Poll #2

How are you feeling about scientific uncertainty in the context of climate adaptation decision making?

Building Resilience to a Changing Climate:

A Technical Training in Water Sector
Utility Decision Support

WUCA
Water Utility Climate Alliance

Climate Science for Water Professionals: What Insight do We Get from the Climate Models?

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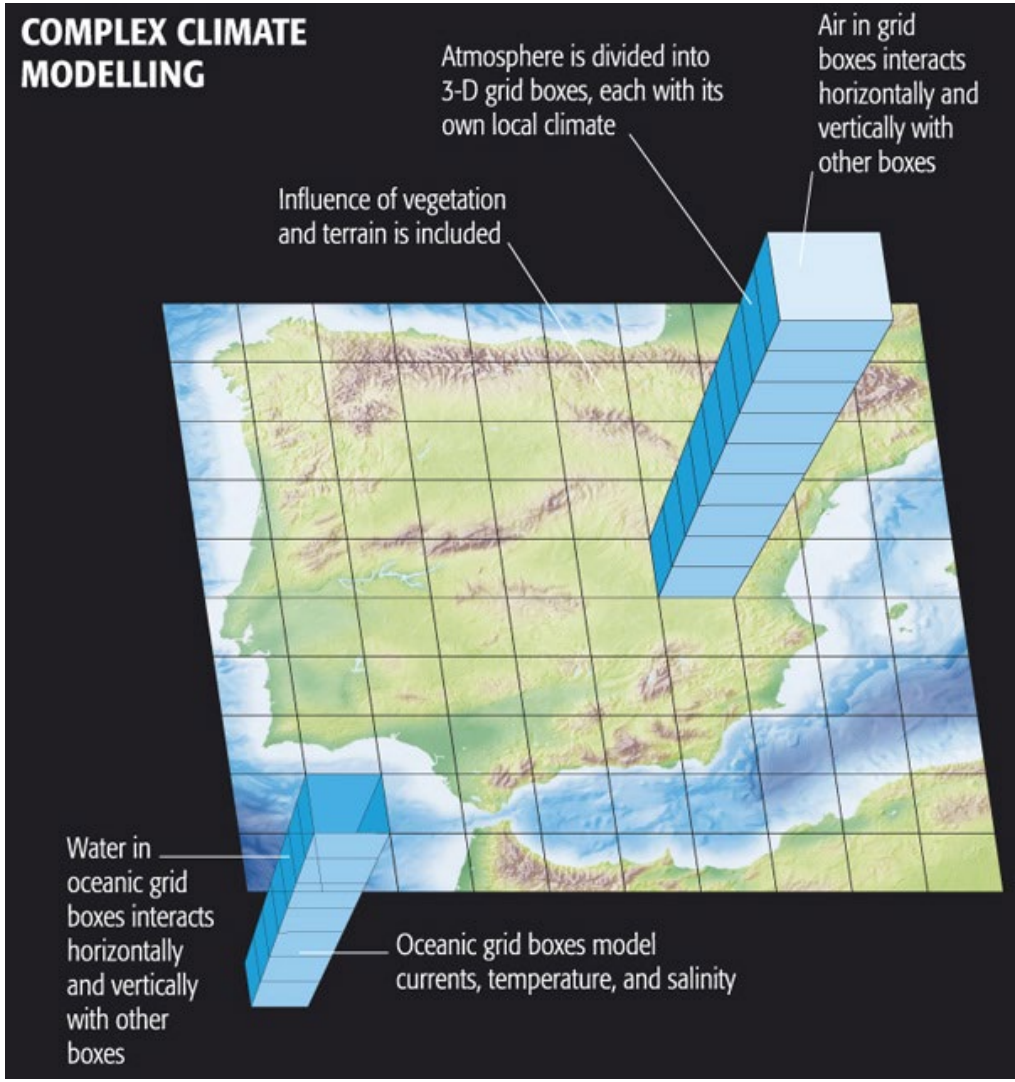
Key Takeaways

- Climate models are the best source of information on future climate
  - Assumptions about future emission scenarios are used as input to drive climate models
  - Climate models have important limitations
  - Their outputs are projections, not predictions
  - The models tend to be improving but require extensive vetting and assessment before use

What are Global Climate Models (GCMs)?

- Main tool used to project future climate change
- a.k.a General Circulation Models (GCMs), climate models, earth system models
- Model the entire earth system
  - Mathematical equations used to calculate general circulation of physical system within and across grid boxes.
- Divides the earth into grid ~120 to 180 miles across



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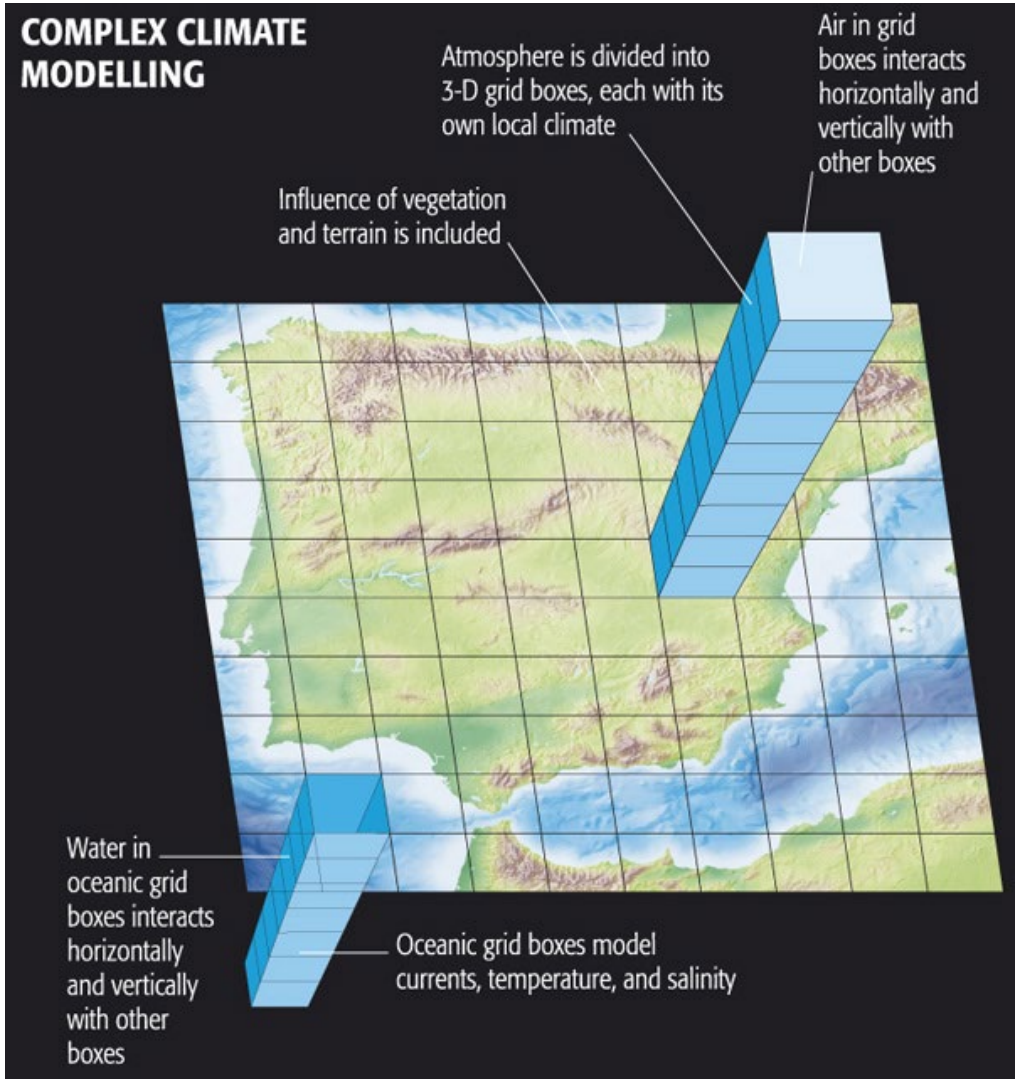

How models handle climate and biophysical processes may be more important than grid size!

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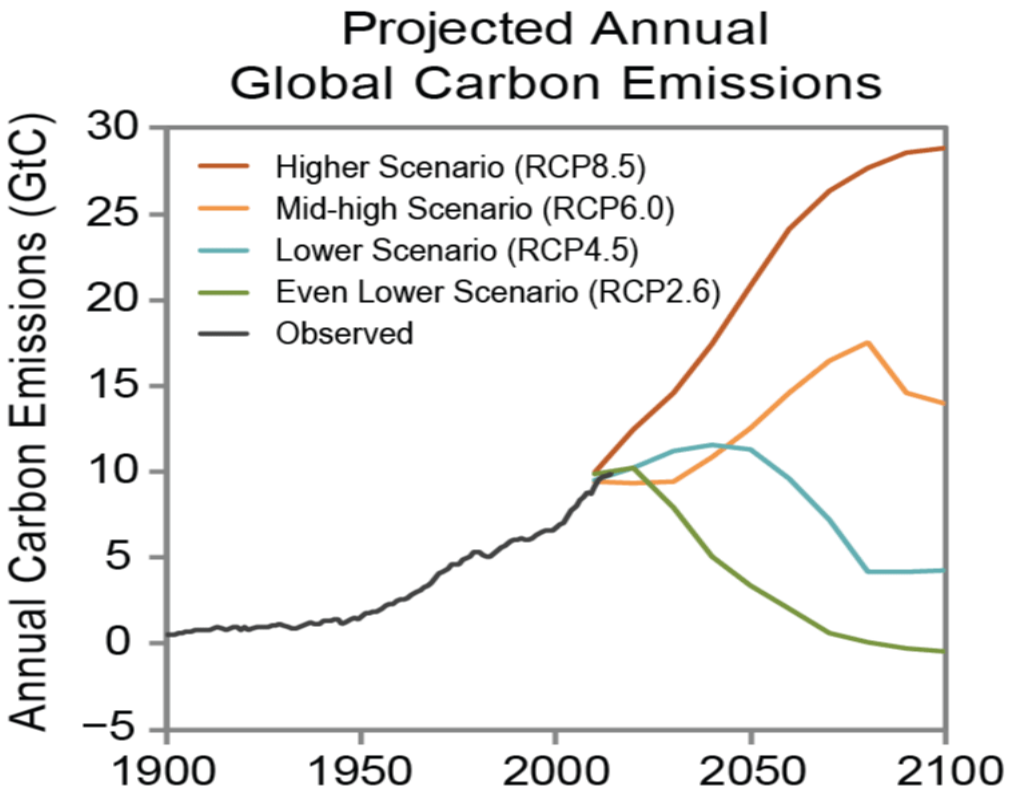
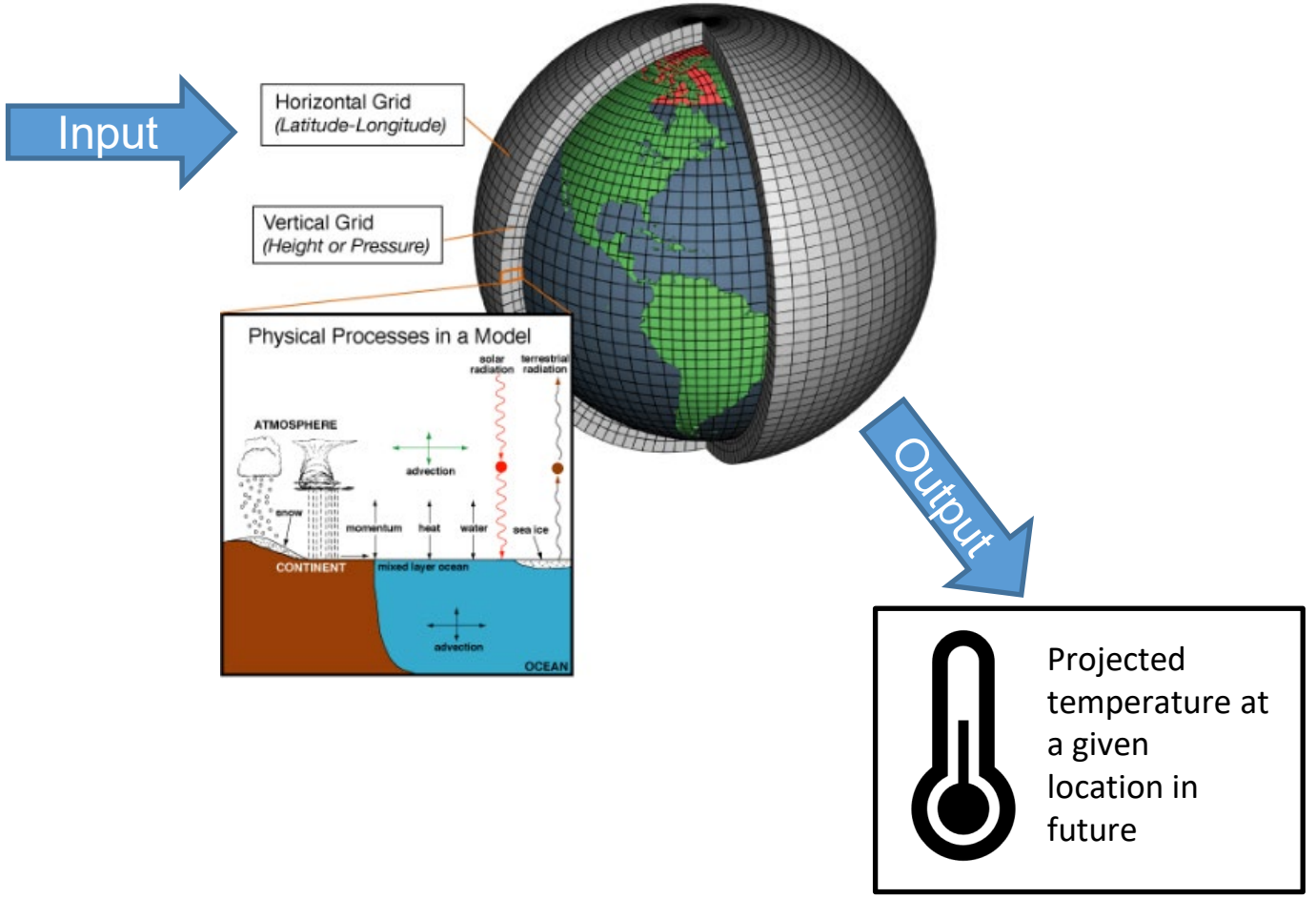
Assumptions about Future Emissions Drive Climate Models

Future CO_2 emissions in five illustrative scenarios

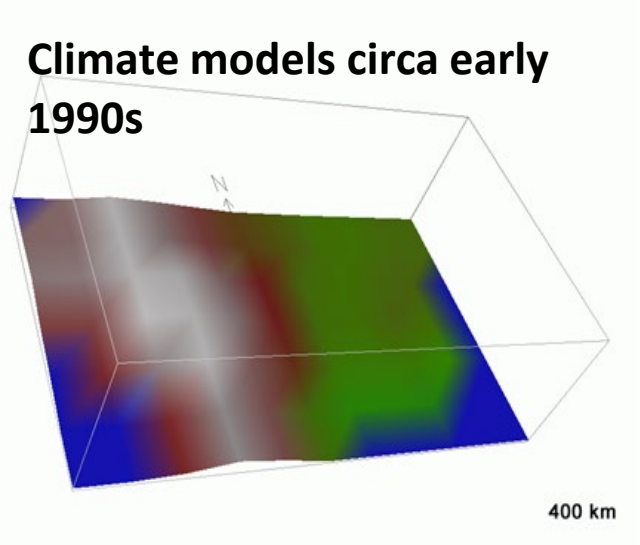


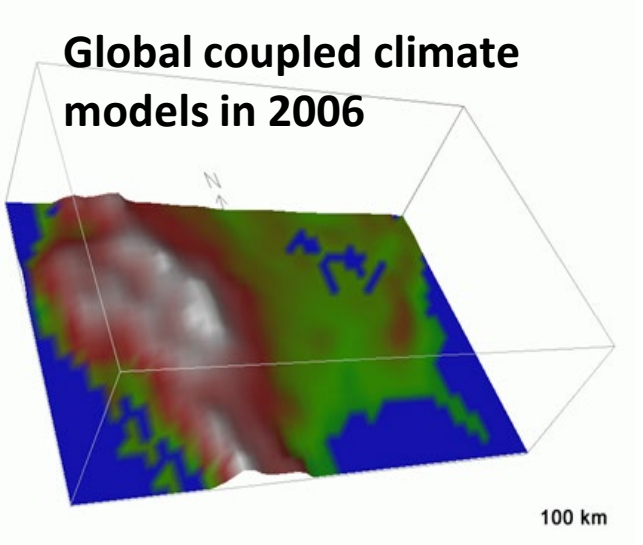


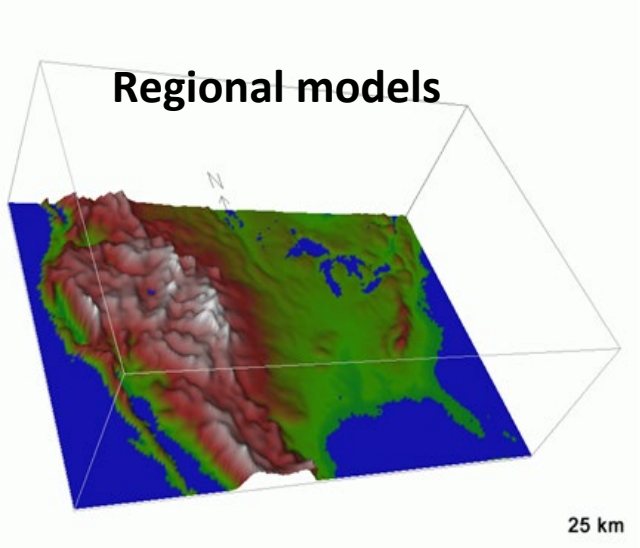
Source: Climate Science Special Report, 2017

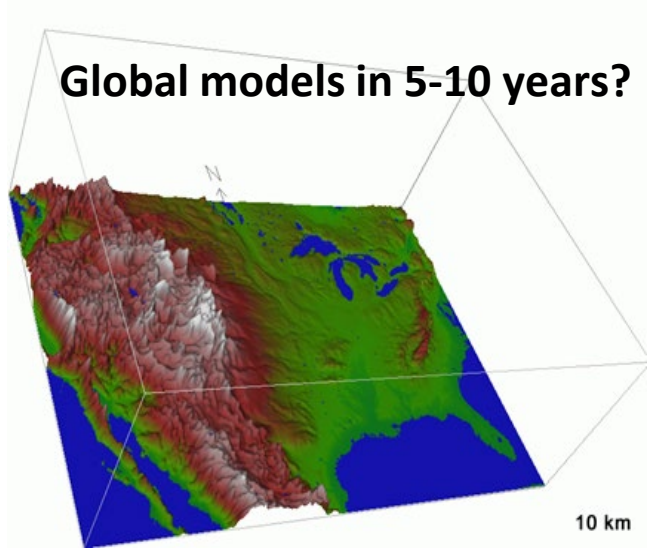
Evolution of Climate Models - Resolution

- Relatively low resolution
  - Give a uniform projection for each grid box
  - Cannot account for sub-grid scale processes
    - For example, convective thunderstorms
  - Particularly problematic along coasts and in mountains
- Resolution is improving because of computing power

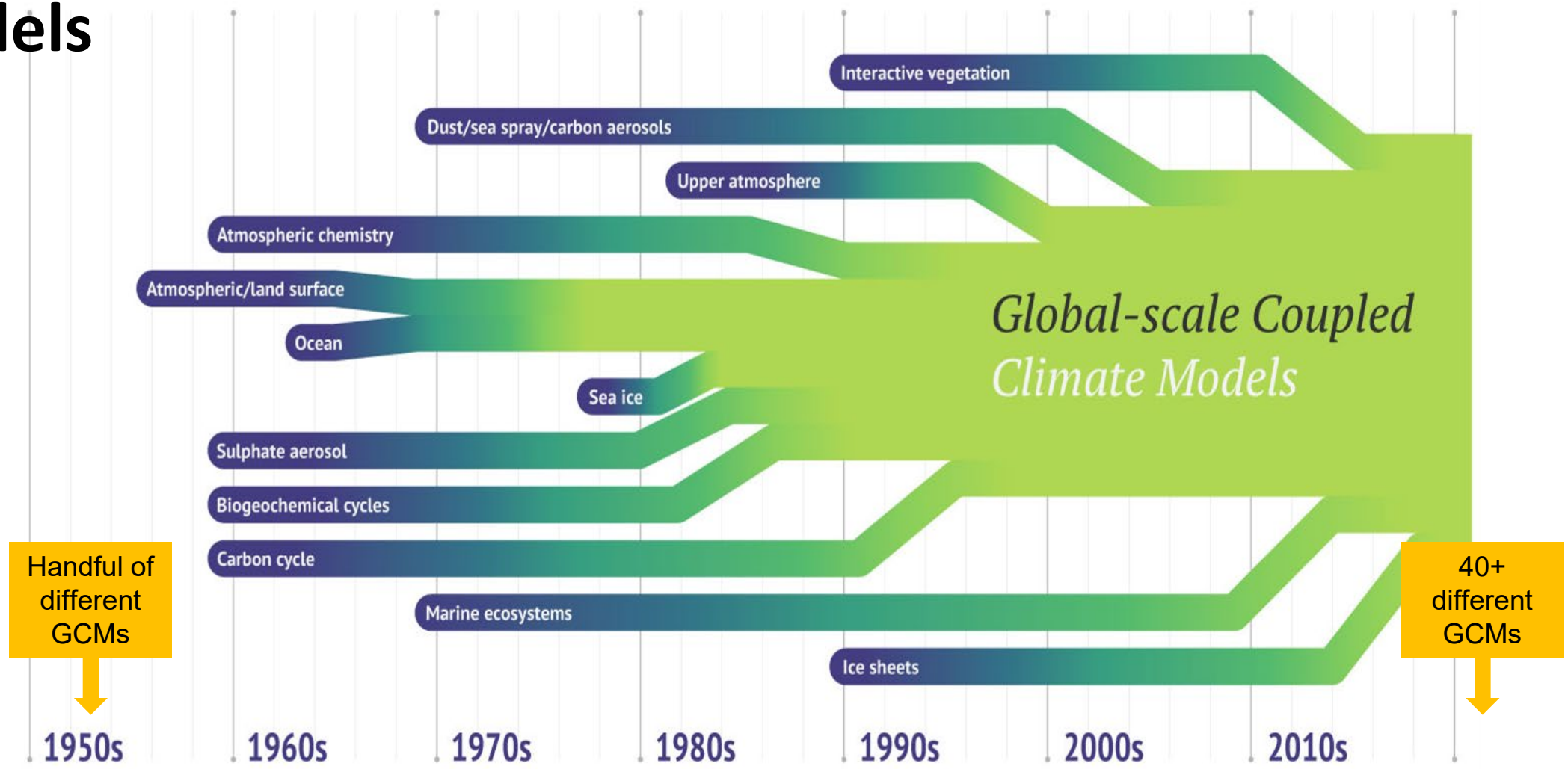








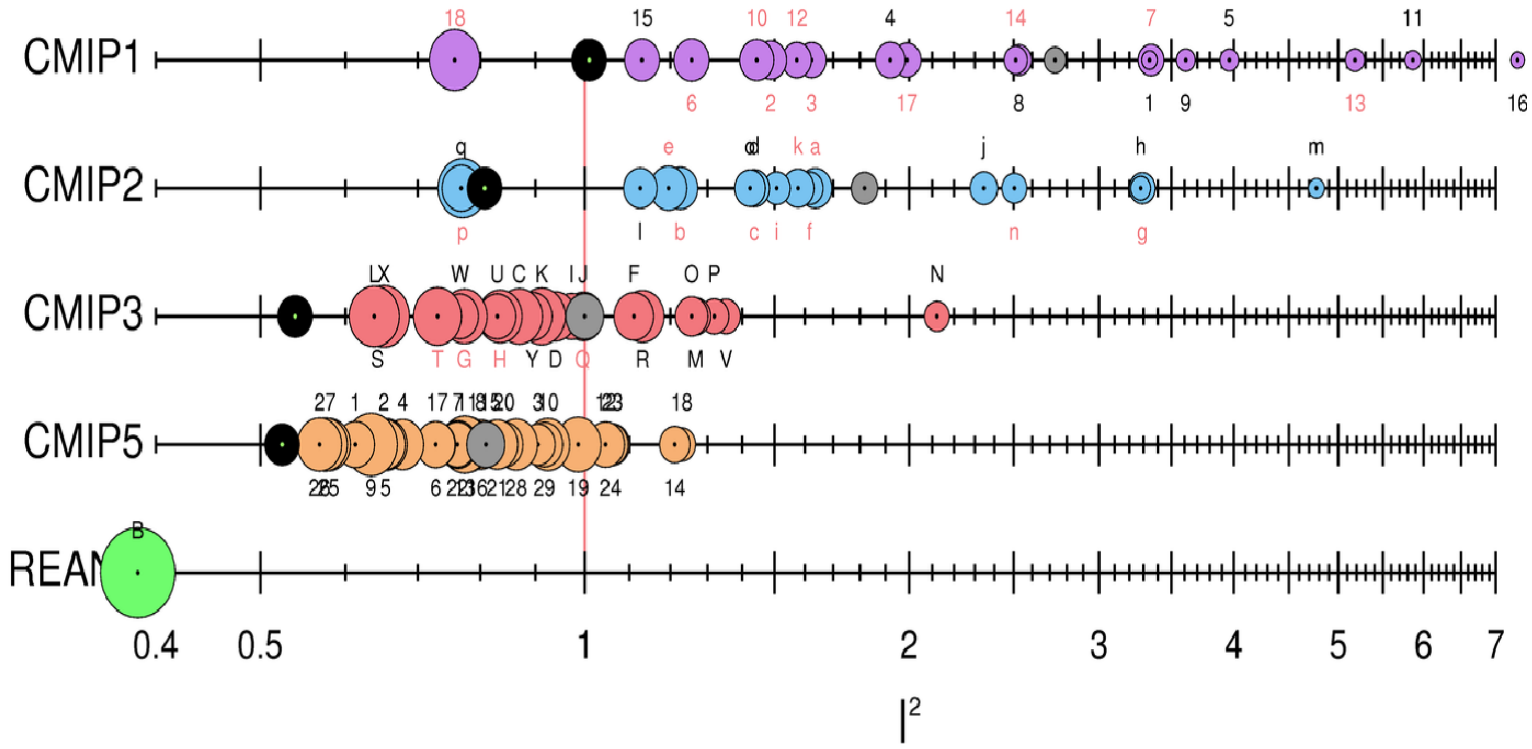
Evolution of Climate Models – Complexity and Number of models



Source: https://www.carbonbrief.org/qa-how-do-climate-models-work

How Are the GCMs Doing?

- Compared via CMIPs
- With each generation of model's - simulation of current climate improves
- Note: graph is missing latest CMIP6
- Generally, average of the models does better than individual models



Source: Thomas Reichler, University of Utah. Personal Communication

A Dose of Humility: Climate Models Are Not Crystal Balls

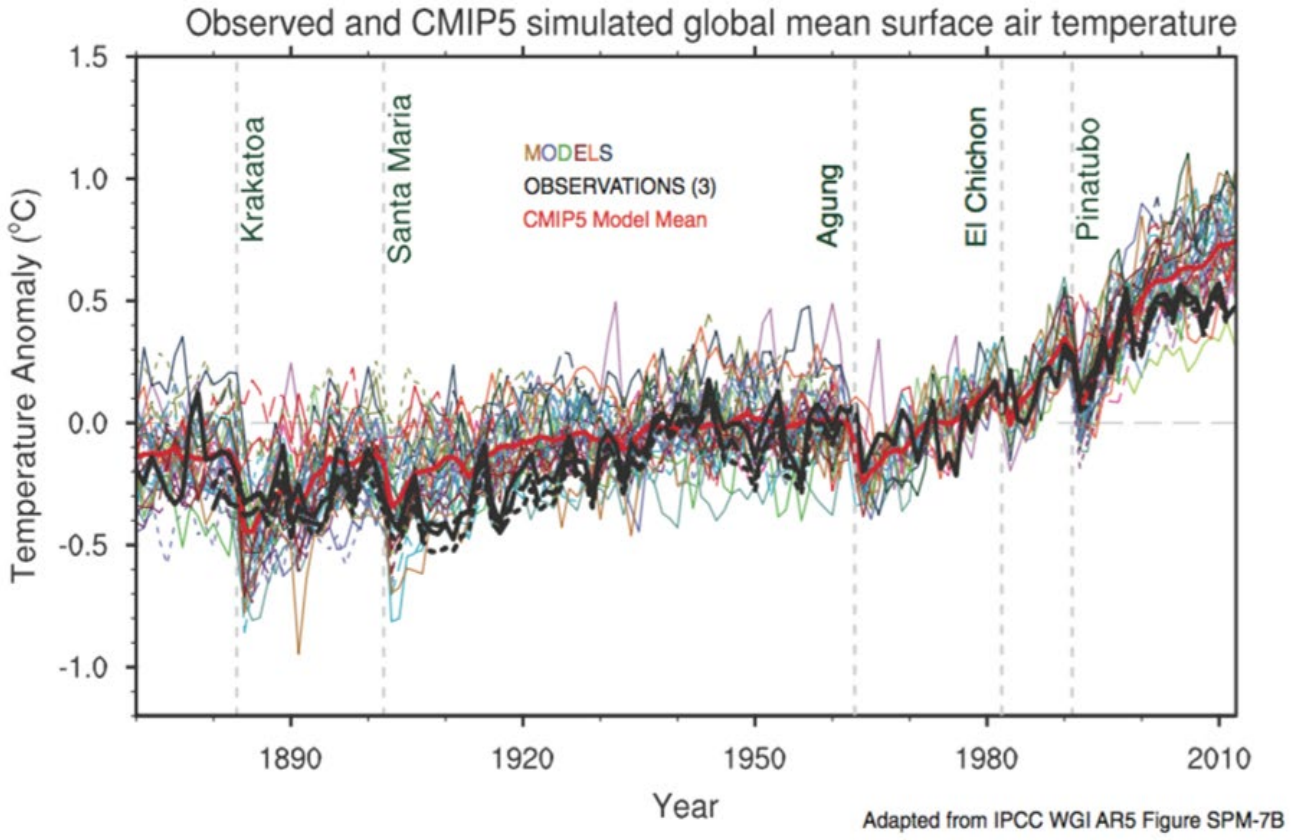
- Projections not predictions
- Models are simplifications of reality
- They can be wrong – even if they all or mostly agree
- They are improving
  - Resolution
  - Processes they simulate
- They are the best source of information we have on climate change

(allows us to test how different emission scenarios will affect climate)

Photo by Brad West on Unsplash

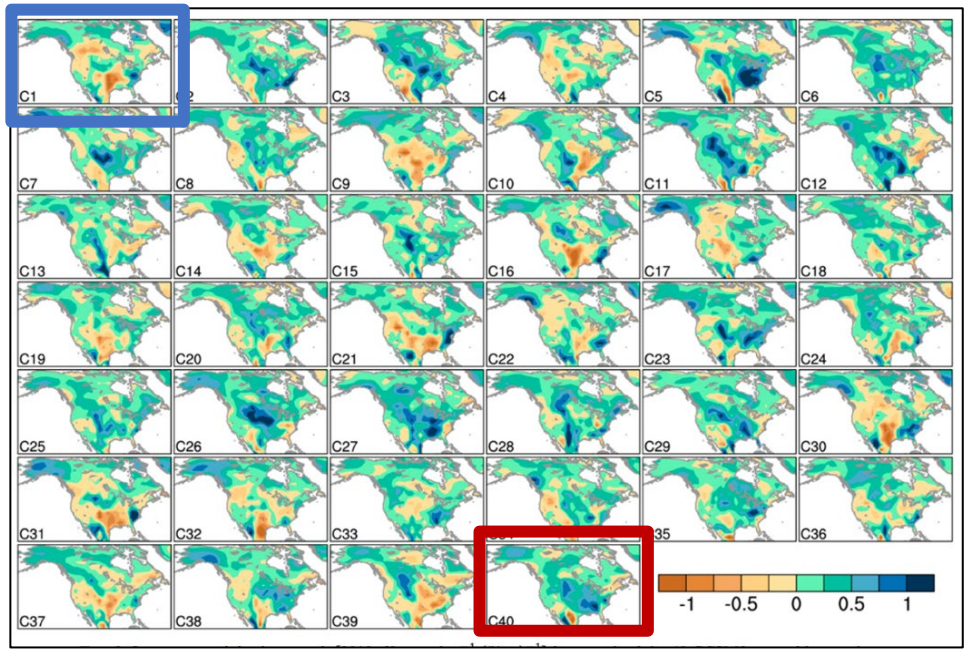
Model Averages vs. Individual Models

- "Ensemble" could mean:
  - Average of many different GCMs
  - Average of multiple runs from the same GCM under different initial conditions
- Generally, ensemble average of multiple GCM simulations better matches observed climate than any individual GCM
- (black vs. red line, right)

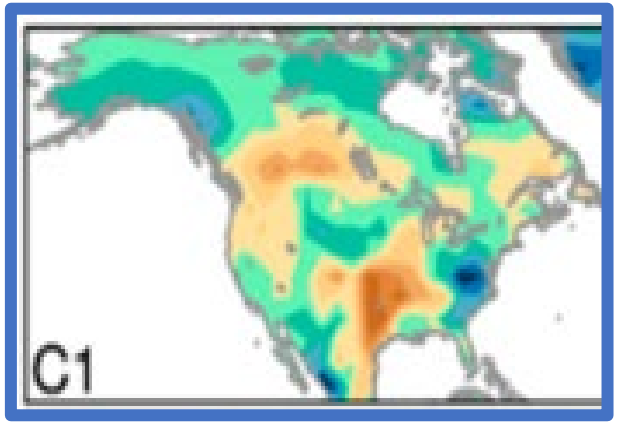


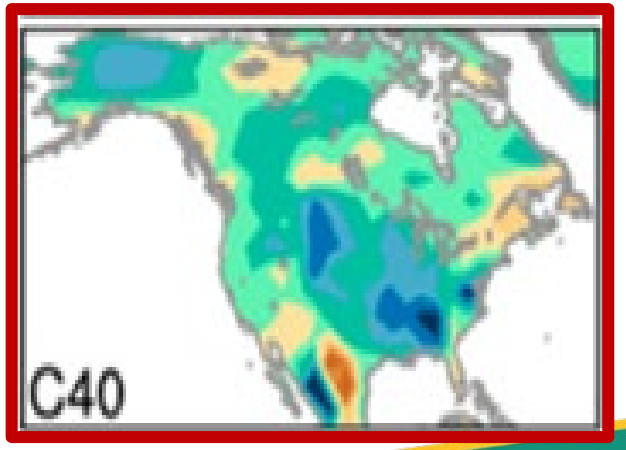
Model Initialization Makes a Difference!

Summer precipitation for 40 CCSM3 simulations



Source: Deser et al, 2014





- Same GCM
- Different initial conditions
- Very different results

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Model Averages Across Models

- Does that mean we should **only use** the average model projection of the future?
  - NO!!
  - The average is useful to show all the models combined
  - The average does not show the range of projections - It is hard to say which model(s) is (are) right or wrong
  - Ok to use the average as **a** scenario
    - Note it can smooth some things out such as year to year variability
  - Should also use ranges across the models to capture uncertainty across key variables
- Note, the range of model output DOES NOT define the true range of possibilities.

Are Some GCMs Better than Others?

- Sometimes certain models are selected based on:
  - How well they simulate climate processes
  - Vintage (newer *tends* to be better)
  - How well they simulate observed climate
    - This is no guarantee projections of future are better than other models

- If going to select models, best to consult experts

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