Climate Change Primer

Outline:

1. Projected changes for the PNW: overview
2. Climate variability vs. climate change
3. Global emissions to decision scales
   – How to get from (A) to (B)

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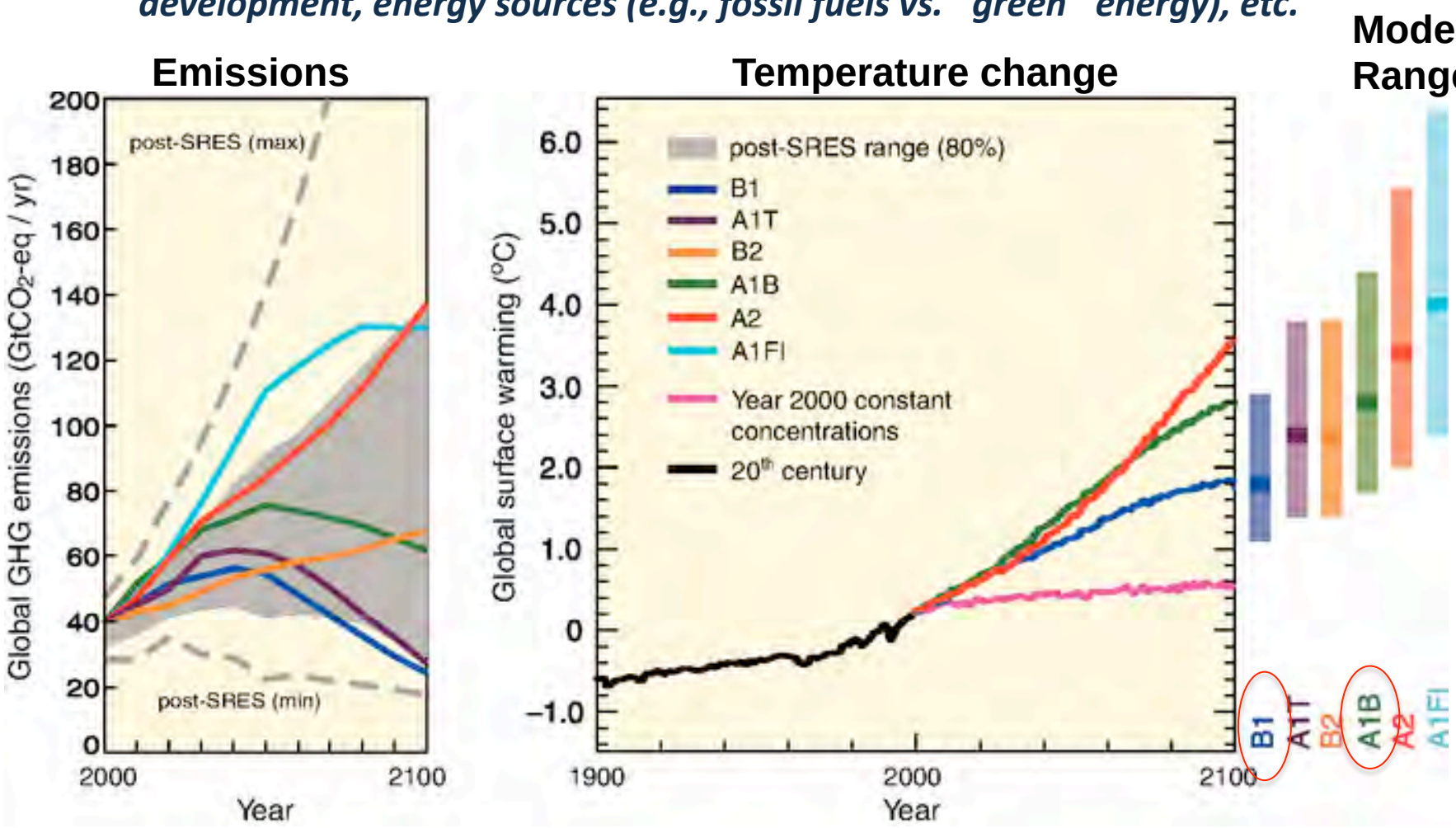
Workshop: *Restoring Salmon Habitat for a Changing Climate in the South Fork Nooksack River, WA*

Projected Changes

Projected Global Temperature Change

Greenhouse gas Emissions Scenarios:

Combine different estimates of population growth, technology development, energy sources (e.g., fossil fuels vs. "green" energy), etc.



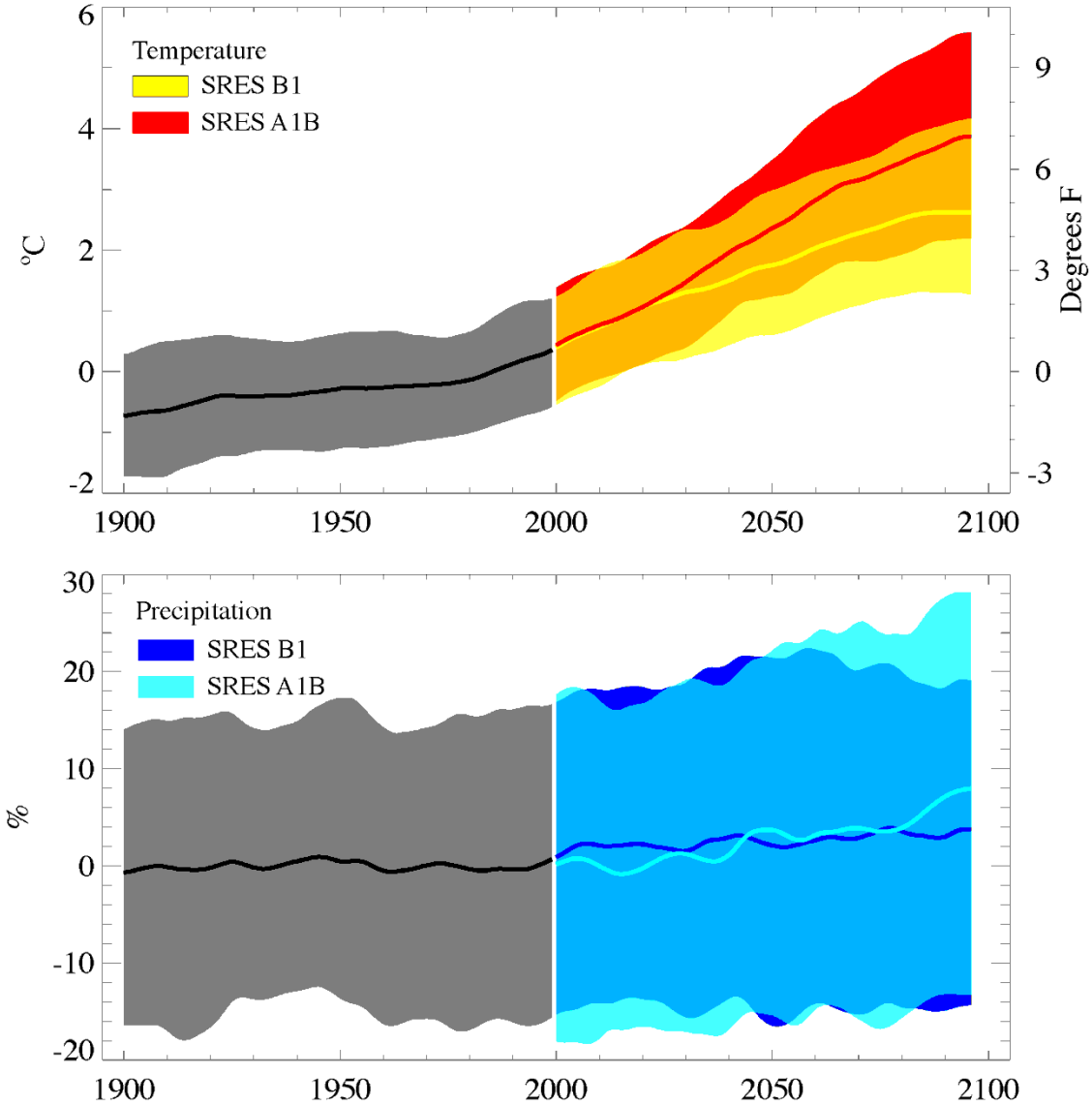
Slide adapted from Lara Whitely-Binder, CIG / UW

Source: IPCC, 2007

Projected Changes: PNW

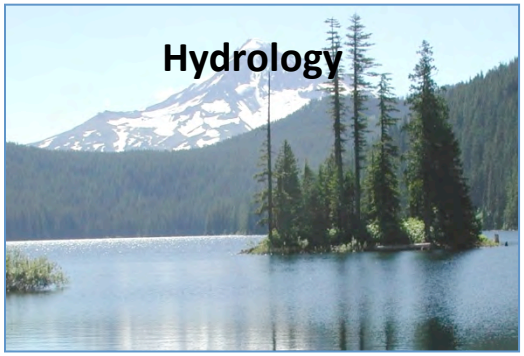
- Significant warming for all seasons, especially summer
- Changes in Annual Precipitation are small compared to year-to-year variability.
- Wetter Falls, Winters, and Springs
- Drier Summers

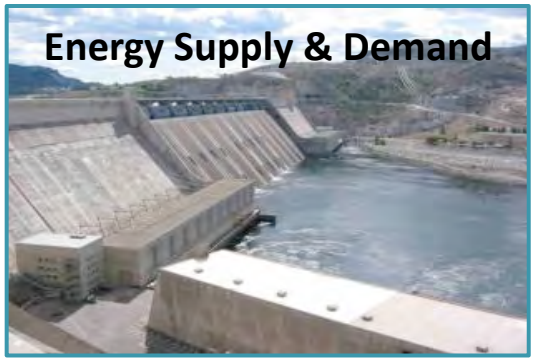
(Figure shows change compared with 1970 - 1999 average).



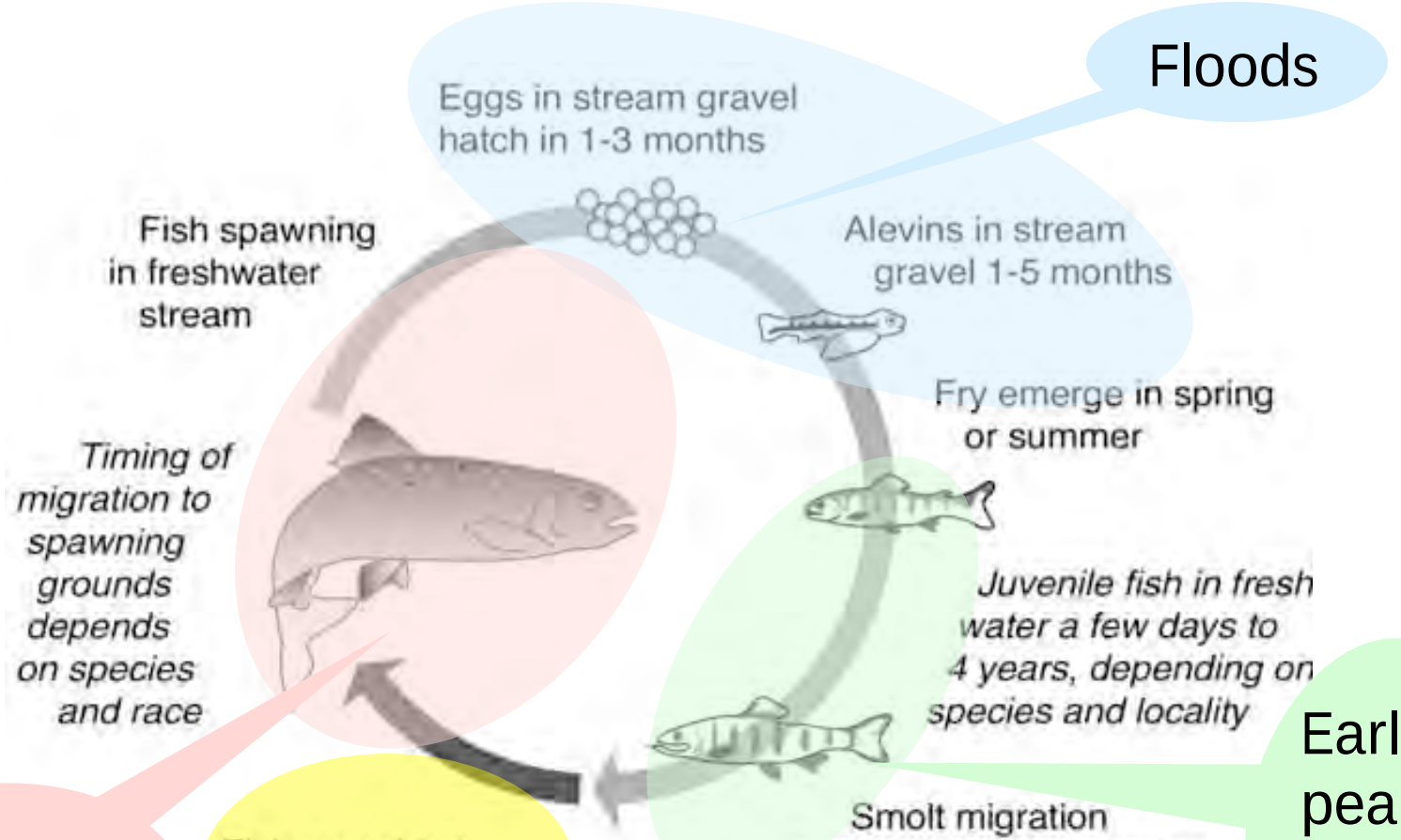
Source: Mote, P.W., and E.P. Salathé, Climatic Change, 2010.

Washington Climate Change Impacts Assessment (WACCIA)

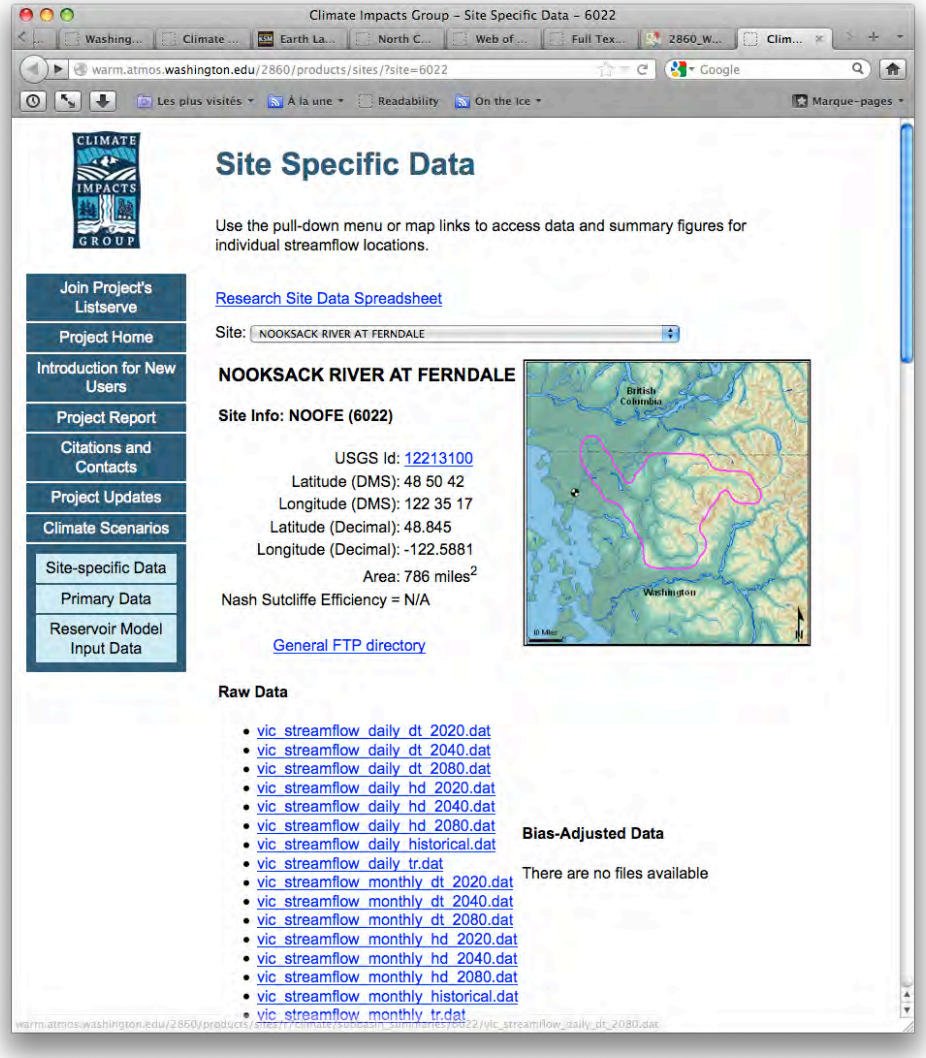


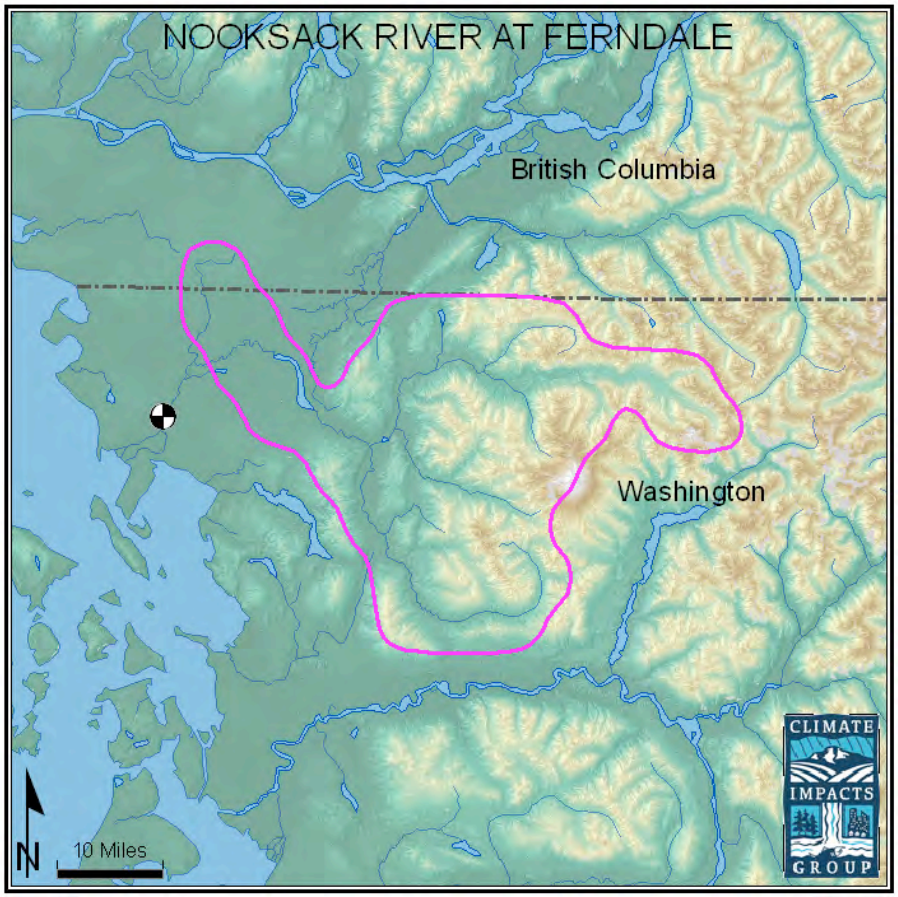


Salmon Impacted Across Full Life-Cycle



Projected Changes: Nooksack





Source: http://warm.atmos.washington.edu/2860/

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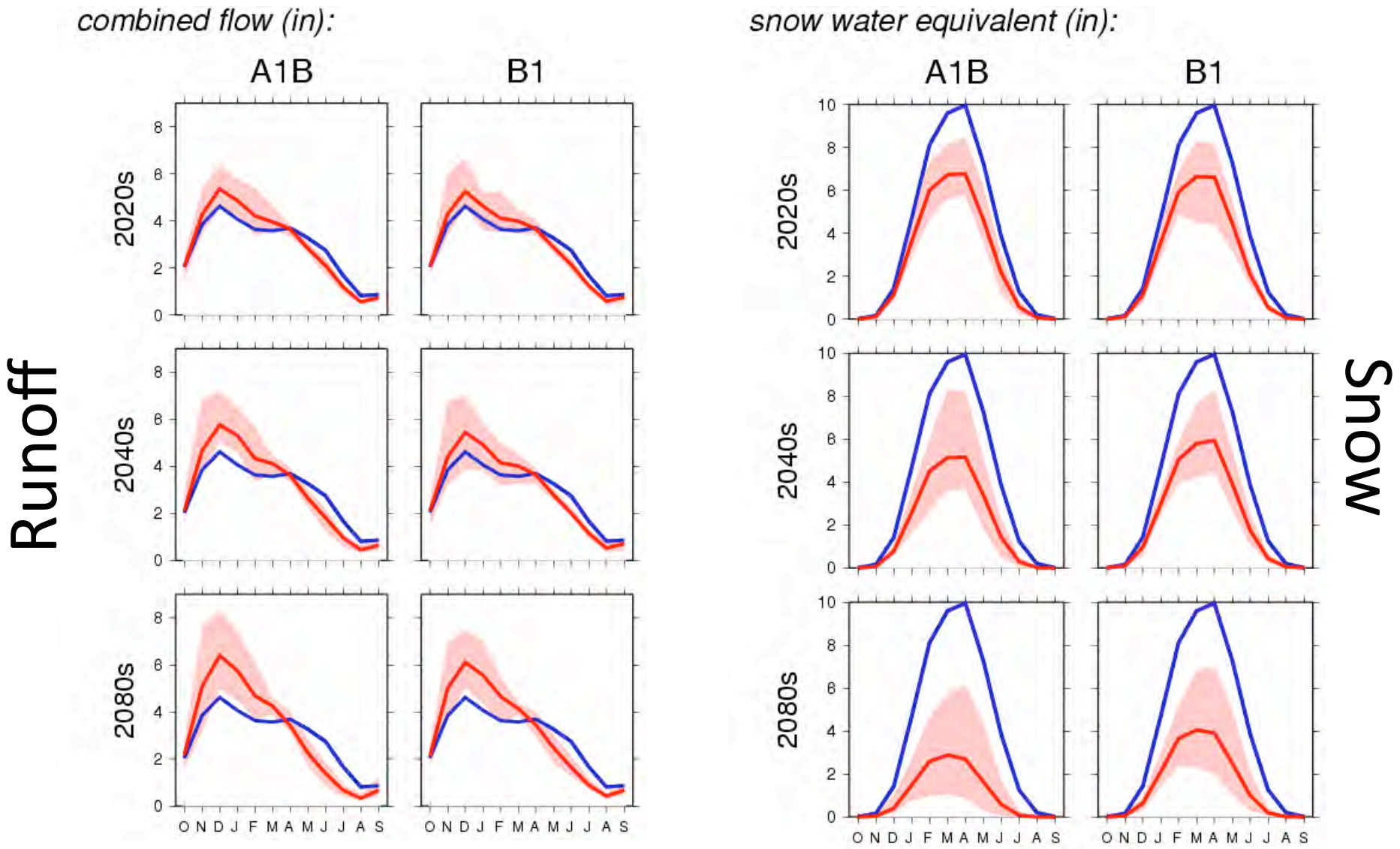
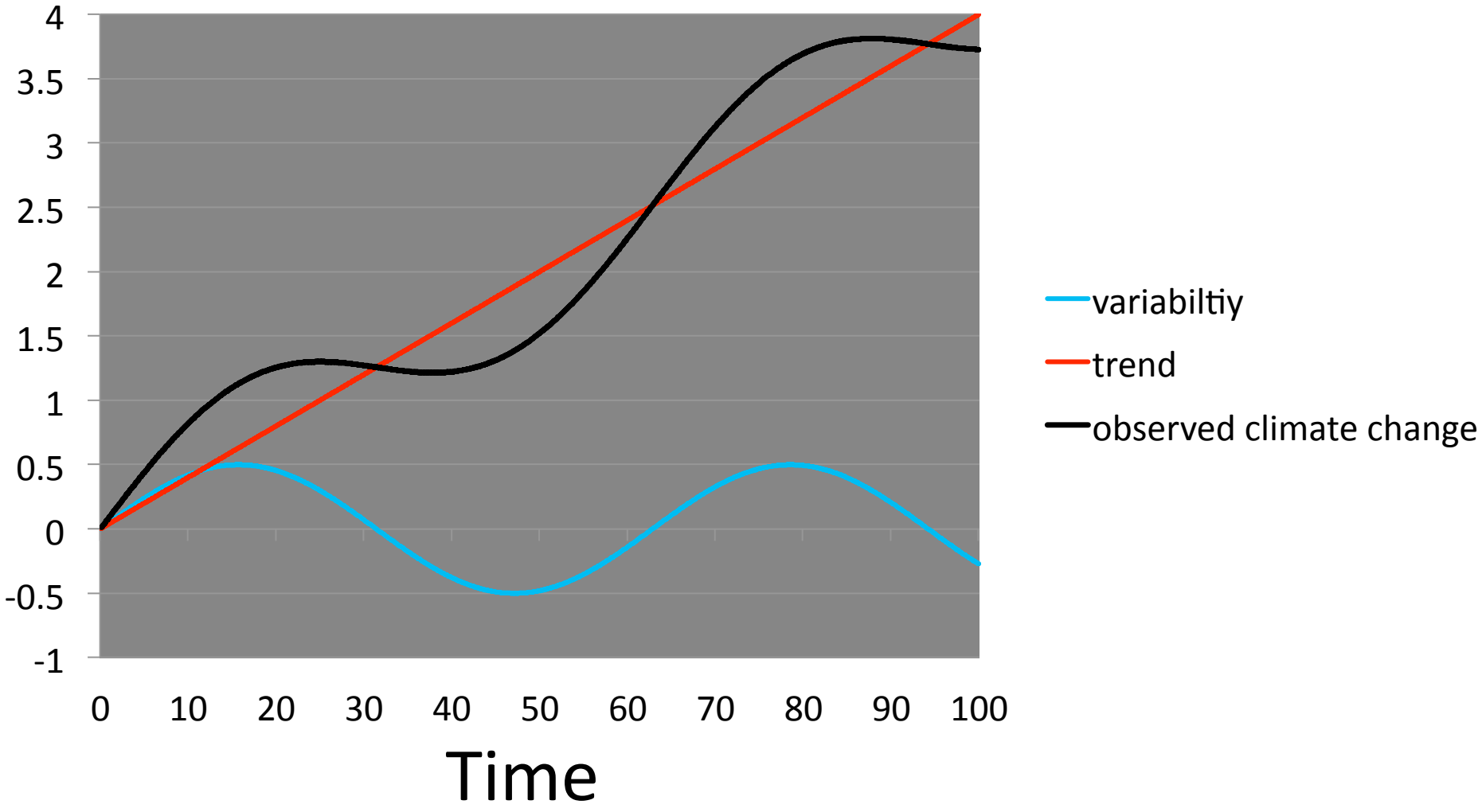
Projected Changes: Nooksack



Climate Variability vs. Climate Change

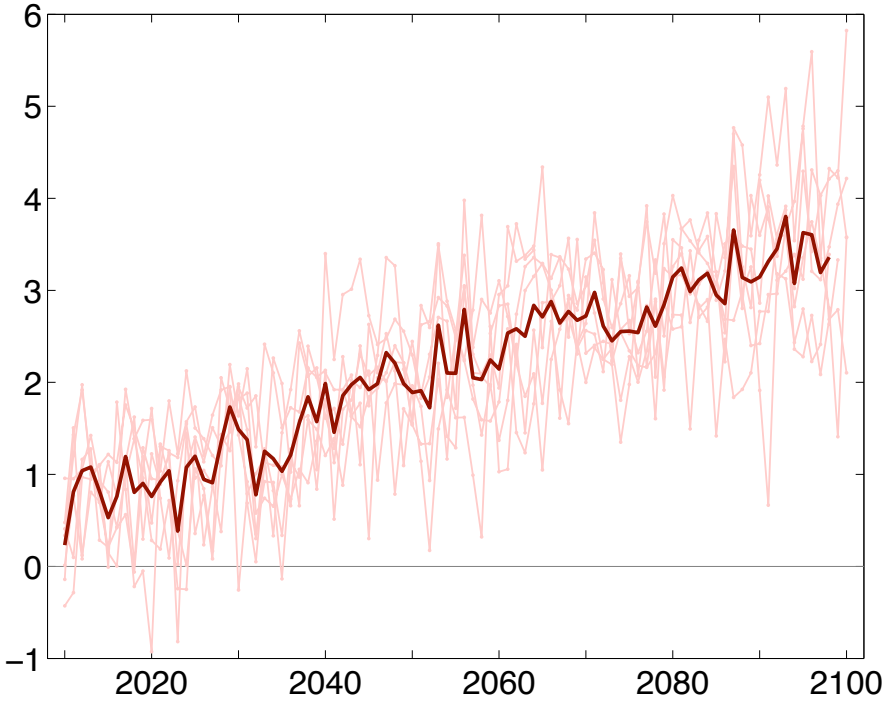
“Climate change” will express itself in real time as a complex combination of variability plus any systematic trend.



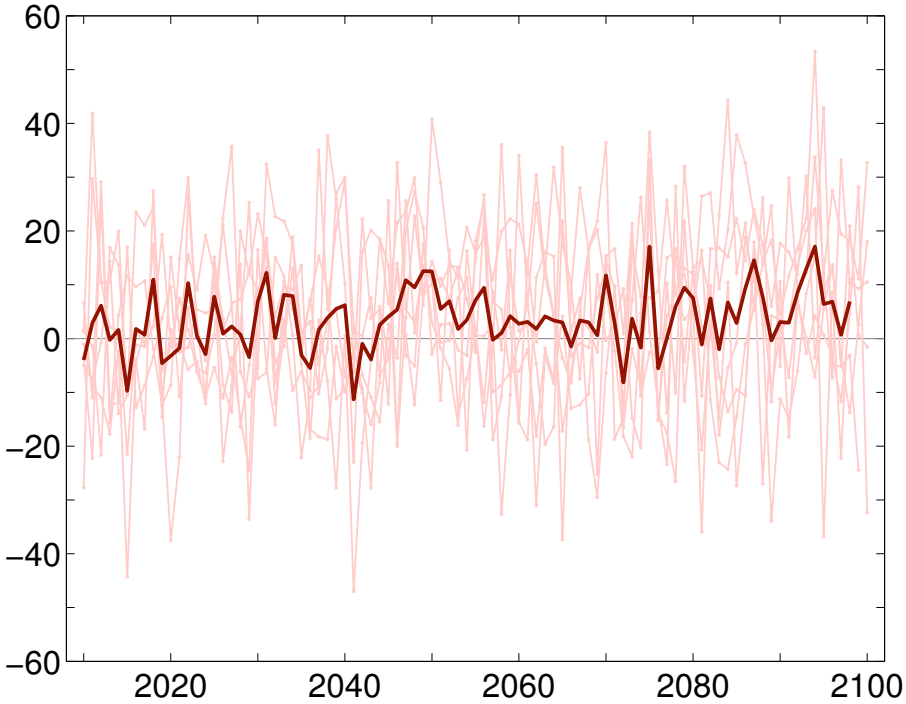
“Bumpy Ride”

Nooksack Watershed

Temperature Change (°C)



Precipitation change (%)

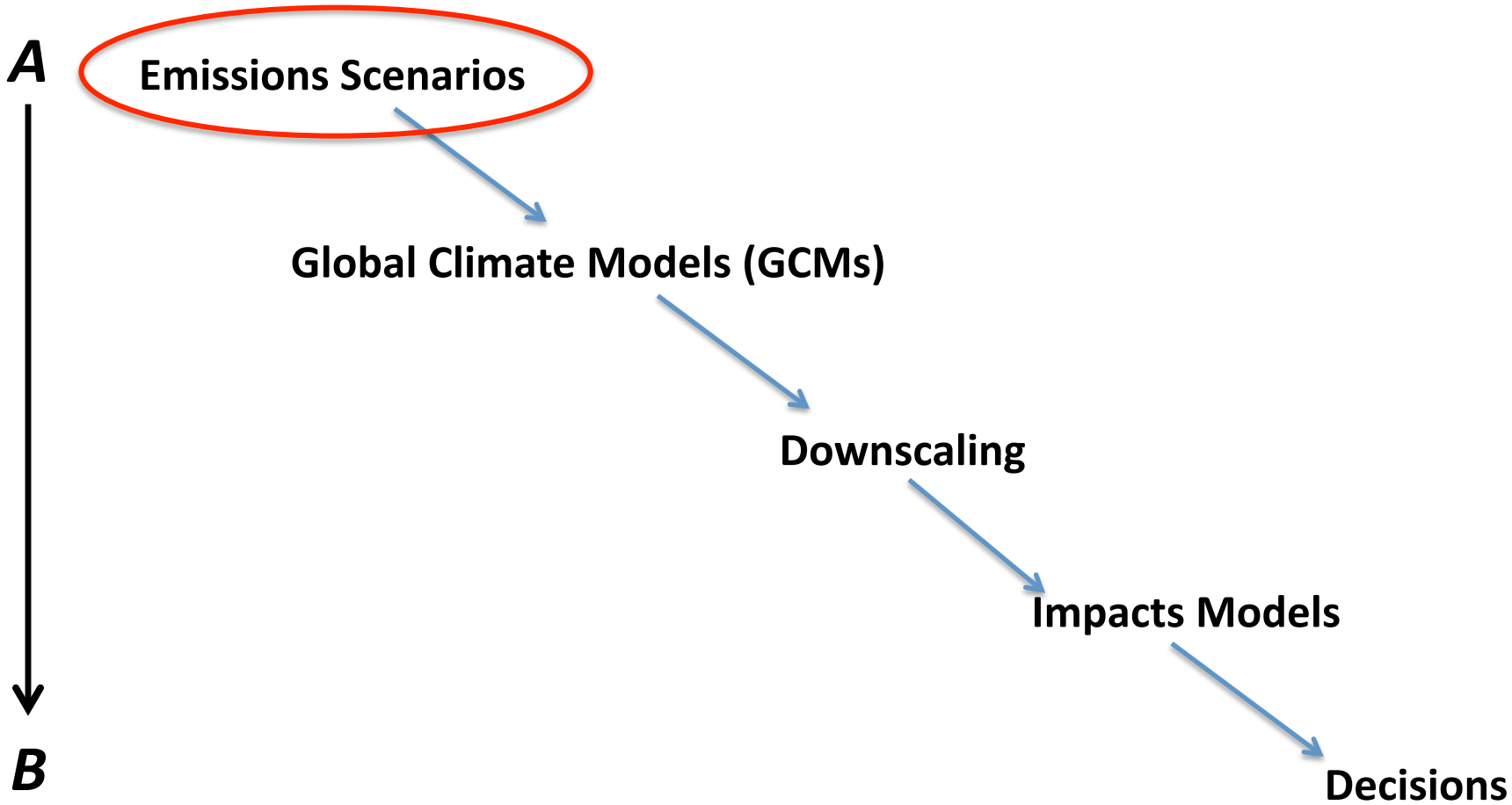


Annual averages.
A1B emissions scenario, BCSD downscaling.
Results from 7 GCMs.

Source: http://warm.atmos.washington.edu/2860/

Emissions Scenarios to Decision Tools

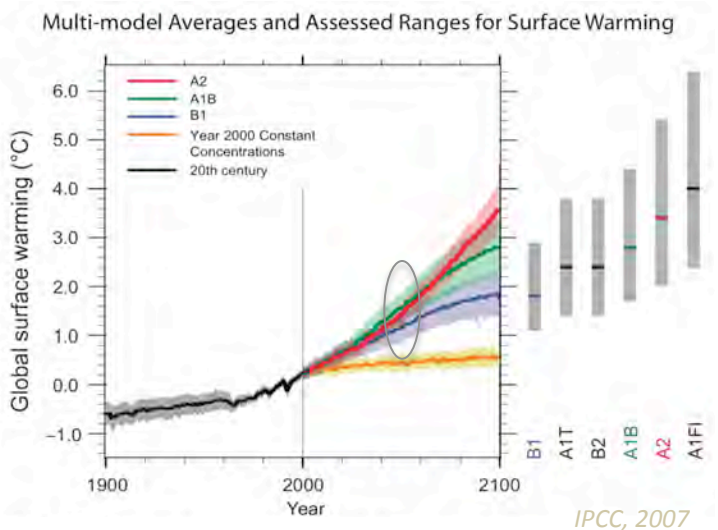
Emissions Scenarios to Decision Tools



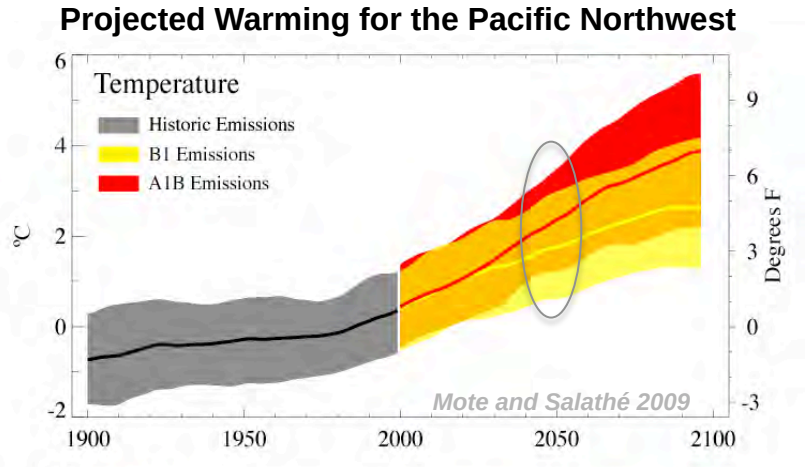
Choosing Greenhouse Gas Emissions Scenarios

- **No one emissions scenario is considered more likely than another.**
- Choice of scenarios is in large part a function of risk management: are you **risk tolerant vs. risk averse**?

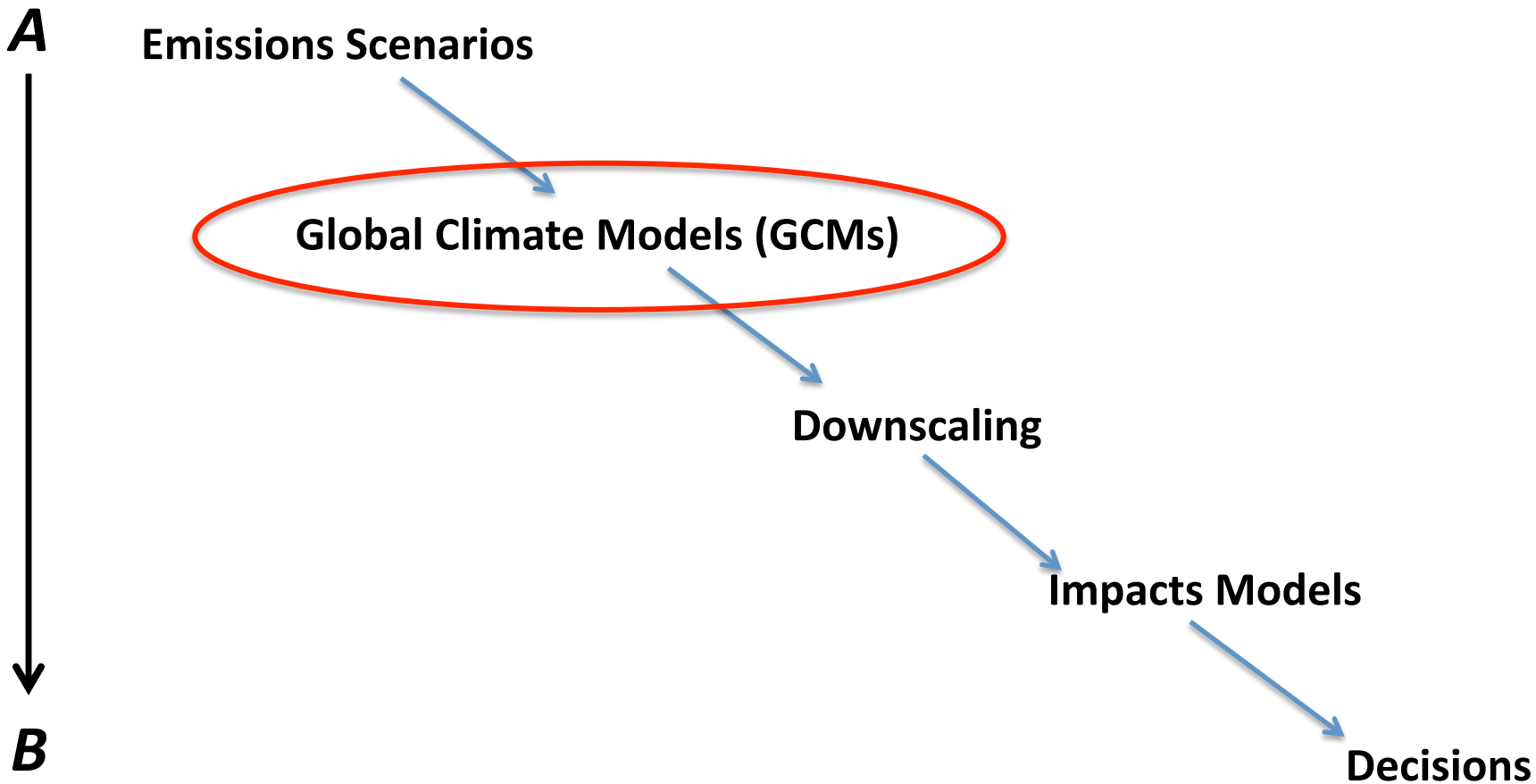
Note: Differences in scenarios - and thus changes in climate and related impacts - ***do not strongly diverge until after mid-21st century.***



IPCC, 2007



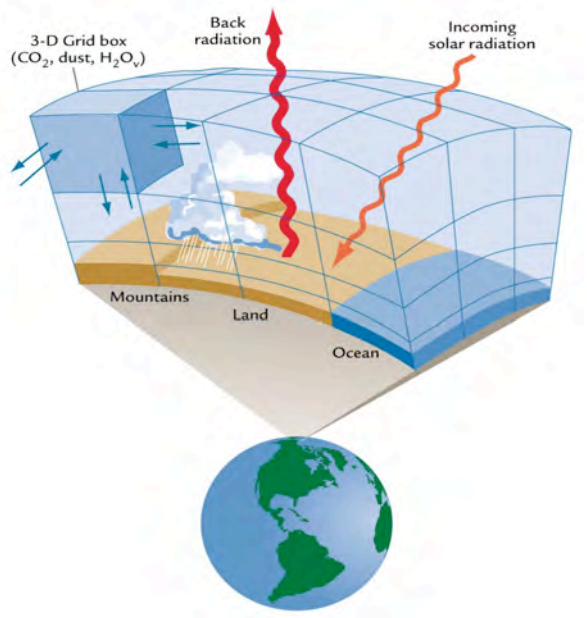
Emissions Scenarios to Decision Tools

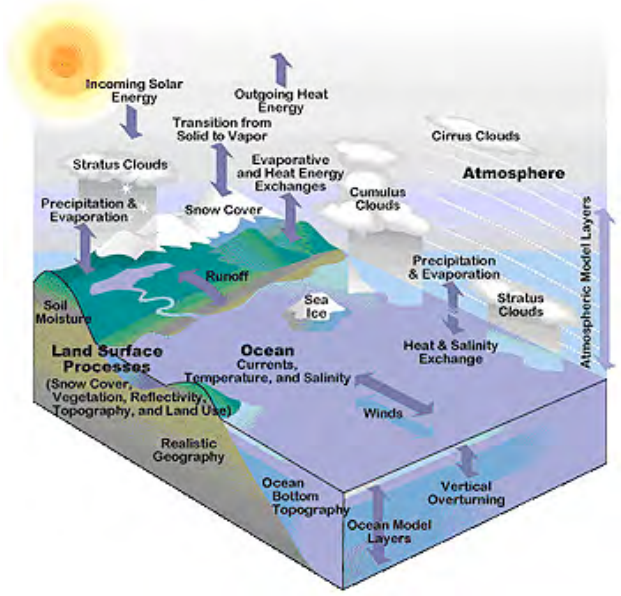


Global Climate models (GCMs):

- **GCMs break the world into large grid sizes (~60 to 180 miles) and model complex interactions within each grid cell.**

- **Today's GCMs are mostly "coupled", meaning that separate models for the land surface, ocean, sea ice, and atmosphere all interact.**

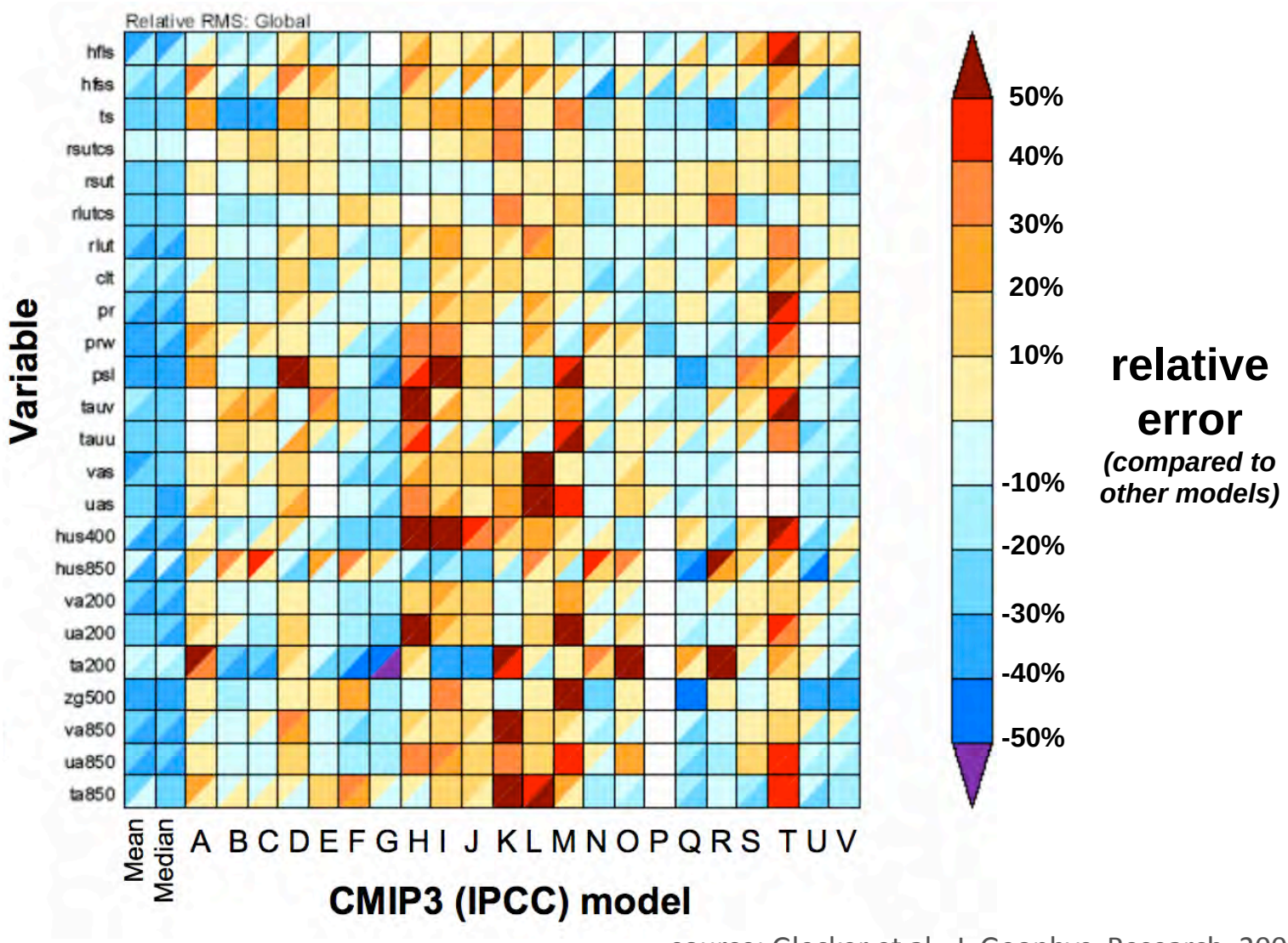




NOAA

There is no one “best” model

the answer depends on your question…



source: Glecker et al., J. Geophys. Research, 2008.

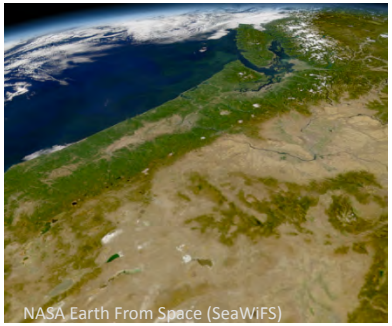
Choosing GCMs combines both:
Evaluating needs, Tire kicking

1. Are **multiple scenarios and multiple GCMs needed** for impacts modeling, or is an ensemble mean sufficient?

2. Do the models and emission scenarios selected **match the risk framework** (risk tolerant vs. risk averse)?

3. Do the models chosen have **good fidelity to 20th century observations** using a regional focus?

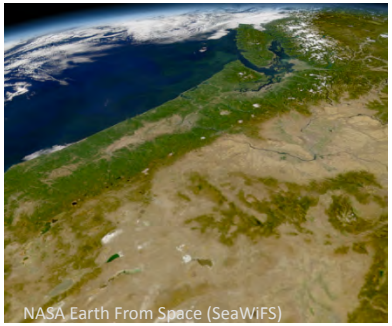
4. Is the spatial and temporal scale of the **climate information appropriate to the intended use** in planning or decision making?


NASA Earth From Space (SeaWiFS)

Approaches to Choosing Climate Models for Regional Assessment

Example:
18 GCMs

Modified from original image: www.psdgraphics.com


NASA Earth From Space (SeaWiFS)

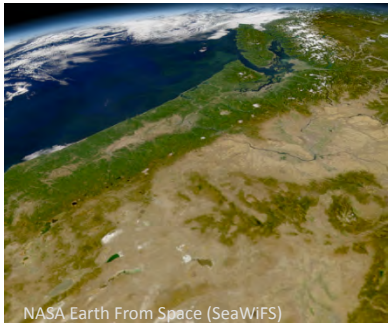
Approaches to Choosing Climate Models for Regional Assessment

Example:
18 GCMs

Modified from original image: www.psdgraphics.com

0. Use all models.

- **This requires the maximum time, effort, and resources, and is rarely a feasible option.**



Approaches to Choosing Climate Models for Regional Assessment

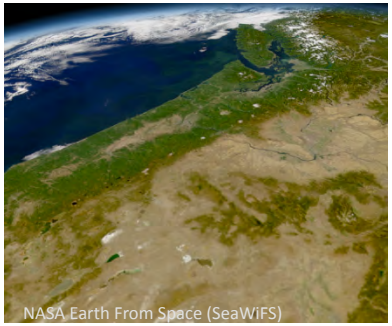
Example:
18 GCMs

Modified from original image: www.psdgraphics.com

1. All models are equally plausible.

- **Average all models together = ensemble**

Ensemble



Approaches to Choosing Climate Models for Regional Assessment

Example:
18 GCMs

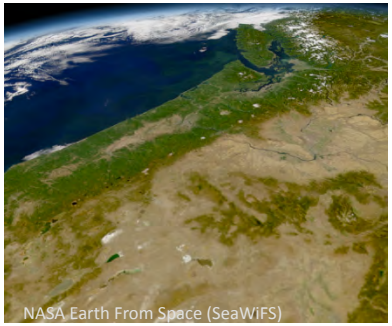
Modified from original image: www.psdgraphics.com

1. **All models are equally plausible.**
   - **Average all models together = ensemble**

Ensemble

2. **All models are equally plausible, but we want to plan for a range of scenarios.**
   - **Select "bracketing" models**

Warmest **Coolest**



Approaches to Choosing Climate Models for Regional Assessment

Example:
18 GCMs

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Ensemble

2. All models are equally plausible, but we want to plan for a range of scenarios.
- **Select "bracketing" models**

Warmest **Coolest**

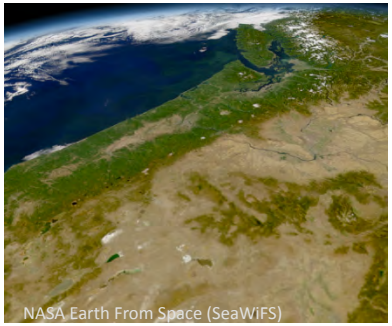
3. Some models perform better than others.
- **Select best performing models for ensemble -**

Filter models based on performance criteria: trend, pressure, means, etc

Ensemble

Driest

Wettest



Approaches to Choosing Climate Models for Regional Assessment

Example:
18 GCMs

Modified from original image: www.psdgraphics.com

4. Some models perform better than others.
- **Select best performing models**
- **Use each model separately to obtain a range of projections**

Filter 18 models based on performance criteria: trend, pressure, means, etc

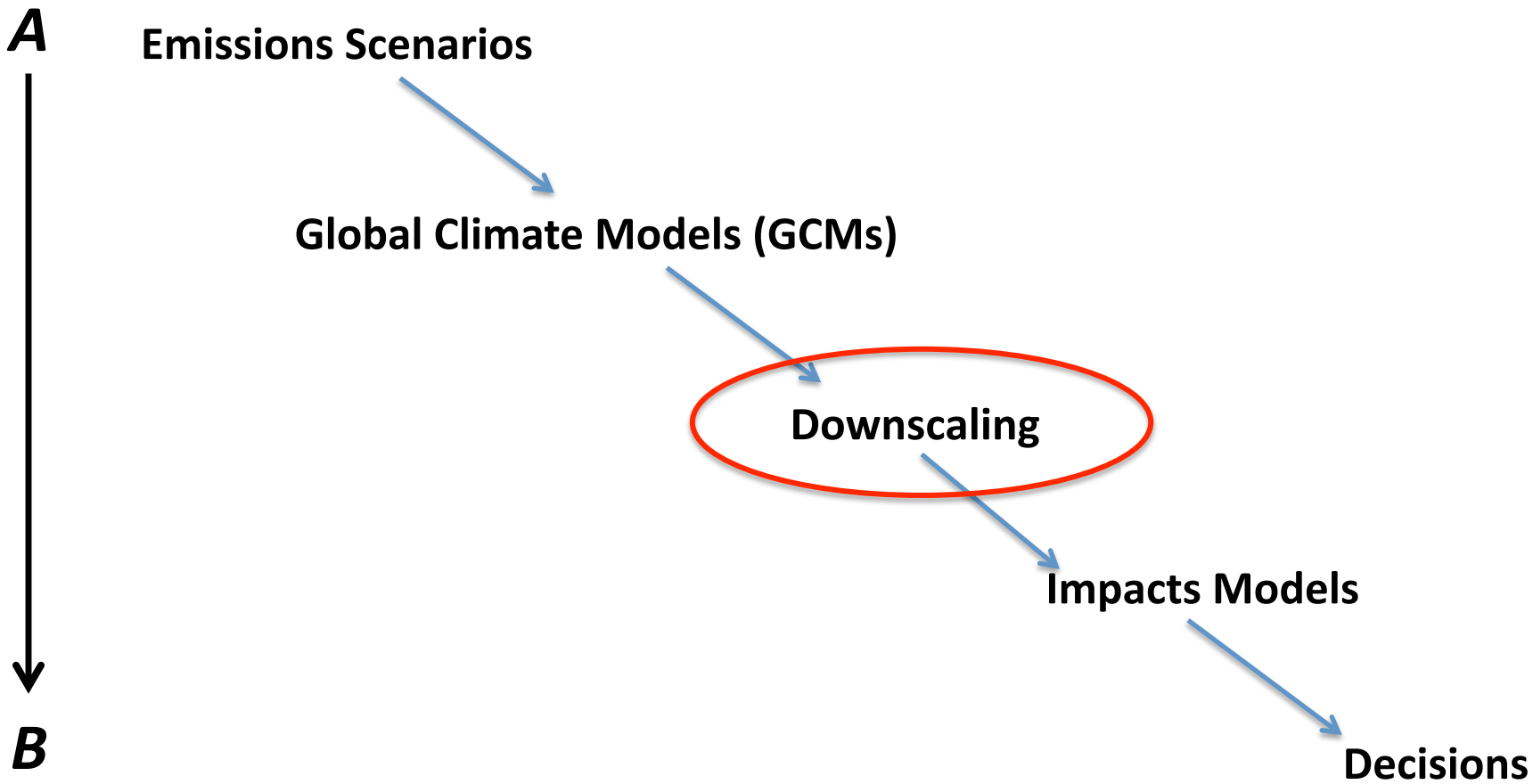
Dry

Wet

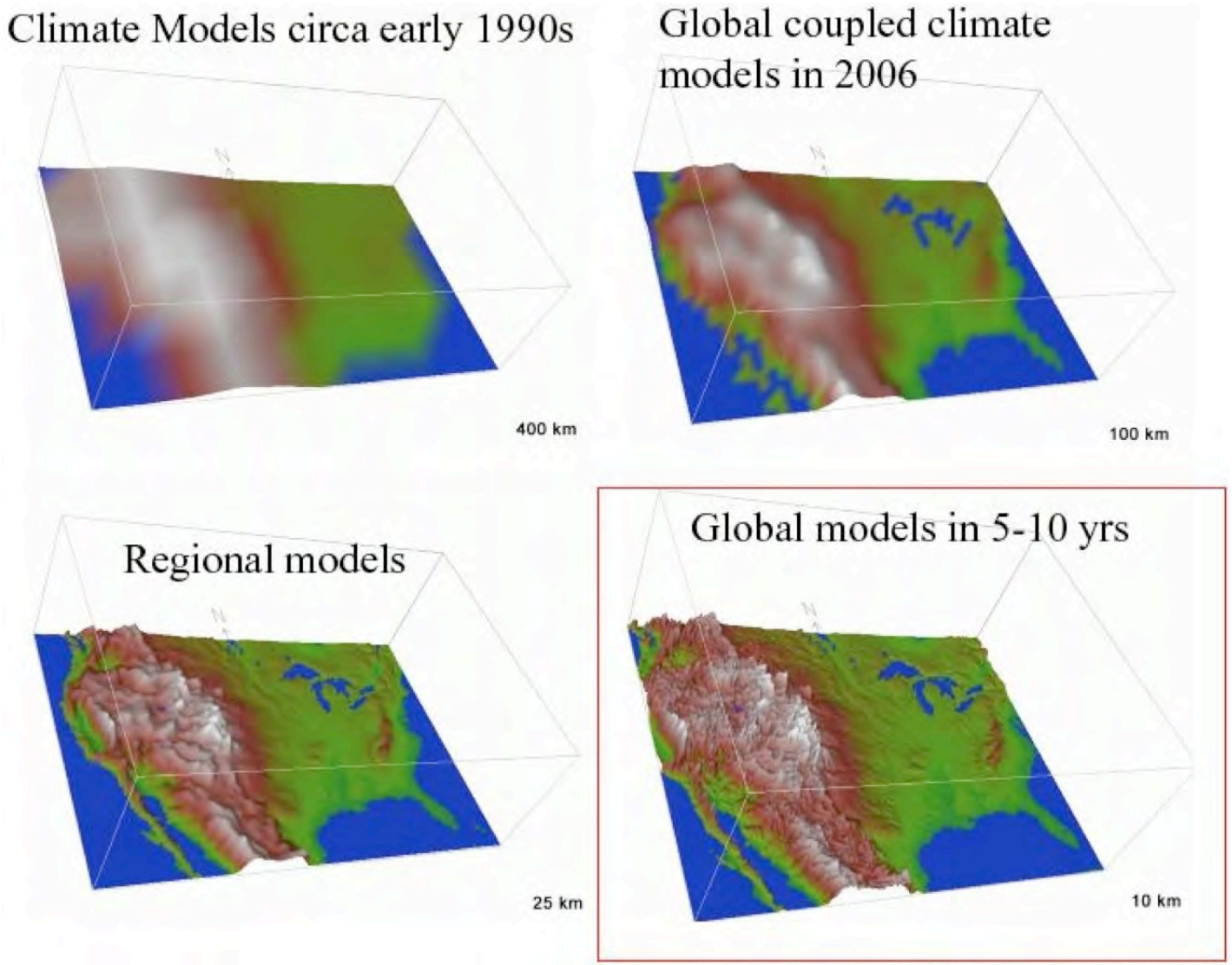
Warm

Cool
(less warm)

Emissions Scenarios to Decision Tools



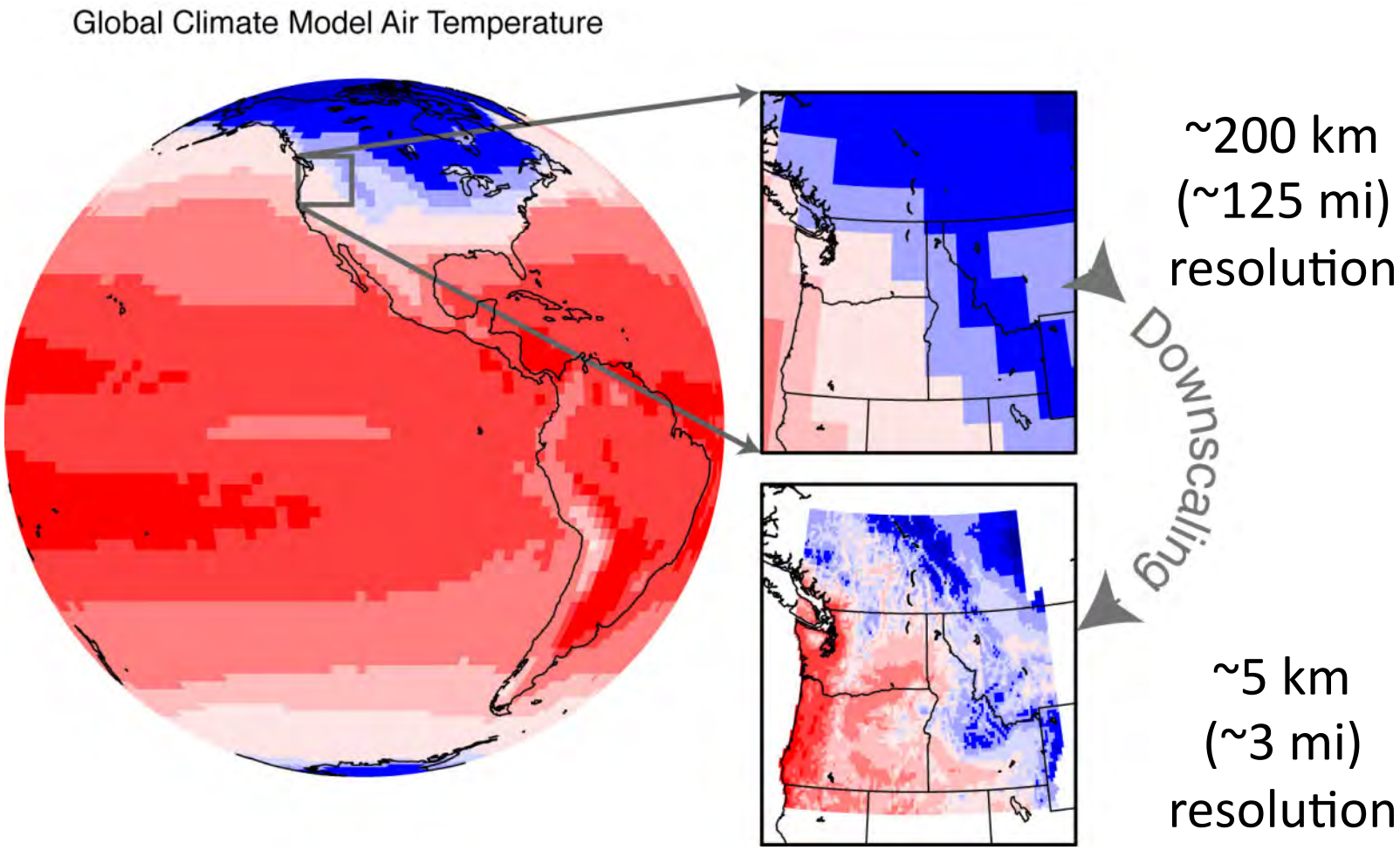
Scale and global land surface in climate models



Source: Strand, NCAR

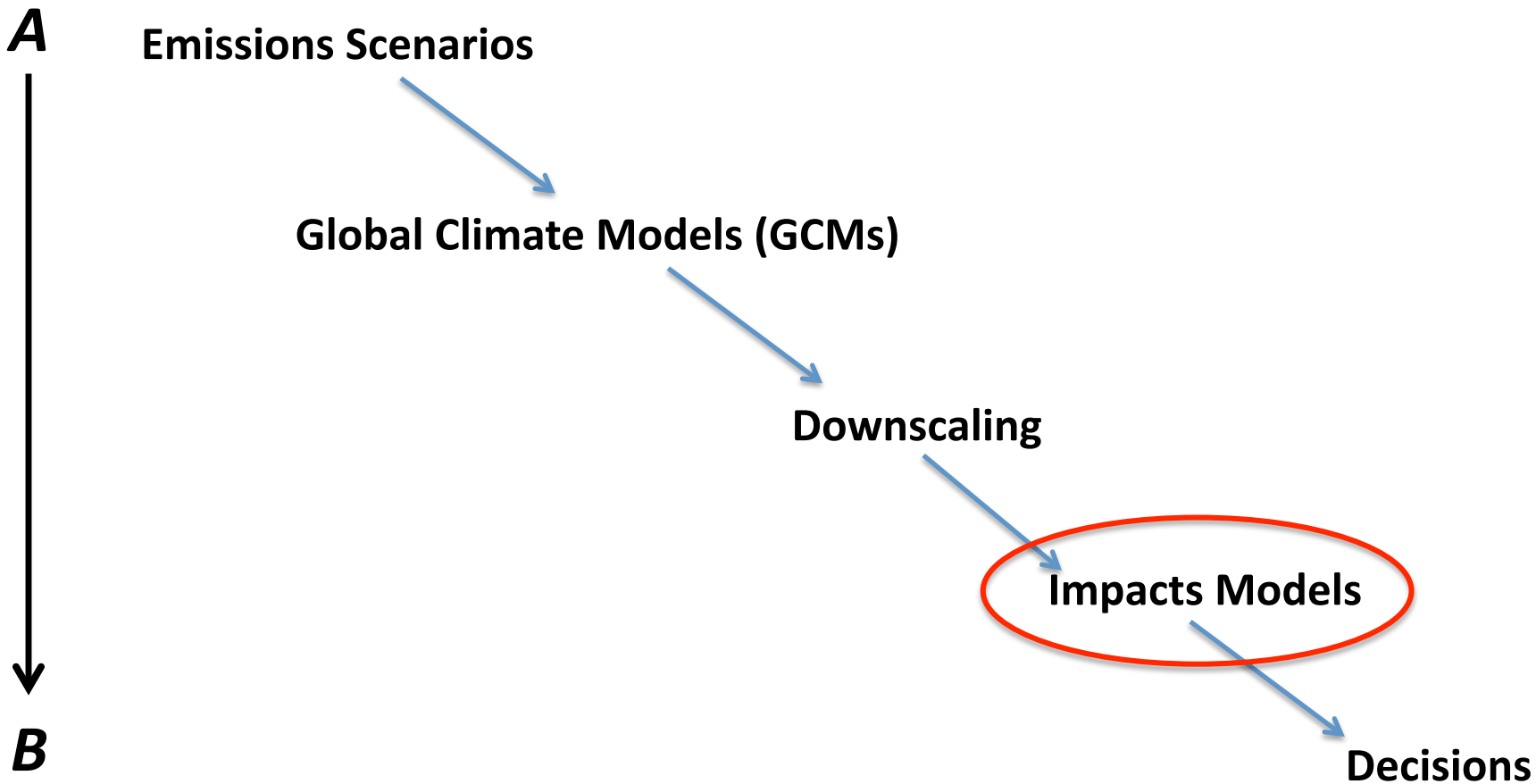
(note: this is probably unrealistically optimistic…)

Downscaling
Relates the "Large" to the "Small"



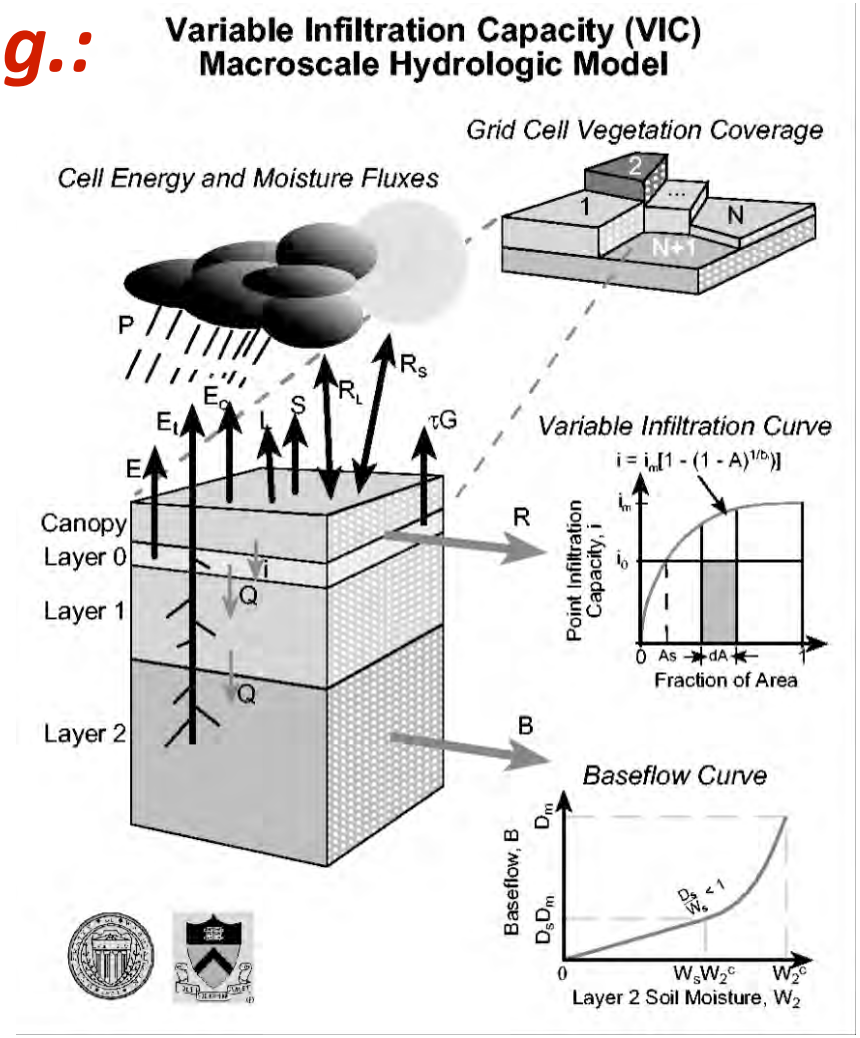
Figures: Eric Salathé

Emissions Scenarios to Decision Tools

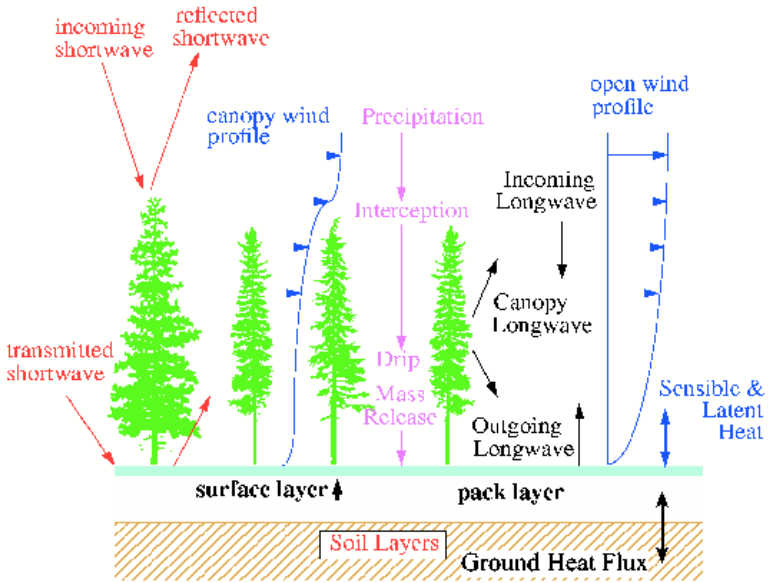


Last step: Use a model to translate climate changes to changes in ecosystem and hydrologic variables

e.g.:



VIC model overview



VIC snow model

Key Questions / Caveats

- Is more to be gained by finer downscaling?
  (A finer scale does not necessarily mean the projections are more realistic or better constrained).
- How does the scale of information match the detail of the ecosystem impact model being used?
- Does the range of futures from the climate model span the range of outcomes in the response?
  - *e.g., losing a forest to fire is more drastic than warming by an extra 2°C*