An Overview of the Columbia Basin Climate Change Scenarios Project:

Approach and Key Results

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CLIMATE IMPACTS GROUP

Climate science in the public interest

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http://www.hydro.washington.edu/2860/products/sites/r7climate/study_report/CBCCSP_chap1_intro_final.pdf

Climate Change Scenarios Need to Address Diverse Planning Needs

Stakeholder requests:

1. Create resources to assess impacts to multiple sectors (terrestrial and aquatic ecosystems, water management, human health, energy, etc.)
2. Provide comprehensive coverage over large geographic areas using consistent methods
3. Increase spatial resolution

   -- address both large-scale and small-scale planning efforts in a consistent manner
4. Increase temporal resolution

   -- address changes at daily timescales and assess changes in hydrologic extremes
5. Quantify uncertainties in future projections

Hydrologic Climate Change Scenarios for the Pacific Northwest Columbia River Basin and Coastal Drainages

- Project Home
- Introduction for New Users
- Join Project's Listserve
- Project Report
- Citations and Contacts
- Project Updates
- Climate Scenarios
  - Site-specific Data
  - Primary Data
  - Reservoir Model Input Data

Climate change is projected to have substantial impacts on Pacific Northwest water resources and ecosystems. Recognizing this, resource managers have expressed growing interest in incorporating climate change information into long-range planning. The availability of hydrologic scenarios to support climate change adaptation and long-range planning, however, has been limited until very recently to a relatively small number of selected case studies. More comprehensive resources needed to support regional planning have been lacking. Furthermore, ecosystem studies at the landscape scale need consistent climate change information and databases over large geographic areas. Products using a common set of methods that would support such studies have not been readily available.

To address these needs, the Climate Impacts Group worked with several prominent water management agencies in the Pacific Northwest to develop hydrologic climate change scenarios for approximately 300 streamflow locations in the Columbia River basin and selected coastal drainages west of the Cascades. Study partners are listed below. The scenarios, provided to the public for free via this website, allow planners to consider how hydrologic changes may affect water resources management objectives and ecosystems.

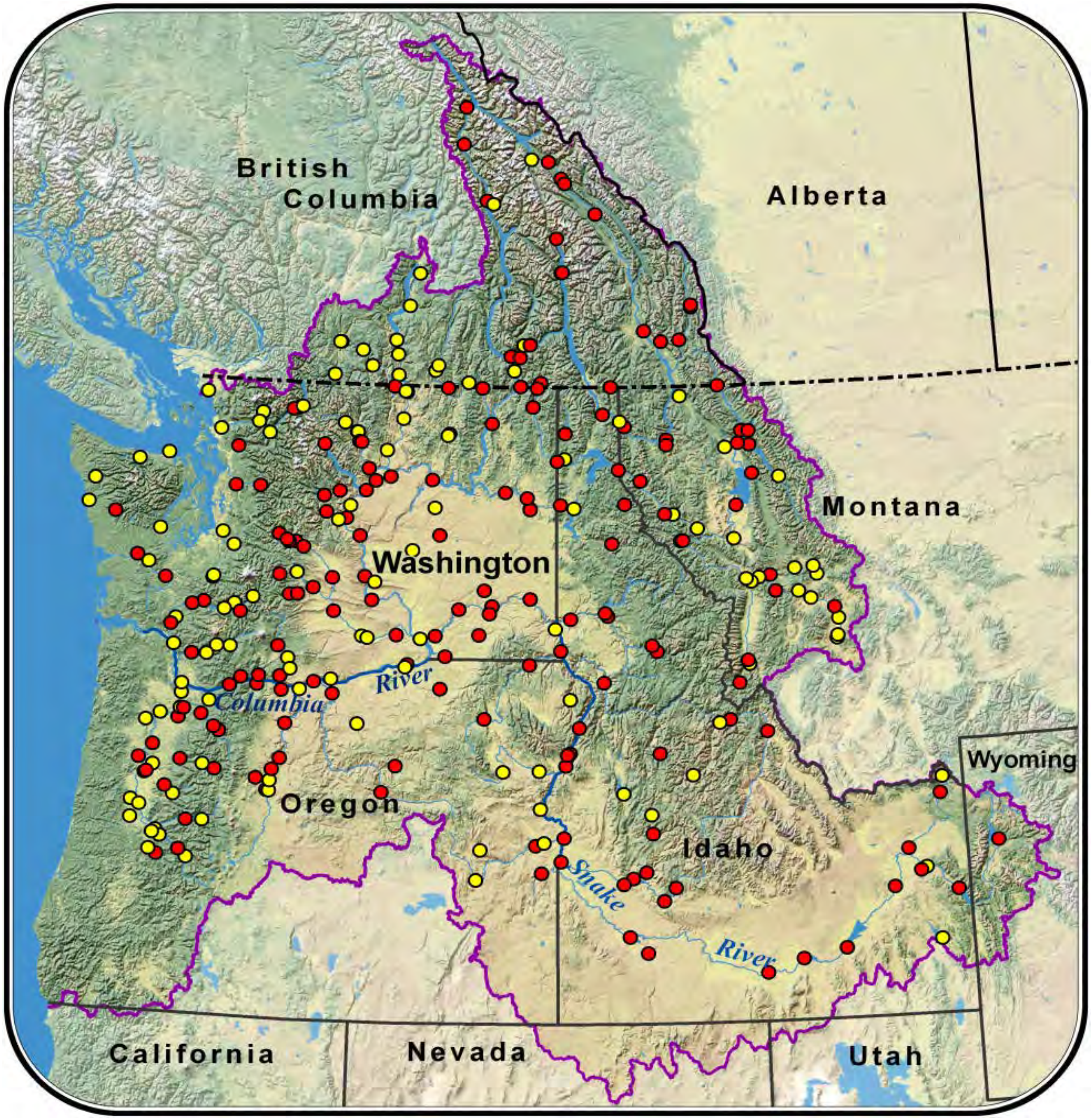
Access to the data and summary products is available from the menu to the left. The hydrologic data produced by the study are based on climate change scenarios produced for the IPCC Fourth Assessment effort. Information on the methods and modeling tools used in the study is provided in the summary report. For new users of the site, a guide to the website and the data resources contained within it is also provided.

The Climate Impacts Group was funded by the following research partners to develop the Columbia River Basin and coastal drainages climate change scenarios:

- WA State Department of Ecology
- Bonneville Power Administration
- Northwest Power and Conservation Council
- Oregon Department of Water Resources
- British Columbia Ministry of Environment

http://www.hydro.washington.edu/2860/

297 Streamflow Sites Included in the CBCCSP



Regional Impacts to Temperature and Precipitation

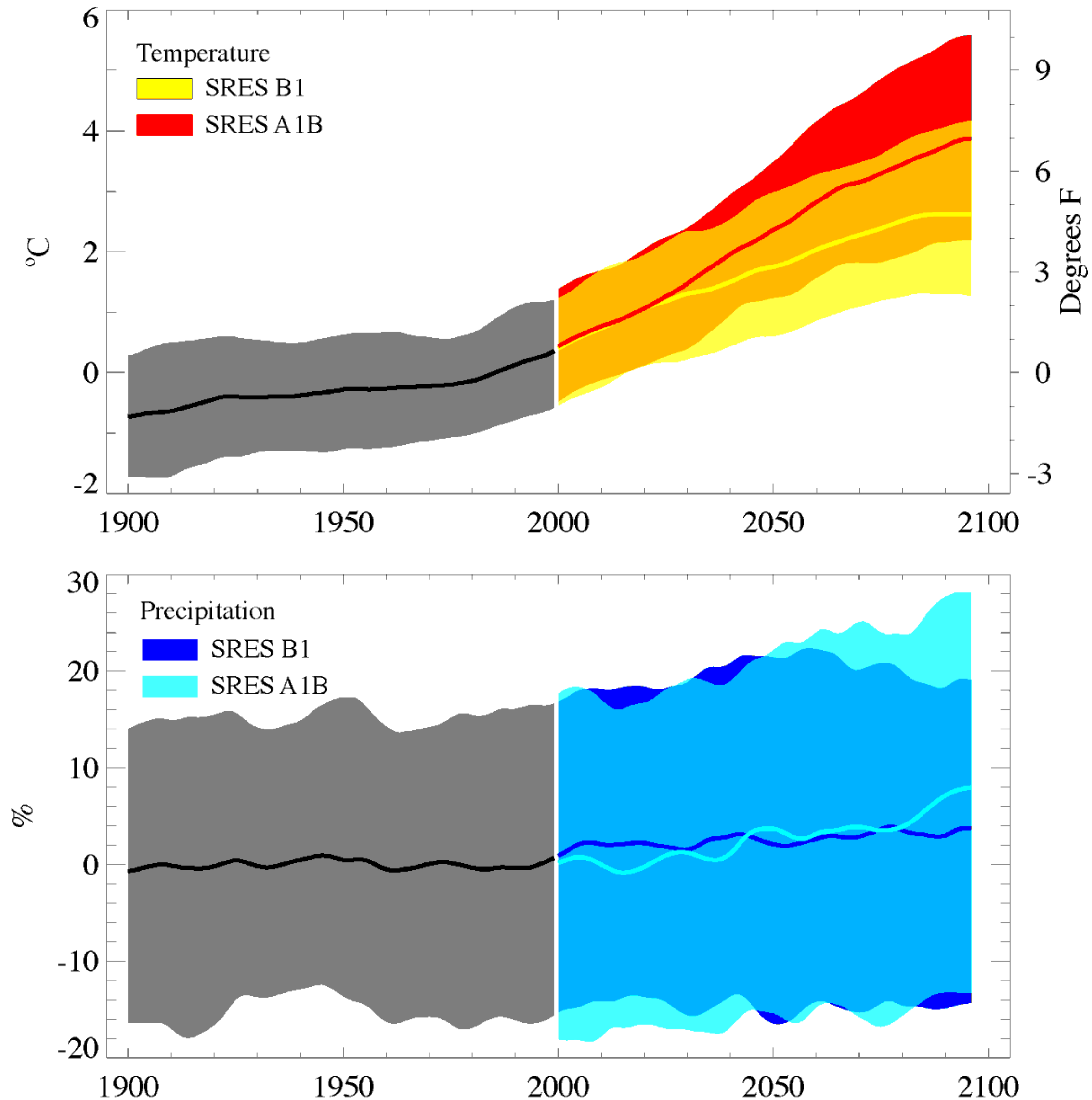
Climate Change Scenarios

IPCC AR 4 Emissions Scenarios:

A1B Medium High

B1 Low

Figure shows change compared with 1970 - 1999 average



Climate Impacts Group 2009, WA Assessment, Ch. 1
http://cses.washington.edu/cig/res/ia/waccia.shtml

Seasonal Precipitation Changes for the Pacific Northwest

2020s

2040s

2080s

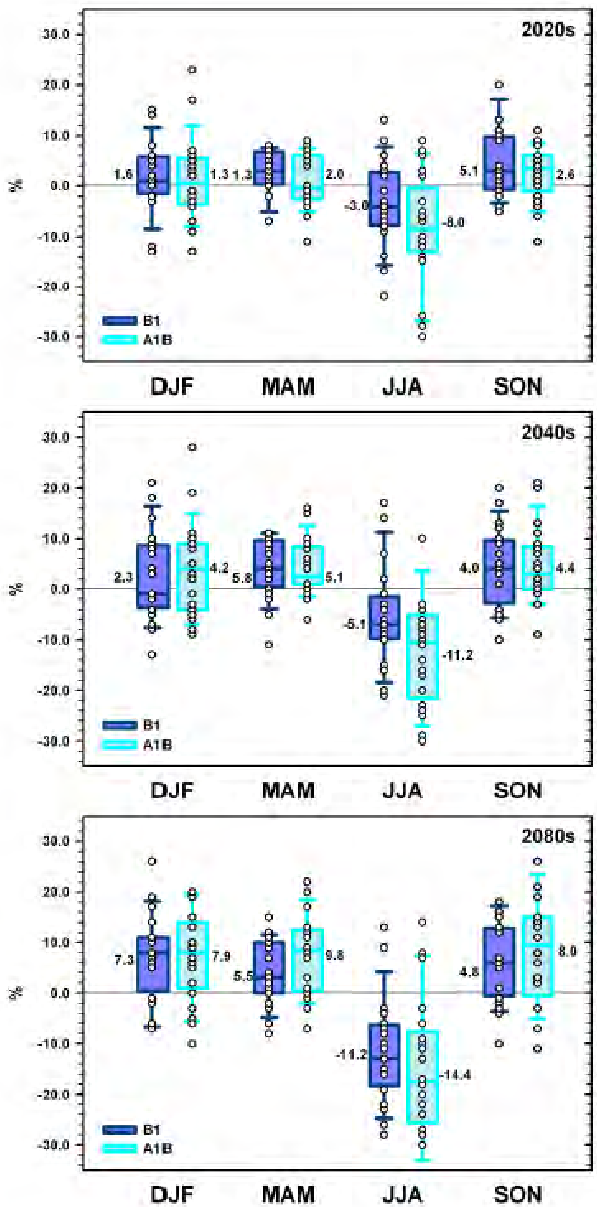


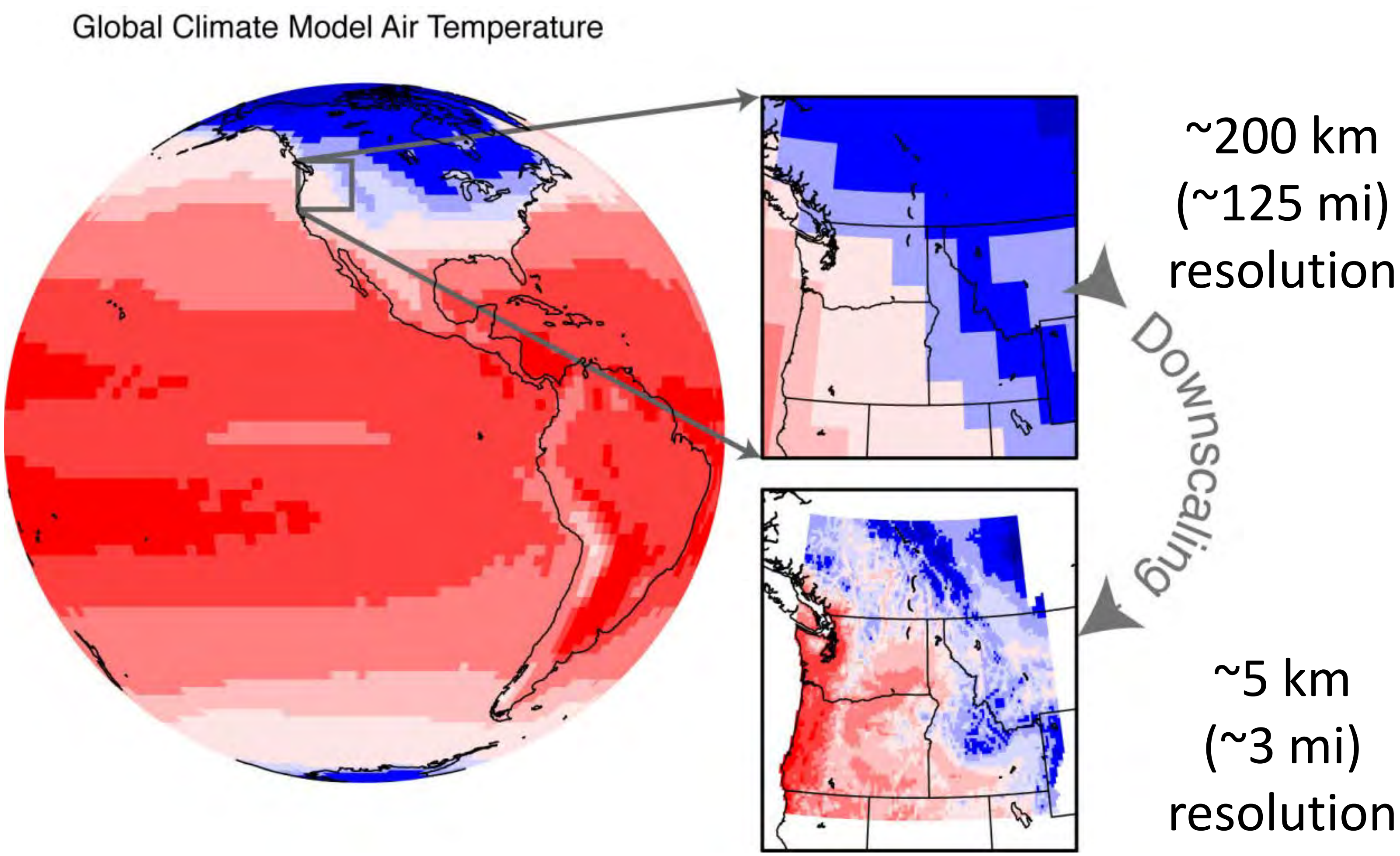
Figure 10. As in Figure 9, but for precipitation. The height of the bars indicates actual water precipitation but the percentages are calculated with respect to a reference value for that season, so that -11% in JJA is much less than -11% in DJF. The reference values for the extremes are that model's 20th century mean for that season (or annual mean), and for the REA average the reference is the all-model 20th century value. Unlike for temperature, for any season some models project increases and some project decreases, though the vast majority project decreases for summer and increases for winter by the 2080s

Model Consensus:

- Wetter Autumns, Winters, Springs
- Drier Summers

http://cses.washington.edu/db/pdf/wacciach1scenarios642.pdf

Downscaling
Relates the "Large" to the "Small"



Available PNW Scenarios

Downscaling Approach			A1B Emissions Scenario	B1 Emissions Scenario
Hybrid Delta	hadcm cnrm_cm ccsm3 echam5 echo_g cgcm3.1_t47 pcm1 miroc_3.2 ipsl_cm4 hadgem1	2020s	10	9
		2040s	10	9
		2080s	10	9
Transient BCSD	hadcm cnrm_cm ccsm3 echam5 echo_g cgcm3.1_t47 pcm1	1950-2098+	7	7
Delta Method	composite of 10	2020s	1	1
		2040s	1	1
		2080s	1	1

2020s – mean 2010-2039; 2040s – mean 2030-2059; 2080s – mean 2070-2099

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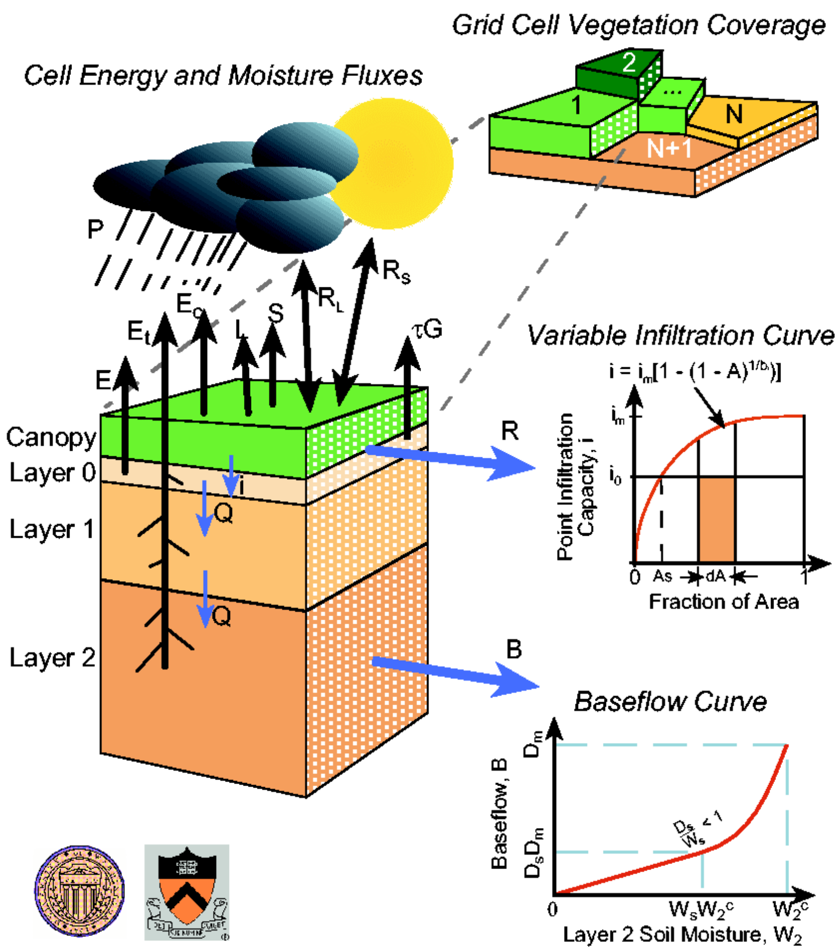
Hydrologic Modeling:

A Translation Between Climate Impacts and Water Impacts

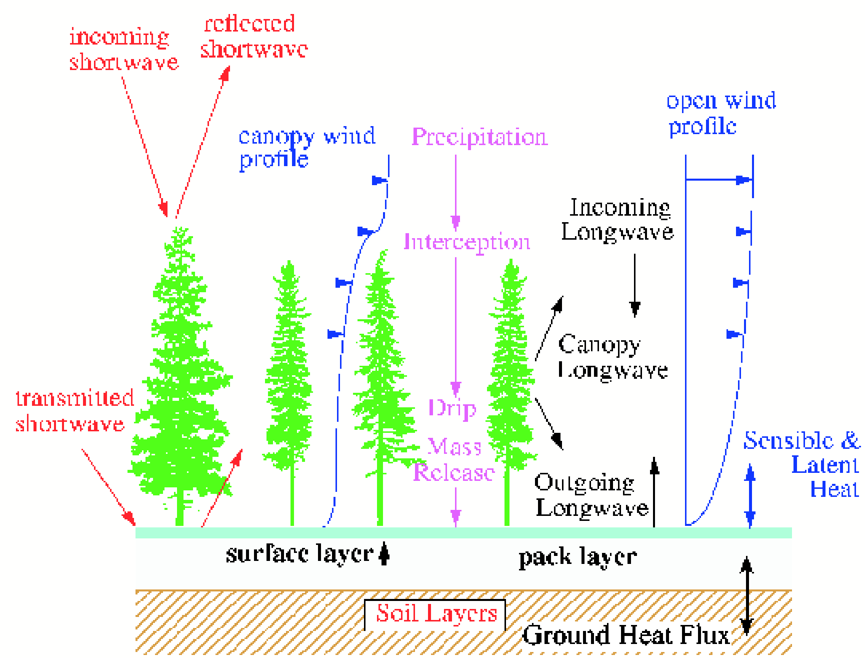
Schematic of VIC Hydrologic Model

Variable Infiltration Capacity (VIC)
Macroscale Hydrologic Model



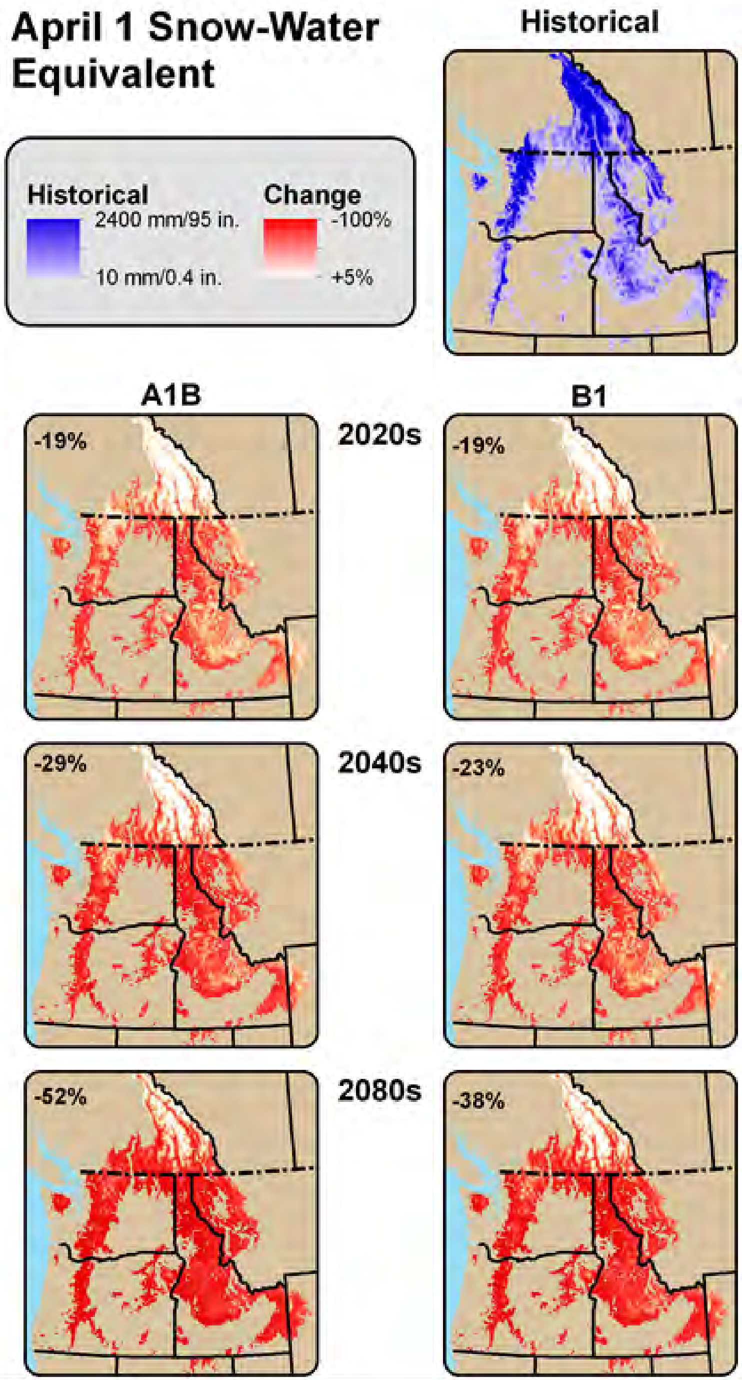
General Model Schematic

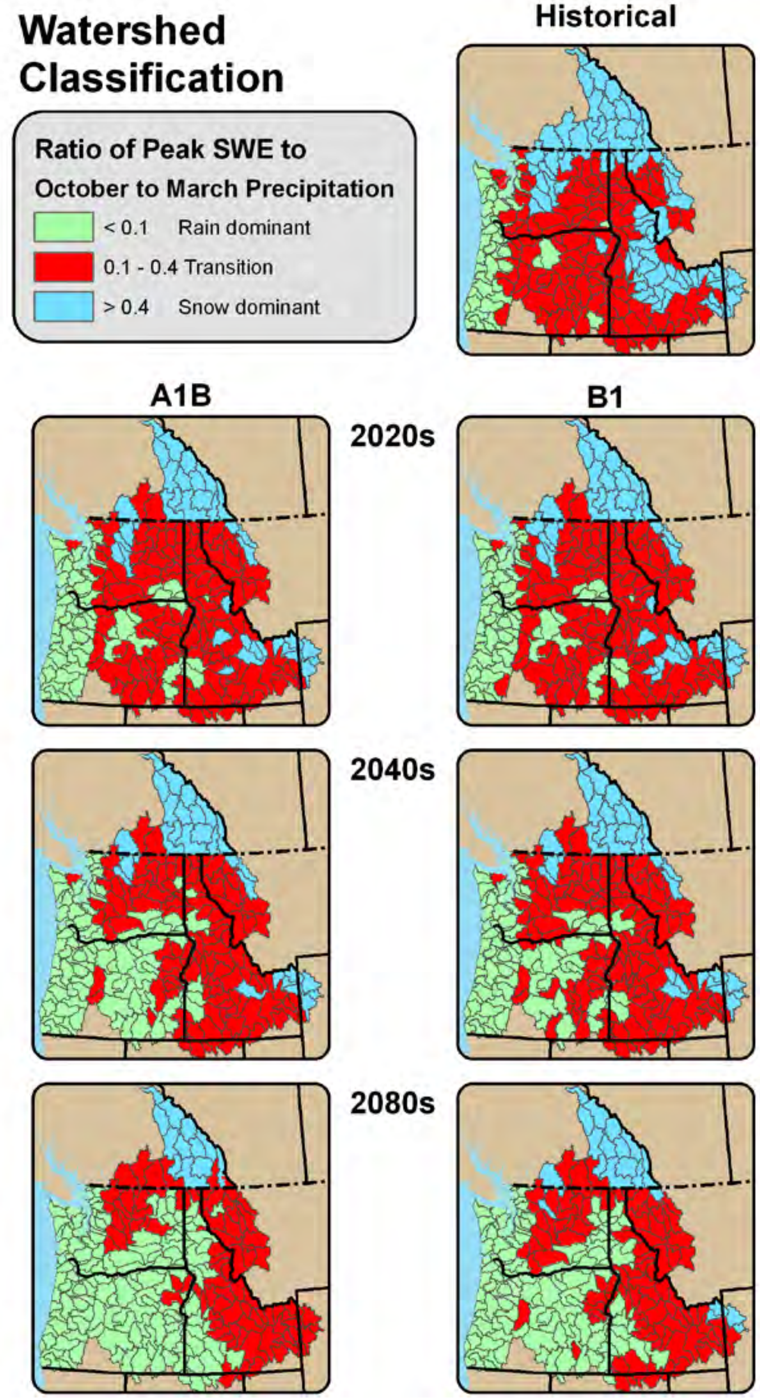
- Sophisticated, fully distributed, physically based hydrologic model
- Widely used globally in climate change applications
- 1/16 Degree Resolution
  (~5km x 6km or ~ 3mi x 4mi)



Snow Model

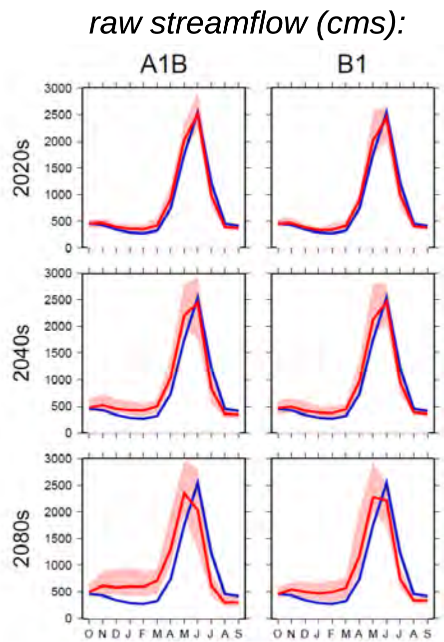
Summary of Key Results


April 1 Snow-Water Equivalent
Historical
Historical
2400 mm/95 in.
10 mm/0.4 in.
Change
-100%
+5%
A1B
B1
2020s
2040s
2080s
-19%
-19%
-29%
-23%
-52%
-38%

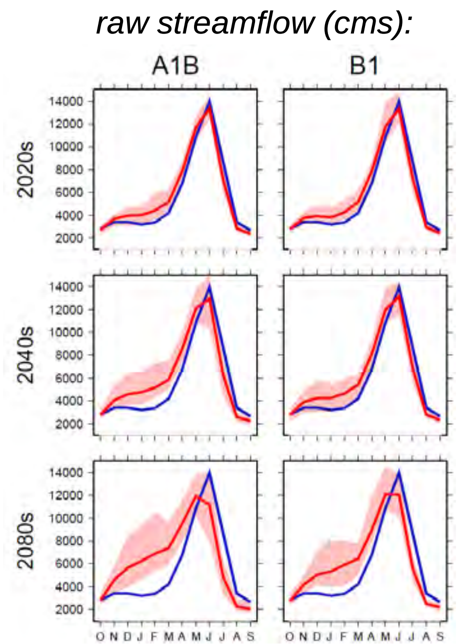

Watershed Classification
Historical
Ratio of Peak SWE to October to March Precipitation
< 0.1 Rain dominant
0.1 - 0.4 Transition
> 0.4 Snow dominant
A1B
B1
2020s
2040s
2080s

Changes in Monthly Hydrographs

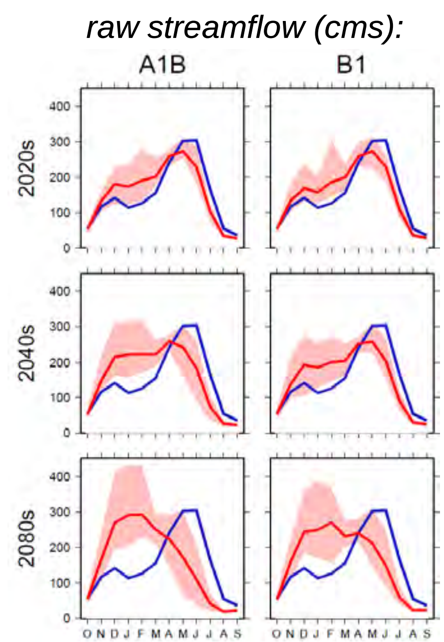
Kootenay River at Corra Linn Dam



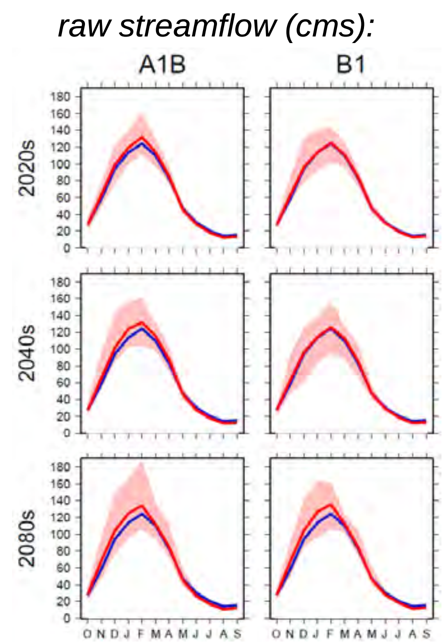
Columbia River at The Dalles



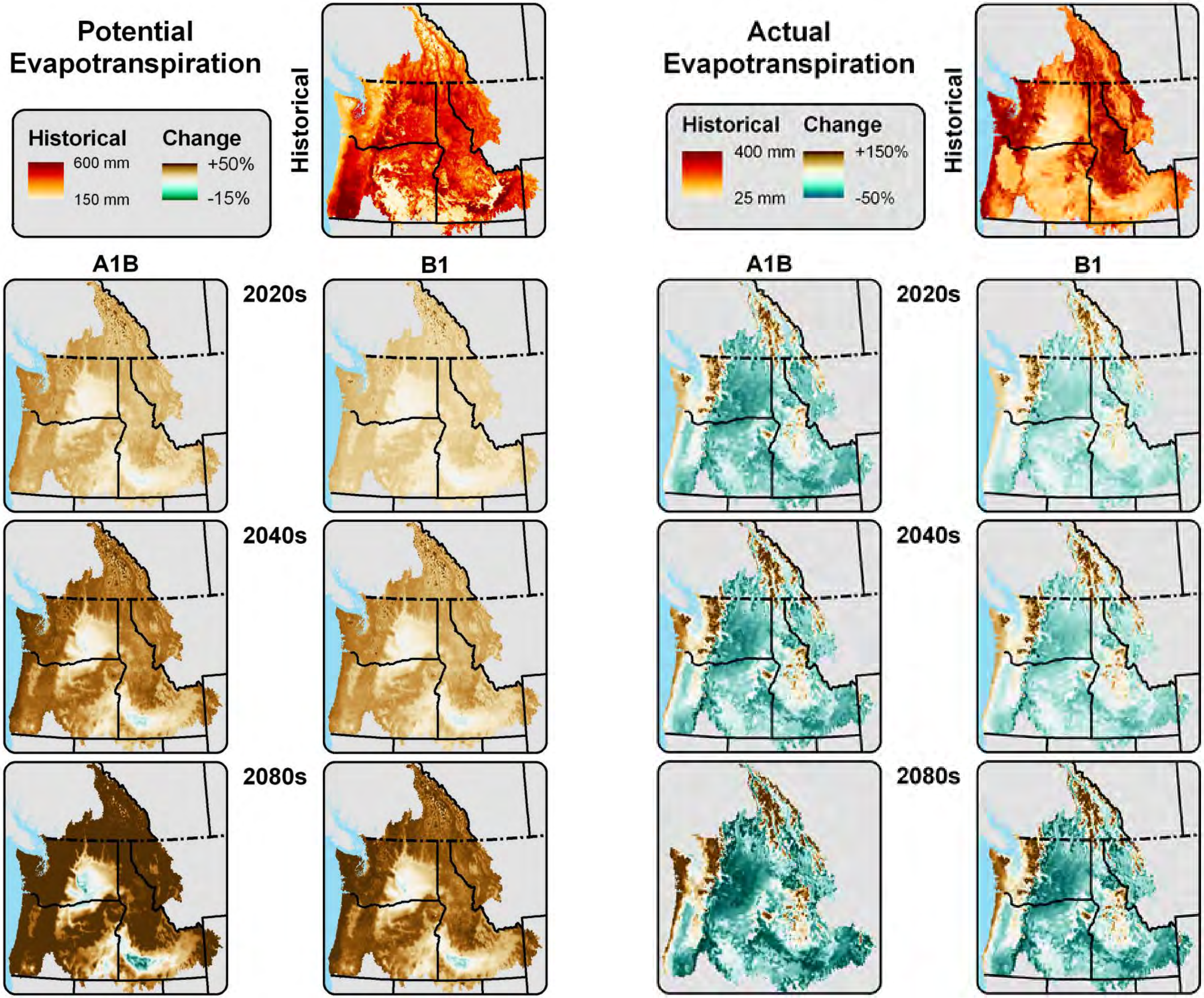
Yakima River at Parker

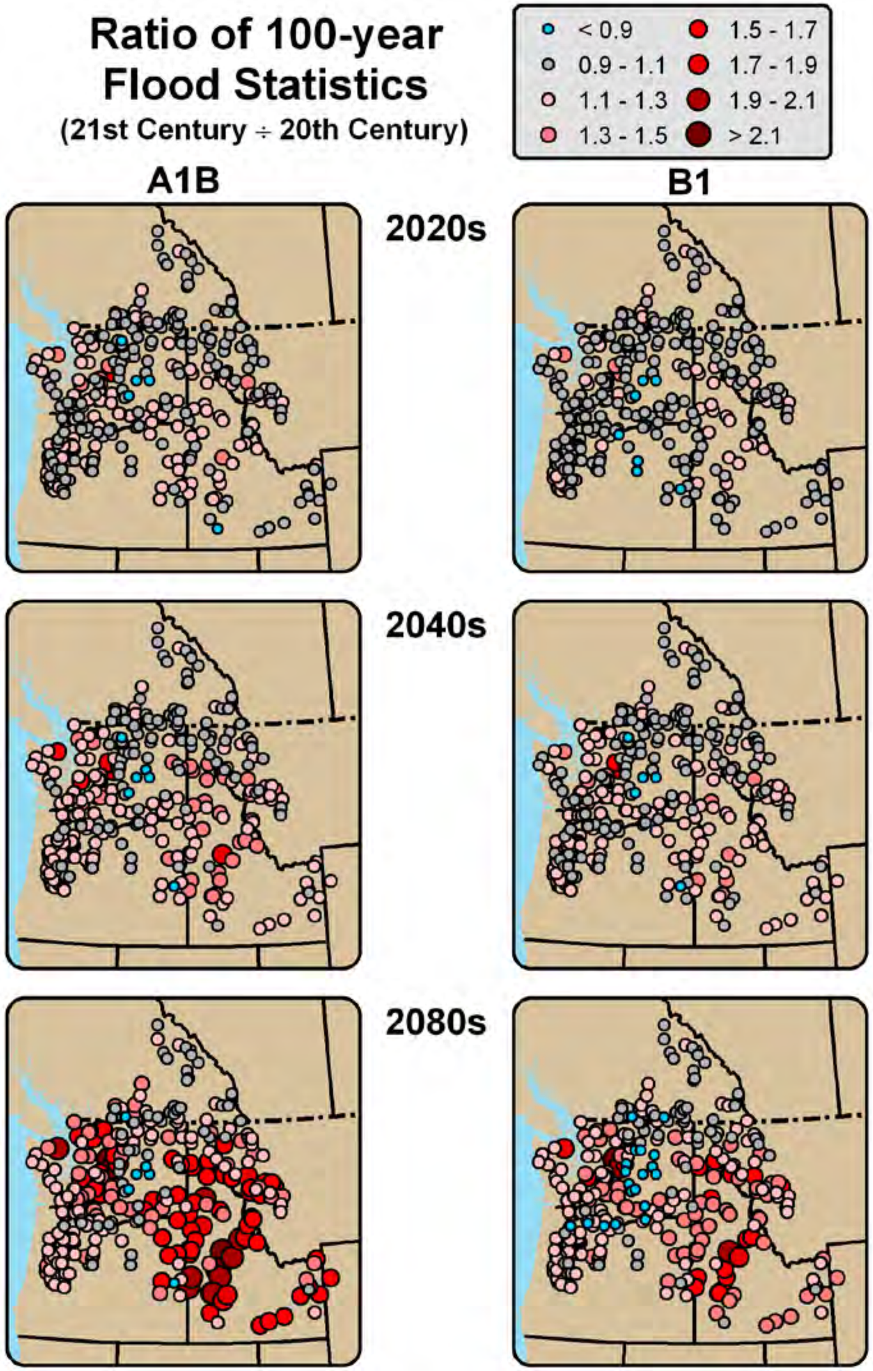


Chehalis River at Grand Mound

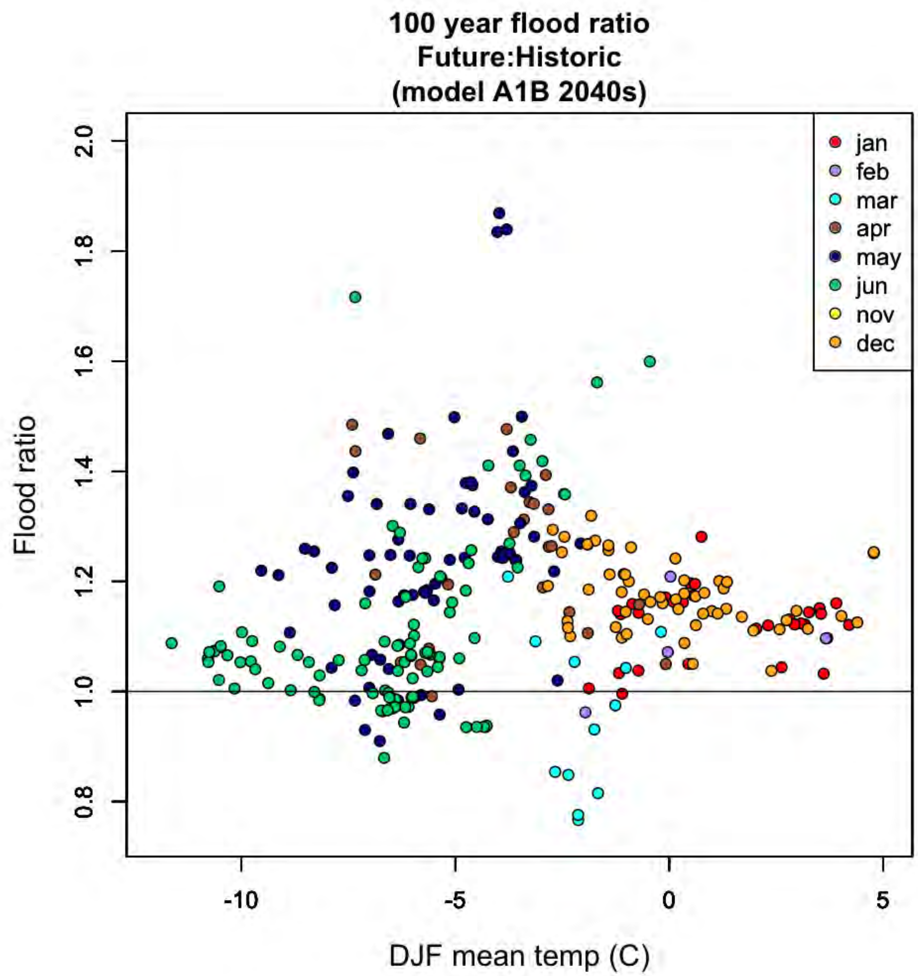


Changes in Summer Evapotranspiration

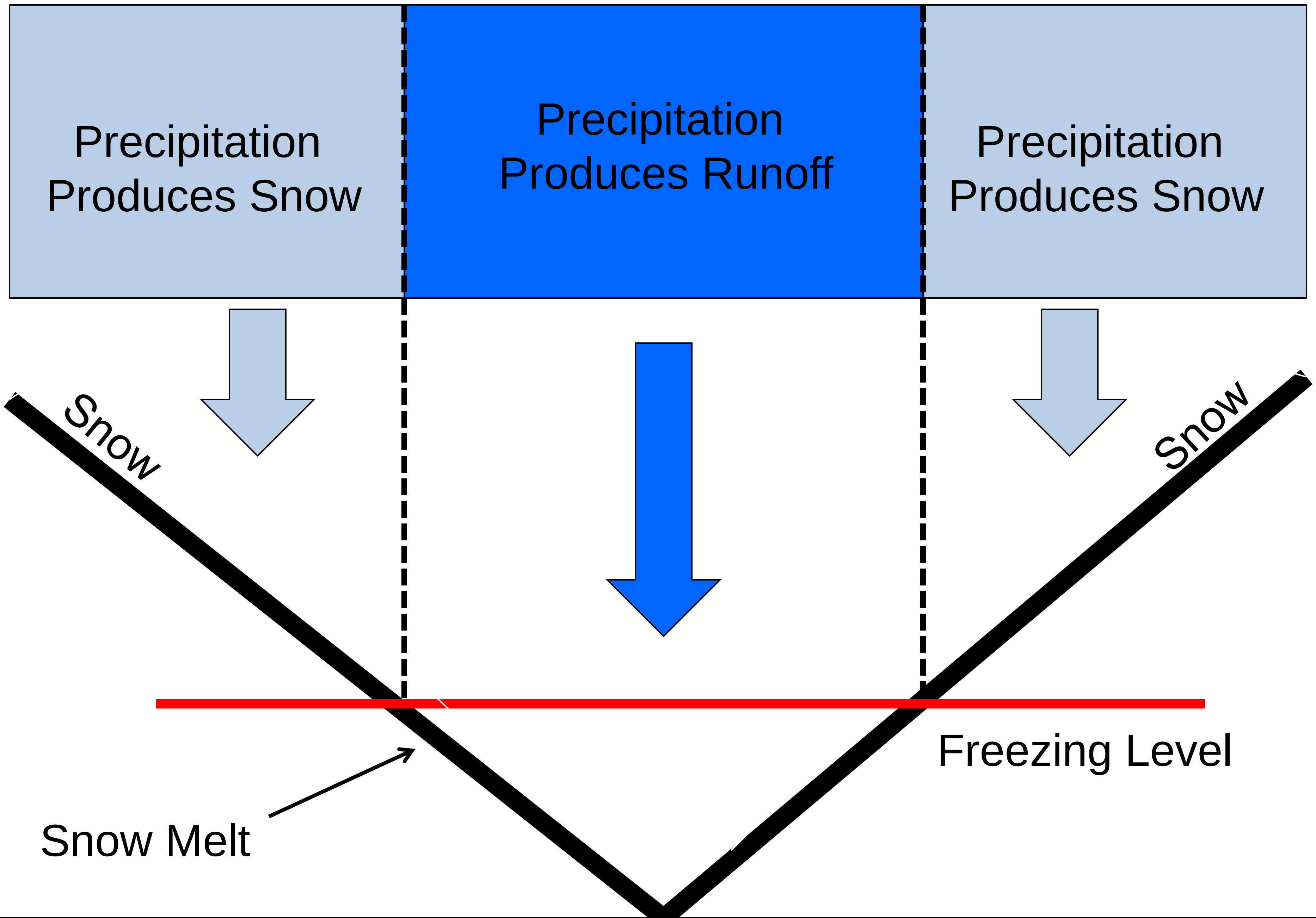




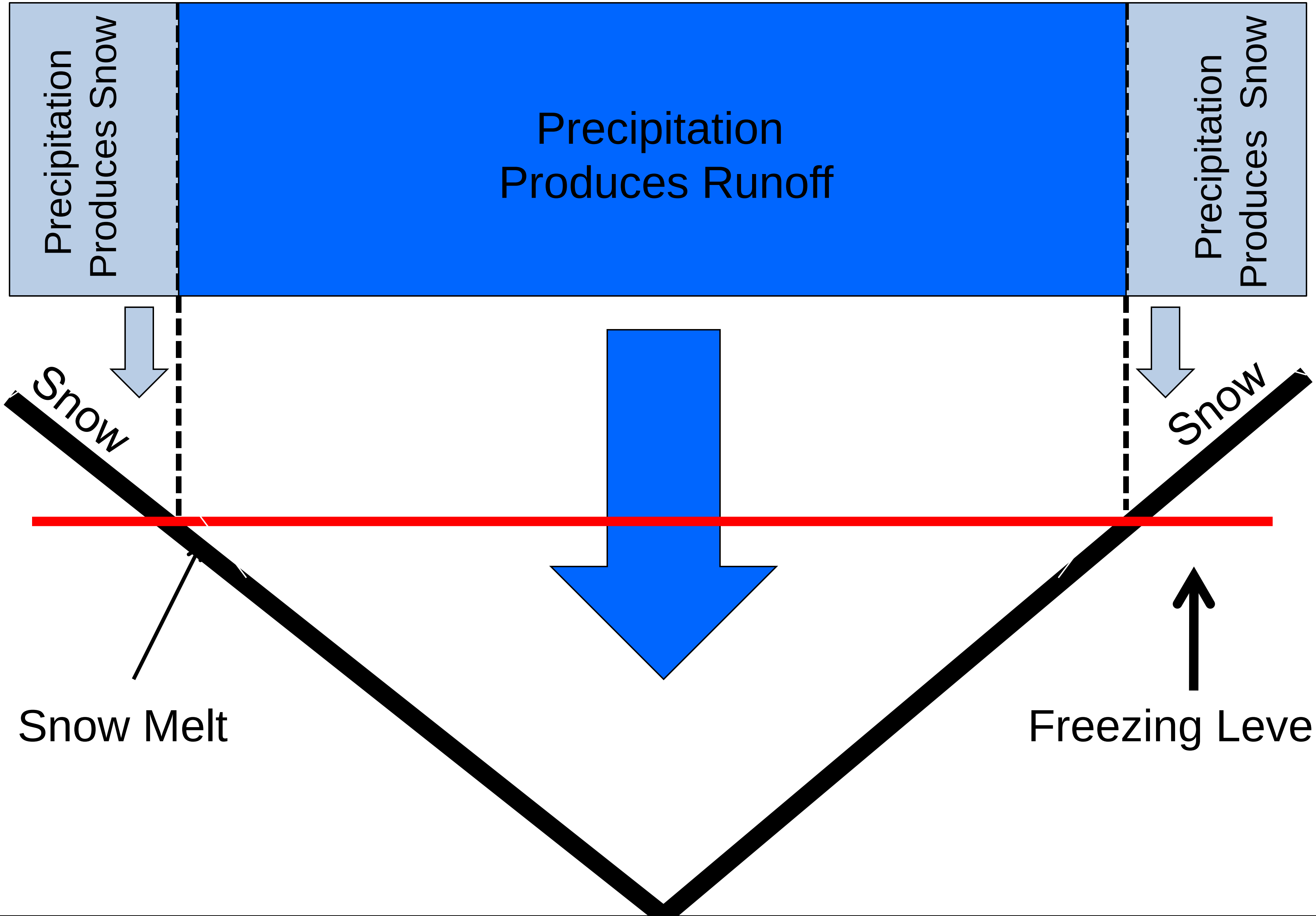
Changes in Flood Statistics



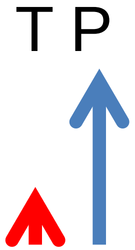
Schematic of a Cool Climate Flood



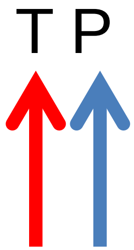
Schematic of a Warm Climate Flood



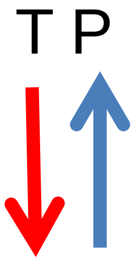
Summary of Flooding Impacts



Rain Dominant Basins:
Possible increases in flooding due to increased precipitation intensity, but no significant change from warming alone.



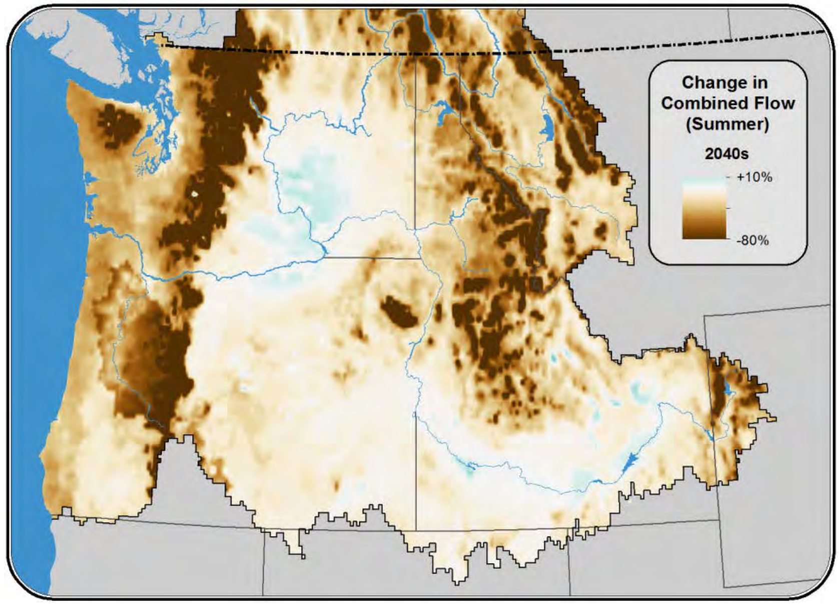
Mixed Rain and Snow Basins Along the Coast:
Strong increases due to warming and increased precipitation intensity (both effects increase flood risk)



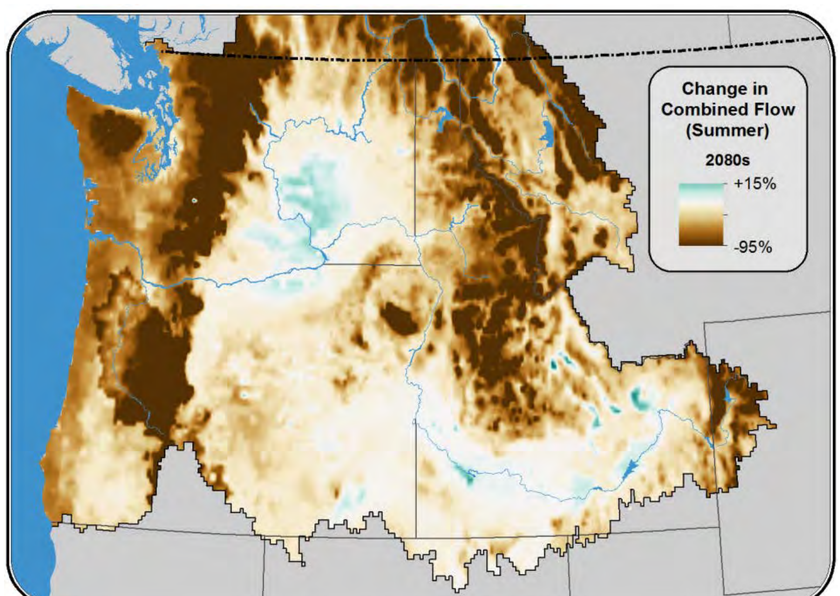
Inland Snowmelt Dominant Basins:
Relatively small overall changes because effects of warming (decreased risks) and increased precipitation intensity (increased risks) are in the opposite directions.

Changes in Summer (JJA) Runoff + Baseflow

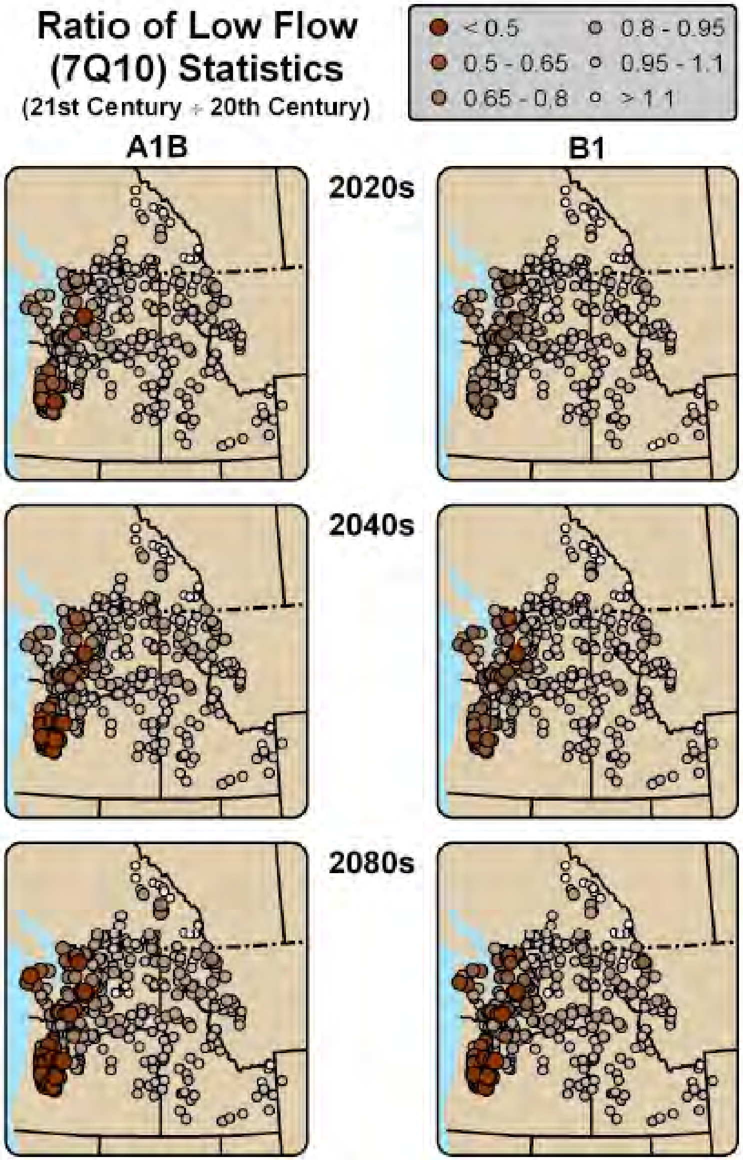
2040s



2080s



Changes in Extreme Low Flows



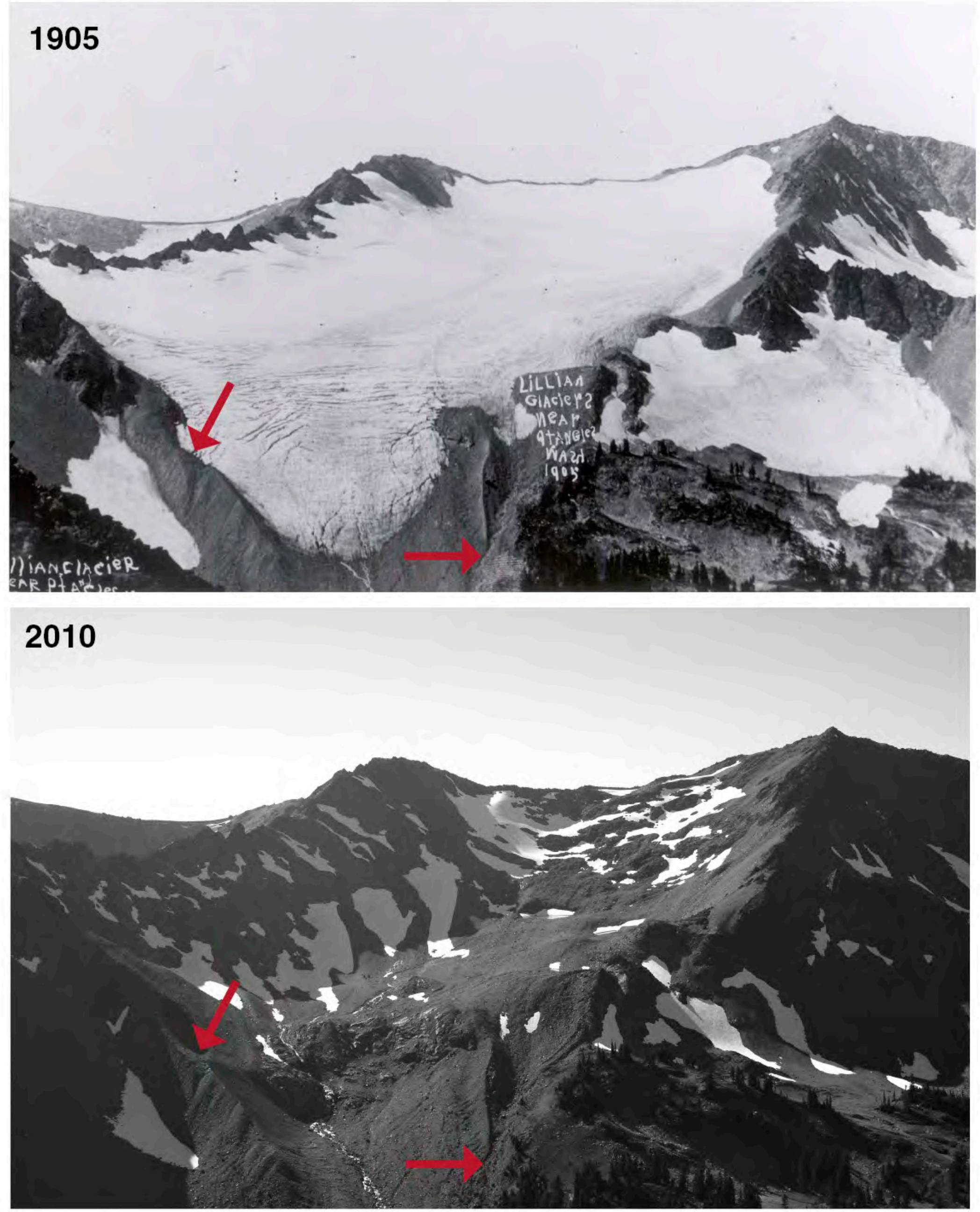
7Q10 values are projected to systematically decline in many areas due to loss of snowpack and projected drier summers.

http://www.hydro.washington.edu/2860/products/sites/r7climate/study_report/CBCCSP_chap7_extremes_final.pdf

PNW Glaciers are rapidly receding.

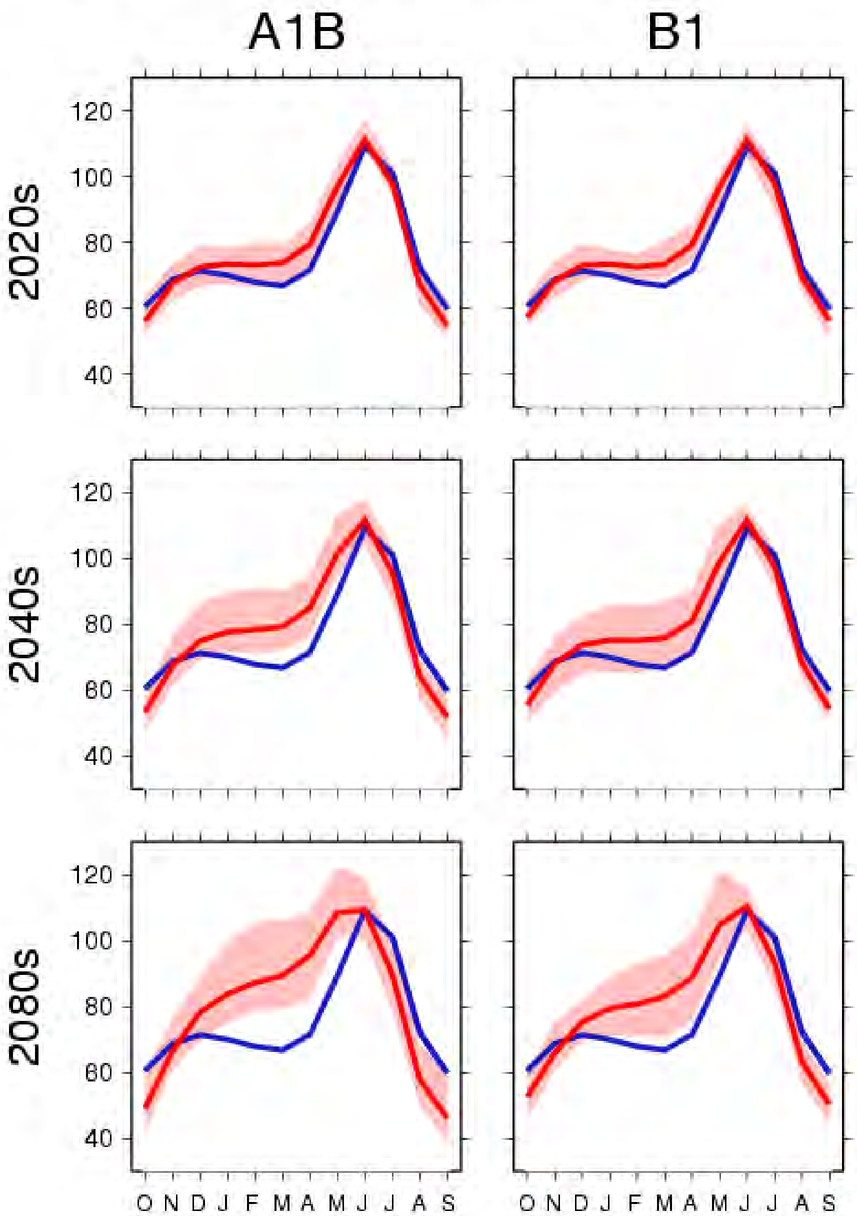
Some, like Lillian Glacier in the ONP, are already gone.

Olympic National Park - Lillian Glacier



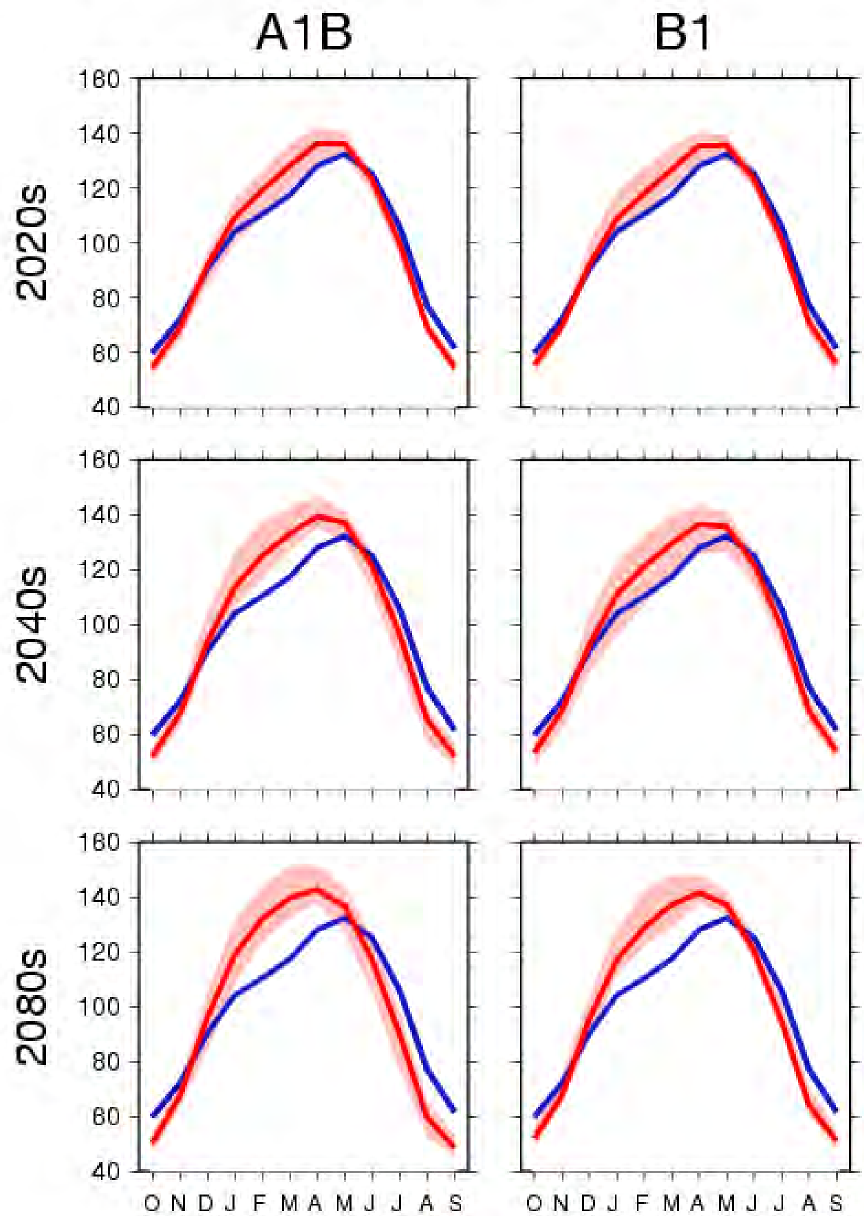
Loss of glacial mass is expected to *decrease* late summer flow in the long term, exacerbating impacts related to loss of snowpack.

total col. soil moisture (mm):



Kootentay at Corra Linn

total col. soil moisture (mm):



Yakima at Parker

Examples of Studies Using the CBCCSP Data

- *RMJOC Studies by the USBR, BPA, USACE*

[http://www.usbr.gov/pn/programs/climatechange/reports/index.html]

- *Columbia River Treaty Studies (BPA, many others)*

- *Washington State University (WSU, WADOE) Crop Water Demand and Water Supply Studies Under HB2860*

- *Washington State Integrated Climate Change Response Strategy --following the WA Climate Change Impacts Assessment in 2009*

- *West-Wide Modeling Extensions to Support USFS USFW Needs (e.g. Lynx, Wolverine, Trout studies)*

http://cses.washington.edu/picea/USFS/pub/Littell_etal_2010/Littell_etal._2011_Regional_Climatic_And_Hydrologic_Change_USFS_USFWS_JVA_17Apr11.pdf

- *2010 Seattle City Light Case Study*

http://cses.washington.edu/db/pdf/snoveretalscl709.pdf

Related Impacts

Agriculture

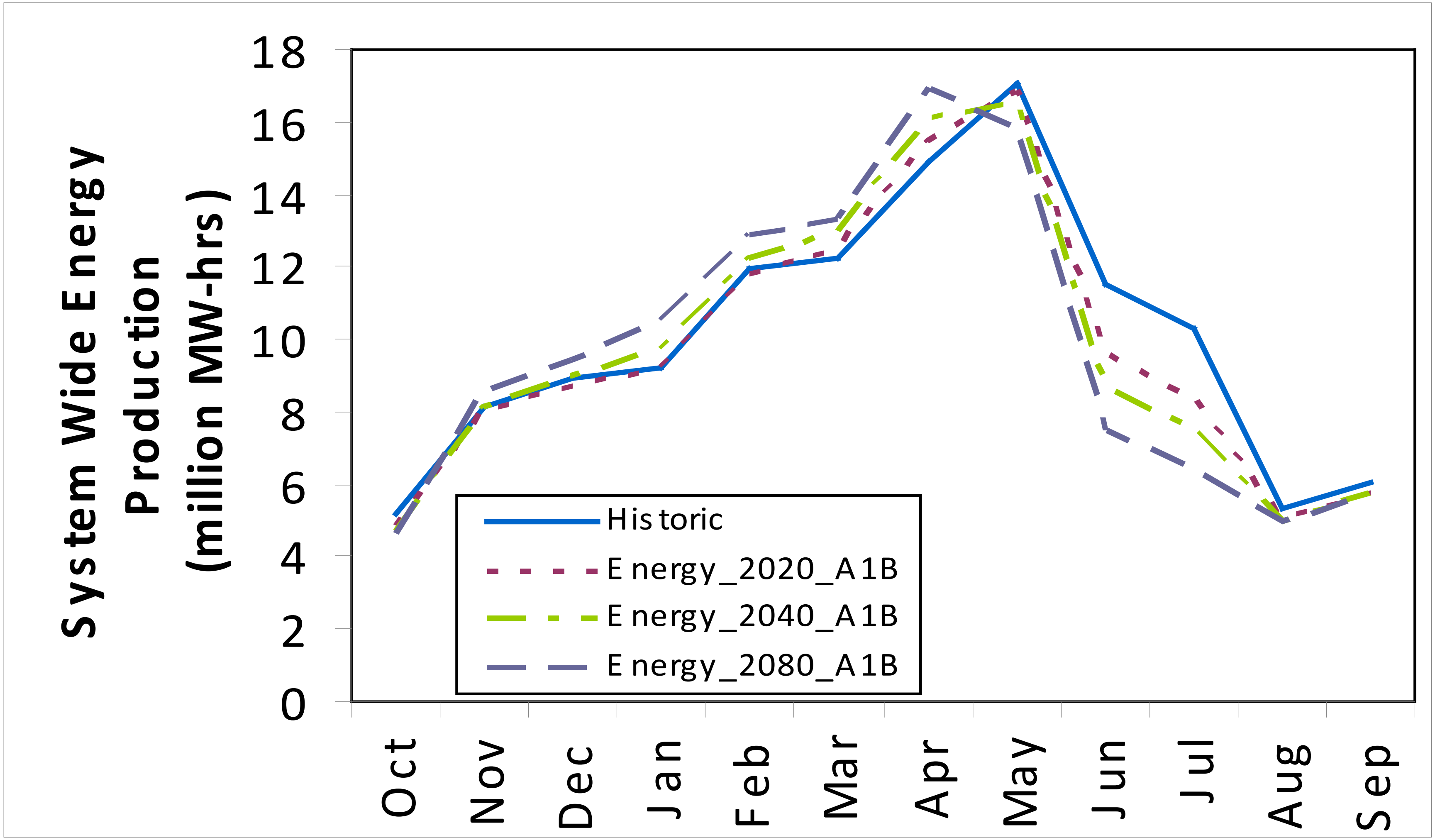
Municipal Water Supply

Damage to Infrastructure

Nisqually River at Sunshine Point (Nov, 2006)

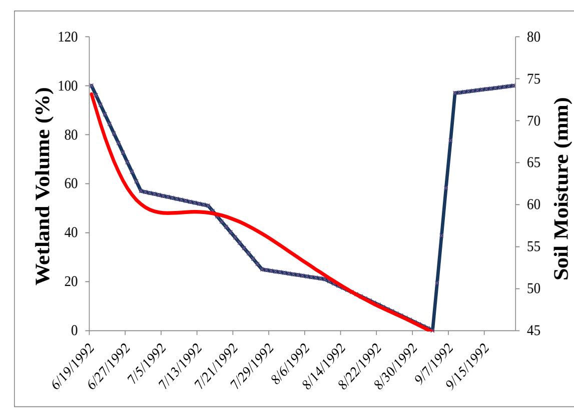
http://www.nps.gov/mora/parknews/upload/flooddamagev3.pdf

Streamflow Timing Shifts in the Columbia River Will Impact Regional Electrical Energy Production



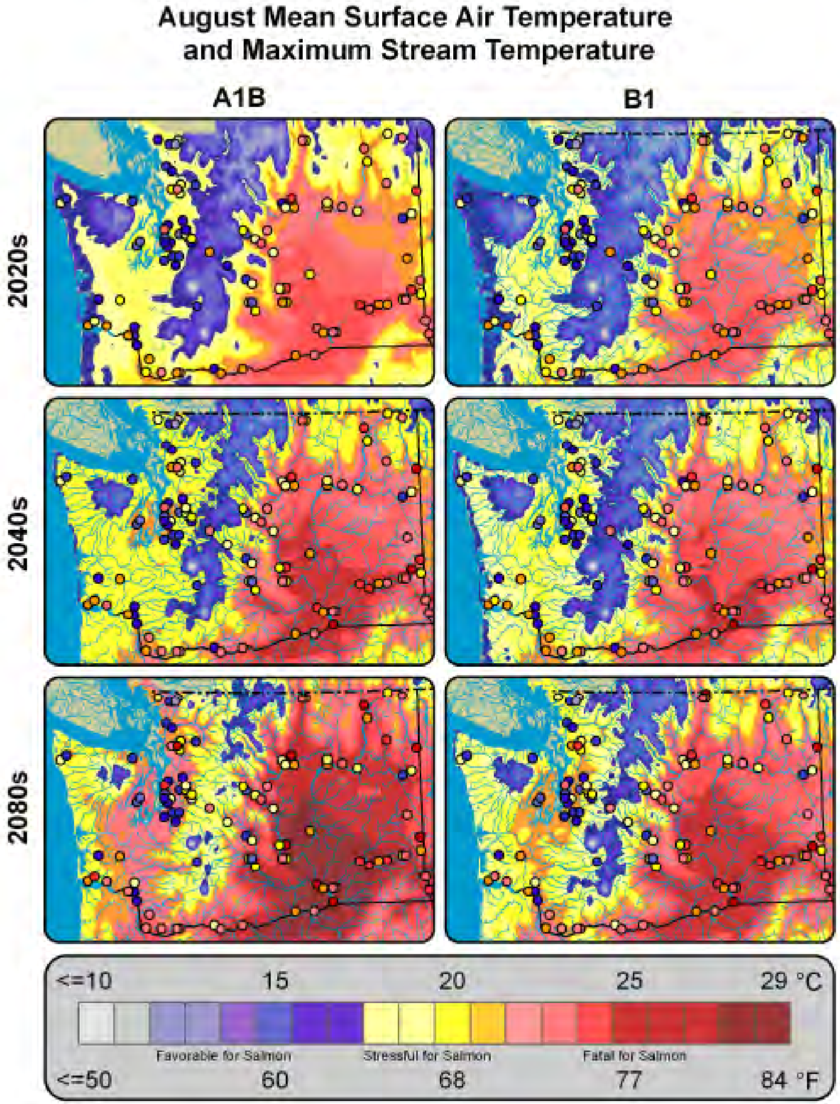
Hamlet et al., 2010: Effects of Projected Climate Change on Energy Supply and Demand in the Pacific Northwest and Washington State

Wetland Impacts



Red = Simulated Soil Moisture
Blue = Observed Wetland Volume

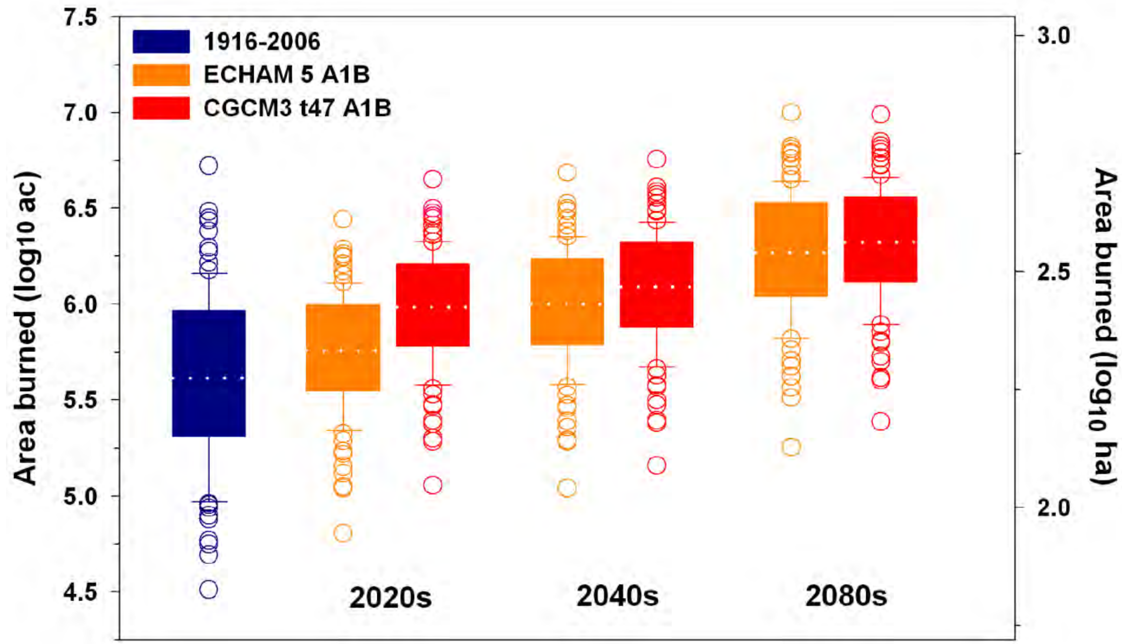
Impacts to Cold Water Fish



Mantua, N., I. Tohver, A.F. Hamlet, 2010: Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State, *Climatic Change*, online first, doi: 10.1007/s10584-010-9845-2

Forest Disturbance

July 30, 2010



Projected Area Burned in WA

Littell, J.S., E.E. Oneil, D. McKenzie, J.A. Hicke, J.A. Lutz, R.A. Norheim, and M.M. Elsner. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change 102(1-2): 129-158, doi: 10.1007/s10584-010-9858-x

Insect Attacks

Mountain Pine Beetle Damage in British Columbia

Increased Landslide Risks

Sediment Impacts

RAINIER'S ROCKS ARE FILLING RIVERBEDS

Dr. Tim Abbe 01.04.10 Restoration 2 Comments

The fallout from Mount Rainier's shrinking glaciers is beginning to roll downhill, and nowhere is the impact more striking than on the volcano's west side.

By Sandi Doughton
Seattle Times science reporter

Related:
Paul Kennard, NPS [by Steve Ringman, Seattle Times] flows (PDF)
Archive | State's shrinking glaciers: Going ... going ... gone? (2006)

The fallout from Mount Rainier's shrinking glaciers is beginning to roll downhill, and nowhere is the impact more striking than on the volcano's west side.

"This is it in spades," said Park Service geologist Paul Kennard, scrambling up a 10-foot-tall mass of dirt and boulders bulldozed back just enough to clear the road.

As receding glaciers expose crumbly slopes, vast amounts of gravel and sediment are being sluiced into the rivers that flow from the Northwest's tallest peak. Much of the material sweeps down in rain-driven slurries called debris flows, like those that repeatedly have slammed Mount Rainier National Park's Westside Road.

http://www.abbegeomorphology.com/?p=69

Winter Recreation


Summer Recreation

Coastal Impacts

Effects of a “King Tide” at the Nisqually Wildlife Refuge in Sound Puget Sound on Feb 2, 2010 (photo by Russ McMillan).