

What's in store for Methow waters? ... Wetter, drier and hotter ...

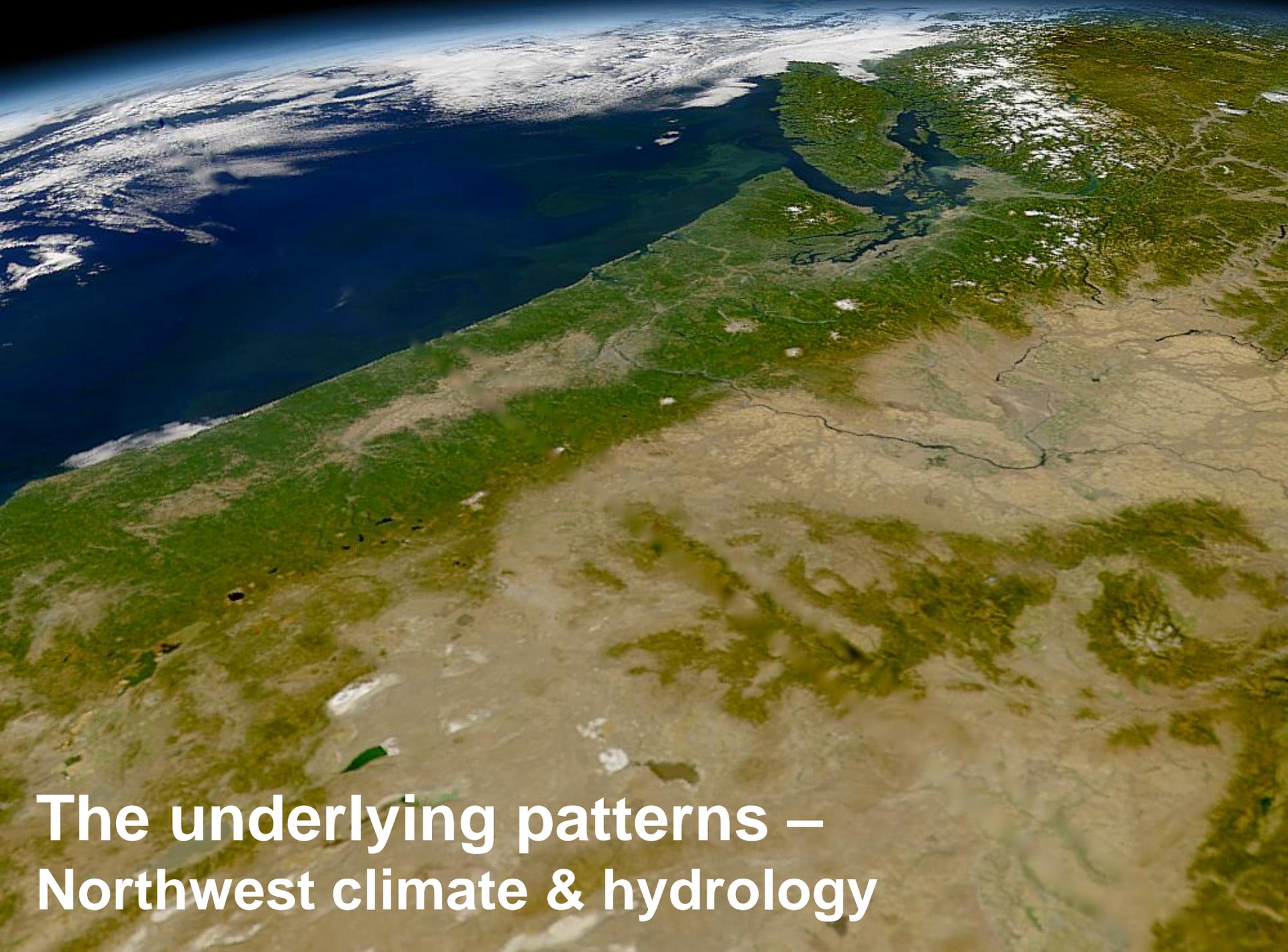




Linking science and decision making to build regional climate resilience since 1995.



W COLLEGE OF THE ENVIRONMENT
UNIVERSITY of WASHINGTON



**The underlying patterns –
Northwest climate & hydrology**



Climate Impacts Group



Linda Brubaker, Chris Earle (UW)



Climate Impacts Group



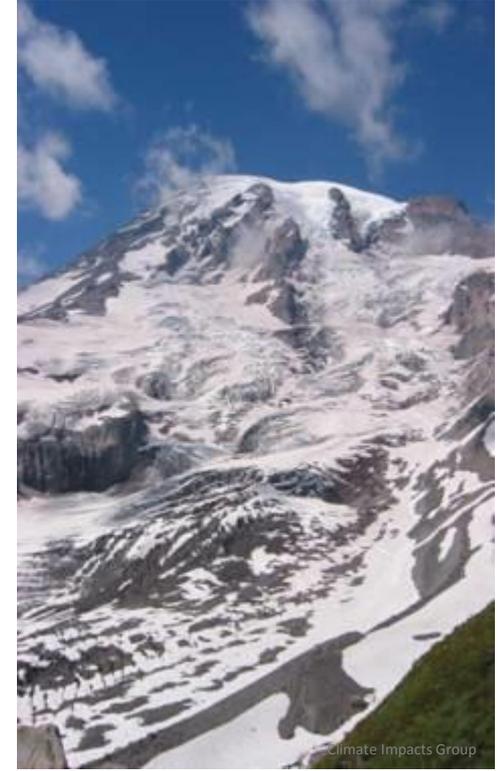
Climate Impacts Group



Climate Impacts Group



<http://www.yakima.net/>



Climate Impacts Group



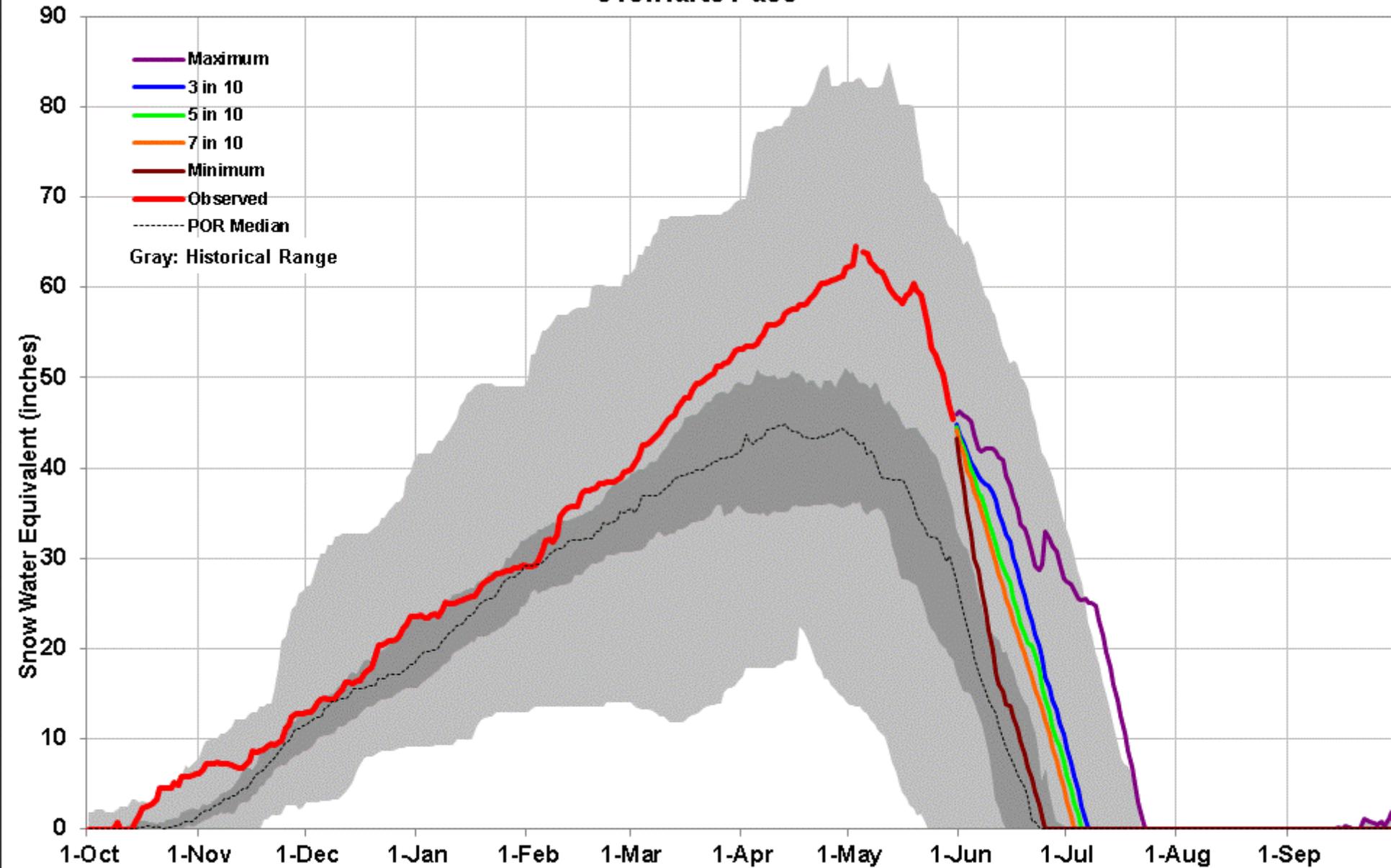
NO
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NEXT
1 1/2 MILES



515:Harts Pass

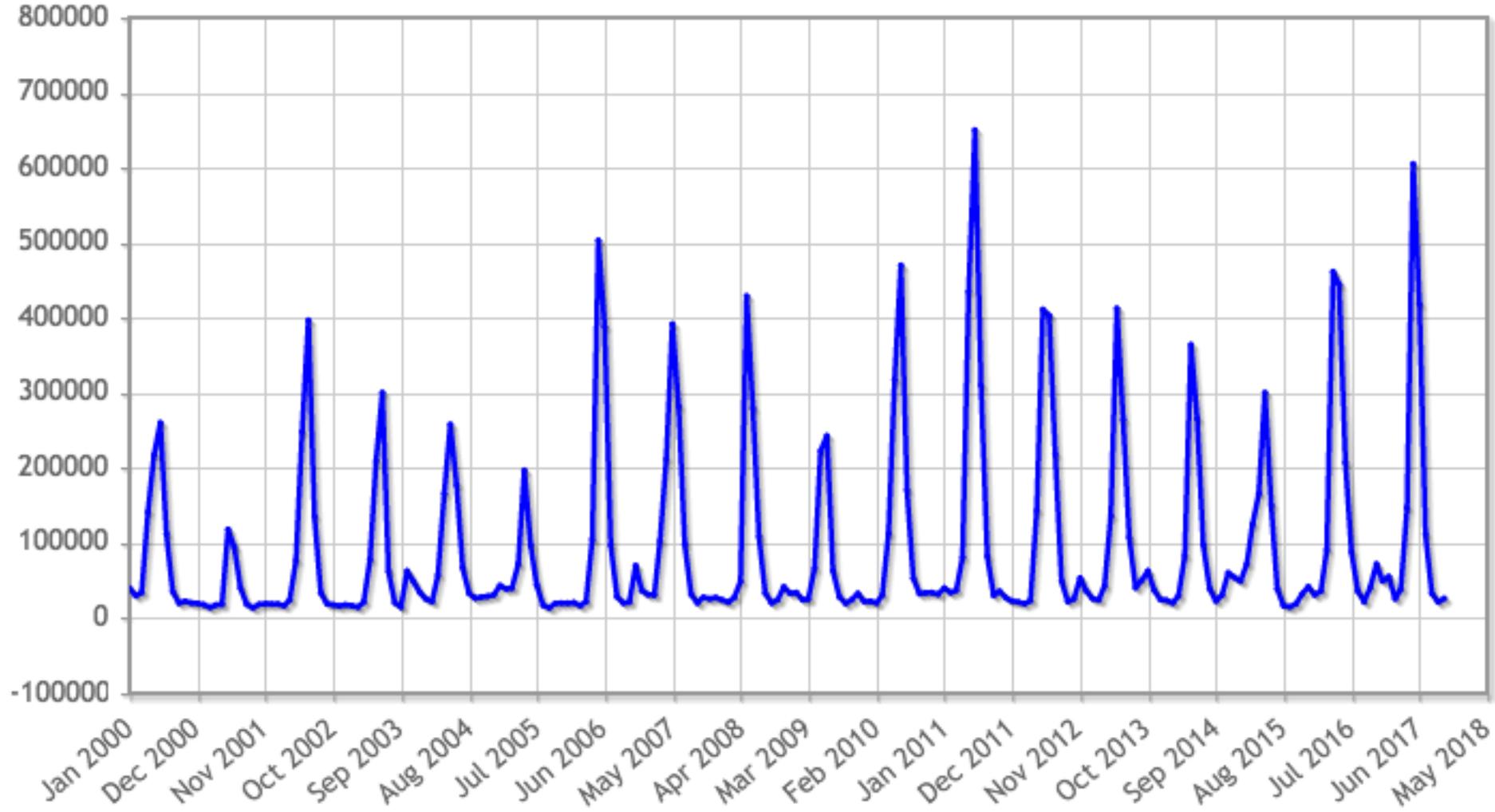
Created: 11:31 AM May 30, 2017



This is an automated product based on SNOTEL data, provisional data are subject to change. This product combines the historical period of record data (gray background) with the recent daily data (heavy red, left) to project into the future (colored lines, right). This product does not consider climate information such as El Nino or short range weather forecasts and therefore should only be used as a seasonal planning tool. Contact Jim.Marron@por.usda.gov 503 414 3047

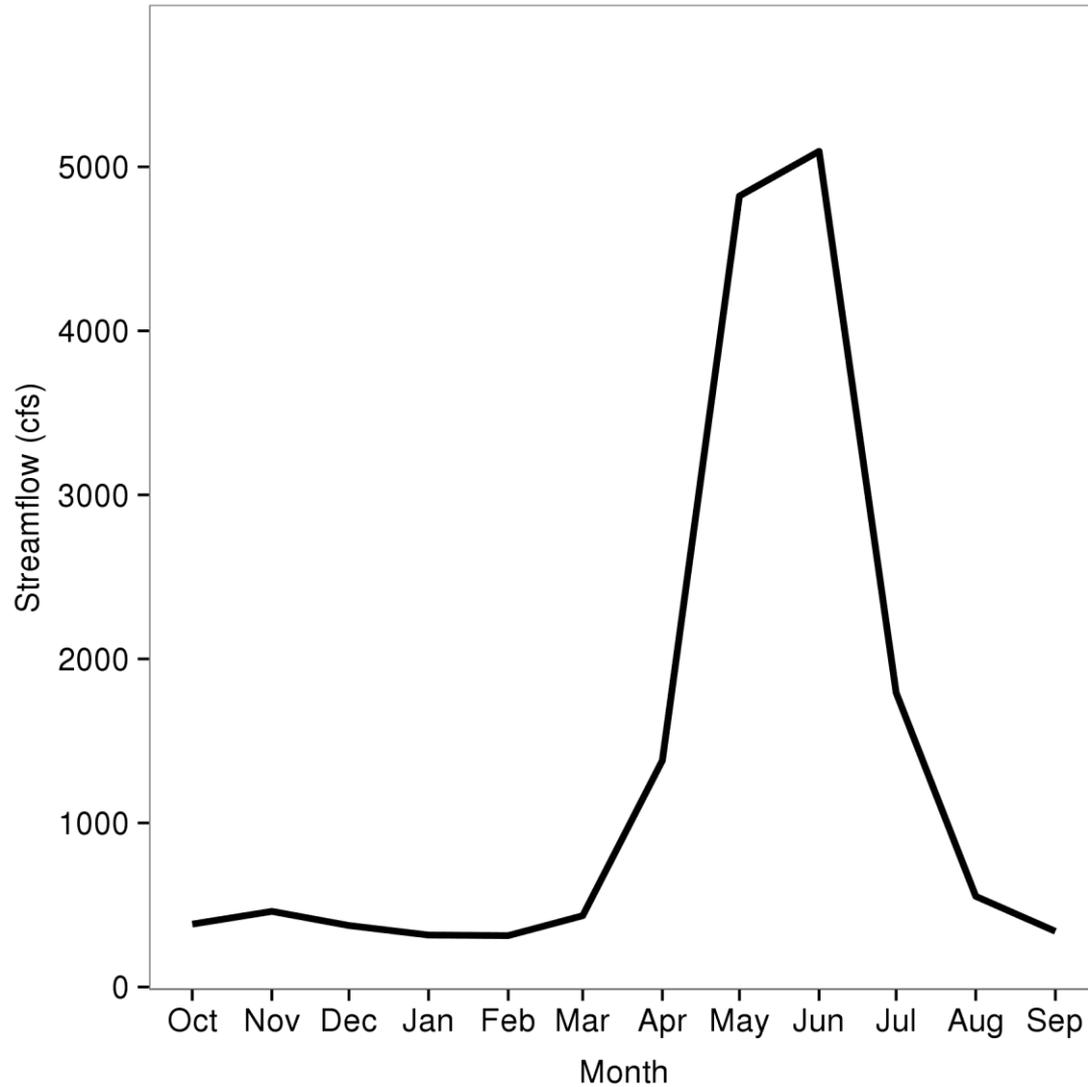
https://www.wcc.nrcs.usda.gov/ftpref/data/water/wcs/snow_proj/Chart515_s.gif

Methow R Nr Pateros (12449950) Washington STREAMFLOW Site - 900 ft
Reporting Frequency: Monthly; Date Range: Jan 2000 to Nov 2017



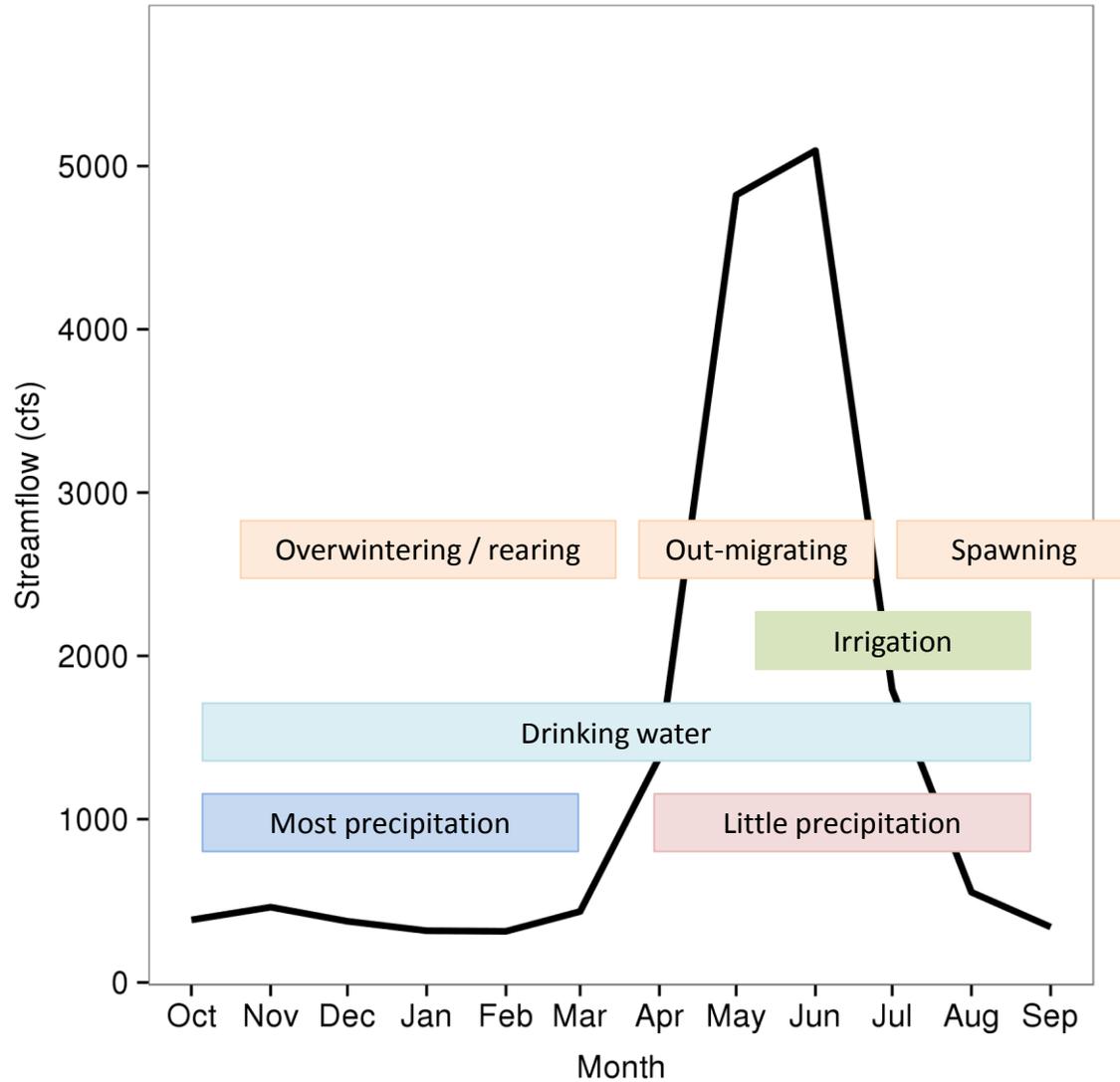


Historical flows: Methow R @ Twisp





Many uses of NW rivers

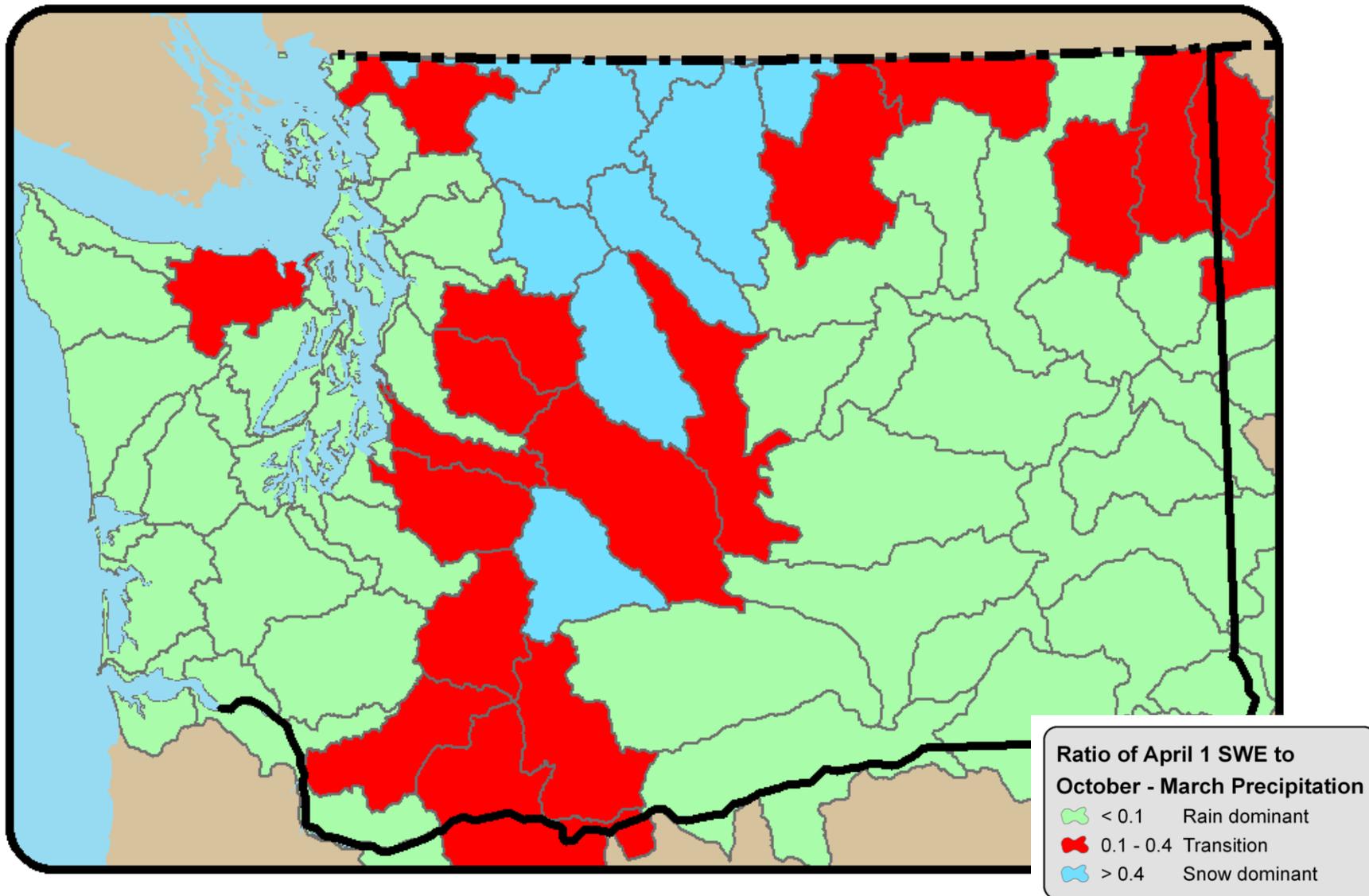




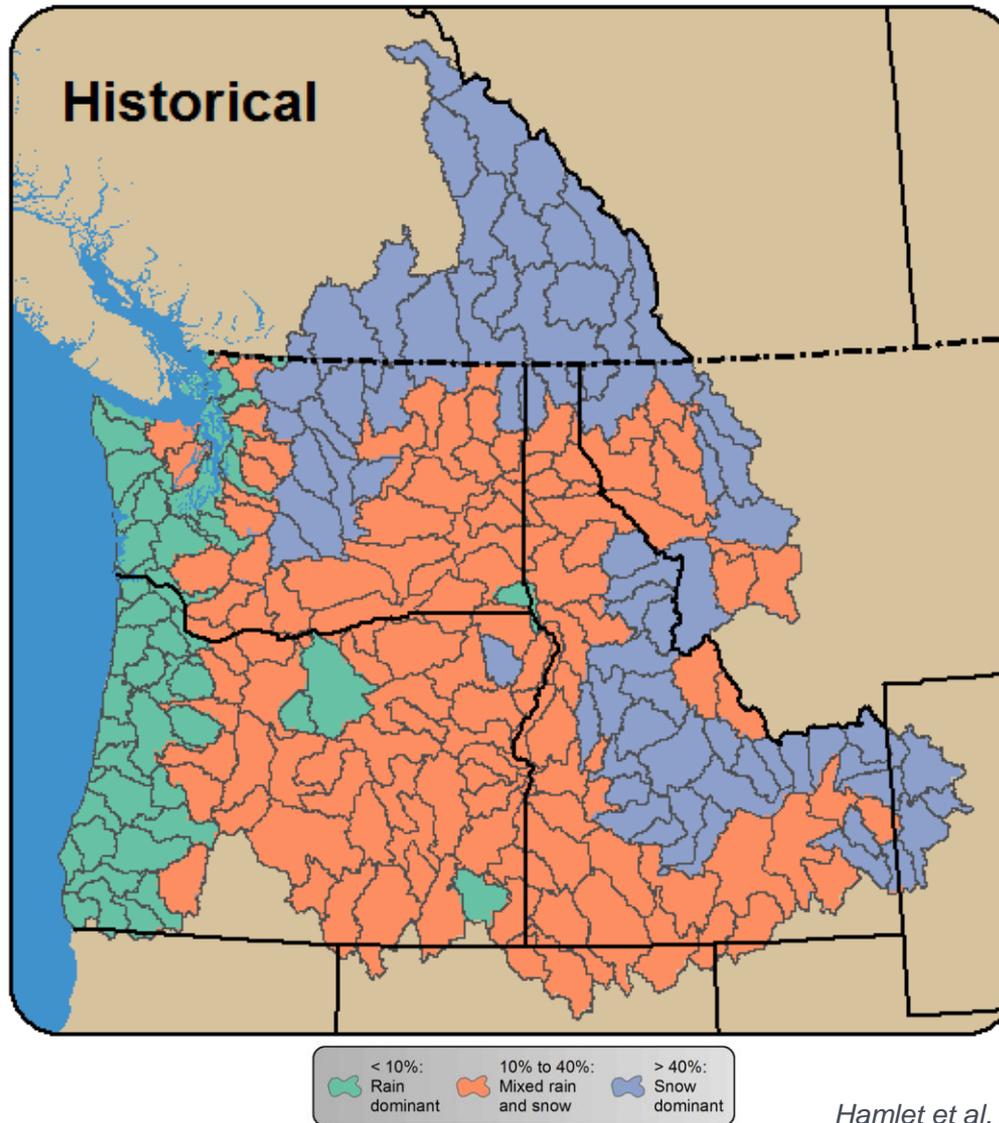
Broader context



The broader context: WA watersheds



The broader context: NW watersheds







Human activities have changed the atmosphere ...





... in ways that have committed the climate and local environmental conditions to centuries of change.



Observed changes in PNW climate

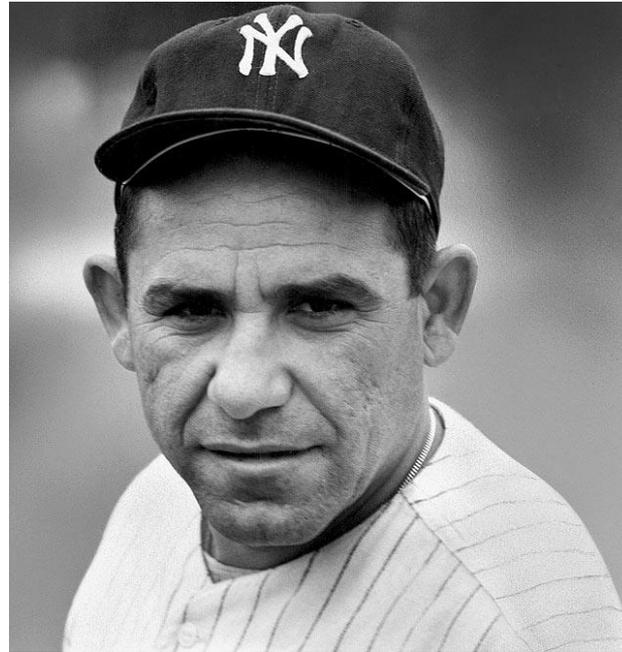
Warming. Washington and the Pacific Northwest have experienced long-term warming (+1.3F, 1885-2011), a lengthening of the frost-free season, and more frequent nighttime heat waves.

Hydrologic change. Long-term reductions in snow and ice, and shifts in streamflows reflect the influence of warming.

Sea level change. Sea level is rising along some parts of the Washington coastline and falling in others.

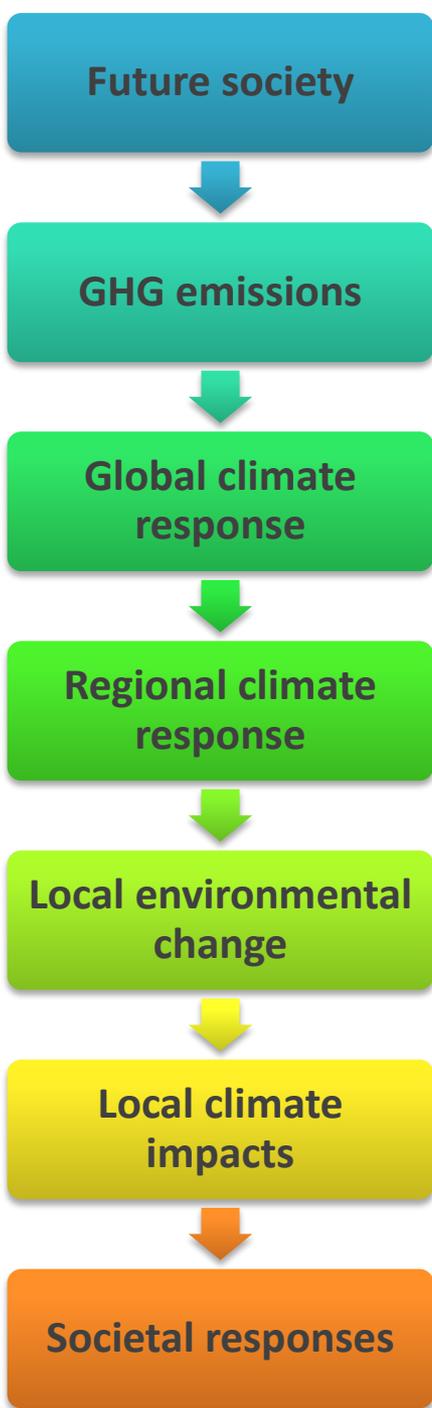
Ocean acidification. The coastal ocean is acidifying and some local inshore coastal waters are warming.

Attribution. PNW climate is changing in ways consistent with climate change projections, however natural variability continues to play a key role in observed trends.



If **“the future ain’t what it used to be”**,
what is it?





Future society



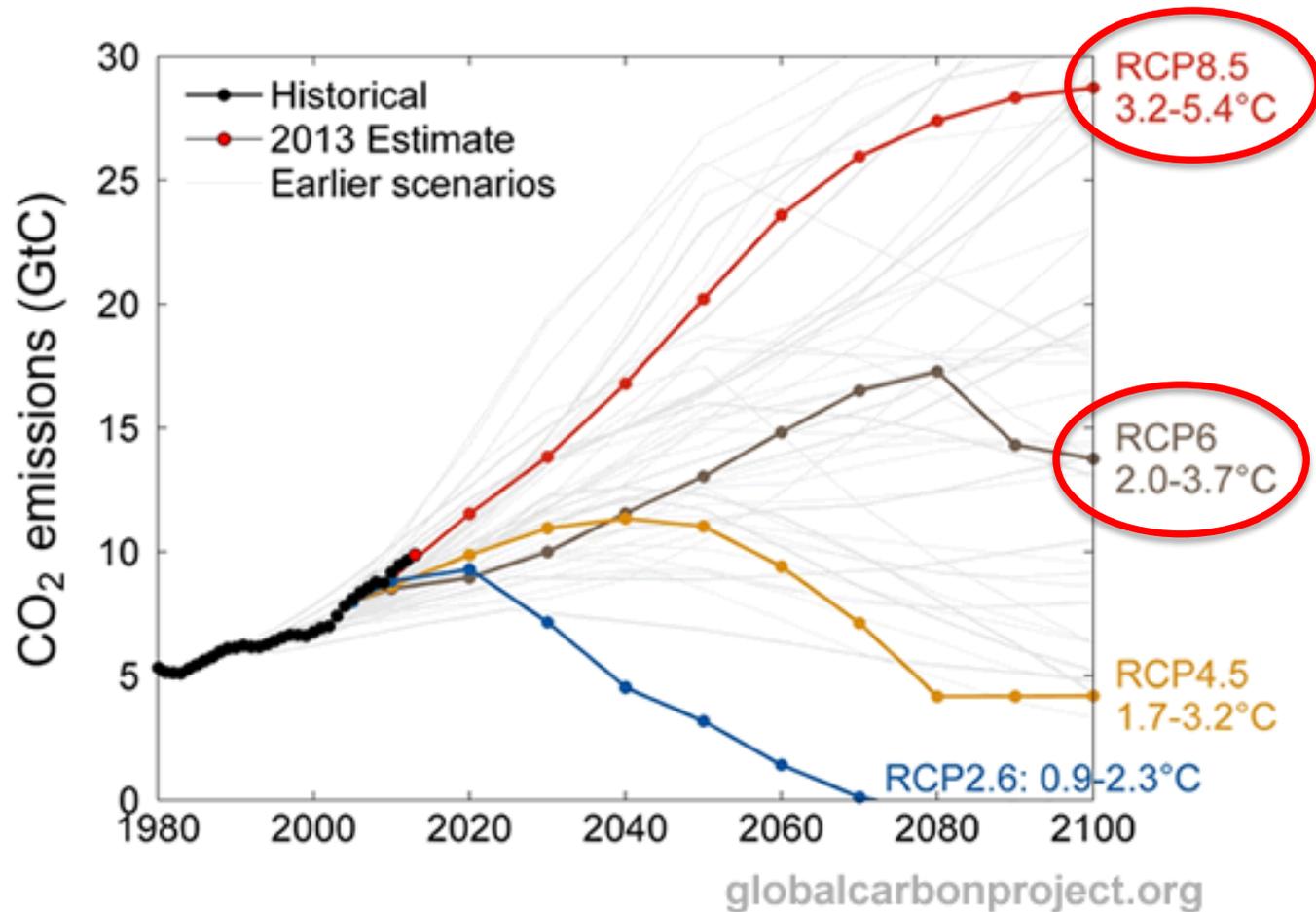
GHG emissions

Future society



GHG emissions

A range of societal pathways, from continued emissions to rapid reductions & drawdown

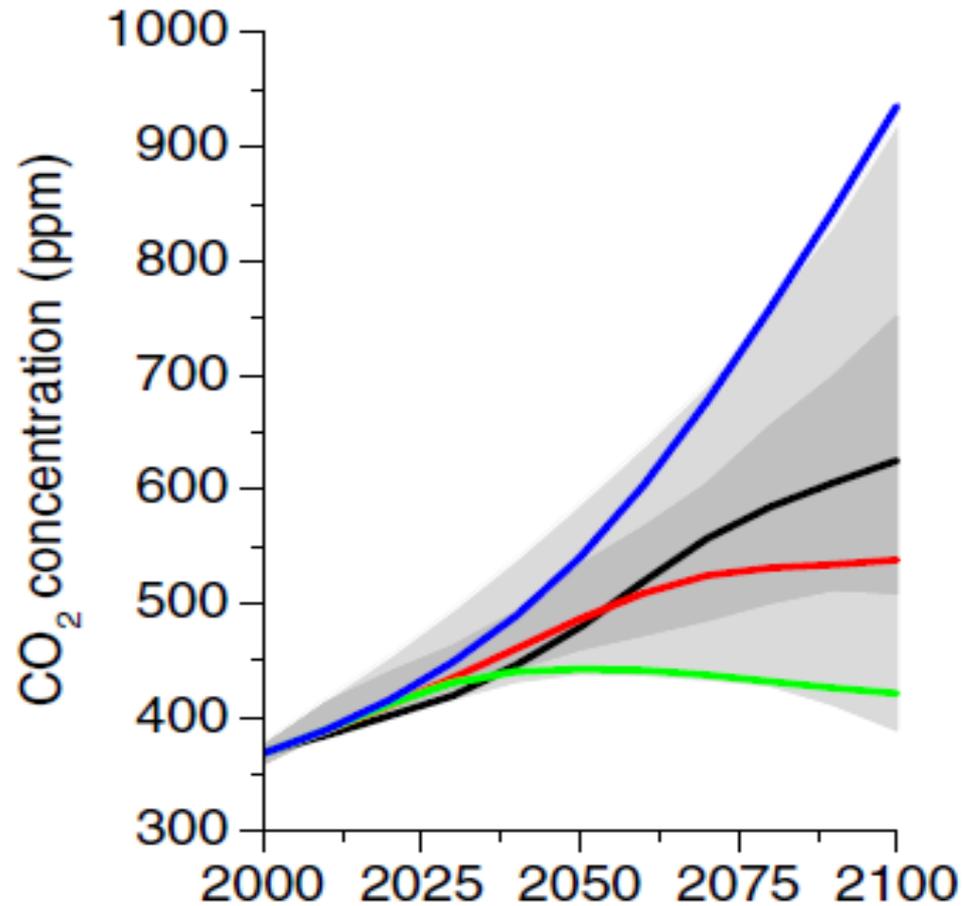


Future society



GHG emissions

... lead to different trajectories for future greenhouse gases in the atmosphere



Future society



GHG emissions



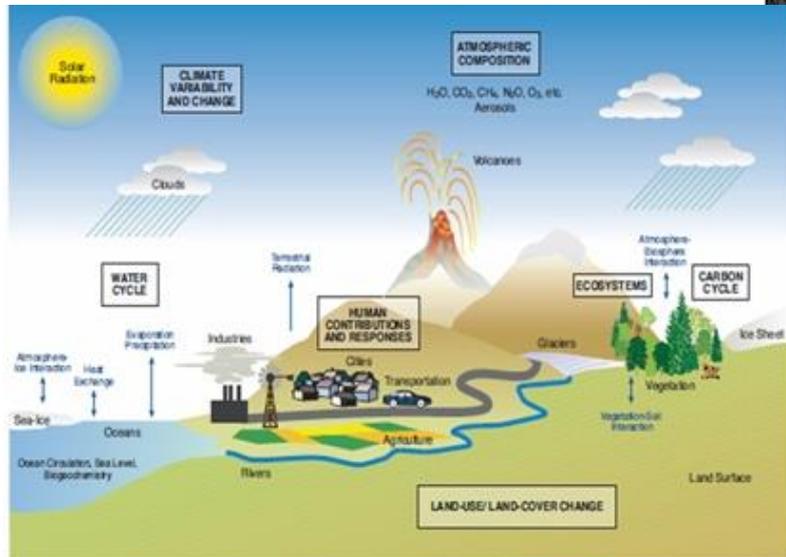
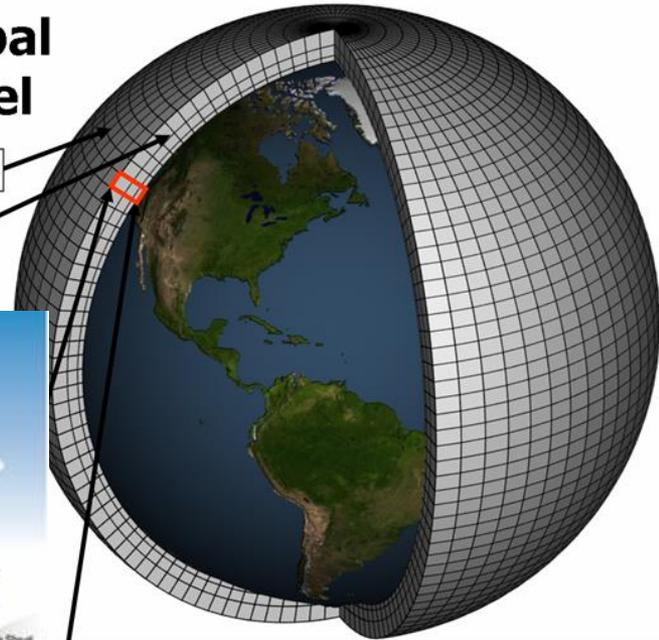
Global climate response

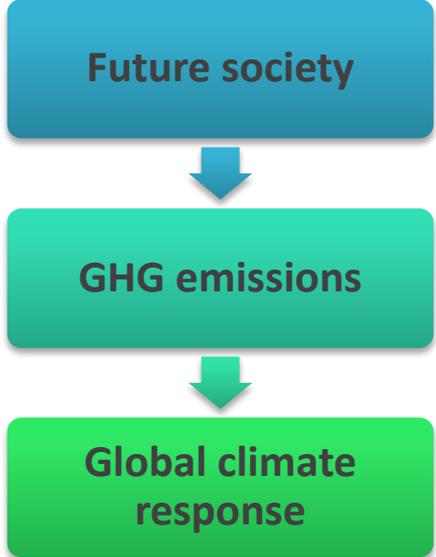
Global climate models simulate the response of the global climate to these changes in atmospheric composition

Schematic for Global Atmospheric Model

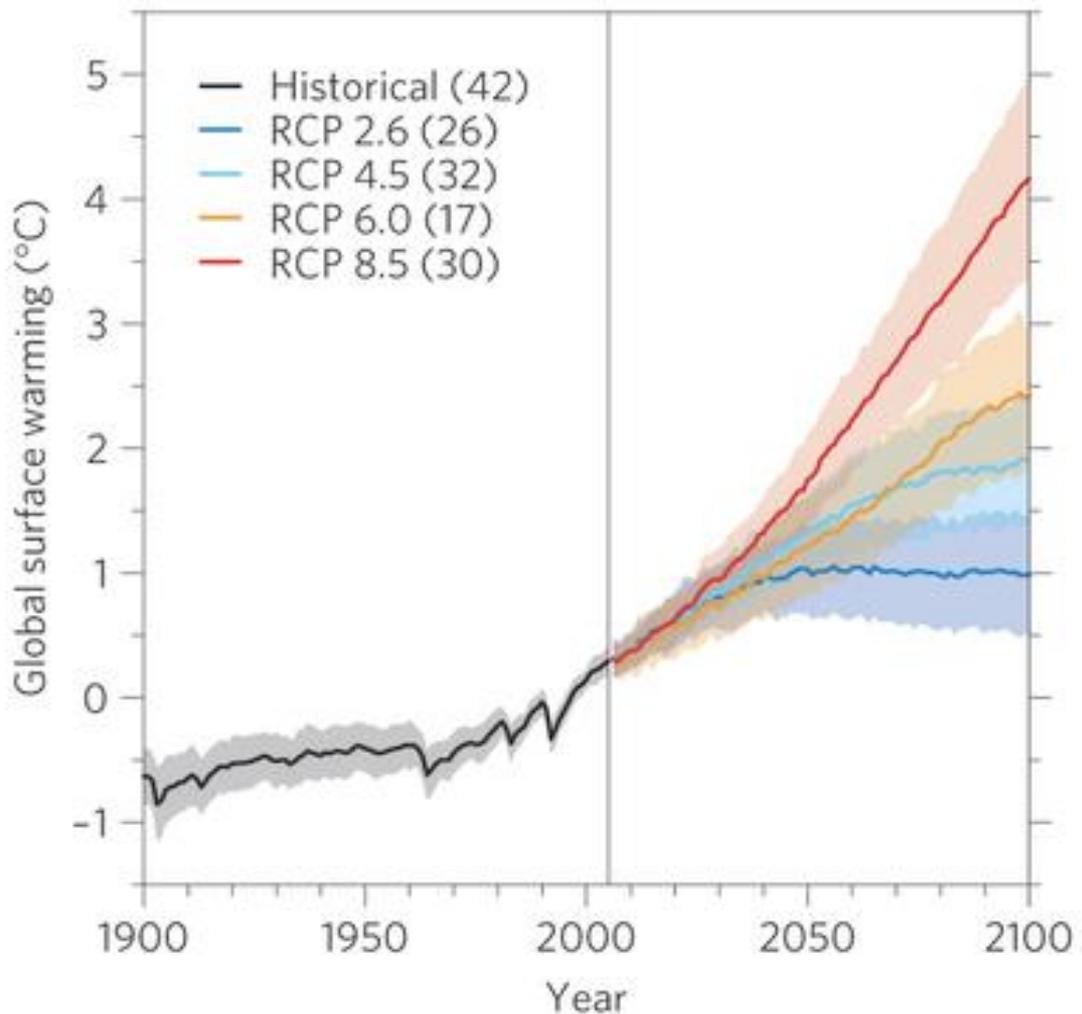
Horizontal Grid (Latitude-Longitude)

Vertical Grid (Height or Pressure)





All scenarios result in continued global warming

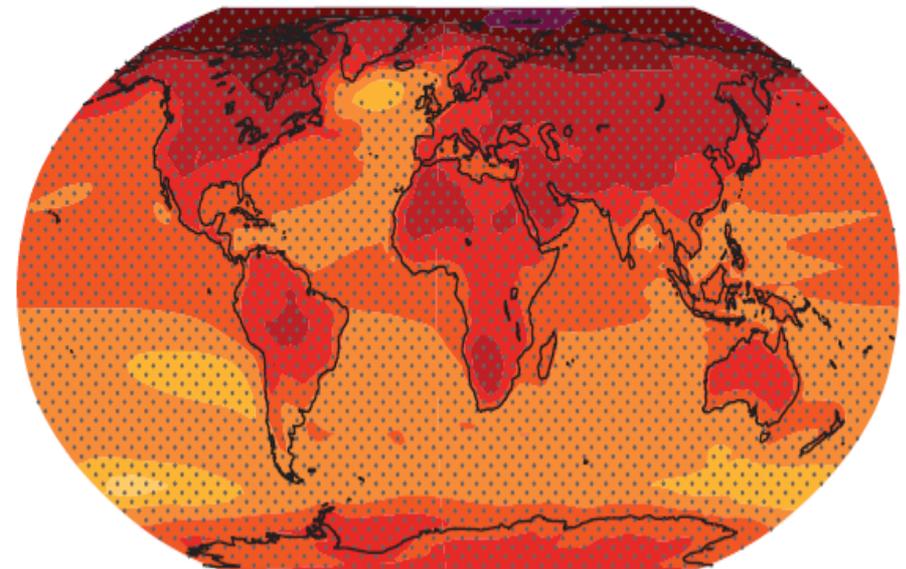
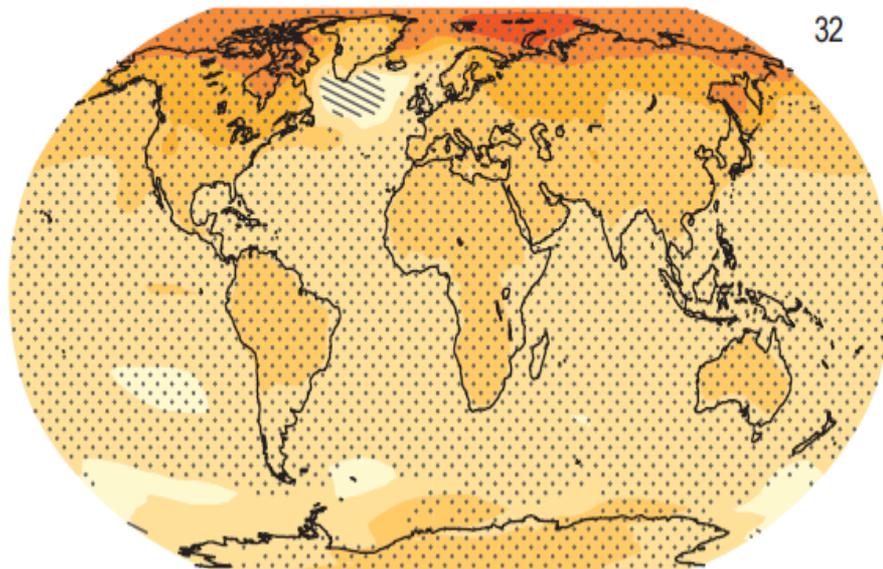


Which future? Average annual global temperature is projected to rise +2°F to +7°F by 2100

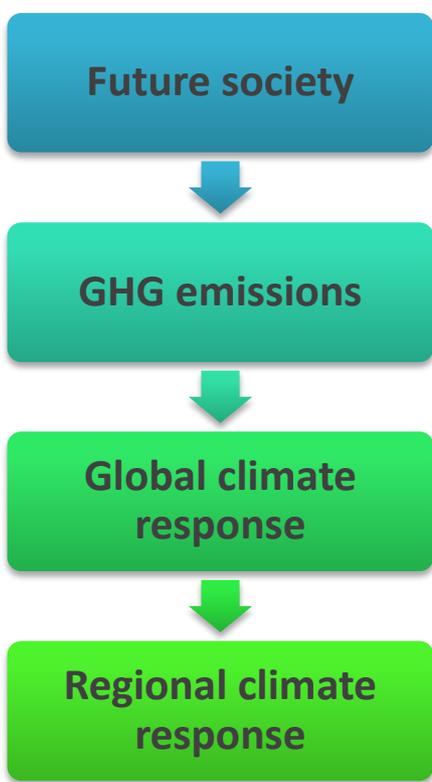
RCP 2.6 (Very low emissions)

RCP 8.5 (High emissions)

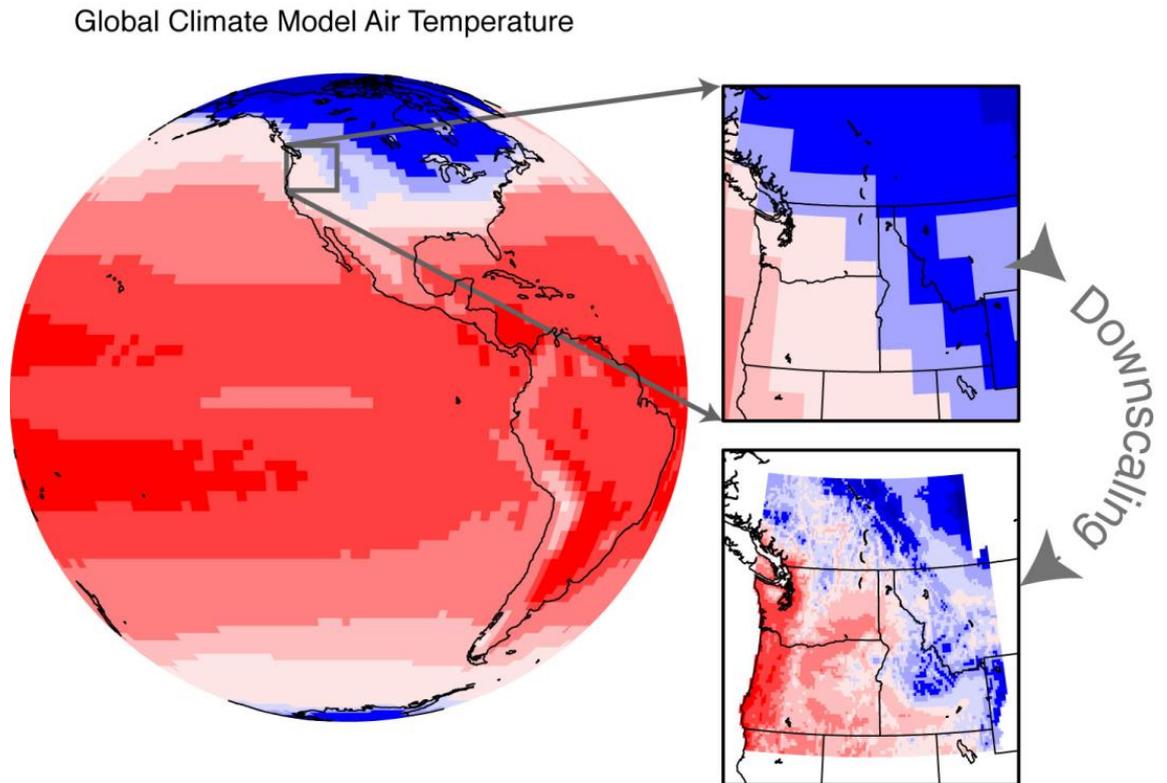
Change in average surface temperature (1986–2005 to 2081–2100)

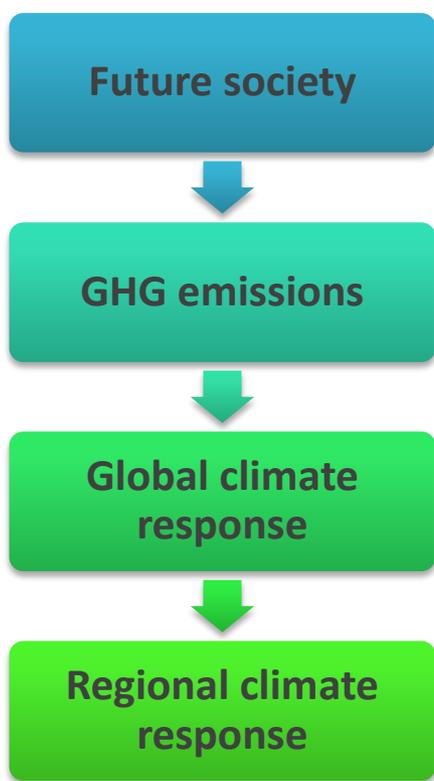


relative to 1986–2005

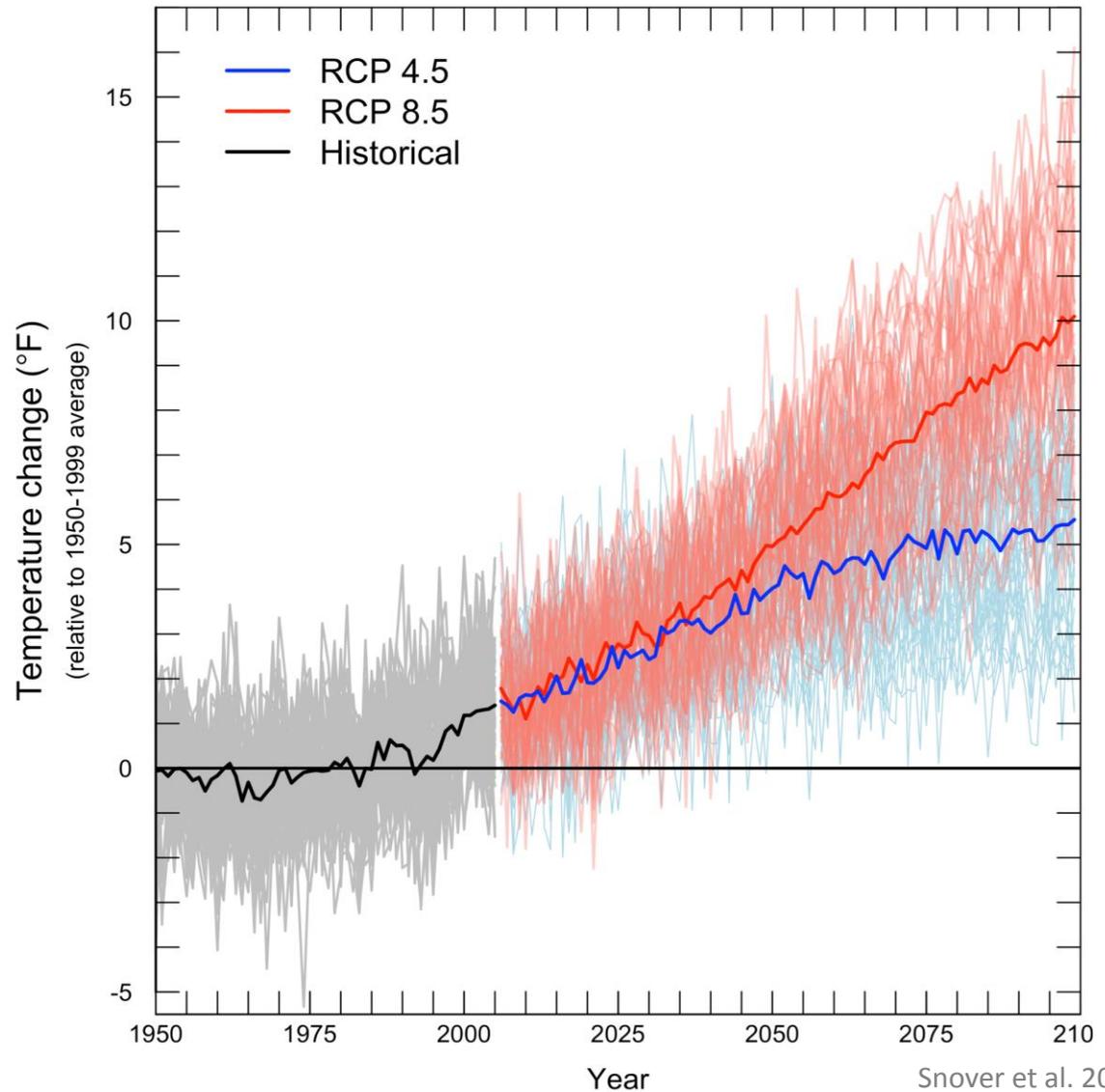


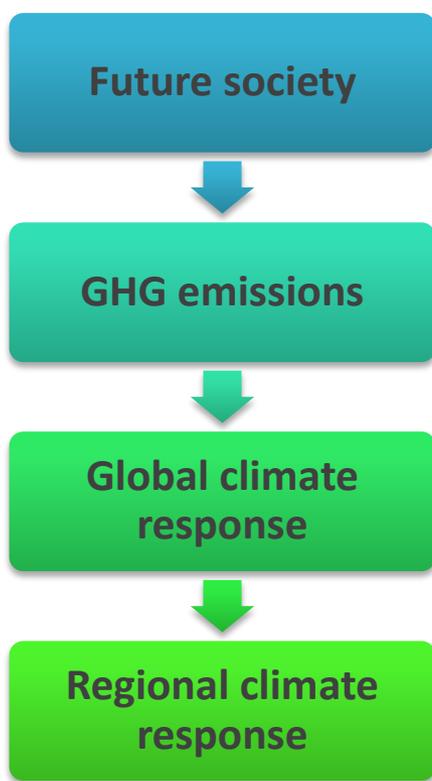
Global climate projections are “downscaled” to the Northwest using a variety of tools, including regional climate models





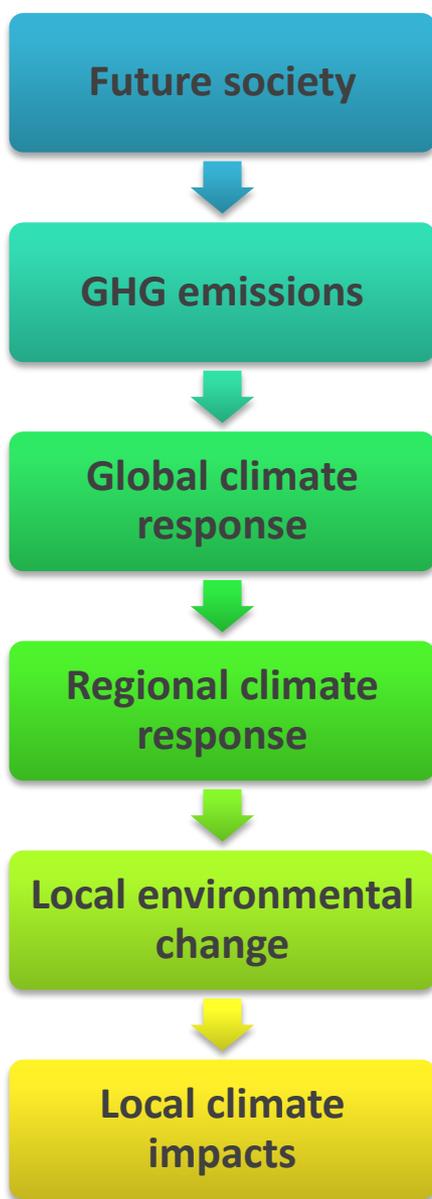
All scenarios result in continued Northwest warming





Global climate change will affect many important aspects of Northwest climate

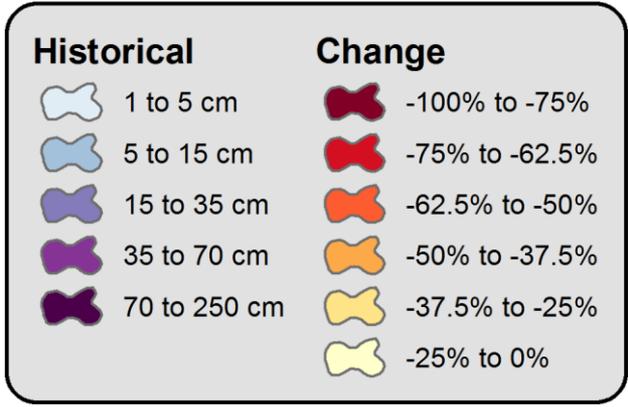
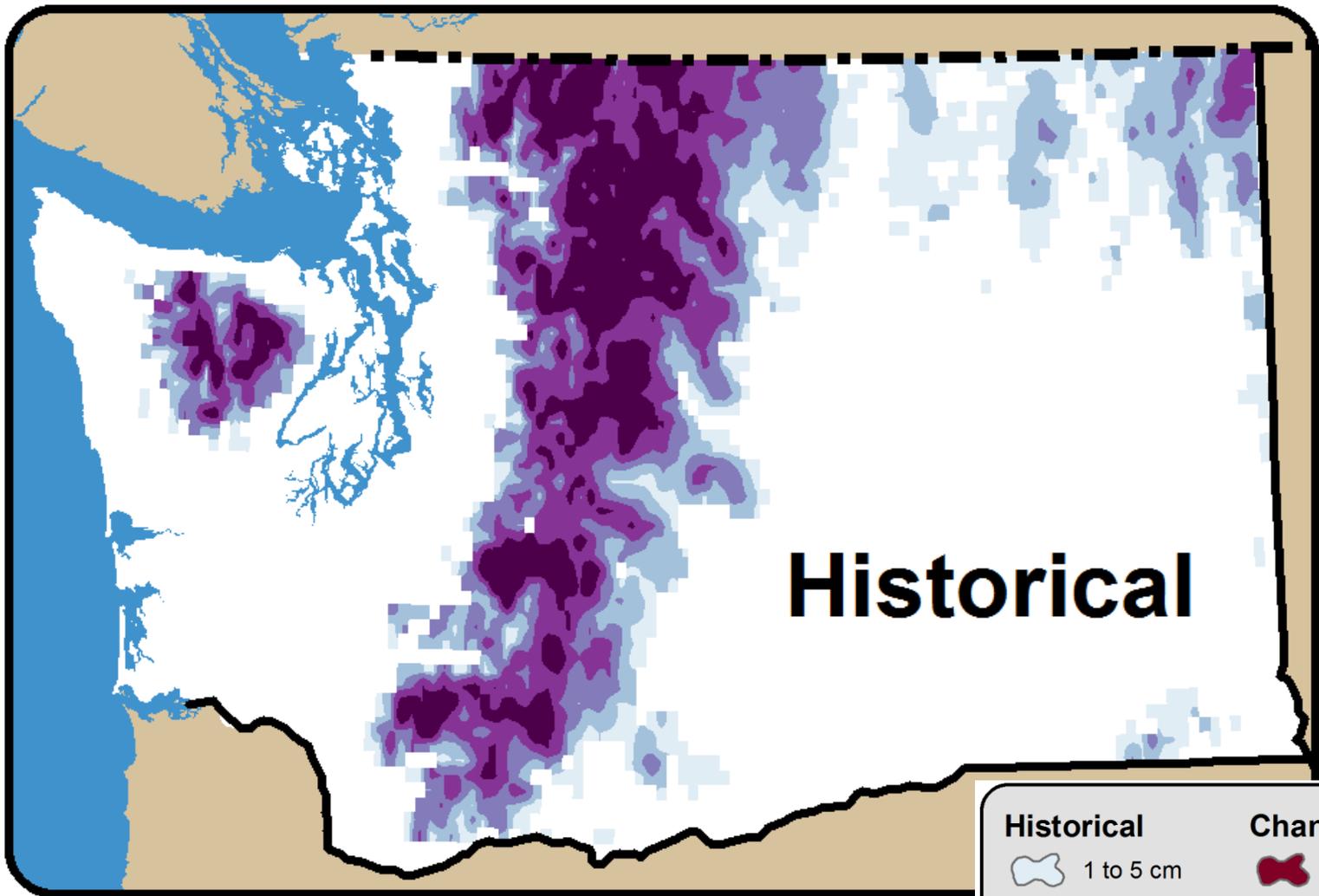
- Substantial warming
- Little change in annual precipitation
- Increasing heavy rainfall
- Sea level rise
- Ocean acidification
- Natural variability



Global and regional climate change will cause dramatic changes in Northwest watersheds

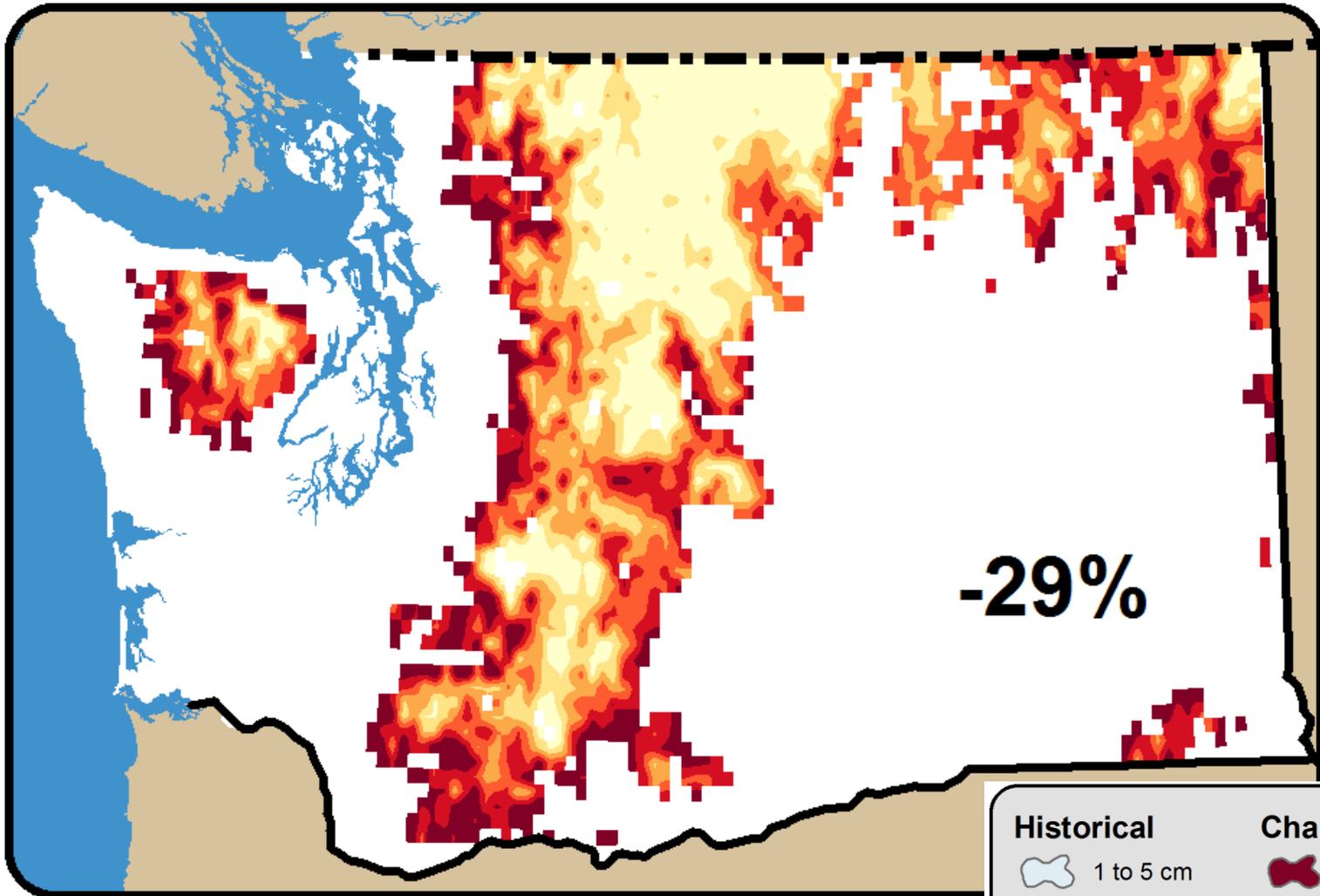
- **Snowpack**
- **Streamflow**
- **Fundamental hydrologic characteristics**
- **Stream temperature**
- **Watershed conditions**





April 1 Snow Water Equivalent

2020s



-29%

Historical

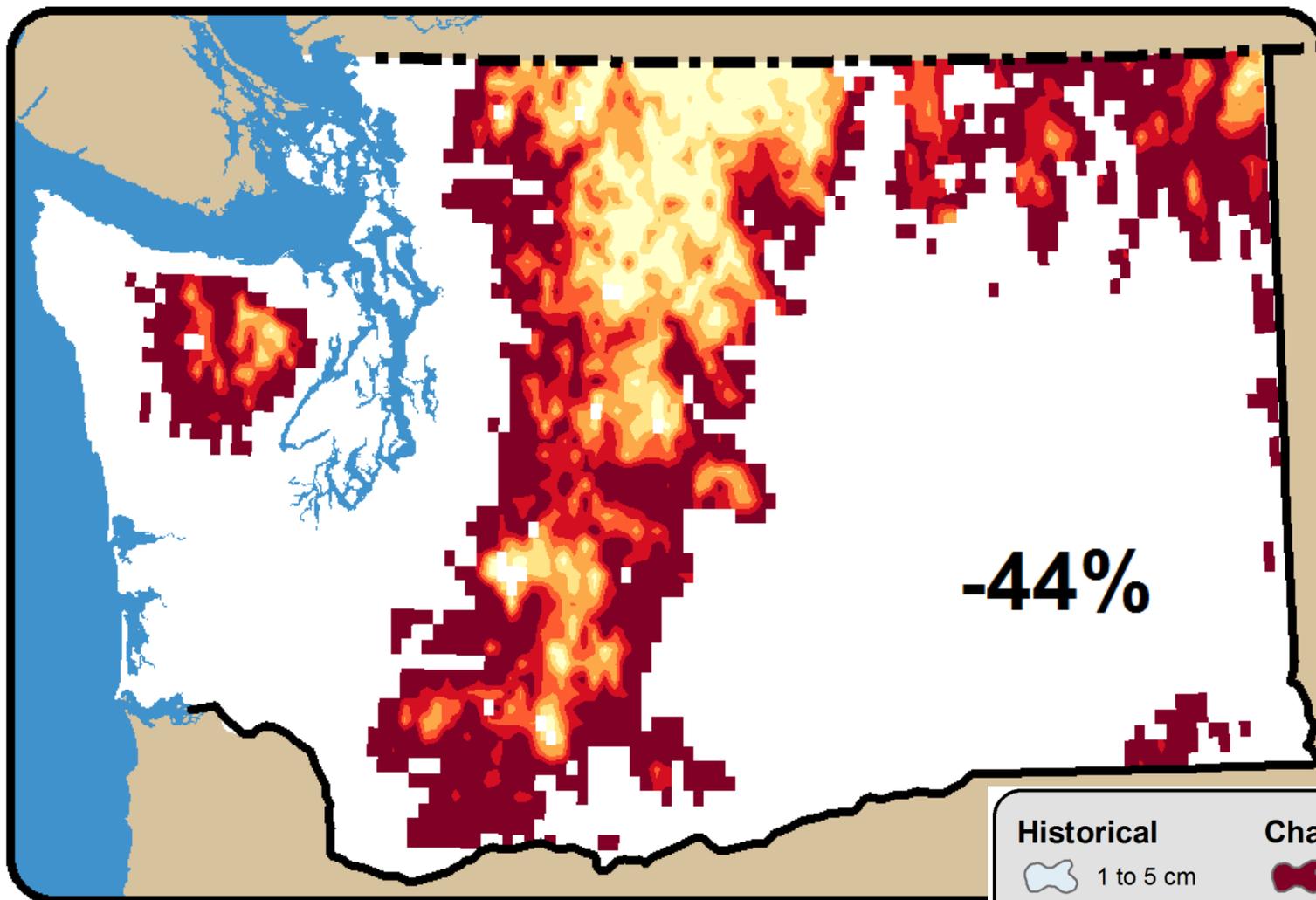
- 1 to 5 cm
- 5 to 15 cm
- 15 to 35 cm
- 35 to 70 cm
- 70 to 250 cm

Change

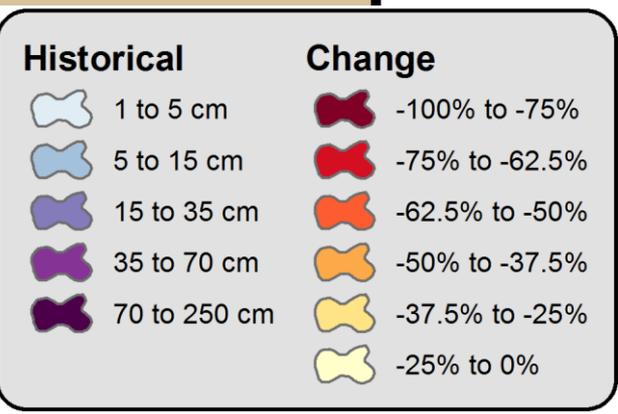
- 100% to -75%
- 75% to -62.5%
- 62.5% to -50%
- 50% to -37.5%
- 37.5% to -25%
- 25% to 0%

April 1 Snow Water Equivalent

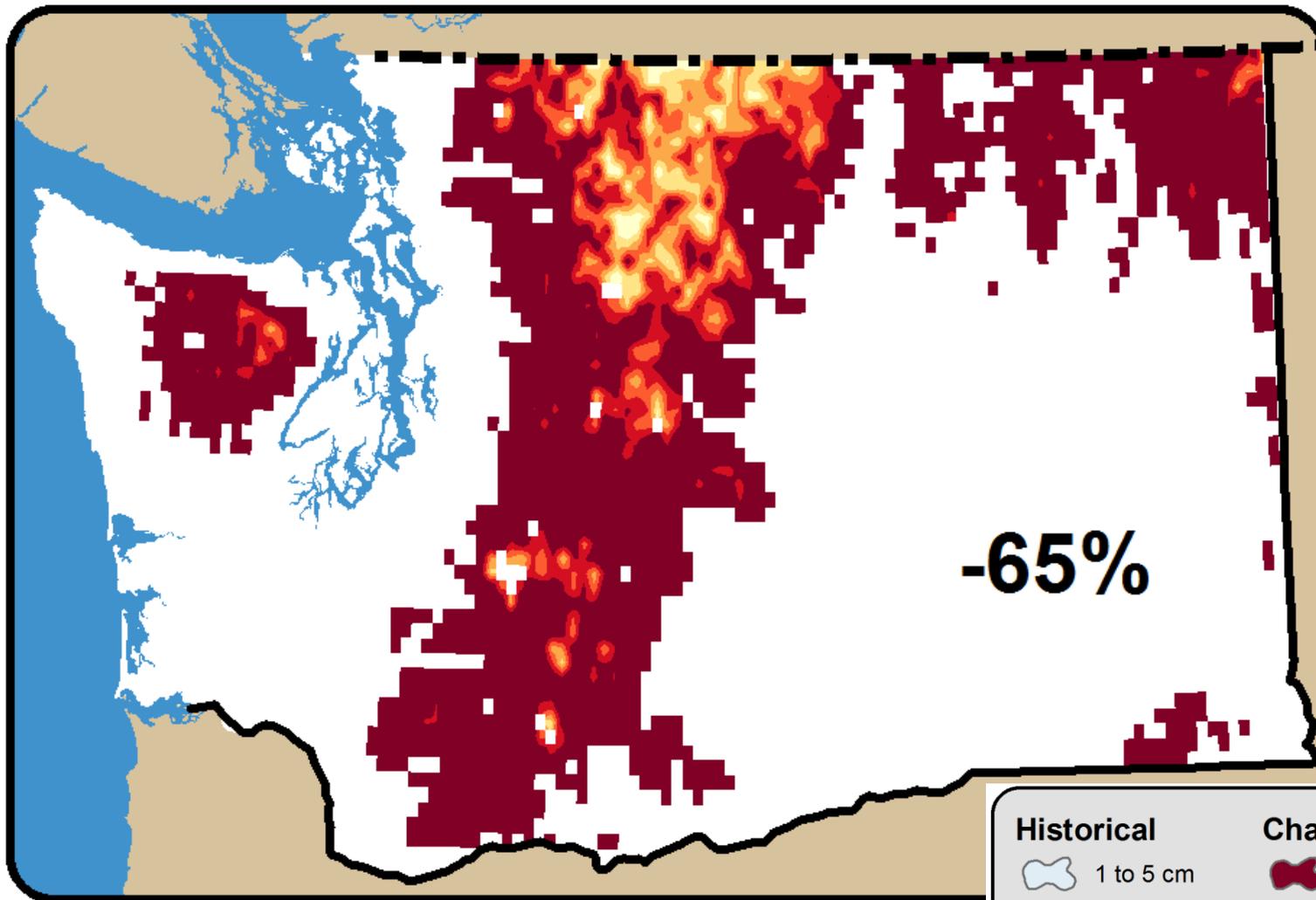
2040s



April 1 Snow Water Equivalent



2080s



-65%

April 1 Snow Water Equivalent

Historical

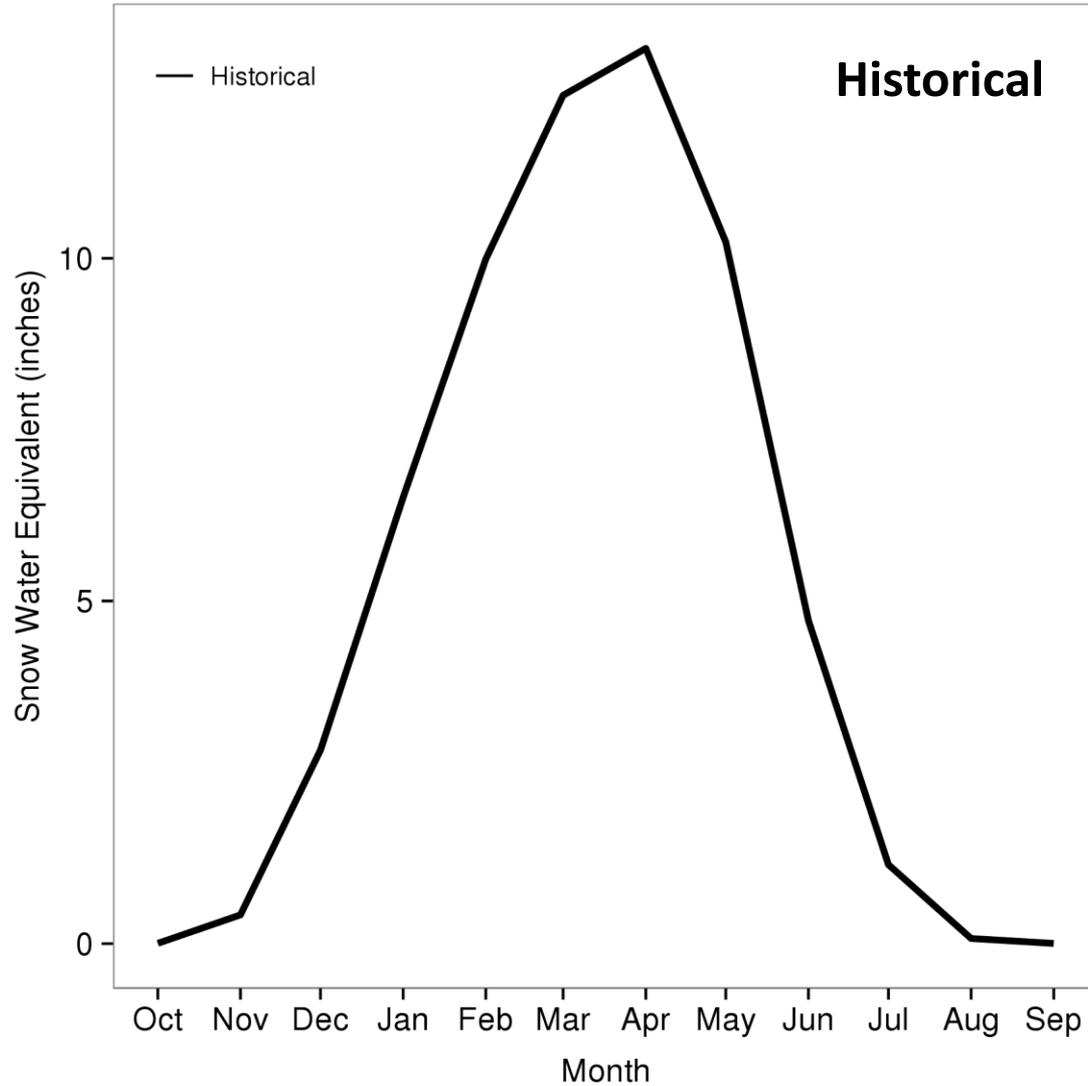
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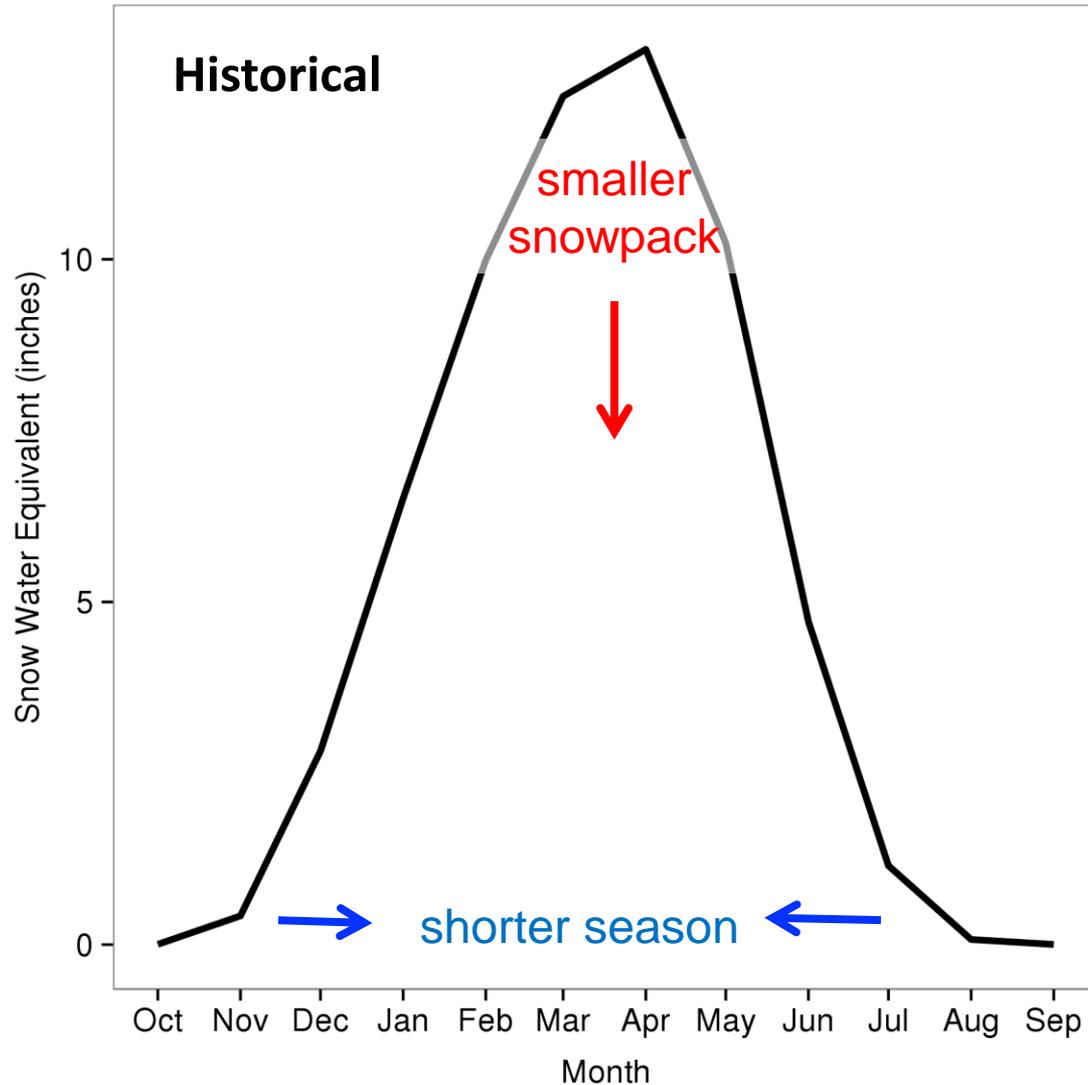


Historical Snowpack: Methow basin



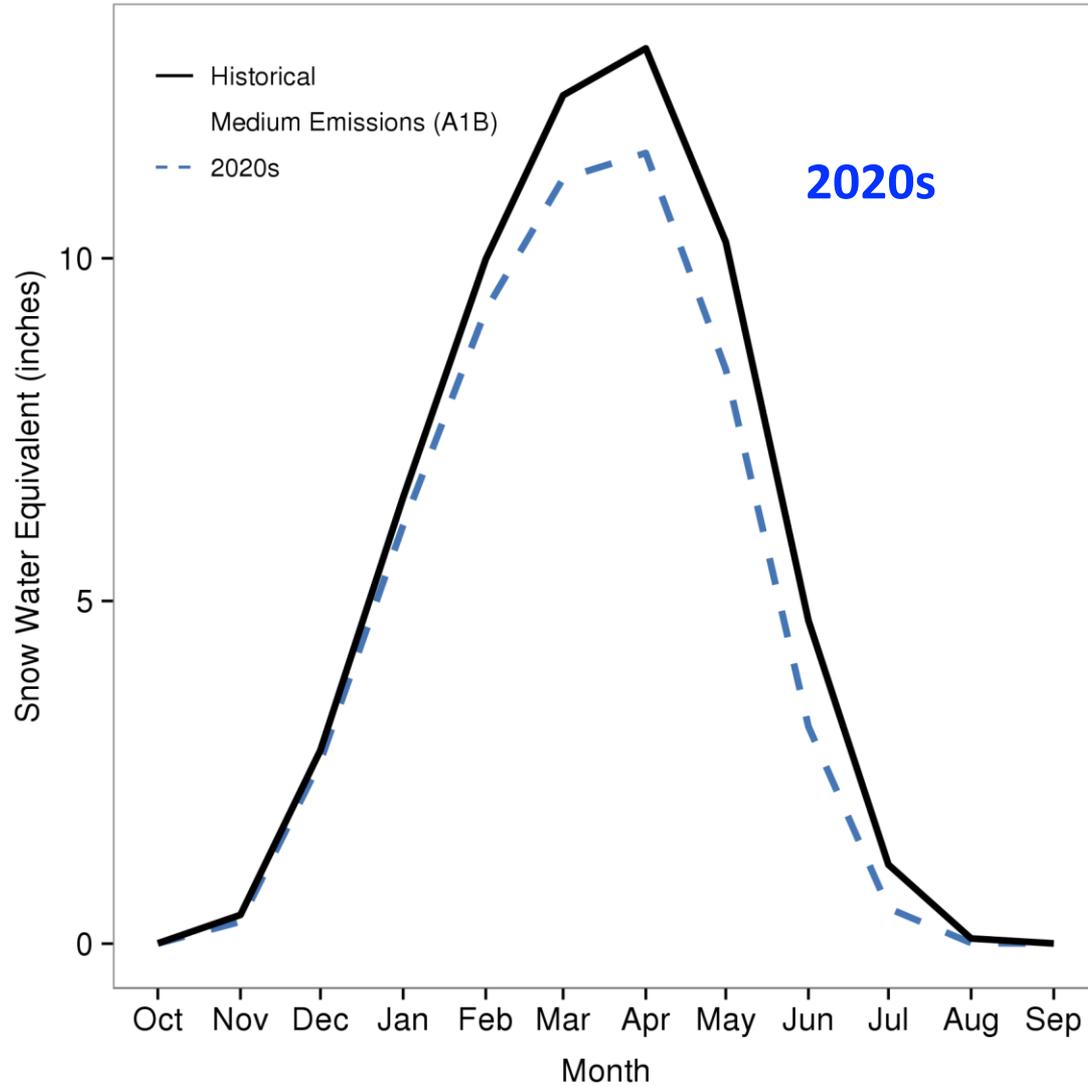


Climate change decreases snowpack



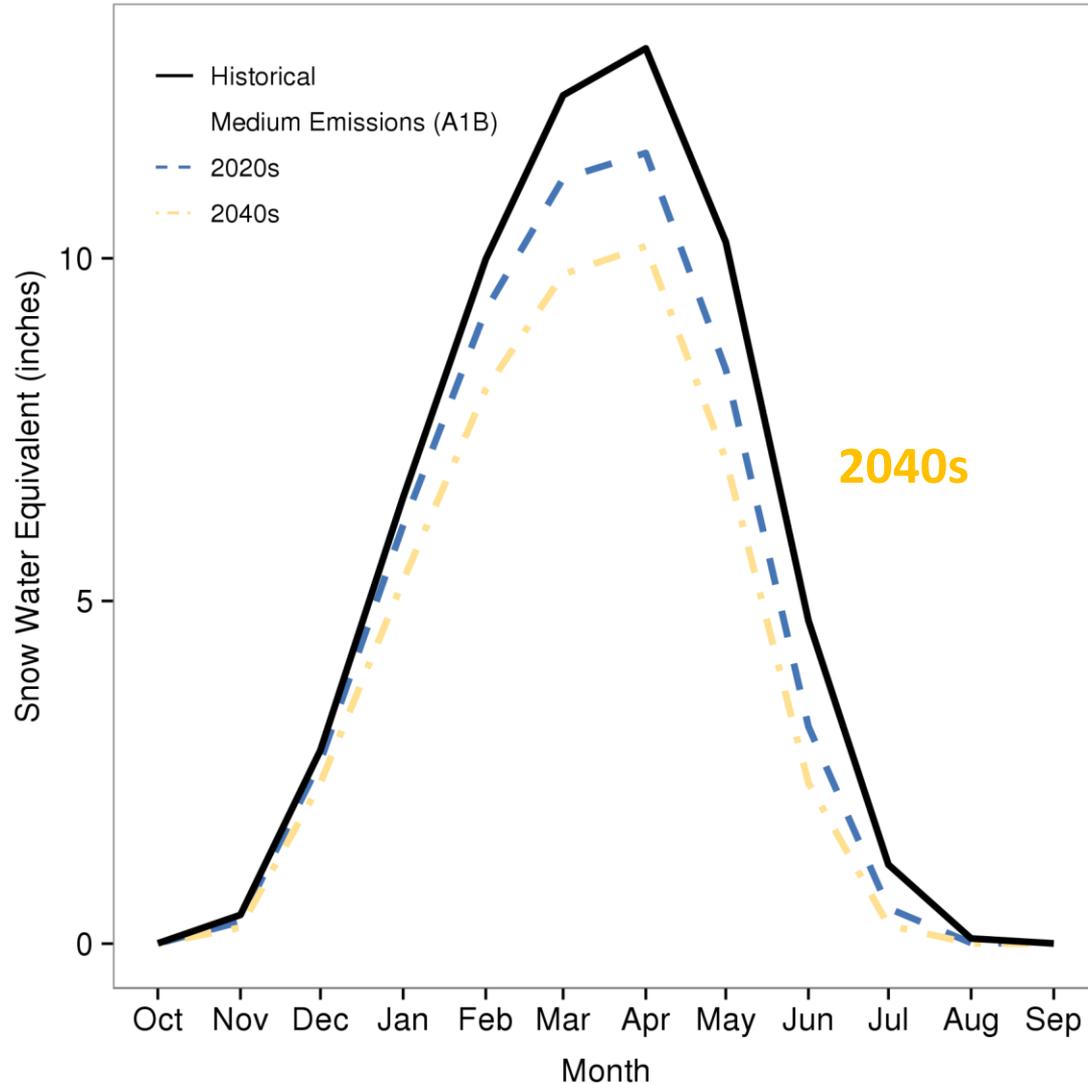


Decreasing snowpack: Methow basin



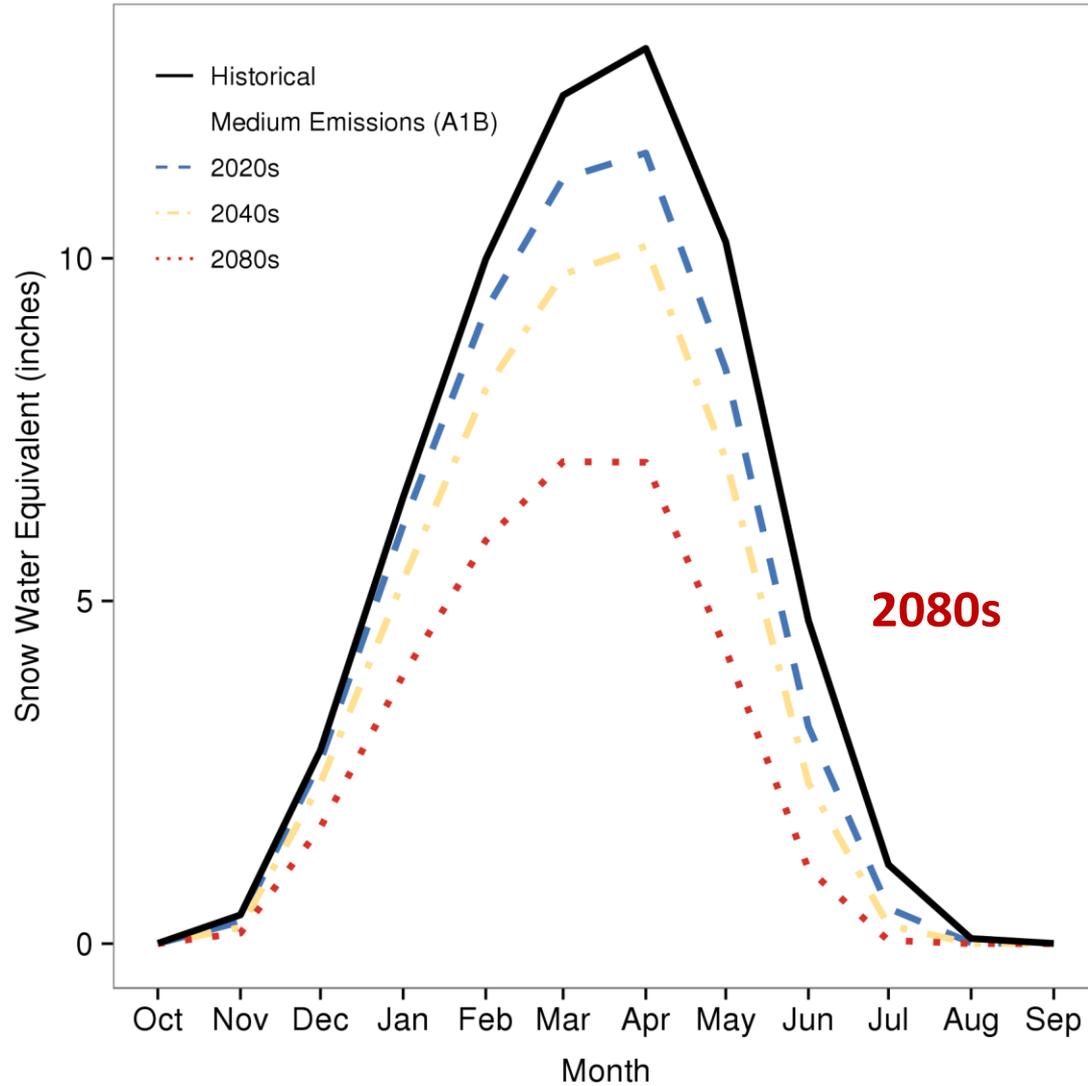


Decreasing snowpack: Methow basin





Decreasing snowpack: Methow basin



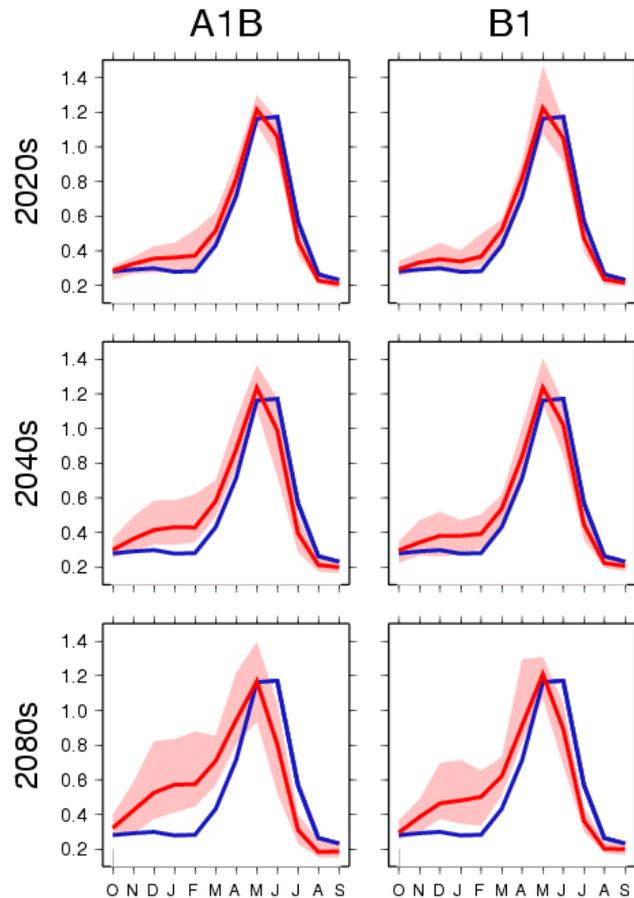


Sali Kilmer

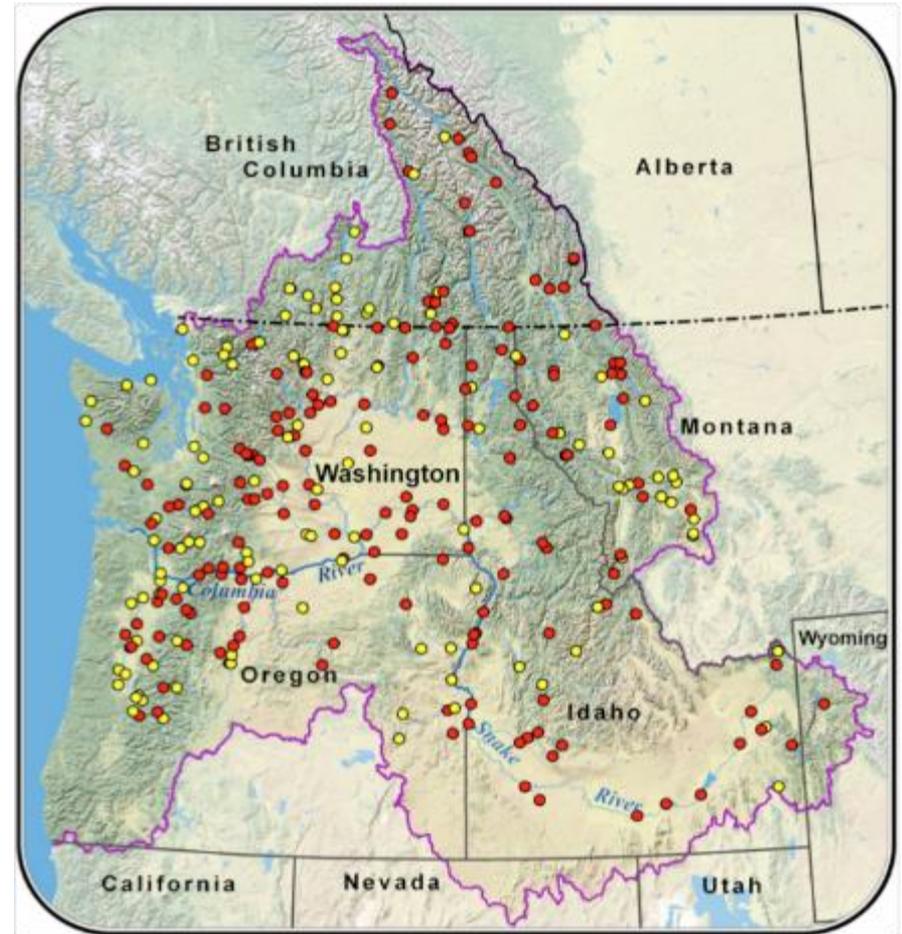


Online tool: Columbia Basin Climate Change Hydrologic Scenarios

combined flow (in):



Example of available products
Columbia River at The Dalles

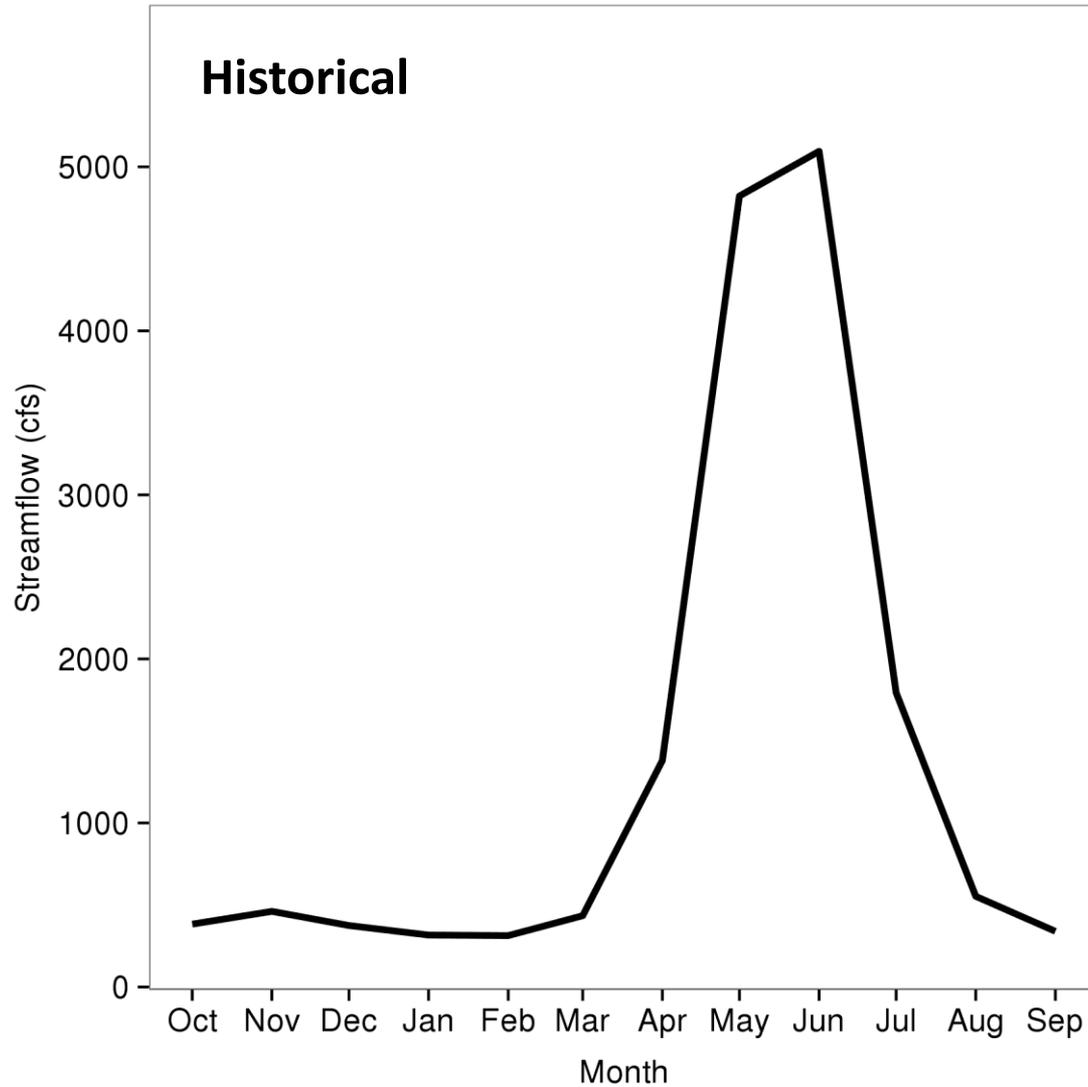


<http://hydro.washington.edu/2860>

Developed with support from the Washington State Dept of Ecology, BPA, Northwest Power and Conservation Council, Oregon Dept of Water Resources, BC Ministry of Environment

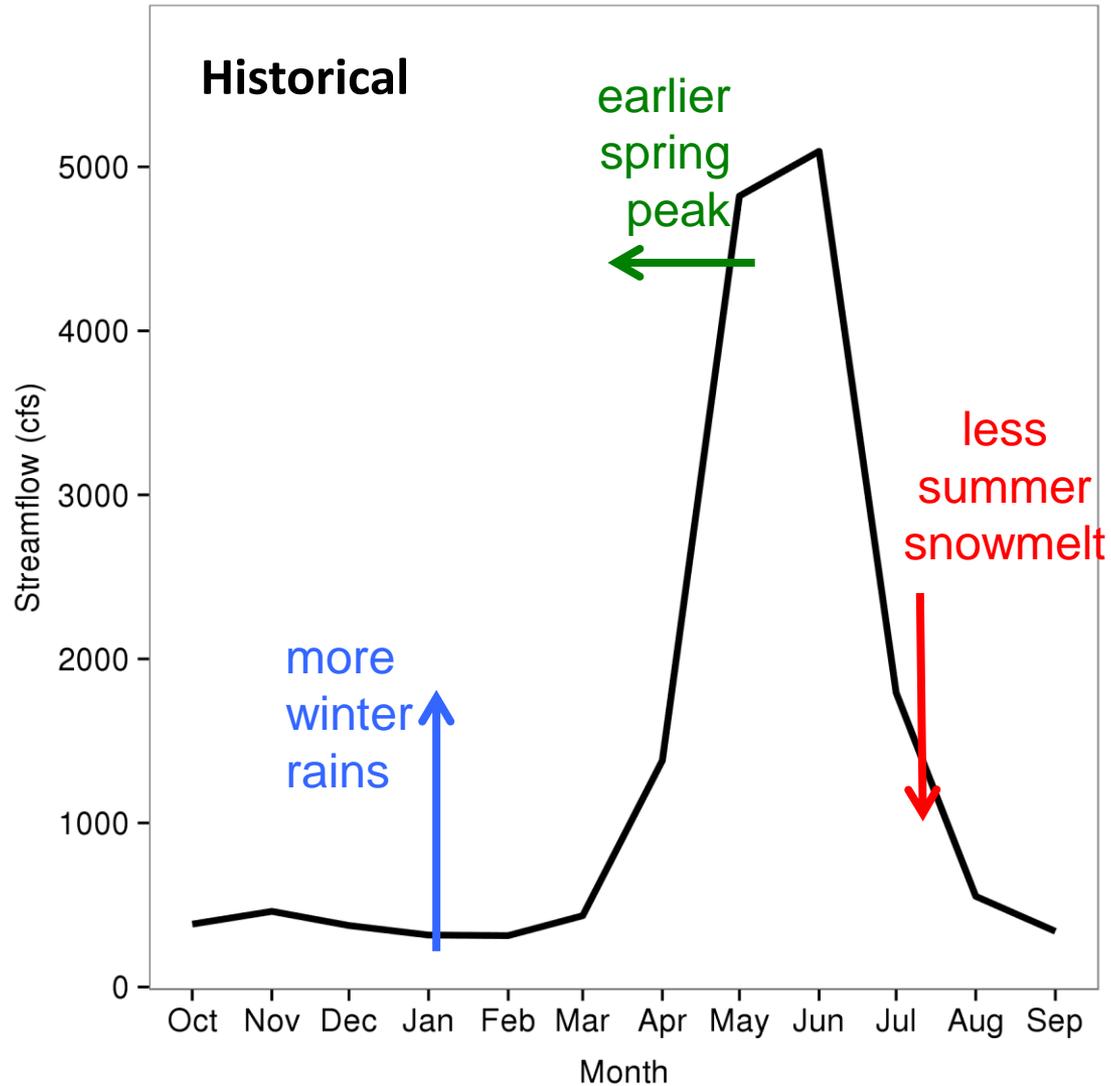


Methow River @ Twisp: historical flow



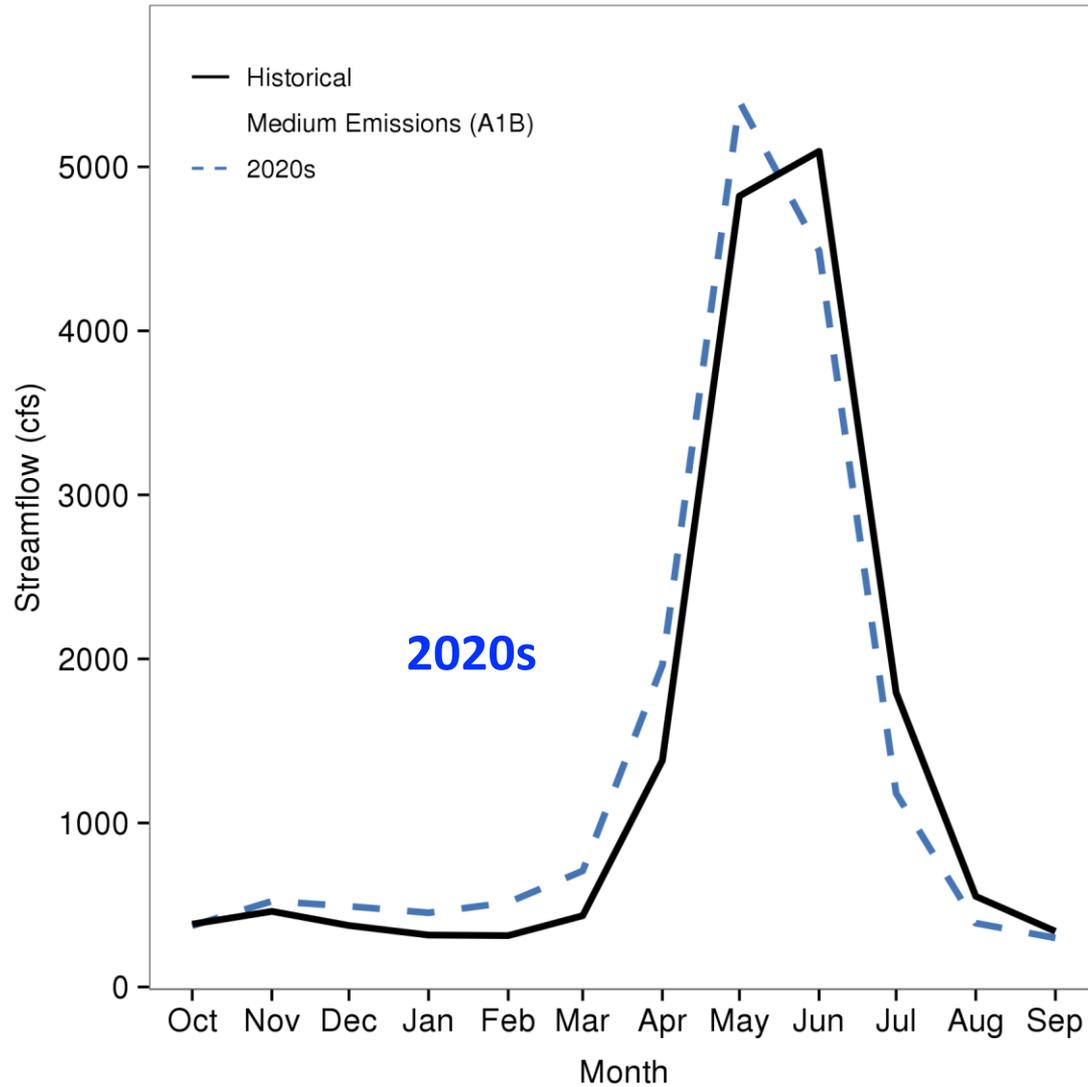


Climate change shifts streamflow



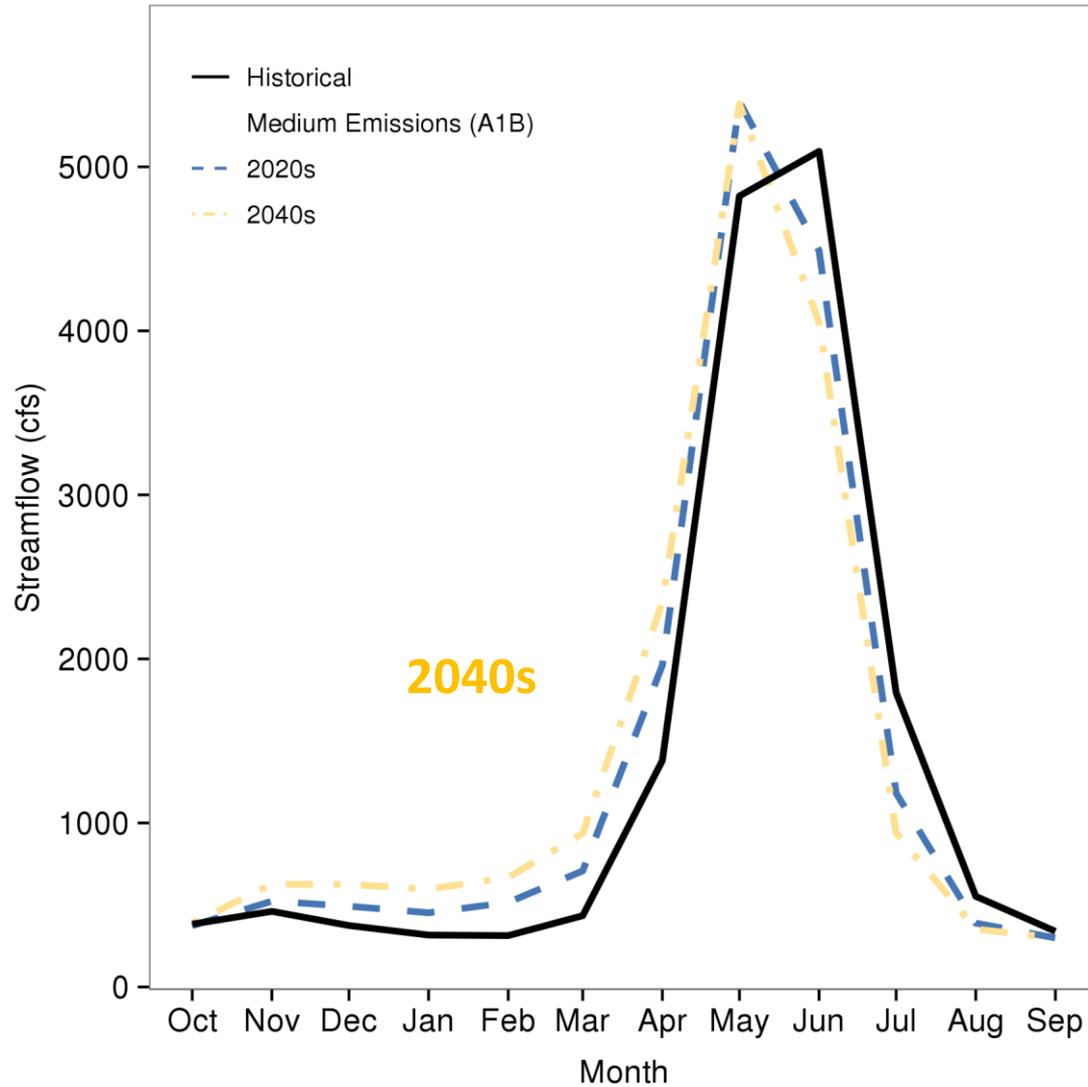


Shifting streamflow: Methow @ Twisp



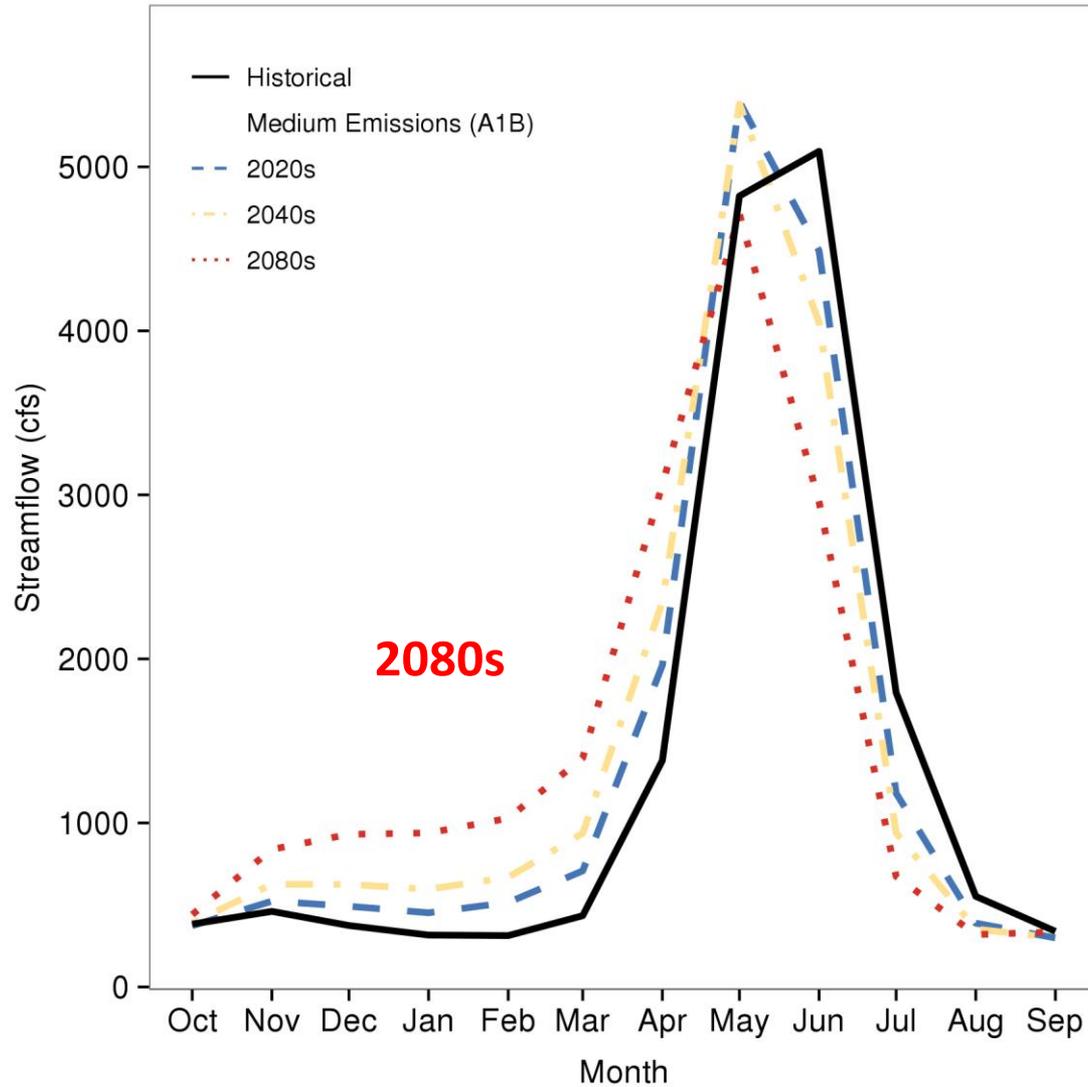


Shifting streamflow: Methow @ Twisp



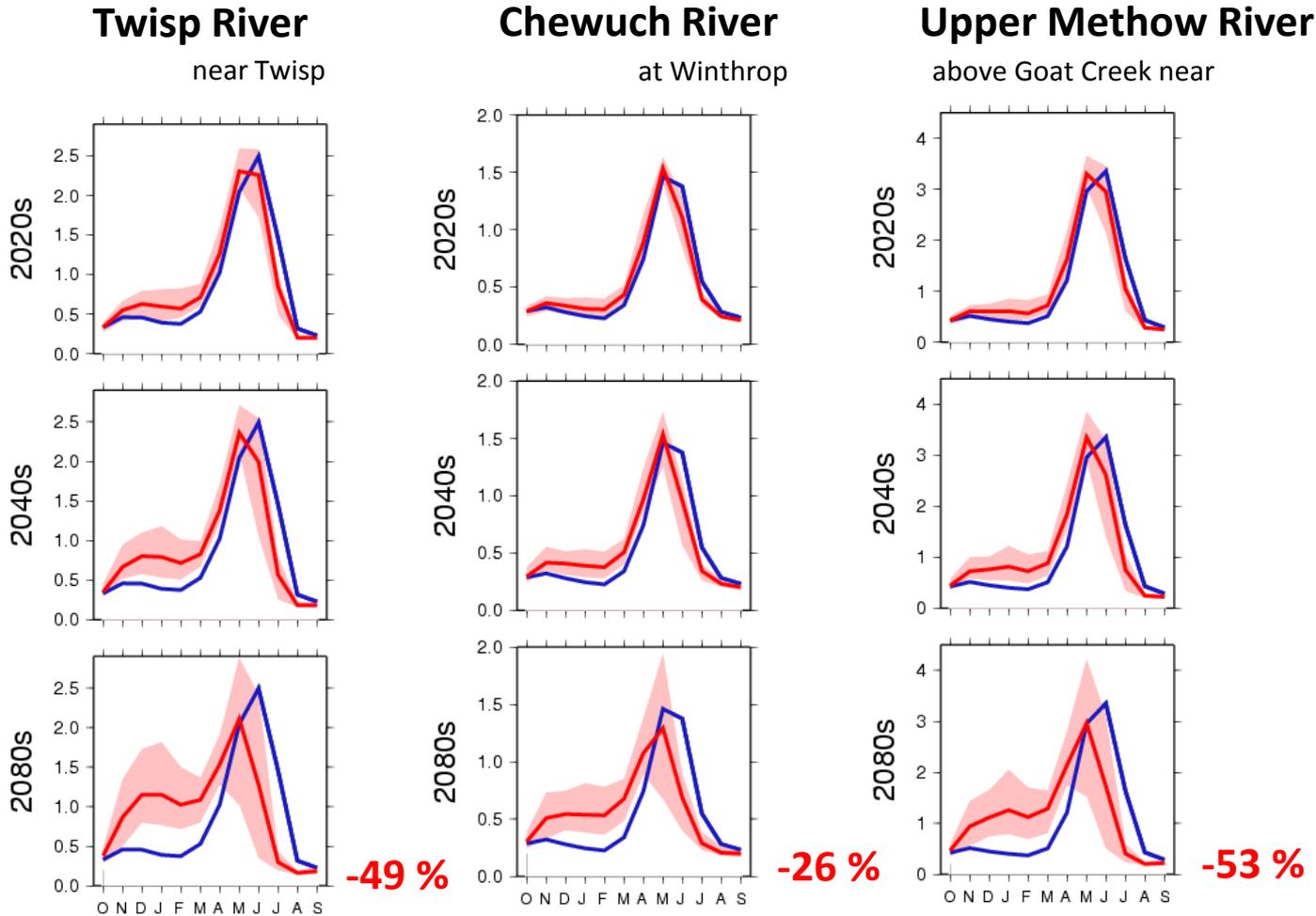


Shifting streamflow: Methow @ Twisp





Similar changes across the watershed



Naturalized flows; blue line = historical (1916-2006)

Combined flows (in) for a moderate (A1B) warming scenario

What about future extremes?

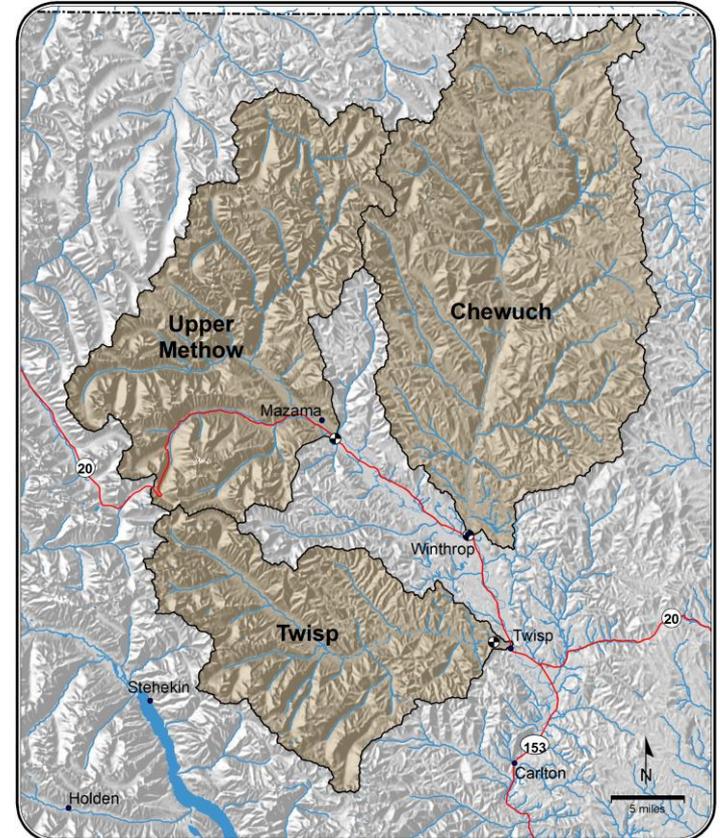
High flows

- Near/mid-term: Little change expected for most Methow basins
- Longer term: Significant increases (+30-300%) in most Methow basins

Low flows

- Decreasing low flows expected mid-century and beyond in most Methow basins

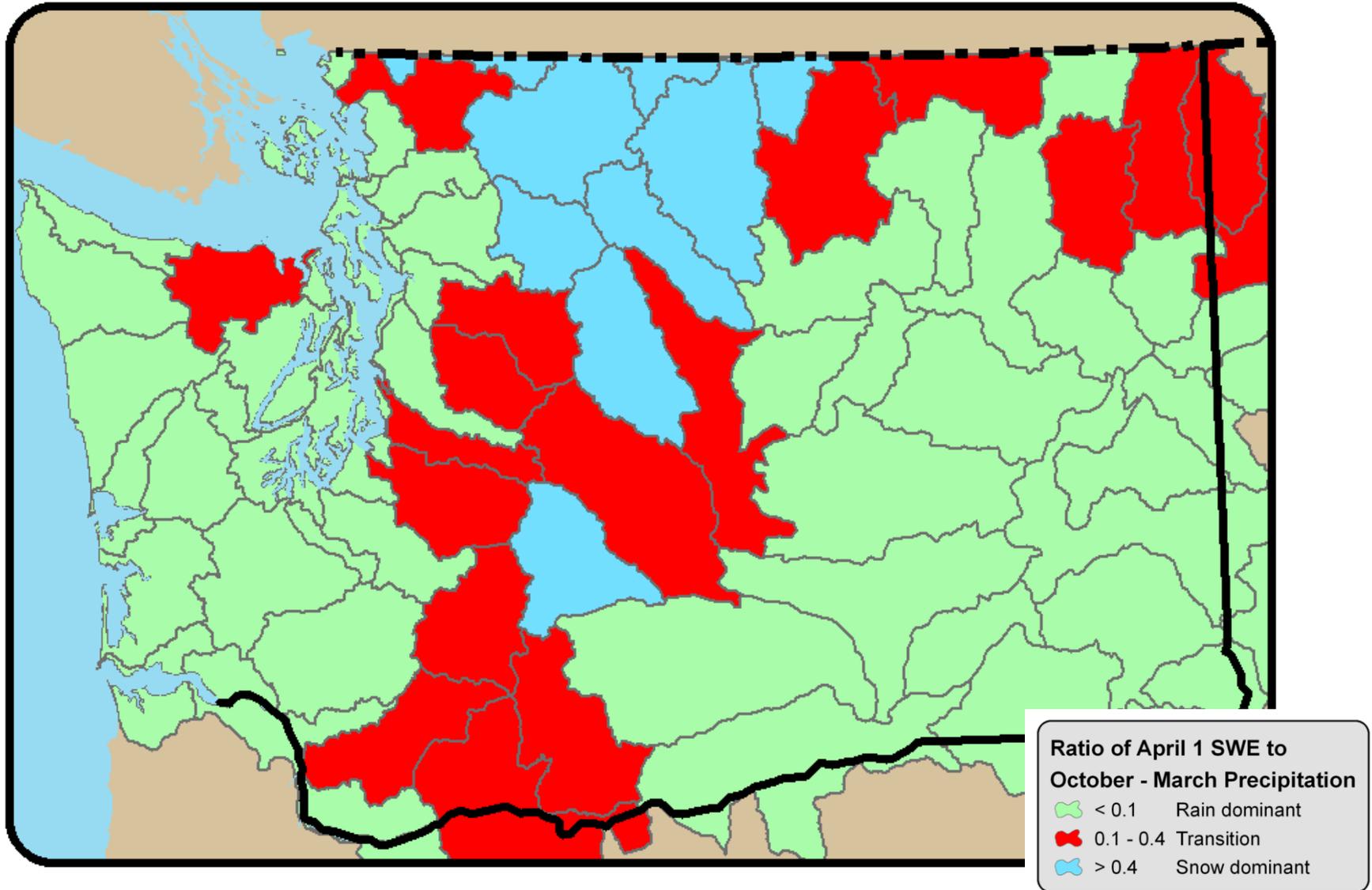
Upper Methow more sensitive and Chewuch less sensitive than other sub-basins



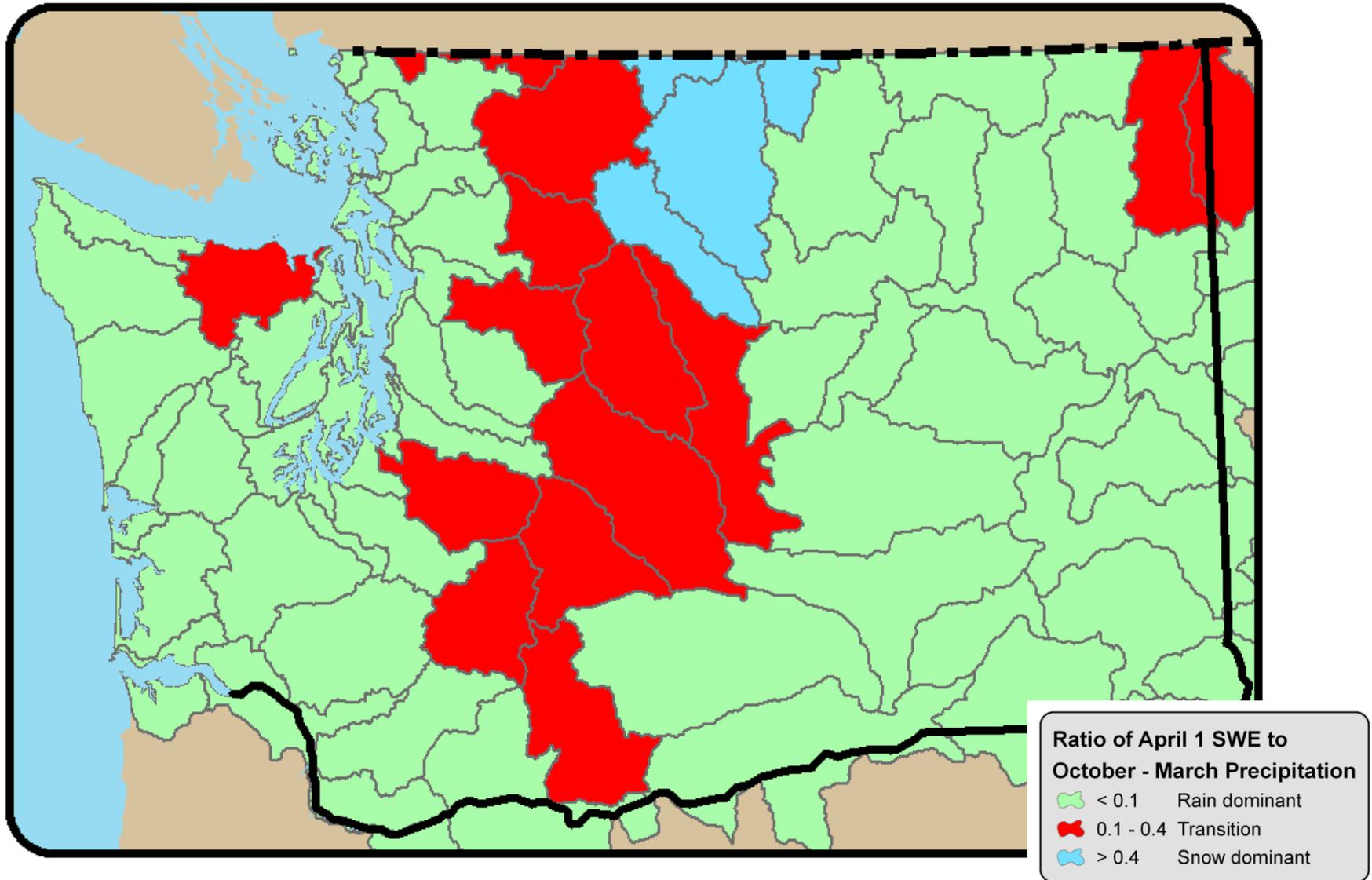


Broader context

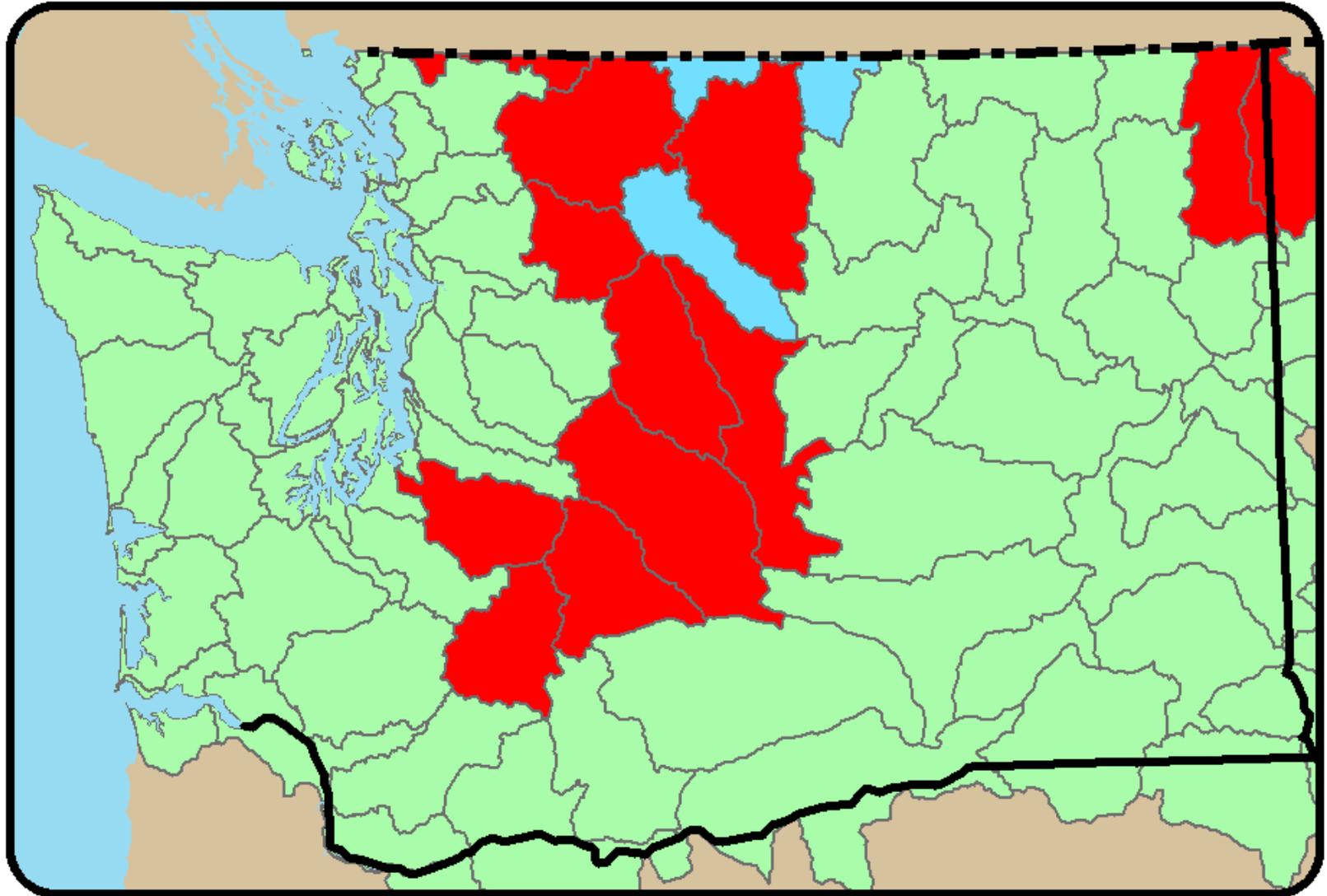
Historical



2020s

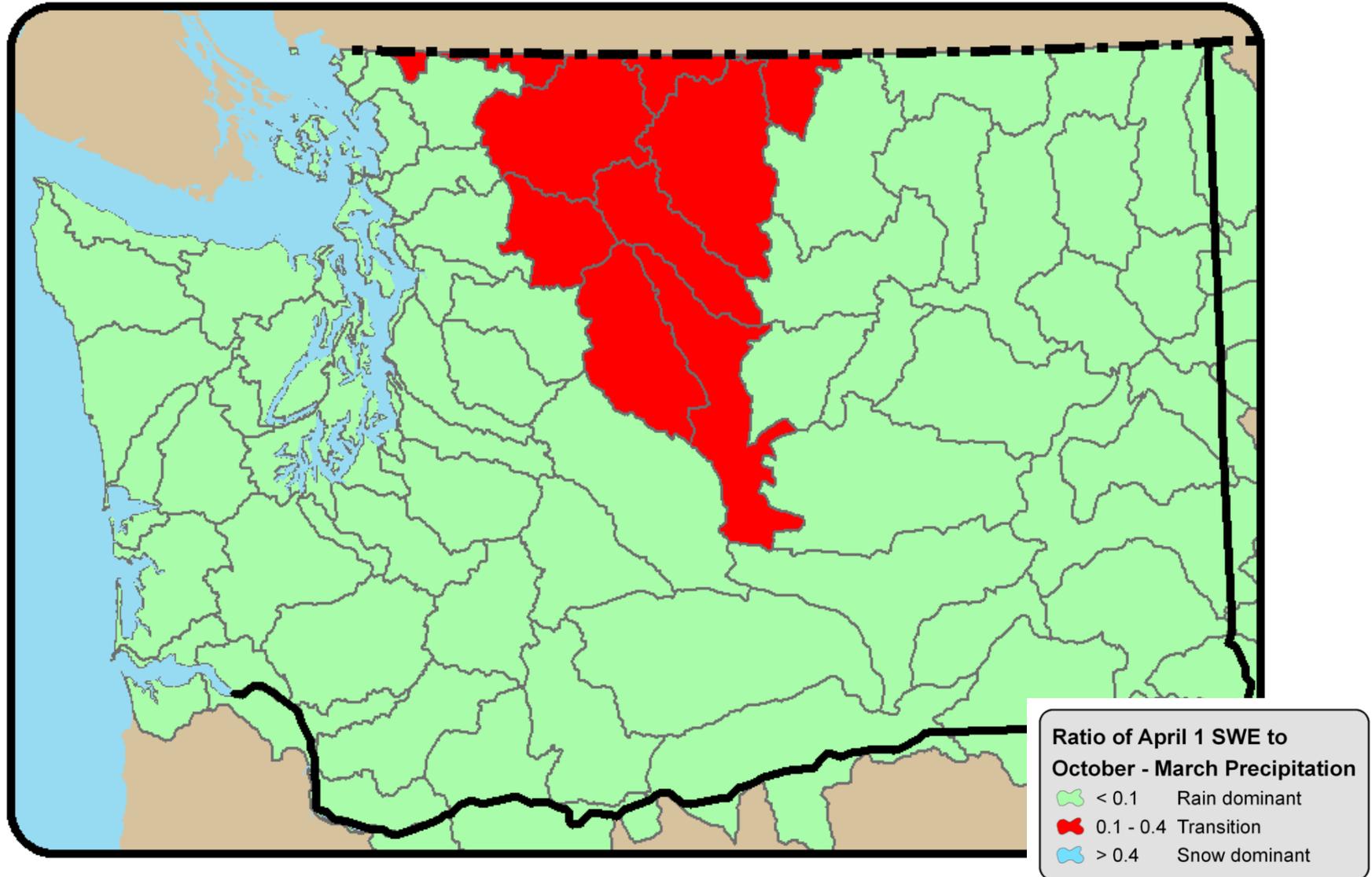


2040s

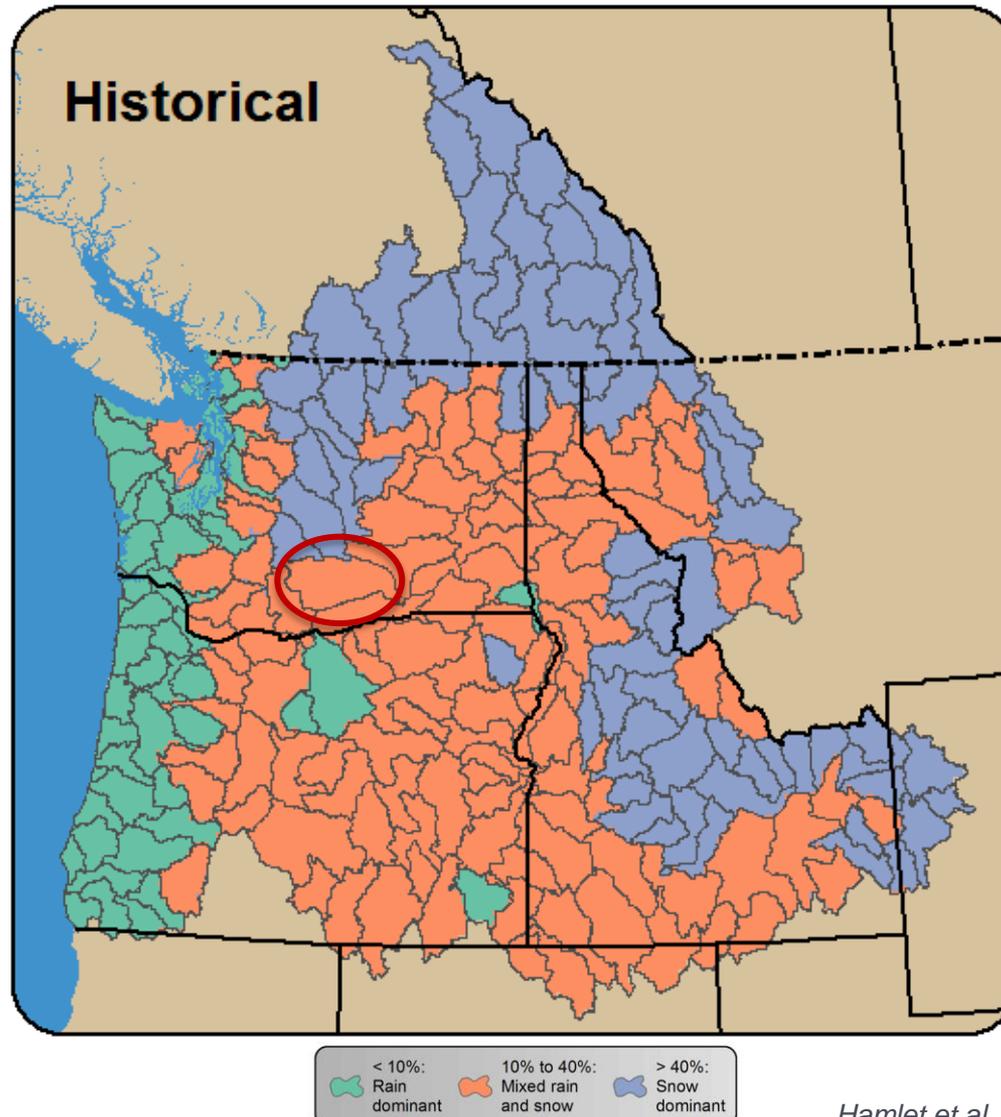


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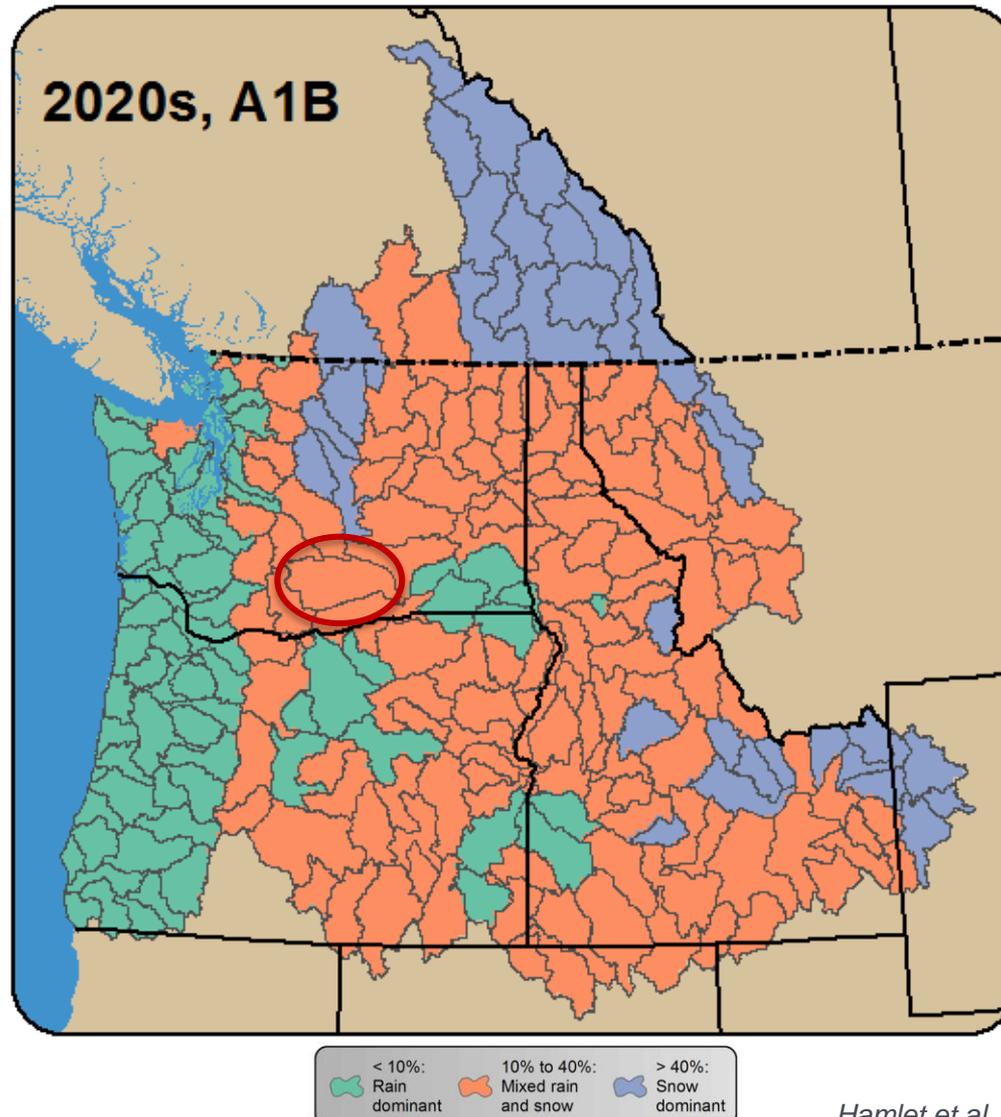
2080s



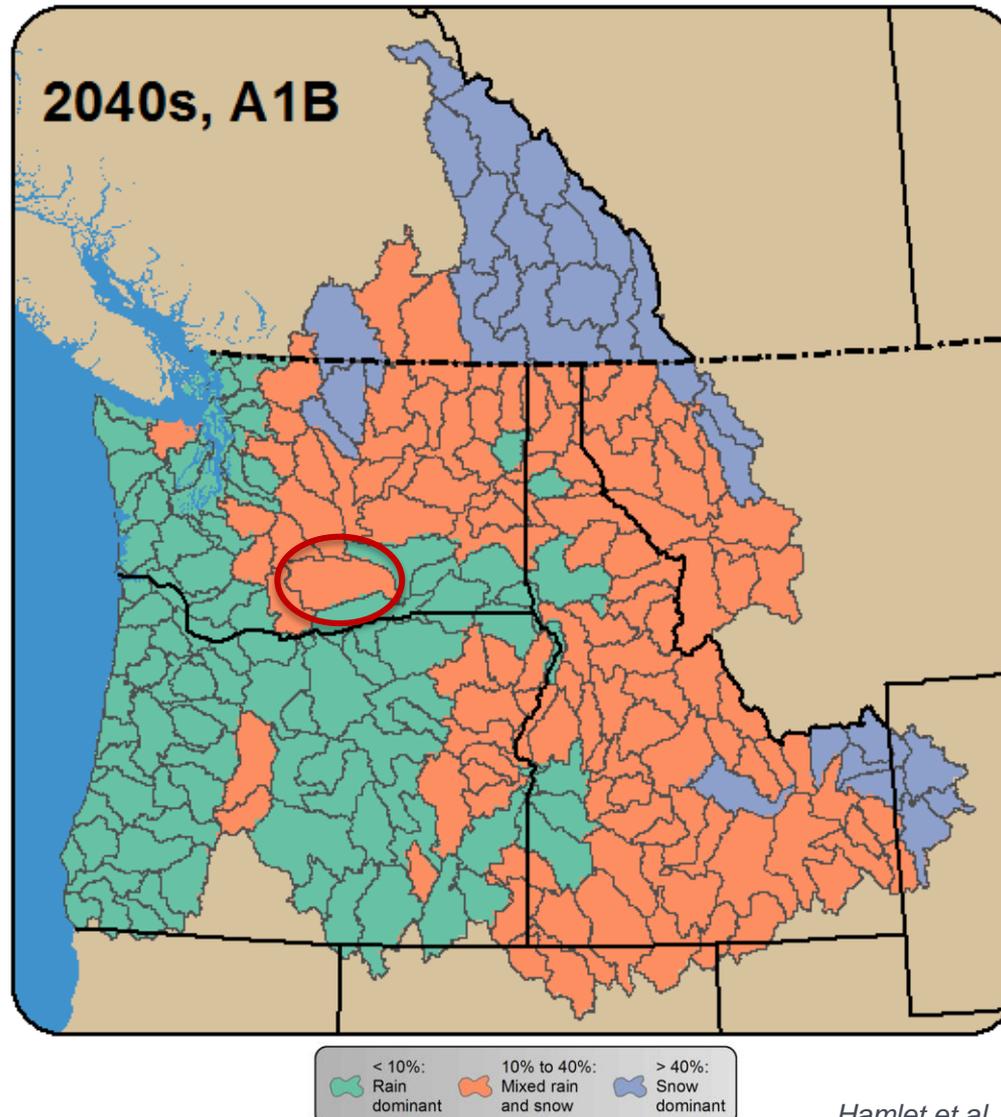
Mid-elevation basins most sensitive to warming



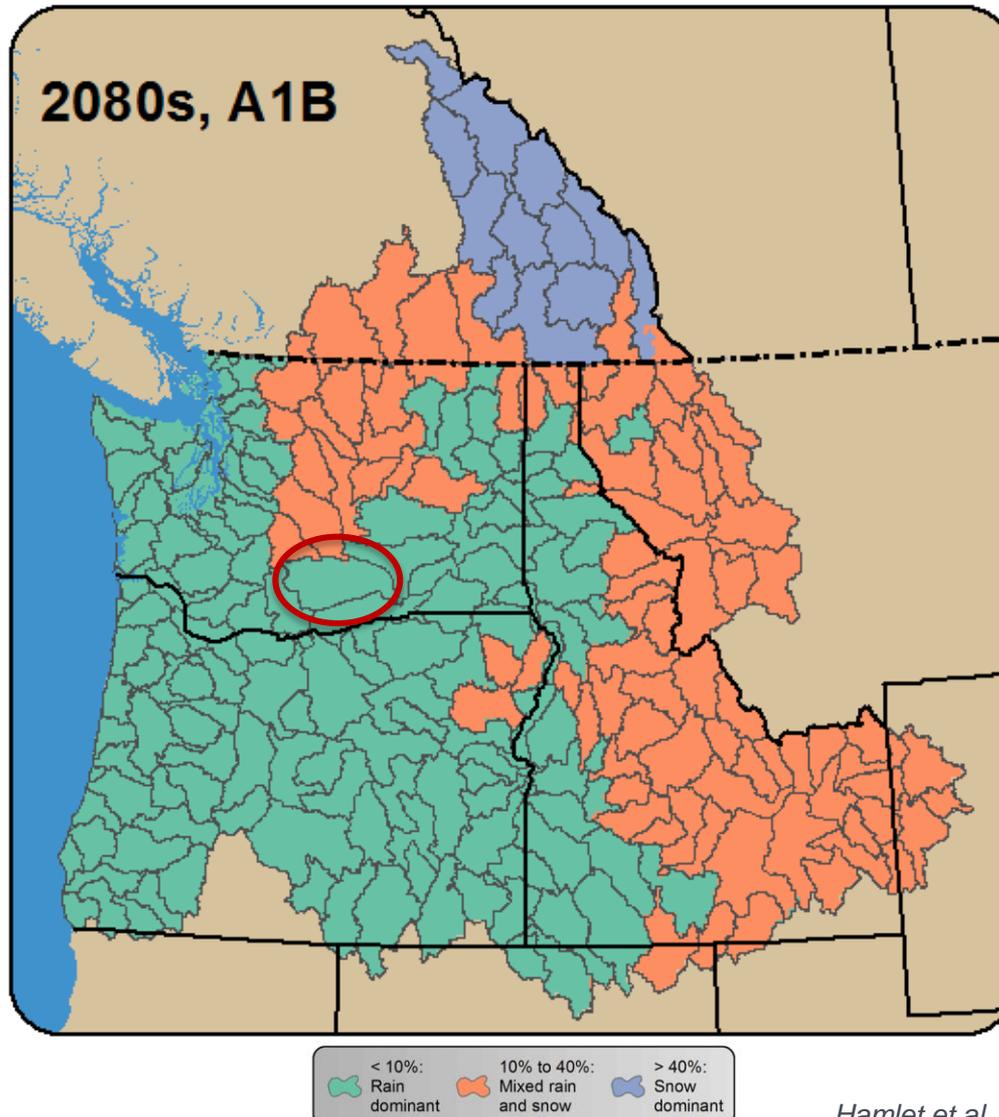
Mid-elevation basins most sensitive to warming

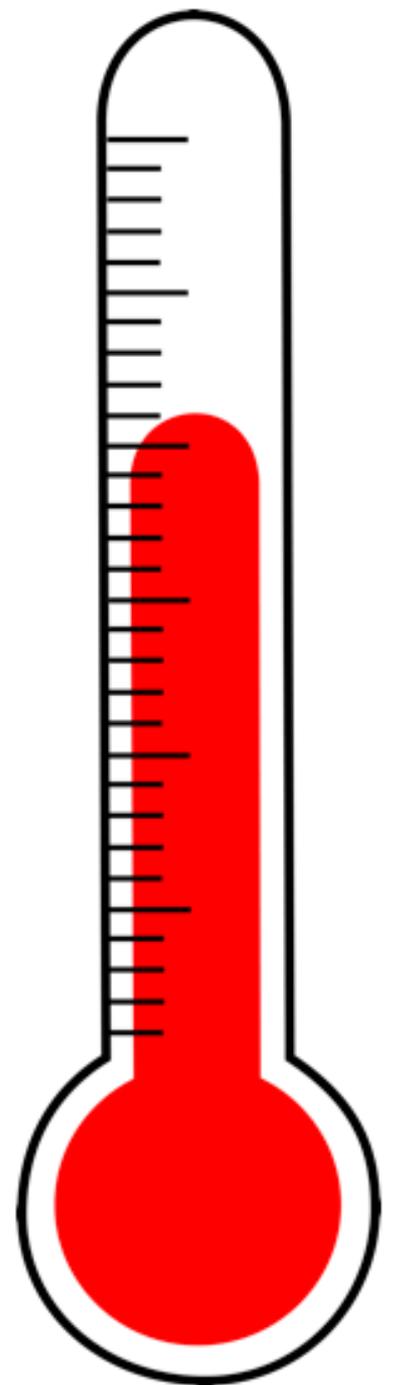


Mid-elevation basins most sensitive to warming

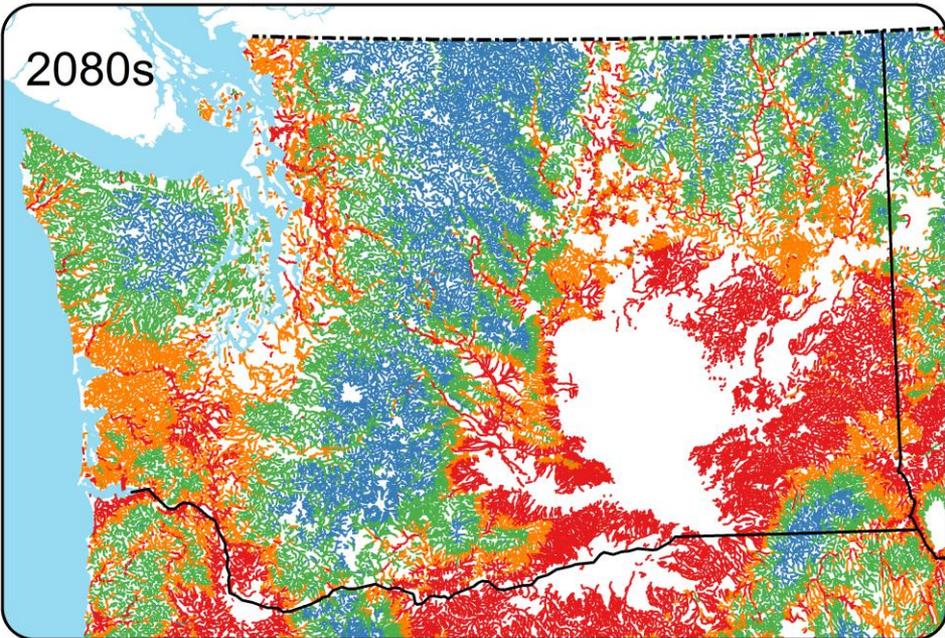
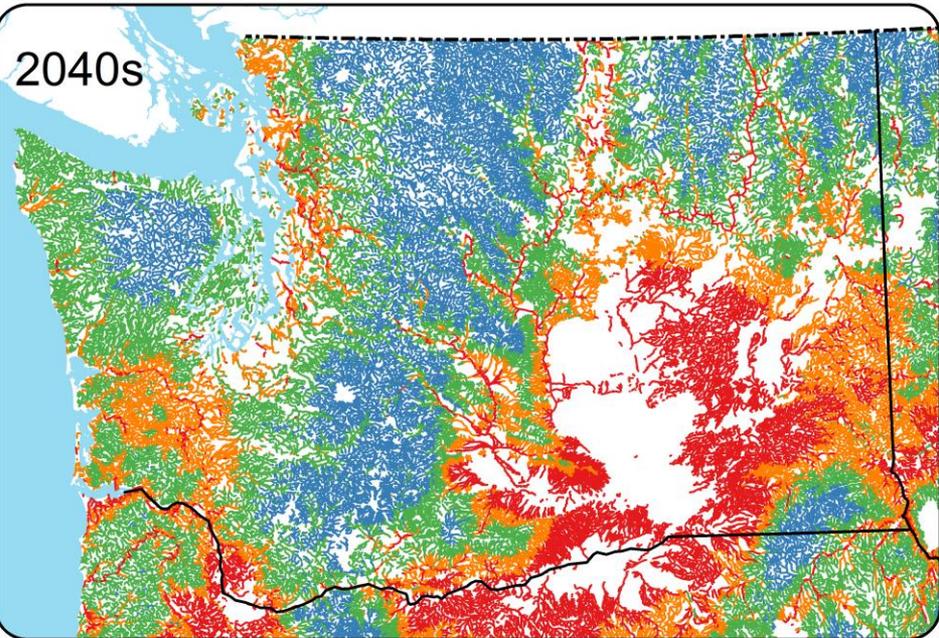
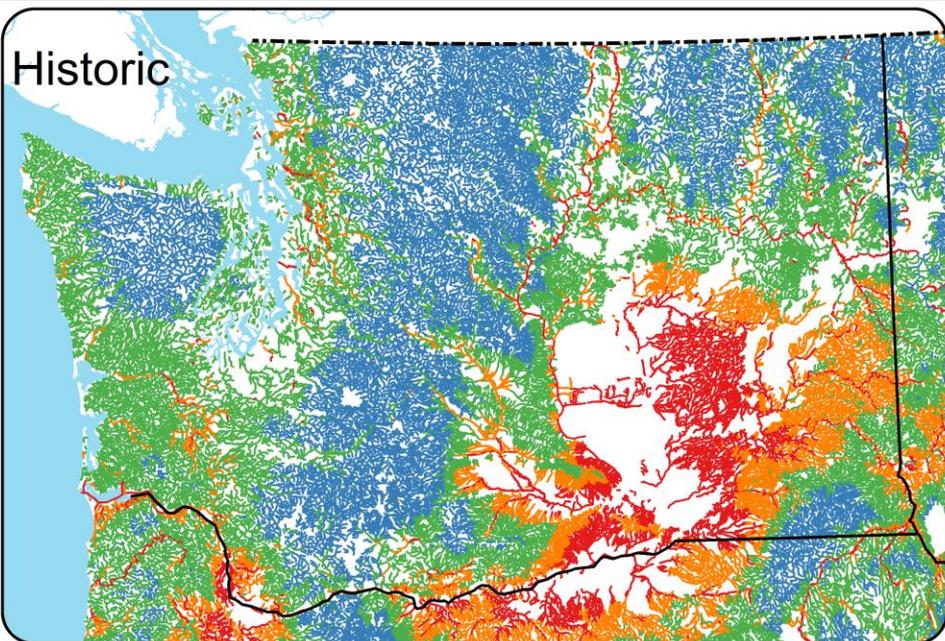
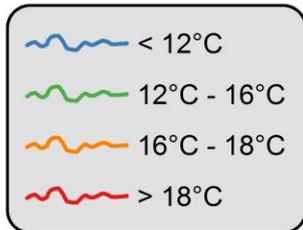


Mid-elevation basins most sensitive to warming

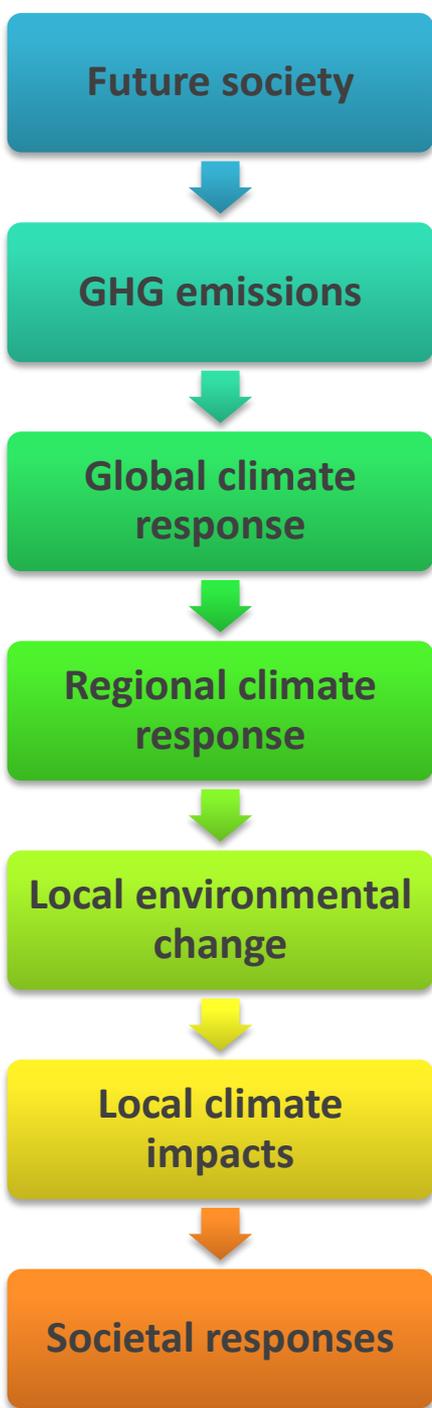




Stream Temperatures







Reducing the risks of climate change

Address the root cause

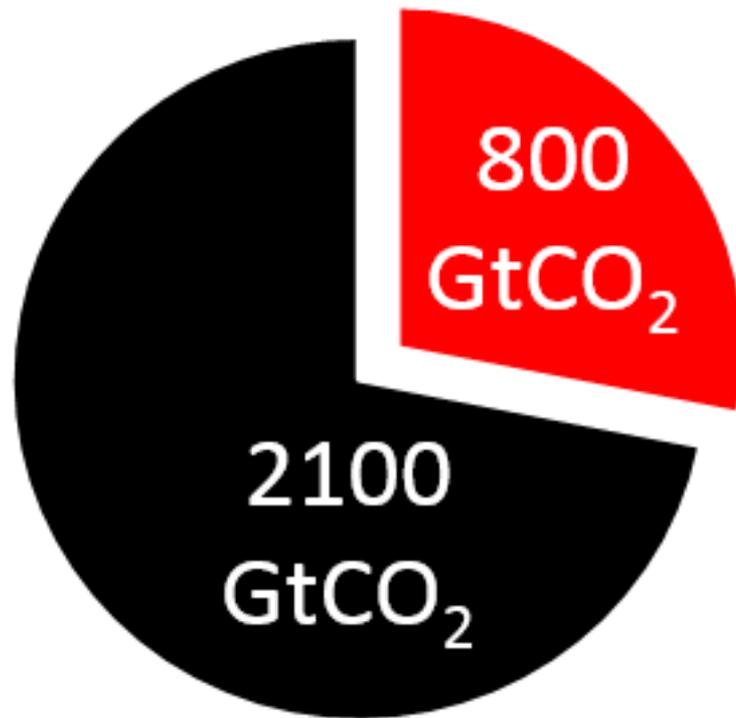
Reduce atmospheric greenhouse gases



Prepare for the consequences

Reduce vulnerabilities and build resilience

Our Carbon Budget



Carbon budget insights: 1; We have already emitted 2100 billion tonnes CO₂, and if we emit 800 billion tonnes more, then there is a 66% chance we will stay below 2°C. 2; We will have emitted this CO₂ by about 2040 at current emission rates. 3; A beautifully simple concept, but one that is far more complex in reality.





Stages of Considering Climate Change

1

Ignore/Resist

Aim for existing goals
using existing
strategies



Stages of Considering Climate Change

1

Ignore/Resist

Aim for existing goals
using existing
strategies

2

Adjust

Aim for existing goals
using climate-smart
strategies



Stages of Considering Climate Change





Preparing for a Changing Climate: Act

- 1. Address identified risks**
- 2. Adjust efforts and expectations to align with changing conditions**
- 3. Build capacity for ongoing change**



Preparing for a Changing Climate: Collaborate

- 1. Work within existing boundaries, using existing authorities**
- 2. Work in partnership with others to address risks outside of your control and those necessitating a collective response**
- 3. Build longer-term transformative approaches to addressing climate risk**



King County



SOUNDTRANSIT



City of Seattle



Snohomish County



City of OLYMPIA



CHELAN COUNTY



GRAY'S HARBOR COUNTY

1854



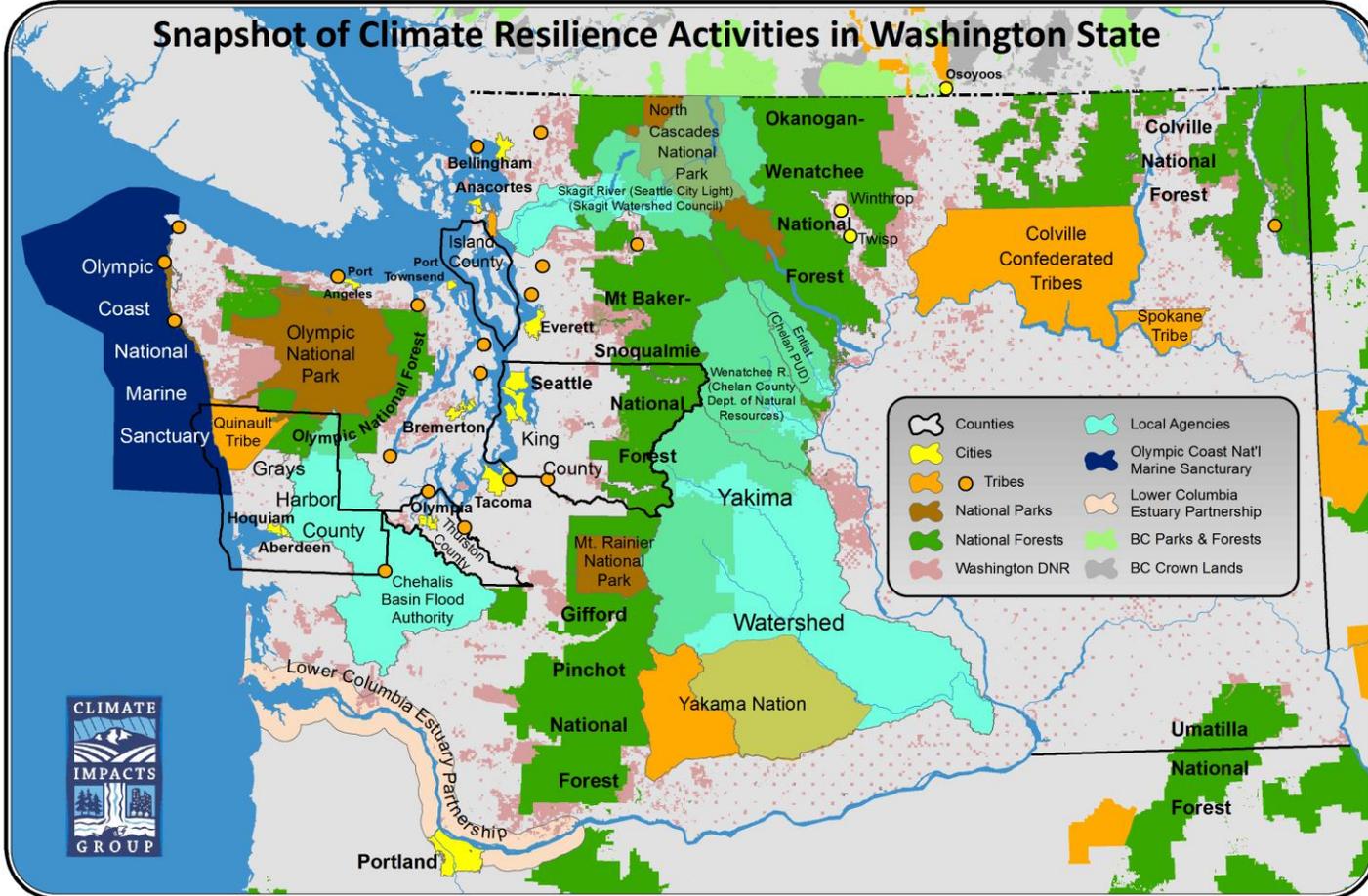
Swinomish Indian Tribal Community

PugetSoundPartnership

our sound, our community, our chance



NOOKSACK INDIAN TRIBE



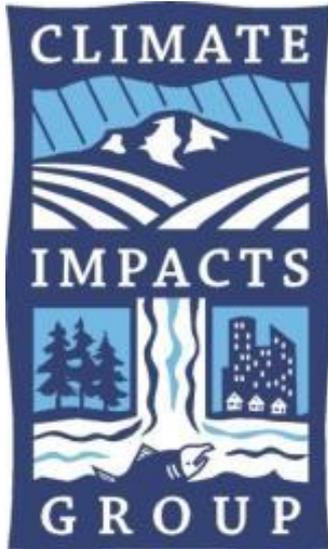
US ARMY CORPS OF ENGINEERS



FEMA



NATIONAL MARINE SANCTUARIES



The Climate Impacts Group

www.cig.uw.edu

Amy Snover

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NW CSC
Northwest Climate Science Center



COLLEGE OF THE ENVIRONMENT

UNIVERSITY *of* WASHINGTON