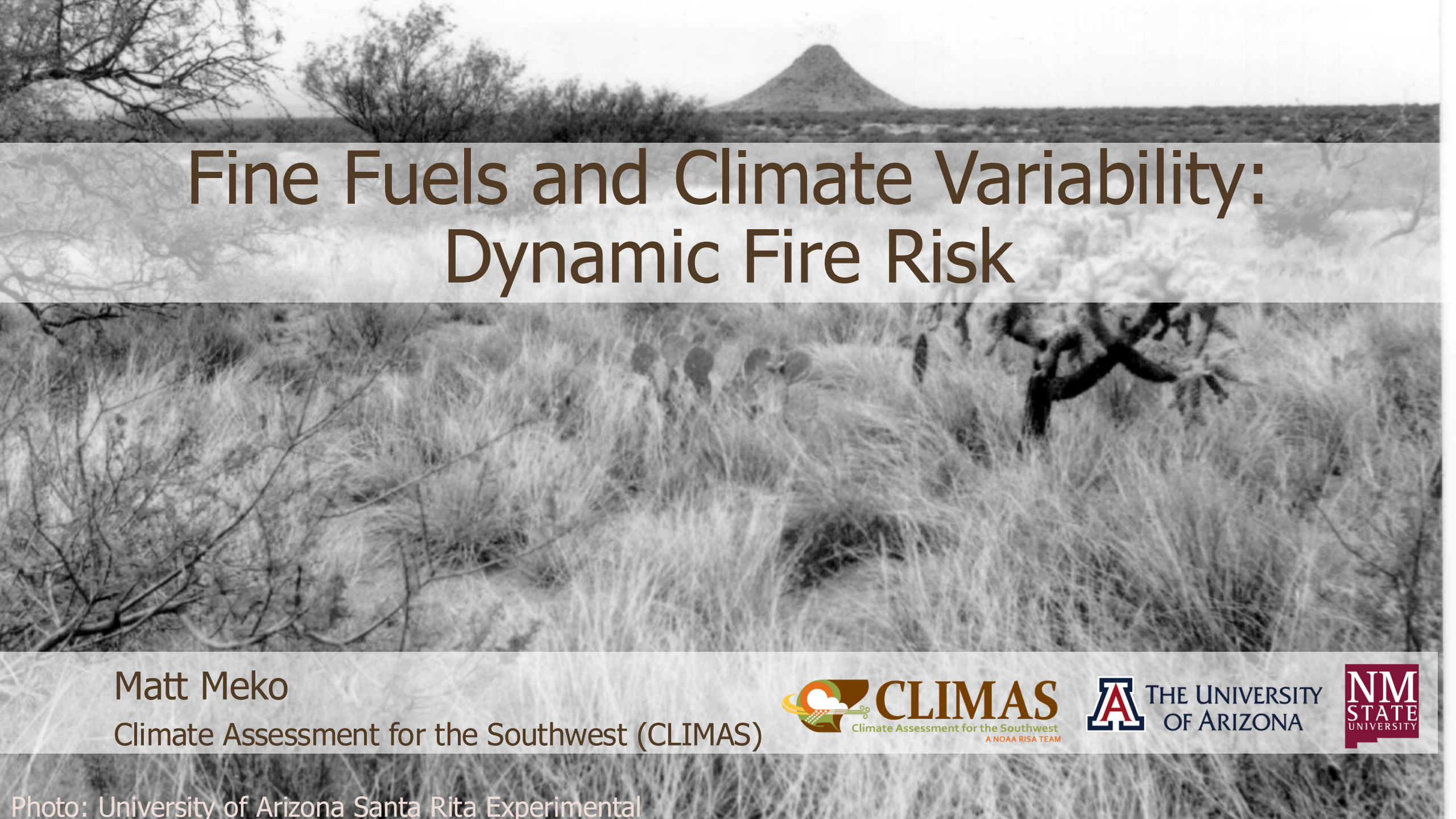


Fine Fuels and Climate Variability: Dynamic Fire Risk

Matt Meko
Climate Assessment for the Southwest (CLIMAS)

CLIMAS
Climate Assessment for the Southwest
A NOAA RISA TEAM

THE UNIVERSITY OF ARIZONA

NM STATE UNIVERSITY

Photo: University of Arizona Santa Rita Experimental

	CONIFERS	GRASSLAND	SHRUBLAND
ANTECEDENT CONDITIONS			
	Dry preceding Fall & Winter	Wet preceding Spring & Summer, fuel buildup	Wet preceding Fall & Winter, fine fuel buildup
		Dry preceding Fall & Winter	
EXTREME WILDFIRE SEASON	Drought conditions persist through Spring	Dry Spring, dry fuels	Dry Spring, dry fine fuels

Crimmins et al. 2025 *Earth Interactions*

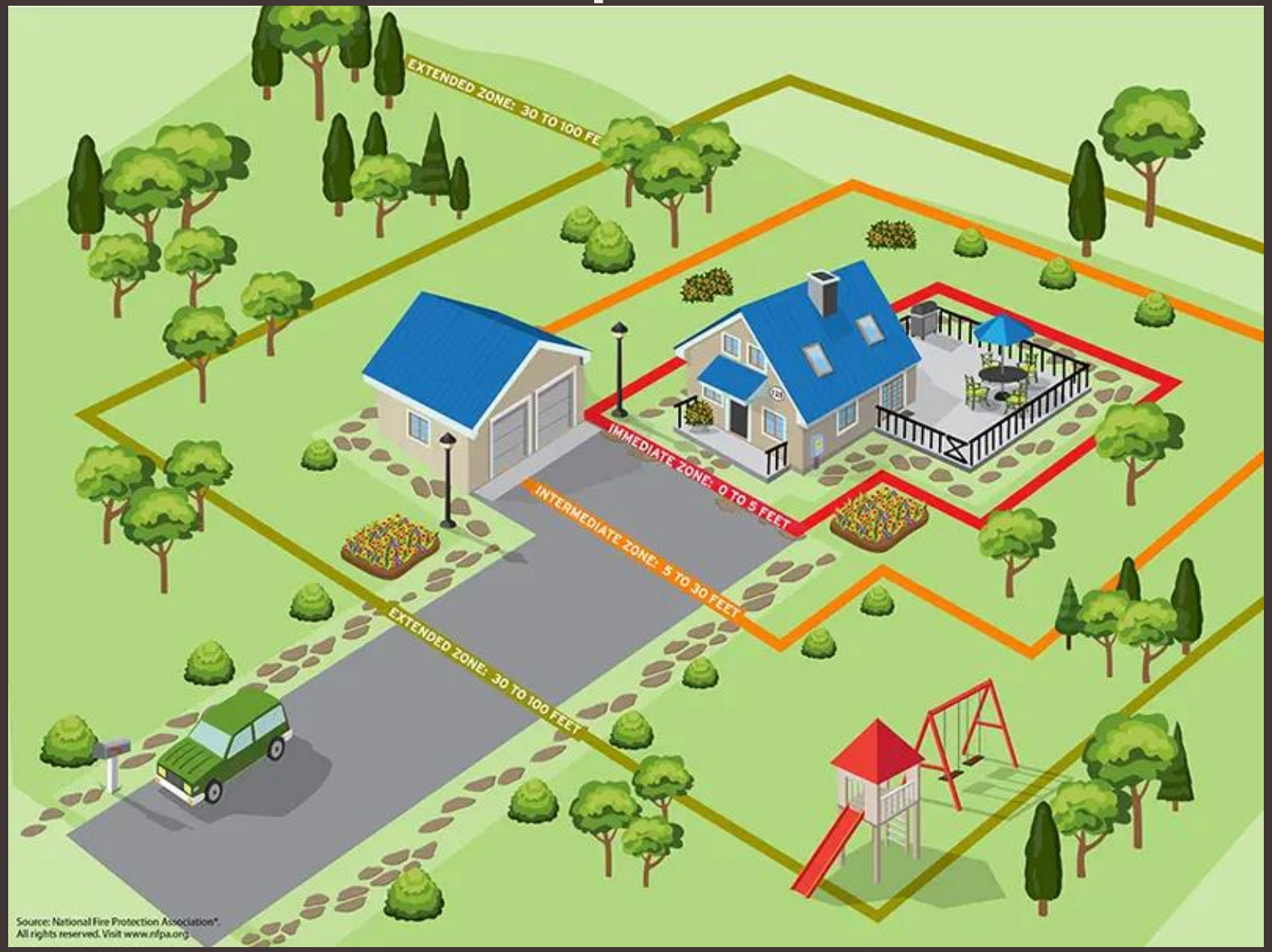
Fuel-limited landscapes

- Weather conditions are regularly hot and dry enough to sustain wildfire, but—
- Fire spread is restricted because of sparse or discontinuous fuels.

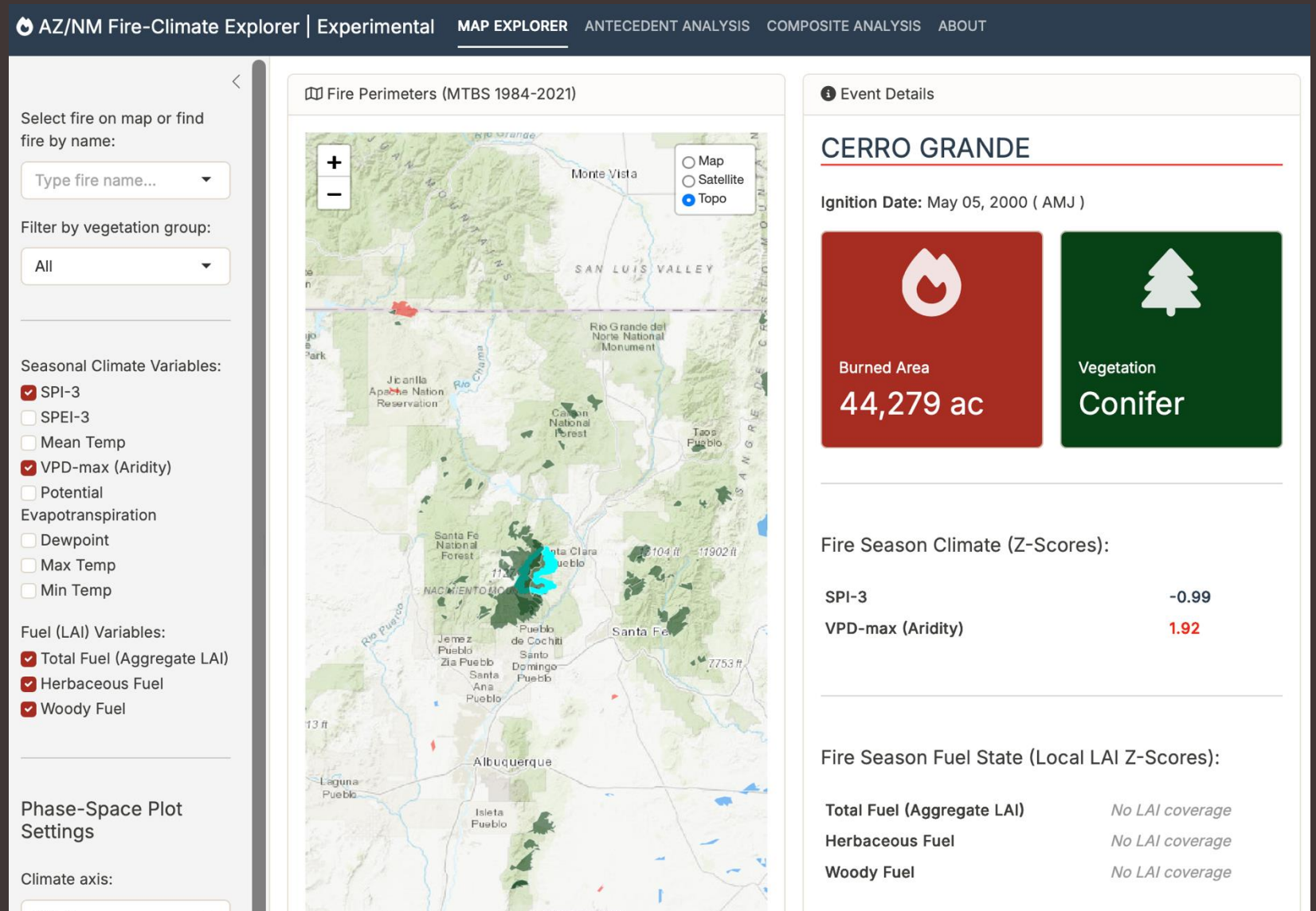
Fuel-limited landscapes

- Deserts
- Grasslands
- Pinyon-Juniper
- Ponderosa Pine

Fuel-limited landscapes



AZ/NM Fire-Climate Explorer

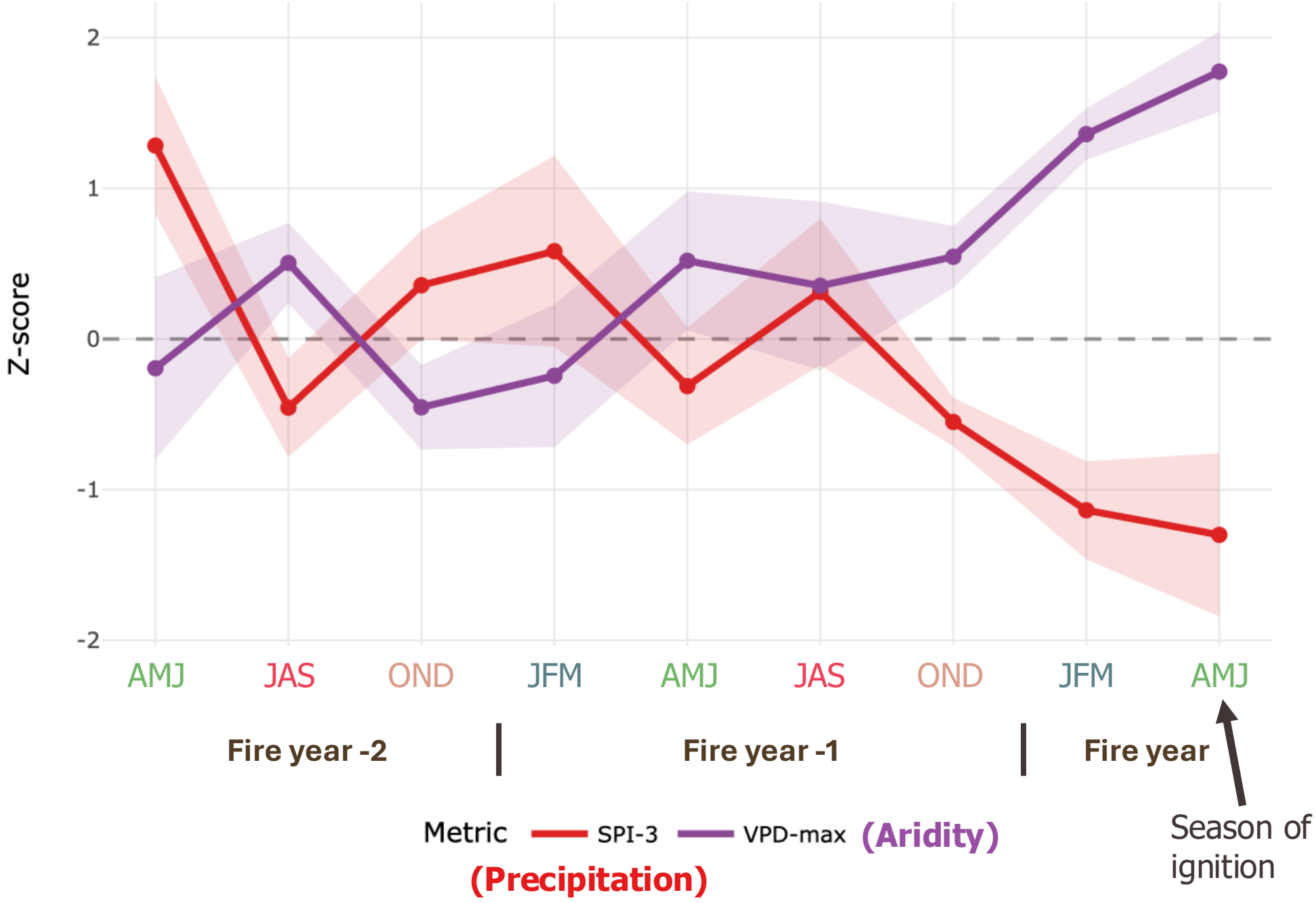


SW NM Fires Climate Composite

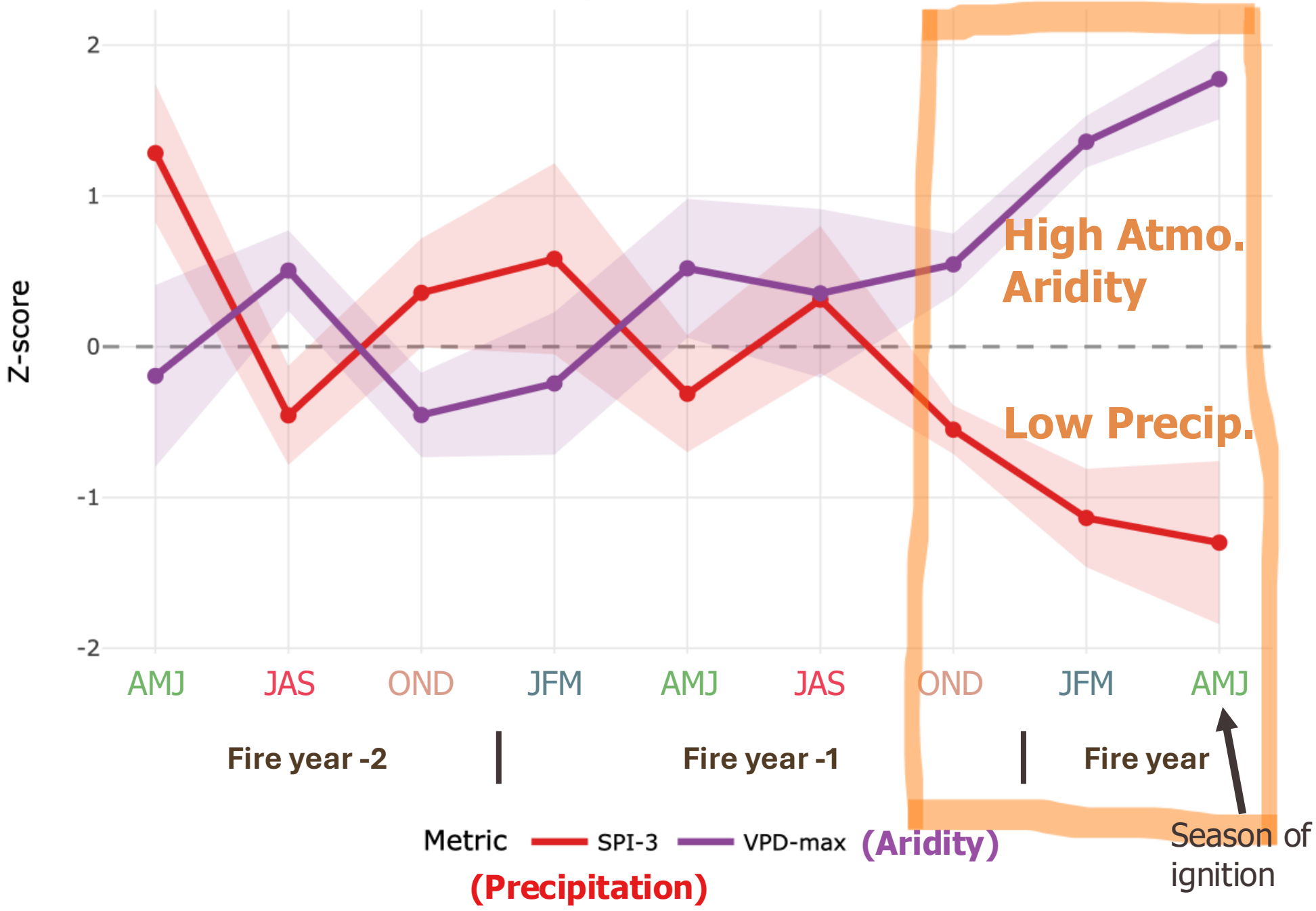
Using the AZ/NM Fire-Climate Explorer:

- Timelines of seasonal climate leading up to fires
- Average across multiple timelines to see common signal of seasonal climate conditions
- I selected 5 years where multiple fires burned in lower (non-forested) elevations.
- 1989, 1994, 2002, 2006, 2011

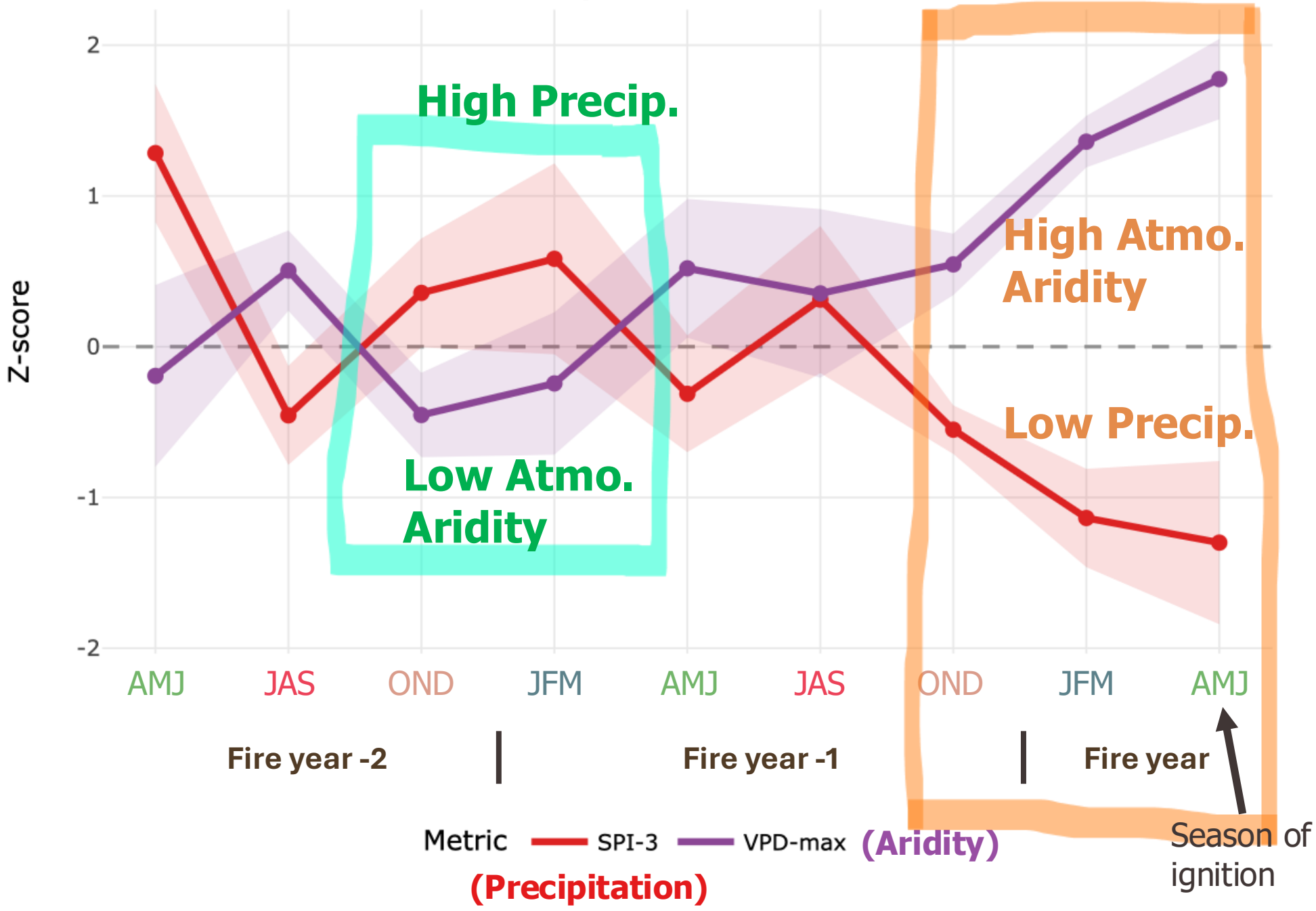
Seasonal Climate Composite—SW NM Fires



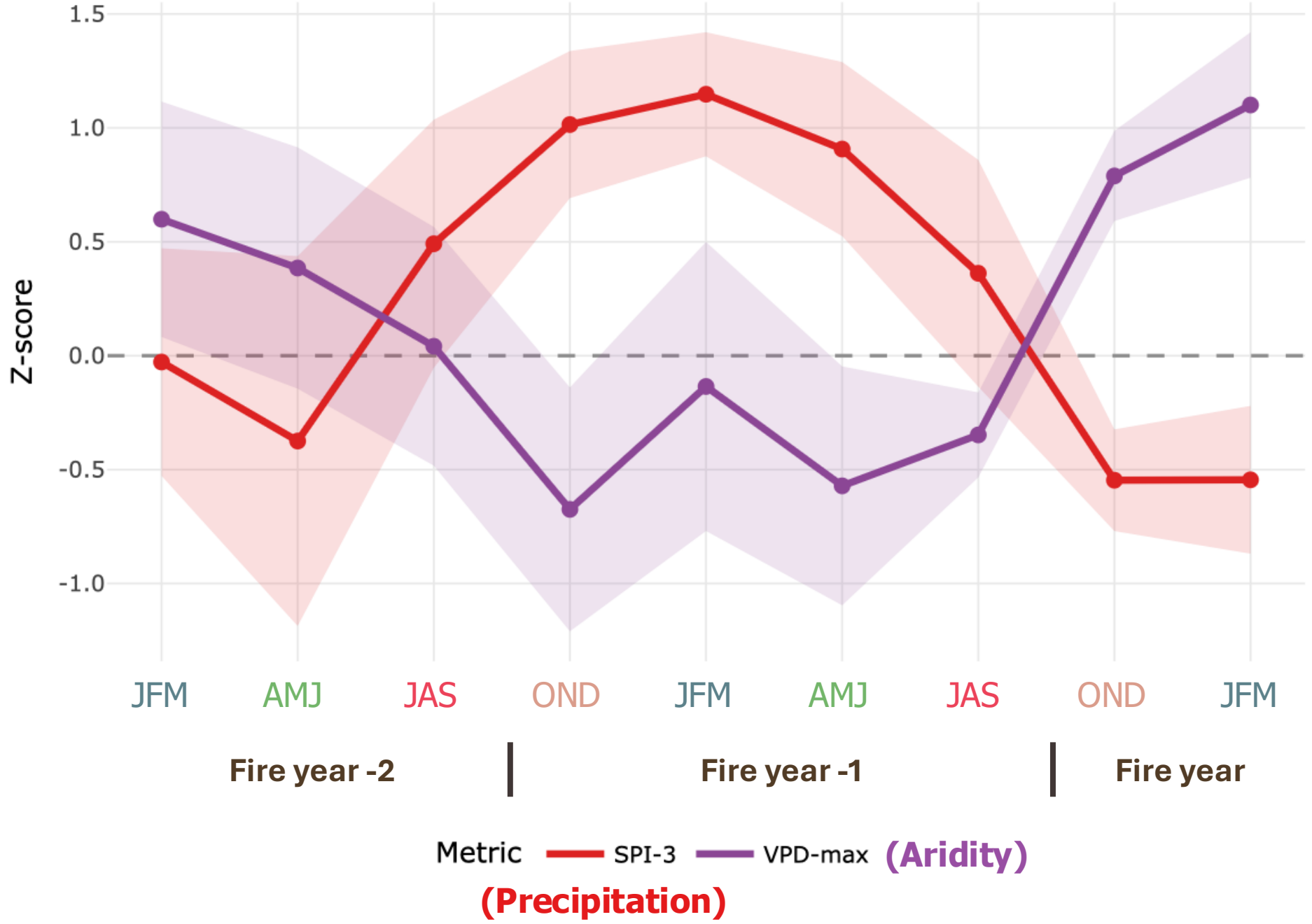
Seasonal Climate Composite—SW NM Fires

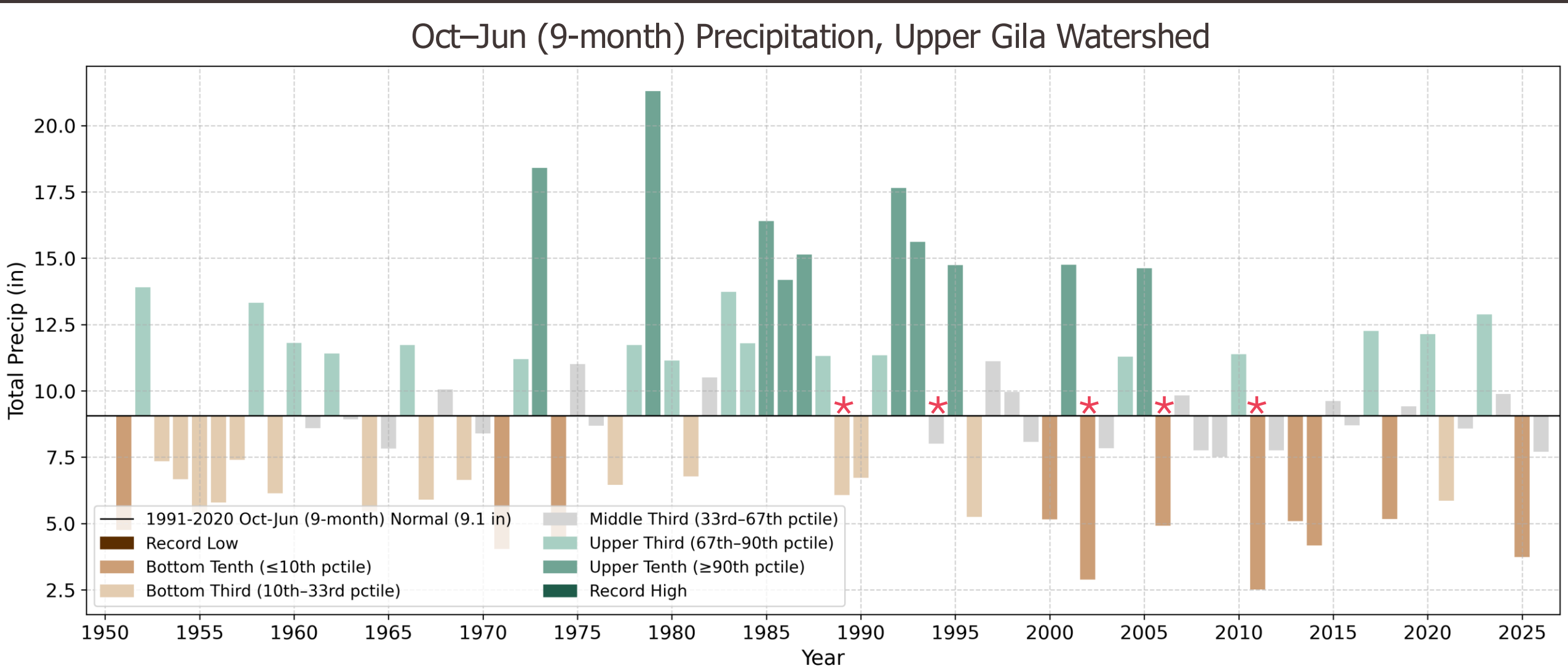


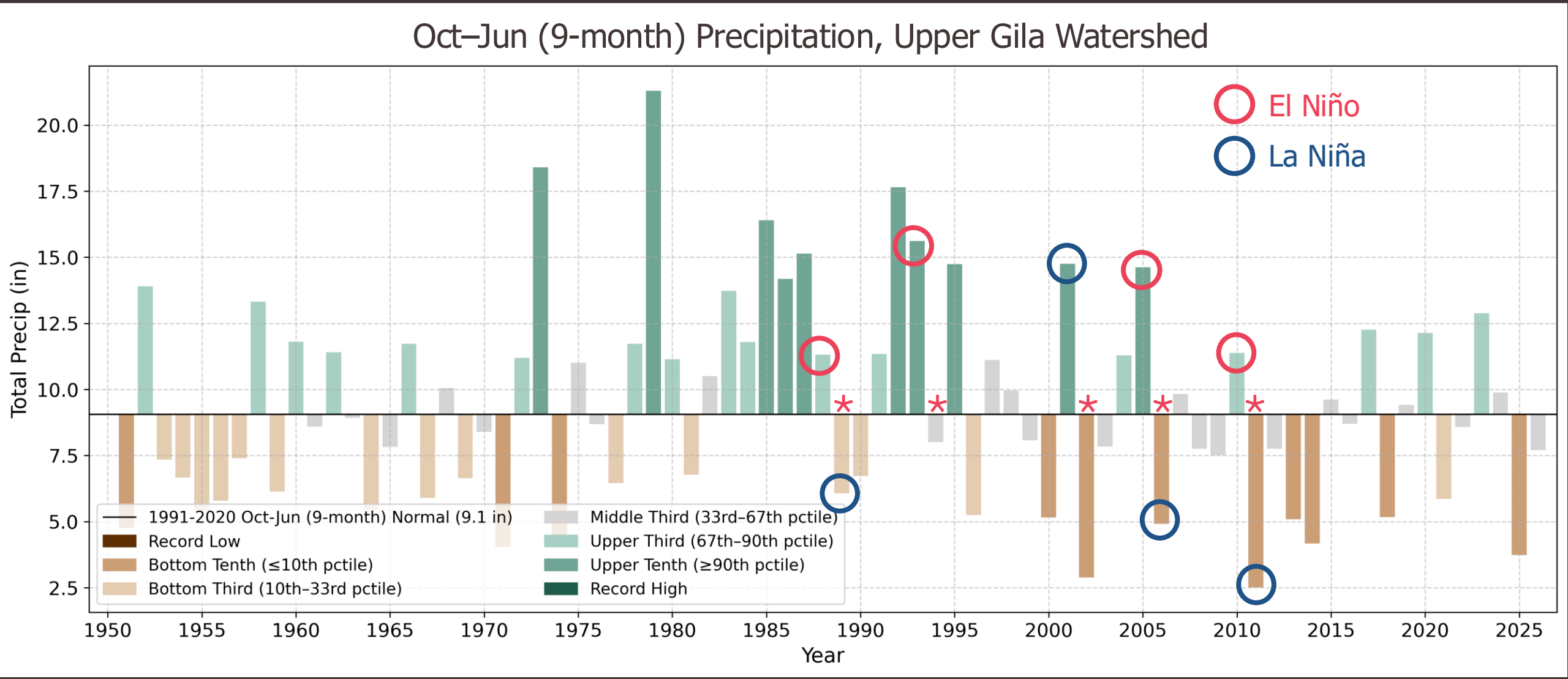
Seasonal Climate Composite—SW NM Fires

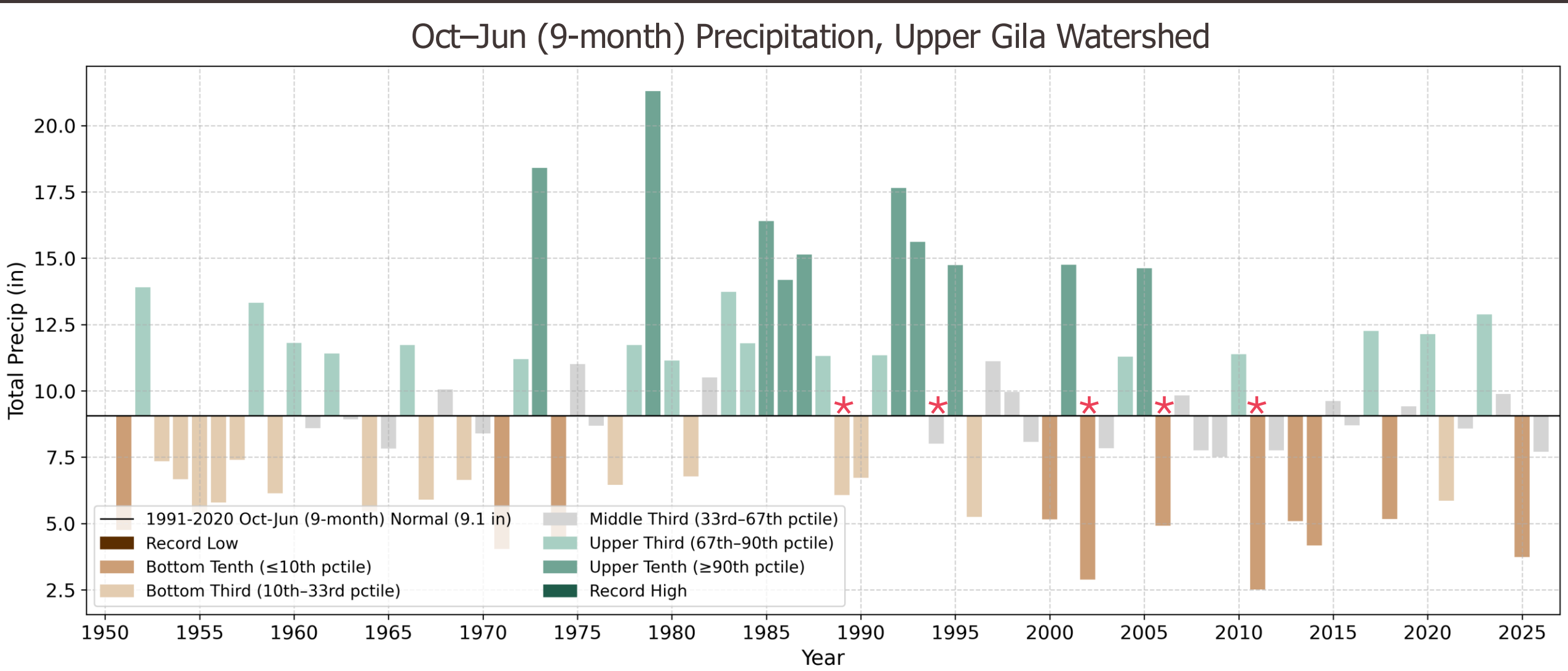


Seasonal Climate Composite—East NM Fires




Oct–Jun (9-month) Precipitation, Upper Gila Watershed
Total Precip (in)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Year
1991-2020 Oct-Jun (9-month) Normal (9.1 in)
Record Low
Bottom Tenth (≤10th pctile)
Bottom Third (10th–33rd pctile)
Middle Third (33rd–67th pctile)
Upper Third (67th–90th pctile)
Upper Tenth (≥90th pctile)
Record High


Oct–Jun (9-month) Precipitation, Upper Gila Watershed
El Niño
La Niña
Total Precip (in)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Year
1991-2020 Oct-Jun (9-month) Normal (9.1 in)
Record Low
Bottom Tenth (≤10th pctile)
Bottom Third (10th–33rd pctile)
Middle Third (33rd–67th pctile)
Upper Third (67th–90th pctile)
Upper Tenth (≥90th pctile)
Record High


Oct–Jun (9-month) Precipitation, Upper Gila Watershed
Total Precip (in)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Year
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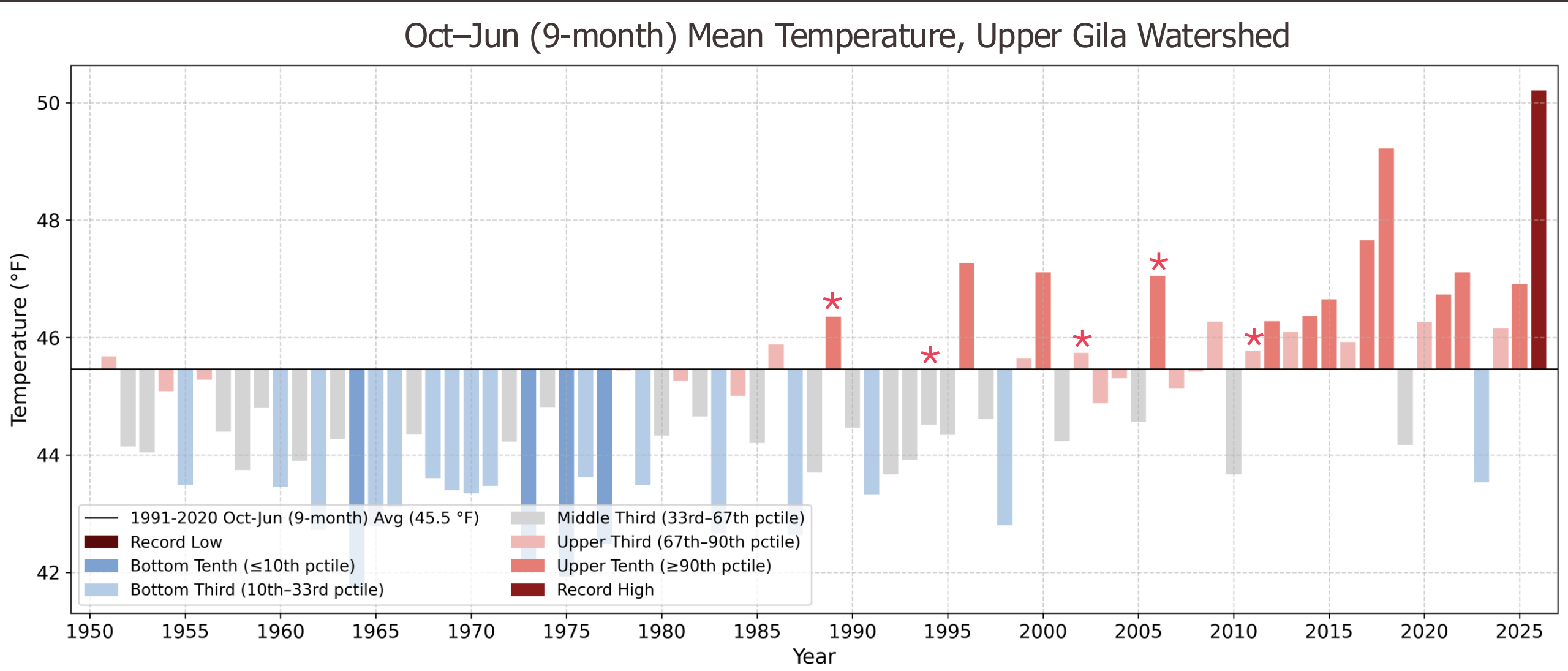
Record Low
Bottom Tenth (≤10th pctile)
Bottom Third (10th–33rd pctile)
Middle Third (33rd–67th pctile)
Upper Third (67th–90th pctile)
Upper Tenth (≥90th pctile)
Record High

Precipitation variability and fine fuels

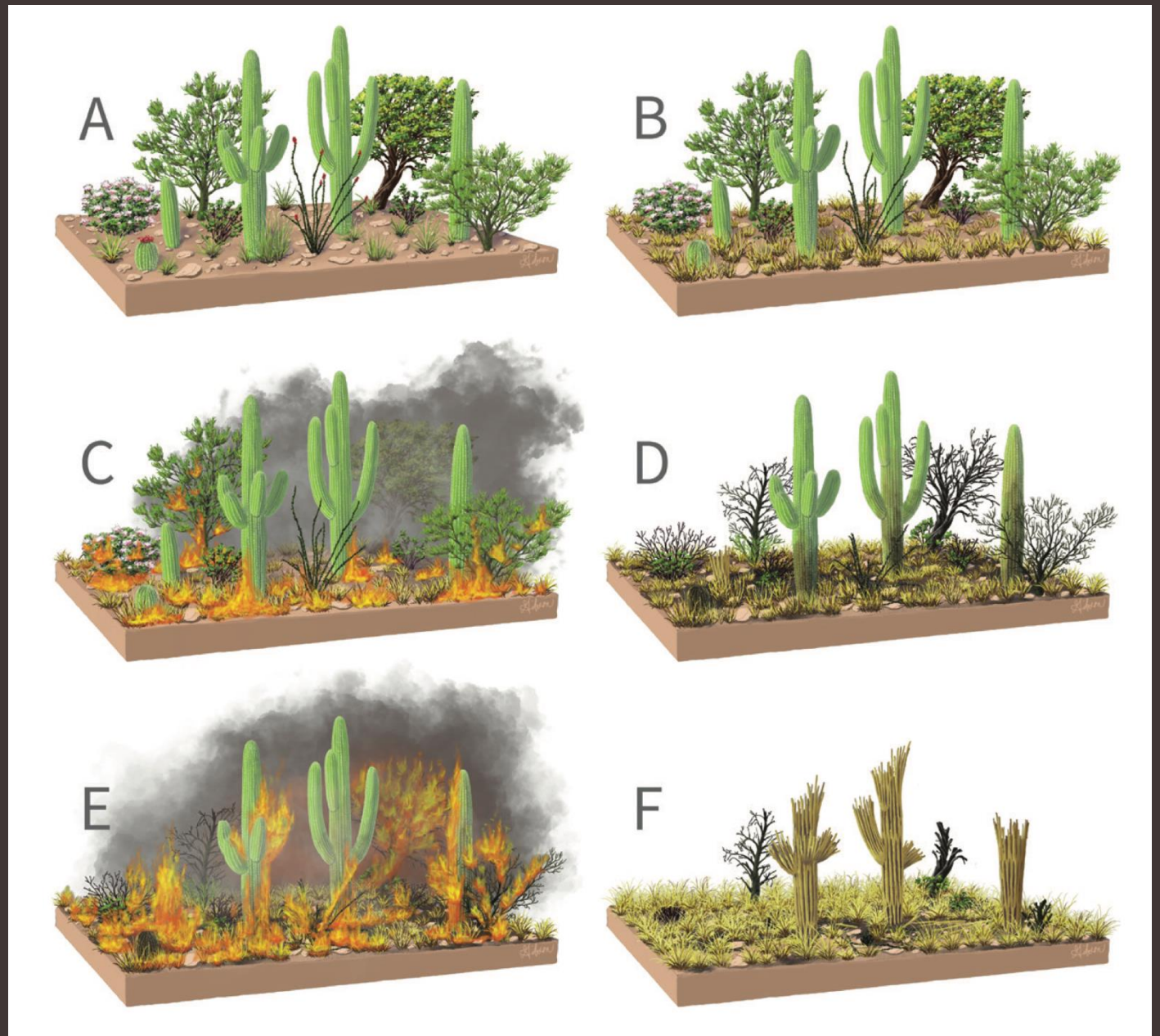
- High year-to-year variability means very wet conditions can be followed by very dry conditions.
- ENSO is a component in this pattern
- Decadal–multidecadal variability means that recent decades are not representative of the full range of possible conditions.


Oct–Jun (9-month) Mean Temperature, Upper Gila Watershed
Temperature (°F)
50
48
46
44
42
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Year
1991-2020 Oct-Jun (9-month) Avg (45.5 °F)
Record Low
Bottom Tenth (≤10th pctile)
Bottom Third (10th–33rd pctile)
Middle Third (33rd–67th pctile)
Upper Third (67th–90th pctile)
Upper Tenth (≥90th pctile)
Record High

Temperature trend and fine fuels

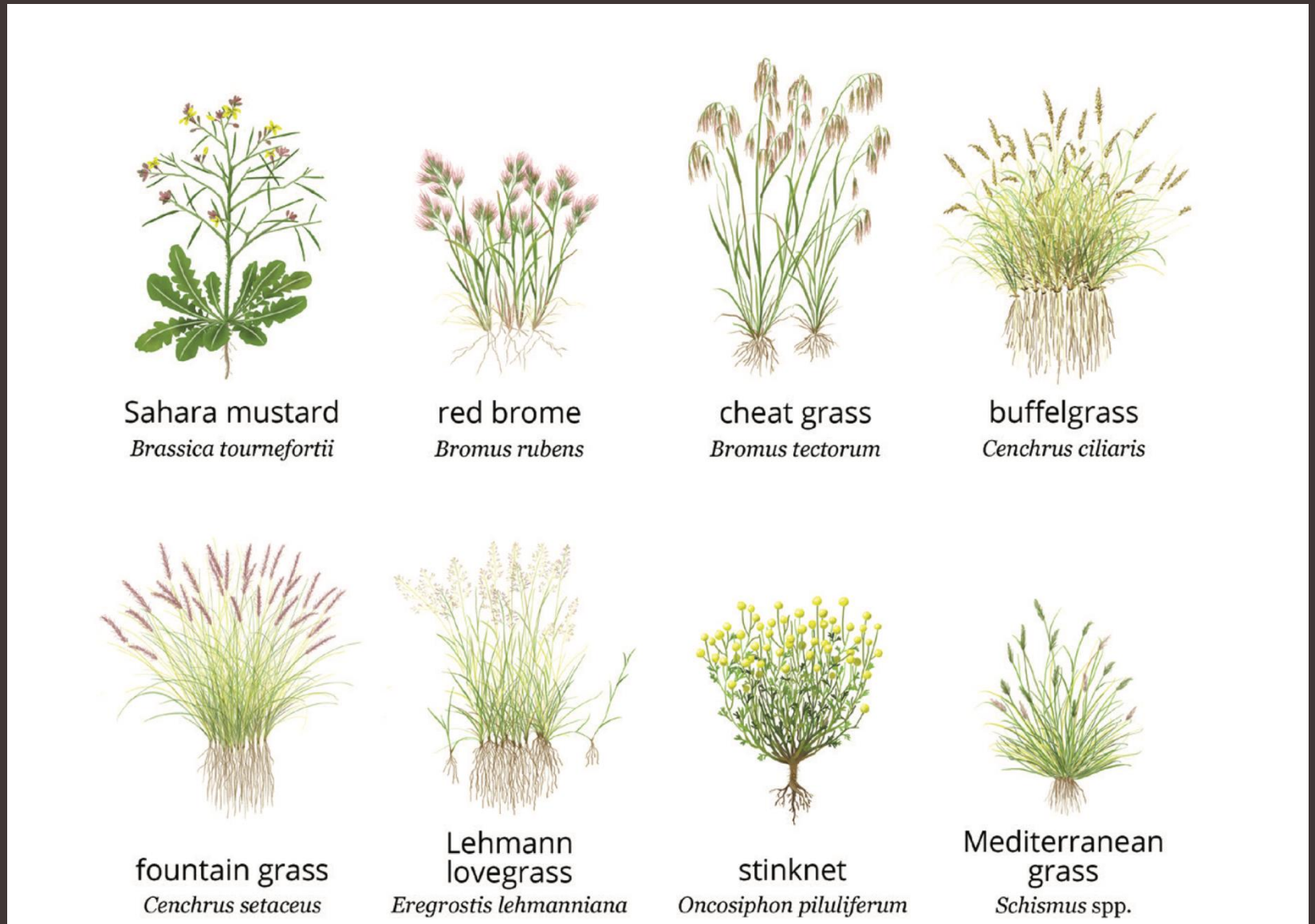
- Increasing aridity—more efficient drought-conditioning of accumulated fuels.
- Productivity decrease or increase?
  - Aridity change effect greater for warmer months, warmer locations
  - In cooler months or cooler locations, increased temperatures may provide more favorable growing conditions.

Invasive species “X factor”



Kara S. Gibson,
Southwest Fire Science
Consortium

Invasive species "X factor"



Kara S. Gibson, Southwest Fire Science Consortium

Summary

Expect the Expected

- Wet-to-Dry sequences are built into our climate—the current El Niño means there is a good chance one is underway now.
- Increasing aridity via warming trend makes dry seasons more efficient

Expect the Unexpected

- Decadal–multidecadal variability of precipitation means our mental models—experience and observations—tend to underestimate the true range of possible conditions
- Uncertain/opposing effects of warming on growth
- Invasive species X factor

thank you

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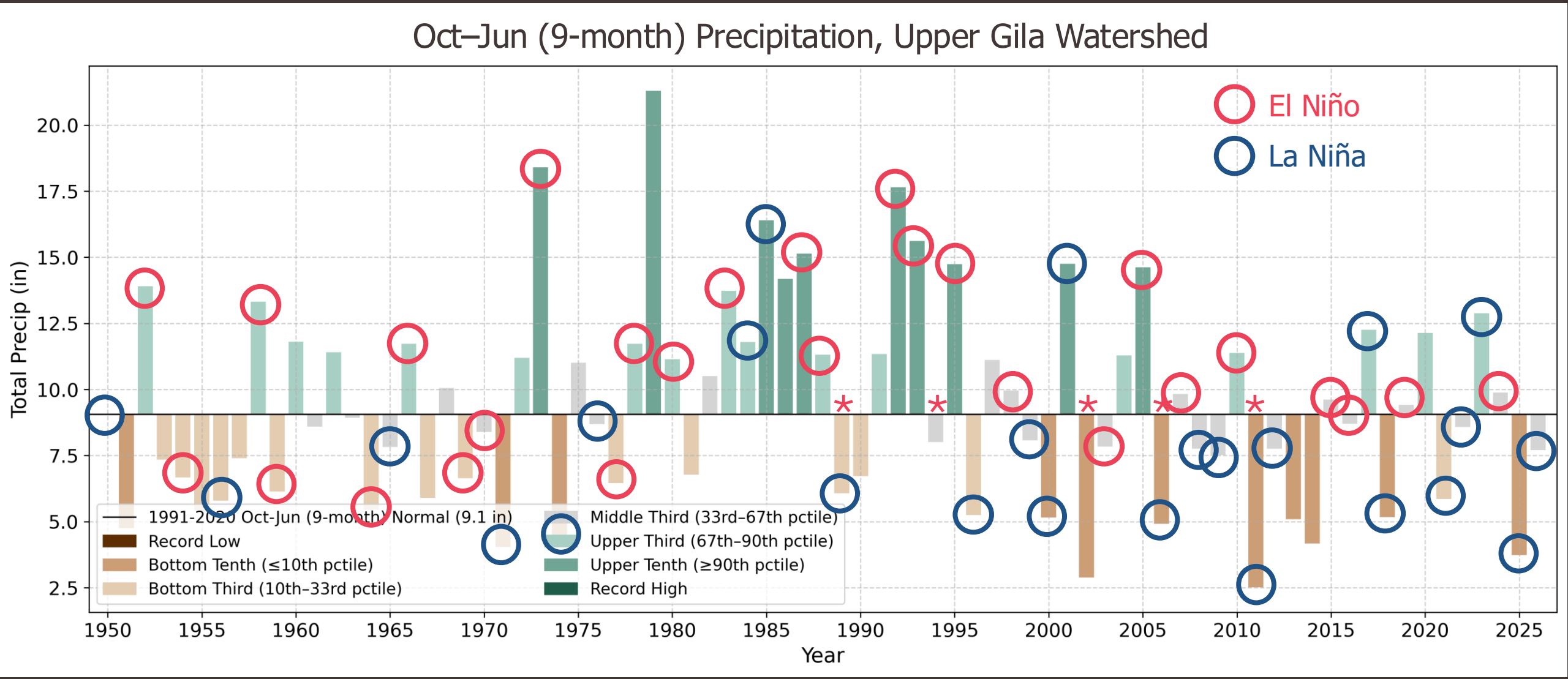
SW Fire-Climate Data Explorer

CLIMAS SW fire-climate fact sheet

CLIMAS El Niño Page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La Niña
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