INCORPORATING FUTURE CLIMATE PROJECTIONS INTO ADAPTATION PLANNING

A LAYMAN'S GUIDE

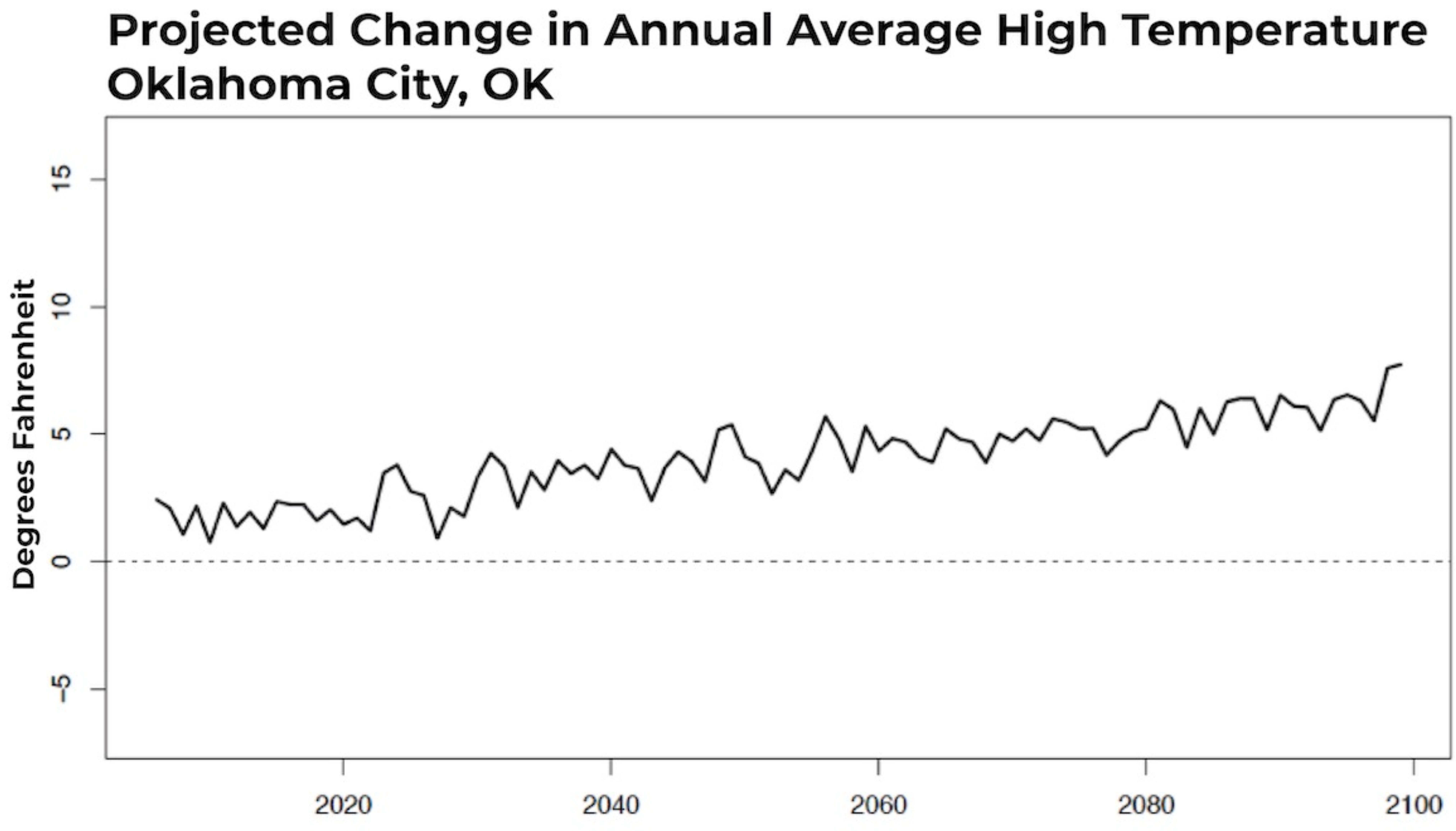
SOUTH CENTRAL
CLIMATE ADAPTATION SCIENCE CENTER

CLIMATE PROJECTIONS – WHAT ARE THEY?

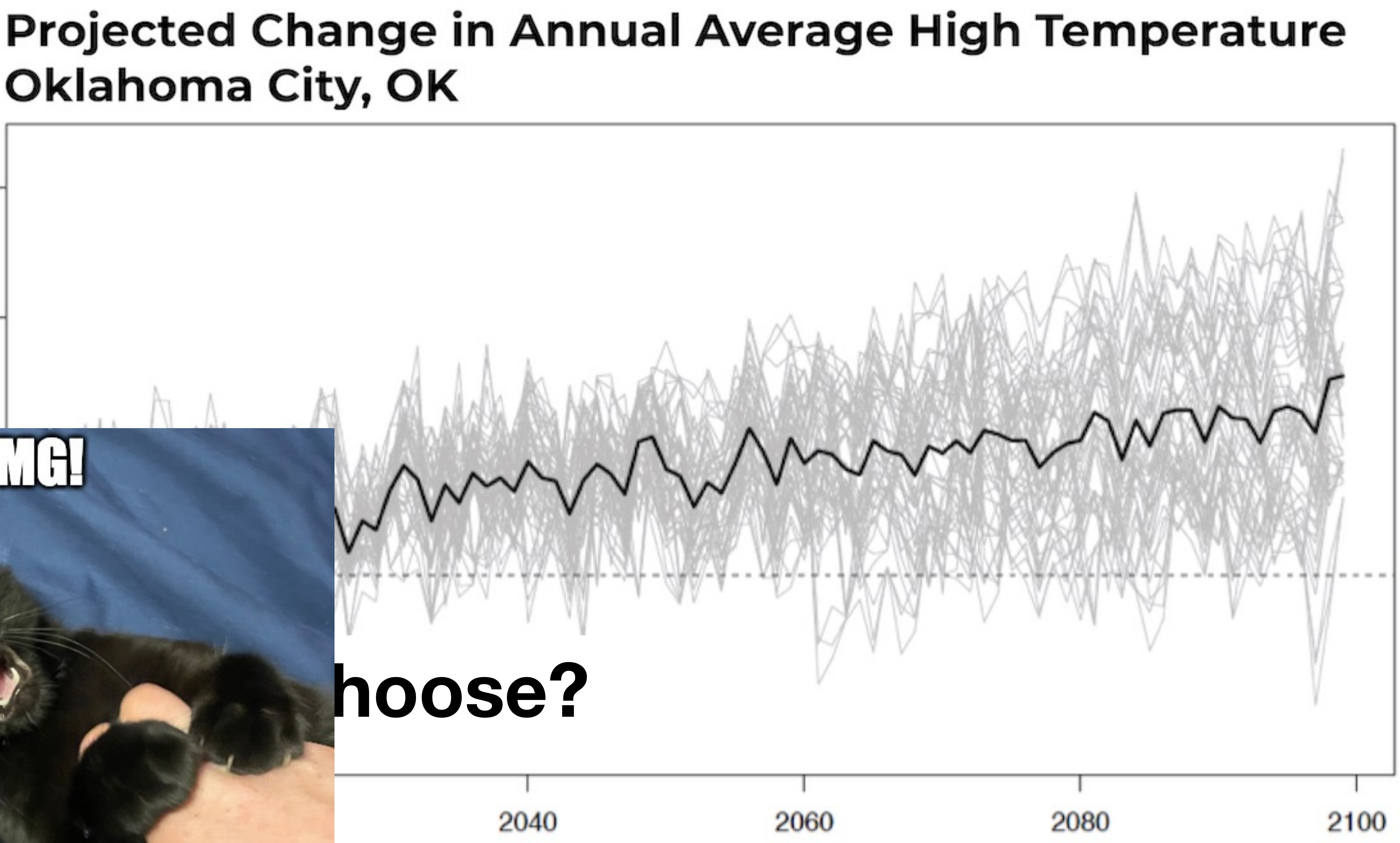
- General – any description of the future climate and the pathway leading to it.

- Specific – model-derived estimates of future climate

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP



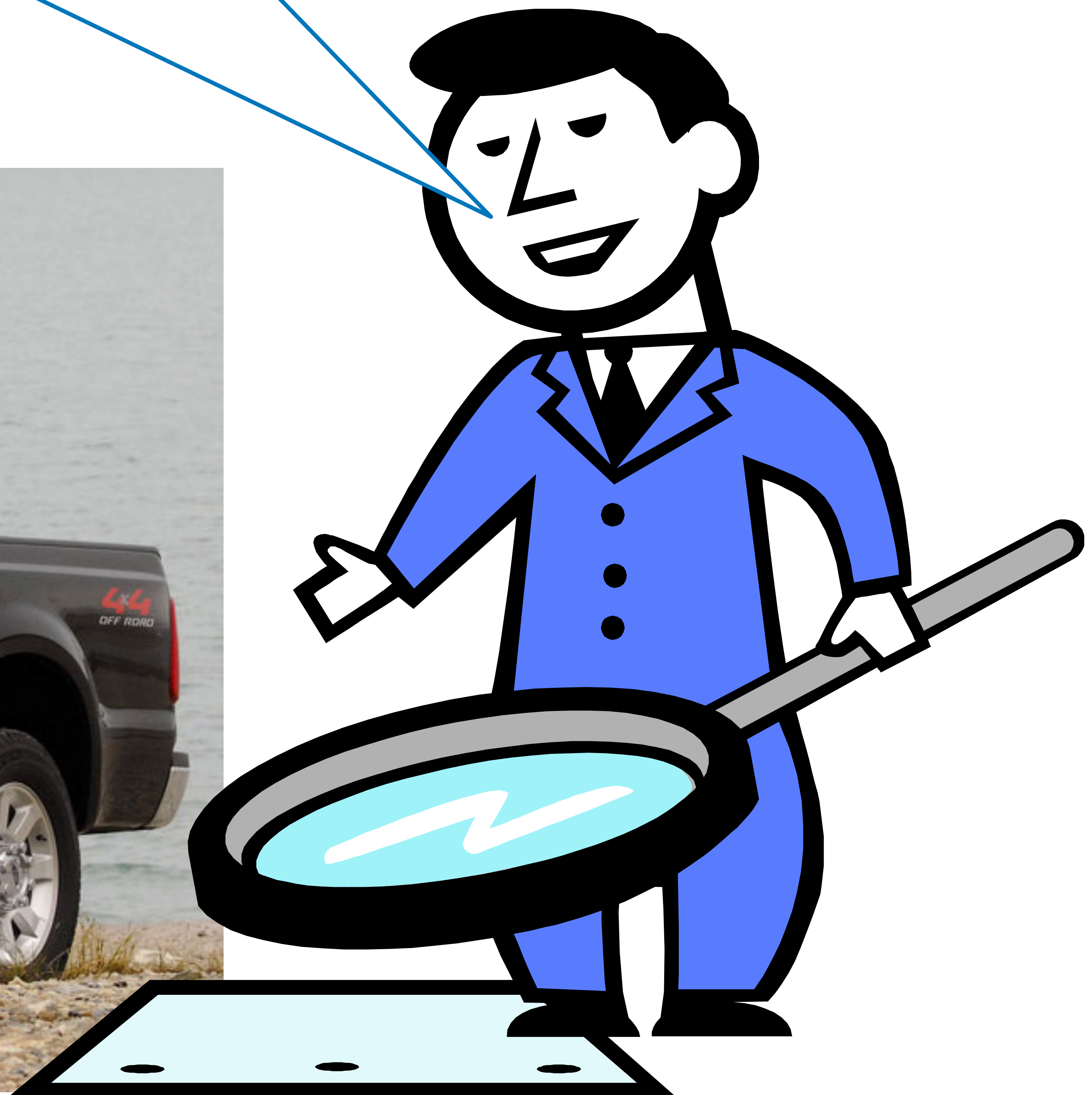
Data from the South Central Climate Projections Evaluation Project (C-PrEP)



hoose?

Data from the South Central Climate Projections Evaluation Project (C-PrEP)

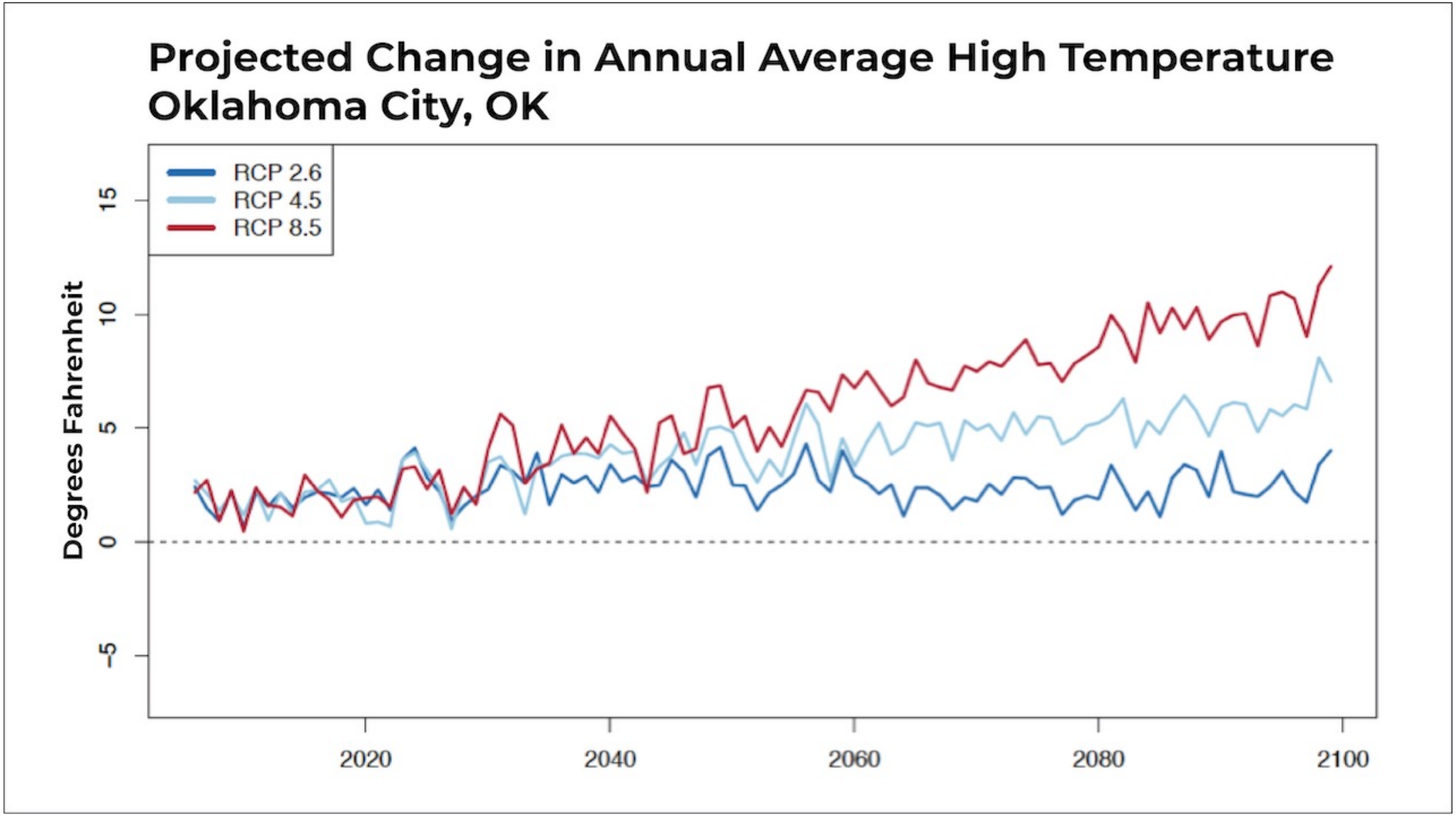
THERE ARE MANY FUTURE PROJECTIONS!



WHY SO MANY PROJECTIONS?

- Human / Societal Action
  - How much emissions? How much development?
- Scientific
  - What don’t we understand well yet?
- Global to Local
  - How to determine what global change means locally?

Why science teachers should not be given playground duty.


Projected Change in Annual Average High Temperature
Oklahoma City, OK
RCP 2.6
RCP 4.5
RCP 8.5
Degrees Fahrenheit
15
10
5
0
−5
2020
2040
2060
2080
2100

Climate is Physics

Things like:

- Conservation of momentum
- Conservation of mass $\dfrac{Du}{Dt} - fv = -\dfrac{\partial \phi}{\partial x} - F_x$
- Conservation of energy $\dfrac{\partial u}{\partial x} + \dfrac{\partial v}{\partial y} + \dfrac{\partial \omega}{\partial p} = 0$
- Conservation of water $\dfrac{\partial T}{dt} + u\dfrac{\partial T}{dx} + v\dfrac{\partial T}{dy} + \omega\left(\dfrac{\partial T}{\partial p} + \dfrac{RT}{pc_p}\right) = \dfrac{J}{c_p}$
- Ideal Gas Law $p = \rho RT$

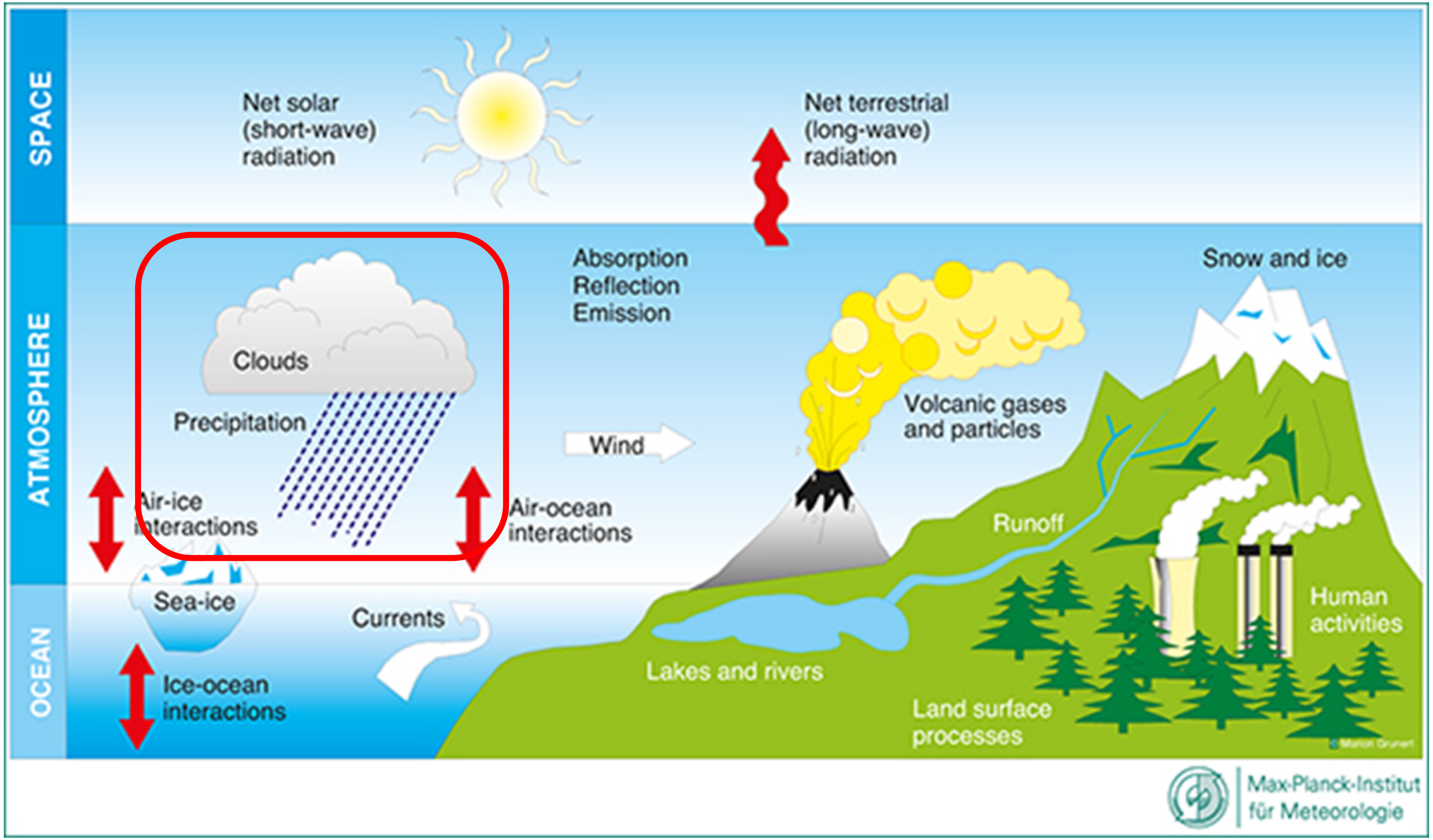
The equations are converted to a form where they can be programmed for computers to solve.

GLOBAL CLIMATE MODELS (GCMS)

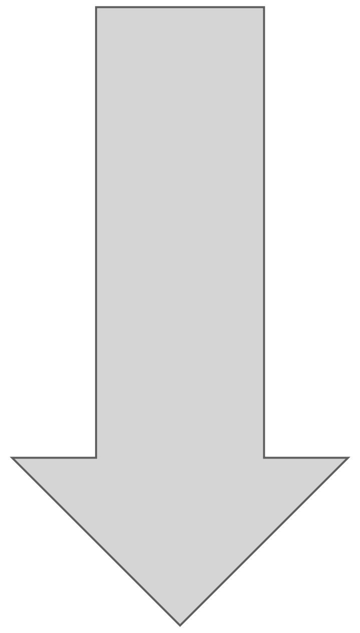
- GCMs are ***not*** trying to predict the weather on any given day.
- Instead – we want to understand how weather ***on average*** will change given some changes in external forcing.
  - What happens if CO_2 doubles?

THERE ARE MANY MODELS OUT THERE! WHY?

FOR EXAMPLE... LET'S TAKE CLOUD FORMATION



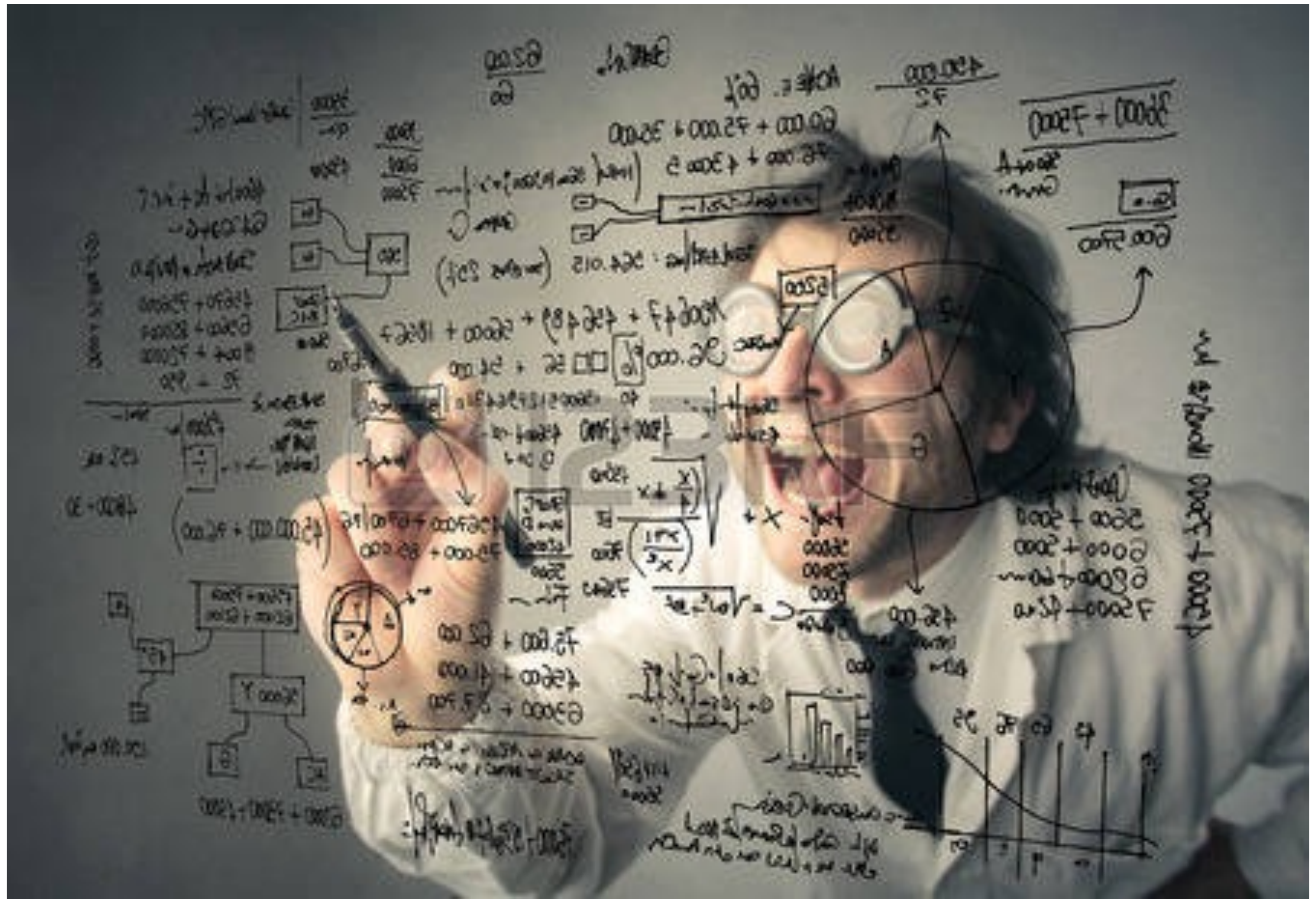
Different equations

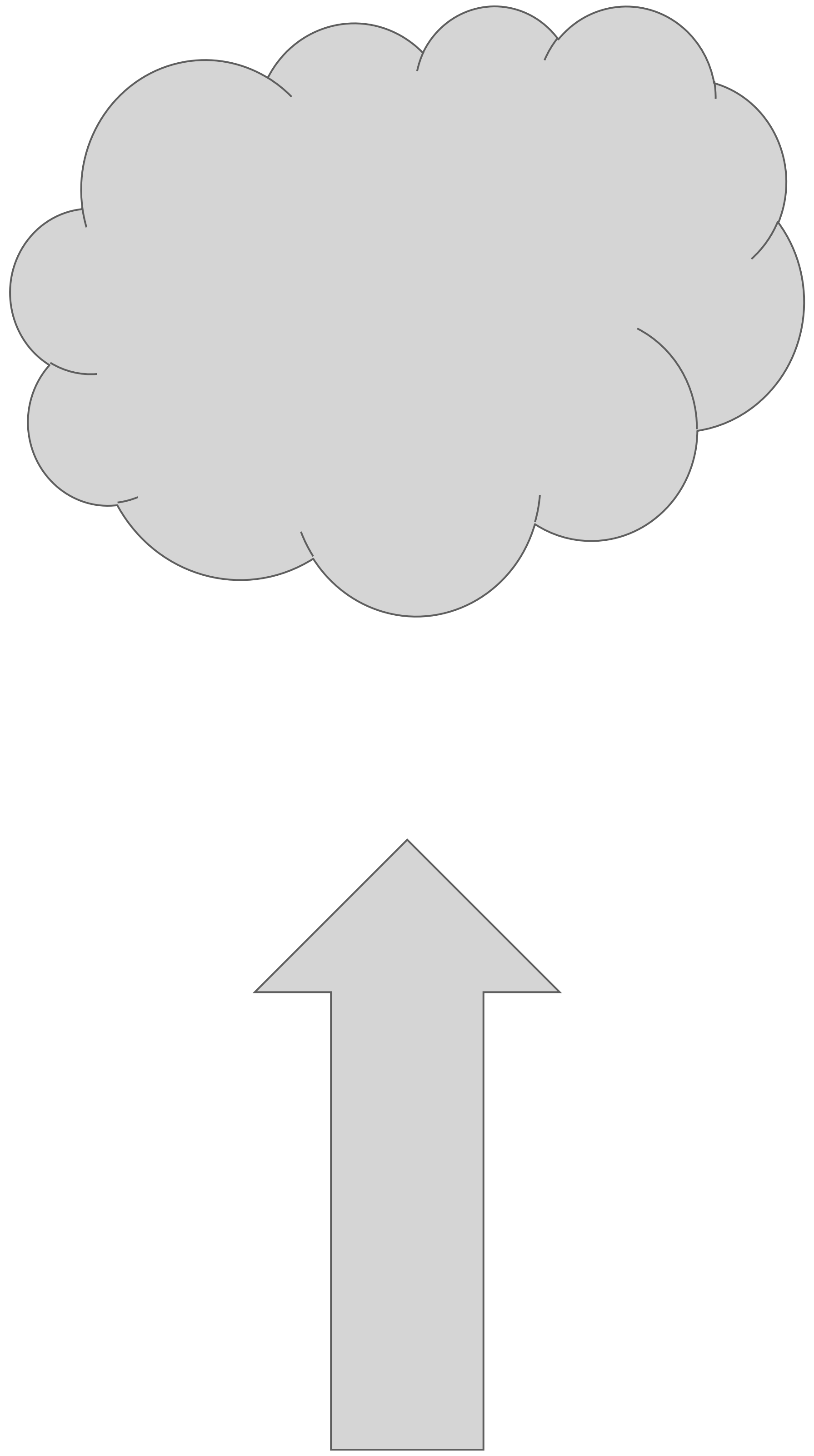


Different models

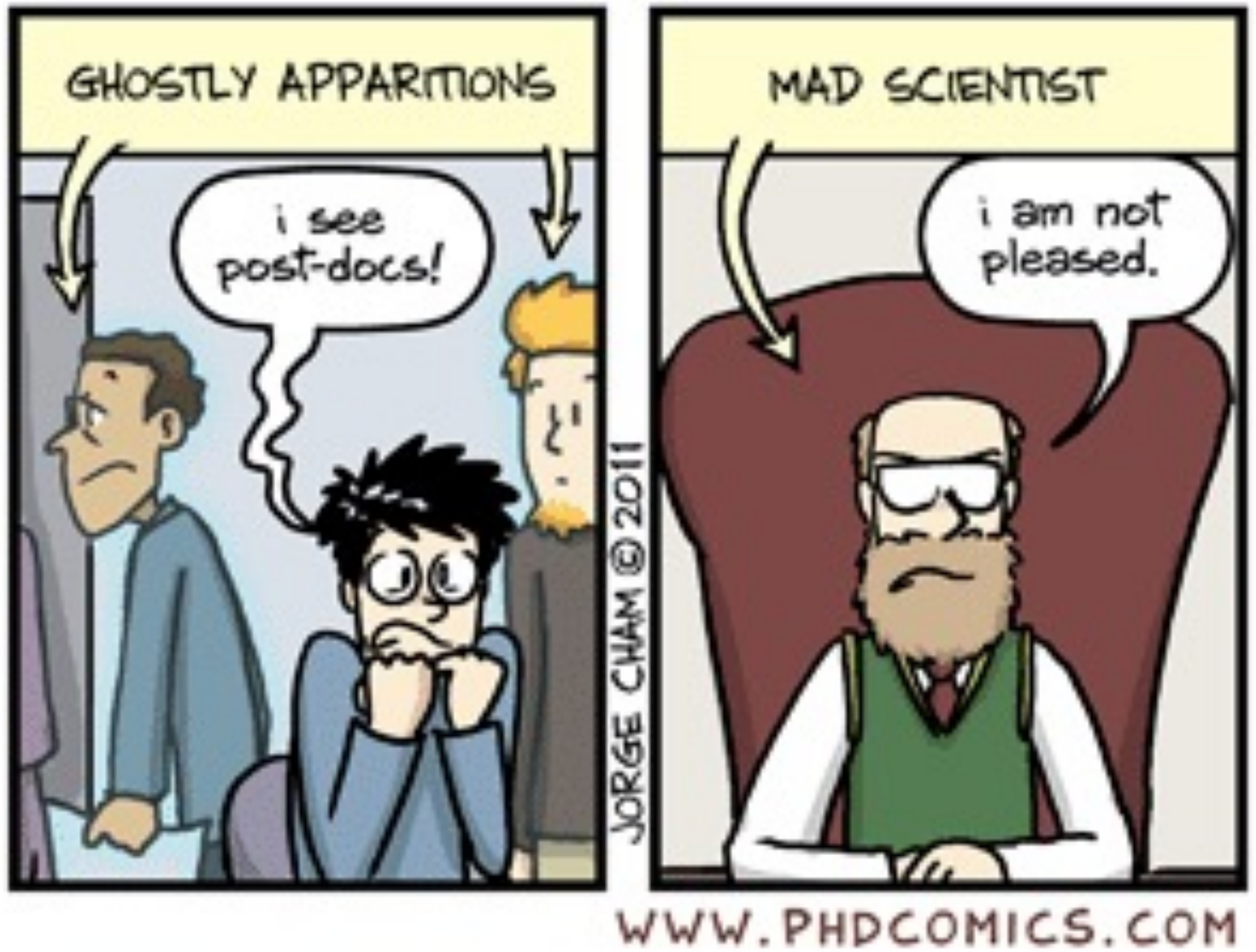
A COUPLE WAYS TO REPRESENT CLOUD FORMATION

$$C = 5.13 \times T$$

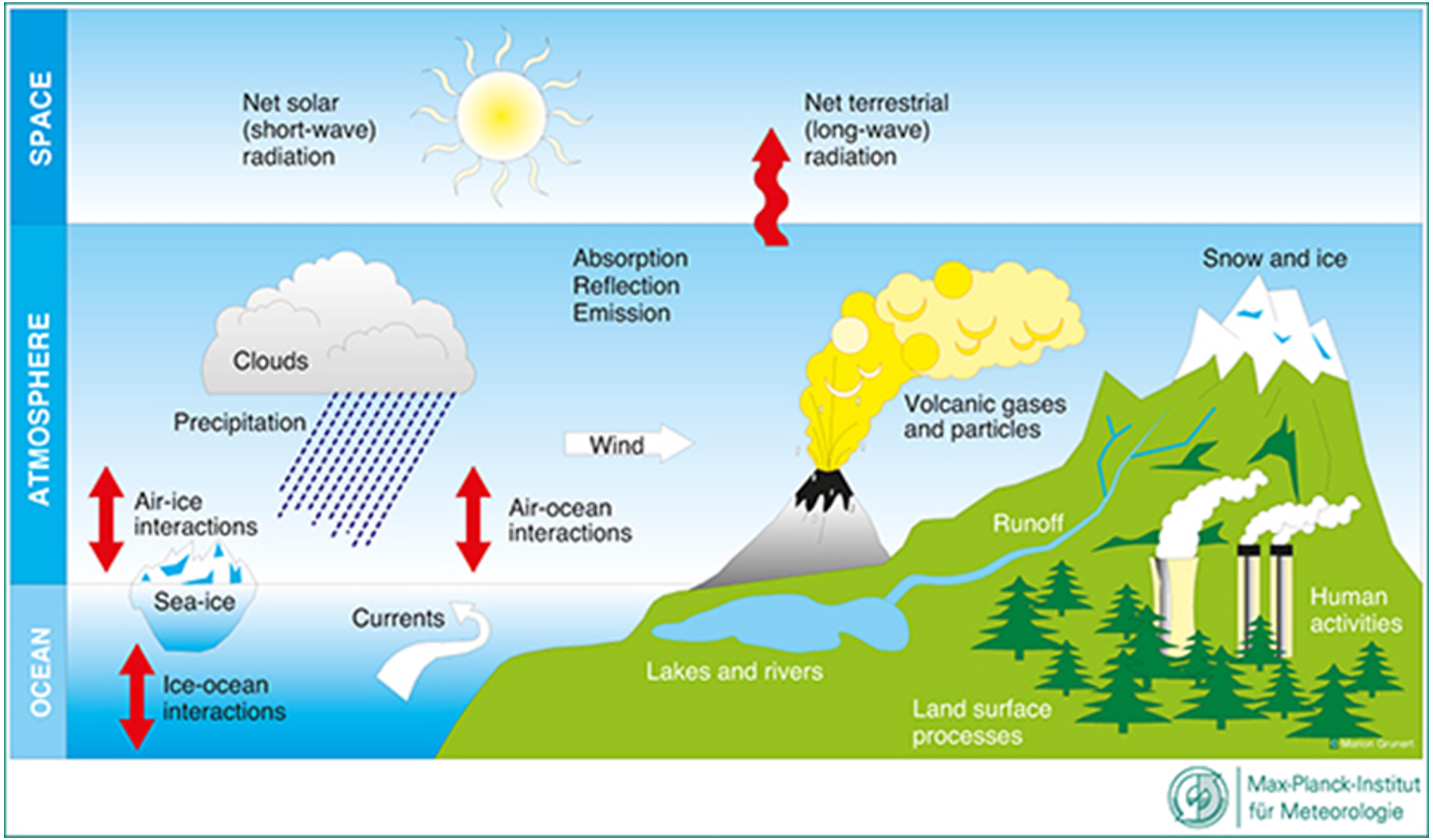




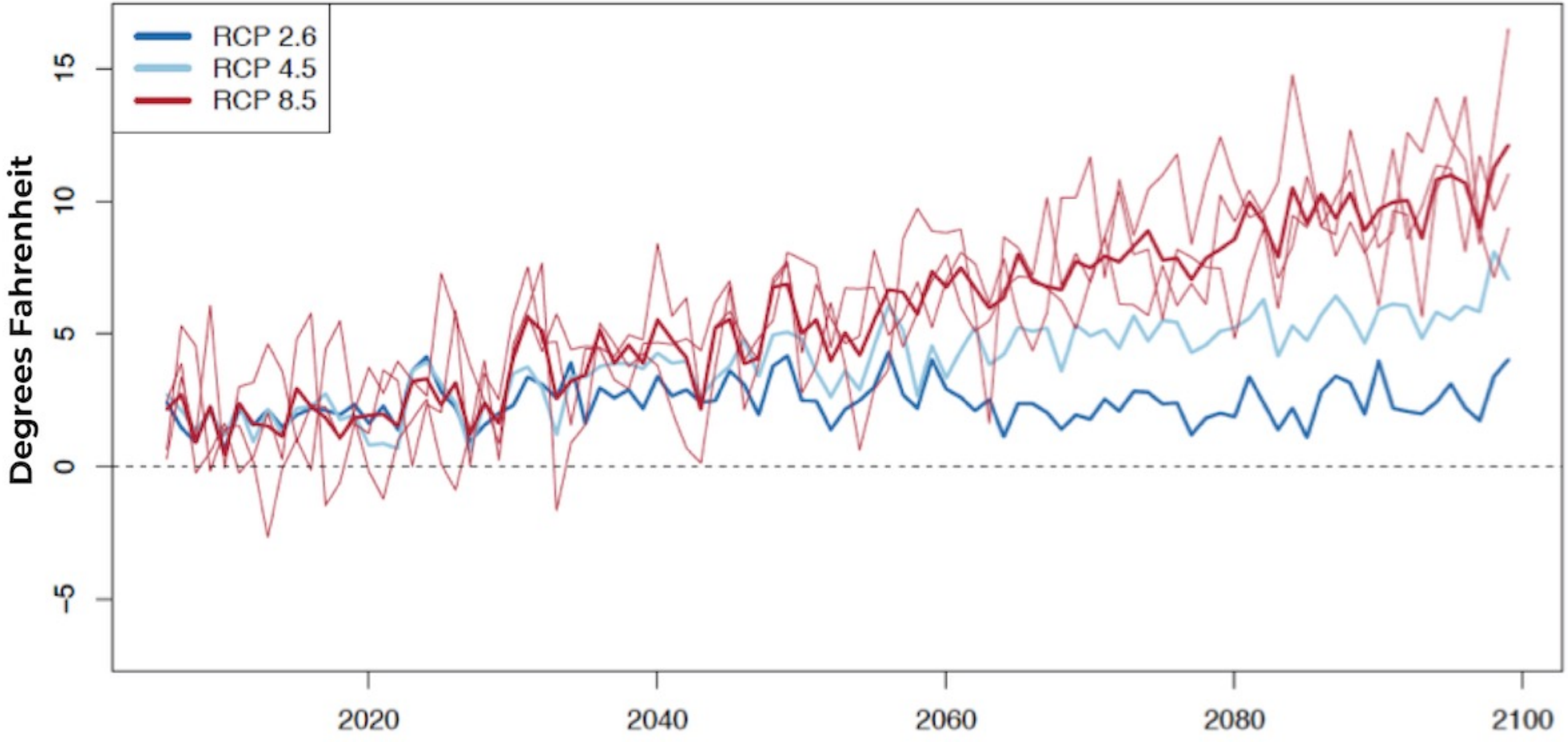
$$C = 4.82 \times T$$



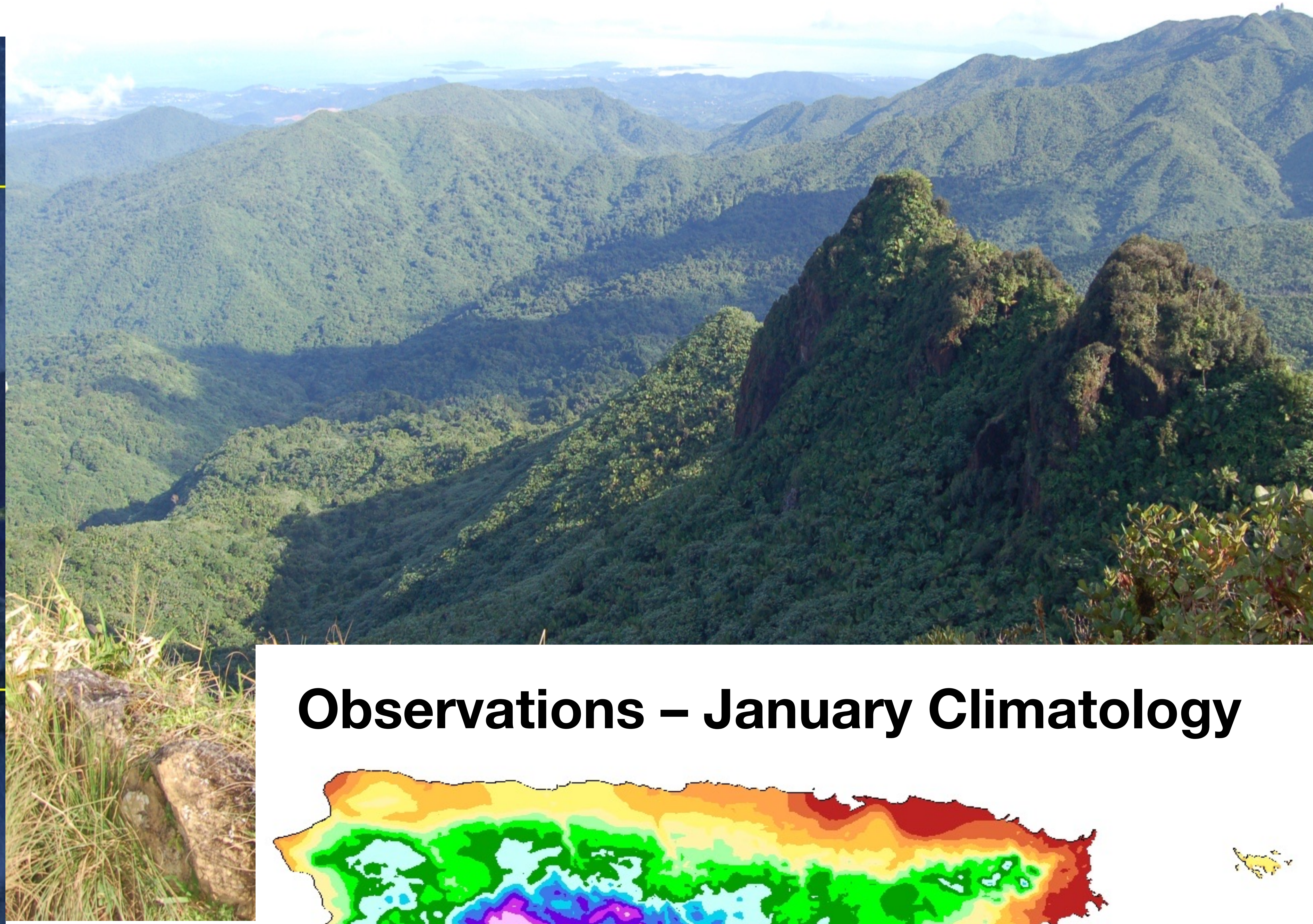
...AND THERE ARE MANY, MANY MORE PROCESSES!



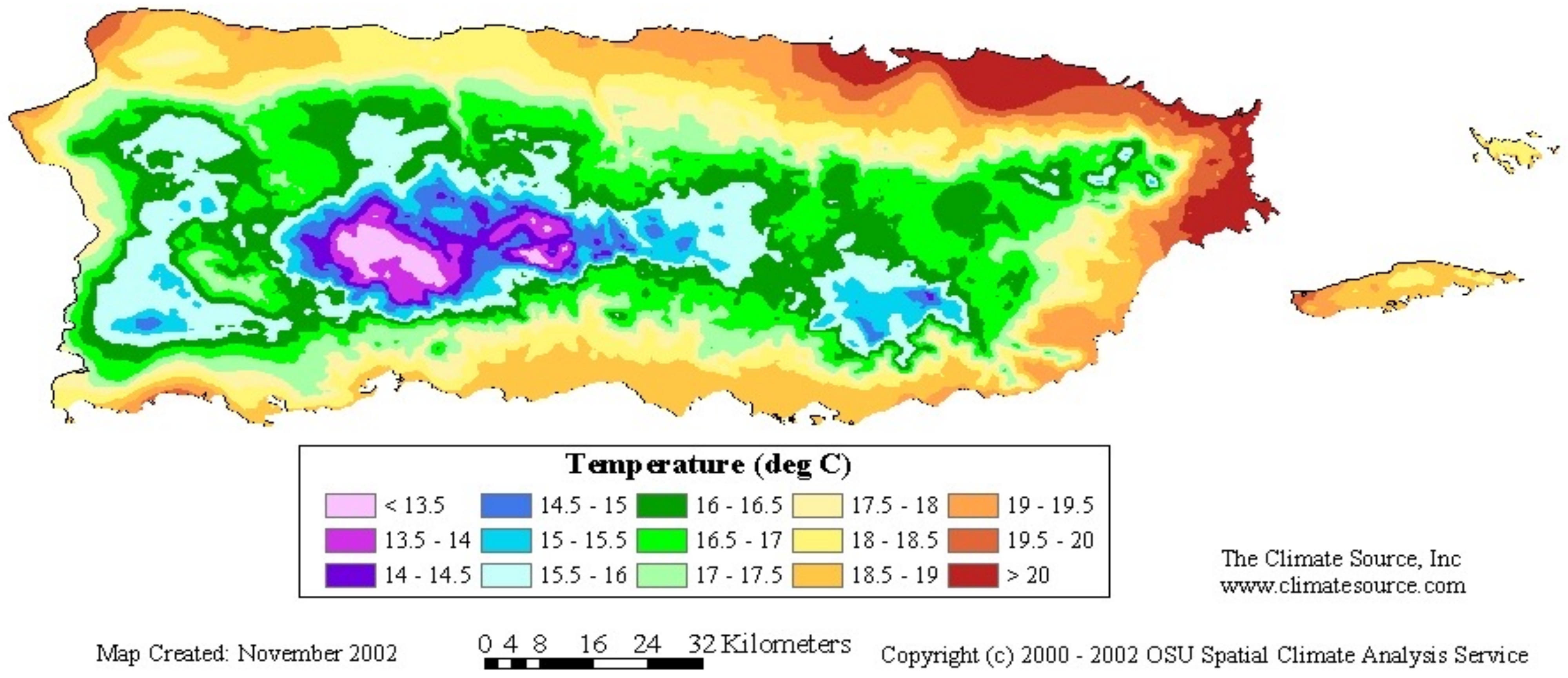
Projected Change in Annual Average High Temperature
Oklahoma City, OK



DOWNSCALING

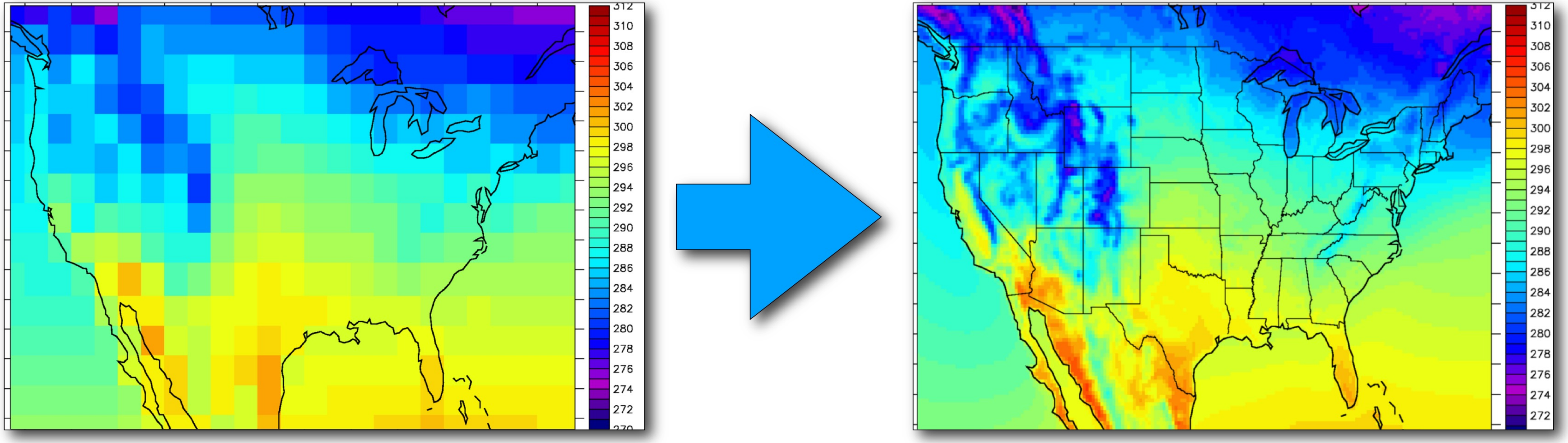


Observations – January Climatology



DOWNSCALING

- Used to increase the resolution of global climate model
- Helps answer stakeholders' questions about how the climate will change in their location (i.e., impacts assessments) & better represent local climates



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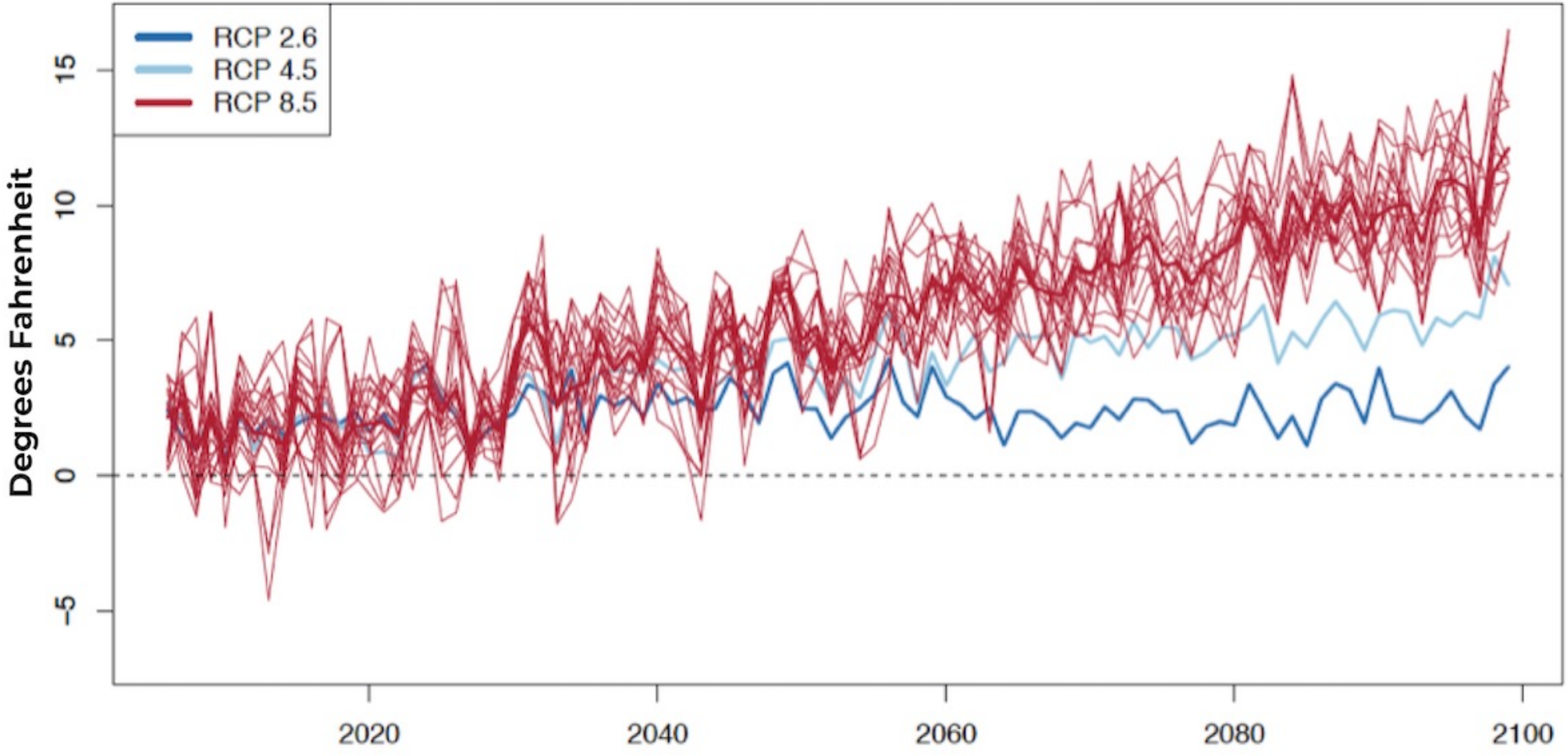

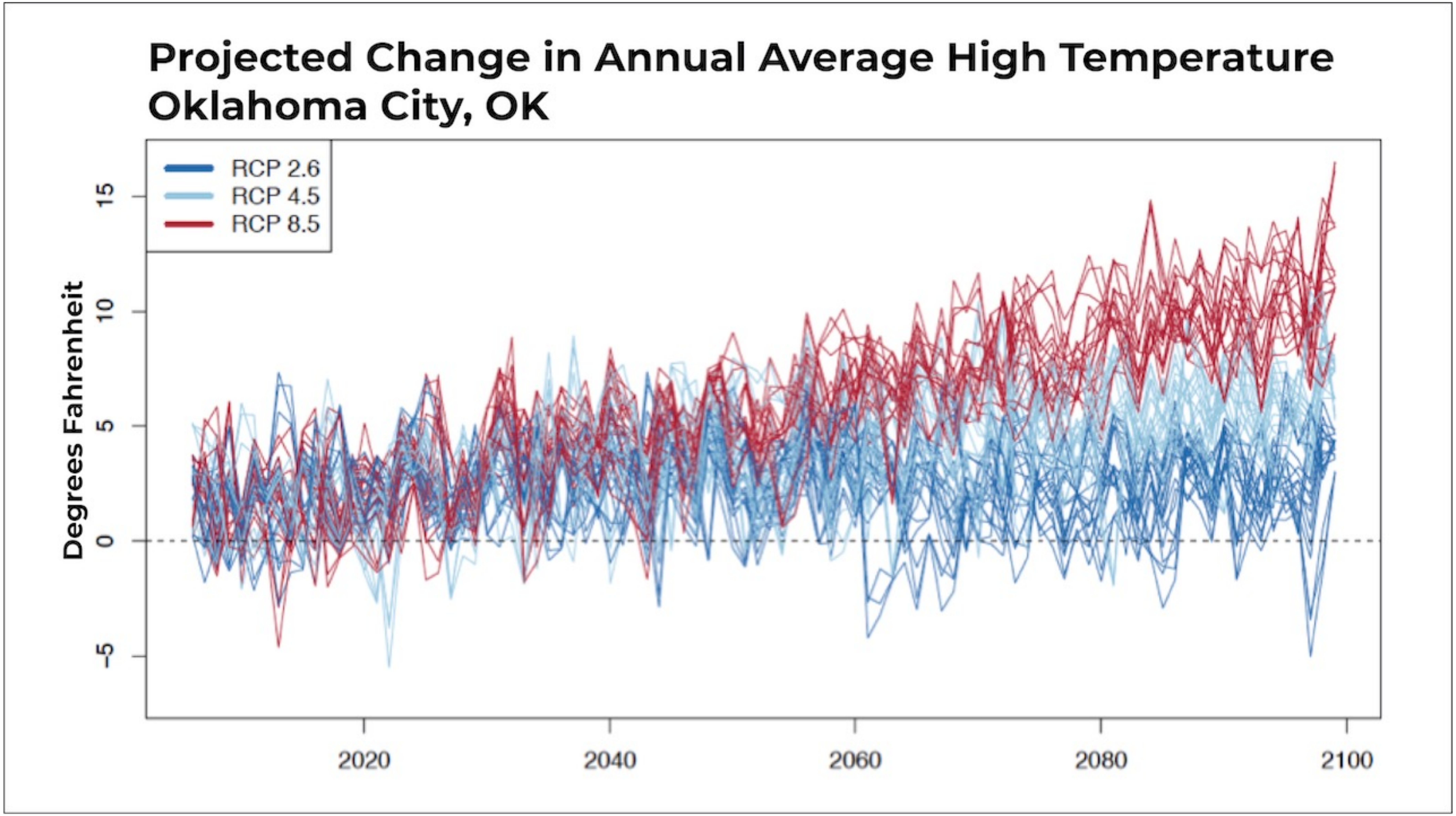
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LOCAL CLIMATE EXPERTS HELP ANSWER QUESTIONS LIKE….

- *Which climate projections are right for you?*
- *What do the projections say (for your area and system, uniquely)?*
- *How well can we trust the projections? What can/can't we trust?*
- *What caveats are important, and how to consider them in your planning?*
- *What impacts might these changes in climate have on my system?**

*** using our network of impacts research collaborators (ecologists, biologists, hydrologists, etc.)**

…the answers to each are unique for _each application_!

NOW IT'S YOUR TURN!

MANAGEMENT CHALLENGE

Your group represents natural resource managers overseeing a sagebrush area of concern in the Great Western Sagebrush State.

<u>You have been tasked with the following:</u>

- **Assess the future climate** (precipitation) and potential risk of increased wildfire, cheatgrass expansion, and woody encroachment using climate model projections.
- **Provide a recommendation** about managing sagebrush (using the Resist-Accept-Direct framework).

MANAGEMENT CHALLENGE

Background Information

- The sagebrush area is a vast and biodiverse ecosystem for your state.
- If annual precipitation drops below 20% of the historical average, there is a significant increase in wildfire conditions and cheatgrass expansion.
- If annual precipitation increases above 20% of the historical average, there is a significant risk of woody encroachment.
- Your group is interested in maintaining the current sagebrush ecosystem as much as feasible.
- You have limited funding available for implementing management strategies.

MANAGEMENT CHALLENGE

Assess Future Climate

Climate Futures →	Much Drier	Drier	Slightly Drier	No Change	Slightly Wetter	Wetter	Much Wetter
Mid-Century							
Late-Century							

- And resulting implications for sagebrush ecosystem.

MANAGEMENT CHALLENGE

Identify Possible Management Strategies

	Resist	Accept	Direct
Management Strategy			
Near-term Costs			
Long-term costs			

- What is your final recommendation? Might it change in long-term future?

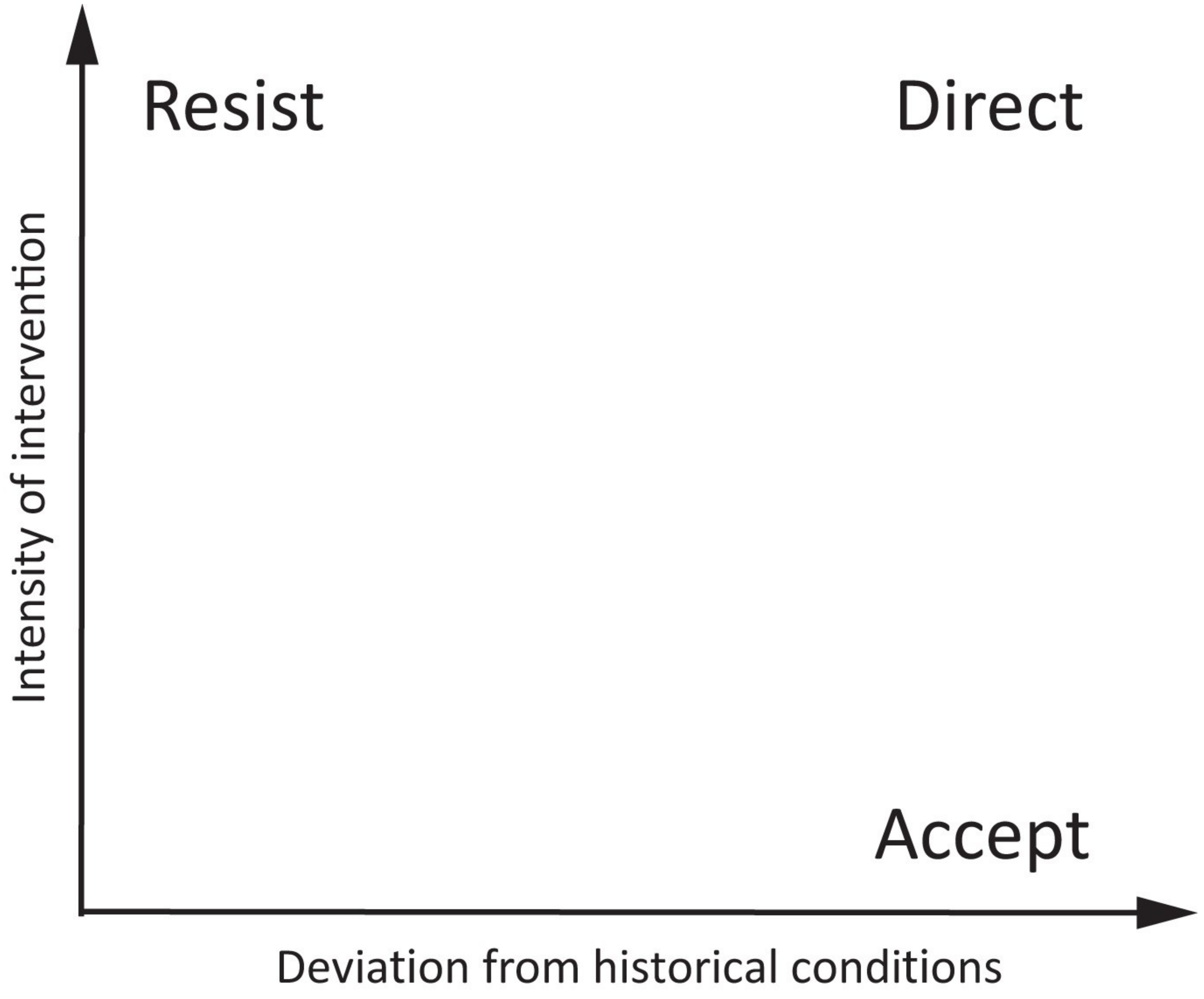
MANAGEMENT CHALLENGE

Resist–Accept–Direct Framework

- **Resist**: Managers focus on maintaining current historical ecosystem structure and function.

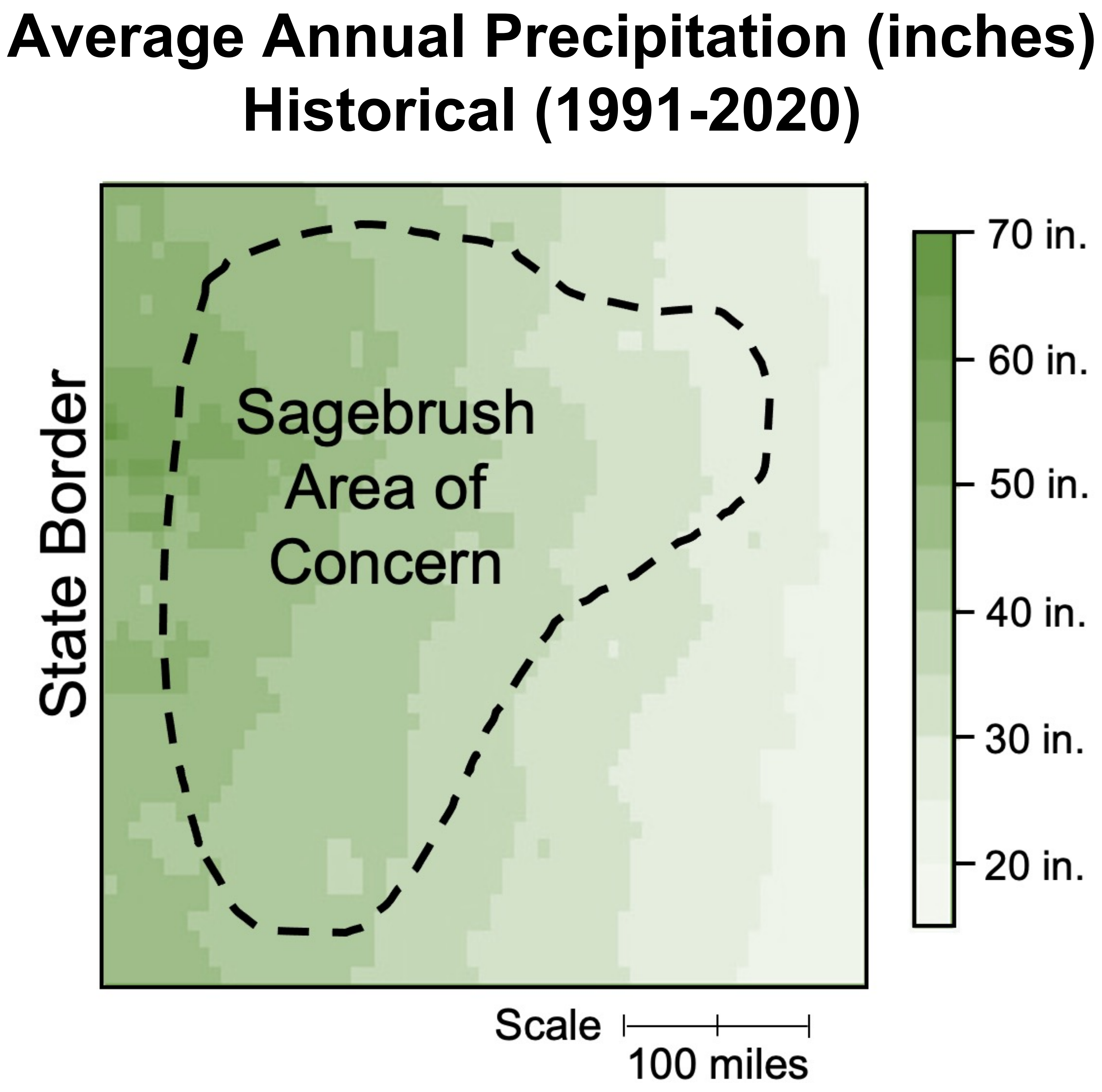
- **Accept**: Managers do not intervene and allow the ecosystem structure and function to emerge from ongoing transformations.

- **Direct**: Managers actively steer the transformation towards a particular ecosystem structure and function



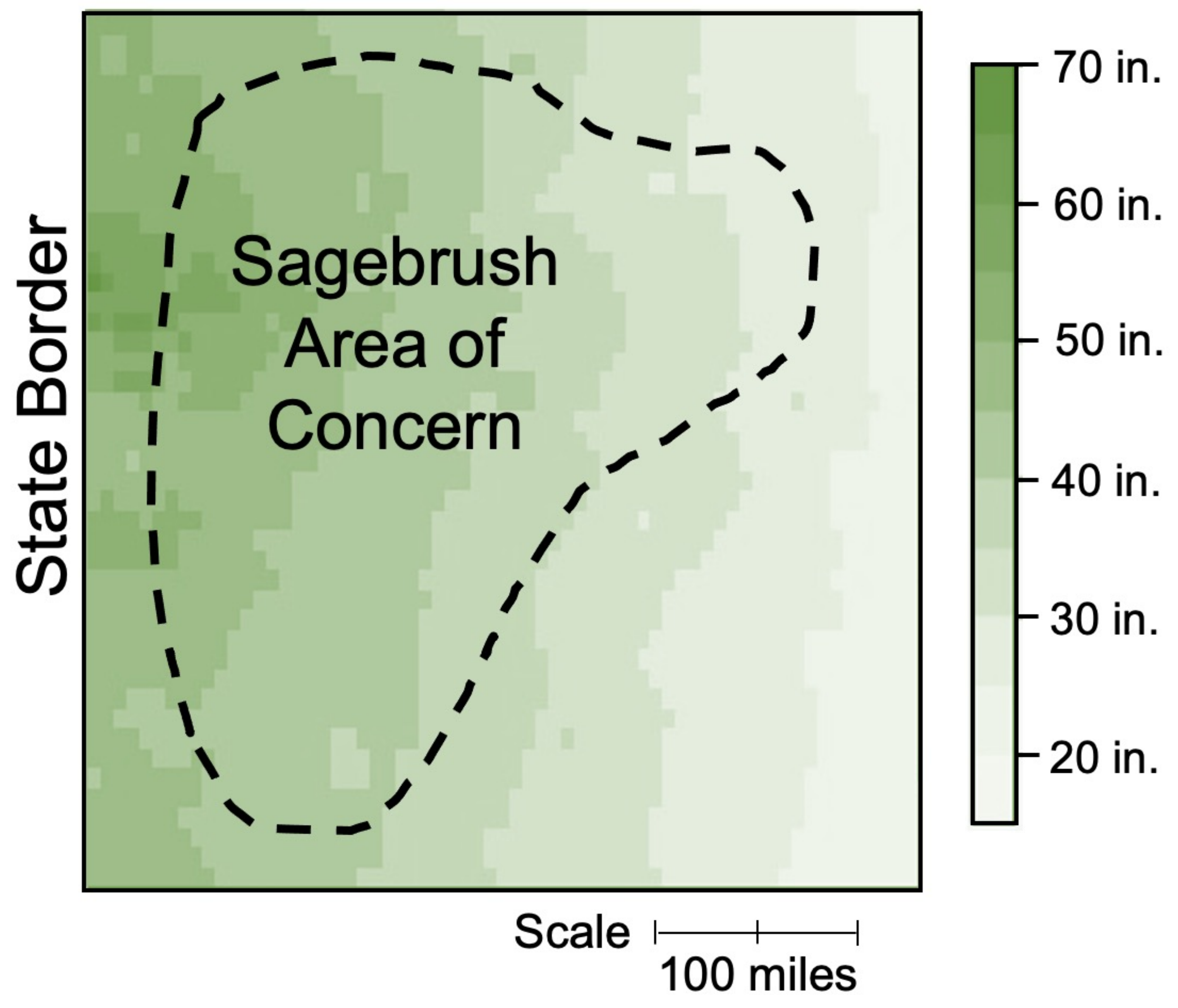
(Schuurman et al. 2022 - https://doi.org/10.1093/biosci/biab067)

MANAGEMENT CHALLENGE

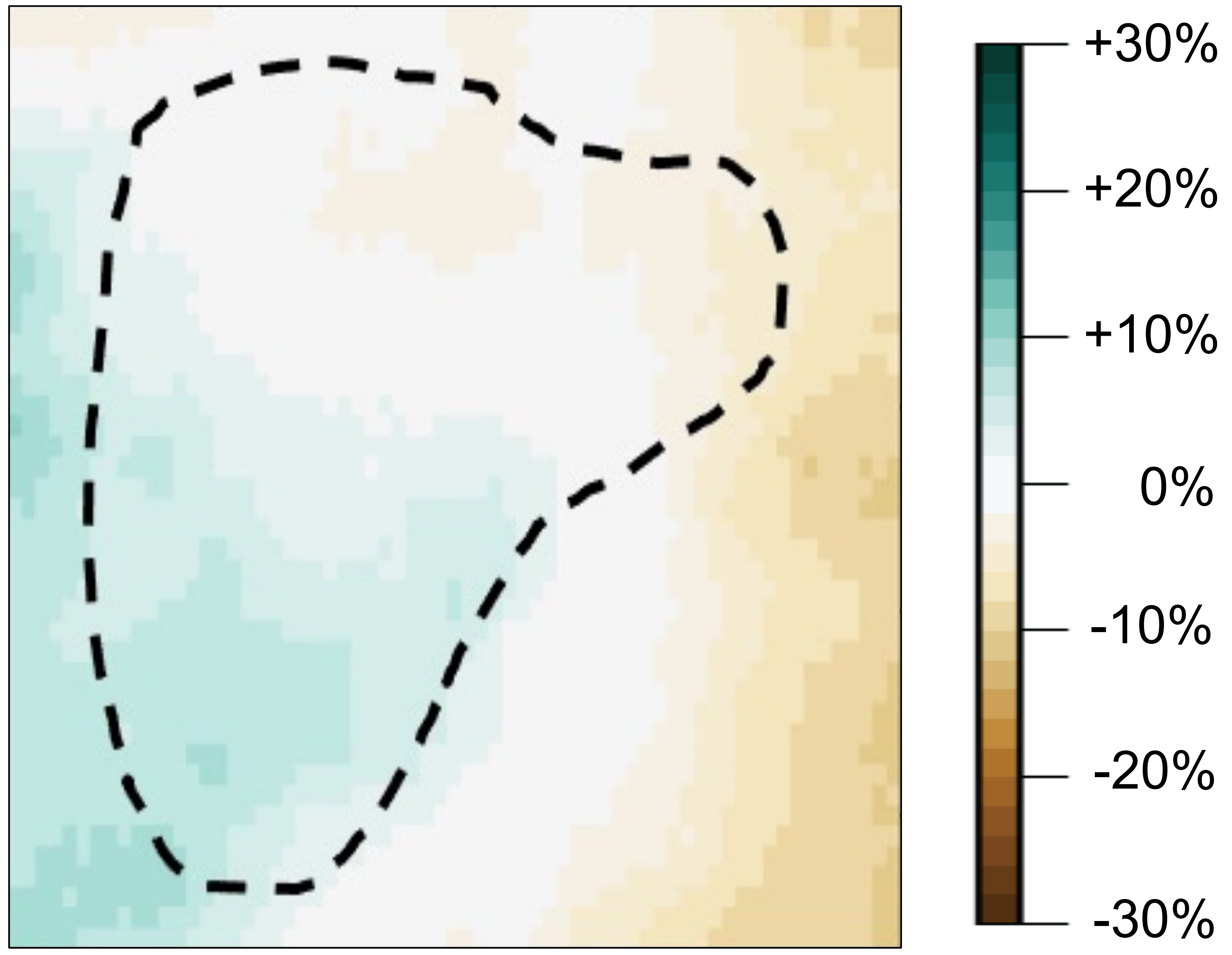


MANAGEMENT CHALLENGE

Average Annual Precipitation (inches)
Historical (1991-2020)



Future Change in Average Annual Precipitation (%)
Late-Century (2061-2090)



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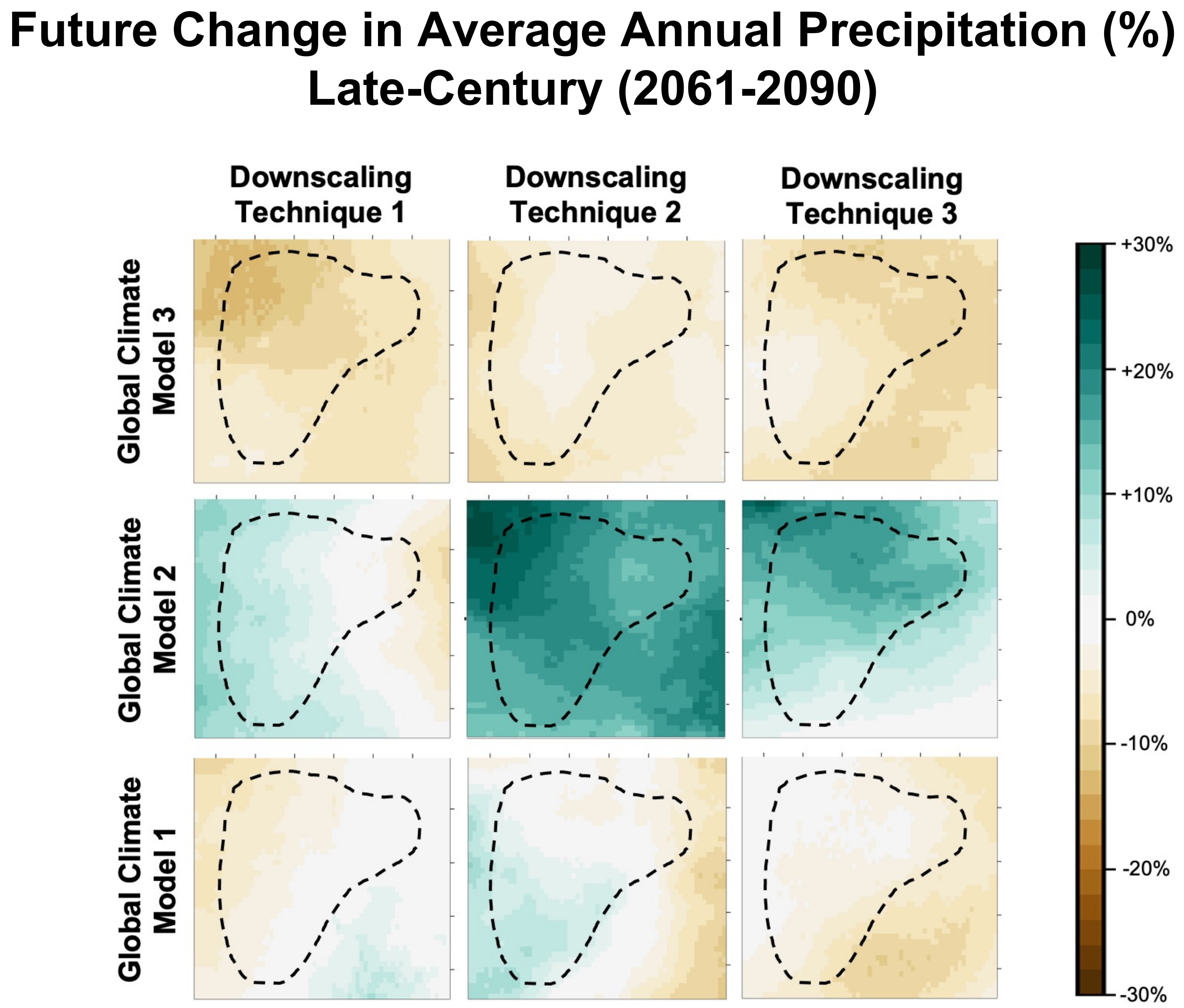

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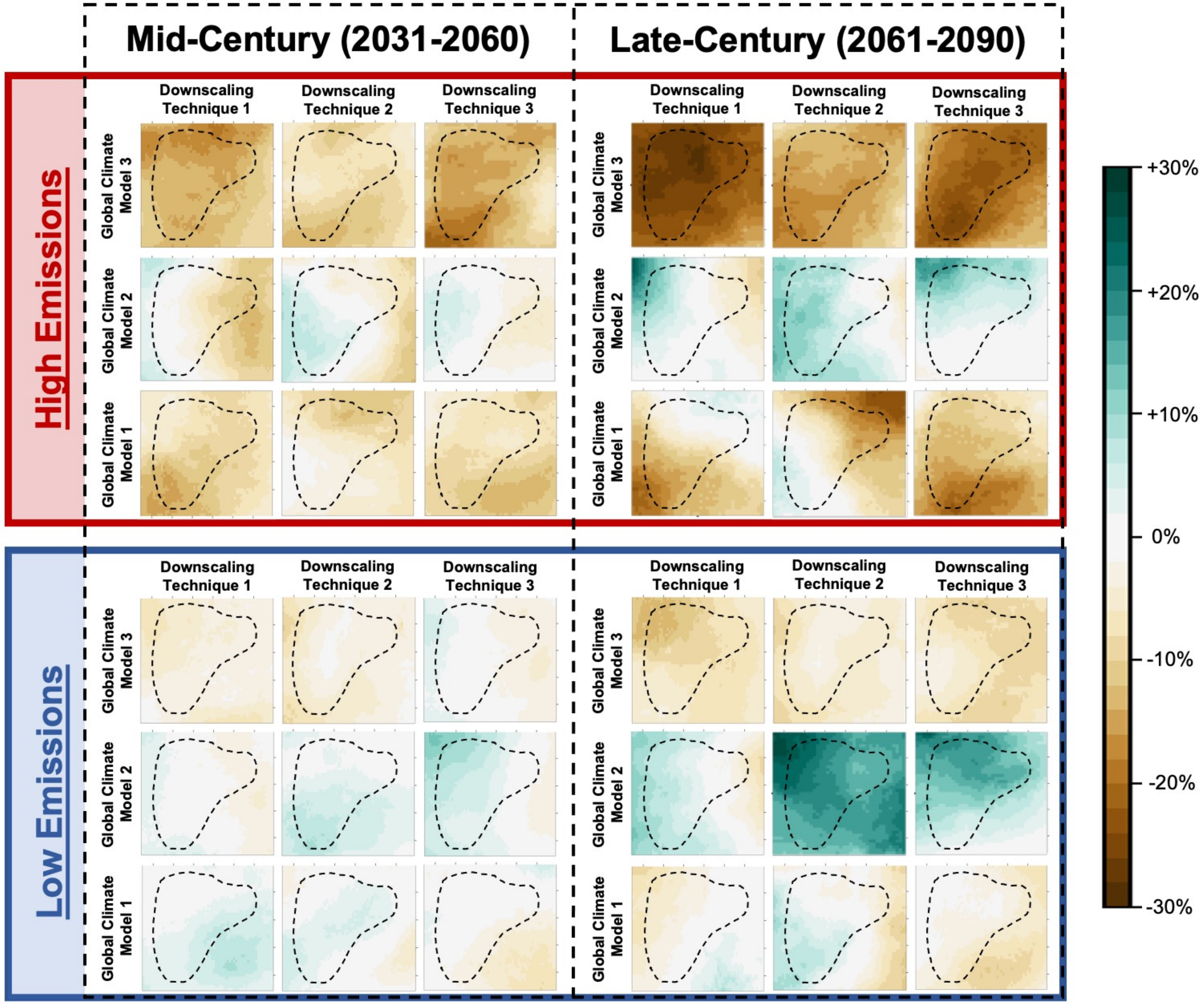

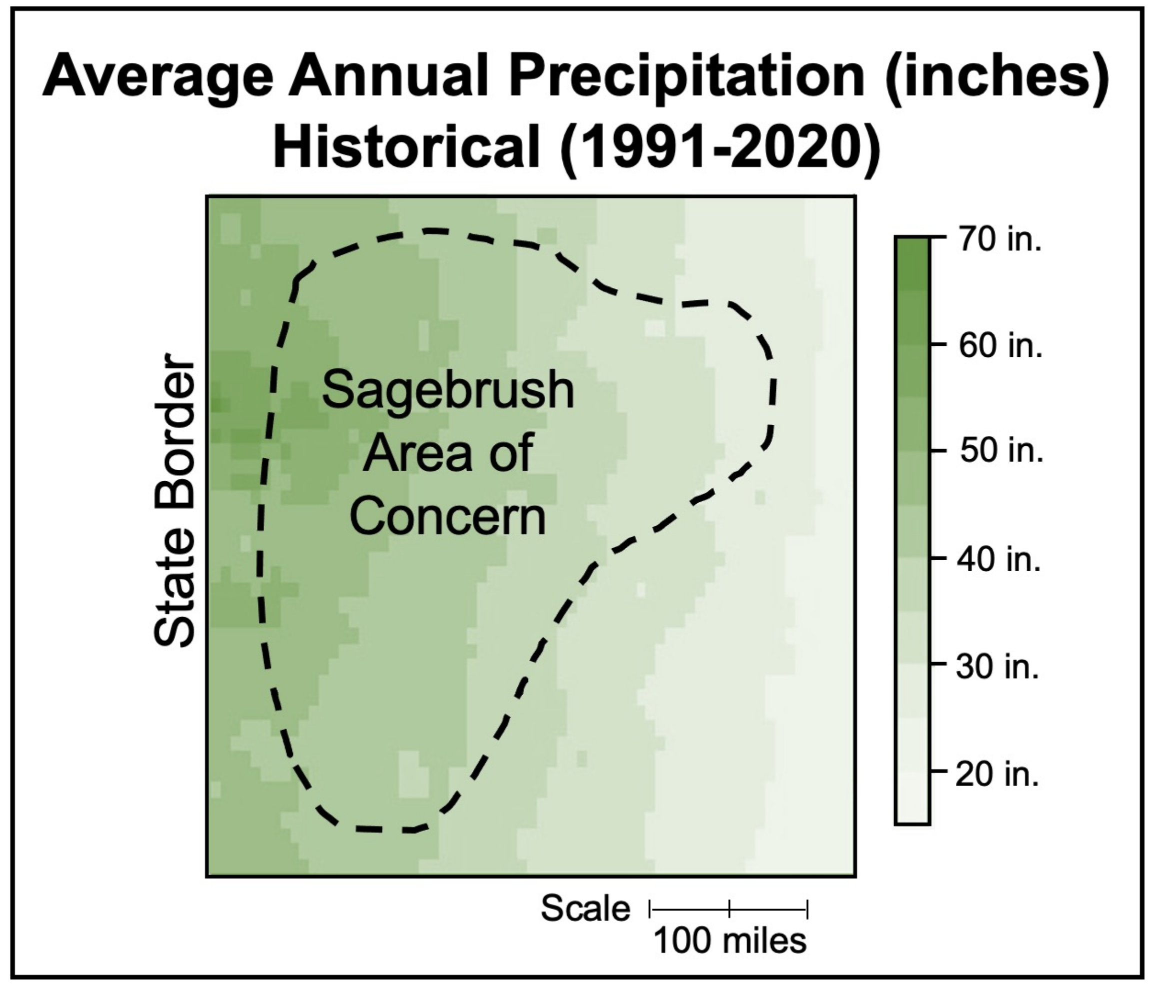

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	Resist	Accept	Direct
Management Strategy			
Near-term Costs			
Long-term costs			

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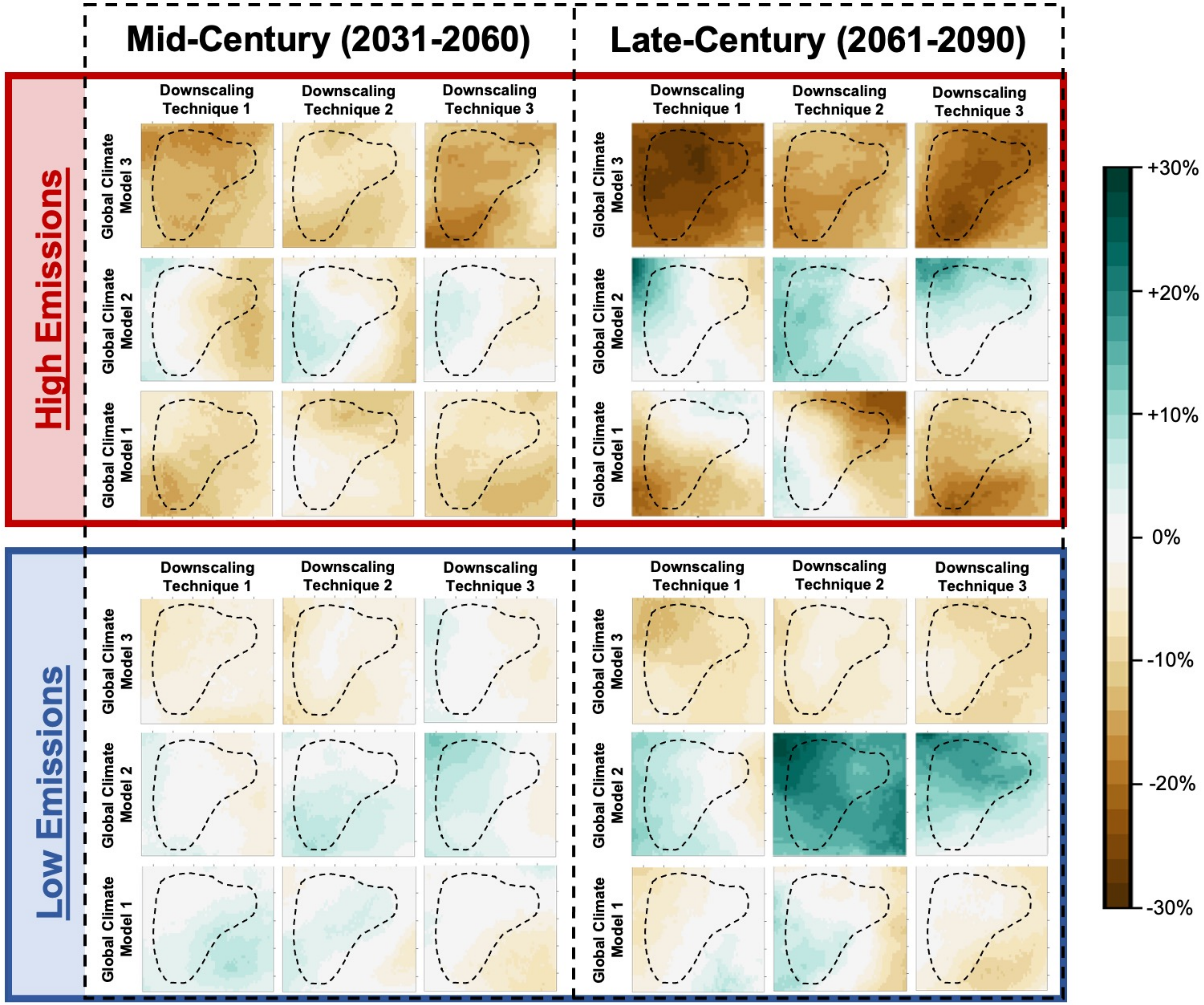


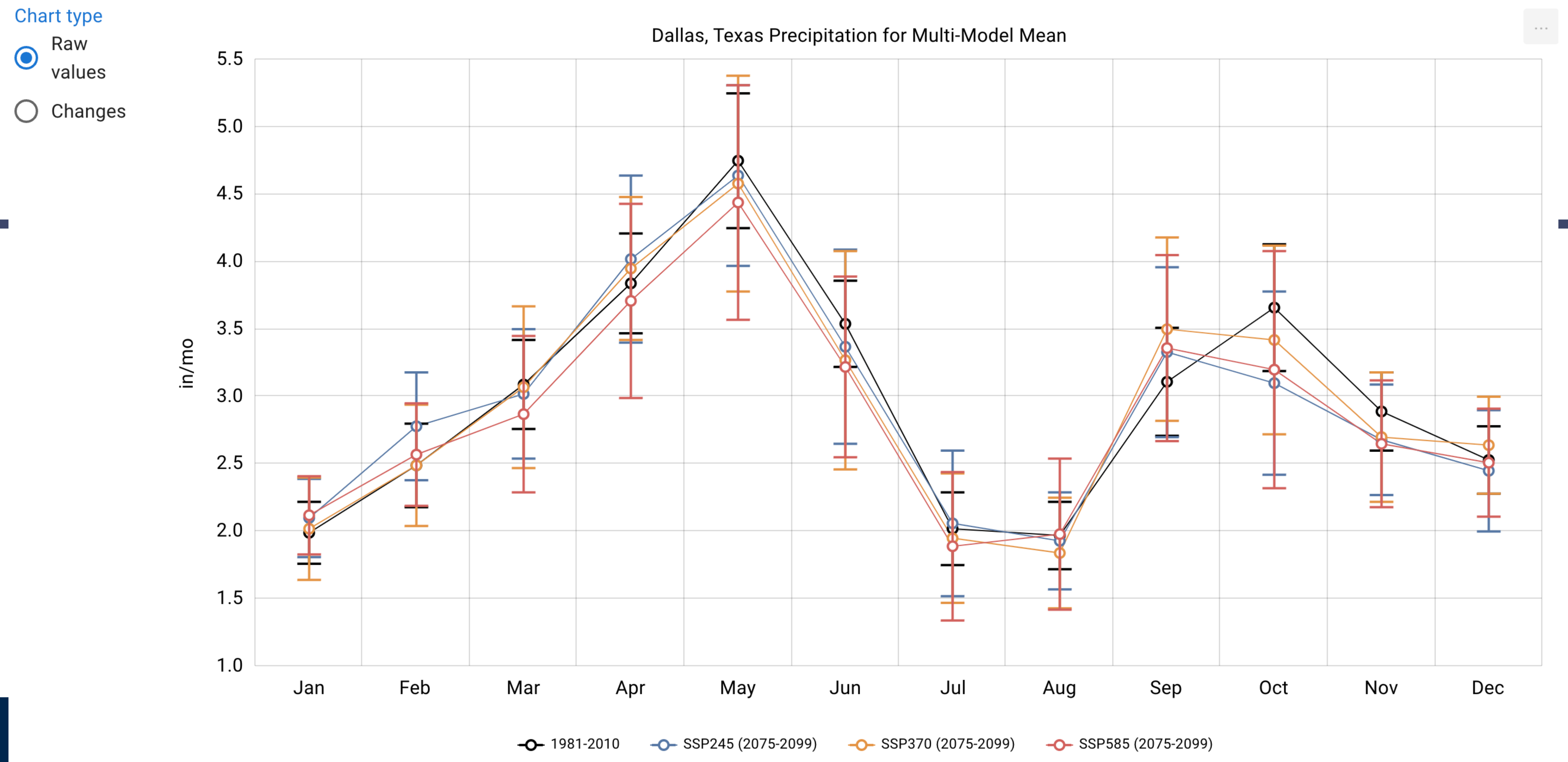
TOOLS YOU CAN USE

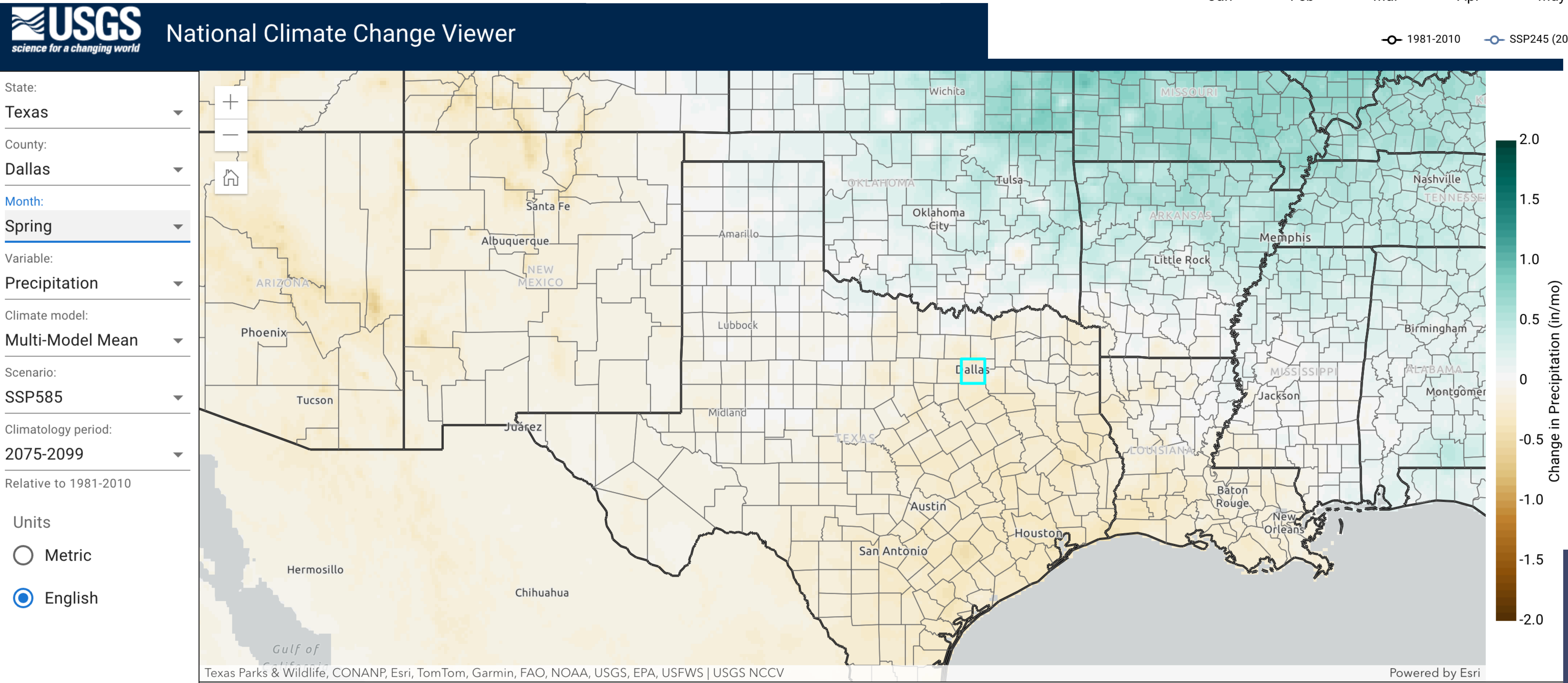
- USGS National Climate Change Viewer (NCCV)
- Climate Mapping for Resilience and Adaptation (CMRA) Tool
- USGS GeoData Portal

- Assistance for Data usage
  - DOI Climate Adaptation Science Centers
  - USDA Climate Hubs
  - NOAA CAP programs (Southern Climate Impacts Planning Program)

USGS NCCV

https://www.usgs.gov/tools/national-climate-change-viewer-nccv





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