June 2022 in WA State

Steve Ringman/Seattle Times

AP Photo/John Froschauer

The Teanaway River, a tributary of the Yakima River, during the 2015 drought (Robert Granger, WDFW)

Office of the Washington State Climatologist

Cooperative Institute for CLIMATE, OCEAN & ECOSYSTEM STUDIES

PREDICTING AND RESPONDING TO DROUGHT CONDITIONS IN WASHINGTON STATE

Nick Bond & Karin Bumbaco
Office of the Washington State Climatologist

Flavors of Drought
Historical Data
Predictive Tools and Protocols

Bumbaco and Mote (2010): Three Recent Flavors of Drought in the Pacific Northwest

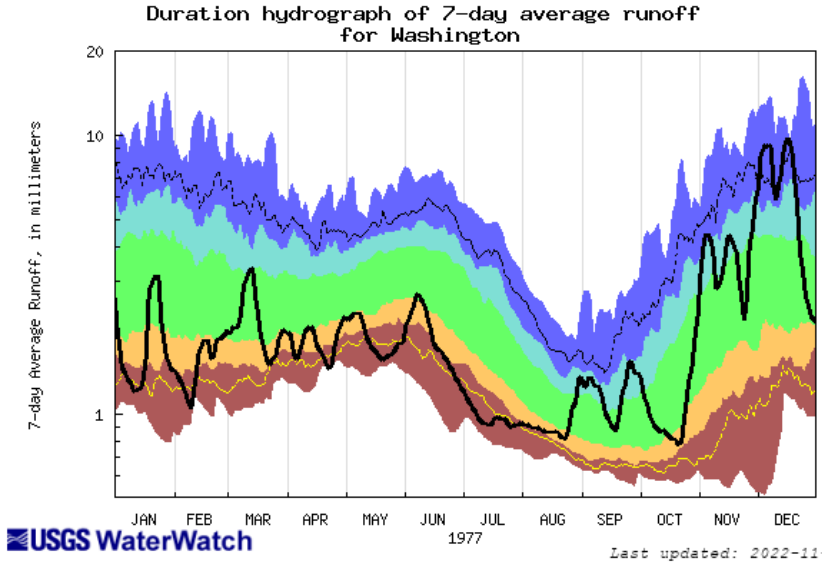
- Abnormally low winter precipitation (2001)
- Low summer precipitation (2003)
- Warm winter temperatures (2005)

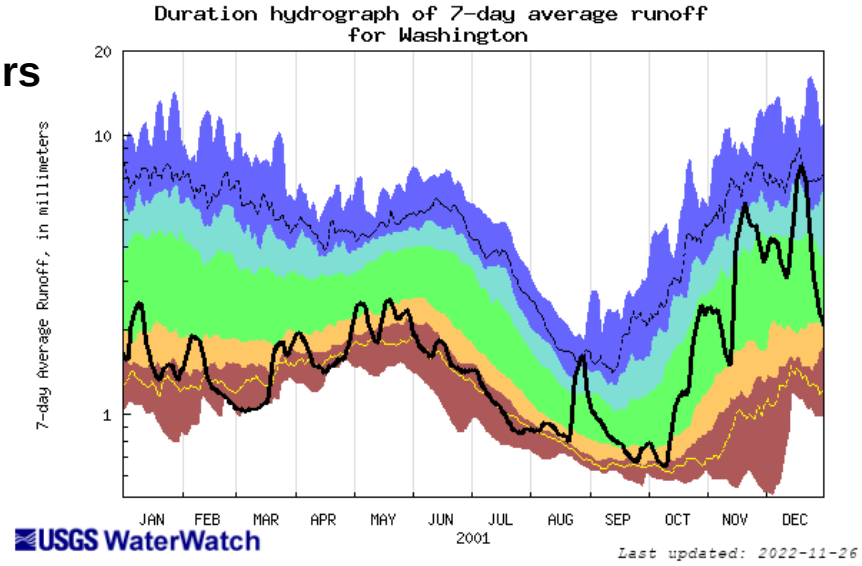
Bumbaco and Mote (2010): Three Recent Flavors of Drought in the Pacific Northwest

- Abnormally low winter precipitation (1976; 2001): ***Agriculture and hydropower***
- Low summer precipitation (2003; 2022): ***Freshwater and terrestrial ecosystems***
- Warm winter temperatures (2005; 2015): ***Wide variety of impacts on human and natural systems***
- Warm and dry spring (2021): ***Agriculture, possibly the severe heat wave of summer 2021***

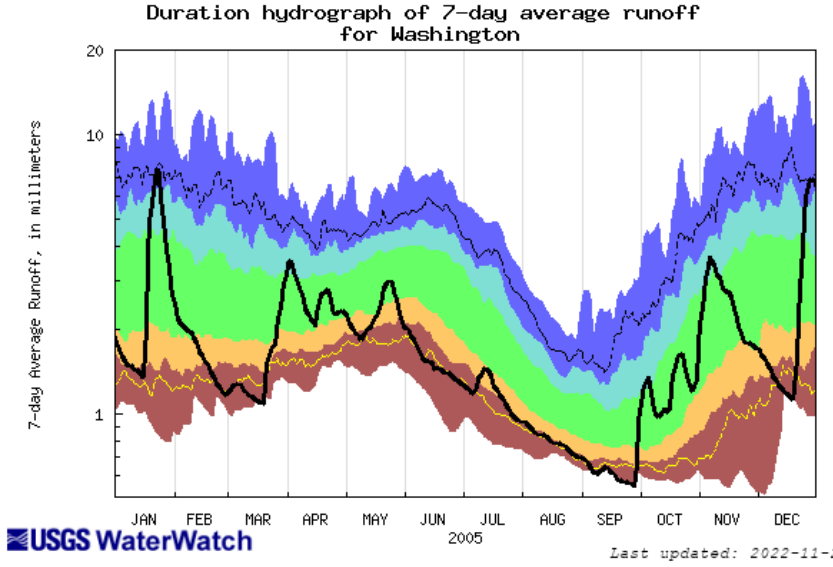
WA State Streamflows with Various Flavors of Drought

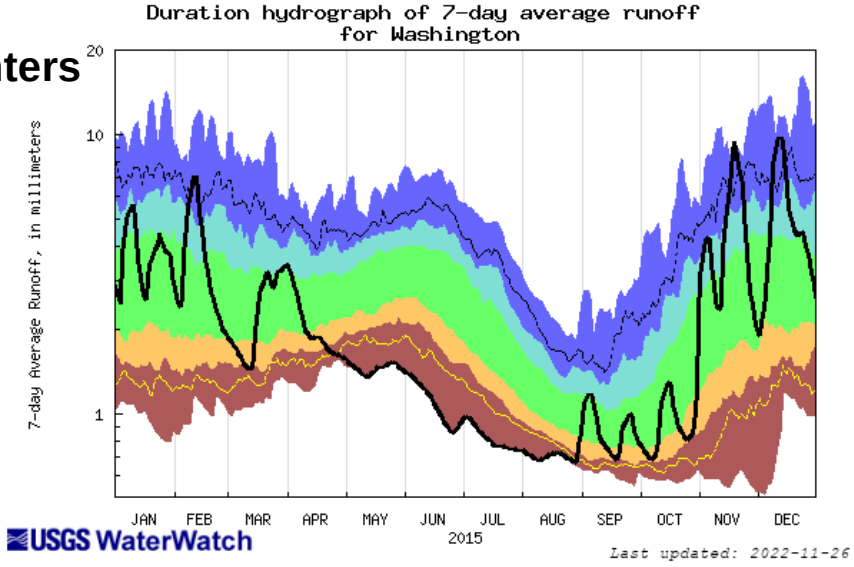
Dry Winters





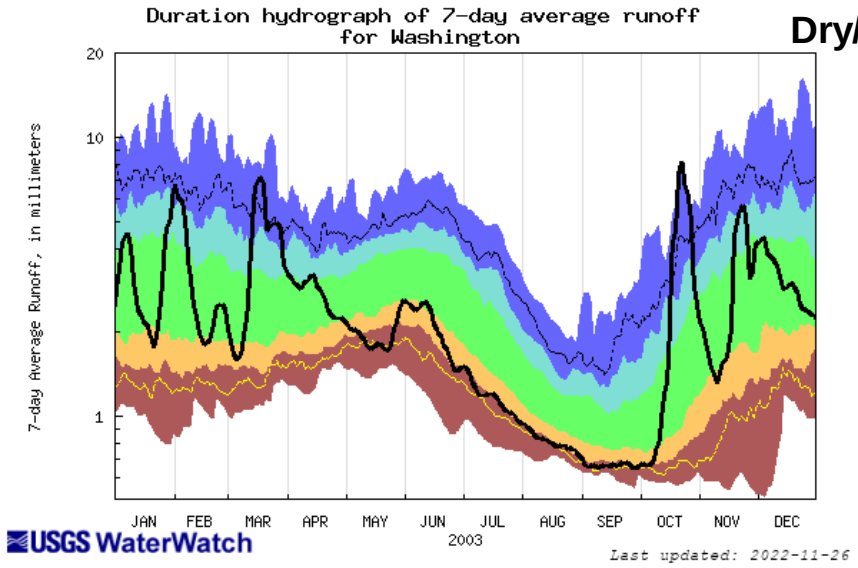
Warm Winters

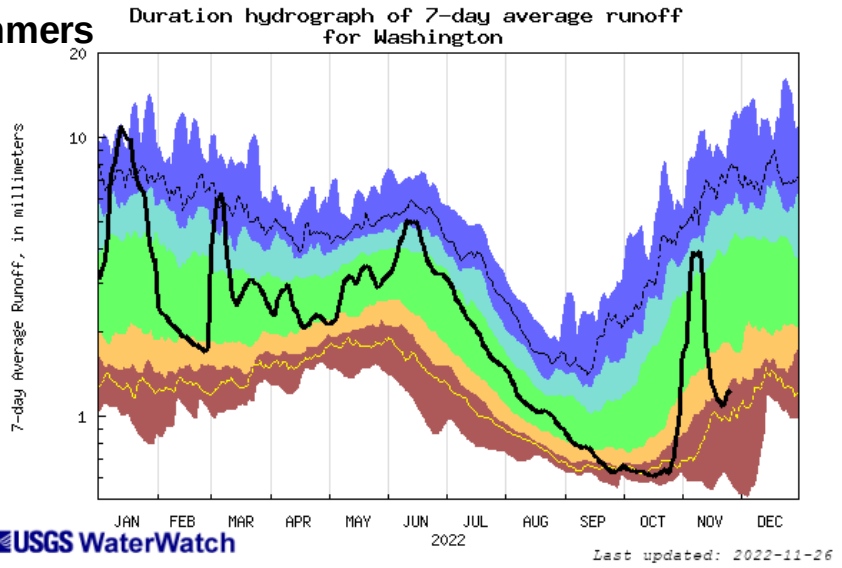


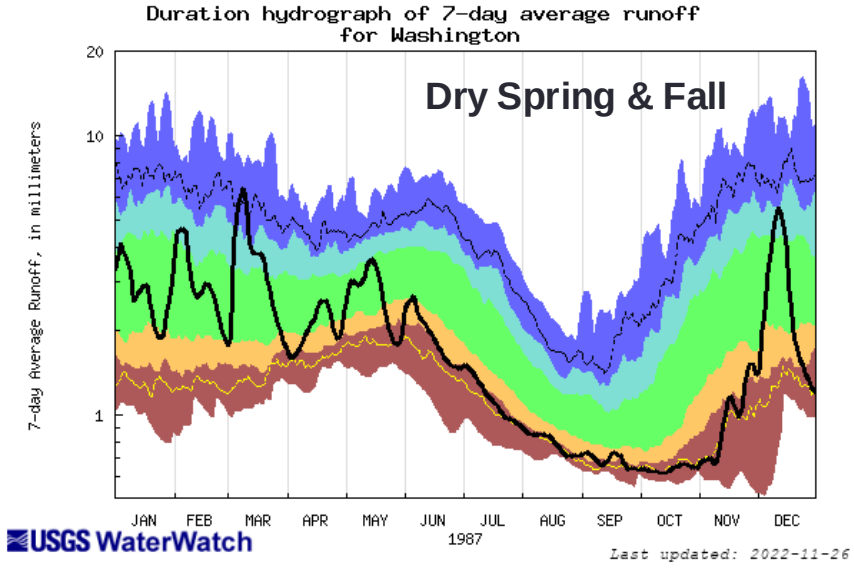


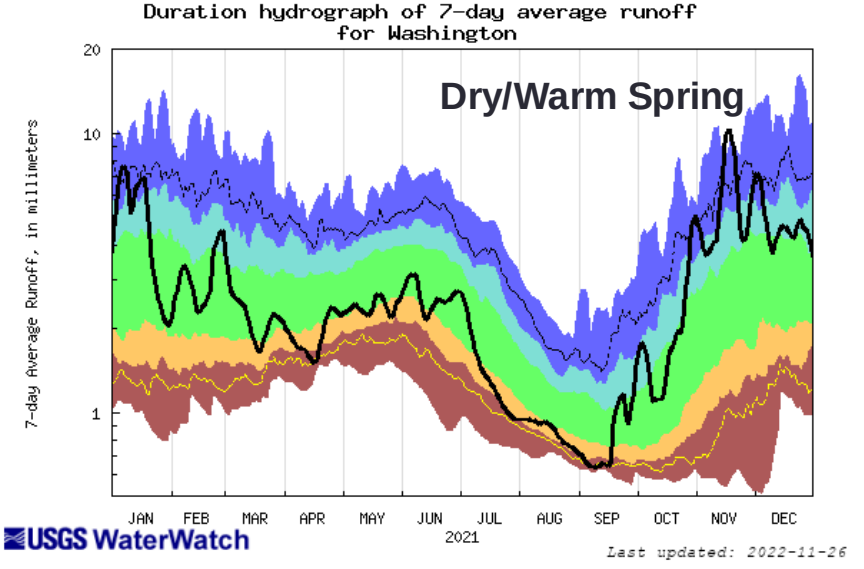
More Flavors

Dry/Warm Summers



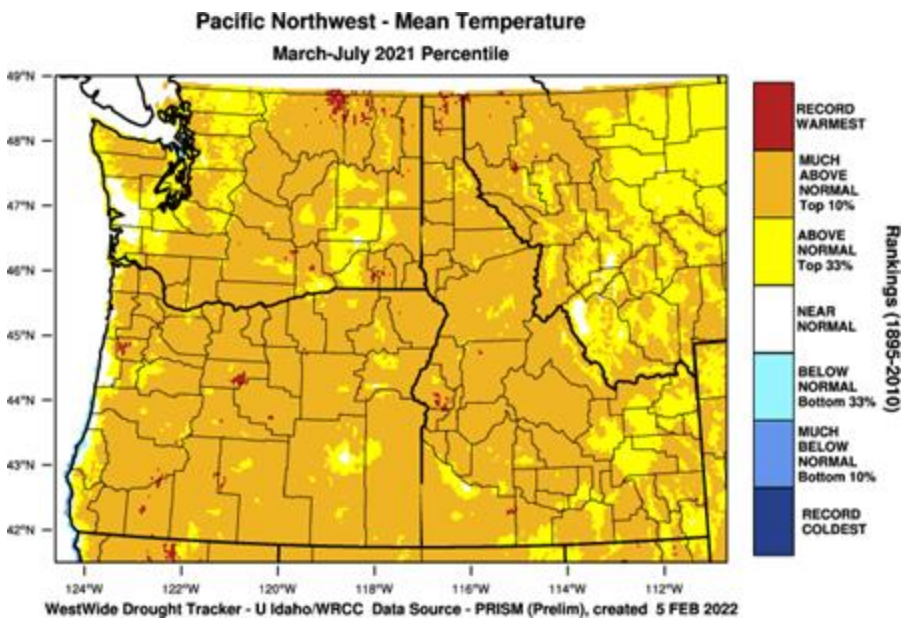




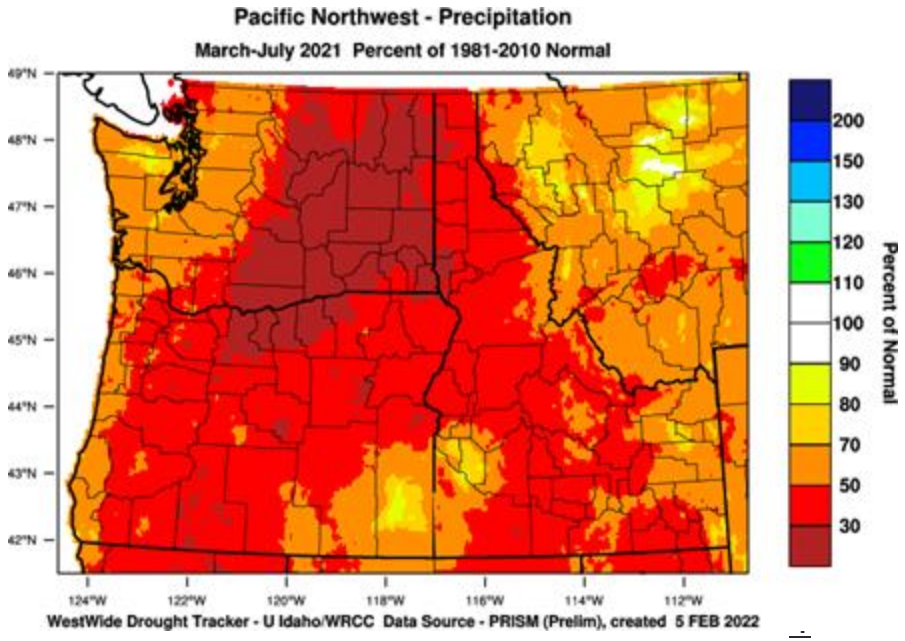


March-July 2021

Temperature

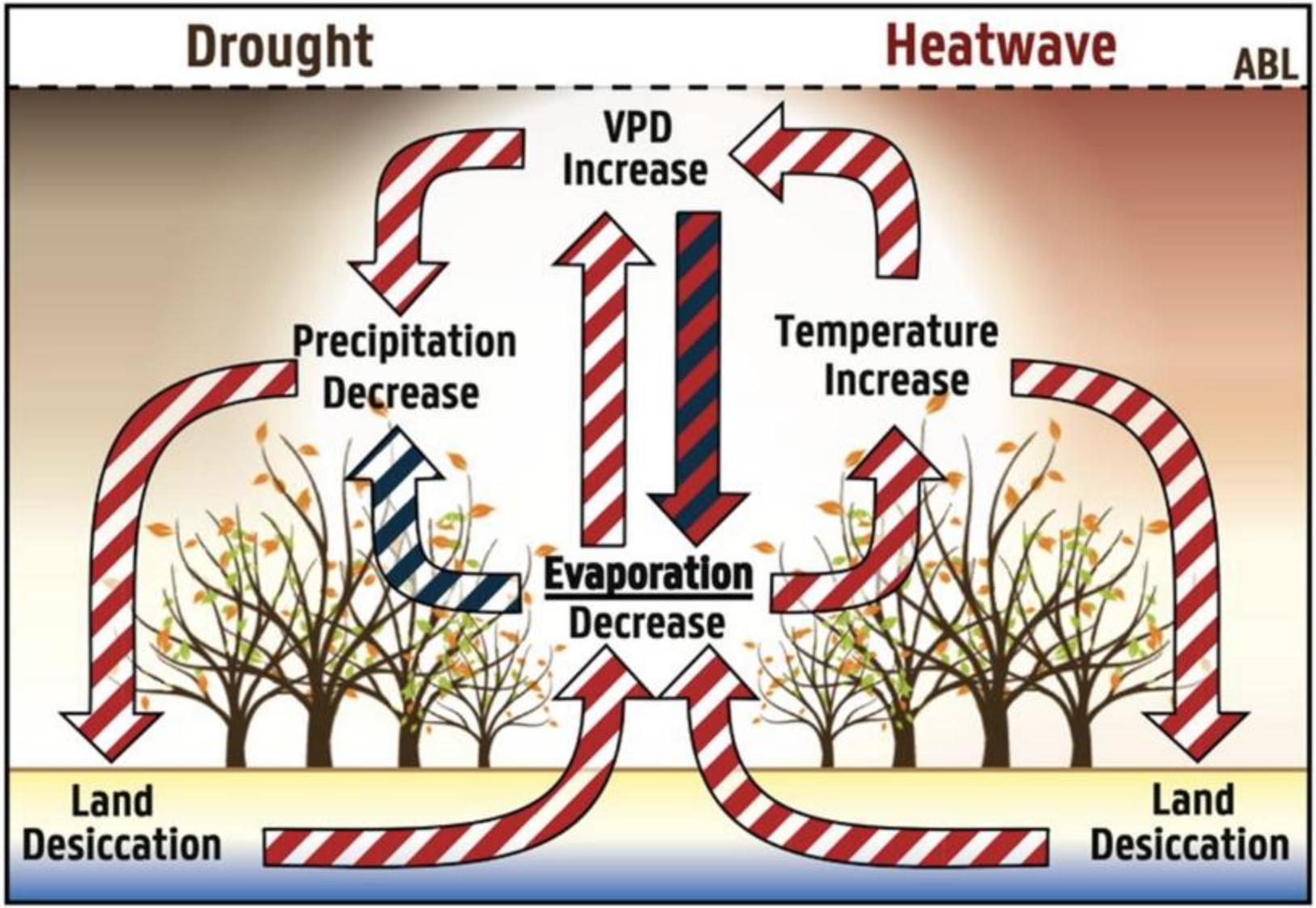


Precipitation

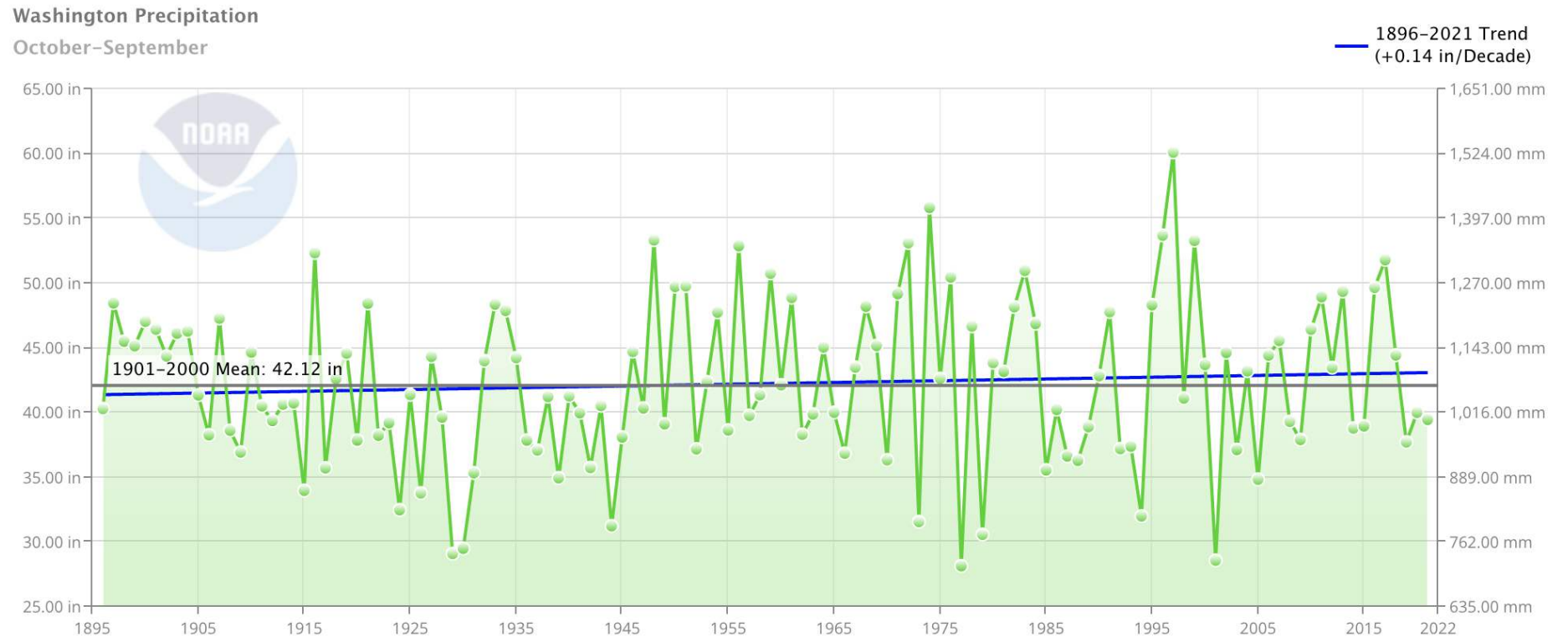


- Regional Average: 4th warmest* March-July on record (+3.7°F)
- Regional Average: 2nd driest* March-July on record (-5.17”)

*Records since 1895



from Miralles et al. (NYAS, 2018)


Washington Precipitation
October–September
1896–2021 Trend
(+0.14 in/Decade)
1901–2000 Mean: 42.12 in
65.00 in
60.00 in
55.00 in
50.00 in
45.00 in
40.00 in
35.00 in
30.00 in
25.00 in
1,651.00 mm
1,524.00 mm
1,397.00 mm
1,270.00 mm
1,143.00 mm
1,016.00 mm
889.00 mm
762.00 mm
635.00 mm
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
2022

Trends in End of Winter (1 Apr) Snow Water Equivalent (SWE)

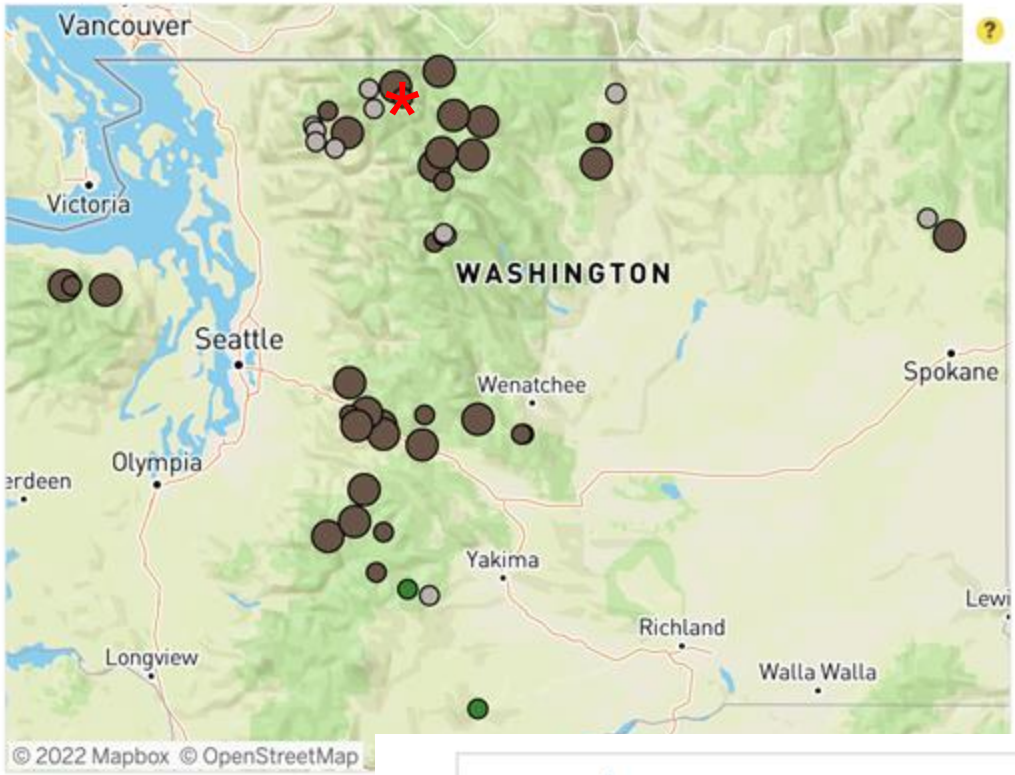
Year Range
1946 2021

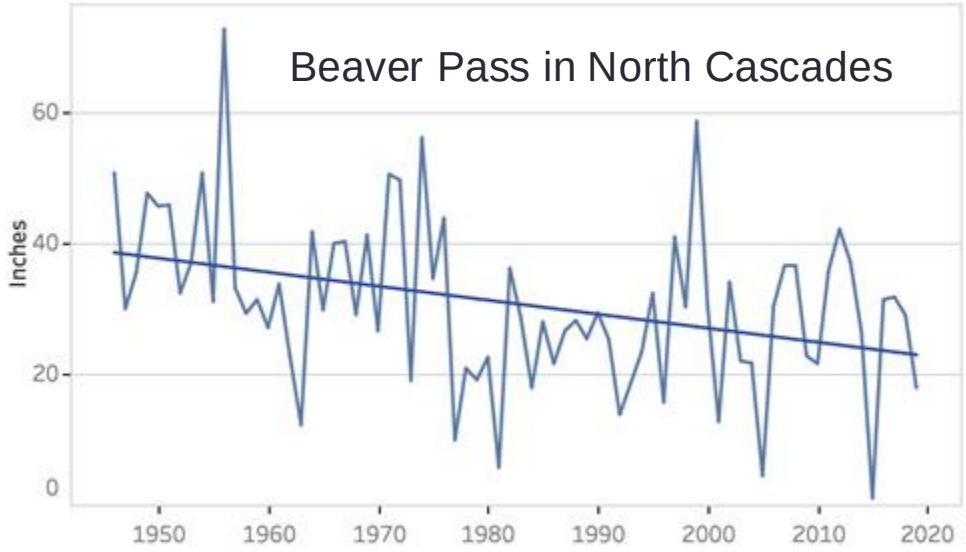
Time Frame
April

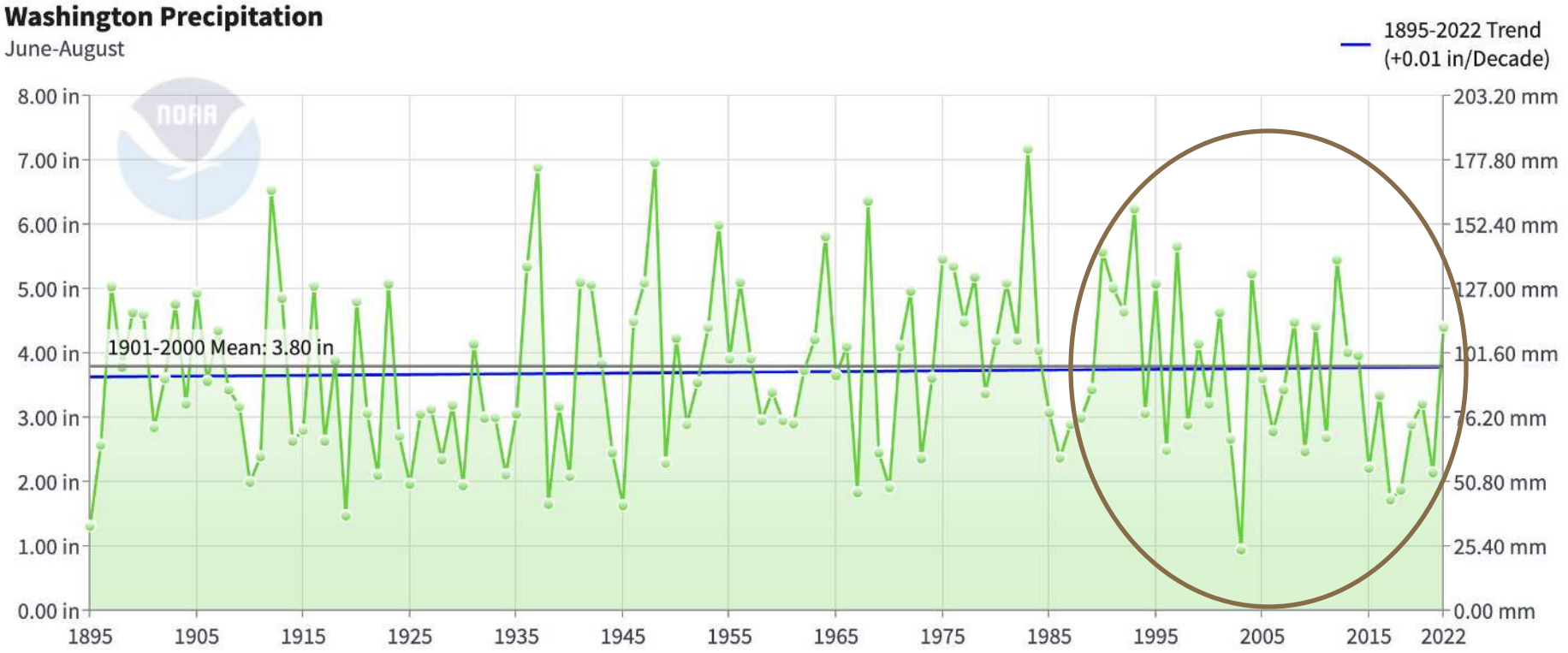
Trend Range
Per Decade

Trend	-	0	+
Significant (S)	●		●
Not Significant (NS)	●	○	●
Insufficient Data (I)	●	●	●

Add to Graph
- (•) None
- ( ) Average
- ( ) Trend Line






Washington Precipitation
June-August
1895-2022 Trend
(+0.01 in/Decade)
1901-2000 Mean: 3.80 in
8.00 in
7.00 in
6.00 in
5.00 in
4.00 in
3.00 in
2.00 in
1.00 in
0.00 in
203.20 mm
177.80 mm
152.40 mm
127.00 mm
101.60 mm
76.20 mm
50.80 mm
25.40 mm
0.00 mm
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
2022

Temperature | **Precipitation** | Snow Water Equivalent

Year Range

1961 — 2021

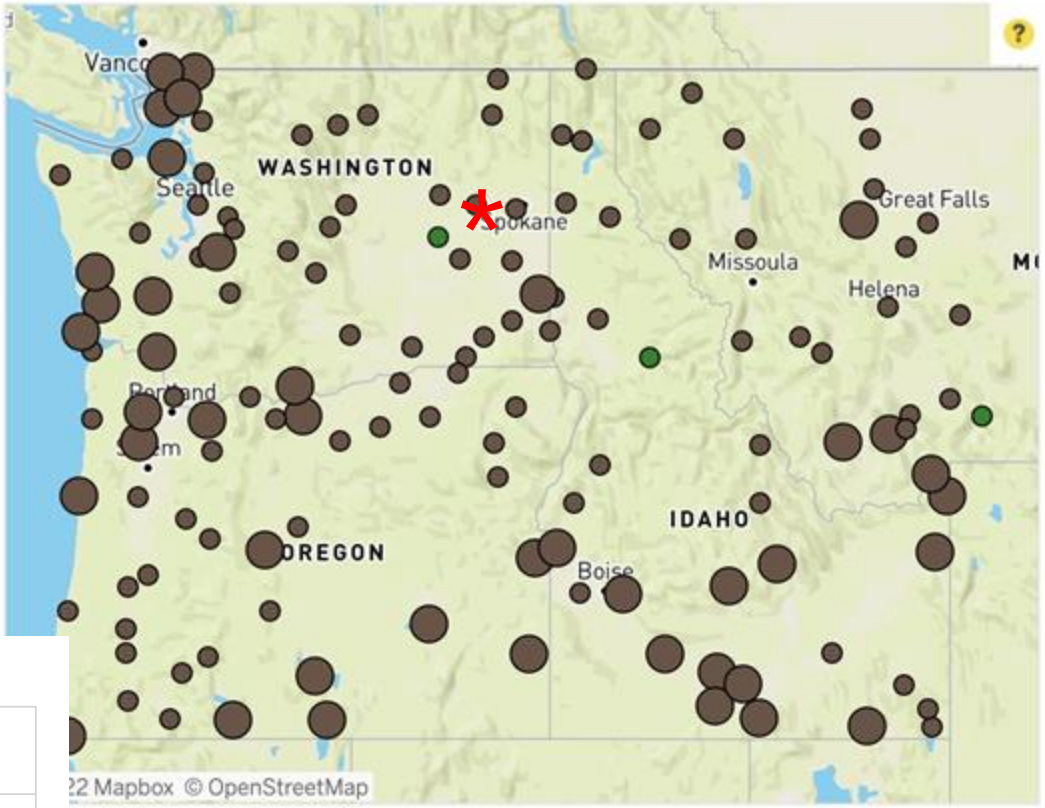
Time Frame

Summer (JJA)

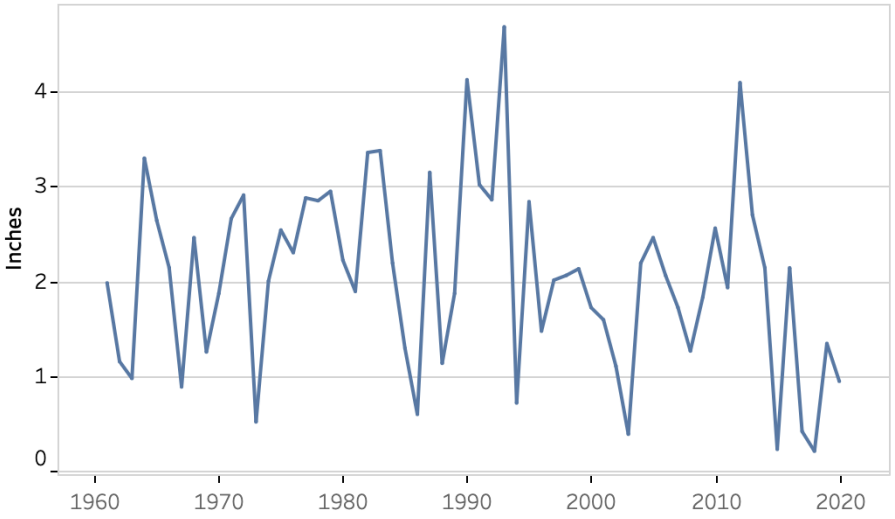
Trend Range

Per Decade

Trend	-	0	+
Significant (S)	●		●
Not Significant (NS)	●	○	●
Insufficient Data (I)	●	●	●



Summer (JJA) Precipitation (1961-2020)

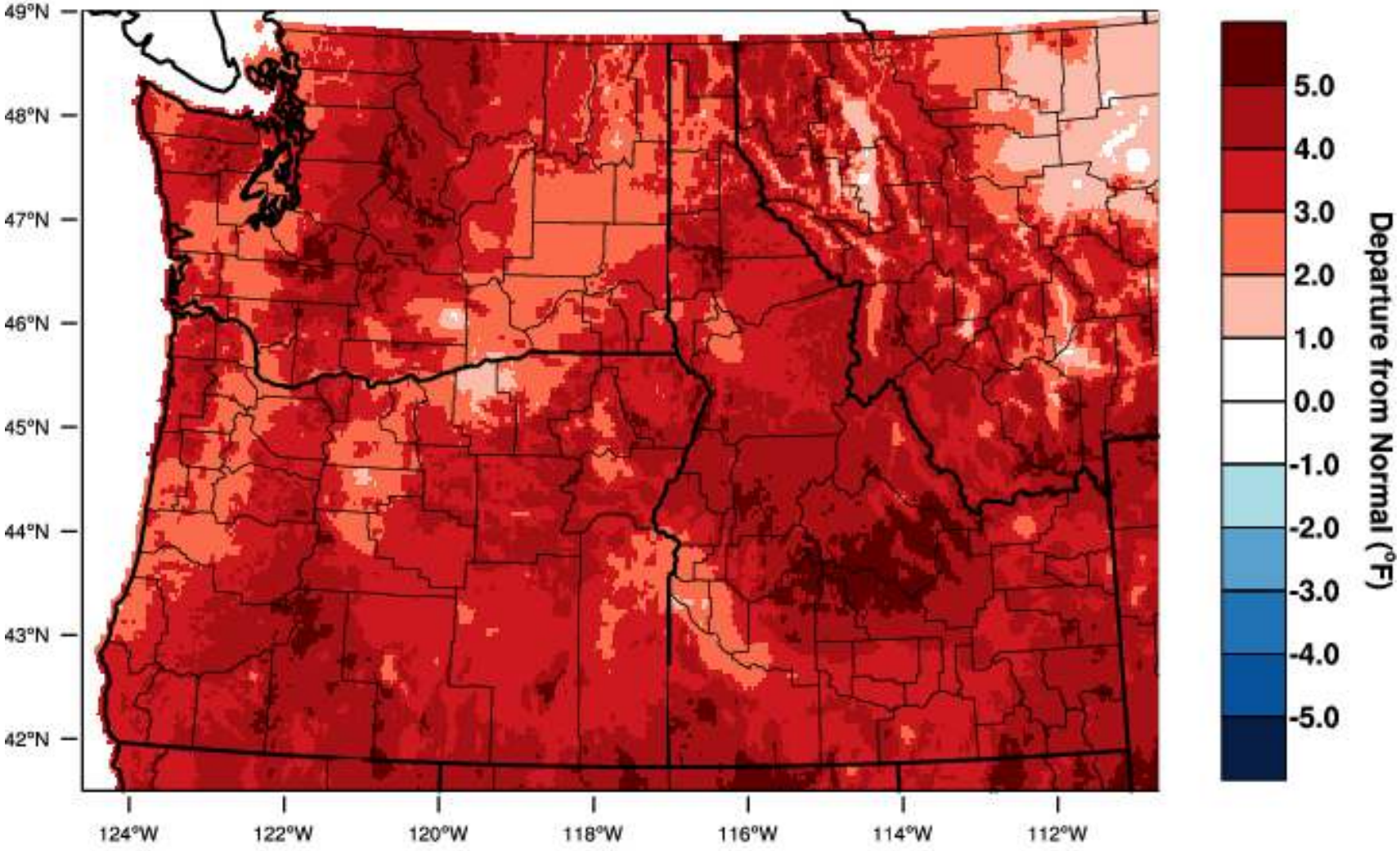


Summer Precipitation in Davenport, WA

INDESCRIBABLE...
INDESTRUCTIBLE!
NOTHING CAN STOP IT!
THE BLOB
STEVEN McQUEEN
ANETA CORSEAUT · EARL ROWE
PRODUCED BY JACK H. HARRIS · DIRECTED BY IRVIN S. YEAWORTH, JR. · SCREENPLAY BY THEODORE SIMONSON AND KATE PHILLIPS

Pacific Northwest - Mean Temperature

October-April 2015 Departure from 1981-2010 Normal

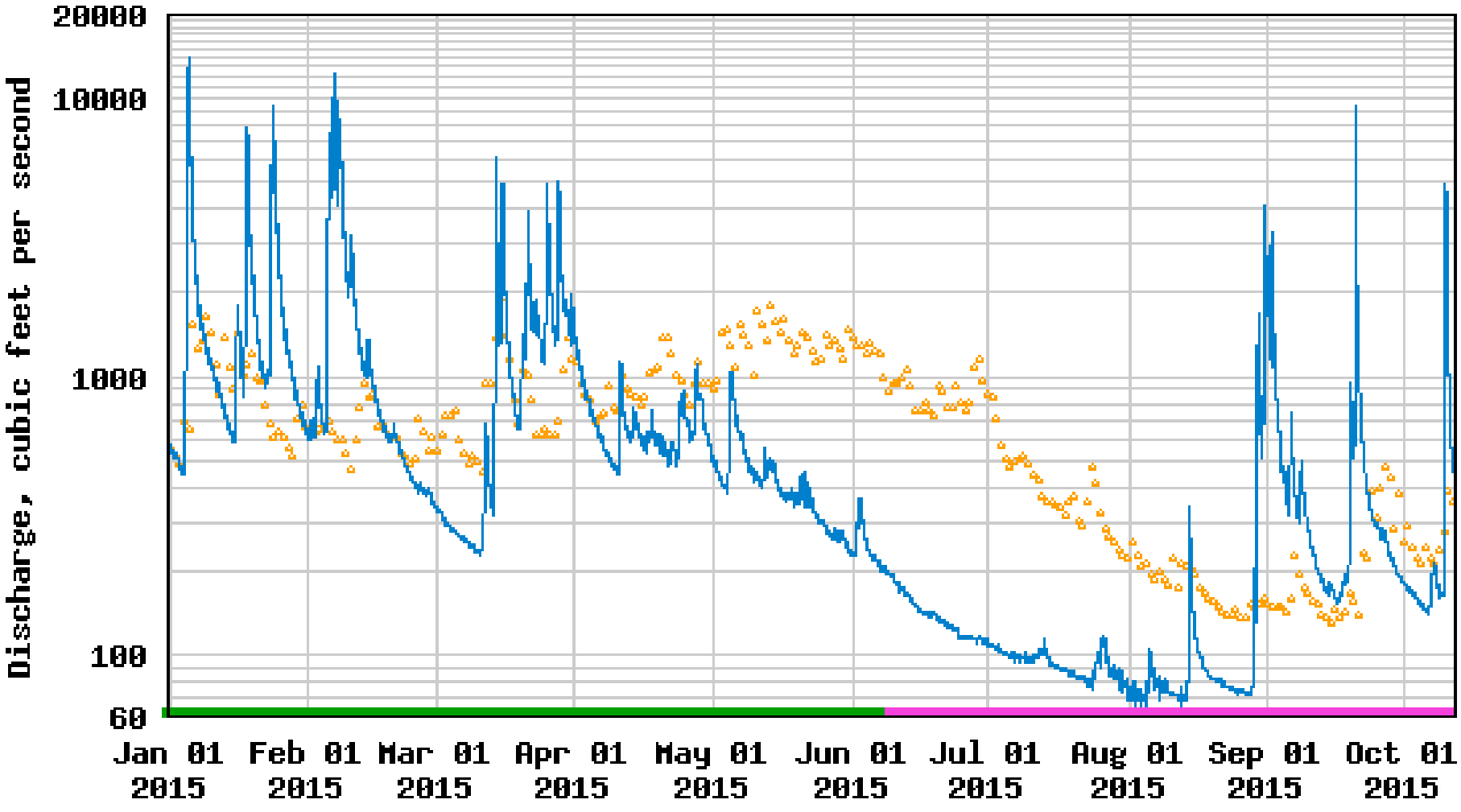


WestWide Drought Tracker - Uldaho/WRCC Data Source - PRISM (Prelim), created 16 NOV 2015

Capital Press – March 2015

USGS

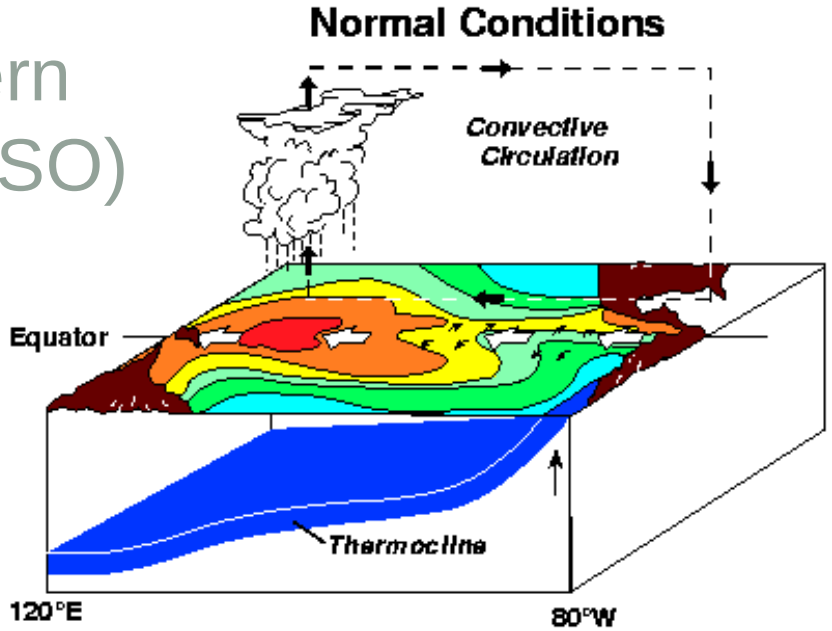
USGS 12210000 SF NOOKSACK RIVER AT SAXON BRIDGE, WA



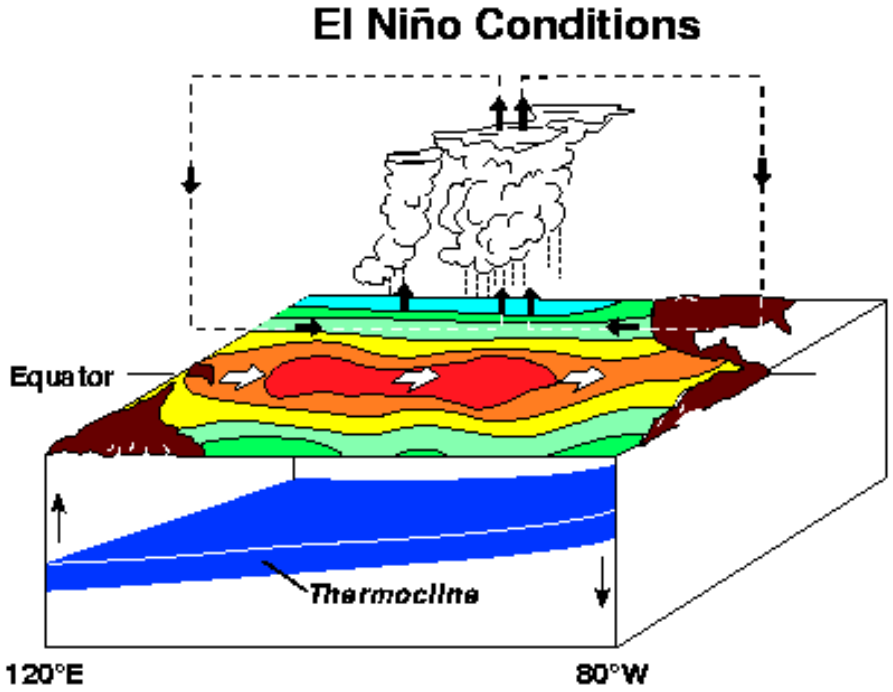
Climate Prediction Center Seasonal Forecasts

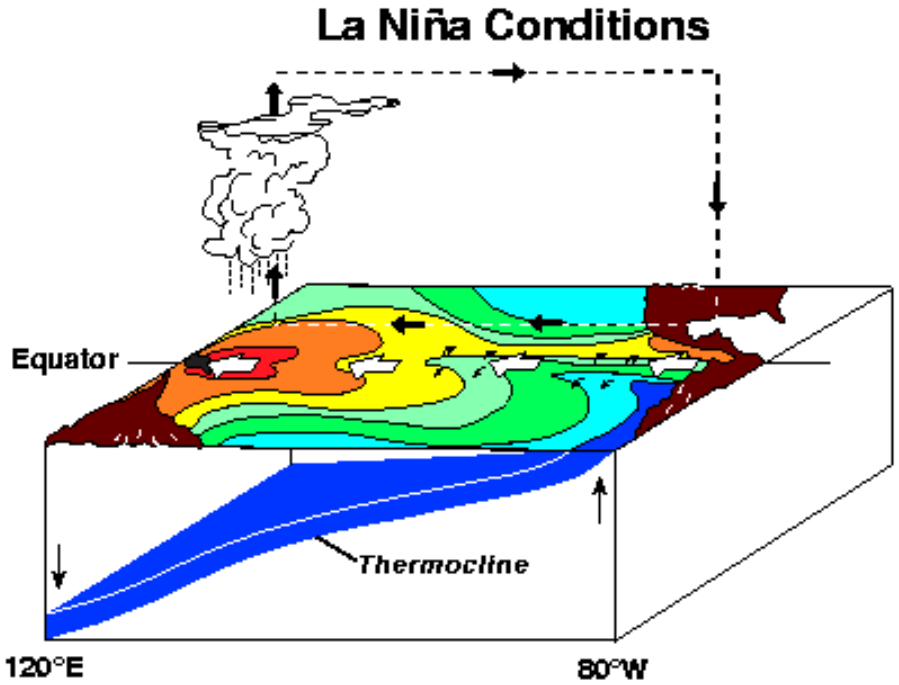
- Released monthly: www.cpc.ncep.noaa.gov
- Multiple factors taken into account, including:
  - climate (atmosphere & ocean) computer models
  - atmospheric and oceanic patterns during last 3 seasons
  - historical El Nino/La Nina relationships
  - persistence and trends
- Forecast skill peaks in late winter; temperature more skillful than precipitation all year
- Probabilities are split into three tiers: below normal, normal, and above normal

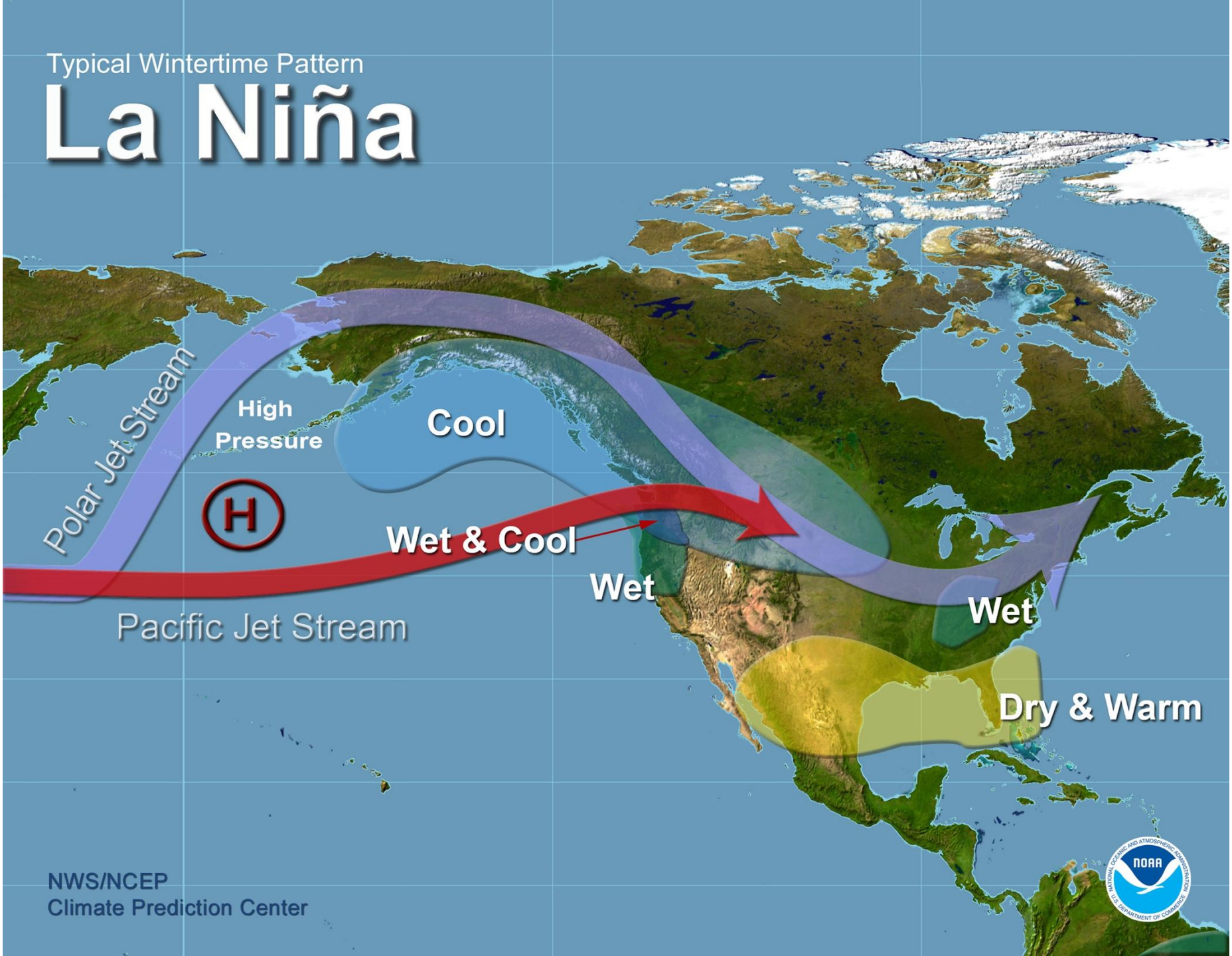
El Niño-Southern Oscillation (ENSO)



Relaxed trade winds
Larger warm pool
Reduced upwelling
Rainfall further east

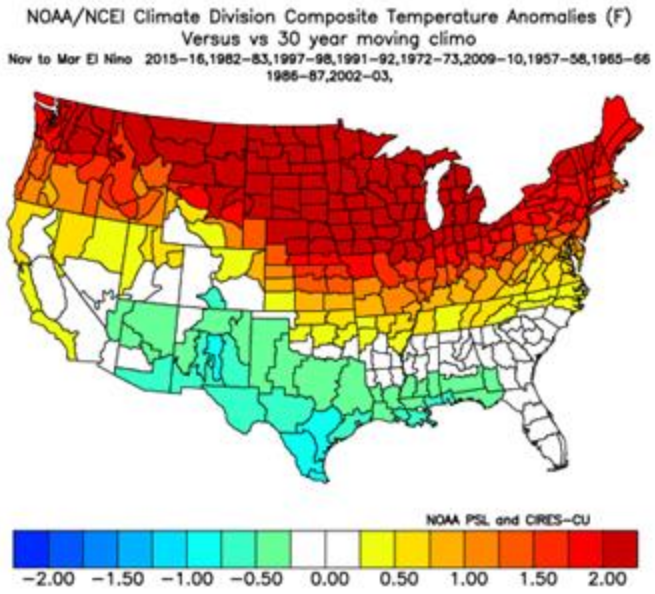




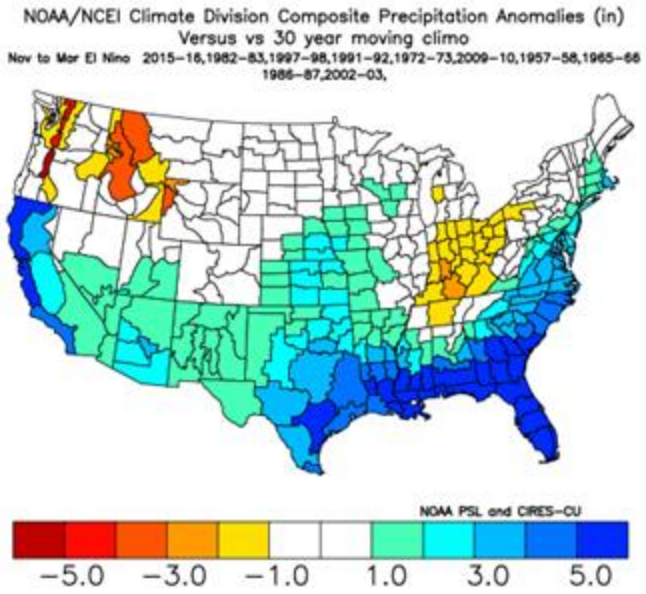

Typical Wintertime Pattern
La Niña
Polar Jet Stream
High Pressure
H
Cool
Wet & Cool
Wet
Wet
Dry & Warm
Pacific Jet Stream
NWS/NCEP
Climate Prediction Center
NOAA

El Nino – Southern Oscillation and US **Winter** Weather Anomalies

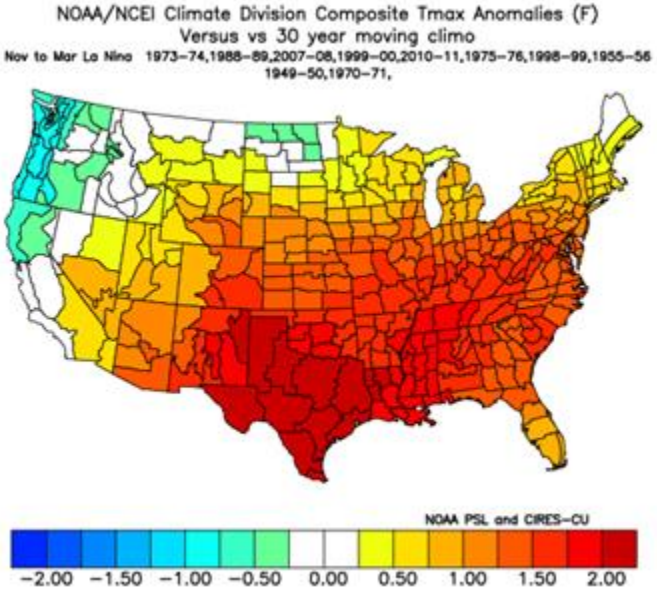
Temperature



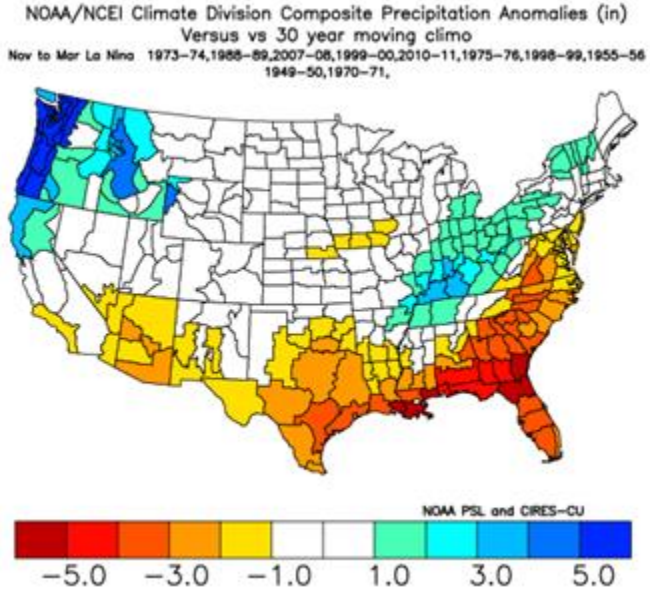
Precipitation



El Nino

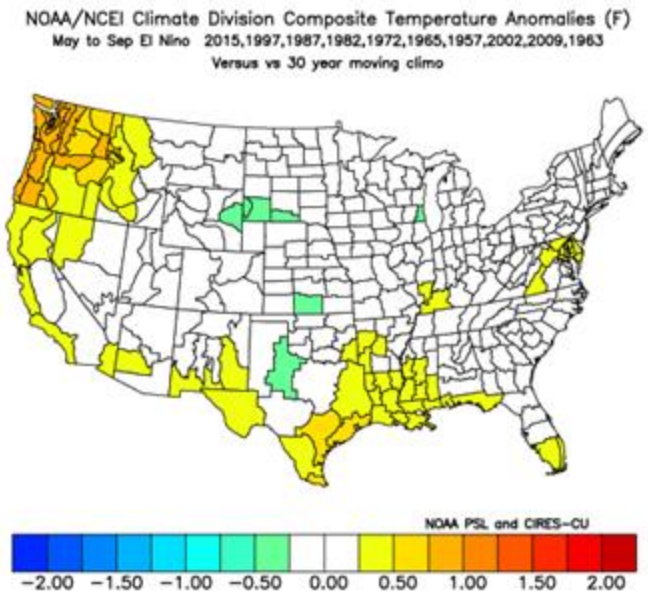


La Nina



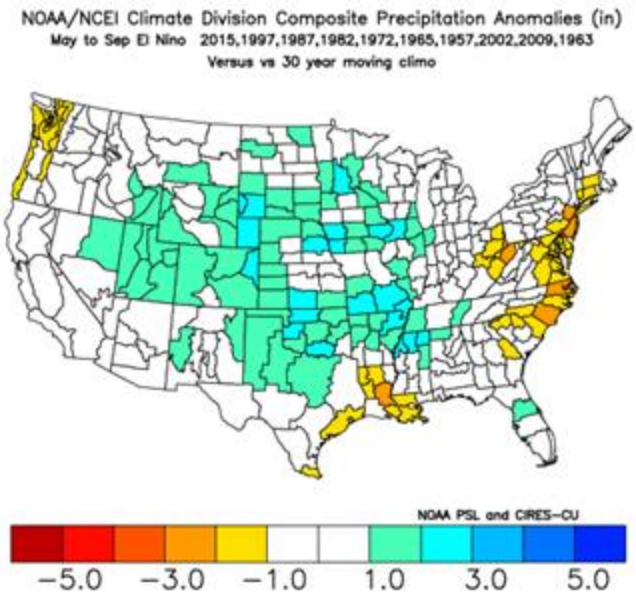
El Nino – Southern Oscillation and US **Summer** Weather Anomalies

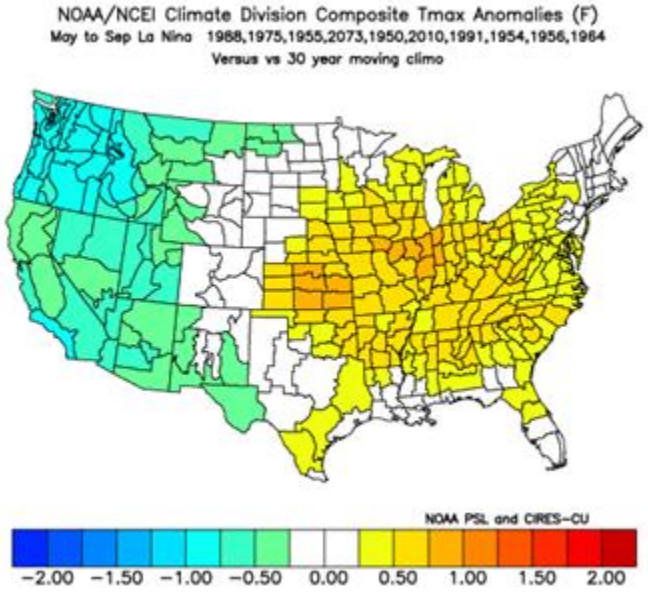
Temperature



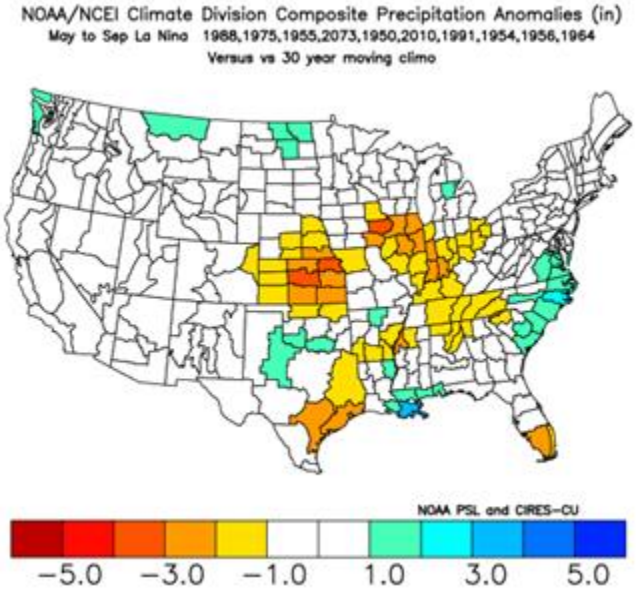
El Nino

Precipitation





La Nina



Skill of NOAA/CPC Seasonal Forecasts

Table 1 The HSS for 0.5/3.5-month lead times (1995-2015) for WA State. The bolded HSS scores are considered to have forecast skill while the red HSS scores lack skill.

Heidke Skill Scores	Temperature		Precipitation	
	0.5-month lead	3.5-month lead	0.5-month lead	3.5-month lead
Oct-Dec	-1.5	1.0	-7.5	6.5
Jan-Mar	**38.1**	**24.0**	7.6	**22.5**
Apr-Jun	**22.5**	**21.5**	-1.5	3.5
Jul-Sep	**30.0**	**31.0**	**25.0**	17.5

$$HSS = \frac{c - e}{t - e} * 100$$

c: # of correct forecasts
e: # of correct forecasts by chance
t: # total forecasts

Perfect forecast: 100
No skill: 0
Worst Possible: -50 (three tier system)

DEPARTMENT OF
ECOLOGY
State of Washington

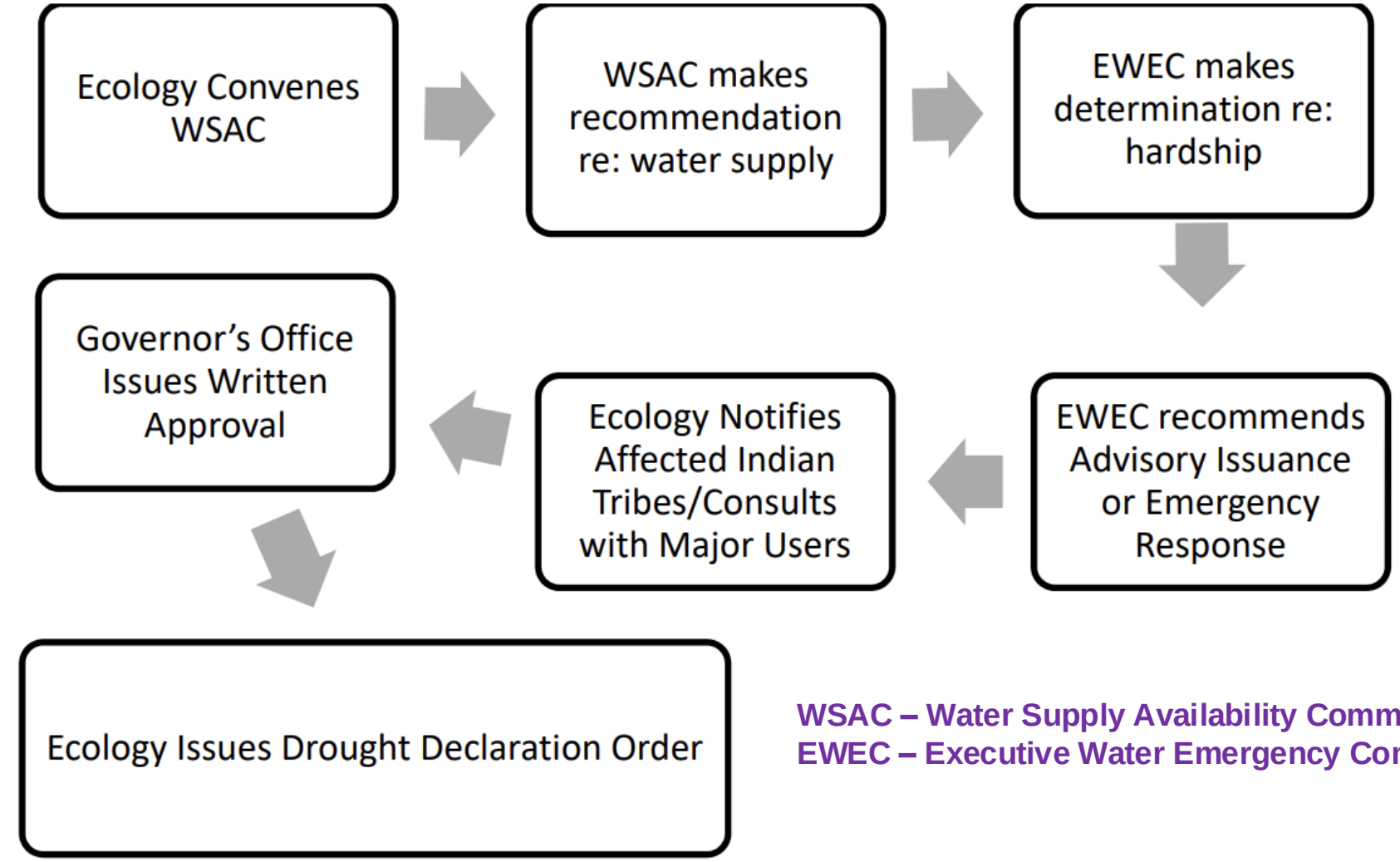
Drought Coordinator: Jeff Marti

Washington State Drought Contingency Plan

Drought is relatively well defined in WA

"…'drought condition' means that the water supply for a geographical area or for a significant portion of a geographical area is below seventy-five percent of normal and the water shortage is likely to create undue hardships for various water uses and users."

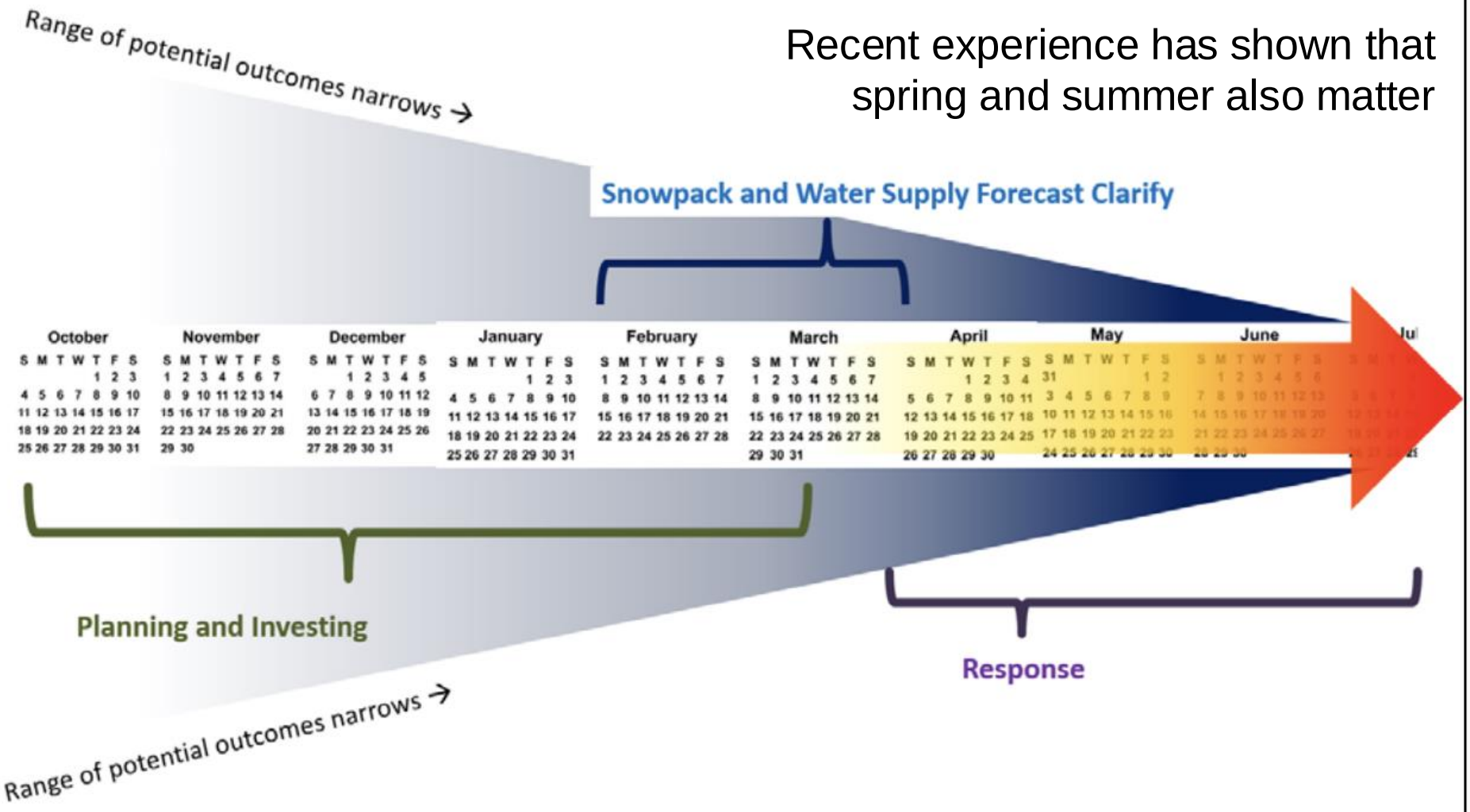
RCW 43.83B.400 & WAC 173-166-050



WSAC – Water Supply Availability Committee
EWEC – Executive Water Emergency Comm.

Figure 12. Schematic for Drought Declaration (Advisory or Emergency)

Recent experience has shown that spring and summer also matter



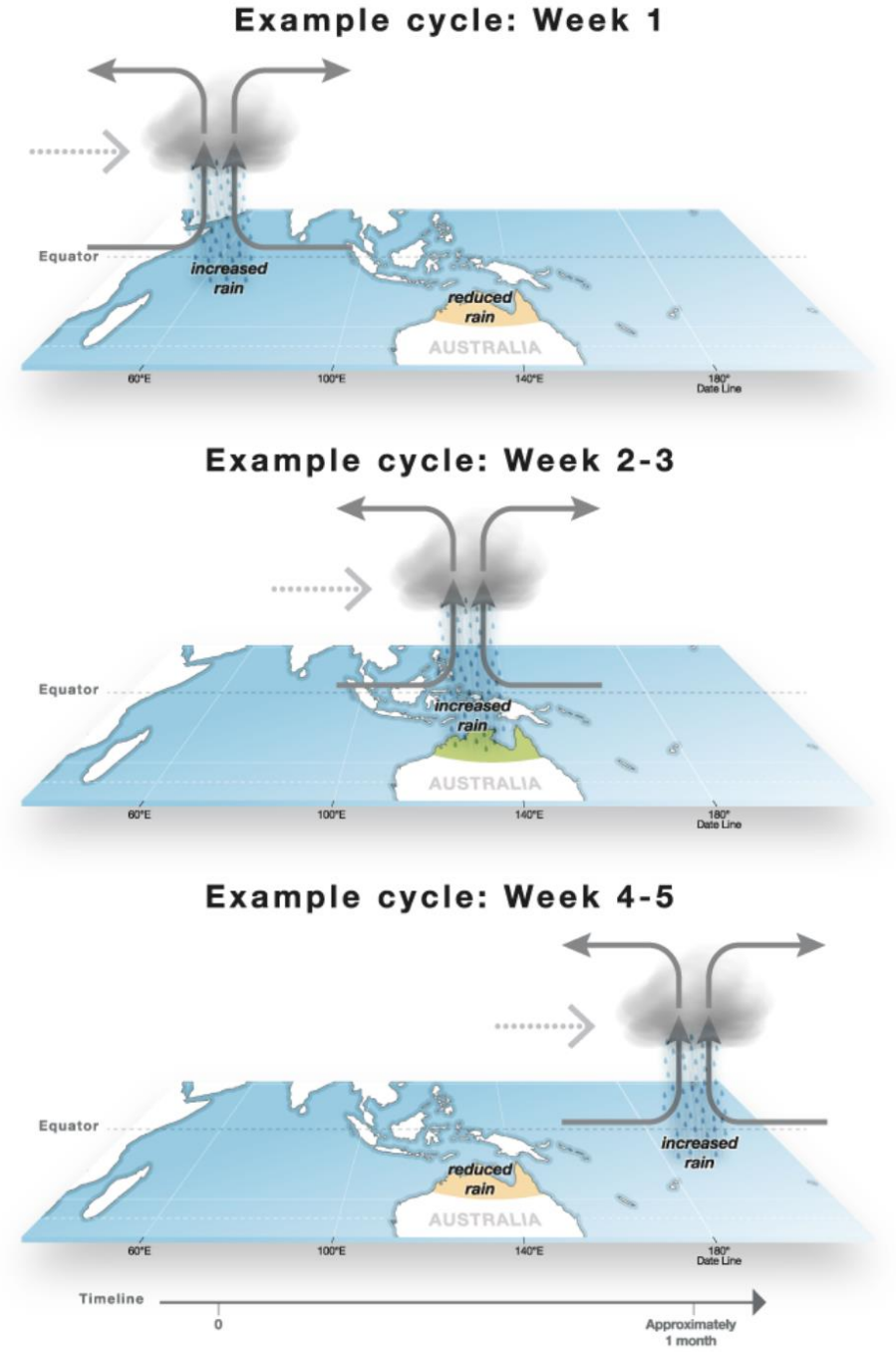
From WA State Drought Contingency Plan

What is Flash Drought?

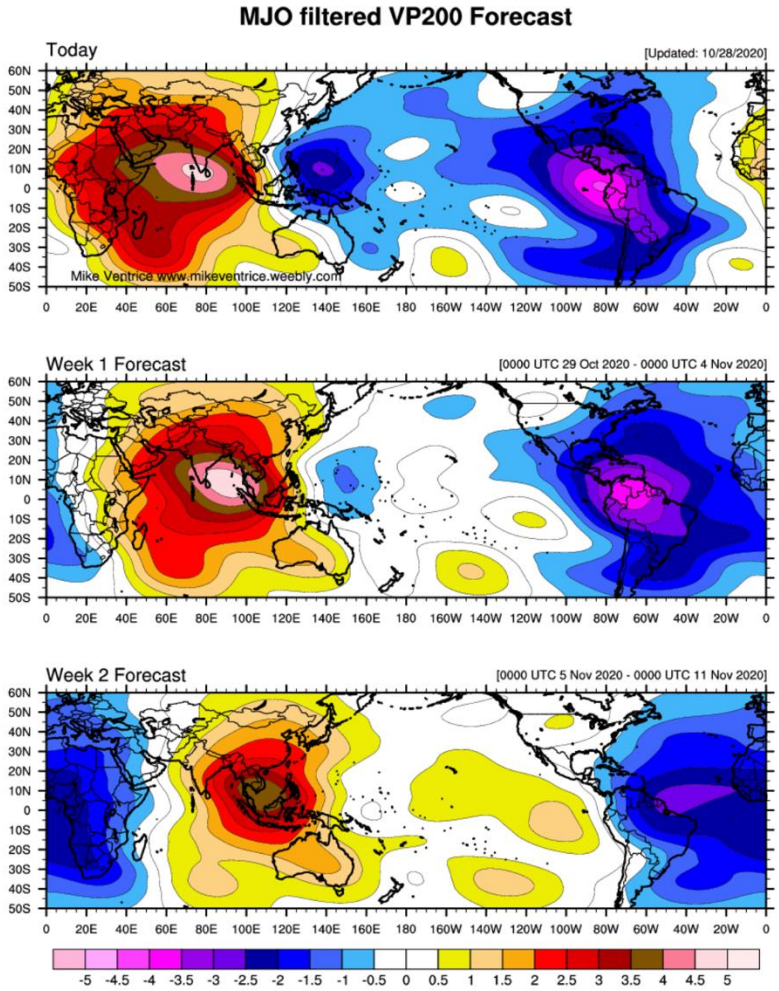
Flash drought is simply the rapid onset or intensification of drought. It is set in motion by lower-than-normal rates of precipitation, accompanied by abnormally high temperatures, winds, and radiation. Together, these changes in weather can rapidly alter the local climate.

National Integrated Drought Information System (NIDIS)

Madden–Julian Oscillation (MJO)

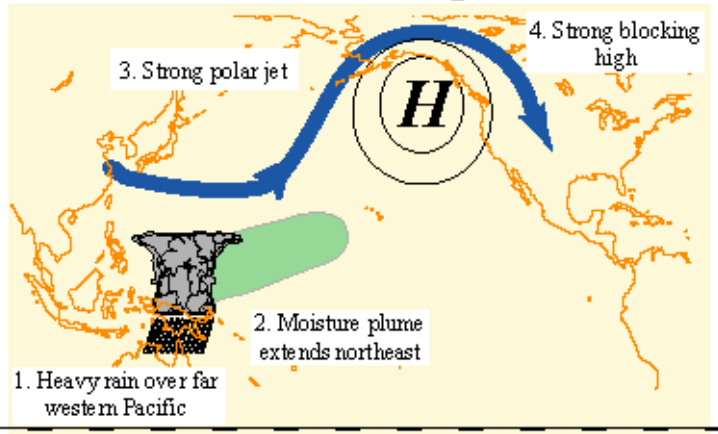


The MJO is being considered in NOAA's experimental extended weather predictions

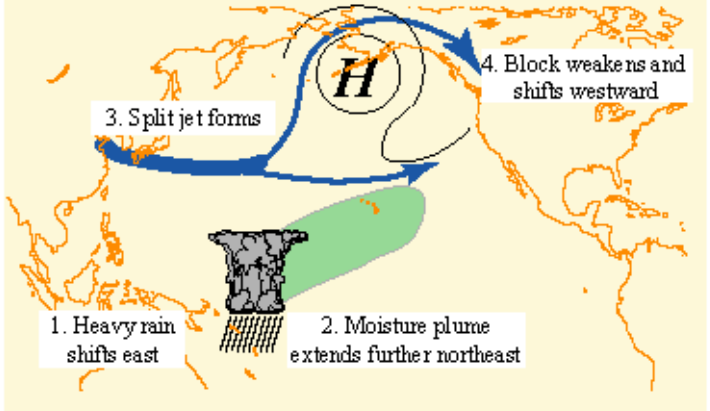


Typical Wintertime Weather Anomalies Preceeding
Heavy West Coast Precipitation Events

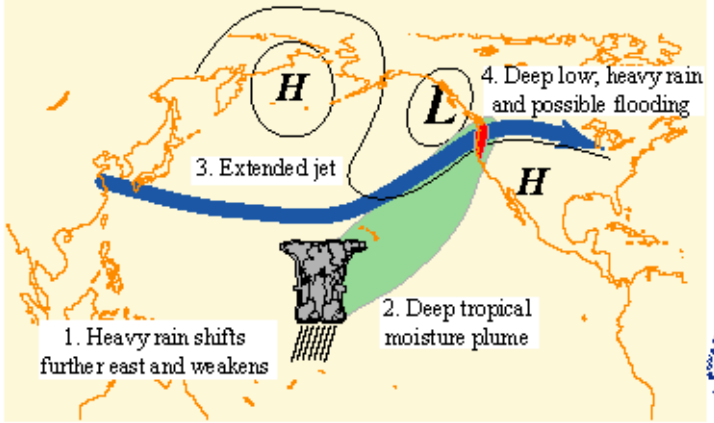
7-10 Days Before Event



3-5 Days Before Event

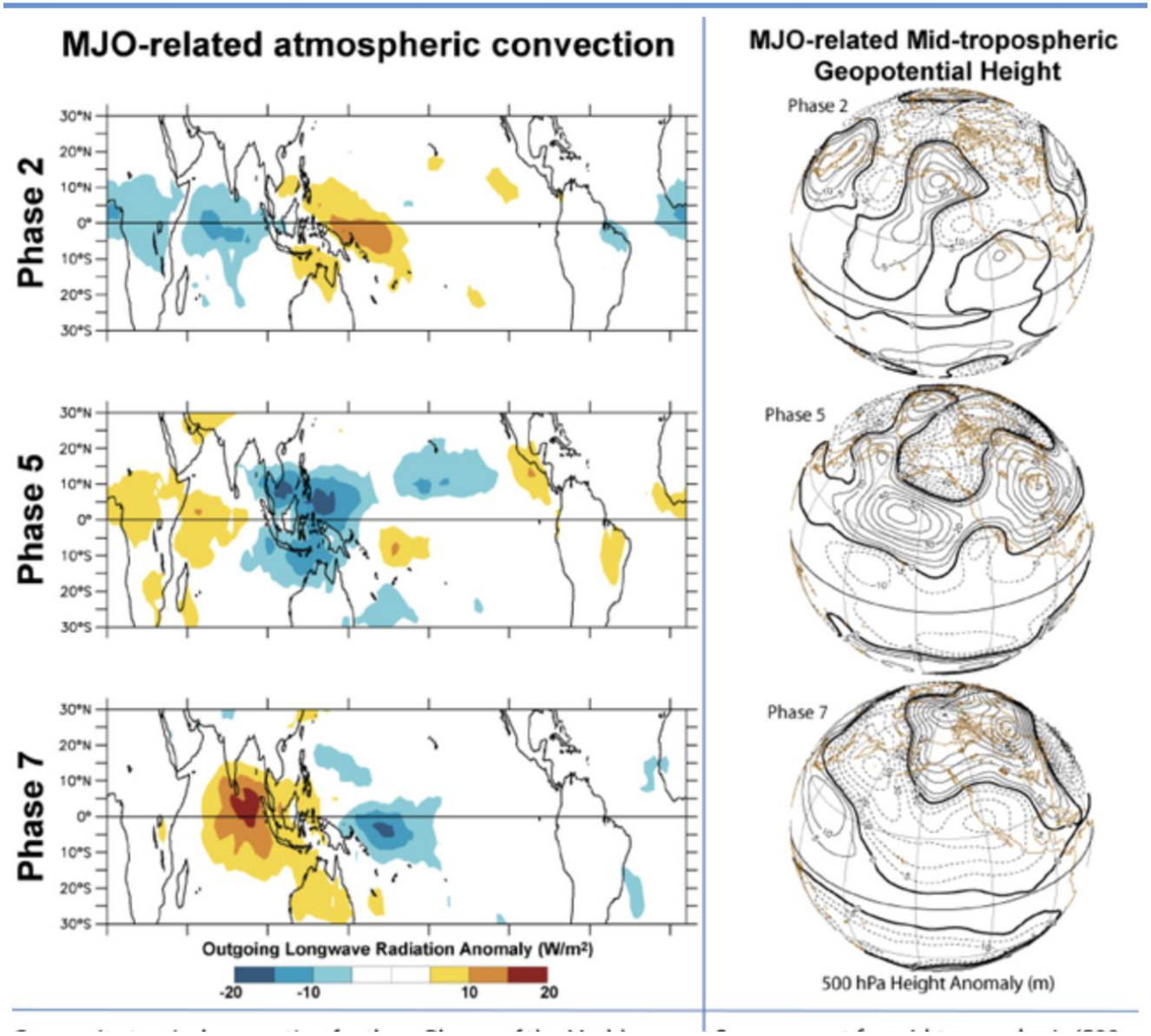


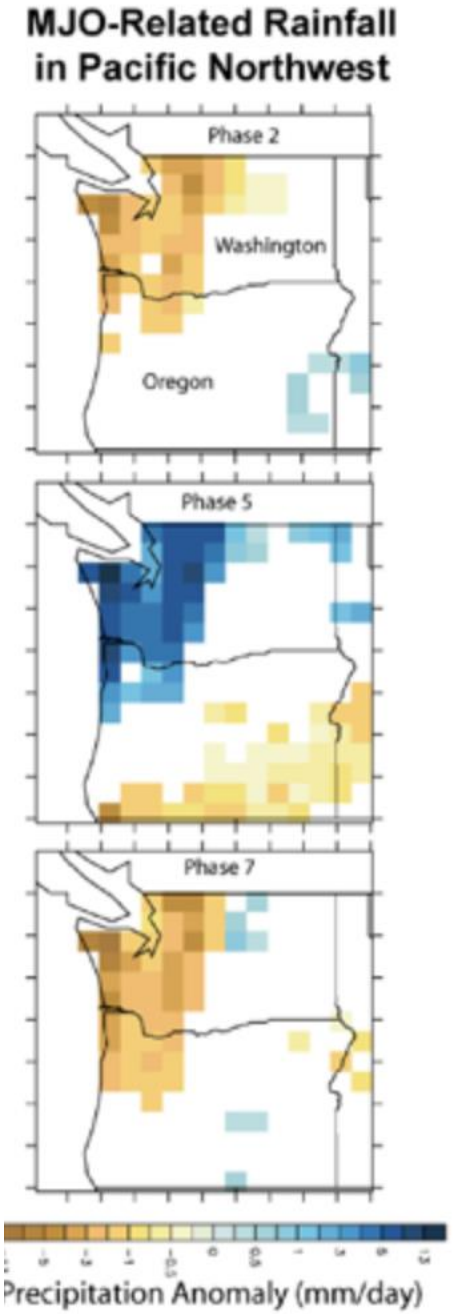
Precipitation Event



Climate Prediction Center/NCEP/NWS

The MJO and its Influence on Precipitation in WA & OR





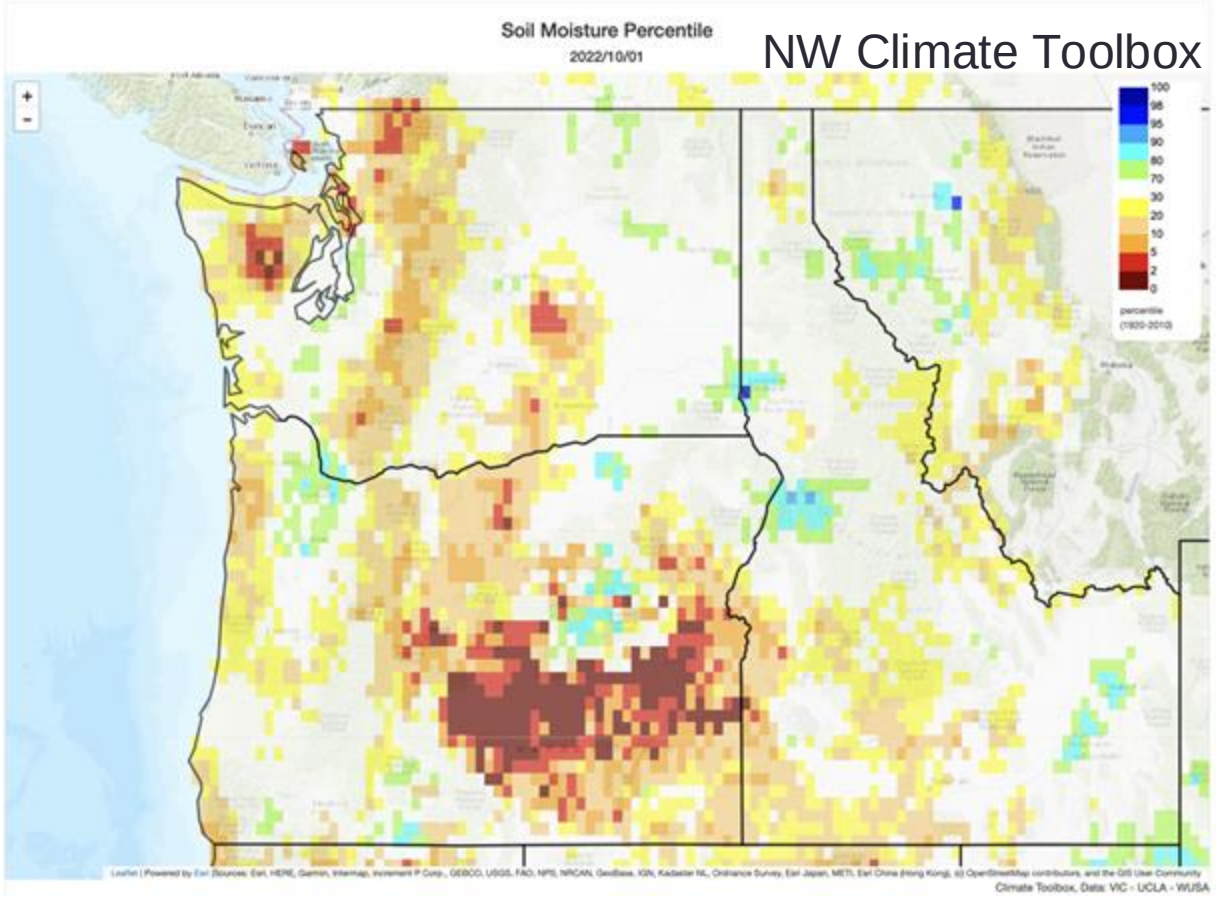
Bond and Vecchi (2003)

Summary

- Many droughts in the Pacific NW can be attributed to paltry snowpack associated with warm and/or dry winters.
- The drought of 2021 was primarily associated with the warm and dry weather that prevailed in WA during the spring (March through June).
- Over the last 50 years, our summers have become warmer (and drier in the last 30 years).
- Our seasonal weather projections will always feature limited skill; we need to figure out how to best account for the inherent uncertainties
- There may be predictability on sub-seasonal time scales (2-6 weeks) that could be better exploited

Comment on a news story about El Nino and its potential impacts on precipitation in the western US (27 May 2015):

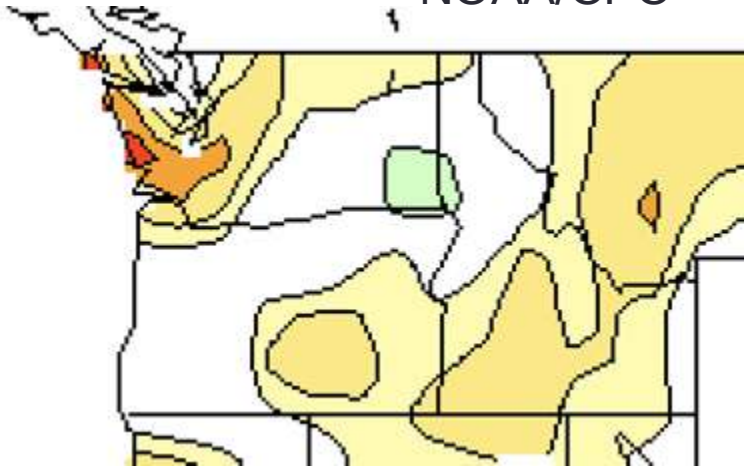
“This is wrong. They're always wrong about predicting this stuff. They said the same thing last year. Pay no attention. Its just a bunch of snot eating knuckle draggers who continually predict the end of the world because of climate change, the glaciers are melting, polar bears are drowning, we're all going to be boiled alive, etc. etc. Occasionally, by accident, these guys can correctly predict the weather tomorrow. But that's about it.”



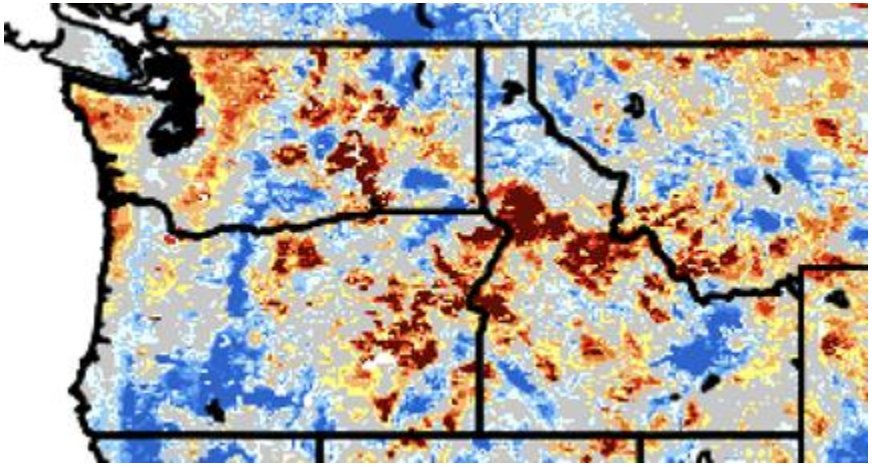
NW Climate Toolbox

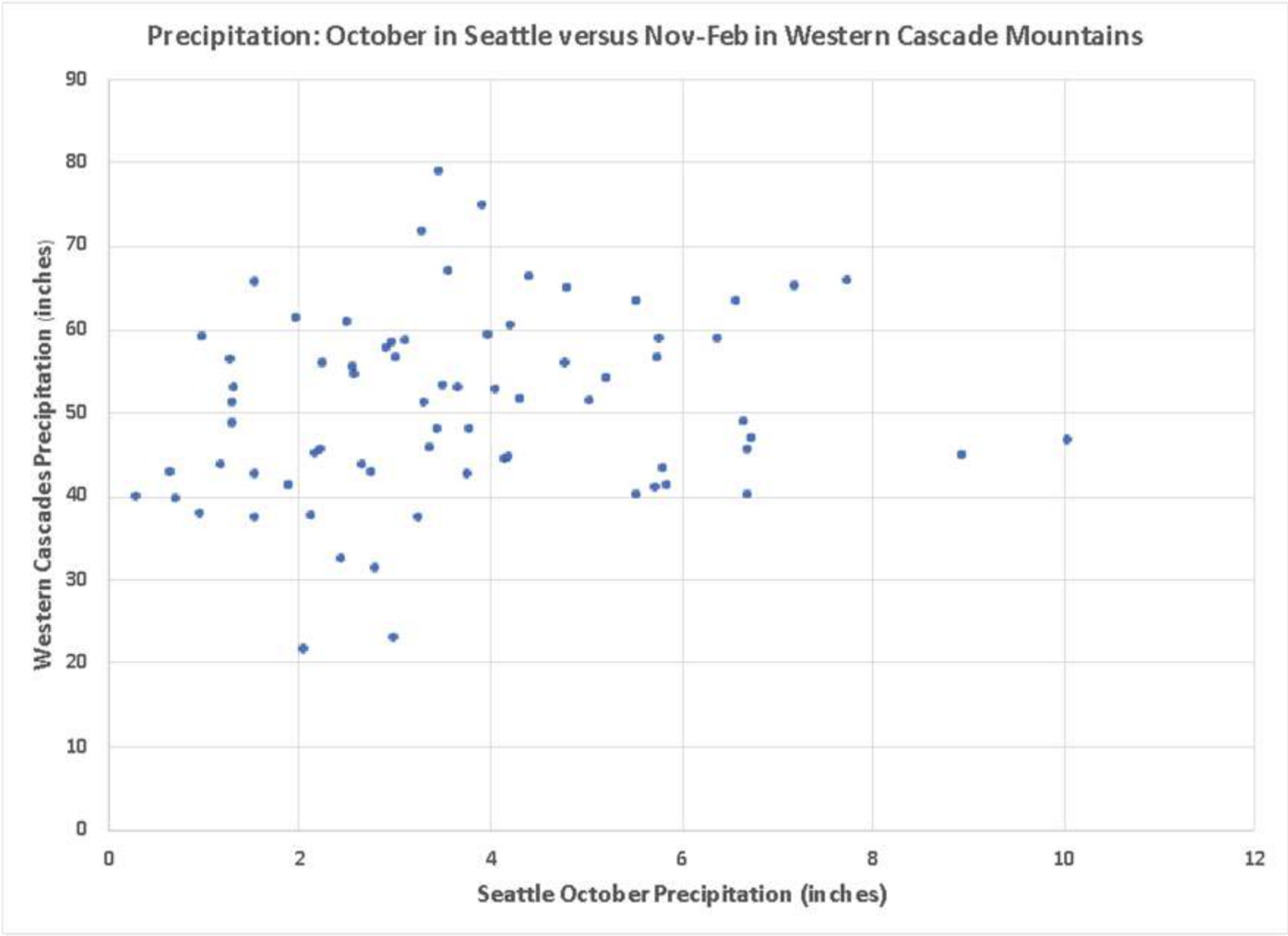
Soil Moisture Anomalies on 1 October 2022

NOAA/CPC



NASA/SPoRT-LiS

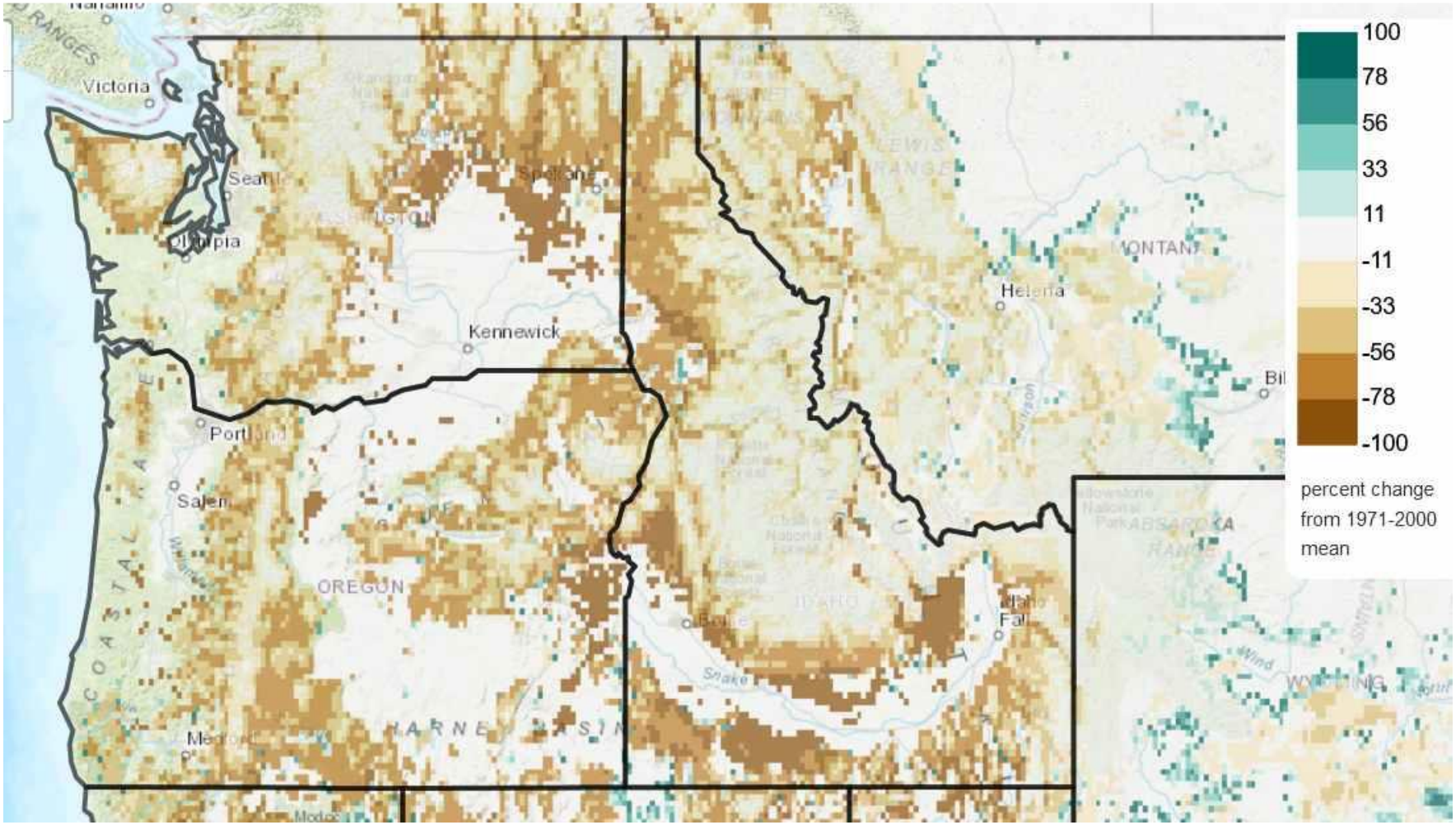



Precipitation: October in Seattle versus Nov-Feb in Western Cascade Mountains
Western Cascades Precipitation (inches)
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
Seattle October Precipitation (inches)

Projected Change in Snow Water Equivalent, April 1st

Lower Emissions (RCP 4.5) 2010-2039 vs. historical simulation 1971-2000, mean change

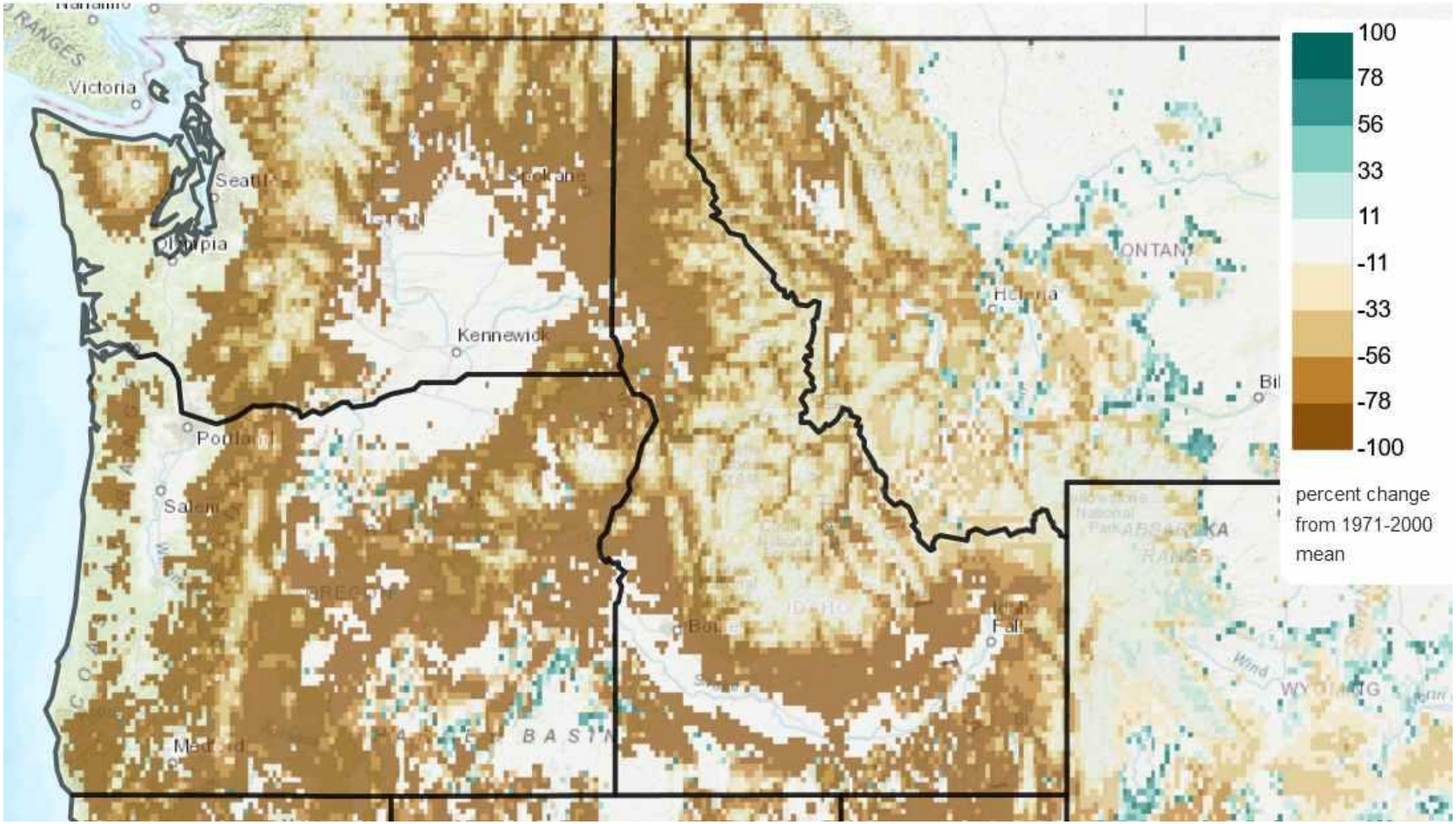
Multi-model mean from 10 VIC runs forced by downscaled CMIP5 models



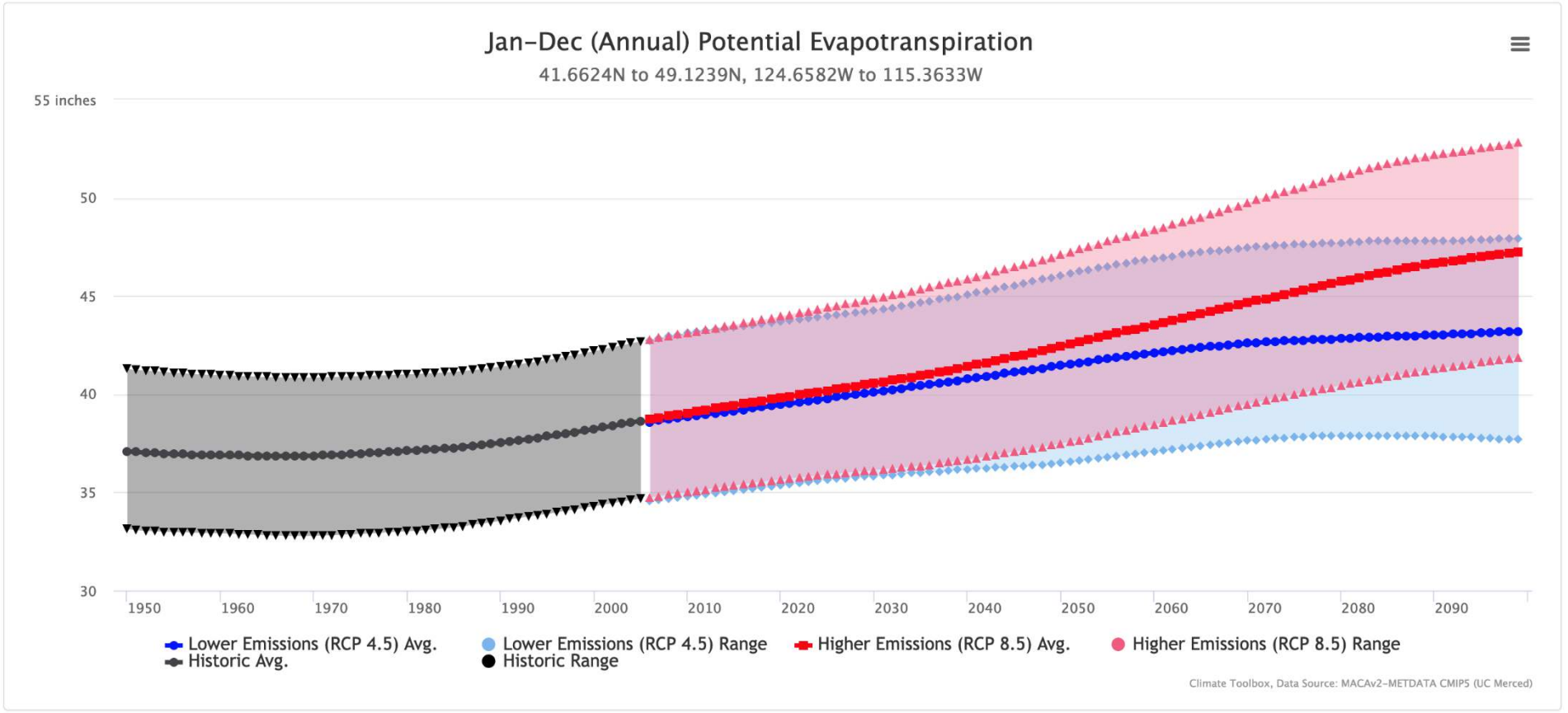
Projected Change in Snow Water Equivalent, April 1st

Higher Emissions (RCP 8.5) 2040-2069 vs. historical simulation 1971-2000, mean change

Multi-model mean from 10 VIC runs forced by downscaled CMIP5 models



Evapotranspiration trends in the Pacific Northwest



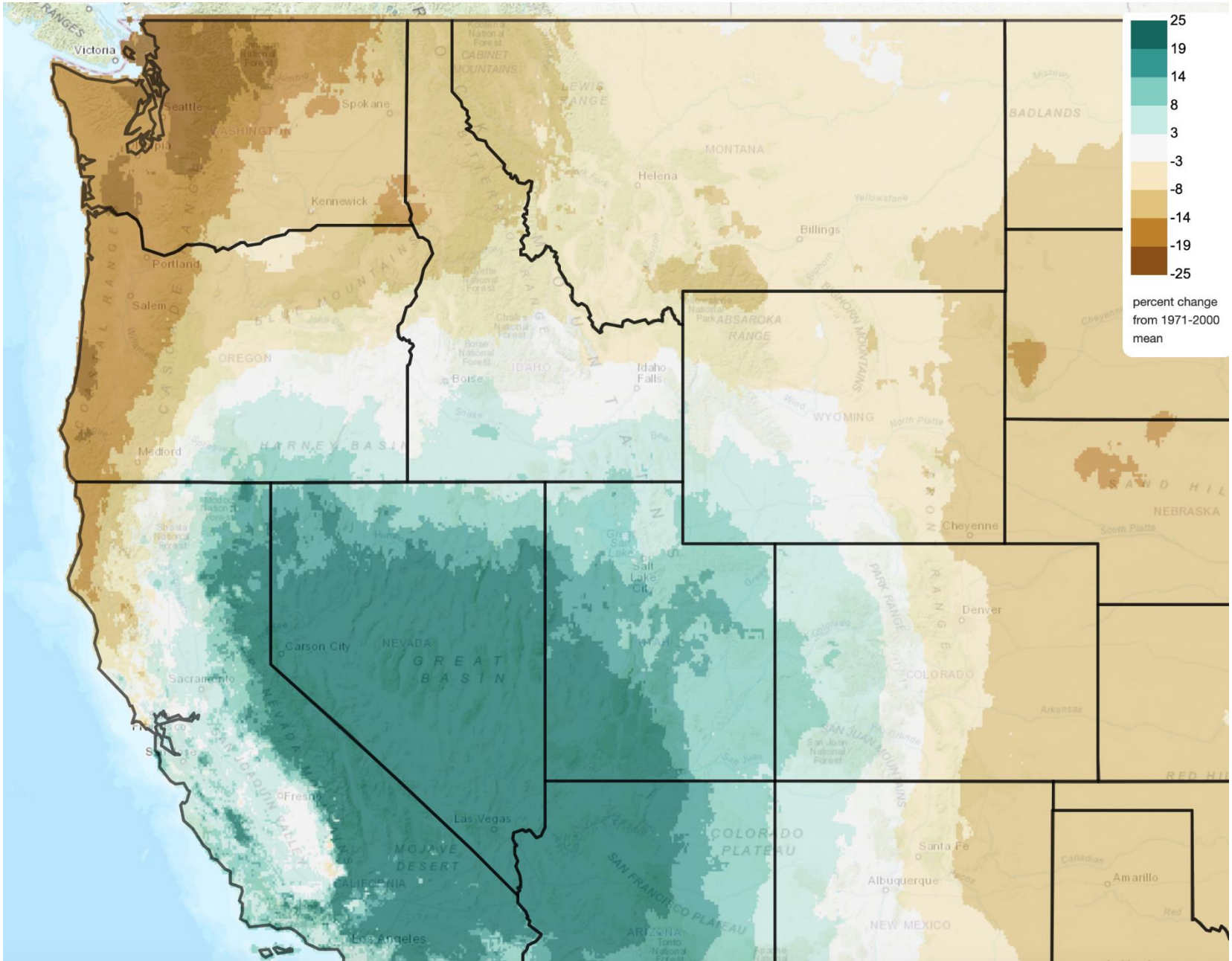
Annual evaporative water losses are expected to increase 10-20% by the end of this century

Because of this, precipitation will not go as far to meet the water needs of society or nature

Projected Change in Precipitation, Summer (Jun-July-Aug)

Higher Emissions (RCP 8.5) 2070-2099 vs. historical simulation 1971-2000, mean change

Multi-model mean derived from 20 downscaled CMIP5 models



Temperature	Precipitation	Snow Water Equivalent

Year Range

1961 2021

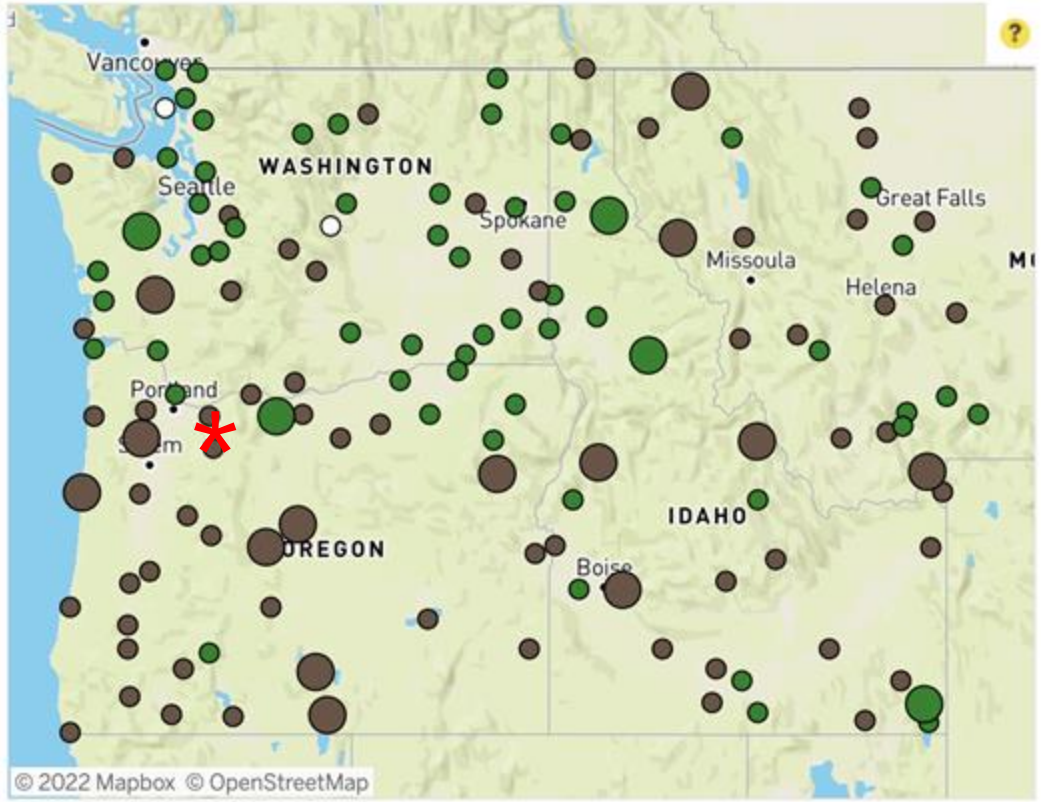
Time Frame

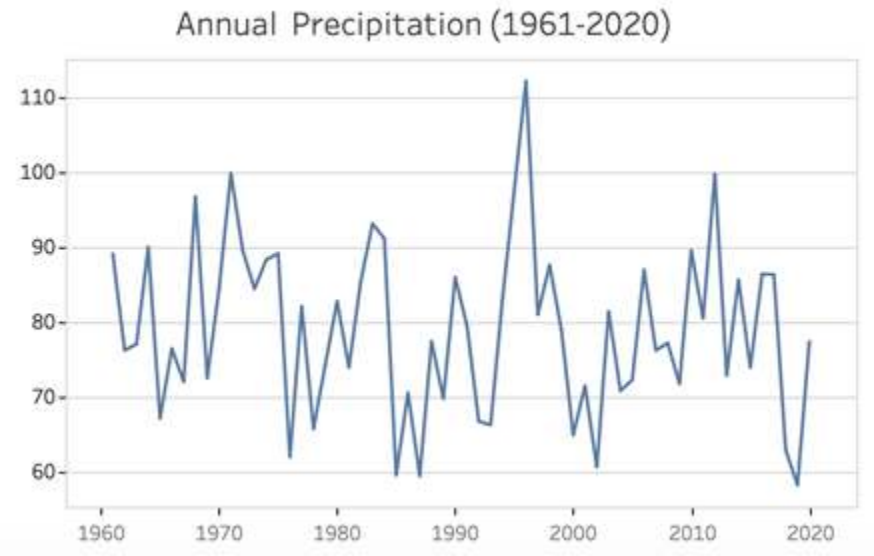
Annual

Trend Range

Per Decade

Trend	-	0	+
Significant (S)			
Not Significant (NS)			
Insufficient Data (I)			





Temperature	Precipitation	Snow Water Equivalent

Year Range

1961 2021

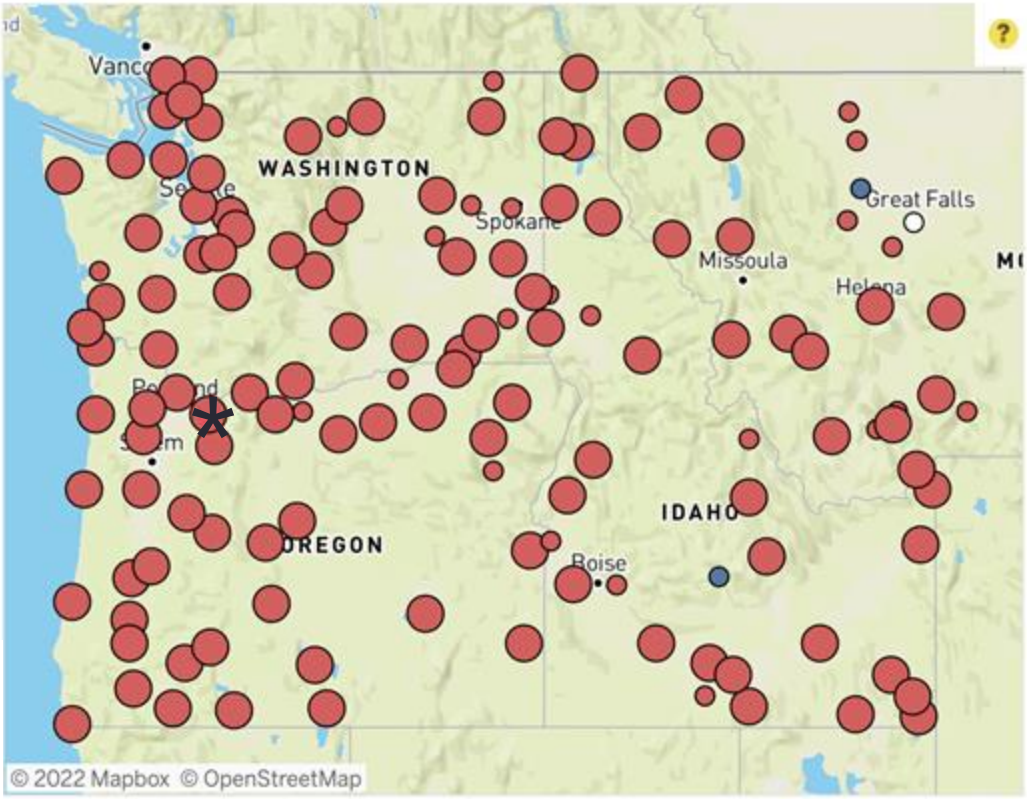
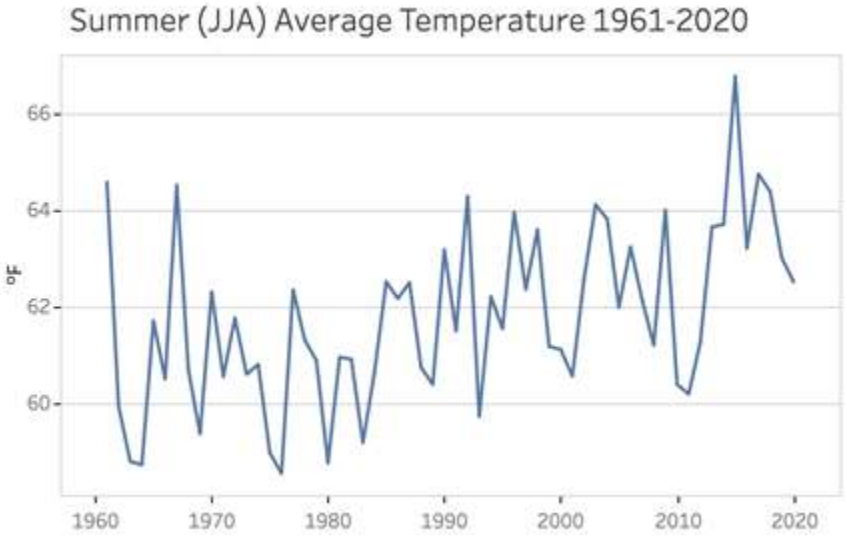
Variable Selection

Average Temperature

Time Frame

Summer (JJA)

Trend Range

Per Decade

Trend	-	0	+
Significant (S)			
Not Significant (NS)