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Impact of Climate Change on Agriculture in the Pacific Northwest

Chad Kruger
Center for Sustaining Ag & Natural Resources

Credit: Kirti Rajagopalan, WSU Biological Systems Engineering

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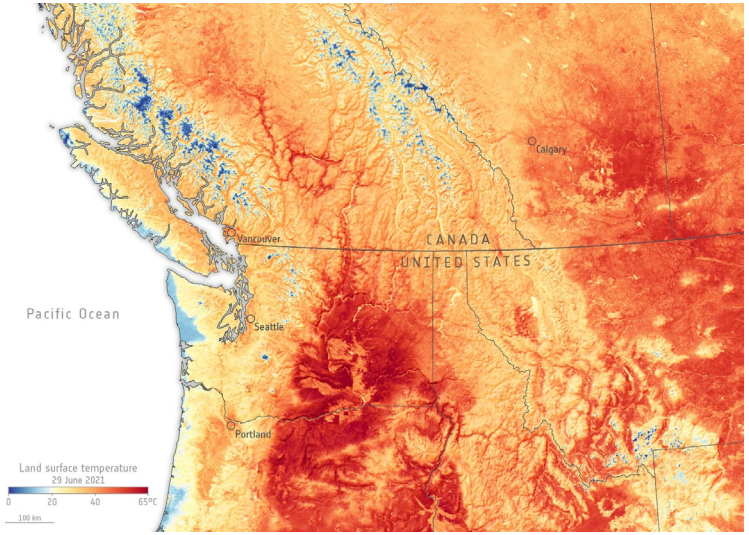
Recent Extreme Weather Events?

Historical climate amplified, loaded dice, or new normal?



The heat wave in June 2021 is one example of an event that is both outside the range of what we expect and where scientists have quantified the extent to which climate change contributed to the event. Image: European Space Agency under CC BY-SA 2.0.

Flooded blueberry field in southwest British Columbia in November 2021. Photo: Sambhav S. (Driscoll's).

24-hour record shattering snowfall event on the Cascade East Slopes (1/6/22) – 24-36". Photo: Chad Kruger

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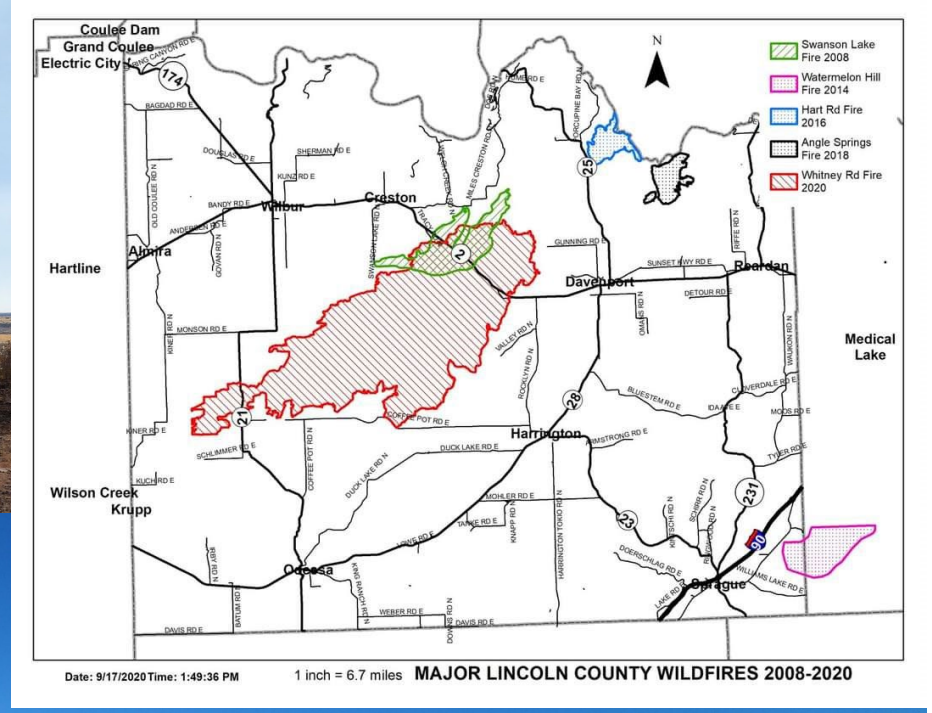
Hazards of the attribution game



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Regional Temperature Trends

1921-2021

Year Range
1921 2021

Variable Selection
Average Temperature

Time Frame
Annual

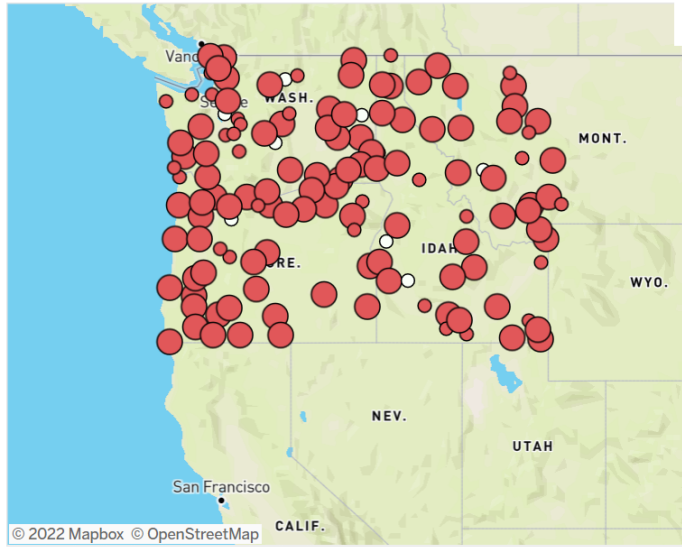
Trend Range
Over Selected Year Range

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

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

Trend Data (°F Over Selected Year Range)

ID	+	1.81
MT	+	1.93
OR	+	2.02
WA	+	1.63



1981-2021

Year Range
1981 2021

Variable Selection
Average Temperature

Time Frame
Annual

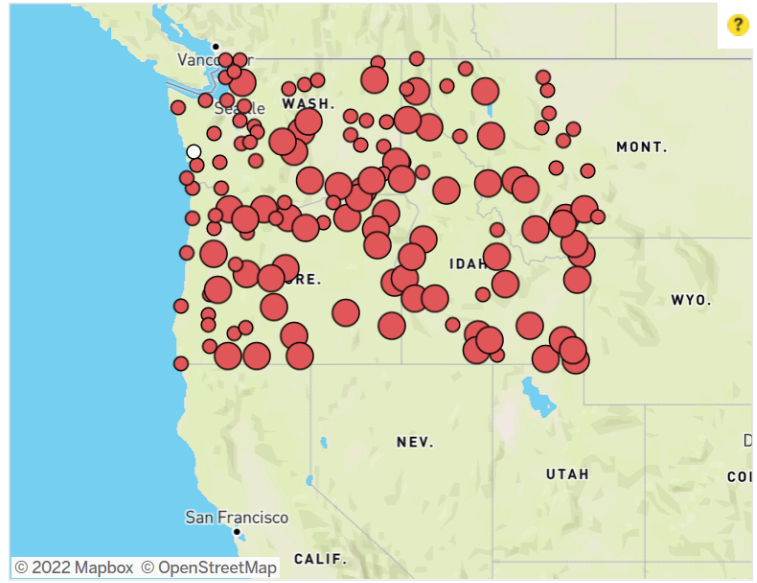
Trend Range
Over Selected Year Range

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

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

Trend Data (°F Over Selected Year Range)

ID	+	1.94
MT	+	0.9
OR	+	1.65
WA	+	1.25



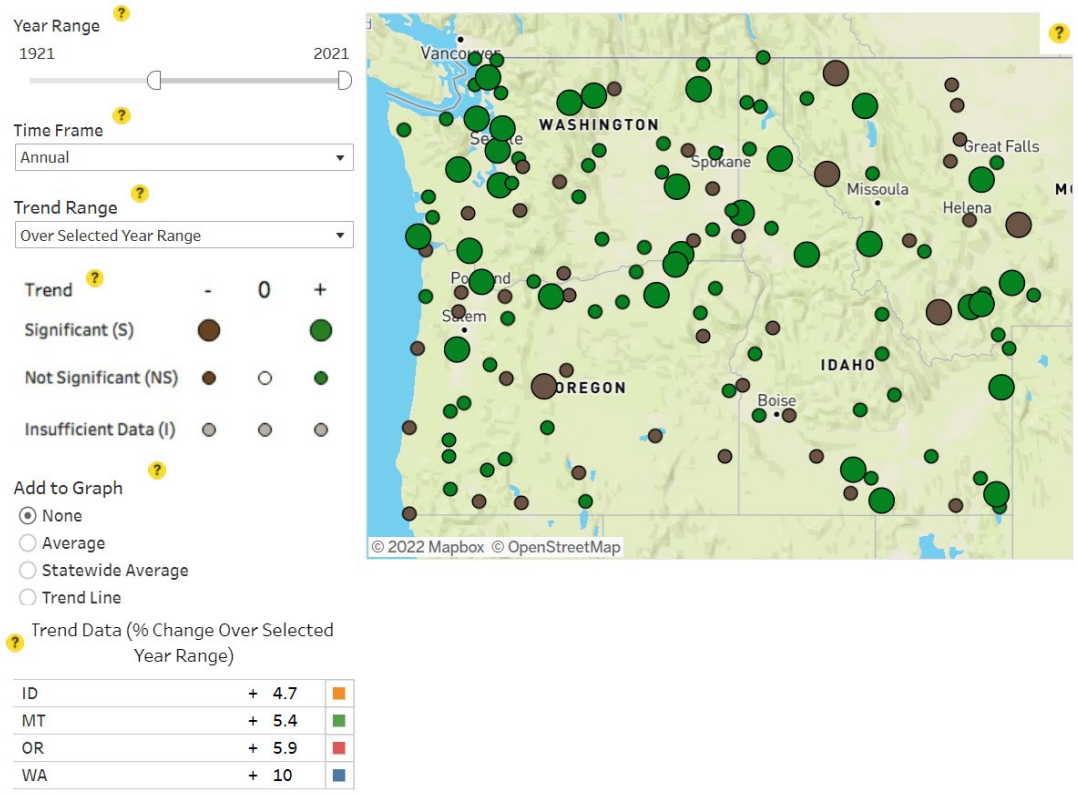
https://climate.washington.edu/climate-data/trendanalysisapp/

Station Data Source: NOAA's U.S. Historical Climatolog Network version 2.5.5.20210712

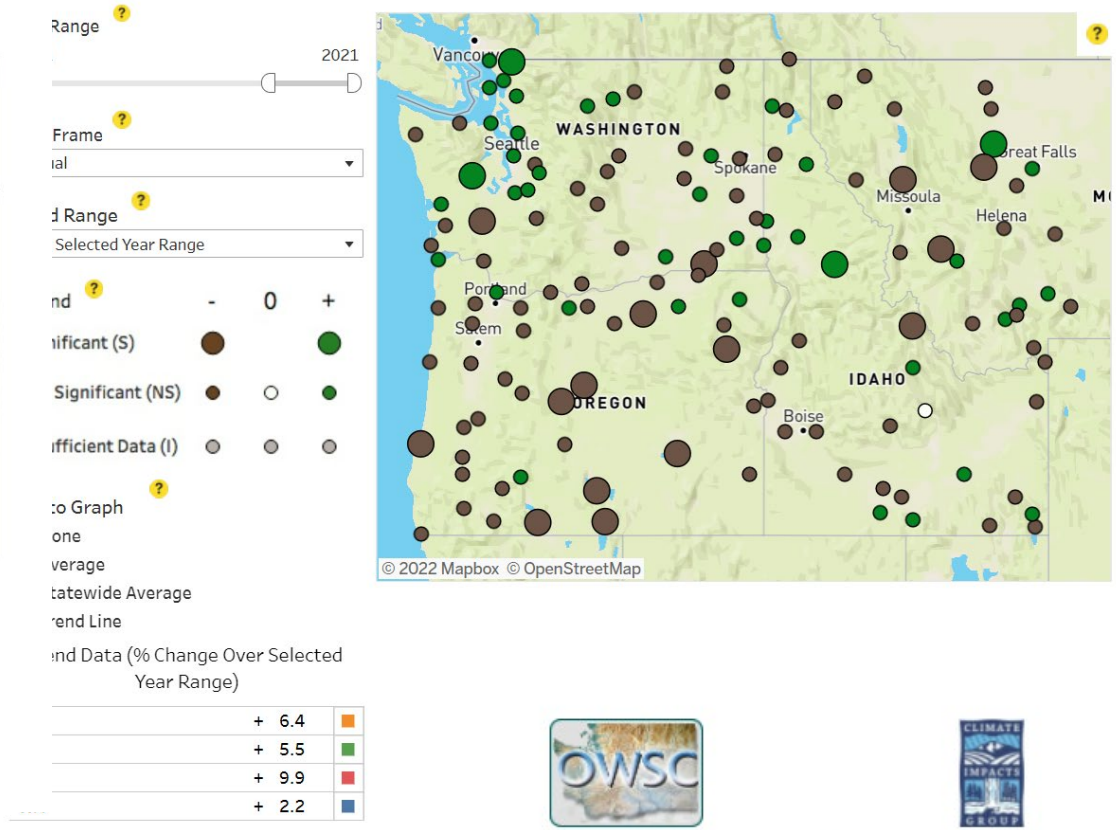
Statewide Data Source: NOAA's US Climate Division Dataset (nClimDiv)

Regional Precipitation Trends

1921-2021



1981-2021



Station Data Source: NOAA's U.S. Historical Climatology Network version 2.5.5.20210712

Statewide Data Source: NOAA's US Climate Division Dataset (nClimDiv)

https://climate.washington.edu/climate-data/trendanalysisapp/

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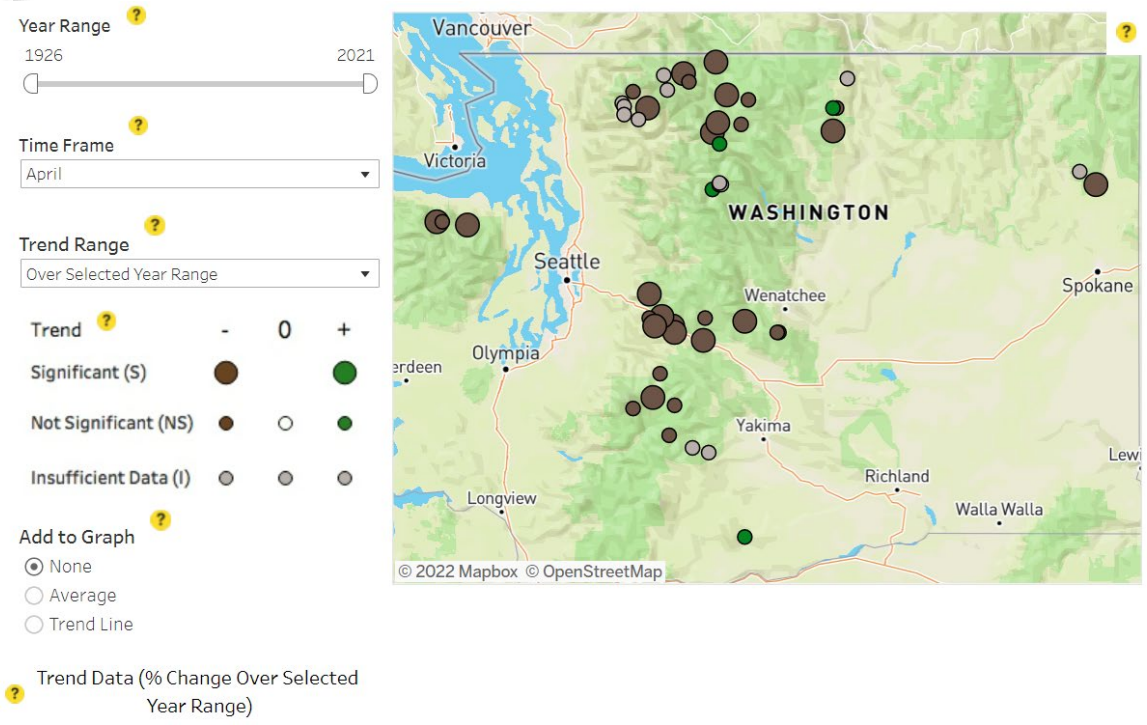
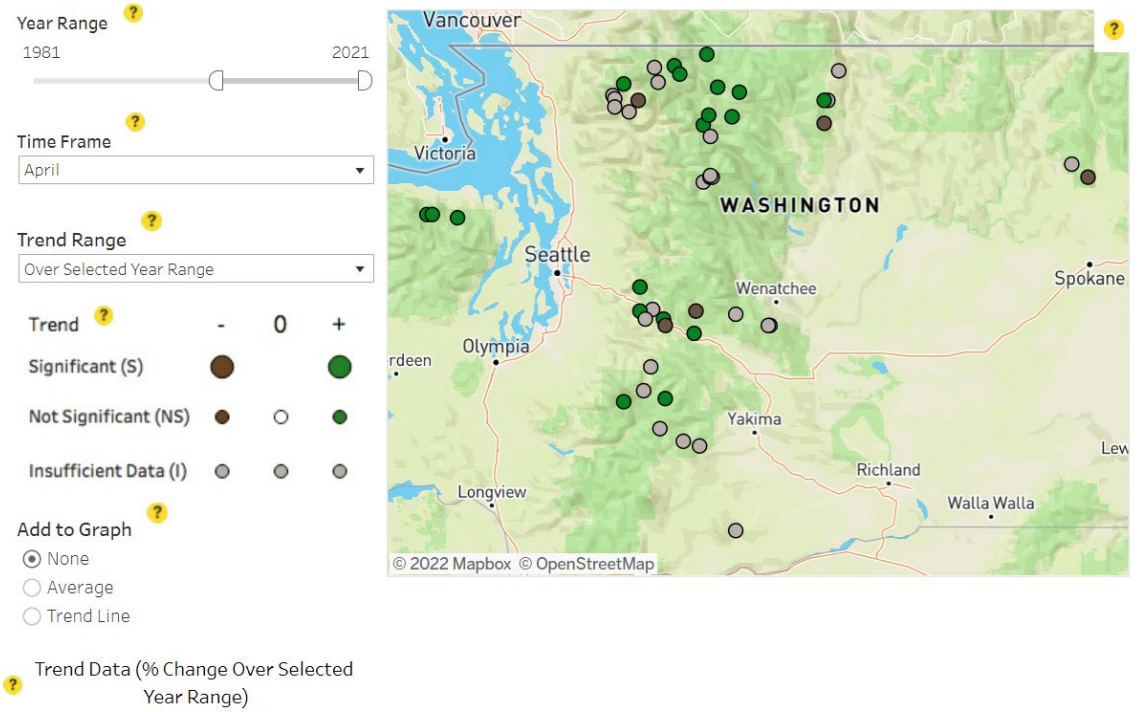
Washington Snow-Water Equivalent Trends

1926-2021



1981-2021



SWE Data Source: National Resources Conservation Service (NRCS) historical snow course data

https://climate.washington.edu/climate-data/trendanalysisapp/

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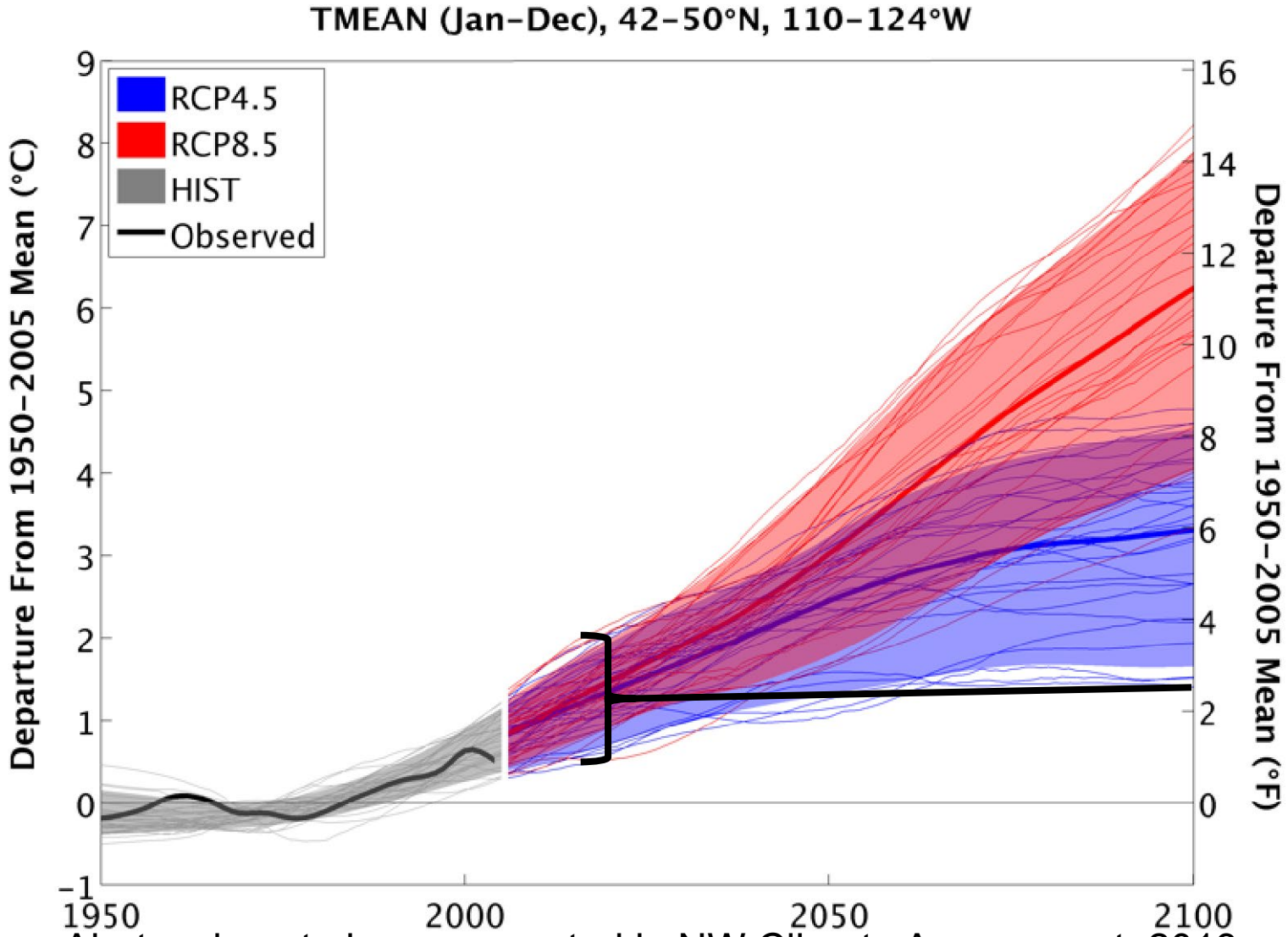
CMIP5 Climate Projections
Mean Annual Temperature

CIRC
Climate Impacts Research Consortium

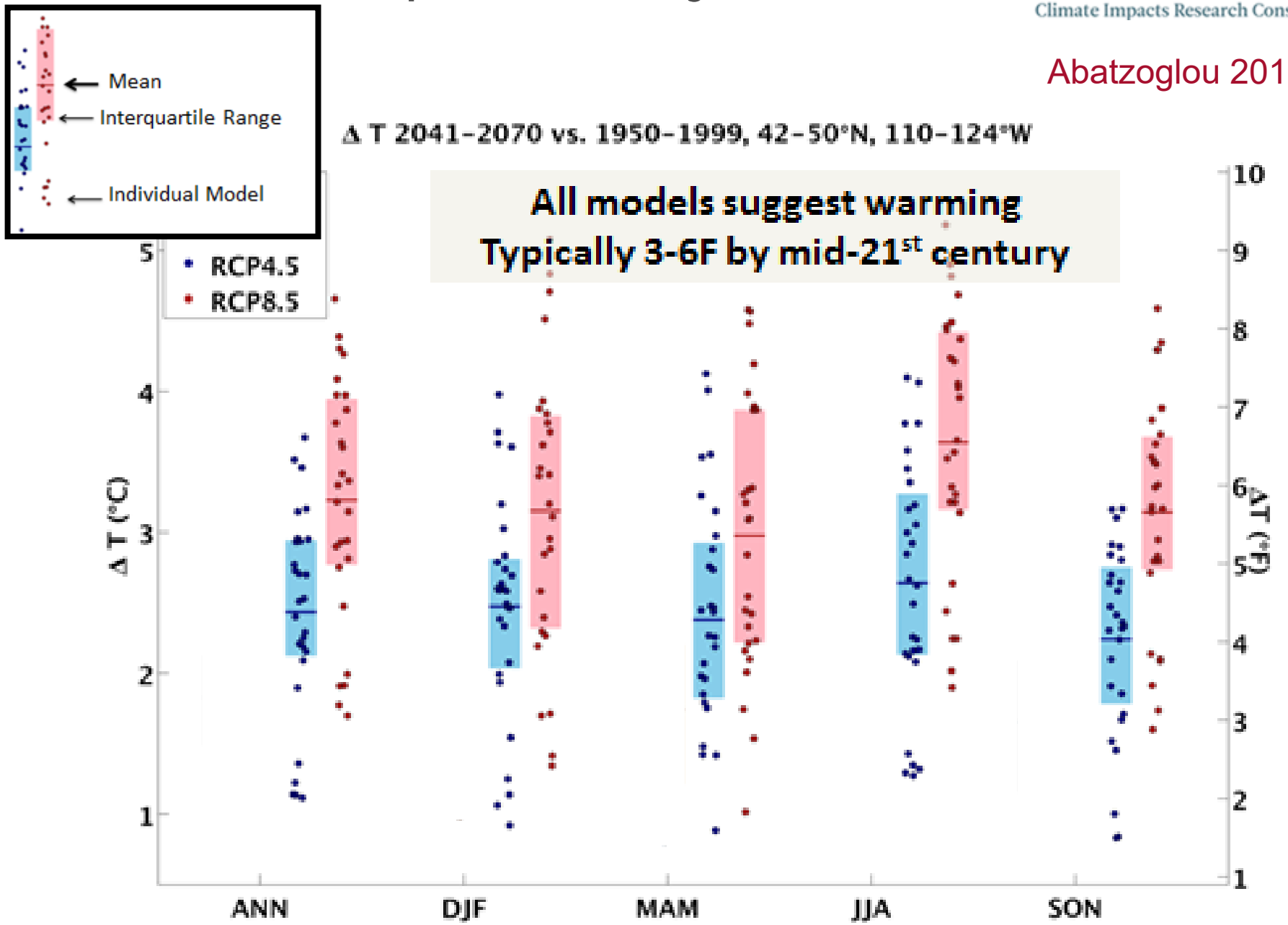
Abatzoglou 2013



Abatzaglou et.al., as presented in NW Climate Assessment, 2013

CMIP5 Temperature Projections

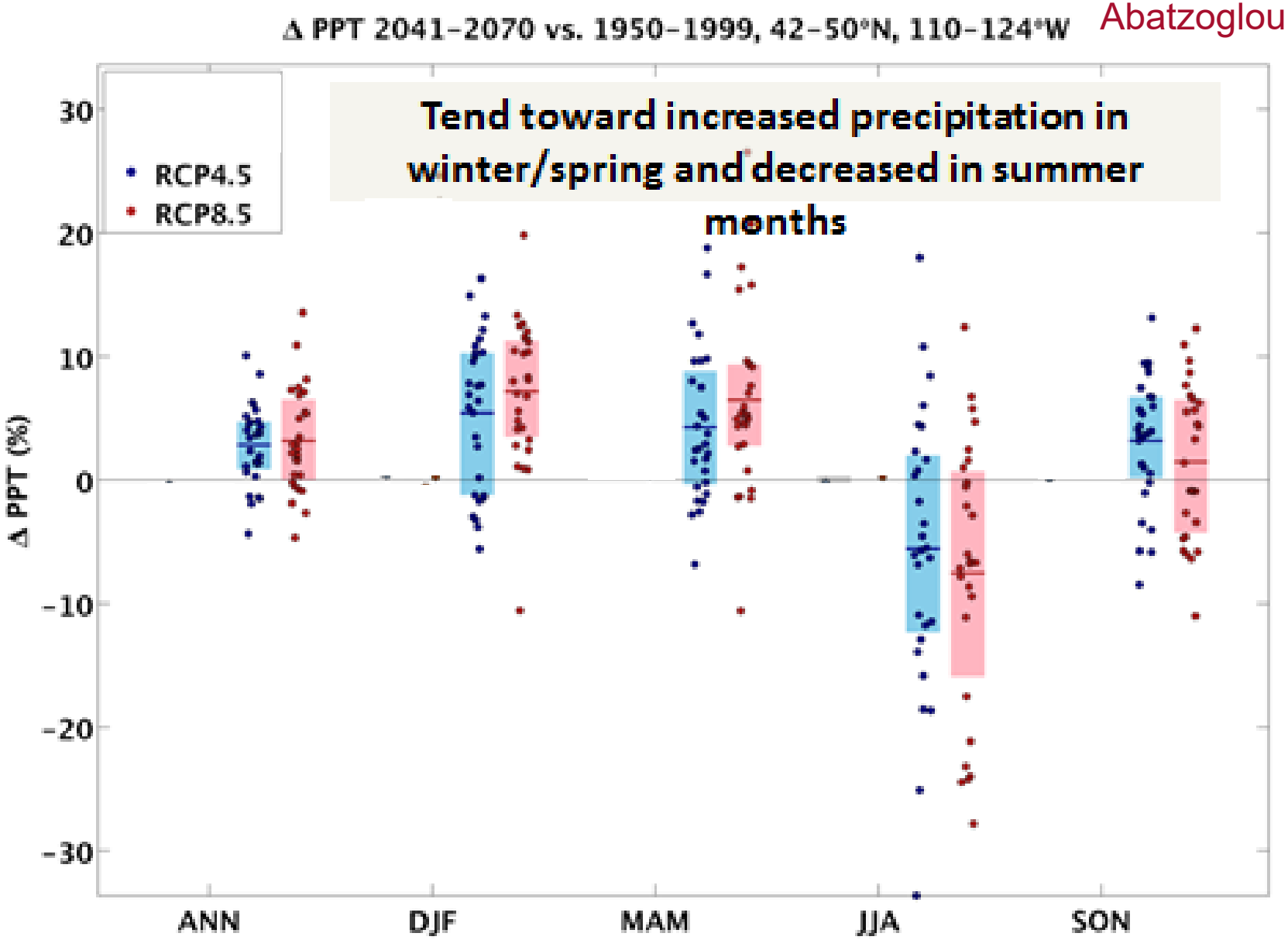
Abatzoglou 2013



CMIP5 Precipitation Projections

Climate Impacts Research Consortium

Abatzoglou 2013



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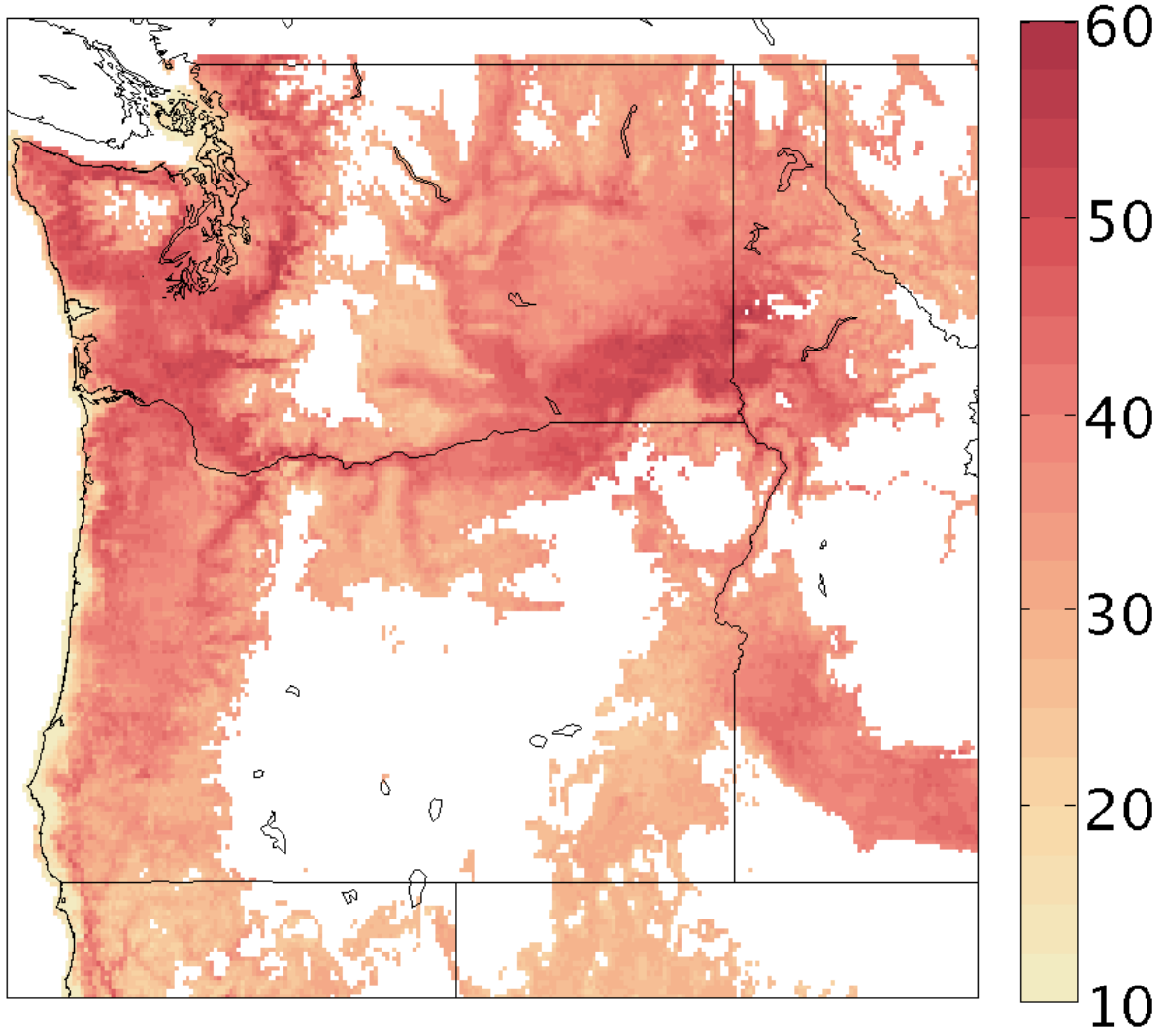
CMIP5 Projected Freeze-free season length

MM RCP4.5 2031-2060 vs. 1971-2000



CIRC
Climate Impacts Research Consortium

Abatzaglou et.al., as presented in NW Climate Assessment, 2013

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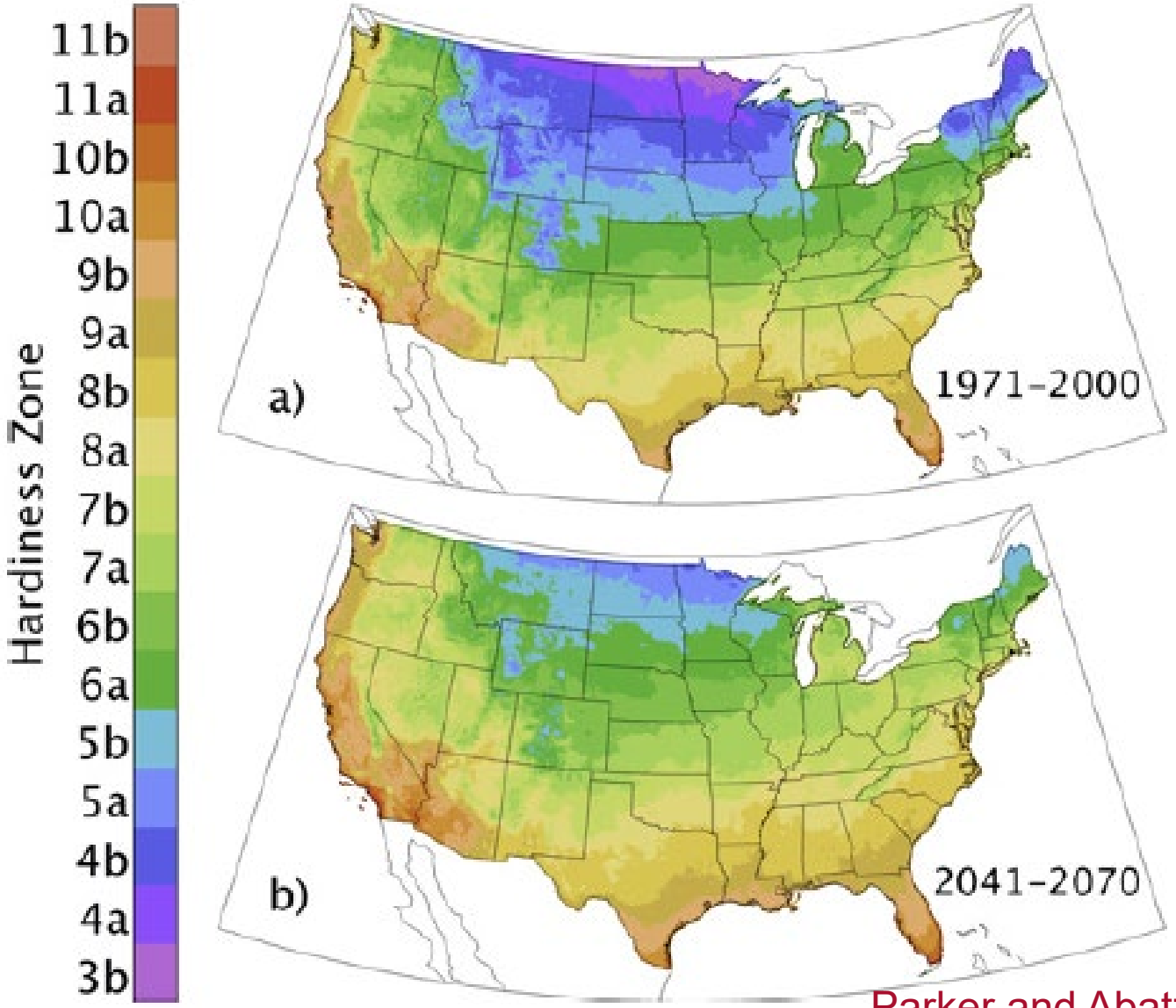
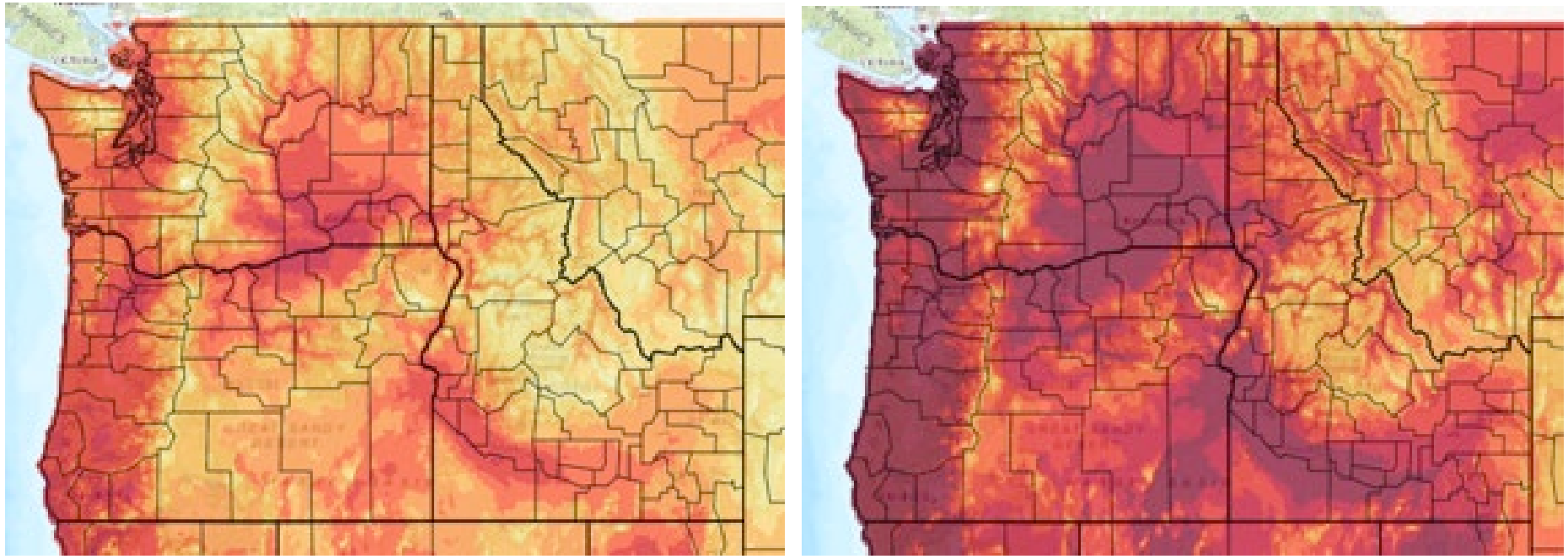
Projected Cold-Hardiness Zones
MM RCP 8.5 2041-2070 vs. 1971-2000



Parker and Abatzaglou 2016

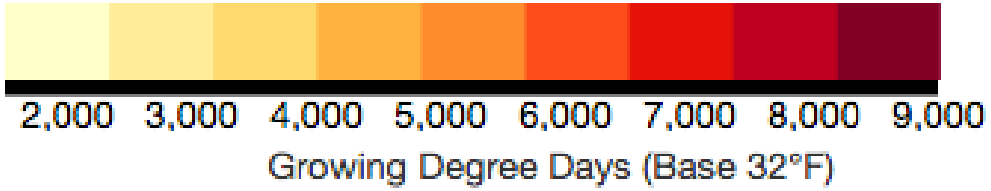
Emerging climate challenges for farmers

- Longer growing seasons and frost-free periods
- Increased heat and *snow* drought stress
- Changing biotic stressors



1971 - 2000

2040 - 2069 under RCP 8.5



Kruger et.al. 2017, courtesy Abatzoglou

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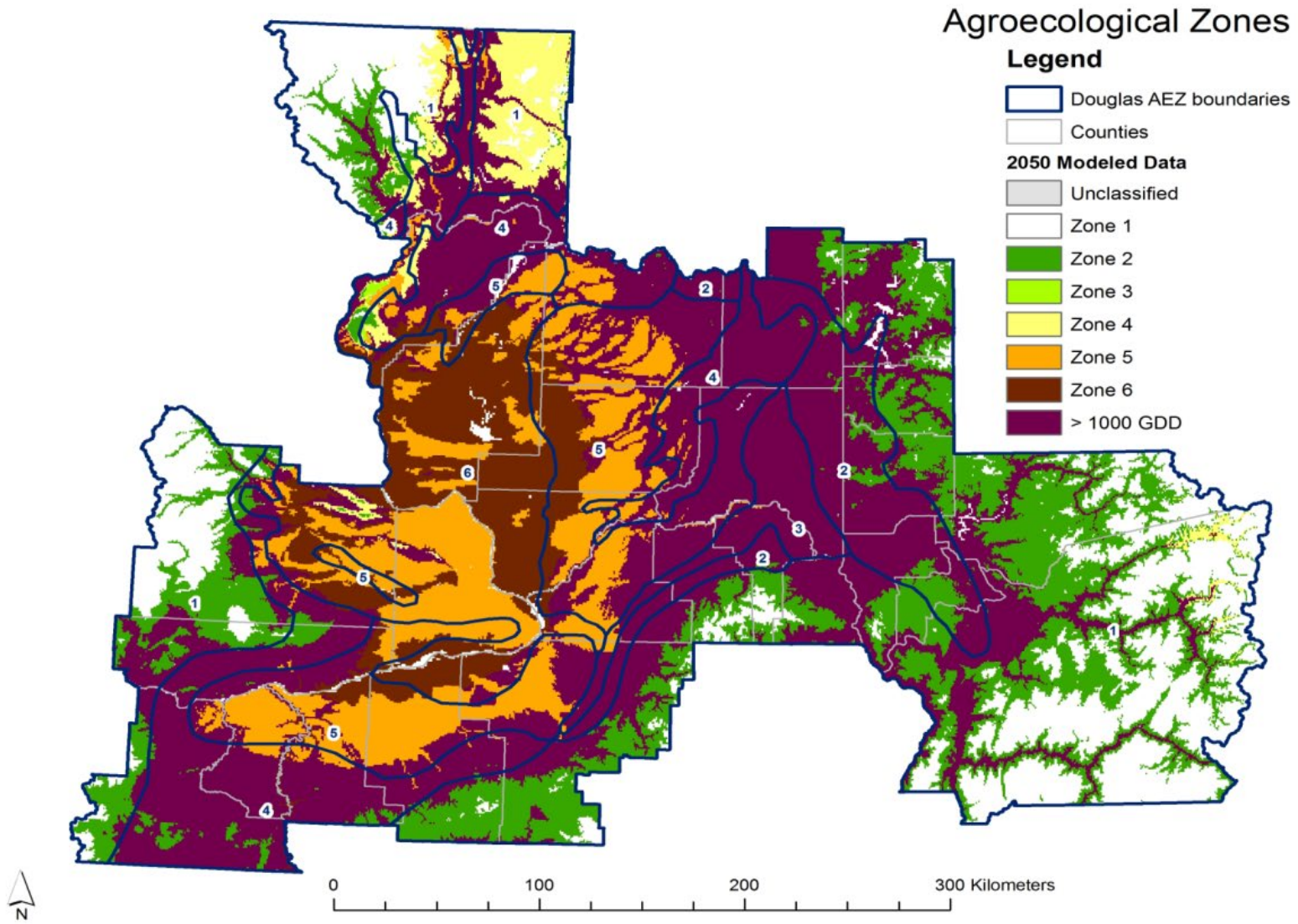
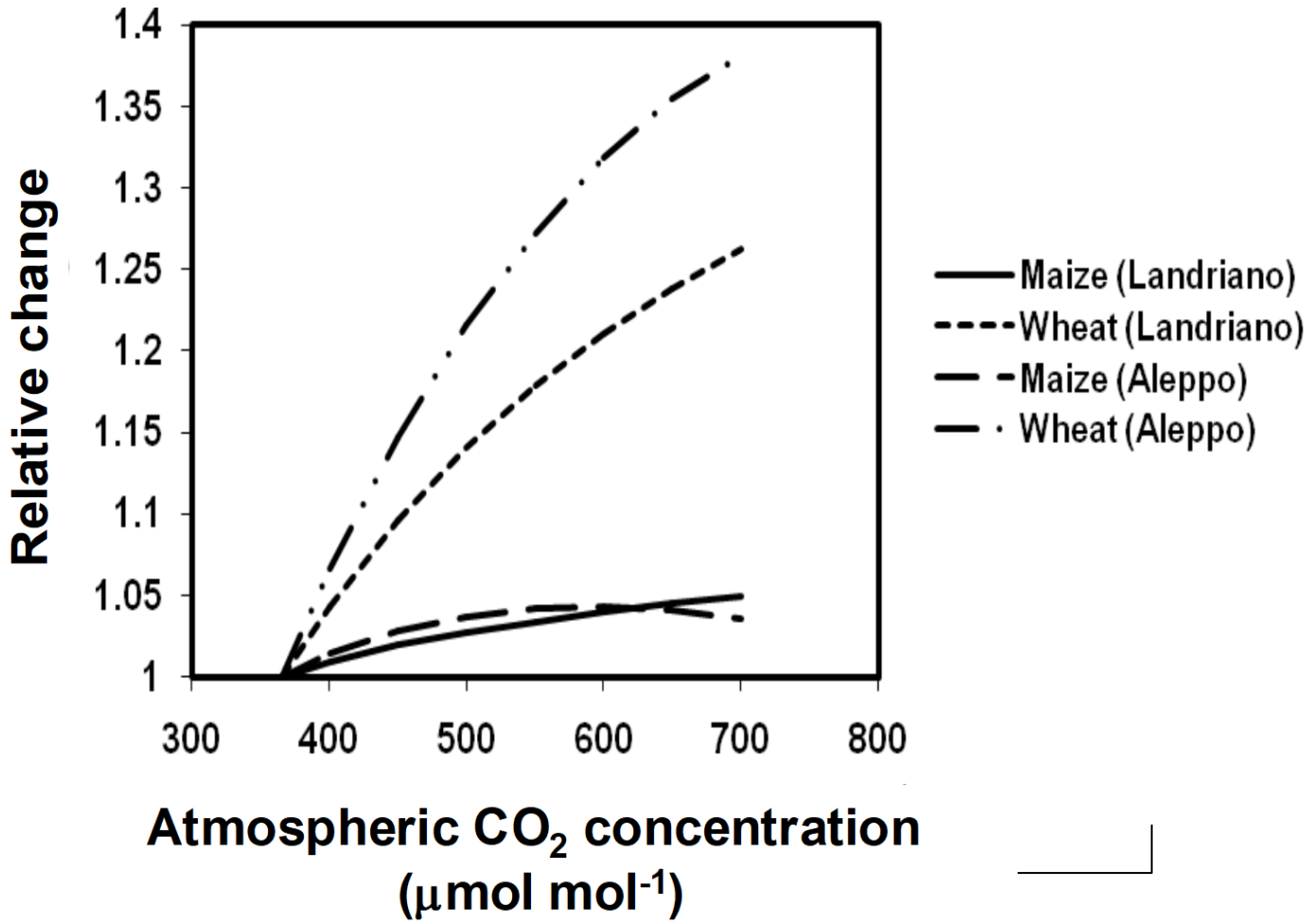
Potential Climate Impact on Inland PNW AEC's



Huggins and Rupp, unpublished. AEC concept detailed in Kaur et.al. 2017

Relative Change of Radiation-Use Efficiency: CO_2 Fertilization of Wheat (C3) & Corn (C4)



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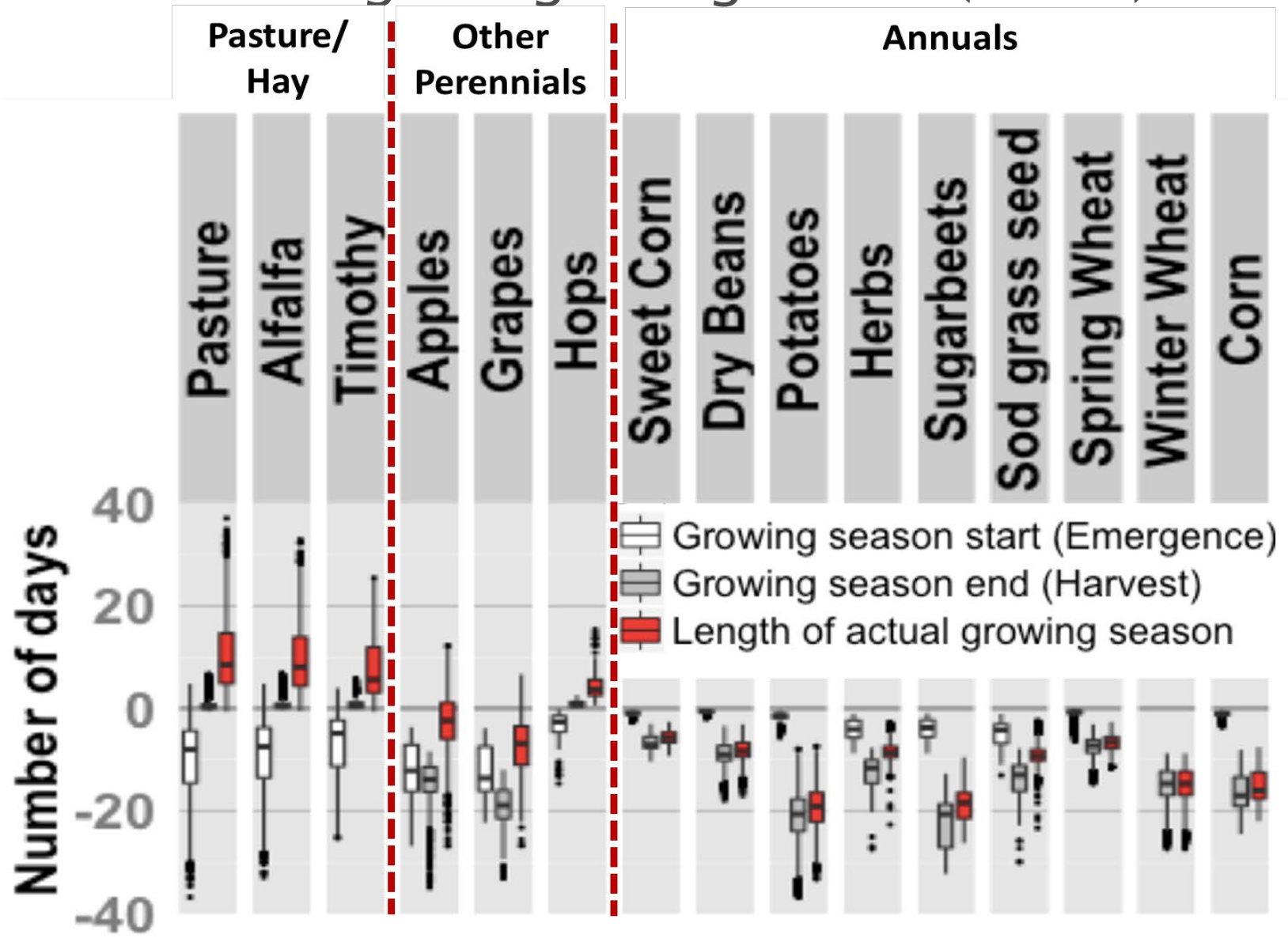
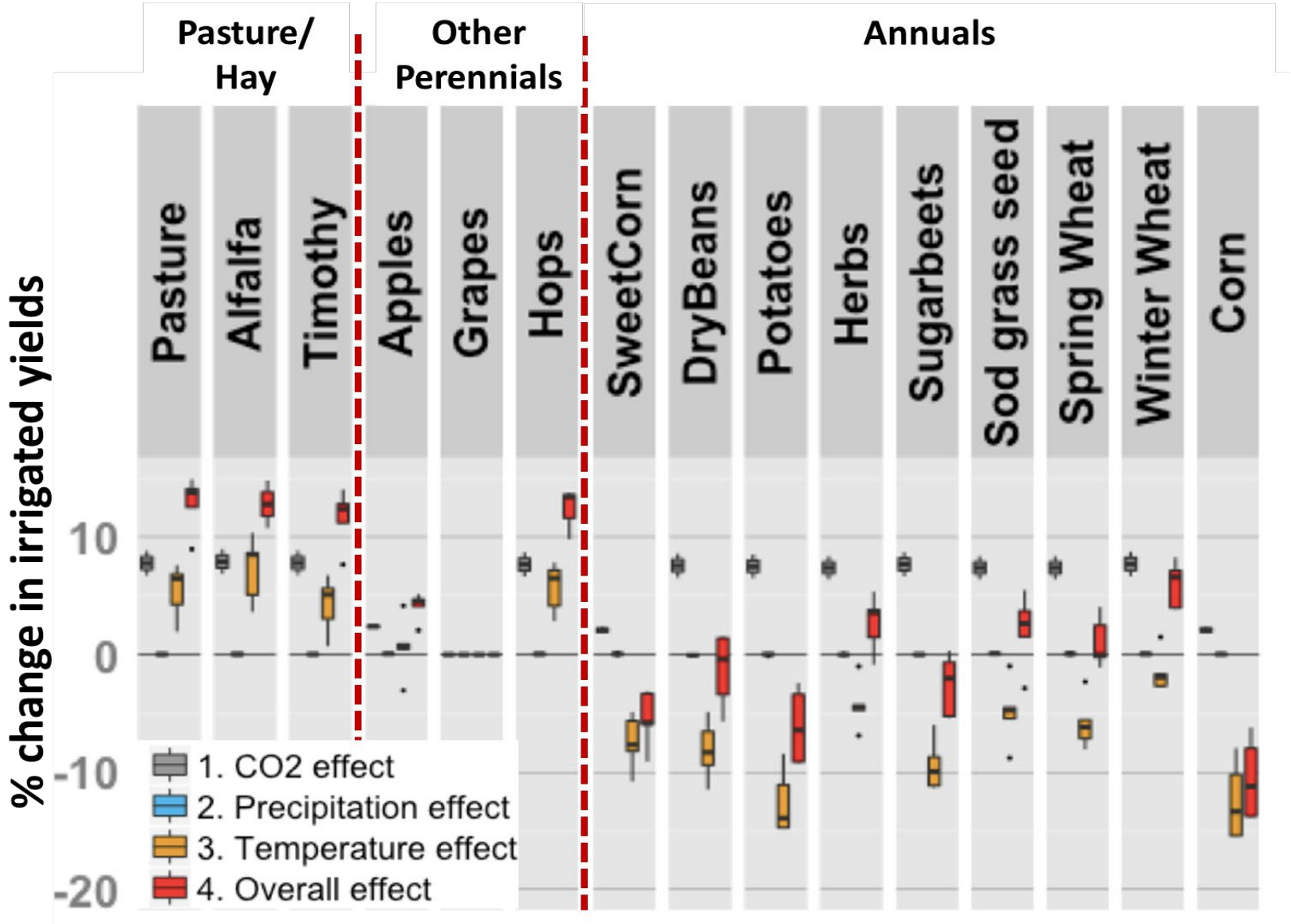
Changes in growing season (2030s)



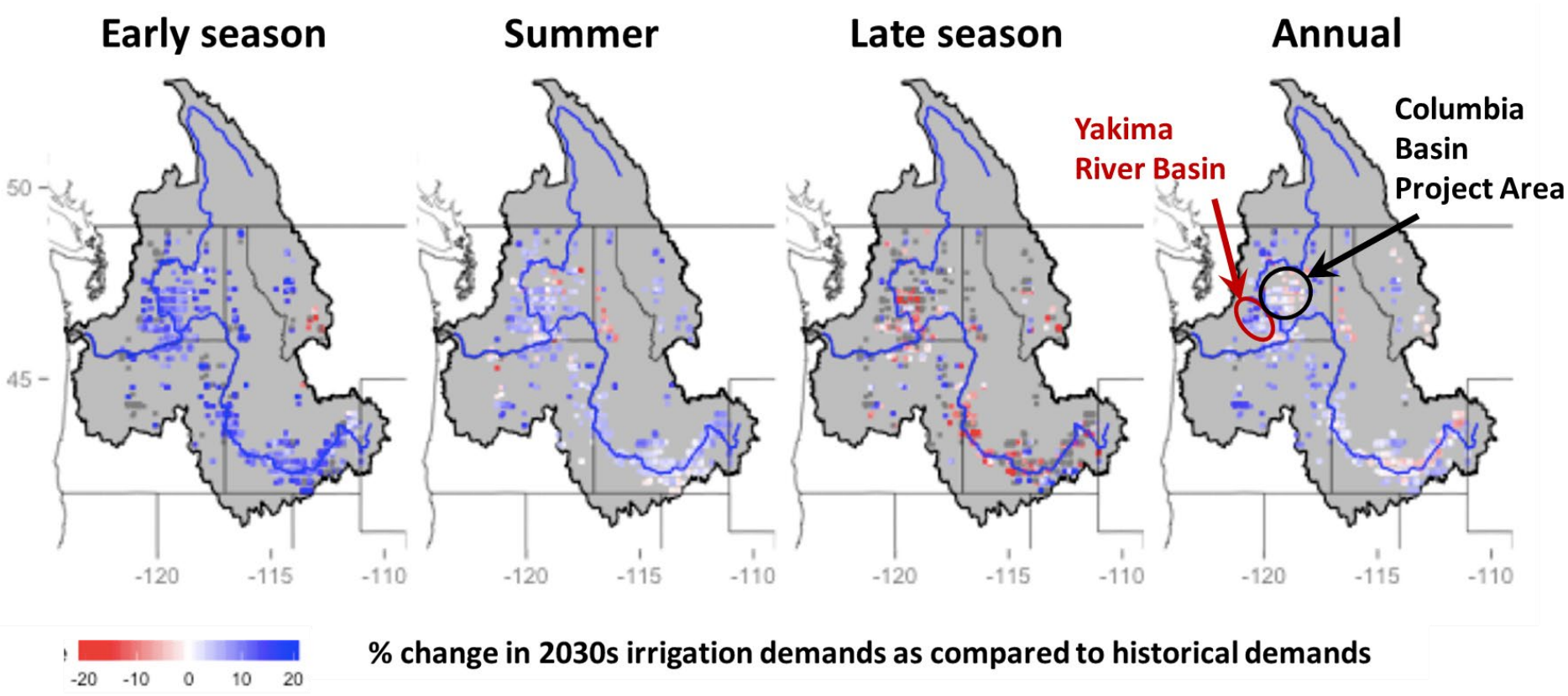
Rajagopalan et al., 2018

Percent Change in Irrigated Crop Yields (2030s)



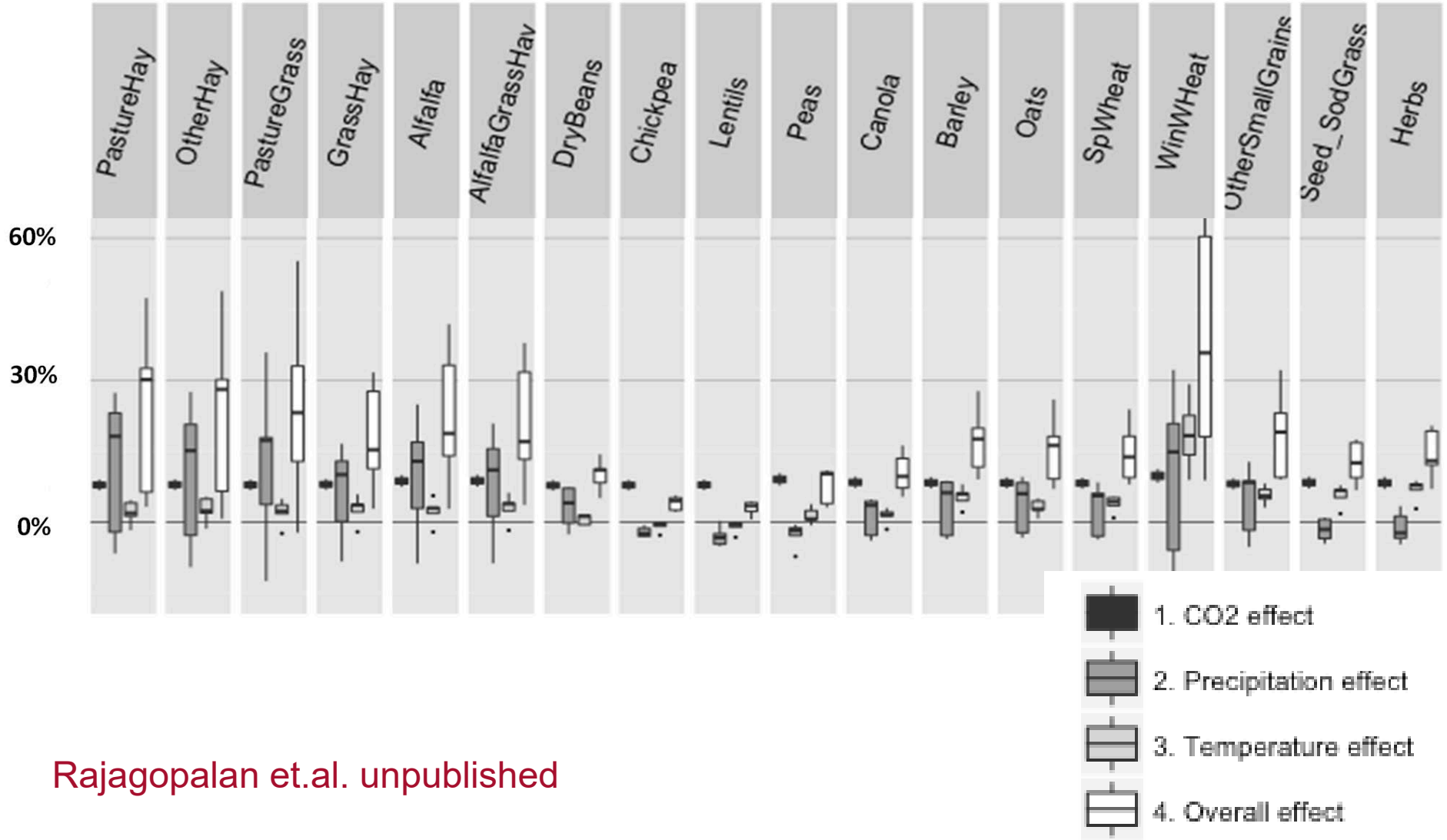
Rajagopalan et al. 2018

Percent Change in Regional Irrigation Demand (2030s)



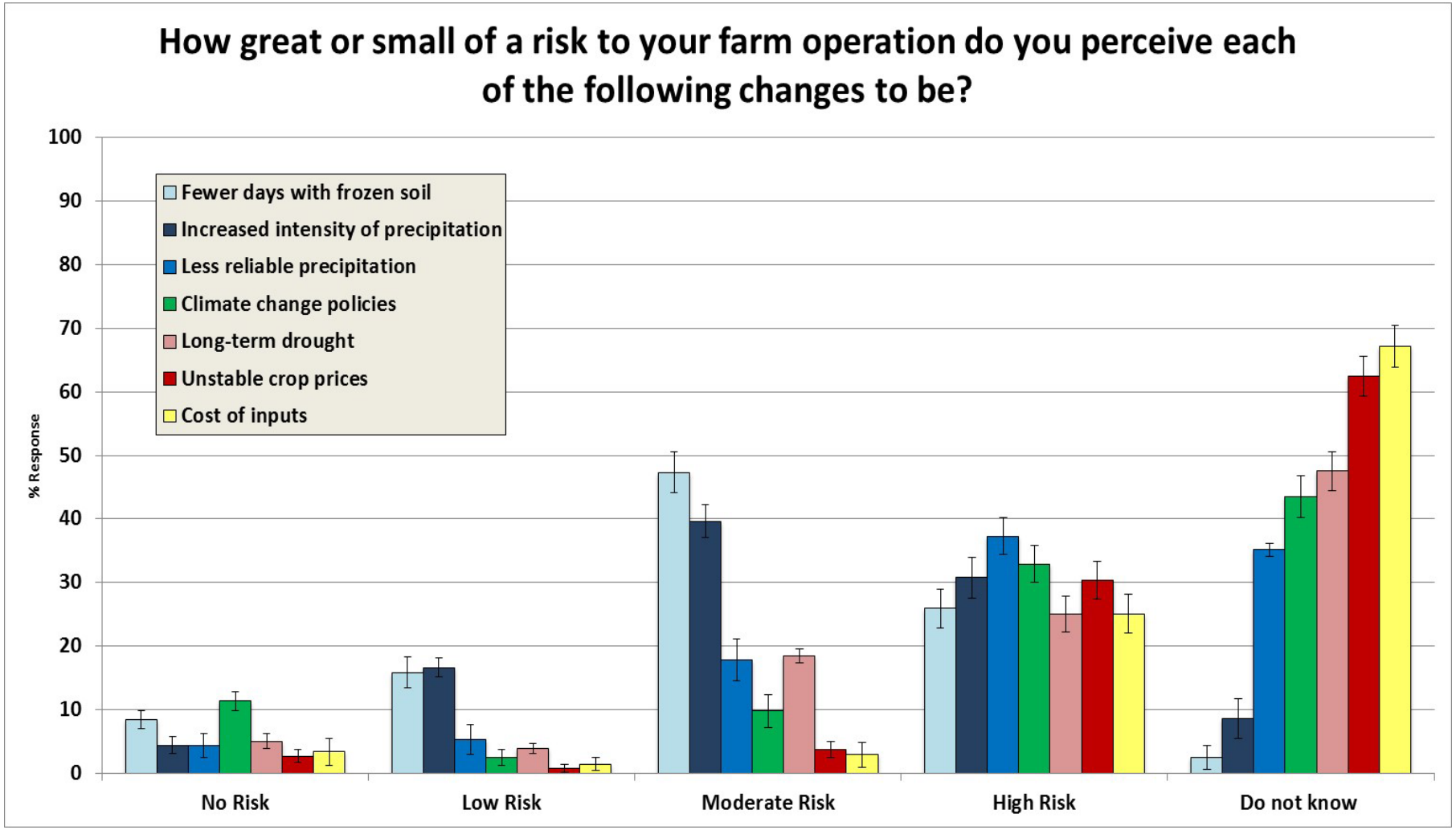
Rajagopalan et al., 2018

Change in dryland crop yields (%)



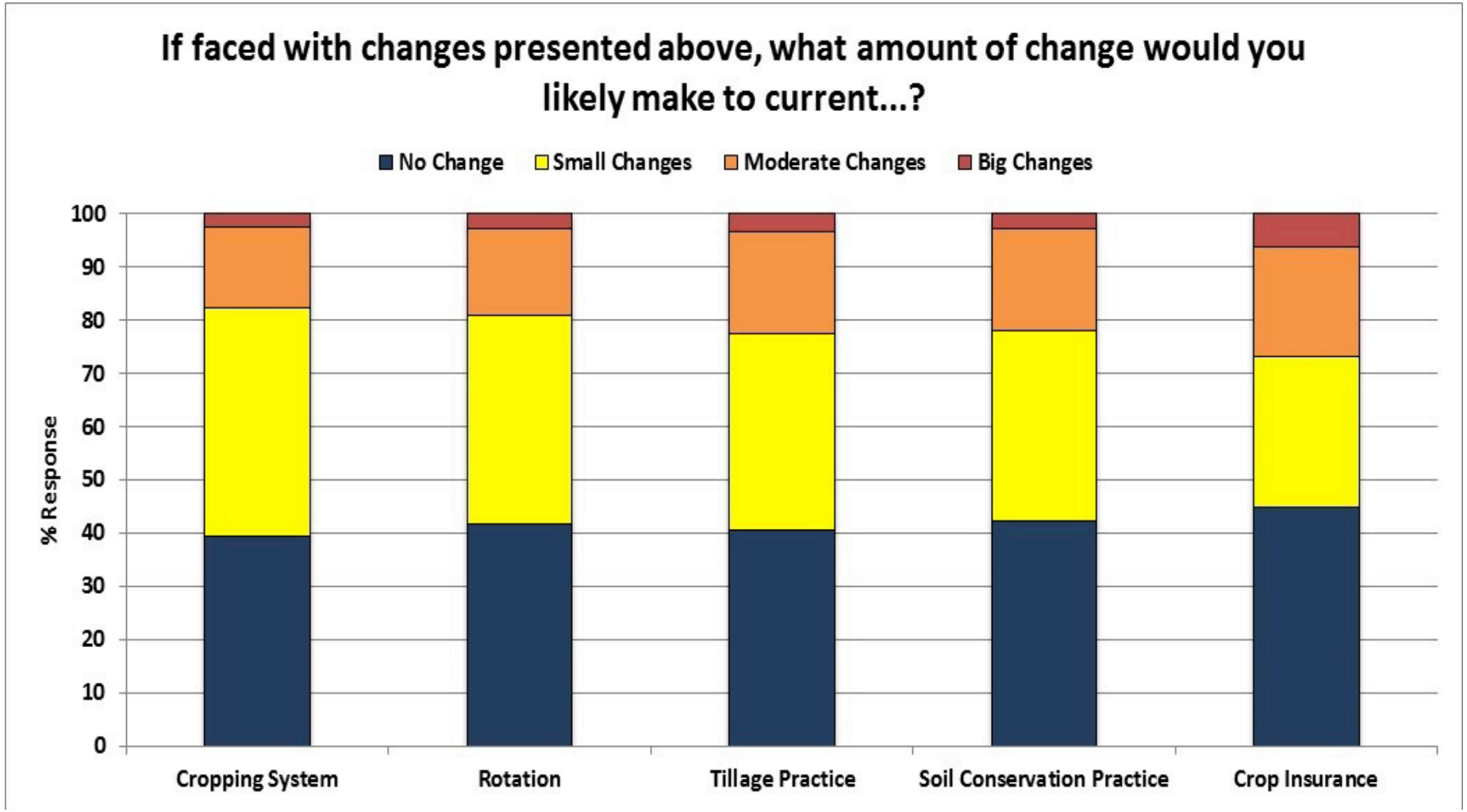
Rajagopalan et.al. unpublished

Do Northwest wheat farmers perceive climate change to be a risk?



Yorgey et.al. 2014

Do NW wheat farmers think they can adapt to climate change?



Yorgey et.al. 2014

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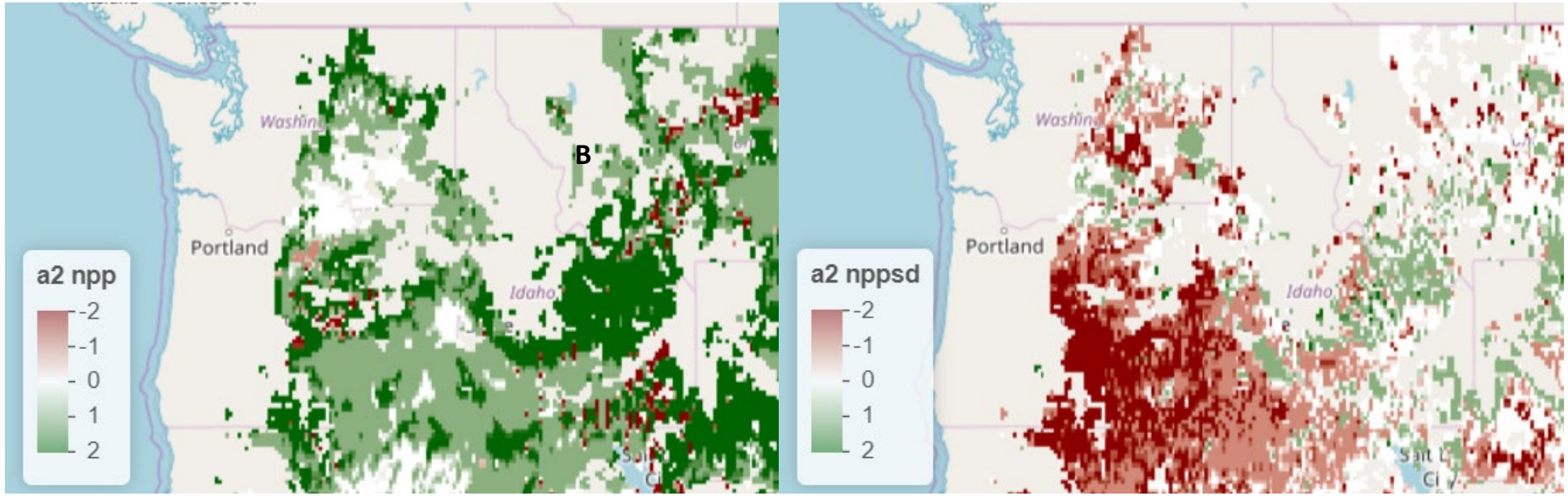
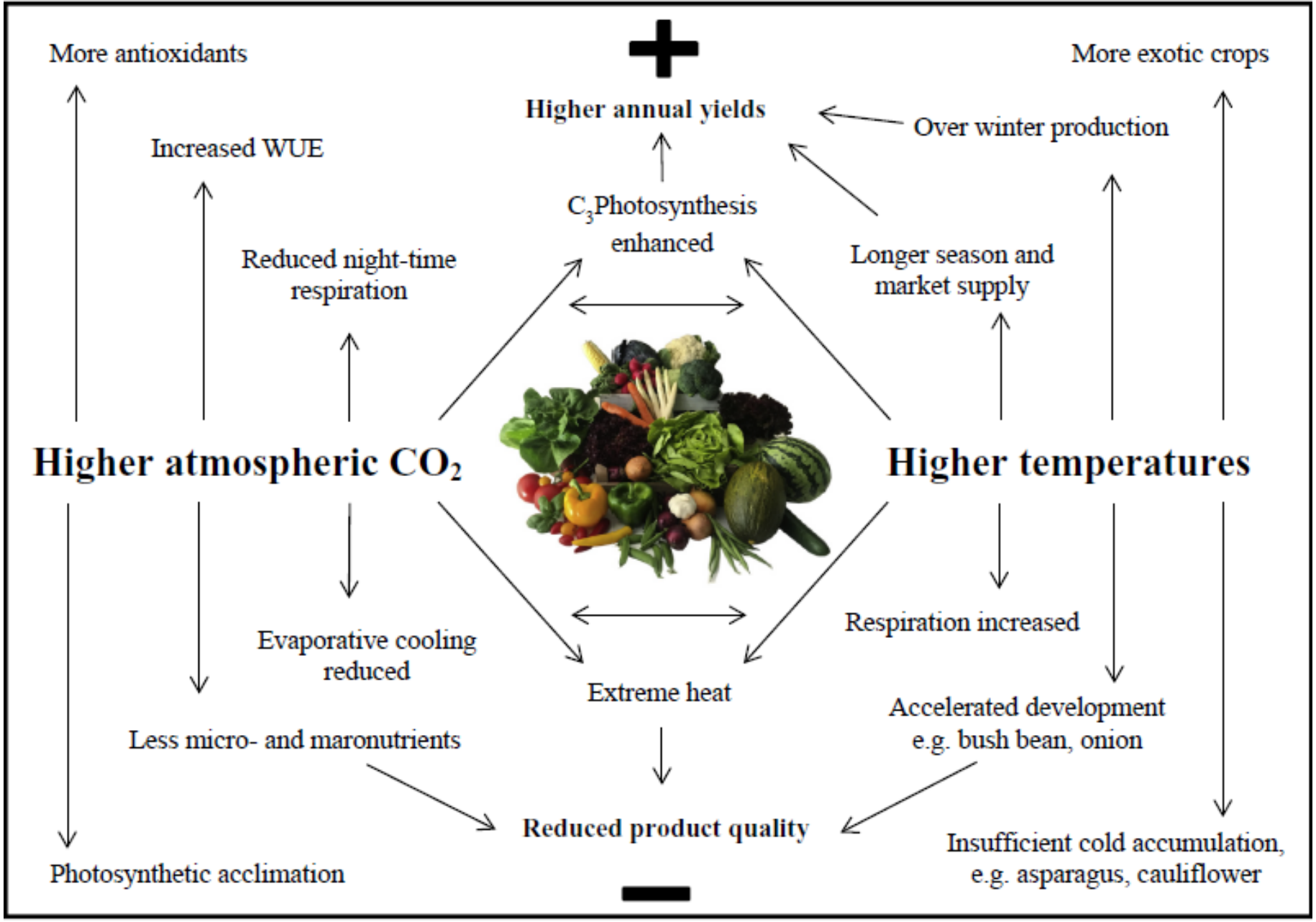
Projections of Climate Impacts to Rangelands



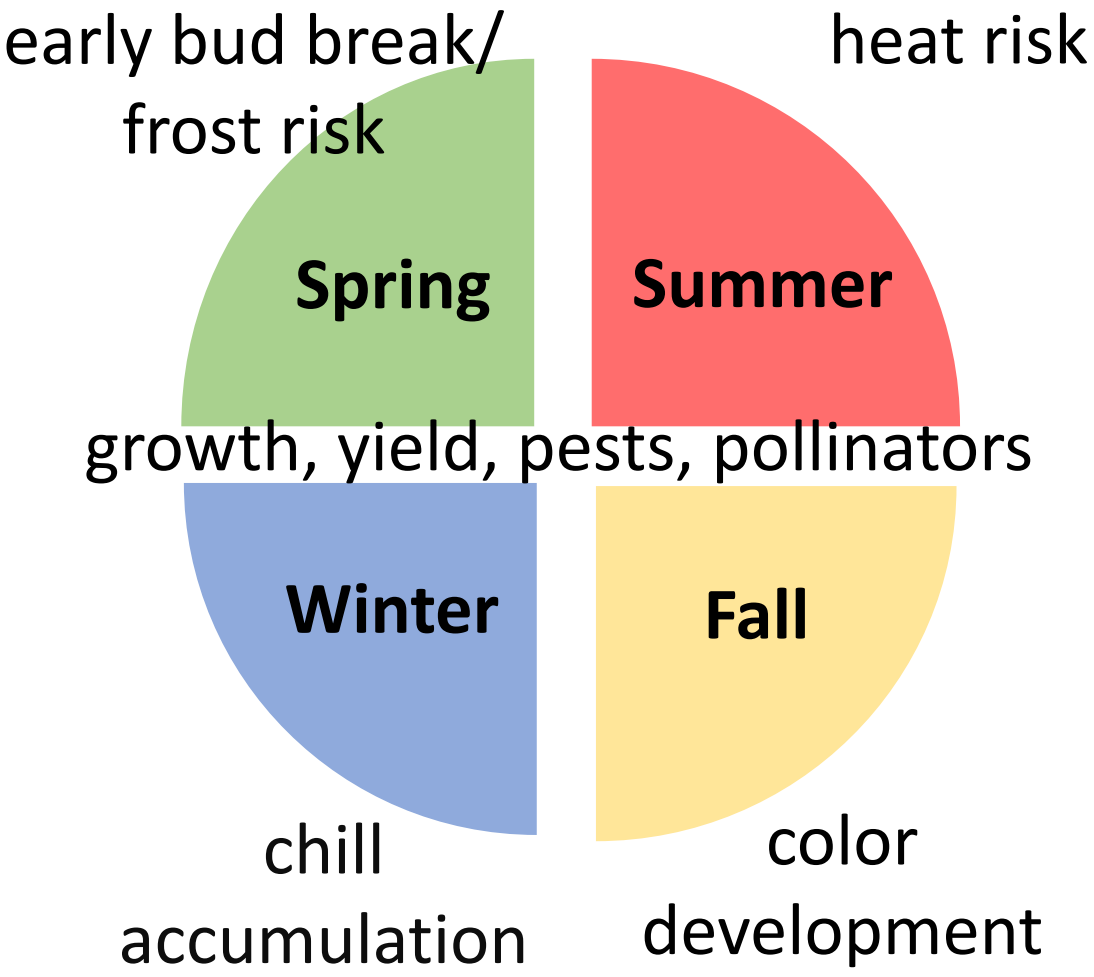
Expected changes in net primary productivity index (left figure, where positive values, shown in green, represent an **increase** in NPP) and expected changes in year to year variability (right figure, where negative values, shown in red, represent an **increase** in variability) by 2050-2060. Changes are shown as +2 to -2 index, compared to historical baseline of 2001-2010. Projections shown were developed using a high greenhouse gas emissions scenario known as A2, and future climate projections from the 3rd Coupled Model Intercomparison Project (CMIP3)..

Data from Reeves et al. 2017; maps Rajagopalan et al.



Bisbis et.al. 2018. Potential impact of climate change on vegetable production and product quality – a review. *Journal of Cleaner Production*

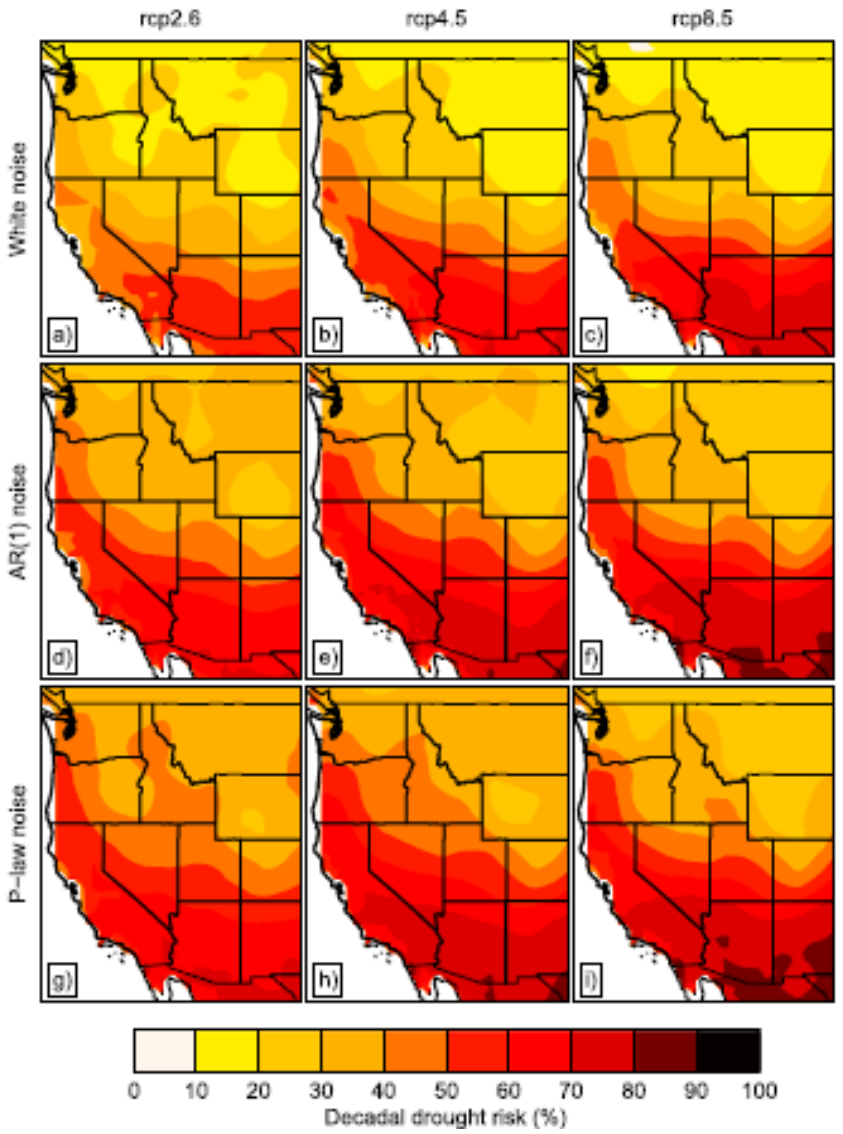
Climate change impacts on tree fruit production and management (temperature effects)

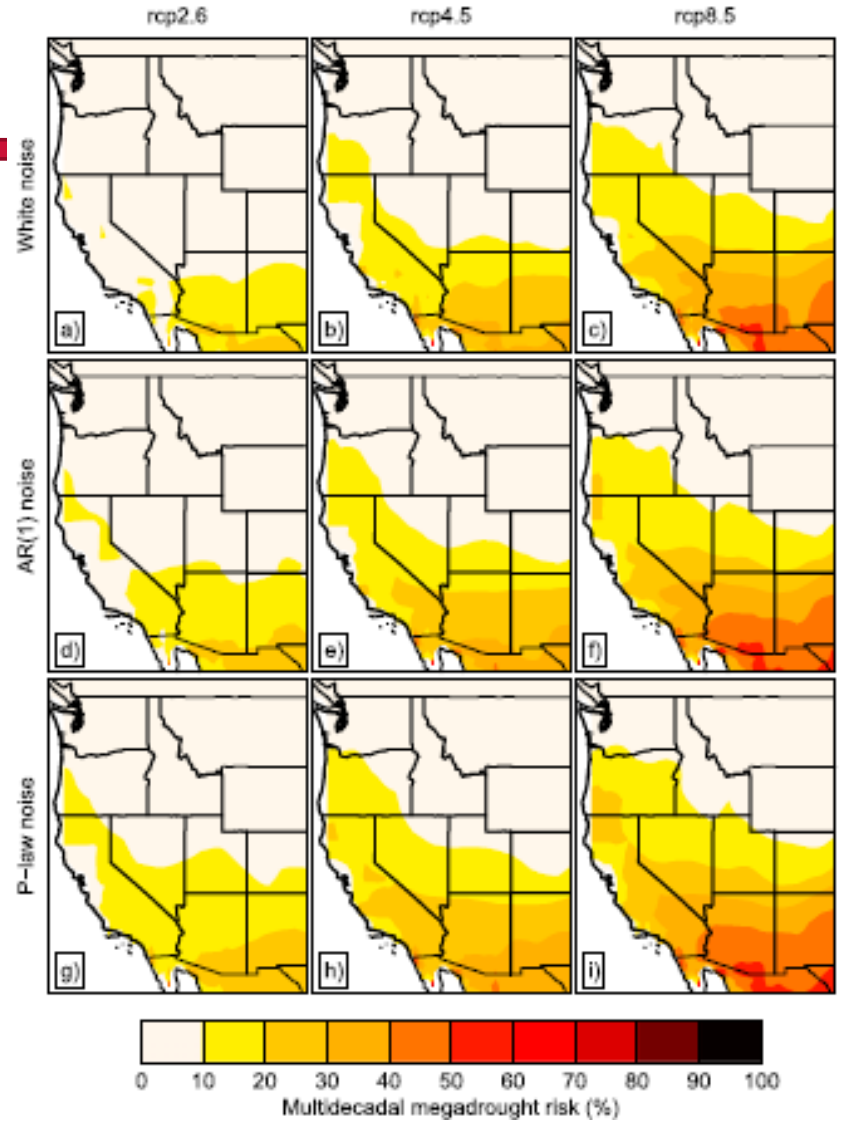


- Sunburn risk in apples
- Honeybee colony dynamics, fall temperature effects
- Codling moth pest pressures

Credit: Rajagopalan

Long-term Drought Risk?





Ault et.al. 2014

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November 7, 2017

Impacts and tools for dryland farmers adapting to climate change

By Liz Allen

As climate and agriculture researchers we're constantly learning from farmers who we interact with. Our conversations with dryland wheat producers in the inland Pacific Northwest have shown us that many farmers are very skilled at managing for multiple risks at once and making decisions under various kinds of uncertainty. Climate models project substantial warming by mid-century (Figure 1) as well as more frequent storm events and more extreme minimum and maximum temperatures in the future. At the same time, a higher concentration of CO_2 in the atmosphere may contribute to more rapid crop growth. As more detailed and sophisticated models of climate change and crop dynamics are developed, it is increasingly clear that managing under observed and projected climate change impacts will require new perspectives for farmers and other agriculture sector decision makers. Those involved in agriculture will need to develop their understanding of climate-related hazards and poise themselves to take advantage of emerging opportunities linked to a changing climate.

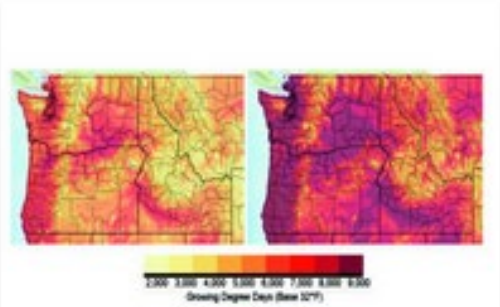

Figure 1. Cumulative growing degree days (base 32°F) 1971–2000 (left) and 2040–2069 representative concentration pathway (RCP) 8.5 (right), projections obtained from the AgClimate atlas. See the Climate Considerations chapter in Advances in Dryland Farming in the Inland Pacific Northwest for more information on how to interpret projections like this. (Source: Kruger et al. 2017)

Acknowledgments

WA Ecology: Columbia River Forecast
BioEarth: NIFA award #: 2011-67003-30346
USDA Northwest Climate Hub
Columbia FEW: NSF EAR1639458
REACCH: NIFA Award #: 2011-68002-30191
Fruit & Veg Supply: NIFA Award #: 2017-68002-26789

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Additional Resources

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agclimate.net

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Thank you!

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