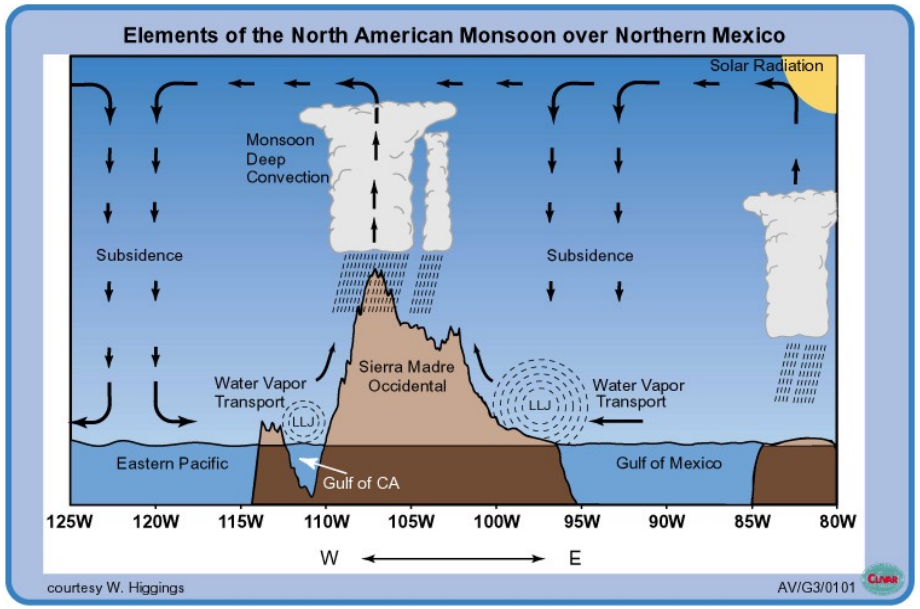
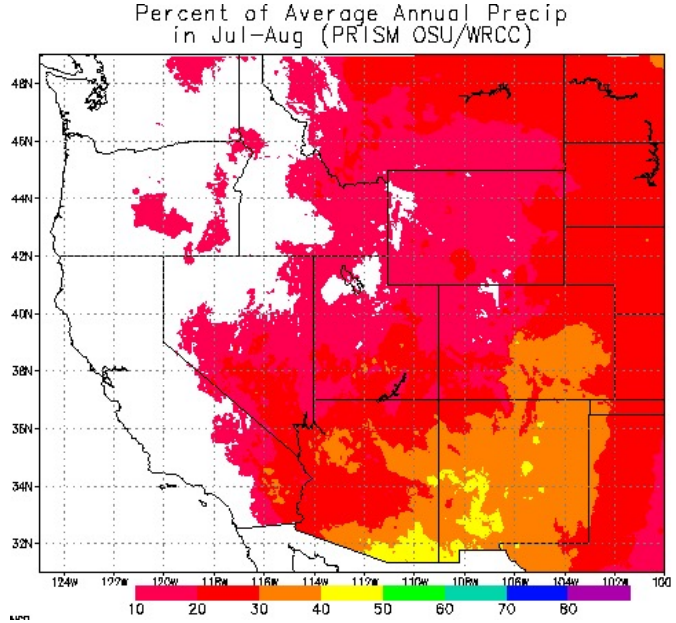
2021 North American Monsoon Recap

2021 North American Monsoon marked by wetter-than-normal conditions in southwestern US

- The North American Monsoon (NAM) refers to a shift in the synoptic-scale wind pattern that transports low-to-midlevel moisture from the Eastern Pacific and Gulf of Mexico into the southwestern US during summer
- The NAM is an important source of annual precipitation for parts of the southwestern US
- Unlike the stronger Indian Monsoon, the NAM is characterized by episodic bursts of moisture transport and rainfall
- The 2021 monsoon season was characterized by an abundance of moisture and frequent precipitation episodes, particularly in Arizona
- Arizona experienced its 9th wettest July–September period since 1895
- Anomalously wet conditions during July–September brought much-needed drought relief to portions of the Four Corners Region



Source: NOAA/NWS Climate Prediction Center, https://www.cpc.ncep.noaa.gov/



Source: CLIMAS, University of Arizona, https://climas.arizona.edu/

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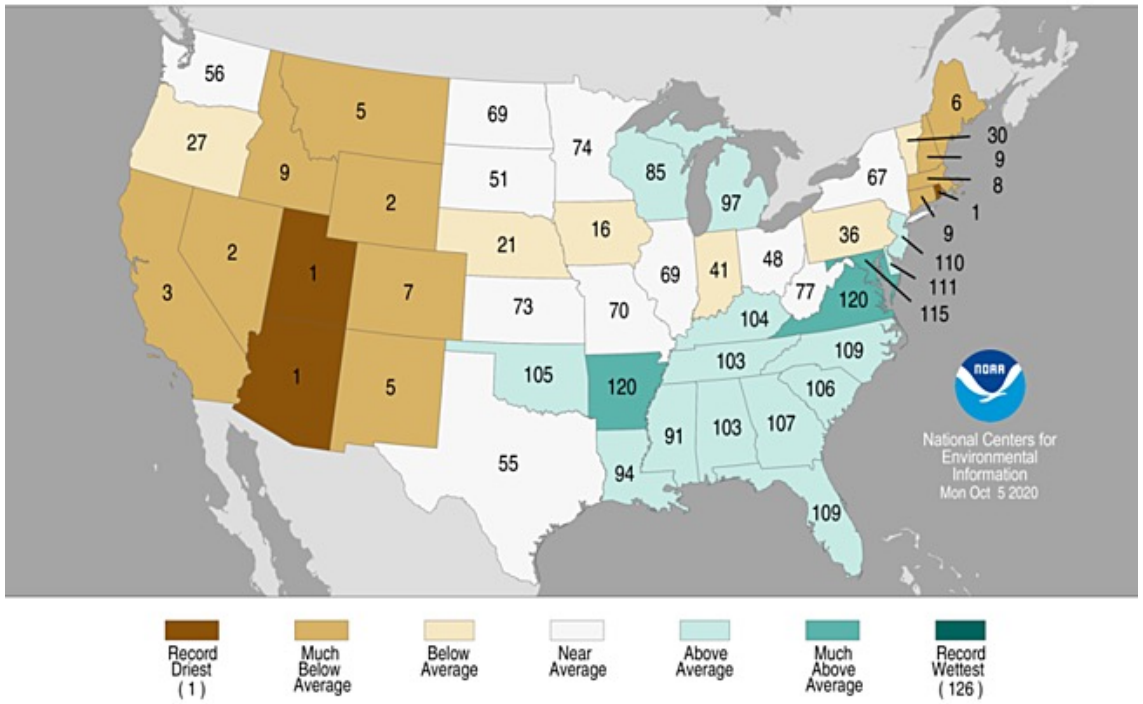
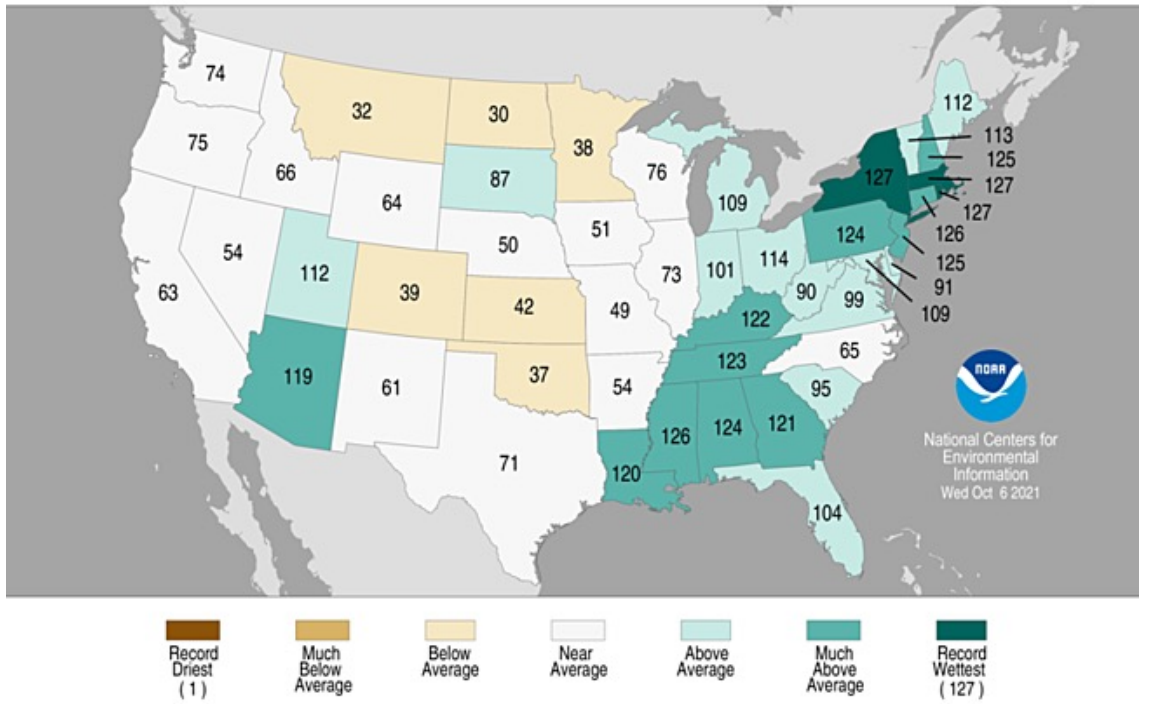
2020



2021



Source: NOAA National Centers for Environmental Information, https://www.ncei.noaa.gov/

- Most states in the southwestern US (i.e., AZ, CA, CO, NM, NV, UT) received near-average or above-average precipitation during July–September 2021
- In contrast, 2020 was one of the top-10 driest July–September periods in all six states (since 1895)
- Arizona recorded its 9th wettest July–September period in 2021 and its driest July–September period in 2020

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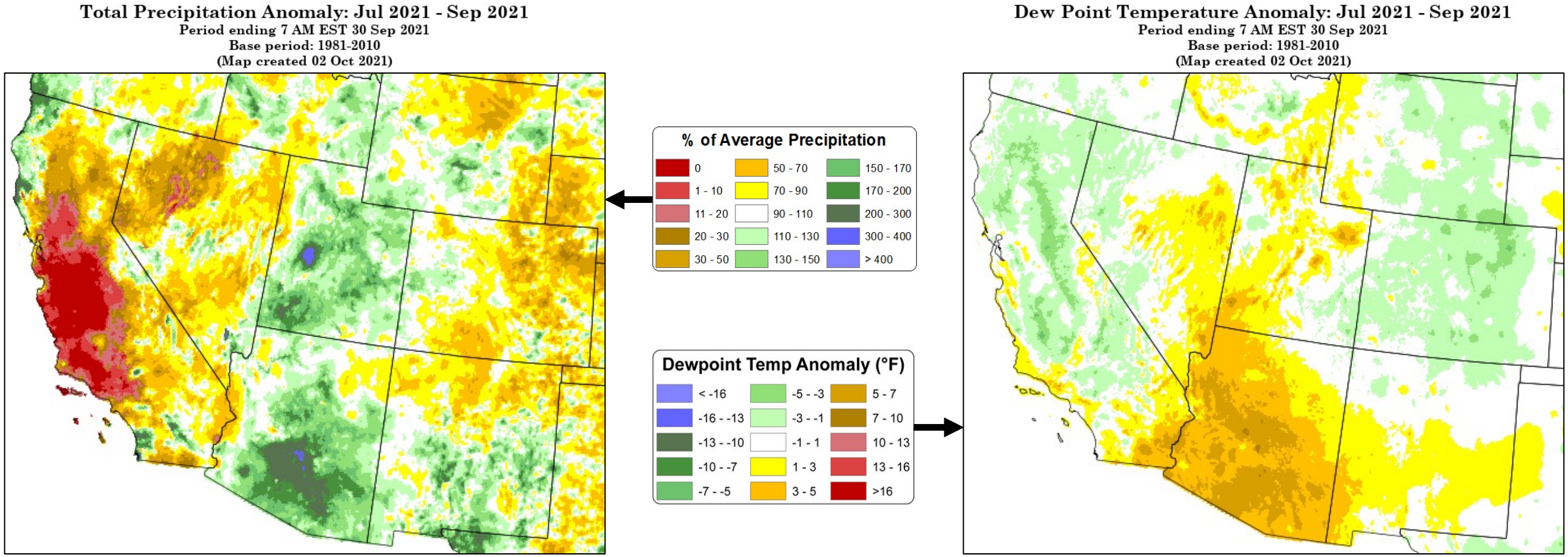

Source: PRISM Climate Group, Oregon State University, https://www.prism.oregonstate.edu/

- Much of Arizona, Utah, southern New Mexico, and far western Texas experienced wetter-than-normal conditions during July–September 2021
- Some areas in Arizona and Utah received more than 200% of the normal (1981–2010 average) July–September precipitation
- Significantly drier-than-normal conditions were observed in eastern Colorado, northern Nevada, and Central California
- This year's active monsoon was underscored by large positive surface dewpoint anomalies (3–7°F above normal) across Arizona

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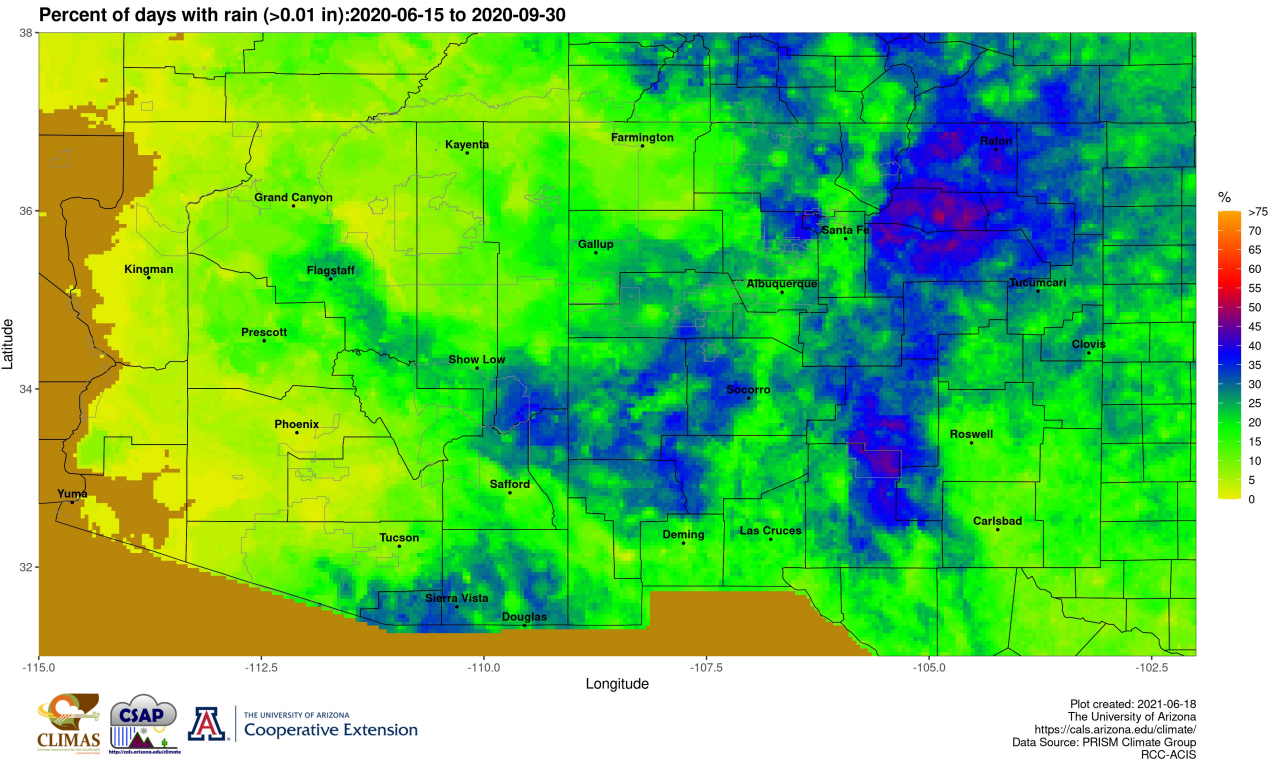
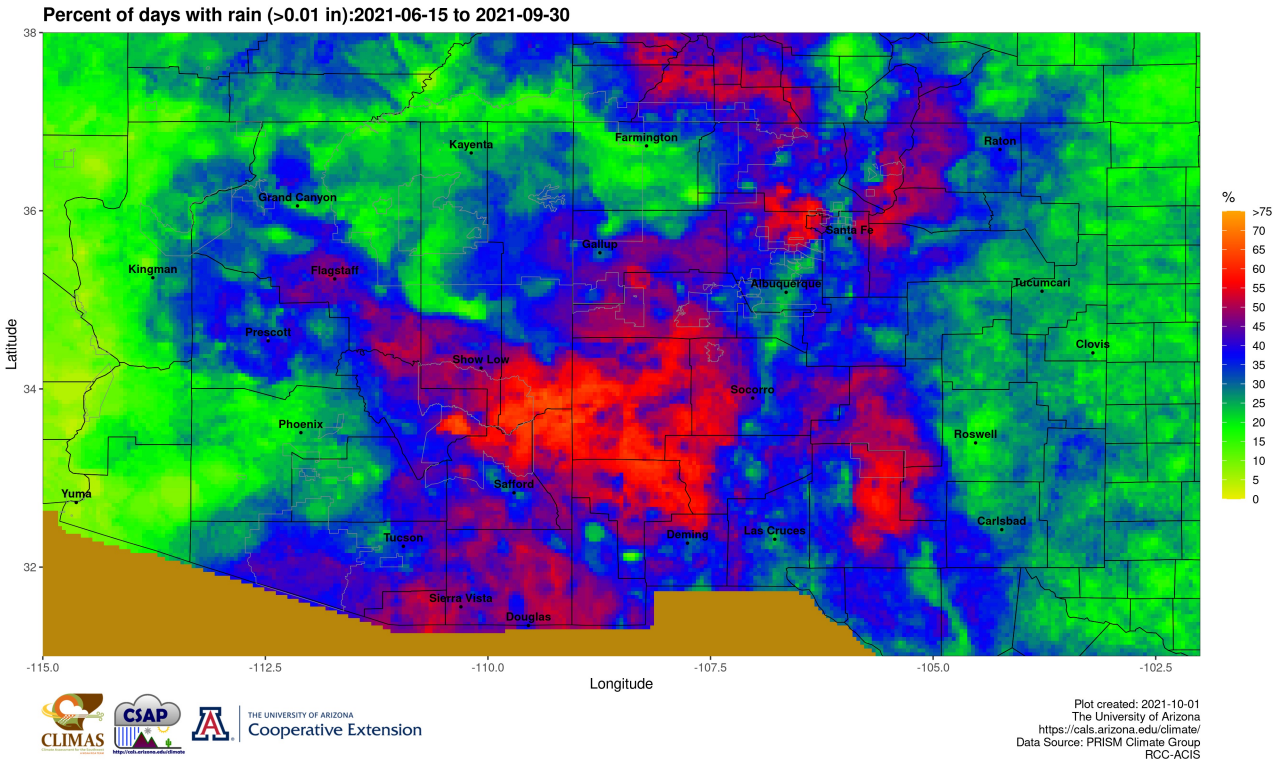
2020



2021



Source: University of Arizona Climate Science Applications Program, https://cals.arizona.edu/climate/

- The 2021 monsoon season was characterized by frequent precipitation episodes, particularly over the higher terrain
- Measurable precipitation was observed on more than 50% of all days between 15 June and 30 September in portions of Arizona and New Mexico
- In contrast, most of Arizona received measurable precipitation on fewer than 25% of all days during the 2020 monsoon season

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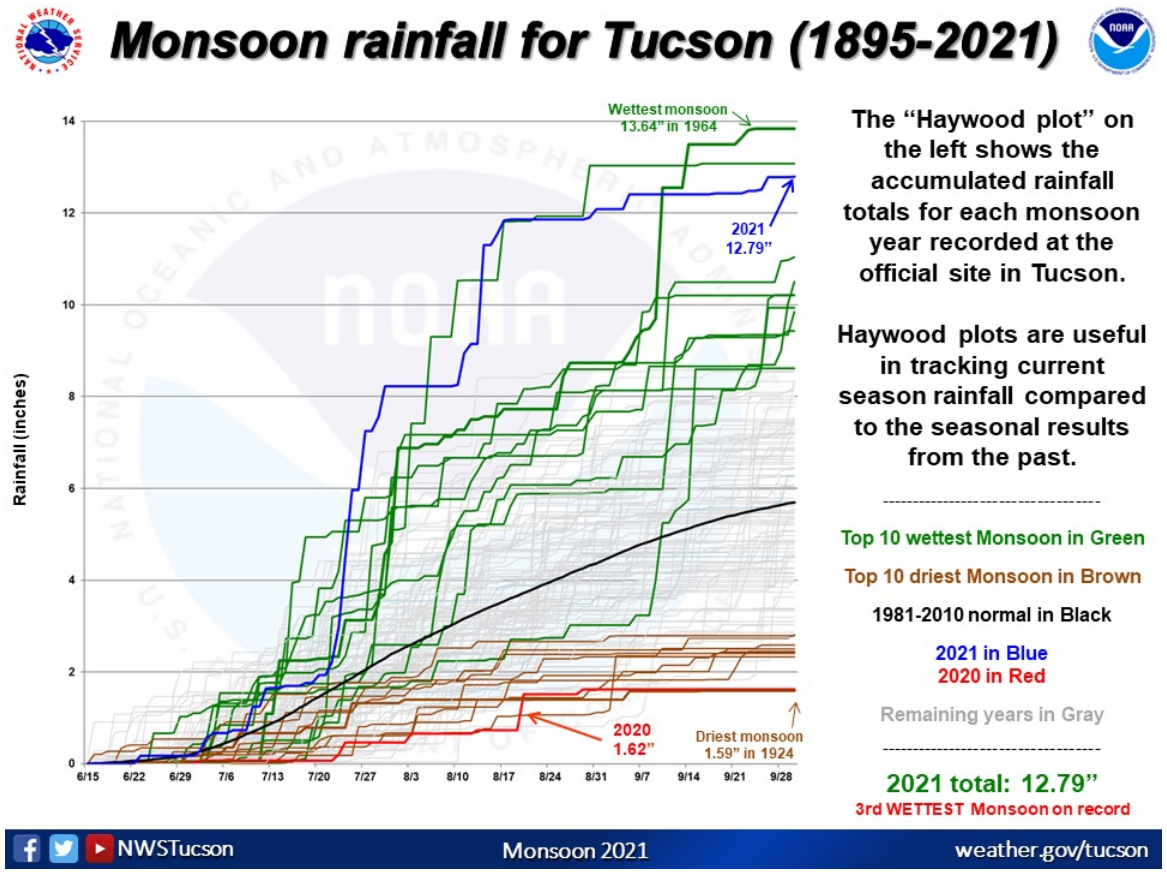


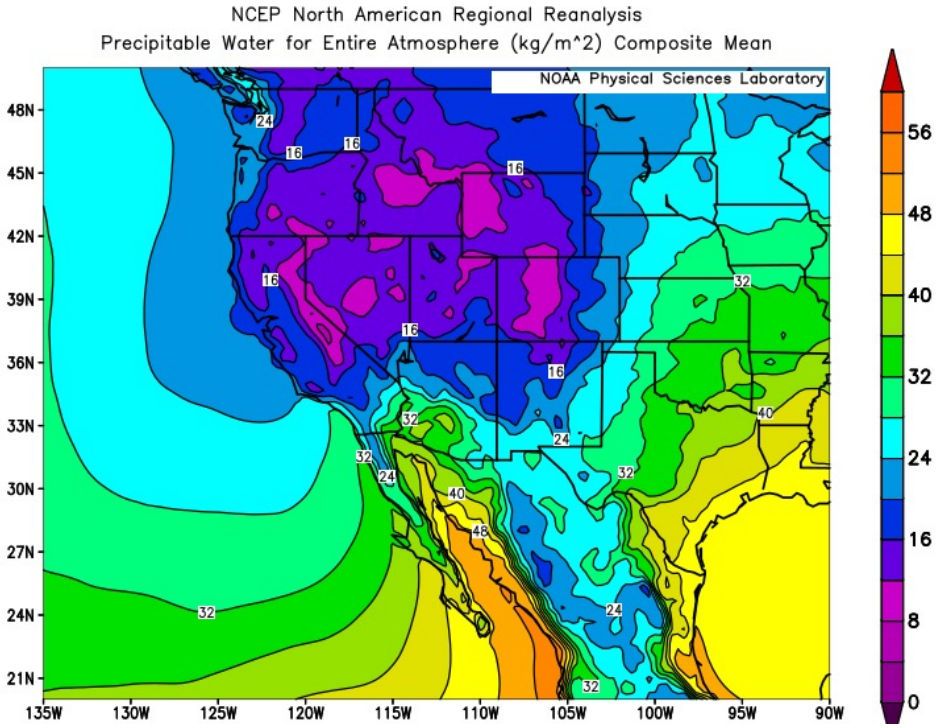
Location	2021 Monsoon Rainfall (in)	Normal Monsoon Rainfall (in)
Flagstaff, AZ	10.90	7.68
Kingman, AZ	5.92	2.78
Phoenix, AZ	4.20	2.43
Tucson, AZ	12.79	5.69
Yuma, AZ	2.11	1.13
Las Vegas, NV	0.65	1.05
Albuquerque, NM	3.49	4.48
El Paso, TX	10.08	5.27

Source: NWS Tucson, https://www.weather.gov/twc/

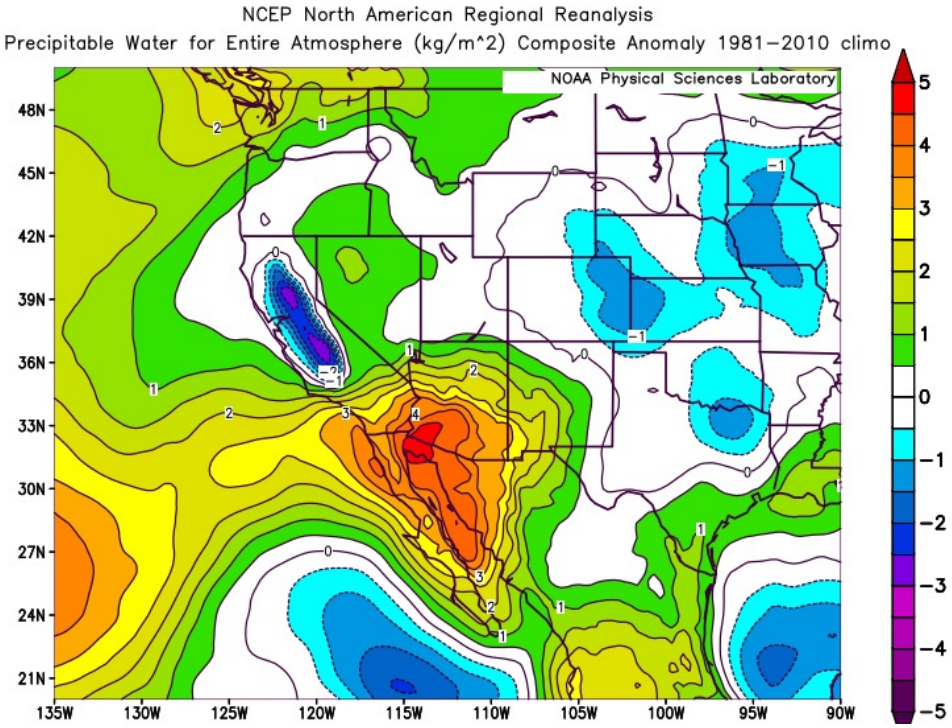
- After experiencing its 2nd driest monsoon season on record in 2020 (1.62 inches of rainfall), Tucson, AZ, recorded its 3rd wettest monsoon season in 2021 (12.79 inches of rainfall)
- July 2021 was the wettest month ever recorded in Tucson, AZ, with 8.06 inches of rainfall
- El Paso, TX (10.08 inches), and Kingman, AZ (5.92 inches), recorded their 4th and 7th wettest monsoon seasons, respectively
- Flagstaff, AZ, Phoenix, AZ, and Yuma, AZ, all recorded above-normal precipitation

2021 North American Monsoon Recap

Precipitable Water
Jul–Sep 2021



Precipitable Water Anomaly
Jul–Sep 2021

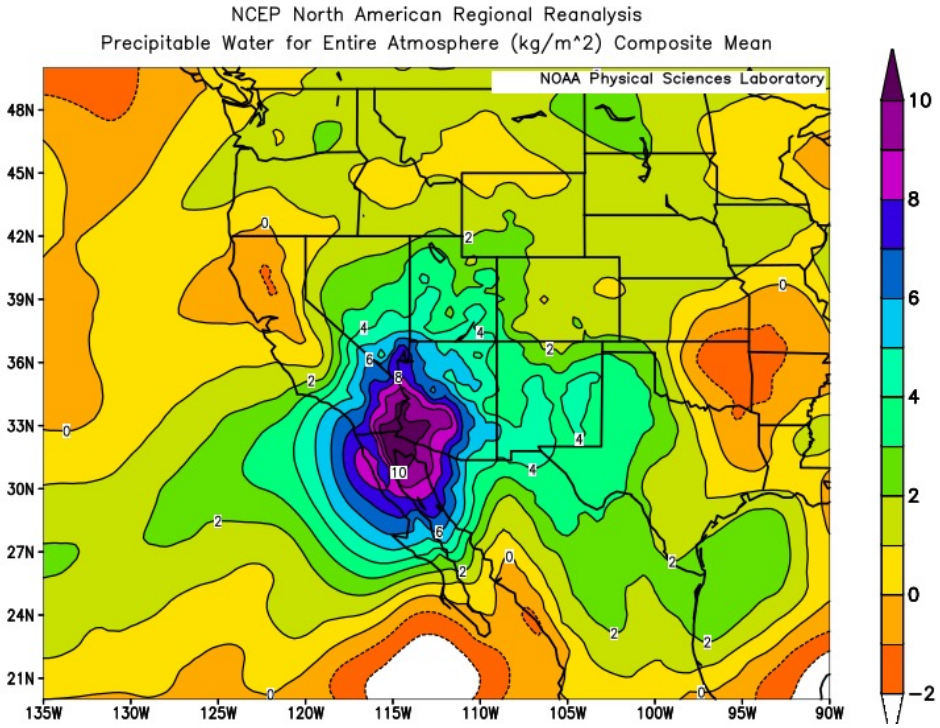


Source: NOAA/ Physical Sciences Laboratory, https://www.psl.noaa.gov/

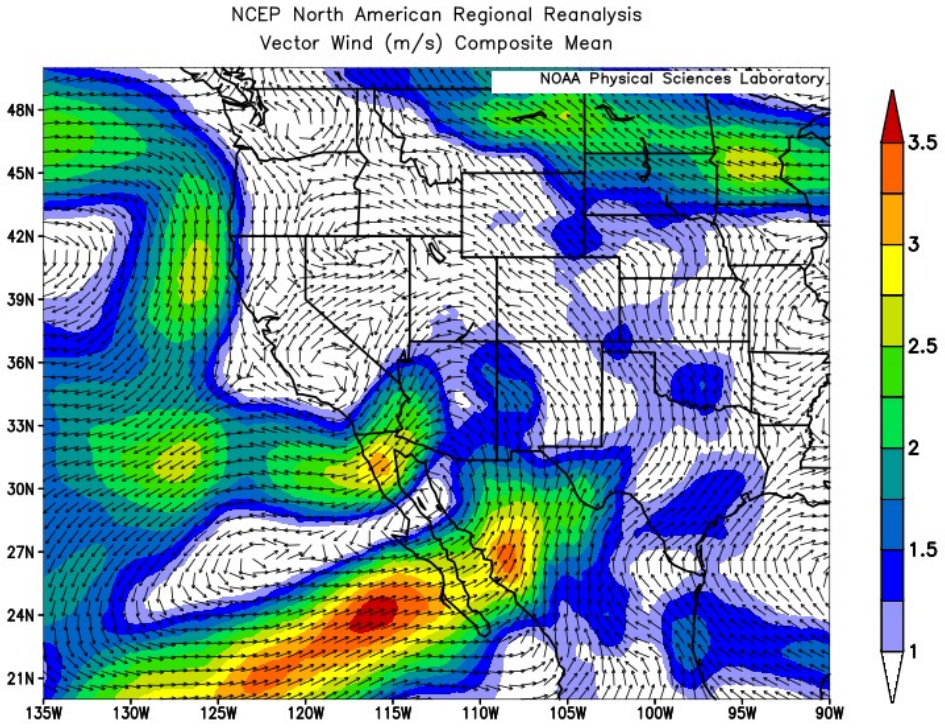
- The July–September composite mean precipitable water map shows a narrow region of very moist air extending northward from the subtropical East Pacific Ocean to southern Arizona
- Seasonal precipitable water values were about 3–5 mm above normal across Baja California, Sonora, southern Arizona, and far southern California

2021 North American Monsoon Recap

Precipitable Water Difference 2021 vs. 2020 (Jul–Sep)



700-hPa Vector Wind Difference 2021 vs. 2020 (Jul–Sep)



Source: NOAA/ Physical Sciences Laboratory, https://www.psl.noaa.gov/

- Compared to 2020, precipitable water values were much higher in 2021, particularly over the Sonoran Desert
- Additionally, the low-to-midlevel synoptic-scale flow between the East Pacific Ocean and northwestern Mexico was stronger relative to 2020
- These differences suggest a more robust moisture connection between the Pacific Ocean and the southwestern US during 2021
- Higher precipitable water values also imply stronger moisture convergence and weaker subsidence in 2021 versus 2020

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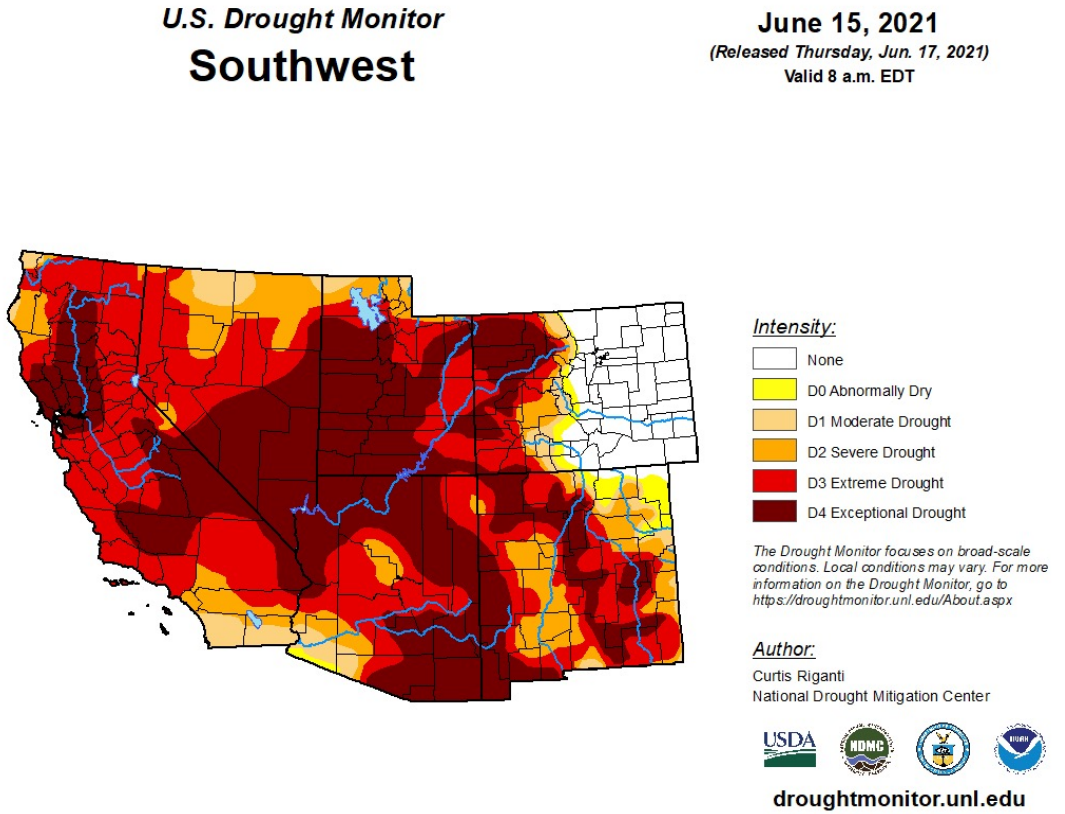
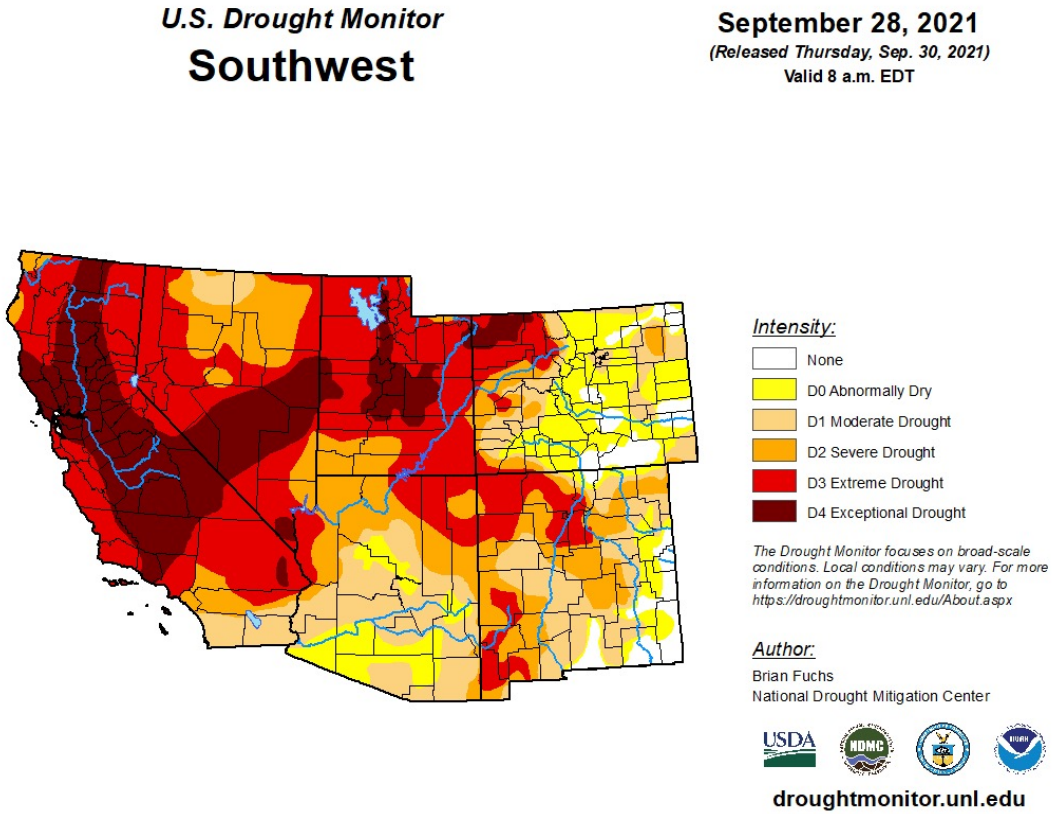


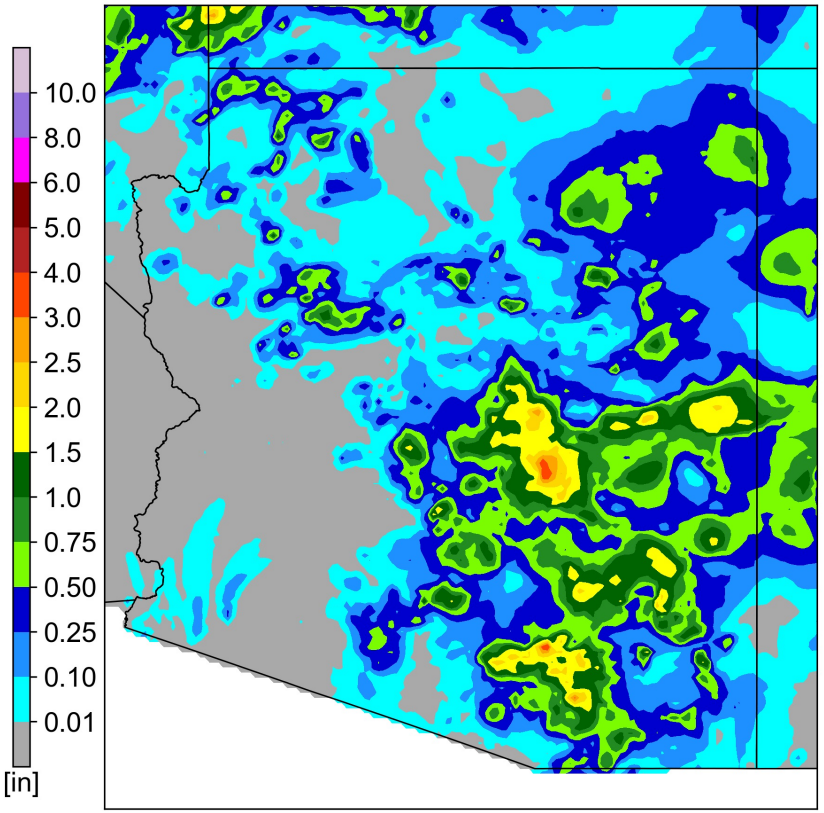


Source: National Drought Mitigation Center, University of Nebraska-Lincoln, https://www.ncei.noaa.gov/

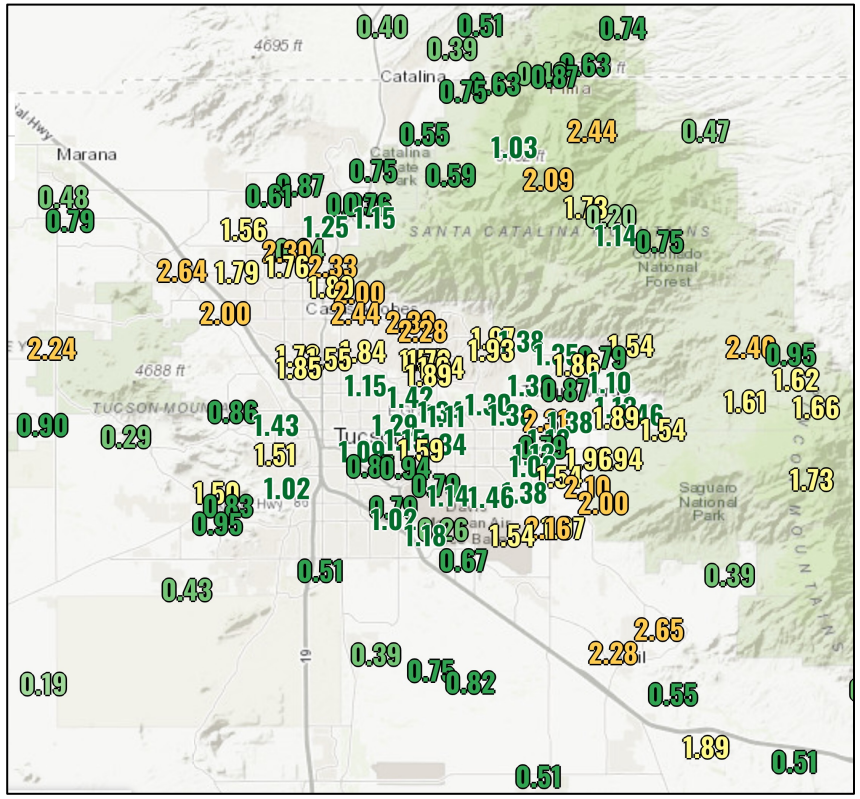
- At the beginning of the monsoon season (15 June), much of the southwestern US was experiencing extreme-to-exceptional (D3-D4) drought conditions
- While extreme-to-exceptional drought continued to persist across much of California, Nevada, and Utah, the active monsoon season reduced drought severity in portions of the Four Corners region, particularly in Arizona and New Mexico
- Between 15 June and 28 September, the coverage of extreme-to-exceptional drought in Arizona decreased from 87% to 14%

Notable Monsoon Events: 22–23 July 2021

NCEP Stage IV 24-h QPE: Valid 5 AM PT 22–23 Jul

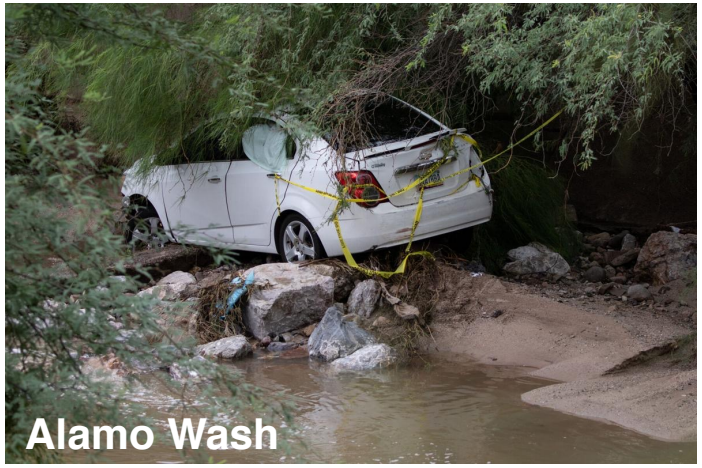


Observed Precipitation: Valid 11 PM PT 22 Jul – 5 AM PT 23 Jul



Source: NWS Western Region, https://www.weather.gov/wrh/

Source: Kelly Presnell, Arizona Daily Star

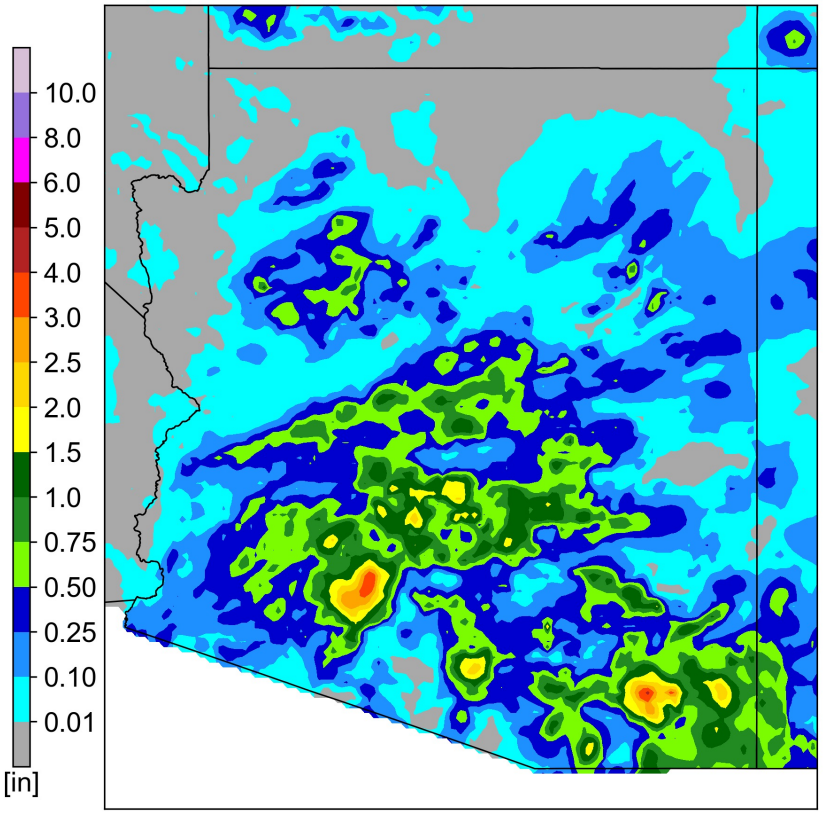


Source: Rick Wiley, Arizona Daily Star

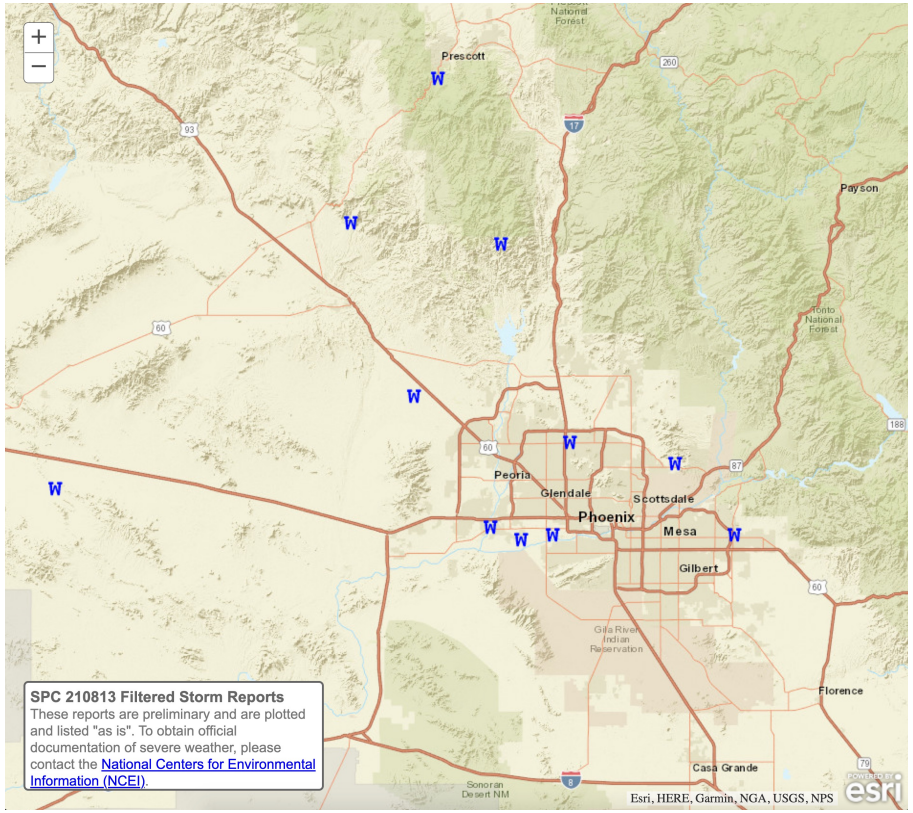
- Monsoon activity on 22–23 July produced heavy rainfall and flooding in central and southeastern Arizona
- The most intense rainfall occurred between 11 PM PT 22 July and 5 AM PT 23 July
- Many weather stations near Tucson recorded more than 2 inches of rainfall over this 6-hour period
- Flash flooding was observed along Alamo Wash, Pantano Wash, and the Rillito River in Pima County, AZ
- Water rescues were required in the cities of Tucson and Green Valley, AZ

Notable Monsoon Events: 13–14 August 2021

NCEP Stage IV 24-h QPE: Valid 5 AM PT 13–14 Aug



SPC Storm Reports: 13 Aug



Source: NOAA/NWS SPC, https://www.spc.noaa.gov/

Source: Buckeye Valley Fire District

Source: Wendy Killeen, The Arizona Republic

- Monsoon thunderstorms produced heavy rainfall, flooding, and damaging winds throughout Maricopa County, AZ, on 13–14 August
- An estimated 2–4 inches of rain fell near Gila Bend, AZ, during the 24-hour period ending 5 AM PT 14 Aug
- Heavy rain flooded roadways and strong winds downed trees in the Phoenix metro area
- Destructive and life-threatening flash flooding occurred in Gila Bend, where more than 30 people were rescued from flash floods, and two fatalities were reported