Drought in a Changing World

The Past, Present, and Future of Drought Adaptation and Resilience in the Columbia and Missouri River Basins

Montana Climate Office

UNIVERSITY OF MONTANA

How have people experienced **abnormal aridity** in the Missouri and Columbia basins?

1) Where we are now

2) Where we've come from

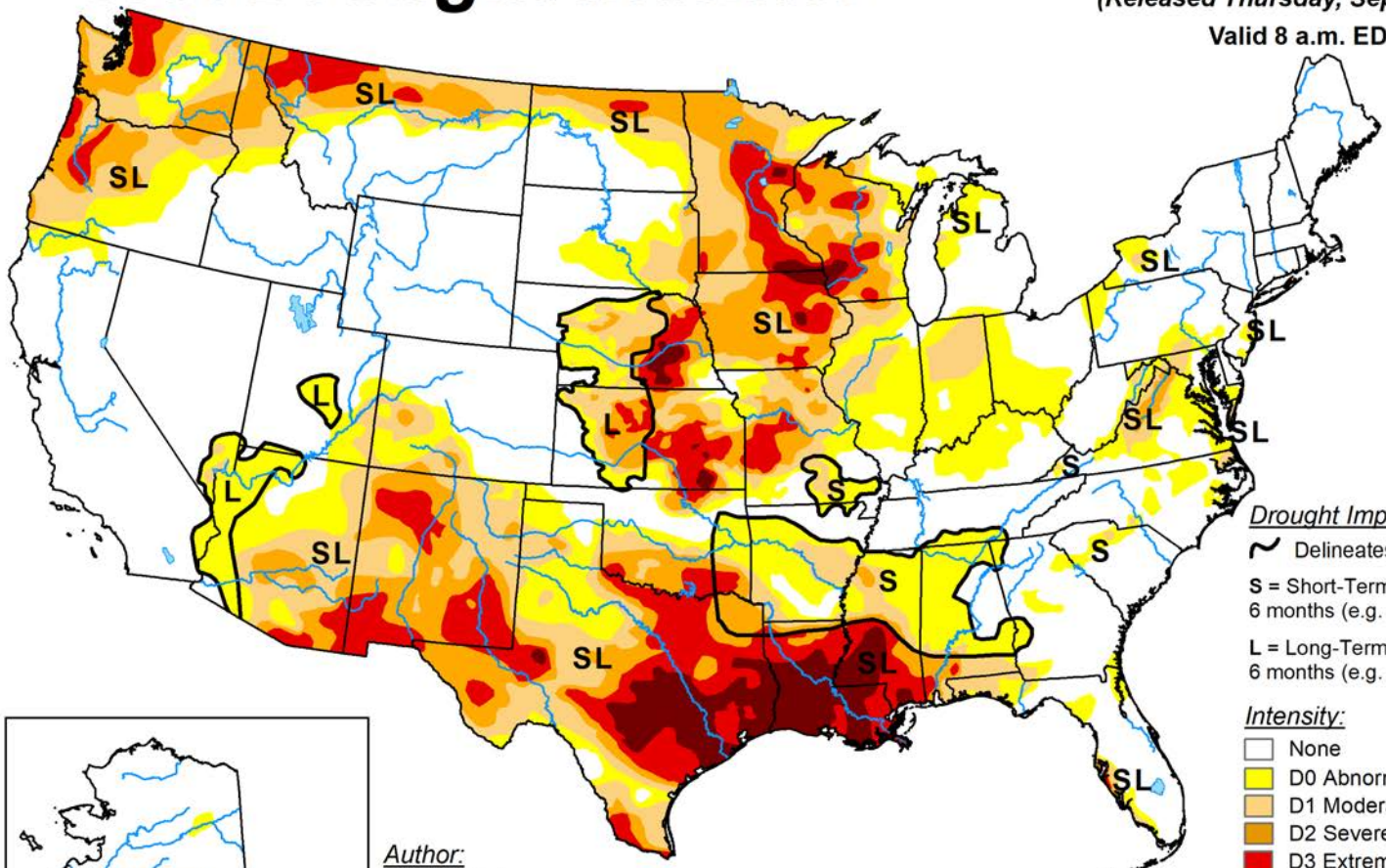
3) Where we are going

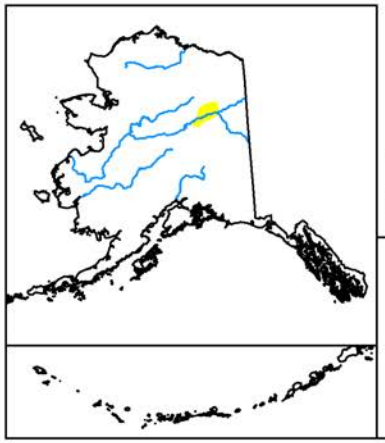
U.S. Drought Monitor

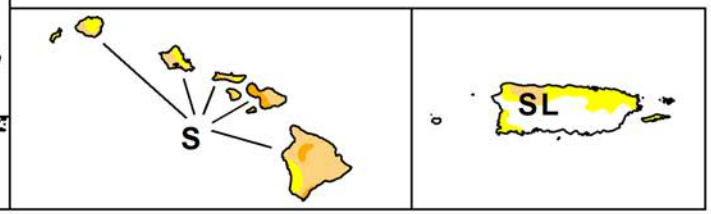
September 19, 2023

(Released Thursday, Sep. 21, 2023)

Valid 8 a.m. EDT







Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

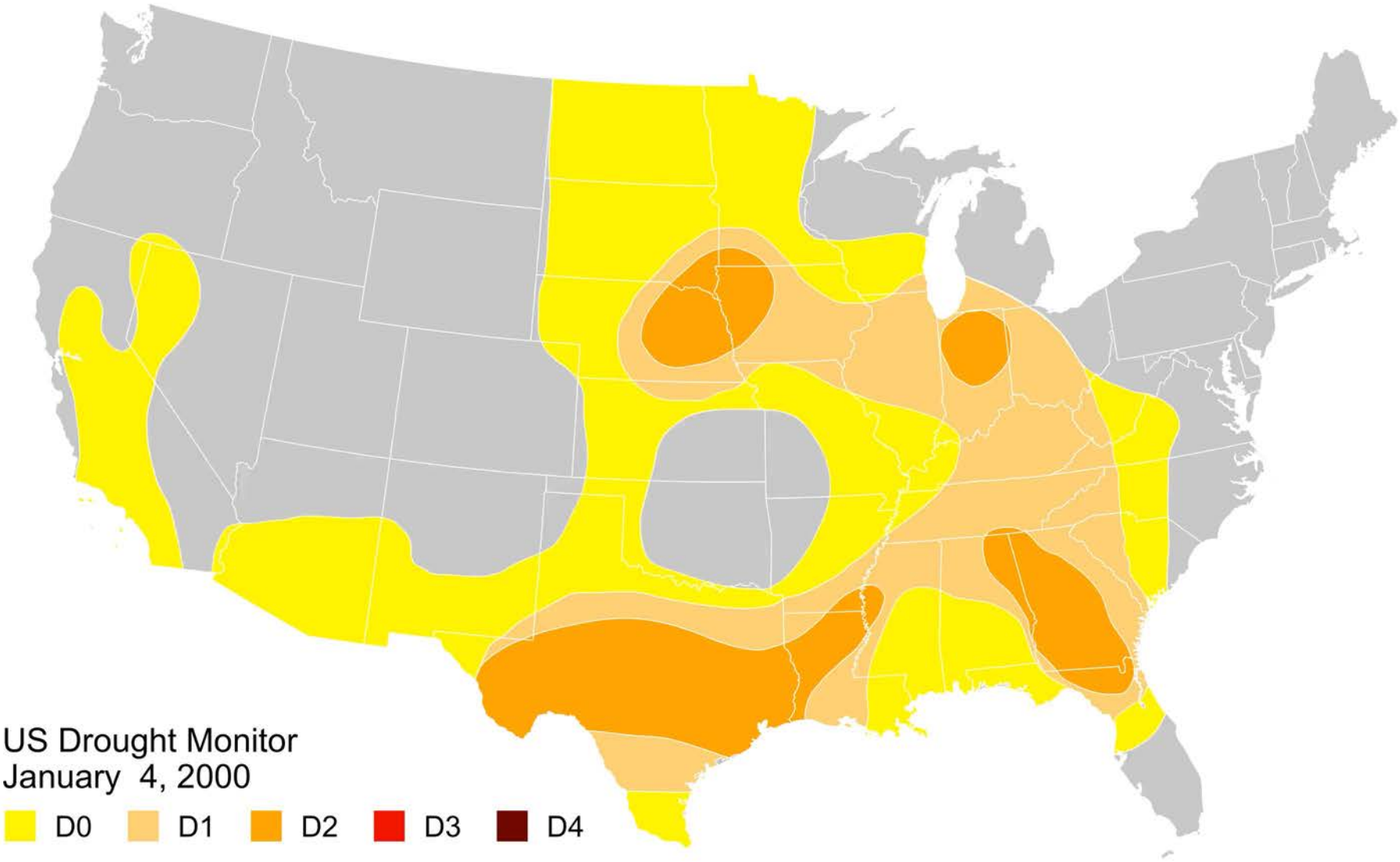
- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

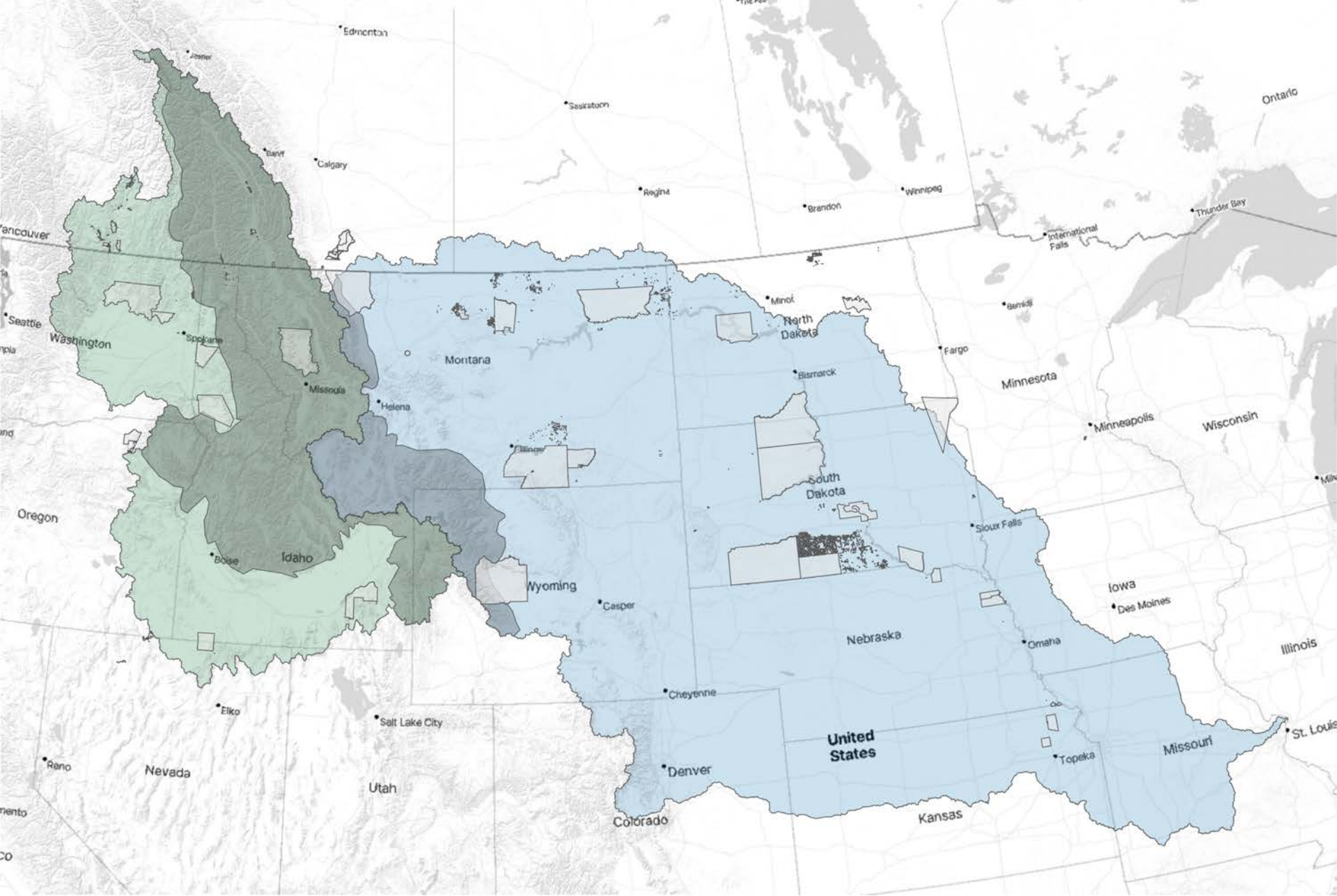
Author:
Richard Heim
NCEI/NOAA

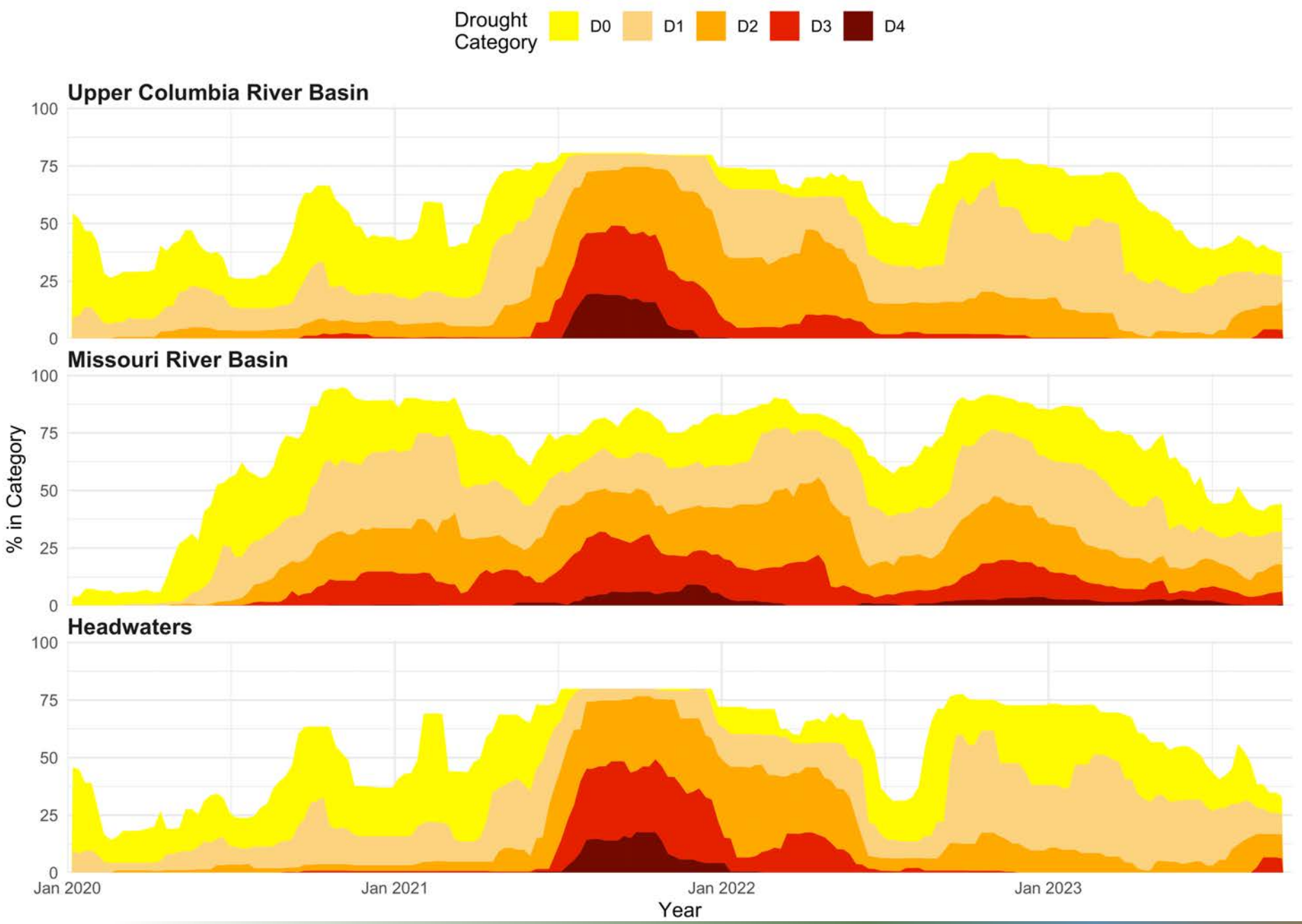
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

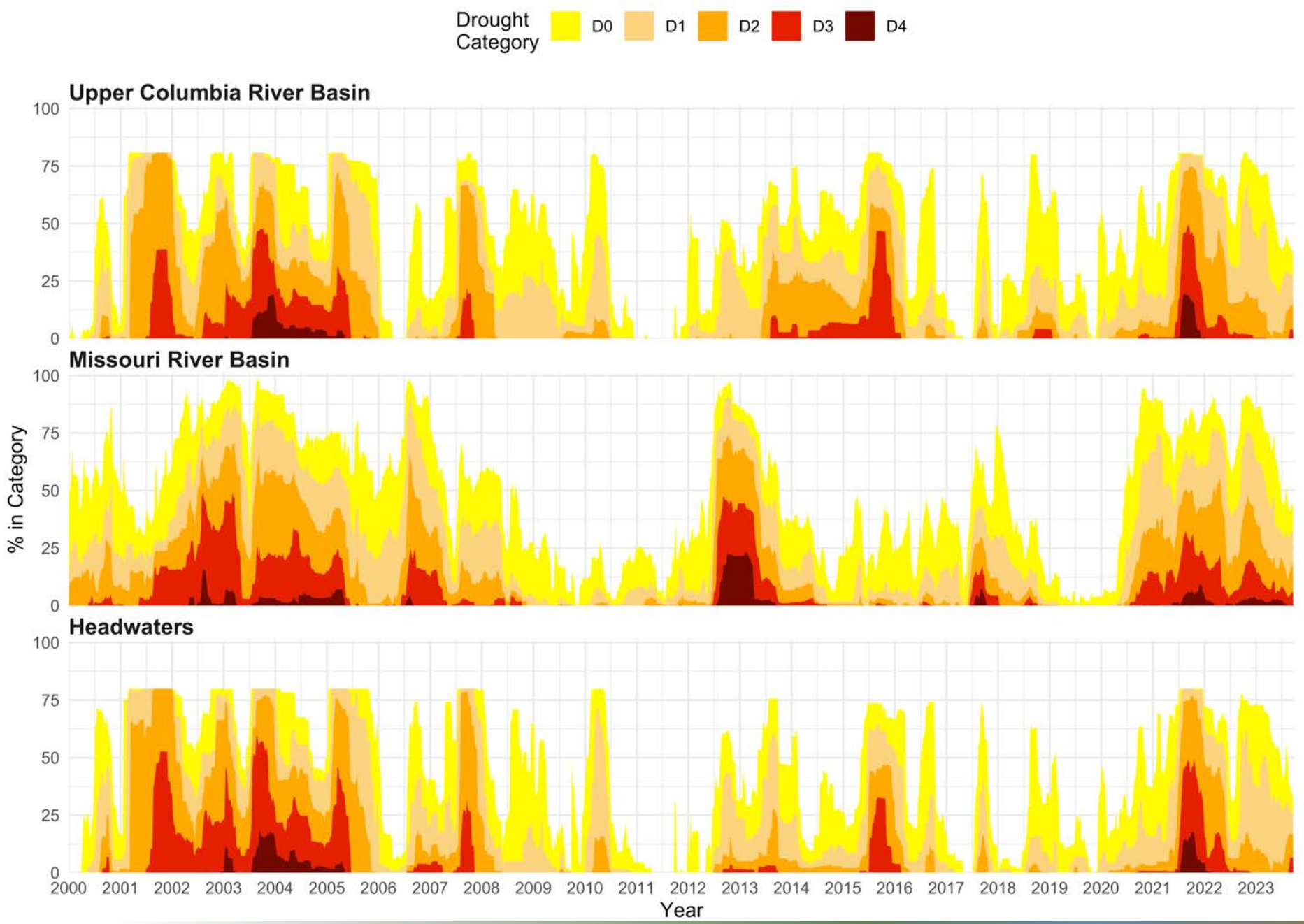
USDA NDMC NOAA

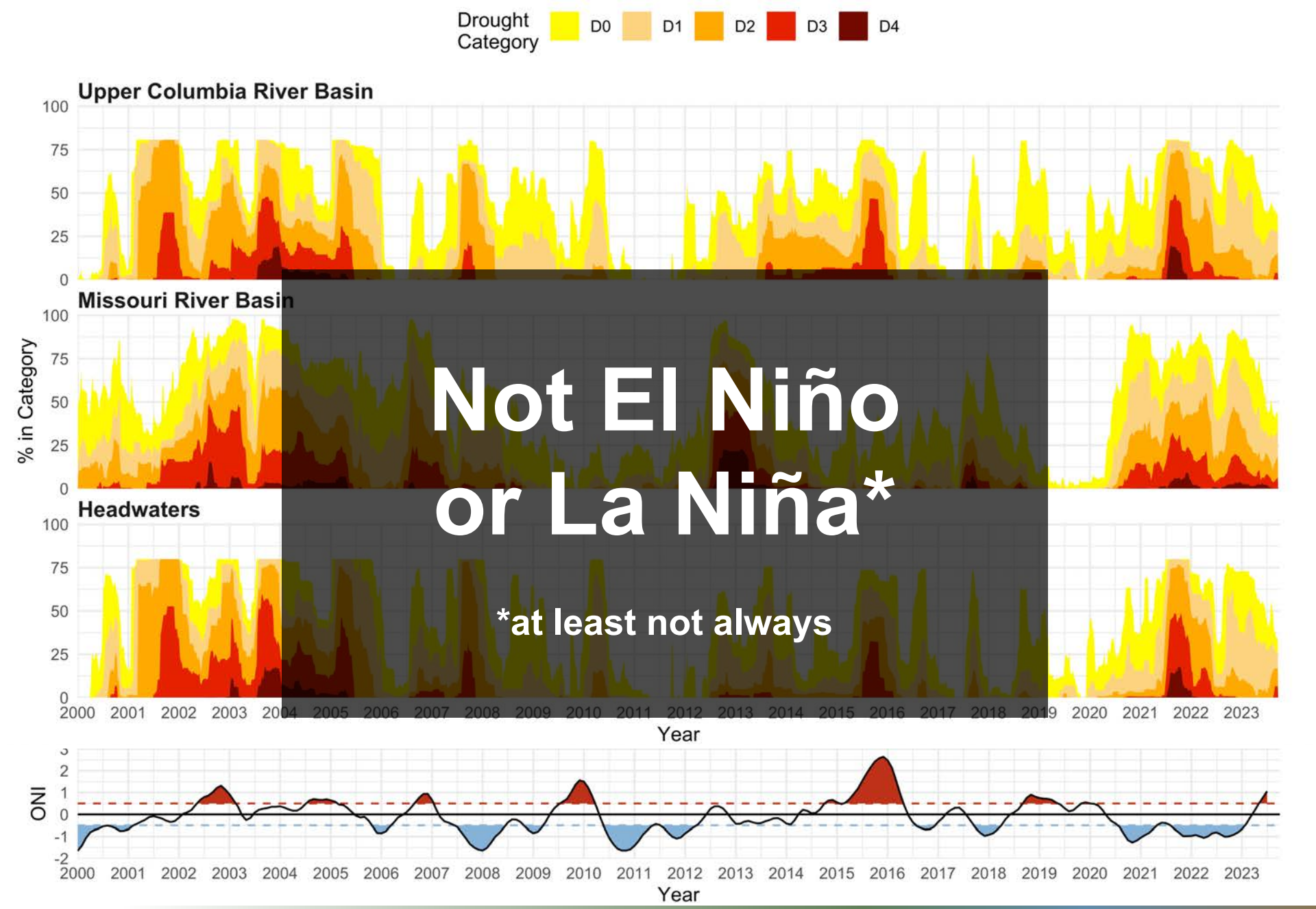
droughtmonitor.unl.edu


US Drought Monitor
January 4, 2000
D0
D1
D2
D3
D4


Edmonton
Saskatoon
Ontario
Calgary
Regina
Winnipeg
Brandon
Thunder Bay
International Falls
Vancouver
Seattle
Washington
Spokane
Minot
North Dakota
Bemidji
Montana
Fargo
Bismarck
Minnesota
Missoula
Helena
Minneapolis
Wisconsin
South Dakota
Oregon
Sioux Falls
Boise
Idaho
Wyoming
Casper
Iowa
Des Moines
Nebraska
Omaha
Illinois
Cheyenne
Elko
Salt Lake City
United States
St. Louis
Reno
Nevada
Utah
Denver
Topeka
Missouri
Colorado
Kansas

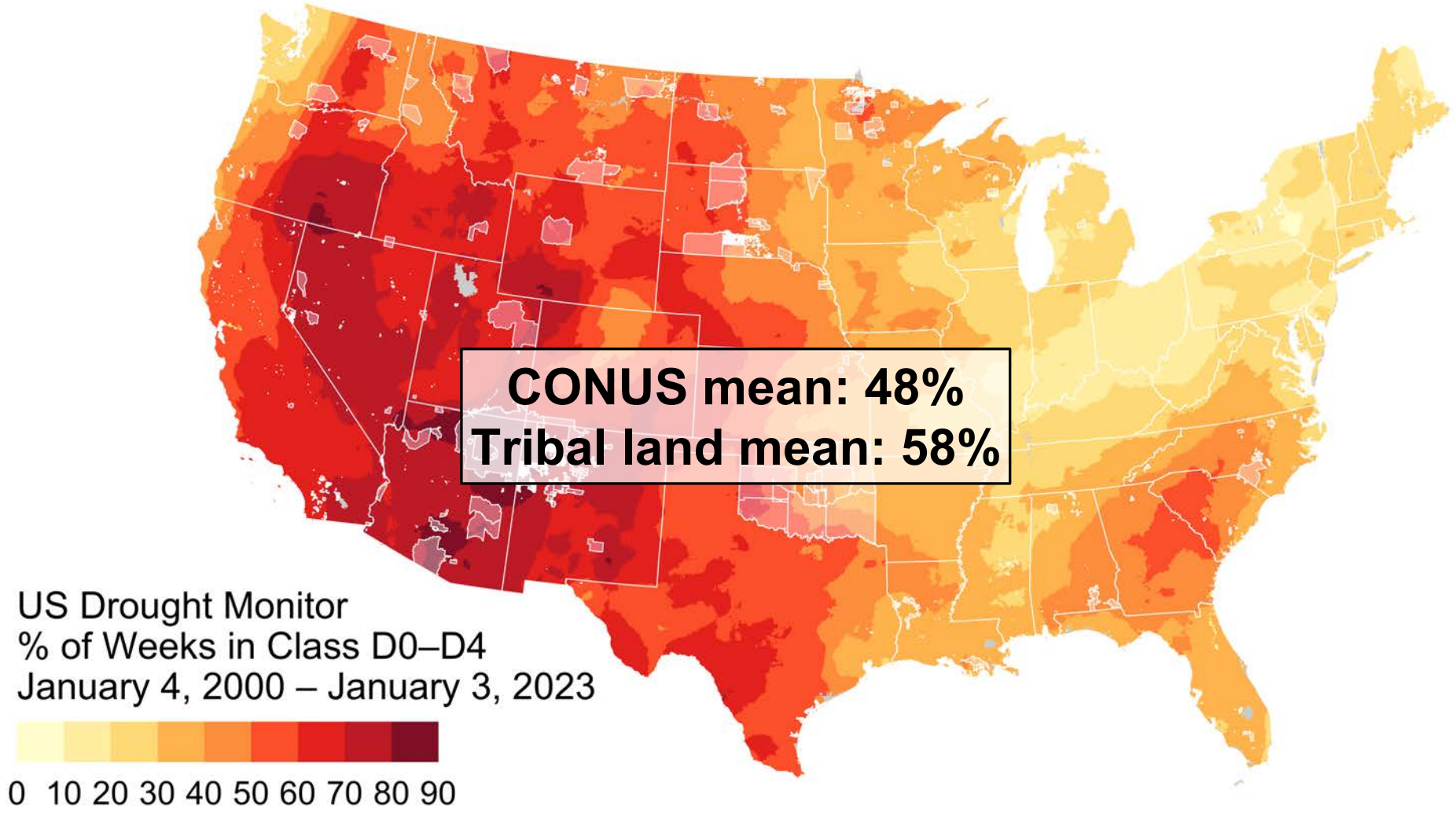

Drought Category
D0
D1
D2
D3
D4
Upper Columbia River Basin
Missouri River Basin
Headwaters
% in Category
100
75
50
25
0
Jan 2020
Jan 2021
Jan 2022
Jan 2023
Year

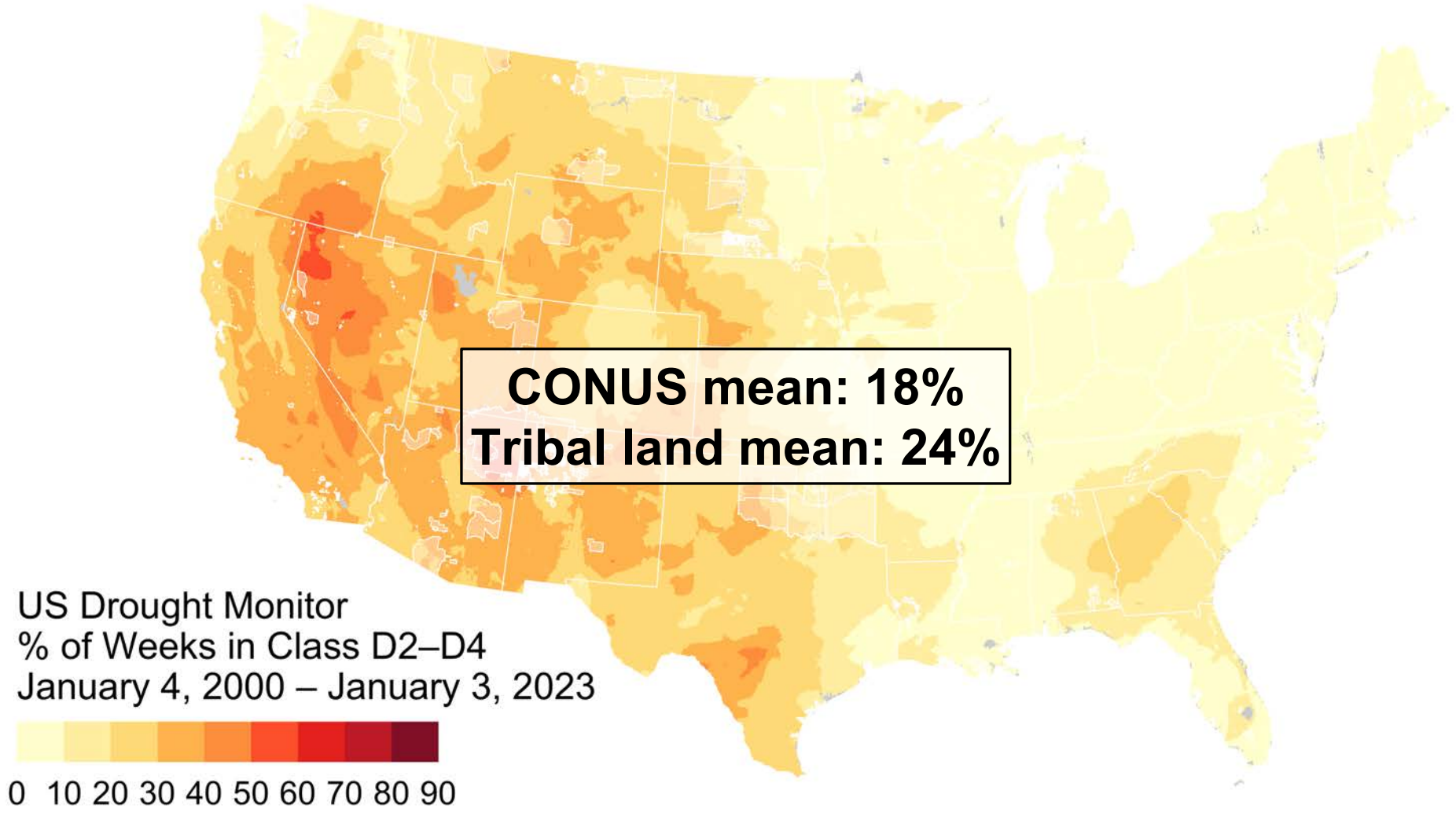

Drought Category
D0
D1
D2
D3
D4
Upper Columbia River Basin
Missouri River Basin
Headwaters
% in Category
100
75
50
25
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

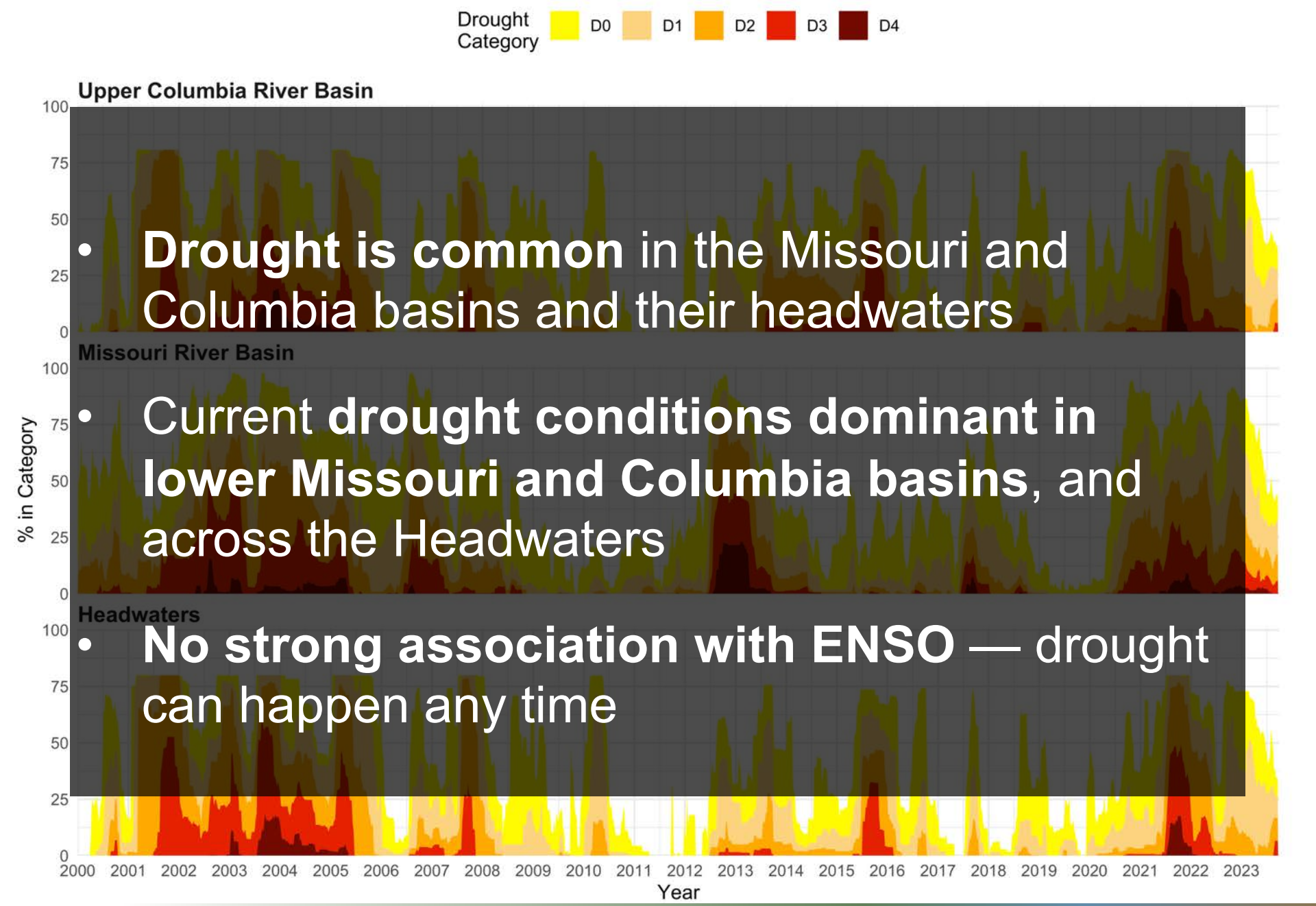


Not El Niño or La Niña*

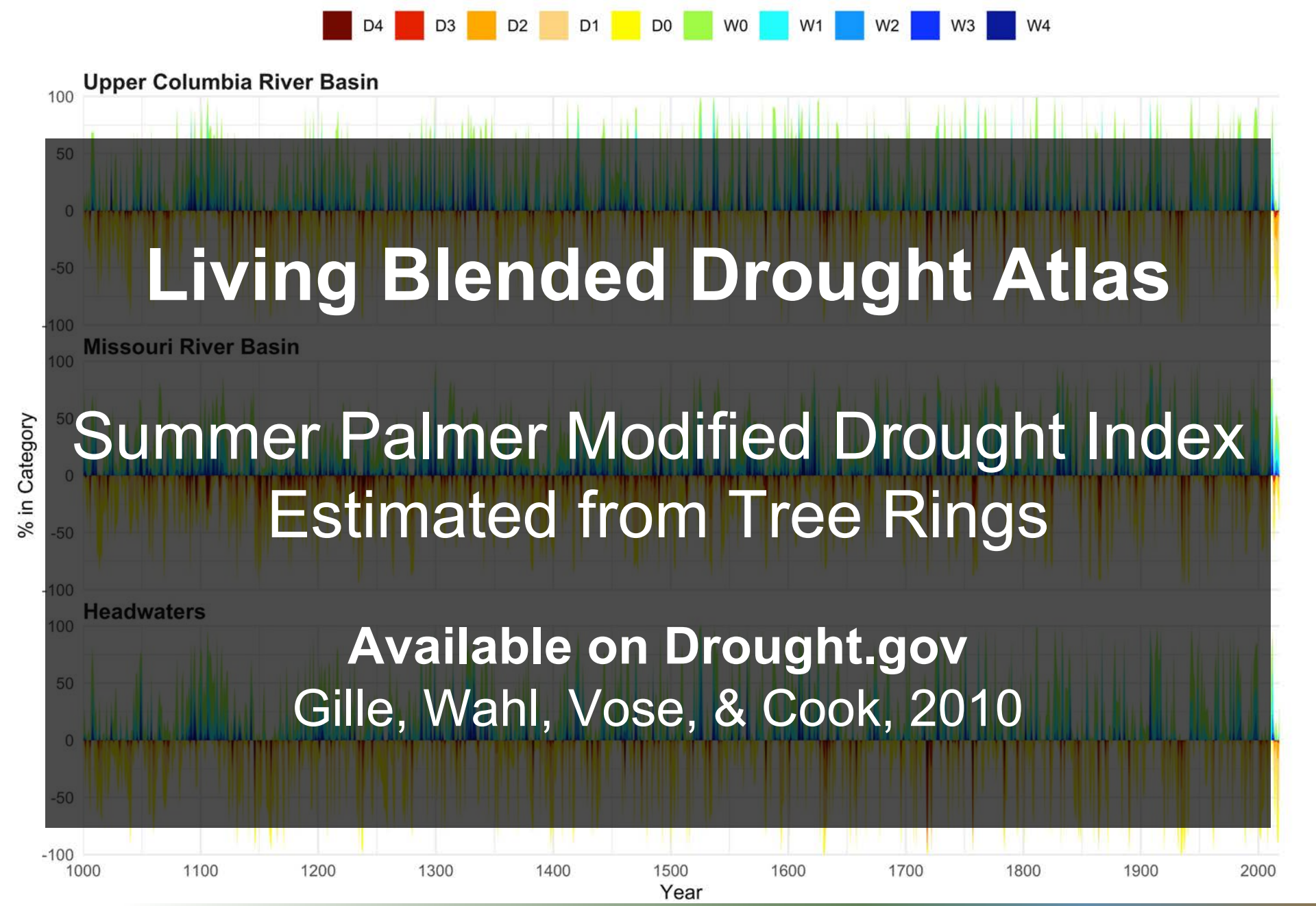
*at least not always


CONUS mean: 48%
Tribal land mean: 58%
US Drought Monitor
% of Weeks in Class D0–D4
January 4, 2000 – January 3, 2023
0 10 20 30 40 50 60 70 80 90


CONUS mean: 18%
Tribal land mean: 24%
US Drought Monitor
% of Weeks in Class D2–D4
January 4, 2000 – January 3, 2023
0 10 20 30 40 50 60 70 80 90



- **Drought is common** in the Missouri and Columbia basins and their headwaters
- Current **drought conditions dominant in lower Missouri and Columbia basins**, and across the Headwaters
- **No strong association with ENSO** — drought can happen any time

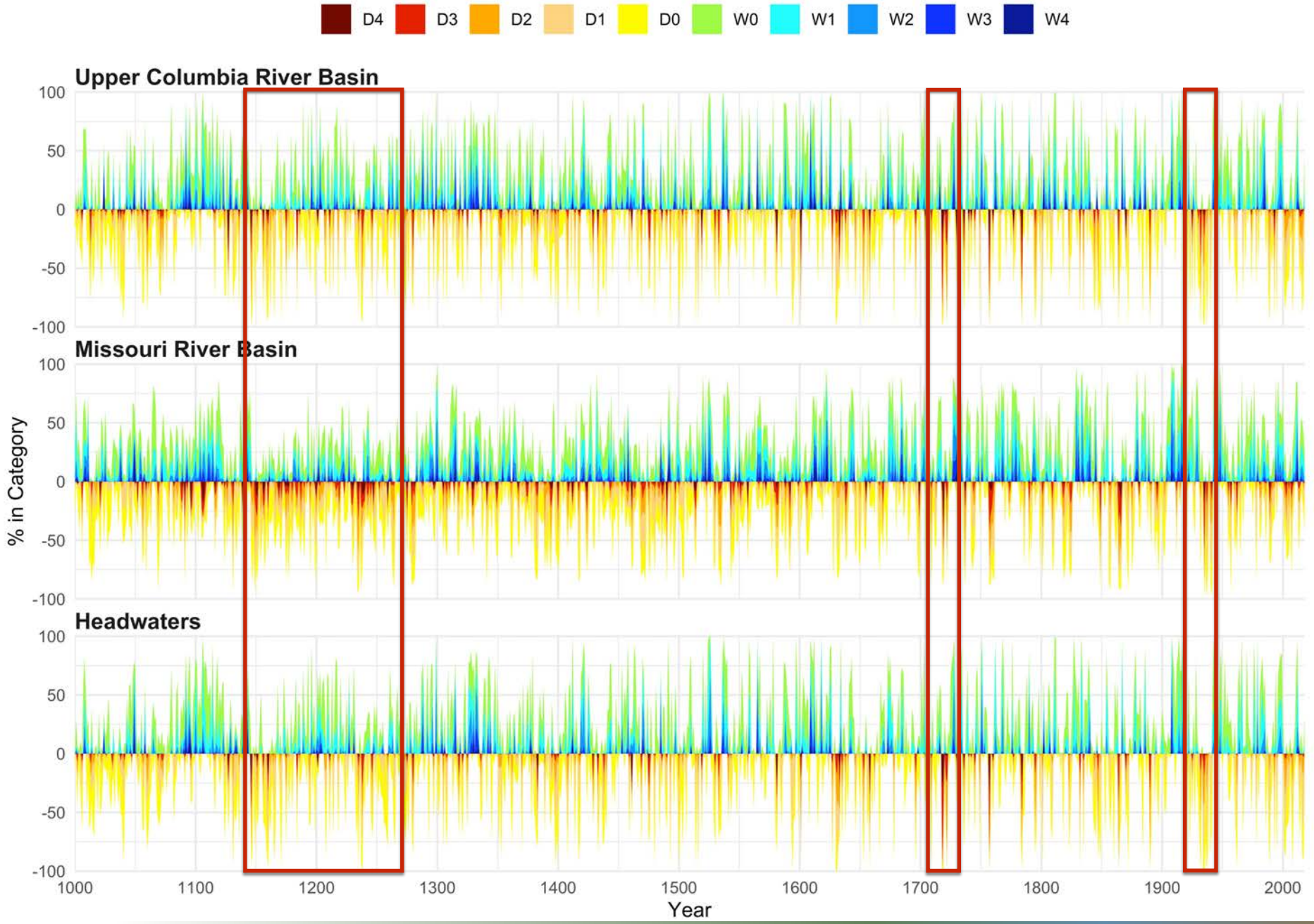


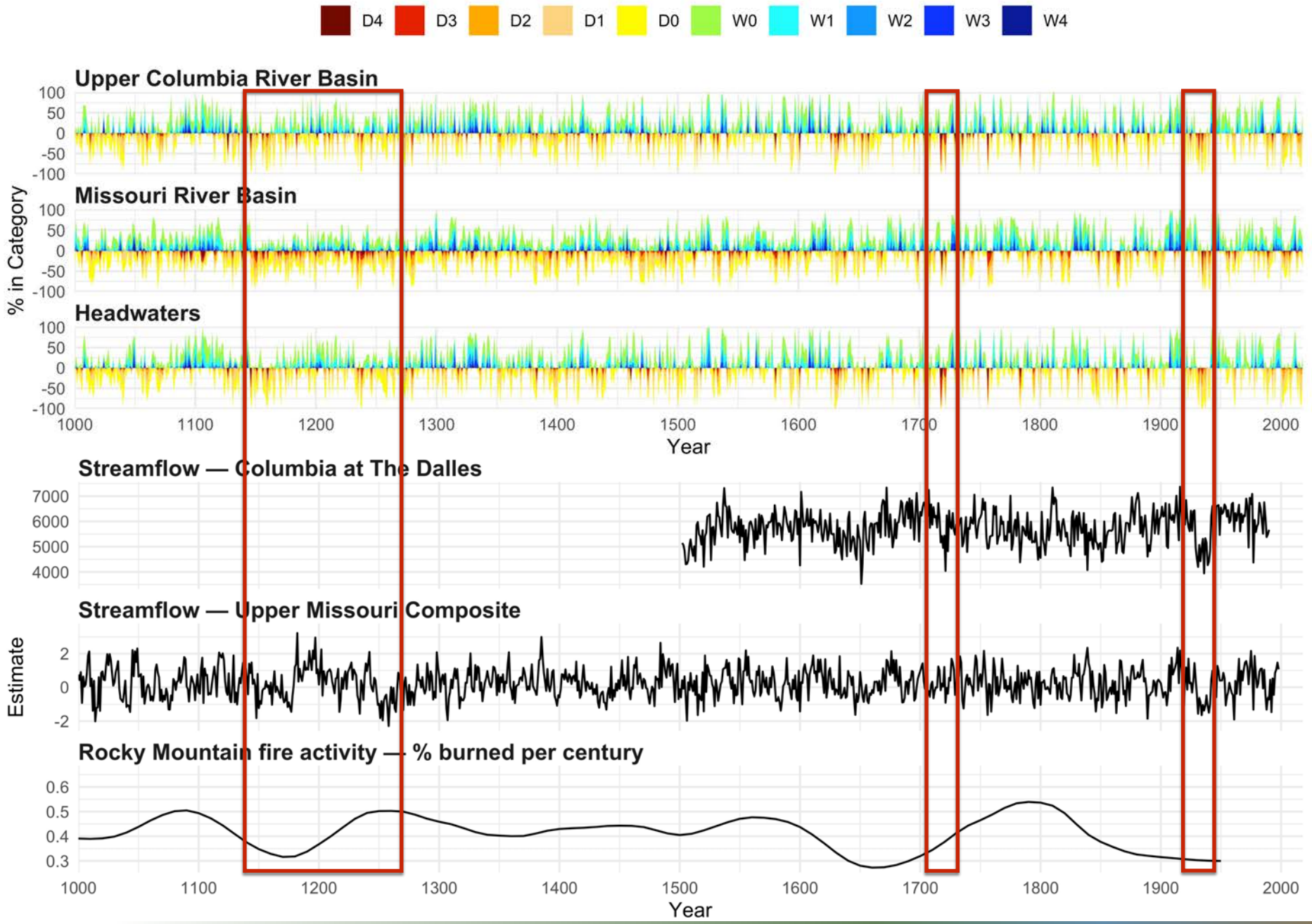
Living Blended Drought Atlas

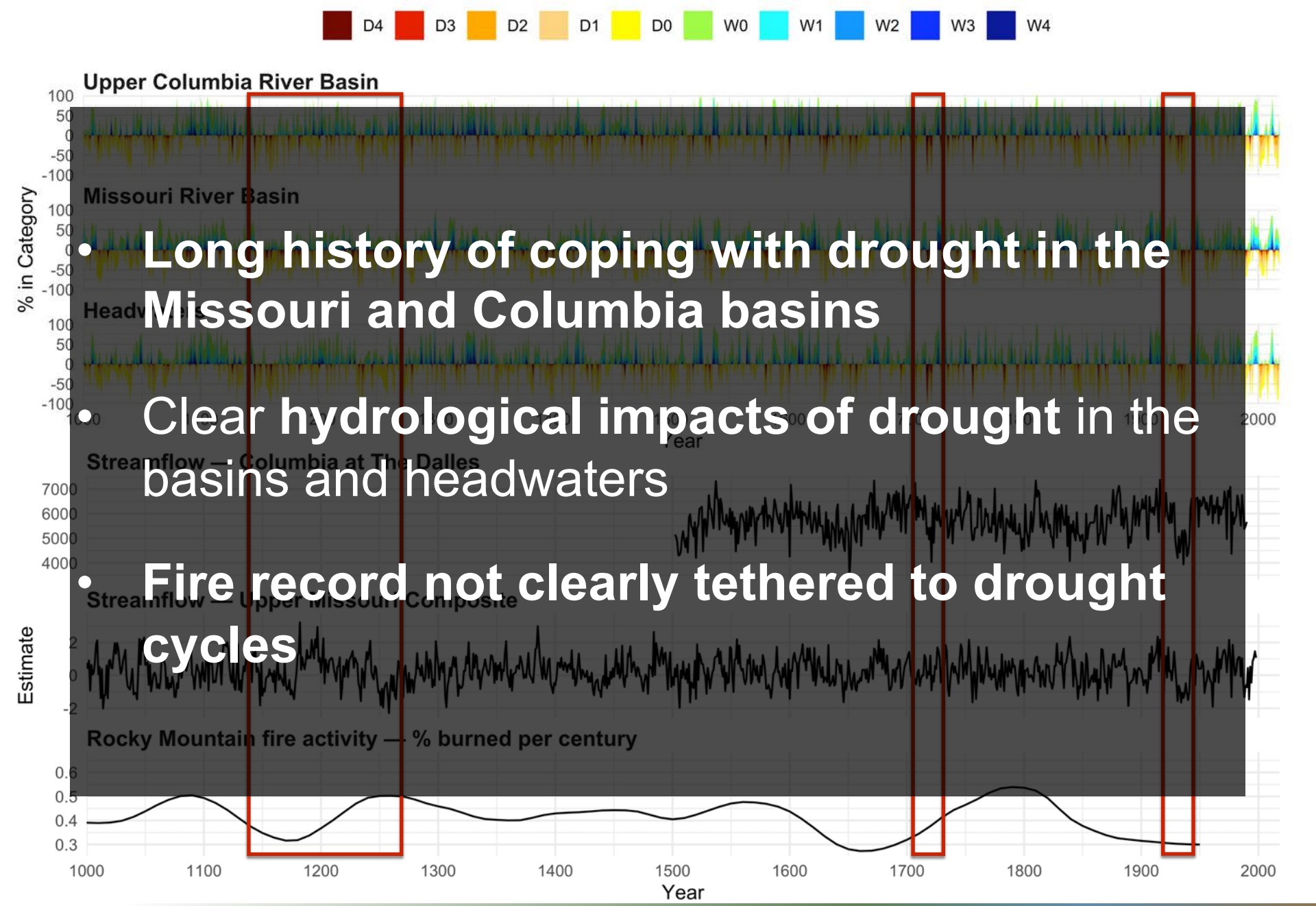
Summer Palmer Modified Drought Index
Estimated from Tree Rings

Available on Drought.gov

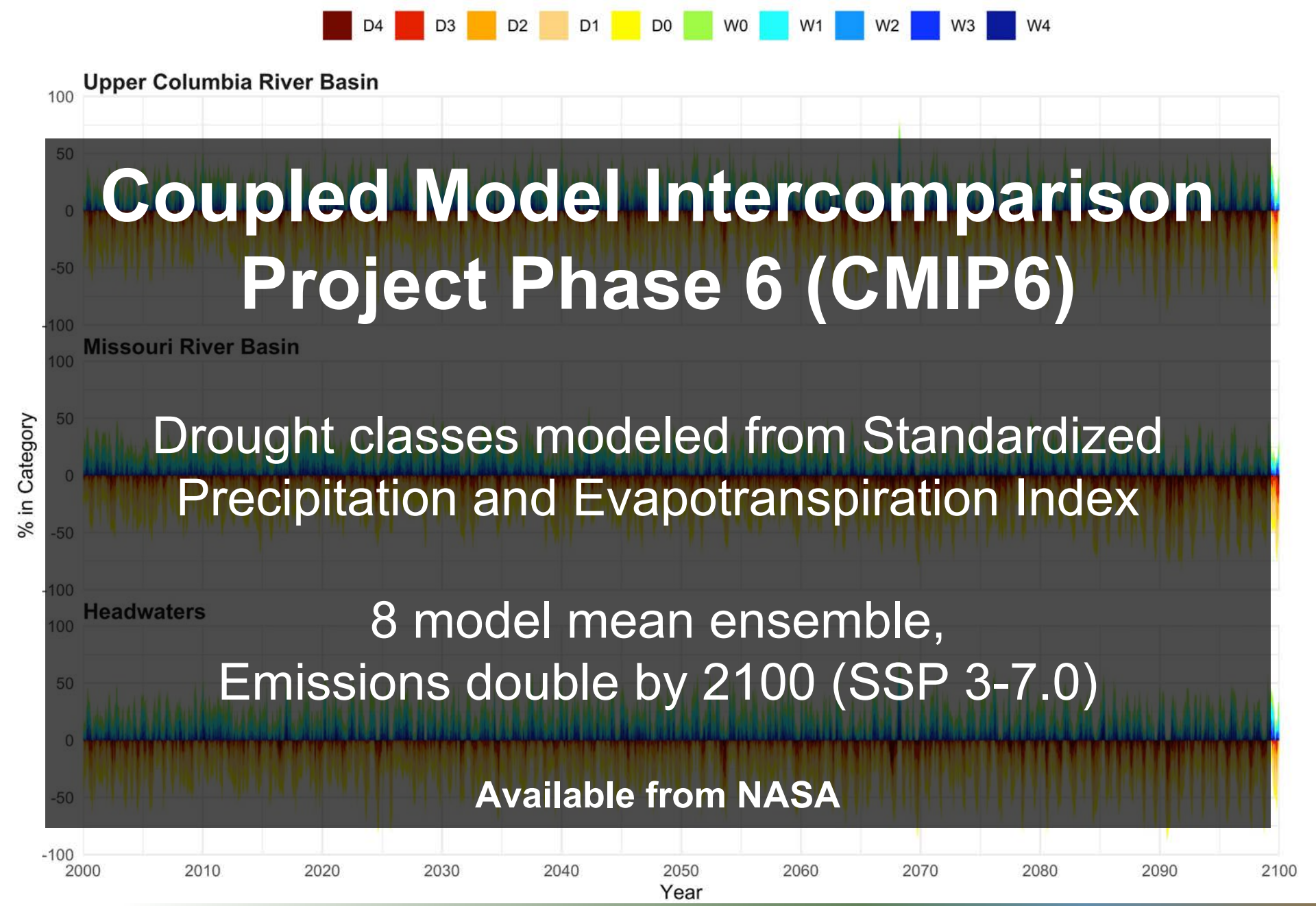
Gille, Wahl, Vose, & Cook, 2010


D4
D3
D2
D1
D0
W0
W1
W2
W3
W4
Upper Columbia River Basin
Missouri River Basin
Headwaters
% in Category
100
50
0
-50
-100
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year


D4
D3
D2
D1
D0
W0
W1
W2
W3
W4
Upper Columbia River Basin
Missouri River Basin
Headwaters
% in Category
100
50
0
-50
-100
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year
Streamflow — Columbia at The Dalles
7000
6000
5000
4000
Streamflow — Upper Missouri Composite
Estimate
2
0
-2
Rocky Mountain fire activity — % burned per century
0.6
0.5
0.4
0.3
Year



- **Long history of coping with drought in the Missouri and Columbia basins**
- Clear **hydrological impacts of drought** in the basins and headwaters
- **Fire record not clearly tethered to drought cycles**

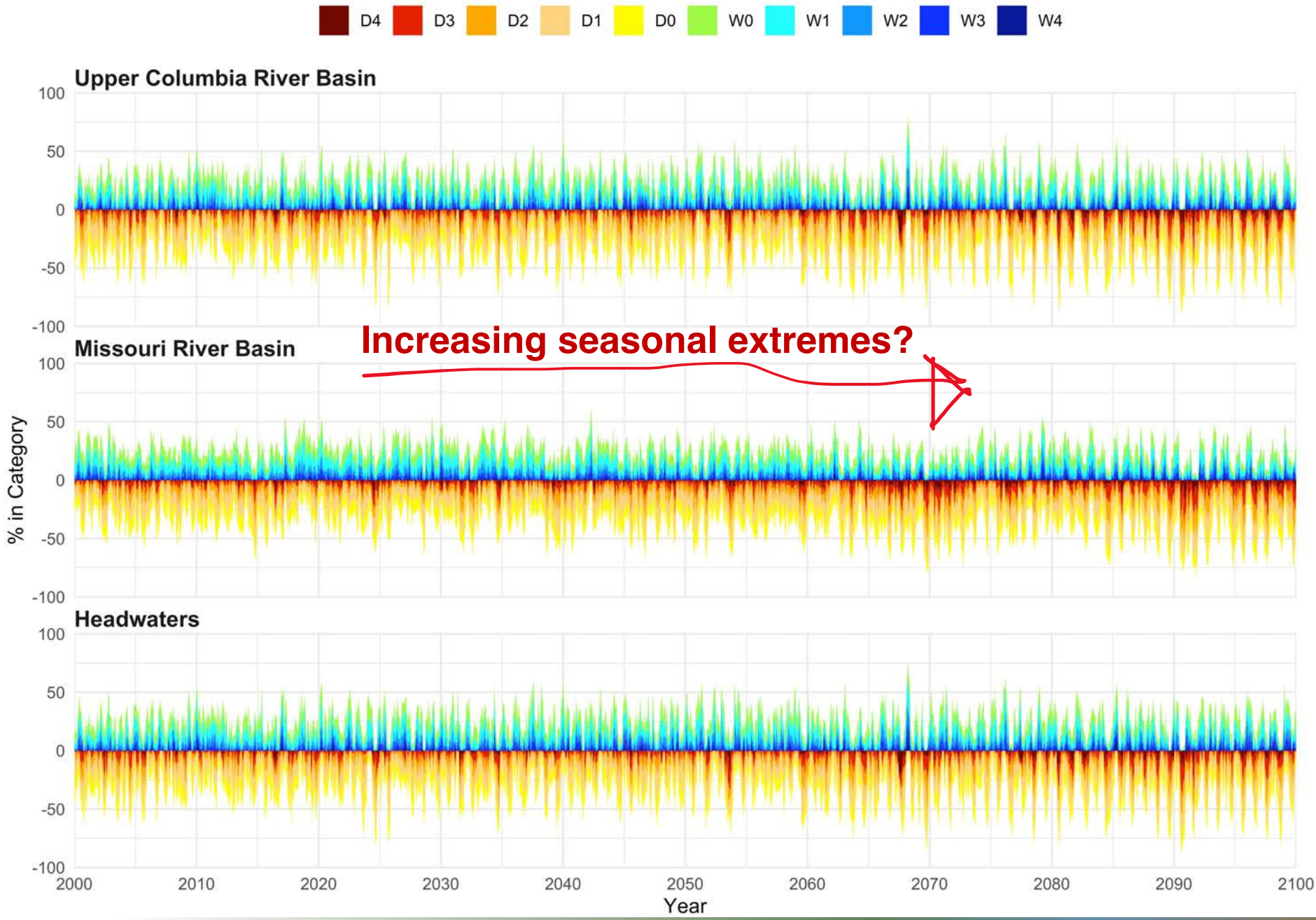


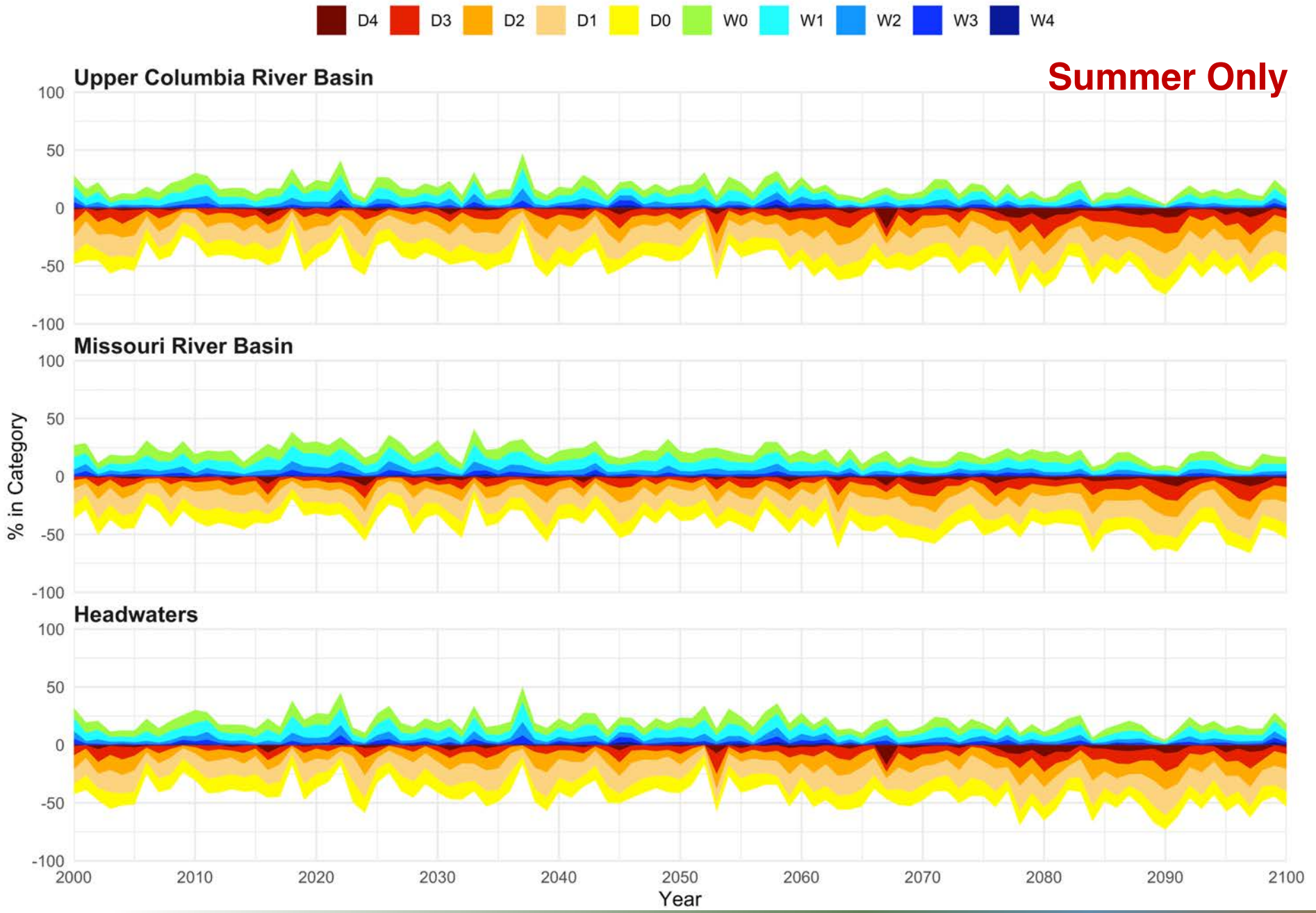
Coupled Model Intercomparison Project Phase 6 (CMIP6)

Drought classes modeled from Standardized Precipitation and Evapotranspiration Index

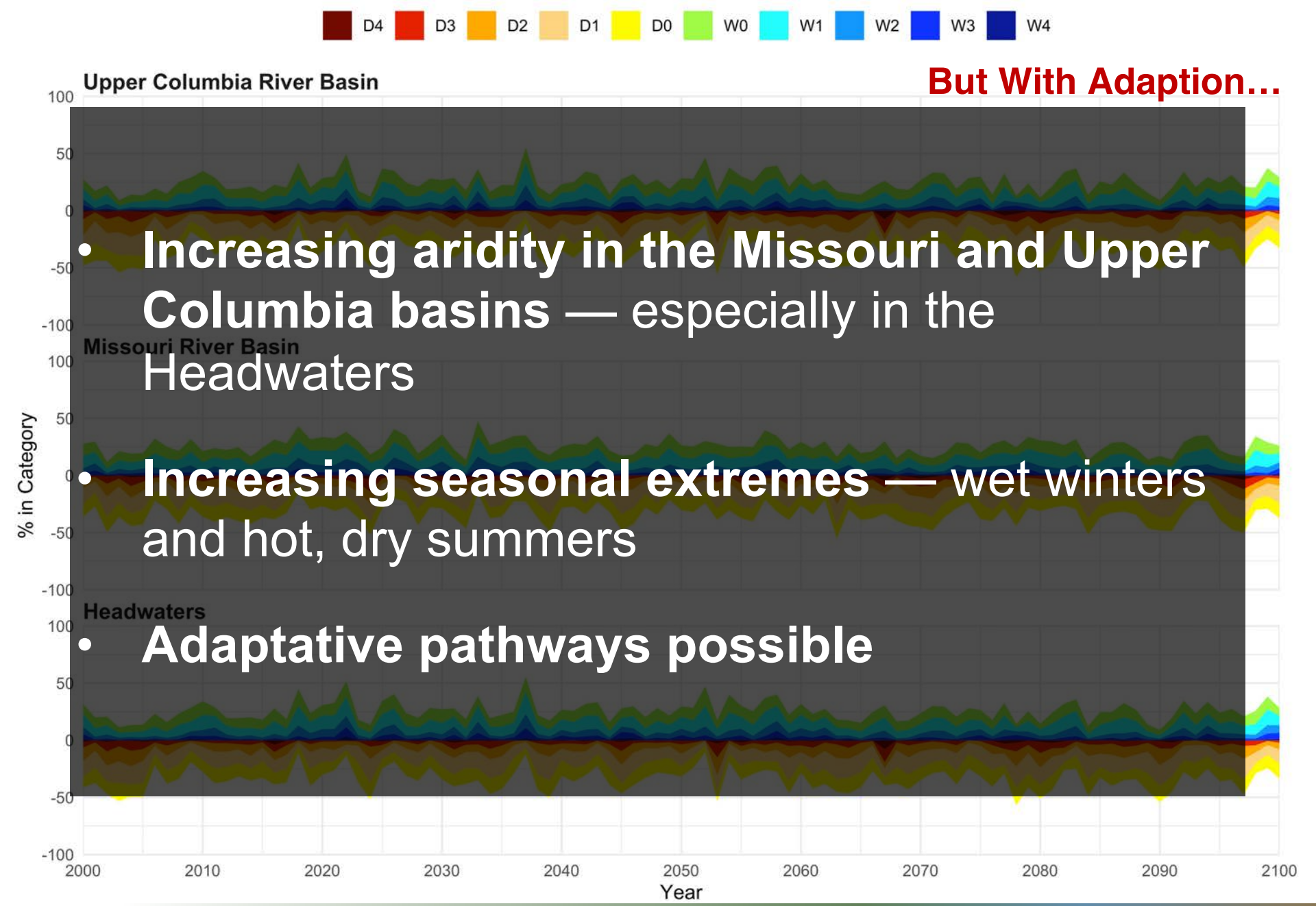
8 model mean ensemble,
Emissions double by 2100 (SSP 3-7.0)

Available from NASA


D4
D3
D2
D1
D0
W0
W1
W2
W3
W4
Upper Columbia River Basin
Missouri River Basin
Headwaters
Increasing seasonal extremes?
% in Category
100
50
0
-50
-100
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year


D4
D3
D2
D1
D0
W0
W1
W2
W3
W4
Summer Only
Upper Columbia River Basin
Missouri River Basin
Headwaters
% in Category
100
50
0
-50
-100
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year


D4
D3
D2
D1
D0
W0
W1
W2
W3
W4
Upper Columbia River Basin
But With Adaption…
Missouri River Basin
Headwaters
% in Category
100
50
0
-50
-100
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year



But With Adaption…

- **Increasing aridity in the Missouri and Upper Columbia basins** — especially in the Headwaters
- **Increasing seasonal extremes** — wet winters and hot, dry summers
- **Adaptative pathways possible**

How will we adapt to **drought in a changing world?**

Points of departure

1) Strengths and vulnerabilities in **taking a long view of drought**
2) **Persistent colonial legacies**
3) **Sovereignty**:
   Food, water, data, culture, trust