Decadal Drought Risk Assessment and Scenario Development for Food and Bio-fuels Agriculture in Four Sub-basins in the Missouri River Basin

Acknowledgements

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The Project People

Vikram Mehta and Katherin Mendoza
The Center for Research on the Changing Earth System, Catonsville, Maryland

Cody Knutson, Nicole Wall, and Tonya Bernadt
National Drought Mitigation Center, Univ. of Nebraska – Lincoln, Nebraska

Stakeholder Advisory Team

Tracy Marlo Daugherty: Regional Community Development Specialist – Univ. Missouri Extension
Valerie Tate: Local Rancher/Plant Sciences Specialist – Univ. Missouri Extension
Kurt Boeckmann: Agriculture Liason – Missouri DNR
Dave Johnson: District Conservationist with NRCS for Linn, Livingston, and Carroll Counties
Terri Bruner: District Conservationist with NRCS for Putnam, Sullivan, Adair, and Schuyler Counties
Dennis McDonald: Local Rancher
Nelson Heil: Presiding County Commissioner for Carroll County
Bill Boelsen: Associate Commissioner for Carroll County
Bob Miller: Land Learning Foundation
Mike Ledbetter: Land Owner in Linn County
Mary Culler: Regional Office Watershed Co-ordinator DNR

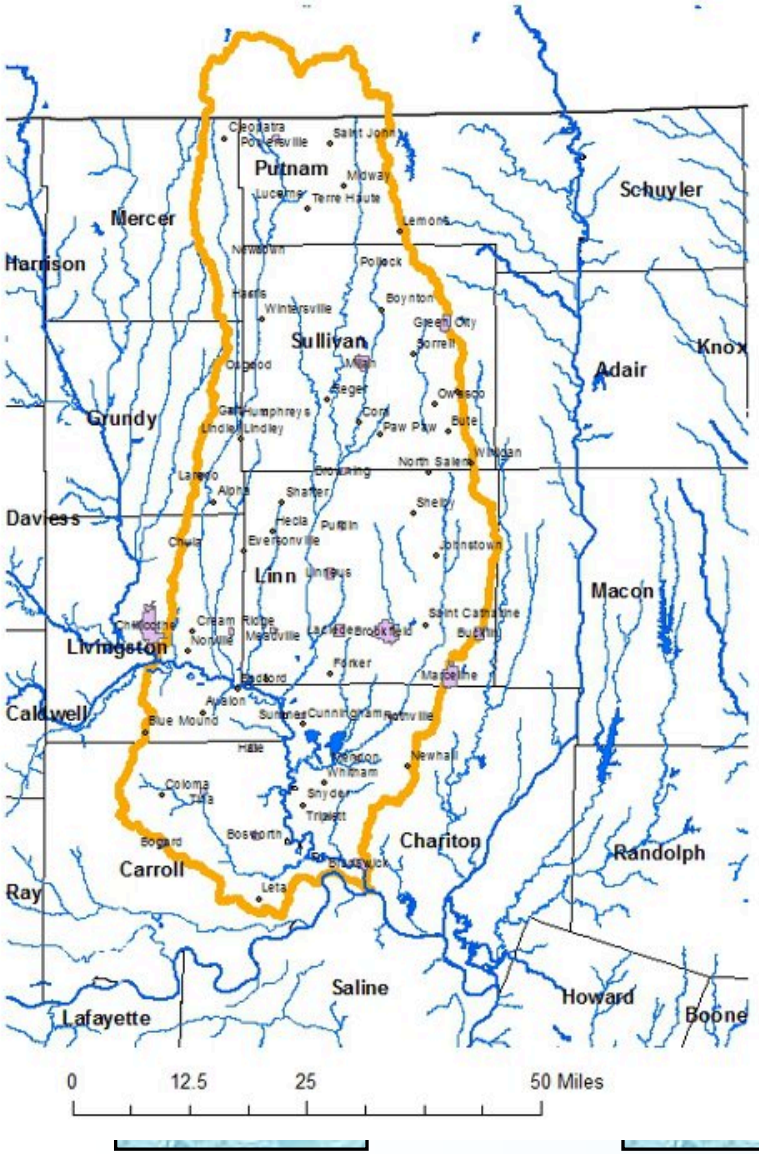
Project Objectives

- To define decadal drought information needs of agricultural stakeholders in four selected sub-basins of the Missouri River Basin.

- To conduct a scenario-planning exercise for coping with multiyear to decadal droughts in these sub-basins.

Round 1
15 March 2017

Development of Climate-Adaptive Water and Agriculture Management System in the Lower Grand Sub-basin



Why the Lower Grand?

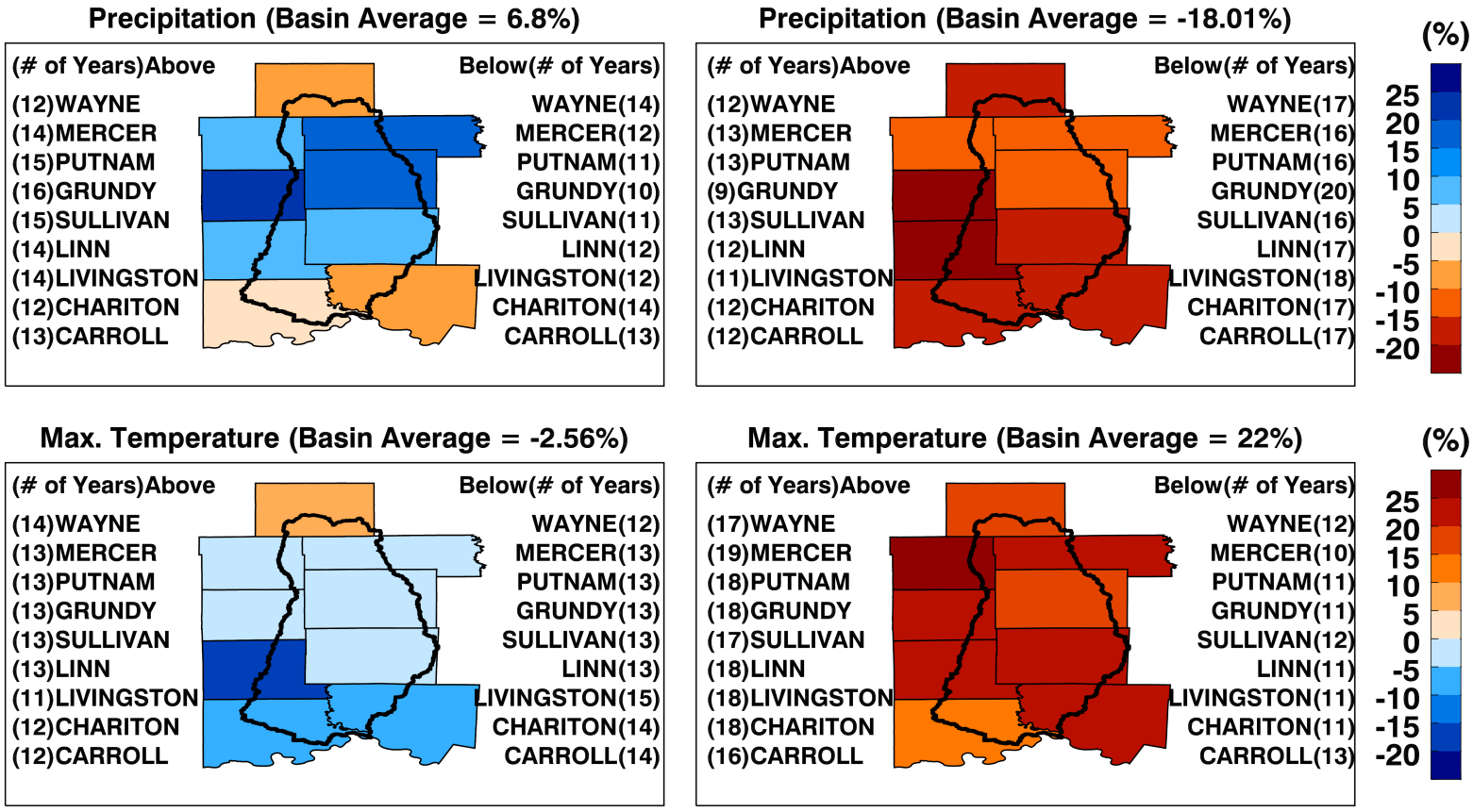
- Substantial and identifiable DCV signals in precipitation, temperature, crops, and stream flow
- Important agricultural region with a mix of dryland and irrigated crops
- Recreation and wildlife/conservation sectors also important
- Drought conditions threaten water supply for many communities; MO DNR's "Our Missouri Waters Initiative" for watershed-based management by developing infrastructure, **policies**, and **procedures**

The PDO and Differences in Probabilities of Above/Below Average Precipitation and Daily Max. Temperature: 1961-2015

PDO Warm

PDO Cold

Probability Difference between Above and Below Average Hydometerology Anomalies During Positive and Negative Phases of Single Annual DCV



PDO Warm – Wet and cool; PDO Cold - Dry and warm

The PDO and Differences in Probabilities of Above/Below Average Streamflow, Precipitation, and Daily Max. Temperature in Grundy, Livingston, and Chariton Counties: 1961-2015

Location (County)	PDO State	Probability Difference of Above/Below Average Streamflow (%)	Probability Difference of Above/Below Average Precipitation (%)	Probability Difference of Above/Below Average Daily Max. Temperature (%)
Grundy (Thompson River at Trenton)	Warm/Cold	-8/-17	23/-38	0/24
Livingston (Grand River near Sumner)	Warm/Cold	0/-38	8/-24	-15/24
Chariton (Chariton River near Prairie Hill)	Warm/Cold	0/-24	-8/-17	-8/24

Probabilities of streamflow changes are in physical agreement with probabilities of precipitation and daily max. temperature changes where we have USGS streamflow data.

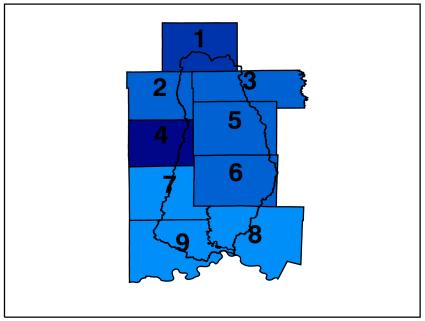
The PDO and Crop Yields in the Lower Grand Sub-basin

PDO Warm | PDO Cold

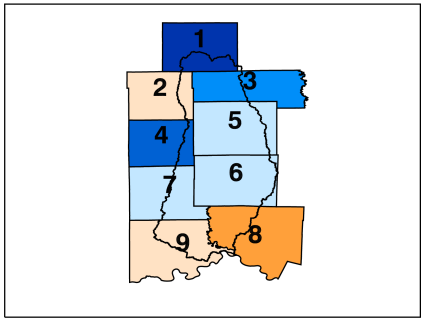
Soybean

1961-2014

PDO+ (Basin Ave = 7.1 bu/acre)



PDO- (Basin Ave = 2 bu/acre)



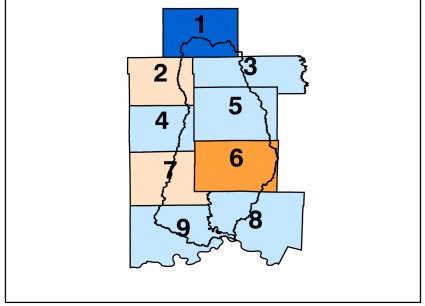
County

1 WAYNE
2 MERCER
3 PUTNAM
4 GRUNDY
5 SULLIVAN
6 LINN
7 LIVINGSTON
8 CHARITON
9 CARROLL

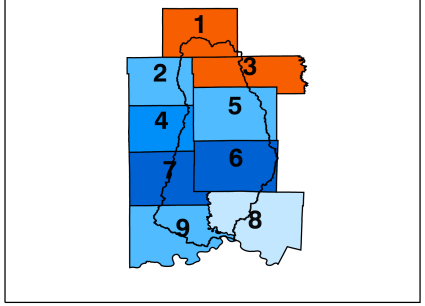
Corn

1961-2014

PDO+ (Basin Ave = 1.4 bu/acre)



PDO- (Basin Ave = 2 bu/acre)

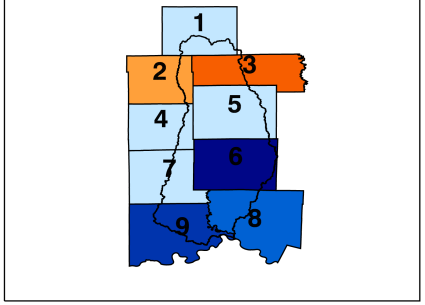


1 WAYNE
2 MERCER
3 PUTNAM
4 GRUNDY
5 SULLIVAN
6 LINN
7 LIVINGSTON
8 CHARITON
9 CARROLL

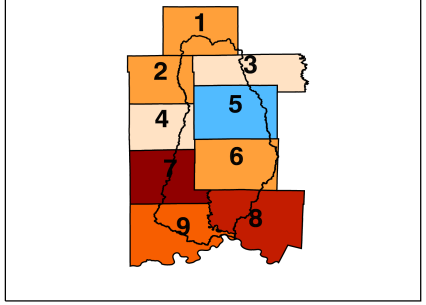
Wheat

1961-2007
Wayne
1974-2007

PDO+ (Basin Ave = 2.9 bu/acre)



PDO- (Basin Ave = -2.8 bu/acre)



1 WAYNE
2 MERCER
3 PUTNAM
4 GRUNDY
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6 LINN
7 LIVINGSTON
8 CHARITON
9 CARROLL

Above - Below Yield Difference (bu/acre)

USDA-NASS data from 1961 to 2014

Wetter and cooler conditions, and above average wheat, corn, and soybean yields in almost all counties In PDO Warm conditions

Vi

2 March 2018

Roles of the Project and Stakeholder Advisory Teams

Project Team

☞ Introduced natural decadal climate variability (DCV) phenomena or cycles.

☞ Showed associations between these climate cycles, and dry/wet cycles, crop yields and productions in Lower Grand (LG).

Stakeholder Advisory Team

☞ Provided detailed and quantitative information about agriculture and water resources in LG; and about present and future use of corn and other crops to produce bio-fuels.

☞ Described perceptions of these dry/wet cycles and impacts on water and crops.

☞ Discussed how they might have used this information if provided as forecasts.

Your Responses

Agriculture and Water Resources

☞ Agricultural irrigation fed largely by groundwater sources in two southern-most counties and by surface water sources, including the Grand River and privately-owned lakes, in the northern part.

☞ Non-irrigated agriculture in middle part – Putnam, Grundy, and Sullivan Counties.

☞ Water for domestic use mostly from surface water sources and wells, some cities along Grand River use water from the River and wells along it.

☞ Water quality a major problem; impaired streams with E. Coli bacteria, sediment, and nutrient loading; sediment loading due to erosion caused by channeling of streams and nutrient loading from row crops, pastures, and water treatment facilities.

☞ In some areas, water quality also affected by clay under top soil.

Your Responses

Perceptions of Dry and Wet Cycles

☞ Observed dry and wet epochs in the 1970s and 1980s, and their impacts on crop yields including quality of grains, corn and soybeans prices, and cattle raising.

☞ Observed stronger water flows during wet epochs increased soil erosion and resulted in water pollution.

☞ Adaptation of cattle-grazing to dry and wet epochs essential; ranchers who did not had to downsize their herds.

Your Responses

Potential usefulness of predictions

☞ Focus mainly on droughts.

☞ Skillful predictions can help in choosing more drought-tolerant crops or varieties within a particular crop; examples of potential choices soybeans or corn, or sorghum or corn.

☞ Skillful predictions can inform decisions about selling or retaining cattle and/or which age group of cattle to sell or retain.

Your Responses

Bio-fuels production

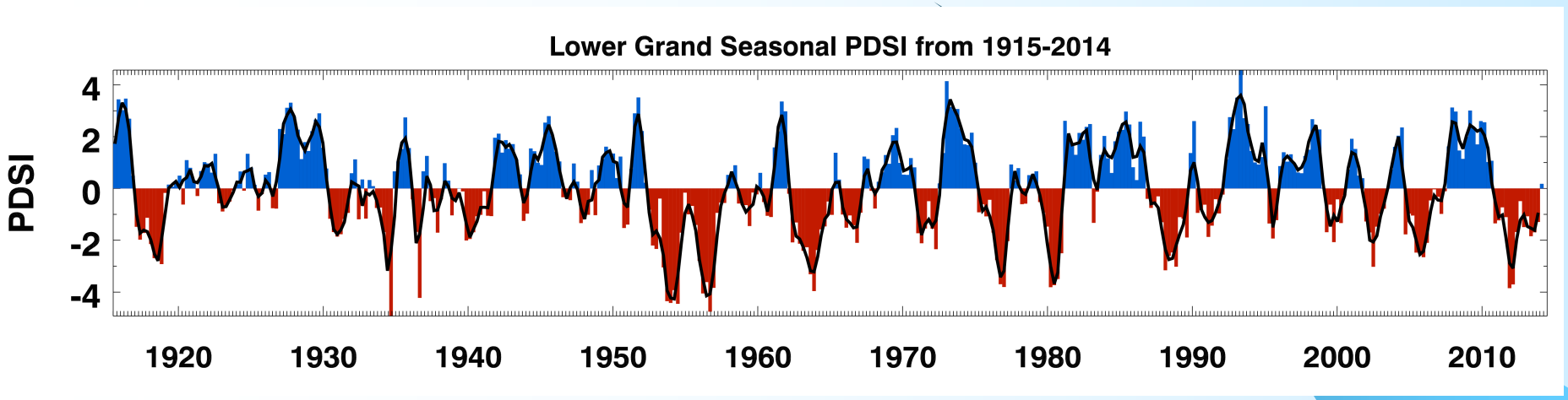
☞ Not much bio-fuels production due to low cost of fossil fuels and cost of transporting bio-fuel crops to processing facility.

Drought Information Needs

- ☞ **Length and severity of drought.**
- ☞ **Water quality – sediment and nutrient loading.**
- ☞ **Prediction of drier/wetter condition in each season over the next year to inform which crop to plant and decision about corn-soybean rotation.**
- ☞ **Pasture and rangeland conditions.**

Round 2
Today

Dry-wet cycles in the Lower Grand
Palmer Drought Severity Index (PDSI) 1915 to 2014



- Red – negative PDSI – dry
- Blue – positive PDSI – wet
- Pronounced dry-wet cycles in the Lower Grand for at least last 100 years
- Very dry to very wet and back to very dry in a few years to a decade

Average persistence of dryness/wetness: 1915 - 2014

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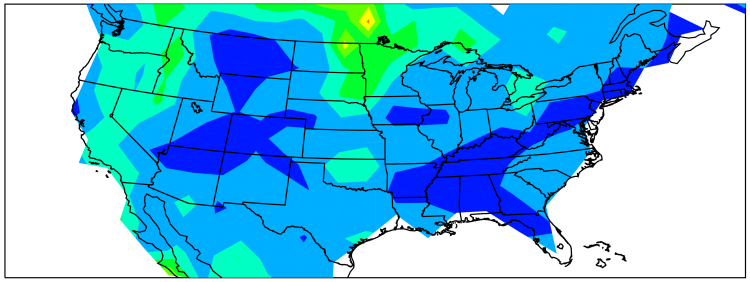
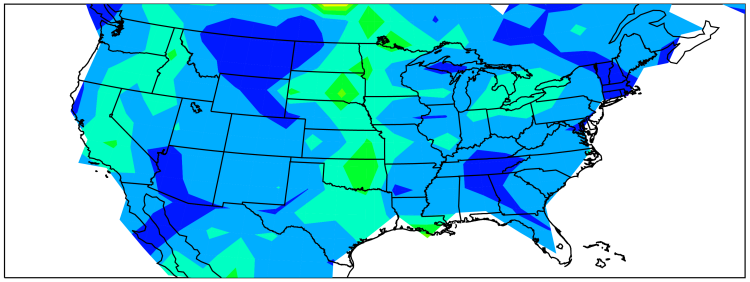
DRYNESS

WETNESS

Dry (PDSI < -0.5)



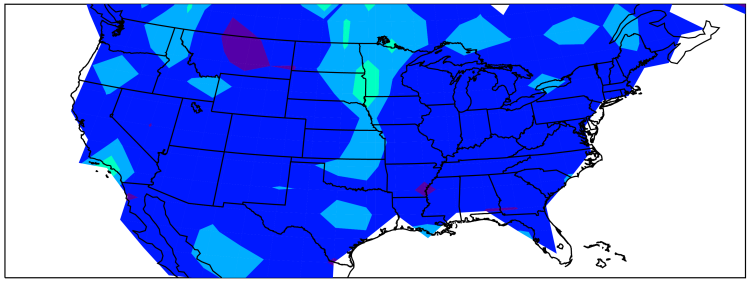
Wet (PDSI > 0.5)



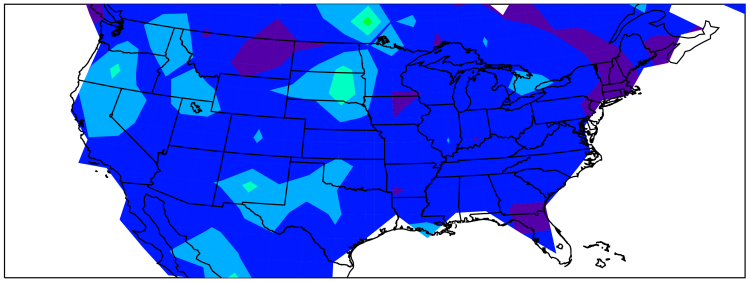
1 yr.

1.5 yrs.

Very Dry (PDSI < -2)



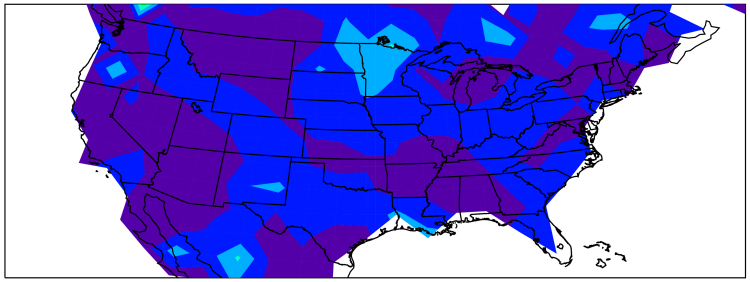
Very Wet (PDSI > 2)



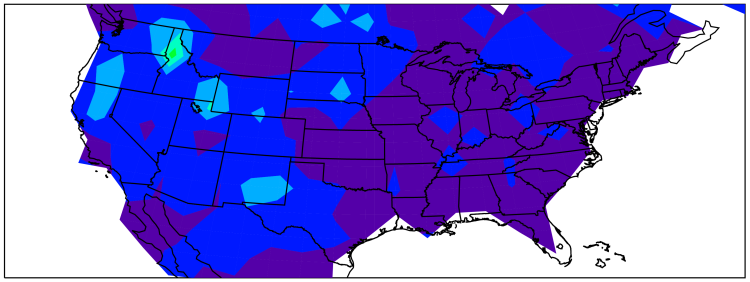
< 1 yr.

< 1 yr.

Extremely Dry (PDSI < -3)



Extremely Wet (PDSI > 3)



< 1 yr.

< 1 yr.

Number of Seasons

1 2 3 4 5 6 7 8 9

Maximum persistence of dryness/wetness: 1915 - 2014

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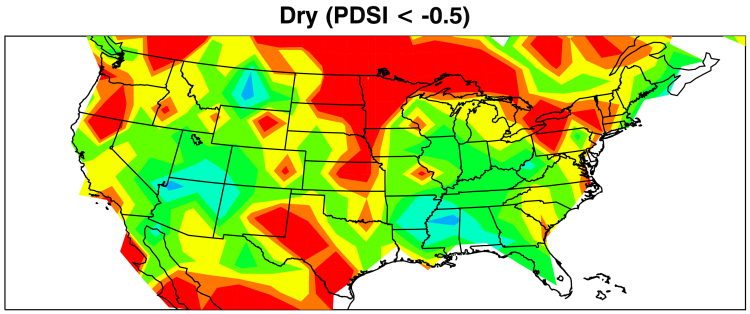
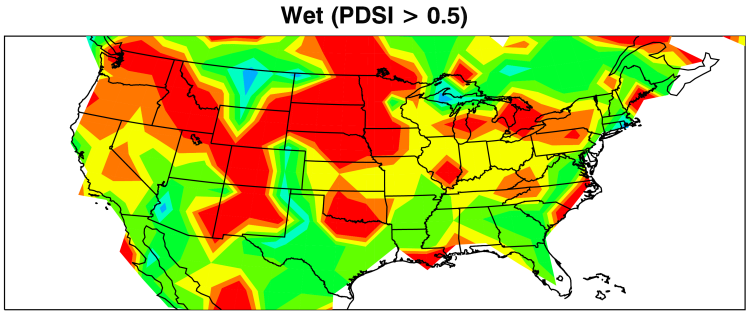
DRYNESS

WETNESS

3 yrs. and longer

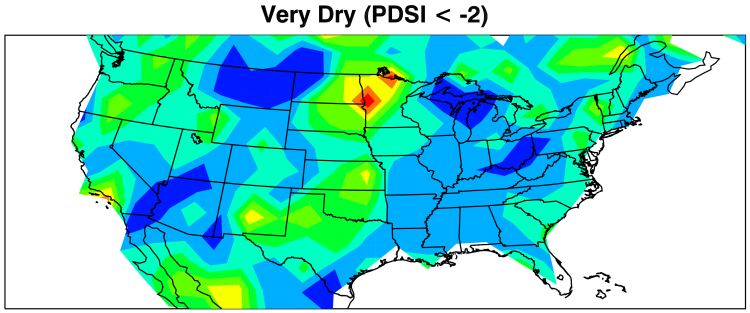
4 yrs. and longer

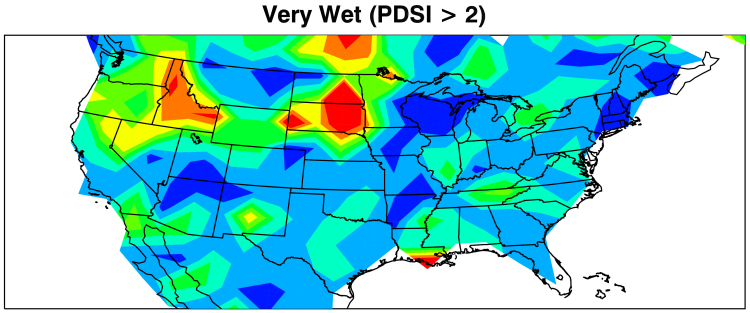




2 yrs.

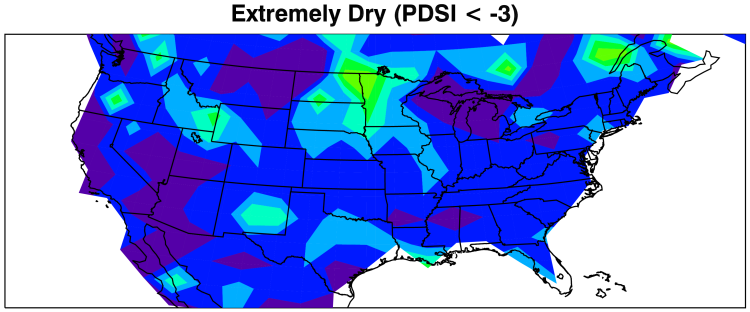
2 yrs.

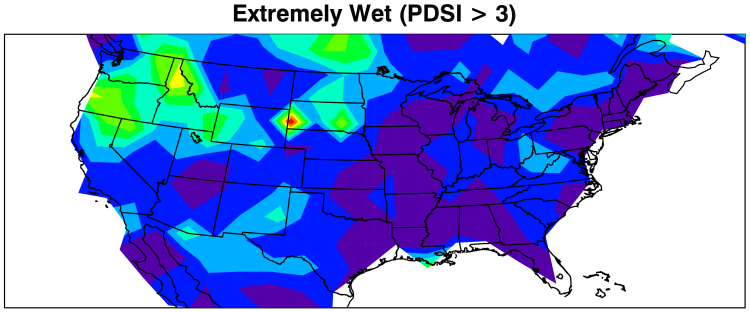


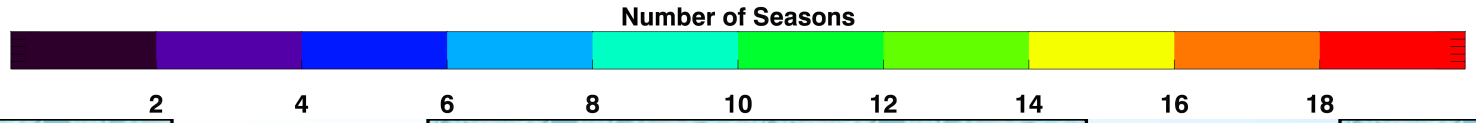


1.5 yrs.

1 yr.







Frequencies of dry and wet epochs 1915 - 2014

DRYNESS

Severity	4 to 7 seasons	8 to 11 seasons	12+ seasons
Low	14	2	1
Medium	8	0	0
High	2	0	0

WETNESS

Severity	4 to 7 seasons	8 to 11 seasons	12+ seasons
Low	7	6	4
Medium	5	0	0
High	1	0	0

Potential predictability of dryness/wetness using SON PDO and TAG indices as predictors: 1915 - 2014

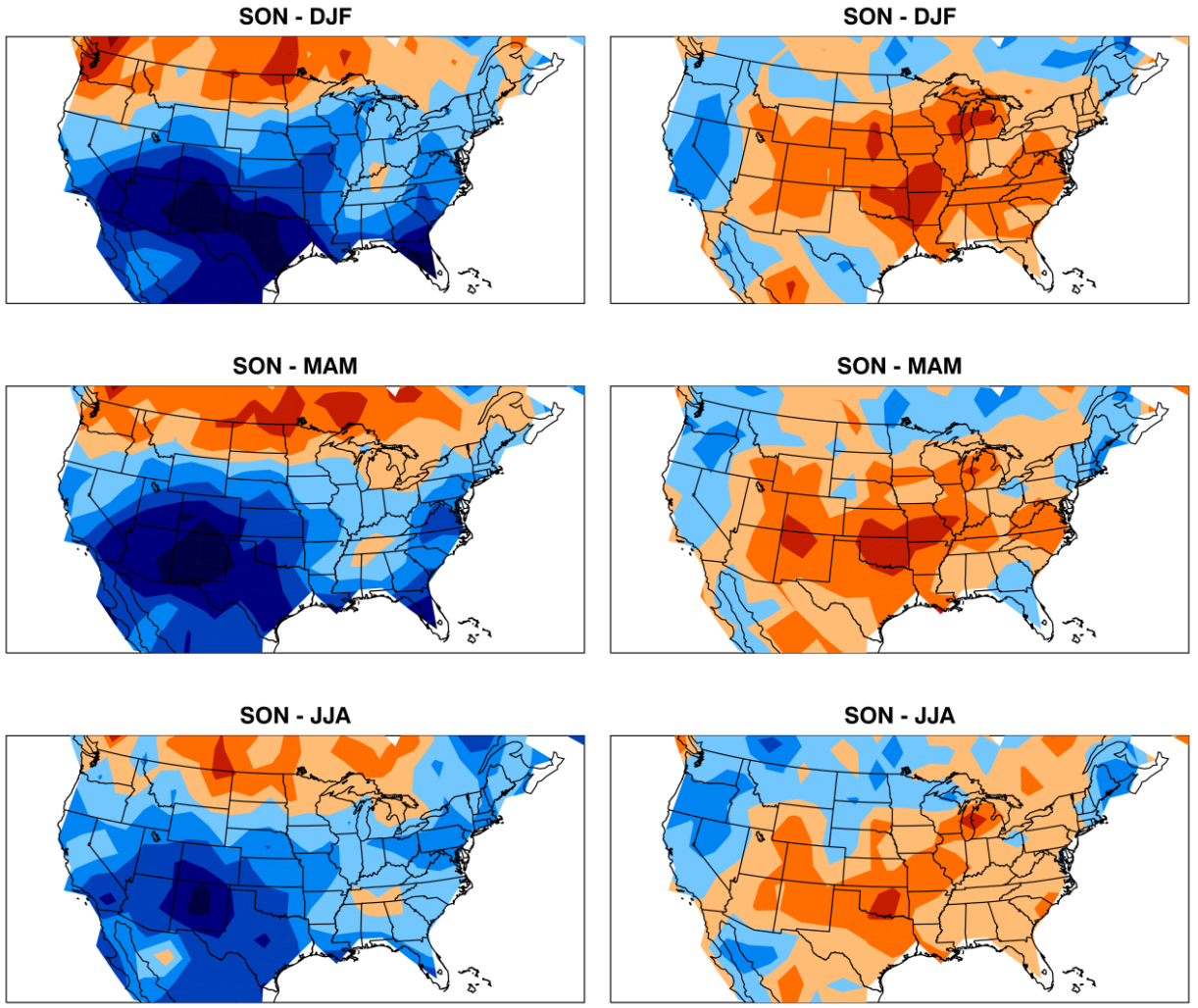
PDO

TAG

DJF pred. Blue-wet, Red-dry if SON PDO positive

MAM pred. Blue-wet, Red-dry if SON PDO positive

JJA pred. Blue-wet, Red-dry if SON PDO positive



DJF pred. Blue-wet, Red-dry if SON TAG positive

MAM pred. Blue-wet, Red-dry if SON TAG positive

JJA pred. Blue-wet, Red-dry if SON TAG positive

Potential predictability of dryness/wetness using DJF PDO and TAG indices as predictors: 1915 - 2014

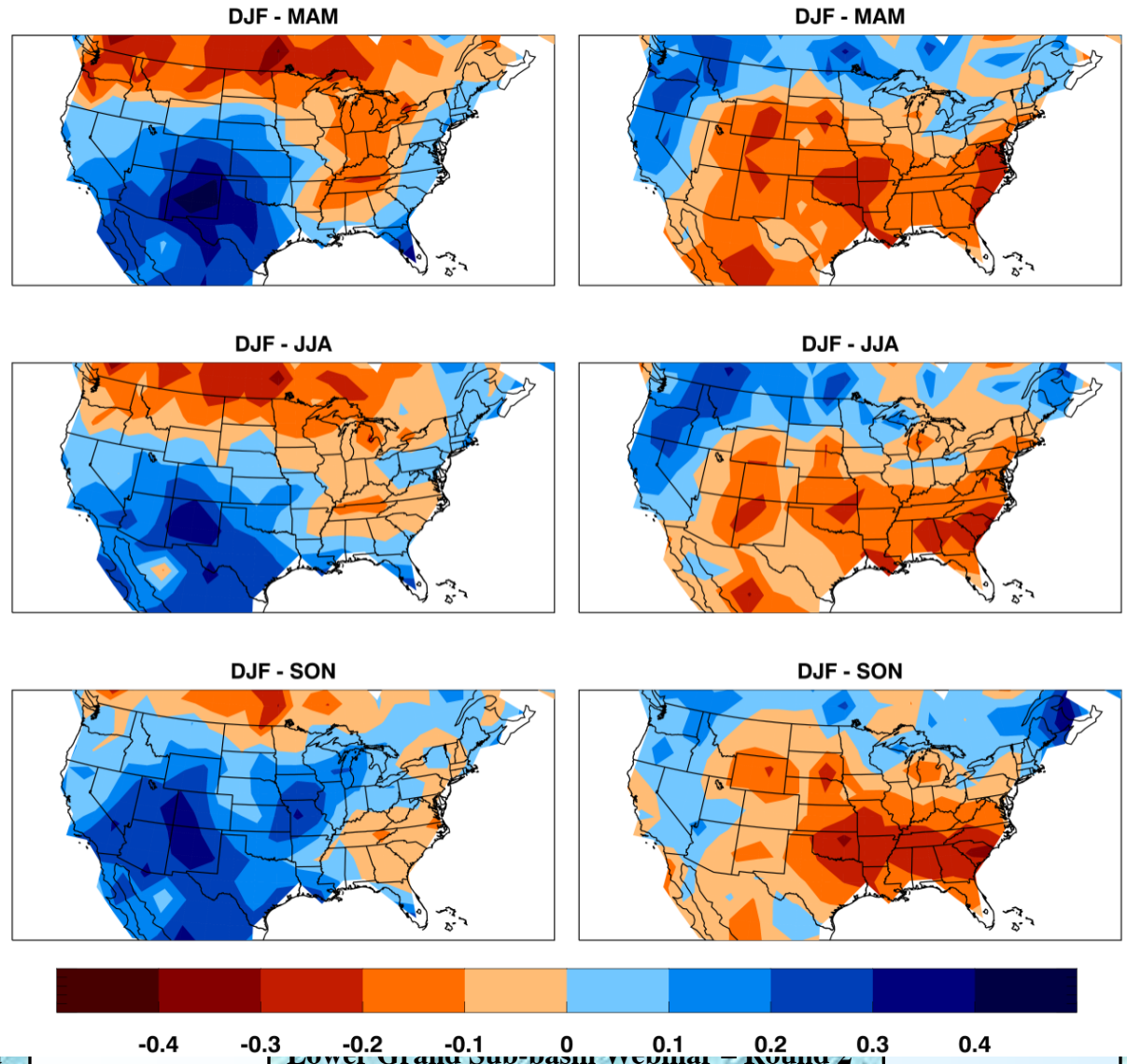
PDO

TAG

MAM pred. Blue-wet, Red-dry if DJF PDO positive

JJA pred. Blue-wet, Red-dry if DJF PDO positive

SON pred. Blue-wet, Red-dry if DJF PDO positive



MAM pred. Blue-wet, Red-dry if DJF TAG positive

JJA pred. Blue-wet, Red-dry if DJF TAG positive

SON pred. Blue-wet, Red-dry if DJF TAG positive

Next part of this webinar

Project Team

✔ Reviewed our previous interactions about this project.

✔ Addressed your suggestions with new results.

Stakeholder Advisory Team

☞ Would these types of drought information be useful to you?

☞ What are your other information needs for droughts persisting for 1 year, 2-3 years, 5 years, and 10 years?

Thank you!!