CLIMATE PROJECTIONS, MODELING, AND THE IMPACT BEYOND CLIMATE SCIENCE

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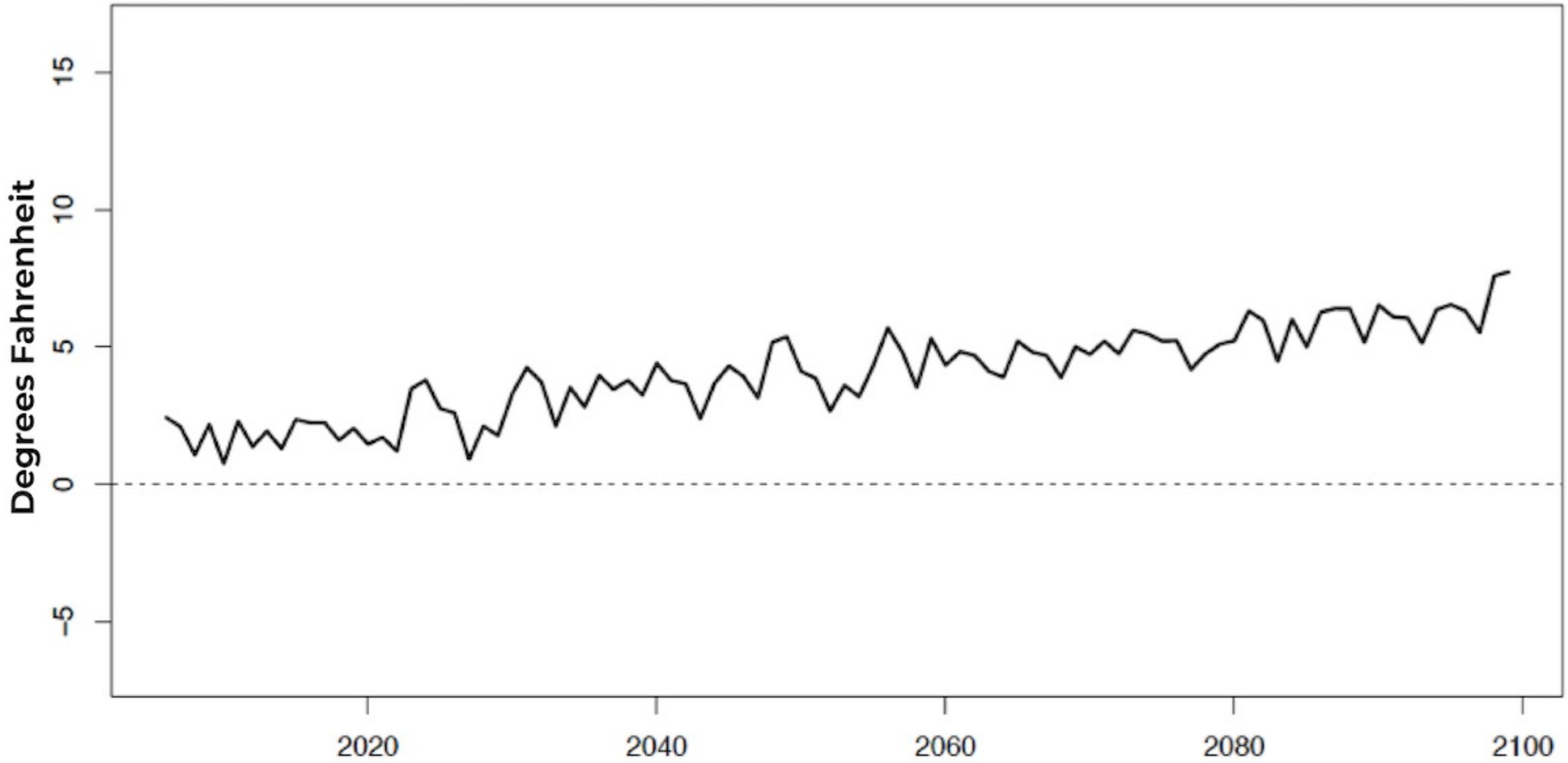
SOUTH CENTRAL
CLIMATE ADAPTATION SCIENCE CENTER

CLIMATE PROJECTIONS – WHAT ARE THEY?

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

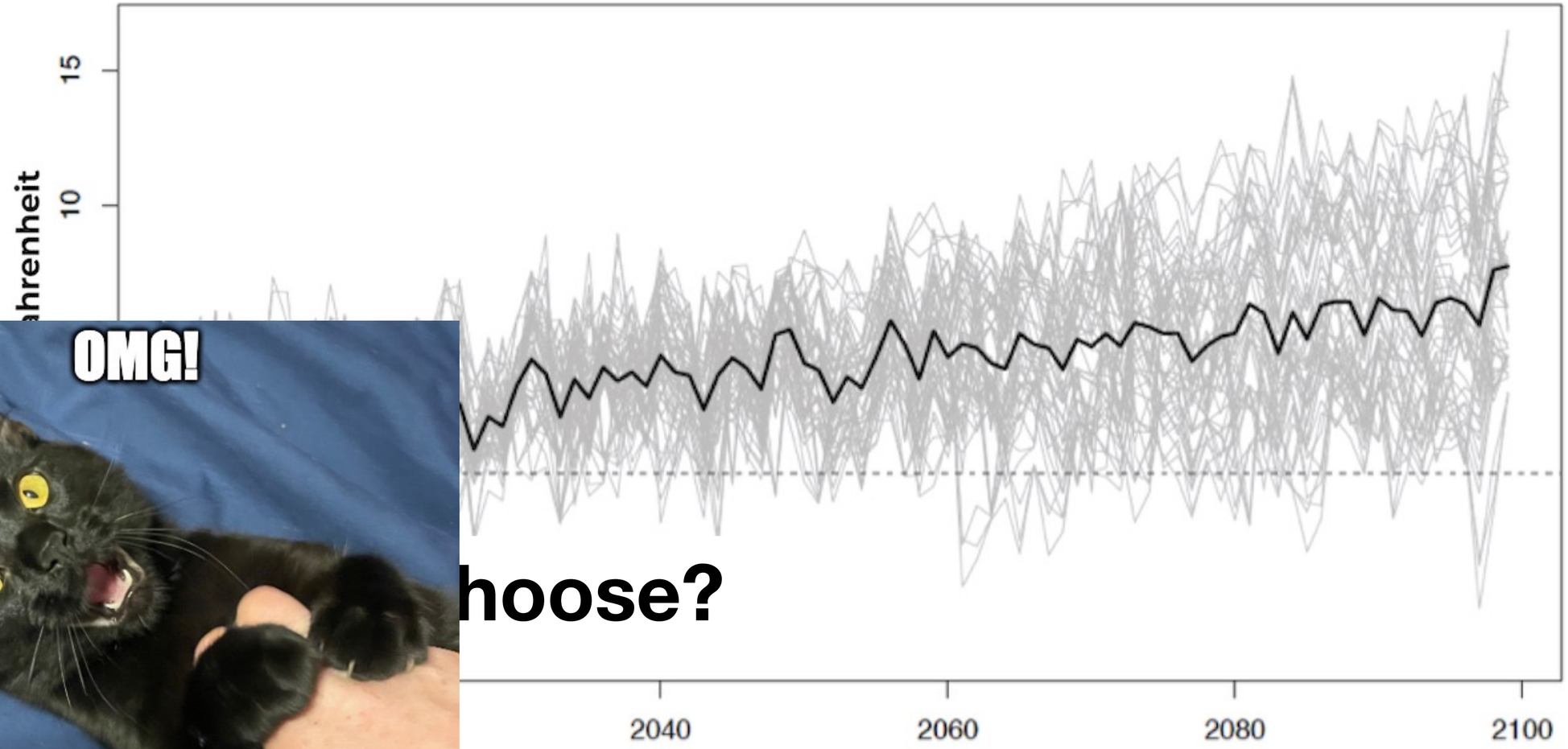
- Specific – model-derived estimates of future climate

Projected Change in Annual Average High Temperature
Oklahoma City, OK



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

Projected Change in Annual Average High Temperature
Oklahoma City, OK



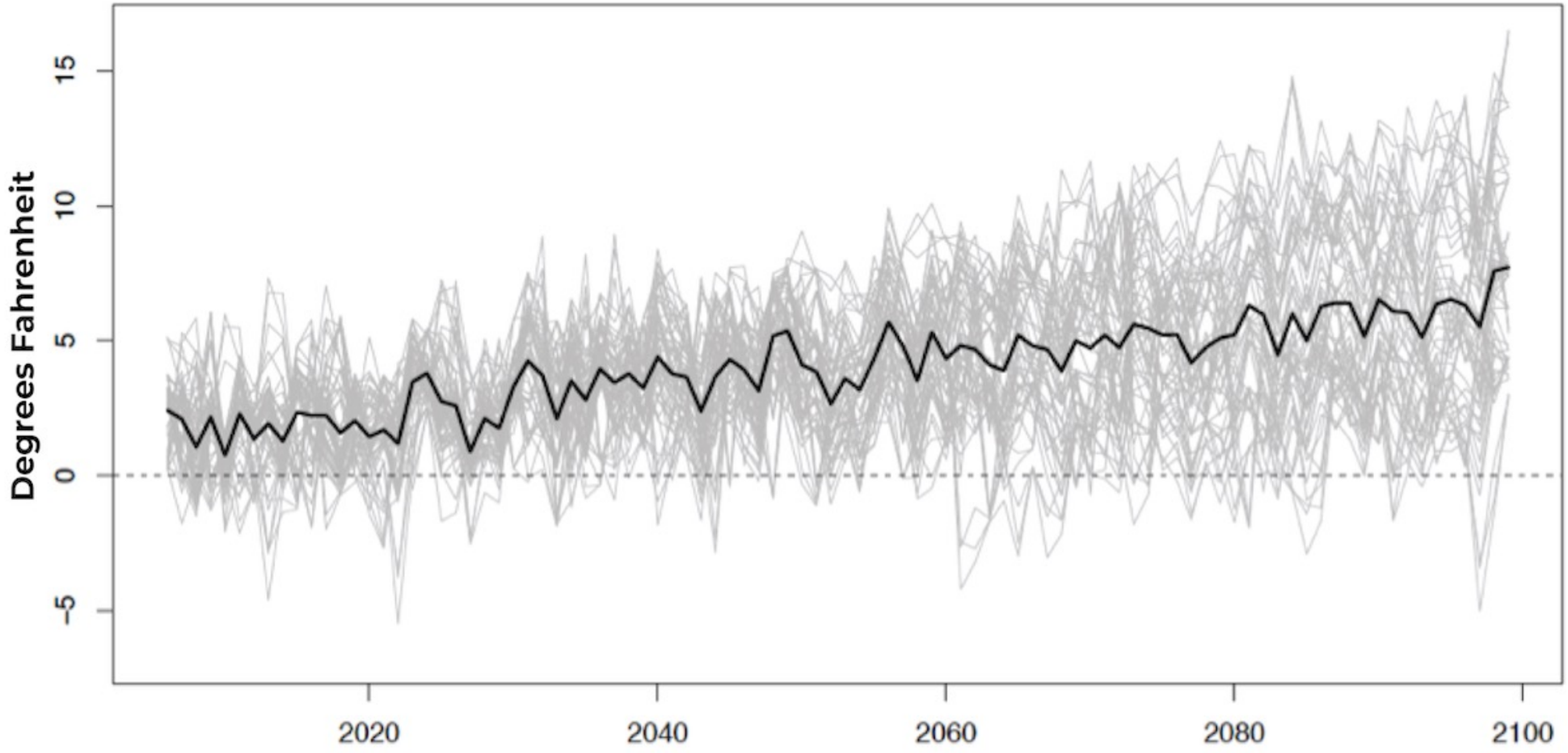
hoose?

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

THERE ARE MANY FUTURE PROJECTIONS!

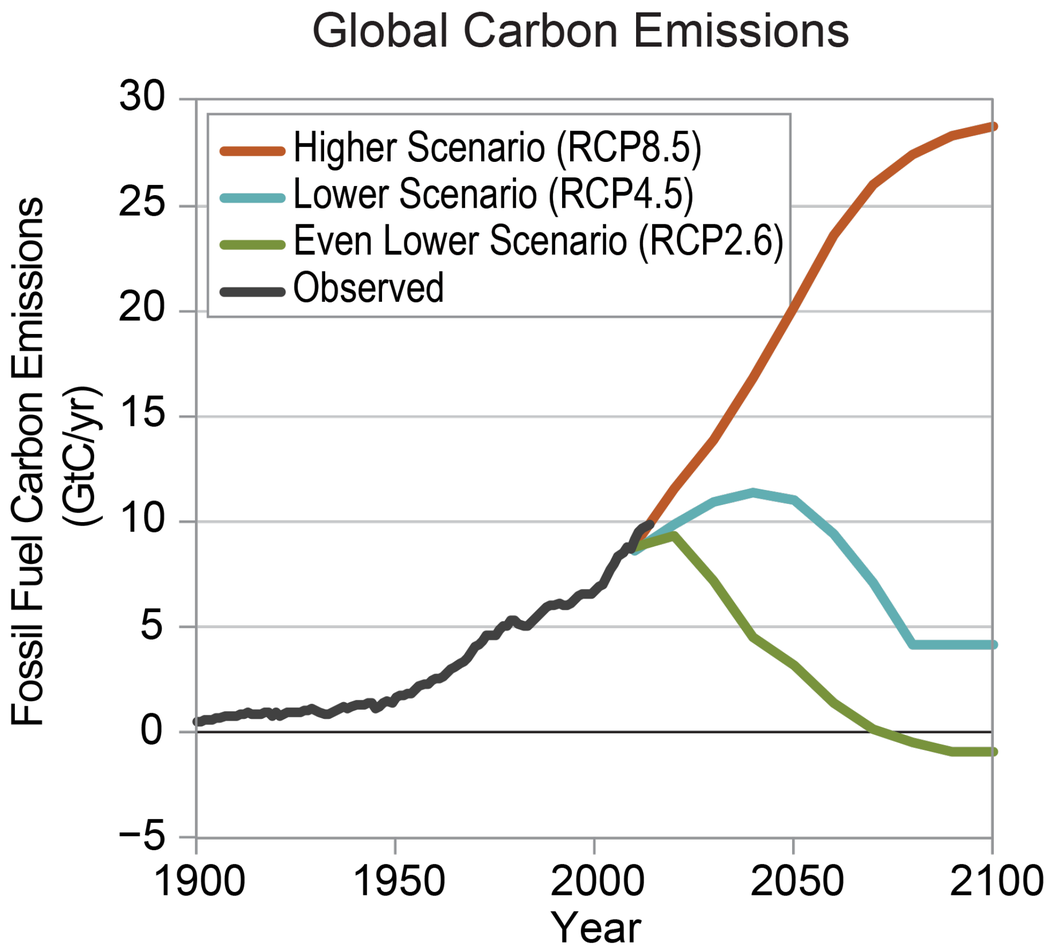
Which one do I choose?
Which one is the best?

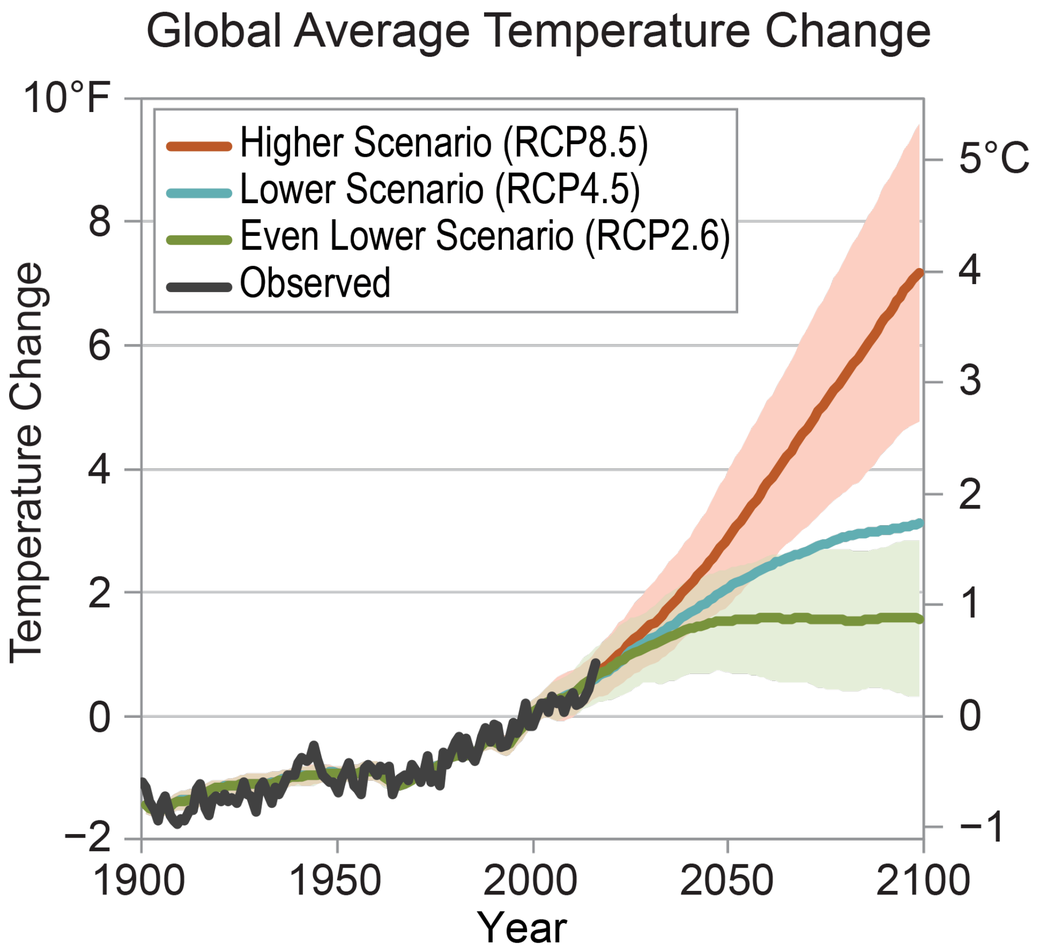
Projected Change in Annual Average High Temperature
Oklahoma City, OK



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

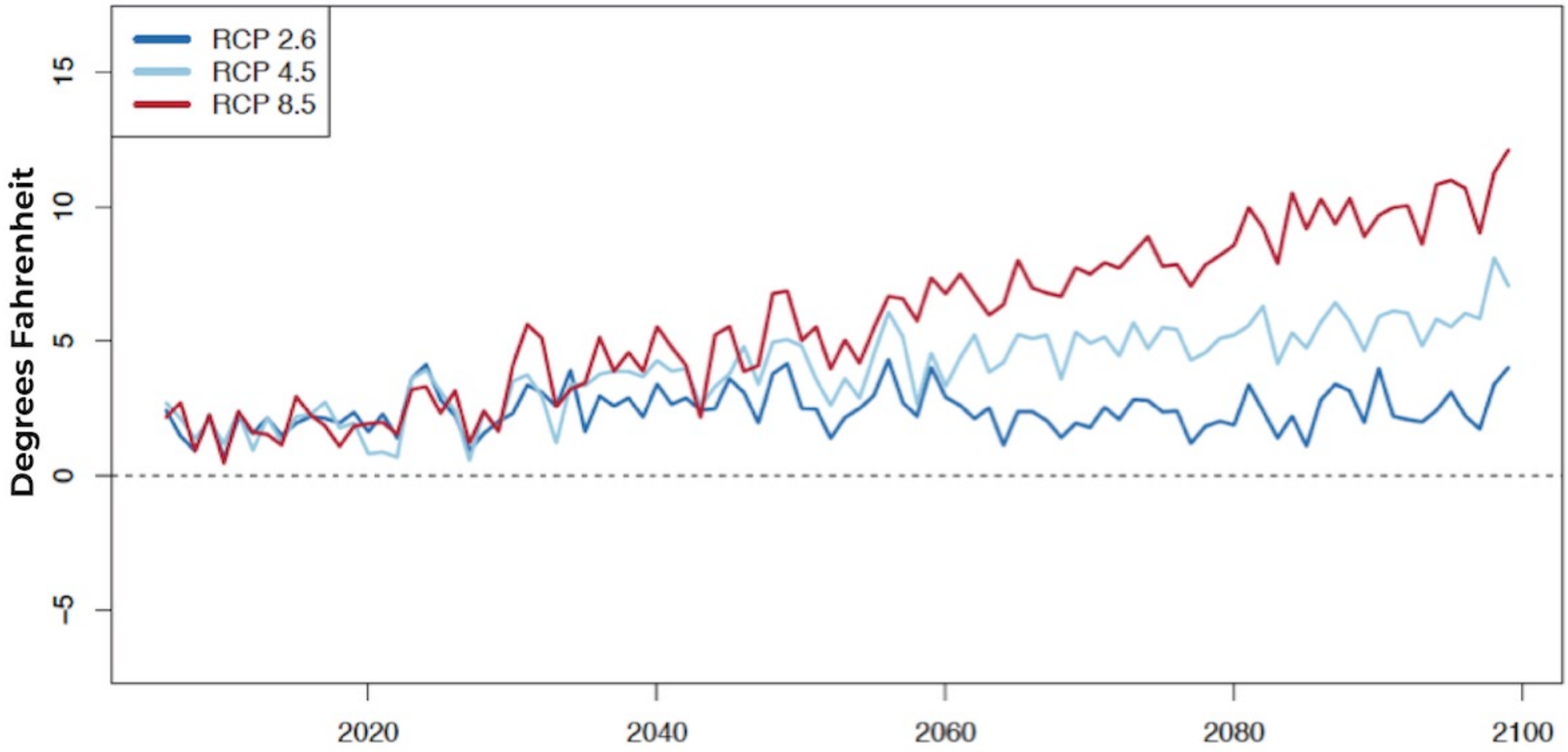
SCENARIOS



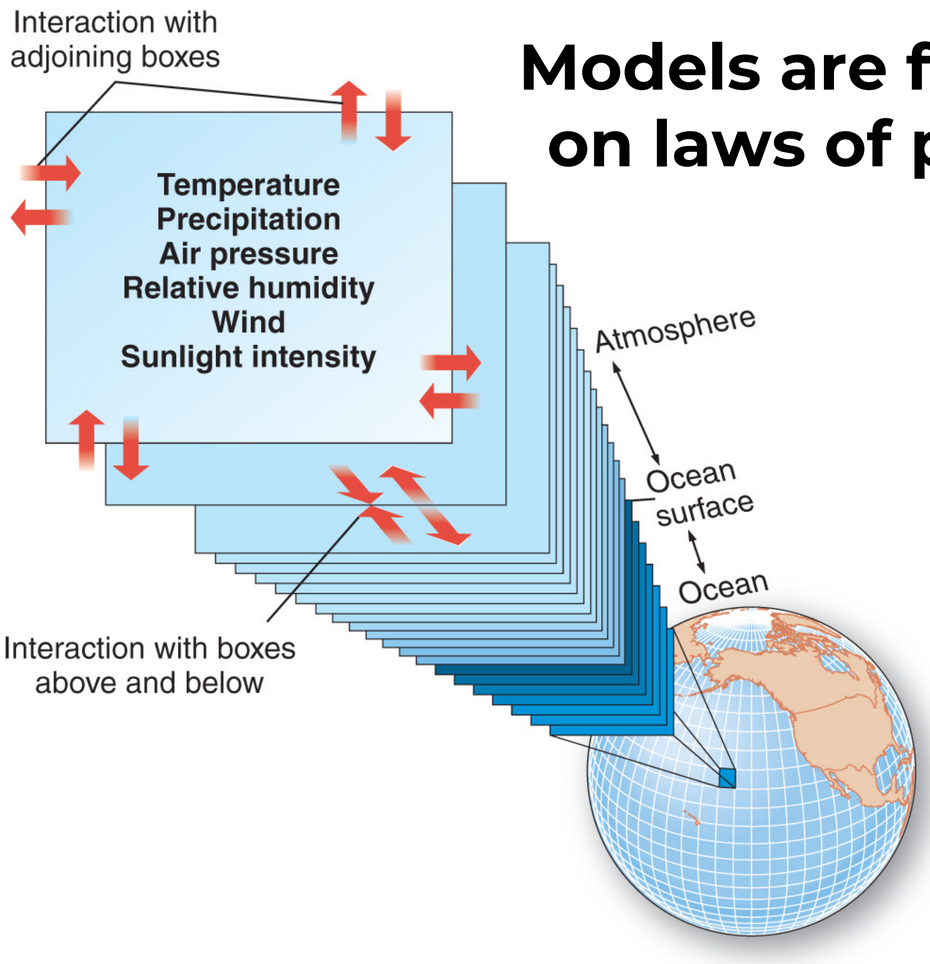


USGCRP CSSR 2017

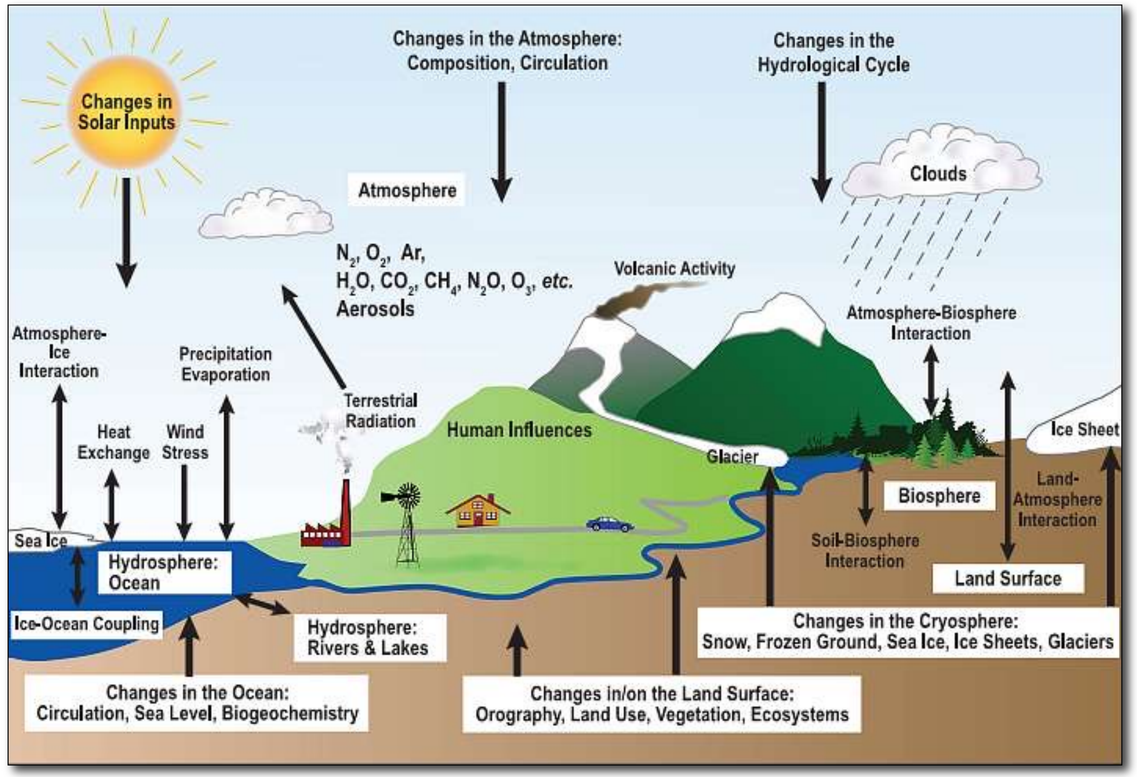
Projected Change in Annual Average High Temperature
Oklahoma City, OK



GLOBAL CLIMATE MODEL



Models are founded on laws of physics



Provide <u>reasonable projections</u> of physical changes, <u>not detailed predictions</u>

Climate is Physics

$$\frac{Du}{Dt} - fv = -\frac{\partial \phi}{\partial x} - F_x$$

Things like:

- Conservation of momentum
- Conservation of mass
- Conservation of energy
- Conservation of water
- Ideal Gas Law

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial \omega}{\partial p} = 0$$

$$\frac{\partial T}{dt} + u\frac{\partial T}{dx} + v\frac{\partial T}{dy} + \omega\left(\frac{\partial T}{\partial p} + \frac{RT}{pc_p}\right) = \frac{J}{c_p}$$

$$p = \rho RT$$

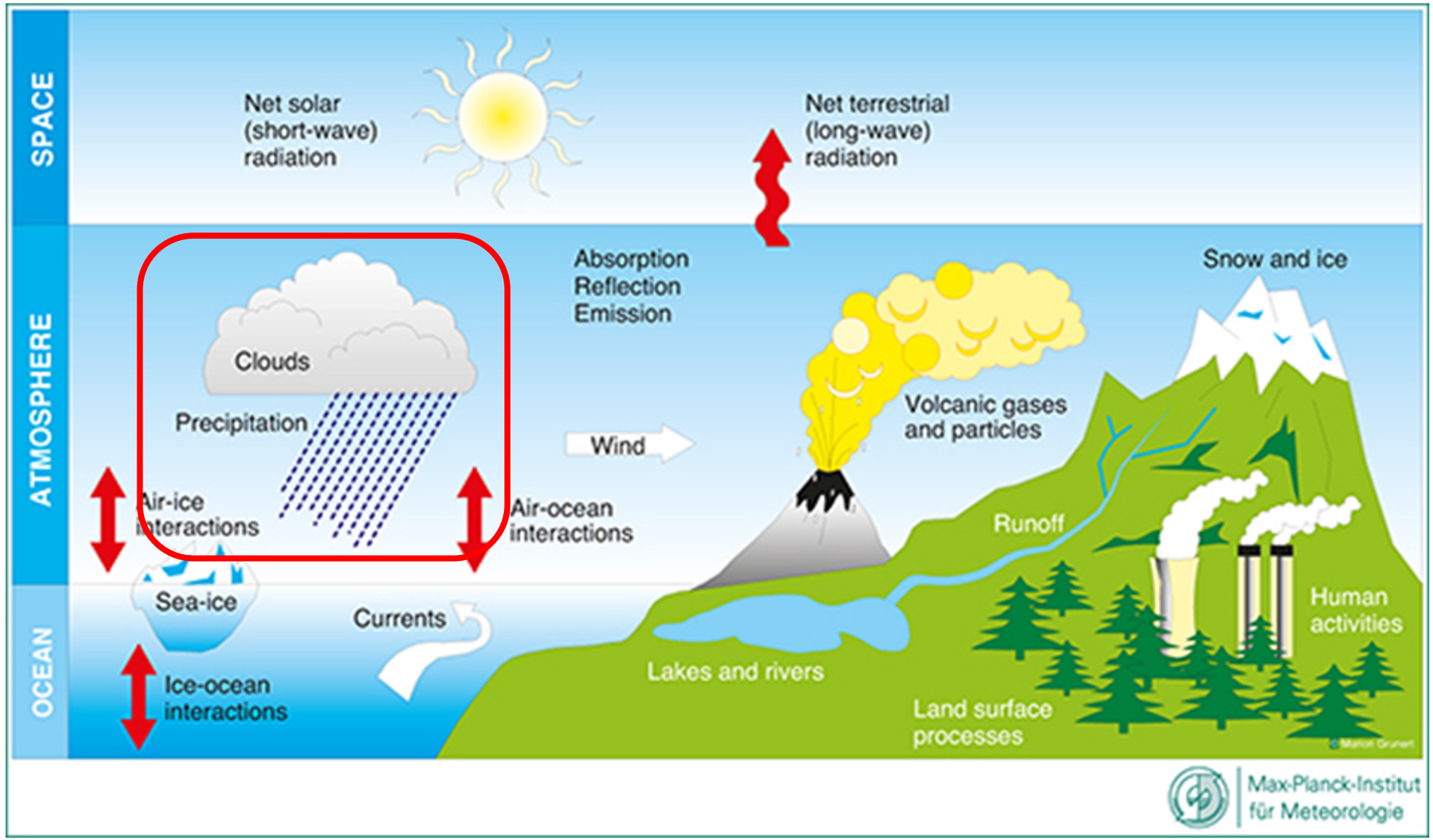
The equations are converted to a form where they can be programmed for computers to solve.

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

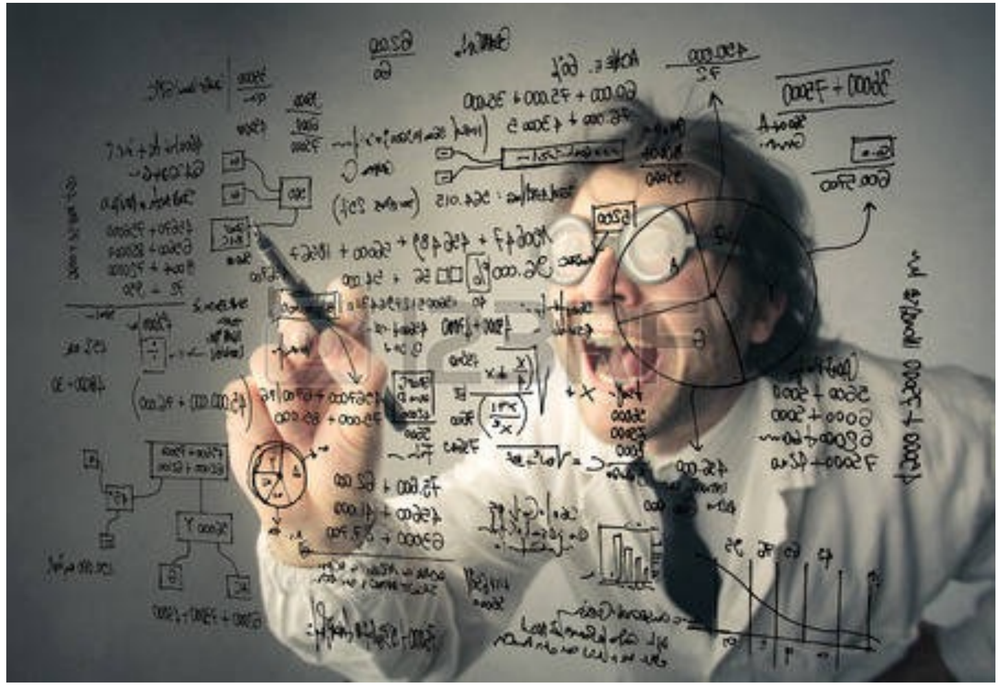


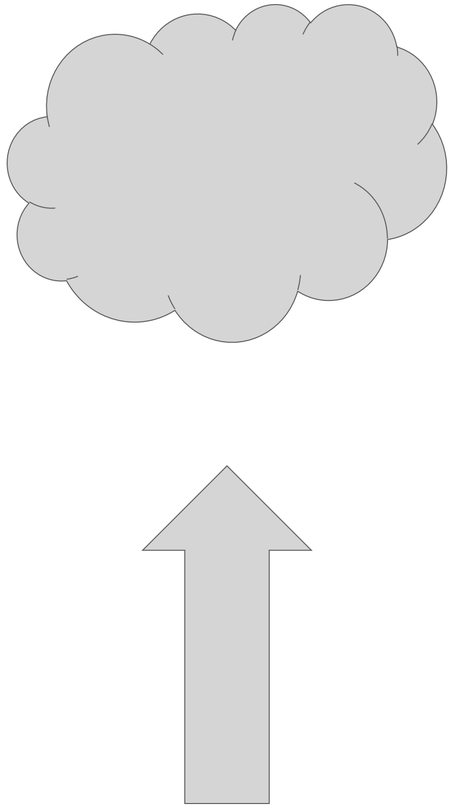
Different equations

Different models

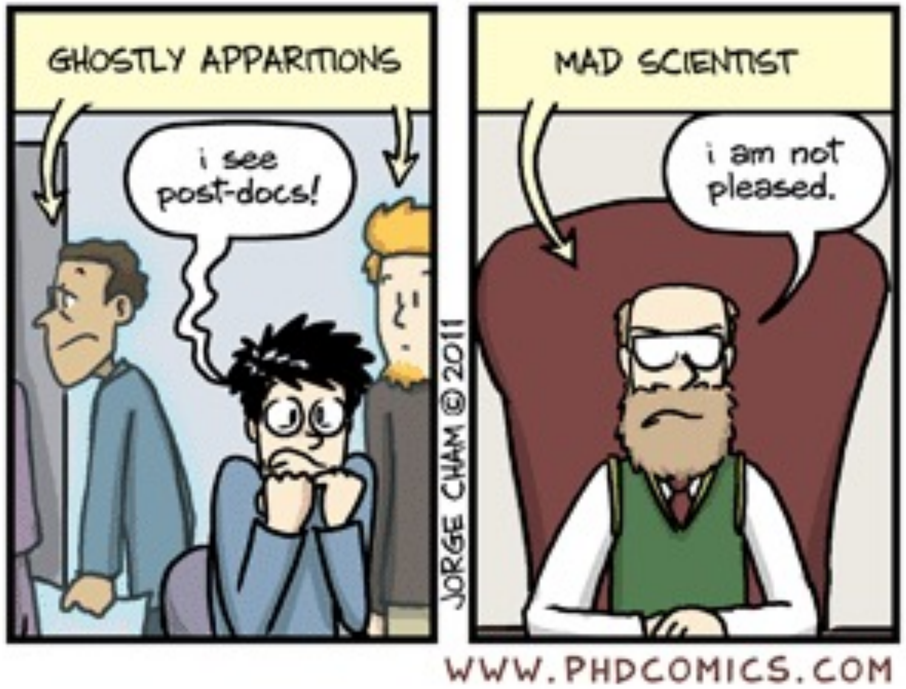
A COUPLE WAYS TO REPRESENT CLOUD FORMATION

C = 5.13 × T

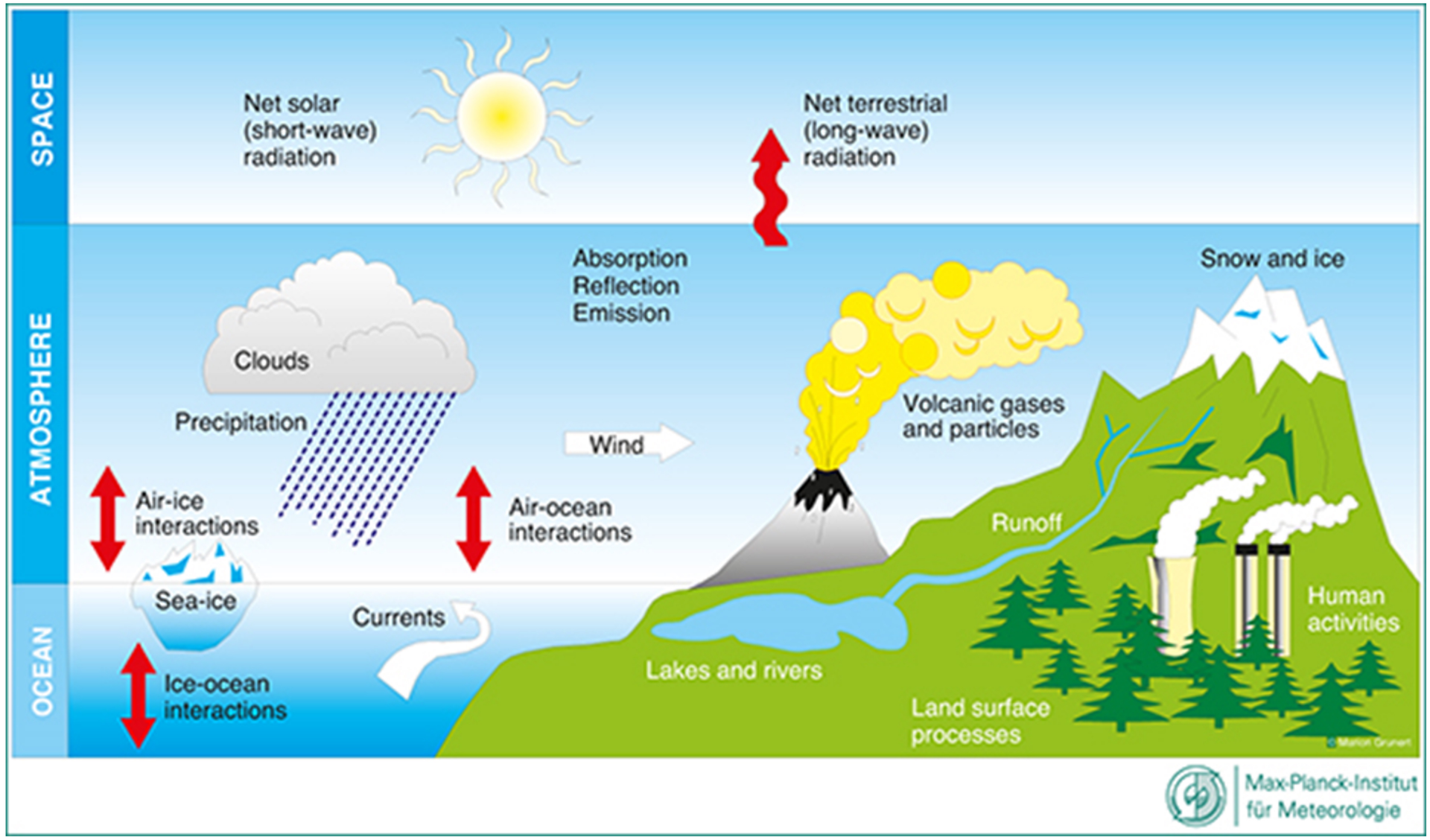




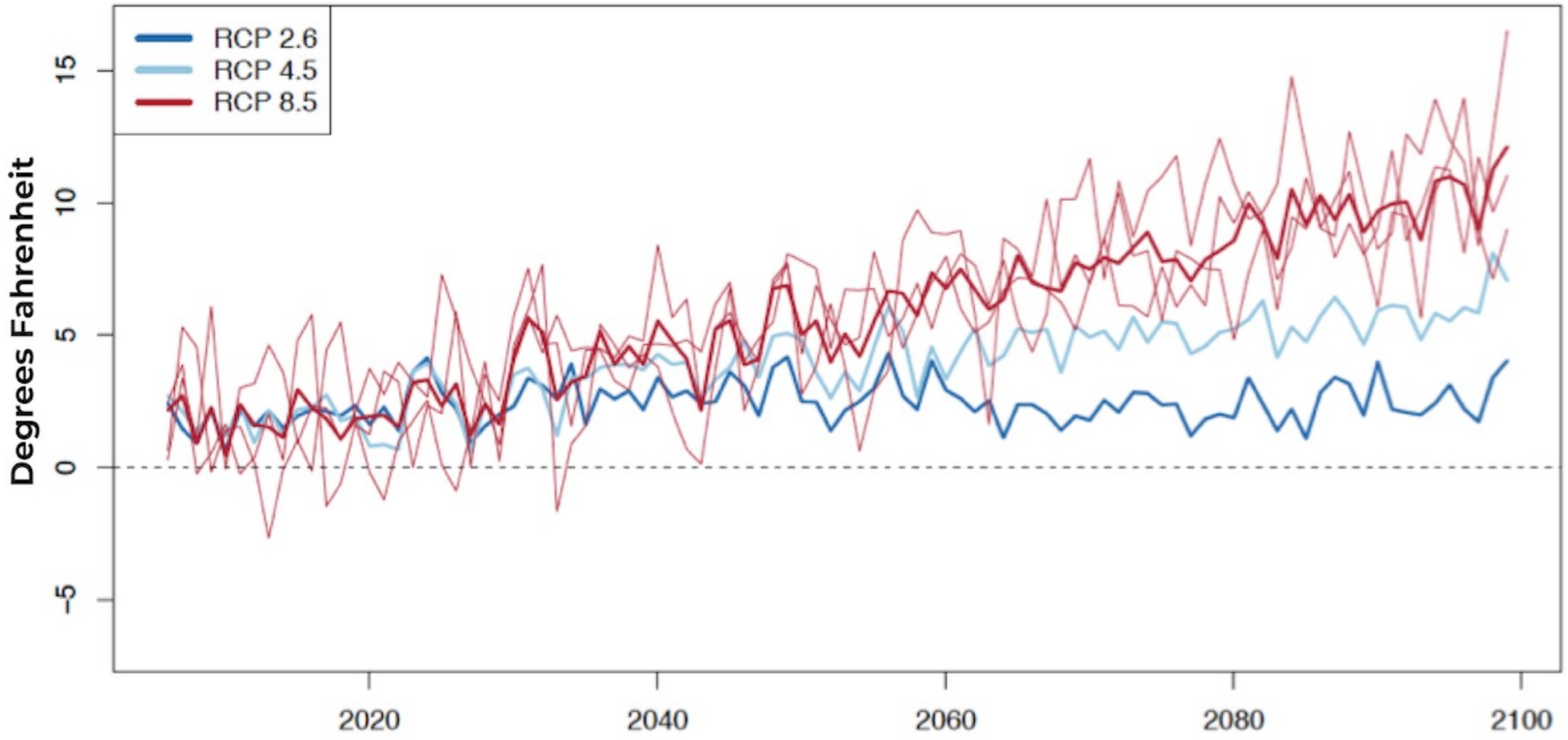
C = 4.82 × T



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



Projected Change in Annual Average High Temperature
Oklahoma City, OK



DOWNSCALING


Guanica, PR

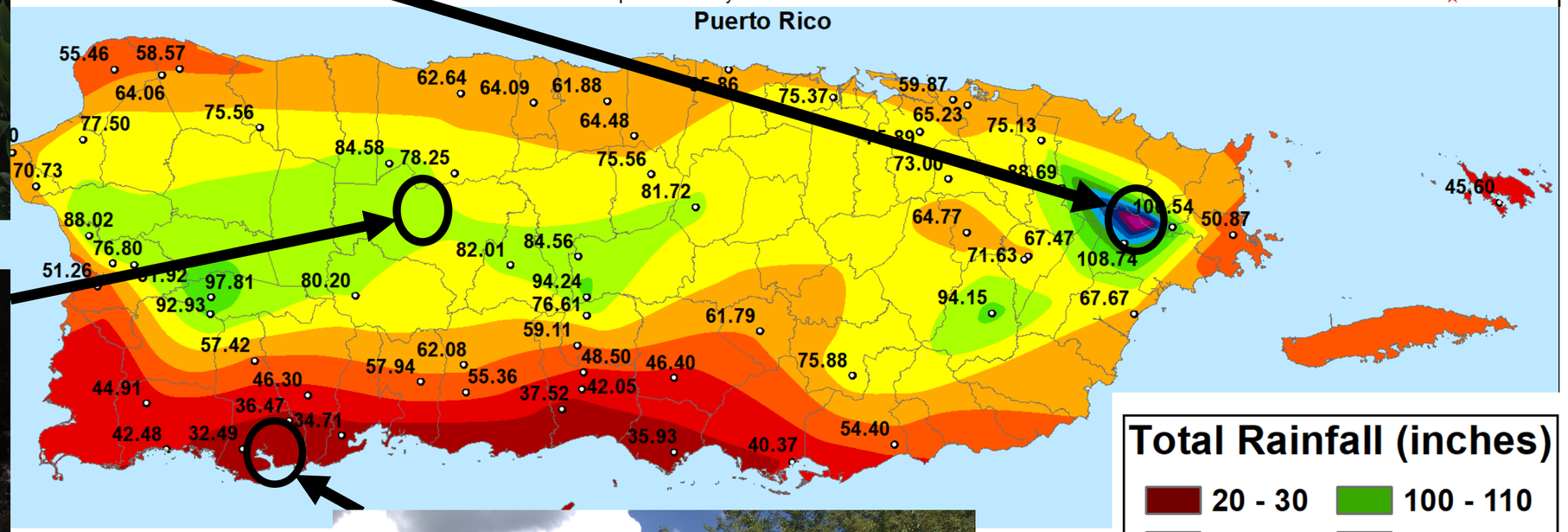

El Yunque, PR


Utuado, PR

Mean Annual Rainfall 1991-2020

Data Source: National Centers of Environmental Information

Map Created by NWS San Juan WFO

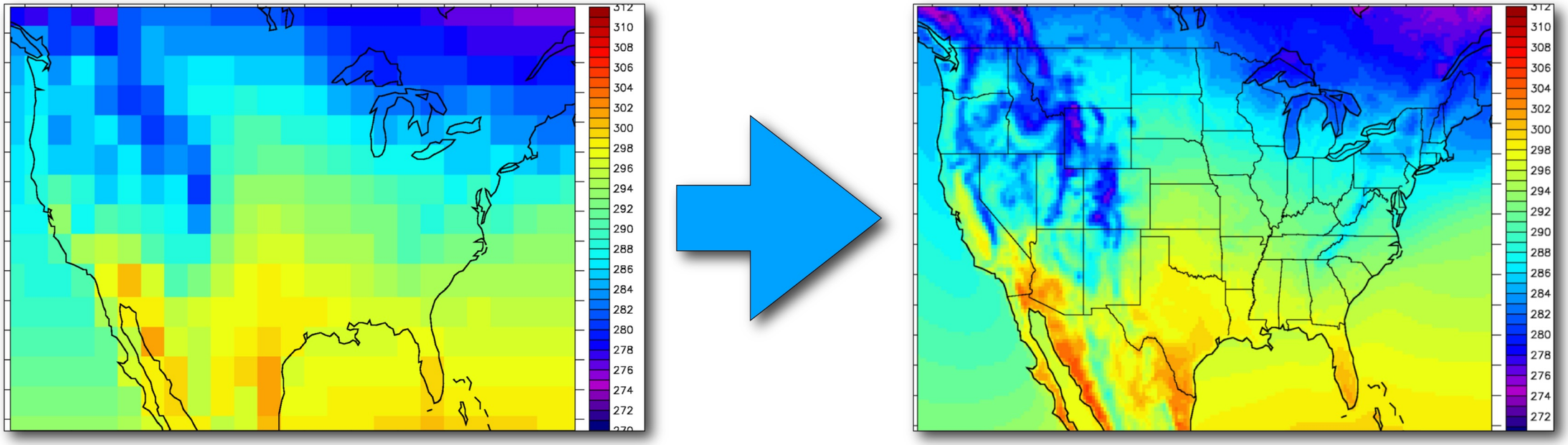


Total Rainfall (inches)

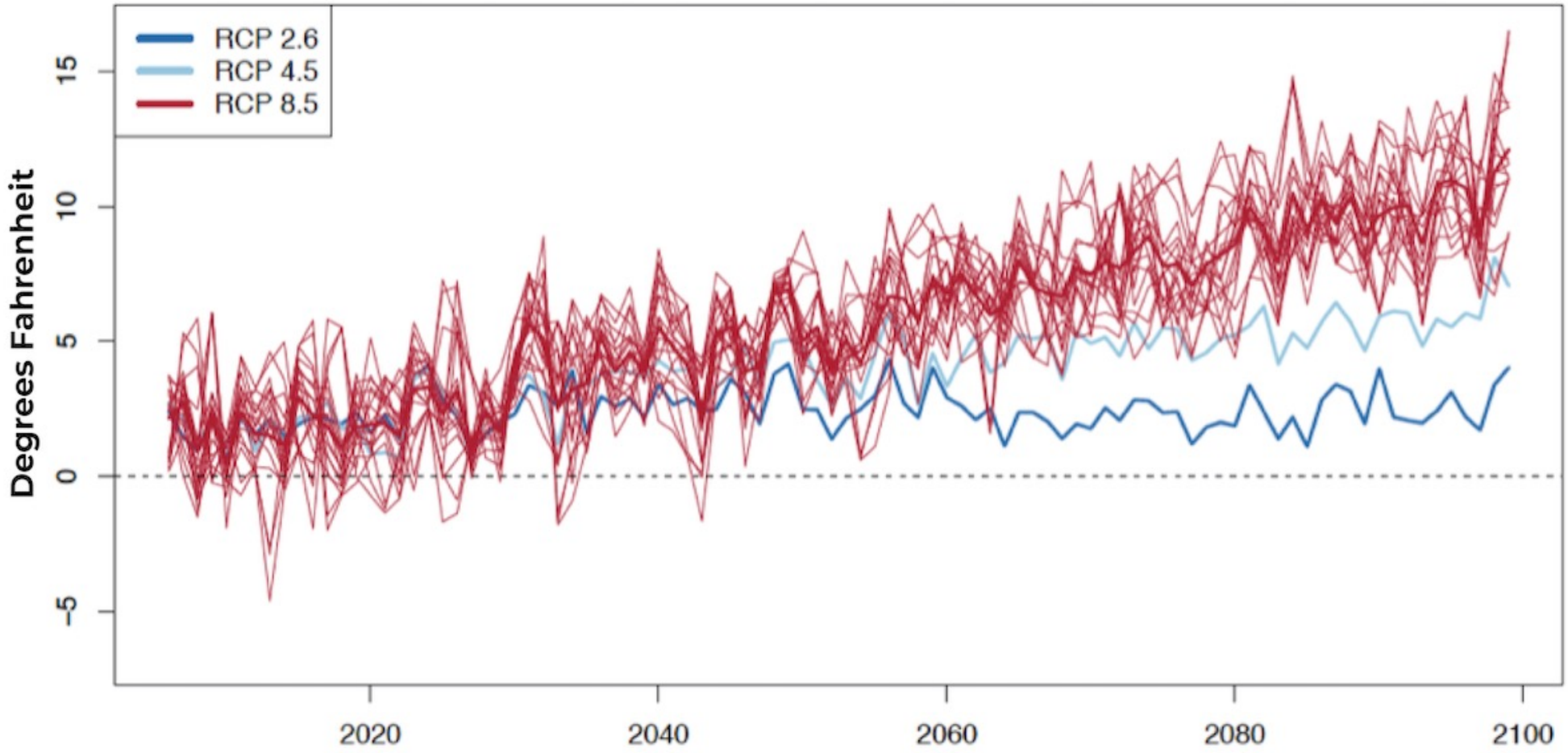
20 - 30	100 - 110
30 - 40	110 - 120
40 - 50	120 - 130
50 - 60	130 - 140
60 - 70	140 - 150
70 - 80	150 - 160
80 - 90	160 - 170
90 - 100	170+

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



Projected Change in Annual Average High Temperature
Oklahoma City, OK



Projected Change in Annual Average High Temperature
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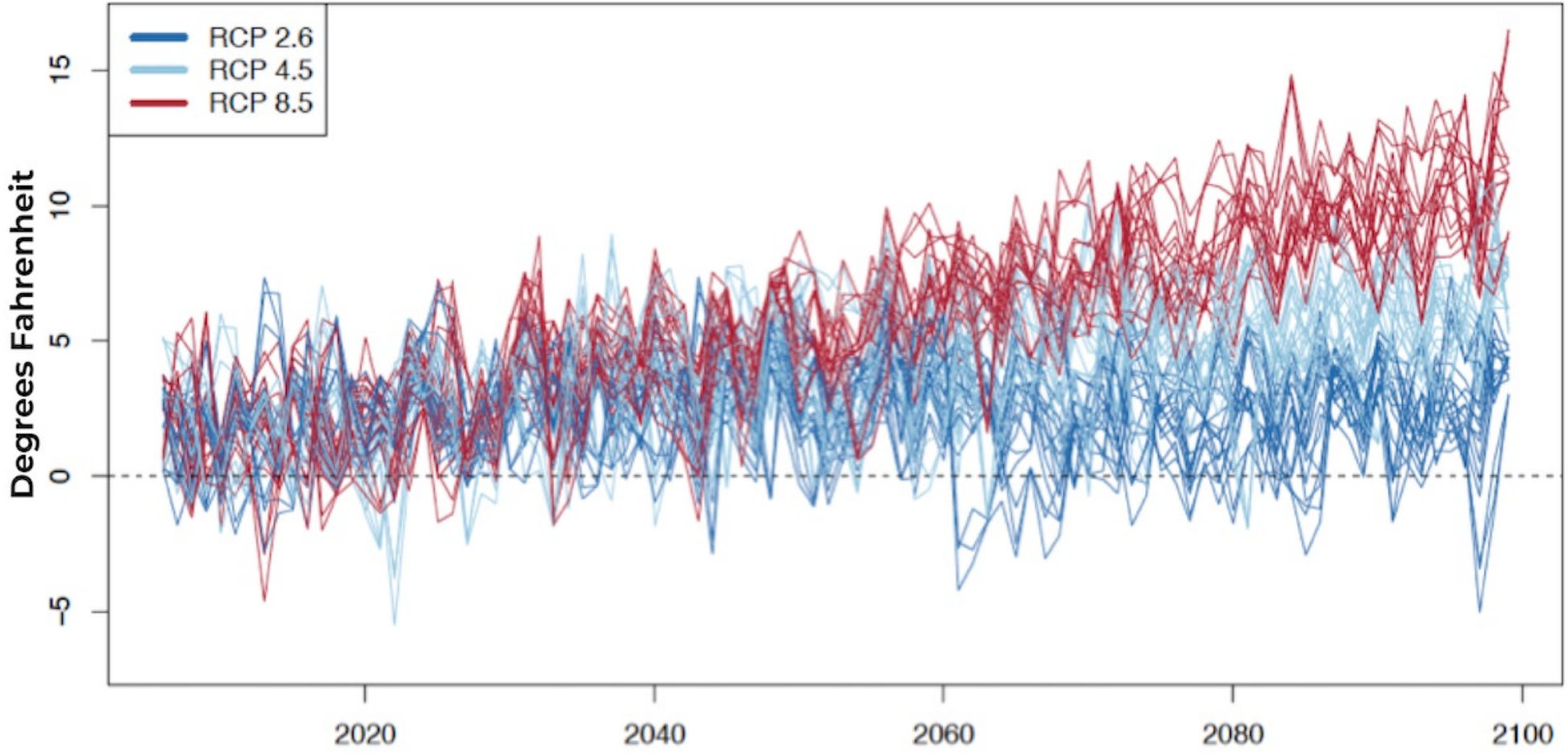


BEYOND CLIMATE SCIENCE

- Climate Science, Modeling, and Projections
  - Researching the climate
  - Large scale assessments
- More people are using climate projections
  - Climate Adaptation Planning, Vulnerability / Impact Assessments, decision-making
  - Urban planning, ecology, agriculture, infrastructure, etc.

LETTER • OPEN ACCESS

Early-winter North Atlantic low-level jet latitude biases in climate models: implications for simulated regional atmosphere-ocean linkages

Thomas J Bracegirdle[3,1], Hua Lu[1] and Jon Robson[2]

Published 30 December 2021 • © 2021 The Author(s). Published by IOP Publishing Ltd

Environmental Research Letters, Volume 17, Number 1

Citation Thomas J Bracegirdle *et al* 2022 *Environ. Res. Lett.* **17** 014025

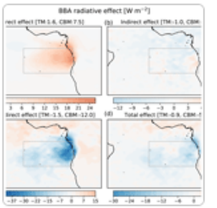
Article PDF Article ePub

Atmos. Chem. Phys., 21, 17–33, 2021
https://doi.org/10.5194/acp-21-17-2021

Article | Assets | Peer review | Metrics | Related articles

Research article 04 Jan 2021

Cloud adjustments dominate the overall negative aerosol radiative effects of biomass burning aerosols in UKESM1 climate model simulations over the south-eastern Atlantic



Haochi Che[1,a], **Philip Stier**[1], **Hamish Gordon**[2,b], **Duncan Watson-Parris**[1], **and Lucia Deaconu**[1]
[1]Atmospheric, Oceanic and Planetary Physics, Department of Physics, University of Oxford, Oxford, OX1 3PU, UK
[2]School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK
[a]now at: Department of Geophysics, Tel Aviv University, Tel Aviv 69978, Israel
[b]now at: Engineering Research Accelerator, Carnegie Mellon University, Pittsburgh, PA 15217, USA

Article | Open Access | Published: 11 March 2022

Enhanced jet stream waviness induced by suppressed tropical Pacific convection during boreal summer

Xiaoting Sun, Qinghua Ding ✉, Shih-Yu Simon Wang, Dániel Topál, Qingquan Li, Christopher Castro, Haiyan Teng, Rui Luo & Yihui Ding

Nature Communications **13**, Article number: 1288 (2022) | Cite this article

Article | Published: 24 November 2021

Mechanical forcing of the North American monsoon by orography

William R. Boos ✉ & Salvatore Pascale

Nature **599**, 611–615 (2021) | Cite this article

ACADEMIA | Letters

Progress in understanding North American Monsoon Using a Climate Model

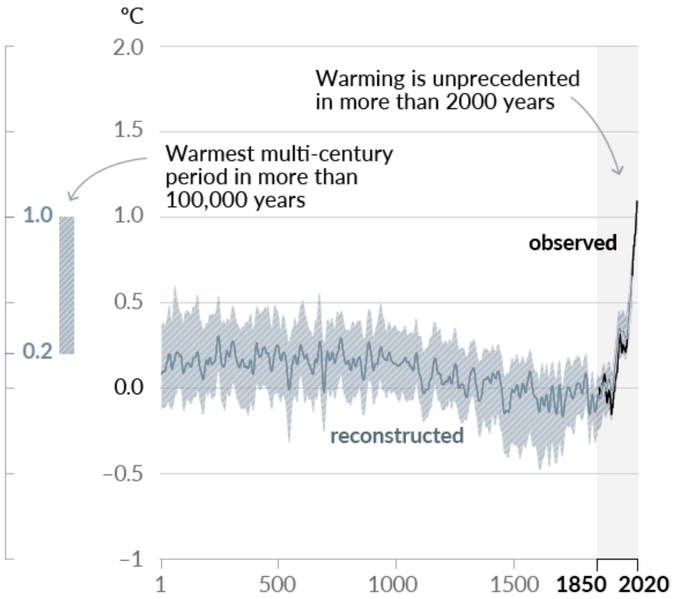
Ehsan Erfani
David Mitchell

The Intergovernmental Panel on Climate Change _

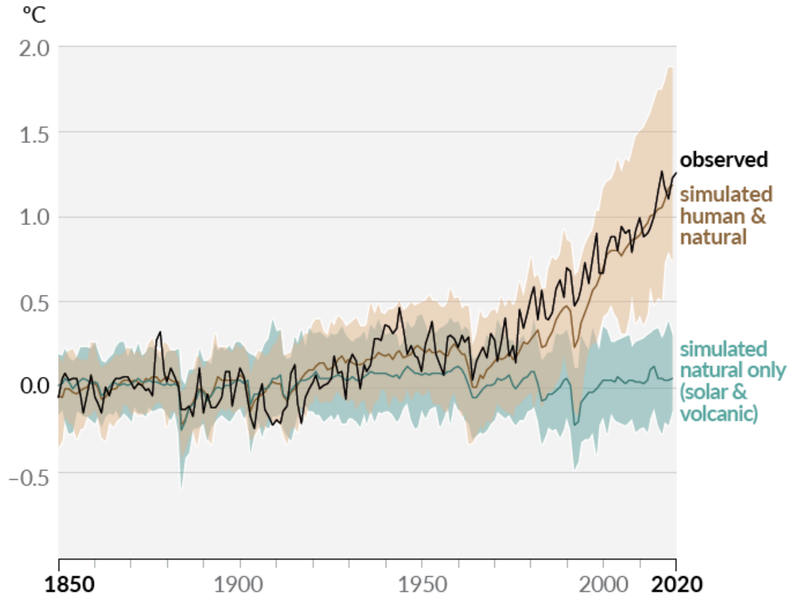
The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

Changes in global surface temperature relative to 1850–1900

(a) Change in global surface temperature (decadal average) as reconstructed (1–2000) and **observed** (1850–2020)



(b) Change in global surface temperature (annual average) as **observed** and simulated using human & natural and only natural factors (both 1850–2020)

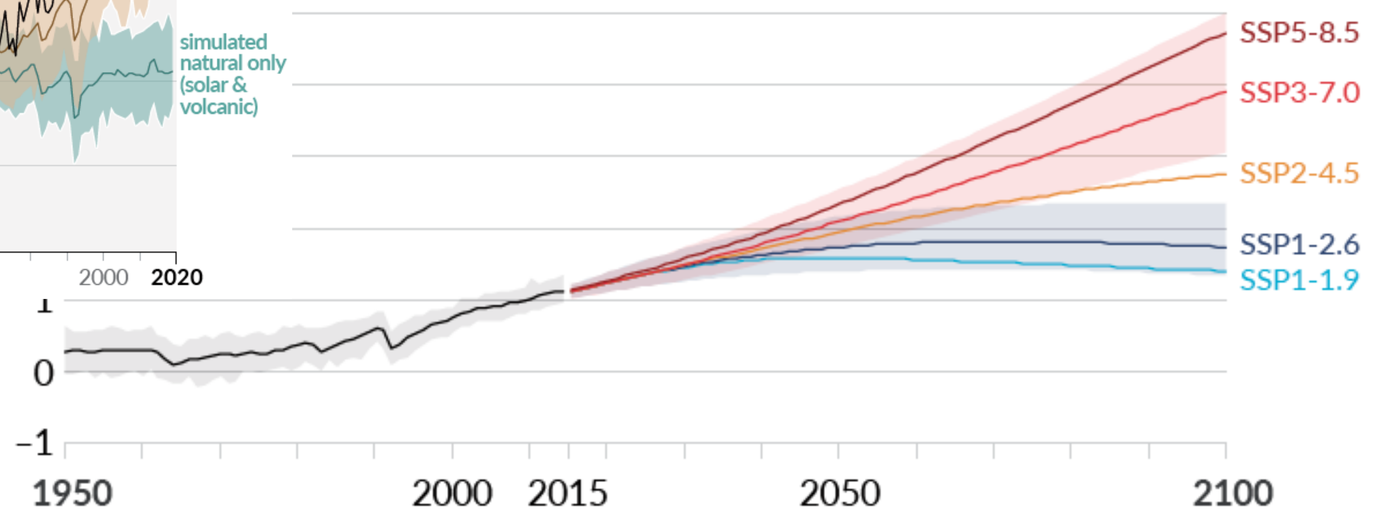


Sixth Assessment Report _

The Working Group I contribution was released on 9 August 2021. The Working Group II and III contributions were released on 28 February and 4 April 2022 respectively.

WORKING GROUP II | WORKING GROUP III (LATEST REPORT)

ce temperature change relative to 1850–1900



Climate Science Special Report

Fourth National Climate Assessment (NCA4), Volume I

This report is an authoritative assessment of the science of climate change, with a focus on the United States. It represents the first of two volumes of the Fourth National Climate Assessment, mandated by the Global Change Research Act of 1990.

Recommended Citation

FOURTH NATIONAL CLIMATE ASSESSMENT

Volume II: Impacts, Risks, and Adaptation in the United States

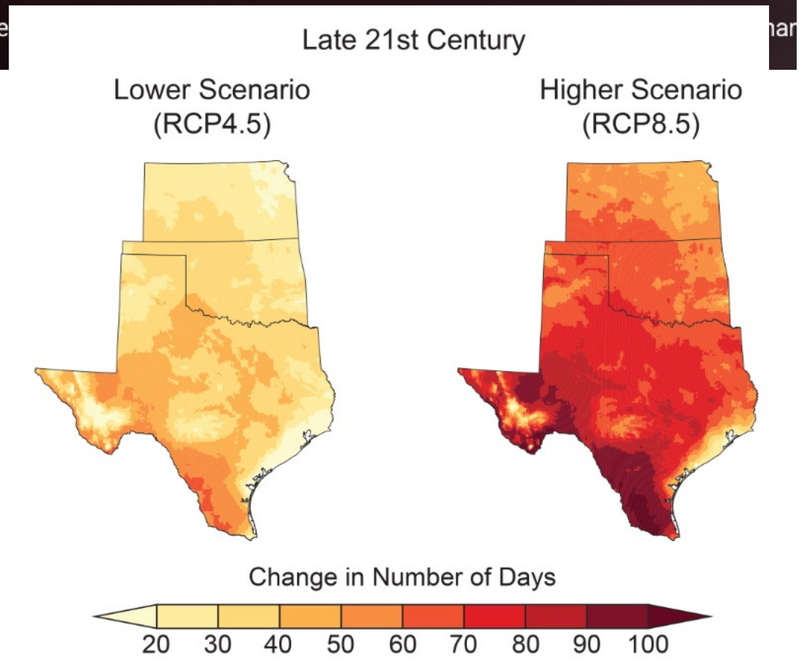
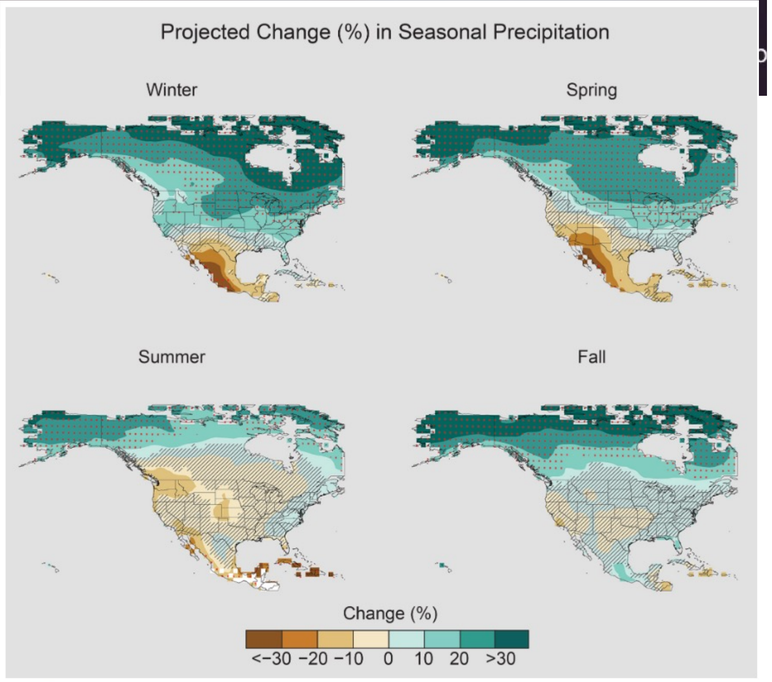
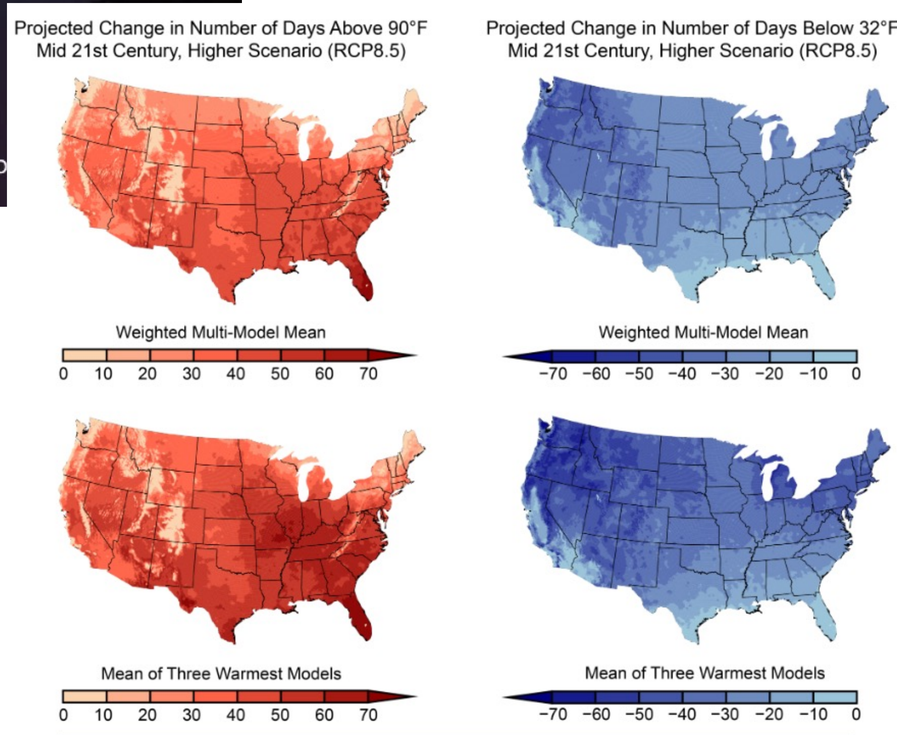


Figure 23.4: Under both lower- and higher-scenario climate change projections, the number of days exceeding 100°F is projected to increase markedly across the Southern Great Plains by the end of the century (2070–2099 as compared to 1976–2005). Sources: NOAA NCEI and CICS-NC.



Projected change (%) in total seasonal precipitation from CMIP5 simulations for 2070–2099. The values are weighted multimodel means and expressed as the percent change relative to the 1976–2005 average. These are results for the higher scenario (RCP8.5). Stippling indicates that changes are assessed to be large compared to natural variations. Hatching indicates that changes are assessed to be small compared to natural variations. Blank regions (if any) are where projections are assessed to be inconclusive. Data source: World Climate Research Program's (WCRP's) Coupled Model Intercomparison Project. (Figure source: NOAA NCEI).



Projected changes in the number of days per year with a maximum temperature above 90°F and a minimum temperature below 32°F in the contiguous United States. Changes are the difference between the average for mid-century (2036–2065) and the average for near-present (1976–2005) under the higher scenario (RCP8.5). Maps in the top row depict the weighted multimodel mean whereas maps on the bottom row depict the mean of the three warmest models (that is, the models with the largest temperature increase). Maps are derived from 32 climate model projections that were statistically downscaled using the Localized Constructed Analogs technique.[89] Changes are statistically significant in all areas (that is, more than 50% of the models show a statistically significant change, and more than 67% agree on the sign of the change[90]). (Figure source: CICS-NC

FUTURE PROJECTIONS AND IMPACTS

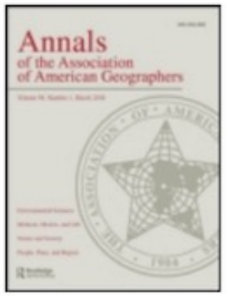
- Climate projections are tools and visuals
  - Climate: typical weather, frequency of extremes
  - Why does it matter to see how climate will change?

Frequency of Droughts

Average Growing Season Length

Frequency of Heavy Rains

Average High Temperature



Annals of the Association of American Geographers

Routledge
Taylor & Francis Group

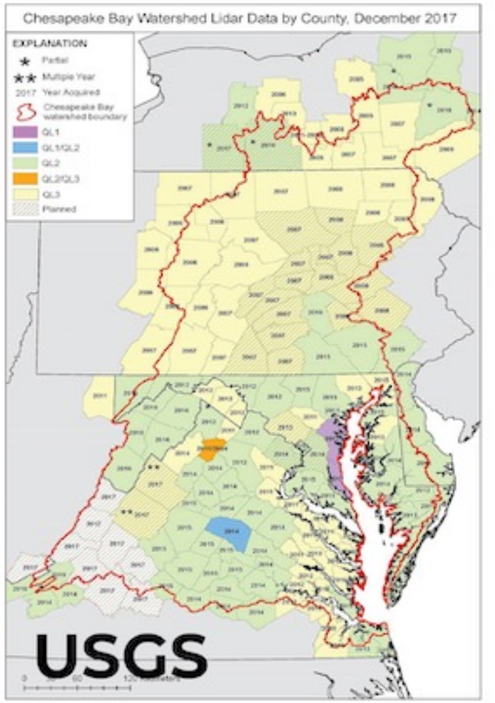
ISSN: 0004-5608 (Print) 1467-8306 (Online) Journal homepage: https://www.tandfonline.com/loi/raag20

Simulating the Impacts of Projected Climate Change on Streamflow Hydrology for the Chesapeake Bay Watershed

Timothy W. Hawkins

To cite this article: Timothy W. Hawkins (2015) Simulating
Change on Streamflow Hydrology for the Chesapeake Bay
American Geographers, 105:4, 627-648, DOI: 10.1080/000

To link to this article: https://doi.org/10.1080/00045608



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Climate Change Implications for Tropical Islands: Interpolating and Interpreting Statistically Downscaled GCM Projections for Management and Planning*

AZAD HENAREH KHALYANI,[+,#] WILLIAM A. GOULD,[+] ERIC HARMSEN,[@] ADAM TERANDO,[&] MAYA QUINONES,[#] AND JAIME A. COLLAZO**

[+] *International Institute of Tropical Forestry, U.S. Department of Agriculture Forest Service, San Juan, Puerto Rico*
[#] *North Carolina Cooperative Fish and Wildlife Research Unit, Department of Applied Ecology, North Carolina State University, Raleigh, North Carolina*
[@] *Department of Agricultural and Biosystems Engineering, University of Puerto Rico, Mayaguez, Puerto Rico*
[&] *Southeast Climate Science Center, U.S. Geological Survey, Raleigh, North Carolina*
** *U.S. Geological Survey, and North Carolina Cooperative Fish and Wildlife Research Unit, Department of Applied Ecology, North Carolina State University, Raleigh, North Carolina*

Climatic Change (2019) 156:15–30
https://doi.org/10.1007/s10584-019-02491-w

Check for updates

Climate change increases potential plant species richness on Puerto Rican uplands

Azad Henareh Khalyani[1] · William A. Gould[2] · Michael J. Falkowski[1] · Robert Muscarella[3] · María Uriarte[4] · Foad Yousef[5]

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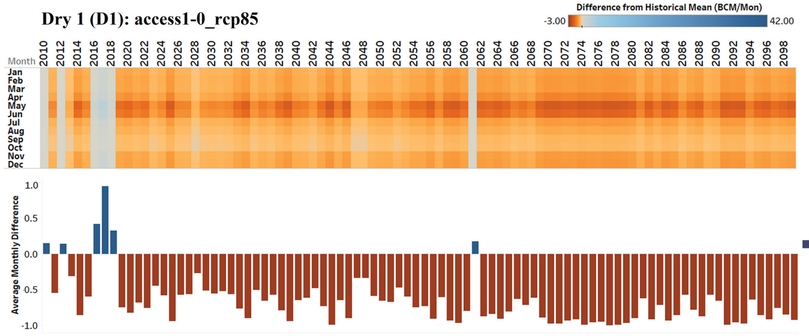

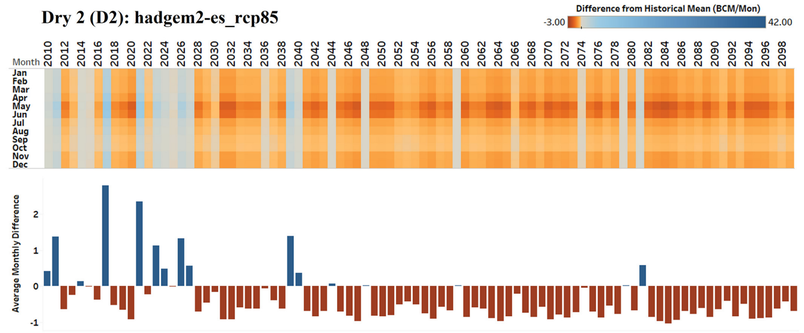

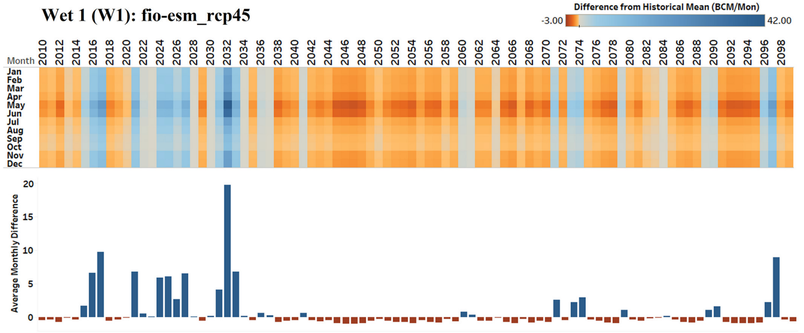

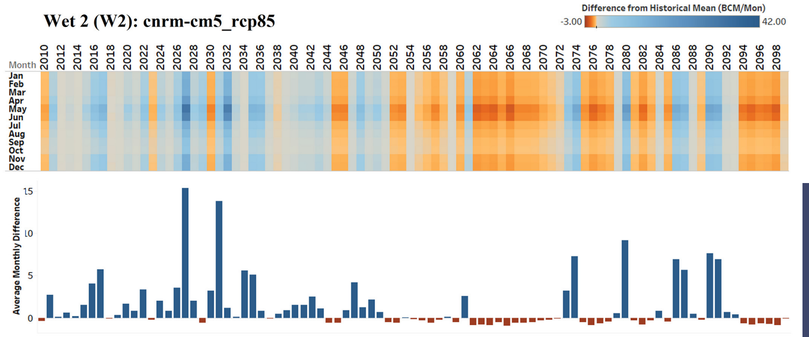

JAWRA
JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION
AMERICAN WATER RESOURCES ASSOCIATION

Research Article | Full Access

Climate Change Impacts on Agricultural Water Availability in the Middle Rio Grande Basin

Maryam Samimi, Ali Mirchi, Nolan Townsend, David Gutzler, Subhash Daggubati, Sora Ahn, Zhuping Sheng, Daniel Moriasi, Alfredo Granados-Olivas, Sara Alian, Alex Mayer, William Hargrove

First published: 06 February 2022 | https://doi.org/10.1111/1752-1688.12988

"**The results indicate that the EB-Caballo reservoir system will become a much less reliable water source in the future.** Consequently, the region will likely become more groundwater-dependent. It is highly likely that maintaining the region's agricultural production will lead to fresh groundwater depletion within the 21st Century."

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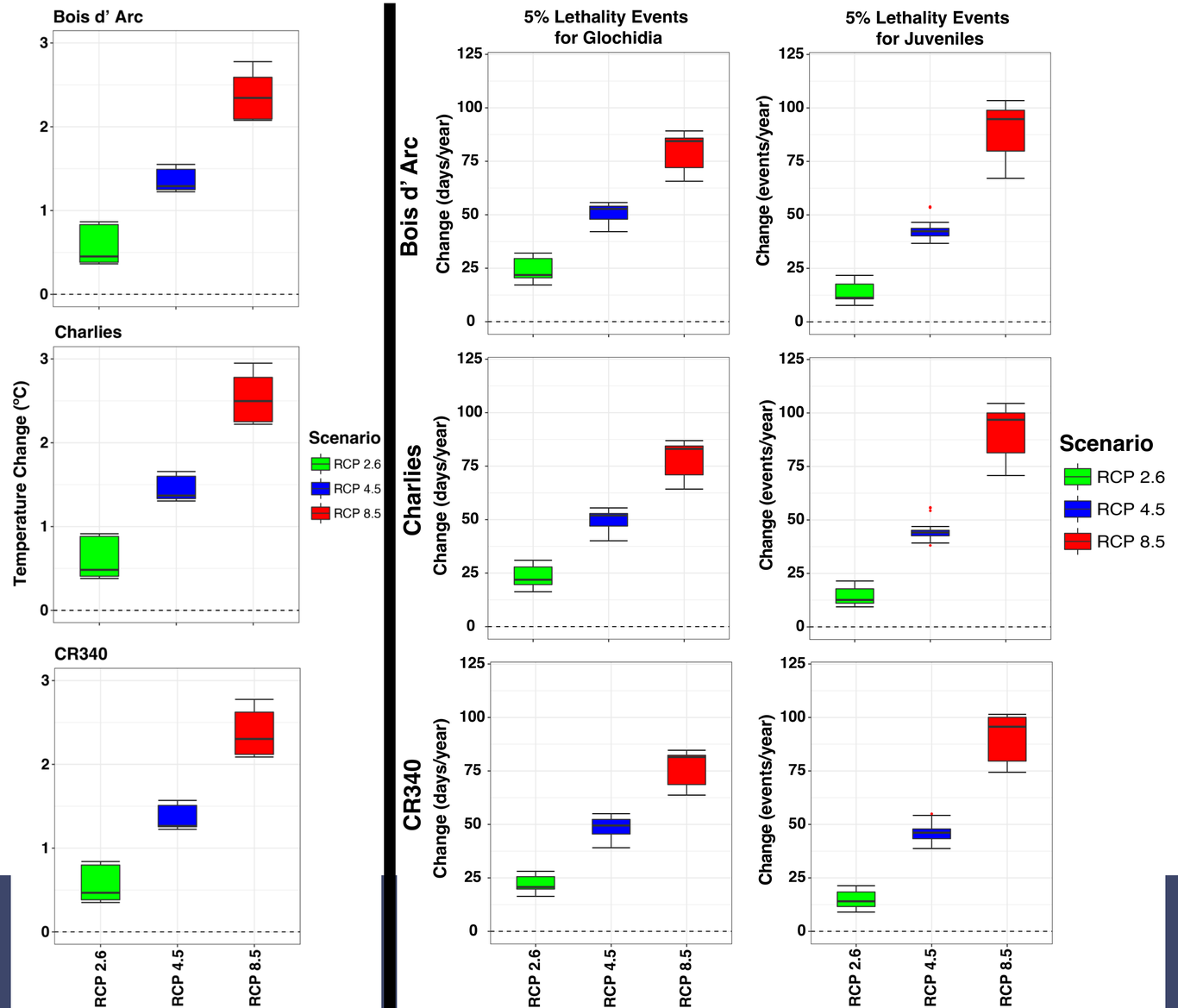
Article Type: Research Article

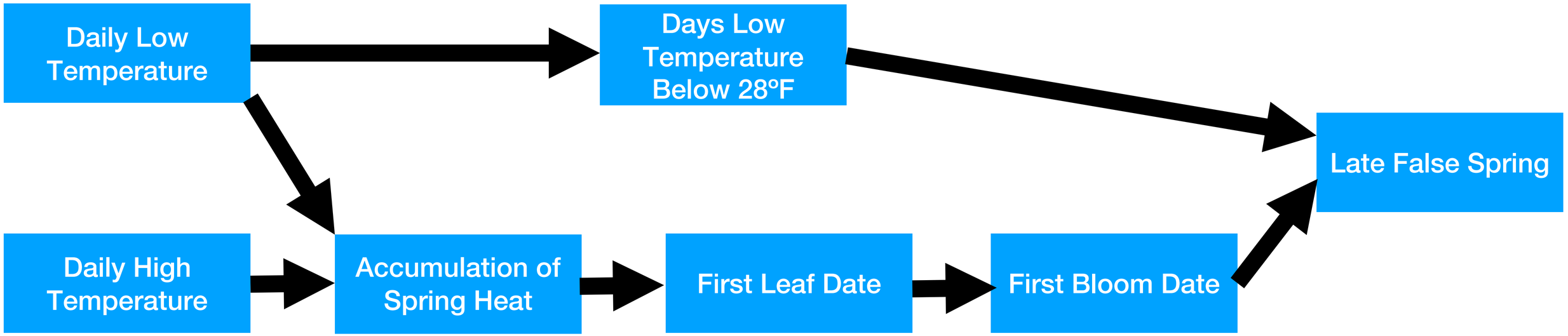
Projected Changes to Streamflow and Stream Temperature in Central Texas: How Much Will the River Flow?

Adrienne M. Wootten, Elinor Martin, Charles R. Randklev, and Ryan Smith

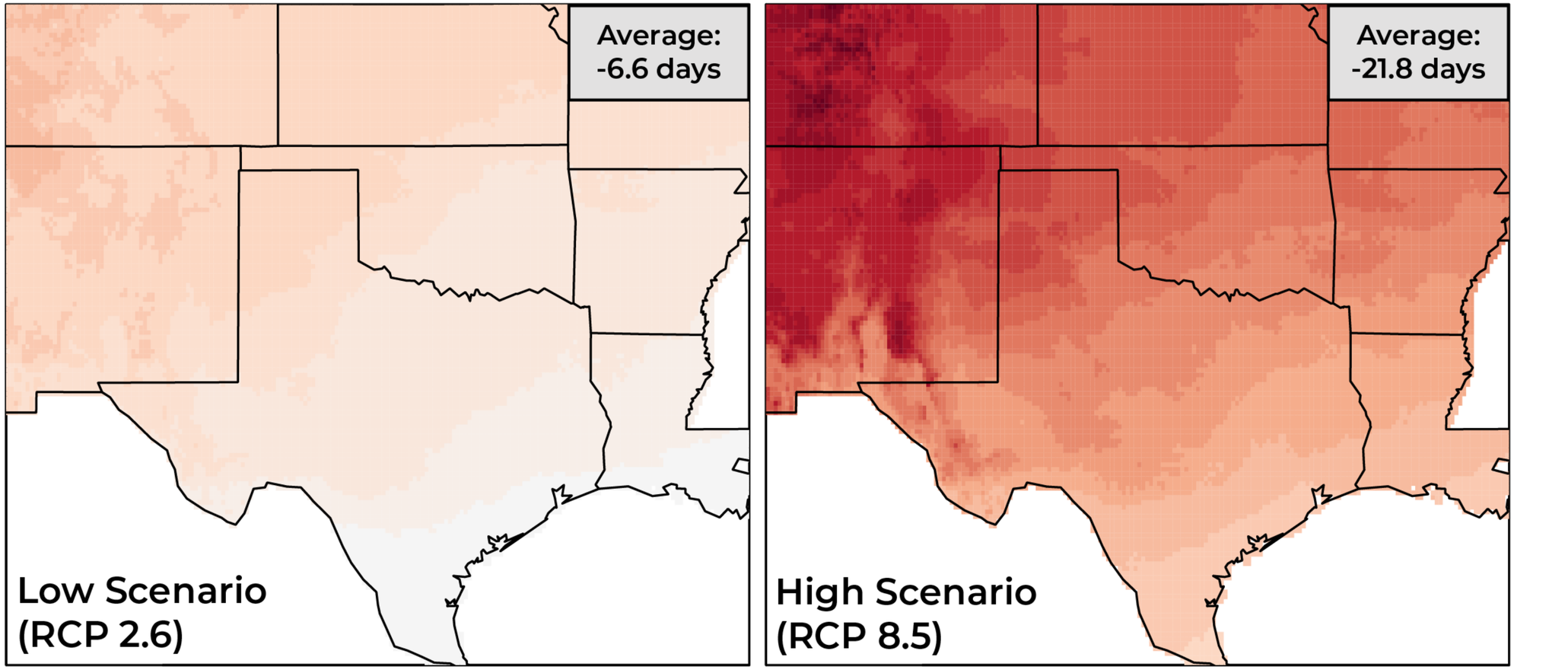


SPRING PHENOLOGY

- Late False Spring – a hard freeze (≤ 28°F) occurring after first bloom
- Dependent on first bloom date and timing / intensity of cold extremes



End-of-Century Projected Change of the Annual Average **Day of First Bloom**



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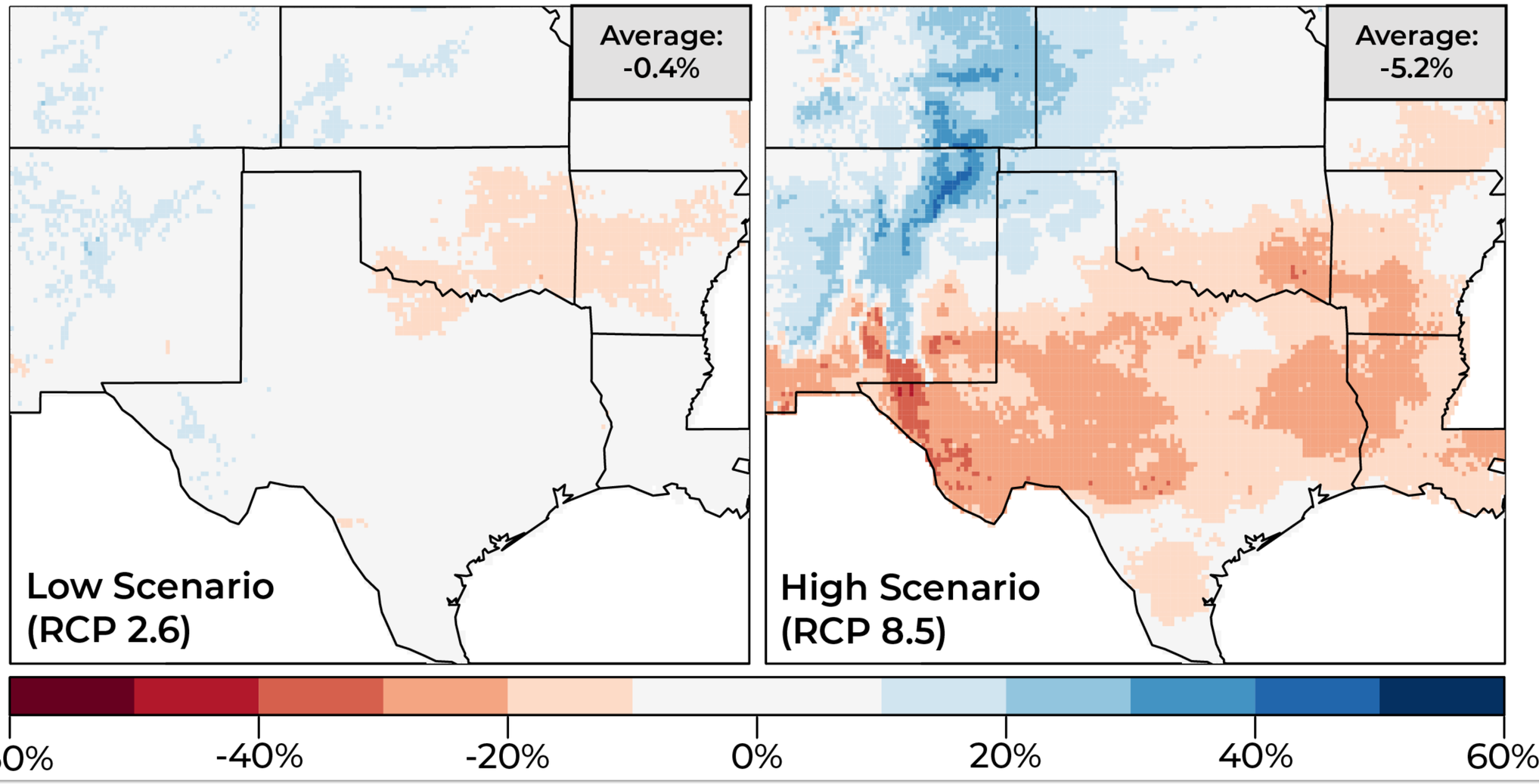
Ensemble Mean
C-PrEP
2022-03-21

End-of-Century Projected Change of the **Risk of a Late False Spring**



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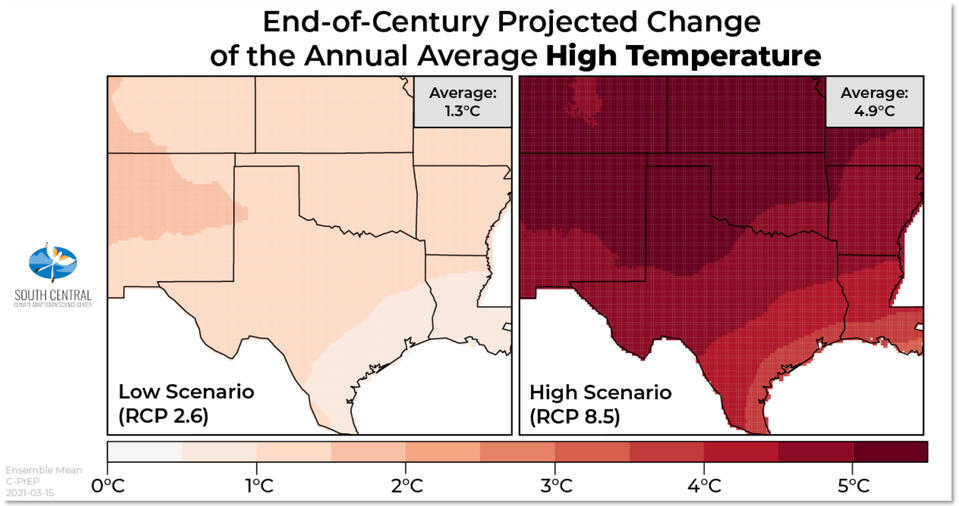
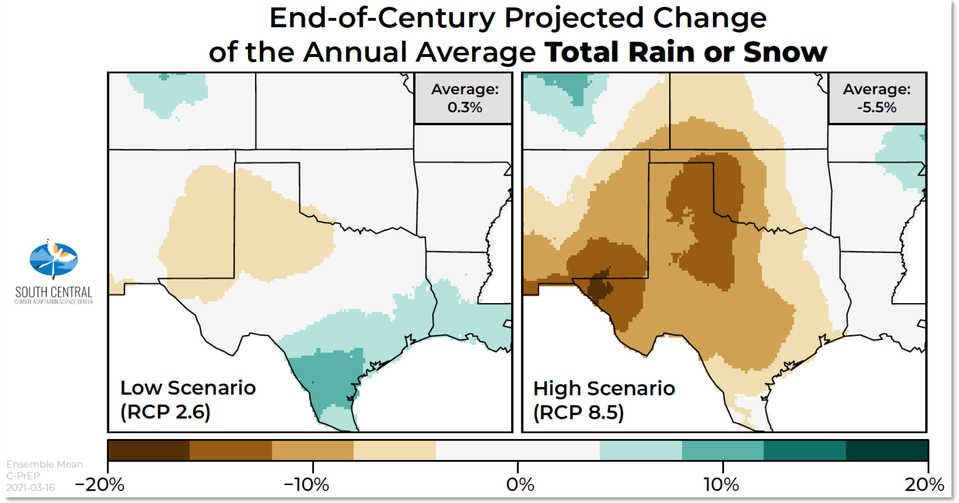
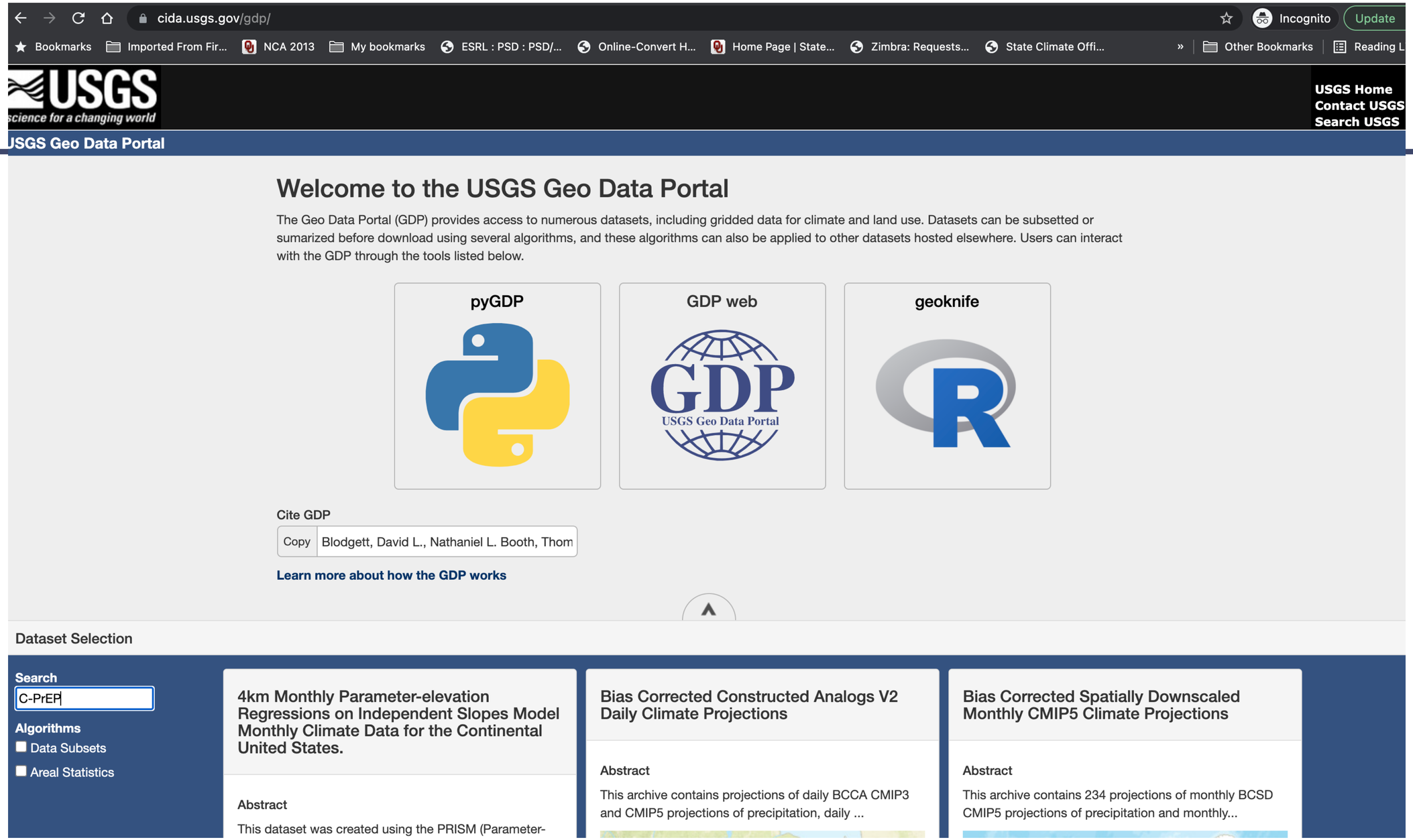
Ensemble Mean
C-PrEP
2022-03-21

AVAILABLE DATASETS





- Climate Projections Evaluation Project (CPrEP)
  - Designed and built for South Central CASC region
  - Update coming in 2024
- LOCA (Localized Canonical Analogs)
- MACA (Multivariate Adaptive Constructed Analogs)
- Other datasets and tools



SOUTH CENTRAL
CLIMATE ADAPTATION SCIENCE CENTER

USGS
science for a changing world

New Mexico Water Science Center

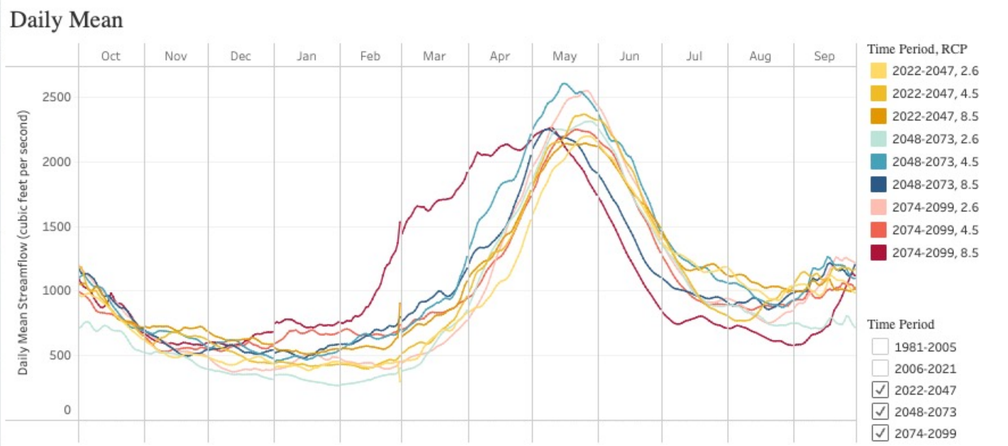
Streamflow Response to Potential Changes in Climate

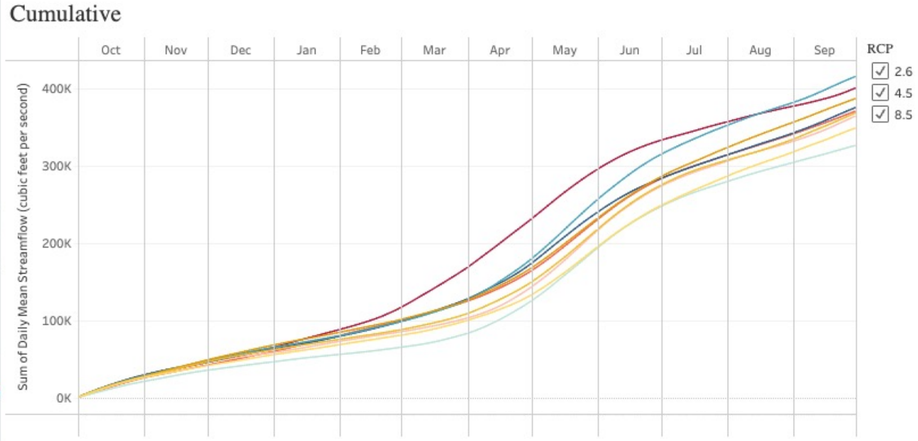
Upper Rio Grande Basin

Select a stream segment point on the map to filter line graphs and see streamflow details for the selected site.
Click anywhere on the map to reset selection.

Hydrograph | Percent Change

Hover over stream segment points on the map to see site details.
Hover over line graphs to see streamflow details.
Toggle through Time Periods and RCP to see change over time.





New Mexico Water Science Center
Upper Rio Grande Streamflow Projections
https://webapps.usgs.gov/urgb-prms/

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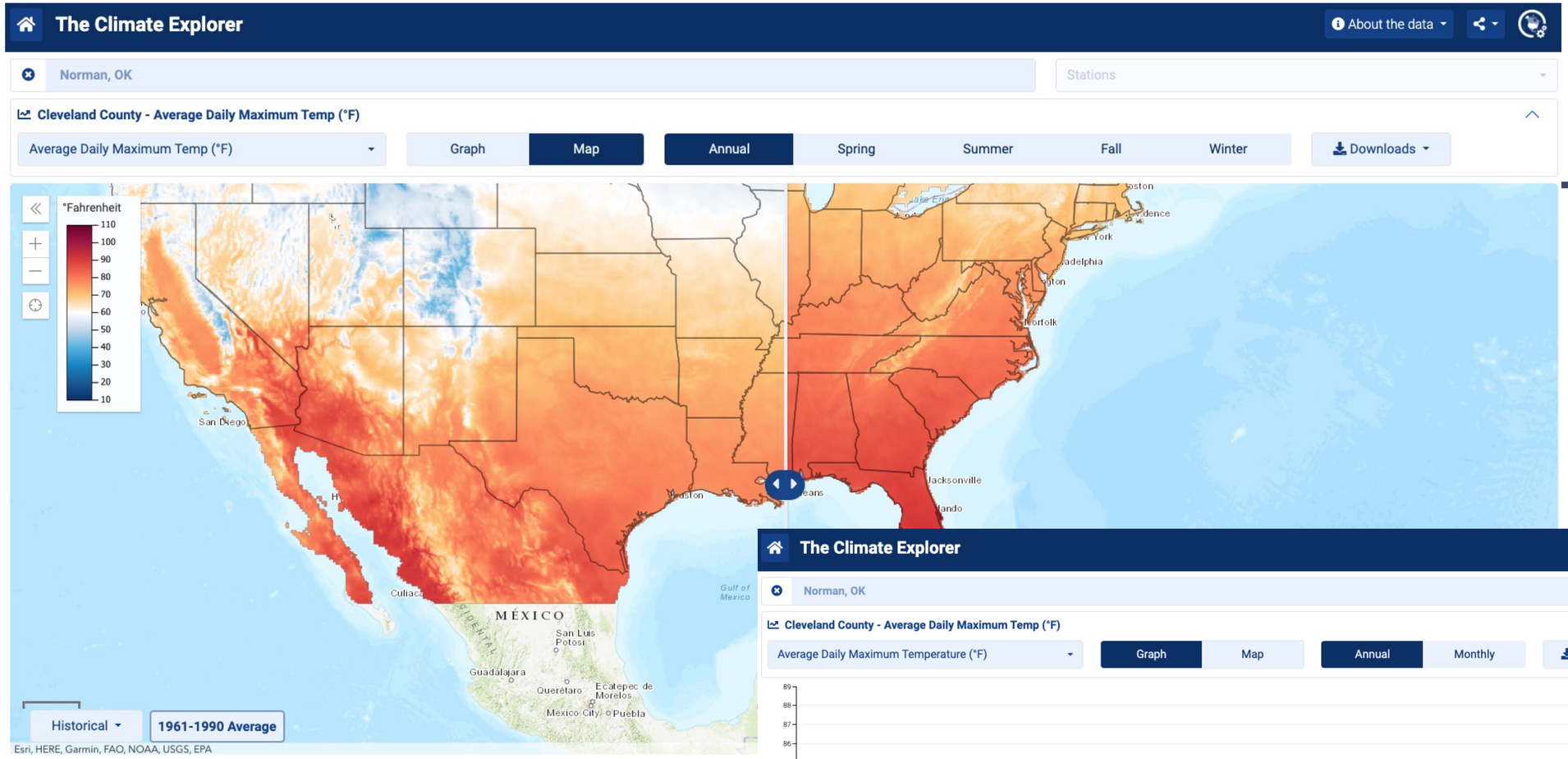
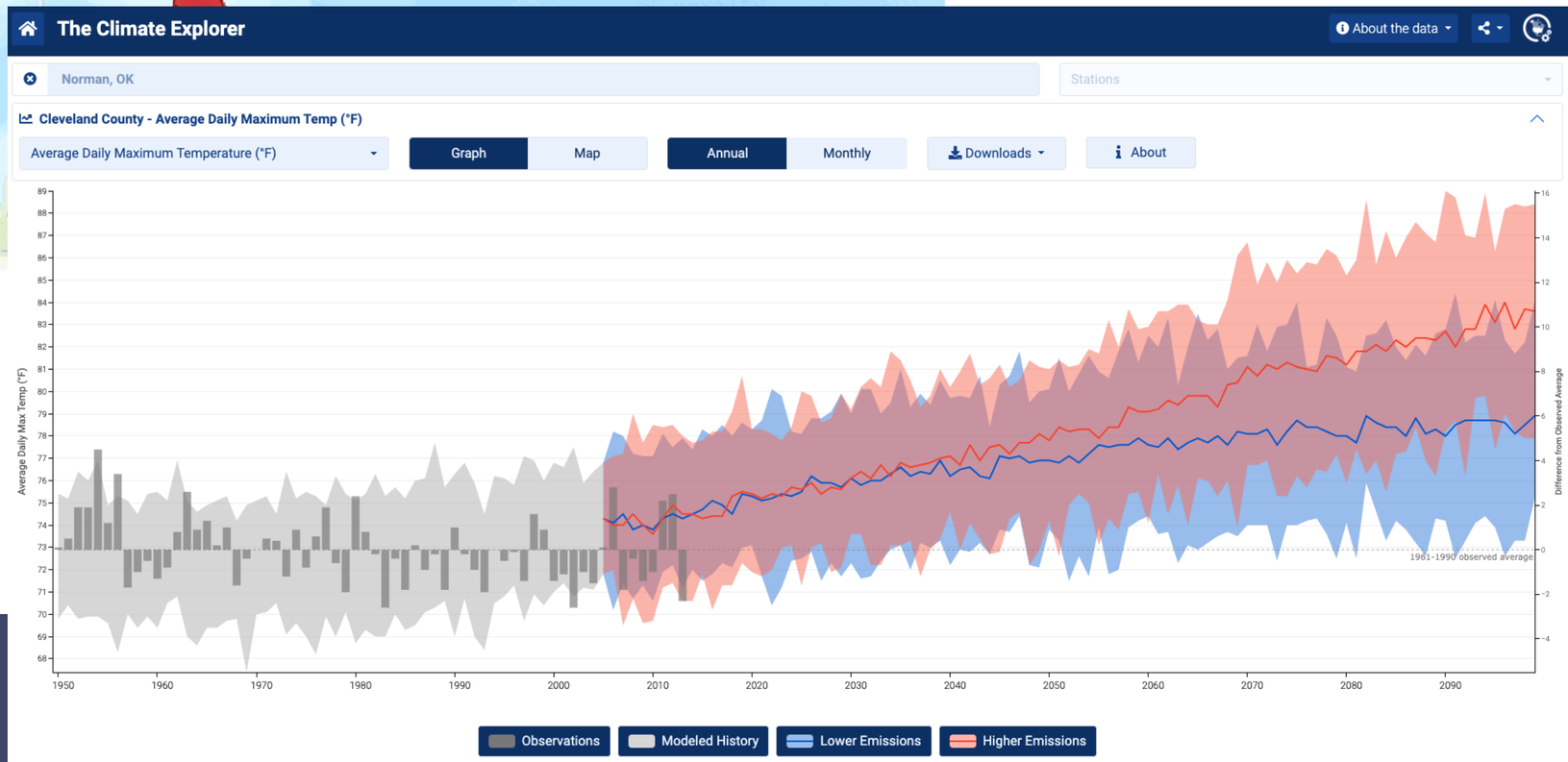


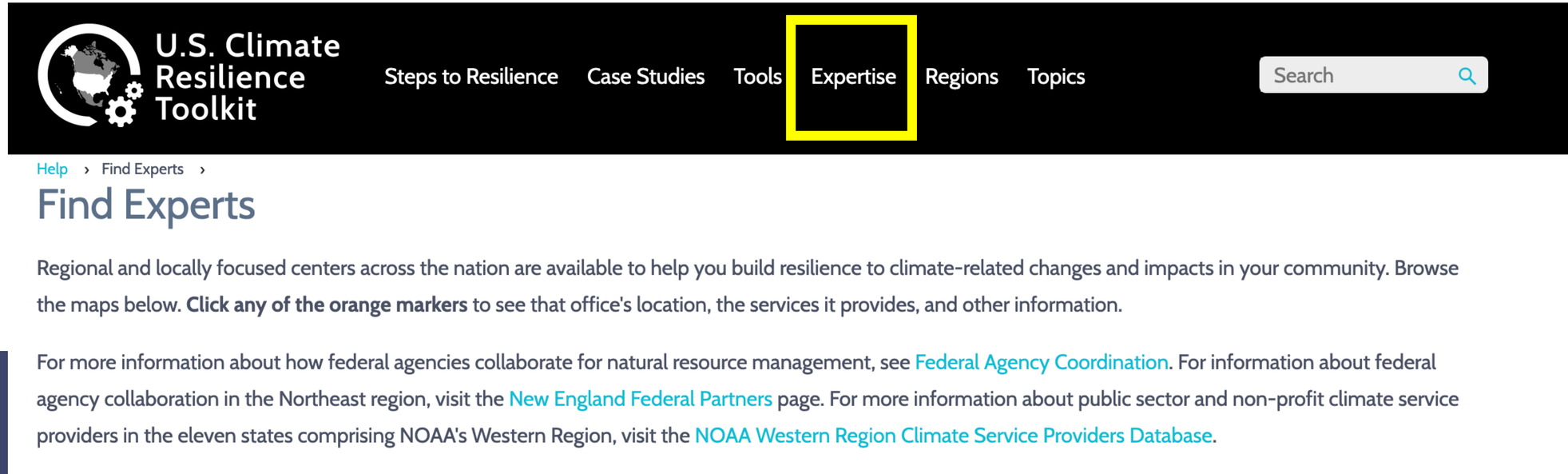


Climate Explorer

CONNECTIONS

- DOI Climate Adaptation Science Centers (CASCs)
- NOAA Regional Integrated Sciences and Assessments (RISAs)
- USDA Climate Hubs

- Expertise section of the Climate Resilience Toolkit




ONE DOES NOT SIMPLY
USE ANY CLIMATE PROJECTION


CAUTION
Climate data can't tell you everything!
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