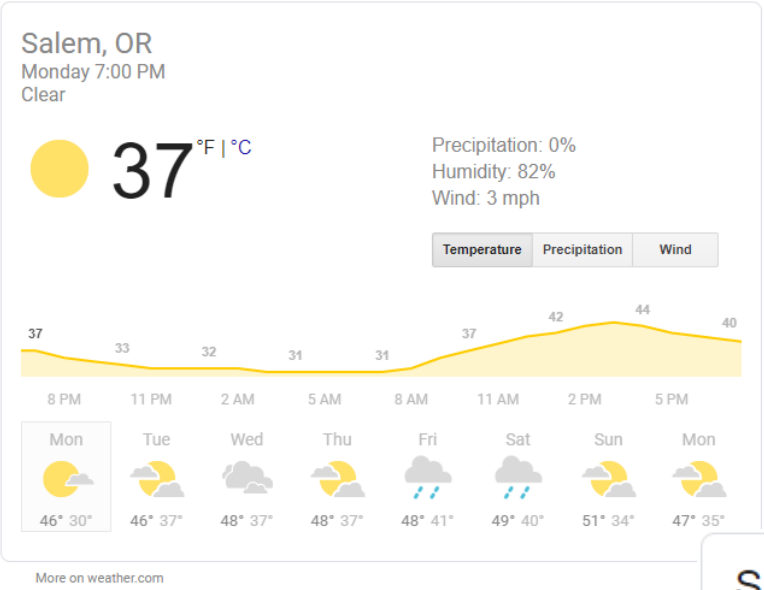
Climate Change in the Northwest

Holly Prendeville

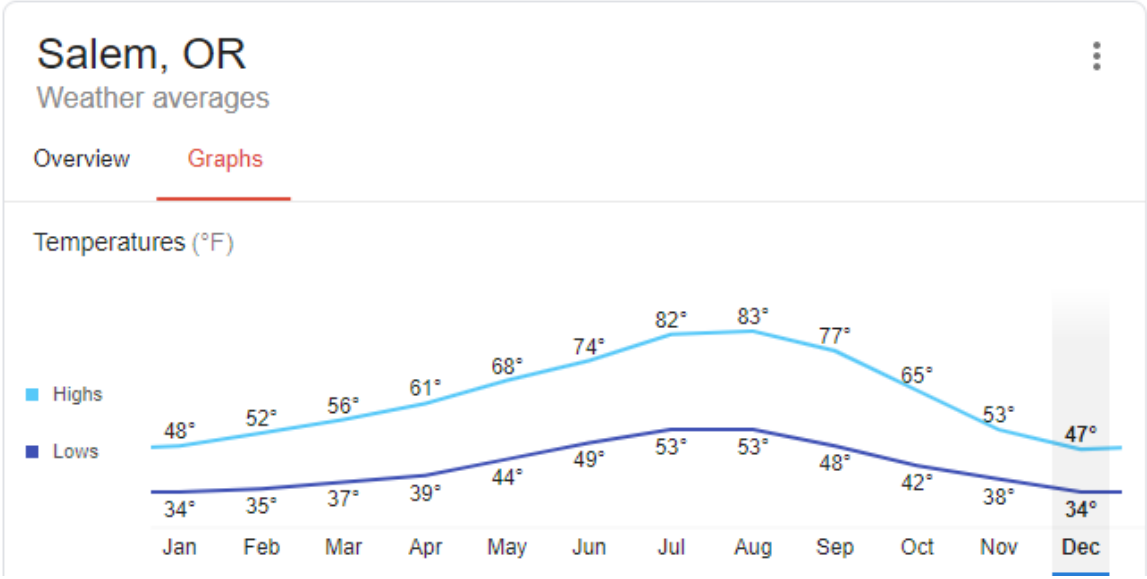
USDA Northwest Climate Hub

Weather, climate, and climate change

The difference between weather and climate is <u>time</u>

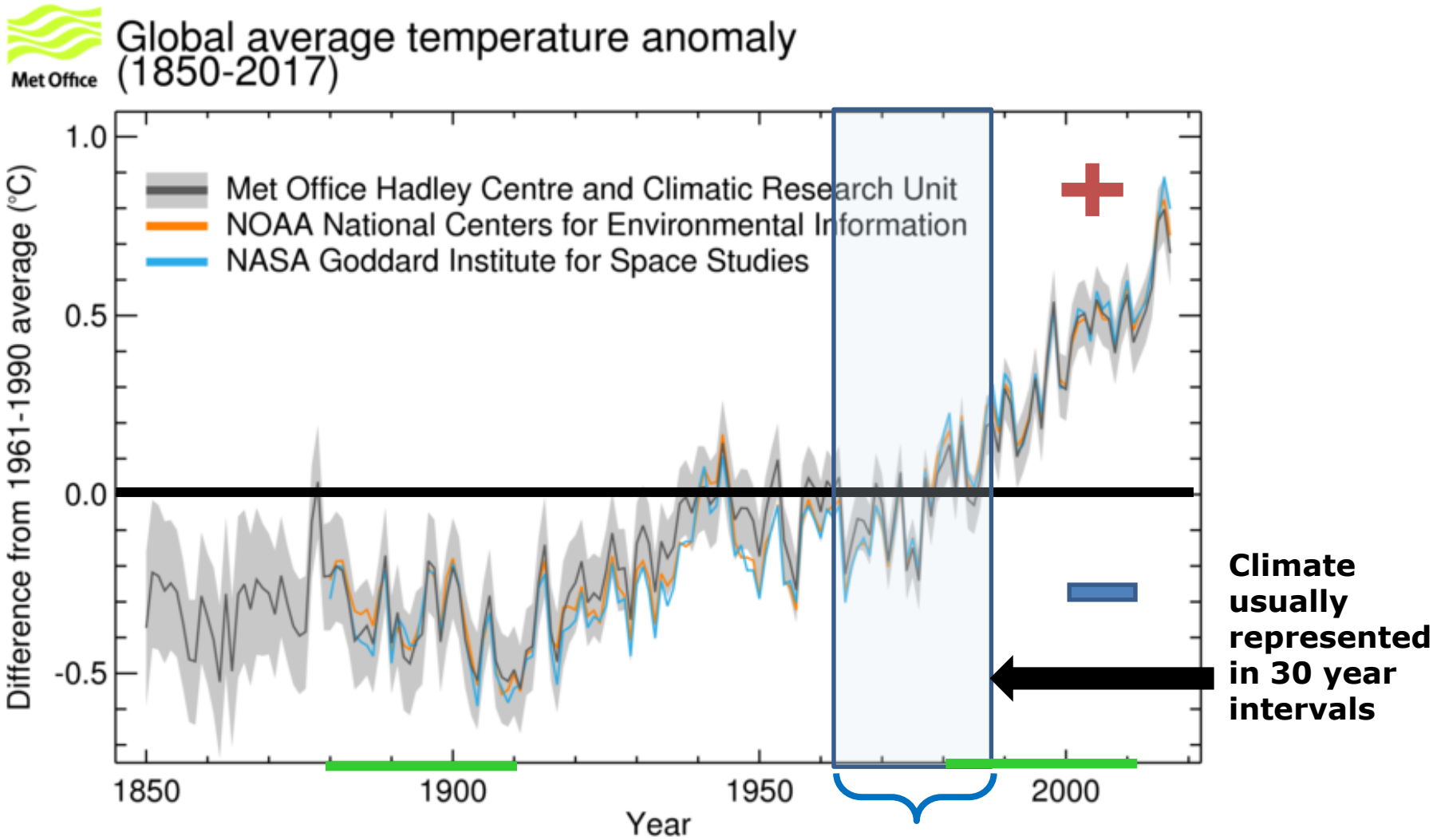


Weather: minutes to months

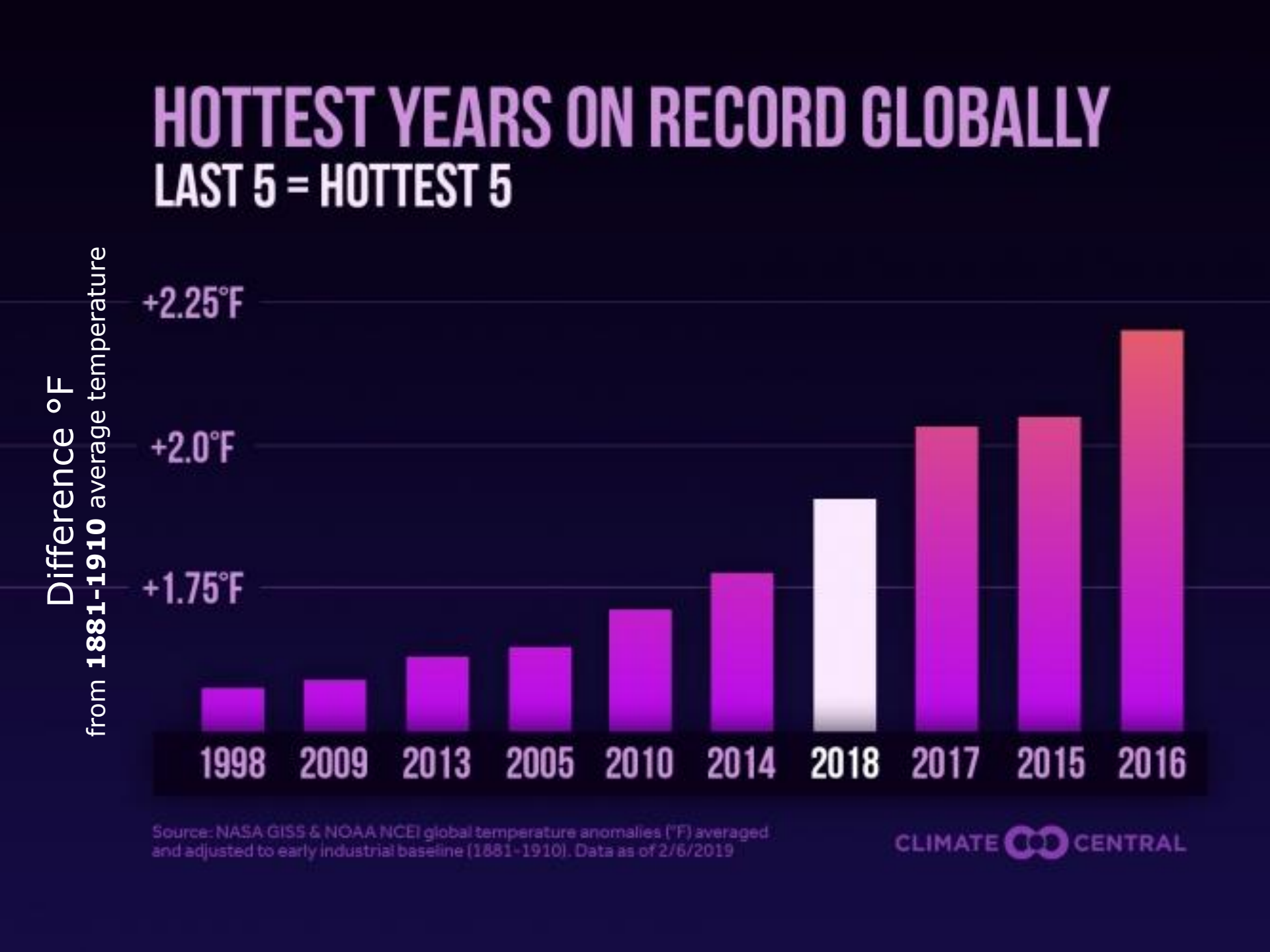


Climate: months, years+

Observations in Global Climate

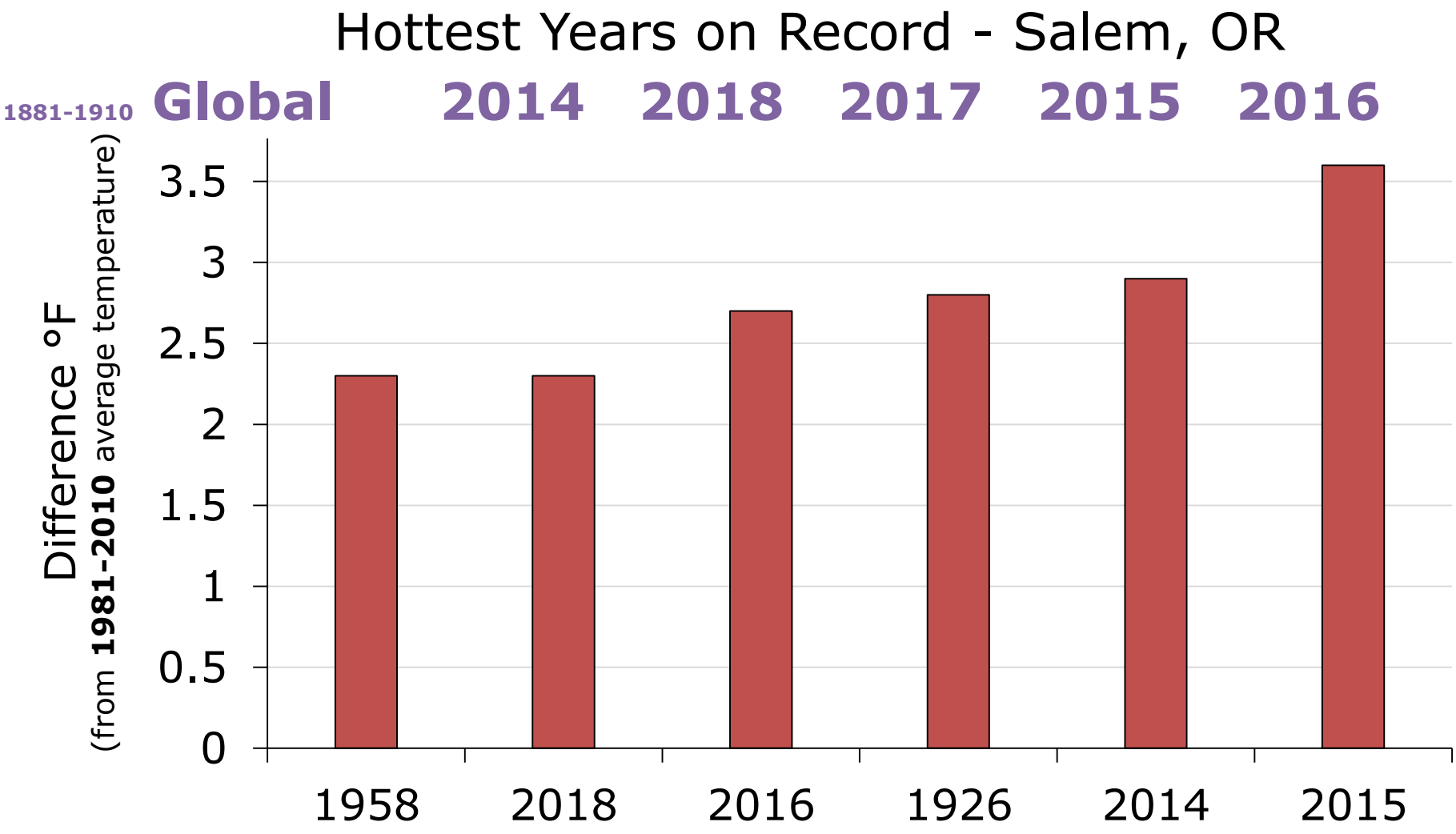


http://www.metoffice.gov.uk/research/monitoring/climate/surface-temperature#how


HOTTEST YEARS ON RECORD GLOBALLY
LAST 5 = HOTTEST 5
Difference °F
from 1881-1910 average temperature
+2.25°F
+2.0°F
+1.75°F
1998
2009
2013
2005
2010
2014
2018
2017
2015
2016
Source: NASA GISS & NOAA NCEI global temperature anomalies (°F) averaged and adjusted to early industrial baseline (1881-1910). Data as of 2/6/2019
CLIMATE CENTRAL

Hottest Years on Record - Salem, OR

Data from the National Weather Service-Portland, 1981-2010 averages
https://www.wrh.noaa.gov/pqr/sleclimate/pg36.pdf



Dry November 2019

Astoria

5th Driest in ~125 years
2019 : 2.20"
Average : 11.15"

Portland

5th Driest in ~75 years
2019 : 1.52"
Average : 5.63"

Salem

3rd Driest in ~125 years
2019 : 0.80"
Average : 6.50"

Eugene

5th Driest in ~125 years
2019 : 1.23"
Average : 7.72"

Santiam Park Fire burns 189 acres near Lyons, but all evacuations lifted

Bill Poehler, Zach Urness and David Davis, Salem Statesman Journal Published 10:10 p.m. PT March 19, 2019 | Updated 7:57 a.m. PT March 21, 2019

It's the First Day of Spring and It's Already Wildfire Season in Oregon

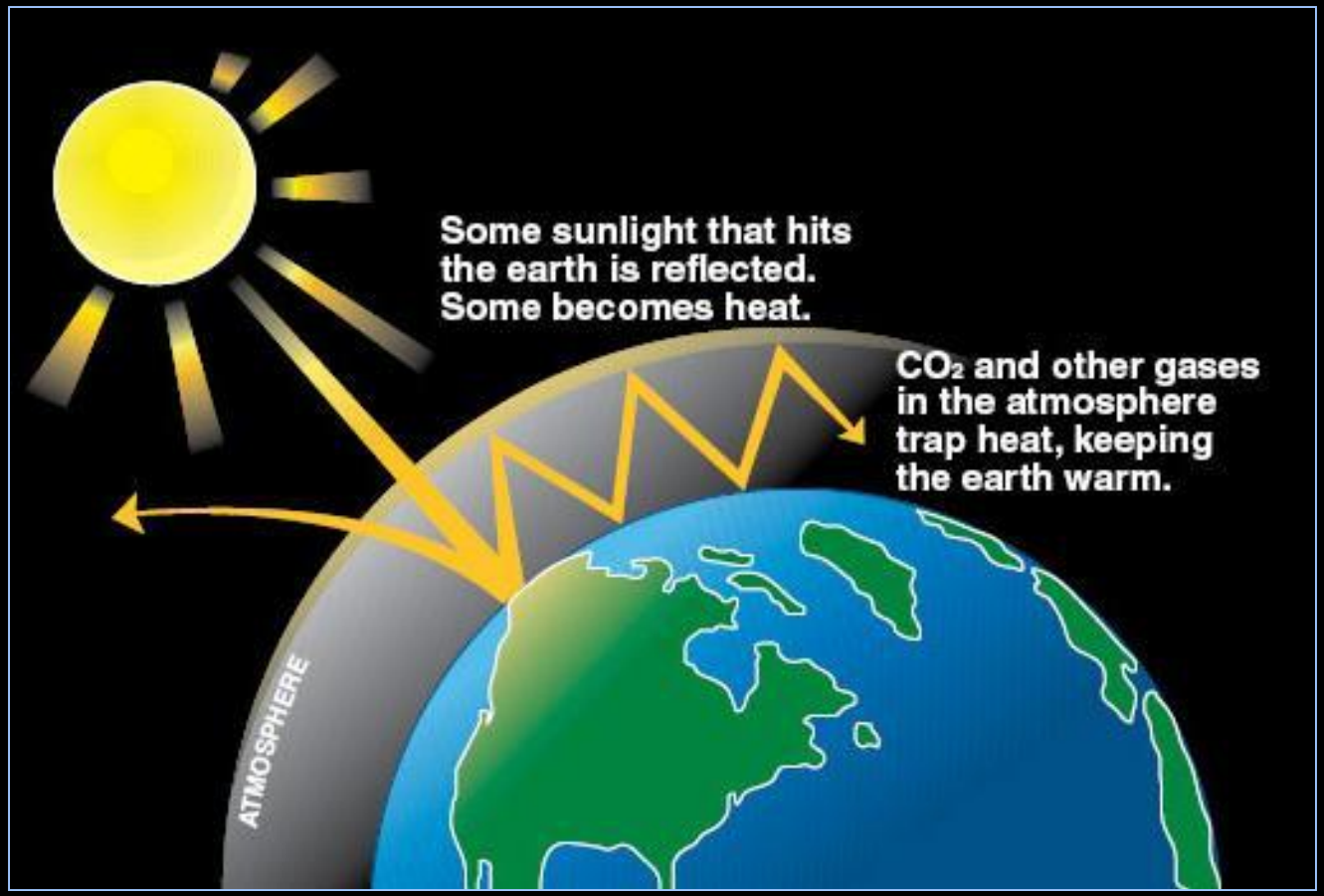
by Ned Lannamann • Mar 20, 2019 at 1:46 pm

WILDFIRES

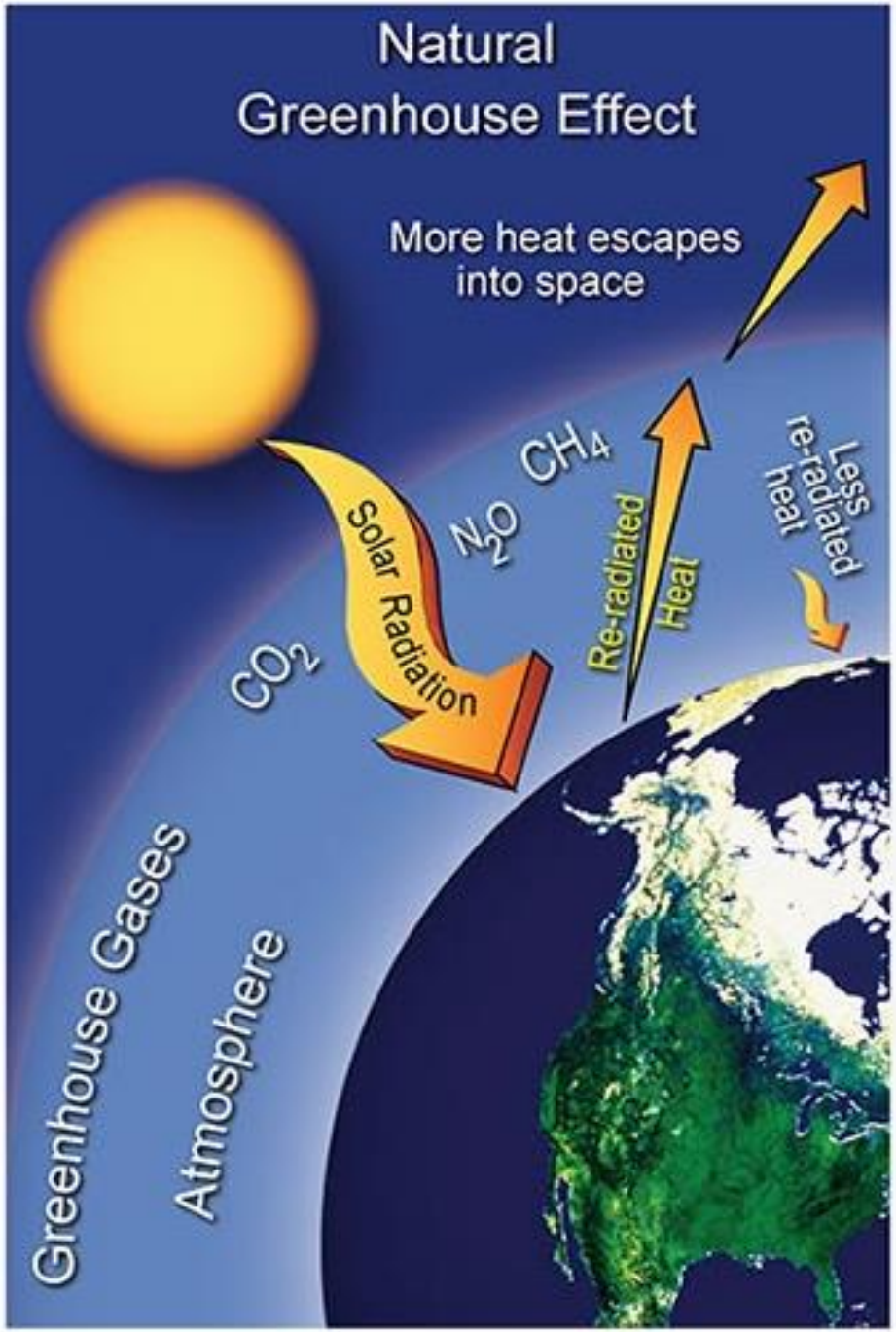
2019 Oregon wildfire season shortest this century

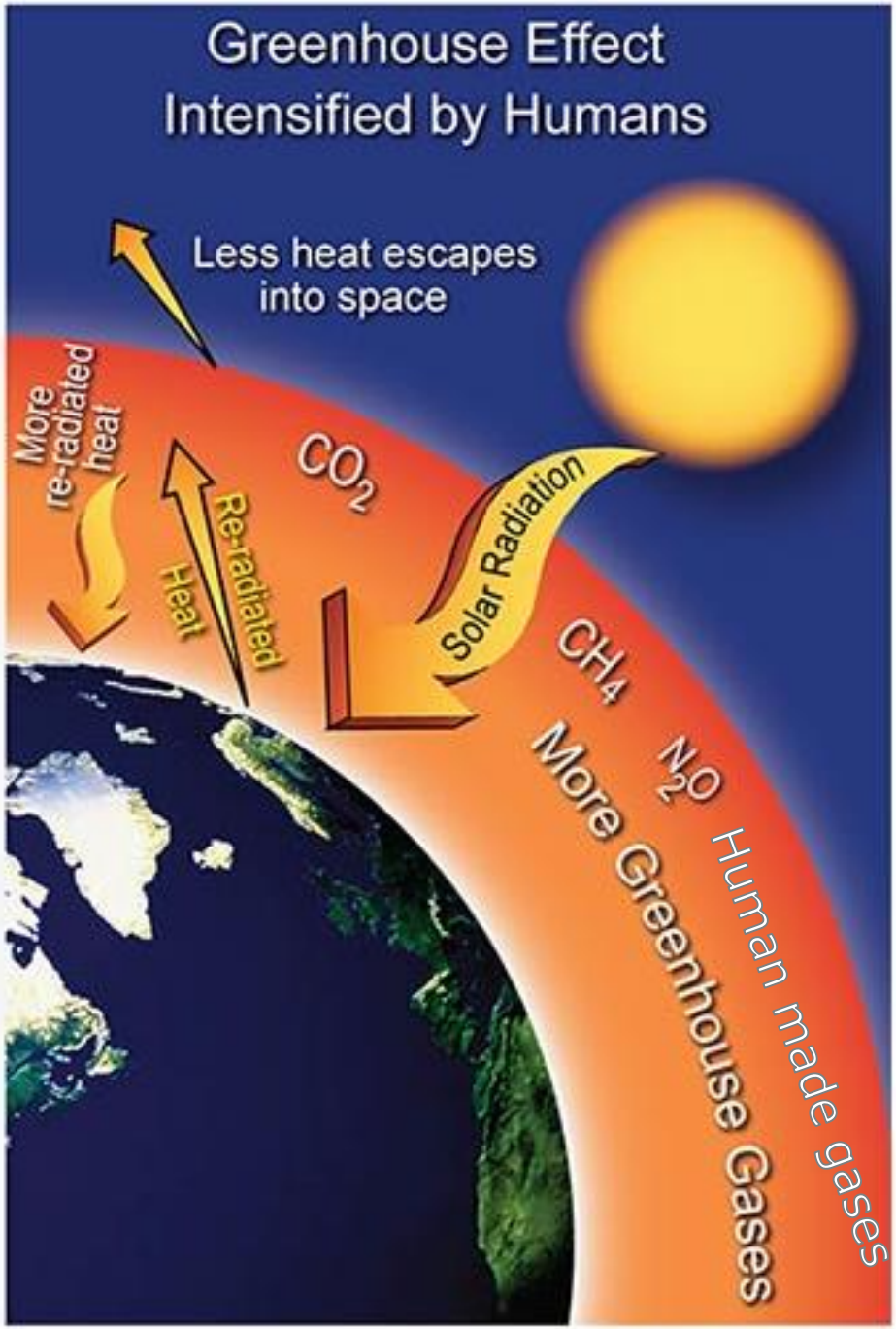
2019 wildfire season was only 99 days

Greenhouse gases (water vapor, CO_2, CH_4, N_2O) play a critical role in determining global temperature



Rapid increases in greenhouse gases are changing this natural balance

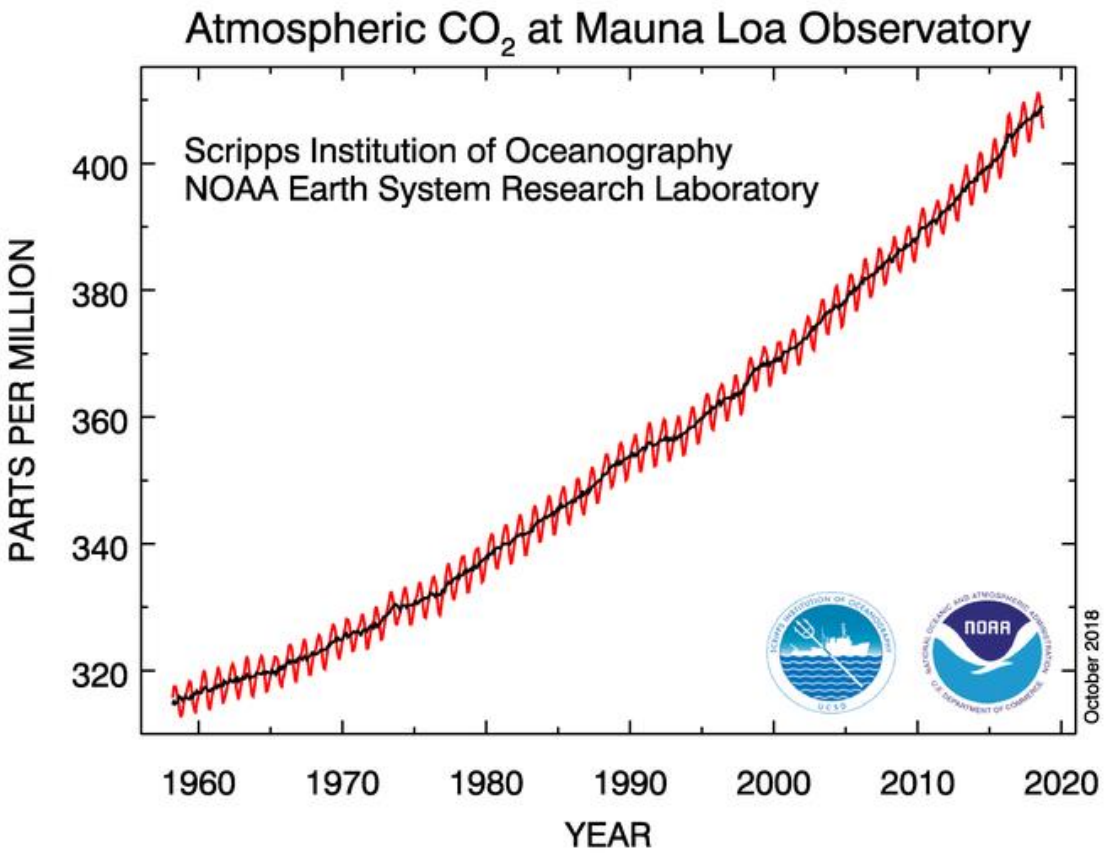

Natural
Greenhouse Effect
More heat escapes
into space
Solar Radiation
CO_2
N_2O
CH_4
Re-radiated
Heat
Less
re-radiated
heat
Greenhouse Gases
Atmosphere


Greenhouse Effect
Intensified by Humans
Less heat escapes
into space
More
re-radiated
heat
Re-radiated
Heat
CO_2
Solar Radiation
CH_4
N_2O
More Greenhouse Gases
Human made gases

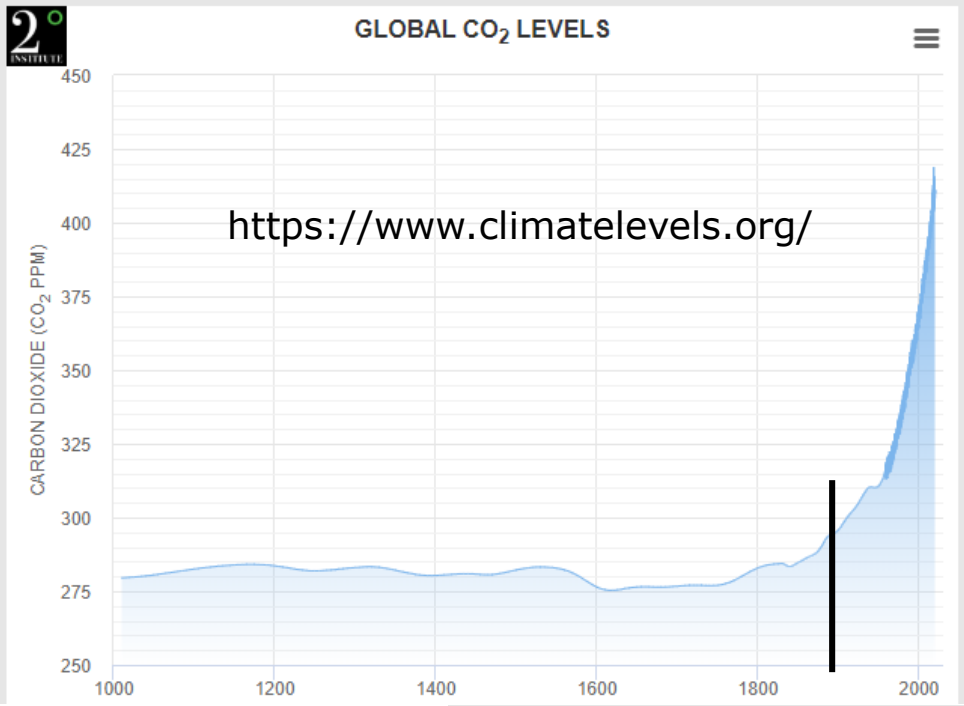
Carbon dioxide is increasing

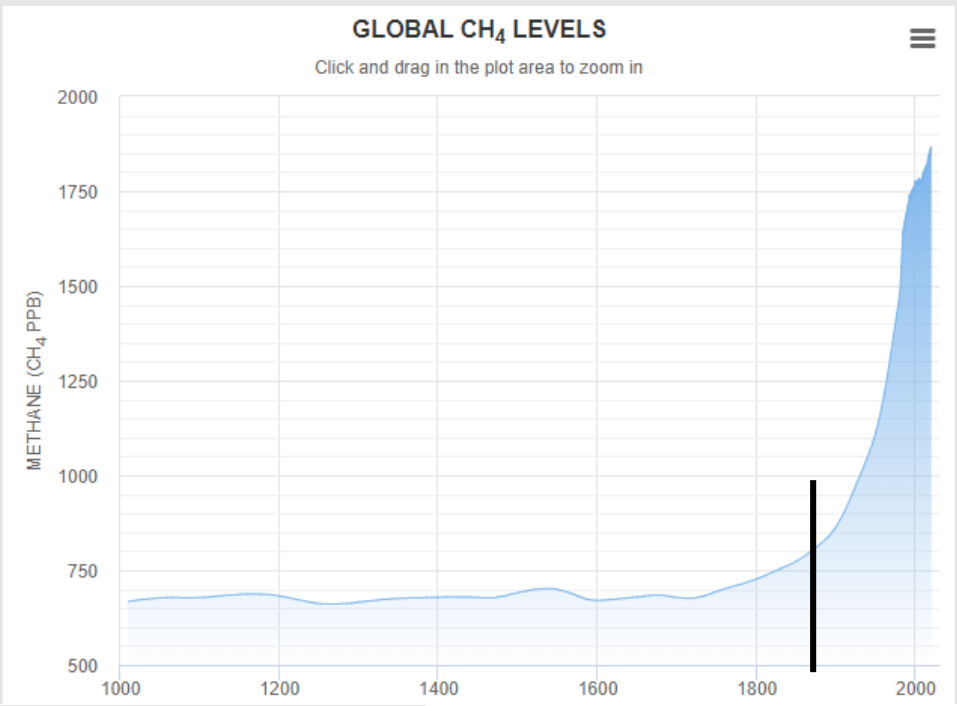
Atmospheric CO_2 is now **410.90 ppm**

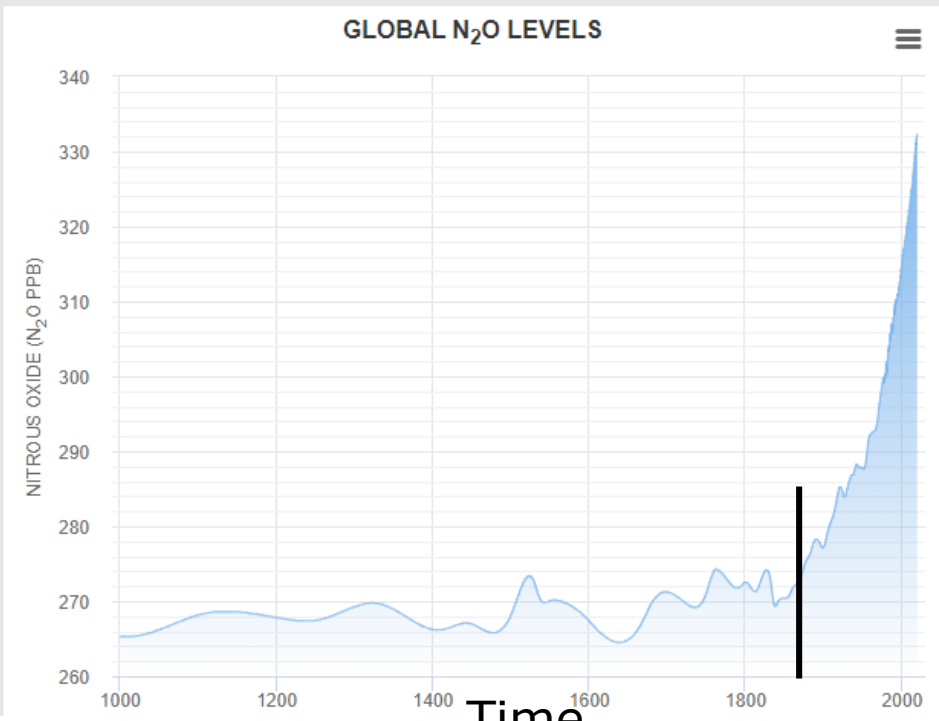
It was **260 ppm** in 1850



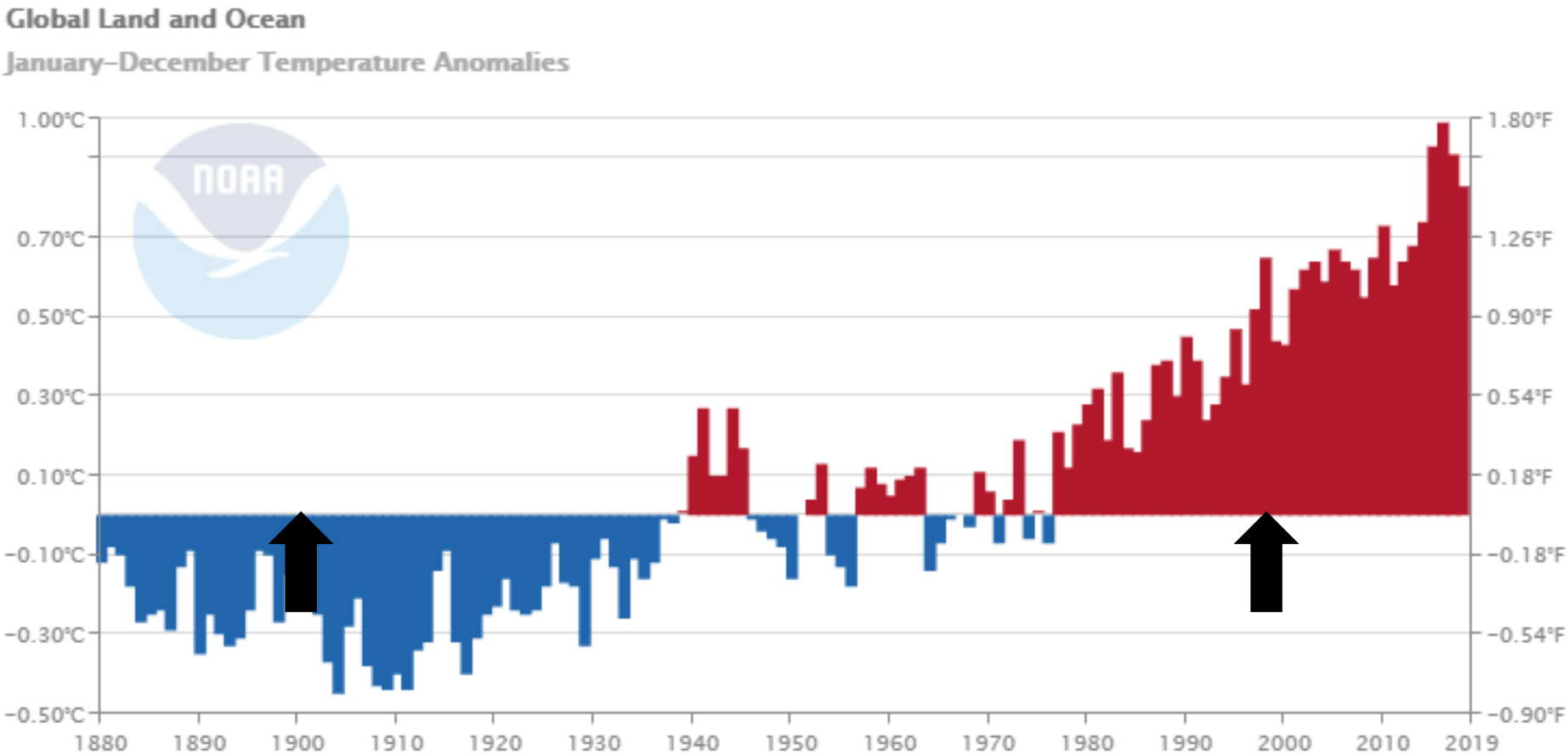
Source: https://www.esrl.noaa.gov/gmd/ccgg/trends/full.html


GLOBAL CO_2 LEVELS
https://www.climatelevels.org/
CARBON DIOXIDE (CO_2 PPM)
450
425
400
375
350
325
300
275
250
1000
1200
1400
1600
1800
2000
Time


GLOBAL CH_4 LEVELS
Click and drag in the plot area to zoom in
METHANE (CH_4 PPB)
2000
1750
1500
1250
1000
750
500
1000
1200
1400
1600
1800
2000
Time


GLOBAL N_2O LEVELS
NITROUS OXIDE (N_2O PPB)
340
330
320
310
300
290
280
270
260
1000
1200
1400
1600
1800
2000
Time

Global temperatures



Anomalies = Difference from 1901 to 2000 average temperature

Source: https://www.ncdc.noaa.gov/cag/time-series/global

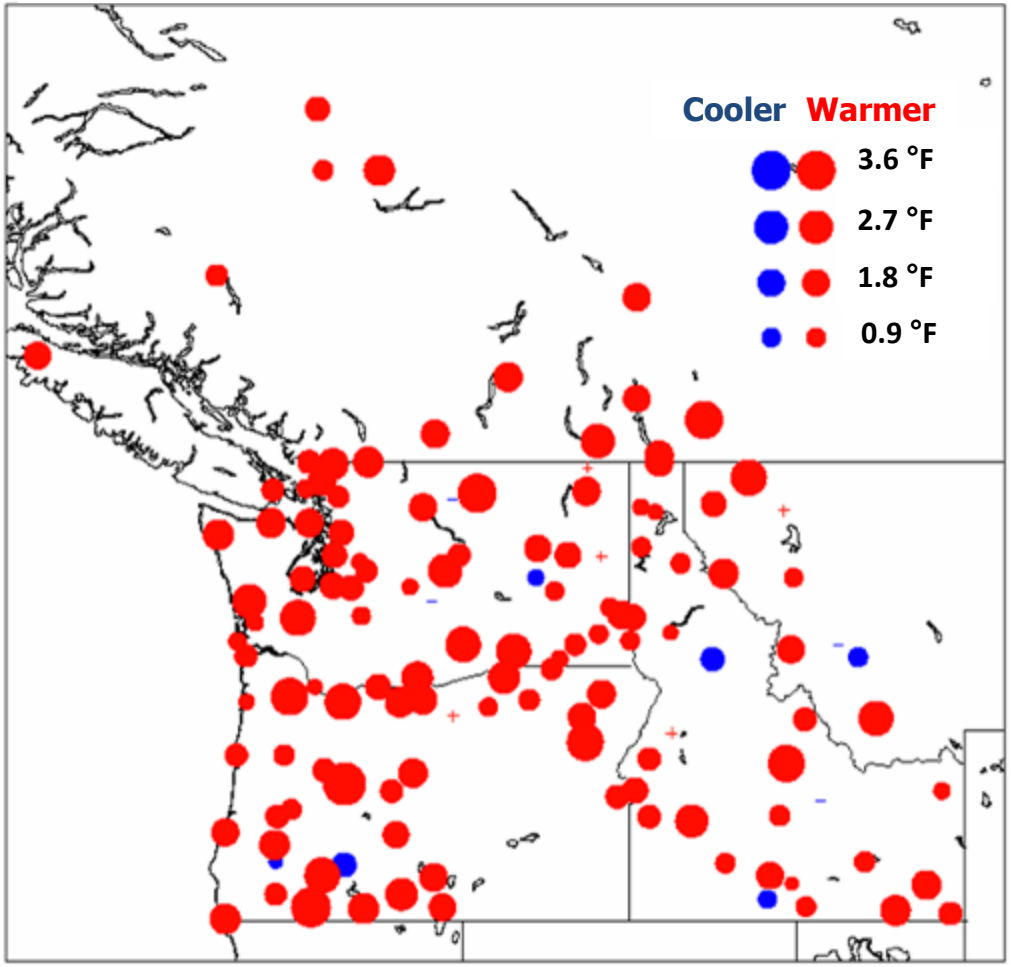
Temperature trends by station

Average annual temperature has increased +1.6°F since 1920.

Almost every station shows warming.

Extreme cold conditions have become rarer.

Minimum temperatures rose faster than maximum temperatures.



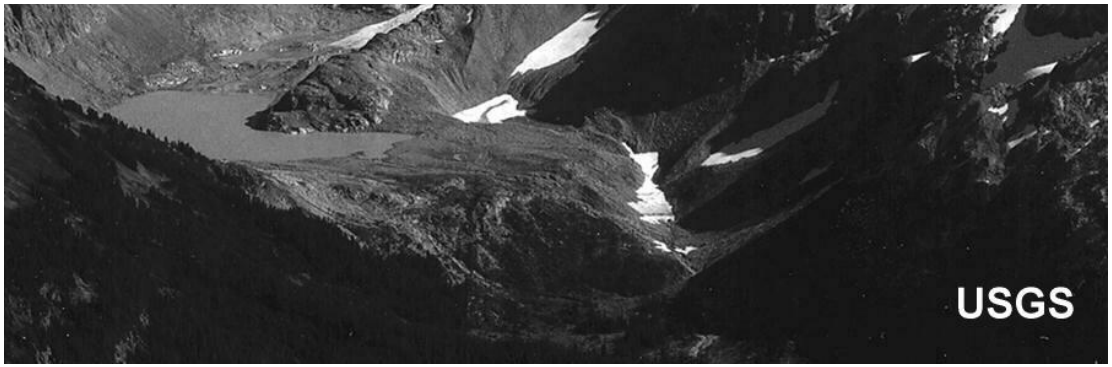
Nearly every glacier in the Cascade Range has retreated during the past 100 years

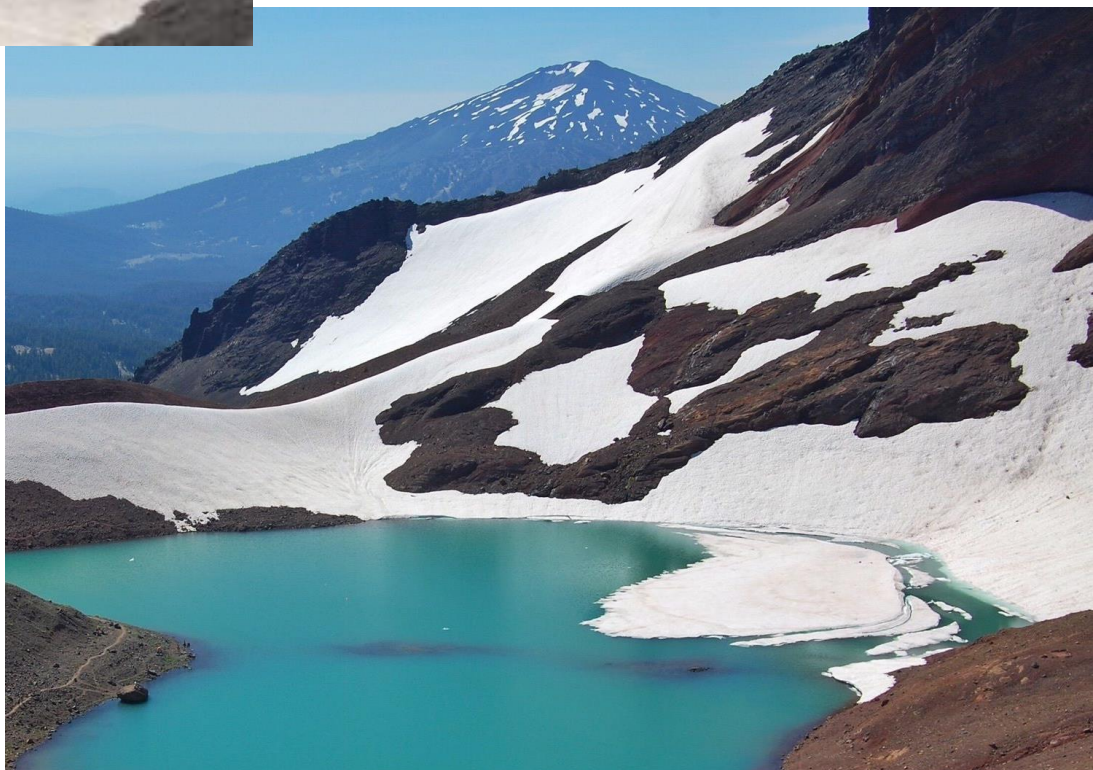
South Cascade Glacier, 1928 (top) 2016 (right)

Nearly every glacier in the Cascade Range has retreated during the past 100 years

Since 1900, glacial area in the North Cascades
has decreased by 46%

1928 (top)
2016 (right)



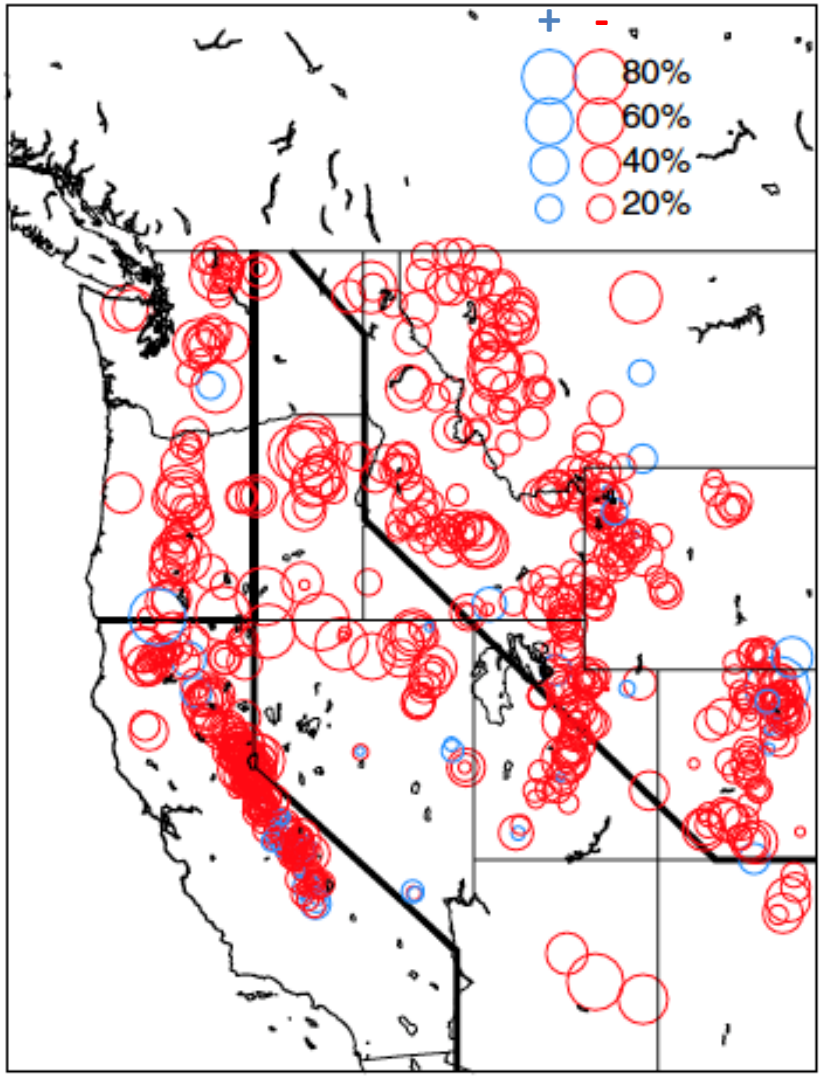


Bend Glacier, 1938 (top) 2016 (right)

Snowpack is decreasing

Snow-water equivalent

1955-2016



Mote et al. 2018

Snowpack is decreasing

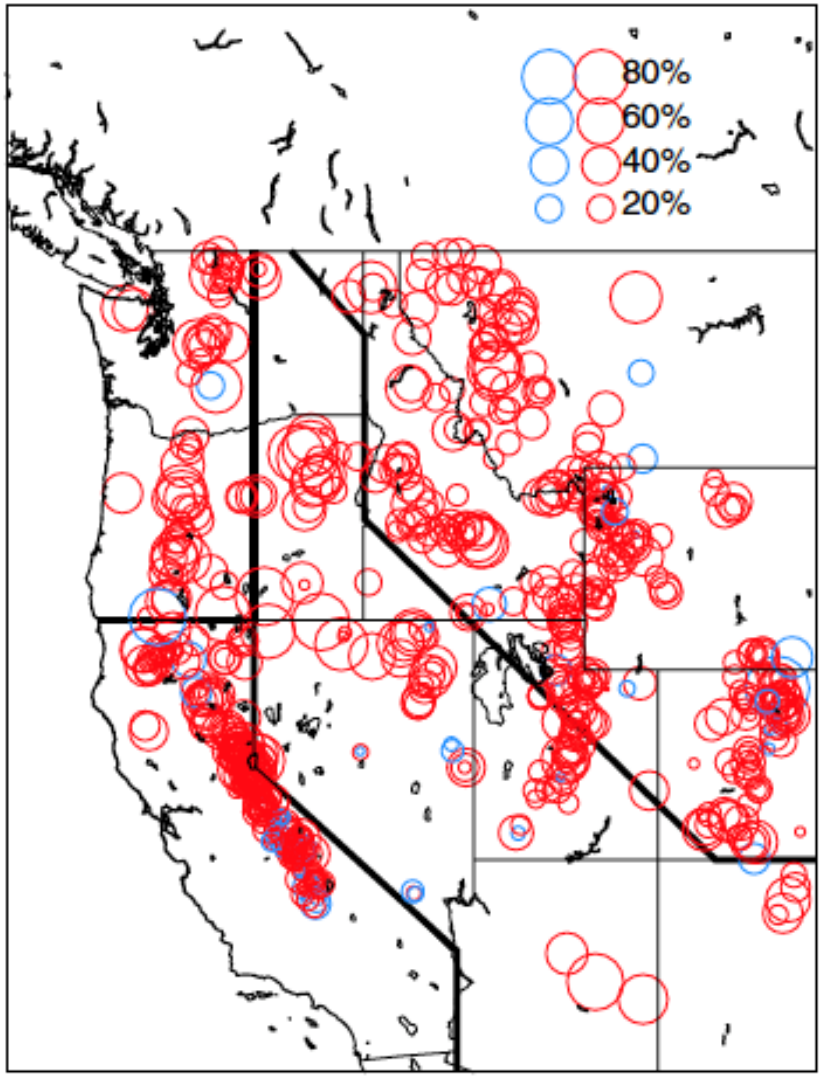
Snow-water equivalent

1955-2016

Snow-dominant watersheds

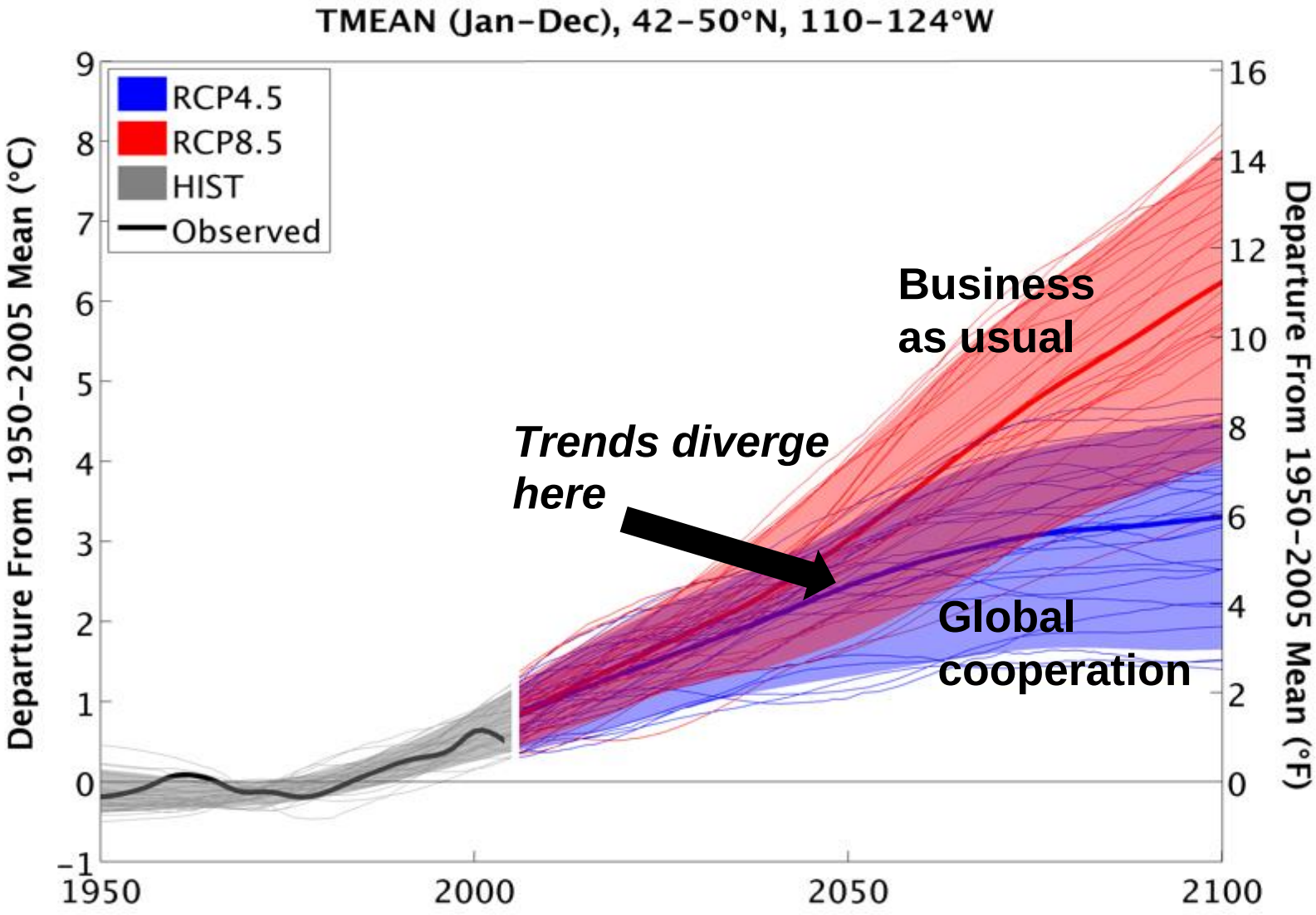
↓

Rain-dominant watersheds



Mote et al. 2018

Projected temperature in Pacific Northwest

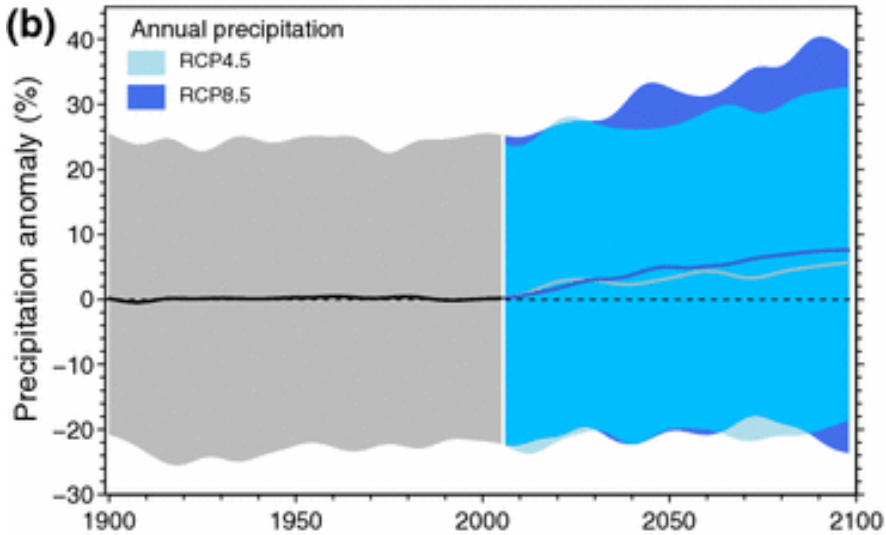


Precipitation projections

Small increase in average winter precipitation and year-to-year variability.

Low precipitation and extended drought conditions are expected.

Extreme events, like heavy rainfall associated with atmospheric rivers, are also anticipated to occur more often.



What will future climate feel like?

Salem, OR

Future climate feel like…

Granite Bay, CA

Northeast of Sacramento, CA

https://fitzlab.shinyapps.io/cityapp/

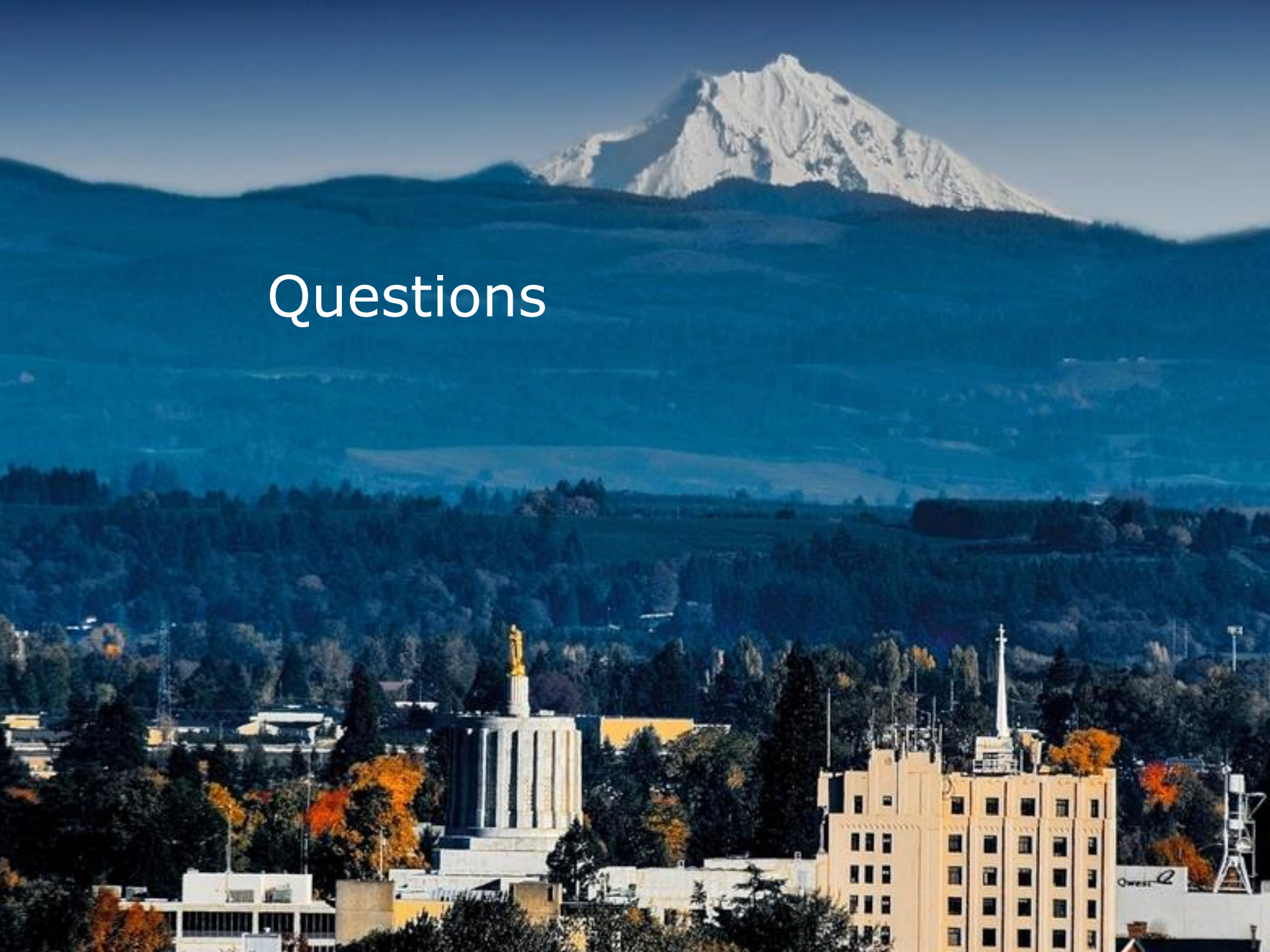
This is what we know…

There is a natural greenhouse effect.

Humans are increasing the greenhouse effect by adding gases to the atmosphere.

Effects of a changing climate are already apparent.

There will be more global warming to come.


Questions

Climate controls ecosystem processes

The hydrologic cycle

Climate controls ecosystem processes

The hydrologic cycle

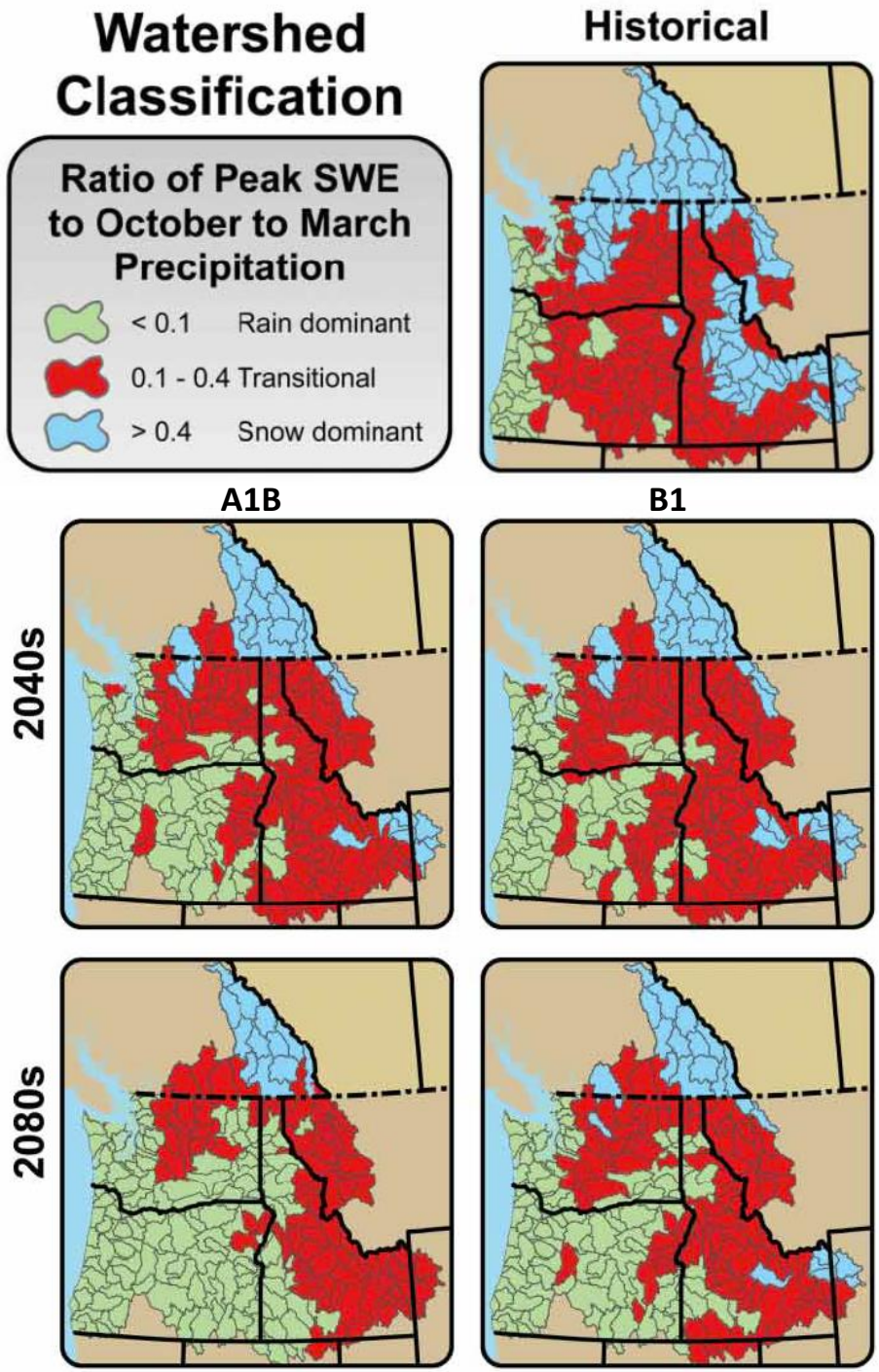
Plant establishment, growth, and mortality

Climate controls ecosystem processes

The hydrologic cycle

Plant establishment, growth, and mortality

Disturbance

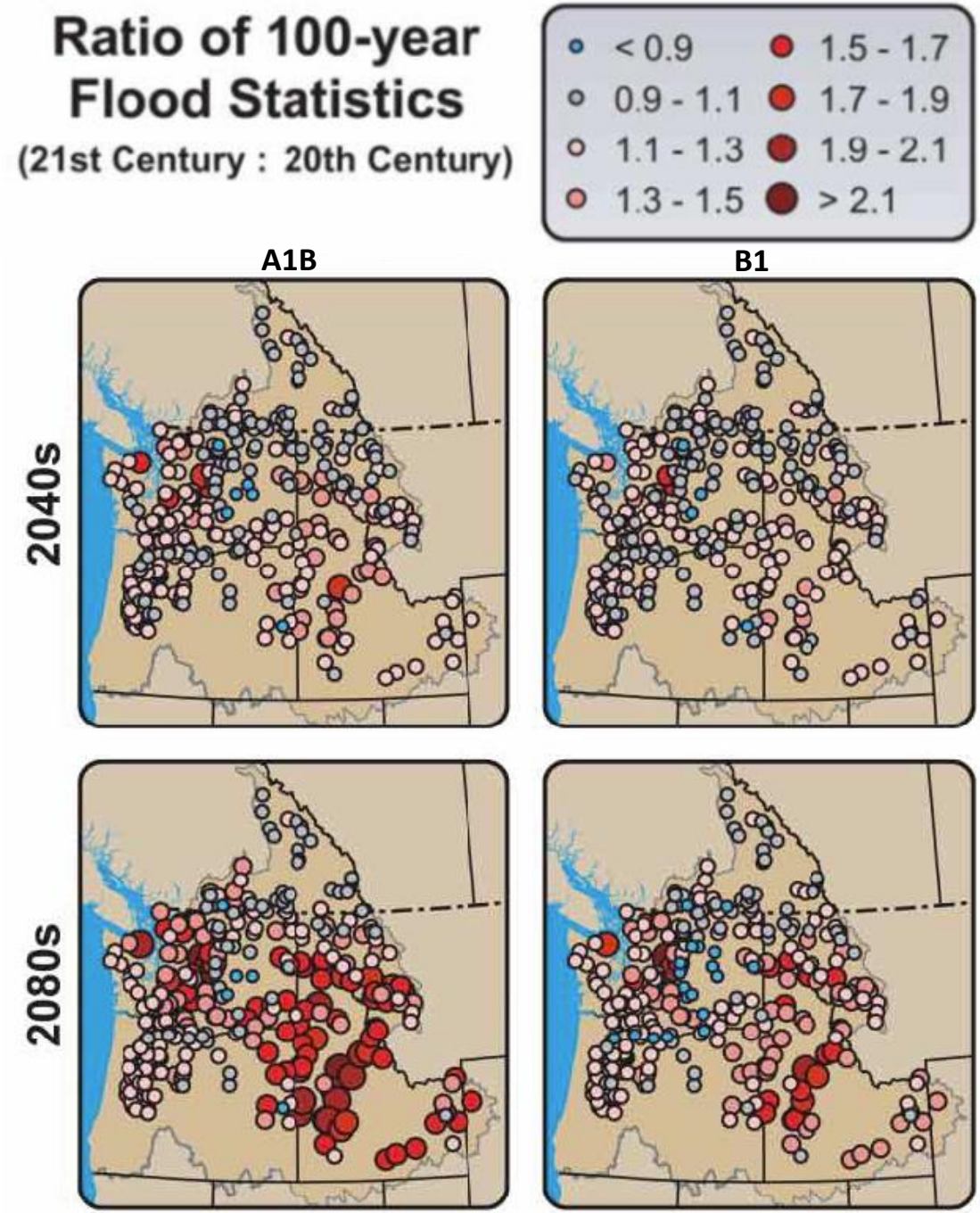


Watershed types will shift

Snow dominant watersheds become transitional (mixed rain and snow).

Transitional watersheds become rain dominant.

Hamlet et al. 2013

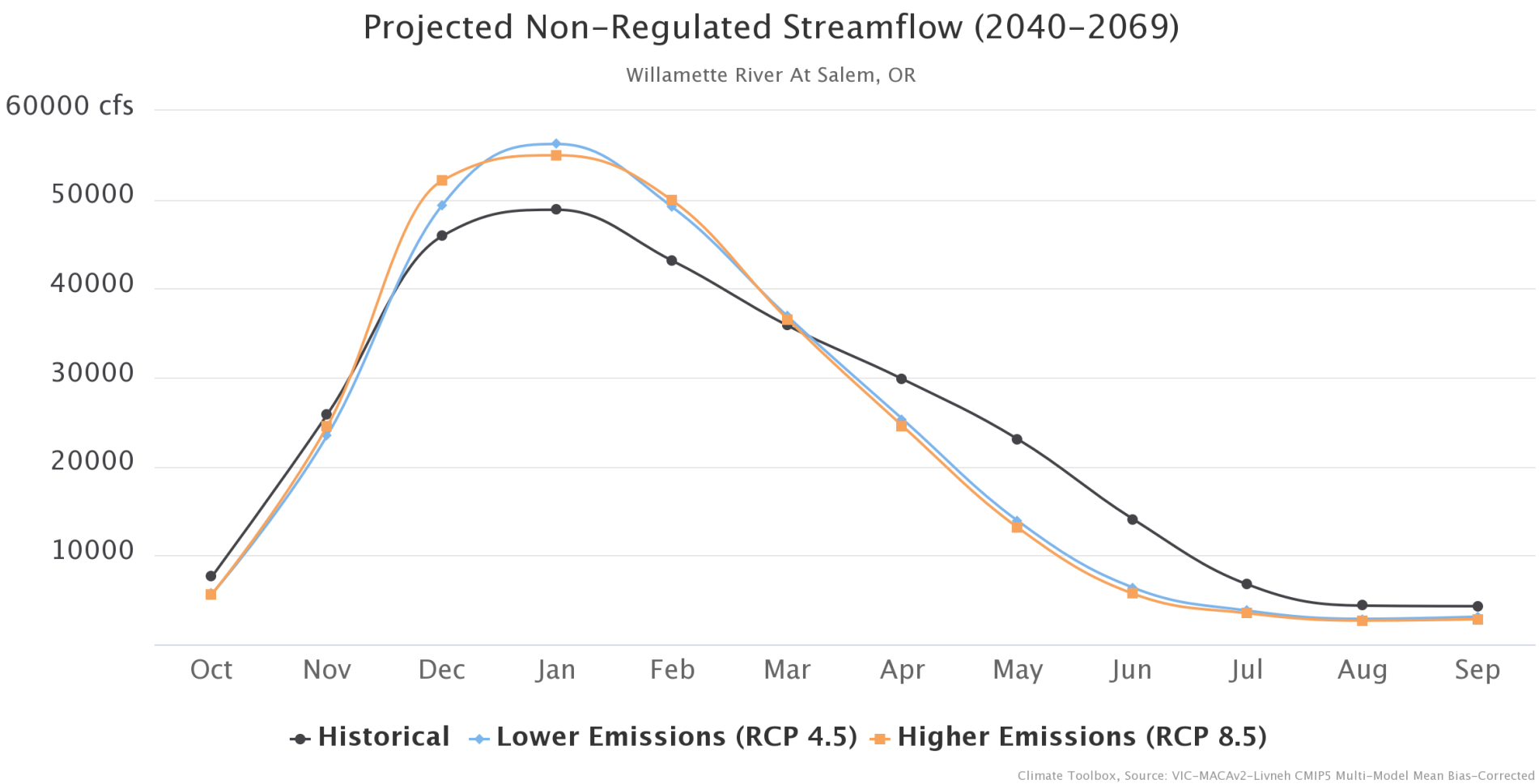


Future projections of flood risk in the PNW

Hamlet et al. 2013

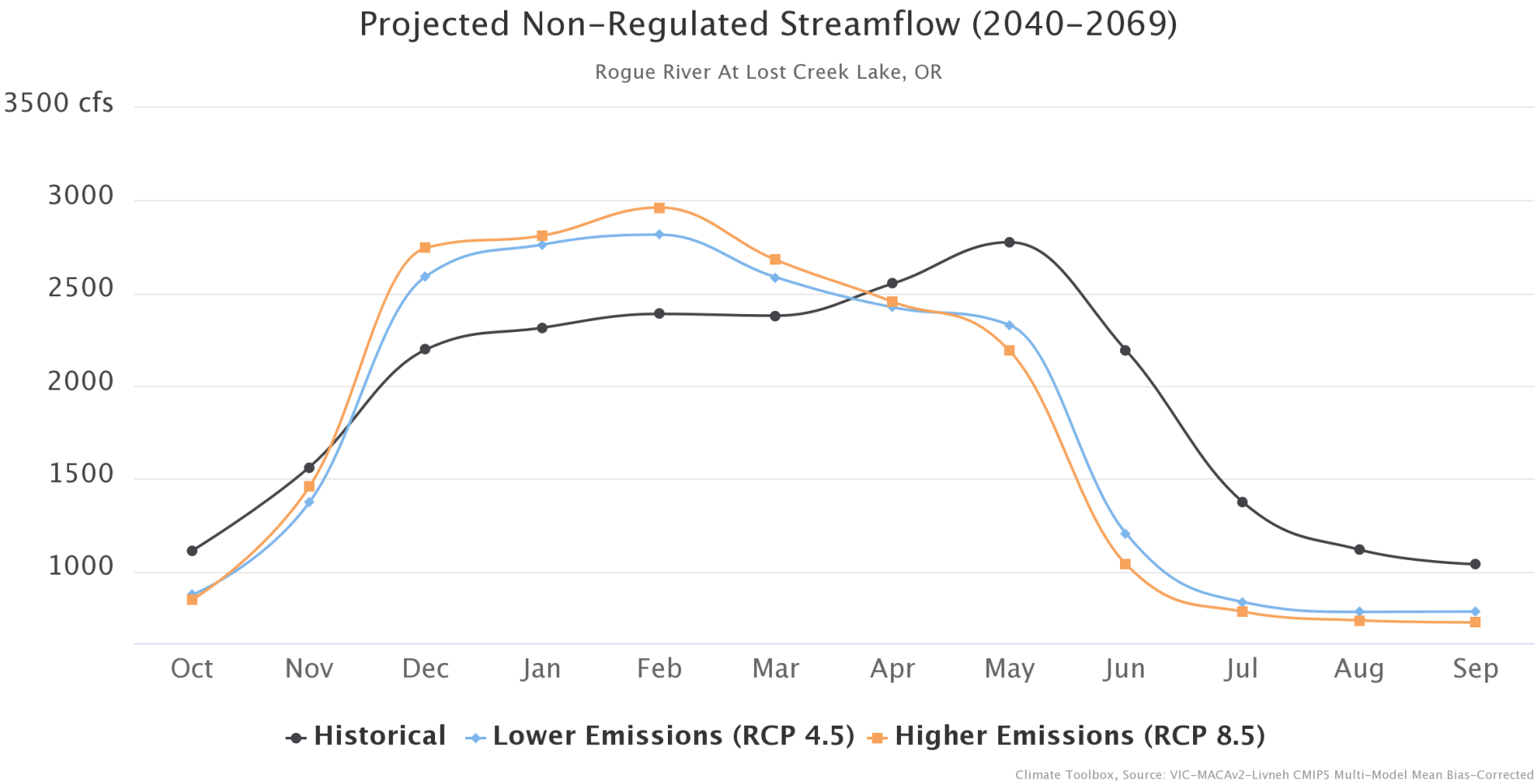
Changes in Hydrologic Extremes

Streamflow will change Willamette River at Salem, OR



https://climatetoolbox.org/tool/Future-Streamflows

Streamflow will change
Rogue River at Lost Creek Lake, OR



https://climatetoolbox.org/tool/Future-Streamflows

Mapping Vulnerabilities to Climate Change

NOAA Fisheries assessed the vulnerability of 33 population groups* of Pacific salmon & steelhead to climate change along the West Coast.

Number & Risk Level of Population Groups

Vulnerability

Very High — High — Moderate — Low

F = fall run
W = winter run
Sp = spring run
Sp/Su = spring/summer run
Su = summer run

*Population groups refer to distinct population segments (DPS) & evolutionarily significant units (ESU).

Marine Threats

- Sea surface temperature
- Ocean acidification
- Sea level rise
- Upwelling

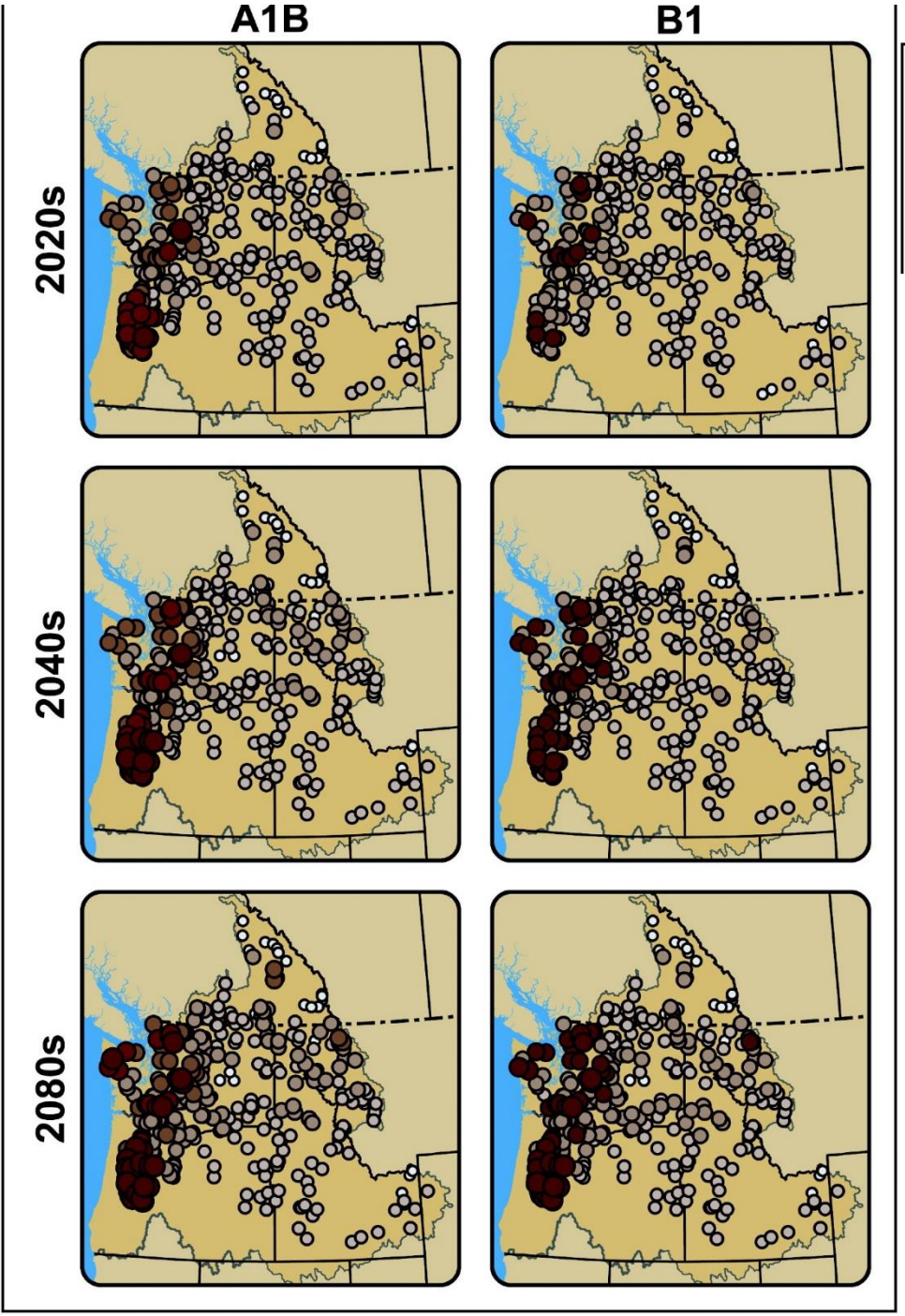
Freshwater Threats & Constraints

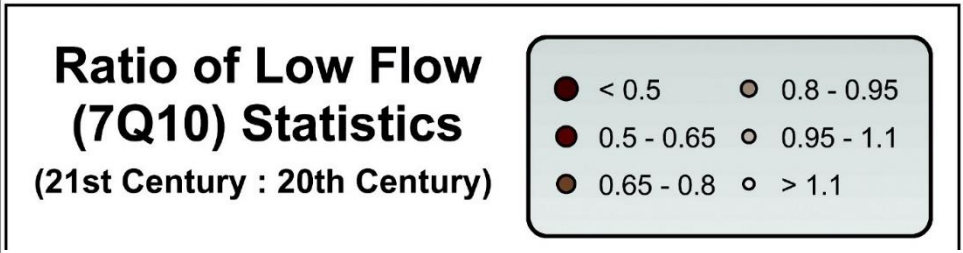
- Stream temperature
- Drought
- Flooding
- Snow melt
- Other stressors**
- Population viability
- Hatcheries

**Salmon populations are affected by numerous stressors not directly related to climate but that potentially reduce their ability to cope with climate change. The most common of these are habitat loss, habitat degradation, toxic chemicals, pathogens endemic to fish culture, displacement by invasive species through competition and predation, and harvest.

NOAA FISHERIES

Higher temperatures will stress salmon





Future projections of low flow risks in the Northwest

Hamlet et al. 2013

Changes in Hydrologic Extremes

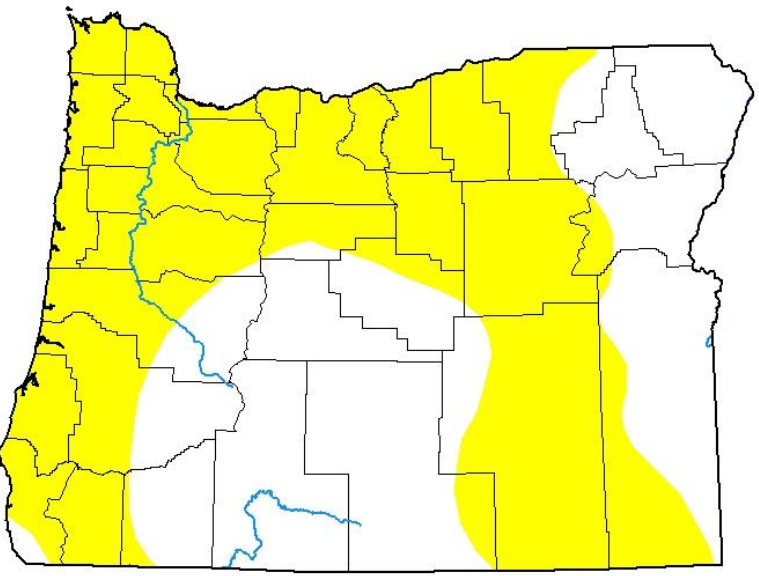
U.S. Drought Monitor

Oregon

November 26, 2019

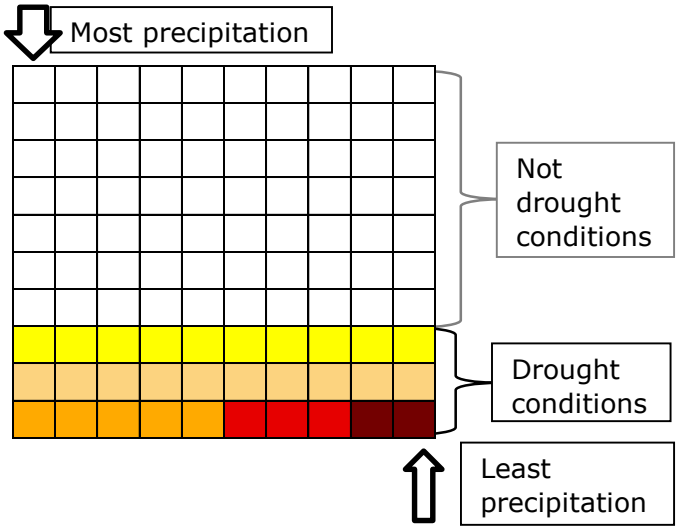
(Released Wednesday, Nov. 27, 2019)

Valid 7 a.m. EST

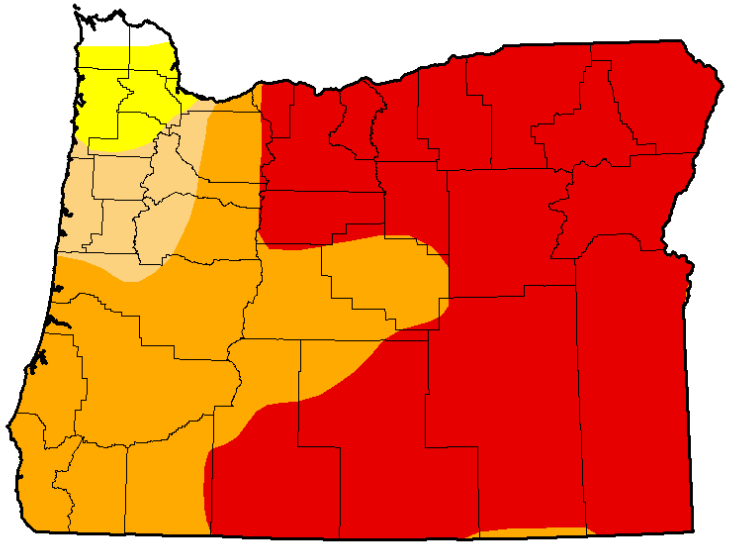


Intensity:

- None
- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No Data



November 24, 2015



Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scal conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:

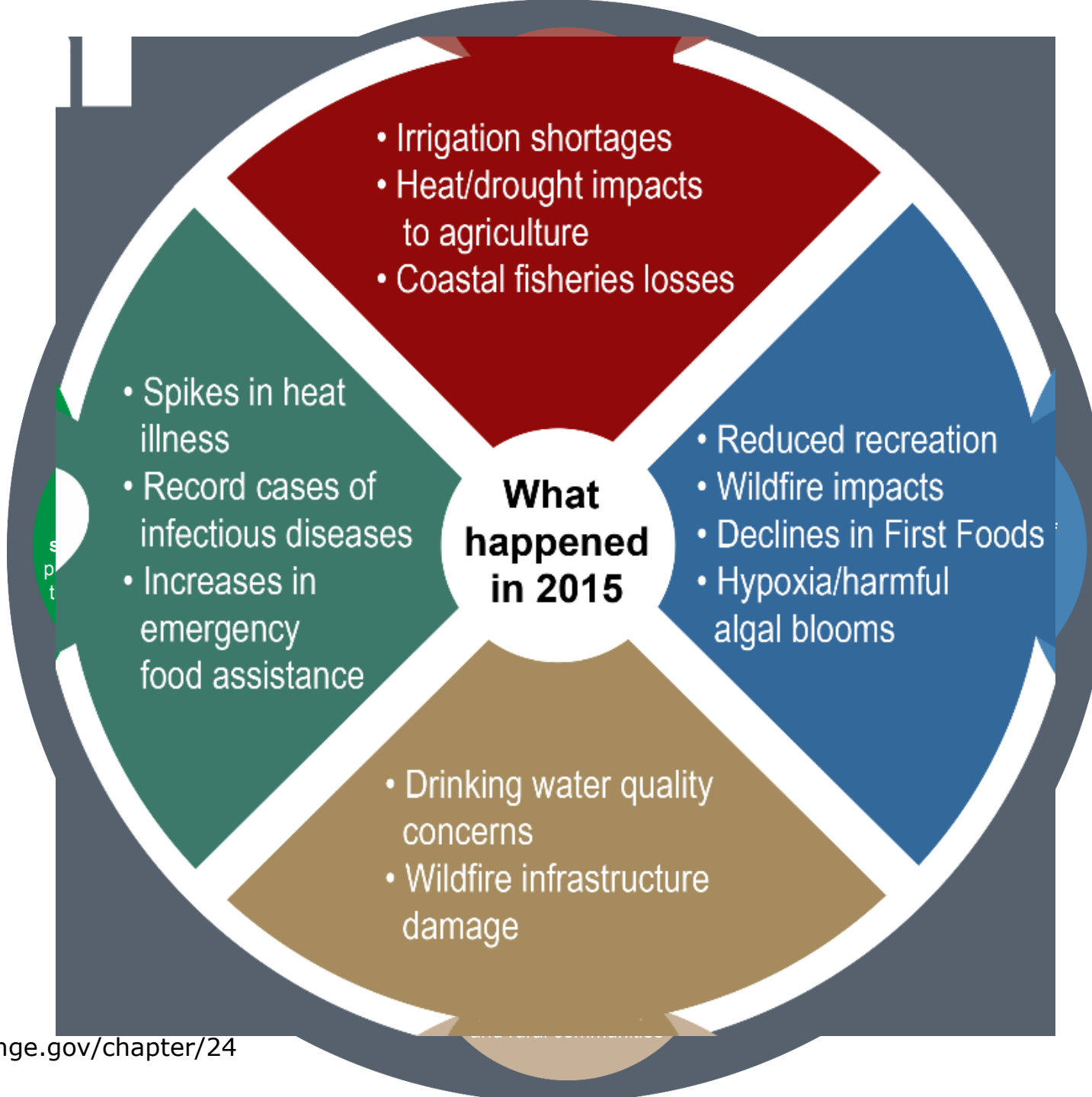
Richard Heim

NCEI/NOAA

http://droughtmonitor.unl.ed

4th National Climate Assessment

Climate-related events of 2015 provide a glimpse into the Northwest's future



Source: USGCRP

https://nca2018.globalchange.gov/chapter/24

Climate change affects insects

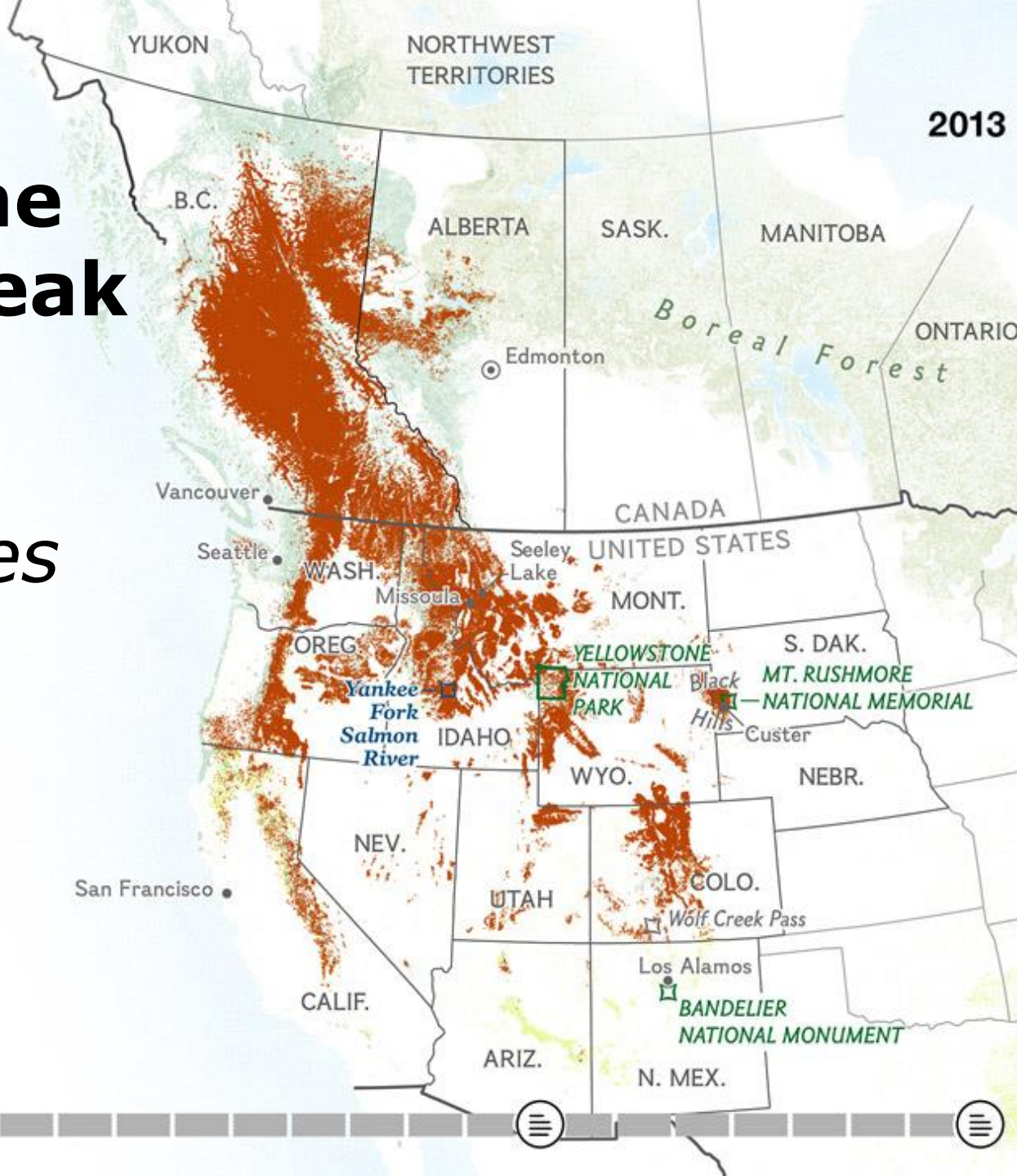
Mountain pine beetle

Warmer temperatures favor insects by:

- Increasing reproductive rate
- Allowing an expanded range

Mountain pine beetle outbreak since 1990

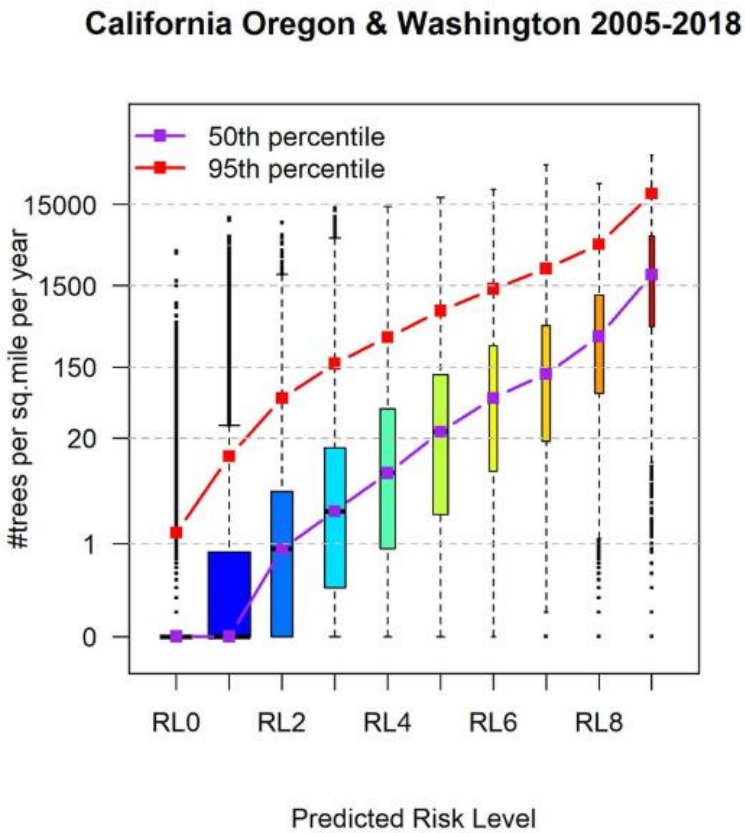
50 million acres

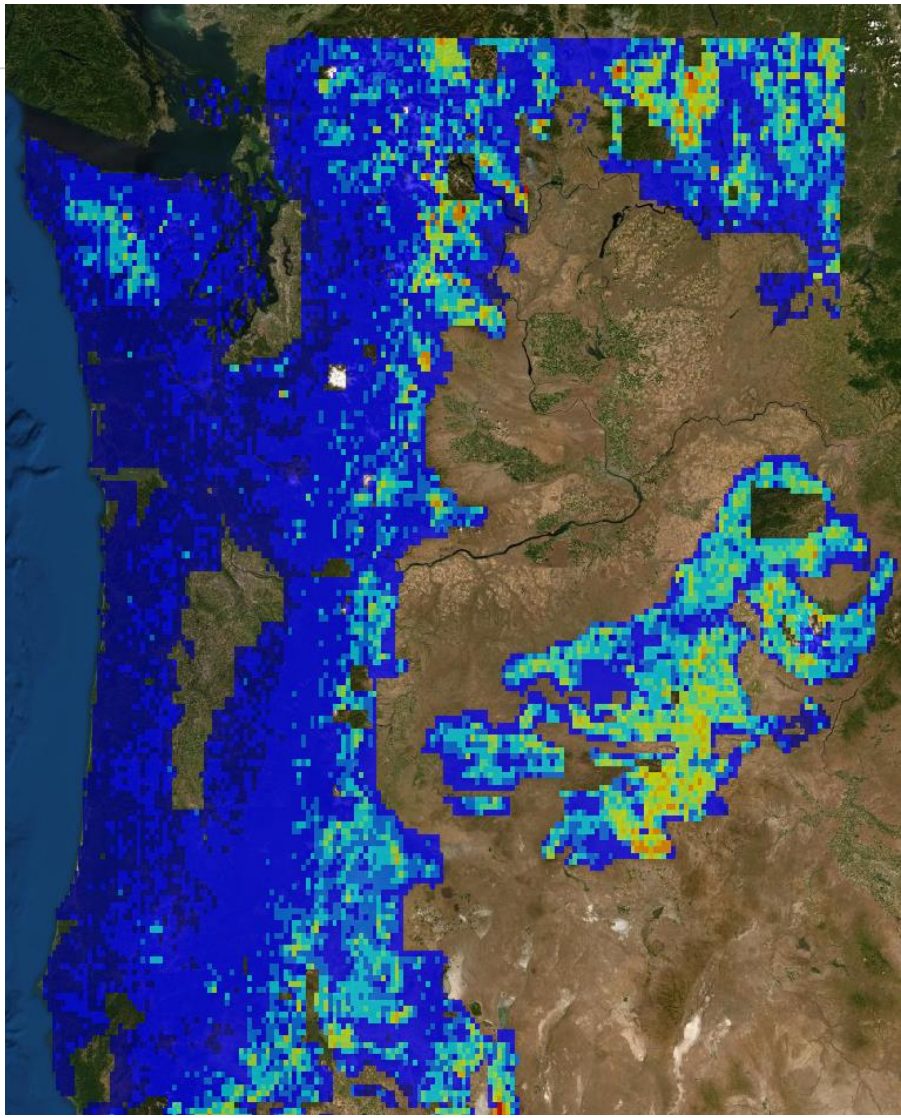


USFS, Pacific Northwest Region

2019 Bark Beetle Forecast for California, Oregon and Washington

The forecast is based on history of drought (amount of precipitation) and bark beetle attacks in each 2.5' (6.5 square mile) grid cell from 1993 to 2018 for California and 1966 to 2018 for Oregon and Washington. Cells with similar histories of bark beetle activity and precipitation were then grouped together into ten risk (color) groups. These risk groups (R) forecast a range of the likely number of trees expected to die from bark beetles by the end of summer 2019.





https://www.arcgis.com/apps/MapJournal/index.html?appid=7b78c5c7a67748808ce298efefceaa46

How will climate change affect wildfire?

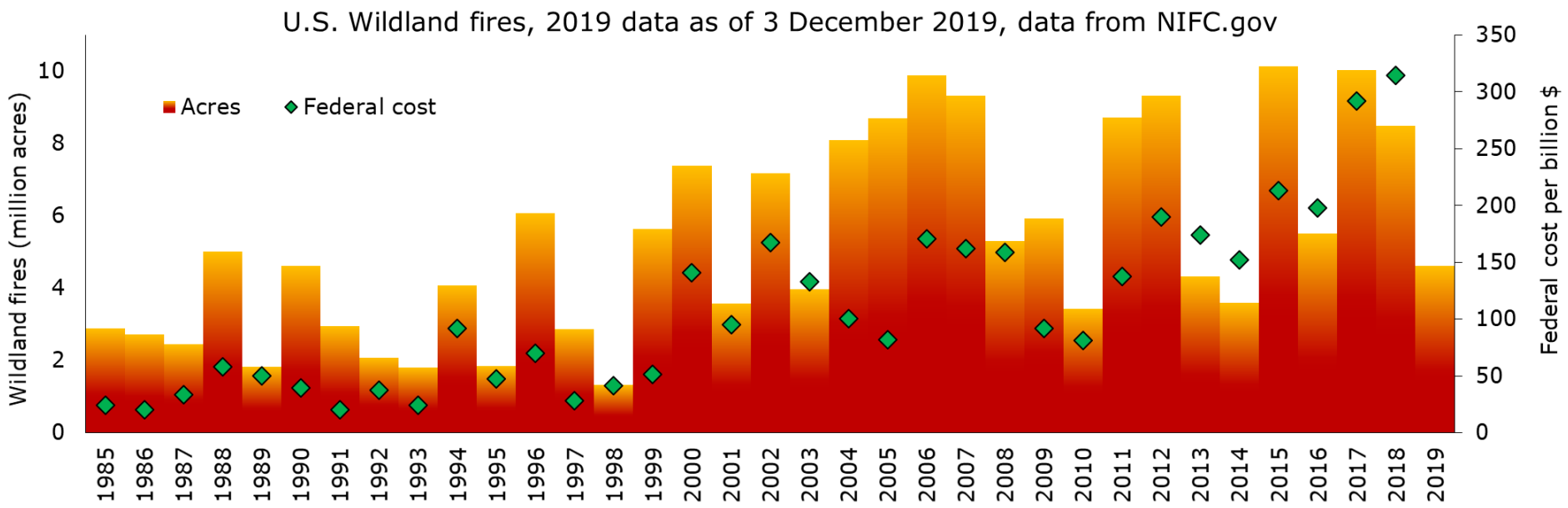


Figure by Holly Prendeville

Largest fire since 1926 in Oregon is the Long Draw Fire in 2012 that burned 557,628-acres

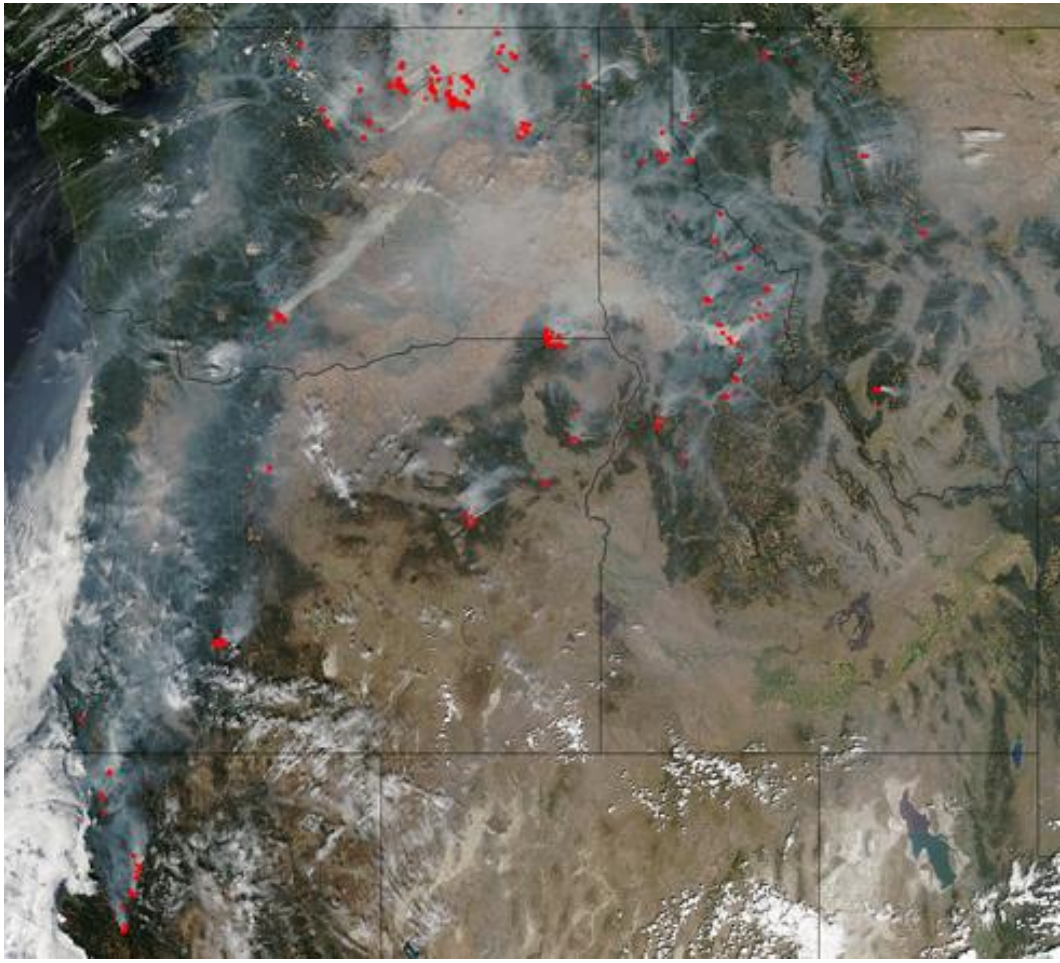
Climatic change and regional wildfires

As temperature increases, more water evaporates from the landscape and plant tissues

Larger areas of low fuel moisture

Regional synchronization of fires occurs

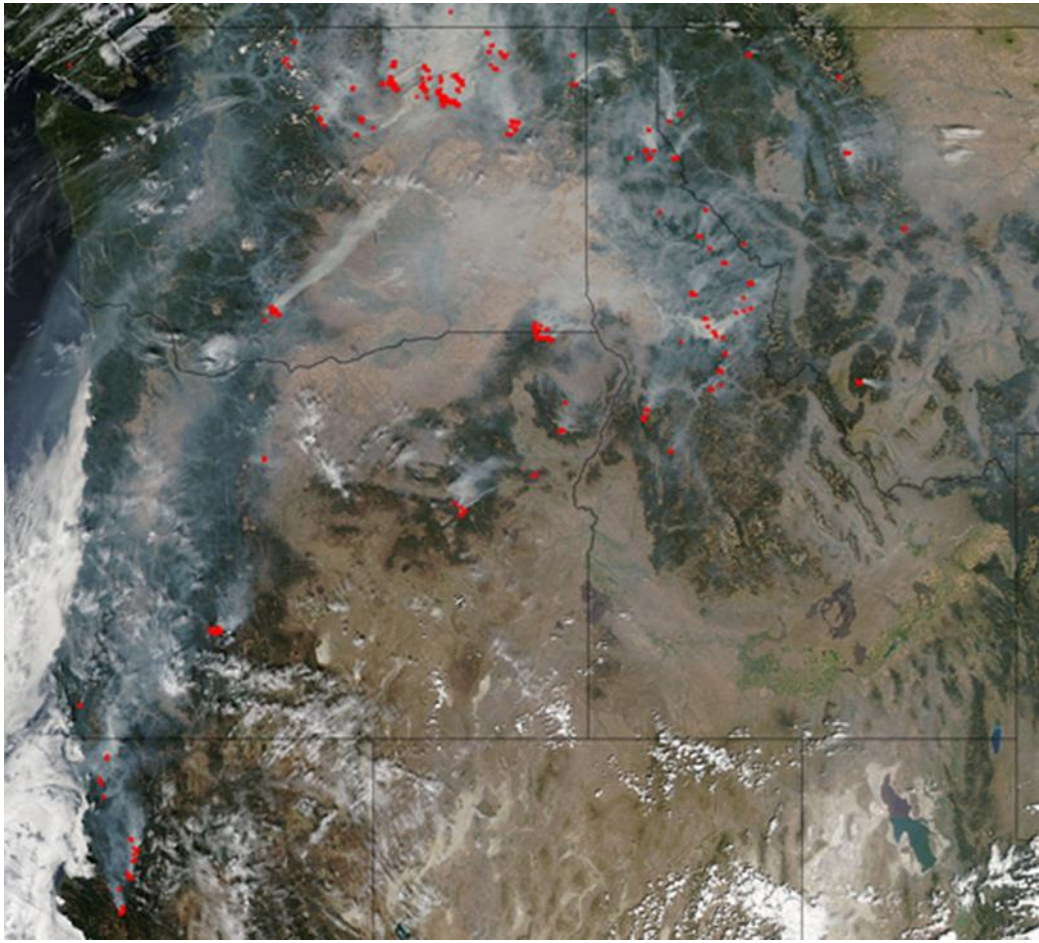
Pacific Northwest, August 30, 2015



MODIS, NASA

In 2015, 1.7 million acres were burned in Oregon and Washington, with over 9 million acres burned in the western United States.

Pacific Northwest, August 30, 2015



NASA MODIS

Several fires in 2015 occurred in west-side conifer forests, including a rare fire event in coastal temperate rainforest on the Olympic Peninsula.

More fires = more smoke

Portland, OR August 2015

Disturbances will interact

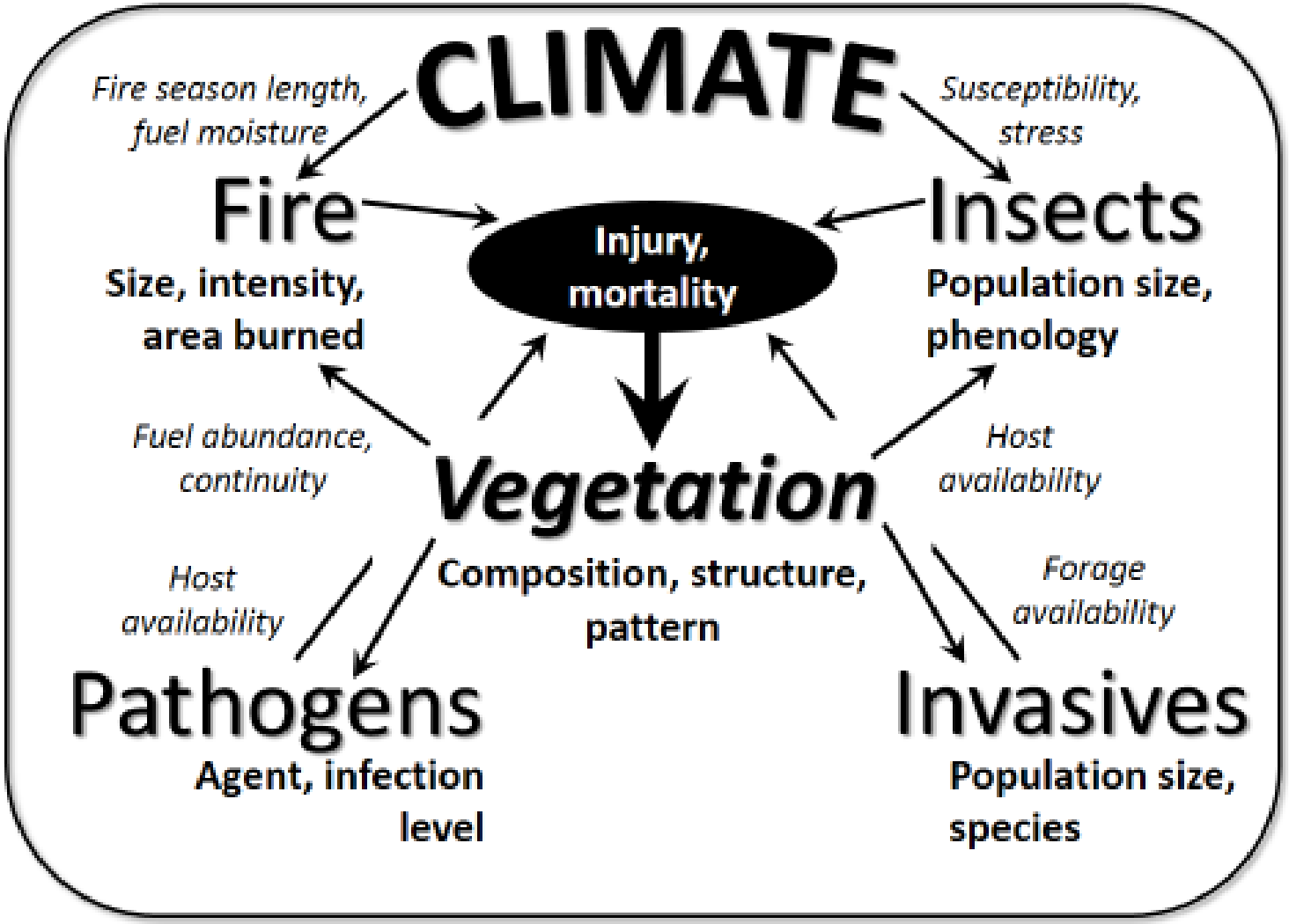
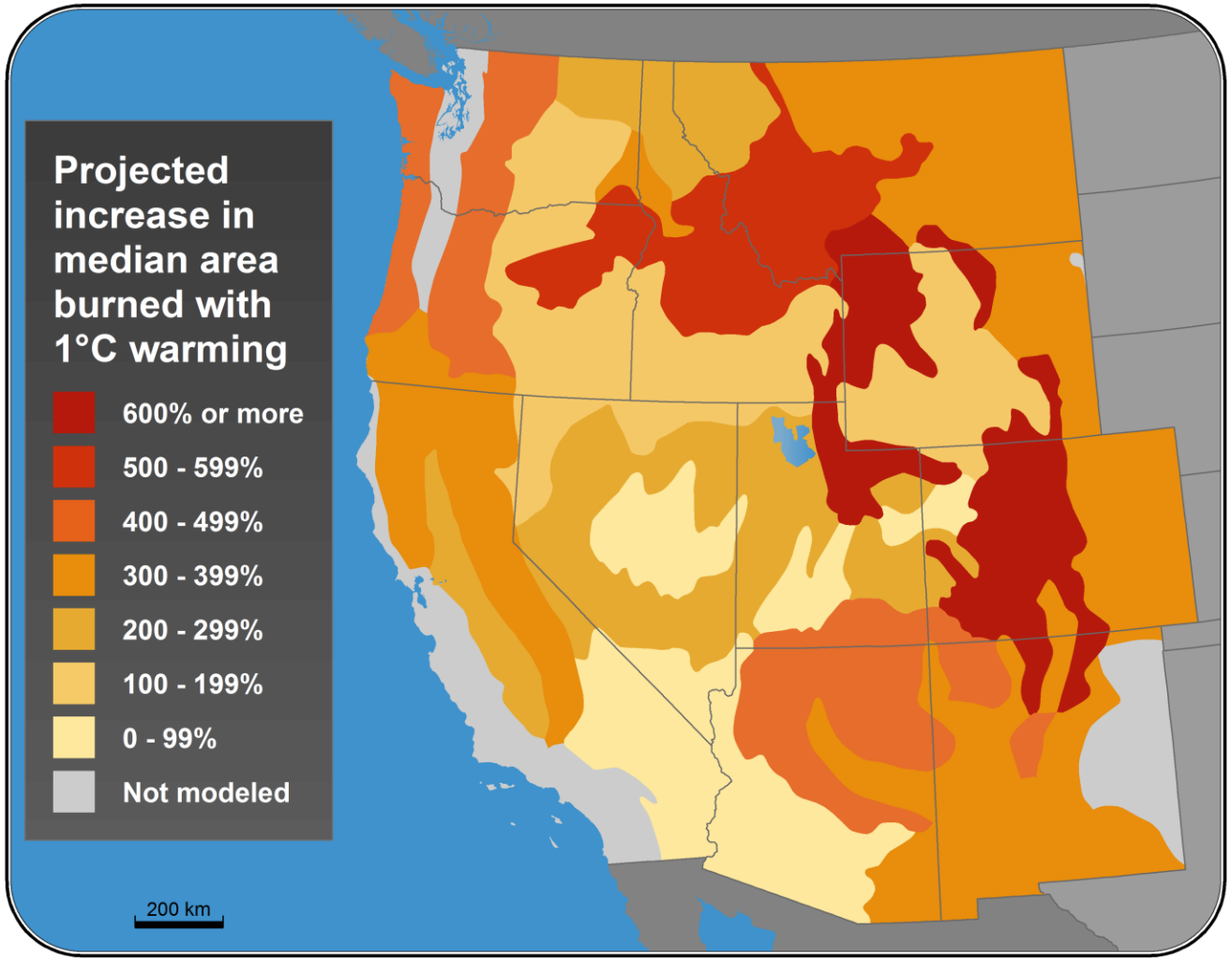


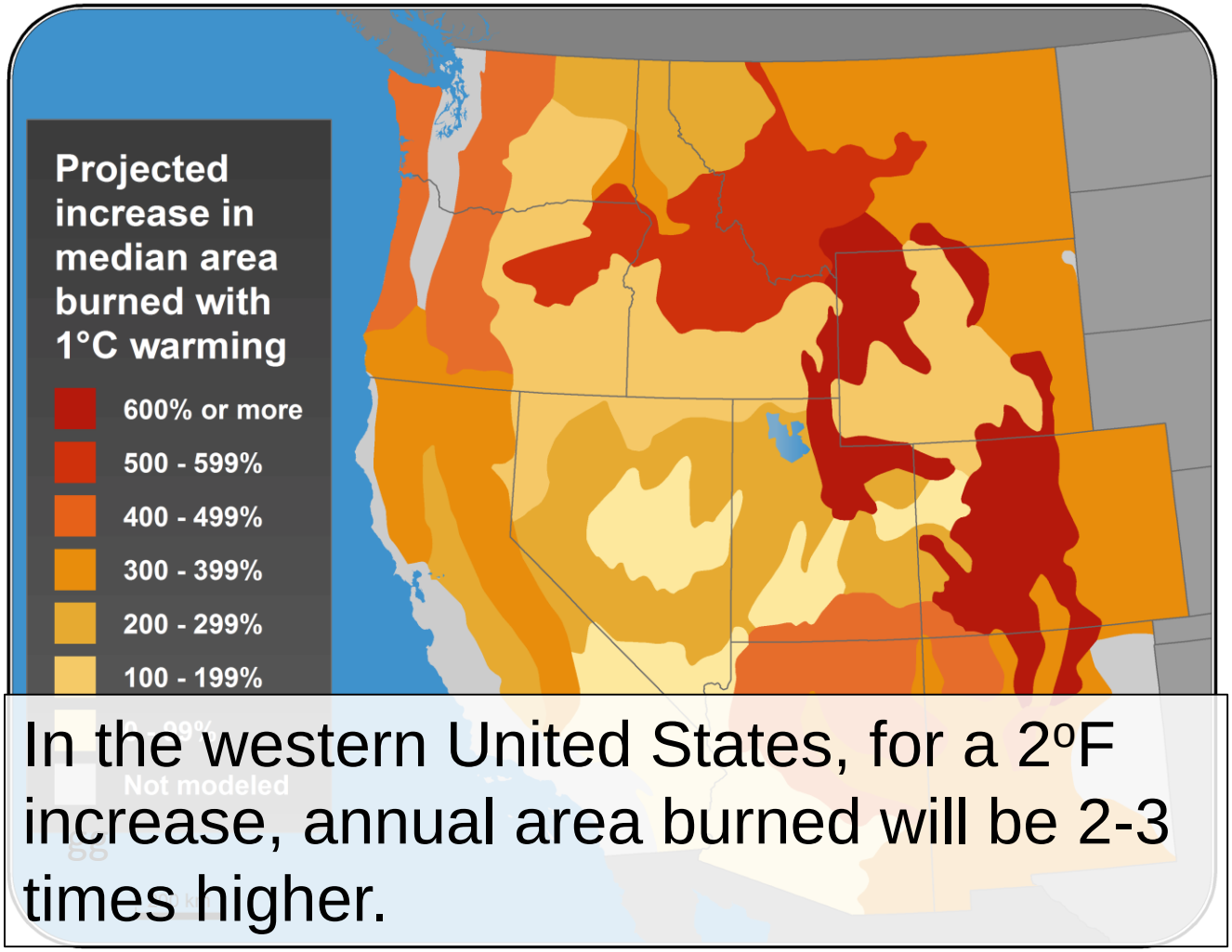
Figure by R. Loehman

Wildfire area burned, 2050



From J. Littell

Wildfire area burned, 2050



In the western United States, for a 2ºF increase, annual area burned will be 2-3 times higher.

From J. Littell

In summary — What to expect

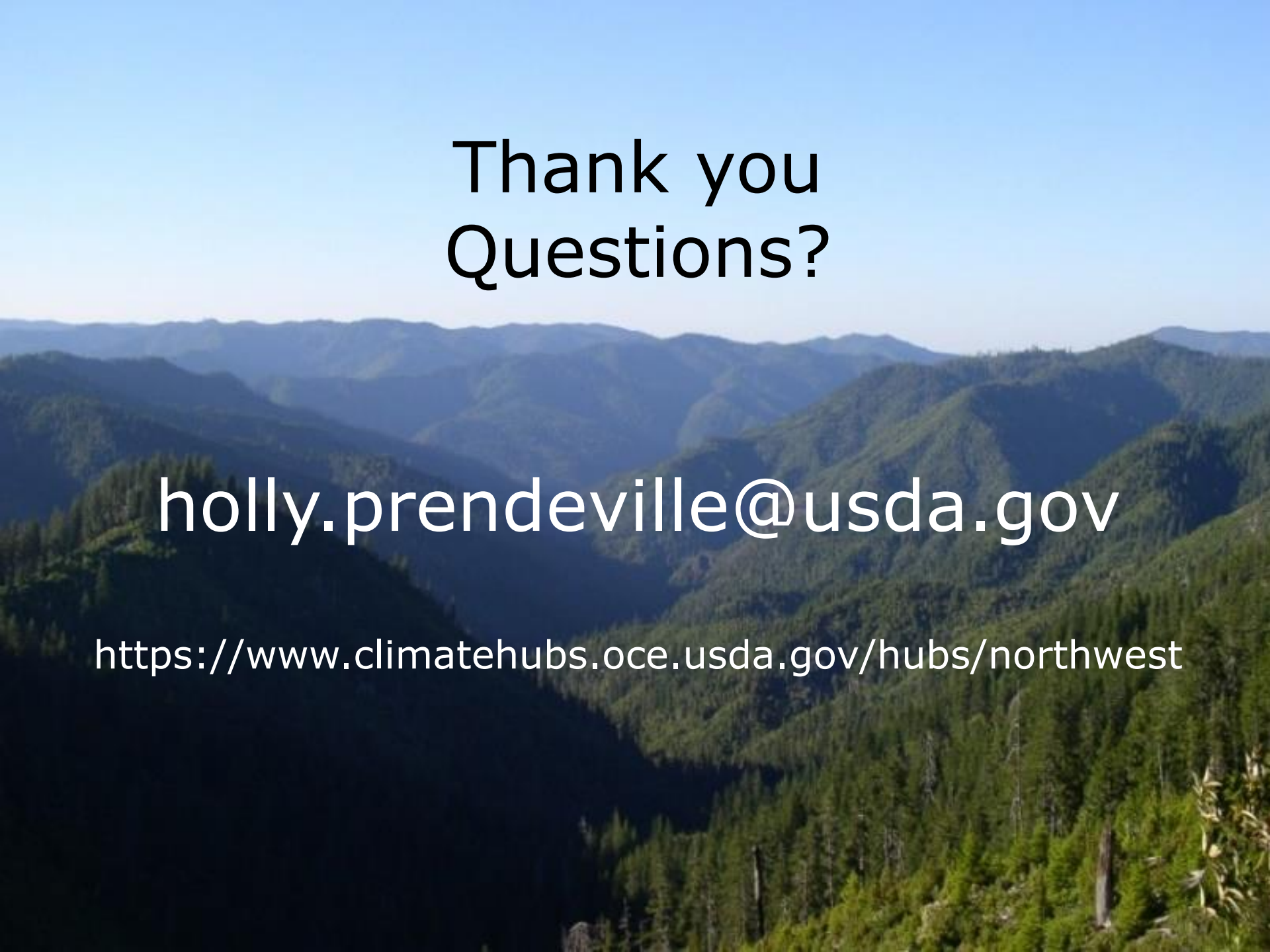
High certainty: Higher temperature, more wildfire, less snowpack, less water in summer

Less certainty: Precipitation

Extreme events (drought, flooding, wildfires) will have the biggest effects on ecosystems.

Things may change quickly after 2050.

There will be surprises.

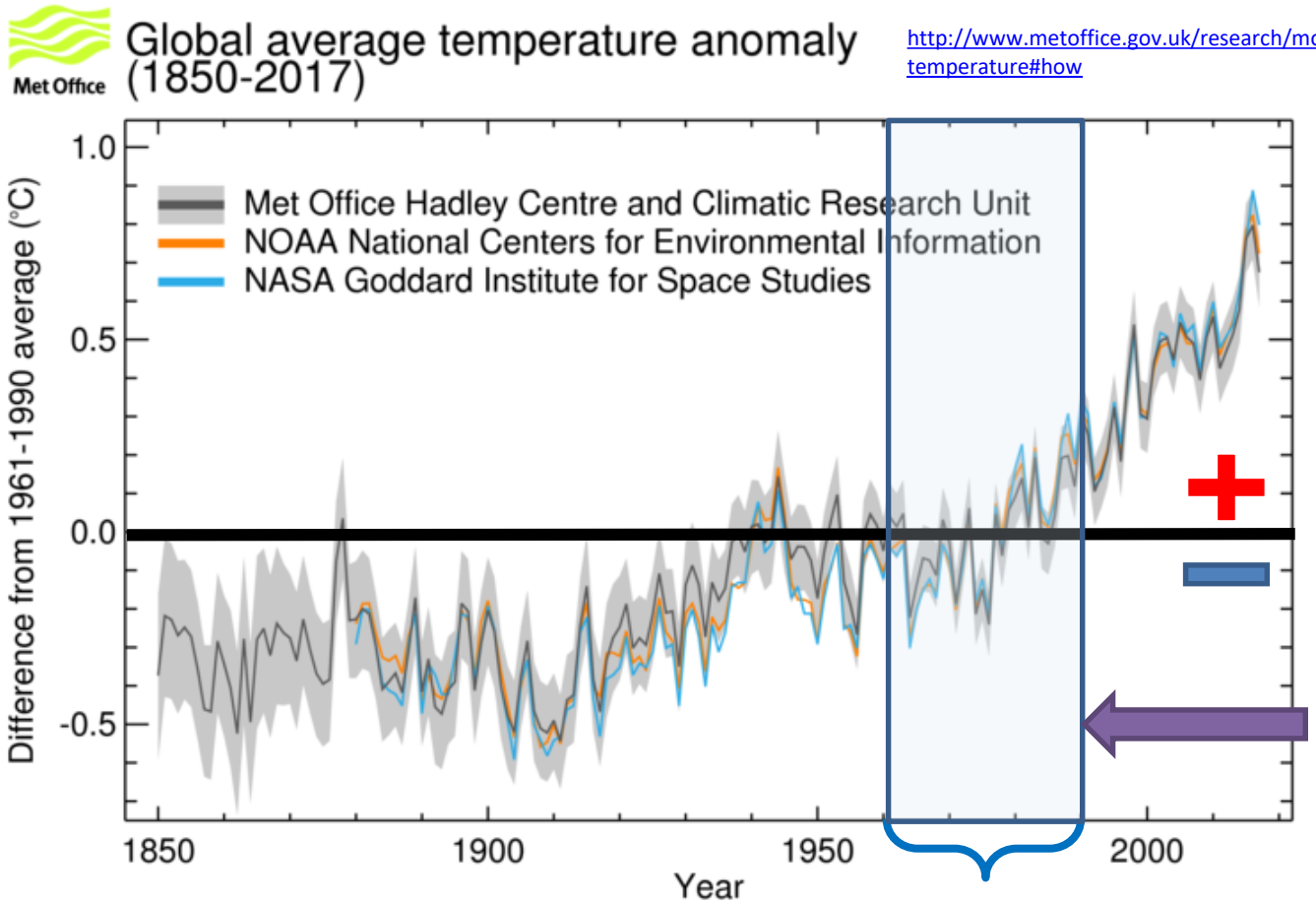


Thank you
Questions?

holly.prendeville@usda.gov

https://www.climatehubs.oce.usda.gov/hubs/northwest

Observations in Global Climate

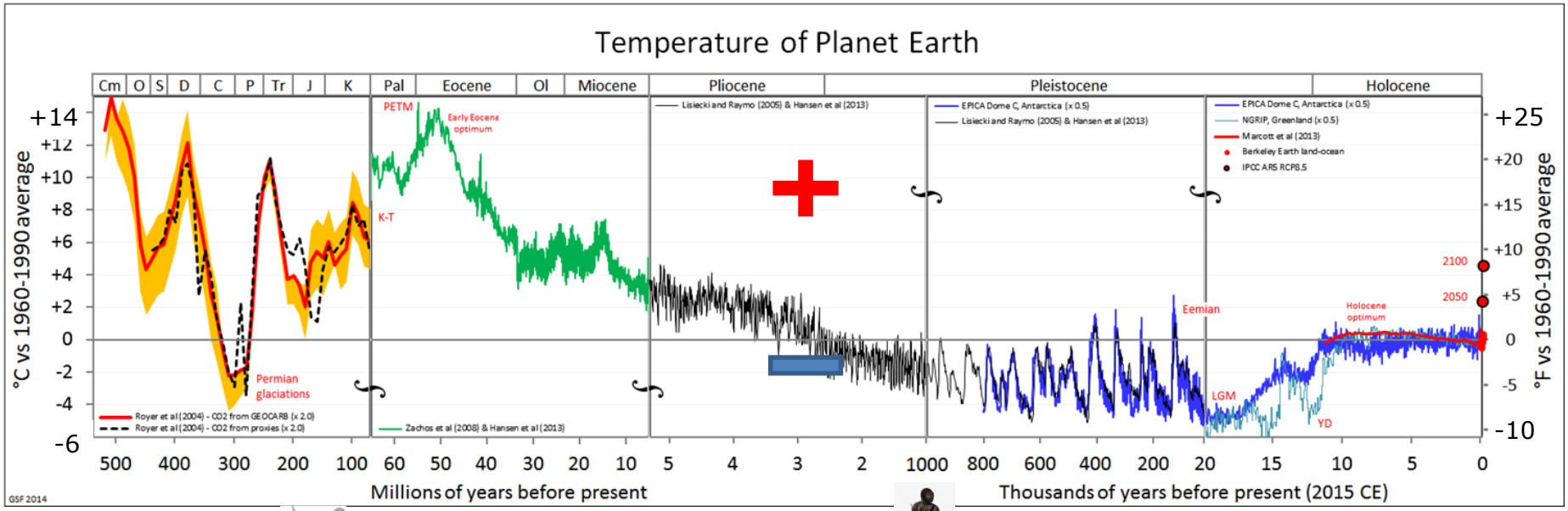


http://www.metoffice.gov.uk/research/monitoring/climate/surface-temperature#how

Climate usually represented in 30 year intervals

Global temperatures over geological time

"Normal" climate has varied throughout the history of the Earth.



http://gergs.net/2015/06/updating-the-geological-temperature-plot/all_palaeotemps/

To understand the climate of the Earth, here are some processes often included in models of the Earth's climate system.

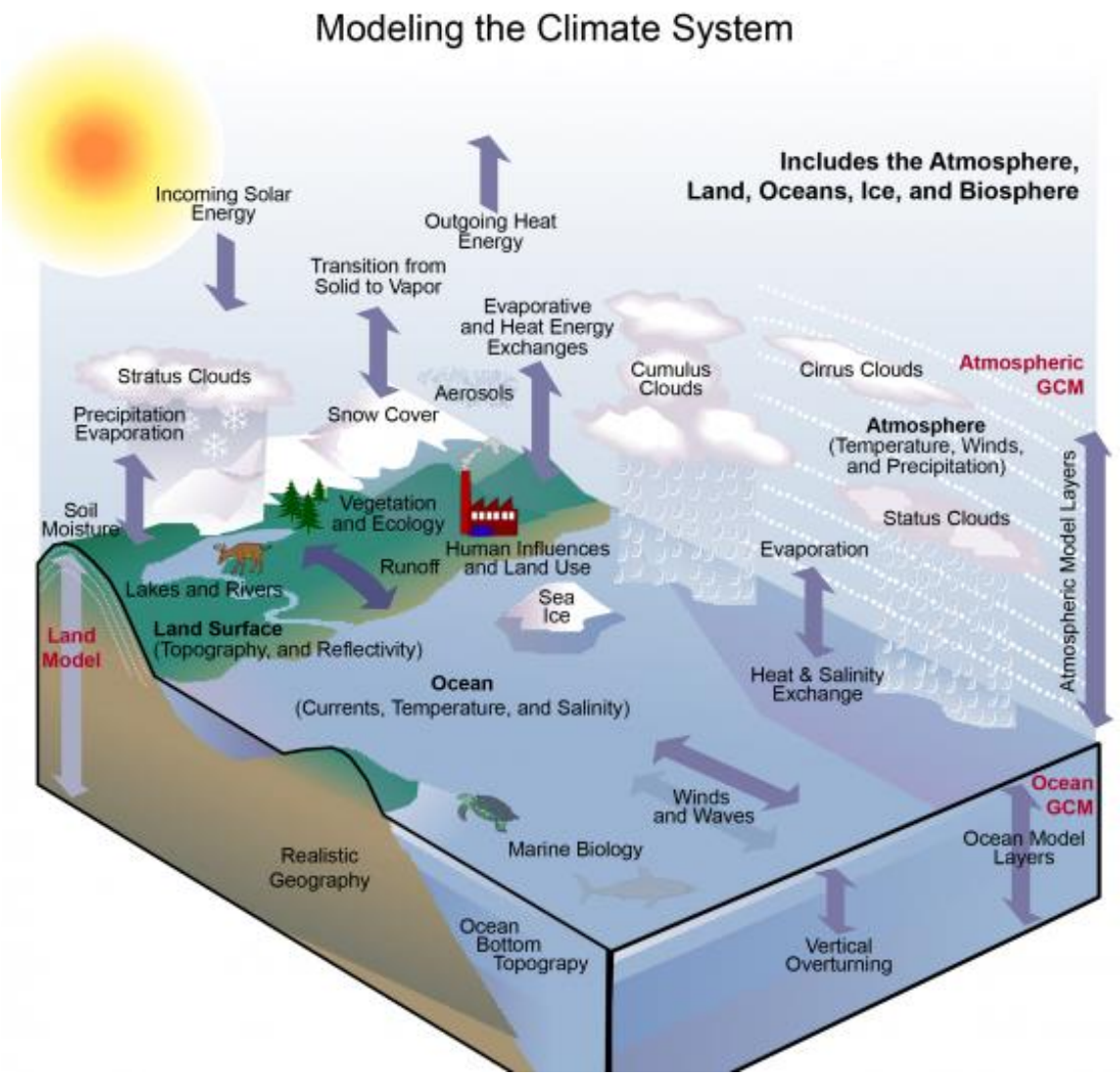


Figure source: Karl and Trenberth 2003

Global Climate Models