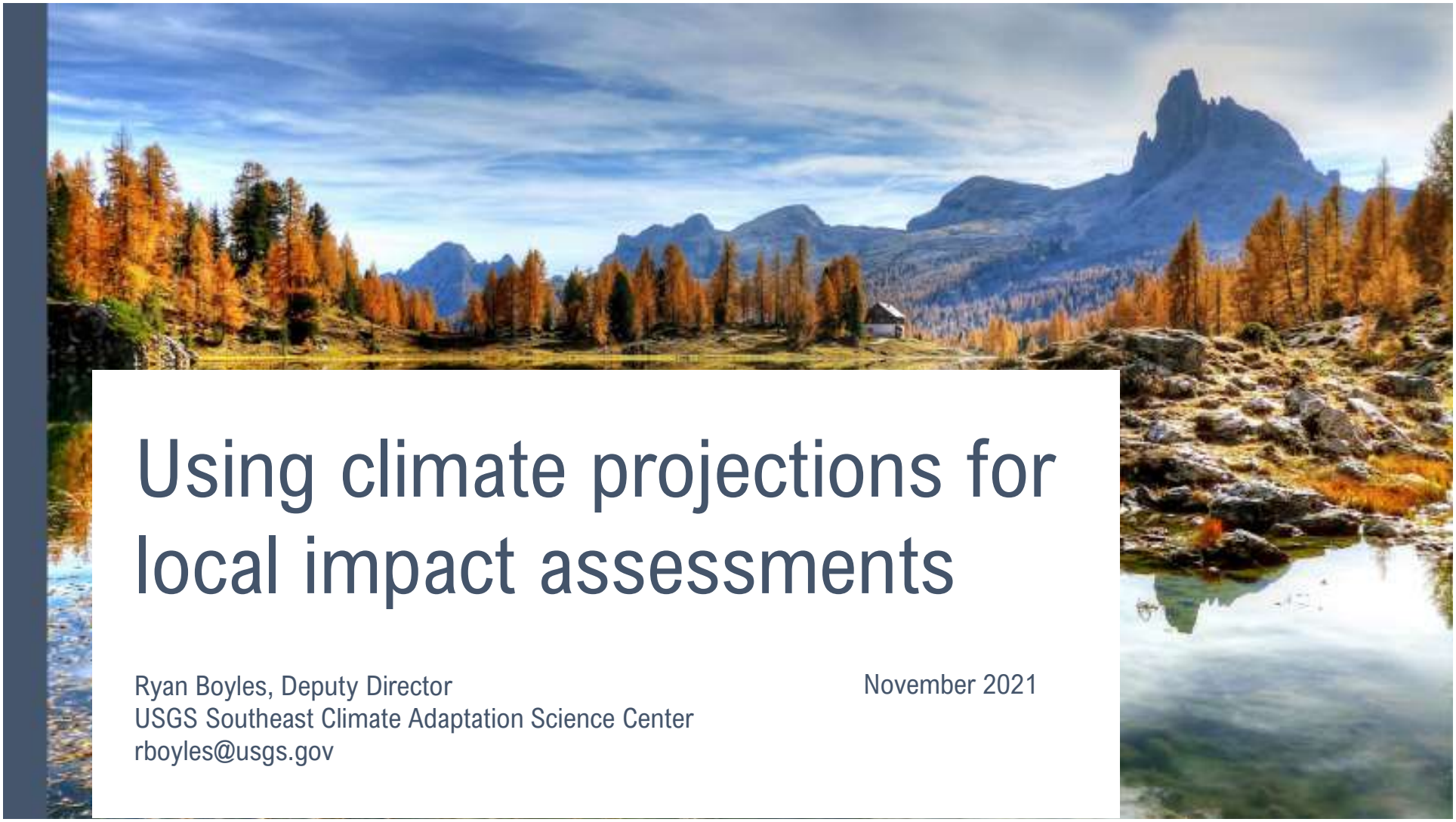

Using climate projections for local impact assessments

Ryan Boyles, Deputy Director
USGS Southeast Climate Adaptation Science Center
rboyles@usgs.gov

November 2021

USGS Climate Adaptation Science Centers

Delivering science to help fish, wildlife, ecosystems, and cultural resources adapt to a changing climate

Actionable Science focused on impacts & adaptation

- Planning, funding, and producing science
- Working groups
- Training & Assistance
- Parnerships

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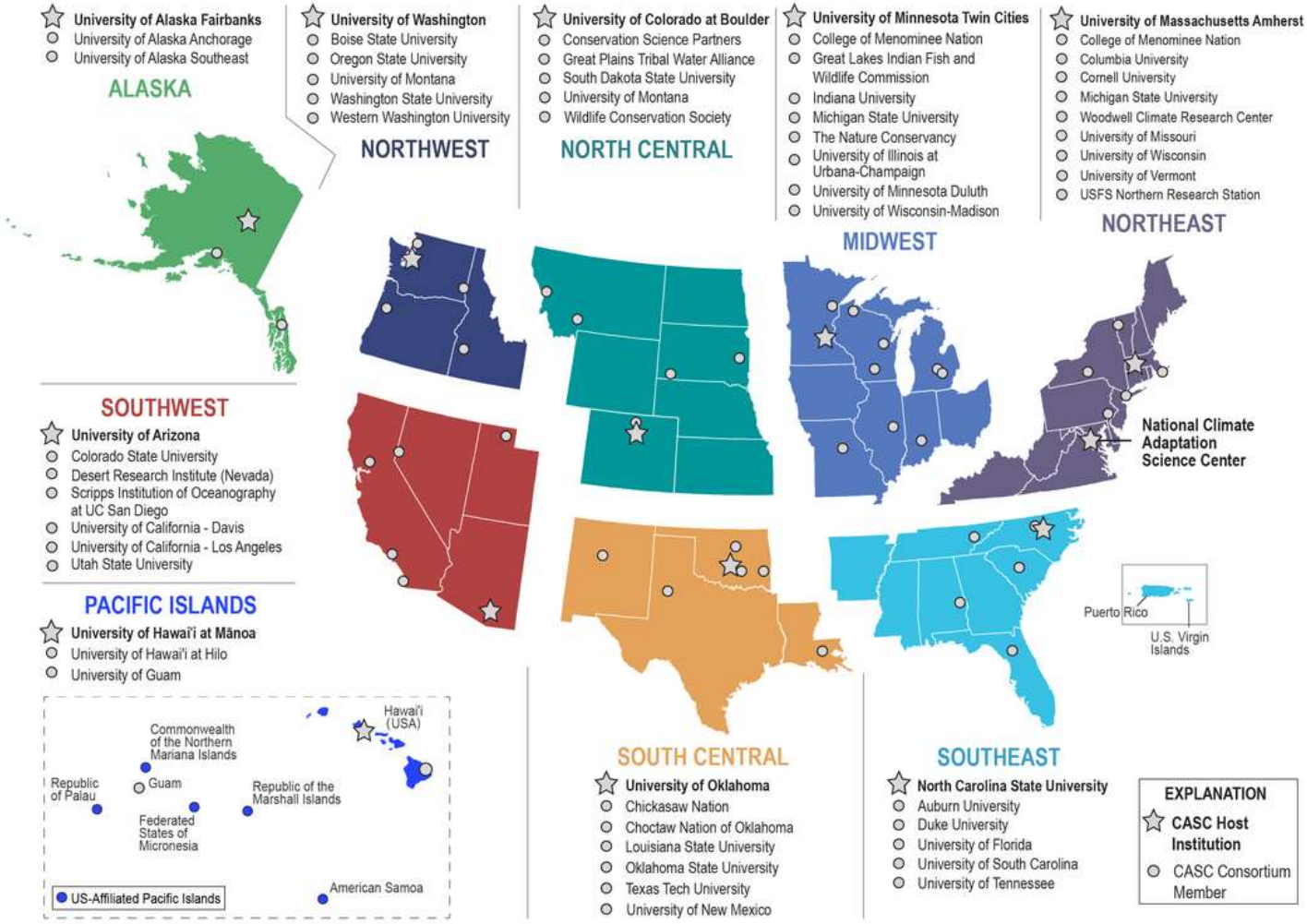
Climate Adaptation Science Center (CASC) Regions

The CASCs collaborate across boundaries to address shared ecosystems, watersheds, and landscapes



How do we use climate models to assess risk?

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Assateague Island National Seashore (post-Sandy)

Key Deer
(*Odocoileus virginianus clavium*)

Climate Change As a Risk Management Problem

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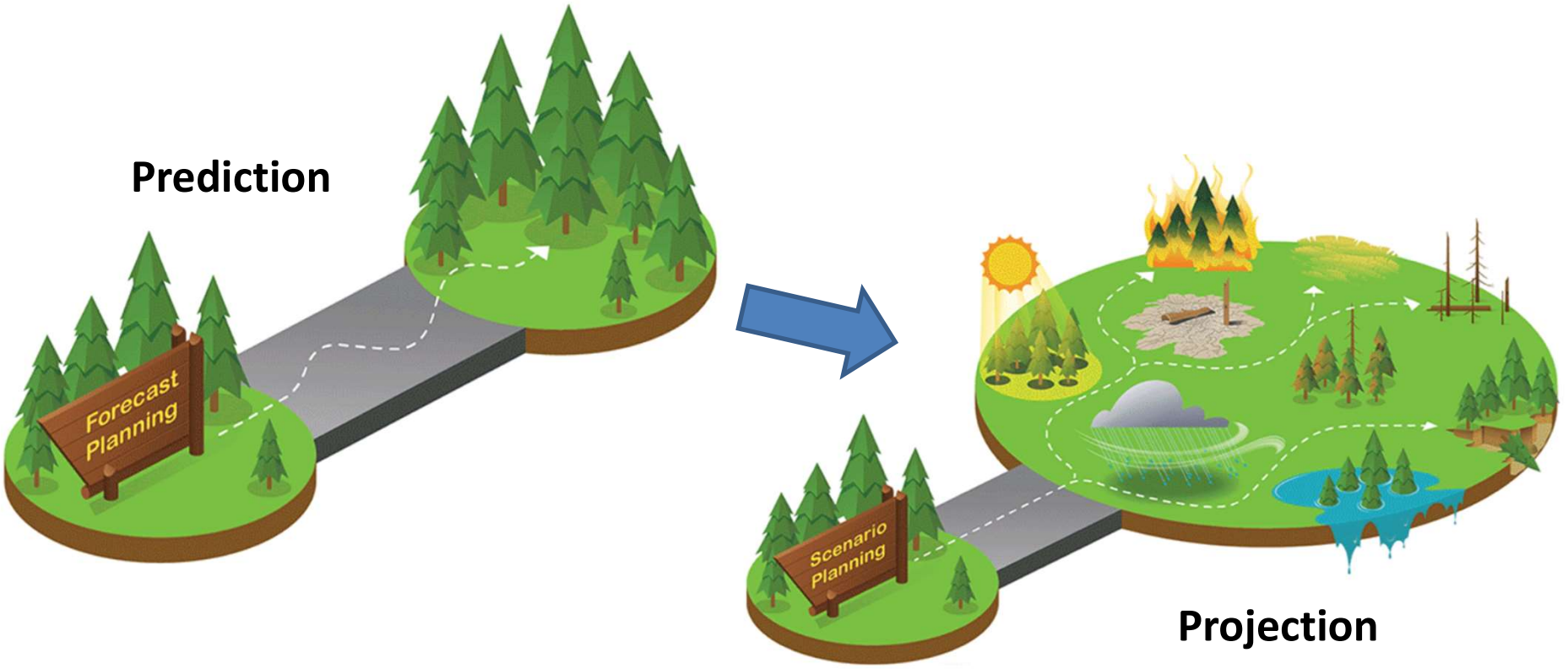
Scenario Planning



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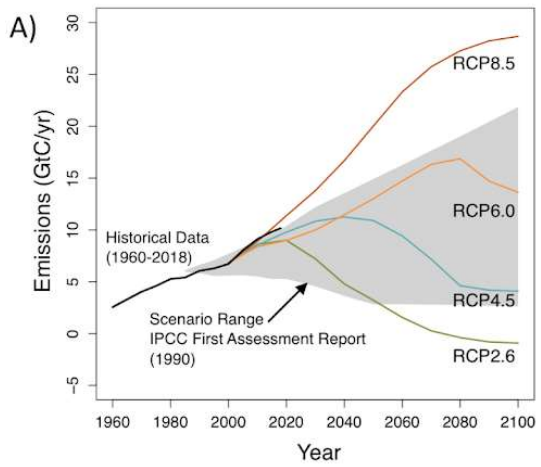
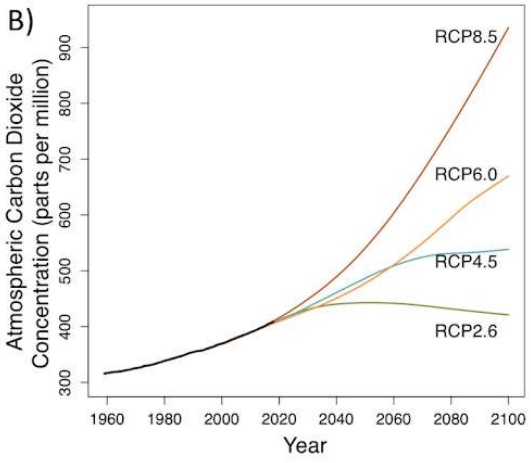
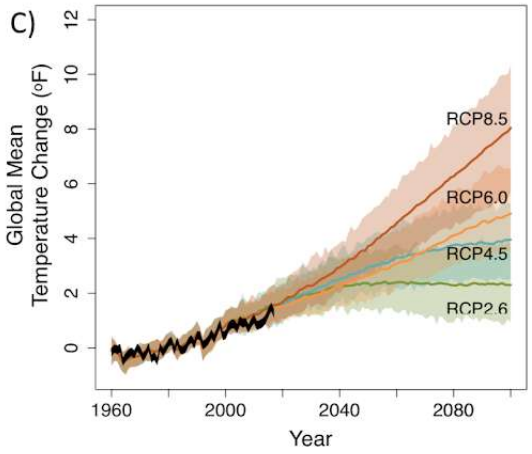
Credit: NPS Climate Change Response Program

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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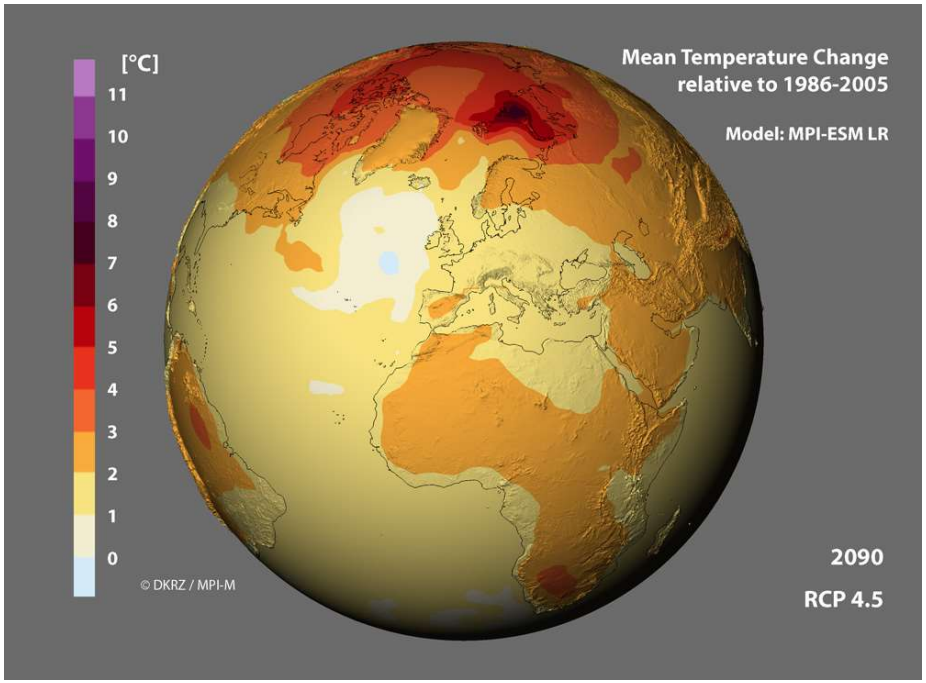

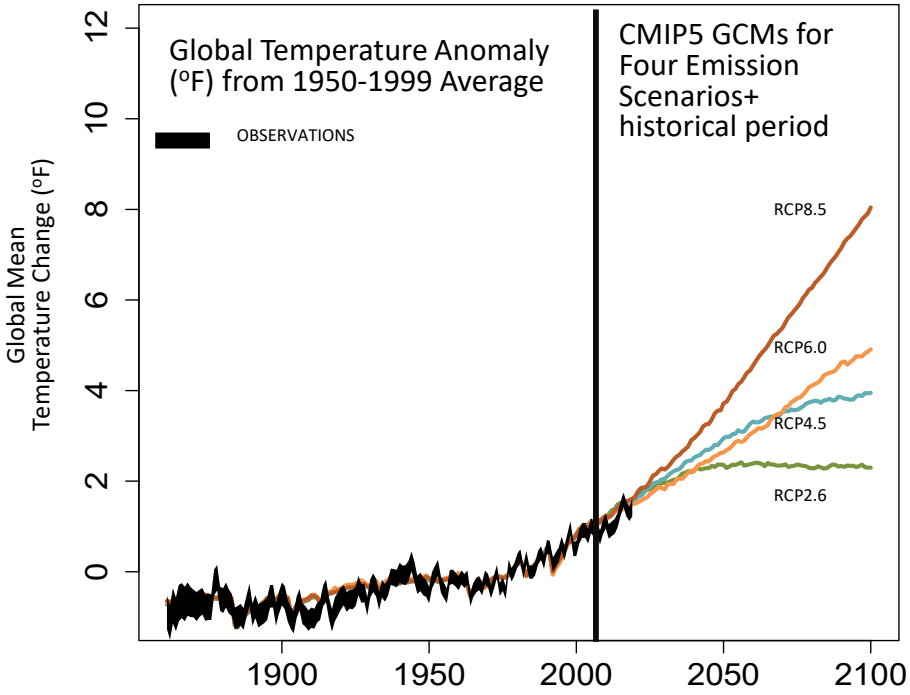

Climate models are used to *project* how the climate could respond to *perturbations* of the system as defined for different *scenarios*

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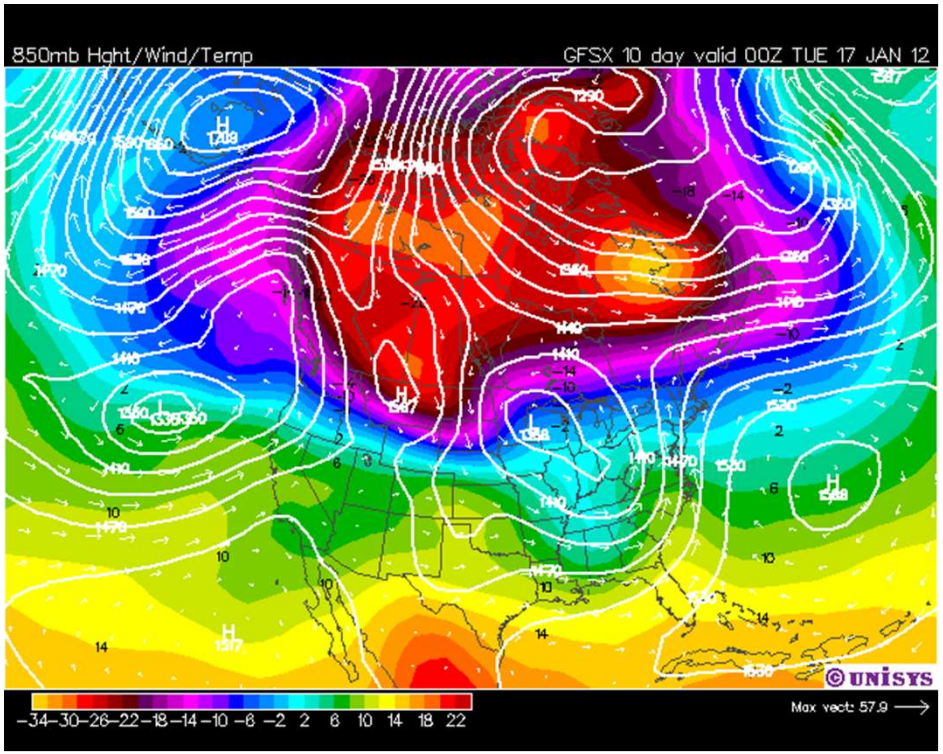

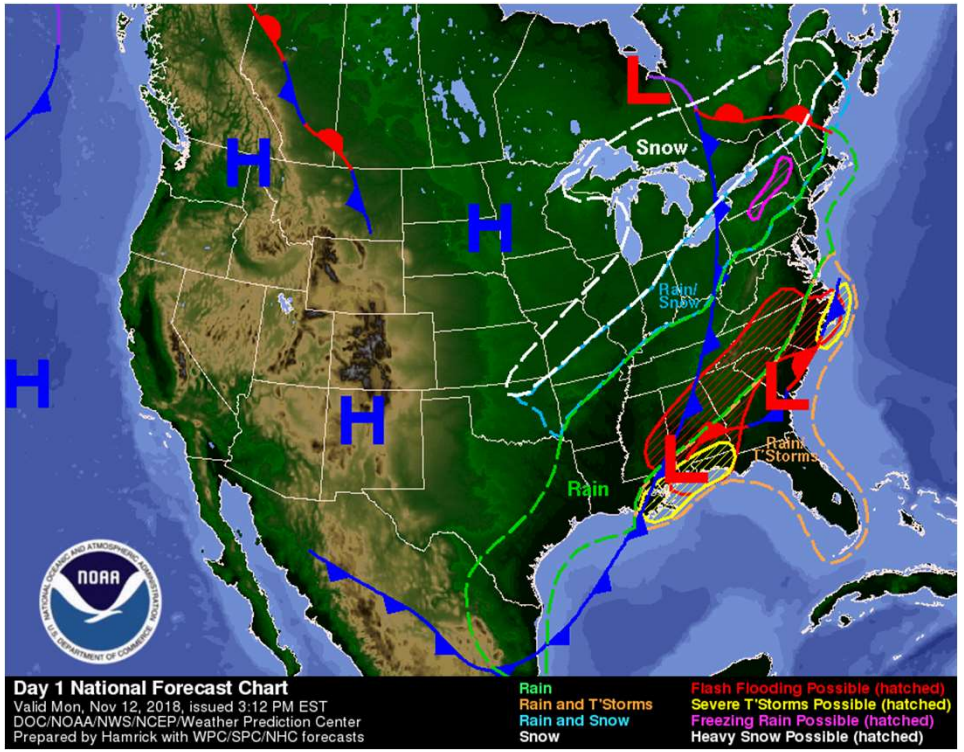

Important distinction from weather models where the goal is to predict the actual observed weather (i.e. the exact condition of the atmosphere) in the future

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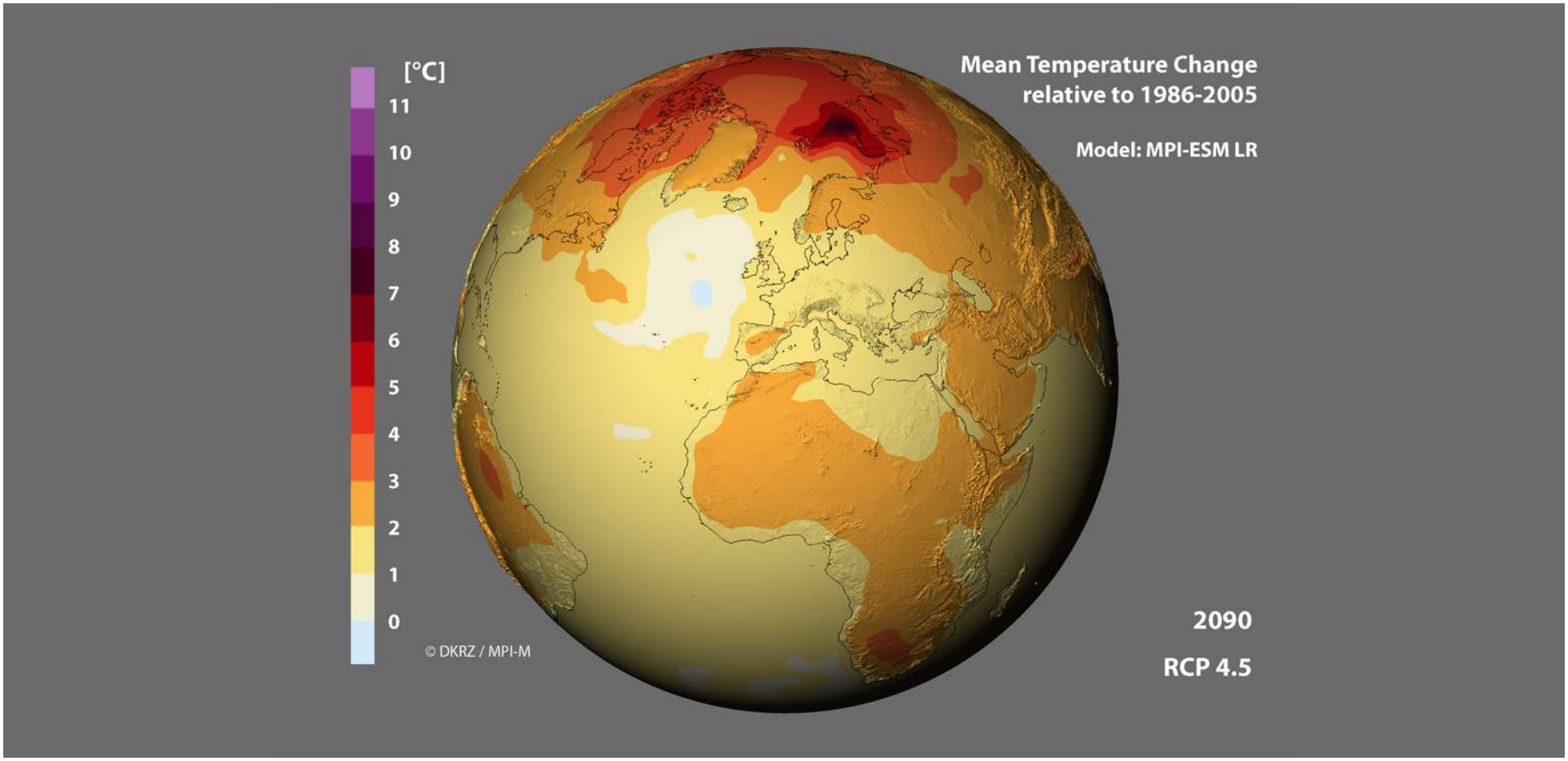

Climate models are ***not*** trying to do this.

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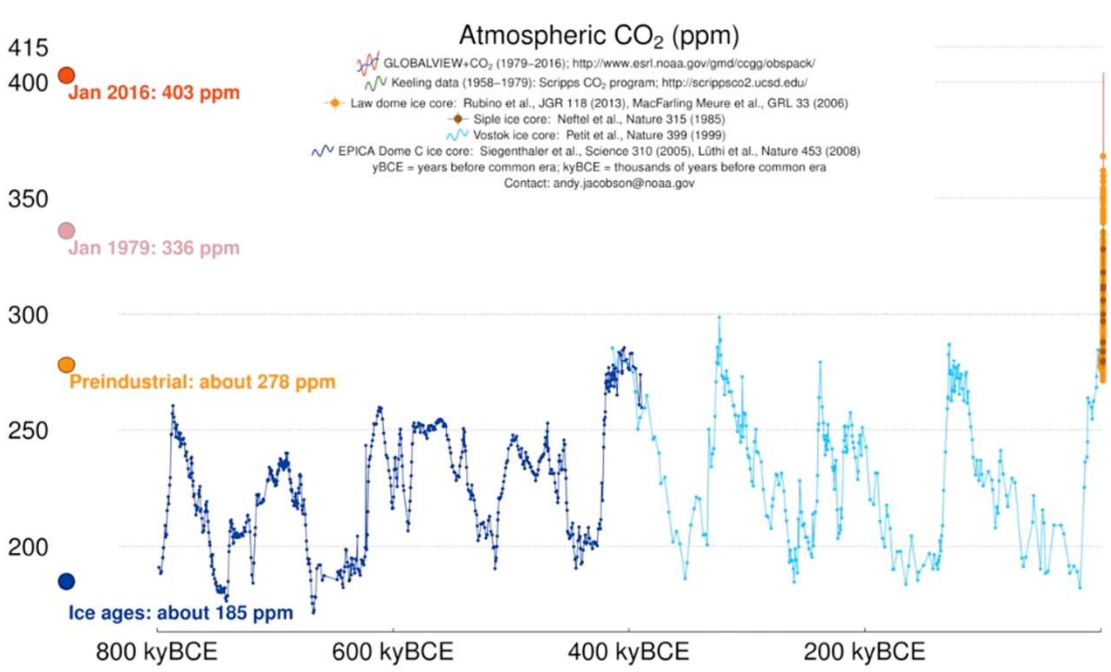

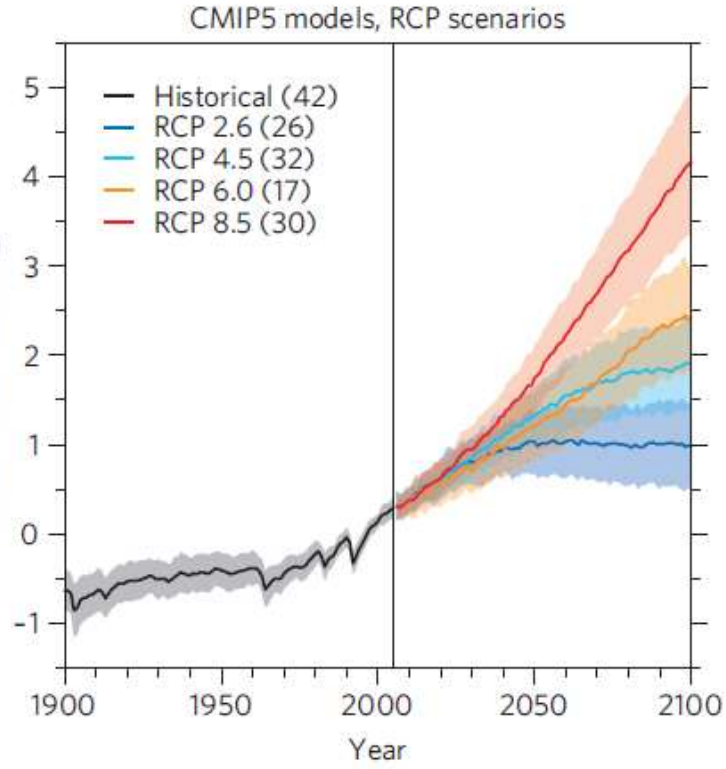

Instead, we construct experiments to simulate how the climate would respond to some change in the system

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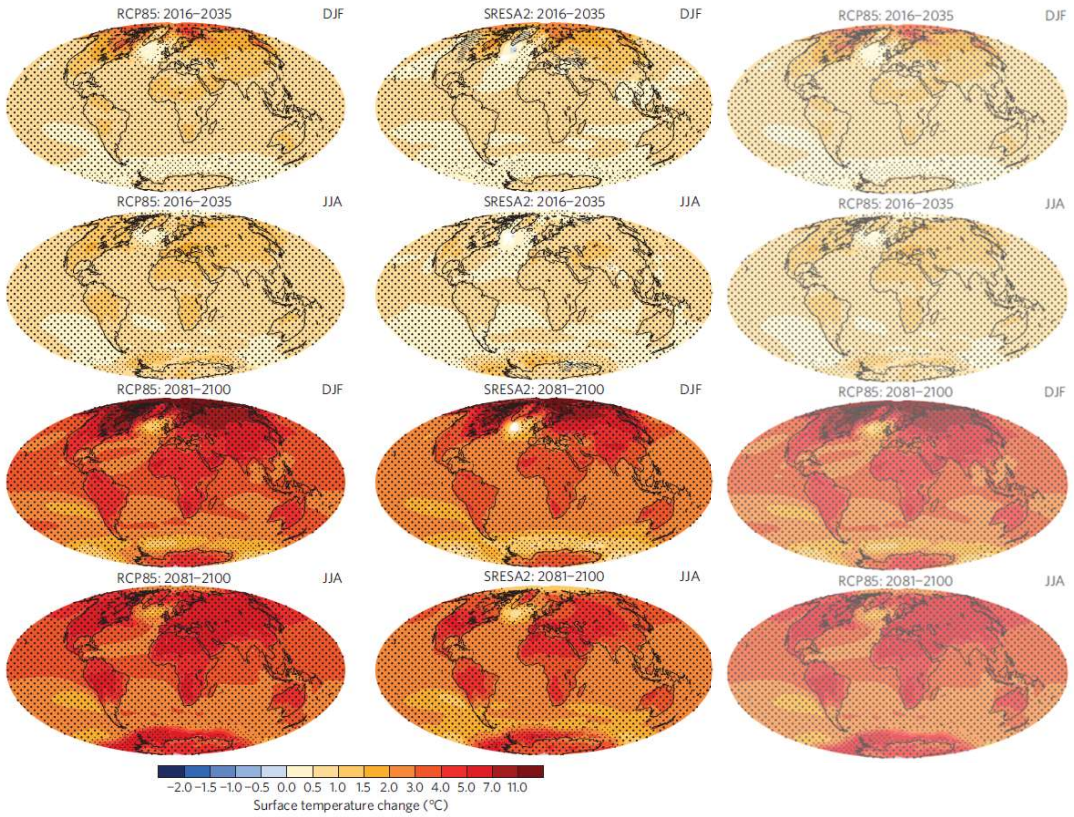

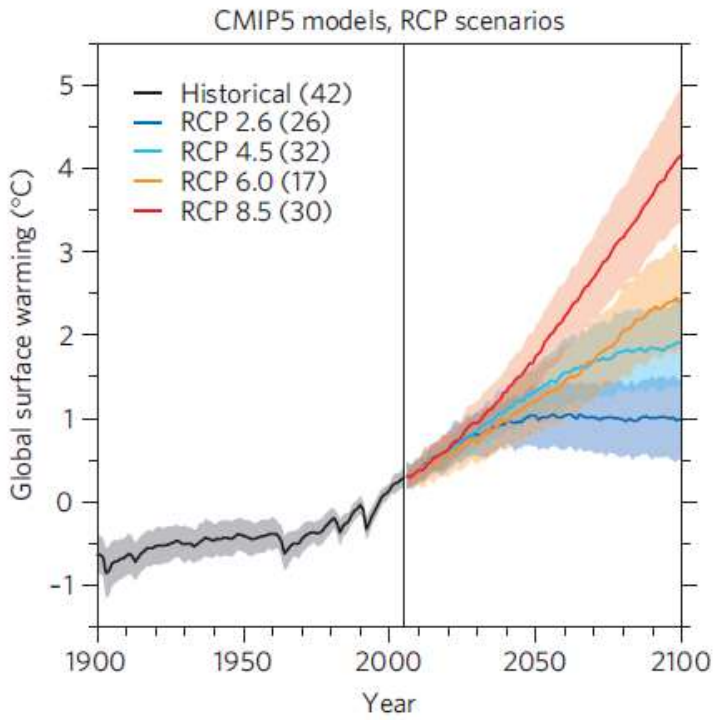

Many global models for each emissions scenario creates an ***ensemble***

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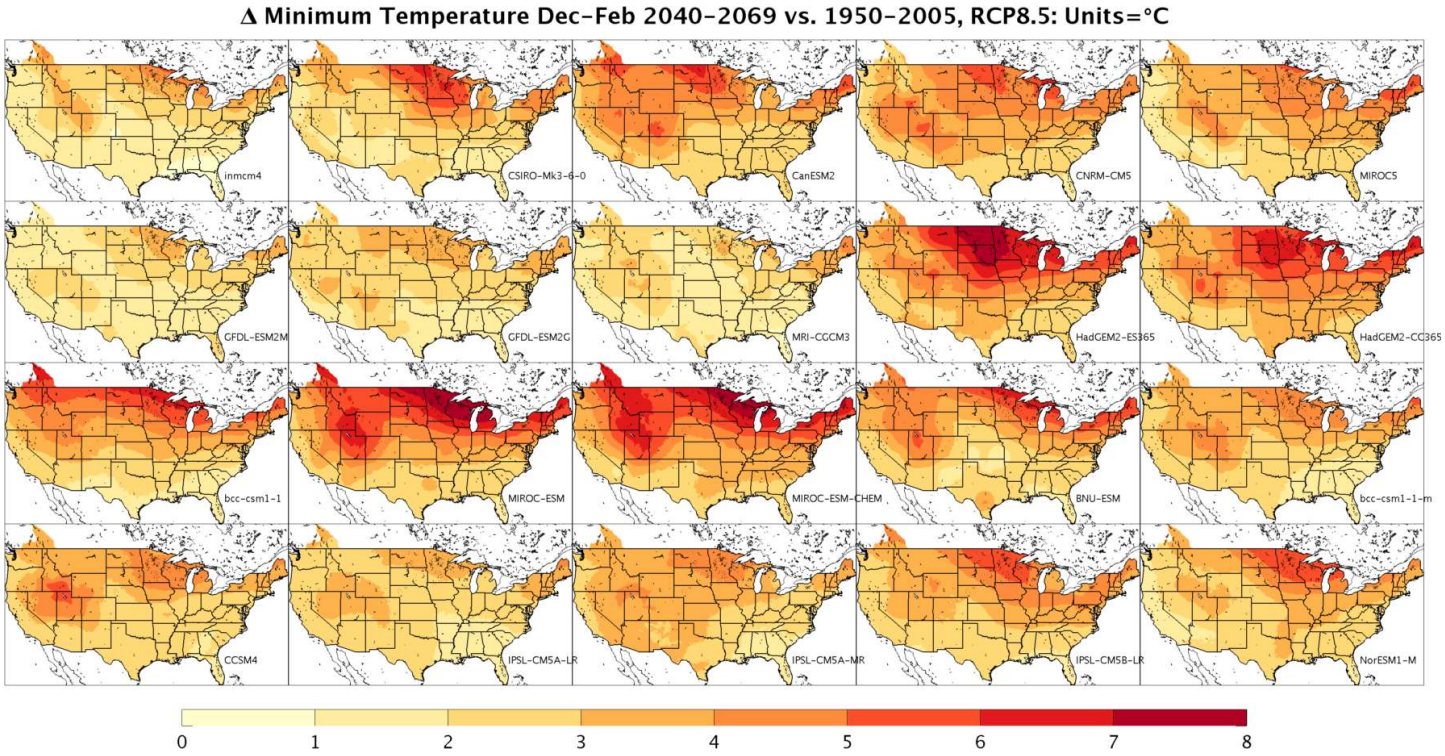

Ensemble of models permits *much* better characterization of uncertainty about future change since models performing same experiment can be analyzed together.

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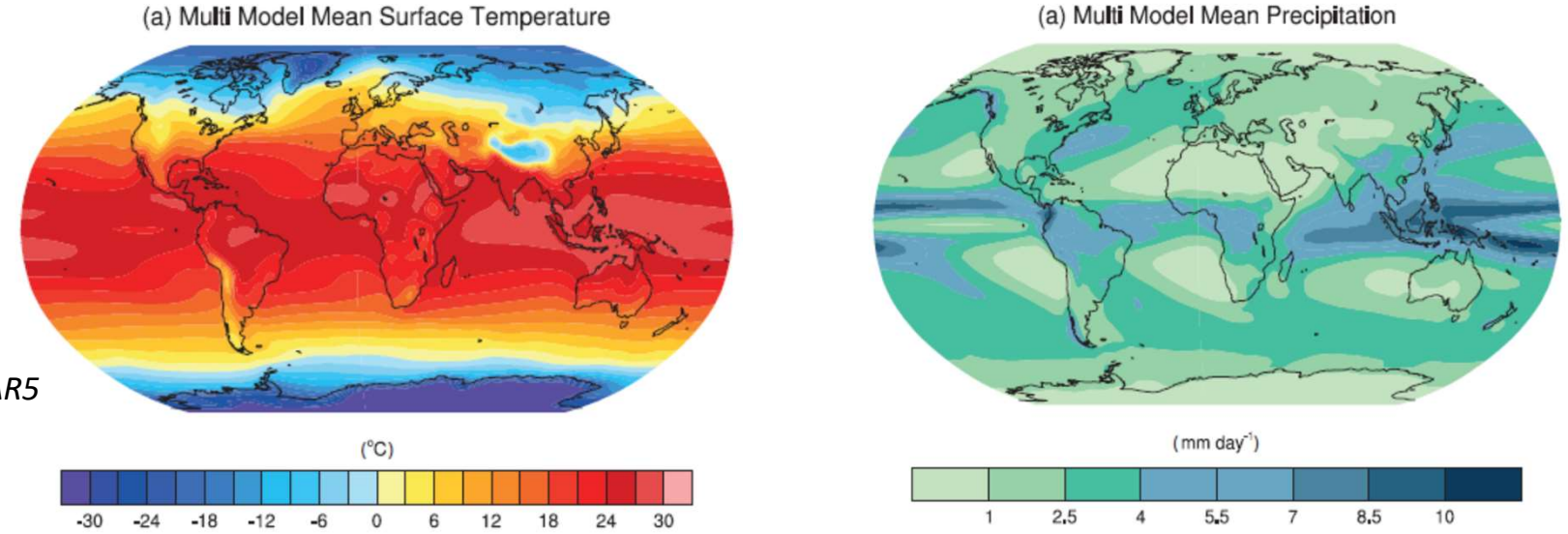
What do Global Climate Models do well?



IPCC AR5

- Global, continental general patterns (Mean Temperature, Temperature Trends, Broad atmospheric circulation)
- Representation of most large-scale climate drivers within the climate system. (GCM natural variability varies regionally)

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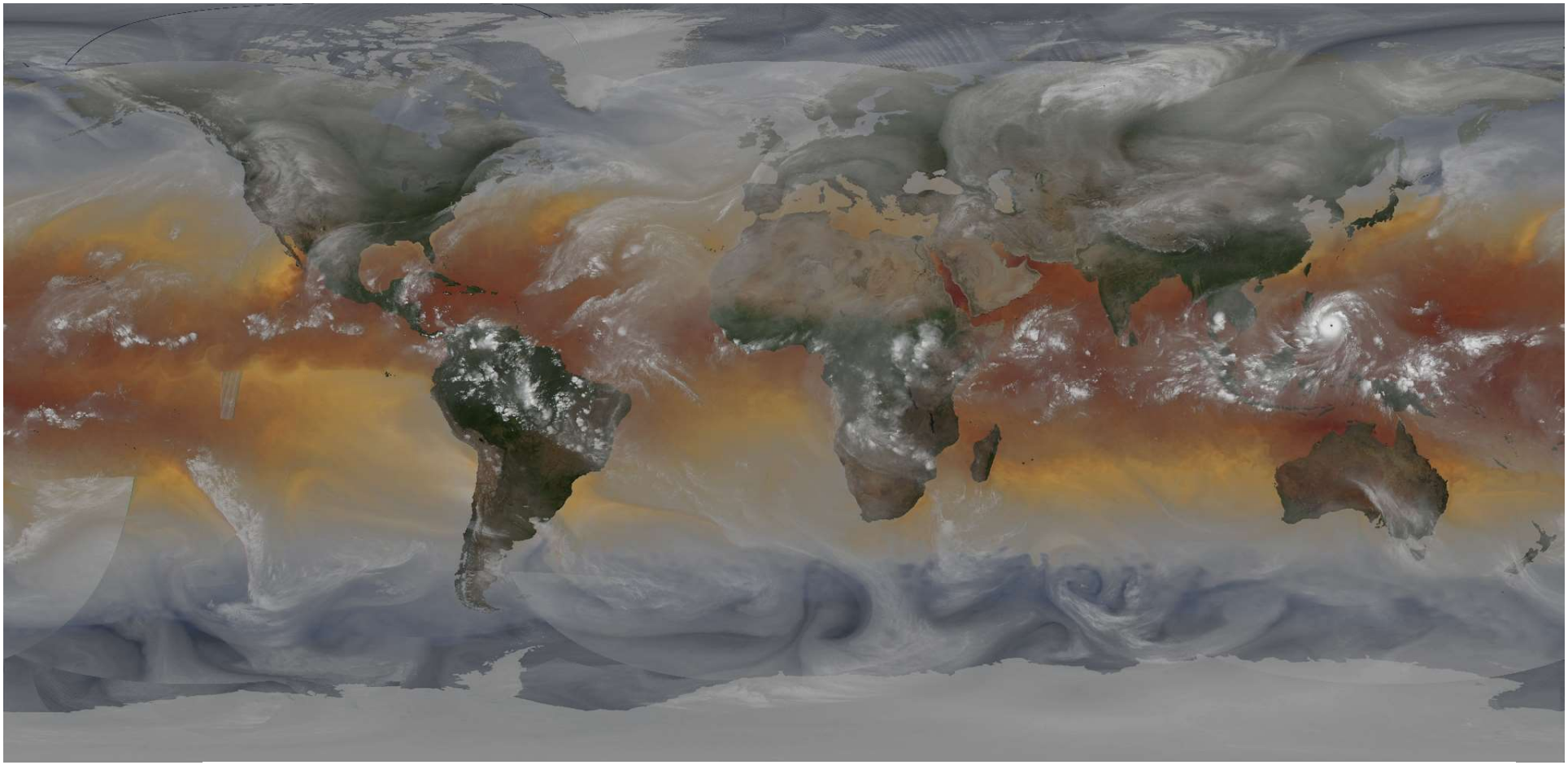

What processes are still the most challenging to model?

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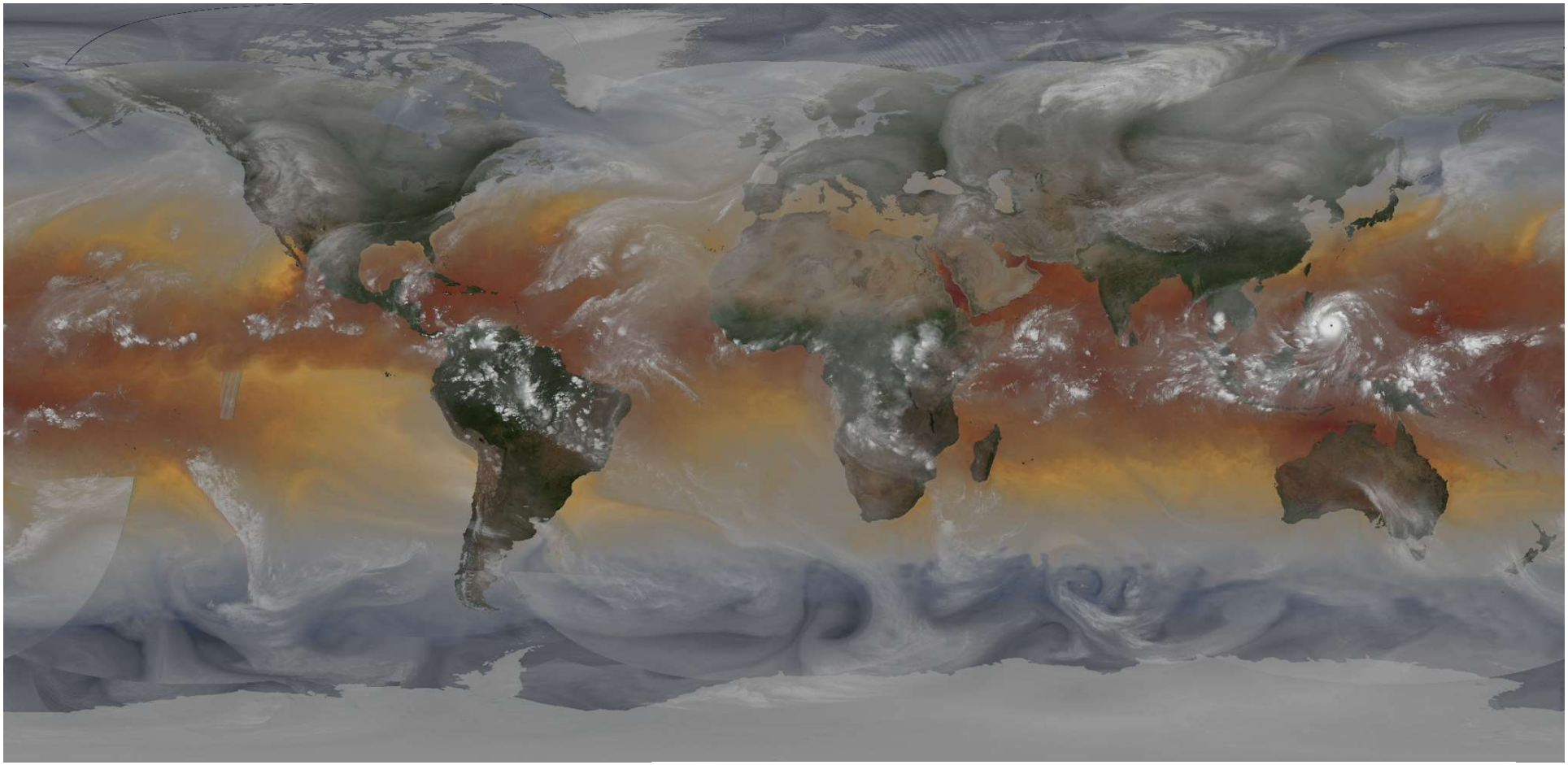

CLOUDS

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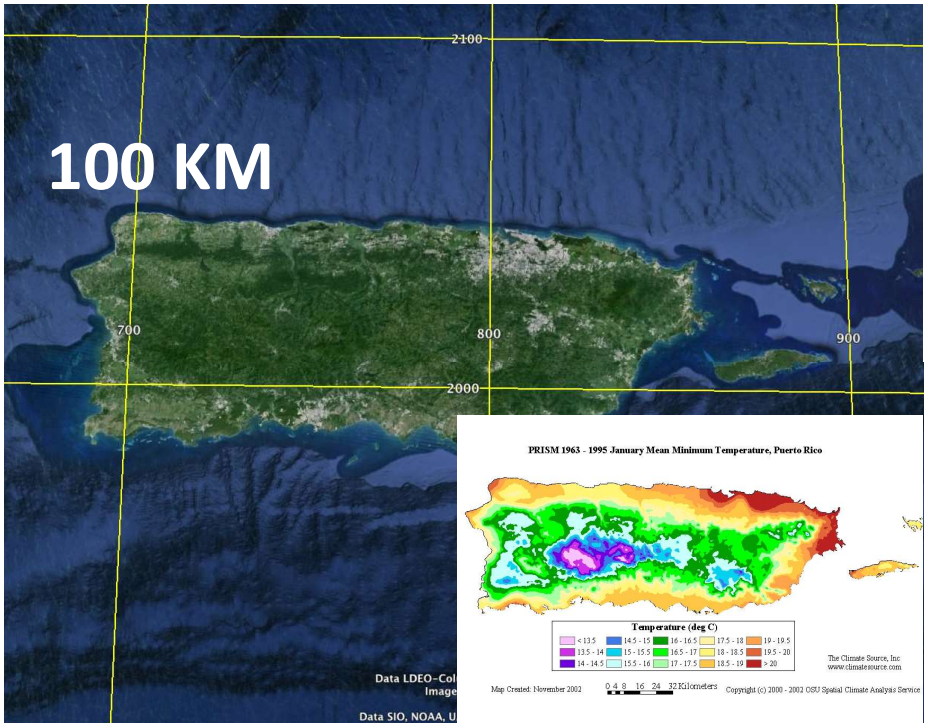

- Regional climate (topography, land cover, island climates, complex coastlines)
- Representing extreme events (i.e. storm frequency and intensity)

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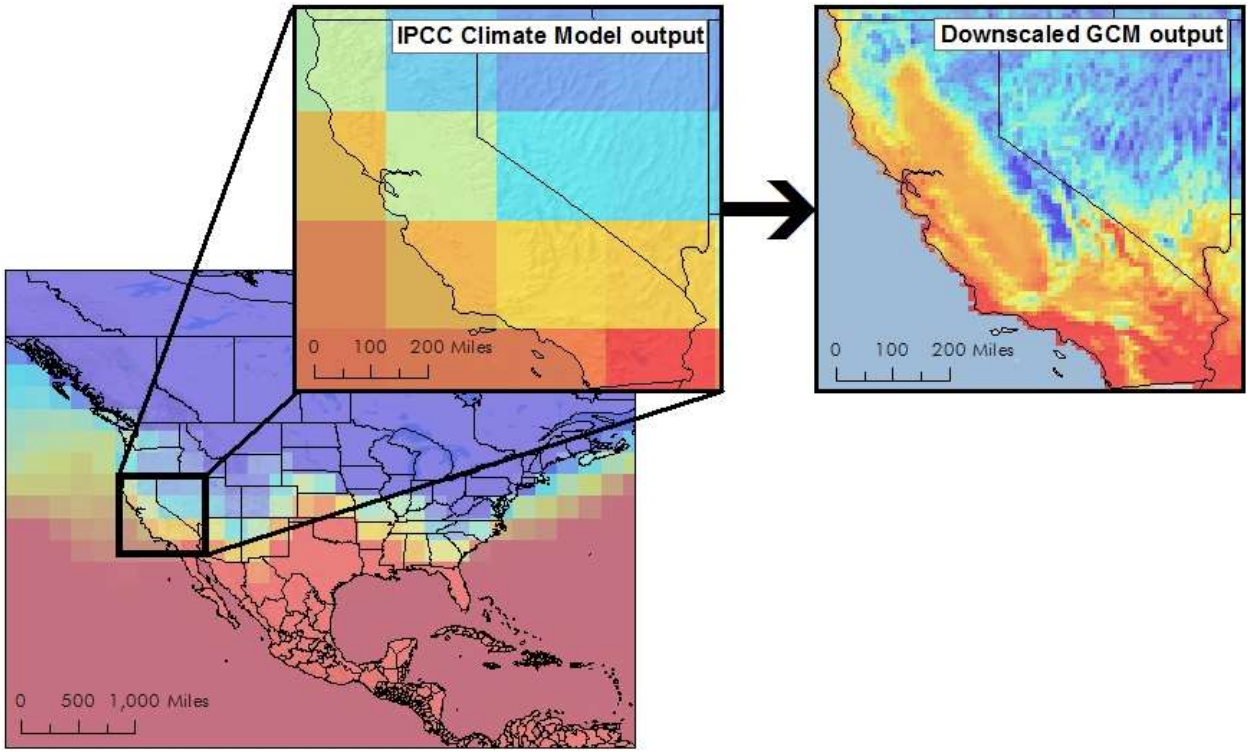
Can we 'downscale' the right predictor variables to relevant spatial scales with accuracy in the right places?



Cal-adapt.org

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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
- Use a collection (ensemble) of projections
  - Often, downscaled climate model projections
  - Choosing the right ones is tricky, based on system of study

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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)

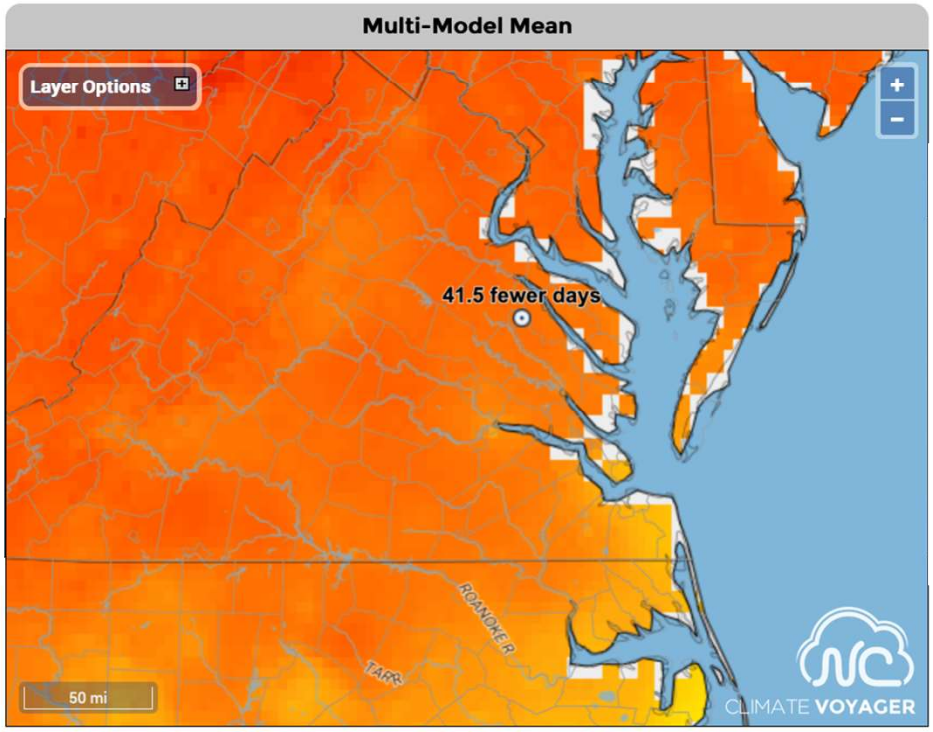
+8 ±0 -8 -16 -24 -32 -40 -48 -56 -64 -72 -80 -88 -96 days

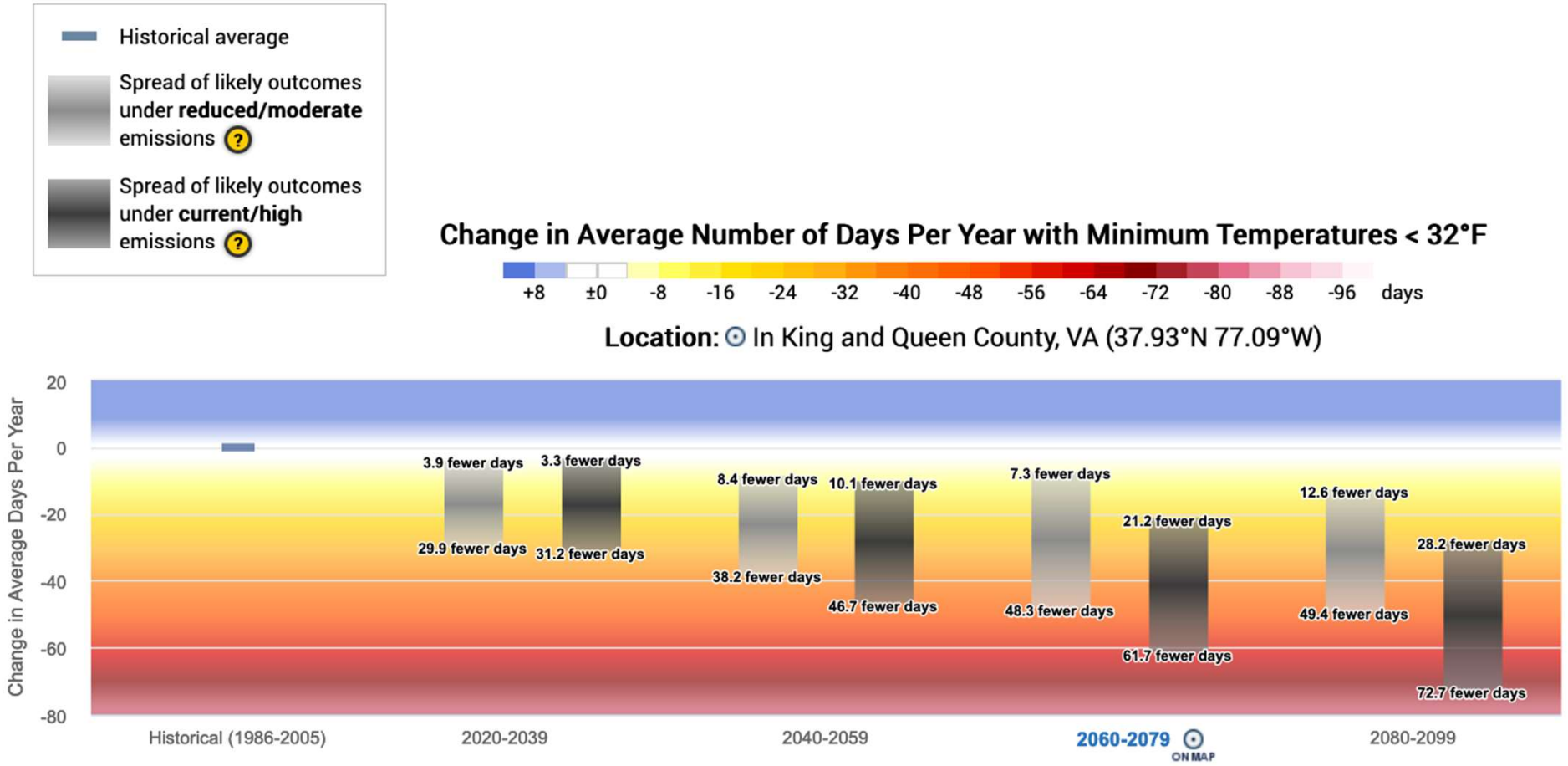
Location: In King and Queen County, VA (37.93°N 77.09°W)

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




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

Projected Change in Average Summer (June - August) Precipitation

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

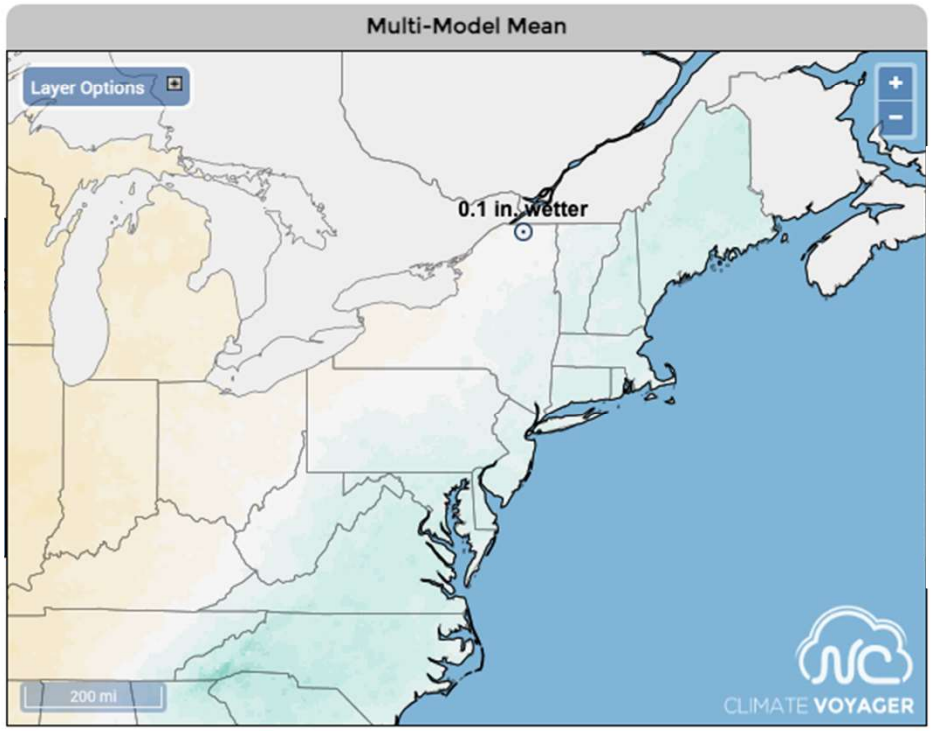
-4 -3 -2 -1 ±0 +1 +2 +3 +4 inches

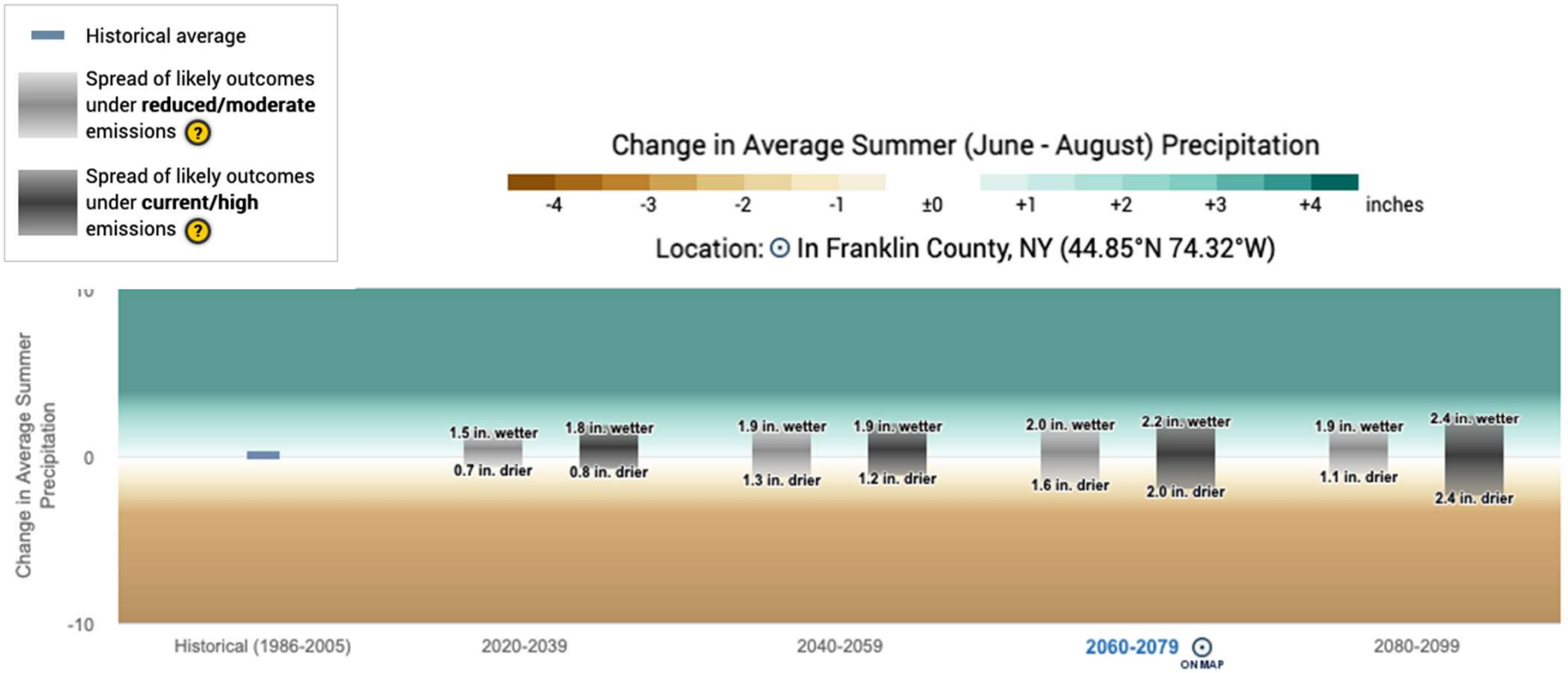
Location: In Franklin County, NY (44.85°N 74.32°W)

To select a location, click on the map or enter your coordinates: 44.85 °N, 74.32 °W Go

? Map Help

? About the Side Maps




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 Franklin County, NY (44.85°N 74.32°W)
Change in Average Summer Precipitation
10
0
-10
1.5 in. wetter
0.7 in. drier
1.8 in. wetter
0.8 in. drier
1.9 in. wetter
1.3 in. drier
1.9 in. wetter
1.2 in. drier
2.0 in. wetter
1.6 in. drier
2.2 in. wetter
2.0 in. drier
1.9 in. wetter
1.1 in. drier
2.4 in. wetter
2.4 in. drier
Historical (1986-2005)
2020-2039
2040-2059
2060-2079
ON MAP
2080-2099

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 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 should be analyzed to better characterize uncertainty and risks

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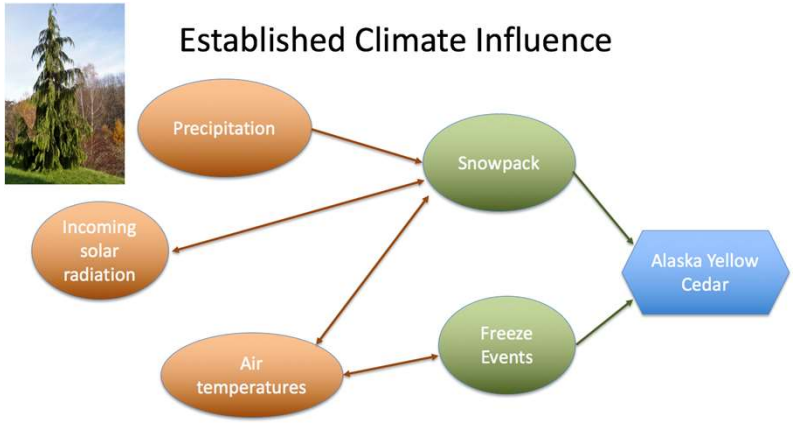
A Few Take Aways:

- 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



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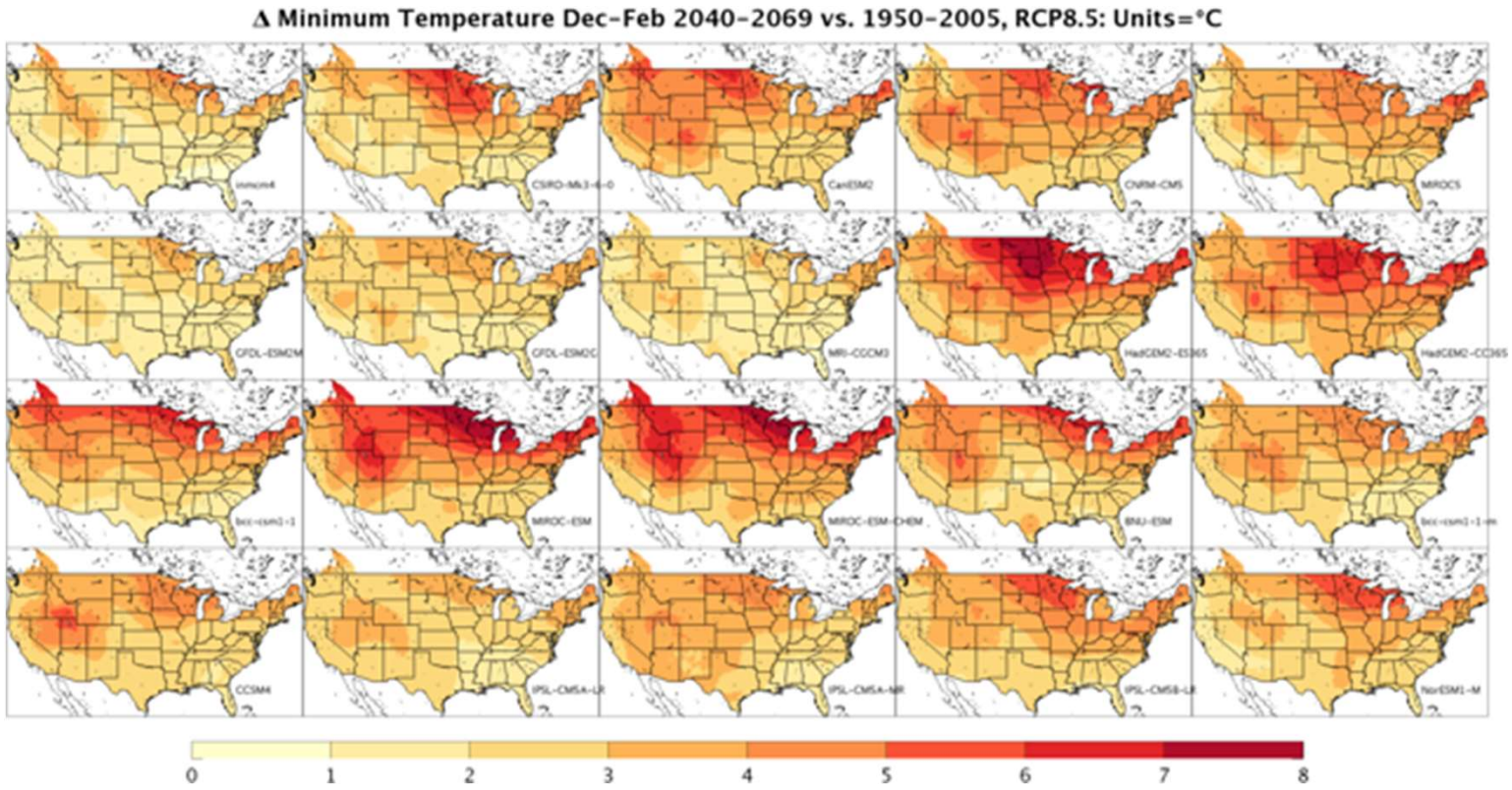
Remember: There is no single best climate model….



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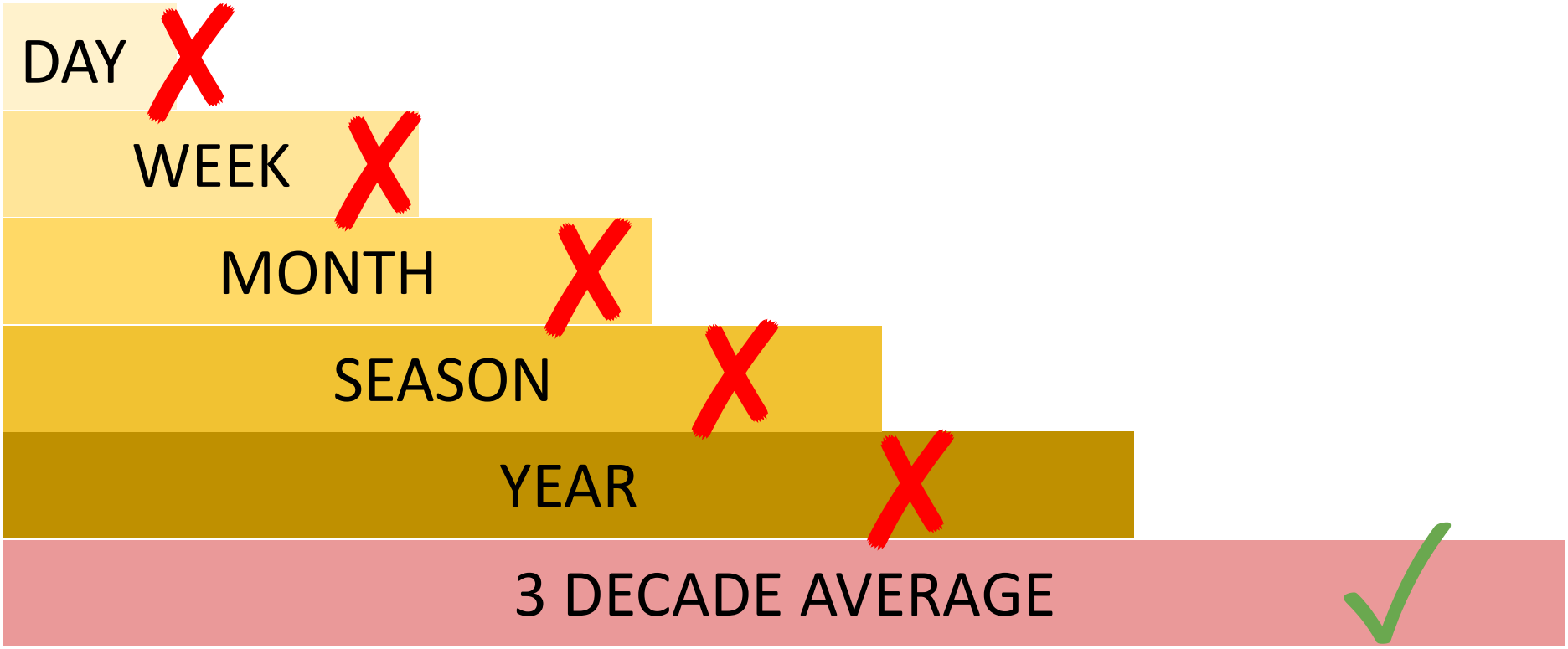
Remember: Projections look at changes over climate time scales



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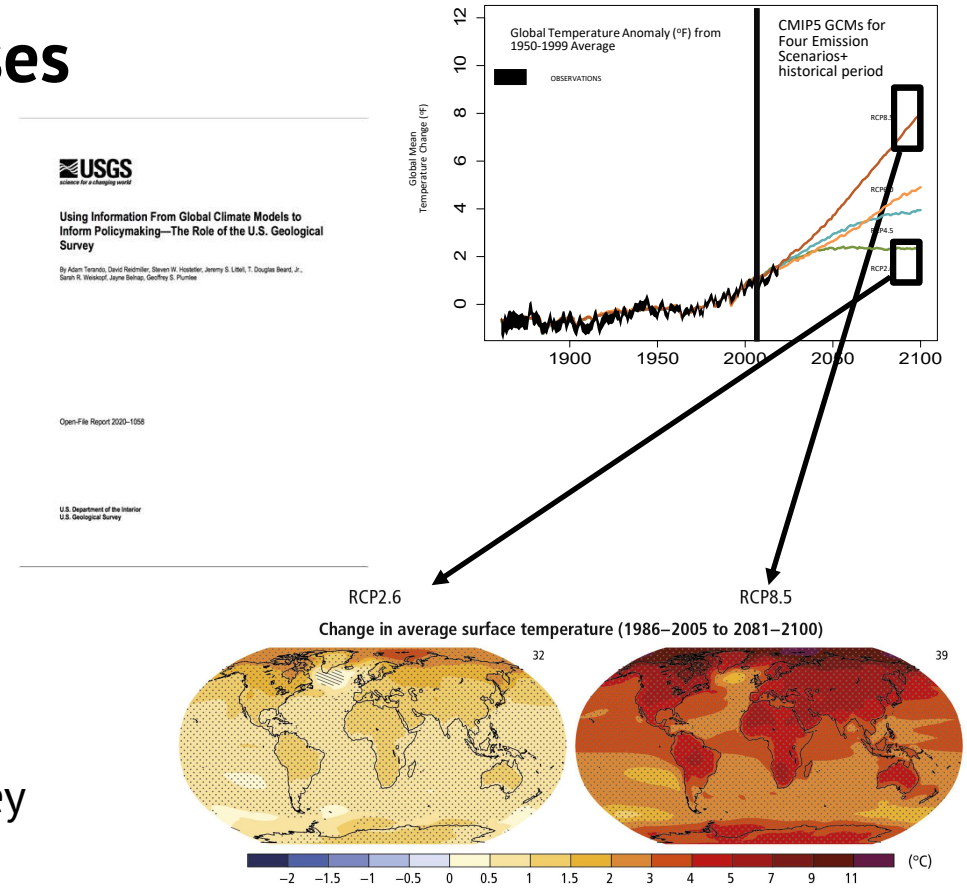
(USGS) Best Practices for Climate Projections & Impacts Analyses

- Use a wide range of scenarios
- Use multiple models
- Consider climate-relevant timescales, including 100+ years if:
  - Delayed impacts may arise from historic emissions (e.g., SLR)
  - There is the potential for irreversible impacts (e.g., species extinction)
  - Crossing thresholds that cause major impacts (e.g., over-wintering)
- Articulate the uncertainties and how they are expected to evolve



EXTRA