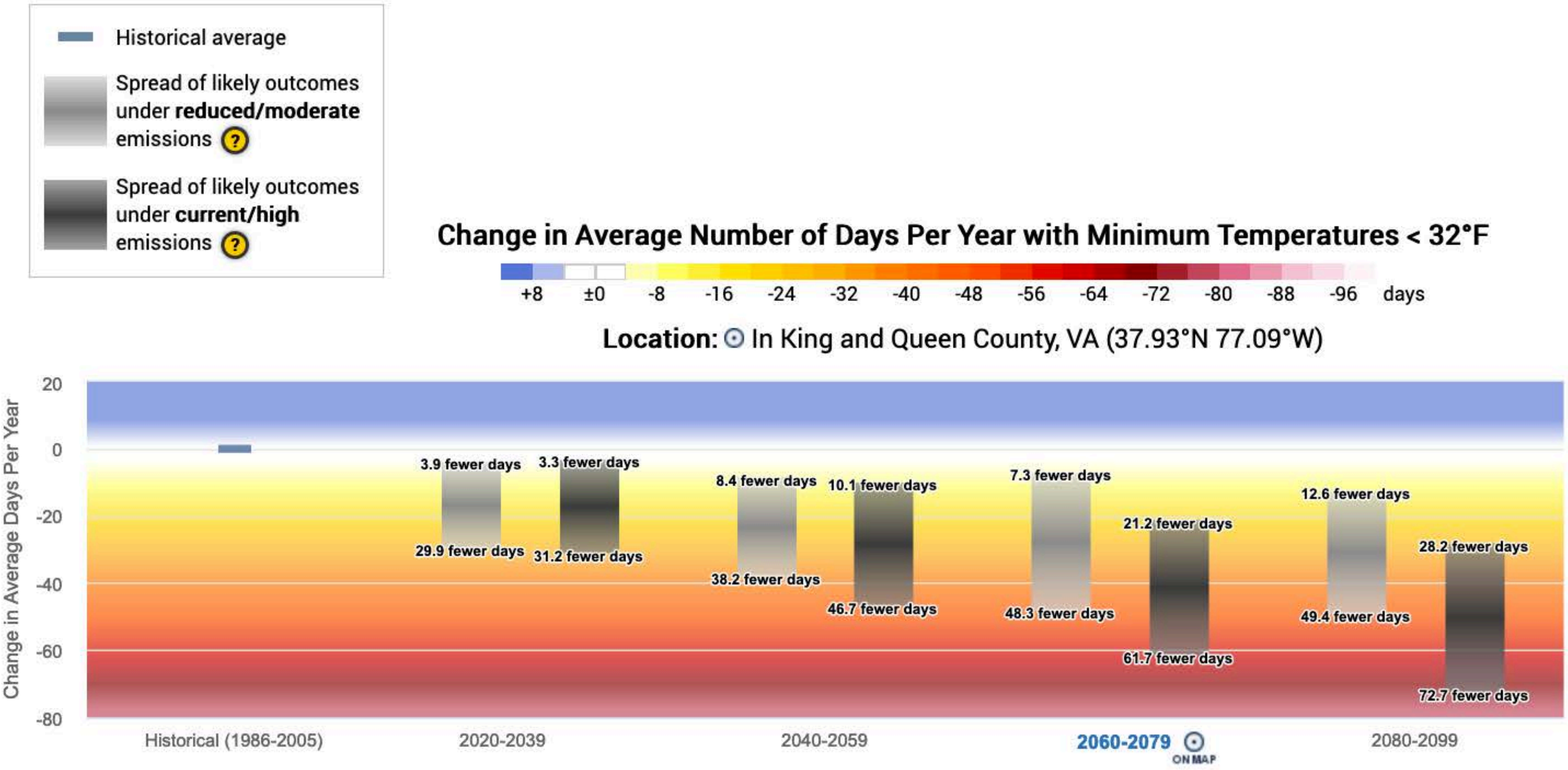
ENLARGE



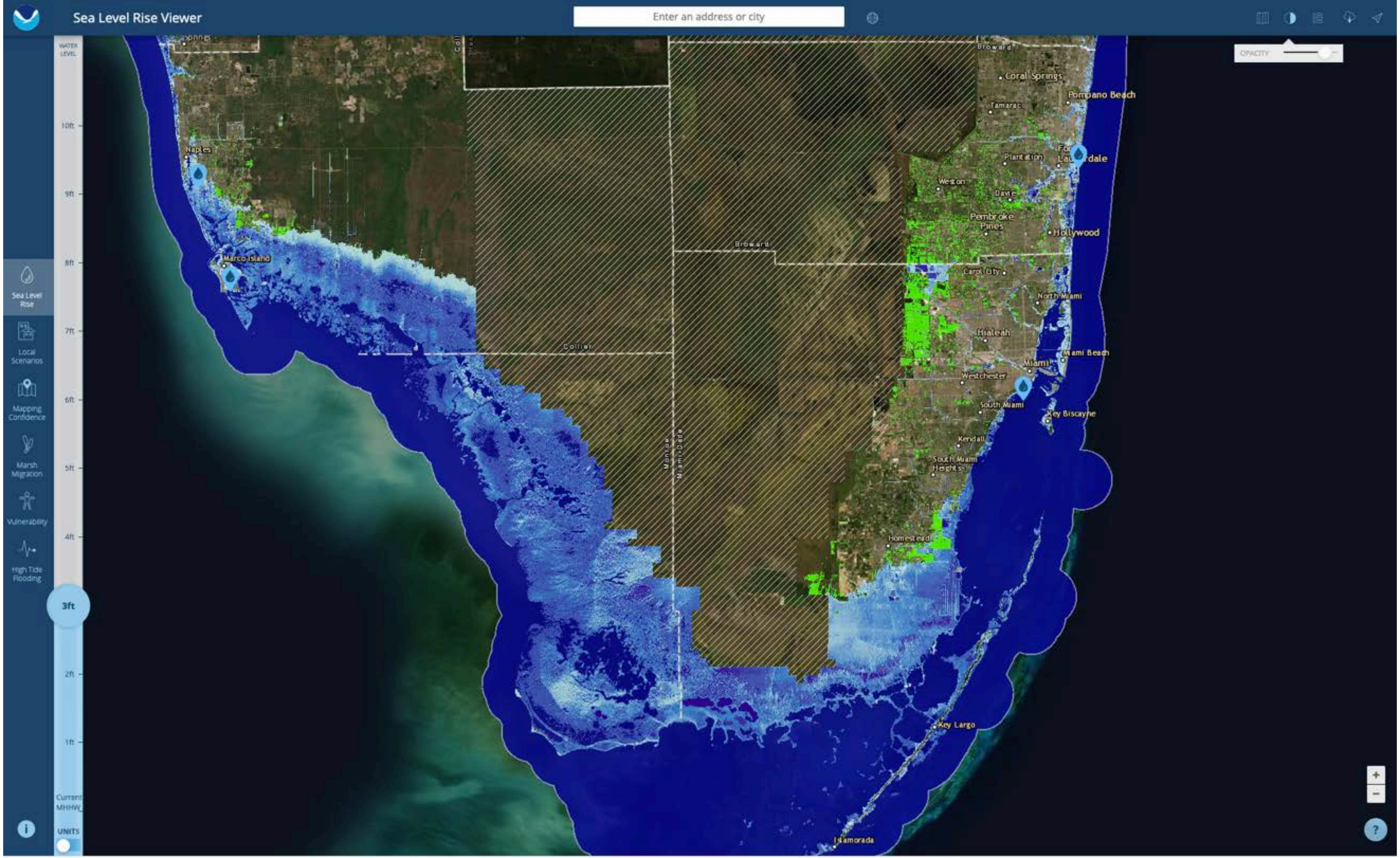
Highest Likely Change

ENLARGE

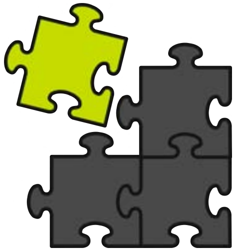




Historical average
Spread of likely outcomes under **reduced/moderate** emissions
Spread of likely outcomes under **current/high** emissions
Change in Average Number of Days Per Year with Minimum Temperatures < 32°F
+8
±0
-8
-16
-24
-32
-40
-48
-56
-64
-72
-80
-88
-96
days
Location: In King and Queen County, VA (37.93°N 77.09°W)
Change in Average Days Per Year
20
0
-20
-40
-60
-80
3.9 fewer days
29.9 fewer days
3.3 fewer days
31.2 fewer days
8.4 fewer days
38.2 fewer days
10.1 fewer days
46.7 fewer days
7.3 fewer days
48.3 fewer days
21.2 fewer days
61.7 fewer days
12.6 fewer days
49.4 fewer days
28.2 fewer days
72.7 fewer days
Historical (1986-2005)
2020-2039
2040-2059
2060-2079
ON MAP
2080-2099


Sea Level Rise Viewer
Enter an address or city
OPACITY
10ft
9ft
8ft
7ft
6ft
5ft
4ft
3ft
2ft
1ft
Current MHHW
UNITS
Sea Level Rise
Local Scenarios
Mapping Confidence
Marsh Migration
Vulnerability
High Tide Flooding
Naples
Marco Island
Collier
Broward
Monroe
Miami-Dade
Coral Springs
Pompano Beach
Tamarac
Plantation
Weston
Davie
Pembroke Pines
Hollywood
Carol City
North Miami
Hialeah
Miami Beach
Miami
Westchester
South Miami
Key Biscayne
Kendall
South Miami Heights
Homestead
Key Largo
Islamorada

A Few Take Aways:

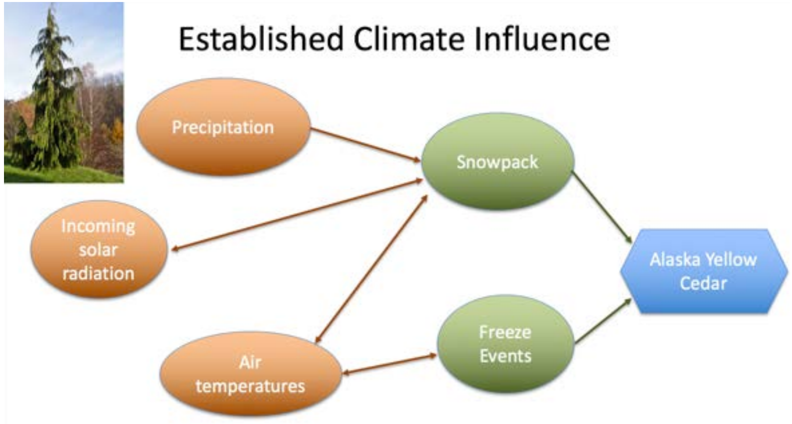


- Climate models represent our current best understanding of how rising greenhouse gases affect the climate
- Can be useful to assess risk
  - Each model outcome is equally plausible based on our scientific understanding of the climate system
  - Each emissions scenario represents a unique set of assumptions about the future
- A range of models can help to better characterize uncertainty and risks

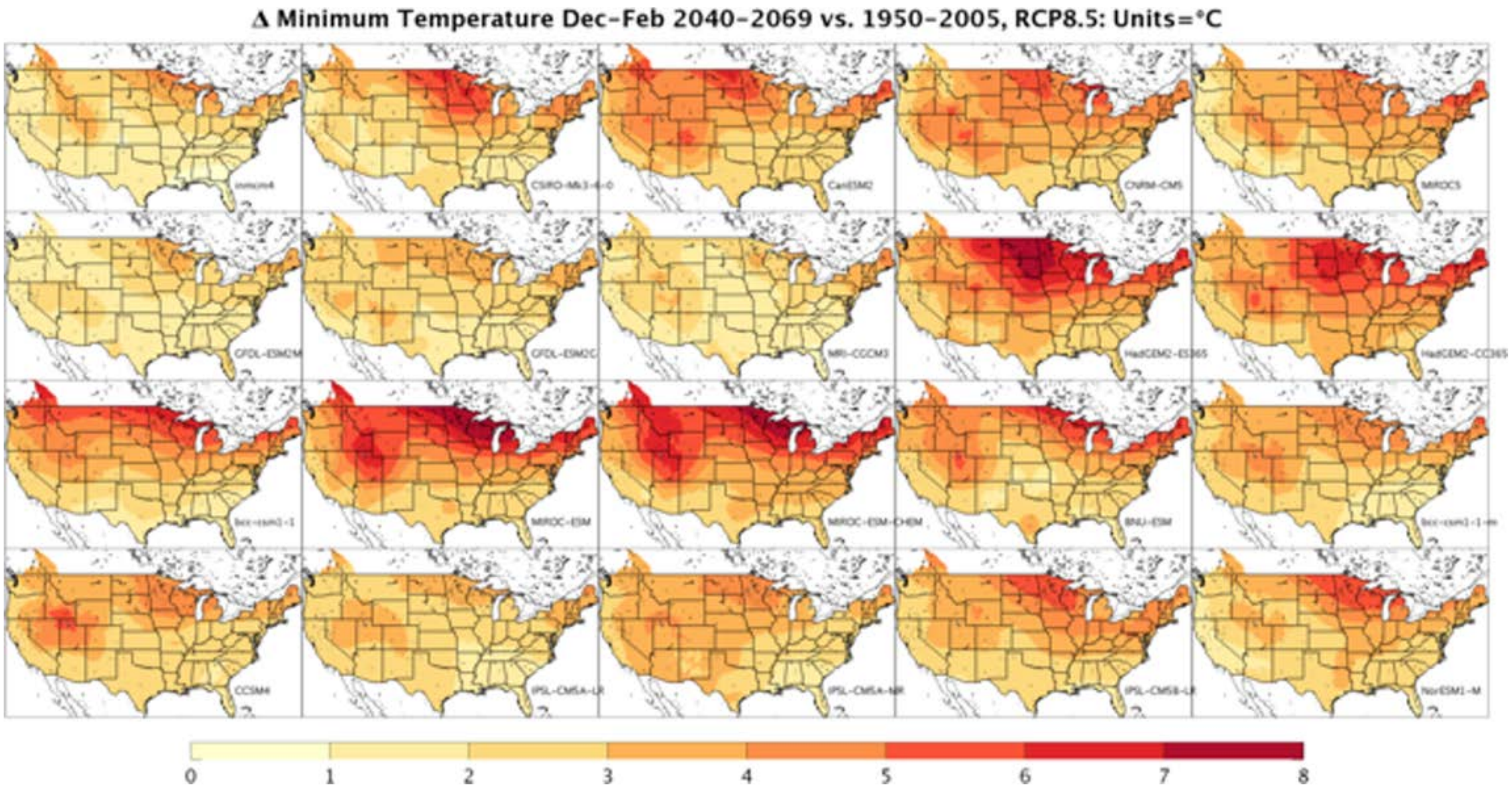
A Few Take Aways:

- Climate models are more useful for characterizing risk when the climate sensitivity is well-understood

- Downscaled projections are likely to be more useful but choosing the right data can be tricky



Remember: There is no single best climate model….



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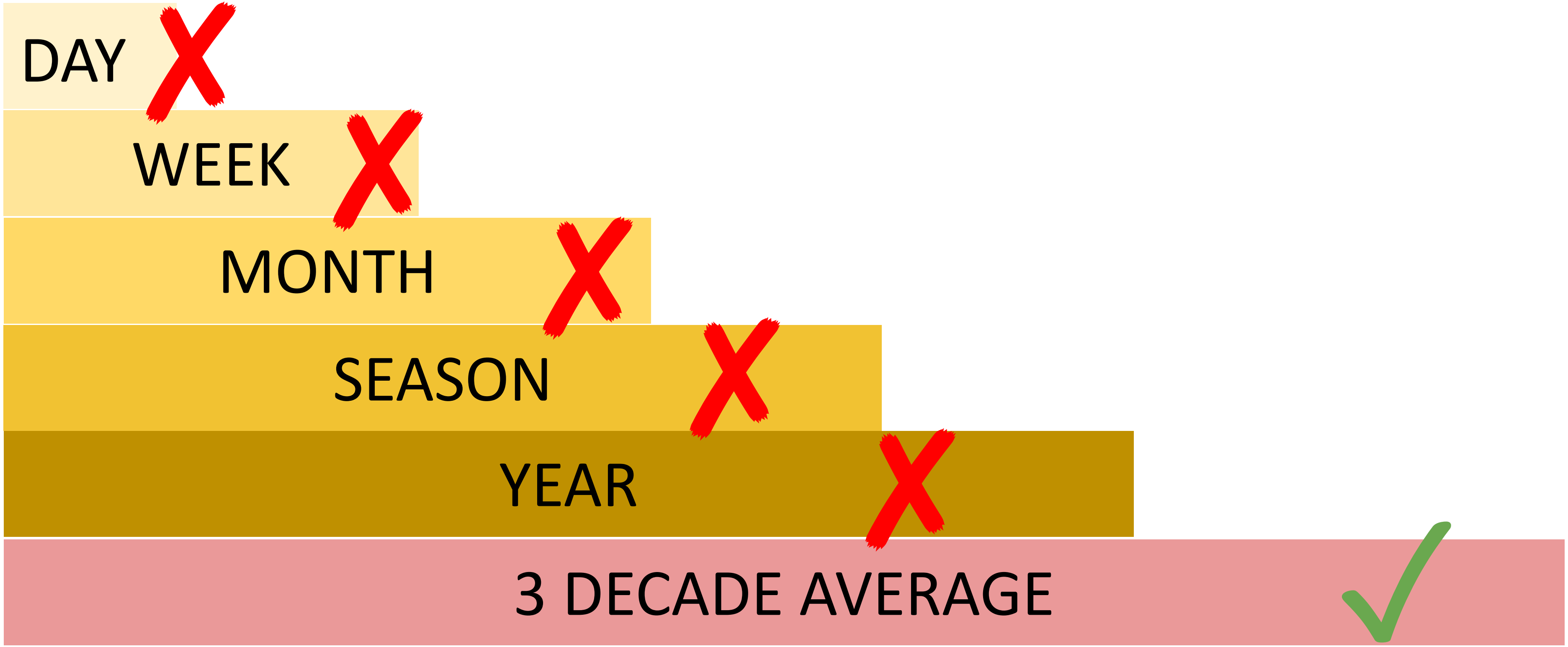
Remember: Projections look at changes over climate time scales



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Climate Resources Overview

NCA4 / CSSR – General reading -the authoritative broad science reference at national, regional scale

USDA Forest Service TACCIMO – connects to literature on impacts in forest ecosystems

NOAA Sea Level Rise Viewer

- Strengths - visually intuitive, nice mapping, can explore range of future water levels
- Weaknesses - bathtub model - doesn't account for sediment, sand dynamics, tidal impacts, saltwater intrusion

USCRT Climate Explorer

- Strengths - visually appealing, local scale, many derived variables
- Weaknesses - tough to decifer range of risks for each emissions scenario, easy to mis-interpret time series for future, model error not captured

USGS National Climate Change Viewer (CURRENTLY NOT AVAILABLE DUE TO FLASH)

- Strengths - produces a nice report, several derived variables including hydrology
- Weaknesses - county-based, tough to decipher range of risks for each emissions scenario, easy to mis-interpret time series for future, model error not captured

NCSU Climate Voyager

- Strengths - appropriate use of model ensemble, addresses limitations above related to range of risks, time series misinterpretation
- Weaknesses - limited variables right now, model error not captured

MACA Repository & ClimateToolBox.org

- Strengths – Preferred downscaled data for many applications, some nice visuals for capturing model spread (scatter, box plots)
- Weaknesses - limited variables, limited to western US for some data, model error not captured

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