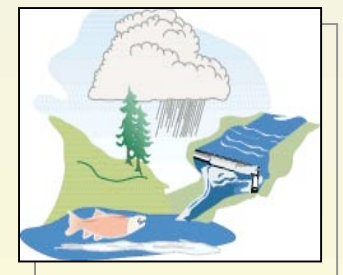


Impacts of Climate Change in the Pacific Northwest

Philip Mote
Climate Impacts Group
University of Washington

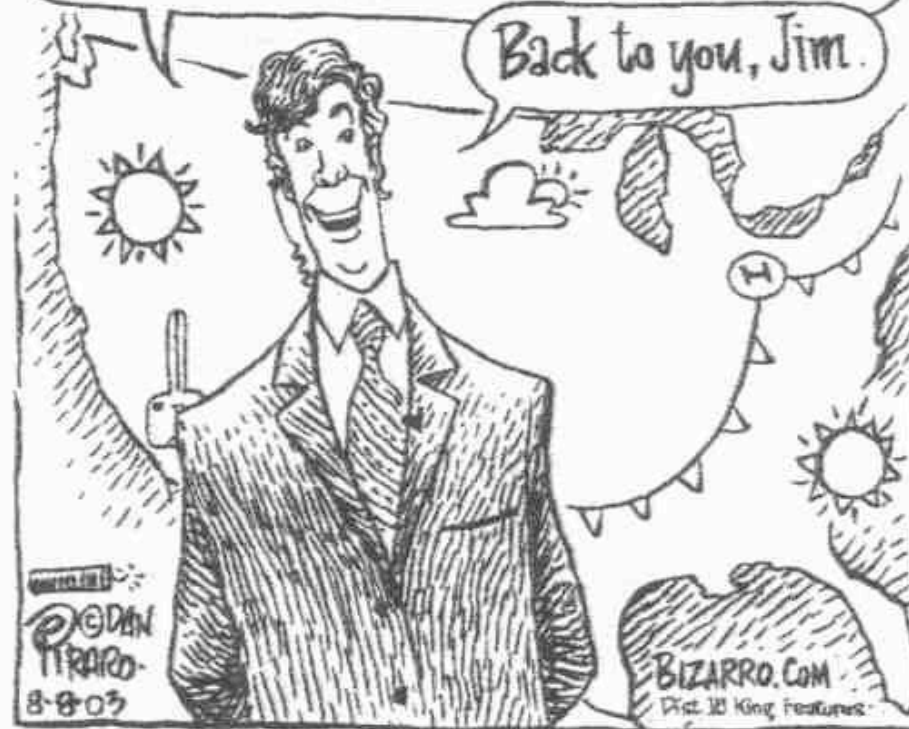


**Climate Science in the
Public Interest**

BIZARRO

By Dan Piraro

Our extended forecast includes global warming & the catastrophic end of the human race. But for the weekend, it's looking like sunny skies, mild temperatures, & a general apathy toward environmental concerns.



Estimating impacts of climate change on X

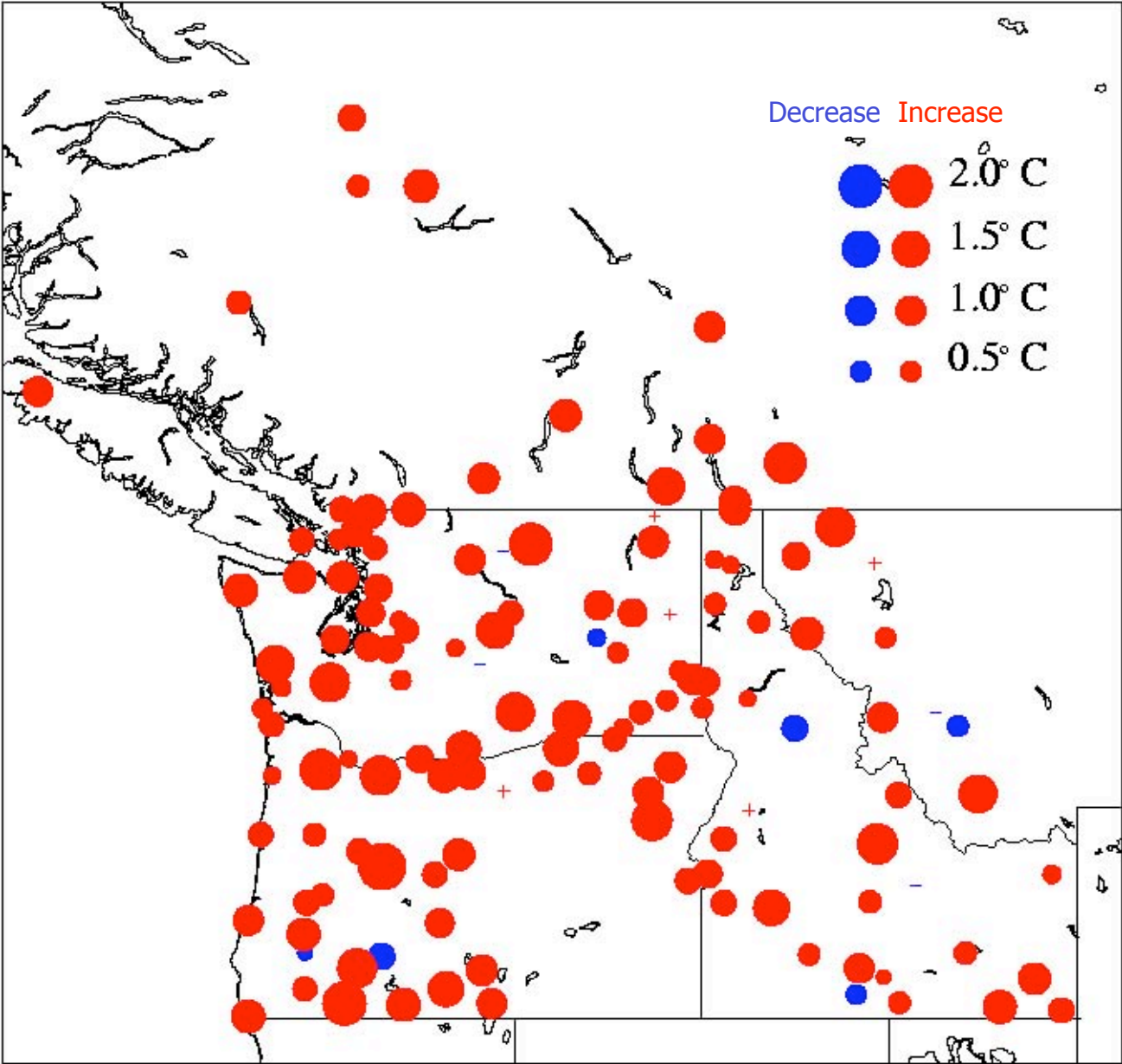
- Is X sensitive to climate?
- Can we separate the influence of climate from other influences?
- To which climate variables is X sensitive?
- Do climate models give plausible changes in those climate variables?

Climate change in the 20th century

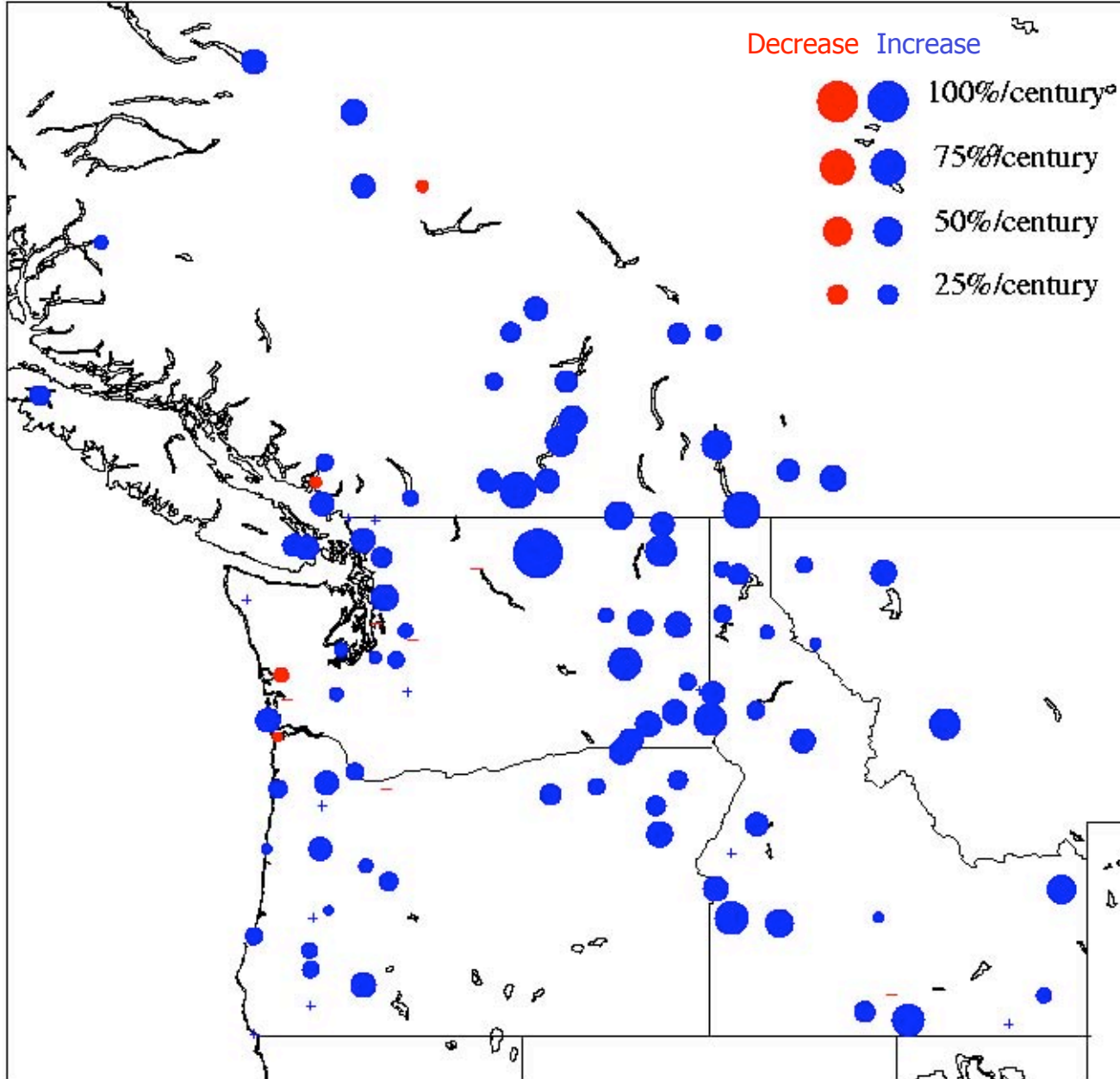
Impacts on

- Snow
- Streamflow
- Forests
- Salmon
- Sea level rise

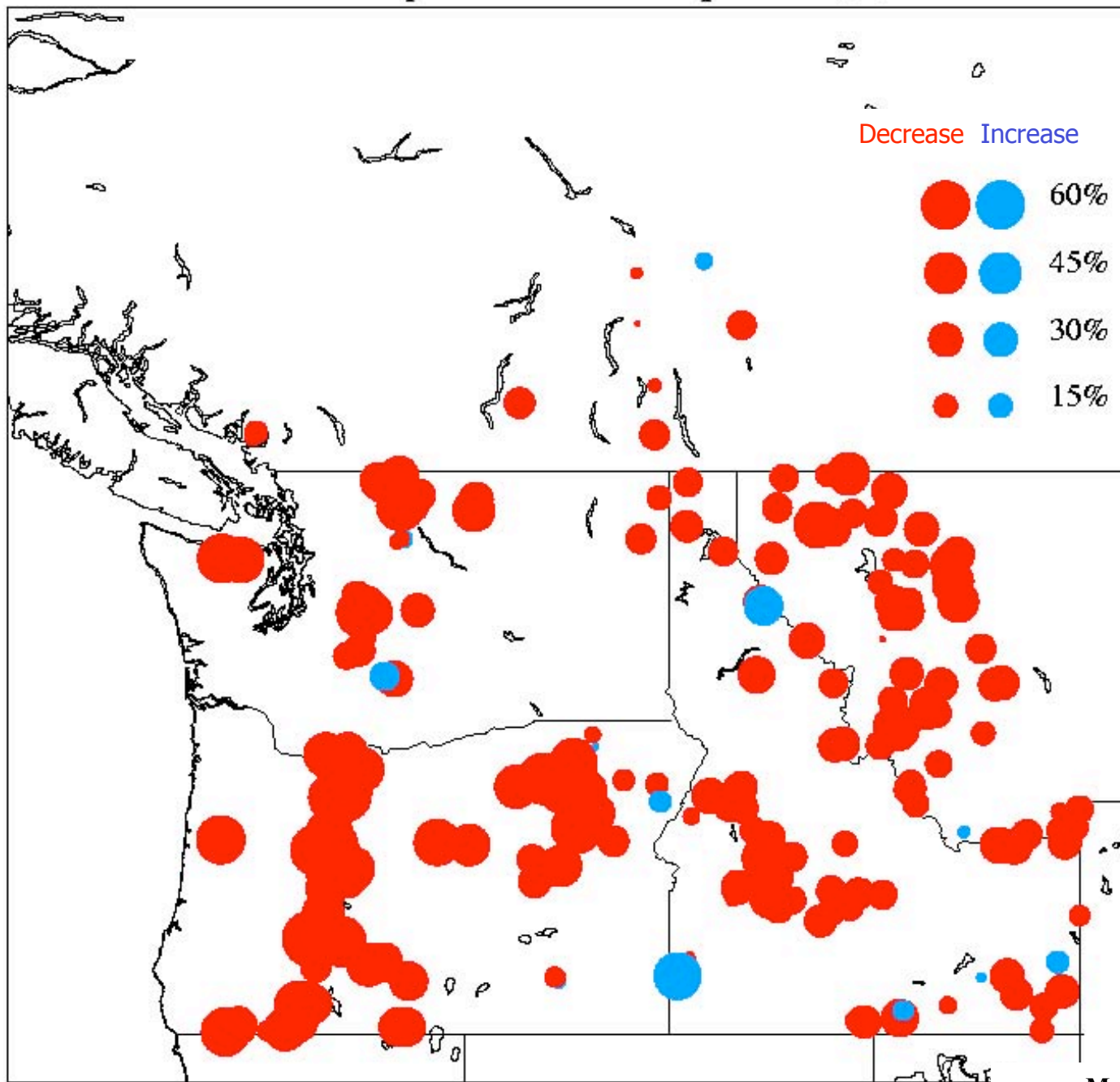
Temperature trends (°C per century), since 1920



Precipitation trends, since 1920



Relative trend in Apr 1 snow water equivalent, 1950-2000



Mote 2003(b)

The South Cascade
glacier retreated
dramatically in the
20th century



1928

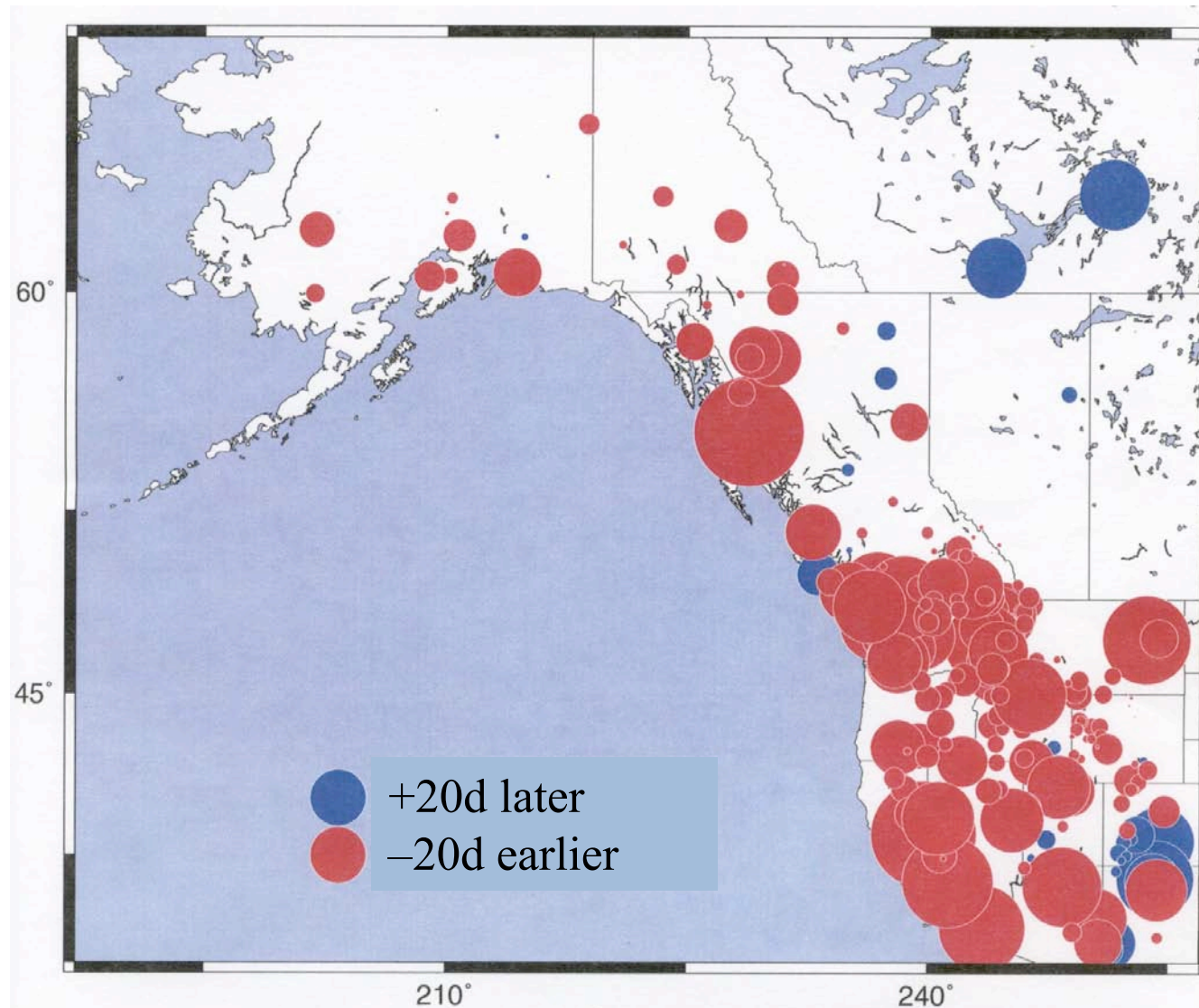
Courtesy of the USGS
glacier group



2000

USGS

Trends in timing of spring snowmelt (1948-2000)

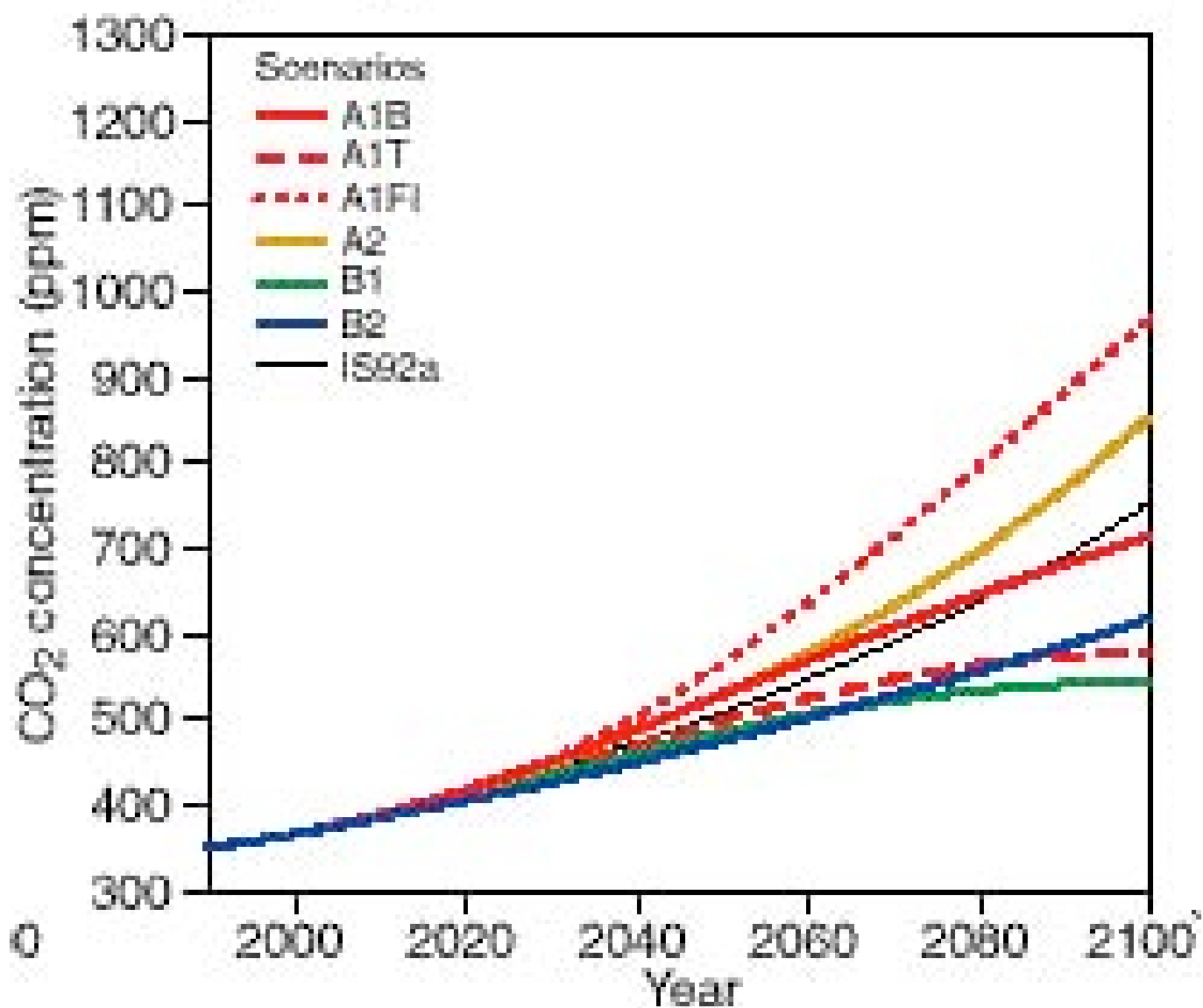


Courtesy of Mike Dettinger, Iris Stewart, Dan Cayan

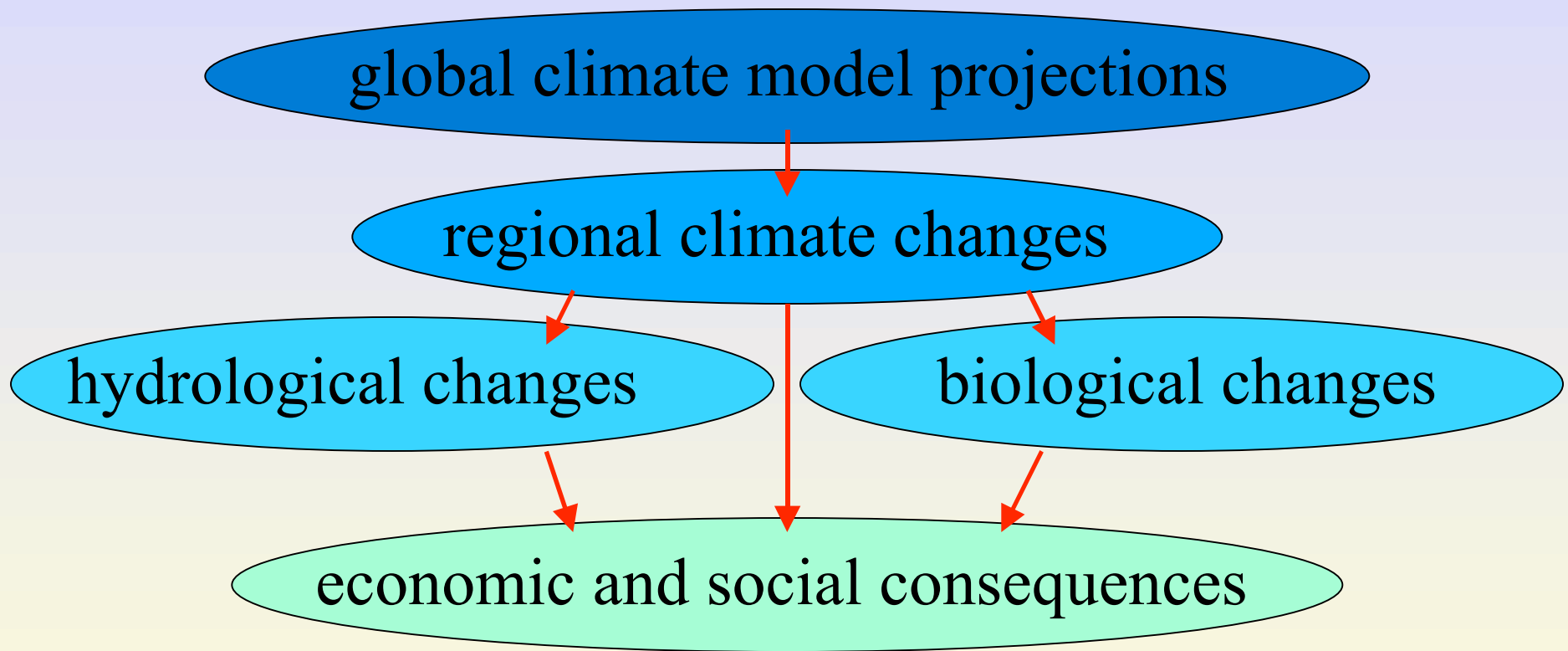
Summary of observed changes

- Significant increases in temperature throughout the Northwest
- Modest increase in precipitation (but more variable than temperature)
- Net hydrologic response: reduction in snowpack, earlier spring freshet. Some evidence of reduction in summer flow.
- Biological responses - forests moving into meadows, plants blooming & leafing earlier

(b) CO₂ concentrations

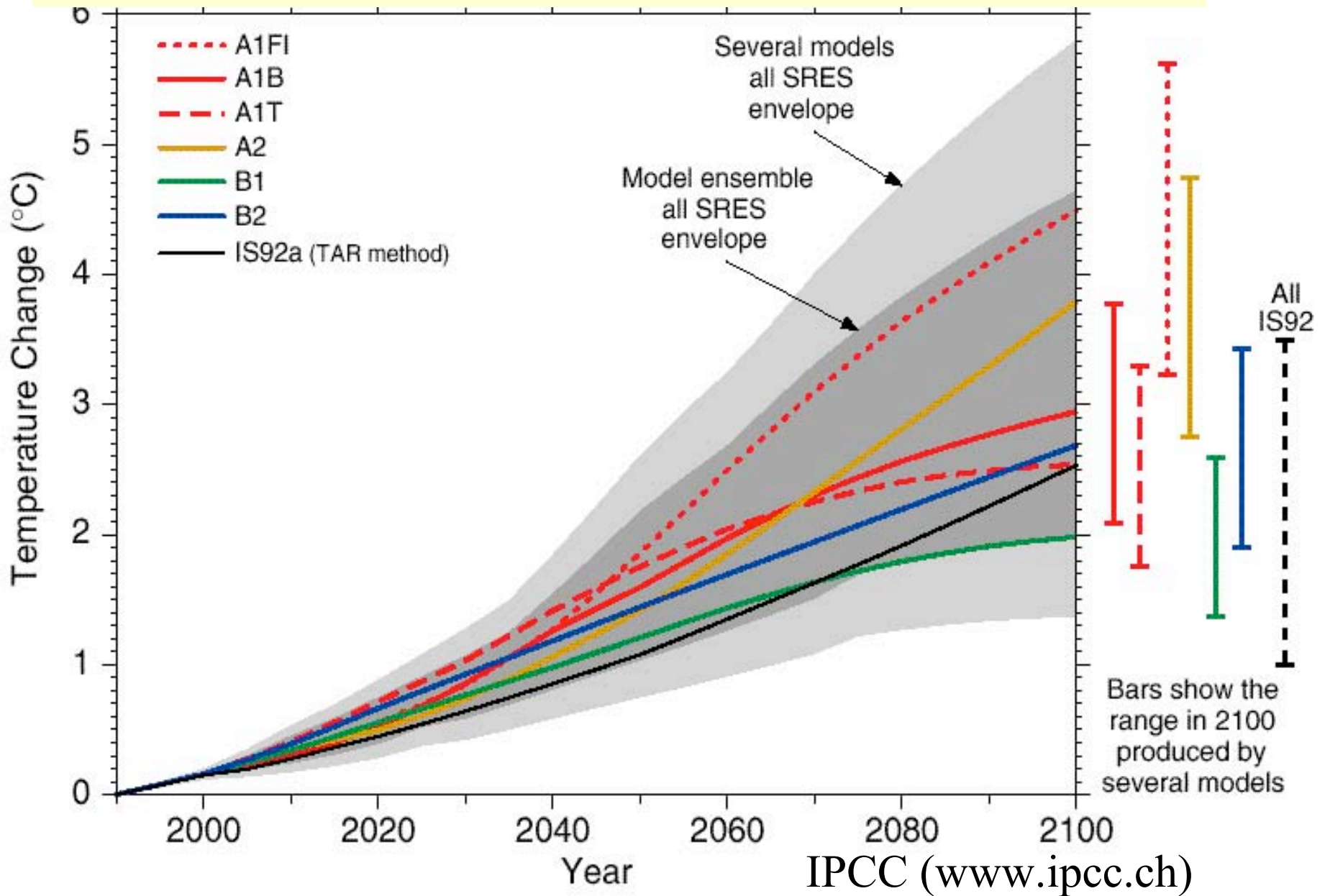


Climate impacts: The multiplier of uncertainty

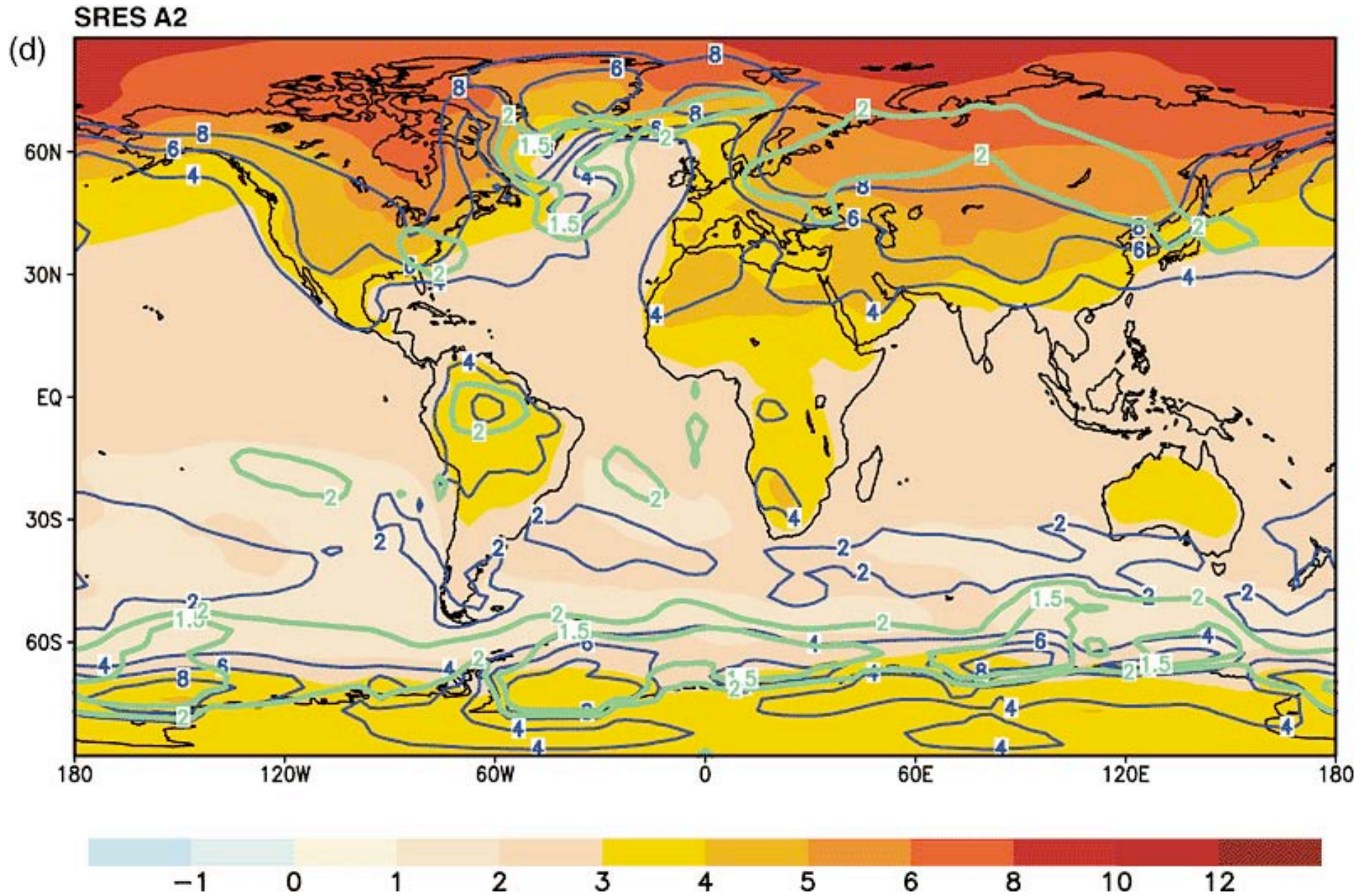


darker colors indicate higher confidence

21st century temperature change



Temperature change, 2071-2100 minus 1961-1990



Projected PNW Climate Change

Projected changes in **average annual PNW temperature and precipitation** for the decades of the 2020s and 2040s.

2020s	Temperature	Precipitation
Low	+ 0.5°C	+ 1.5 %
Mean	+ 1.5°C	+ 6.9%
High	+ 2.5°C	+ 14.4 %

2040s	Temperature	Precipitation
Low	+ 1.5°C	- 3.3 %
Mean	+ 2.3°C	+ 7%
High	+ 3.2°C	+ 13.7 %

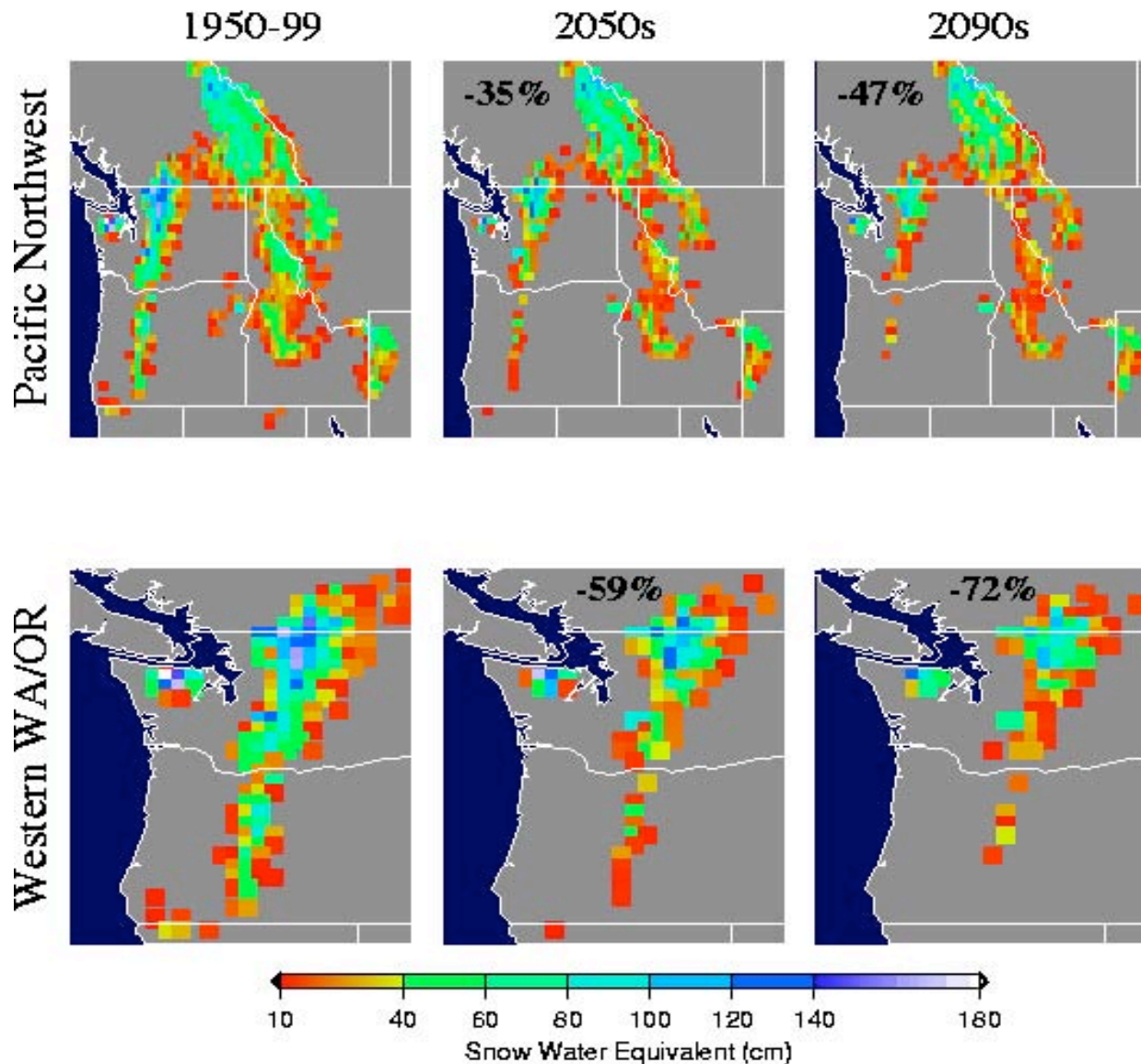
Based on an increase in equivalent CO₂ of 1% per year. Benchmarked to the decade of the 1990s.

Impacts on

- Water resources
- Salmon
- Forests
- Coasts
- Other

Main Impact: Less Snow

April 1 Snowpack Projections

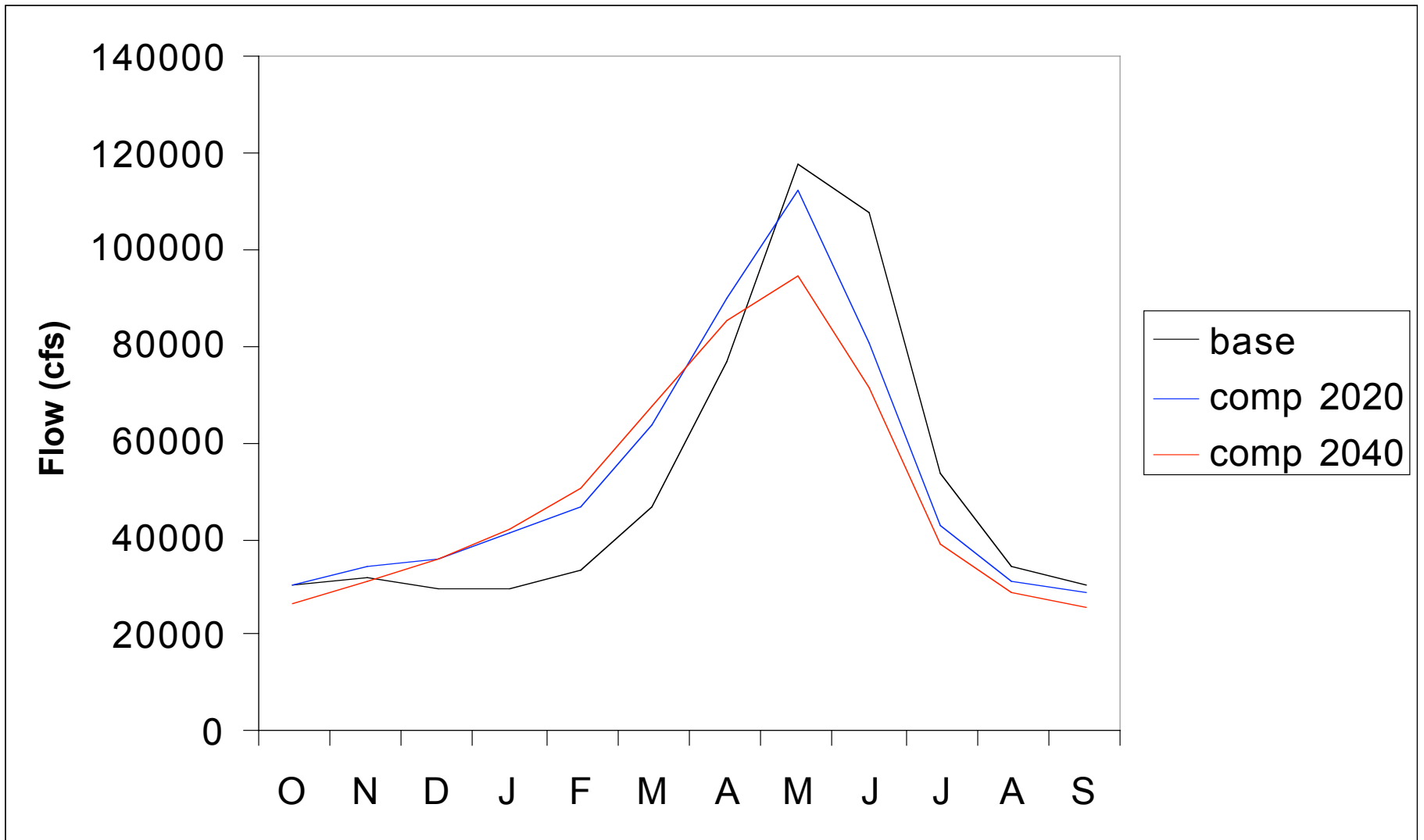


Less snow, earlier melt:

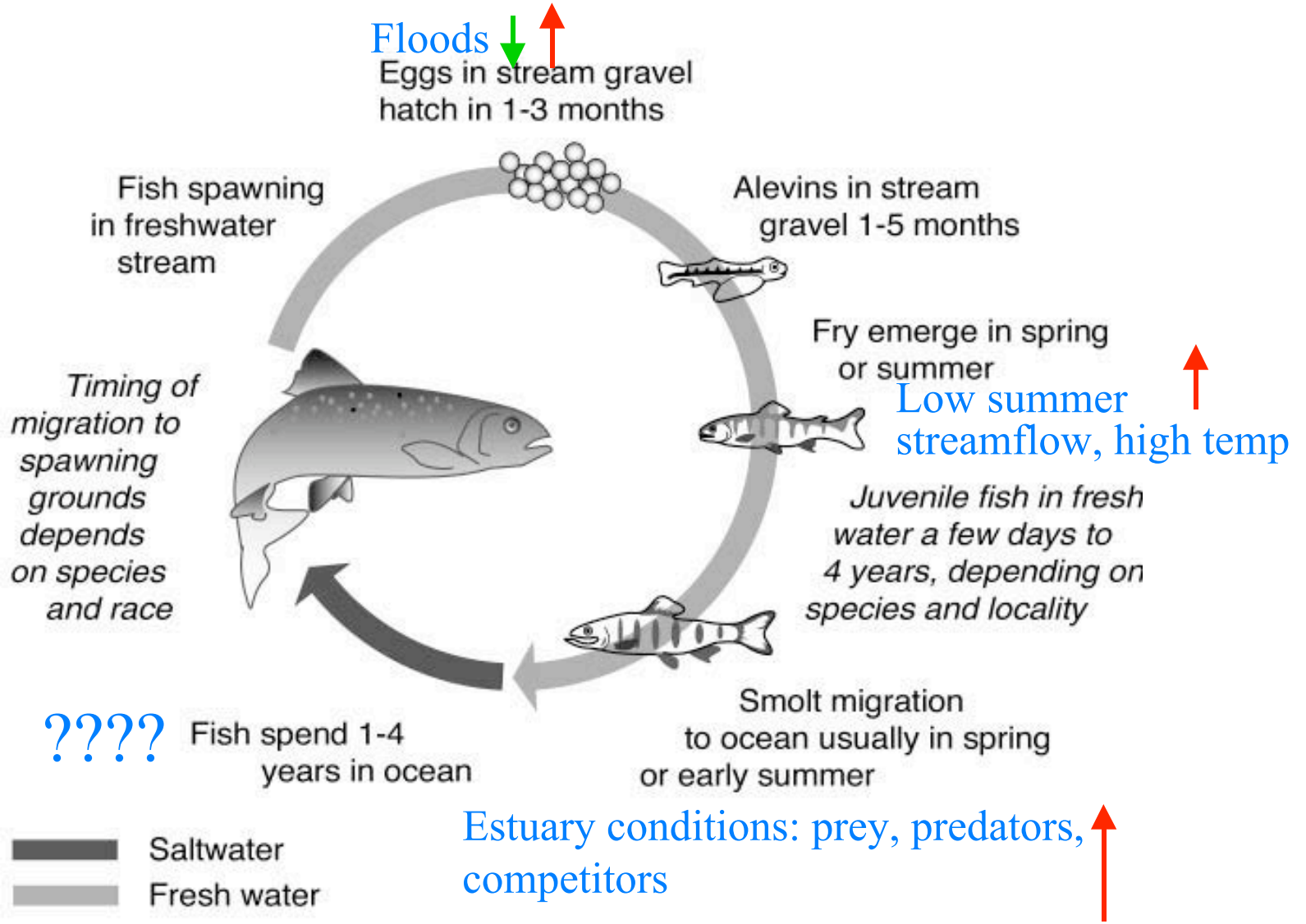
- ☁ More water in winter
- ☀ Less water in summer

April 1 Snow Extent for the Columbia River Basin

Snake River at Ice Harbor



Salmon Life Cycle and climate damage



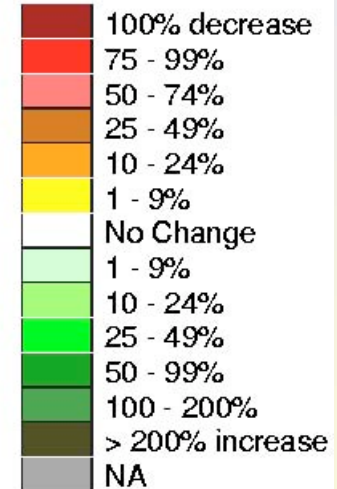
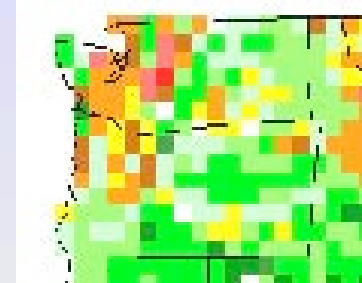
Forests

Vegetation carbon

Vegetation modeling for 2070-2100 including effects of changes in

- temperature
- precipitation (seasonality?)
- CO₂ (uncertain)

Longer, hotter summers likely to take a toll on Northwest forests even with CO₂ fertilization



Courtesy Ron Neilson, USFS/OSU



Cayuse Pass, June 26 2003

Projected Impacts on Coasts

- **Sea level rise**
 - accelerate erosion of various landforms
 - salt water intrusion in freshwater aquifers
 - shrink wetlands
 - beach loss
- **Changing wave climate**
 - redistributing sand
 - accelerating erosion
- **Increased winter rainfall**
 - landslides in loose soil



Other

- Human health:
 - heat/cold??
 - respiratory ailments (ozone)
 - vector-borne diseases?
 - water quality?
- Agriculture:
 - highly adaptable
 - some crops will do worse, others better
 - availability of irrigation water
 - competition from other regions & countries

Conclusions

- Regional climate change will take many forms, most of which we cannot predict
- Warming is virtually certain and has profound impacts: loss of snowpack, reduction in summer water supply, hardships for salmon and forests
- Increases in precipitation have further impacts