RECLAMATION
Managing Water in the West

Results from the RMJOC-II Climate Study

Jennifer Johnson

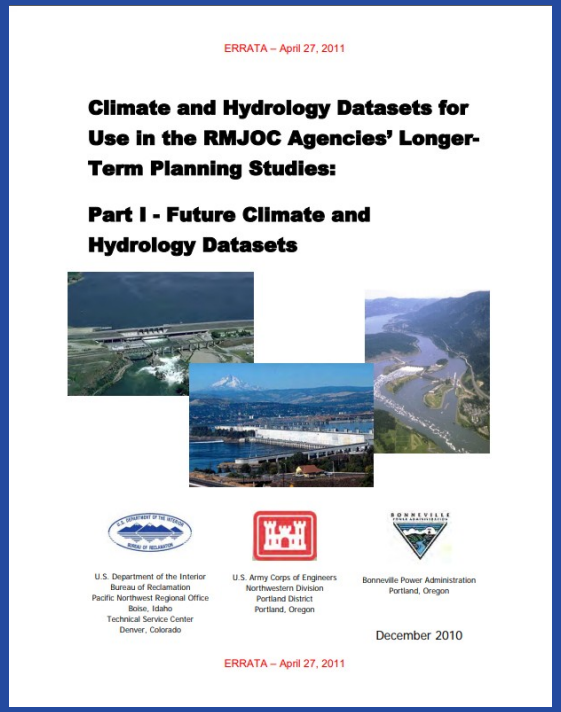
Hydrologic Engineer, Pacific Northwest Region

RMJOC

- River Management Joint Operating Committee (RMJOC)
- Coordinating entity for operating the Federal Columbia River Power System (FCRPS)

RMJOC-I

- Completed in 2011
- Columbia Basin-wide evaluation of potential future hydrology
- First large scale evaluation of future hydrology in the Columbia Basin
- https://www.usbr.gov/pn/climate/planning/reports/


ERRATA – April 27, 2011

Climate and Hydrology Datasets for Use in the RMJOC Agencies' Longer-Term Planning Studies:

Part I - Future Climate and Hydrology Datasets

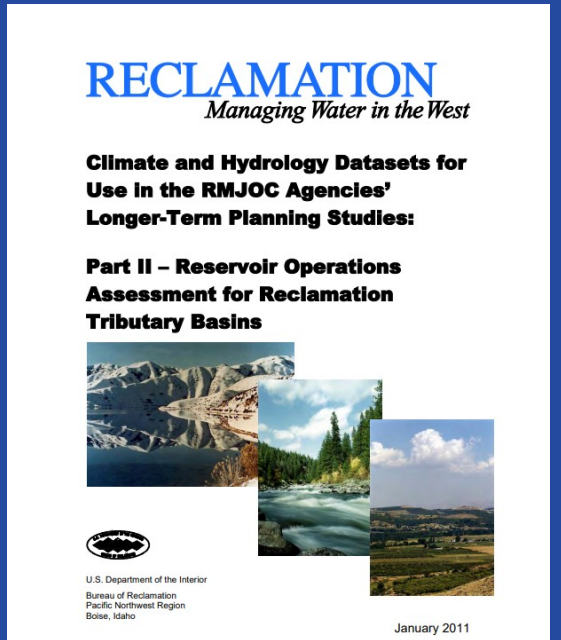
U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Regional Office
Boise, Idaho
Technical Service Center
Denver, Colorado

U.S. Army Corps of Engineers
Northwestern Division
Portland District
Portland, Oregon

Bonneville Power Administration
Portland, Oregon

December 2010

ERRATA – April 27, 2011

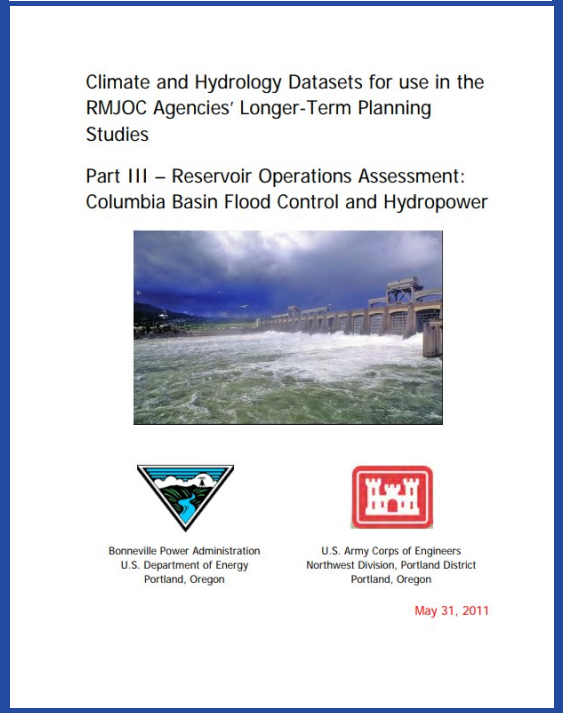

RECLAMATION
Managing Water in the West

Climate and Hydrology Datasets for Use in the RMJOC Agencies' Longer-Term Planning Studies:

Part II – Reservoir Operations Assessment for Reclamation Tributary Basins

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

January 2011

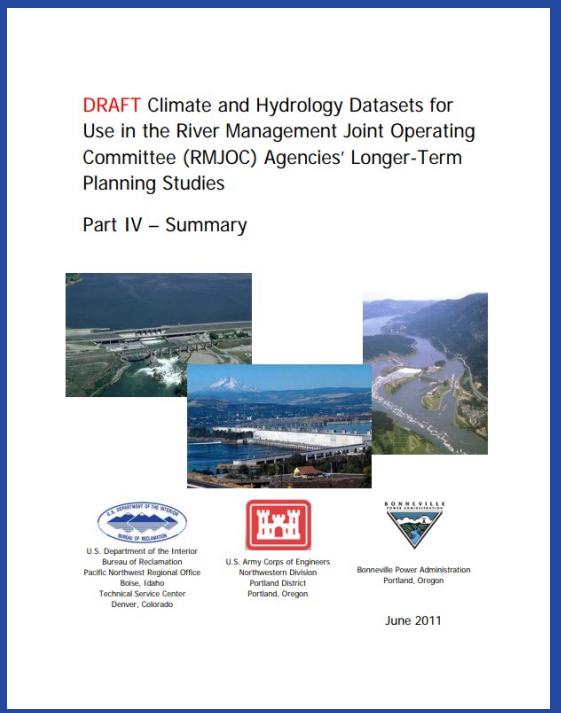

Climate and Hydrology Datasets for use in the RMJOC Agencies' Longer-Term Planning Studies

Part III – Reservoir Operations Assessment: Columbia Basin Flood Control and Hydropower

Bonneville Power Administration
U.S. Department of Energy
Portland, Oregon

U.S. Army Corps of Engineers
Northwest Division, Portland District
Portland, Oregon

May 31, 2011


DRAFT Climate and Hydrology Datasets for Use in the River Management Joint Operating Committee (RMJOC) Agencies' Longer-Term Planning Studies

Part IV – Summary

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Regional Office
Boise, Idaho
Technical Service Center
Denver, Colorado

U.S. Army Corps of Engineers
Northwestern Division
Portland District
Portland, Oregon

Bonneville Power Administration
Portland, Oregon

June 2011

RMJOC-II

- 2nd climate change study commissioned by the RMJOC in 2013
- Further refined technical processes used to develop future streamflows
- Commissioned with University of Washington (Bart Nijssen and Oriana Chegwidden) and Oregon State University (David Rupp and Phil Mote)

UNIVERSITY of WASHINGTON

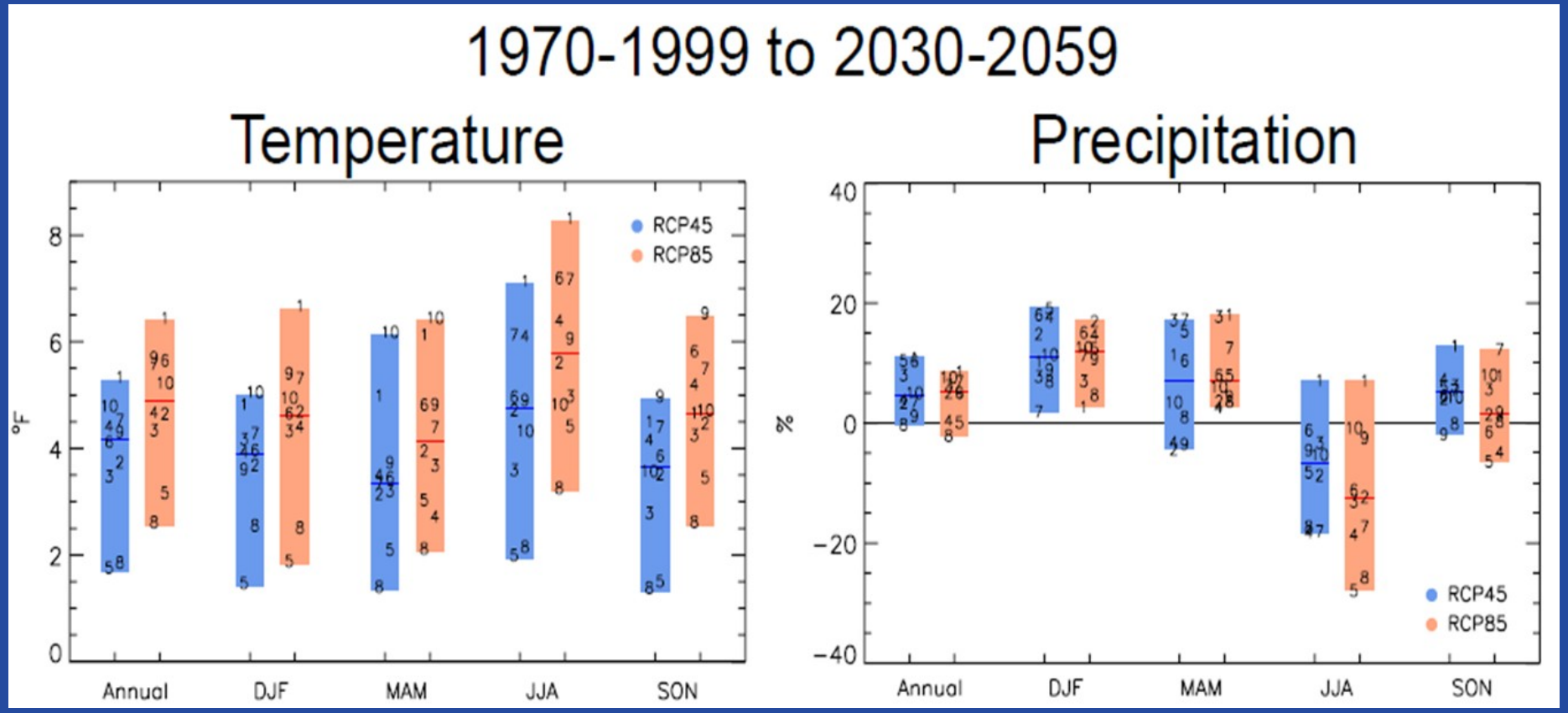
Oregon State University

RMJOC-II – Project Objectives

- **Update climate change streamflow datasets used for regional long-range planning, using latest Global Climate Models (from IPCC-5, 2013)**
- **Better account for *range* of climate change outcomes:**
  - Global climate models agree on overall temperature trends, but indicate different precipitation and weather pattern changes
  - Previous study used a reasonable range of annual temperature and precipitation projections, but in hindsight was too narrow on future winter spreads
- **Better account for hydrologic modeling uncertainties:**
  - Each step in the modeling process introduces uncertainties – some larger/smaller than others
  - RMJOC-I used only one downscaling method and one hydrologic model
  - Even past "observed" temperature, precipitation, snowpack and streamflows have some uncertainty
- **Provide realistic range of possible future scenarios for long range planning, while taking into account warmer global trends**

Slide credit: Erik Pytlak, BPA

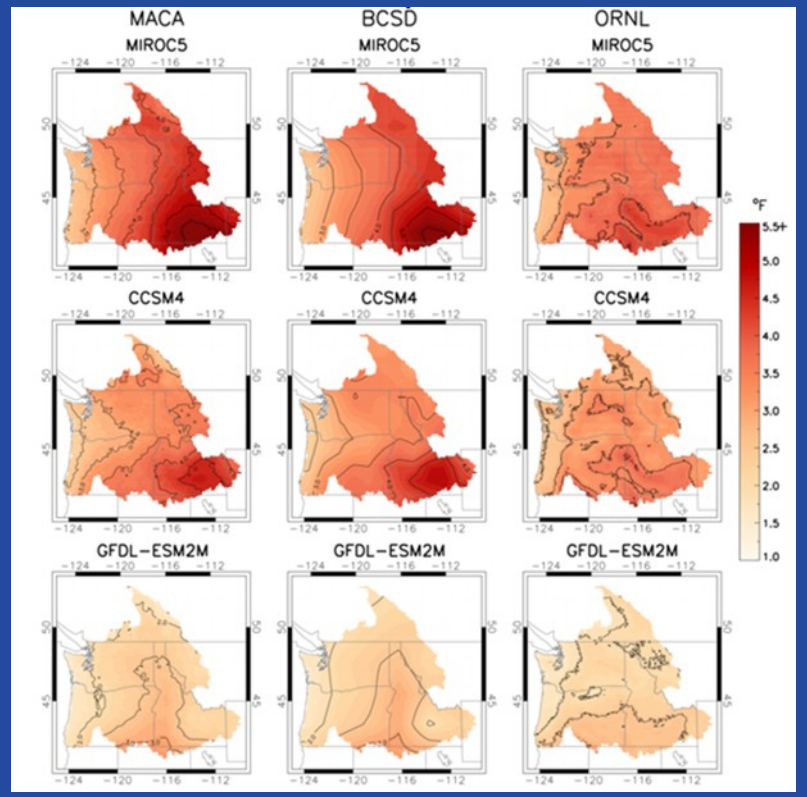
Latest Projections for Columbia Basin (IPCC-5)

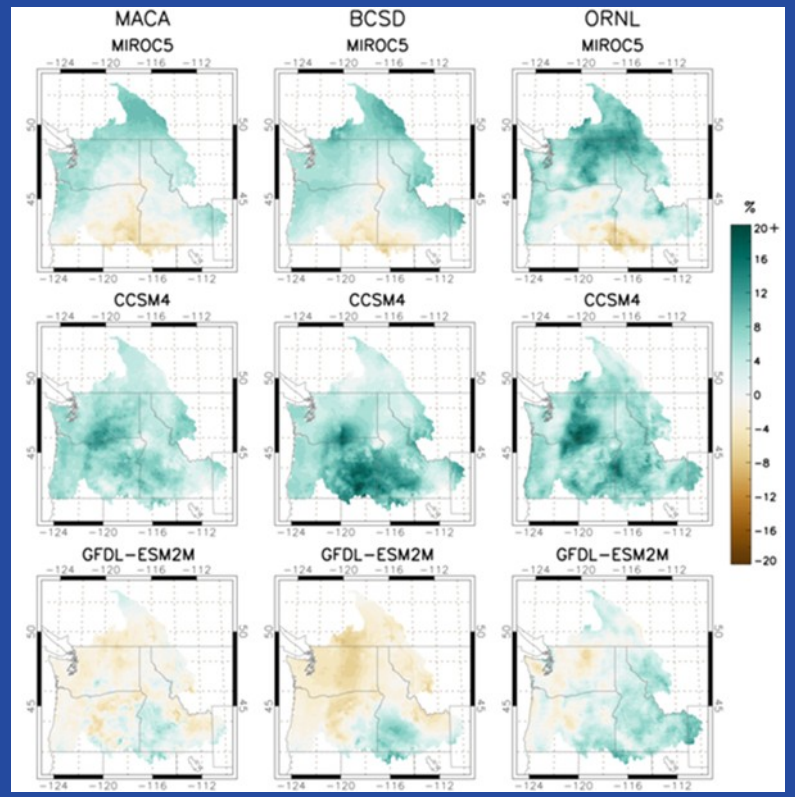


- Warming probably more pronounced in summers
- The majority of the climate models analyzed show either increasing annual basin precipitation or no change
- Good agreement for wetter winters; decent agreement for wetter springs
- Decent agreement on drier summers

Slide credit: Erik Pytlak, BPA

2030s Annual Temp and Precip Trends (averaged over available downscaled data)



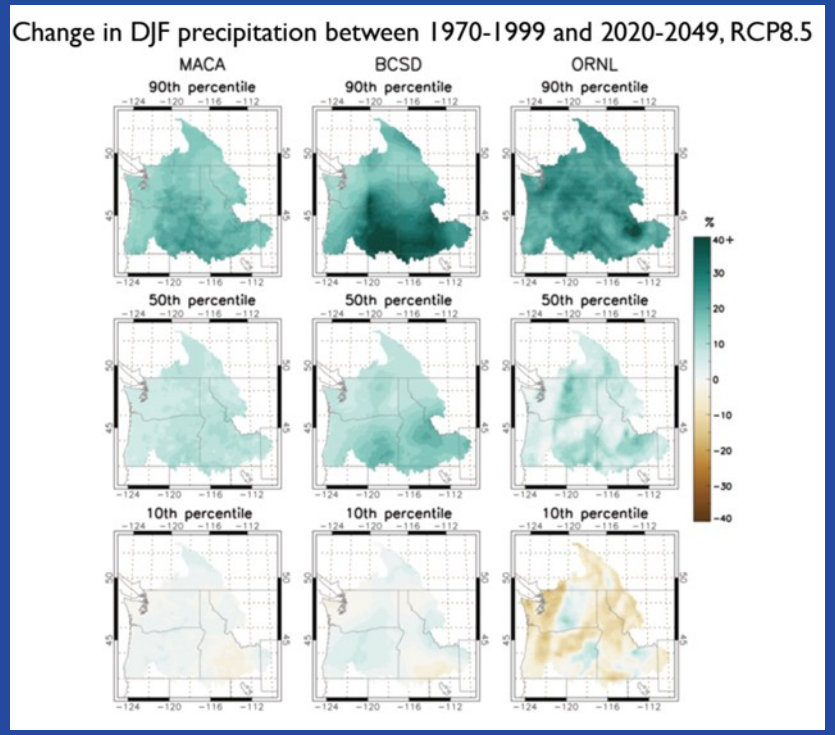


- More warming likely in the interior than the coasts, particularly in the upper Snake Basin
- Greatest uncertainty in amount of warming also in the interior
- Large model-to-model annual precip variability, but most are either no-change or wetter, especially in Canada

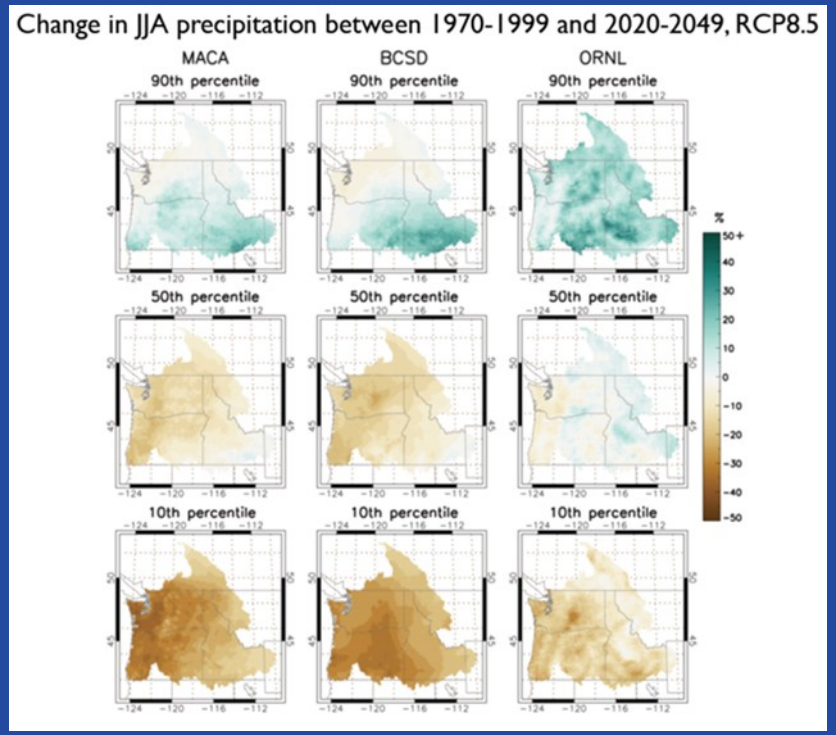
Slide credit: Erik Pytlak, BPA

2030s *Winter* and *Summer* Precip Change in %

Winter



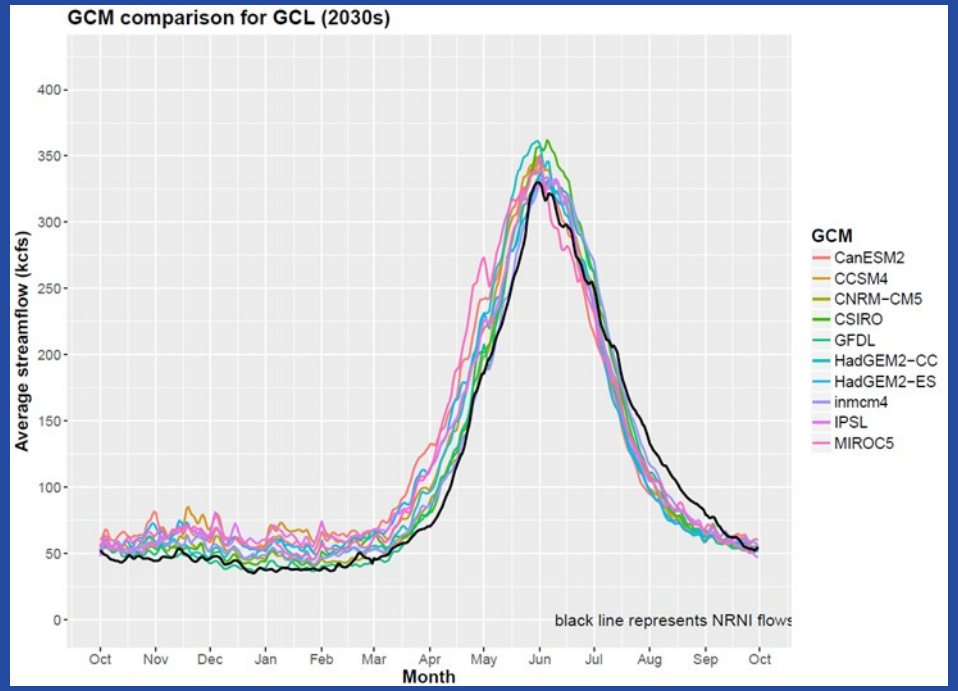
Summer

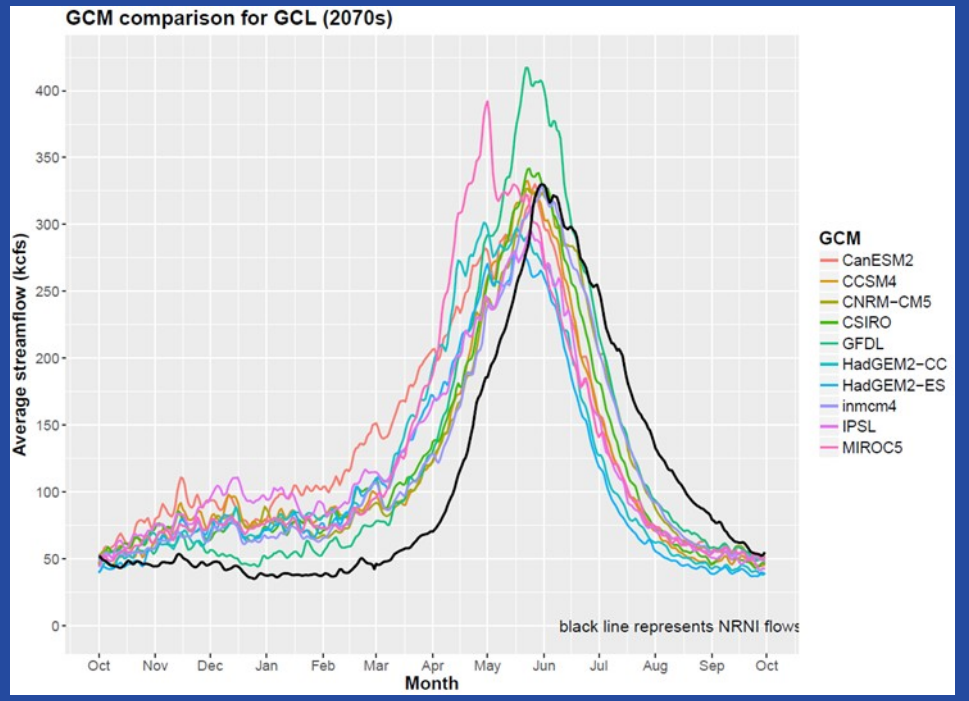


- **Trend toward wetter winters**
- **Perhaps a drier summer trend (but July-August are generally the driest months in the Columbia Basin)**

Slide credit: Erik Pytlak, BPA

Average Grand Coulee Inflows: 2030s and 2070s (All Hydro Models)



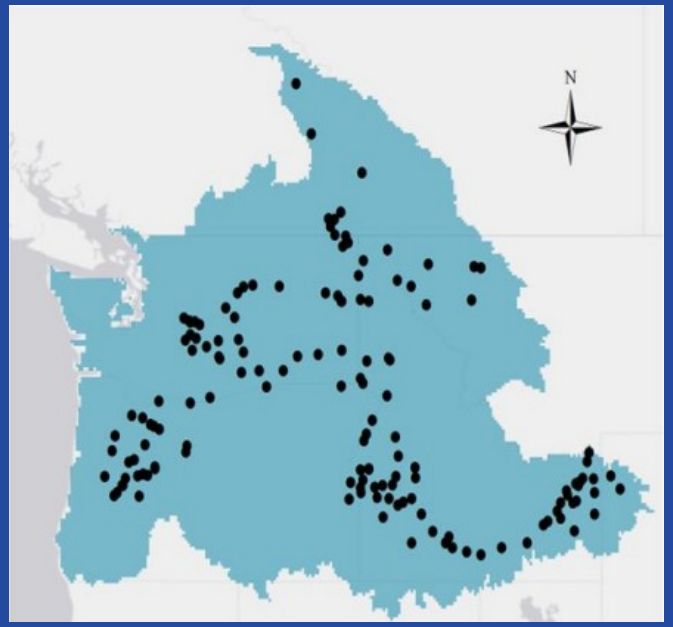


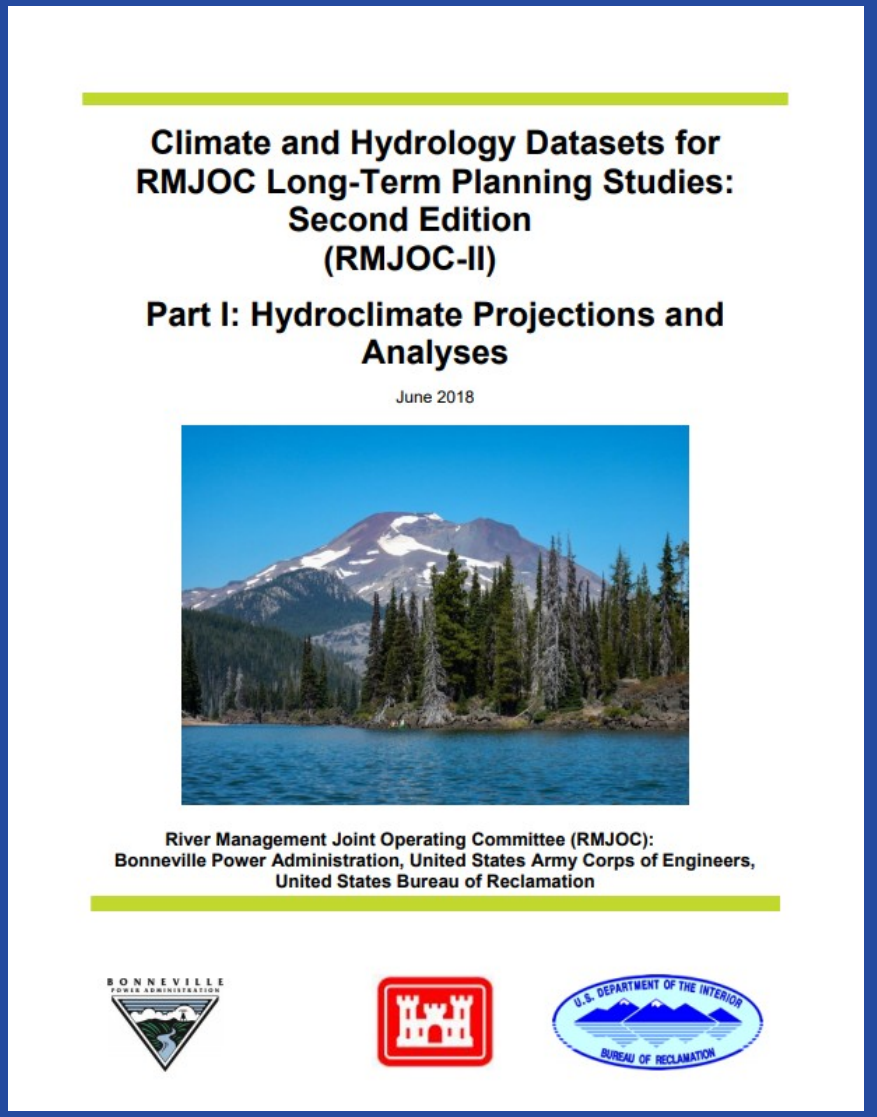
- Spring snowmelt shifts about 2 weeks earlier by the 2030s
- Higher natural flows in November – April
- Lower natural flows in July-August
- Higher annual volumes over time as precipitation increases

Slide credit: Erik Pytlak, BPA

RMJOC-II Part 1

- Report published in June 2018
  - https://www.bpa.gov/p/Generation/Hydro/hydro/cc/RMJOC-II-Report-Part-I.pdf
- Future streamflow projections were developed for 172 ensemble members at 190 locations
- Datasets are available
  - http://hydro.washington.edu/CRCC/data/





Summary of Part 1 Results

- The three agencies of the RMJOC are continuing to monitor climate change as part of overall risk management.
- Temperatures have already warmed about 1.5ºF in the region since the 1970s and are expected to warm another 1 to 4ºF by the 2030s.
- Future precipitation trends are more uncertain, but a general upward trend is likely, particularly in the winter months. Already dry summer months could become drier.
- Average winter snowpacks are very likely to decline over time as more winter precipitation falls as rain instead of snow
- By the 2030s, higher average fall and winter flows, earlier peak spring runoff, and longer periods of low summer flows are very likely. The earliest and greatest streamflow changes are likely to occur in the Snake River Basin, although that is also the basin with greatest modeling and forecast uncertainty

Next Steps

- The unregulated hydrology developed in Part 1 will be run through river-reservoir regulation models at the Corps, BPA, and Reclamation
- Regulated model output will be used to analyze climate change impacts to
  - Flood risk
  - Power generation
  - Irrigation deliveries
  - Hydrologic ecosystem requirements
  - And other important basin needs
- Results will be published in Part 2 report in 2019

Study contributors

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