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 Climate Models?

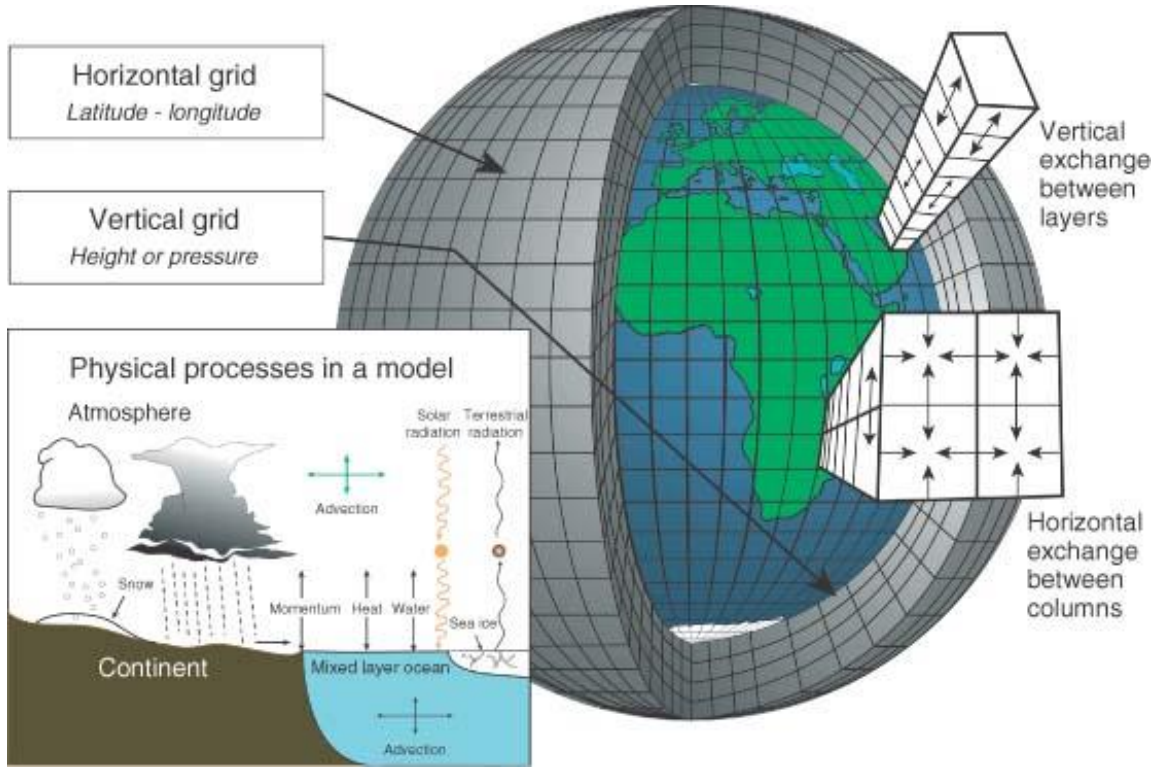
Joel B. Smith, Abt Associates

Key Takeaways

- Climate models are the best source of information on future climate
  - They have important limitations
  - Their outputs are projections, not predictions
  - The models tend to be improving but require extensive vetting and assessment before use

Global Climate Models

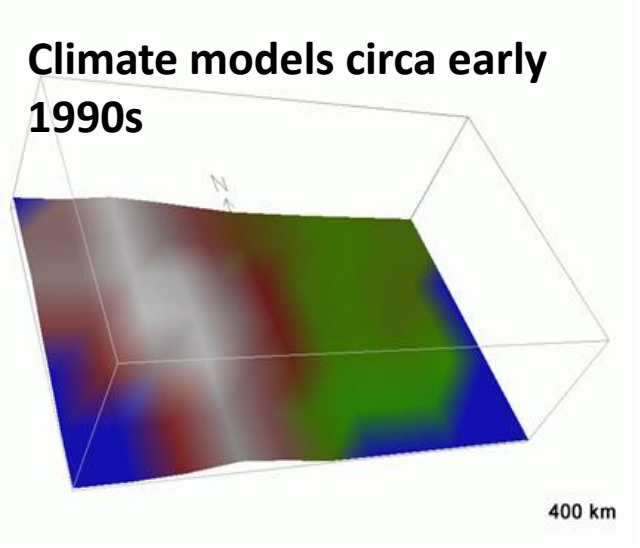
- Global Climate Models (GCMs), a.k.a.
  - General Circulation Models
  - Earth System Models
- Model the entire earth system
  - Atmosphere
  - Oceans
  - Land (including vegetation)
  - Cryosphere
- Divide the system into grid boxes
  - Typical grid boxes in GCMs are about 2 x 3 degrees
  - (~120 to 180 miles across)

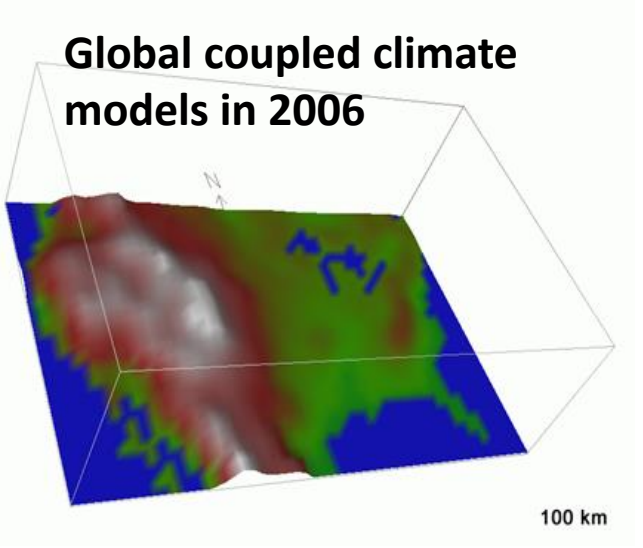


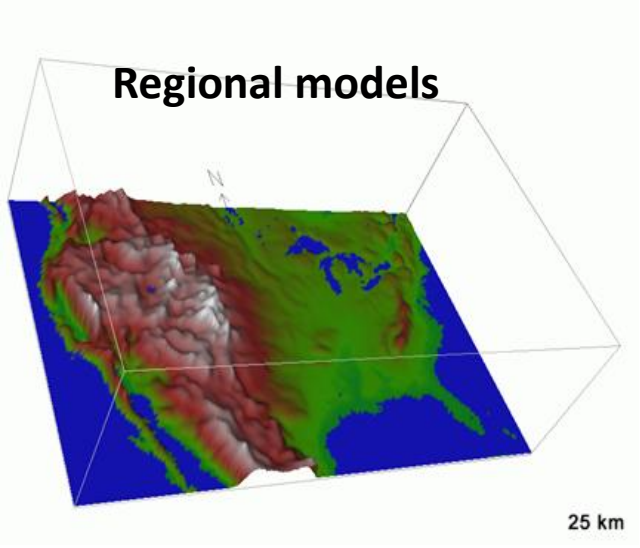
How models handle climate and biophysical processes may be more important than grid size!

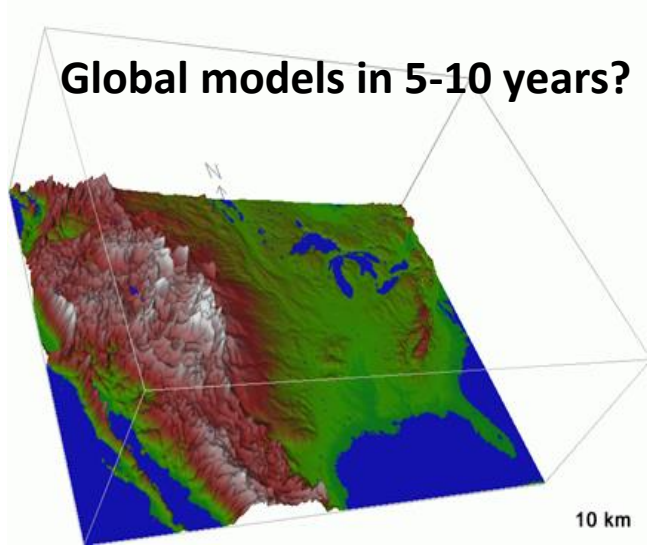
Global Climate Models

- They underlie all the projections we use for climate change
- 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









Global Climate Models

Improving capabilities:

- More elements of earth system added
- More and improved observations
- More observations inform climate models

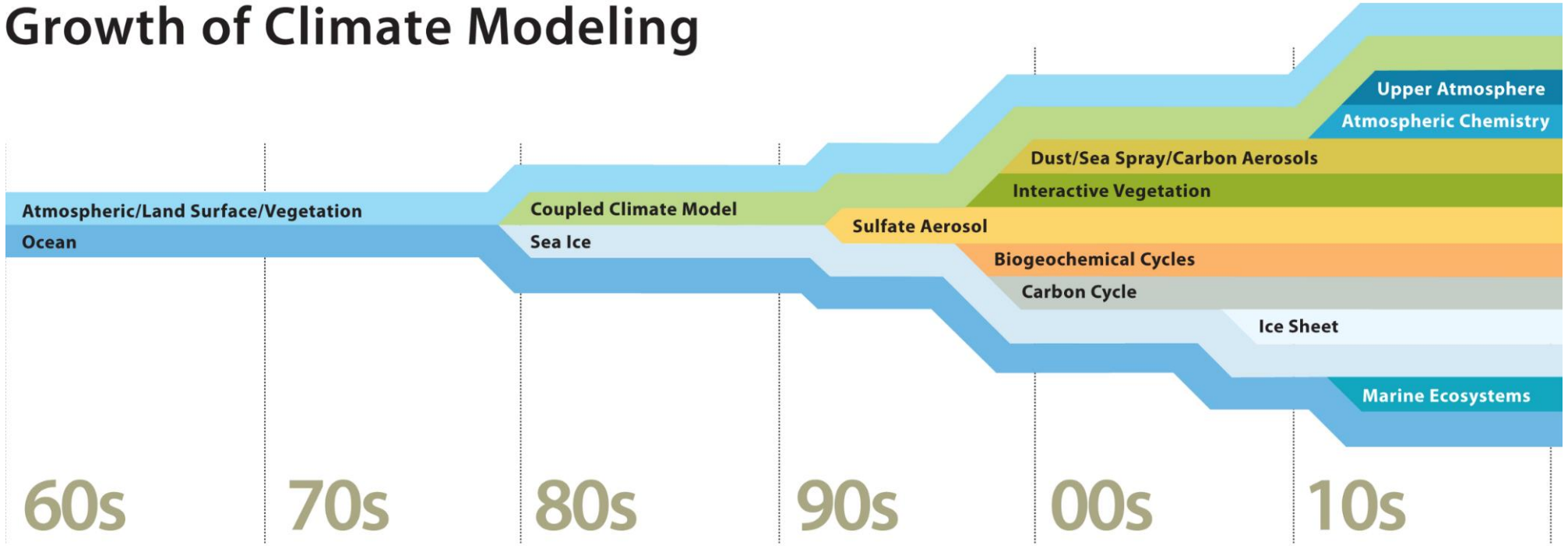


Figure courtesy of UCAR

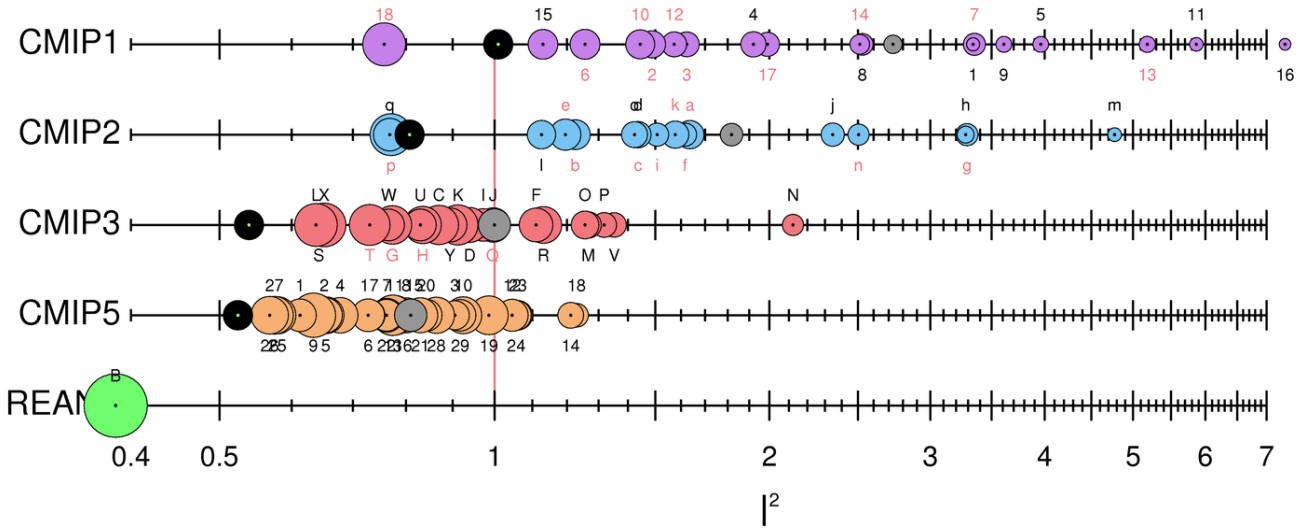
A Dose of Humility: Climate Models Are Not Crystal Balls

- Models are simplifications of reality
- They can be wrong – even if they all or mostly agree
- They are the best source of information we have on climate change
- They are improving
  - Resolution
  - Processes they simulate

How Are the GCMs Doing?

Two key points:

- With each generation of models, simulation of current climate improves
- Generally, average of the models does better than individual models



Source: Thomas Reichler, University of Utah. Personal Communication

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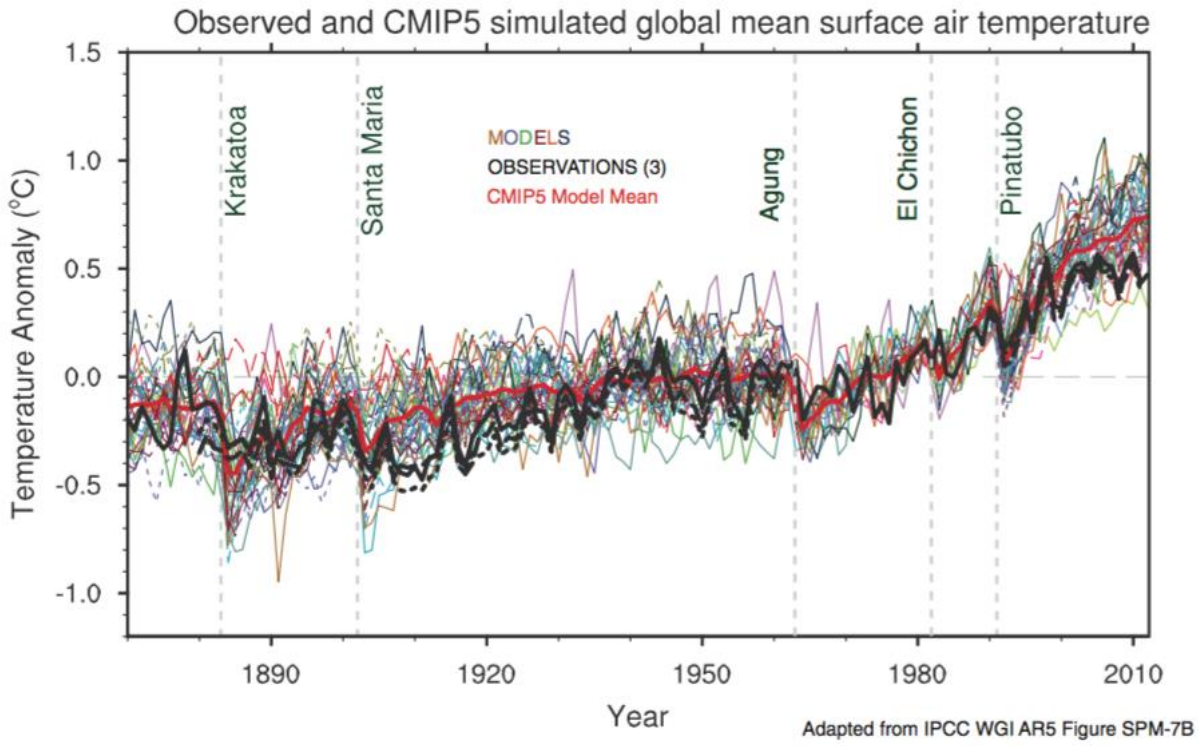
Model Averages vs. Individual Models

- Ensembles of multiple simulations that could include:
  - Many different global models
  - Multiple runs from the same model under different initial conditions
- The average of climate models' simulations of current climate is generally closer to observed climate than any individual model



Model Initialization Makes a Difference!

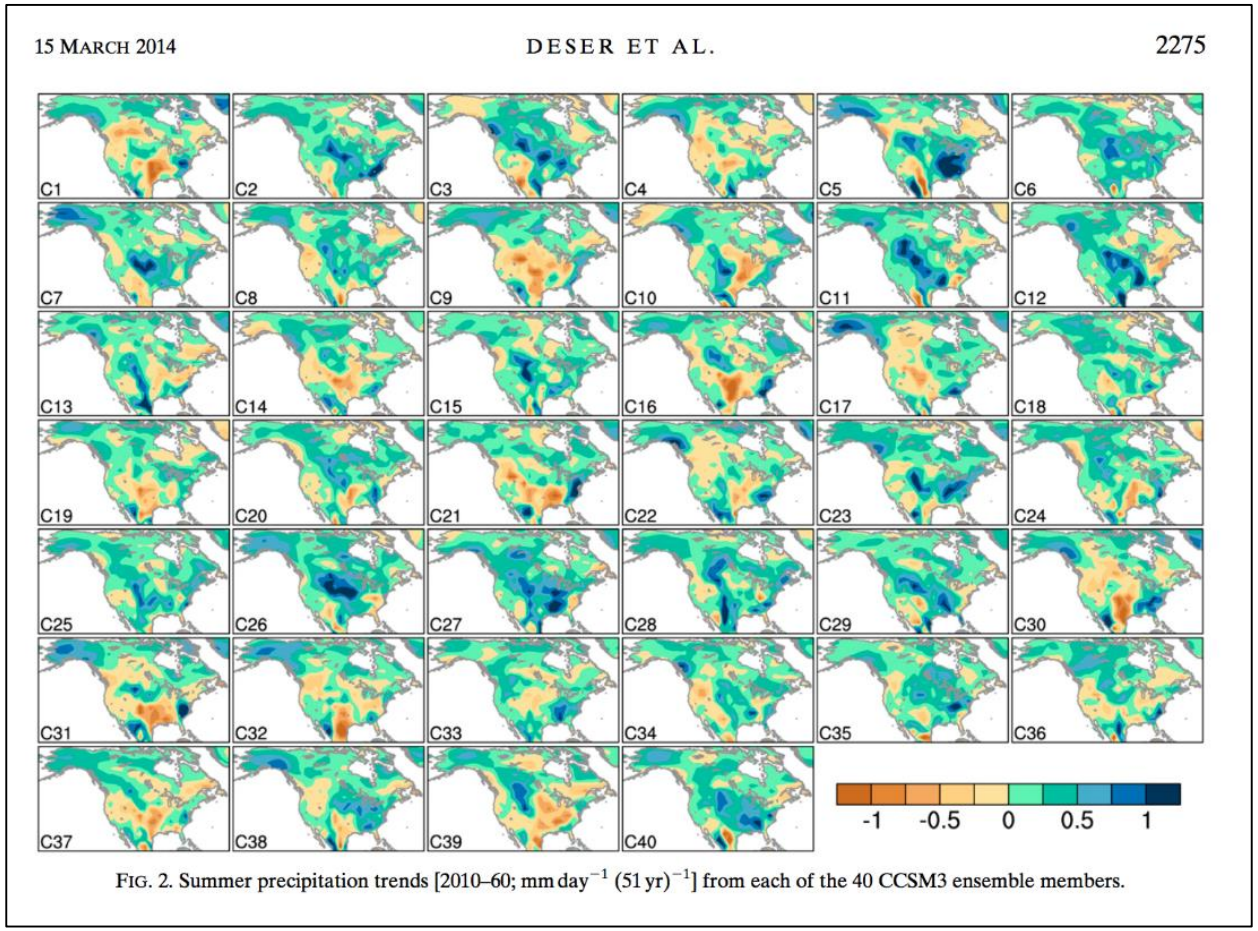


FIG. 2. Summer precipitation trends [2010–60; mm day^{-1} (51 yr)$^{-1}$] from each of the 40 CCSM3 ensemble members.

Model Averages vs. Individual 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 Climate Models 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

This Leads to a Desire for Downscaling

- We downscale because we want information at higher resolution
- Higher resolution is not necessarily more accurate
- The key question should be how does downscaling improve the results?
  - Do the results make physical sense?
  - Do we better understand direction of change at high resolution?
  - Do they project how change varies within the GCM grid box?
  - Does downscaling provide more accuracy or just precision?
  - Does it give us insight into sub-grid scale processes?

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