Potential Effects of Climate Change in the Kootenay Lake Basin

Photo Credit: Douglas Noblet

Chris Frans, Ph.D.

U.S. Army Corps of Engineers, Seattle District

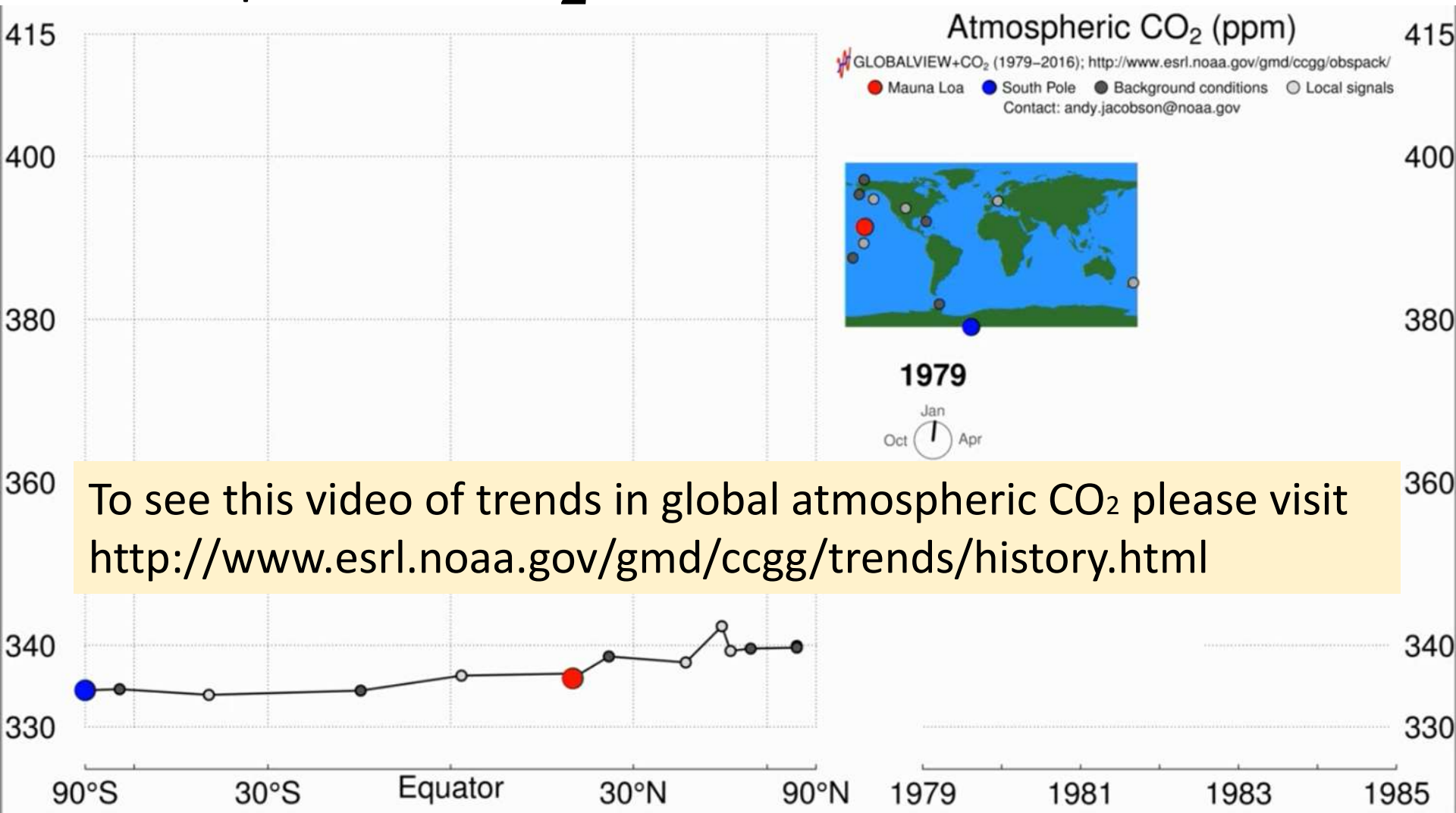International Kootenay Lake Board of Control Meeting

September 22, 2016

US Army Corps of Engineers.

International Joint Commission-United States and Canada

Overview

- Current studies are in progress to assess hydrologic impacts of climate change

- Climate change will likely bring higher unregulated winter flows during the drawdown period on Kootenay lake

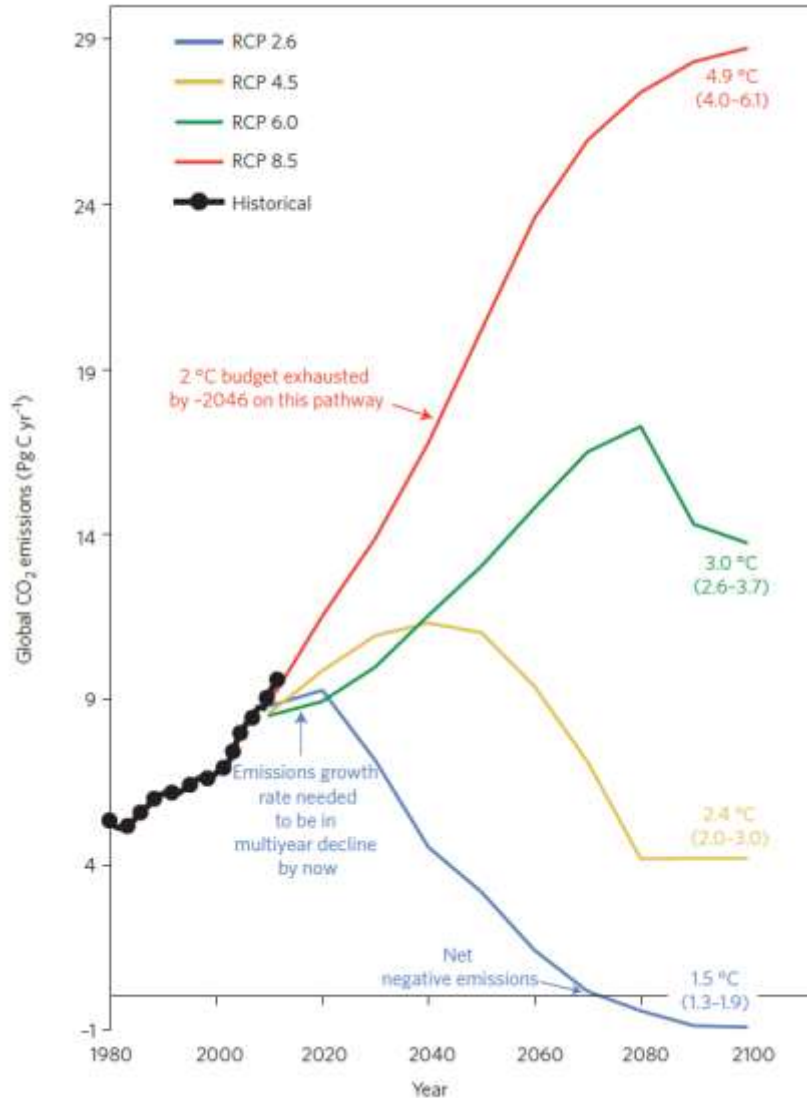- Projected changes in peak spring freshet flows are more uncertain

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Atmospheric CO_2

Atmospheric CO_2 (ppm)

GLOBALVIEW+CO_2 (1979–2016); http://www.esrl.noaa.gov/gmd/ccgg/obspack/

🔴 Mauna Loa   🔵 South Pole   ⚫ Background conditions   ⚪ Local signals

Contact: andy.jacobson@noaa.gov

1979

Jan
Oct | Apr

To see this video of trends in global atmospheric CO_2 please visit http://www.esrl.noaa.gov/gmd/ccgg/trends/history.html

90°S   30°S   Equator   30°N   90°N   1979   1981   1983   1985

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Emissions Scenarios

Scenarios developed by Intergovernmental Panel on Climate Change (IPCC):

RCP8.5
"Business as usual", rising
currently surpassing this rate

RCP6.0
Peak at ~2080, Stabilization after 2100

**RCP4.5**
Peak at ~2050, Stabilization after 2100

RCP2.6
Near term peak, decline to net negative emissions
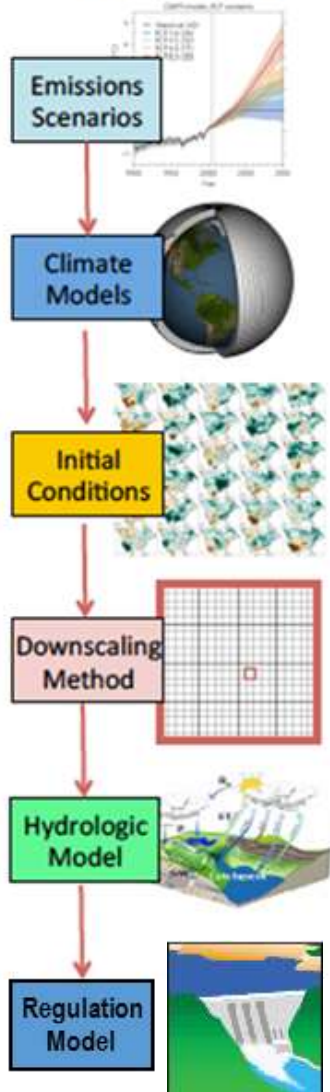*Presently no technology to make feasible*

Image: Sanford, Todd, et al. "The climate policy narrative for a dangerously warming world."
Nature Climate Change 4.3 (2014): 164-166.

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Emissions Scenarios: Warming

CMIP5 models, RCP scenarios
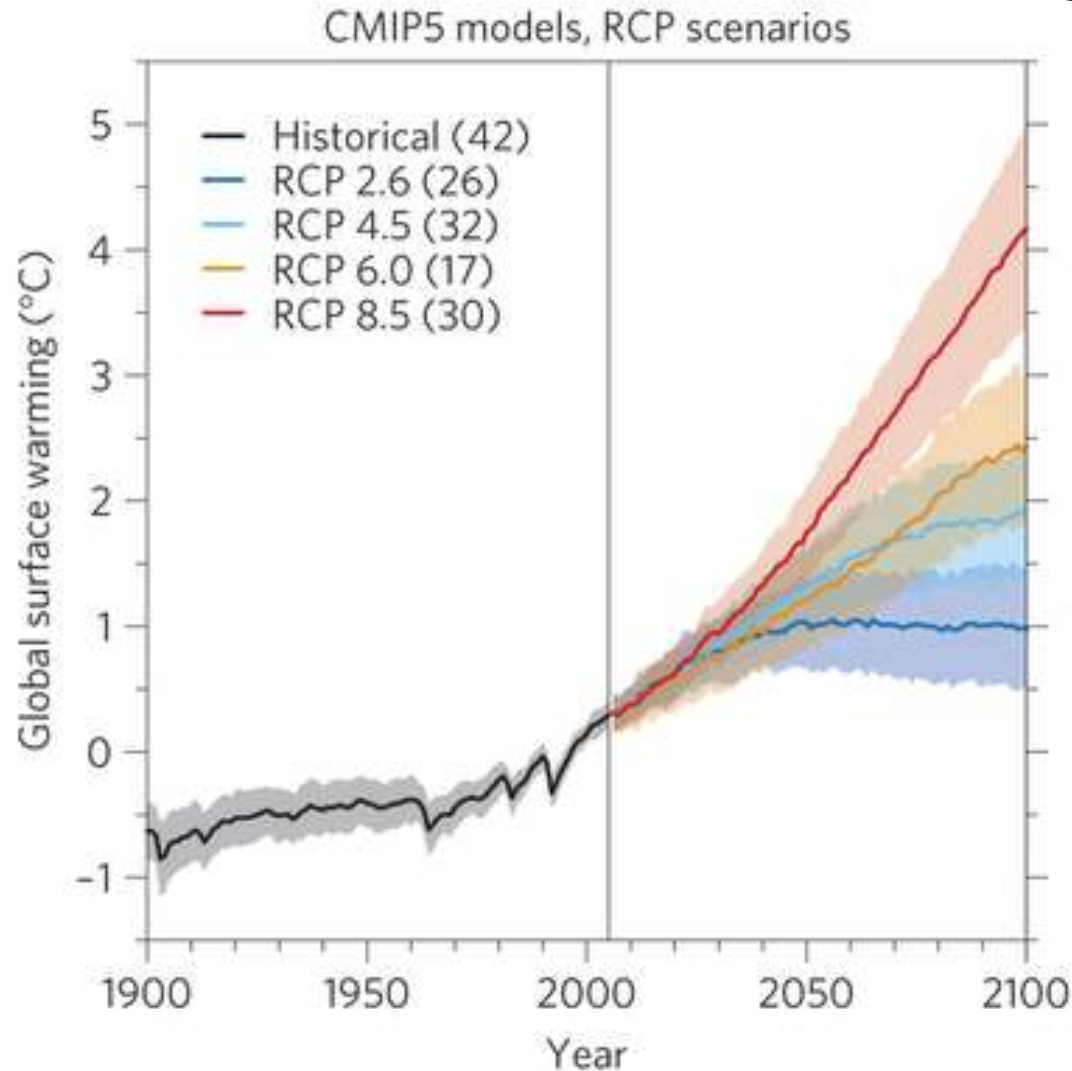
R. Knutti and J. Sedláček *Nature Climate Change* **3**, 369-373 (2013) doi:10.1038/nclimate1716

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Climate Impacts Modeling Chain

Emissions Scenarios

Climate Models

Initial Conditions

Downscaling Method

Hydrologic Model

Regulation Model

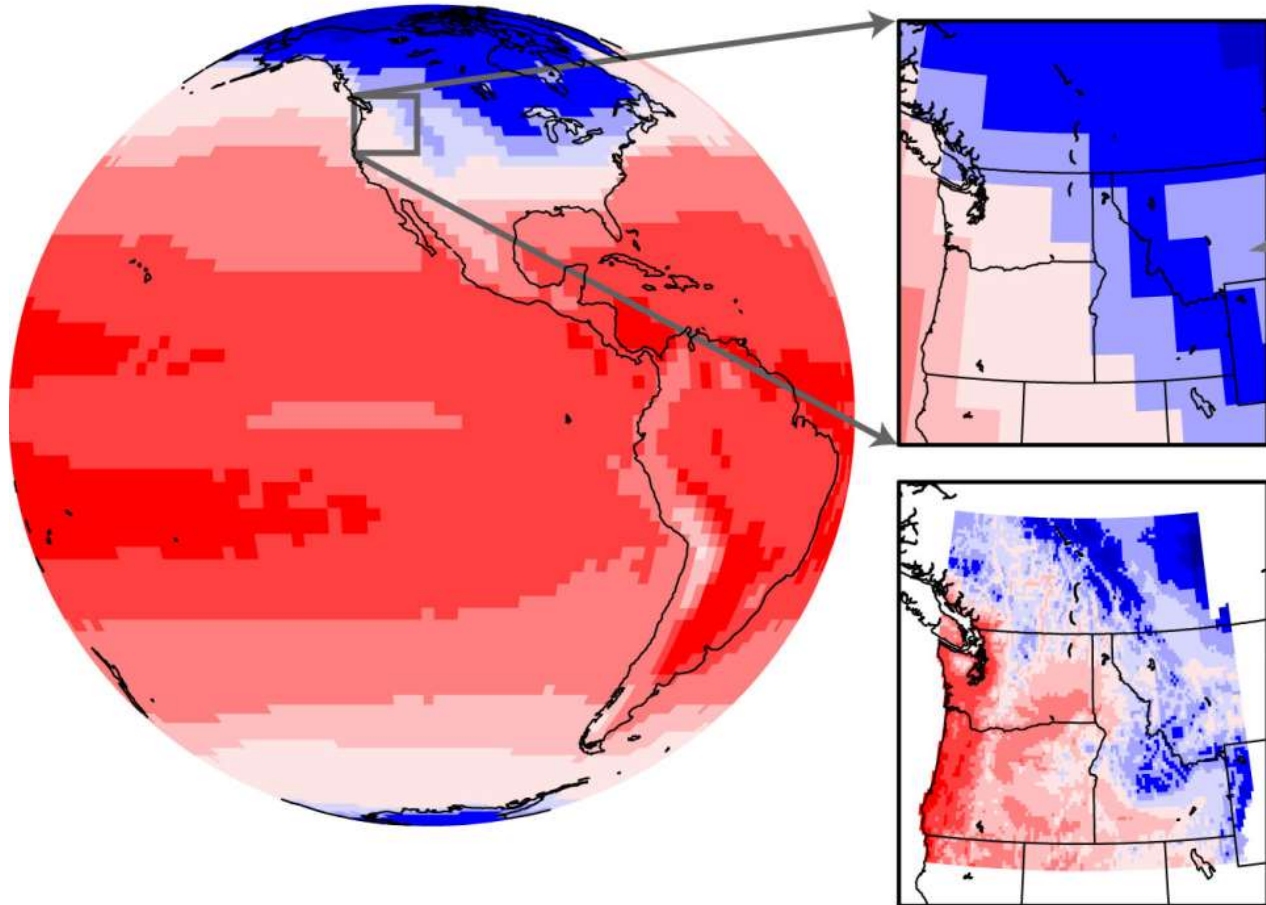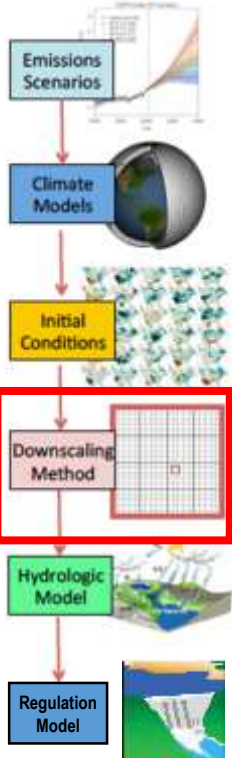# Hydrologic Impact Assessment Process

Global Climate Models
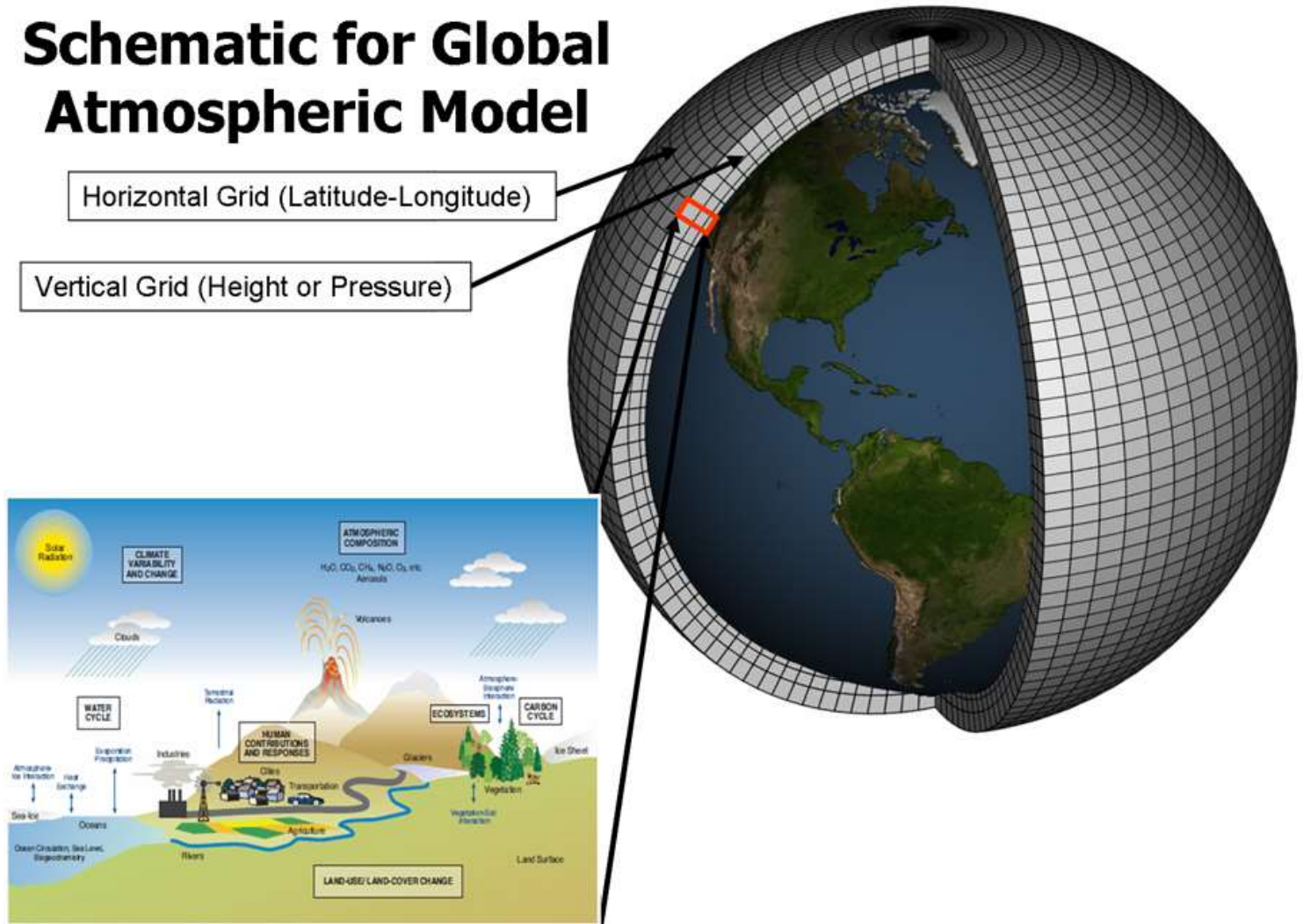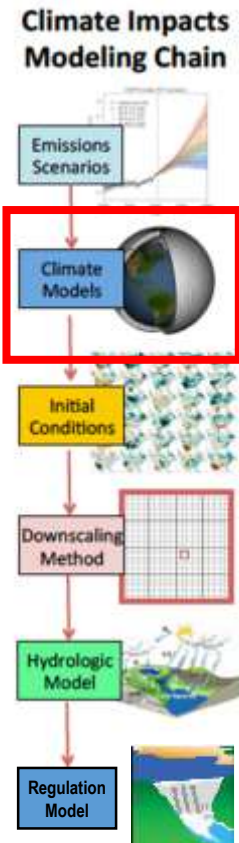
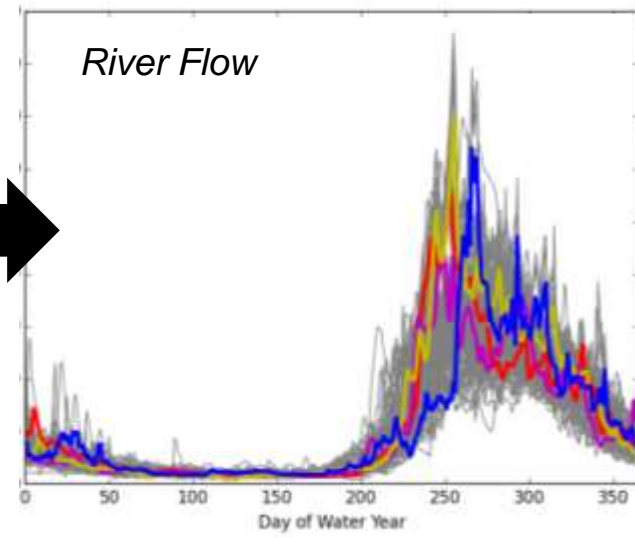Image: http://www.gfdl.noaa.gov/pix/model_development/climate_modeling/climatemodel.png
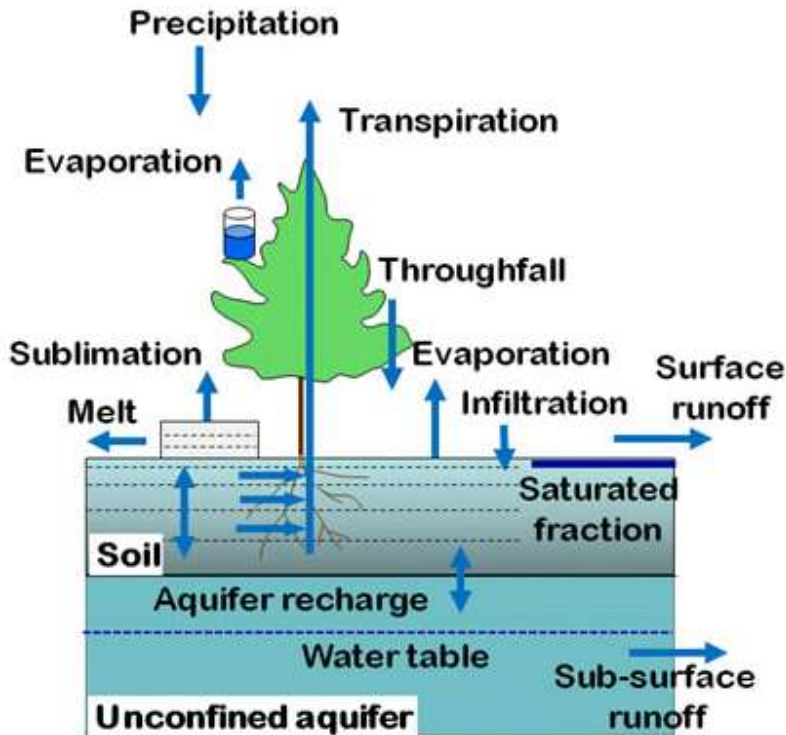
Downscaling

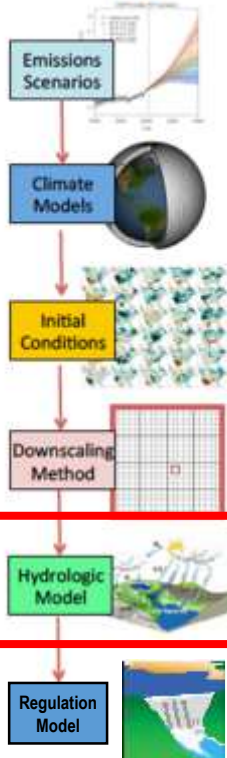**Climate Impacts Modeling Chain**

Emissions Scenarios

Climate Models

Initial Conditions

Downscaling Method

Hydrologic Model

Regulation Model

Downscaling

statistical, psuedo-dynamical, dynamical techniques

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Figure courtesy of UW Climate Impacts Group

Hydrological Models

Climate Impacts Modeling Chain

Emissions Scenarios

Climate Models

Initial Conditions

Downscaling Method

Hydrologic Model

Regulation Model

Precipitation

Transpiration

Evaporation

Throughfall

Sublimation

Evaporation

Surface runoff

Melt

Infiltration

Saturated fraction

Soil

Aquifer recharge

Water table

Sub-surface runoff

Unconfined aquifer

River Flow

Day of Water Year
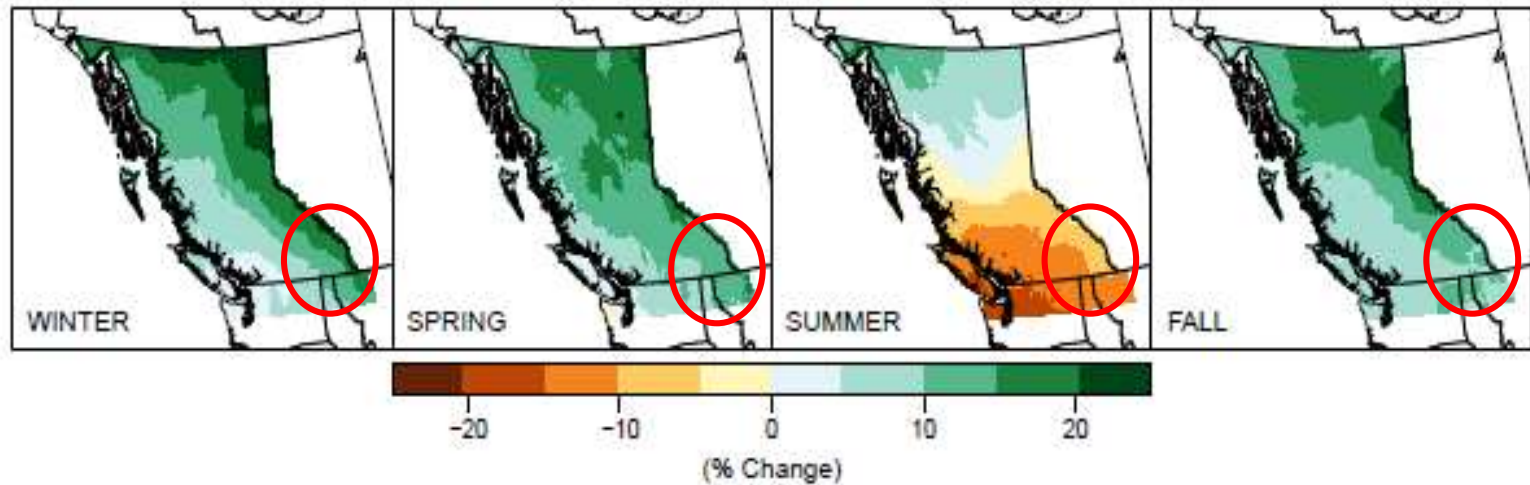
Model image: www.cesm.ucar.edu/models/clm/hydrologic.html

Regulation Models

Potential Changes to the Hydrology of Kootenay Lake

Median Precipitation Change Projected for the 2050s

WINTER SPRING SUMMER FALL

(% Change)

Median Temperature Change Projected for the 2050s

WINTER SUMMER

PACIFIC CLIMATE
IMPACTS CONSORTIUM

1.0   2.0   3.0   4.0
(°C Change)
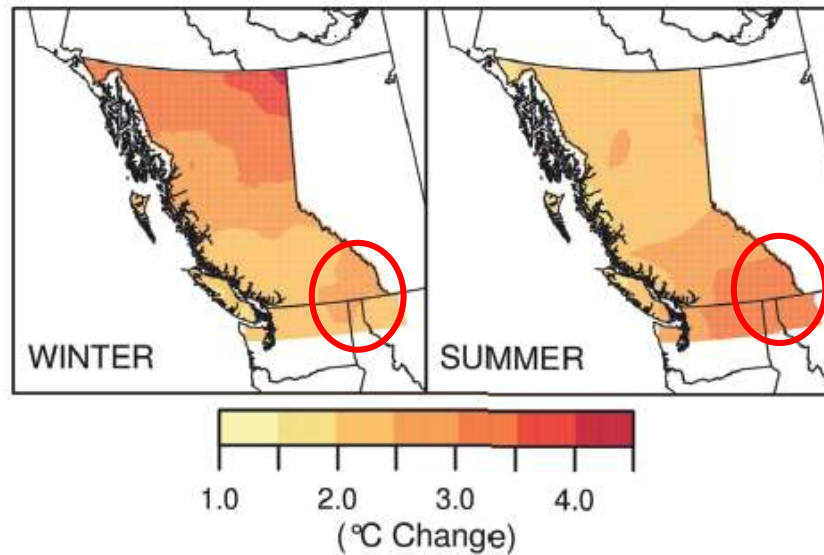
Δ1°C = Δ1.8°F
Δ2°C = Δ3.6°F
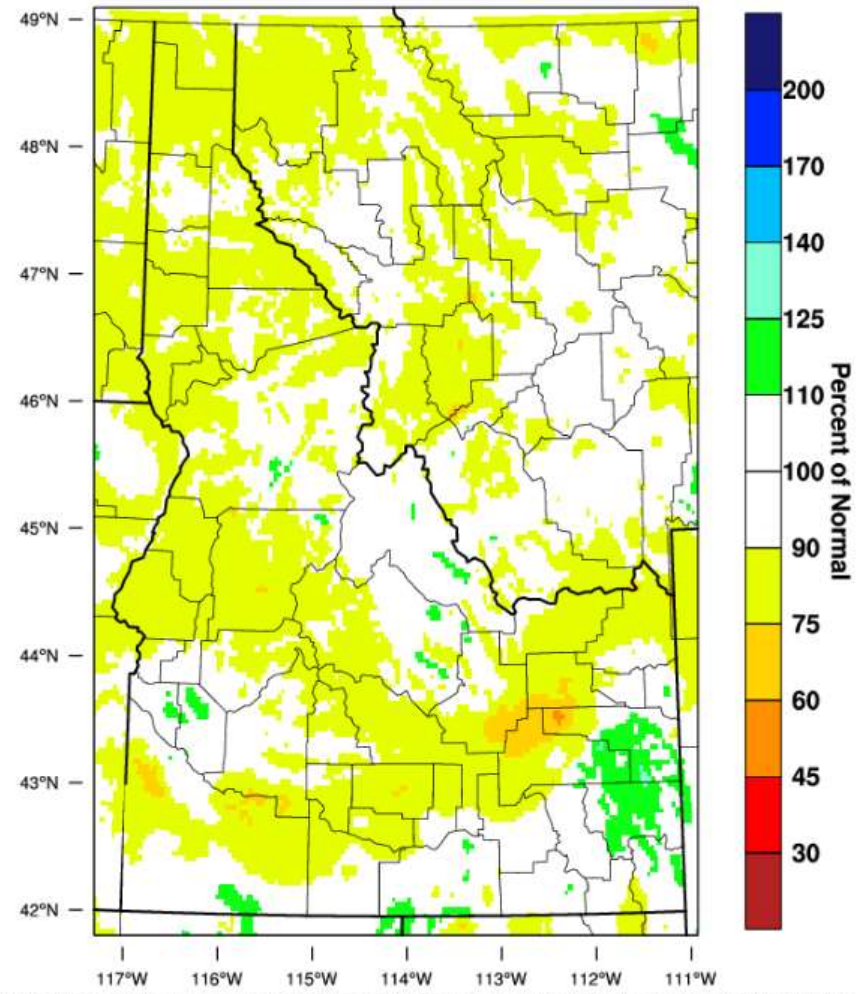Δ3°C = Δ5.3°F
Δ4°C = Δ7.1°F

WY 2015, a trial run of the future?

October-September 2015 Departure from 1981-2010 Normal
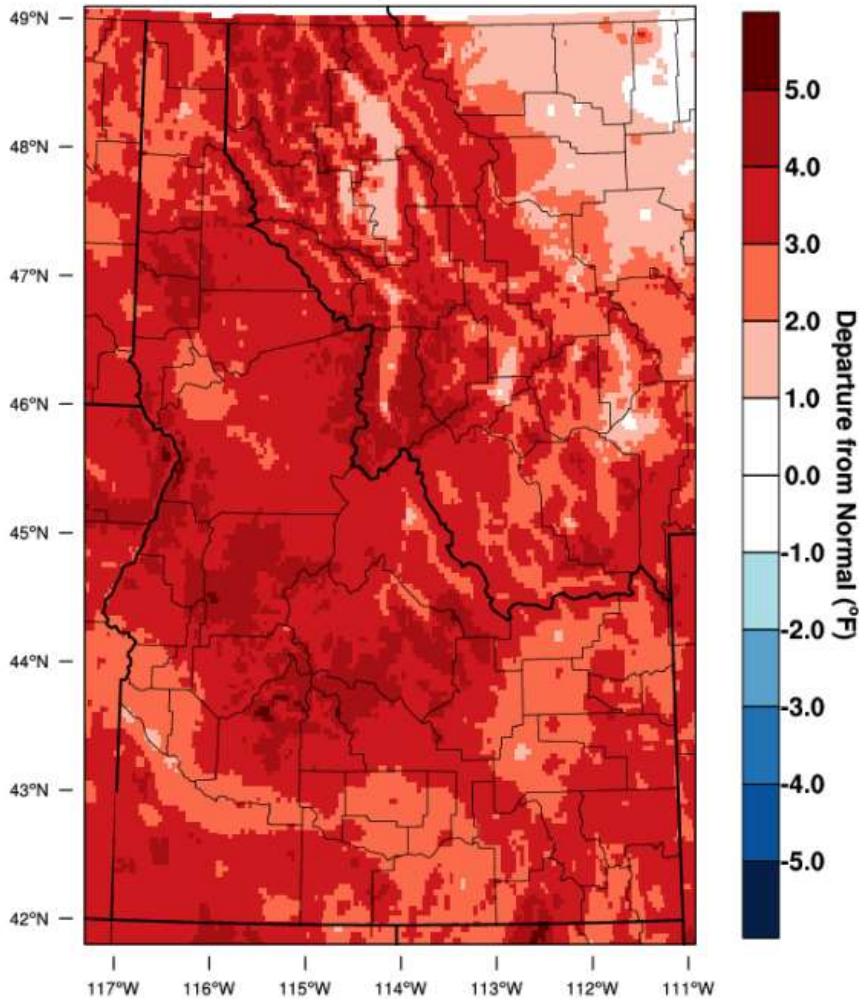
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Final), created 16 APR 2016

October-September 2015 Percent of 1981-2010 Normal

WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Final), created 16 APR 2016

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WY 2015: British Columbia

Temperature

Precipitation
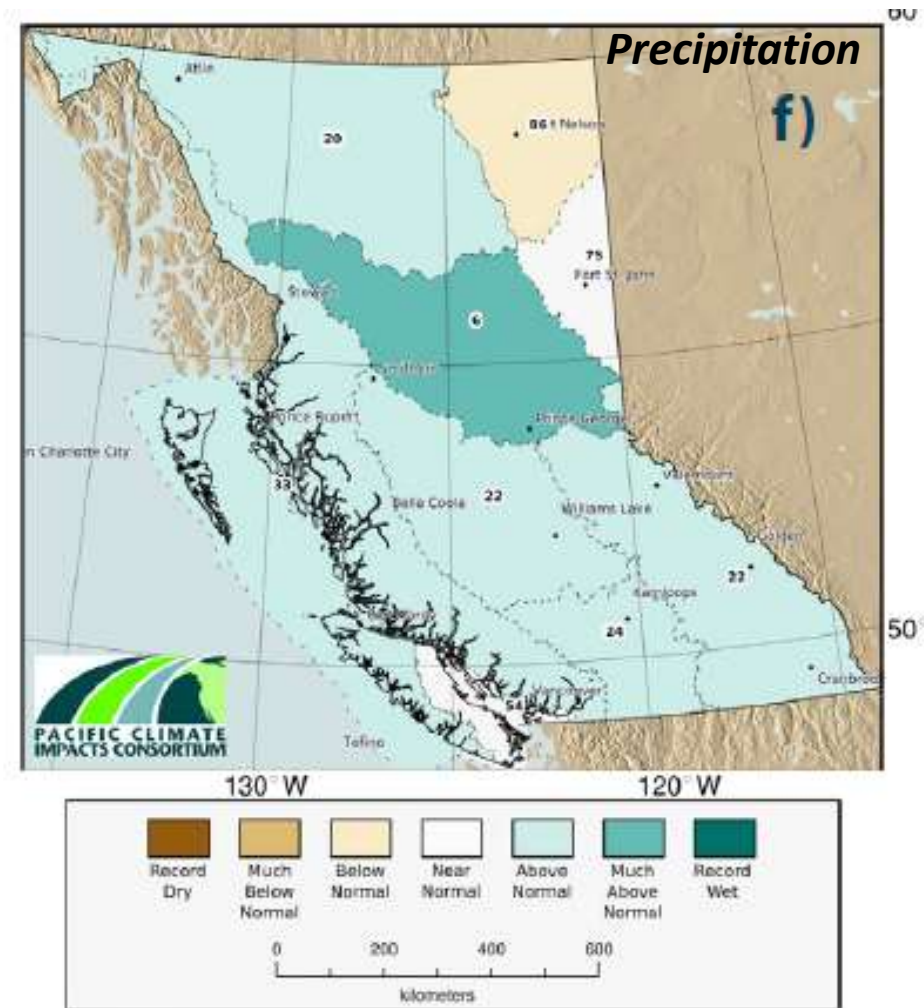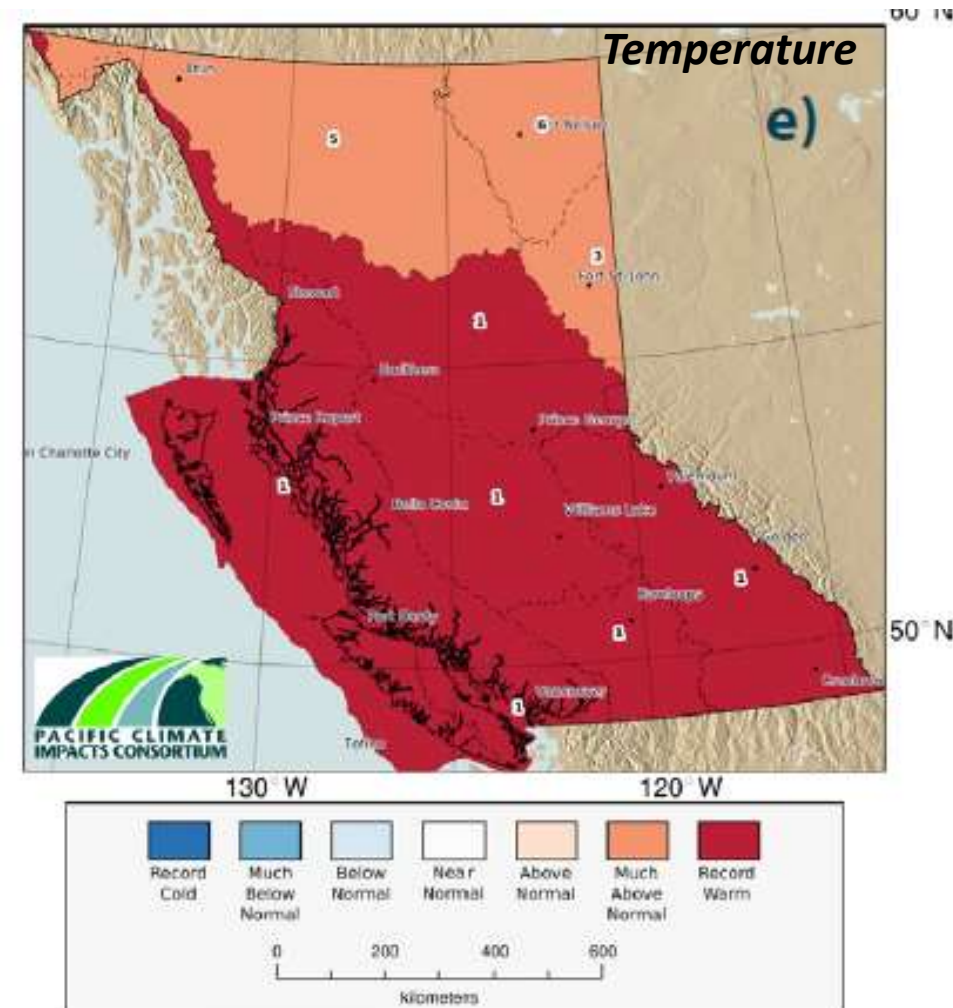
https://pacificclimate.org/sites/default/files/publications/2015_Year_in_Review-Final.pdf
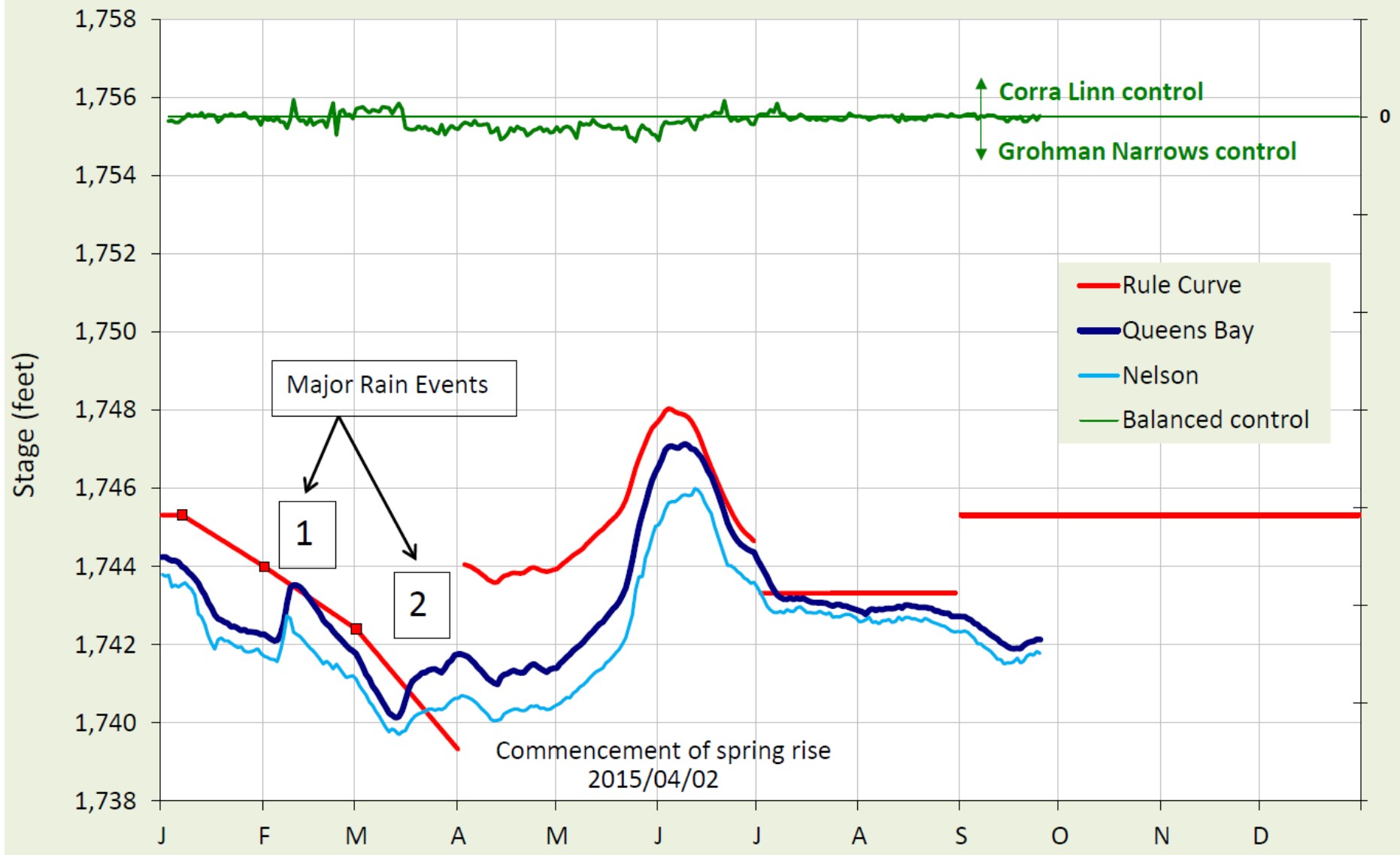
14

RCP8.5 Projected Annual Temperature: Kootenai River Basin
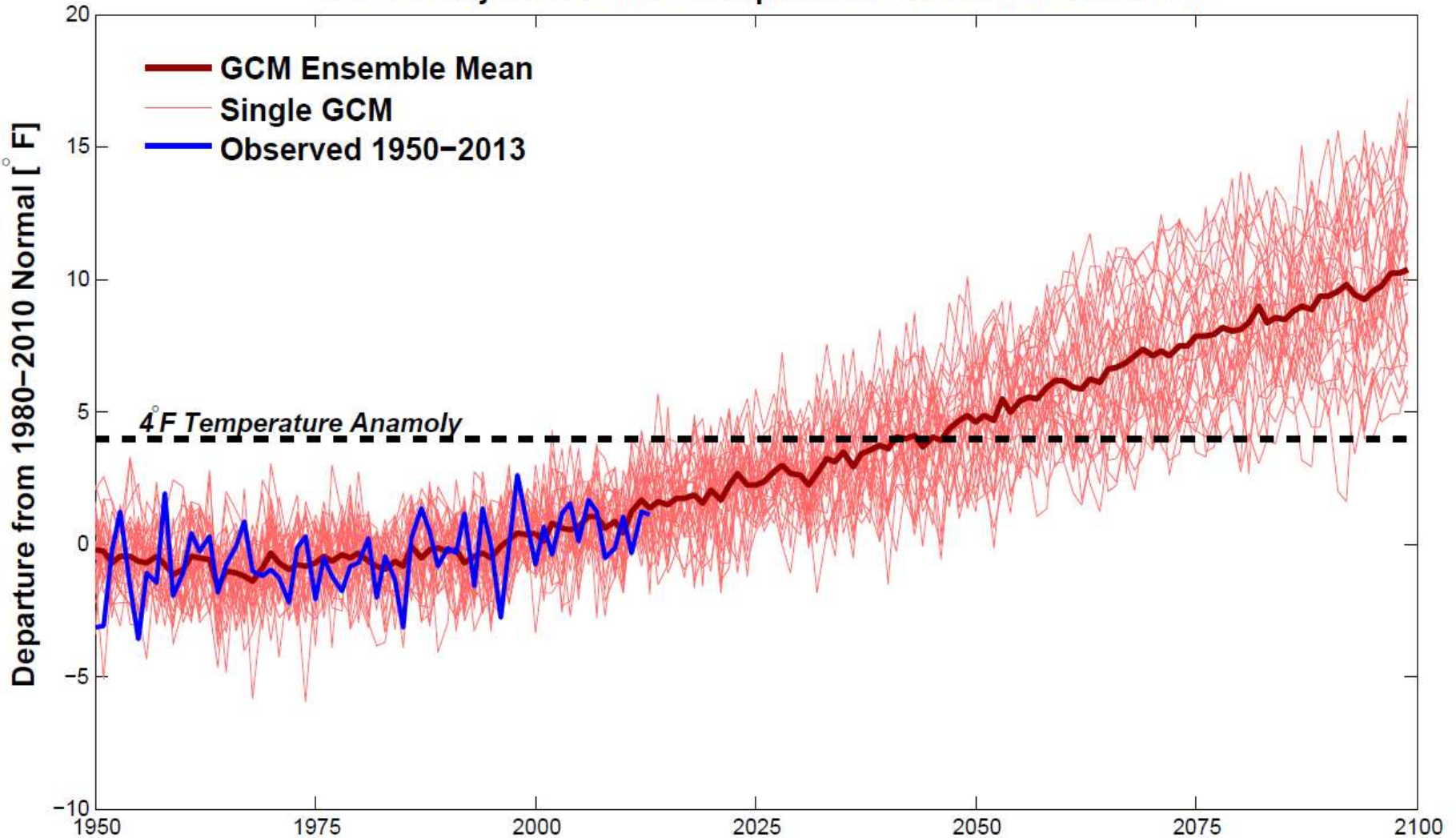
GCM Data Source: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/
Maurer, E. P., L. Brekke, T. Pruitt, and P. B. Duffy (2007), 'Fine-resolution climate projections enhance regional climate change impact studies', *Eos Trans. AGU, 88*(47), 504.

Observed Data Source:
Livneh B., T.J. Bohn, D.S. Pierce, F. Munoz-Ariola, B. Nijssen, R. Vose, D. Cayan, and L.D. Brekke, 2015: A spatially comprehensive, hydrometeorological data set for Mexico, the U.S., and southern Canada 1950-2013, Nature Scientific Data, 5:150042, doi:10.1038/sdata.2015.42.

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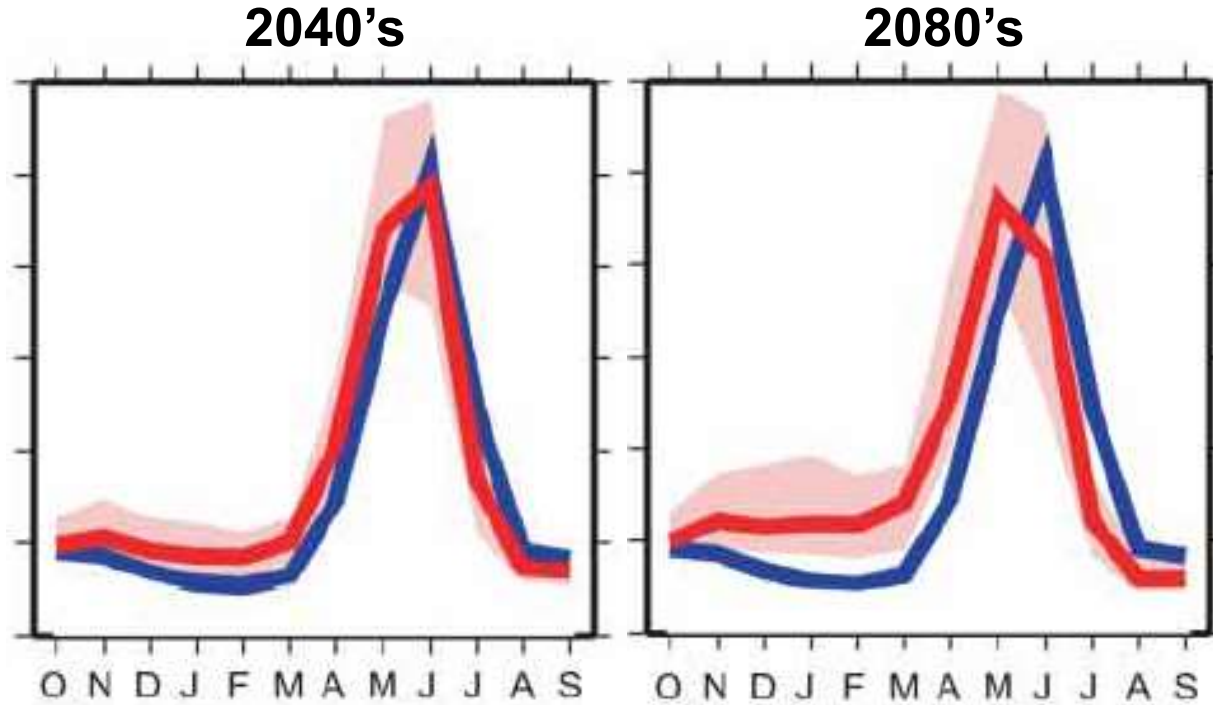Kootenay Lake Hydrograph 2015

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Temperature Sensitivity
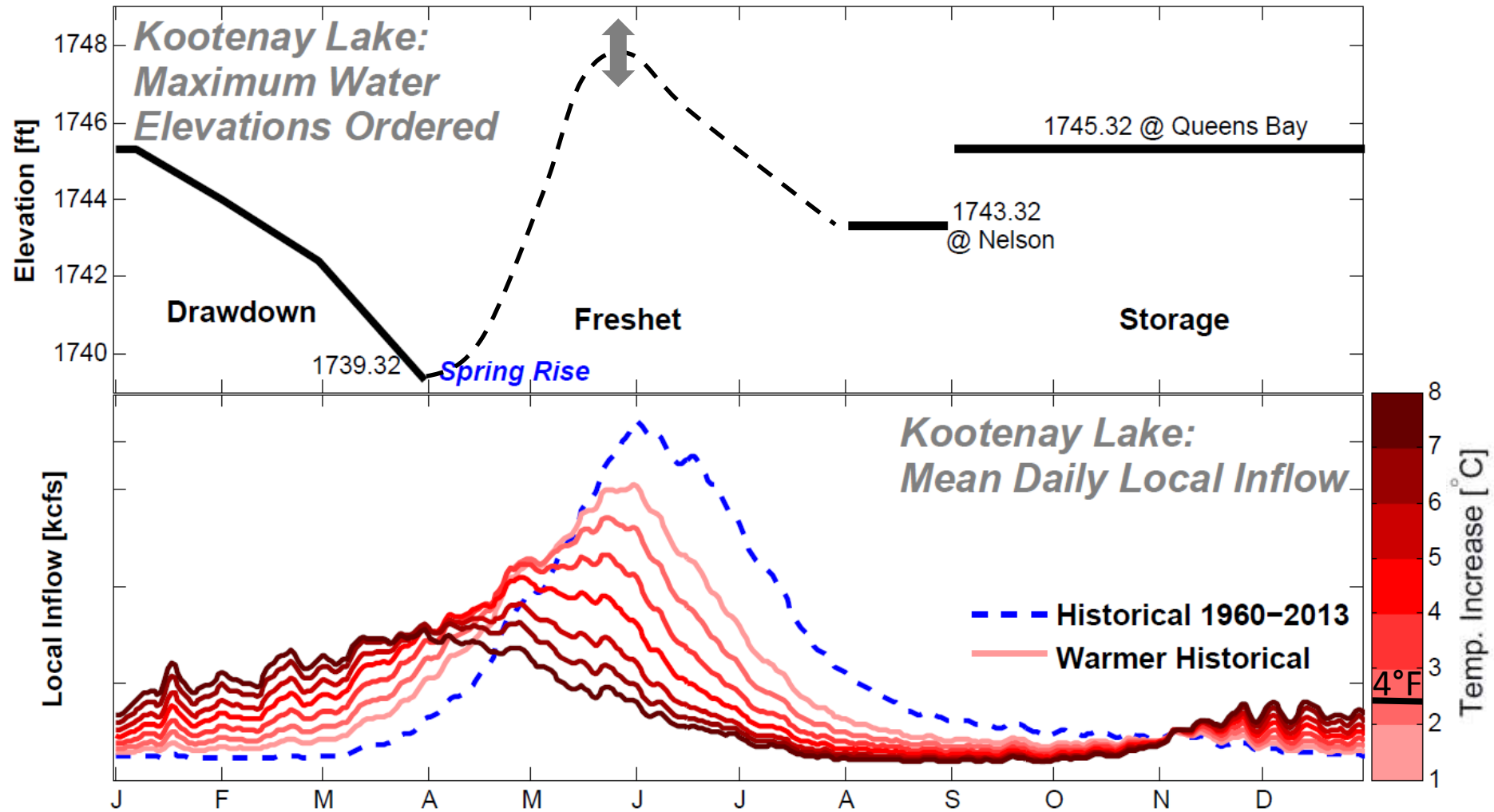
Inflow data simulated by VIC hydrology model

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Projected Kootenay River Unregulated Flow

2040's   **2080's**
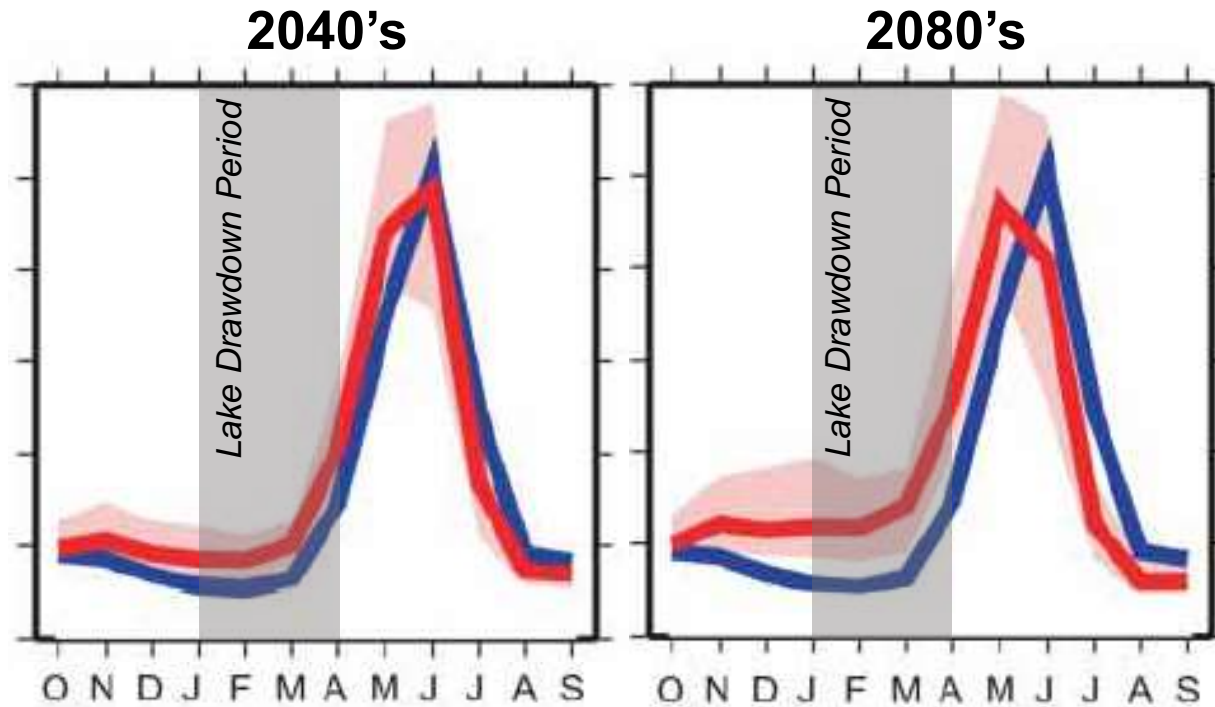

Blue = 1916-2006   Pink = Range (10 models)   Red = Ensemble Mean

Hamlet, Alan F., et al. "An overview of the Columbia Basin Climate Change Scenarios Project: Approach, methods, and summary of key results." *Atmosphere-ocean* 51.4 (2013): 392-415.

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Projected Kootenay River Unregulated Flow

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Projected Kootenay River Unregulated Flow

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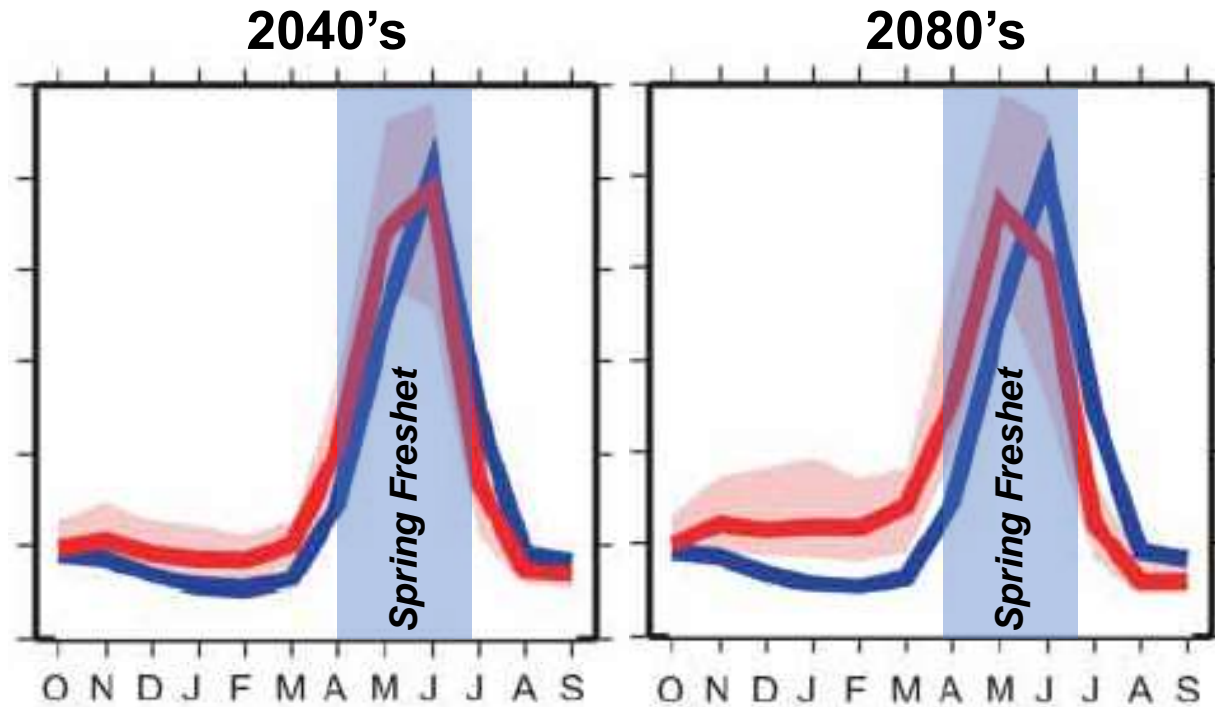

Spring Freshet

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Hamlet, Alan F., et al. "An overview of the Columbia Basin Climate Change Scenarios Project: Approach, methods, and summary of key results." *Atmosphere-ocean* 51.4 (2013): 392-415.

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Ongoing climate change studies in the basin:

(Hydrology and Hydro-regulation modeling)

RMJOC-II
2015-2018

BChydro Study

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Summary

- Current studies are in progress to assess hydrologic impacts of climate change

- Climate change will likely bring higher unregulated winter flows during the drawdown period on Kootenay lake

- Higher uncertainty in changes in projections of peak spring freshet flows

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Thank you!
Questions?