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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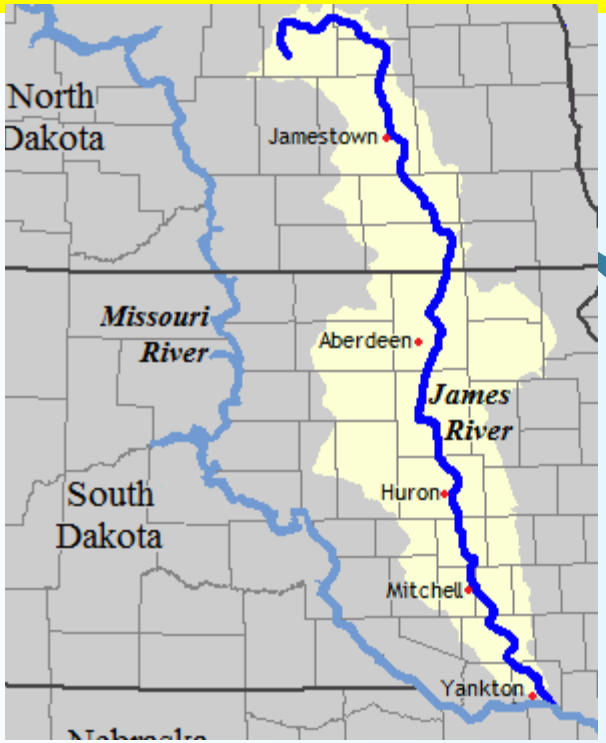
Project Objectives

- 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
13 April 2017

Development of Climate-Adaptive Water and Agriculture Management System in the James River Sub-basin



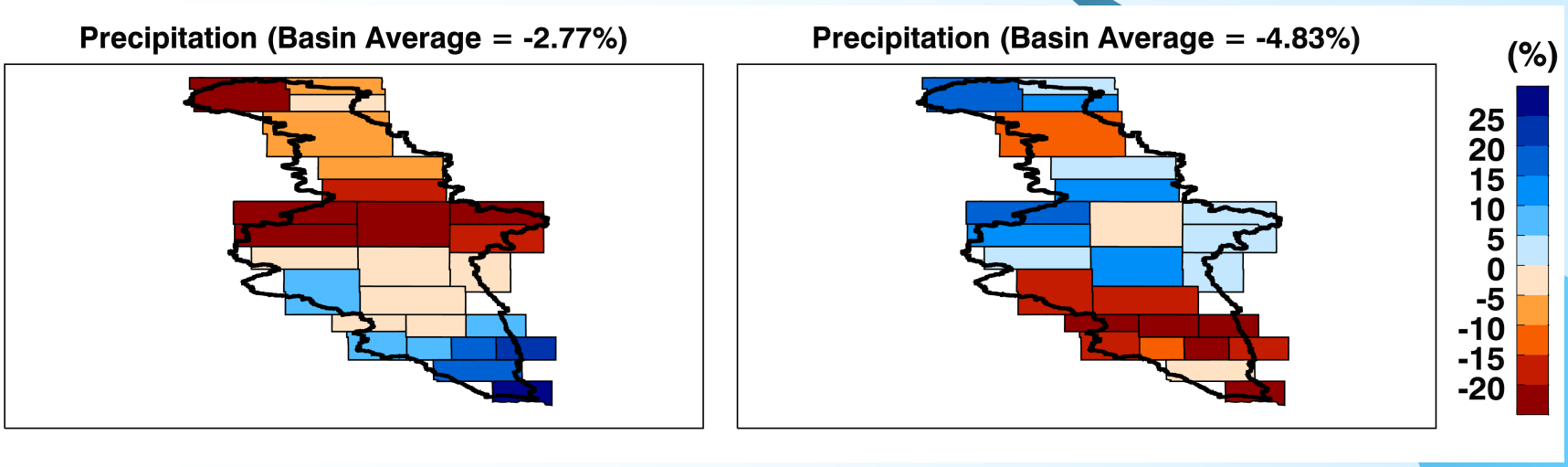
Why the James sub-basin (JSB)?

- Substantial and identifiable DCV signals in precipitation, temperature, crops, and streamflow.
- Important agricultural region producing spring and winter wheat, corn, soybeans, sunflower, and alfalfa; also, major ethanol producing region.
- Recreation and wildlife/conservation sectors also important.
- Soil erosion and water quality degradation due to run-off from crop and livestock production.

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

PDO Warm

PDO Cold

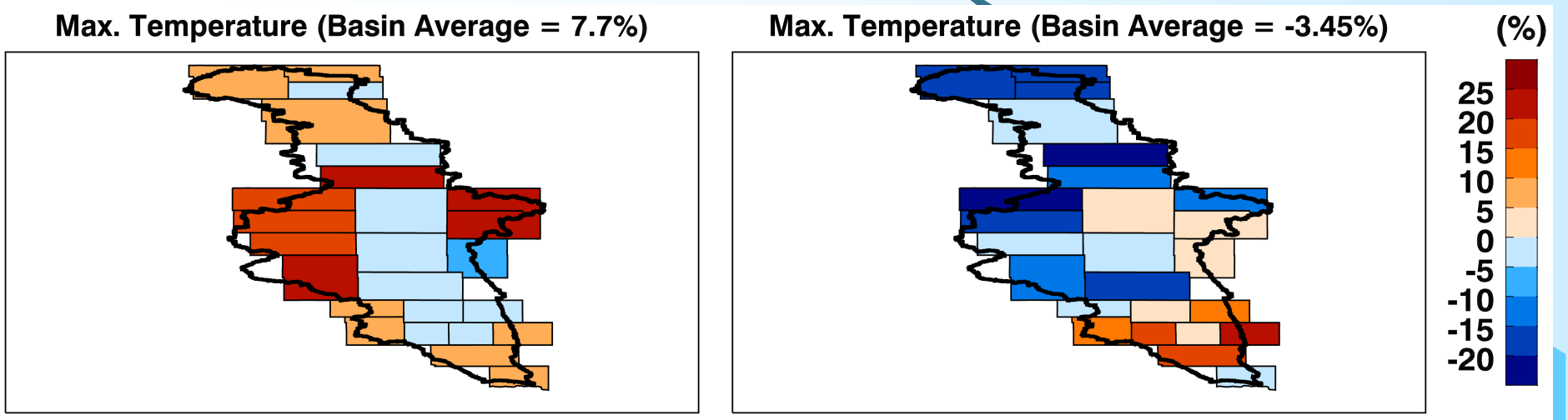


PDO Warm – Wet in the south, dry in the center and north;
PDO Cold – Dry in the south, wet in the center and north

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

PDO Warm

PDO Cold



PDO Warm – Generally warm, except in the center;
PDO Cold – Generally cool, warm in the south

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

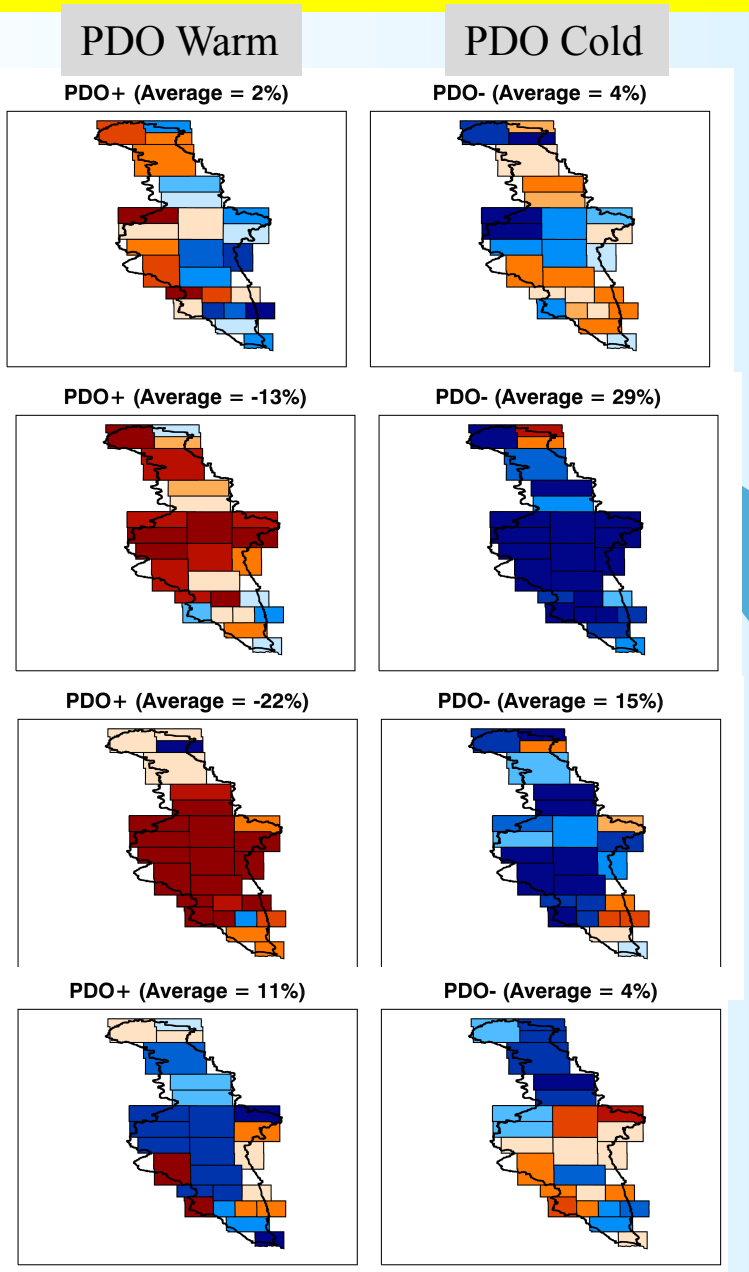
Location (County)	PDO State	Streamflow (%)	Precipitation (%)	Daily Max. Temperature (%)
Sheyenne River Above Harvey, ND (Wells)	Warm/Cold	-23/10	-23/17	8/-17
Sheyenne River Warwick, ND (Eddy)	Warm/Cold	-39/38	-8/3	8/-17
James River Jamestown, ND (Stutsman)	Warm/Cold	-39/10	-8/-10	8/-3
James River La Moure, ND (La Moure)	Warm/Cold	-46/3	-8/3	0/-24
James River Columbia, SD (Brown)	Warm/Cold	-46/10	-23/-3	0/3
Maple River ND-SD State Line (Dickey)	Warm/Cold	-39/-10	-15/10	23/-10
Elm River Westport, SD (Brown)	Warm/Cold	-31/-17	-23/-3	0/3
James River Ashton, SD (Spink)	Warm/Cold	-46/10	0/10	0/-3
James River Huron, SD (Beadle)	Warm/Cold	-39/17	0/-17	0/-17
James River Forestburg, SD (Sanborn)	Warm/Cold	-46/10	0/-24	0/3

The PDO and Crop Yields in the James Sub-basin

The Center for Research on the Changing Earth System (CRCES)

USDA-NASS data from 1961 to 2014

PDO Warm phase: Above average soybean and hay yields, and below average wheat and corn yields in almost all counties; generally opposite behavior in PDO Cold phase



Soybean
1961-2014

Corn
1961-2014

Wheat
1961-2007

Hay
1961-2014

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 the James River sub-basin (JSB).

Stakeholder Advisory Team

☞ Provided detailed and quantitative information about agriculture and water resources in JSB; 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

☞ Surface and groundwater used for irrigation, especially in the northern part of the sub-basin where groundwater aquifers fully appropriated.

☞ Groundwater withdrawn from aquifers throughout the basin, with the withdrawals restricted by the requirement that the average annual use cannot exceed average annual recharge.

☞ In South Dakota, both surface and groundwater used, with James River surface water allocated by the Water Management Board with a limit on the amount of diversions allowed.

☞ Main crops: Corn, soybeans, wheat, and potatoes.

☞ Corn and soybeans most frequent irrigated crops, needing water later in the growing season.

Your Responses

Perceptions of Dry and Wet Cycles

- 7 - 12 years and 22 - 25 years wet/dry cycles.
- Wet epochs in combination of cold phase of the PDO and La Niña.
- Prominent decadal variability of precipitation in eastern North Dakota.

Your Responses

Potential usefulness of predictions

☞ Can attract the attention of urban and agricultural communities.

☞ In North Dakota, a lack of understanding of community vulnerabilities to droughts and how to cope with them; local and tribal levels need more guidance; information from this project useful for increasing awareness.

☞ Farmers would change crop varieties before changing crop types if a dry/wet epoch predicted; would probably use the information to plant specific hybrids if dry or wet epoch prediction.

☞ Other adaptation actions such as planting a type of crop that may need water in spring if a wetter spring and drier summer/autumn predicted rather than crops which require water in summer/autumn.

☞ Change in tilling practices depending on prediction of dry/wet epoch.

Your Responses

Bio-fuels production

☞ Since the first bio-fuels plant was built in 2007, a substantial fraction of the corn production used to make ethanol.

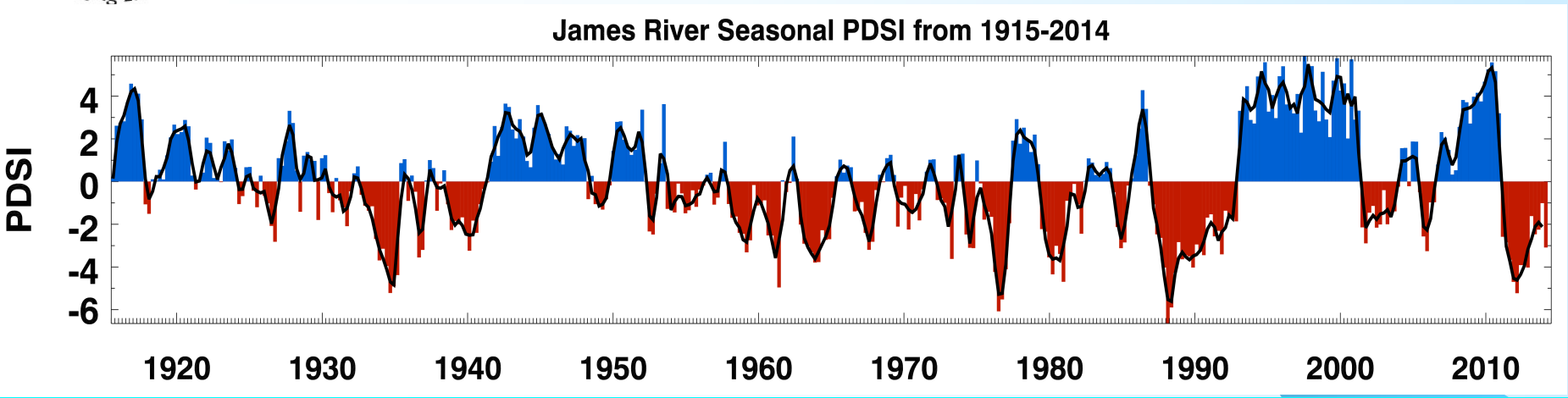
☞ Soybean production impacted by DCV phenomena, so future climate variability will influence oil and bio-diesel productions.

Drought Information Needs

- ☞ **Length and severity of drought.**
- ☞ **Prediction of drier/wetter condition in each season over the next year to inform which crop to plant and decision about corn-soybean rotation.**

Round 2
Today

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



- Red – negative PDSI – dry
- Blue – positive PDSI – wet
- Pronounced dry-wet cycles in the James for at least last 100 years
- Very dry epoch from early 1950s to early 1990s
- Very dry to very wet and back to very dry in a decade in the last 25-30 years

Average persistence of dryness/wetness: 1915 - 2014

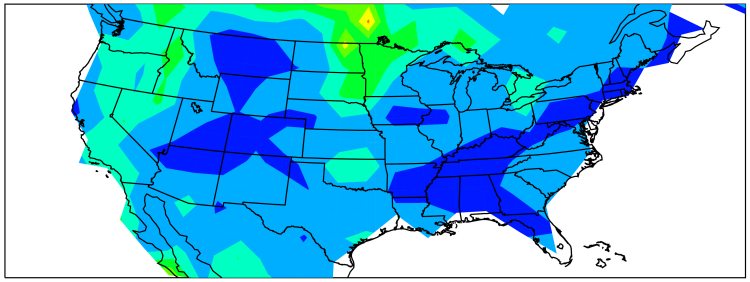
The Center for Research on the Changing Ea CRCES

DRYNESS

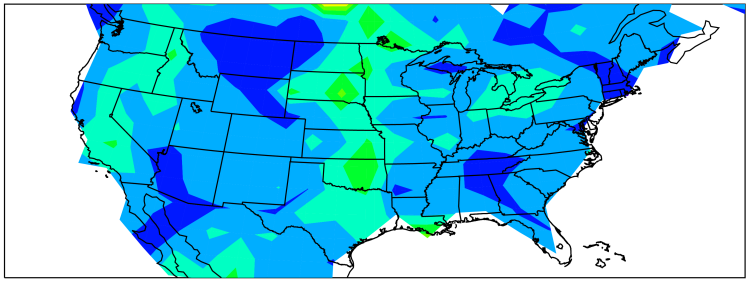
WETNESS

1.5 yrs.

Dry (PDSI < -0.5)



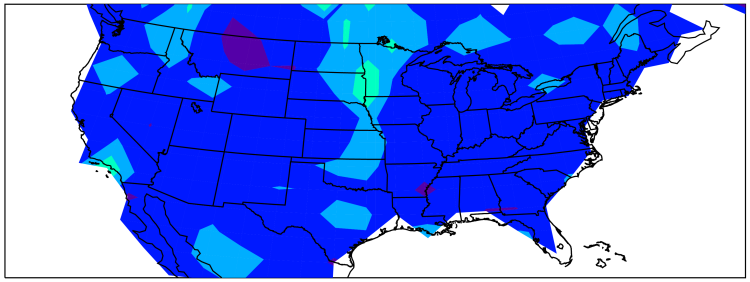
Wet (PDSI > 0.5)



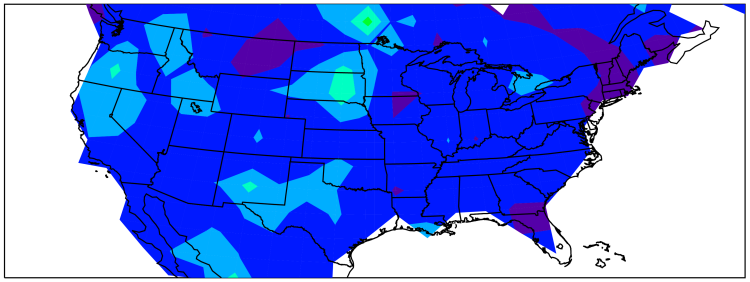
1.5 yrs.

1 yr.

Very Dry (PDSI < -2)



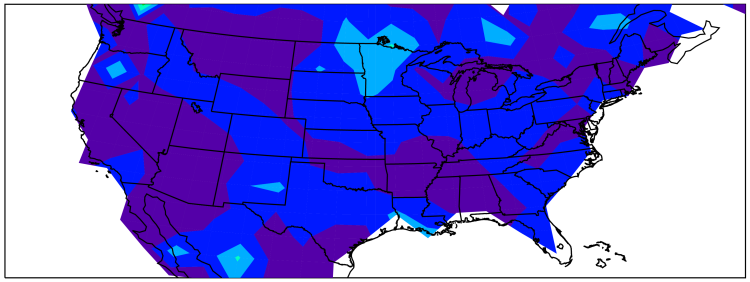
Very Wet (PDSI > 2)



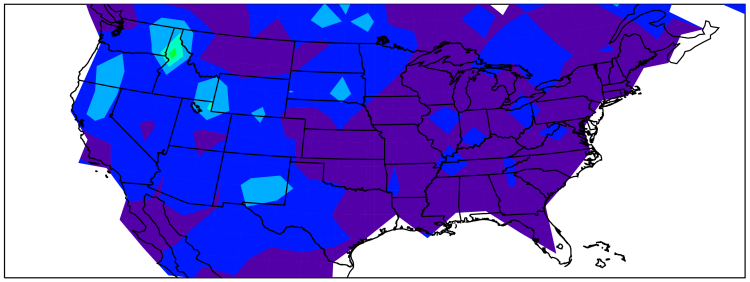
1 yr.

.5-1 yrs.

Extremely Dry (PDSI < -3)



Extremely Wet (PDSI > 3)



< 1 yr.

Number of Seasons

Maximum persistence of dryness/wetness: 1915 - 2014

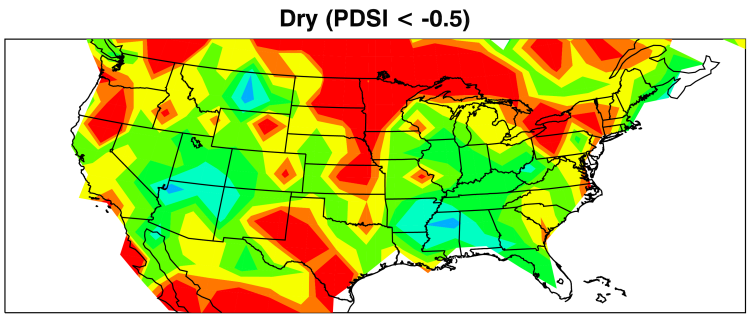
DRYNESS

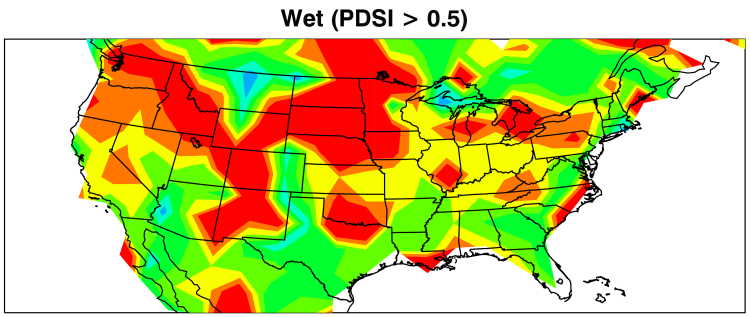
WETNESS

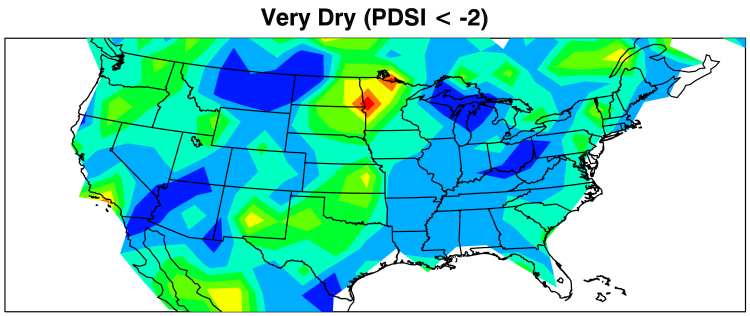
4 yrs. and longer

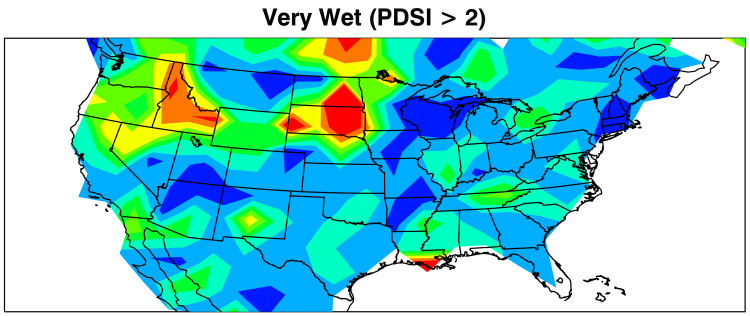
3-4 yrs.

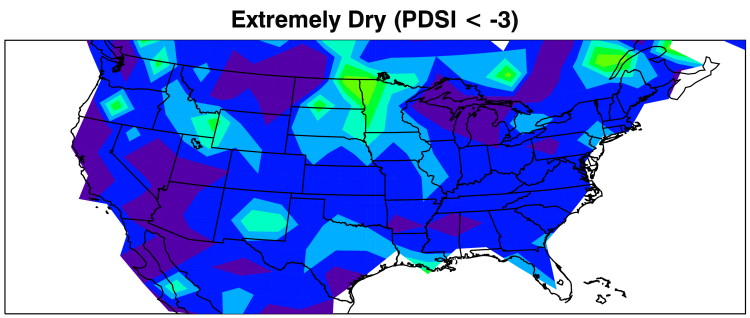
2-3 yrs.

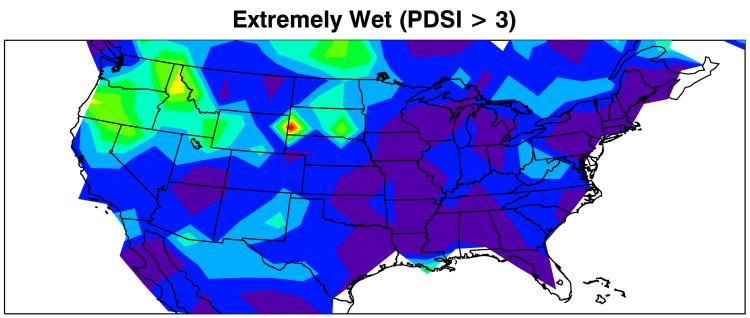


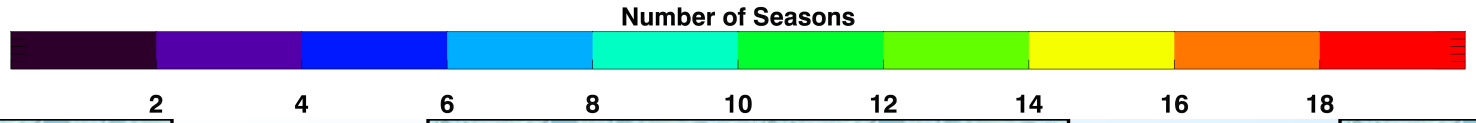












4 yrs. and longer

4 yrs. and longer

2-3 yrs.

Frequencies of dry and wet epochs 1915 - 2014

DRYNESS

Severity	4 to 7 seasons	8 to 11 seasons	12+ seasons
Low	10	5	2
Medium	5	2	1
High	7	0	0

WETNESS

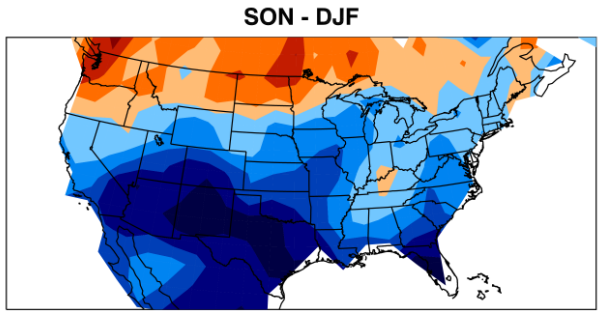
Severity	4 to 7 seasons	8 to 11 seasons	12+ seasons
Low	6	3	3
Medium	3	1	2
High	5	1	0

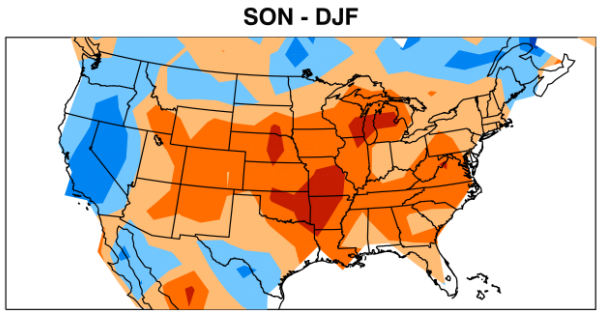
Potential predictability of dryness/wetness using SON PDO and TAG indices as predictors: 1915 - 2014

PDO

TAG

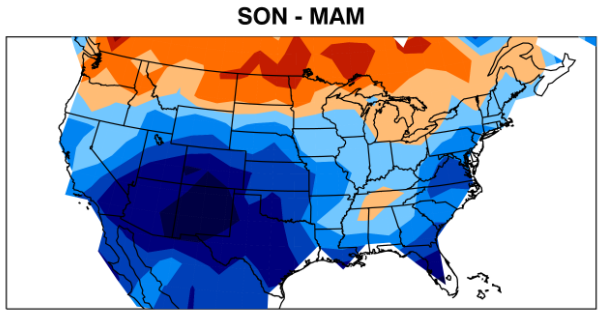
DJF pred. Blue-wet, Red-dry if SON PDO positive

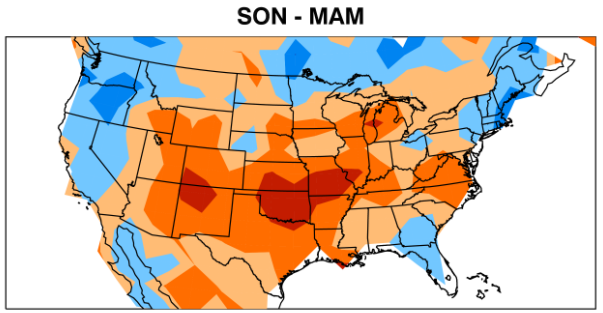




DJF pred. Blue-wet, Red-dry if SON TAG positive

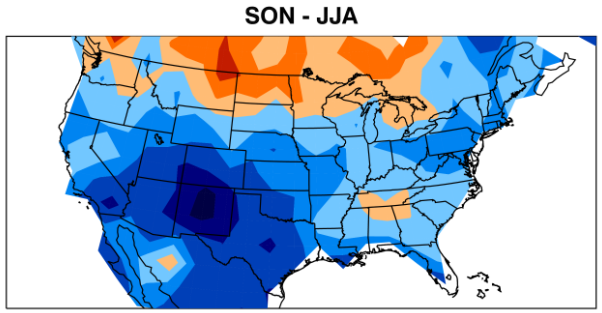
MAM pred. Blue-wet, Red-dry if SON PDO positive

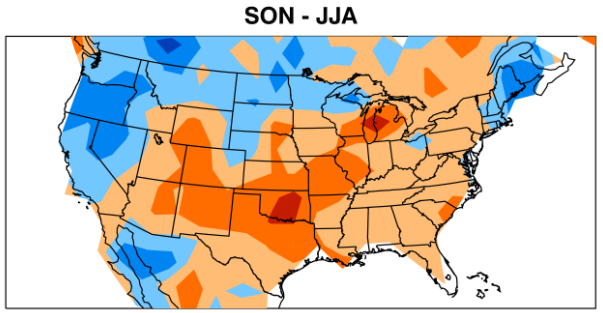




MAM pred. Blue-wet, Red-dry if SON TAG positive

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

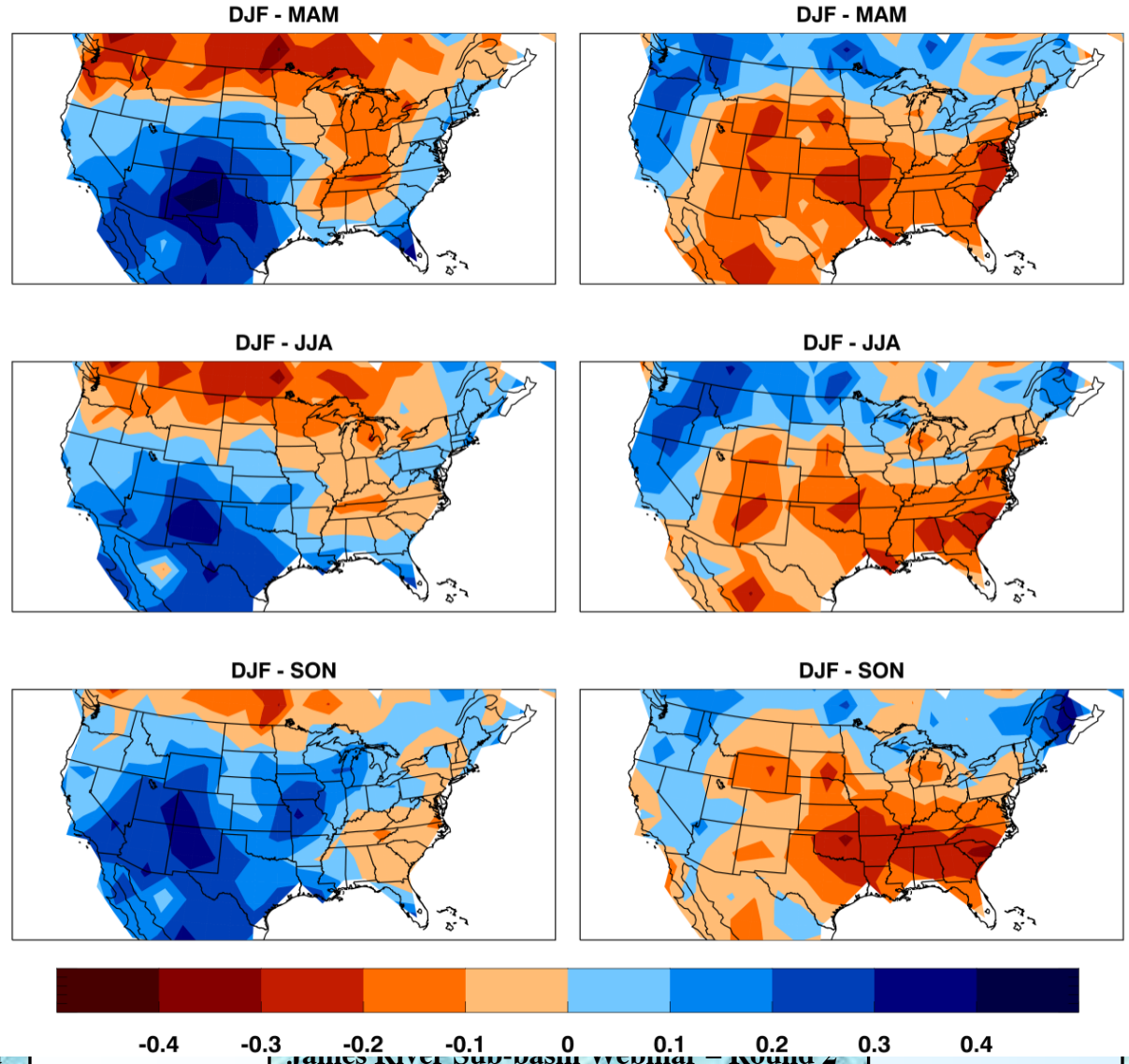
PDO

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 interest with new results.

Stakeholder Advisory Team

☞ Are we addressing your interest in drought information?

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

Thank you!!