Climate Change Concepts & Applications - 101

NC CASC Climate Solution Days

April 19, 2:00-3:30 pm MDT

Imtiaz Rangwala
NC CASC
University of Colorado Boulder

Katherine Hegewisch
University of California, Merced

Note Taker: Sarah Jaffe
Discussion & Chat Monitoring: Jane Wolken

North Central Climate Adaptation Science Center

The Climate Toolbox

A collection of web tools for visualizing past and projected climate and hydrology of the contiguous United States.

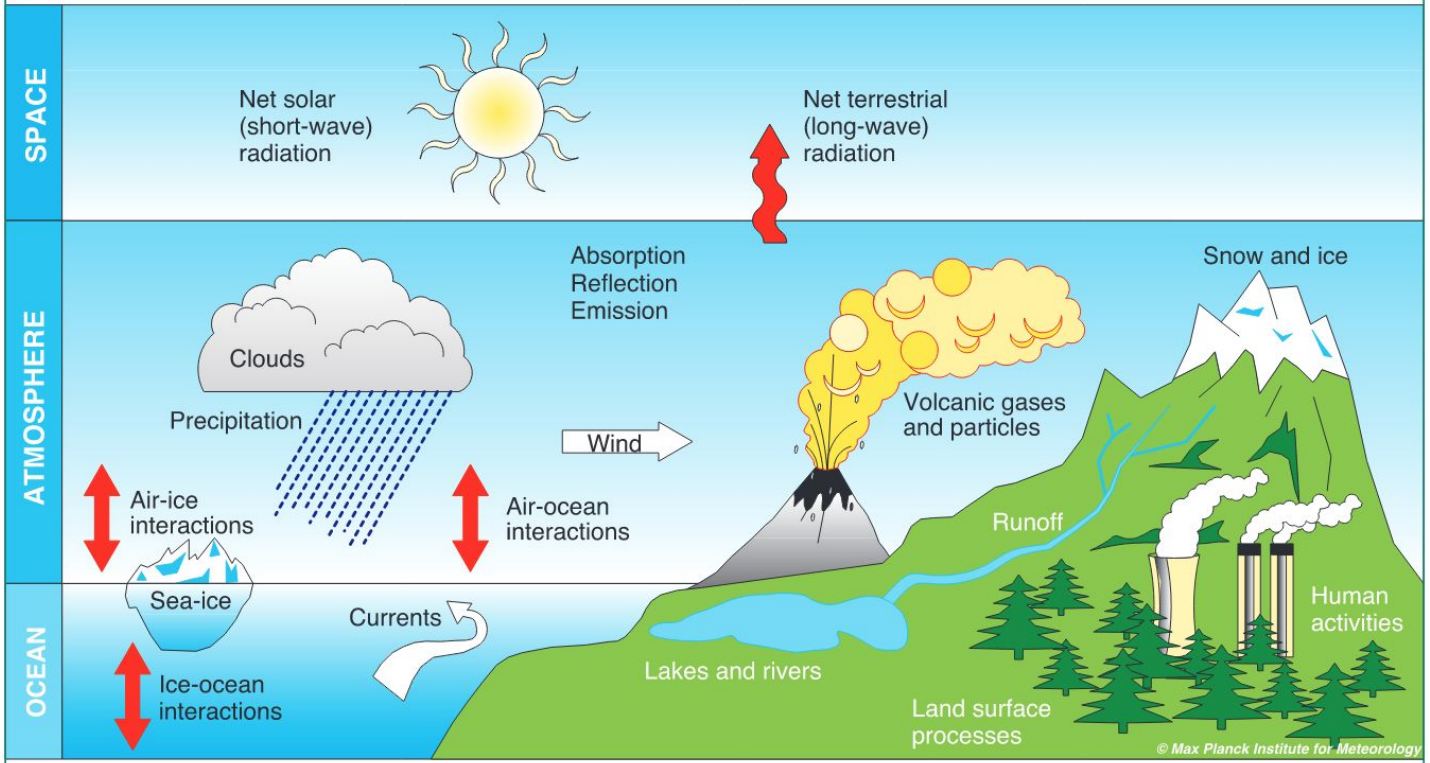
Mentimeter Activity

(anonymous)

Agenda

- Climate Change Concepts
  - Rapid Heating of the climate system
  - Future Climate Projections & Uncertainty
  - Sources of Climate Projections Uncertainty
  - Working with that Uncertainty
- Climate Toolbox
  - Exploration and discussion of tools to extract and examine historical and future climate data

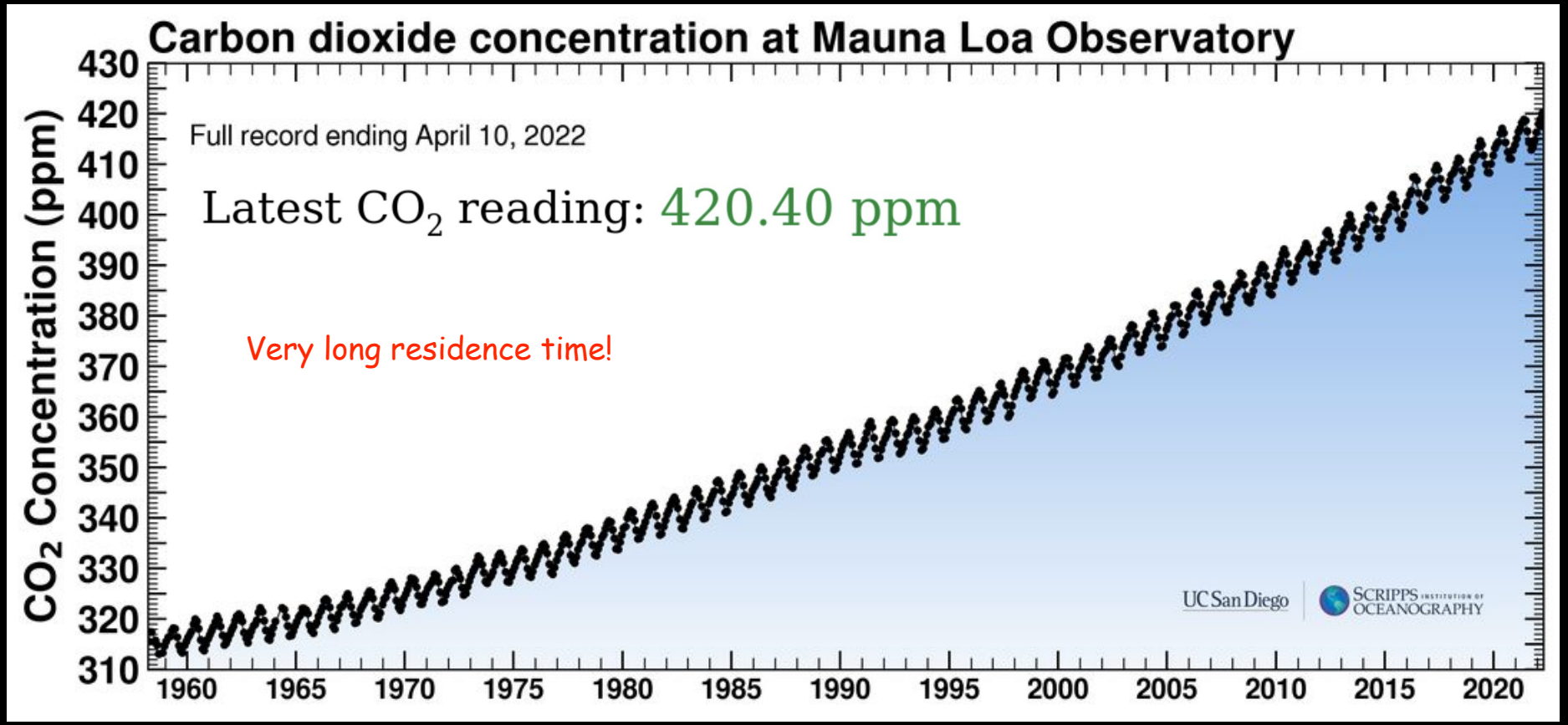
The Climate System



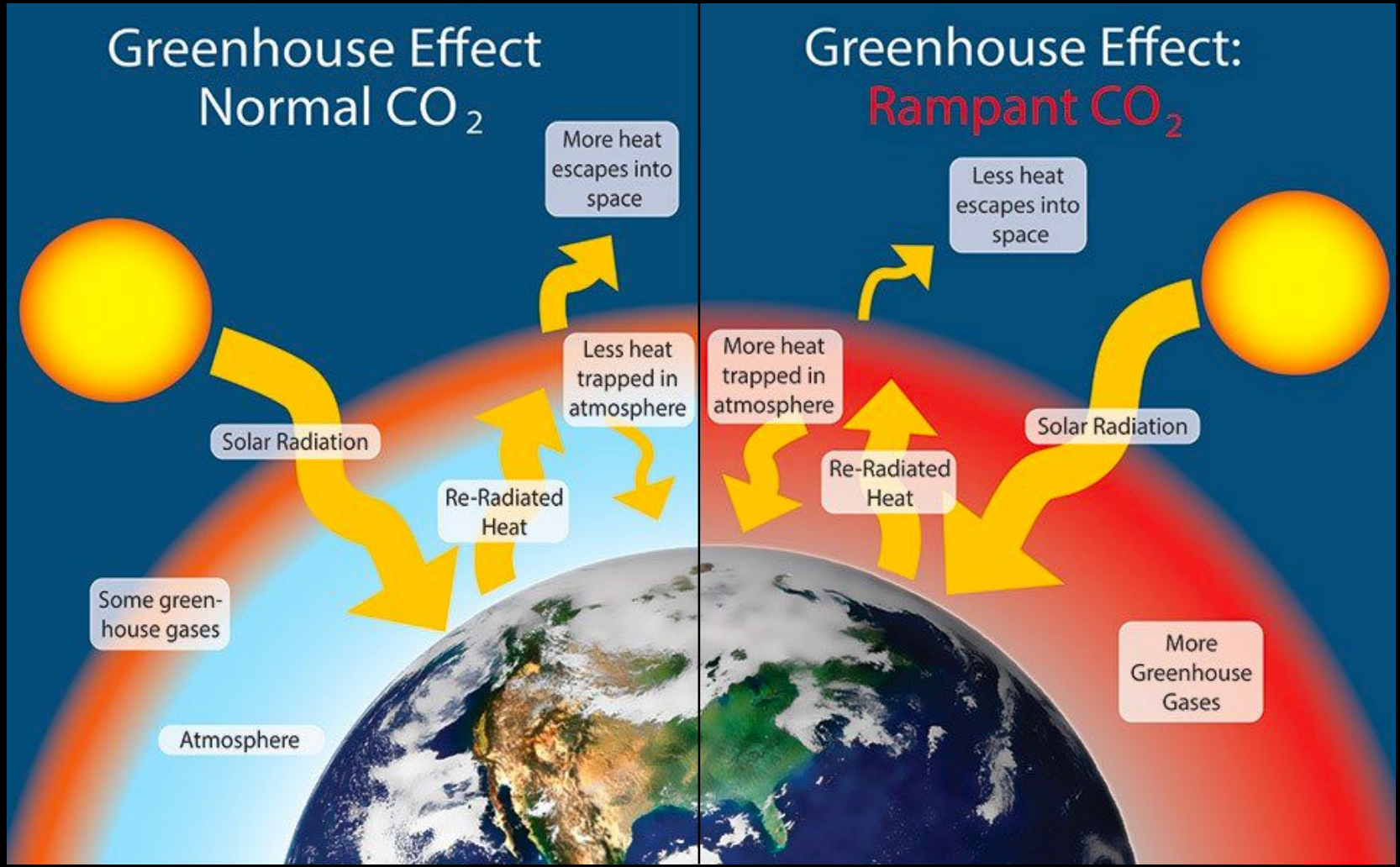
Max-Planck-Institut für Meteorologie

Image: https://mpimet.mpg.de/fileadmin/communication/Mediathek/Bilder_und_Grafik/2020/Klimasystem/Klimasystem_2020_uk.X3.pdf

Climate Change Causing Greenhouse Gases Continue to Increase Rapidly in our Atmosphere



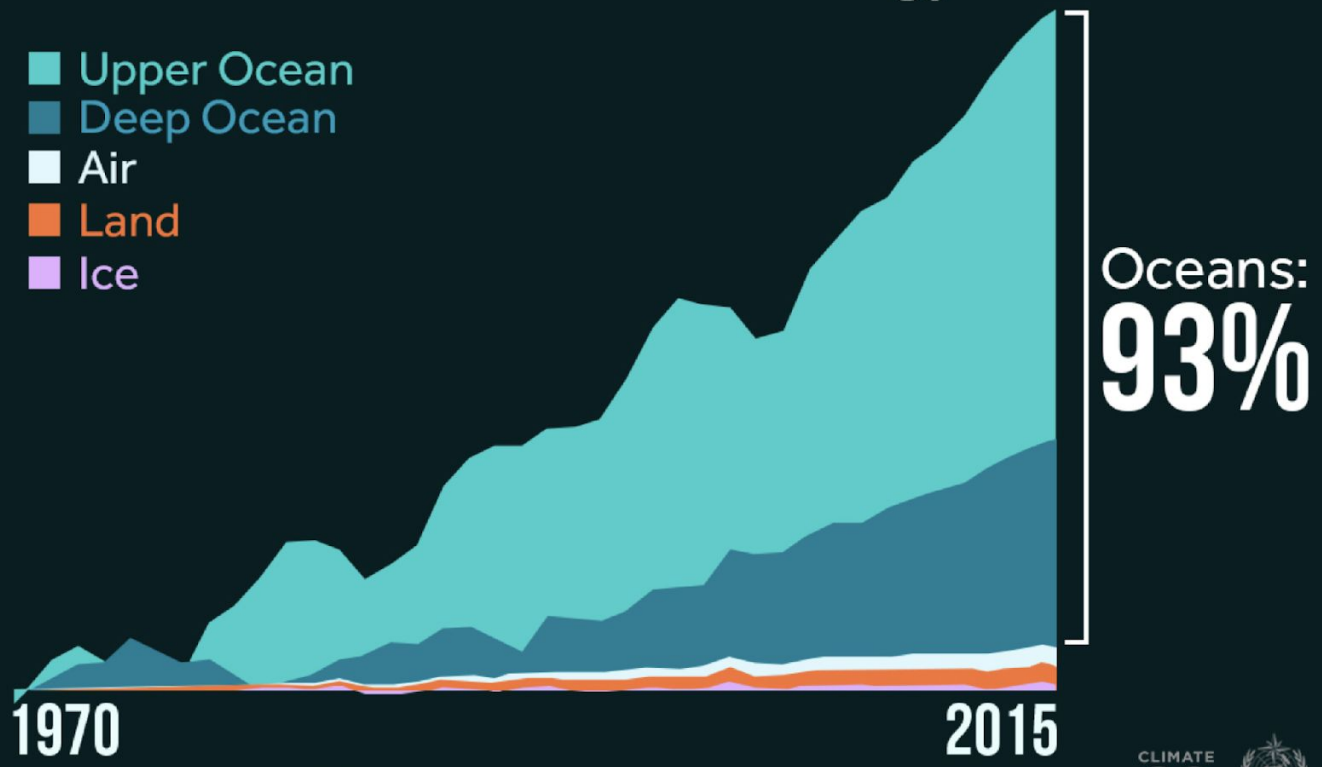
https://keelingcurve.ucsd.edu/



https://www.nps.gov/goga/learn/nature/climate-change-causes.htm

WHERE'S THE HEAT?

Earth's Accumulated Energy

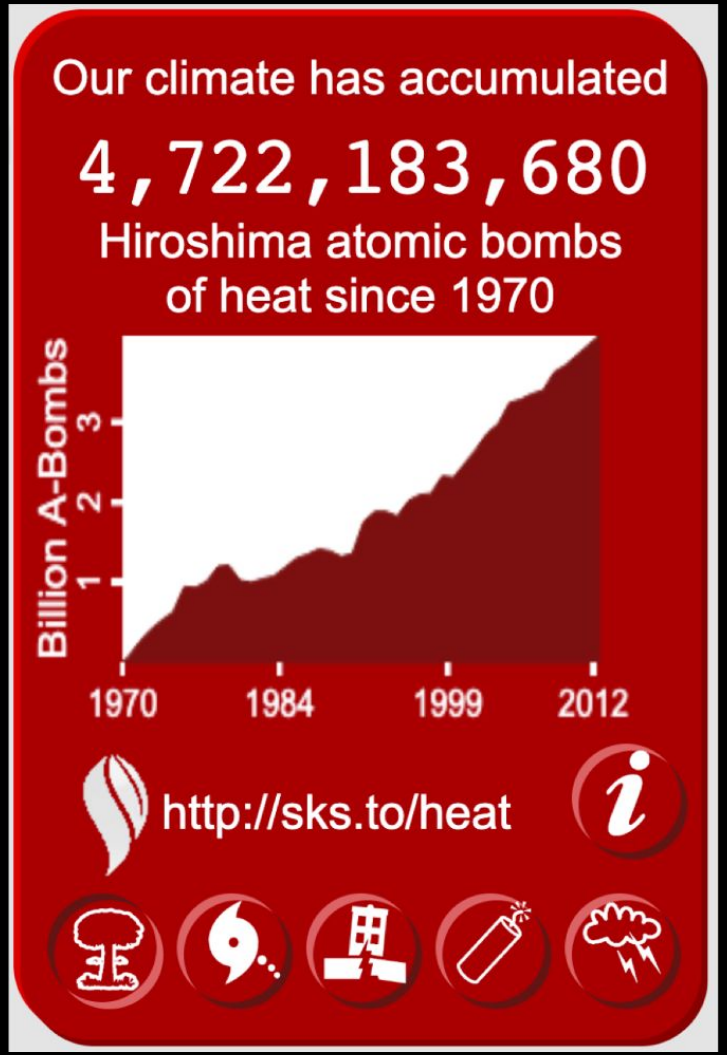


Accumulated heat energy measured in Zettajoules

Source. Climate Change 2013: the Physical Science Basis (IPCC) Chapter 3

CLIMATE CENTRAL

WMO



- Current climate change = rapid heating of our climate system
- In recent decades, our climate system is heating at the rate of four atomic bombs per second

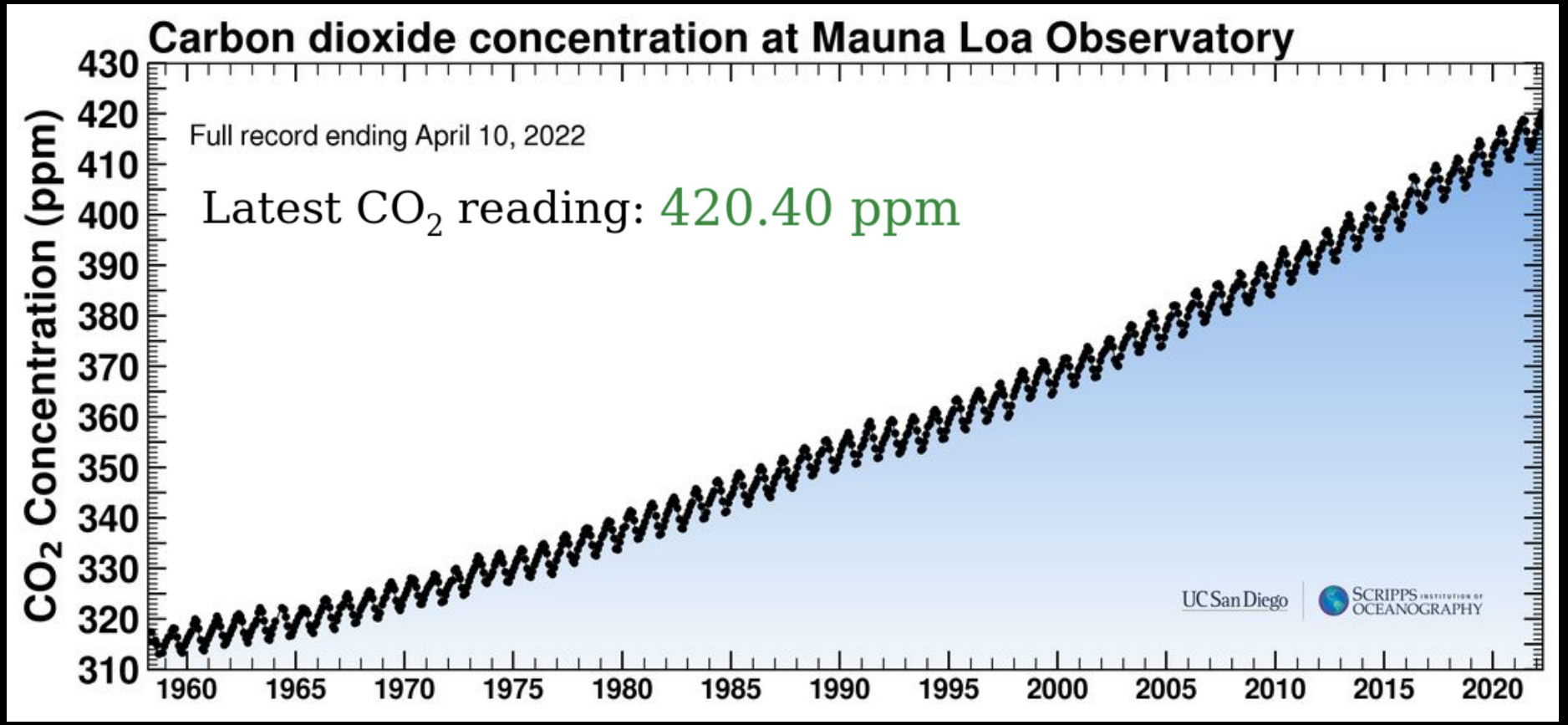
Oceans absorbed heat equivalent to seven Hiroshima nuclear explosions every second, expert says

By Shirin Ali | Jan. 11, 2022

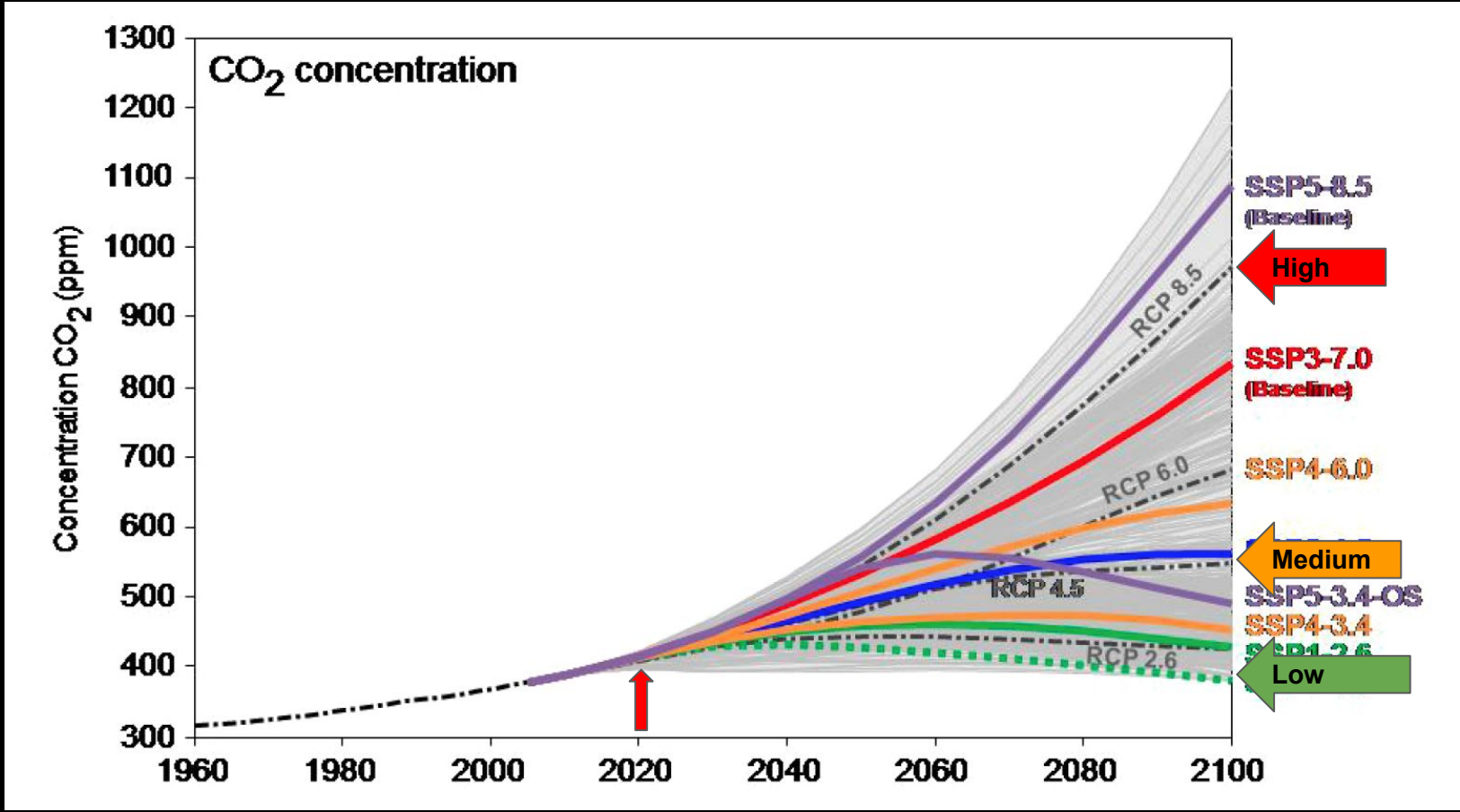
https://thehill.com/changing-america/sustainability/climate-change/589187-oceans-absorbed-heat-equivalent-to-7-hiroshima/

Understanding climate change and its impacts

Climate Change Causing Greenhouse Gases Continue to Increase Rapidly in our Atmosphere



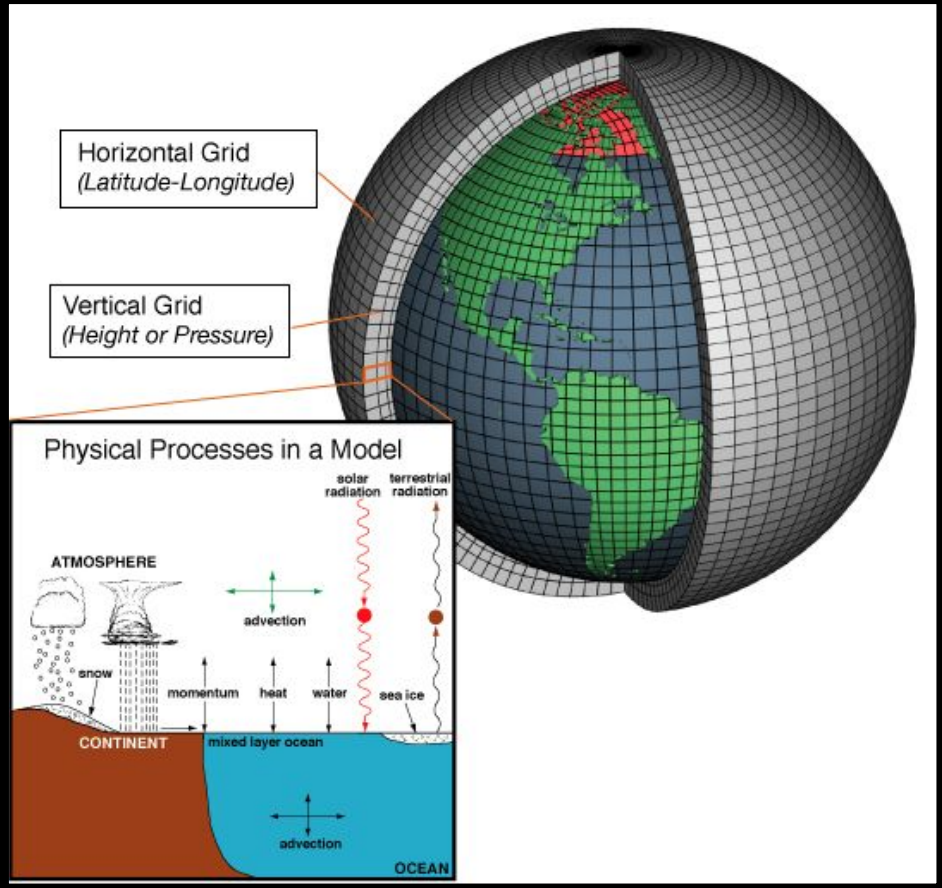
Scenarios of increases in atmospheric CO_2 during this century



Source: O'Neill et al., Geosci. Model Dev., 9, 3461–3482, 2016

Global Climate Models (GCMs)

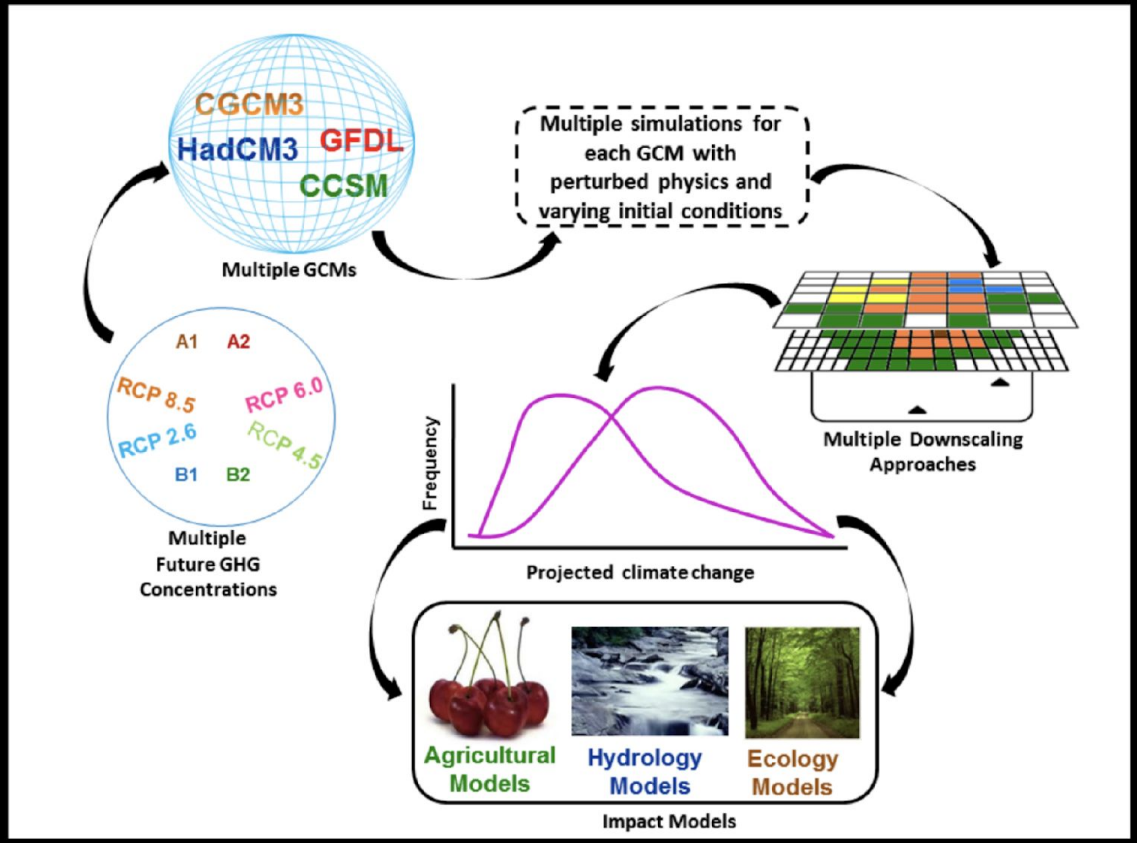
- Primary tools to project future climate
- Represent and model physical processes that govern the Earth's Climate System
- >20 "independent" modeling centers across the globe
- CMIP5 & CMIP6



https://celebrating200years.noaa.gov/breakthroughs/climate_model/modeling_schematic.html

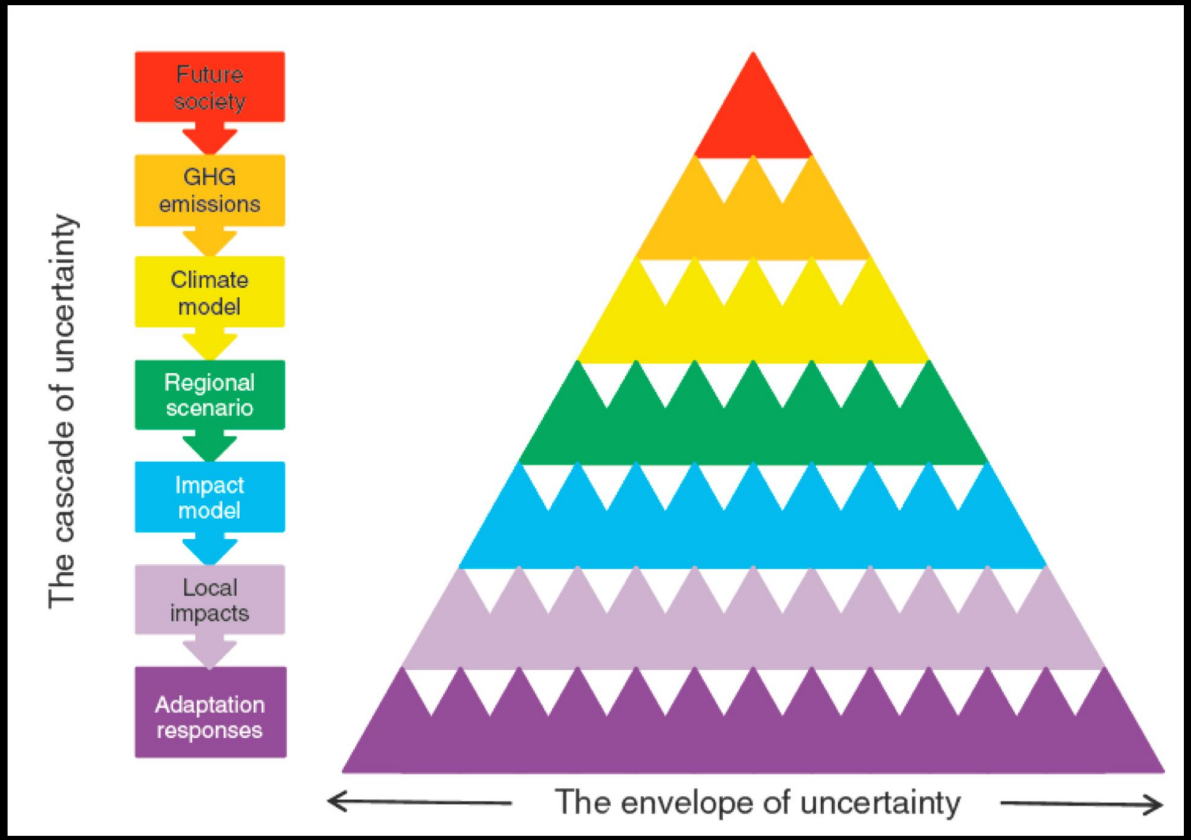
Climate Projections to Regional Impacts

Often require use of multiple tools and data processing steps



http://glisa.umich.edu/media/files/NCA/MTIT_Future.pdf

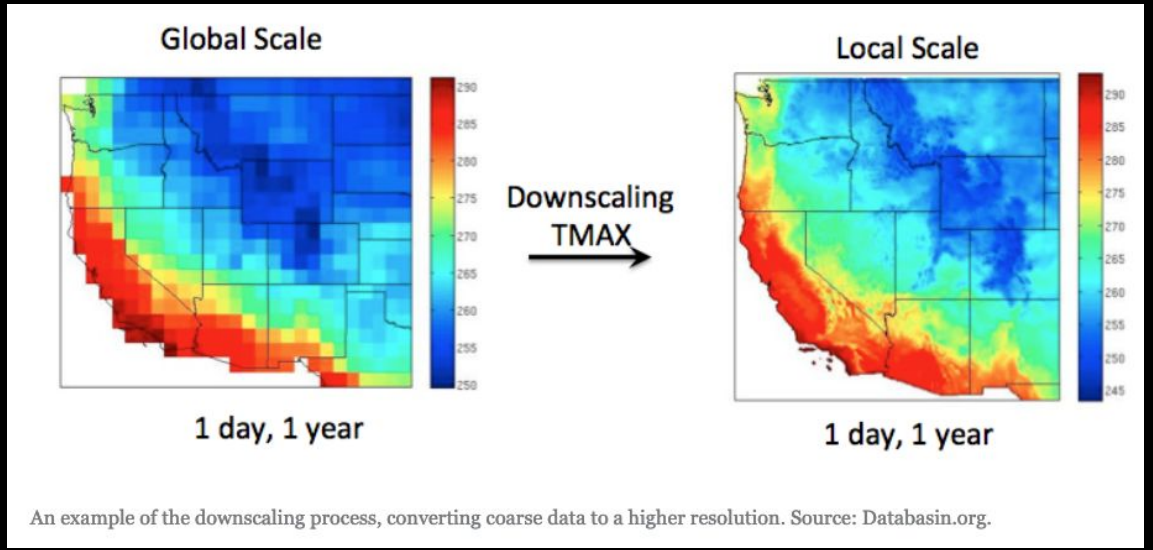
Climate Projections to Impacts: *Compounding of Uncertainty*



Wilby & Dessai, 2010 (Weather)

Downscaling of GCM Climate Projections

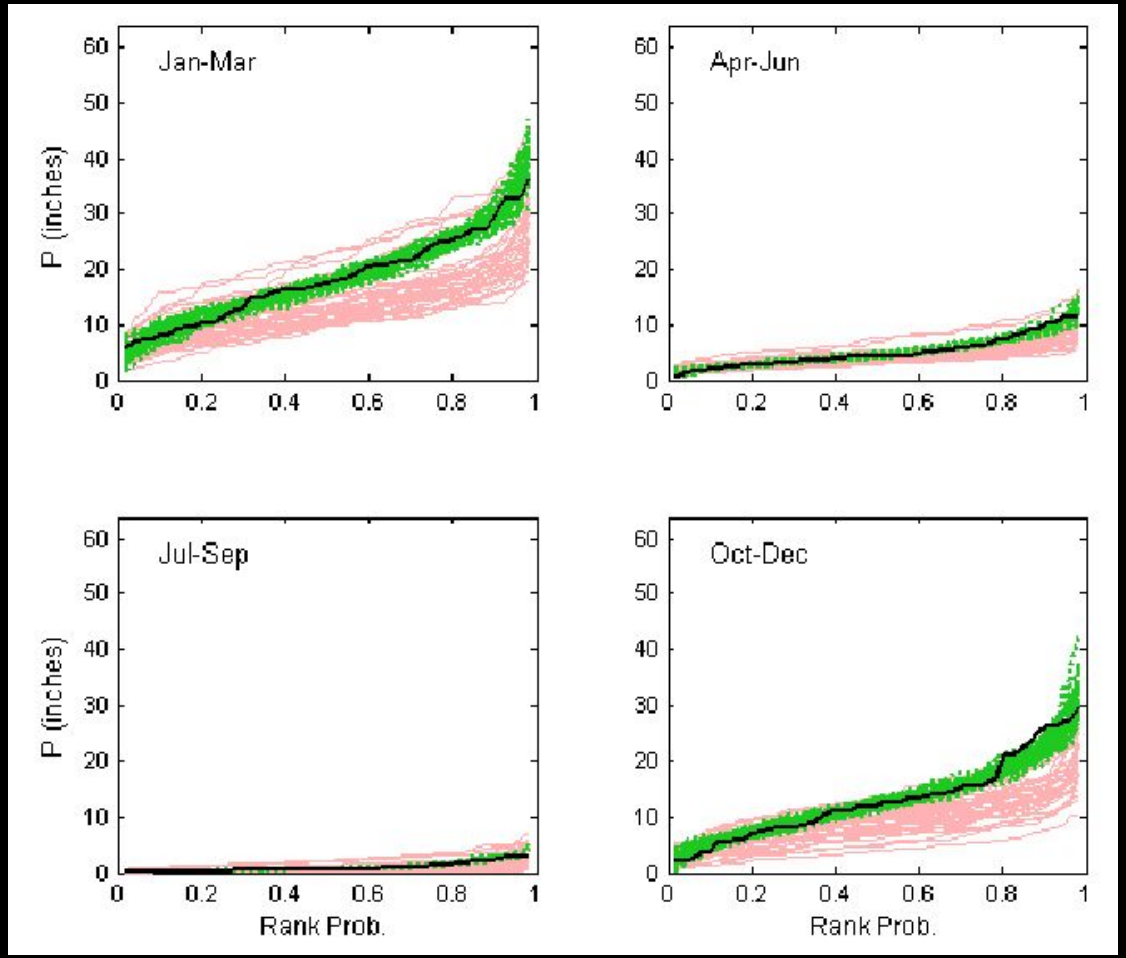
- One main reason to do downscaling is to have data at the right scale to run an impacts model
- Bias correction + Increasing spatial resolution
- Different downscaled datasets could be appropriate for a particular assessment — consult a climate scientist!



An example of the downscaling process, converting coarse data to a higher resolution. Source: Databasin.org.

https://www.slideshare.net/VMMeu/1-patrick-willems-camino2015

Climate Projections Bias Correction Example: Seasonal Precipitation



Observations

Raw GCM

Bias Corrected Data

West-Wide Climate Risk Assessments:
BCSD Surface Water Projections

Q & A

Climate Toolbox Demonstration

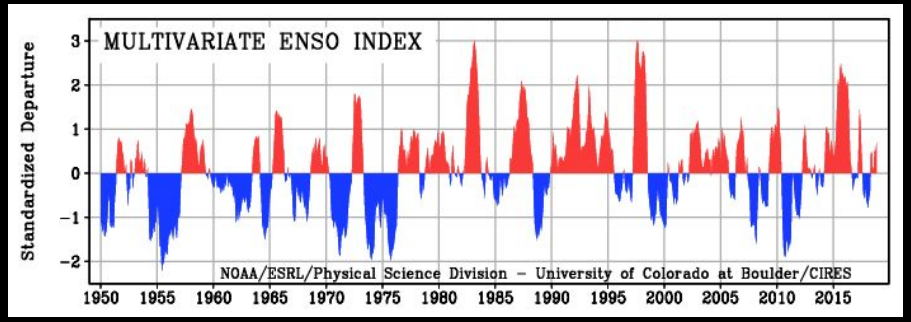
- Quick intro to CTB
- Datasets in CTB - gridMET and MACA Downscaled Climate Data
- Tools to examine historical climate trends

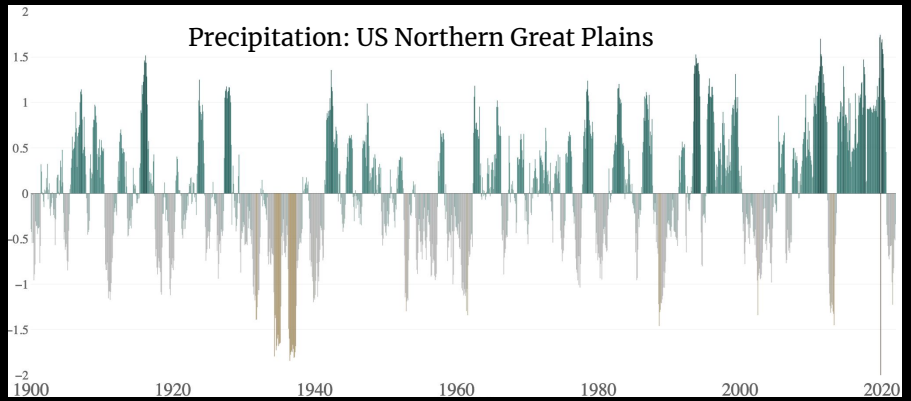
Q & A

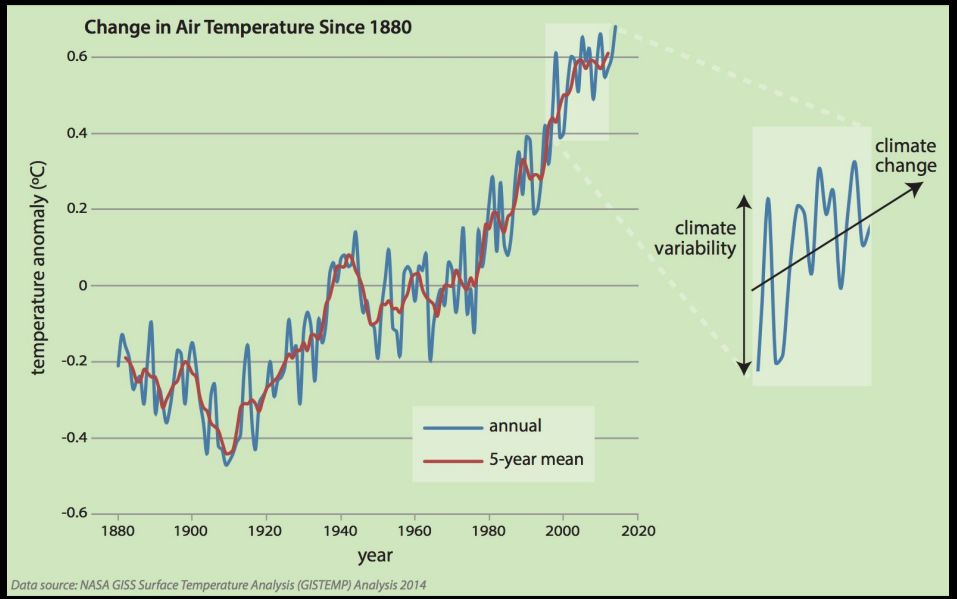
Sources of uncertainty in climate projections

Climate Variability

➔ Fluctuations (ups and downs around a long-term mean) in climatic conditions on time scales of months, years, decades, centuries and beyond



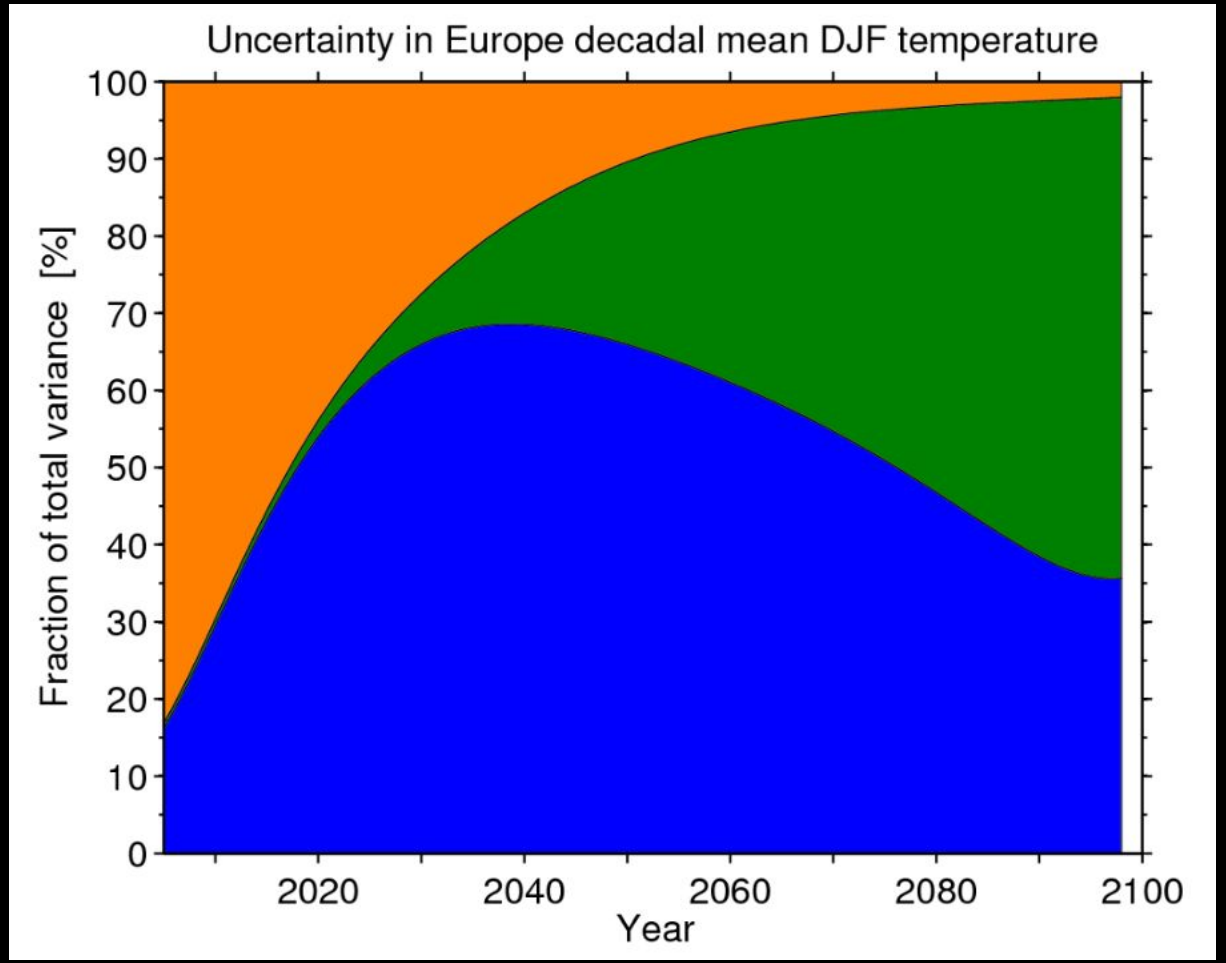




Climate and Weather Extremes!

Temperature

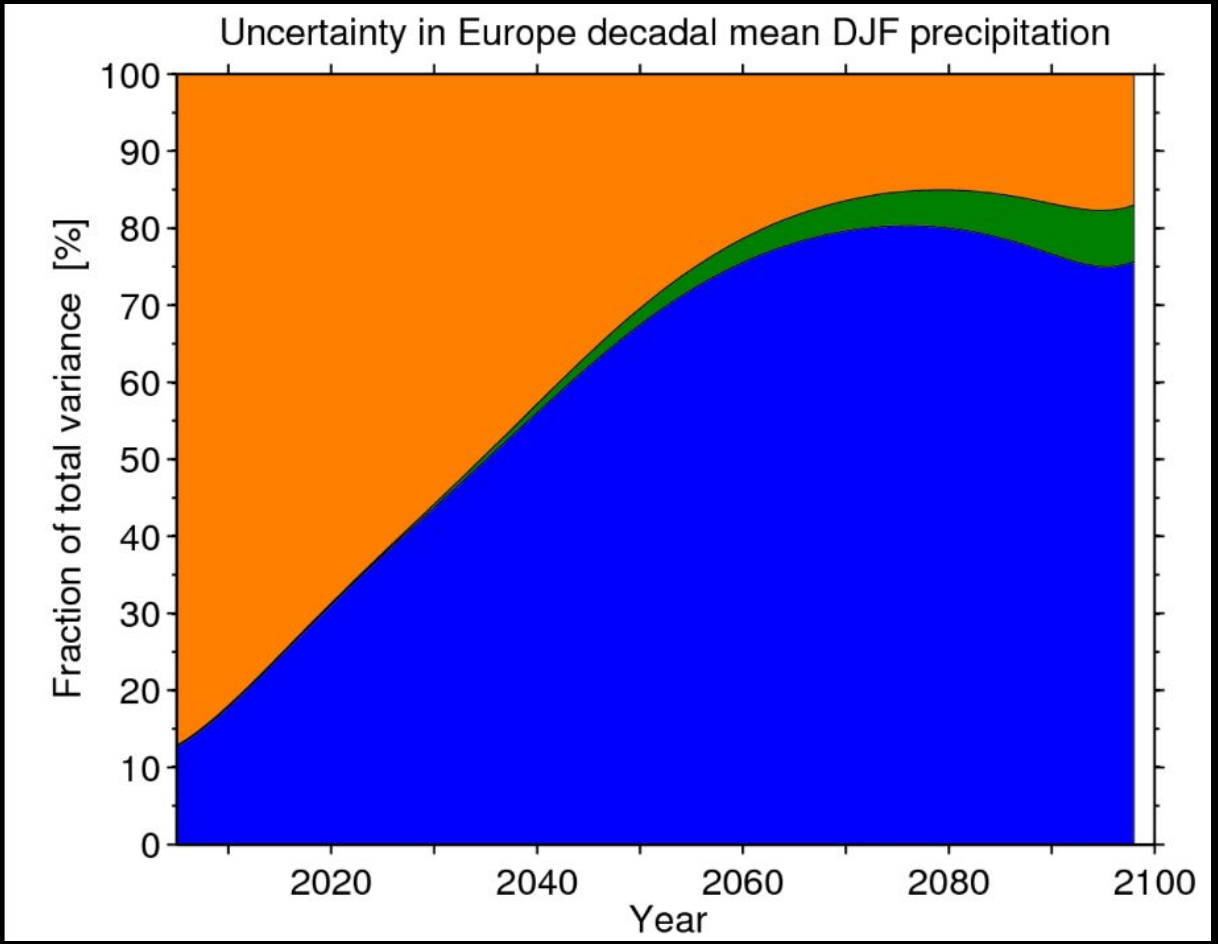
- Inter-model differences contribute significantly to the spread in future projections
- Emissions scenarios become important largely after mid-century



Source: Ed Hawkins; https://www.climate-lab-book.ac.uk/2013/sources-of-uncertainty/

Precipitation

- Inter-model differences and climate variability contribute significantly to the spread in future projections
- Emissions scenarios have a very limited influence

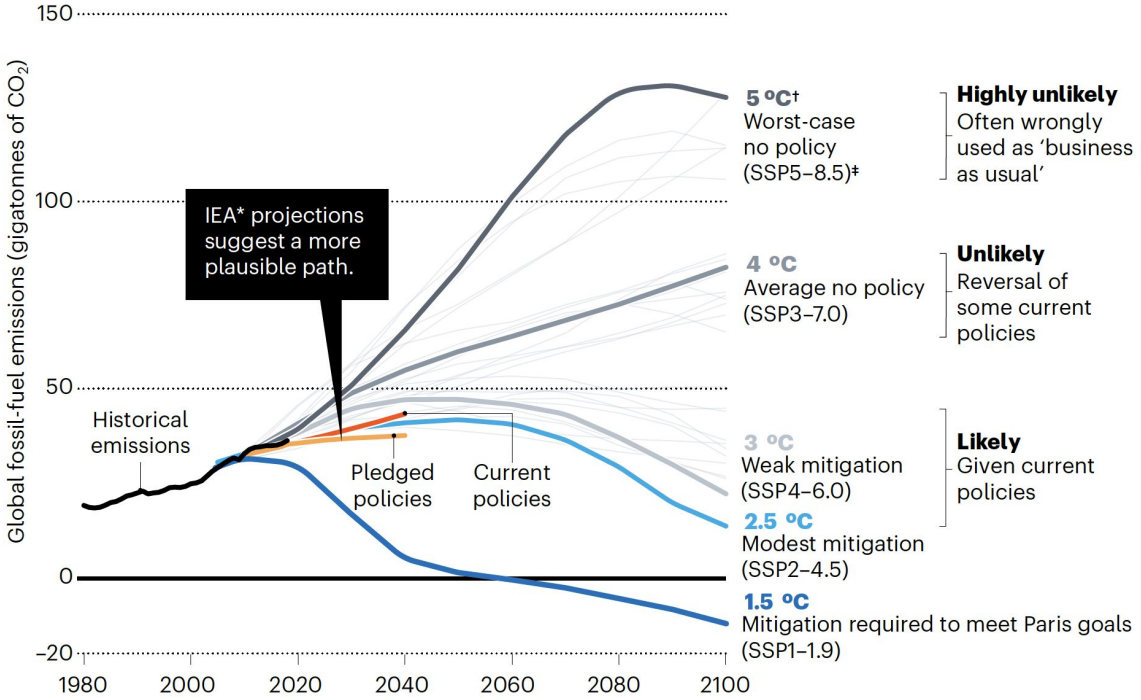


Source: Ed Hawkins; https://www.climate-lab-book.ac.uk/2013/sources-of-uncertainty/

Uncertainty from emission scenarios and inter-model differences

POSSIBLE FUTURES

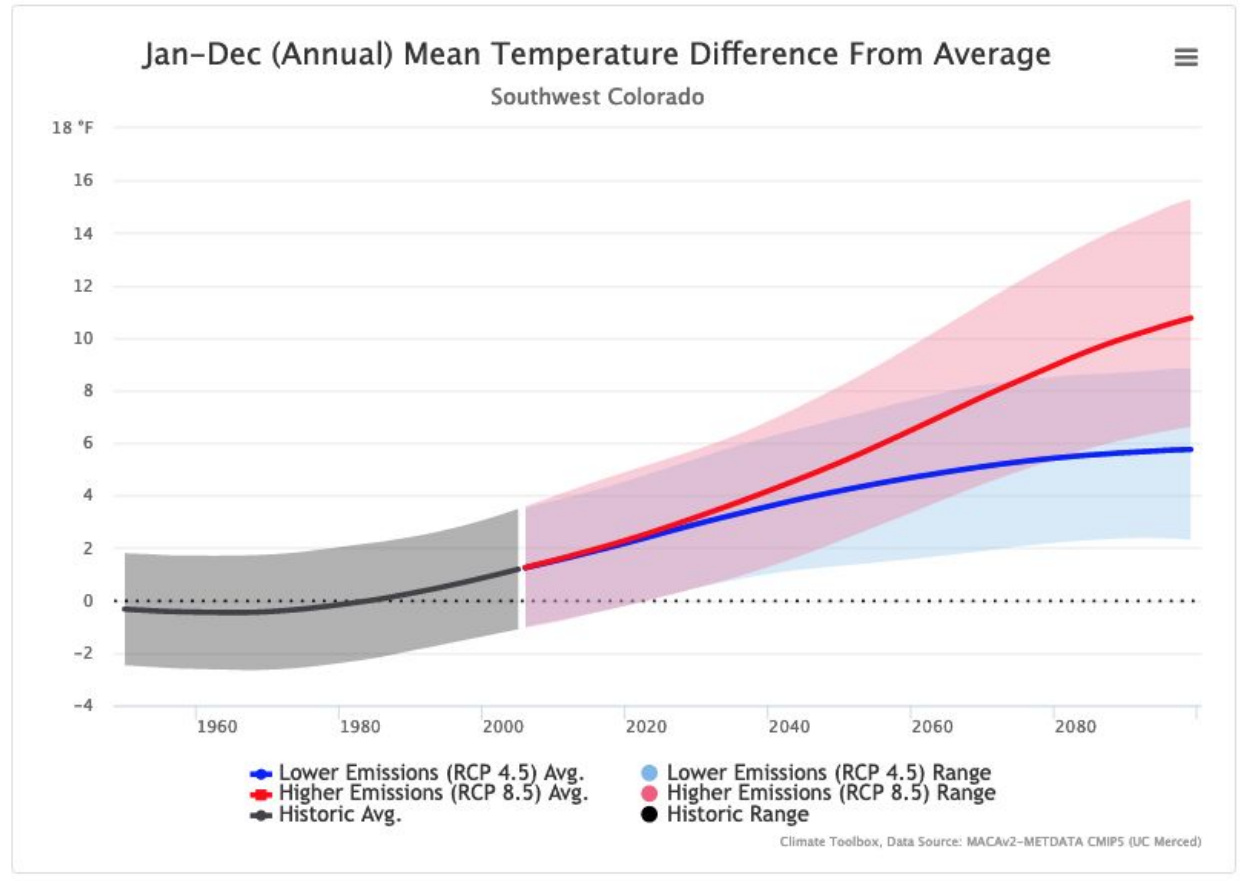
The Intergovernmental Panel on Climate Change (IPCC) uses scenarios called pathways to explore possible changes in future energy use, greenhouse-gas emissions and temperature. These depend on which policies are enacted, where and when. In the upcoming IPCC Sixth Assessment Report, the new pathways (SSPs) must not be misused as previous pathways (RCPs) were. Business-as-usual emissions are unlikely to result in the worst-case scenario. More-plausible trajectories make better baselines for the huge policy push needed to keep global temperature rise below 1.5 °C.



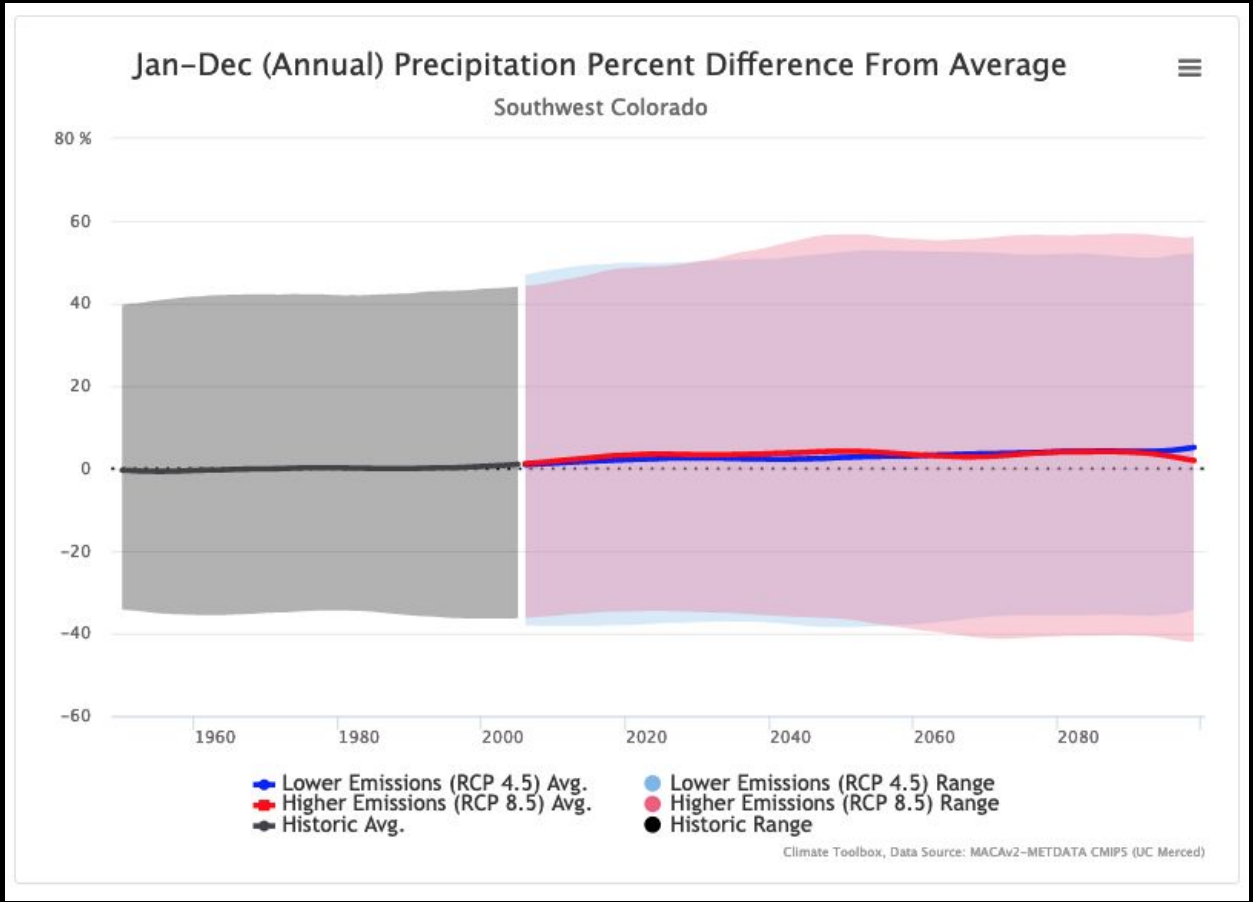
*The International Energy Agency (IEA) maps out different energy-policy and investment choices. Estimated emissions are shown for its Current Policies Scenario and for its Stated Policies Scenario (includes countries' current policy pledges and targets). To be comparable with scenarios for the Shared Socioeconomic Pathways (SSPs), IEA scenarios were modified to include constant non-fossil-fuel emissions from industry in 2018.
†Approximate global mean temperature rise by 2100 relative to pre-industrial levels.
‡SSP5–8.5 replaces Representative Concentration Pathway (RCP) 8.5.

Hausfather & Peters, 2020

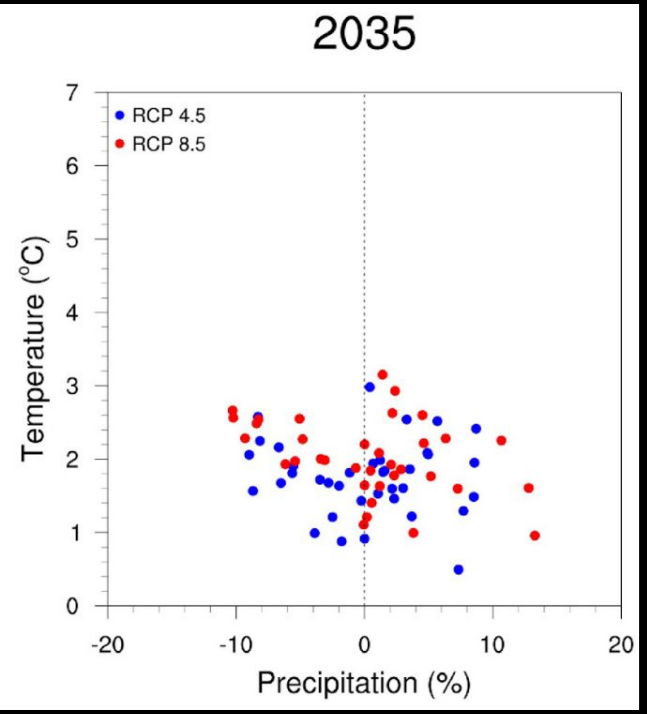
Differences in temperature projections across emission scenarios become important after 2050



Emission scenarios have no significant impact on total precipitation projections



Changes in Annual Temperature and Precipitation in southwestern Colorado



30-year periods with the median year centered on 2035, 2050 and 2070 compared to 1971-2000

climate
MDPI
Article

Uncertainty, Complexity and Constraints: How Do We Robustly Assess Biological Responses under a Rapidly Changing Climate?

Imtiaz Rangwala [1,*], Wynne Moss [1,2], Jane Wolken [1], Renee Rondeau [3], Karen Newlon [4], John Guinotte [4] and William Riebsame Travis [1,5]

Q & A

Working with Climate Projections Uncertainty

Climate Science Applications - Current State of Practice Among NC CASC Stakeholders

Wednesday, April 20, 9:30am-11:00am

Panel presentation/discussion

Facilitated by: **Imtiaz Rangwala**

Panelists: **Brian Miller** (NC CASC), Amber Runyon (NPS), John Guinotee (FWS), Alexandra Kasdin (FWS), Aimee Crittendon (FWS)

Who is invited: The session will be open to everyone. However, it is primarily geared toward managers and practitioners who are interested in understanding how different practitioners are incorporating climate change information into assessments.

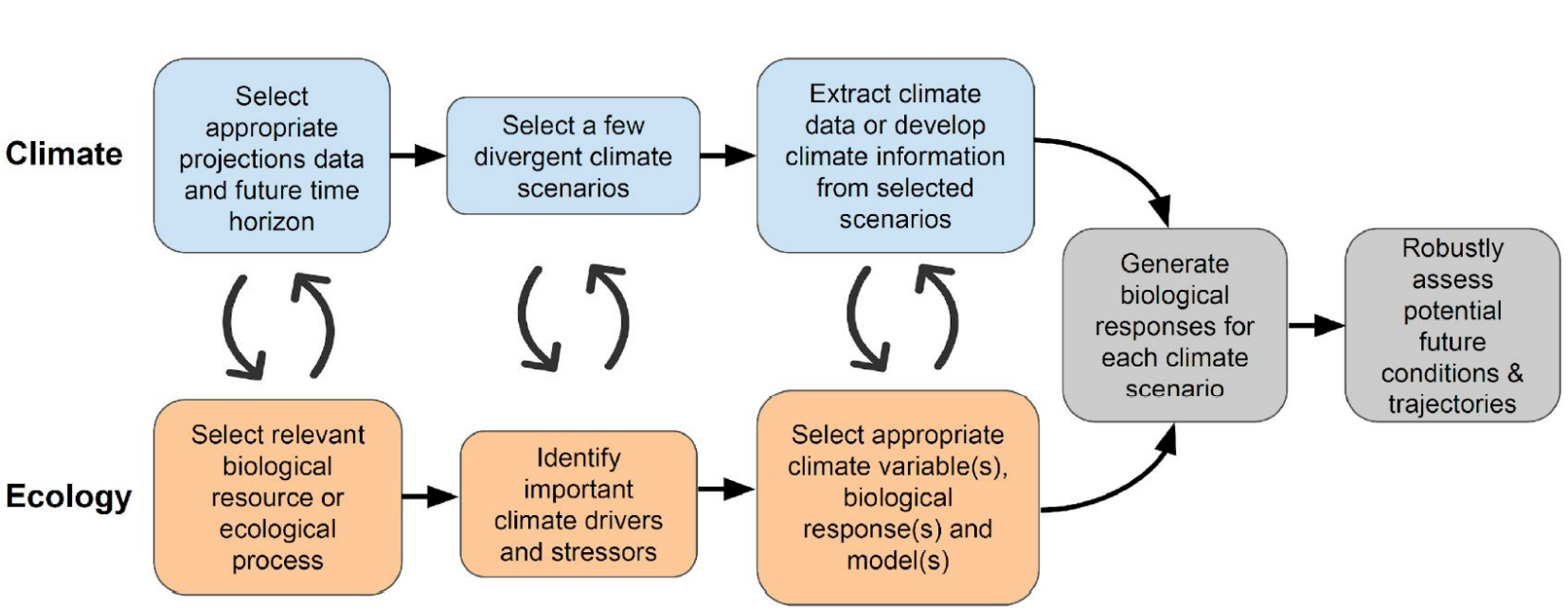


Figure 1. Process flow diagram of a typical approach for conducting biological impact assessments under different future climate scenarios. The curved arrows demonstrate the iterative (i.e., non-linear) process of integrating climate and ecology methods in conservation projects (e.g., Case Study 1 and 2 in Appendix A).

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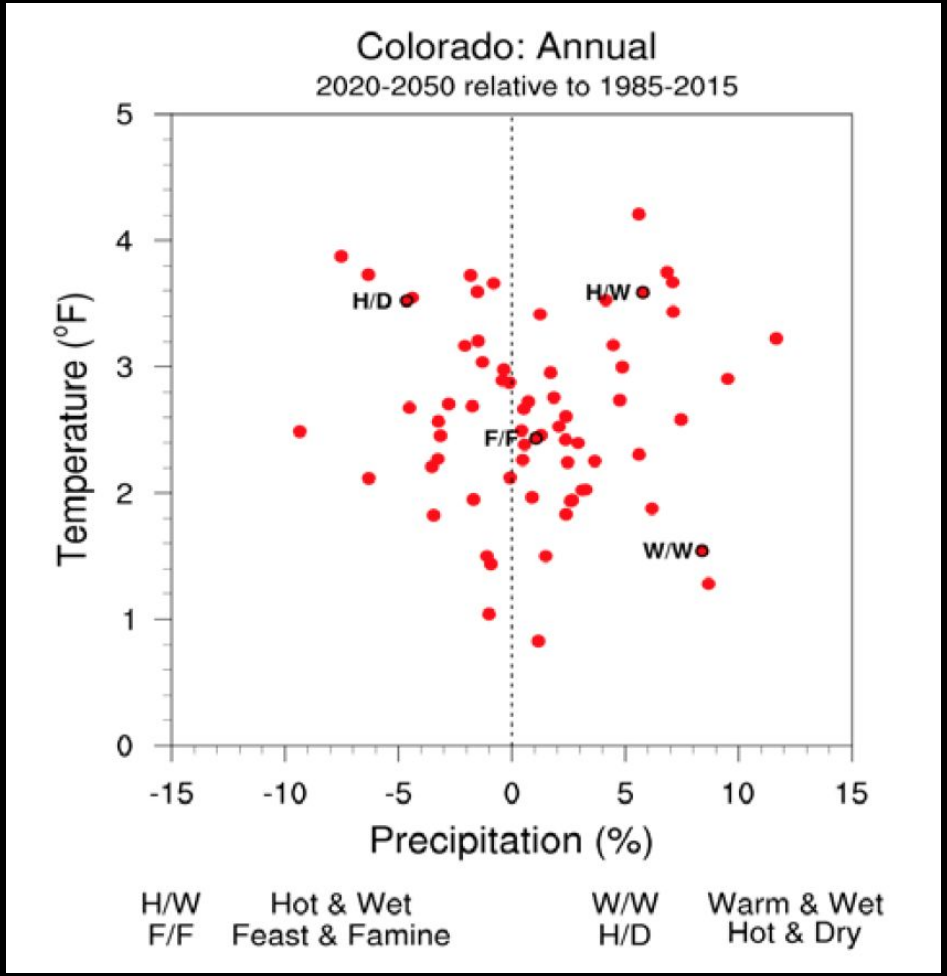
Selecting and working with specific future climate scenarios (or climate futures)

Climate Toolbox can help you do these kinds of scenario selections!



TNC's Colorado Climate Impacts & Opportunities Report, 2018

Climate Toolbox Activity

- Future Scatter Plot
- Future Box Plot
- Future Time Series
- Climate Mapper for Spatial Plots and Data
- Data Download

Q & A