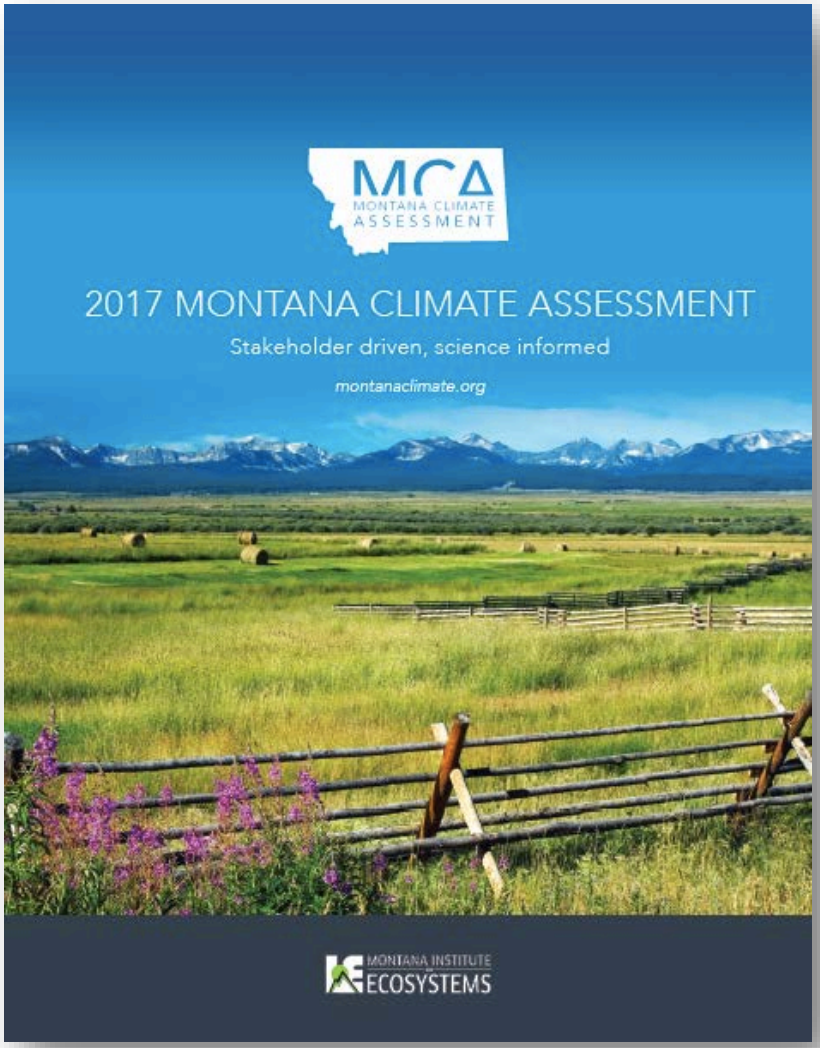
MONTANA CLIMATE ASSESSMENT



http://montanaclimate.org

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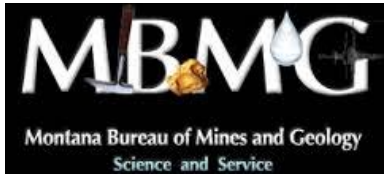
MCA Partners

U.S. National Climate Assessment



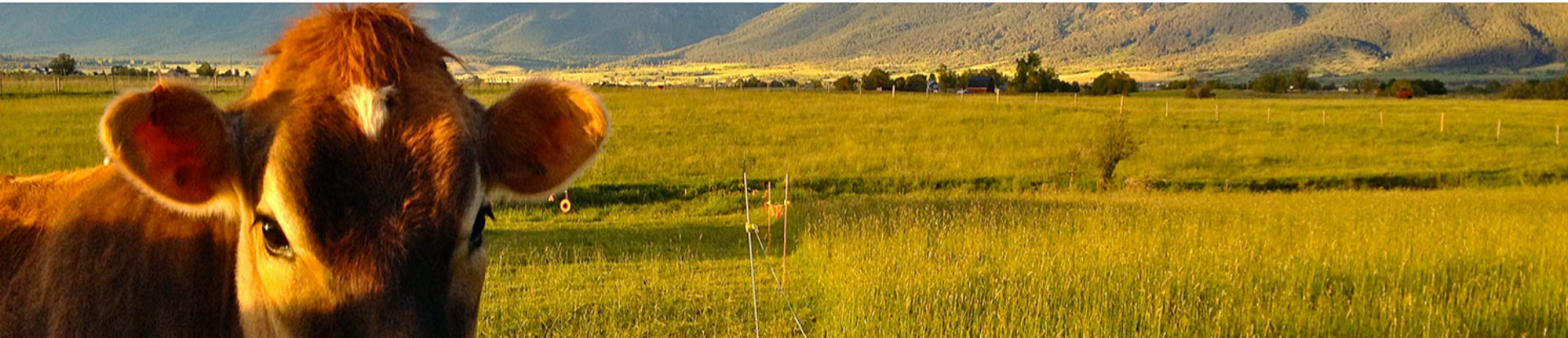
Stakeholder Driven

Stakeholders input throughout process

Listening sessions part of MCA strategy

- Critical decisions and issues impacted by climate
- What type of information they need
- How to disseminate useful information

Support of key state-level organizations



Montana Climate Assessment

Approach for Montana:

- Build on national efforts
- Best-science available
- Build on university research, engagement & partnerships
- Focus on relevant topics
- Useful, updatable products

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How is Montana's Climate Changing?

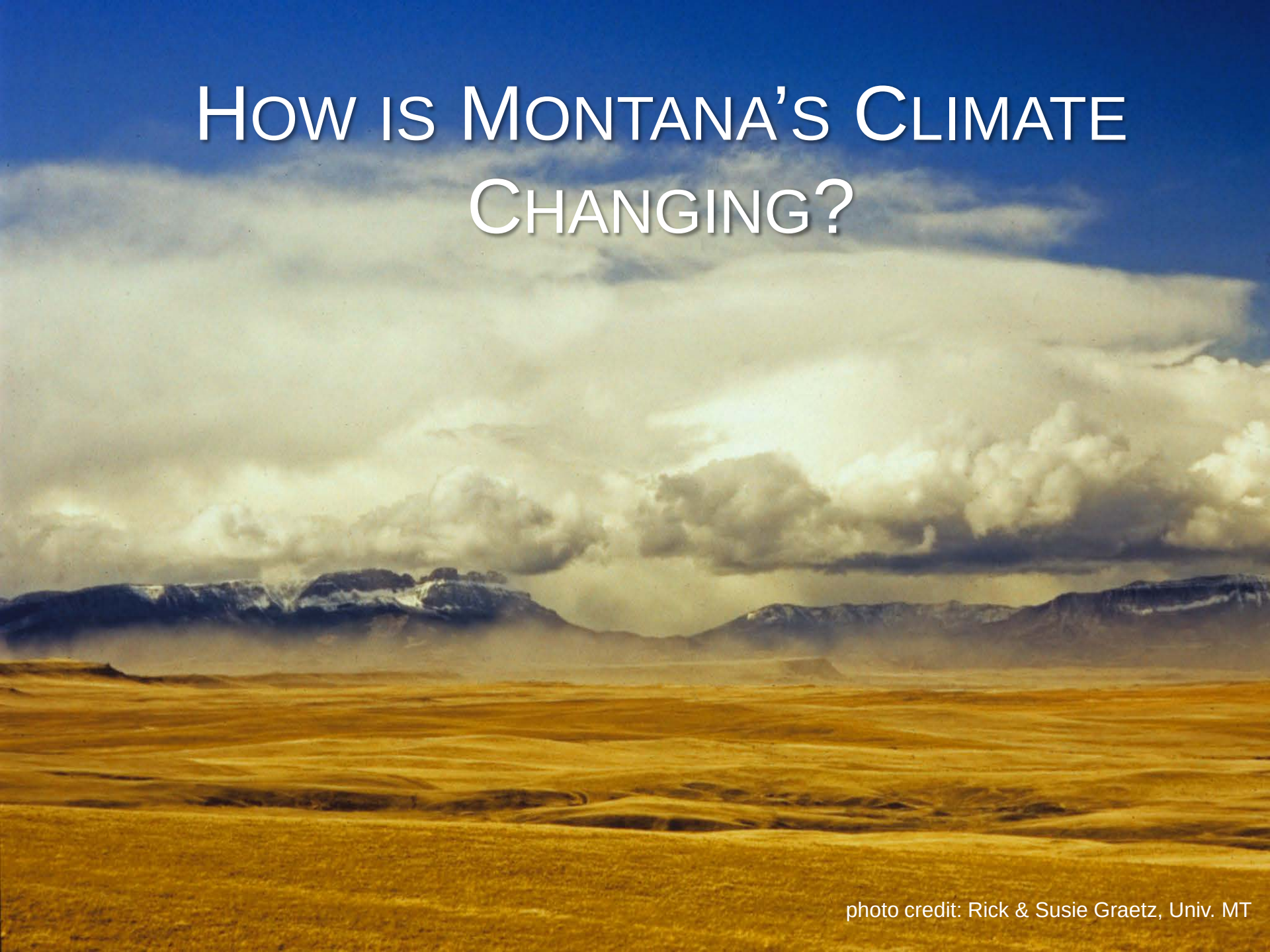
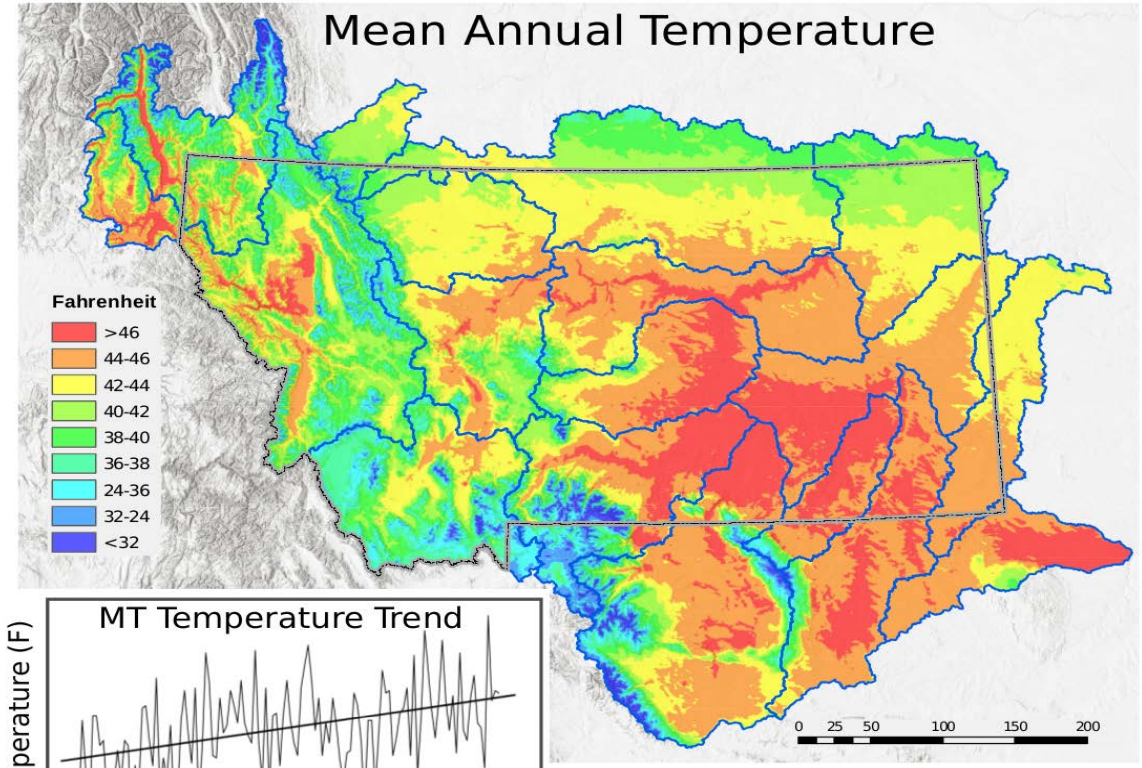
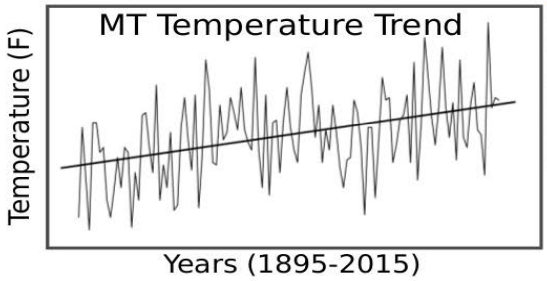


photo credit: Rick & Susie Graetz, Univ. MT

MONTANA TEMPERATURES





Increased by 0.42°F per decade since 1950. Overall increase of 2.7°F.

U.S. annual average has increased by 0.26ºF per decade since 1950.

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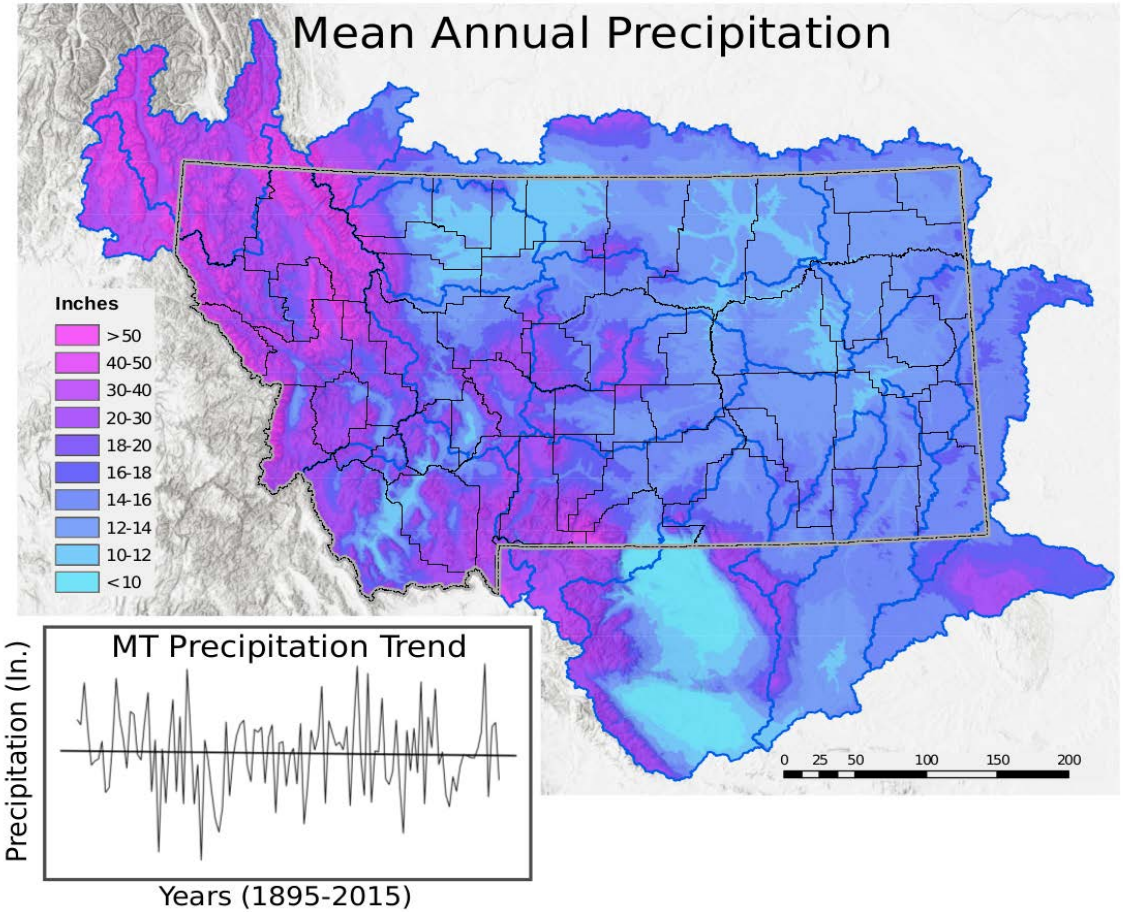
Montana Precipitation



Average annual precipitation is 18.7 inches.

Eastern MT: increased by 1.3 to 2.0 inches in spring

Western MT: decreased by 0.9 inch in winter

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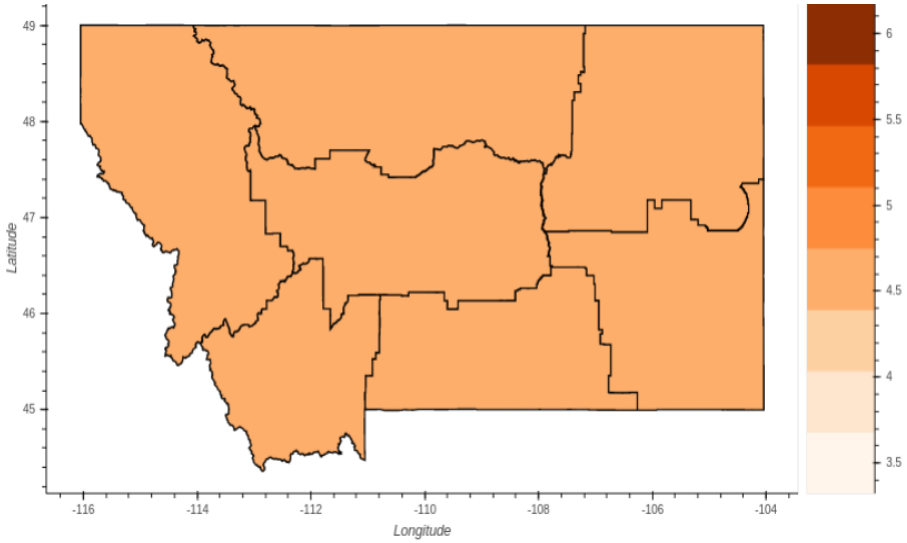
Annual Temperatures by Mid-Century

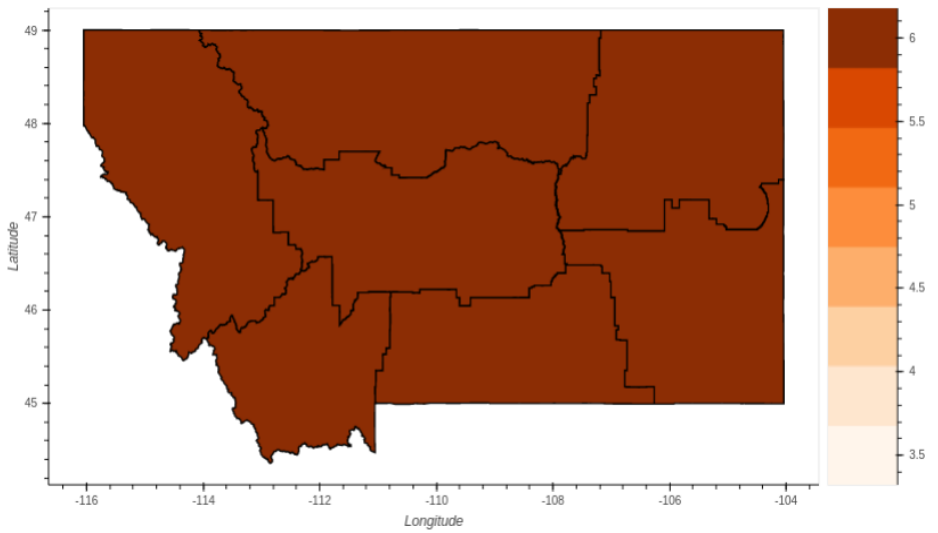
RCP 4.5 (2040-2060)



4.5°F increase

(minimum: 2.7°F, maximum: 6.1°F, model agreement: 100%)

RCP 8.5 (2040-2060)



6°F increase

(minimum: 4.0°F, maximum: 8.2°F, model agreement: 100%)

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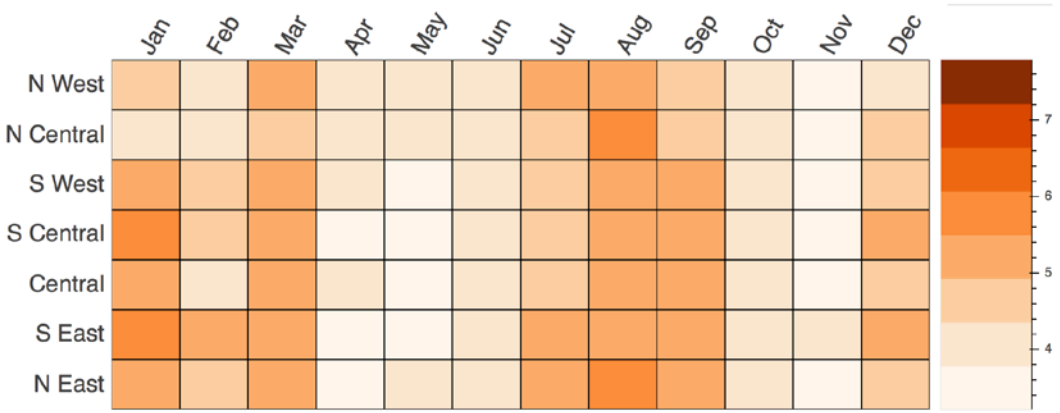
Monthly Temperatures

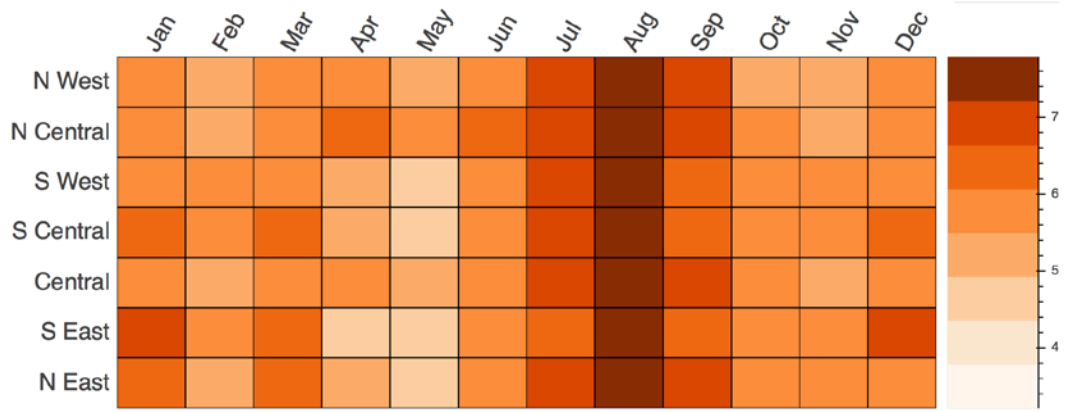
RCP 4.5 (2040-2060)



Greater warming in:

- Winter: 4 to 5°F
- Summer: 5 to 5.5°F

RCP 8.5 (2040-2060)



- Winter: 5 to 7°F
- Summer: 6 to 7.5°F

(100% model agreement)

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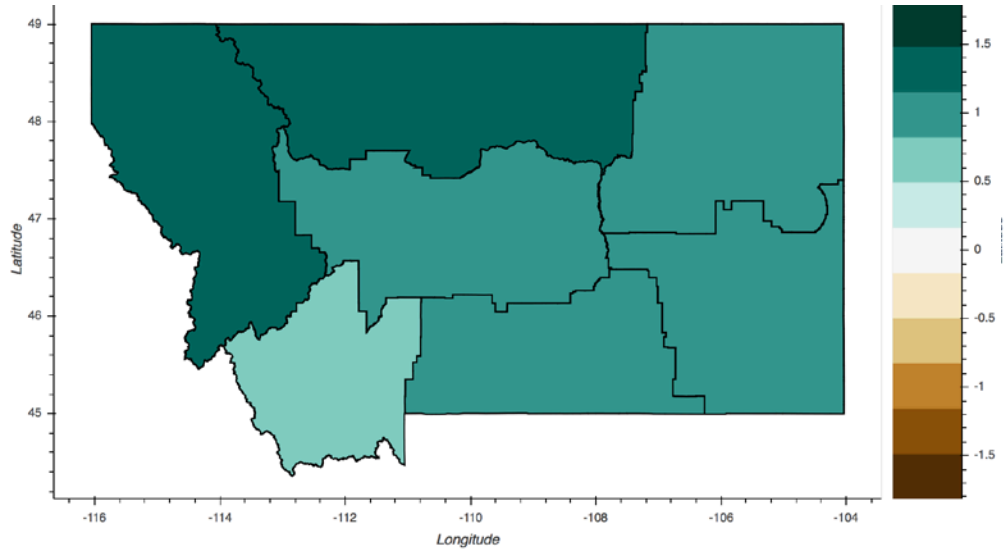
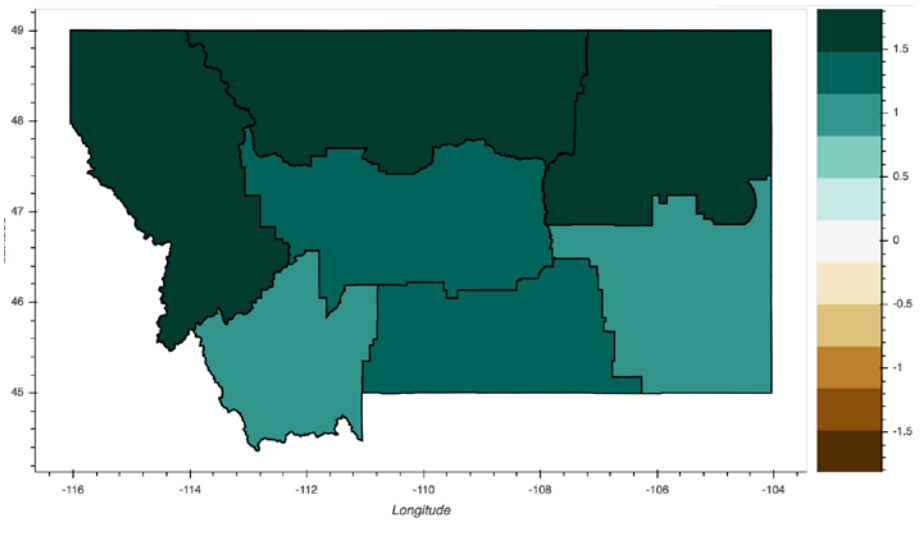
Annual Precipitation

RCP 4.5 (2040-2060)



RCP 8.5 (2040-2060)



Spatially variable
From 1.3 to 0.8 more inches

Spatially variable
From 1.6 to 1.1 more inches

Moderately high model agreement: 85%

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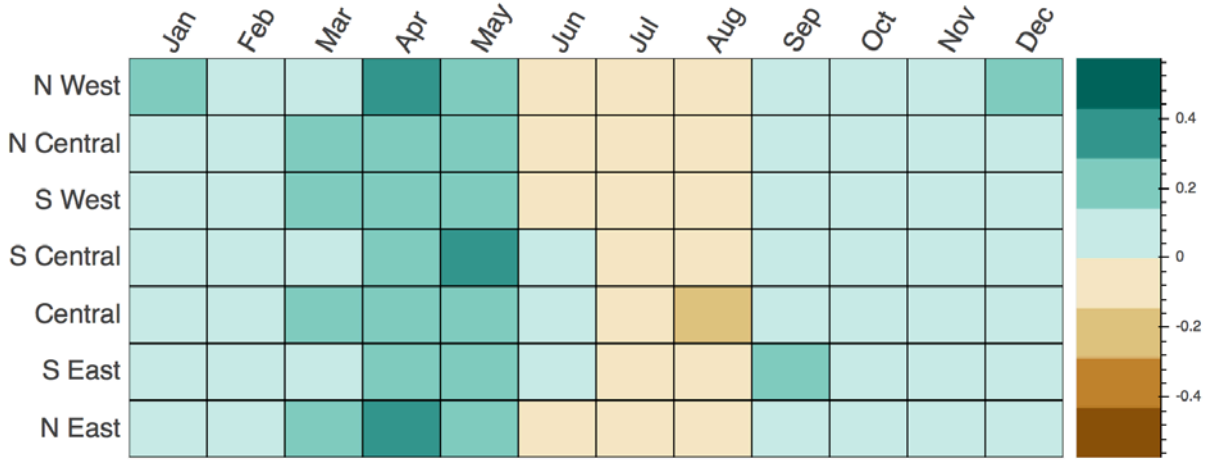
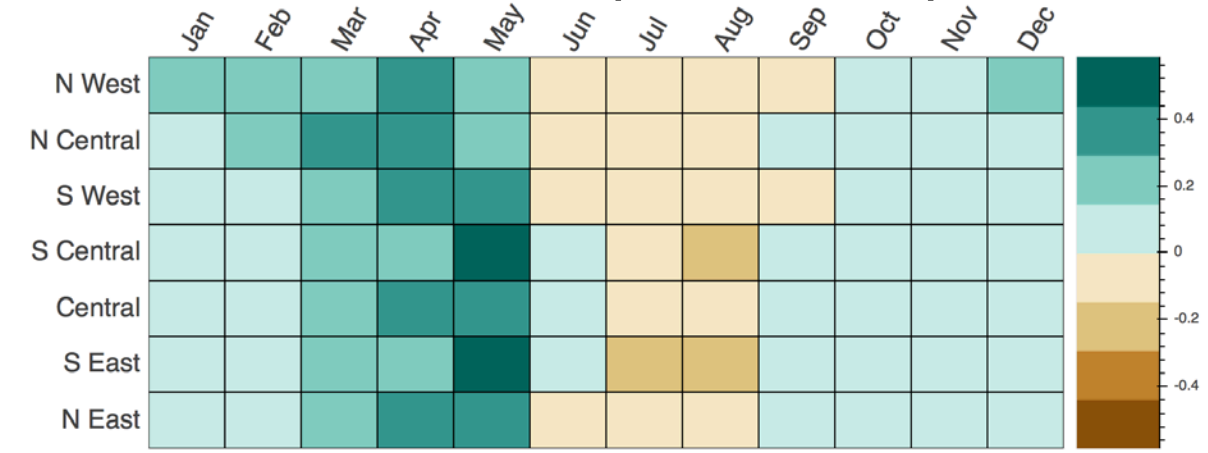
Monthly Precipitation

RCP 4.5 (2040-2060)



Increases in winter, spring, and fall (>85% model agreement)

RCP 8.5 (2040-2060)



Decreases in summer (65% model agreement)

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How is Montana's Climate Changing?

Between 1950-2015:

- Average temperatures have risen 2-3°F. Winter and springs have warmed the most.
- Montana's growing seasons are 12 days longer.
- No changes in annual or seasonal precipitation.

Future:

- Additional warming of 4-6°F by 2050, 9.8°F by 2100.
- Precipitation will increase slightly in winter, spring and fall, and decrease in summer.

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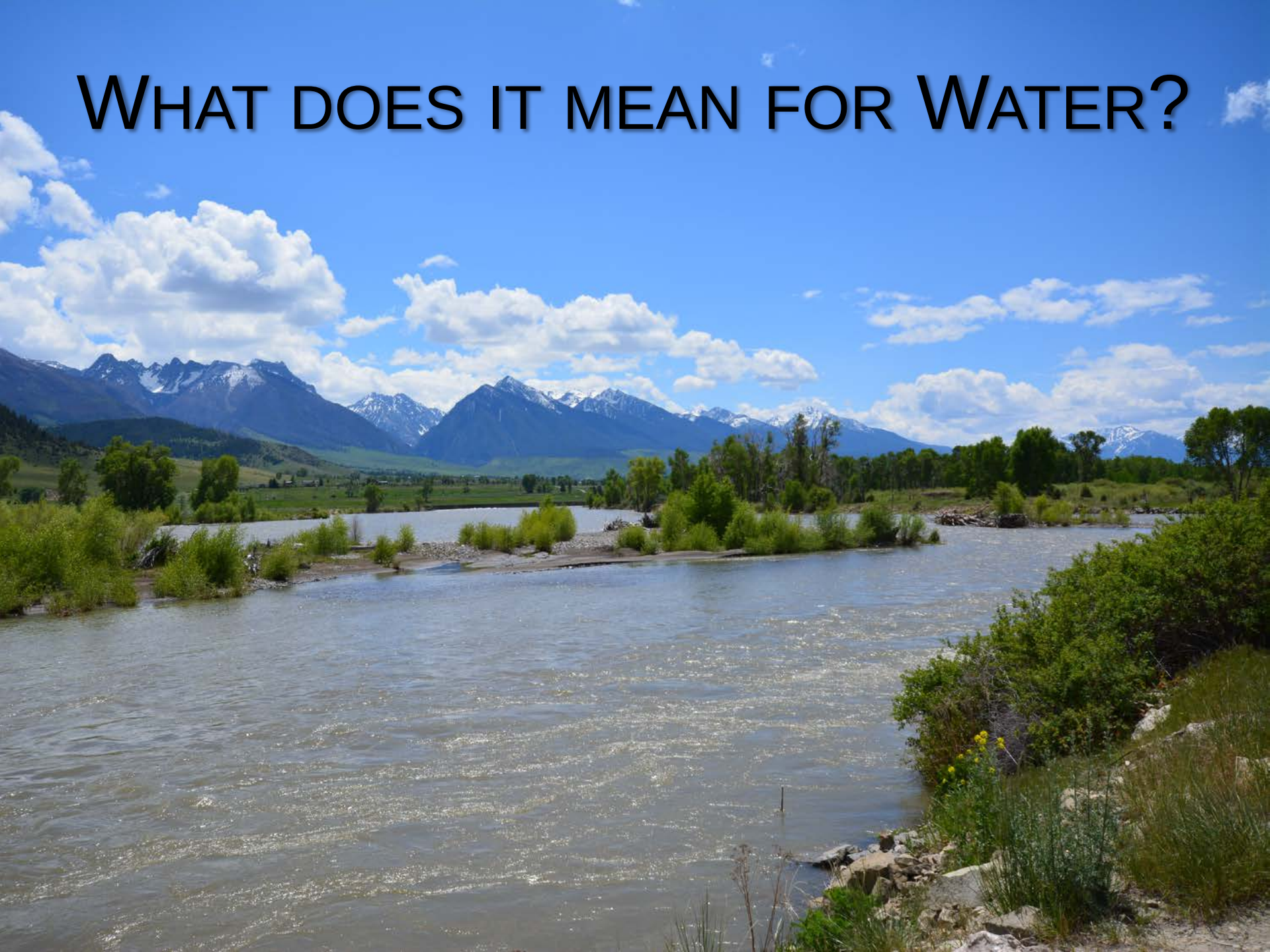
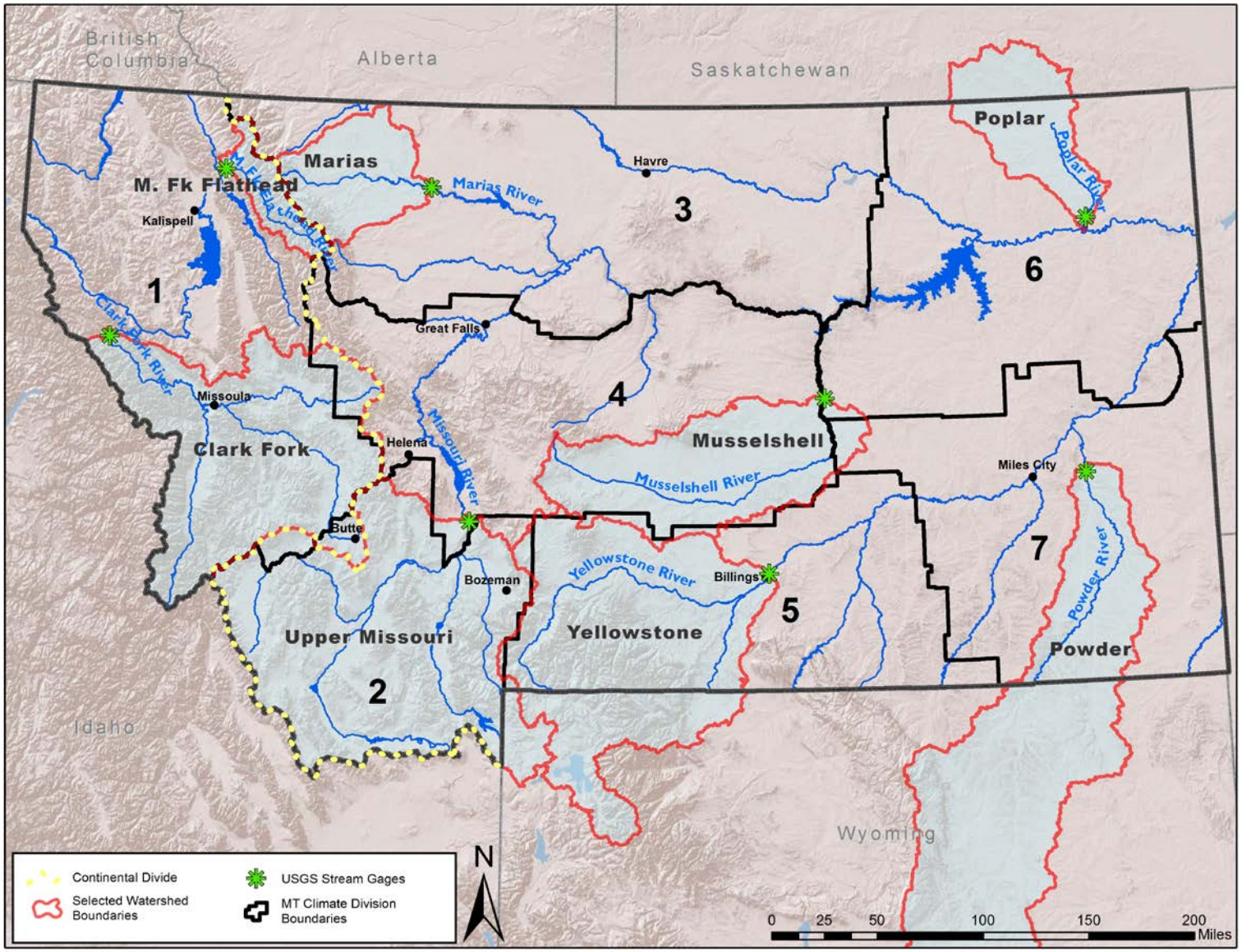
What does it mean for Water?



MONTANA'S FOCAL WATERSHEDS



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Climate & Snowpack

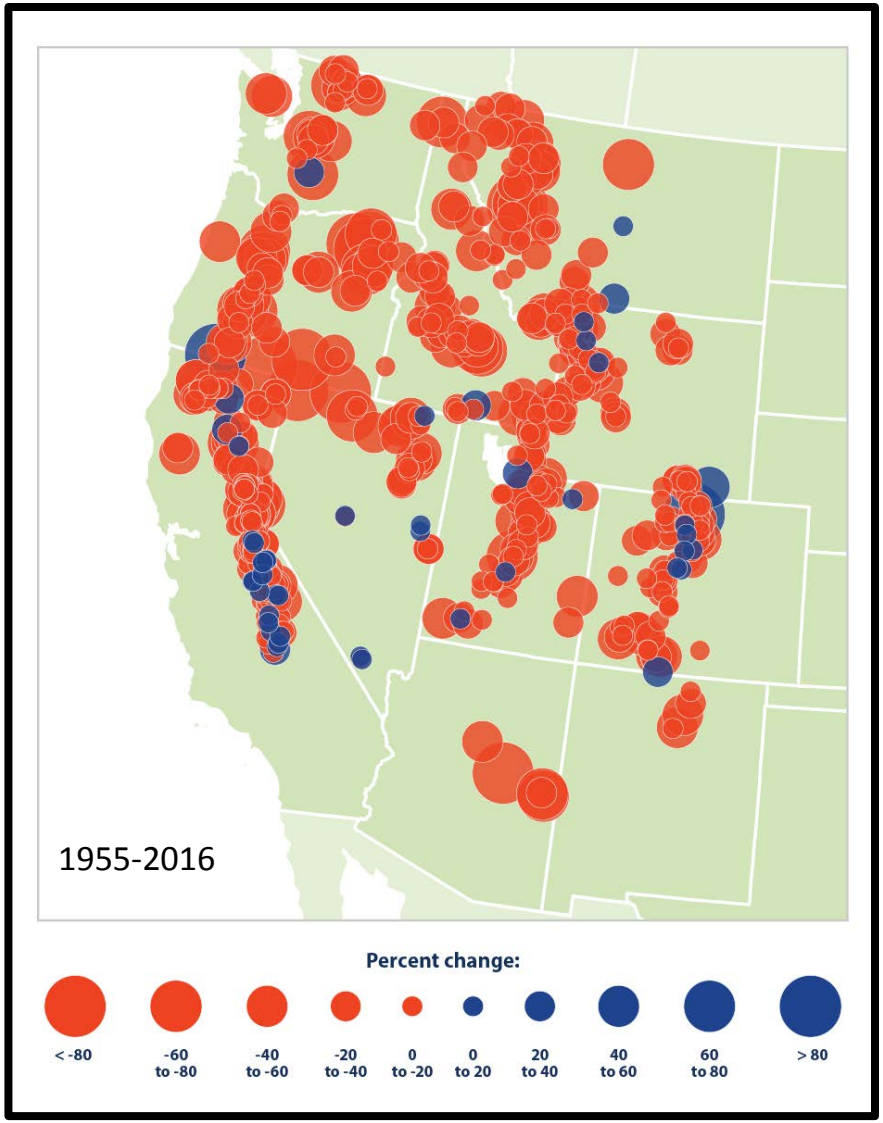
SNOWPACK TRENDS

Red = declining snowpack

Blue = increasing snowpack

Warmer winters = less snowpack

Montana shows 20-70% decline in April 1 SWE



Mote and Sharp 2016

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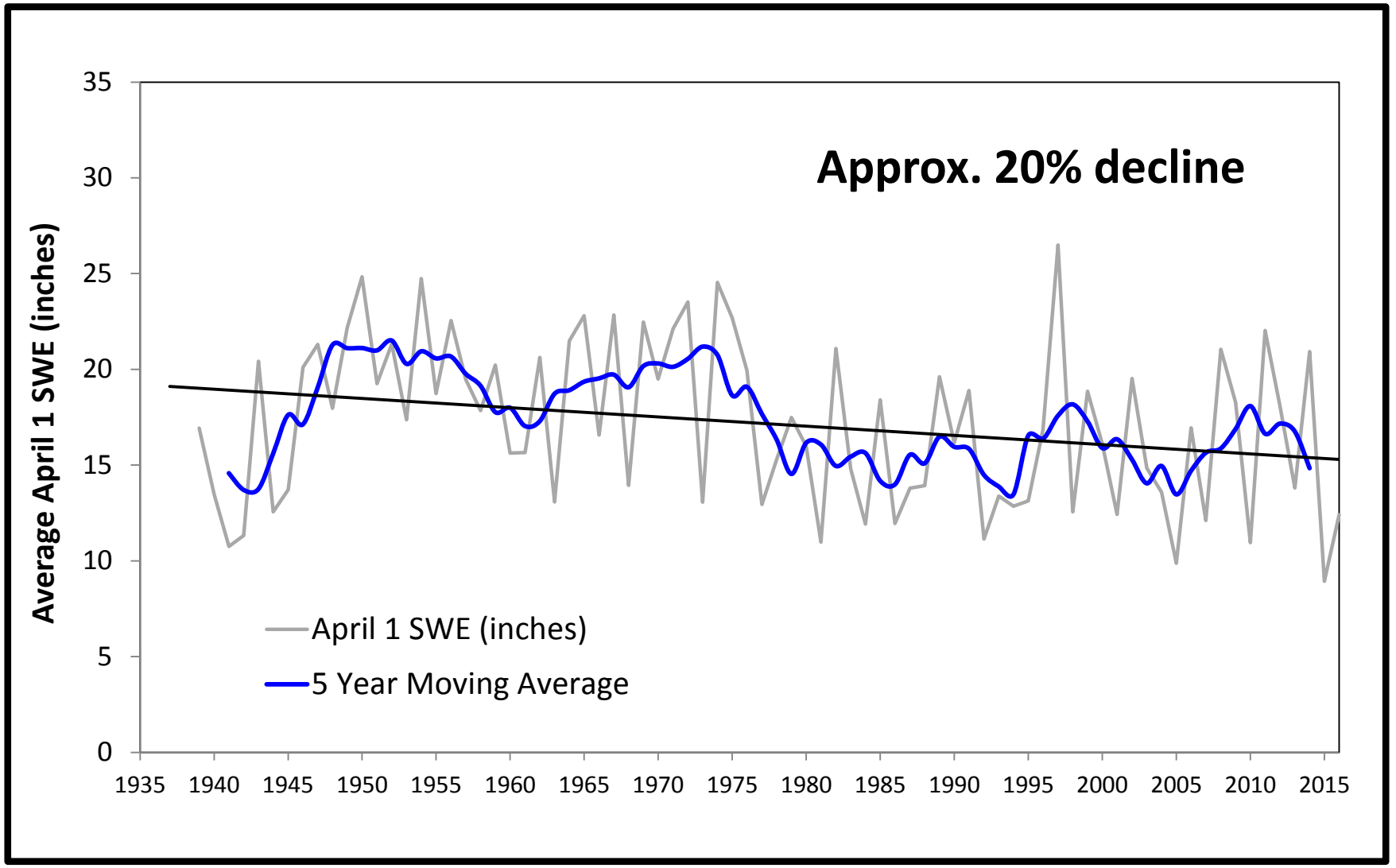
Montana

Snowpack (April 1) West of the Continental Divide



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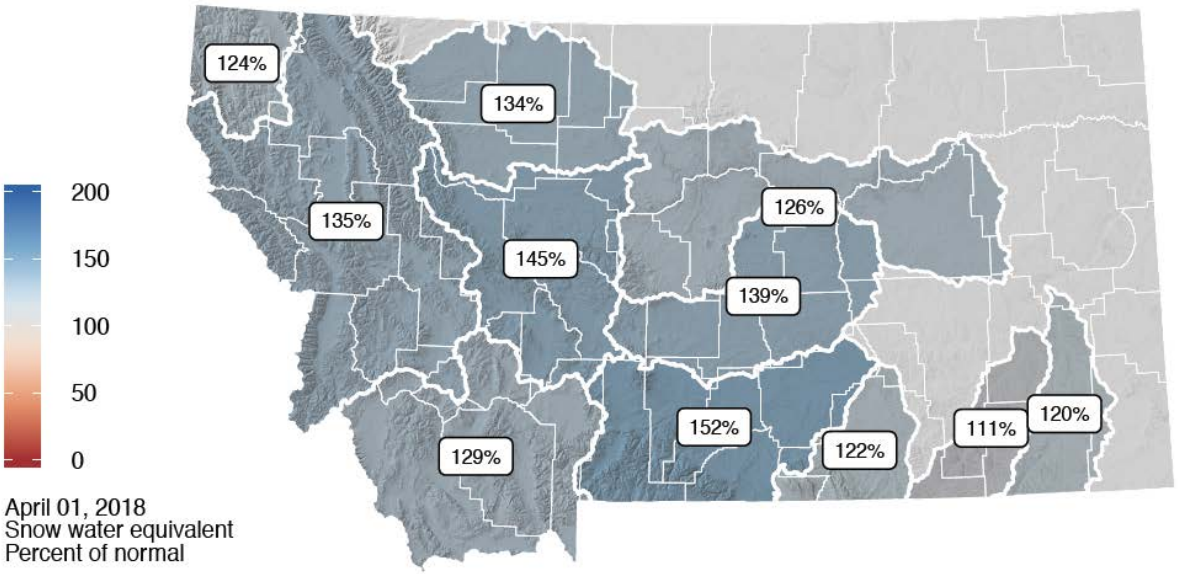
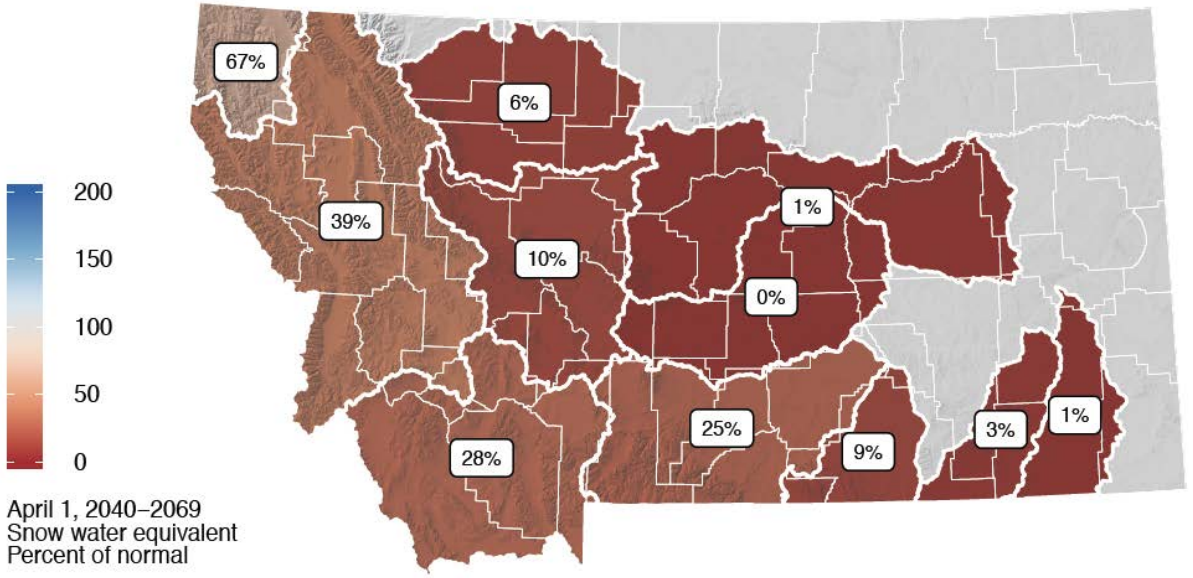
% Change in Snowpack: 2018 & Mid-Century

2018 vs
1981-2010

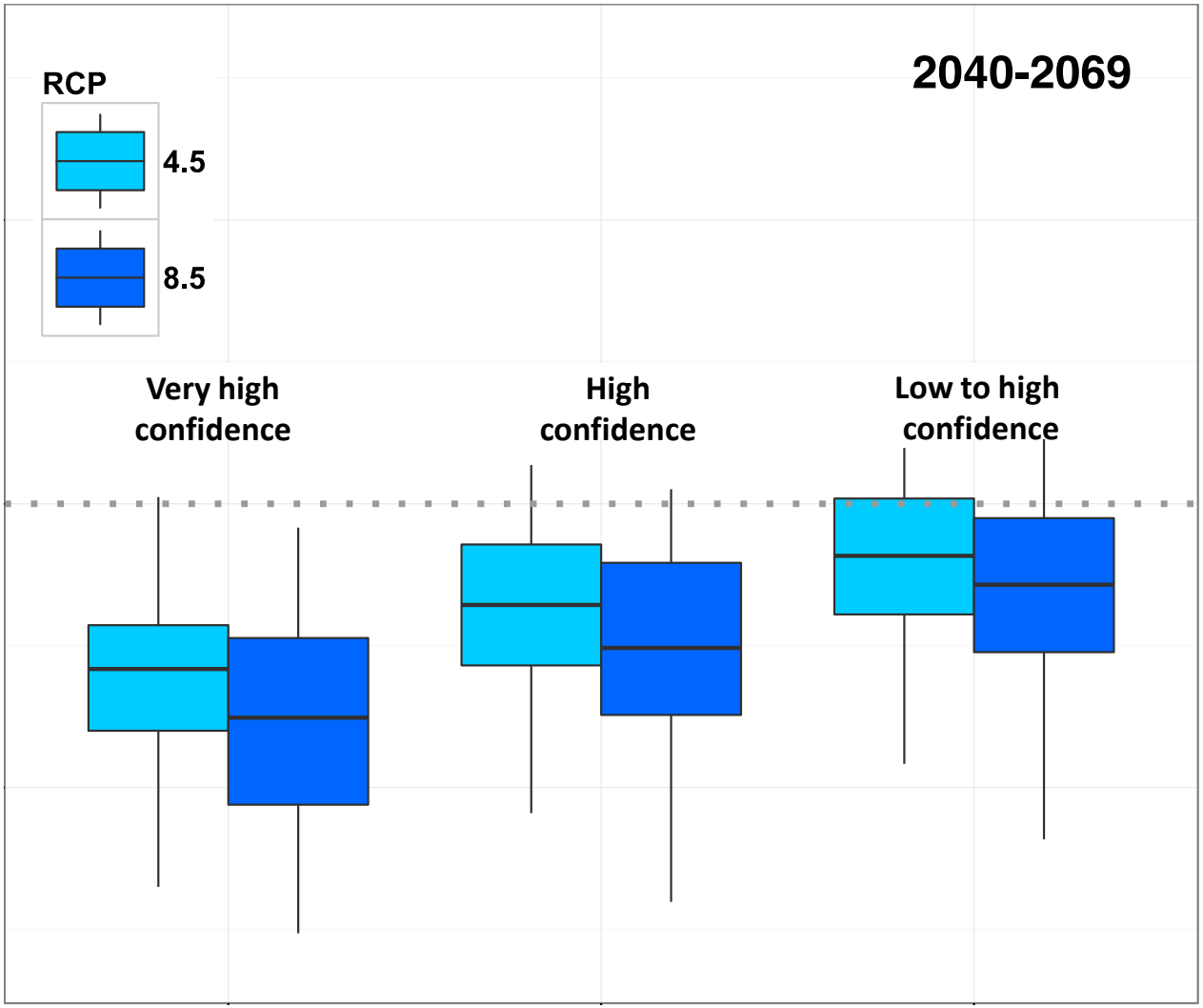


2040-2060 vs
1981-2010



Montana Climate Office

Snowpack Projections



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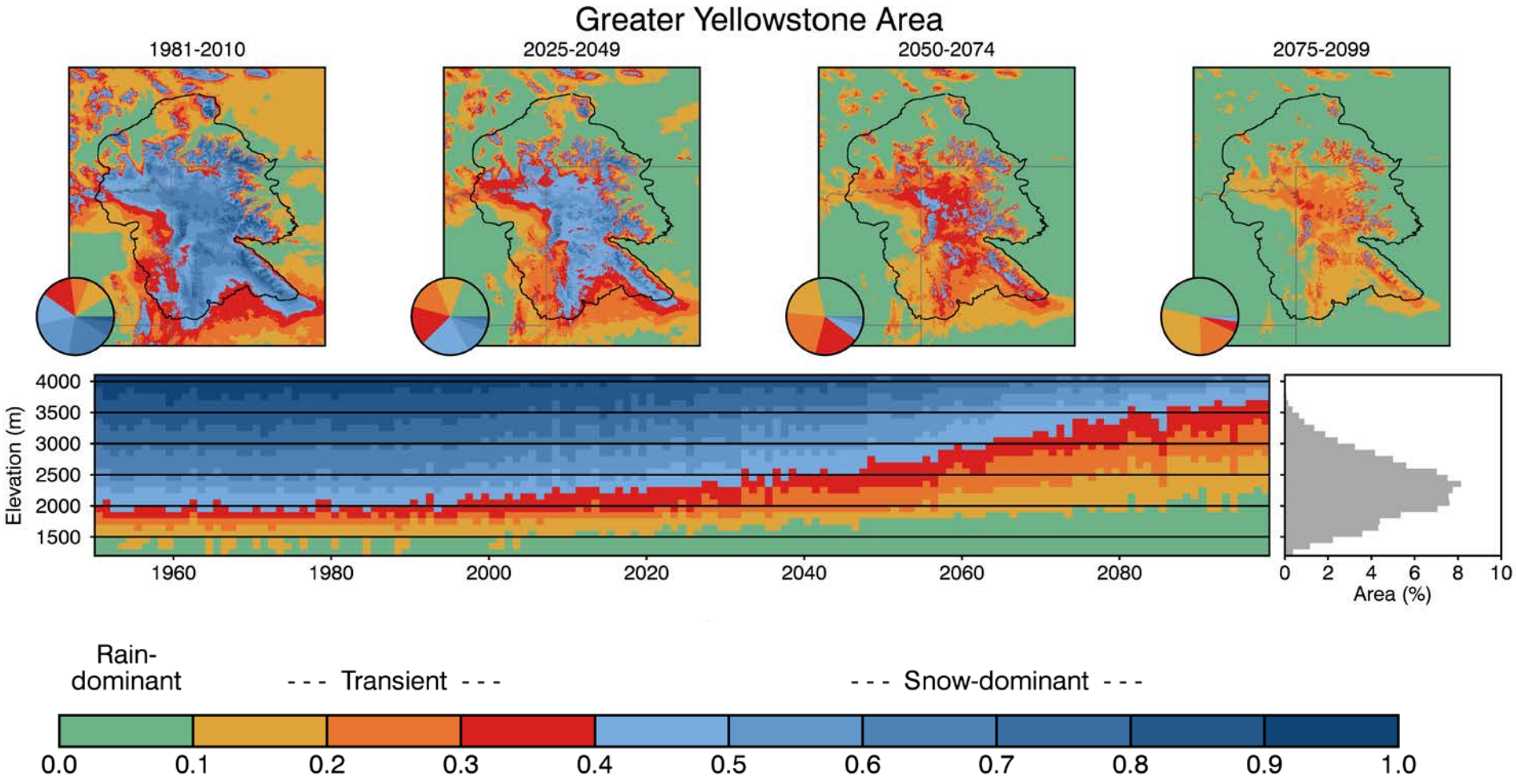
Snow to Rain



Alder & Hostetler, USGS

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Snowpack & Water Supply

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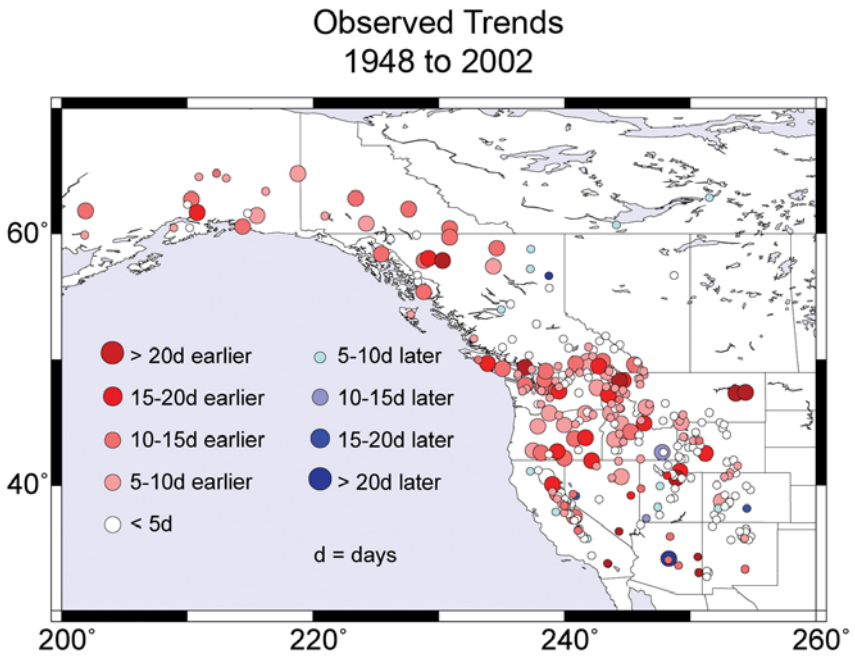
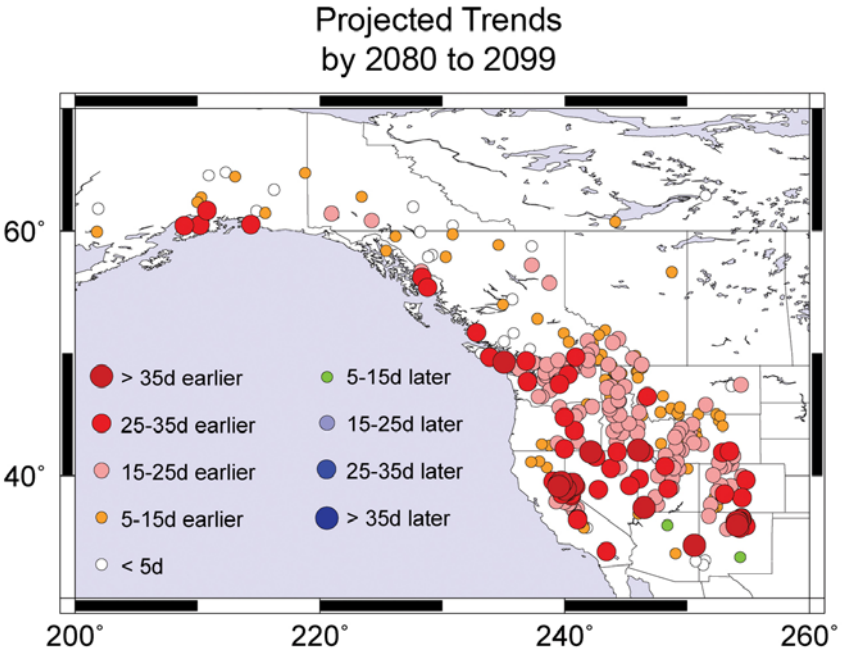
Observed and projected changes in peak runoff across the West

Increased springtime temperatures

Montana peak runoff is now 2-3 weeks earlier

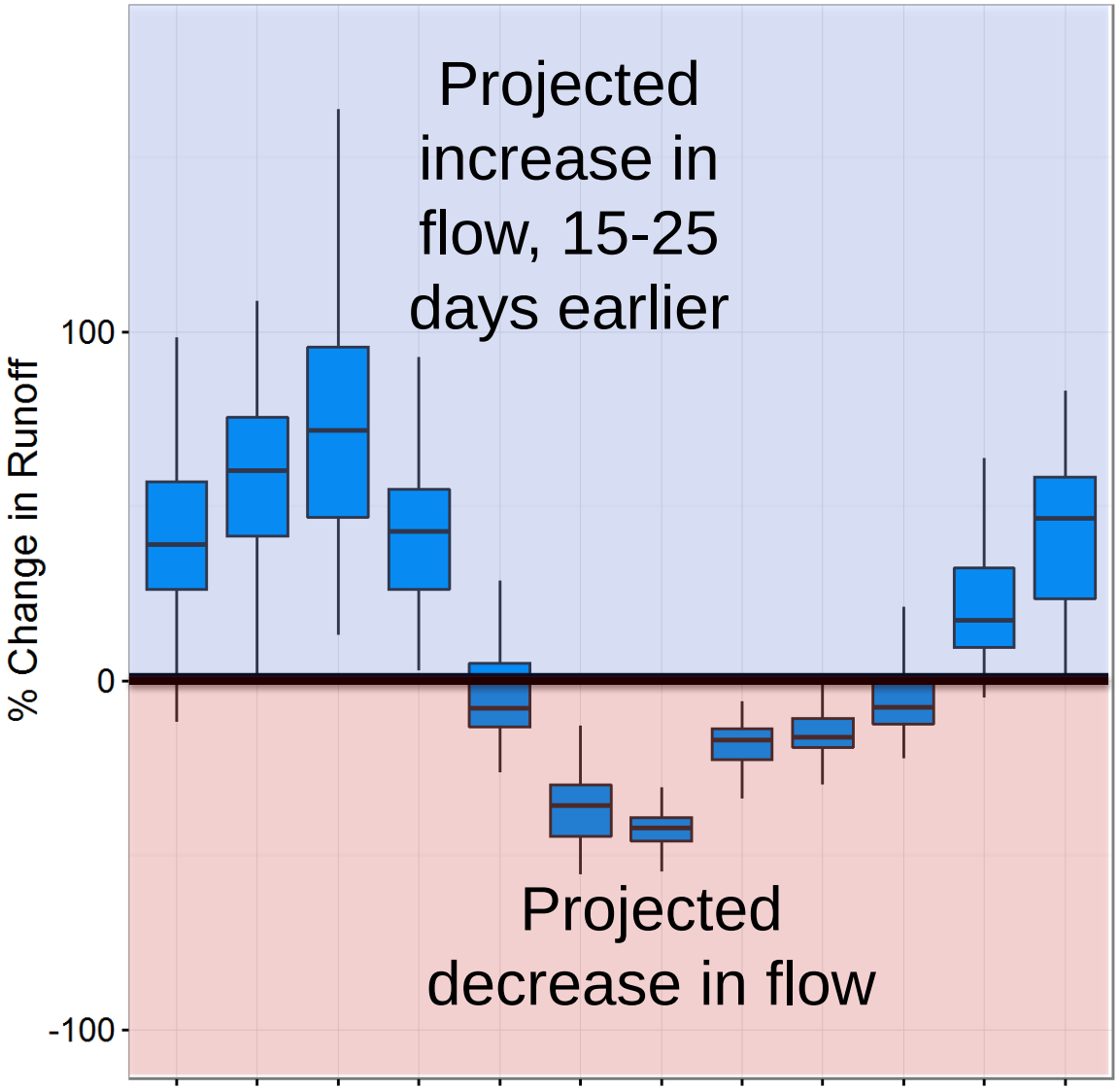




Stewart et al. 2004

Streamflow Projections – Clark Fork

Snowmelt-dominated rivers in the western & north-central Montana



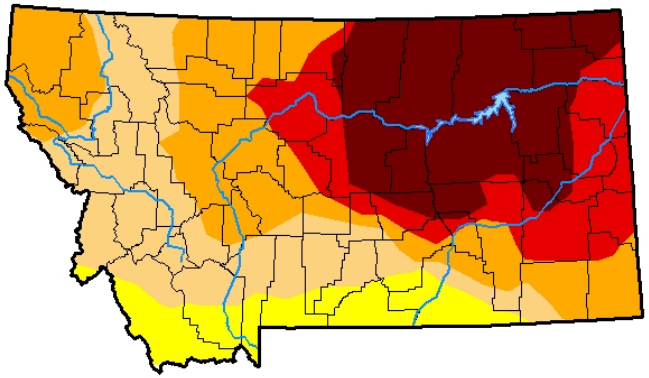
Montana Institute on Ecosystems

Drought

2017 DROUGHT

U.S. Drought Monitor

Montana



August 29, 2017

(Released Thursday, Aug. 31, 2017)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.03	99.97	90.20	66.01	39.42	24.55
Last Week 08-22-2017	2.77	97.23	90.20	59.55	34.34	11.87
3 Months Ago 05-30-2017	67.50	32.50	0.00	0.00	0.00	0.00
Start of Calendar Year 01-03-2017	74.25	25.75	4.87	0.00	0.00	0.00
Start of Water Year 09-27-2016	55.14	44.86	25.49	5.86	0.33	0.00
One Year Ago 08-30-2016	43.00	57.00	24.93	7.60	0.35	0.00

Intensity:

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

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

Author:

Chris Fenimore
NCEI/NESDIS/NOAA

http://droughtmonitor.unl.edu/

MT: $378 million in federal & state funds
1.26 million acres burned

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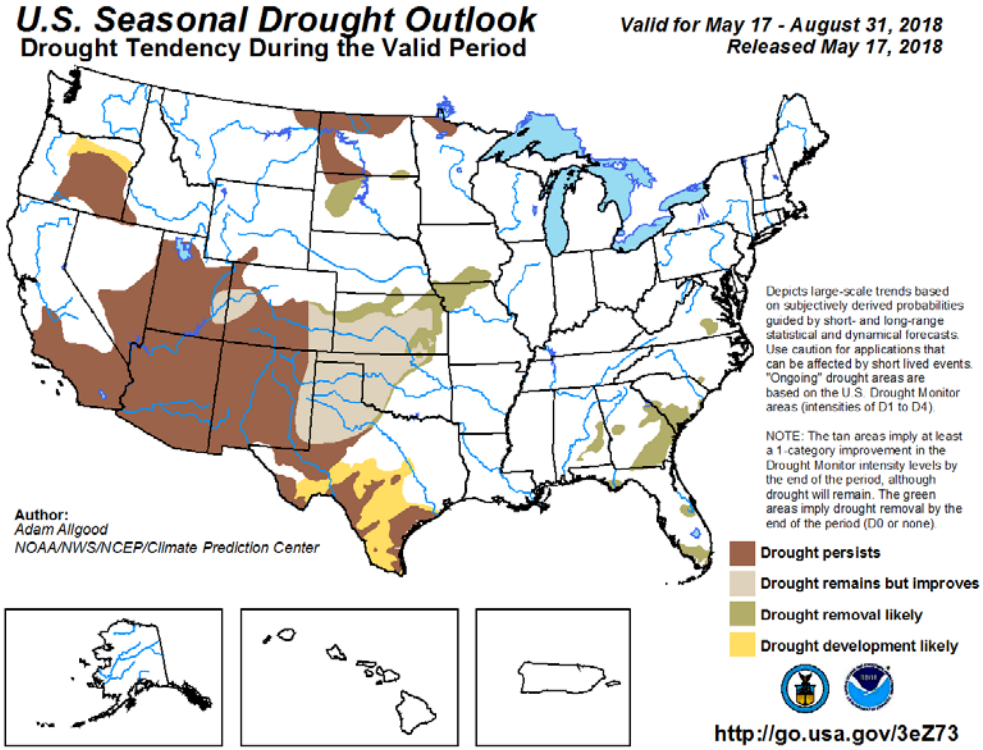
Drought – Summer 2018

Abnormally dry
Moderate drought
Severe drought
Extreme drought
Exceptional drought

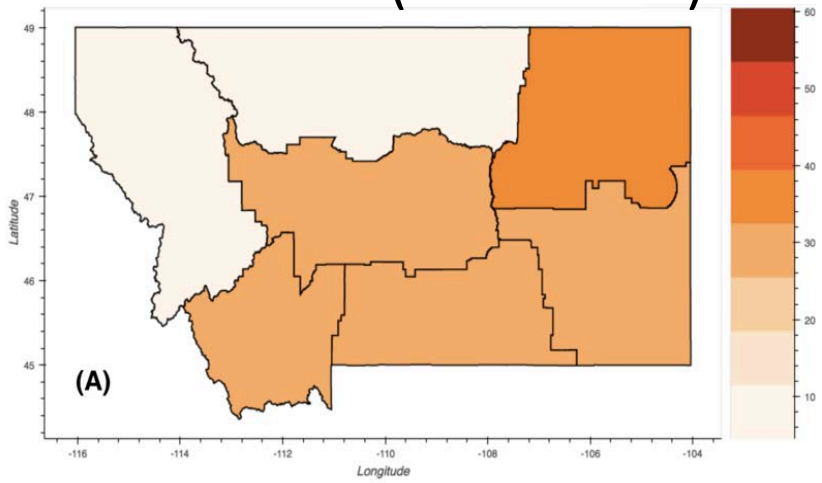
April 03, 2018
Drought intensity



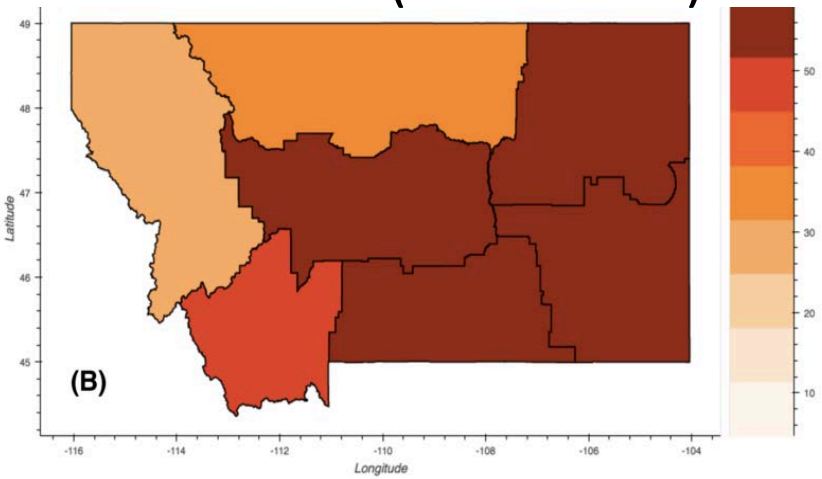
Montana Climate Office

Rising Temperatures exacerbate Drought

RCP 4.5 (2040-2060)



RCP 8.5 (2040-2060)



Increased days >90°F
(up to 35 additional days)

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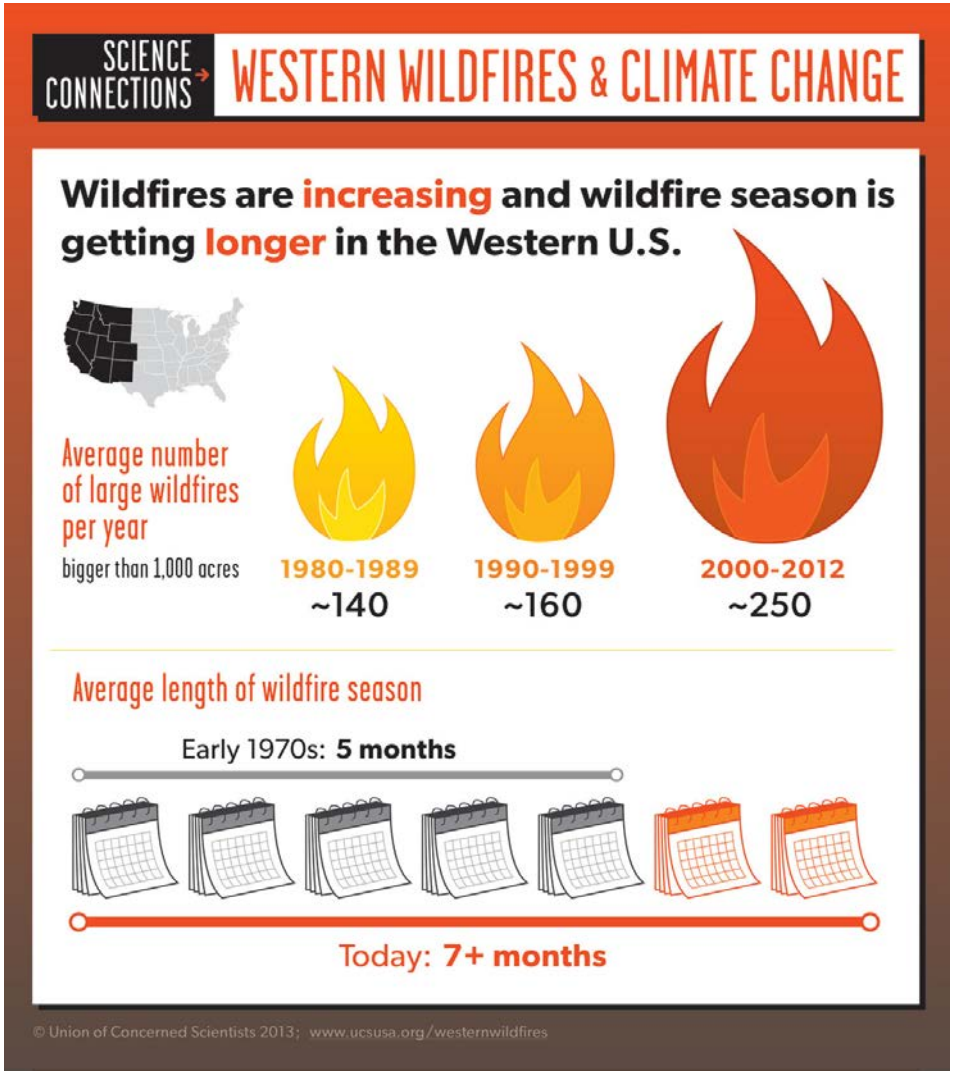
Indirect Effects: Fire

- Fires have increased.
- Fire season is longer.
- Fires will increase (warmer weather & past management policies in some areas)
- Forest carbon is being lost.



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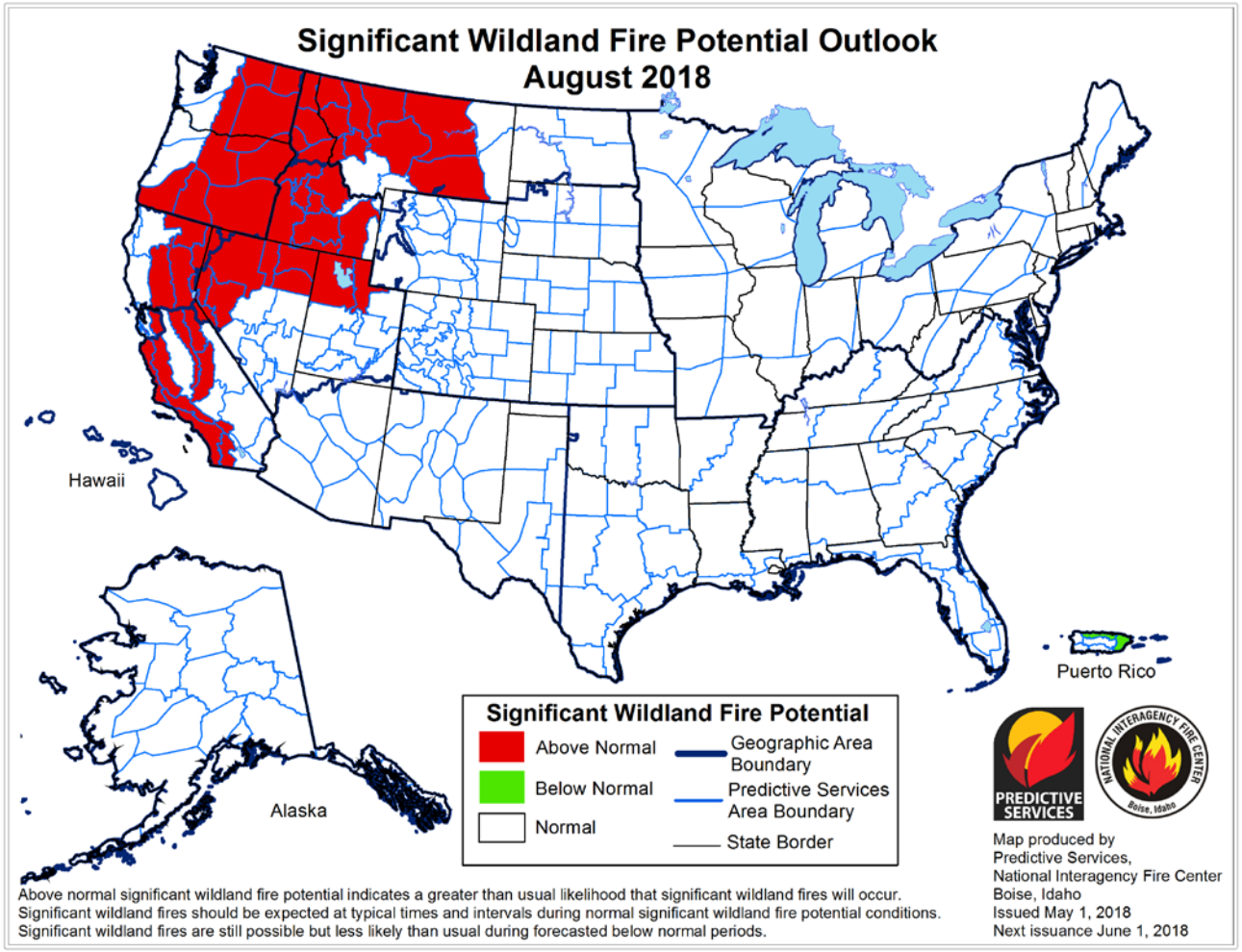
Fire Outlook 2018



Based on expected warmer drier conditions than normal in late summer.

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MCA: Where are we now?

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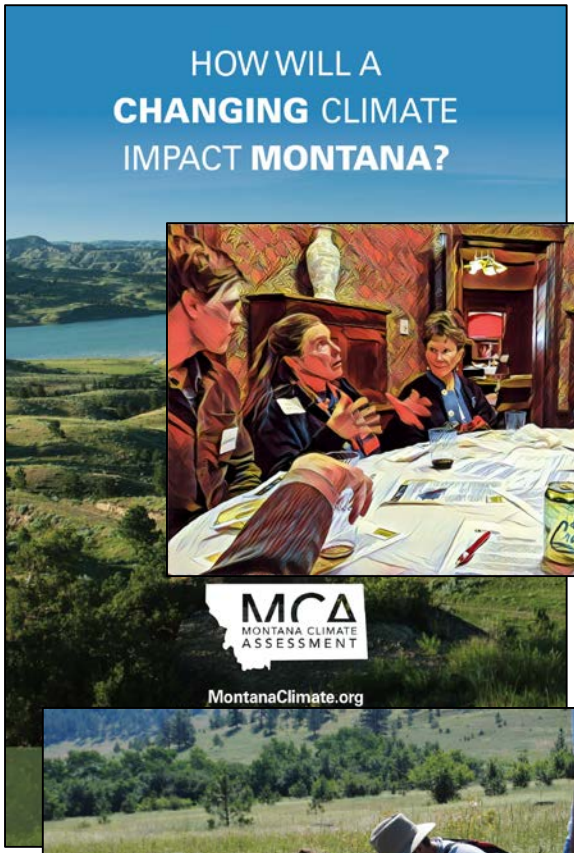
MCA "Road Show"



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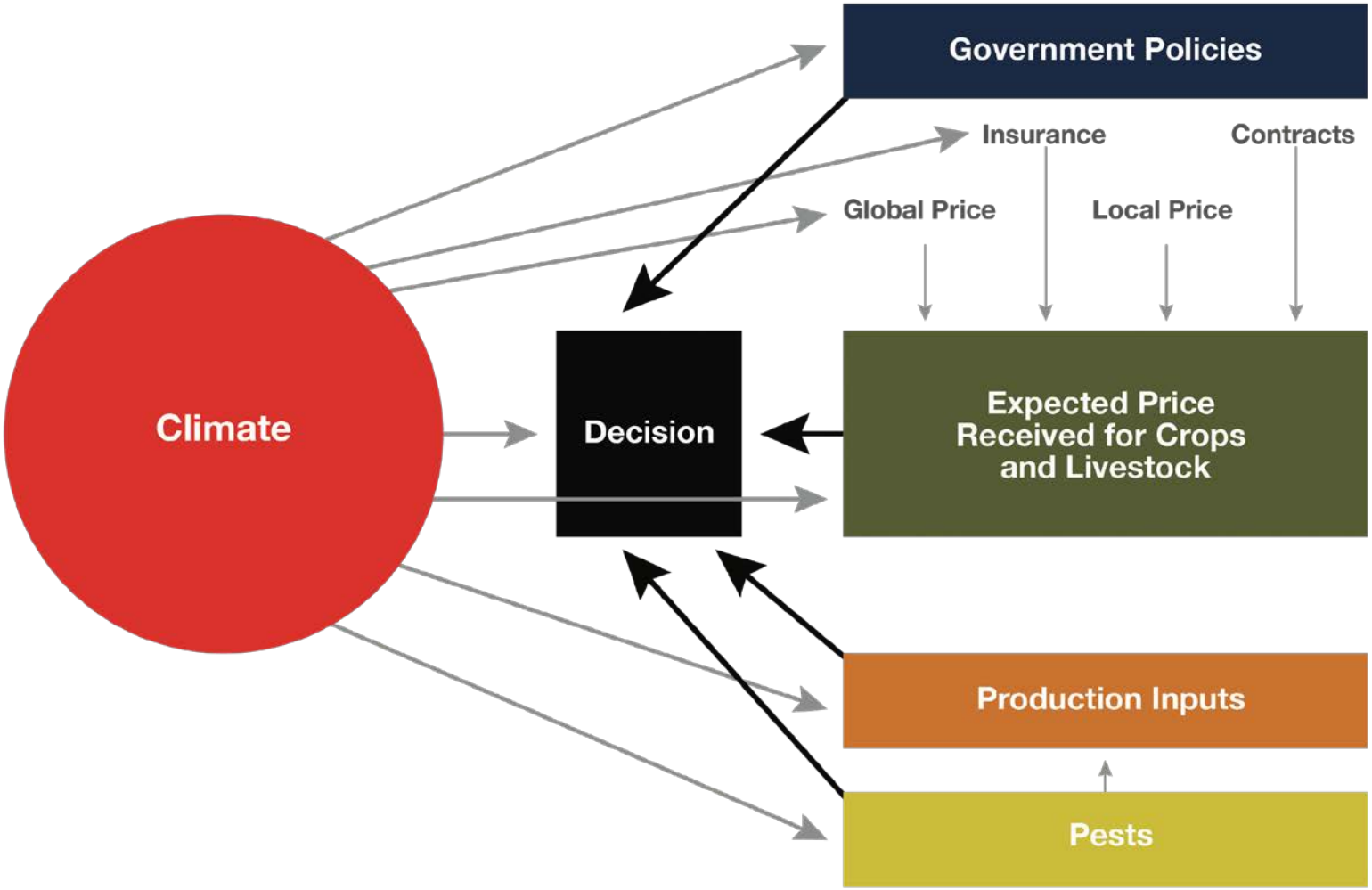
MCA Conversations

- Water & water storage
- Floods & droughts
- Livestock and crop decisions
- Wildfire response
- Economic implications
- Health considerations

What does it mean for Agricultur

Agricultural Decision Making



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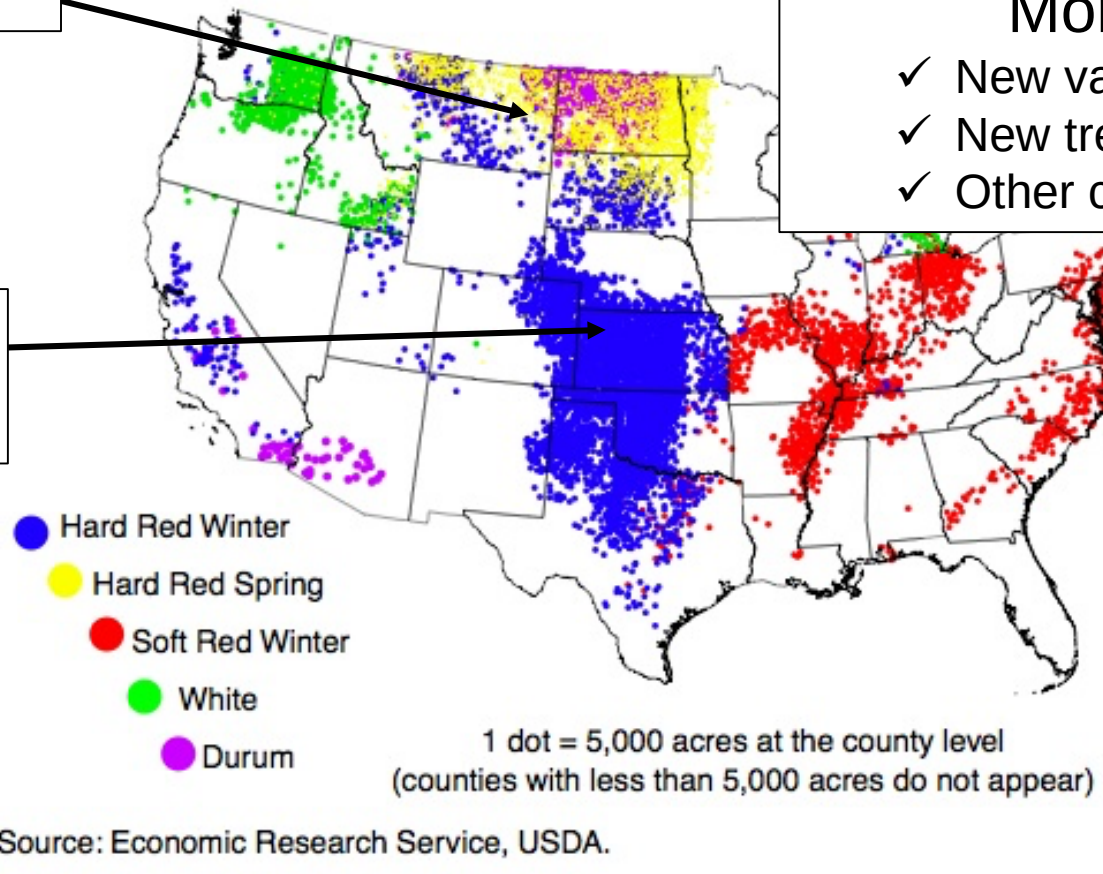
Dryland Agriculture

Summers too hot for spring wheat

Winters too warm for winter wheat



Future of Wheat in Montana?

- ✓ New varieties
- ✓ New treatments
- ✓ Other crops

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Montana Agriculture Projections

- Decreasing snowpack will reduce late-season irrigation capacity (affect hay, sugar beet, malt barley, garden/potato production).
- Longer growing season could enable crop diversity but with greater vulnerability.
- Increase number of days >90^{o}F will impact wheat & stress livestock.
- Winter annual weeds will increase.

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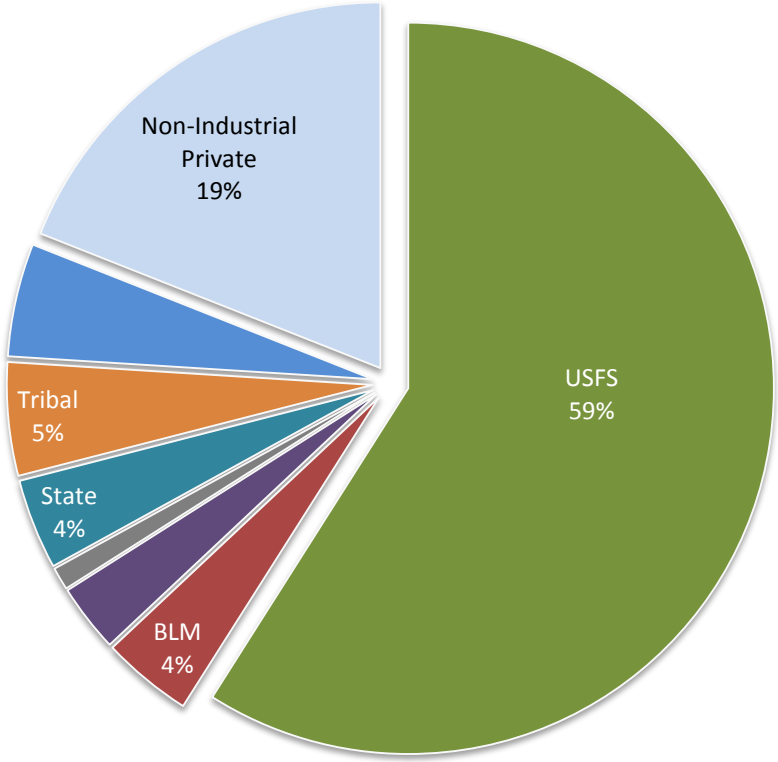
What does it mean for Forests?

photo credit: Philip Higuera, Univ MT

CONTEXT

- Majority on public lands
- Existing forest conditions vary



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Framework for Forest Impacts

- **Direct impacts of climate**
  - Establishment & regeneration
  - Growth and productivity
  - Mortality
  - Range shifts and forest distribution
- **Indirect impacts of climate**
  - Fire
  - Pathogens and insects

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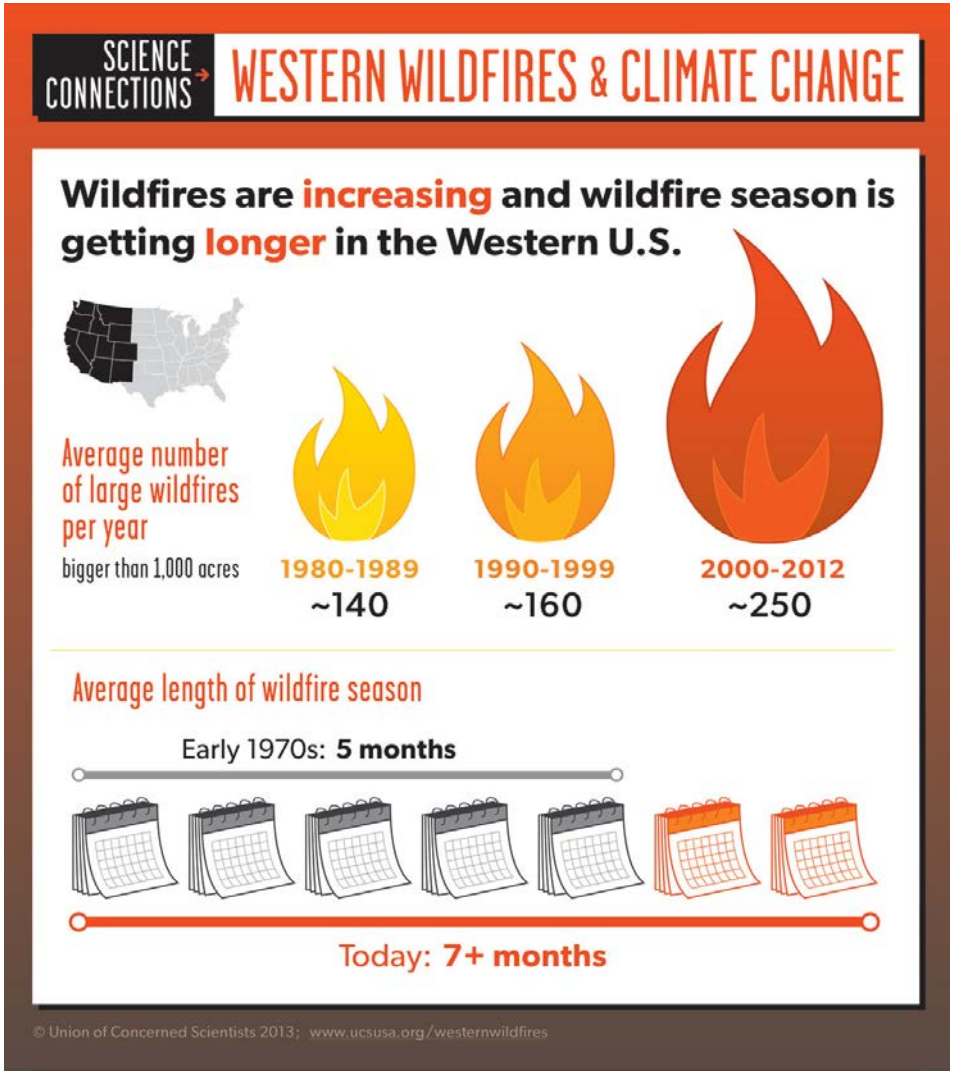
Indirect Effects: Fire

- Fires have increased.
- Fire season is longer.
- Fires will increase (warmer weather & past management policies in some areas)
- Forest carbon is being lost.



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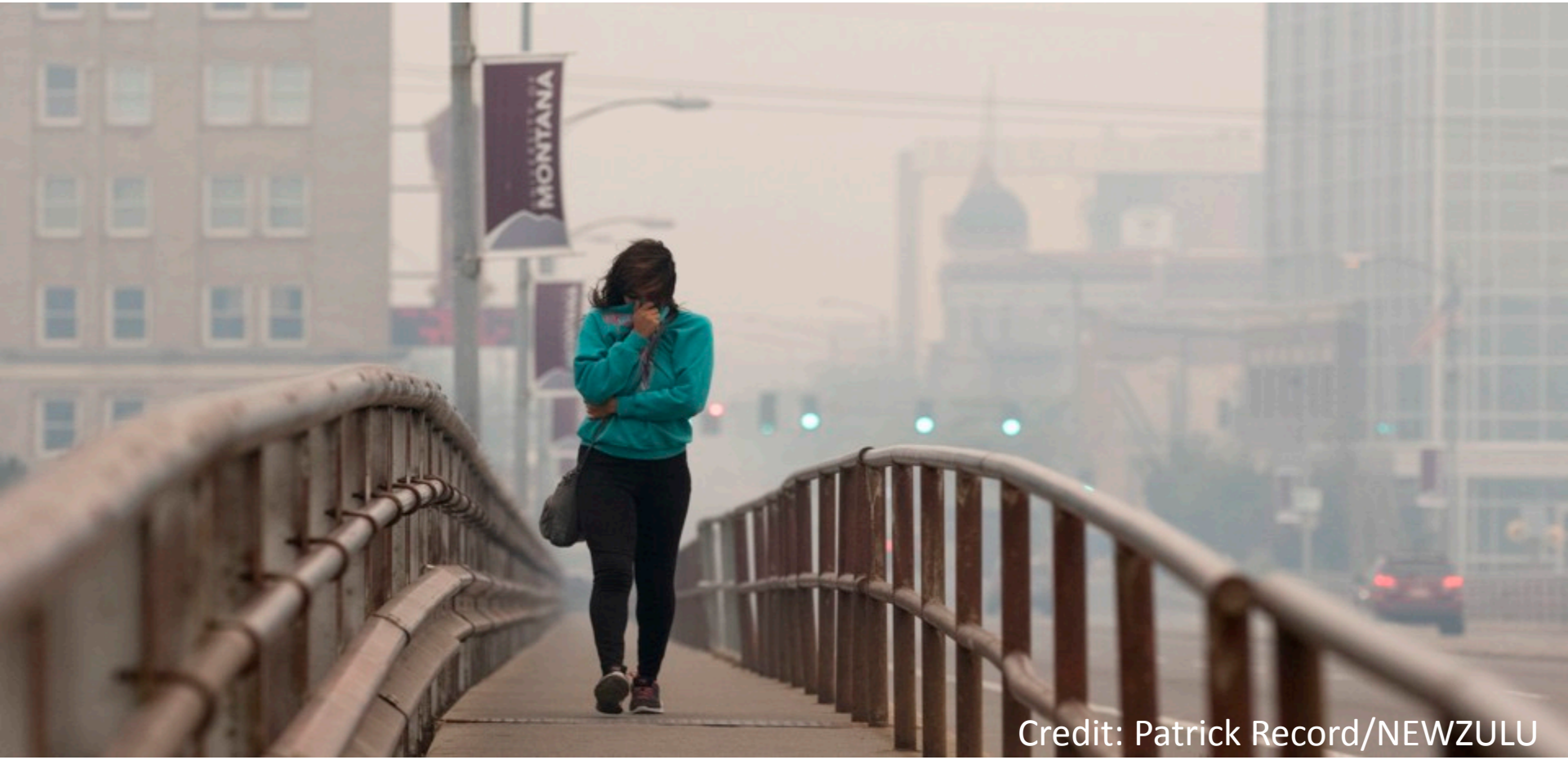
Will Montanans be "Inconvenienced" by Climate Change?



Credit: Patrick Record/NEWZULU

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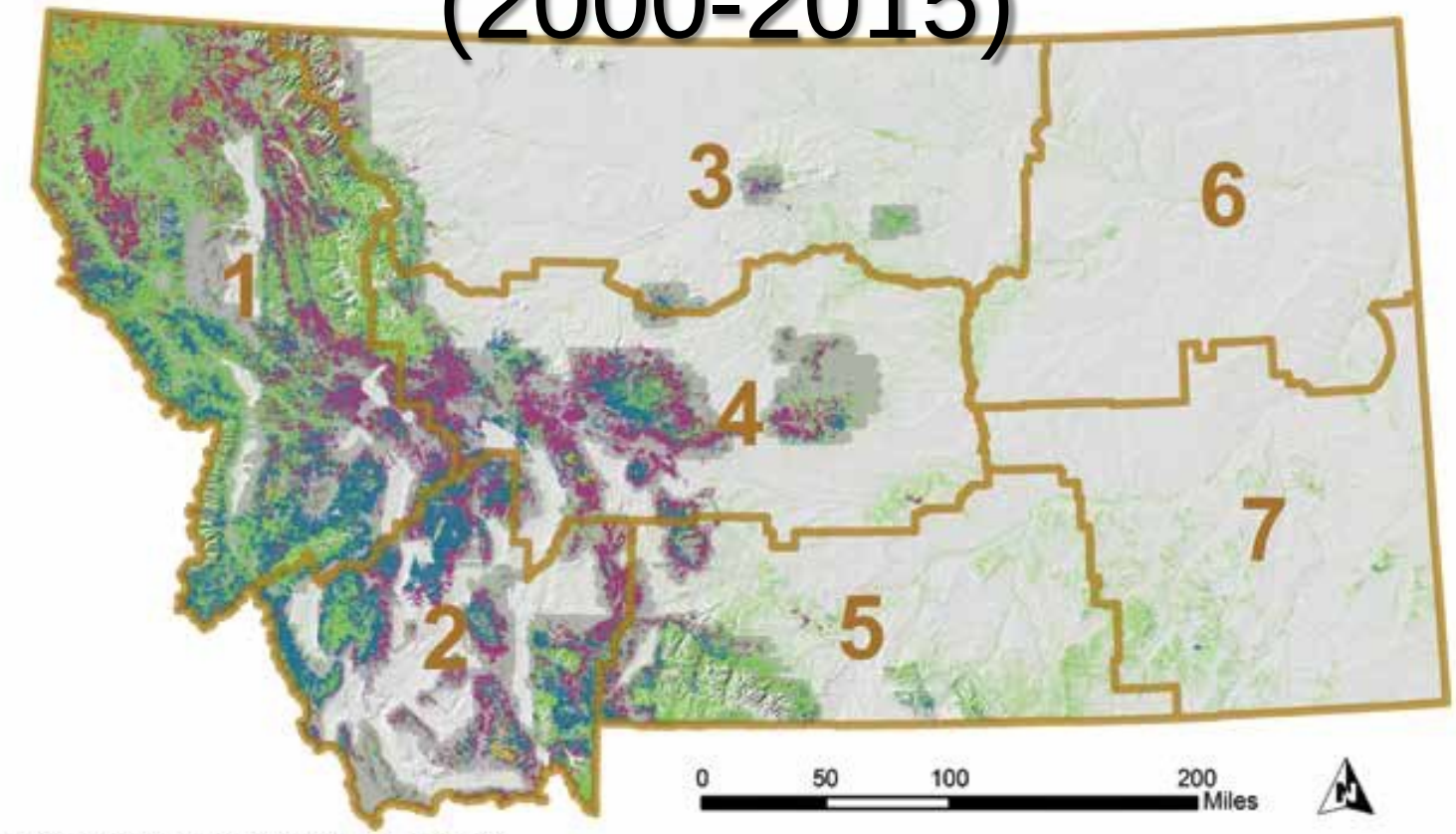
Indirect Effects: Beetle & Pathogens (2000-2015)



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Montana Forest Projections

- Increased temperatures will have negative & positive effects.
- Water availability is key.
- Changes in range distributions
- Altered disturbance regimes
  - Increased fire size, frequency, severity
  - More disturbance from forest insects
- Carbon storage projections are unclear