The Montana Water Summit – Water in a Changing West

Water and Climate in Montana

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Special Acknowledgements to:
Collaborators at UM and MSU:
B. Chaffin, S. Ewing, P. Gardner, Z. Holden, K. Jencso, J. Kimball, B. Maxwell, N. Silverman
Collaborators at DNRC:
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Students: W. Cook, M. He, P. Wurster

Supporting agencies:

- Climate provides key physical constraints to regional water supply and demand
- Ecological and economic systems adjust to find equilibrium under given climatic conditions
- Water demand is a very local phenomenon, water is needed at a very specific place and time

MCA Partners

MONTANA STATE UNIVERSITY

MONTANA STATE UNIVERSITY EXTENSION

UNIVERSITY OF MONTANA

NATIONAL SCIENCE FOUNDATION

MONTANA INSTITUTE ECOSYSTEMS

MONTANA University System WATER CENTER

Montana Climate Office

MONTANA NSF EPSCoR

USDA United States Department of Agriculture CLIMATE HUBS

U.S. National Climate Assessment

1MT ONEMONTANA

NORTH CENTRAL CLIMATE SCIENCE CENTER UNIVERSITY CONSORTIUM

MADISON RIVER GROUP science.knowledge.action

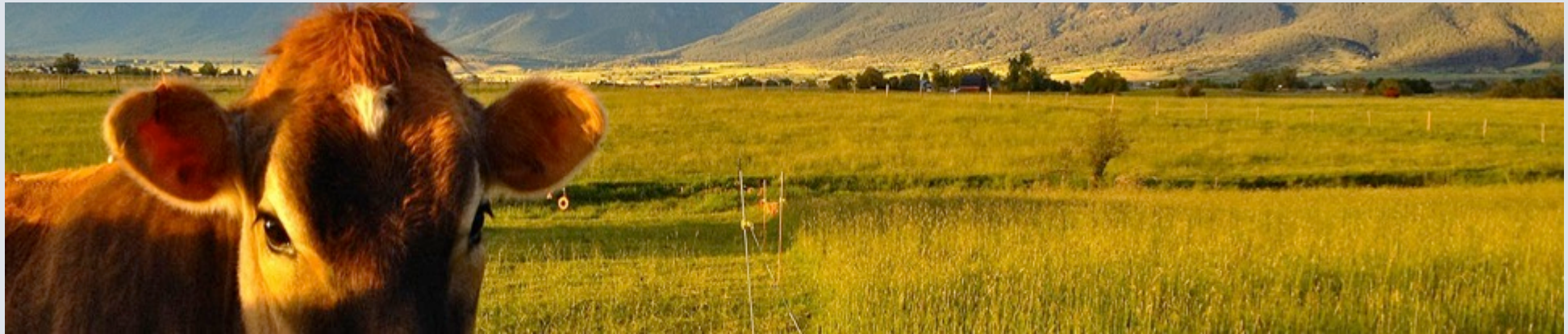
MBMG Montana Bureau of Mines and Geology Science and Service

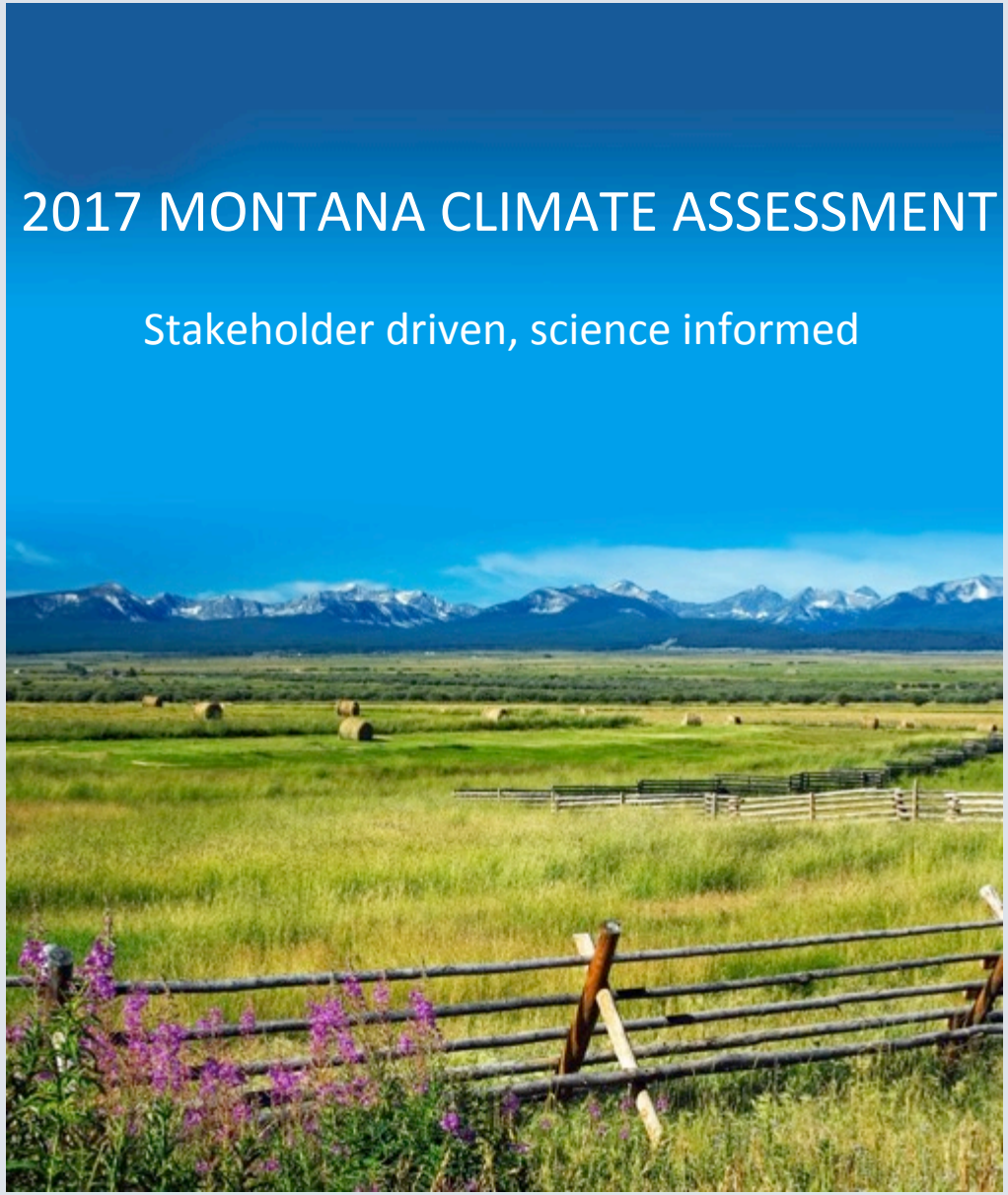
Union of Concerned Scientists Science for a healthy planet and safer world

MCA driven by outreach to ~900 citizens of Montana to determine:

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

Stakeholder responses informed the MCA strategy





Cathy Whitlock, Lead Author
IoE past MSU Director

Climate:
Kelsey Jencso and Nick Silverman (UM)

Agriculture:
Bruce Maxwell, Becky Weed, and others (MSU)

Forestry:
Ashley Ballantyne, Alisa Wade, and others (UM)

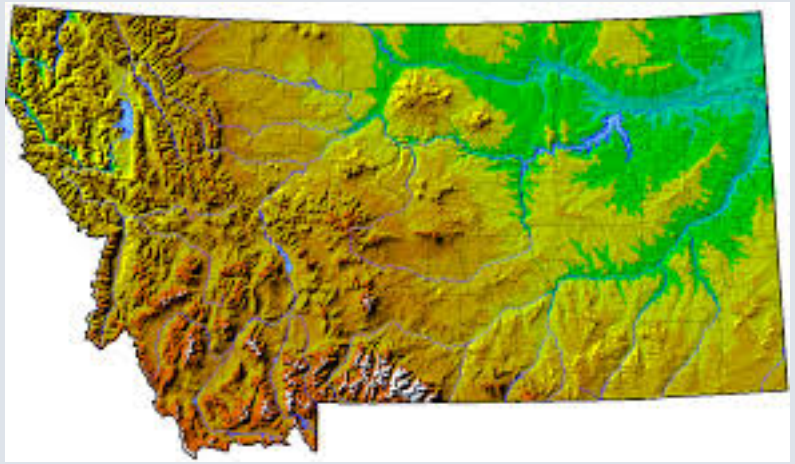
Water:
Wyatt Cross and others (MSU, MT Tech)

www.montanaclimate.org

Released

September 20, 2017

Montana's physiography induces longitudinal climatic gradients



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Air Temperature Statistics in Montana, °F

Montana climate division	Annual	Winter (avg / avg minimum)	Spring	Summer (avg / avg maximum)	Fall
Northwestern	40.6	23.7 / 16.5	39.4	58.5 / 72.0	40.6
Southwestern	38.9	21.2 / 12.4	37.3	57.5 / 71.5	39.4
North central	42.8	21.8 / 10.9	42.1	63.8 / 78.3	43.1
Central	43.3	24.8 / 14.6	41.8	62.7 / 77.1	43.5
South central	44.0	24.6 / 14.2	42.5	64.3 / 78.8	44.2
Northeastern	43.4	18.3 / 7.9	43.3	67.4 / 81.6	44.0
Southeastern	45.5	22.8 / 11.7	44.6	68.6 / 83.2	45.8

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Whitlock et al. 2017 Montana Climate Assessment

Precipitation Statistics in Montana, inches (cm)

Montana climate division	Annual	Winter (avg / avg minimum)	Spring	Summer (avg / avg maximum)	Fall
Northwestern	32.4 (82.2)	9.4 (23.9)	8.9 (22.6)	6.1 (15.5)	8.1 (20.6)
Southwestern	21.2 (53.8)	4.1 (10.4)	7.1 (18.0)	5.5 (14.0)	4.6 (11.7)
North central	15.1 (38.4)	1.9 (4.8)	4.6 (11.7)	5.5 (14.0)	3.1 (7.9)
Central	17.6 (44.7)	2.4 (6.1)	5.8 (14.7)	5.9 (15.0)	3.5 (8.9)
South central	18.4 (46.7)	2.7 (6.9)	6.4 (16.3)	5.2 (13.2)	4.2 (10.7)
Northeastern	12.8 (32.5)	1.0 (2.5)	3.7 (9.4)	5.7 (14.5)	2.4 (6.1)
Southeastern	13.8 (35.1)	1.2 (3.0)	4.6 (11.7)	5.1 (13.0)	2.9 (7.4)

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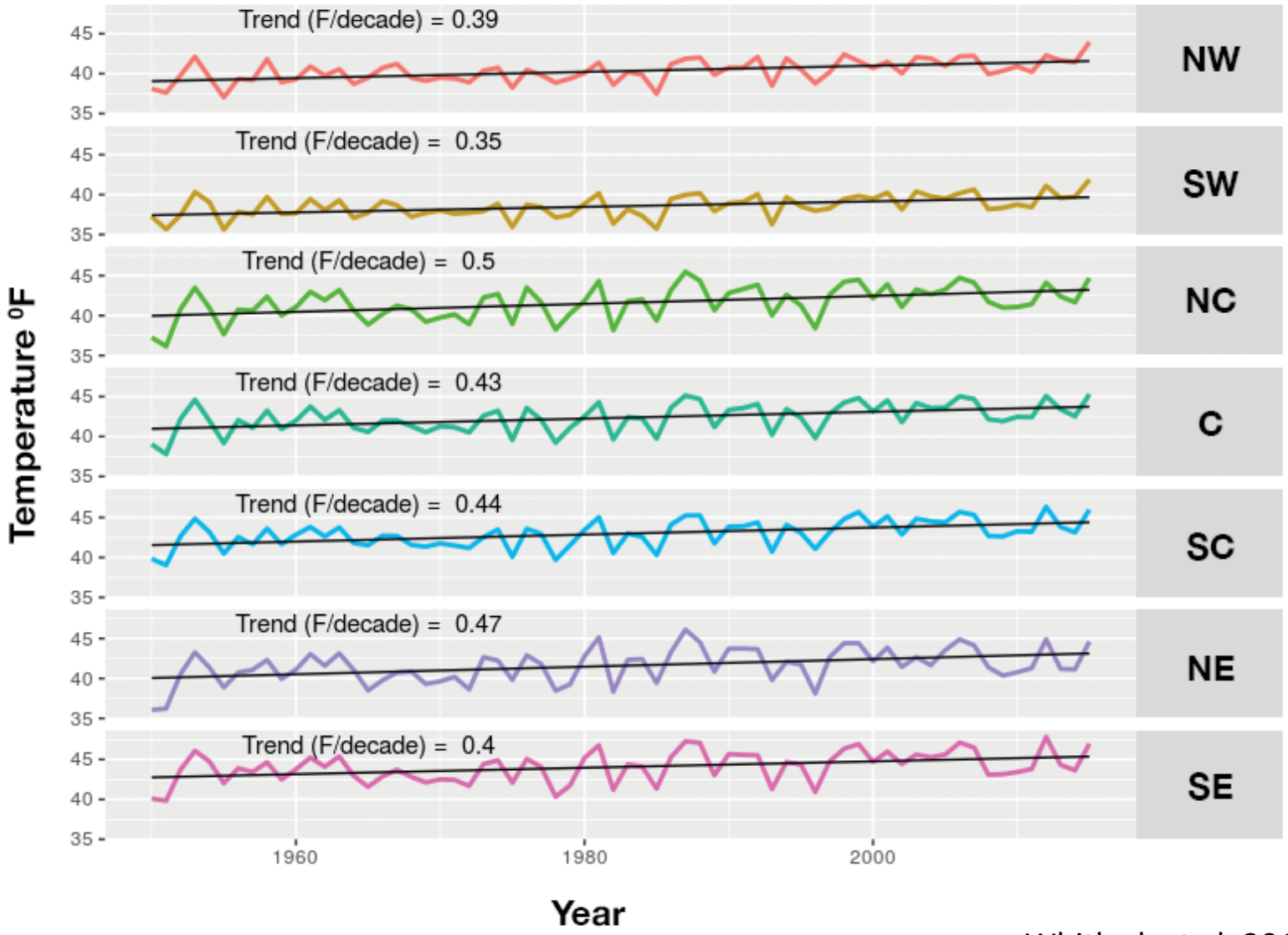
MT Climate Division Temperature Trends from 1950–2015



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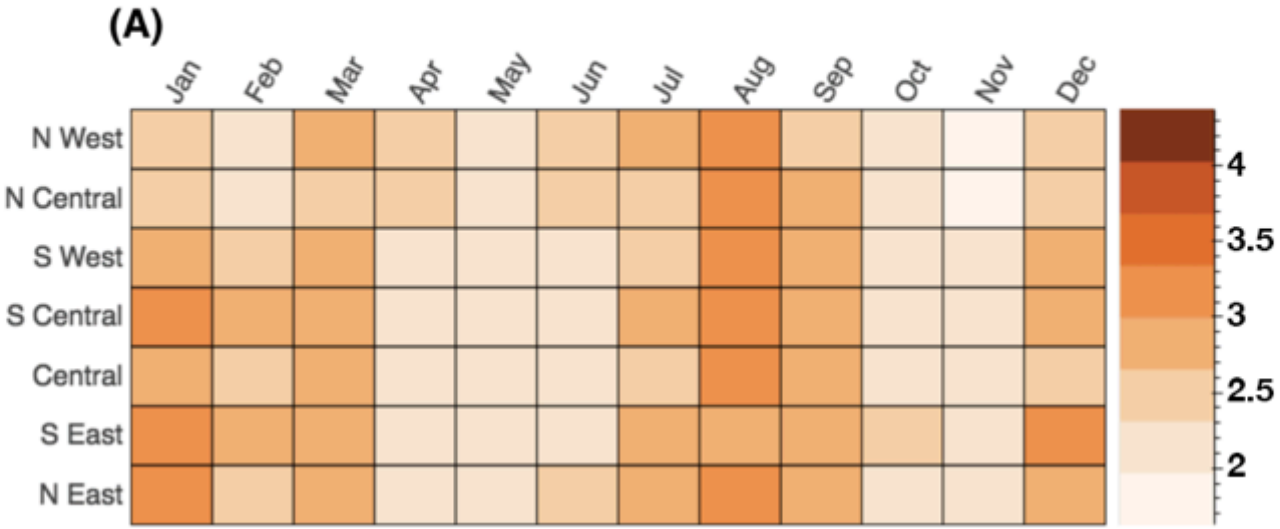
Monthly Change in Average Temperature RCP 4.5 (2040–2069)



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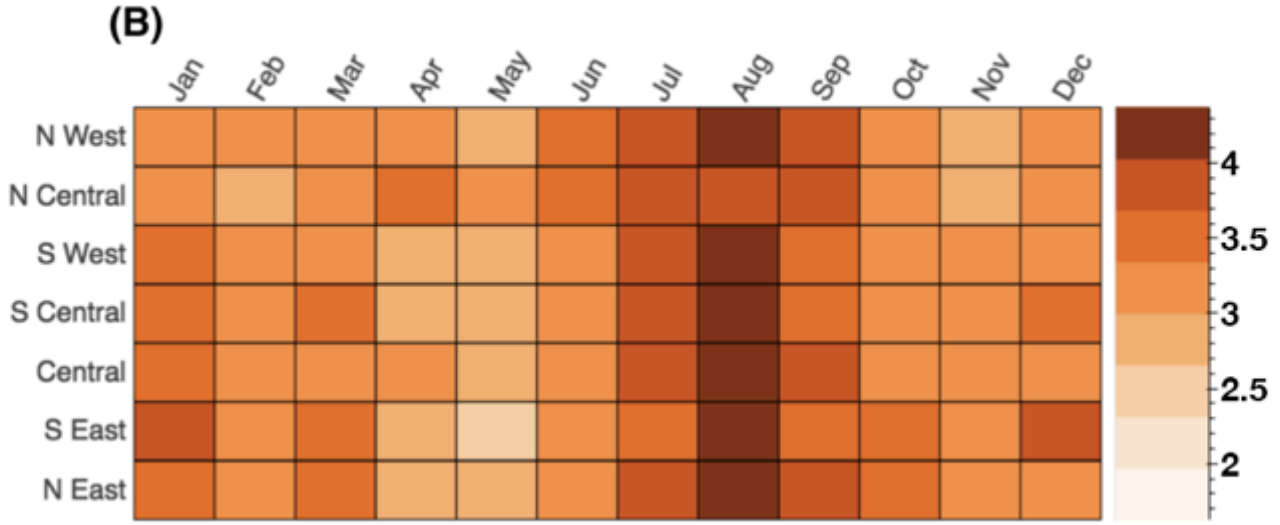

Whitlock et al. 2017 Montana Climate Assessment

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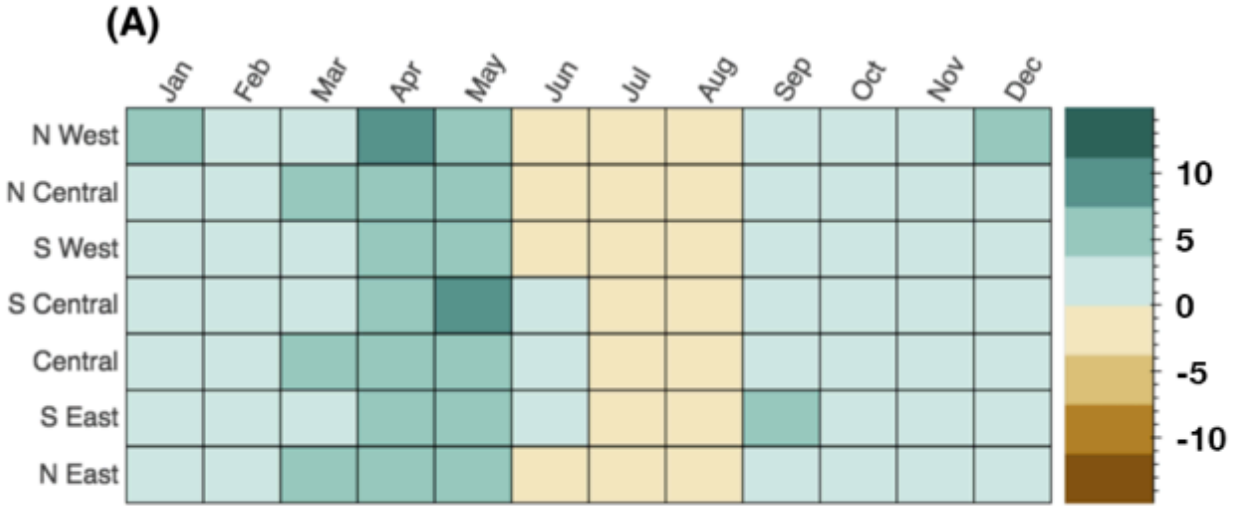
Change in Monthly Precipitation (in.) RCP 4.5 (2040–2069)



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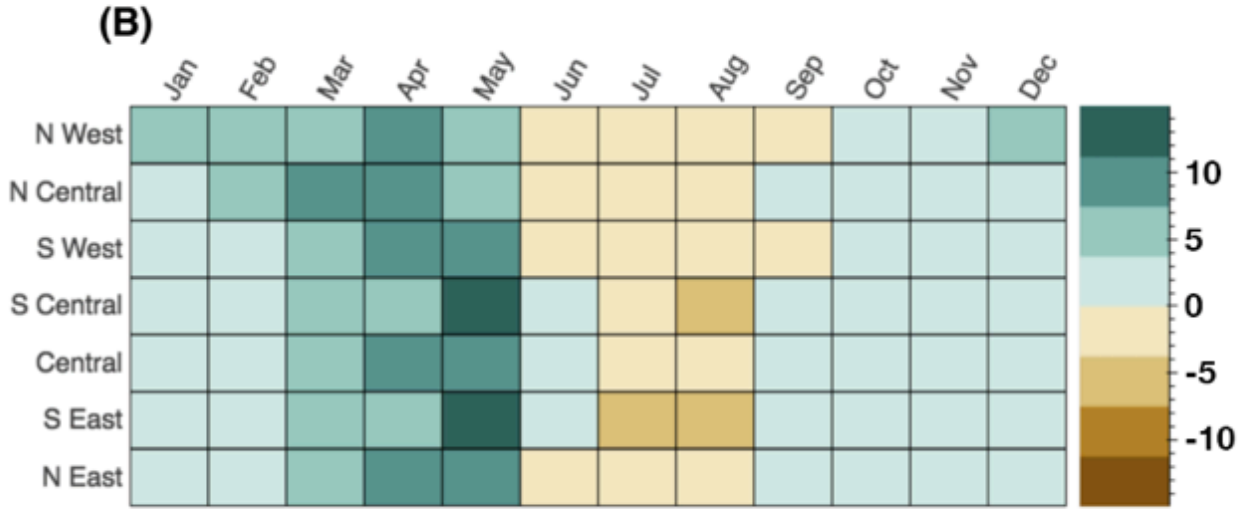

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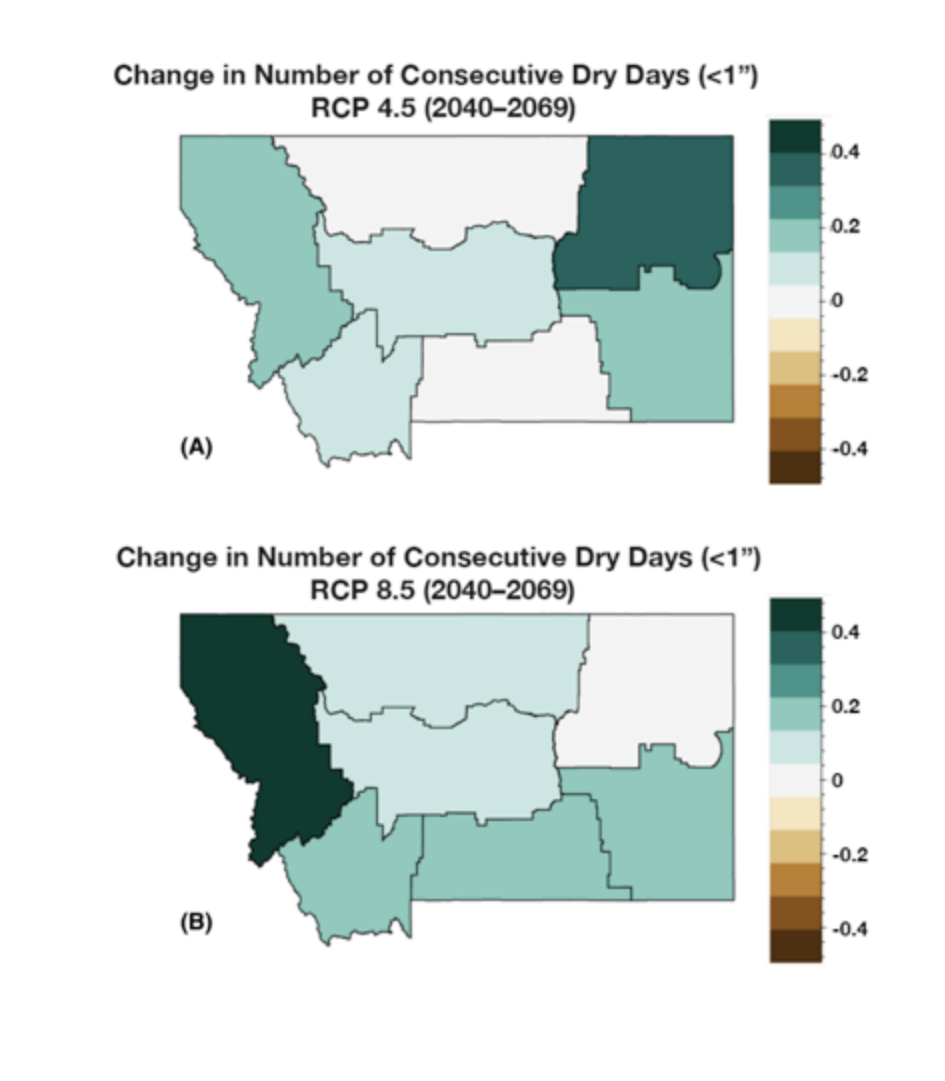
Length of consecutive days without wetting rain are increasing



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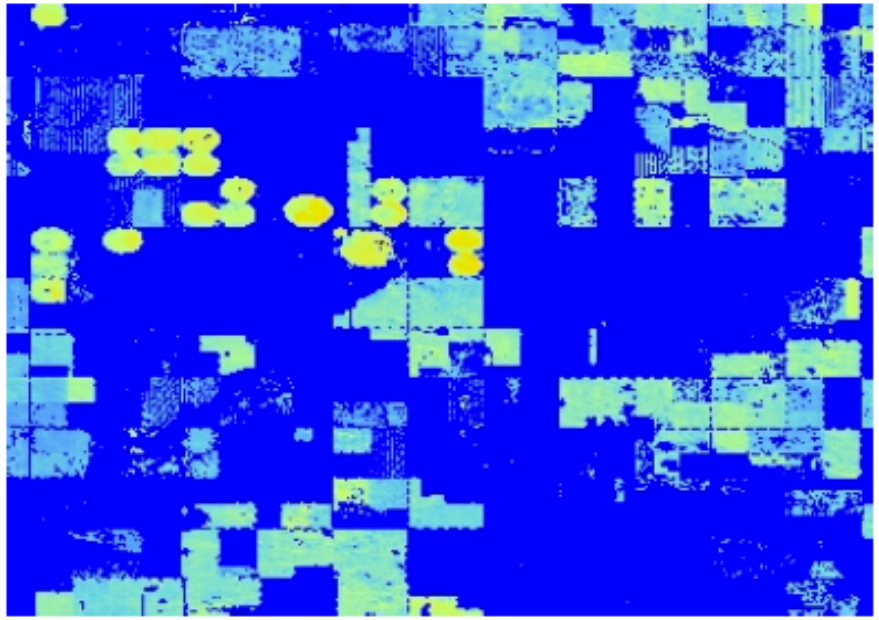
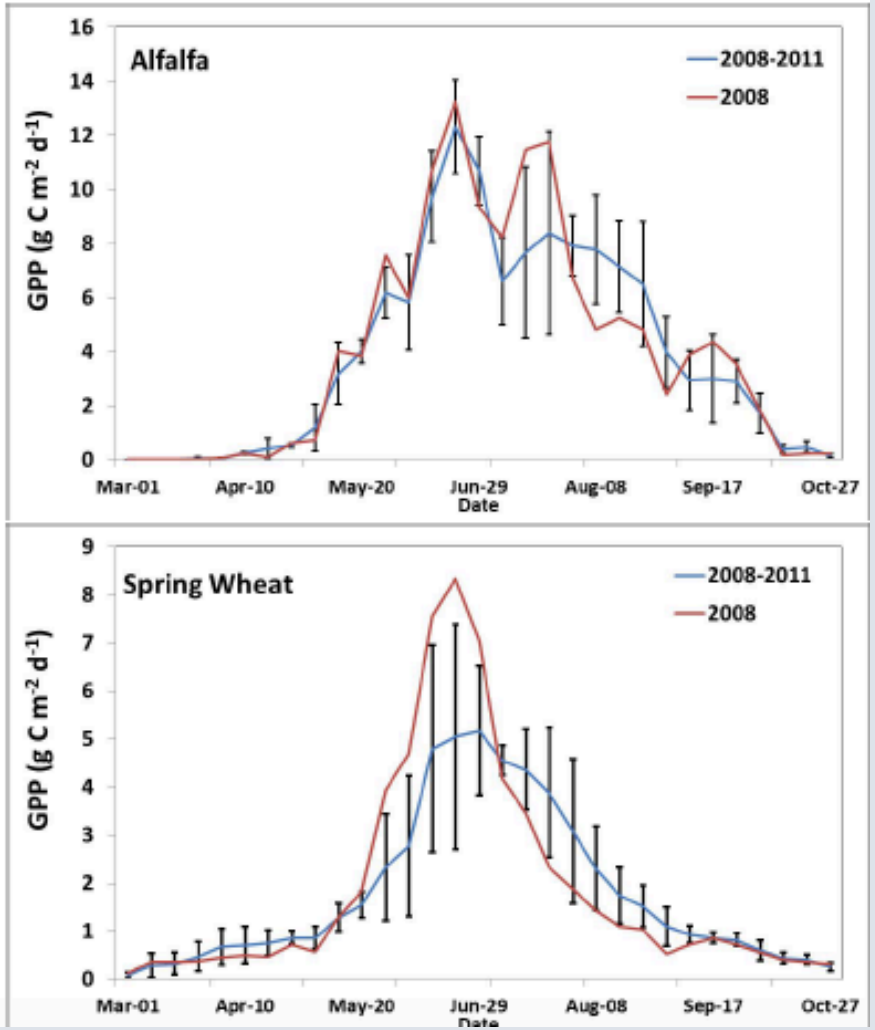
Monitoring agricultural production using new remote sensing methologies

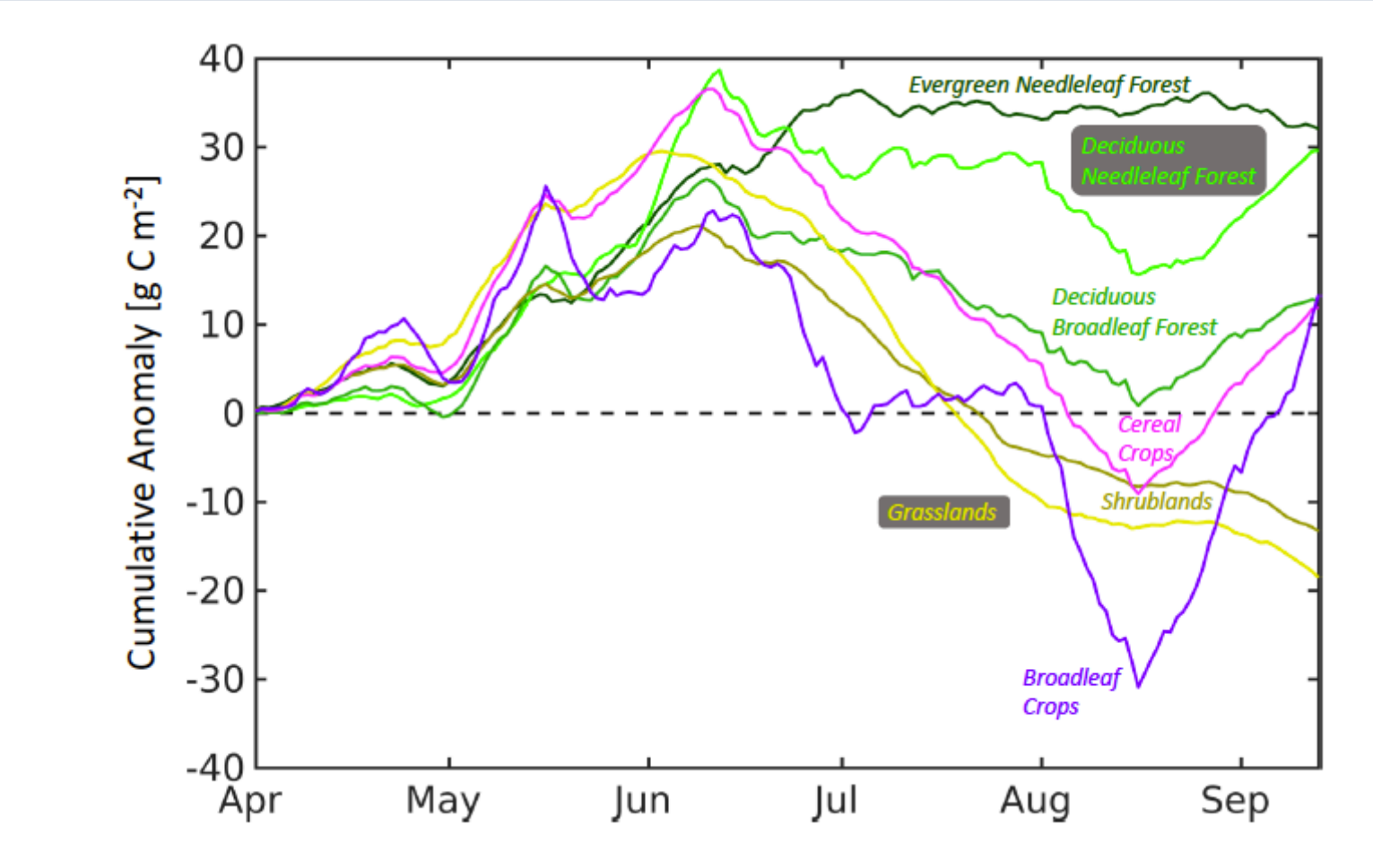
Field Scale crop productivity





He et al. 2018. Remote Sensing Journal

2017 Northern Plain Flash Drought using new SMAP-based GPP product (L4C)



Jones et al., NTSG

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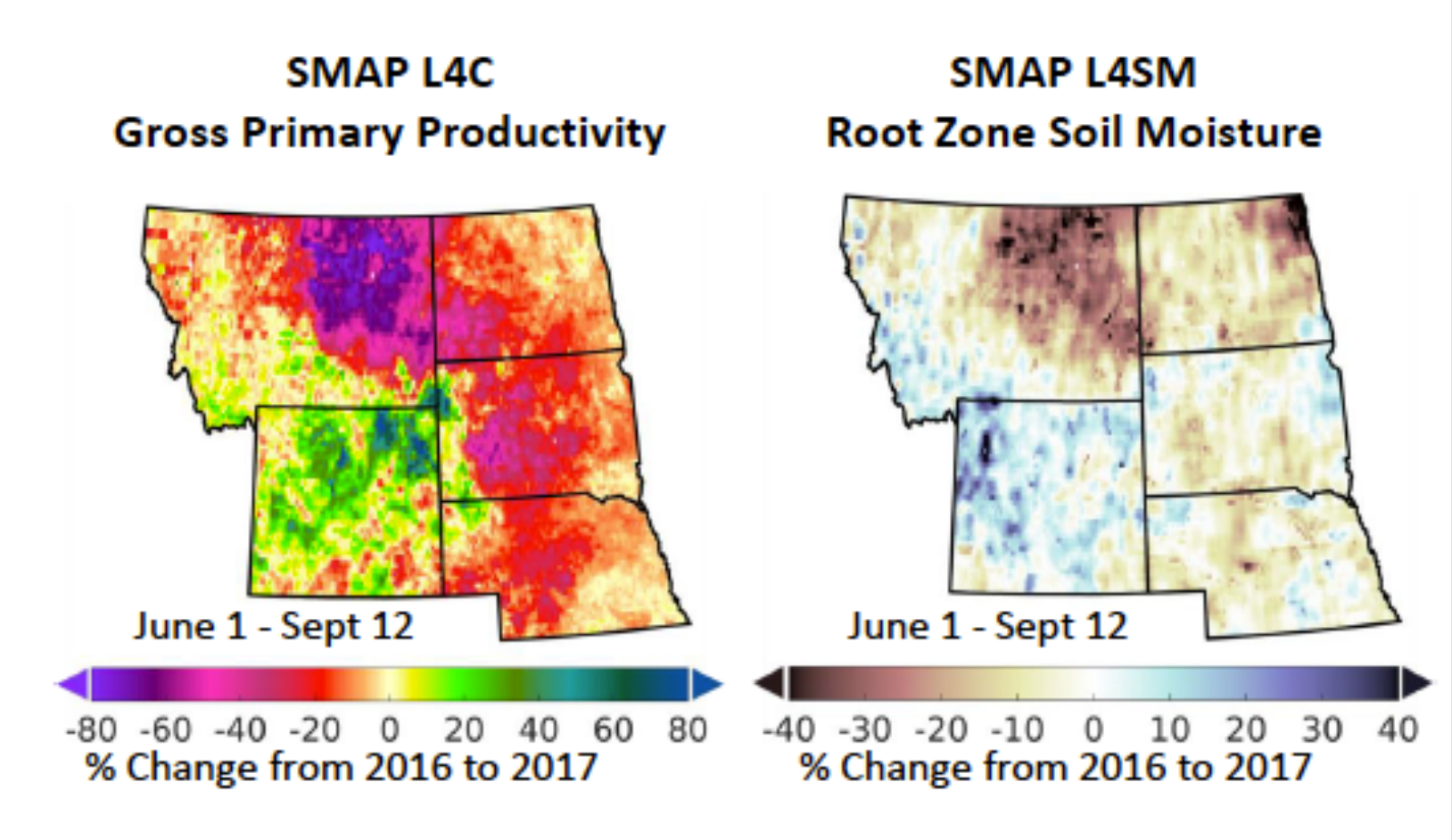

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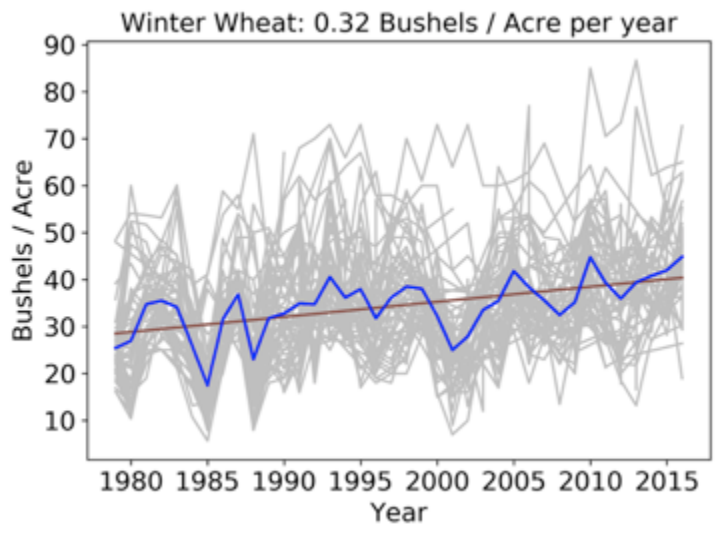
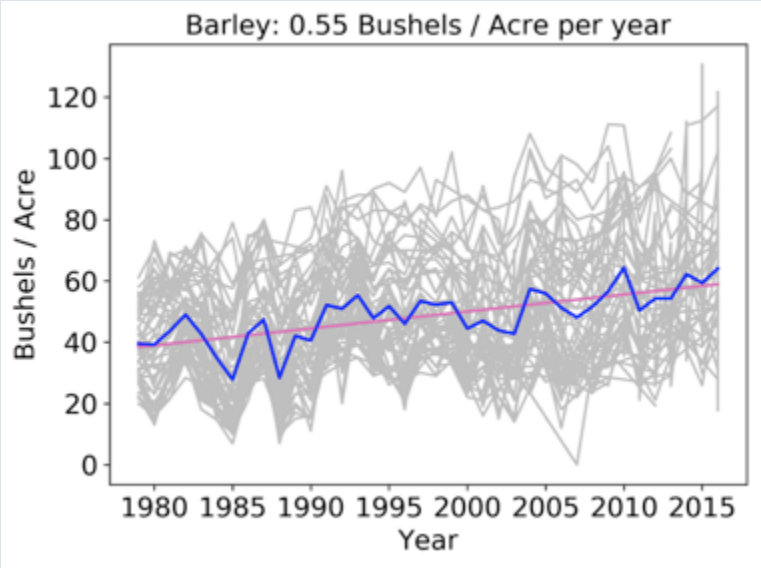
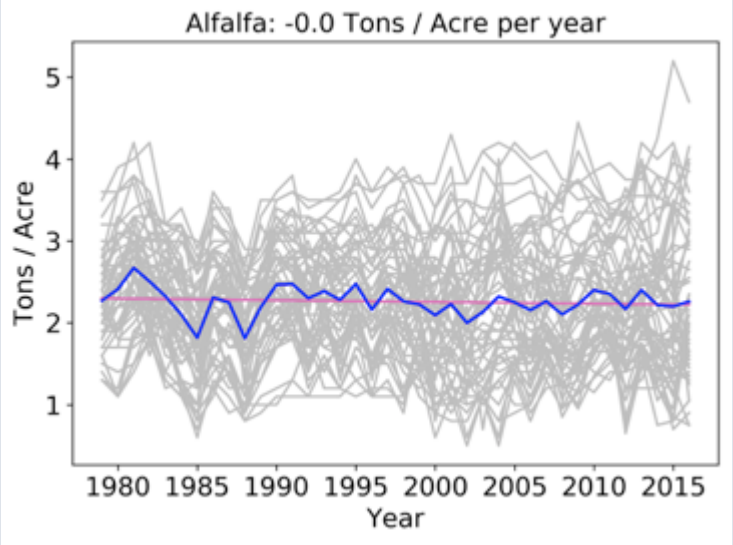
Jones et al., NTSG

Crop yields have increased in Montana, but not the same for all counties

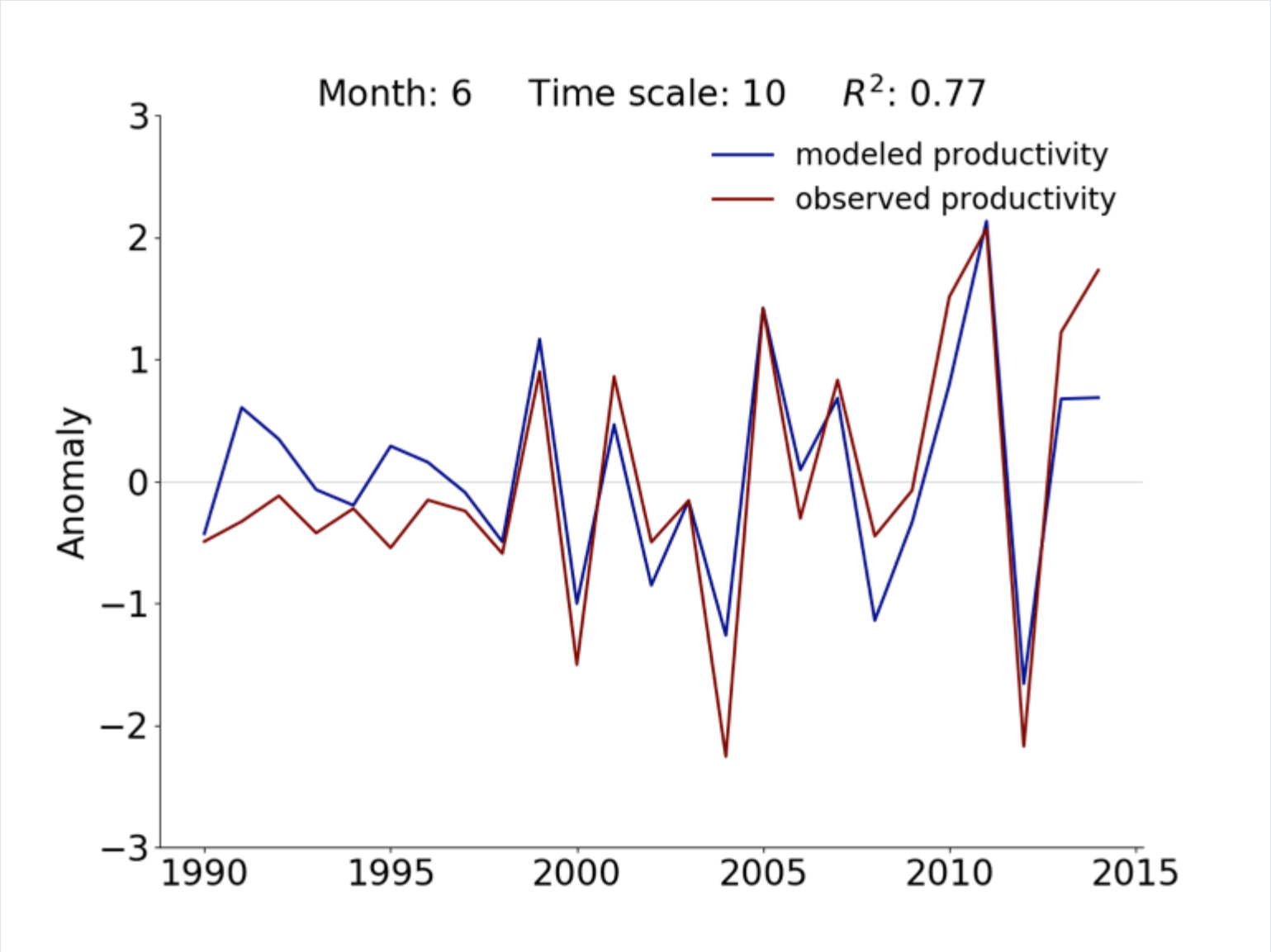






Wurster et al. in prep.

Climatic inertia of agricultural systems



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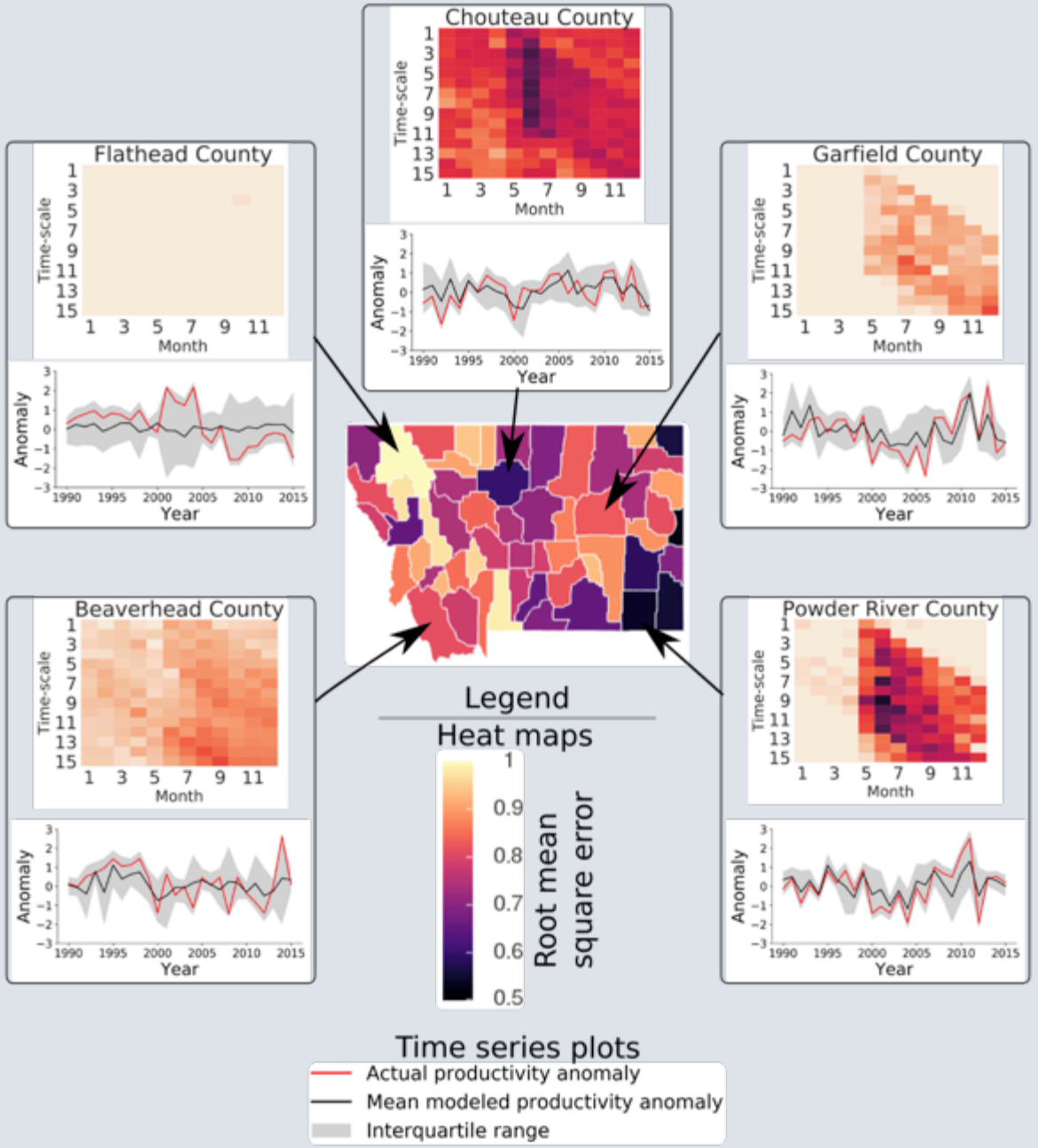
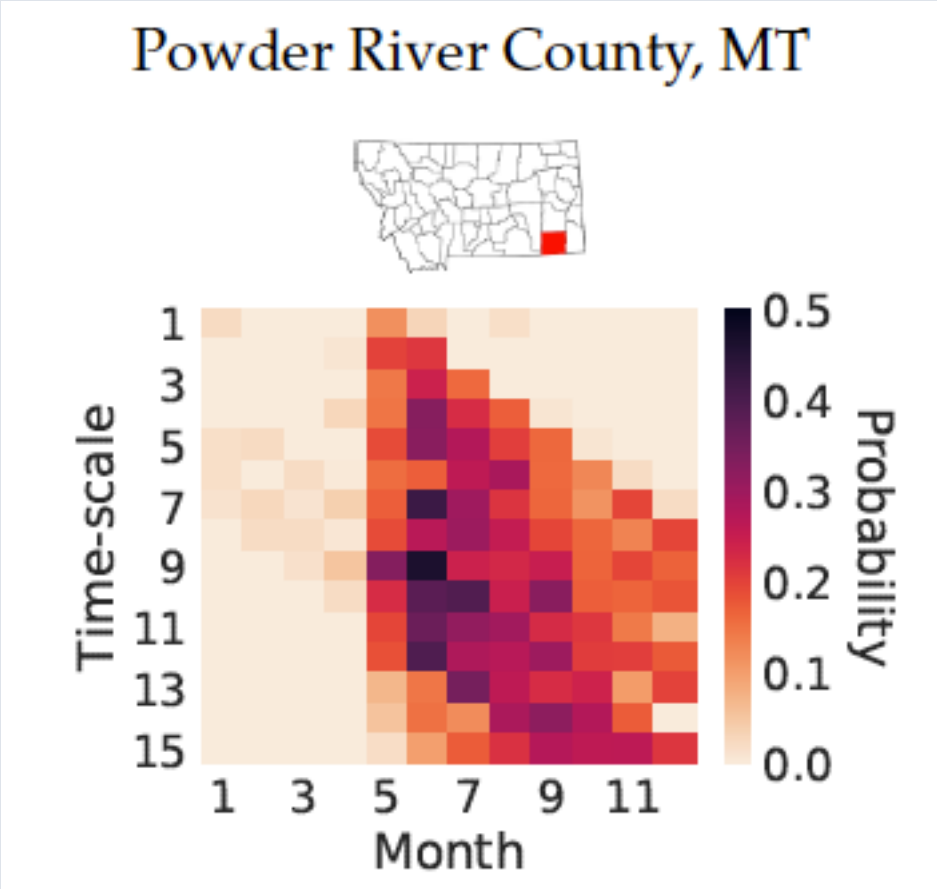
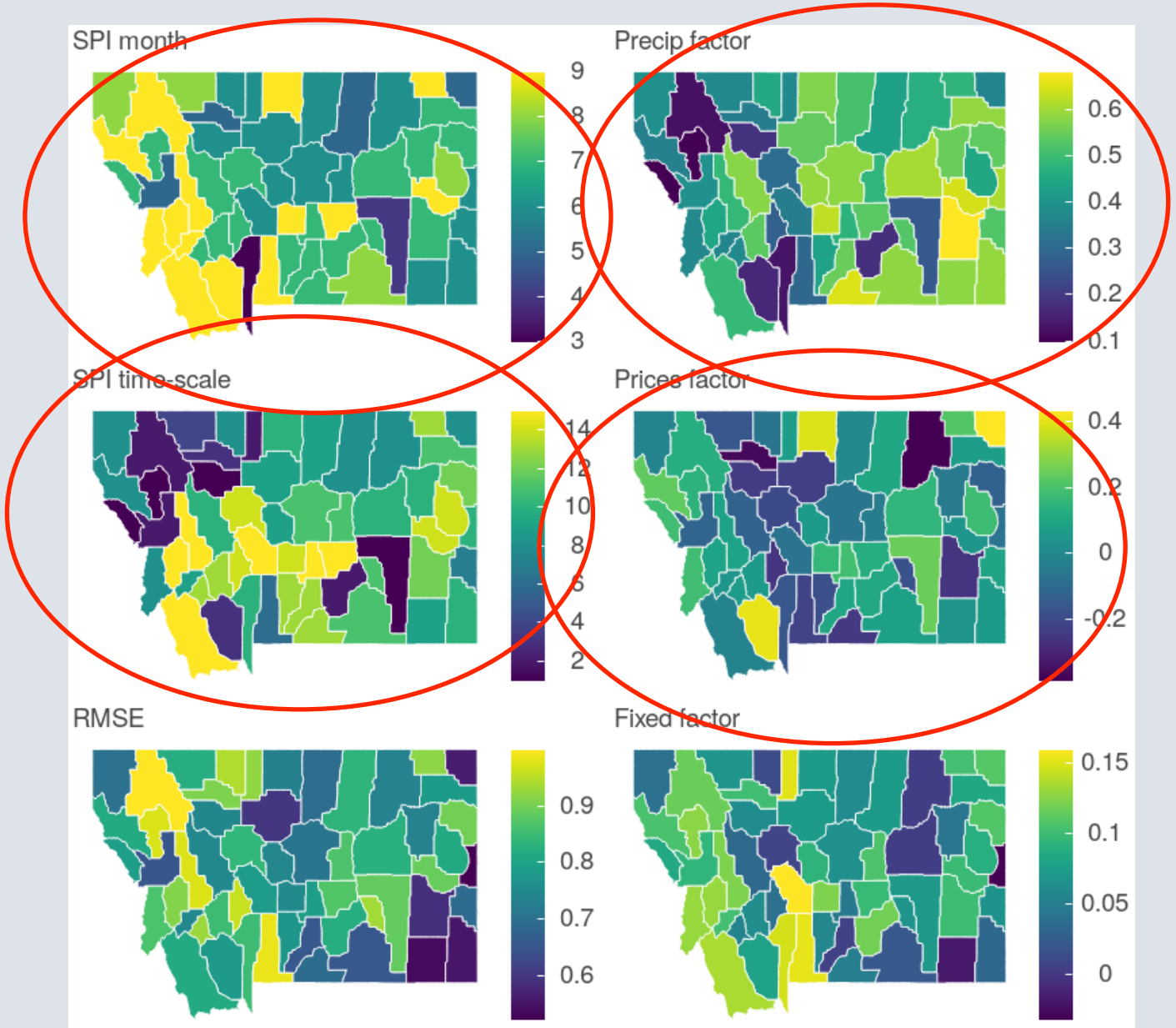
Eastern Montana alfalfa production more exposed to precipitation variability





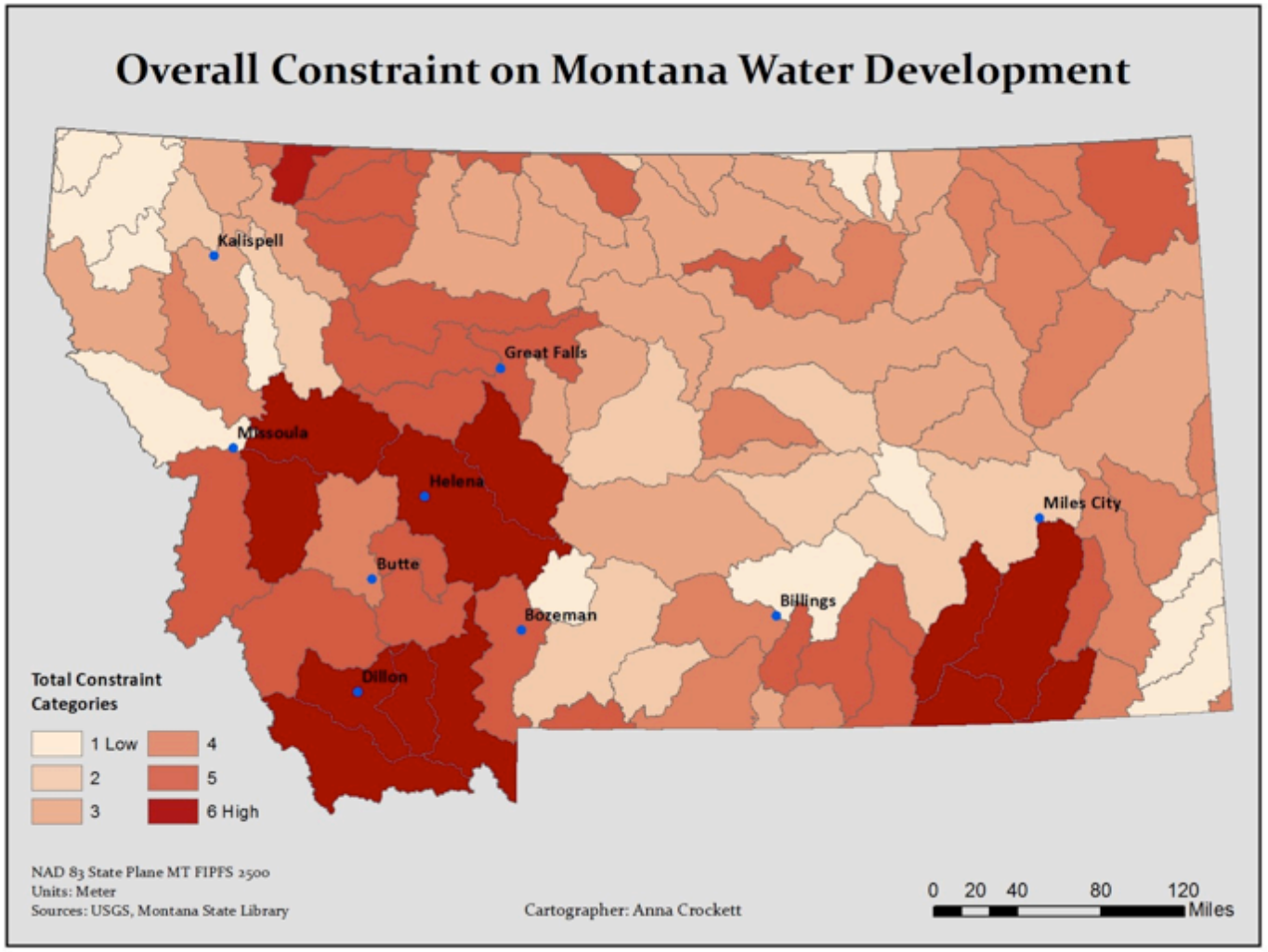
Wurster et al. in preparation

Eastern Montana alfalfa production more exposed to precipitation variability



Wurster et al. in preparation

Institutional constraints can mitigate (or exacerbate) drought impacts



- Constraints used in analysis:
  - Surface water rights
  - Groundwater closures
  - Reserved water right compacts (tribal and federal)
  - Instream flow rights
  - Water quality

Chaffin, DellaRossa, et al. in preparation

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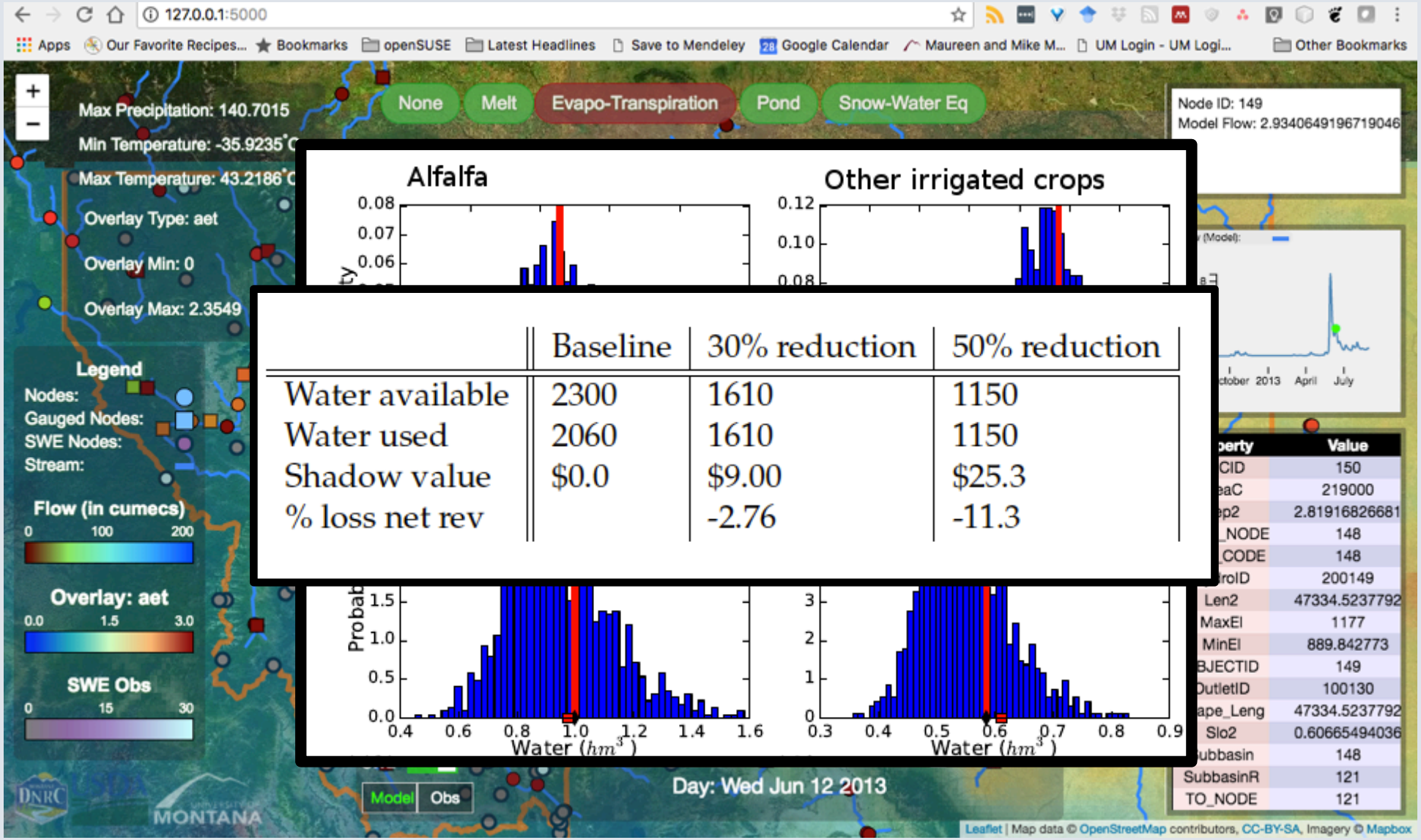
daWUAP – Self-calibrating Hydro-economic model of Water Use and Agricultural Production



	Baseline	30% reduction	50% reduction
Water available	2300	1610	1150
Water used	2060	1610	1150
Shadow value	$0.0	$9.00	$25.3
% loss net rev		-2.76	-11.3

Maneta et al. in prep.

- Temperatures have increased and will continue to increase.
  - Increases more pronounced during growing season.
- Precipitation has increased in the spring and decreased during the growing season.
  - Length of periods without wetting rain are increasing.
- Increases in agricultural yields remain strong fueled by better practices.
  - Production in eastern Montana more sensitive to precipitation variability and therefore more exposed to drought.
  - Western Montana exhibits more resiliency.
- New RS-based hydro-economic tools will permit further insight into the impact of climate on Montana's water resources and agriculture.