



# Weather Risk in Production Agriculture

Sept 14, 2021

Eric Snodgrass

[eric.snodgrass@nutrien.com](mailto:eric.snodgrass@nutrien.com)

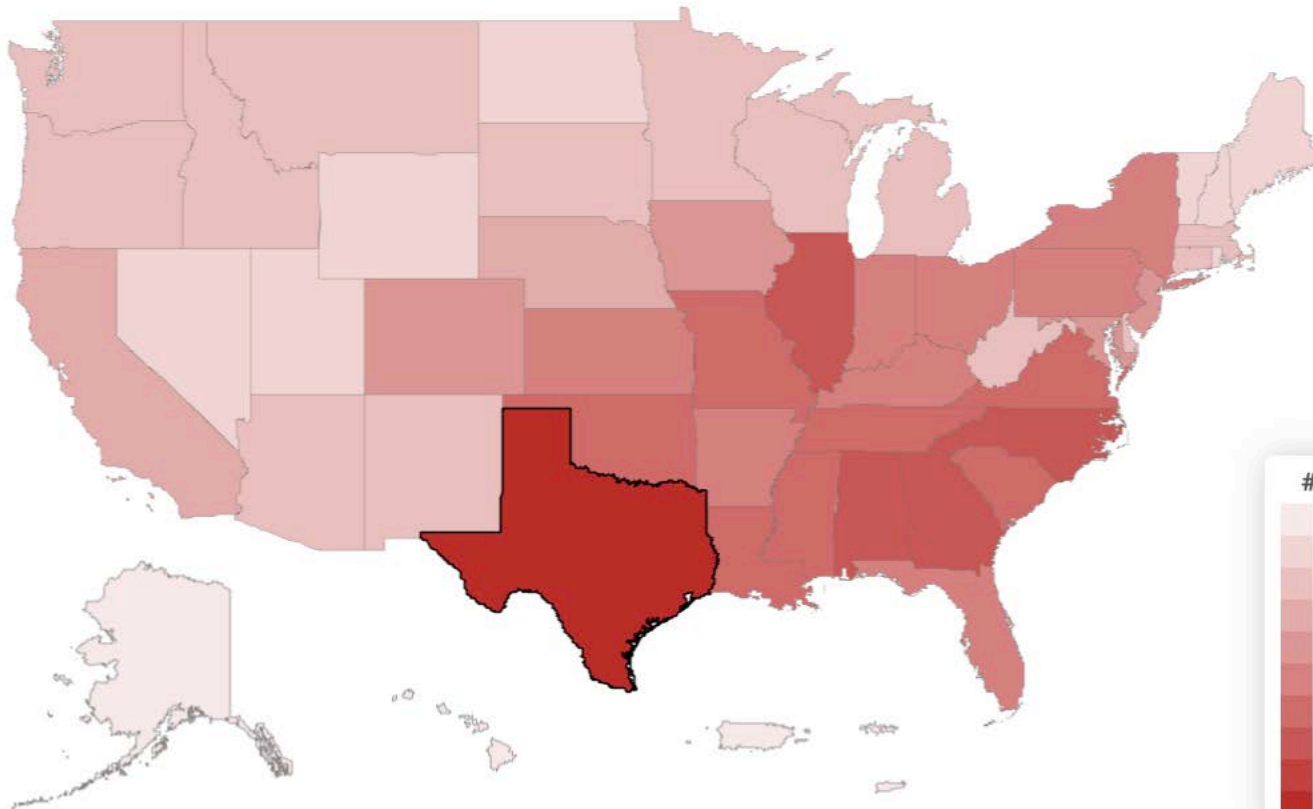
@ag\_weather

Nutrien Science Fellow

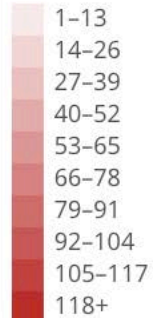
Principal Atmospheric Scientist

Nutrien Ag Solutions

# 1980-2021\* Billion-Dollar Weather and Climate Disasters (CPI-Adjusted)










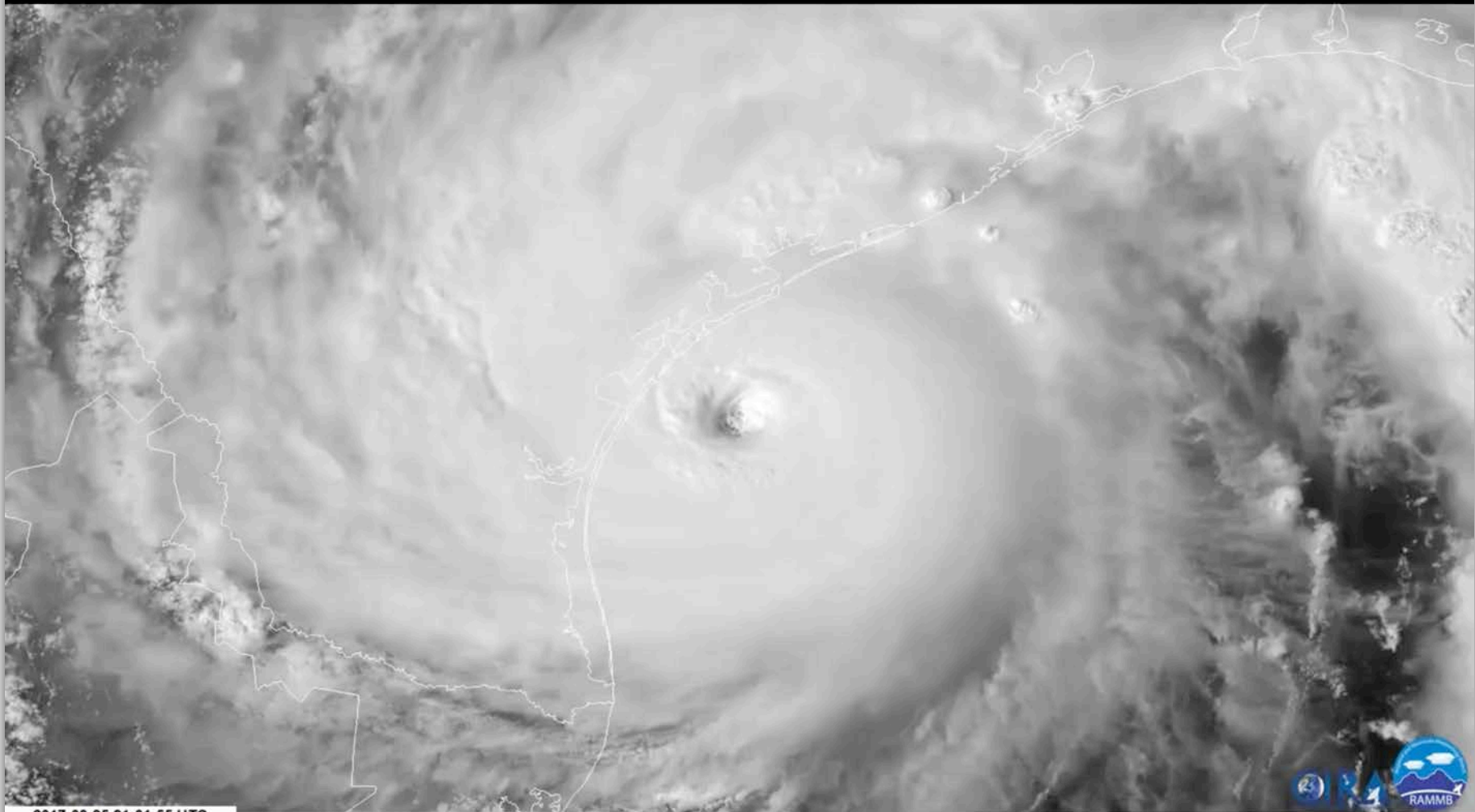
### # Events



## Texas

Drought: 17	Flooding: 9	Freeze: 7	Severe Storm: 1	All Disasters: 79
Tropical Cyclone: 12	Wildfire: 7	Winter Storm: 7		All Disasters: 134

Overview	Mapping	Time Series	Climatology	Summary Stats	Events	FAQ	References
EVENT	BEGIN DATE	END DATE	SUMMARY			ESTIMATED COST (IN BILLIONS)	DEATHS
 <b>Hurricane Katrina</b> <i>August 2005</i>	2005-08-25	2005-08-30	Category 3 hurricane initially impacts the U.S. as a Category 1 near Miami, FL, then as a strong Category 3 along the eastern LA-western MS coastlines, resulting in severe storm surge damage (maximum surge probably exceeded 30 feet) along the LA-MS-AL coasts, wind damage, and the failure of parts of the levee system in New Orleans. Inland effects included high winds and some flooding in the states of AL, MS, FL, TN, KY, IN, OH, and GA.			\$176.3	1,833
 <b>Hurricane Harvey</b> <i>August 2017</i>	2017-08-25	2017-08-31	Category 4 hurricane made landfall near Rockport, Texas causing widespread damage. Harvey's devastation was most pronounced due to the large region of extreme rainfall producing historic flooding across Houston and surrounding areas. More than 30 inches of rainfall fell on 6.9 million people, while 1.25 million experienced over 45 inches and 11,000 had over 50 inches, based on 7-day rainfall totals ending August 31. This historic U.S. rainfall caused massive flooding that displaced over 30,000 people and damaged or destroyed over 200,000 homes and businesses.			\$136.3	89
 <b>Hurricane Maria</b> <i>September 2017</i>	2017-09-19	2017-09-21	Category 4 hurricane made landfall in southeast Puerto Rico after striking the U.S. Virgin Island of St. Croix. Maria's high winds caused widespread devastation to Puerto Rico's transportation, agriculture, communication and energy infrastructure. Extreme rainfall up to 37 inches caused widespread flooding and mudslides across the island. The interruption to commerce and standard living conditions will be sustained for a long period, as much of Puerto Rico's infrastructure is rebuilt. Maria tied Hurricane Wilma (2005) for the most rapid intensification, strengthening from tropical depression to a category 5 storm in 54 hours. Maria's landfall at Category 4 strength gives the U.S. a record three Category 4+ landfalls this year (Maria, Harvey, and Irma). Maria was one of the deadliest storms to impact the U.S., with numerous indirect deaths in the wake of the storm's devastation.			\$98.1	2,981
 <b>Hurricane Sandy</b> <i>October 2012</i>	2012-10-30	2012-10-31	Extensive damage across several northeastern states (MD, DE, NJ, NY, CT, MA, RI) due to high wind and coastal storm surge, particularly NY and NJ. Damage from wind, rain and heavy snow also extended more broadly to other states (NC, VA, WV, OH, PA, NH), as Sandy merged with a developing Nor'easter. Sandy's impact on major population centers caused widespread interruption to critical water / electrical services and also caused 159 deaths (72 direct, 87 indirect). Sandy also caused the New York Stock Exchange to close for two consecutive business days, which last happened in 1888 due to a major winter storm.			\$77.4	159
 <b>Hurricane Irma</b> <i>September 2017</i>	2017-09-06	2017-09-12	Category 4 hurricane made landfall at Cudjoe Key, Florida after devastating the U.S. Virgin Islands - St John and St Thomas - as a category 5 storm. The Florida Keys were heavily impacted, as 25% of buildings were destroyed while 65% were significantly damaged. Severe wind and storm surge damage also occurred along the coasts of Florida and South Carolina. Jacksonville, FL and Charleston, SC received near-historic levels of storm surge causing significant coastal flooding. Irma maintained a maximum sustained wind of 185 mph for 37 hours, the longest in the satellite era. Irma also was a category 5 storm for longer than all other Atlantic hurricanes except Ivan in 2004.			\$54.5	97
 <b>Hurricane Andrew</b> <i>August 1992</i>	1992-08-23	1992-08-27	Category 5 hurricane hits Florida and later impacts Louisiana as a category 3. High winds damage or destroy over 125,000 homes and leave at least 160,000 people homeless in Dade County, Florida alone. Initially rated as a category 4, Andrew was later upgraded to a category 5 upon further analysis. Andrew joins Hurricane Camille (1969) and the Labor Day Hurricane (1935), as the only land falling category 5 hurricanes on record to affect the U.S. mainland. Adjusted to present-day dollars, Andrew is the 6th most costly hurricane to impact the U.S. since 1980, after Katrina (2005), Harvey (2017), Maria (2017), Sandy (2012) and Irma (2017).			\$52.7	61
 <b>U.S. Drought/Heatwave</b> <i>Summer 1988</i>	1988-06-01	1988-08-31	1988 drought across a large portion of the U.S. with very severe losses to agriculture and related industries. Combined direct and indirect deaths (i.e., excess mortality) due to heat stress estimated at 5,000.			\$46.6	454



2017-08-25 21:01:55 UTC





The Major  
The Major who is his friend -  
D. B. [unclear]  
(col. 90)

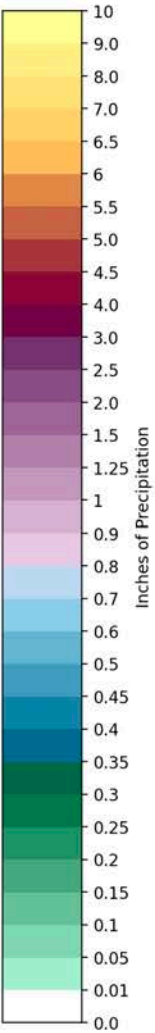
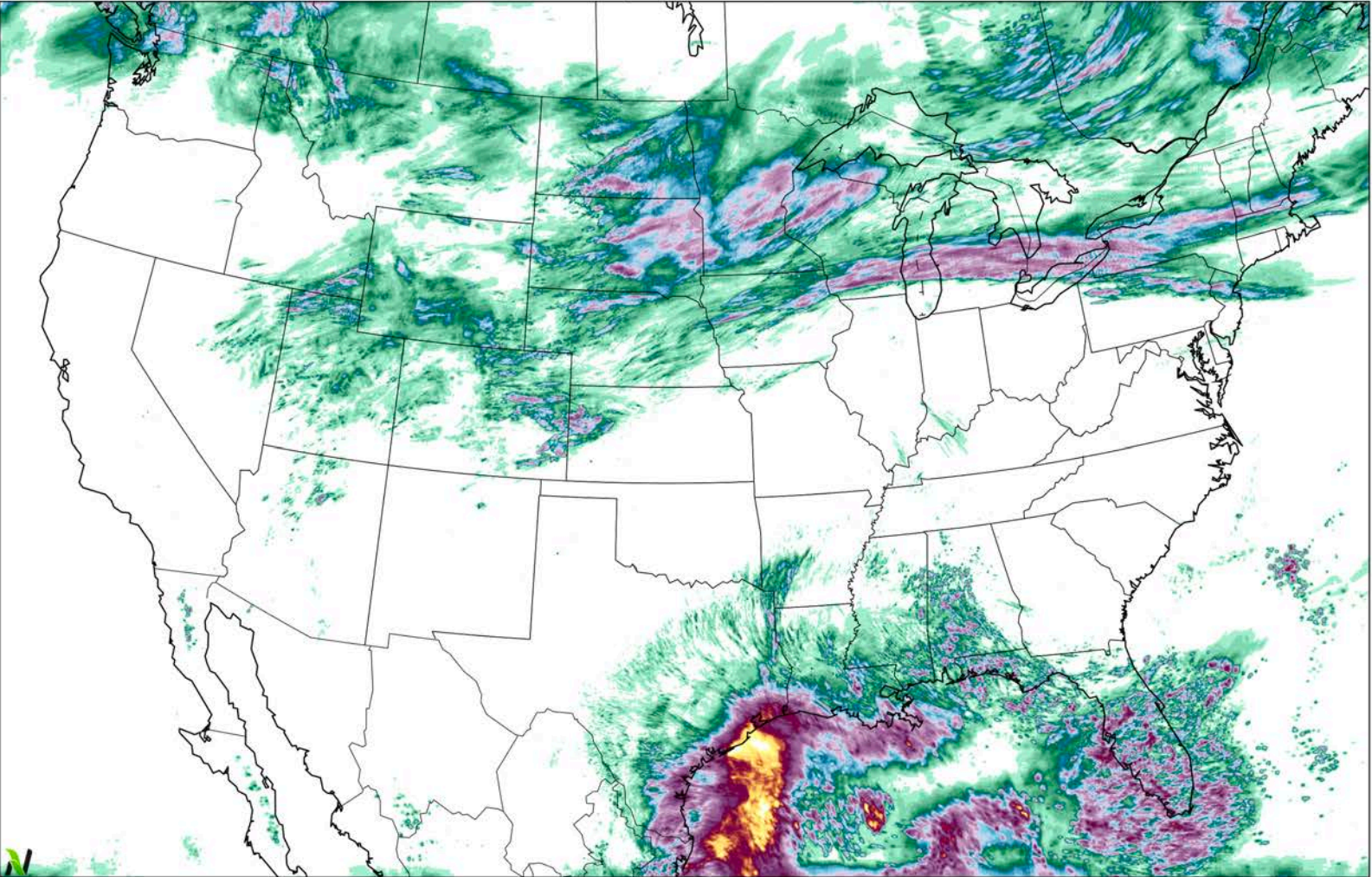
## AT-6 Texan

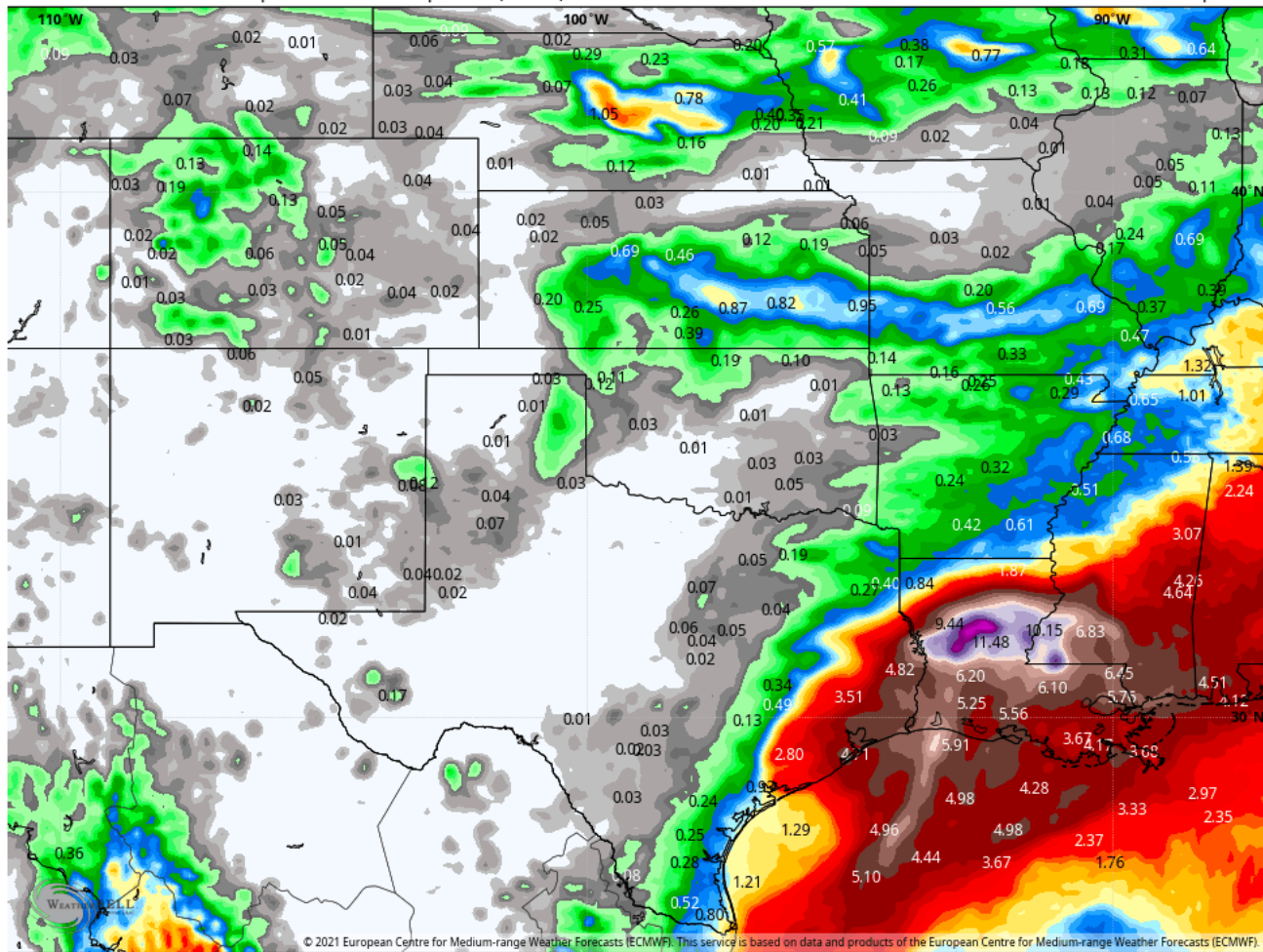
(Max speed = 205 mph)



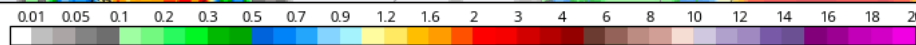
On the morning of July 27, 1943, a hurricane was making landfall near Galveston, Texas. Duckworth and O'Hair were having breakfast with some veteran British pilots who were at the base learning the finer points of instrument flying. The British were kidding Duckworth because American airplanes were being flown away from the storm's path and they made jokes about the frailty of what they considered the unreliable AT-6 Texan. Duckworth got tired of the ribbing and, liking the Texan, bet the British a "highball" libation he could fly through the storm in the plane. No pilot had ever intentionally flown through a hurricane before as it was considered too dangerous. The British took Duckworth up on the bet and he and O'Hair had a AT-6 fueled up.

Last 72 hours of Precipitation valid 2021-09-14 03:00 AM



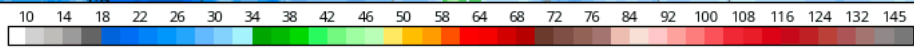
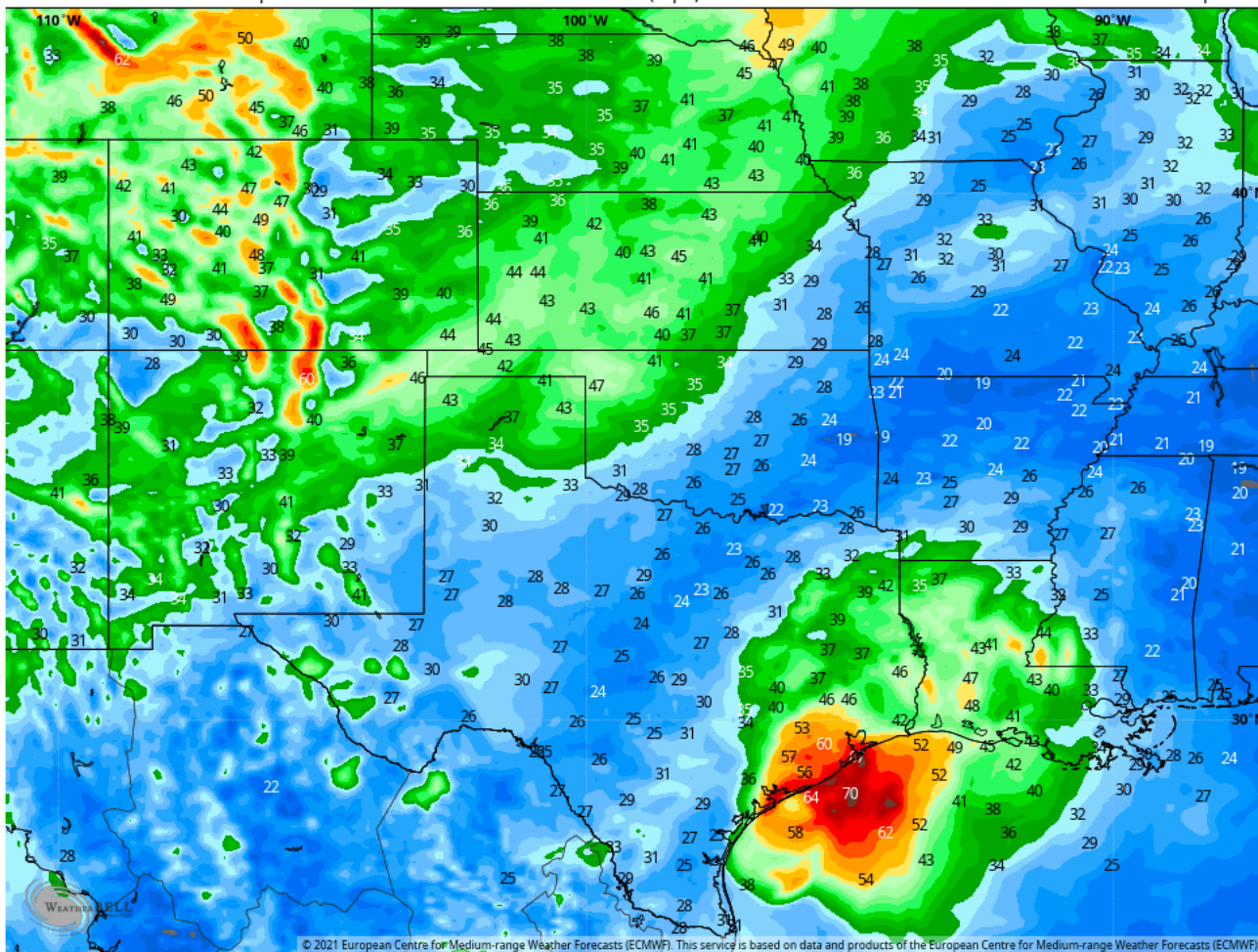


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Max: 18.30





Max: 75.6

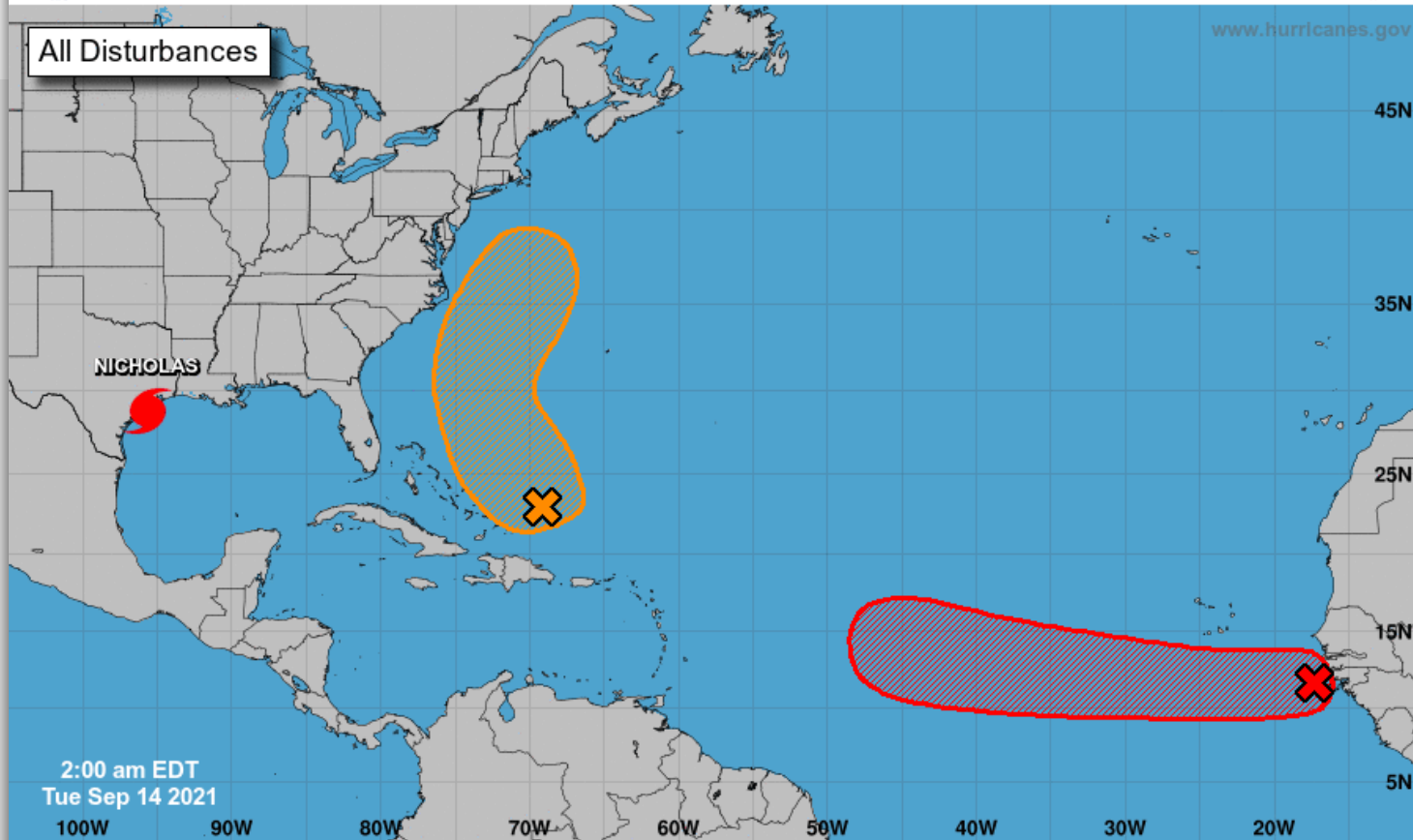


# Five-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



www.hurricanes.gov



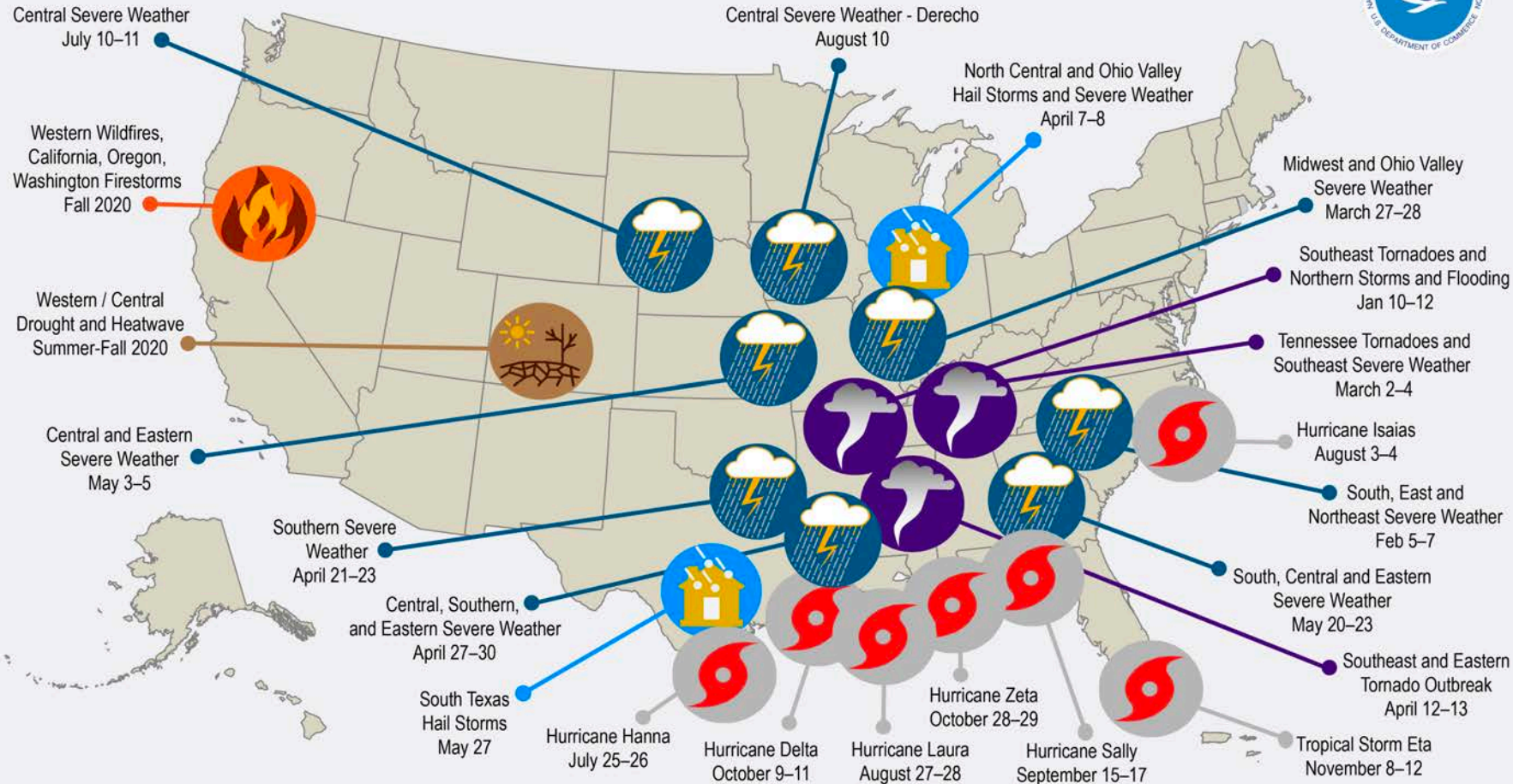
2:00 am EDT  
Tue Sep 14 2021

Current Disturbances and Five-Day Cyclone Formation Chance: < 40% 40-60% > 60%

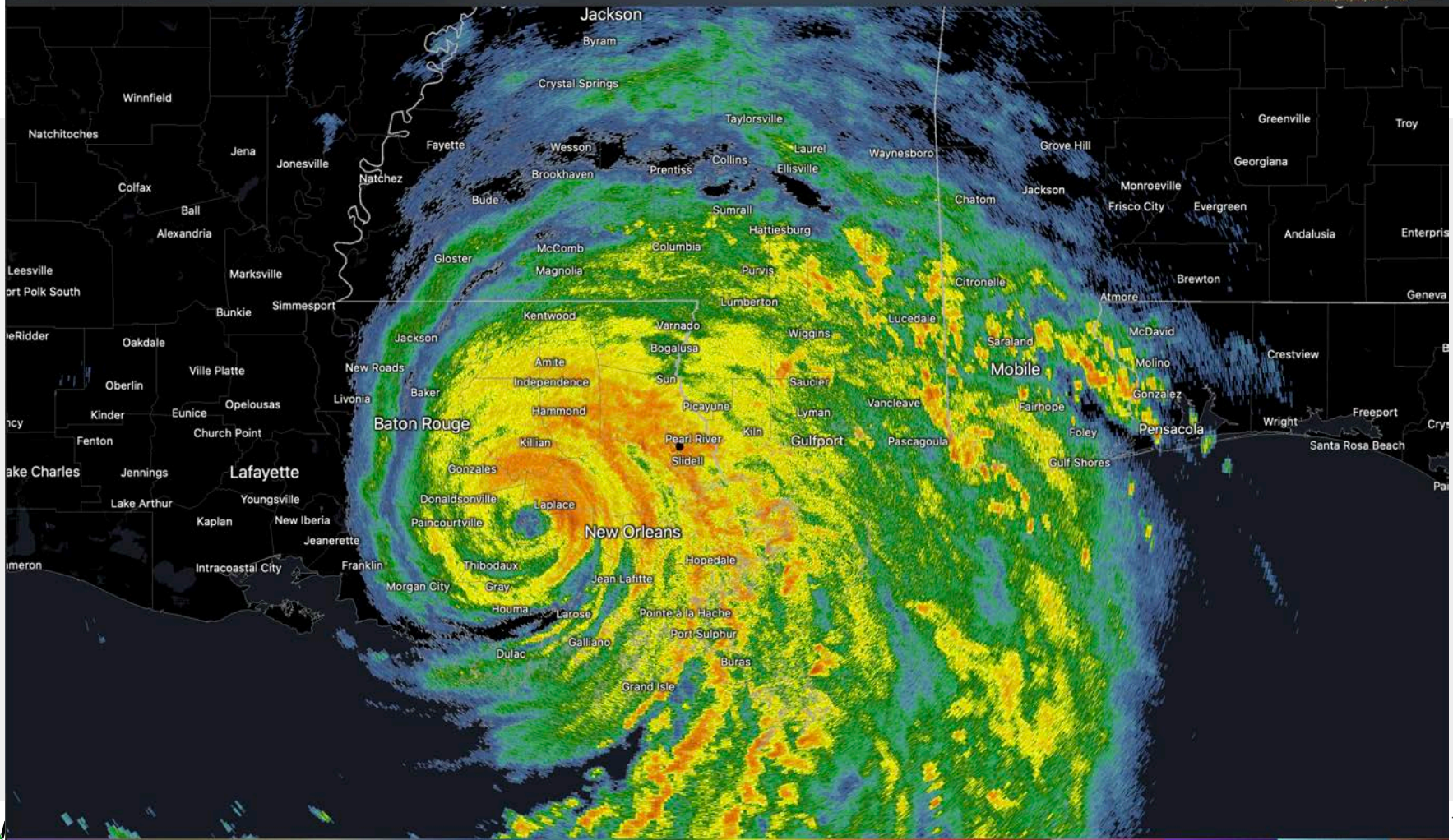
Tropical or Sub-Tropical Cyclone: Depression Storm Hurricane

Post-Tropical Cyclone or Remnants

# U.S. 2020 Billion-Dollar Weather and Climate Disasters



*This map denotes the approximate location for each of the 22 separate billion-dollar weather and climate disasters that impacted the United States during 2020.*





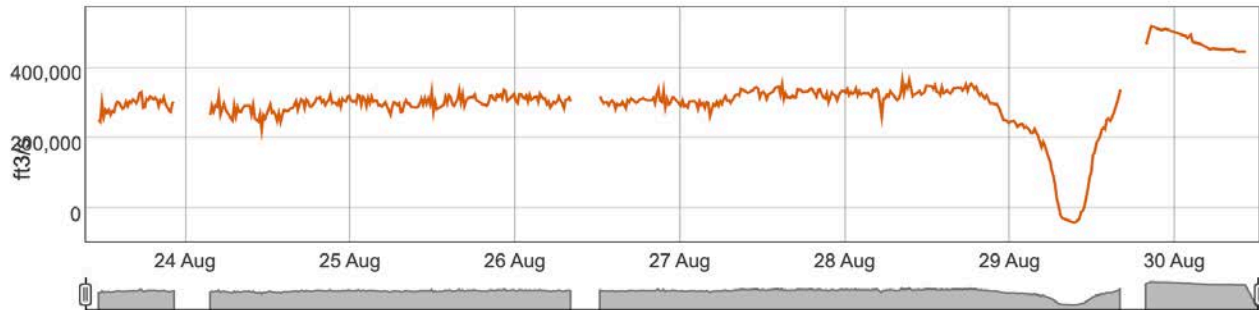
## Mississippi River at Belle Chasse, LA

### USGS 07374525 (Surface Water, Stream)

[Show Map](#) [Open Plots](#) [Site Page](#) [Data](#) [Subscribe](#)

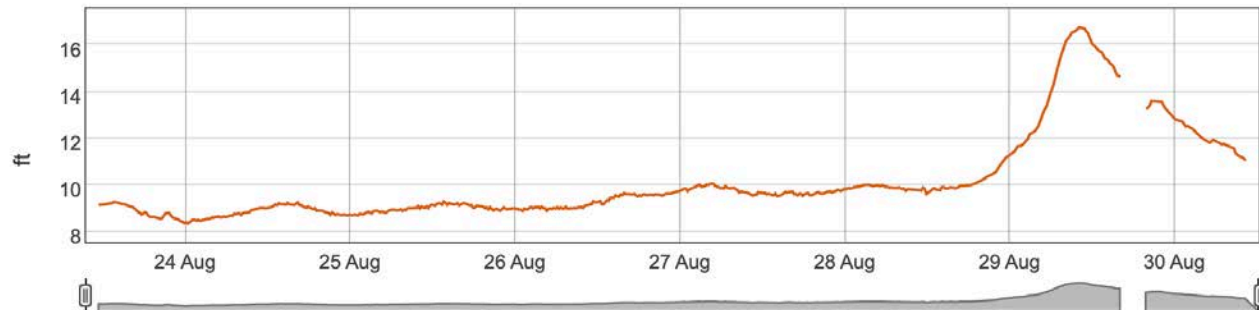
▼ Discharge, cubic feet per second

447,000 @ 10:30 AM (Pacific Daylight)

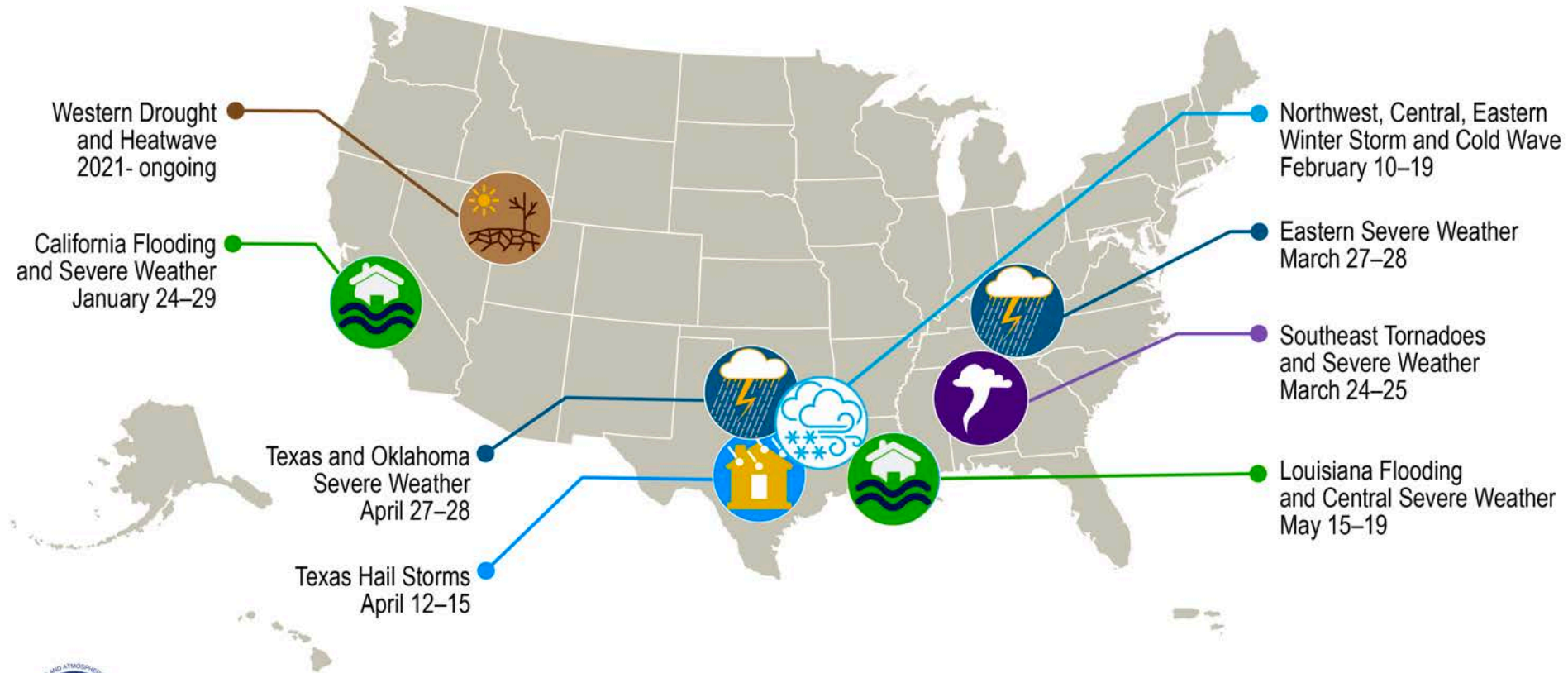


▼ Gage height, feet

11.06 @ 10:30 AM (Pacific Daylight)

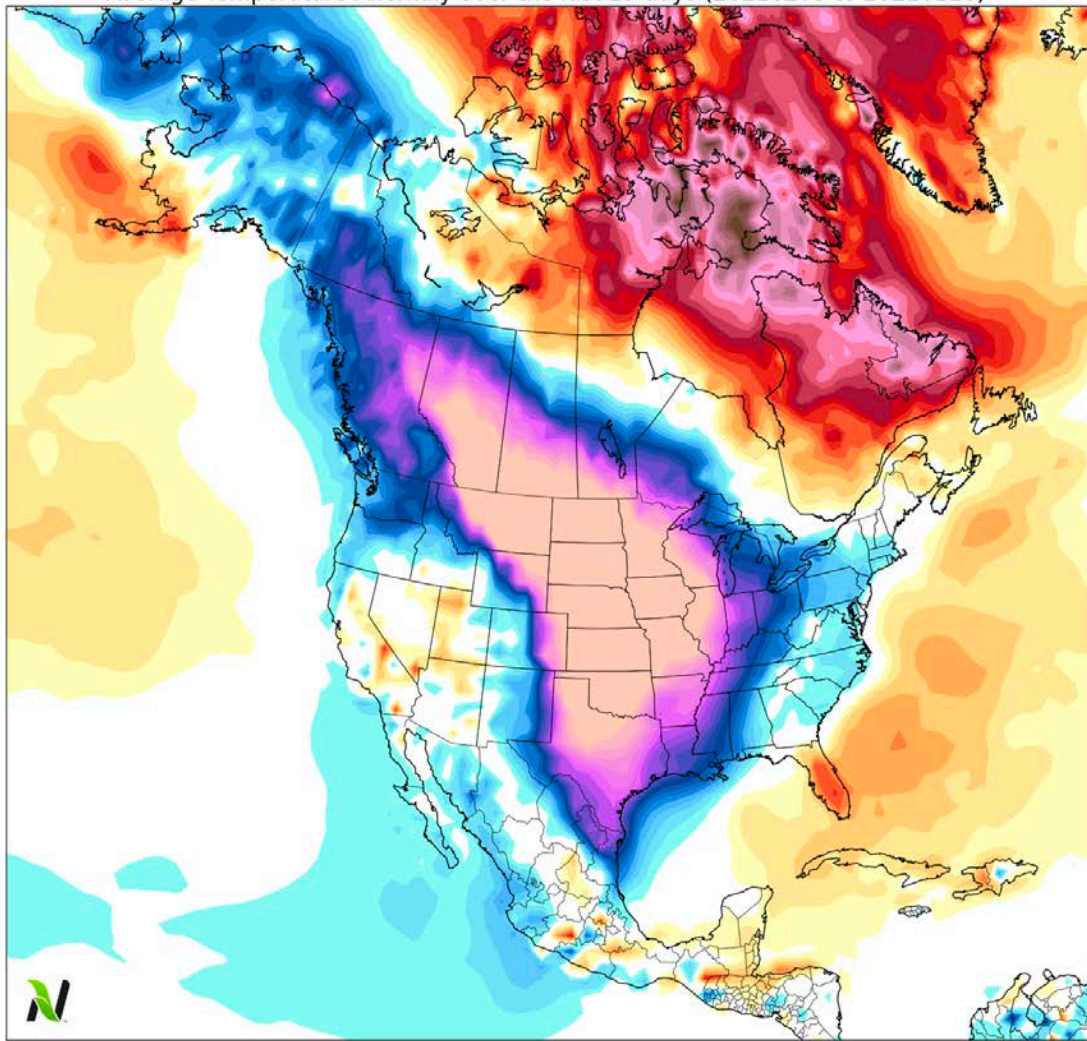


# U.S. 2021 Billion-Dollar Weather and Climate Disasters

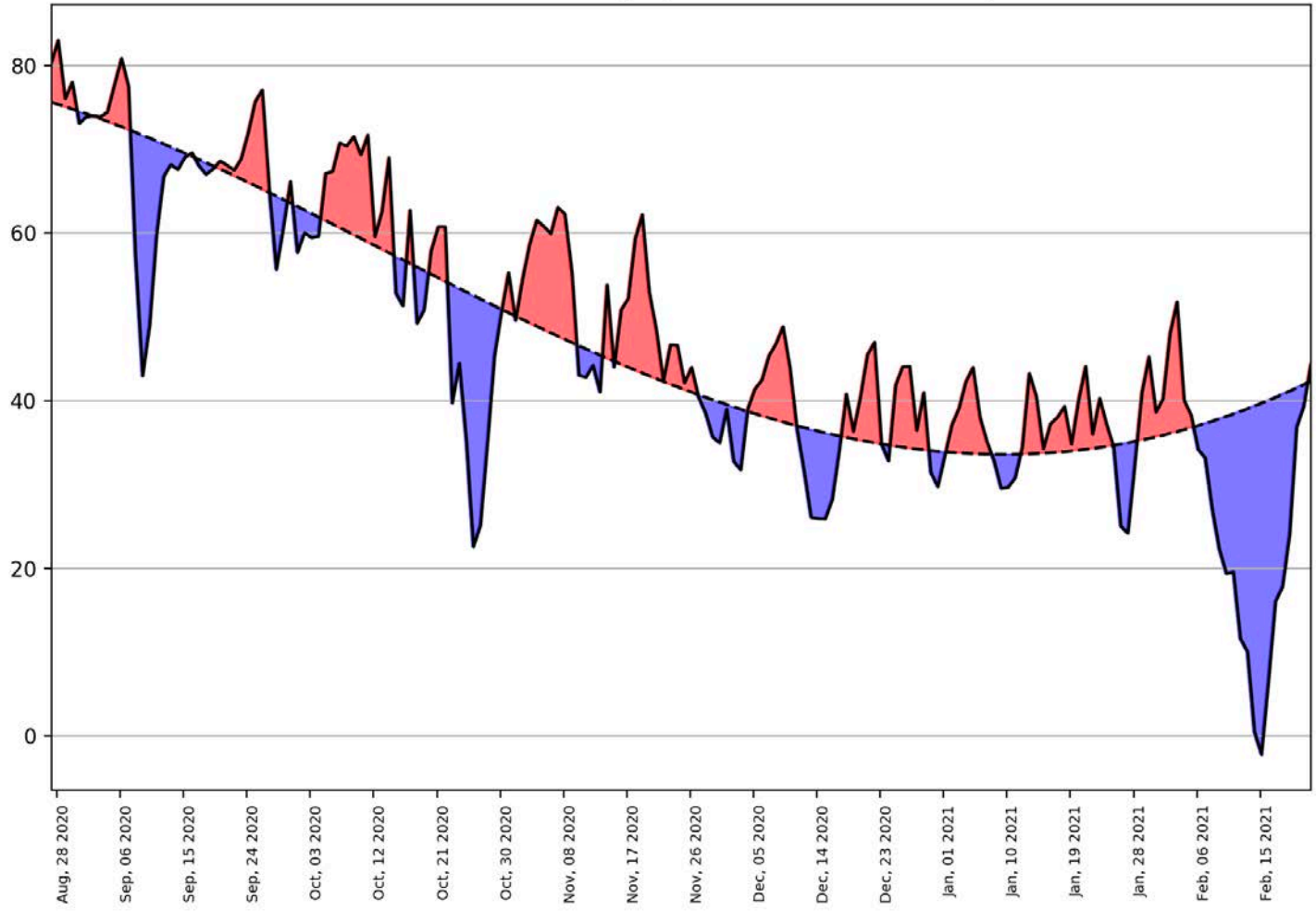


*This map denotes the approximate location for each of the 8 separate billion-dollar weather and climate disasters that impacted the United States January–June 2021.*

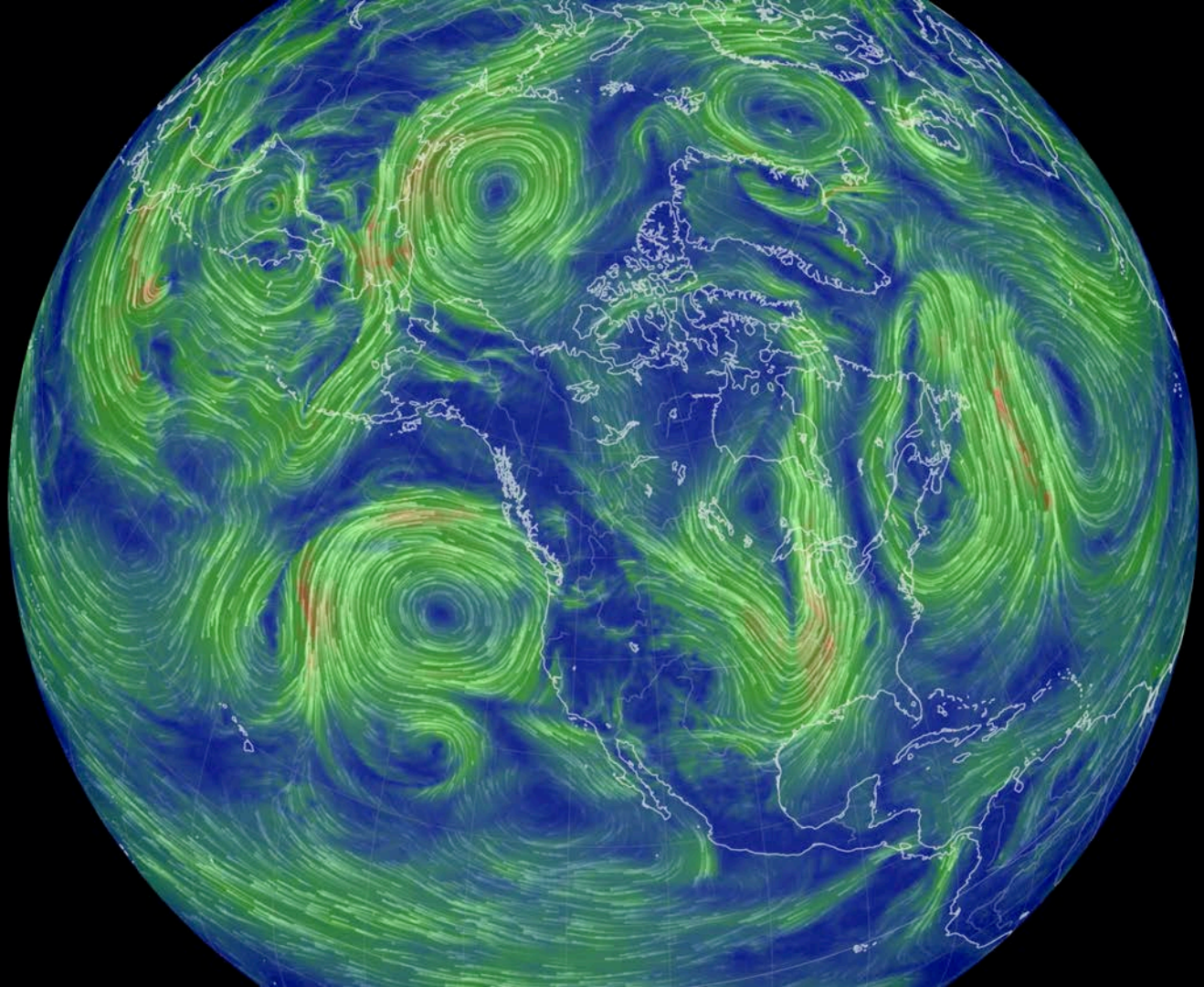
Average Temperature Anomaly over the last 15 days (20210205 to 20210220)



High Plains (CO/TX/OK/KS/NE/NM) Temperature Compared to Normal (F)  
over the last 180-days (2020-08-27 - 2021-02-22)





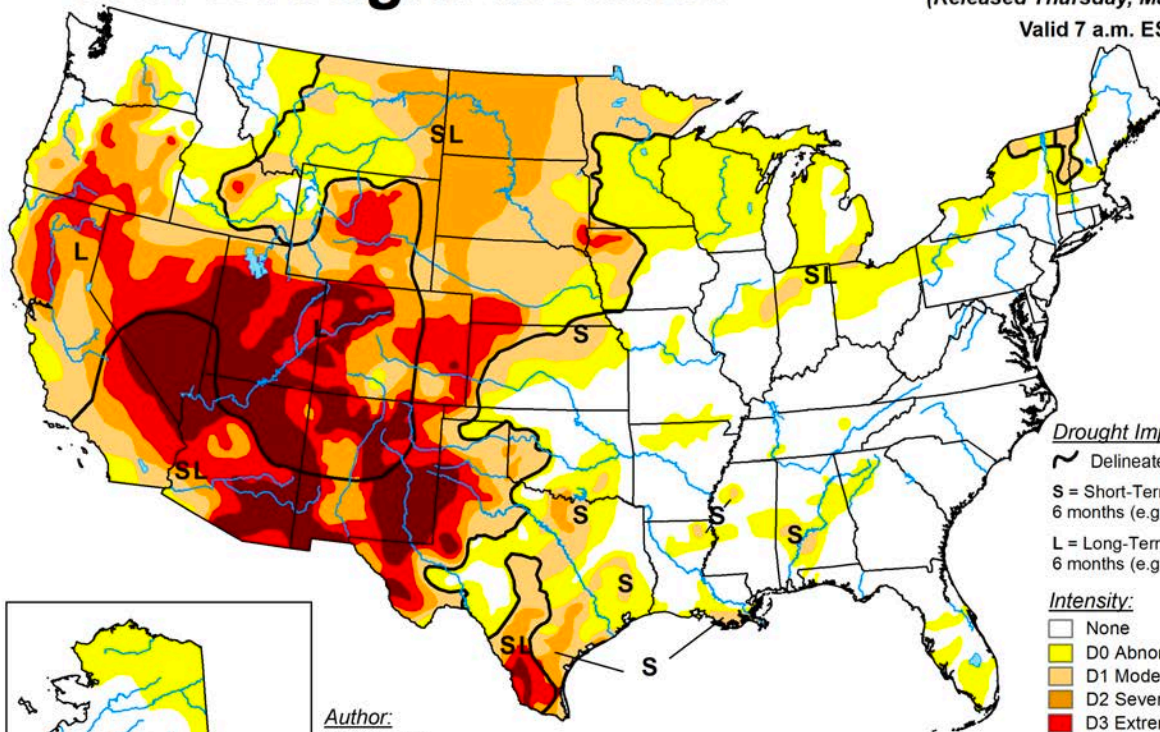


# U.S. Drought Monitor

March 9, 2021

(Released Thursday, Mar. 11, 2021)

Valid 7 a.m. EST

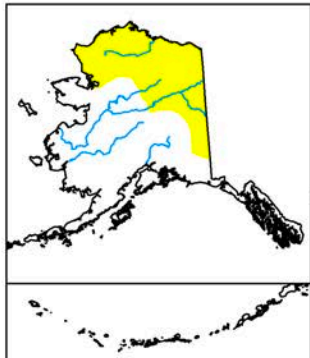


### Drought Impact Types:

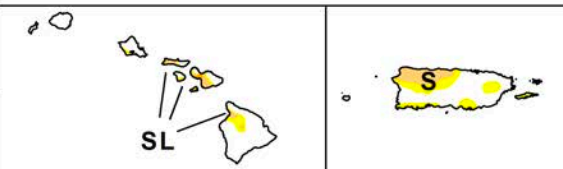
- ~ Delineates dominant impacts
- S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

### Intensity:

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



Author:  
Brian Fuchs  
National Drought Mitigation Center



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>



[droughtmonitor.unl.edu](https://droughtmonitor.unl.edu)

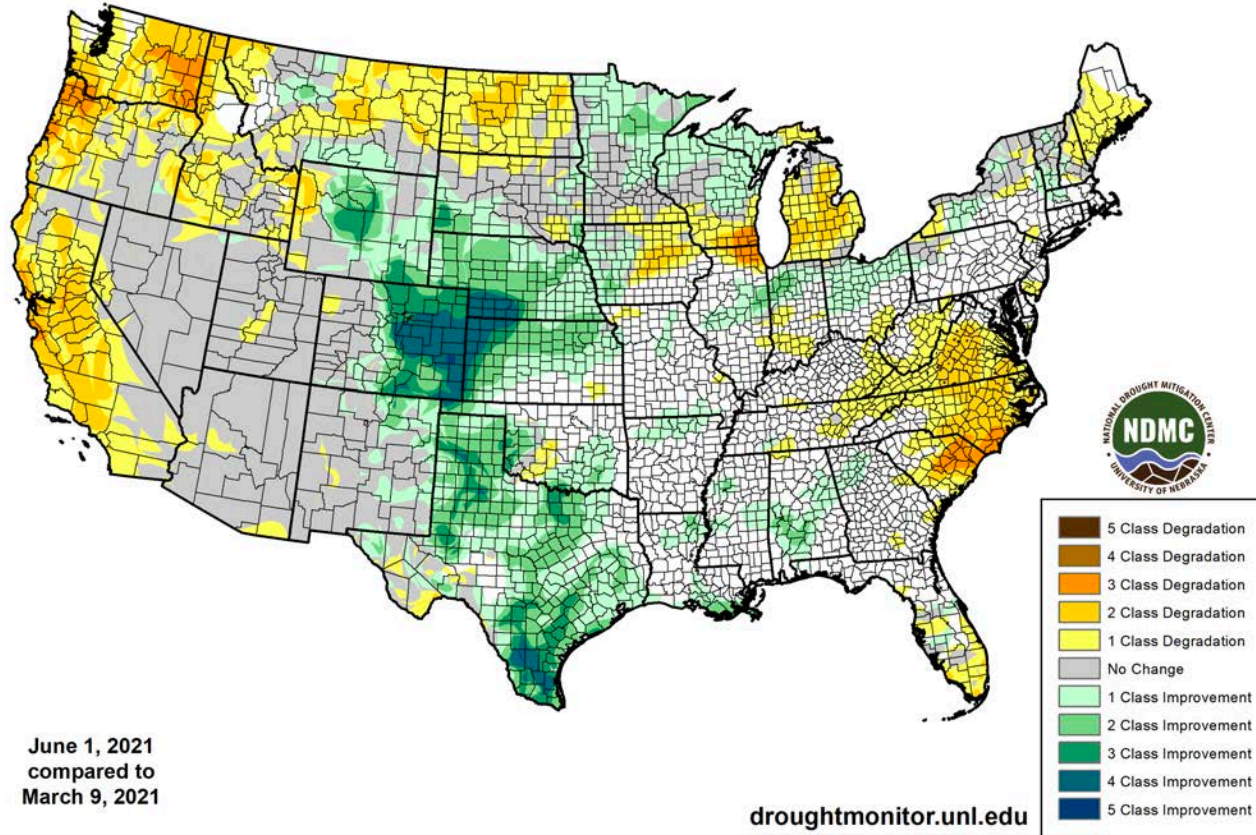
Matt Ernst  
@matternst34  
Near Lubbock, TX



Anthony Franze  
@AnthonyFranzeWX  
March 22, 2021  
Midland-Odessa TX



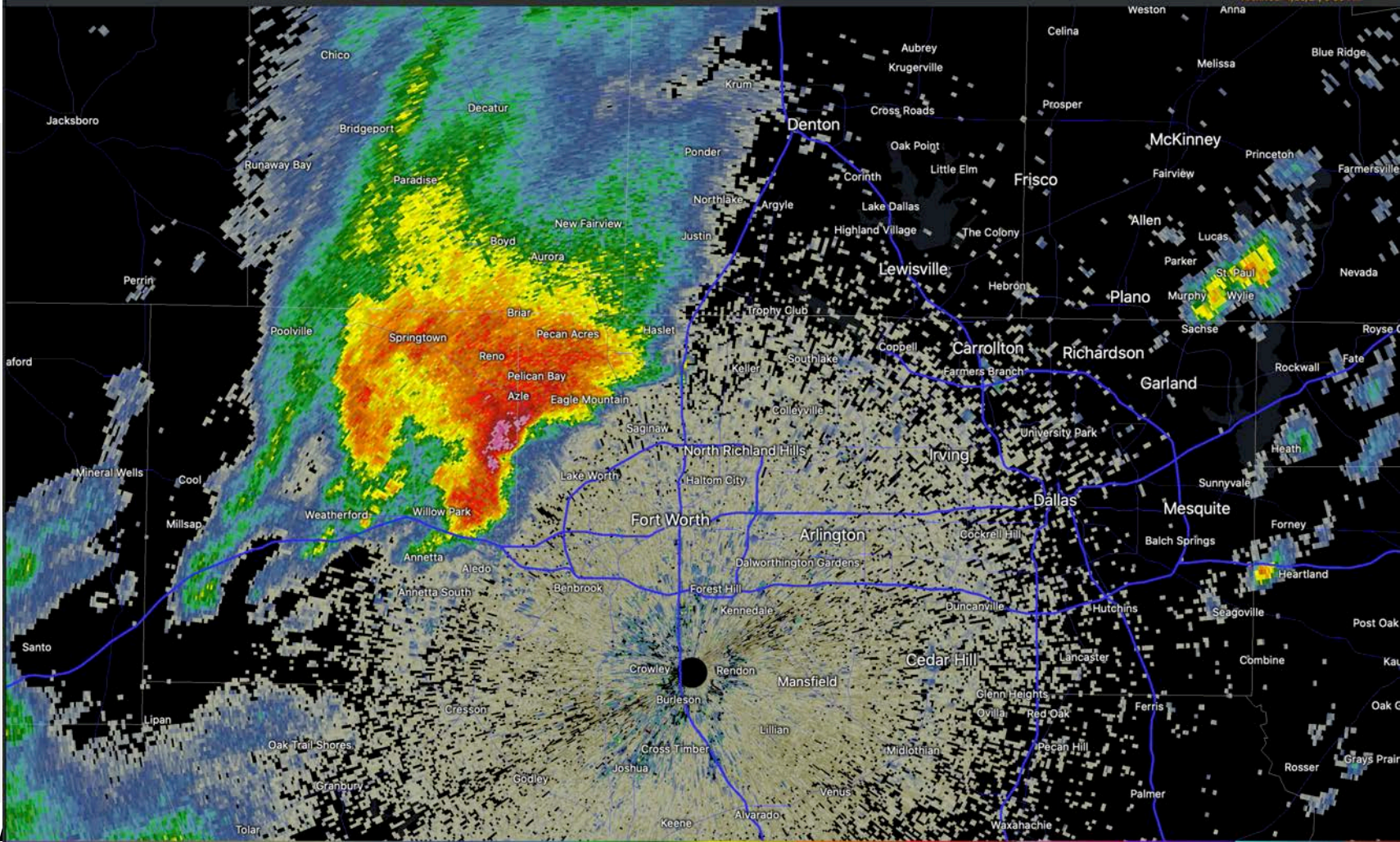
# U.S. Drought Monitor Class Change - Contiguous U.S. (CONUS) 12 Week



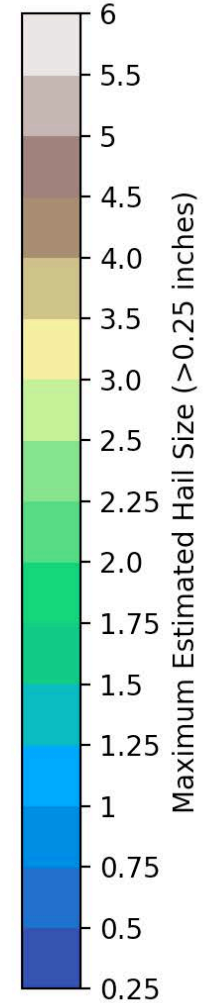
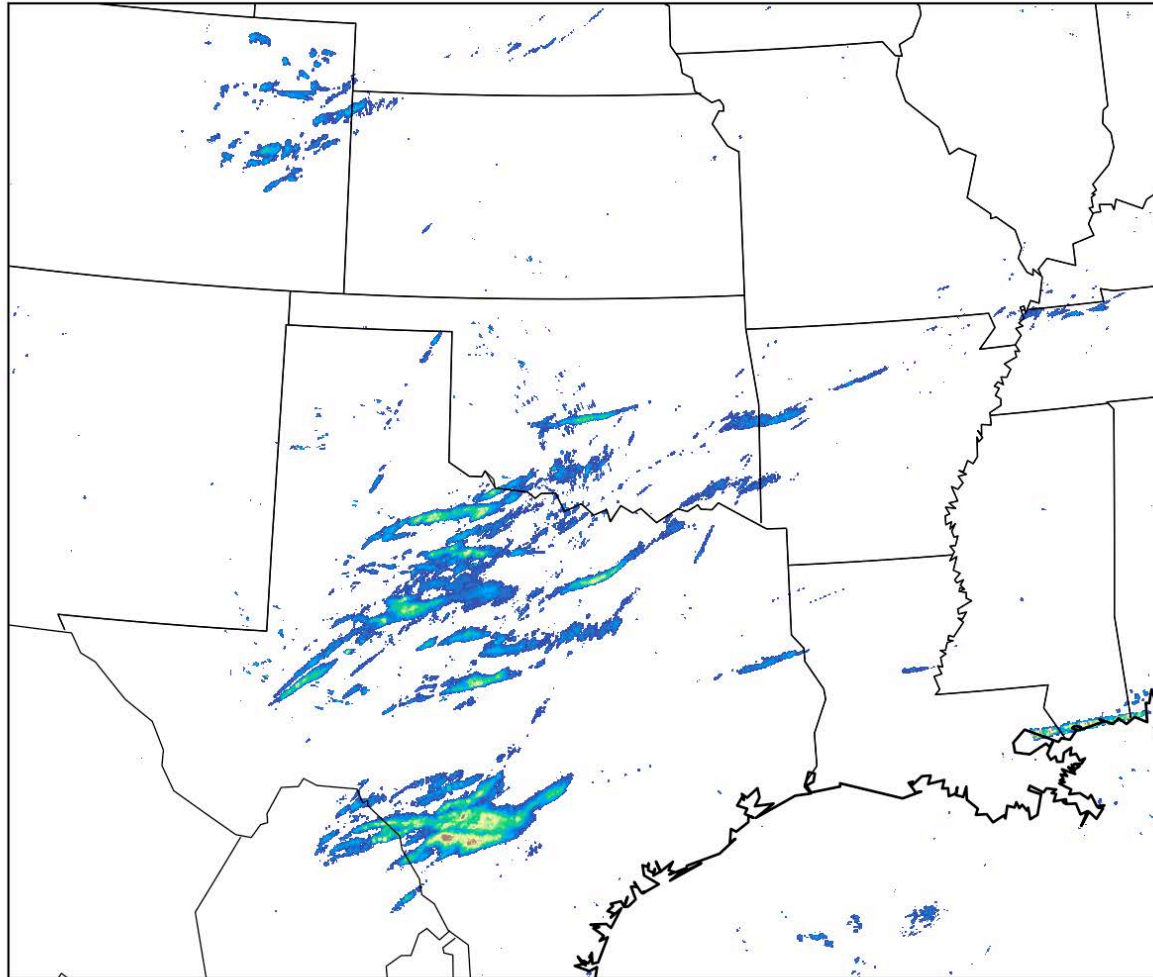
Mike Olbinski  
@MikeOlbinski  
Andrews, TX June 2021

M I K E O L B I N S K I PHOTOGRAPHY





# Maximum Estimate Hail Size 04/27/2021 - 04/30/2021



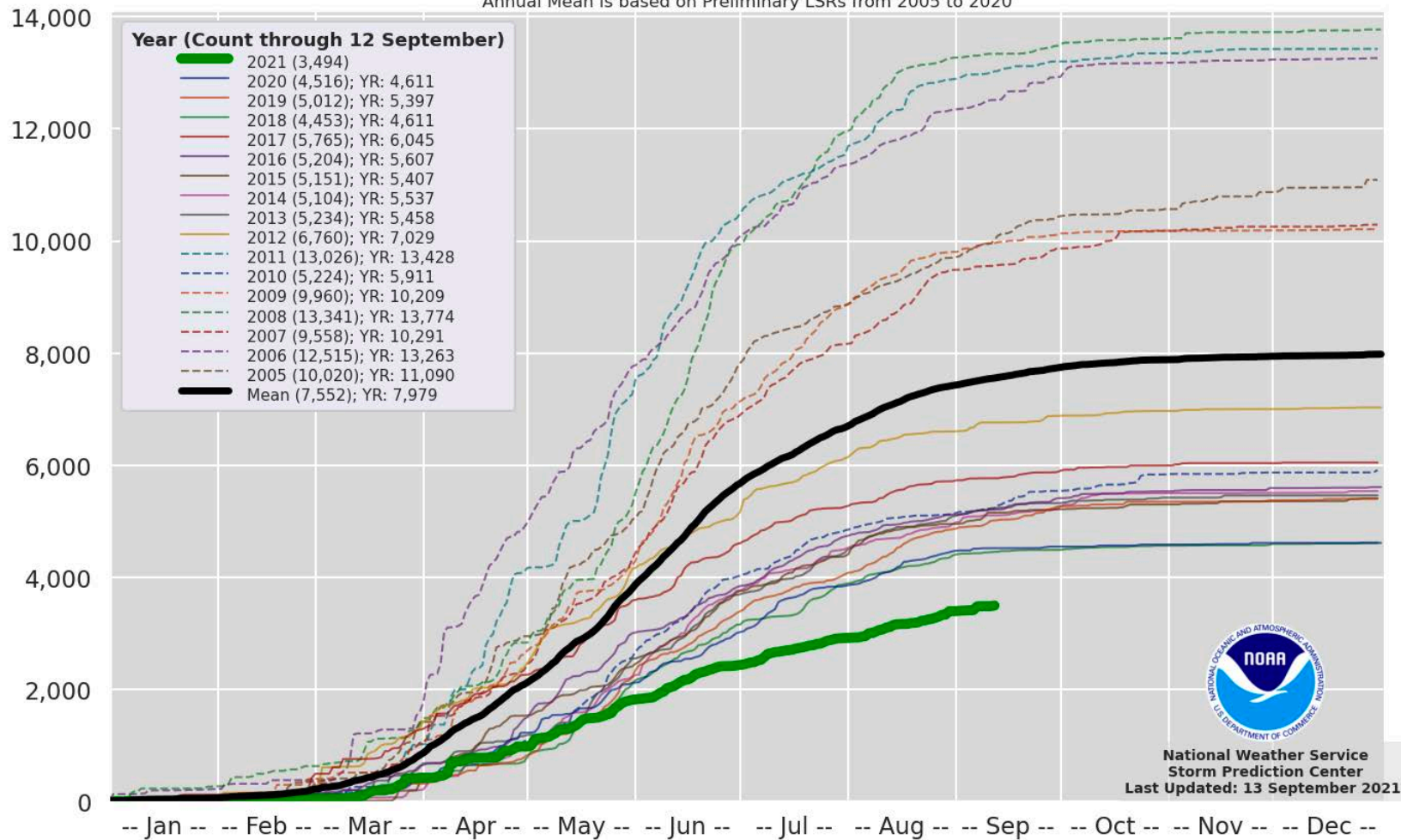






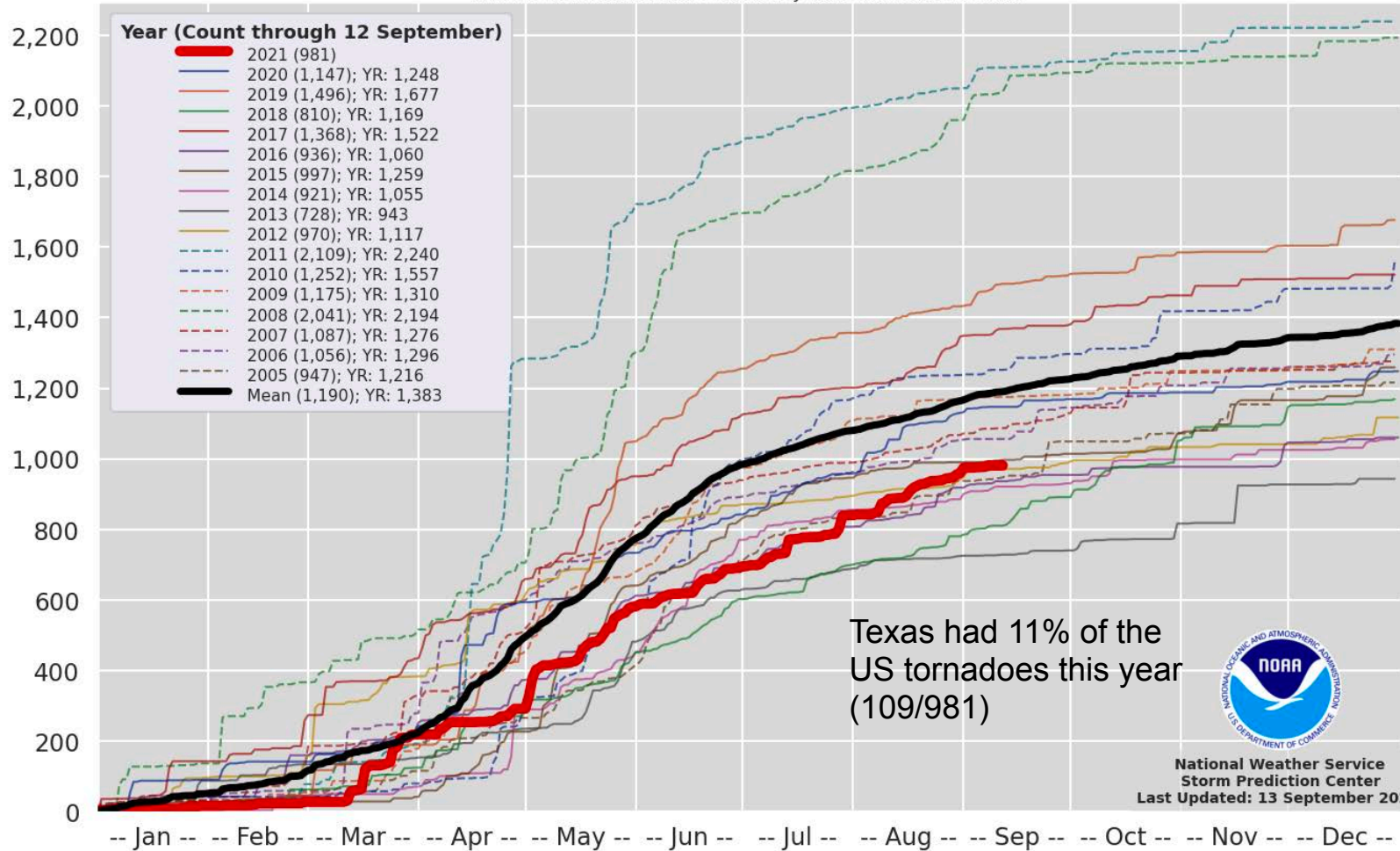
# United States Annual Counts of Hail LSRs\*

\*Preliminary sightings/events from NWS Local Storm Reports (LSRs)  
Annual Mean is based on Preliminary LSRs from 2005 to 2020



# United States Annual Counts of Tornado LSRs\*

\*Preliminary sightings/events from NWS Local Storm Reports (LSRs)  
Annual Mean is based on Preliminary LSRs from 2005 to 2020



Texas had 11% of the US tornadoes this year (109/981)

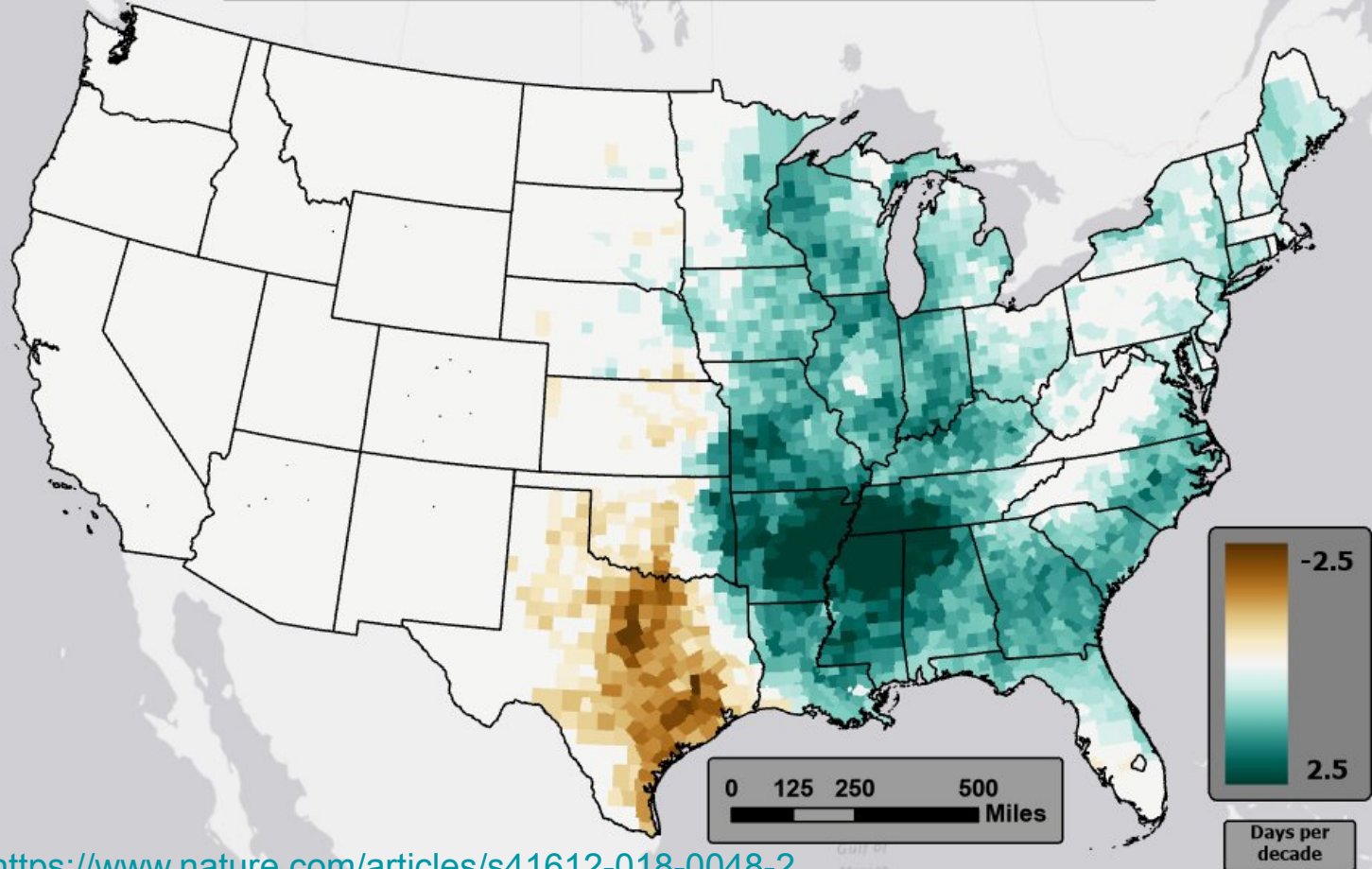


National Weather Service  
Storm Prediction Center  
Last Updated: 13 September 2021

Brian Emfinger  
@brianemfinger  
May 2, 2021  
Mississippi

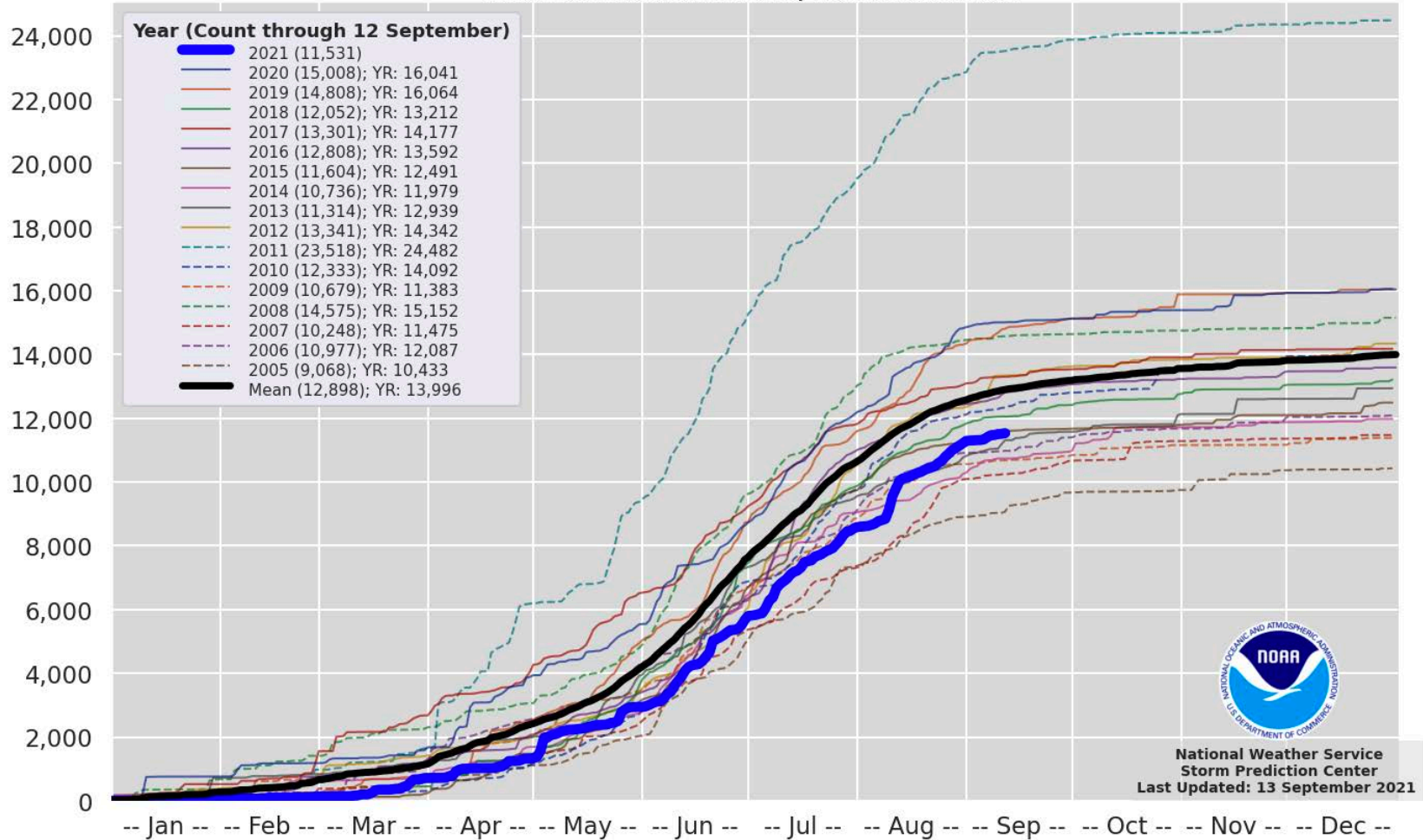


## Change in Favorable Tornado Days (1979-2020)



# United States Annual Counts of Wind LSRs\*

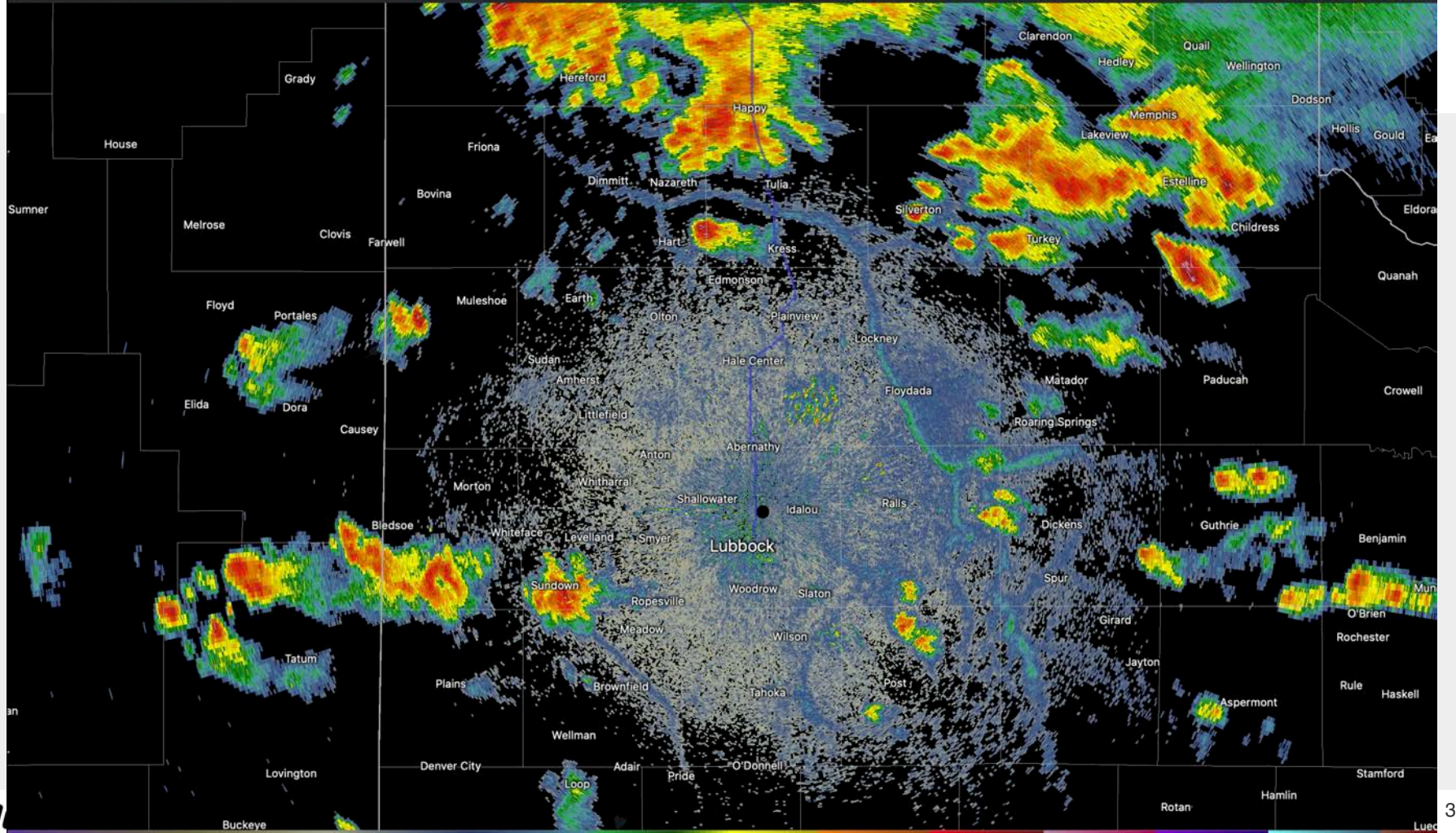
\*Preliminary sightings/events from NWS Local Storm Reports (LSRs)  
Annual Mean is based on Preliminary LSRs from 2005 to 2020



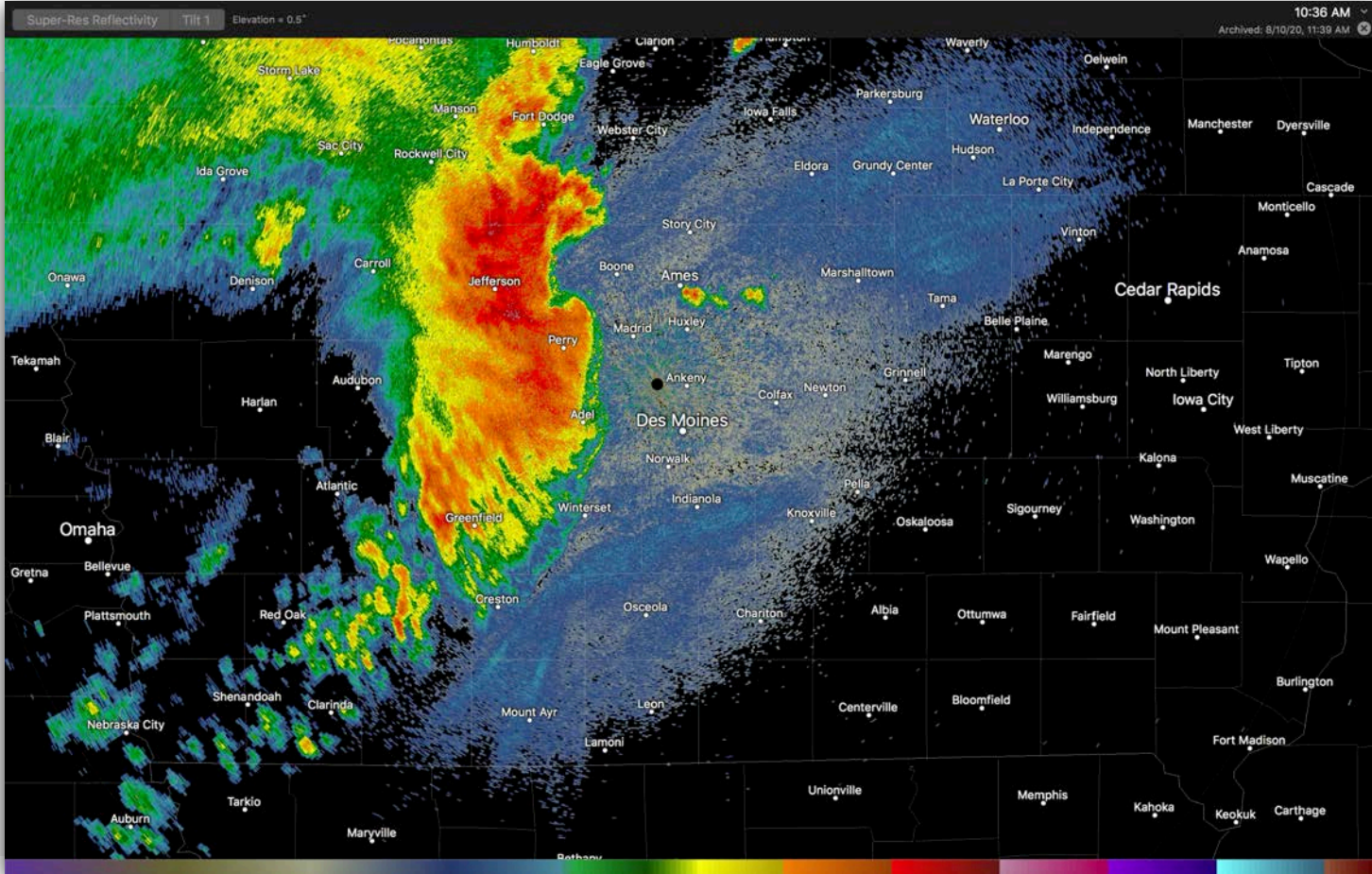
Sudan, TX  
8-16-2021  
Brett Wright  
@WxMstr

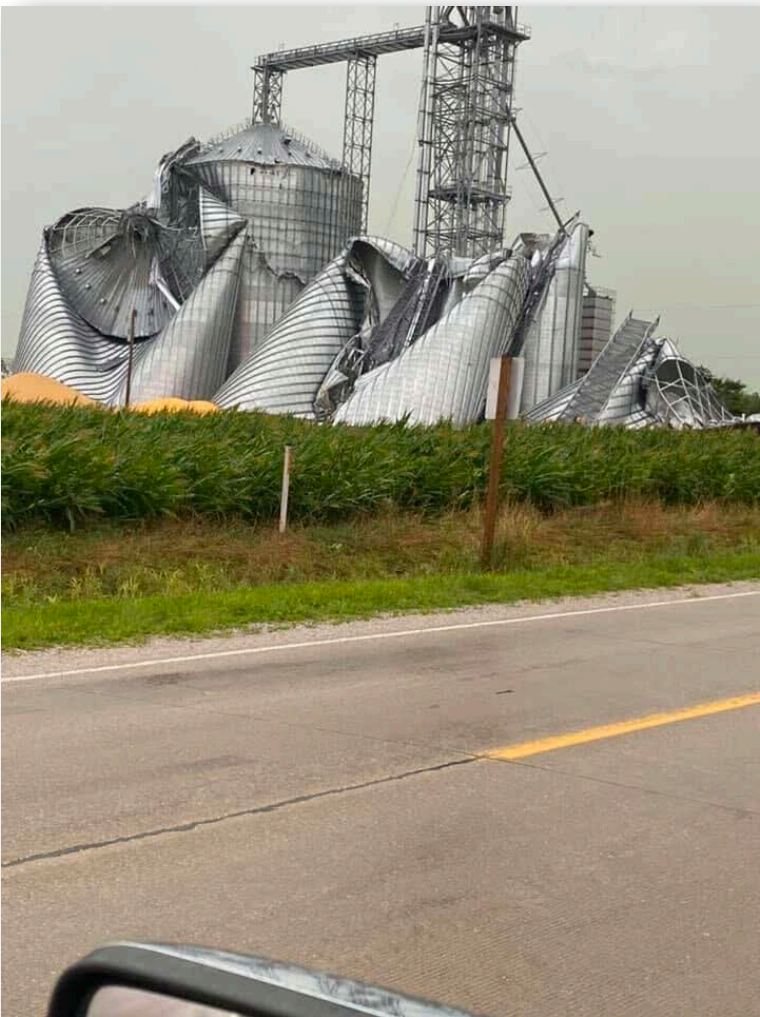


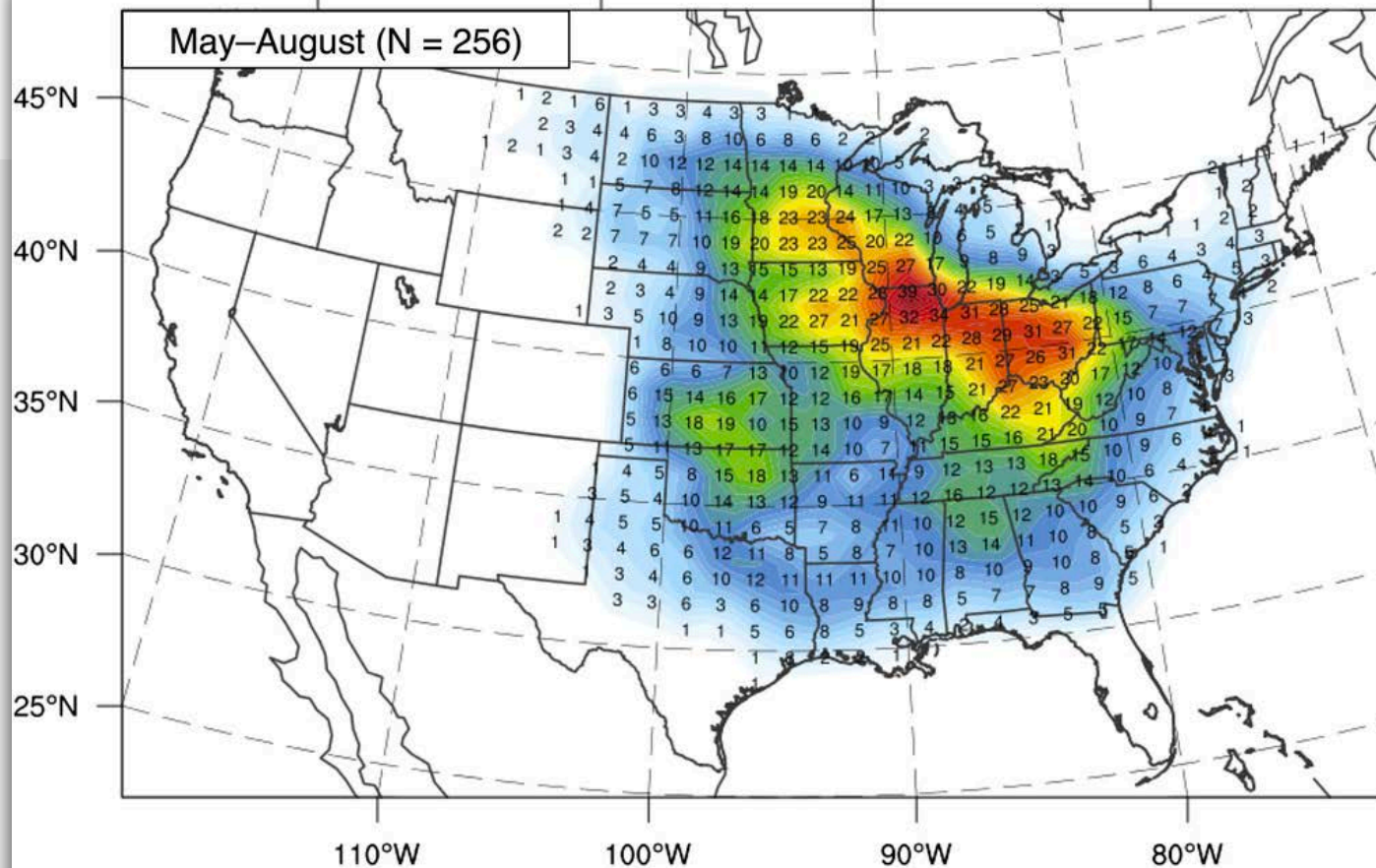




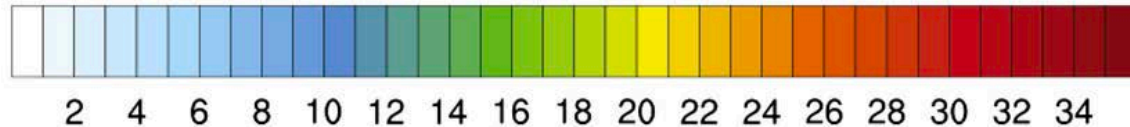
# Bow Echoes and Derechoes







Bosart and Gausini 2016



Megan  
@meg\_ralphio  
Cedar Rapids, IA

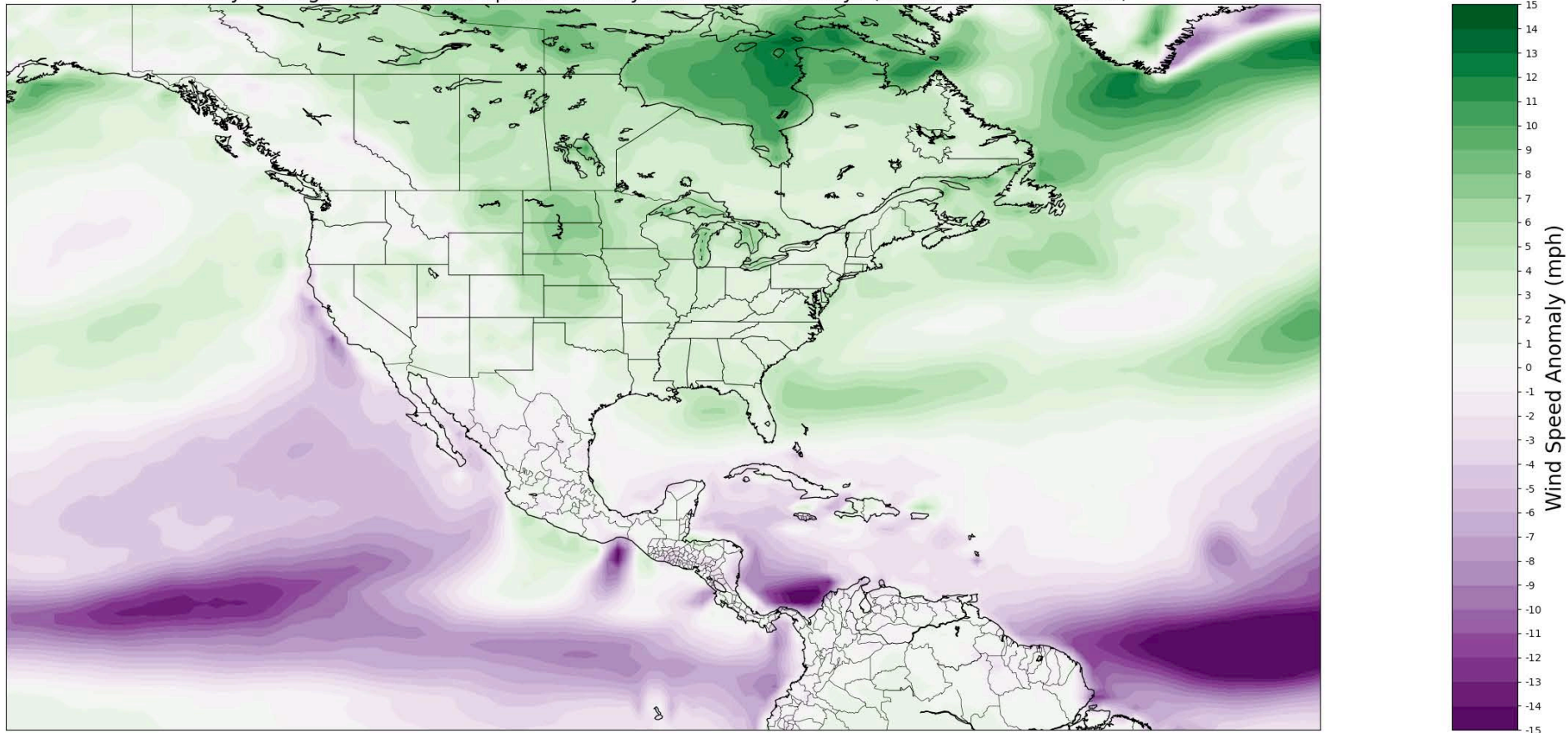


Jessy Wicht  
@jessyeli094  
Minnesota



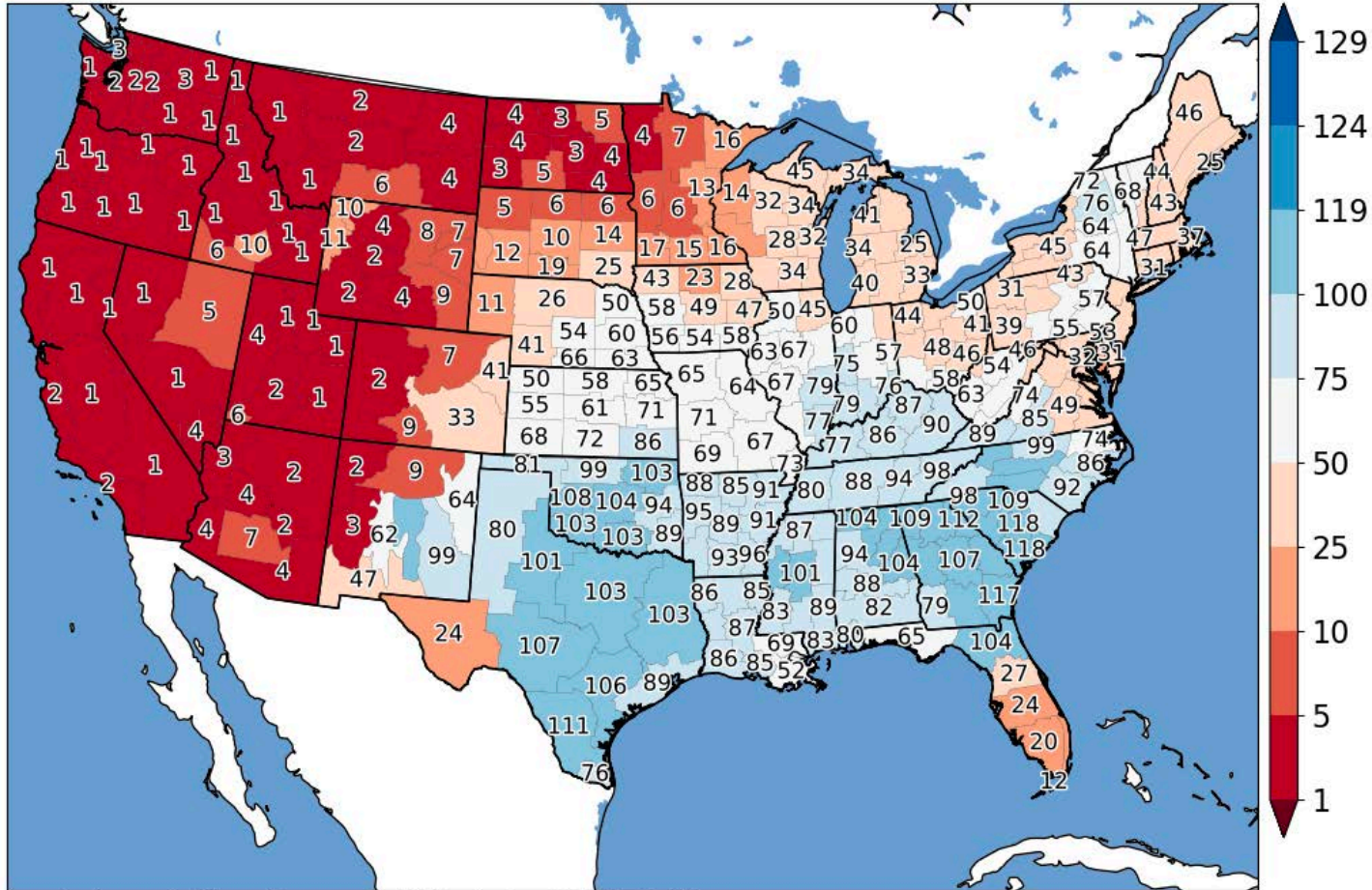
# July through Mid-September Winds Compared to Climatological Average

Daily Average Surface Wind Speed Anomaly over the last 75 days (20210701 to 20210913)

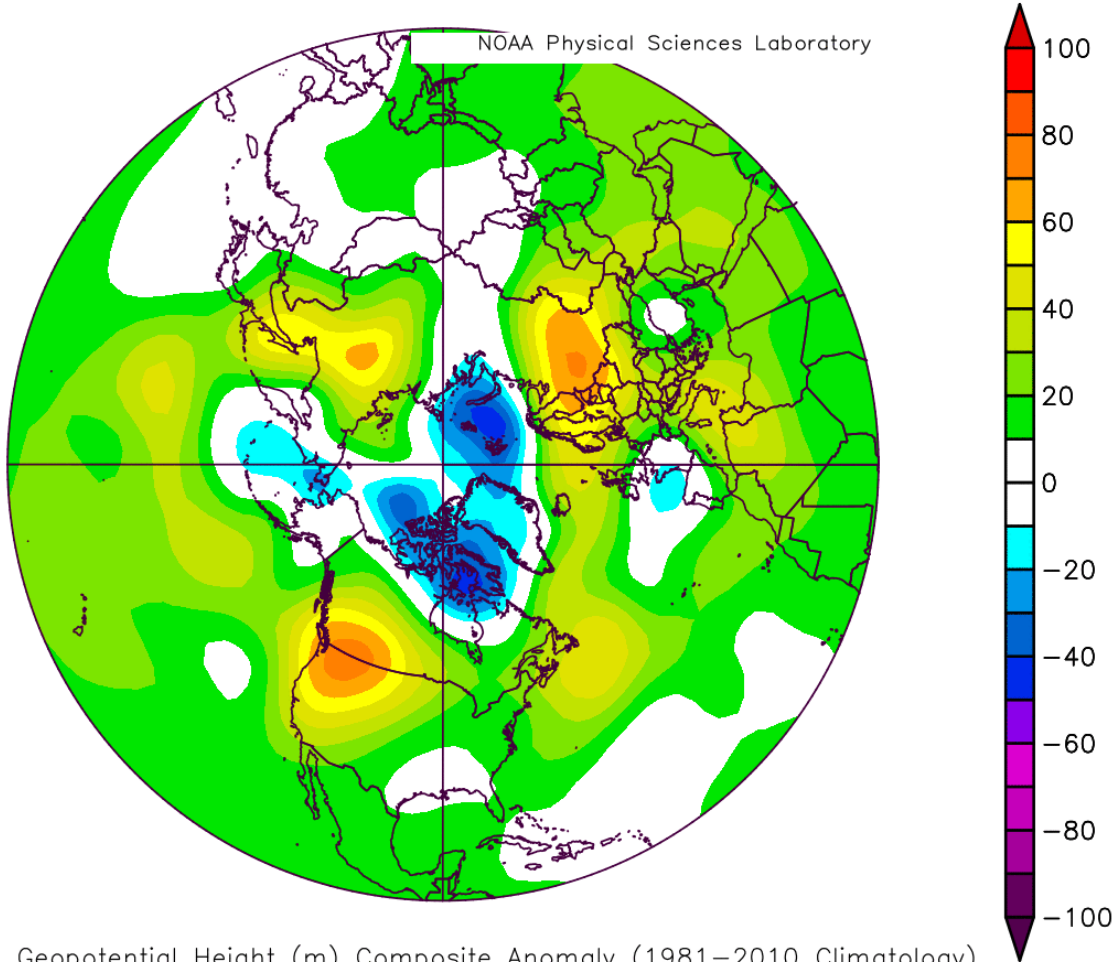




# 31 May 2021 ~7 AM till 15 Aug 2021 ~7 AM Average Temperature Ranks by Climate District Based on IEM Estimates, 1 is hottest out of 129 total years (1893-2021)

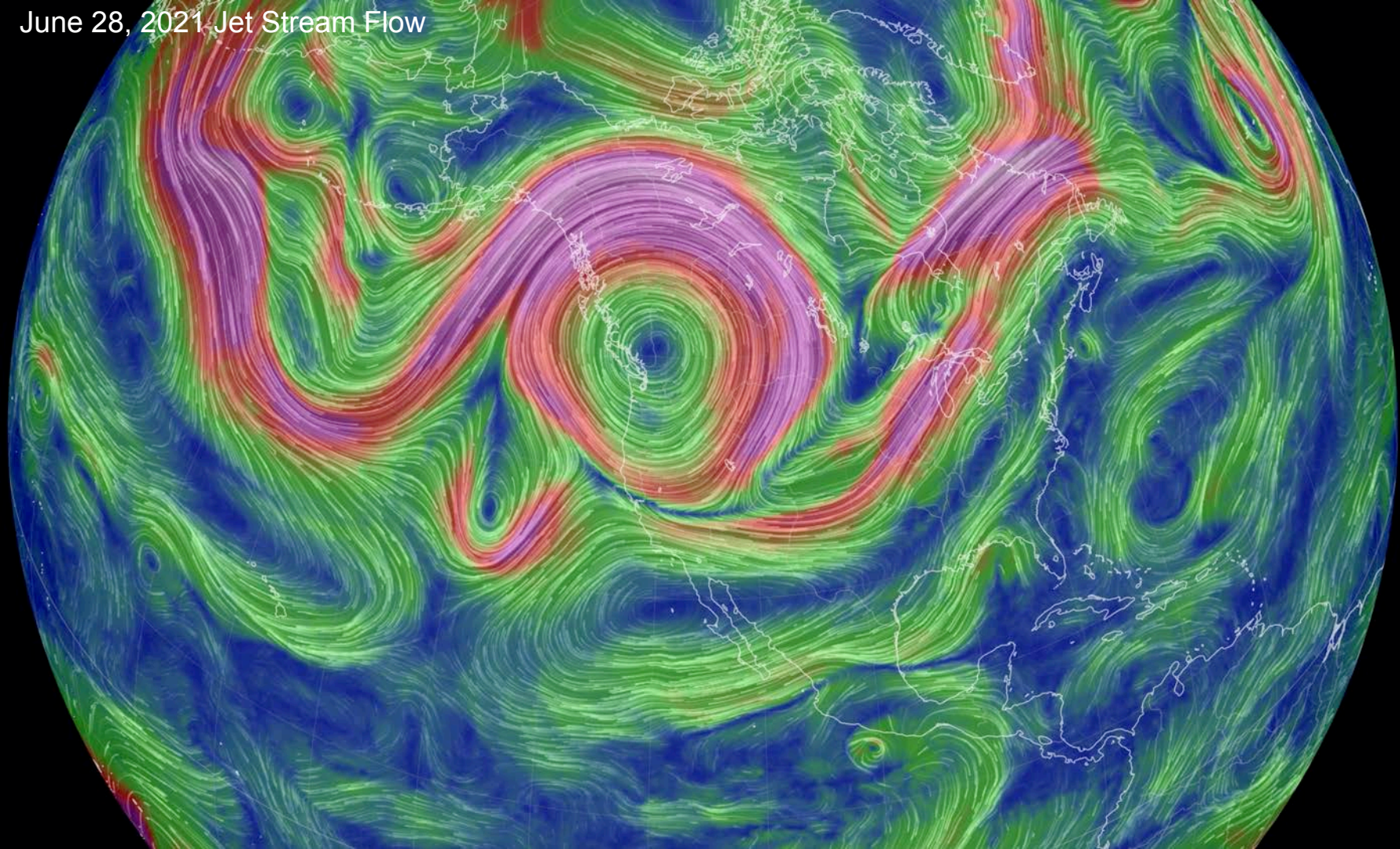






500mb Geopotential Height (m) Composite Anomaly (1981-2010 Climatology)  
6/1/21 to 8/15/21  
NCEP/NCAR Reanalysis

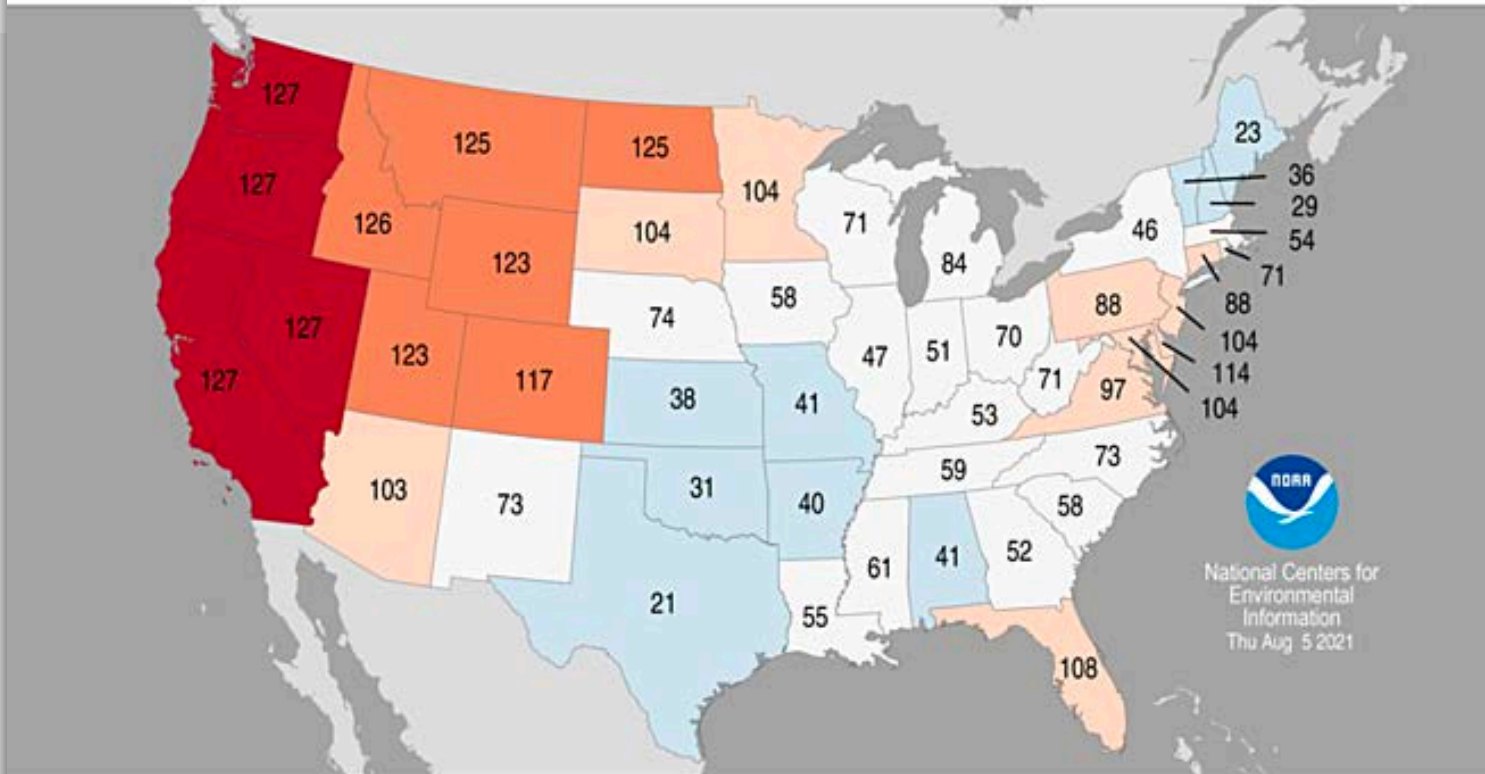
June 28, 2021 Jet Stream Flow





# Statewide Average Temperature Ranks

July 2021  
Period: 1895–2021



National Centers for  
Environmental  
Information  
Thu Aug 5 2021

Record  
Coldest  
(1)

Much  
Below  
Average

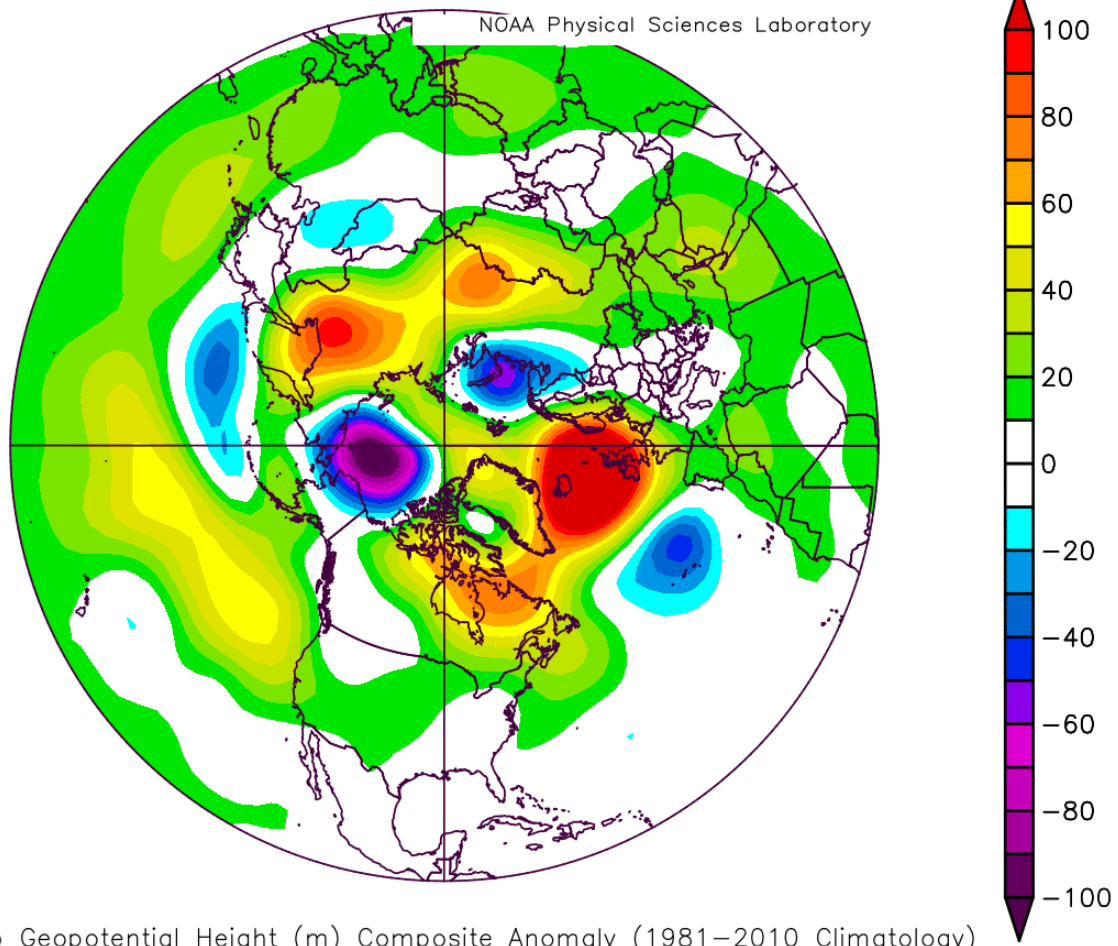
Below  
Average

Near  
Average

Above  
Average

Much  
Above  
Average

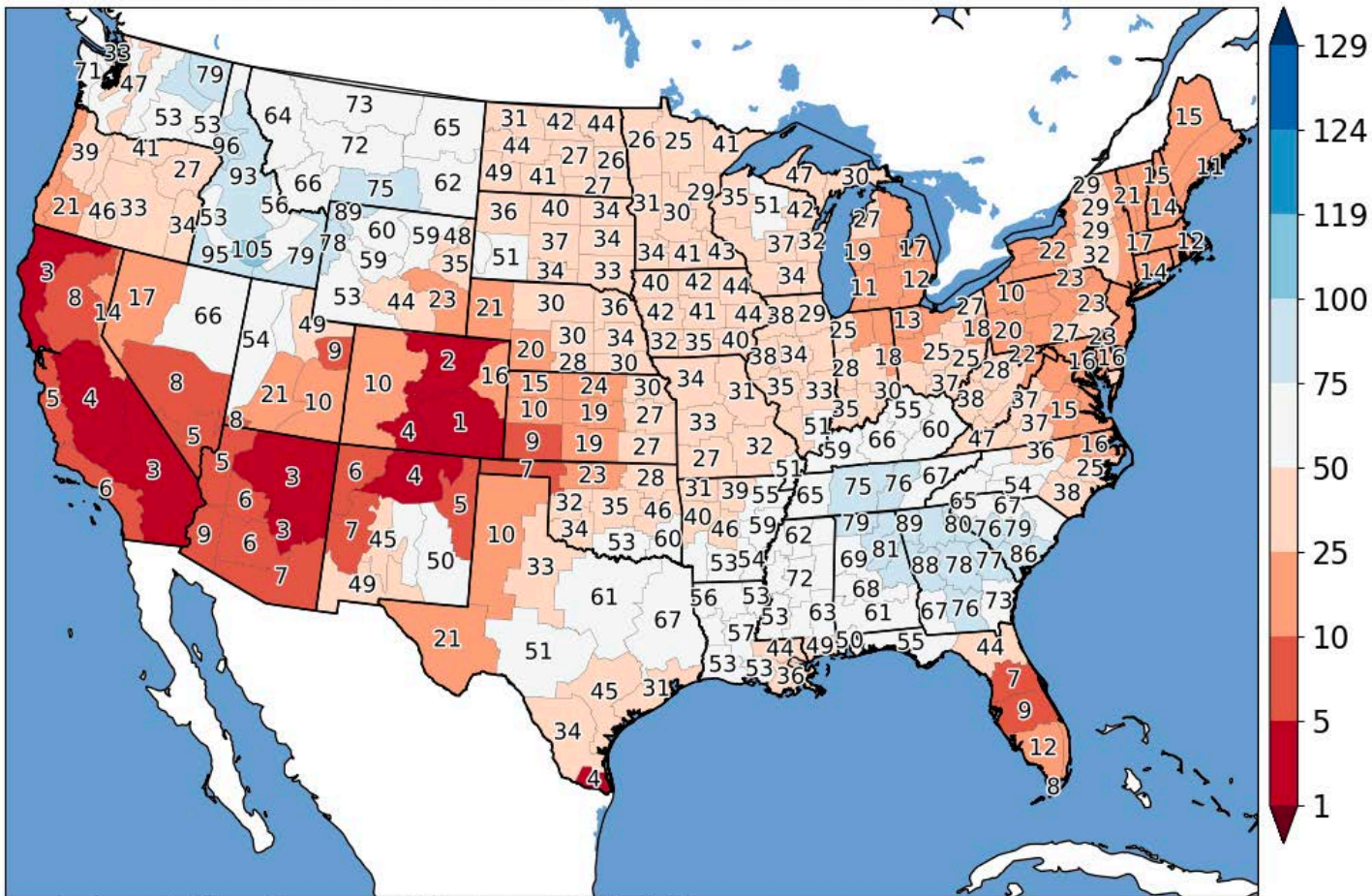
Record  
Warmest  
(127)



500mb Geopotential Height (m) Composite Anomaly (1981–2010 Climatology)  
8/15/21 to 9/11/21  
NCEP/NCAR Reanalysis

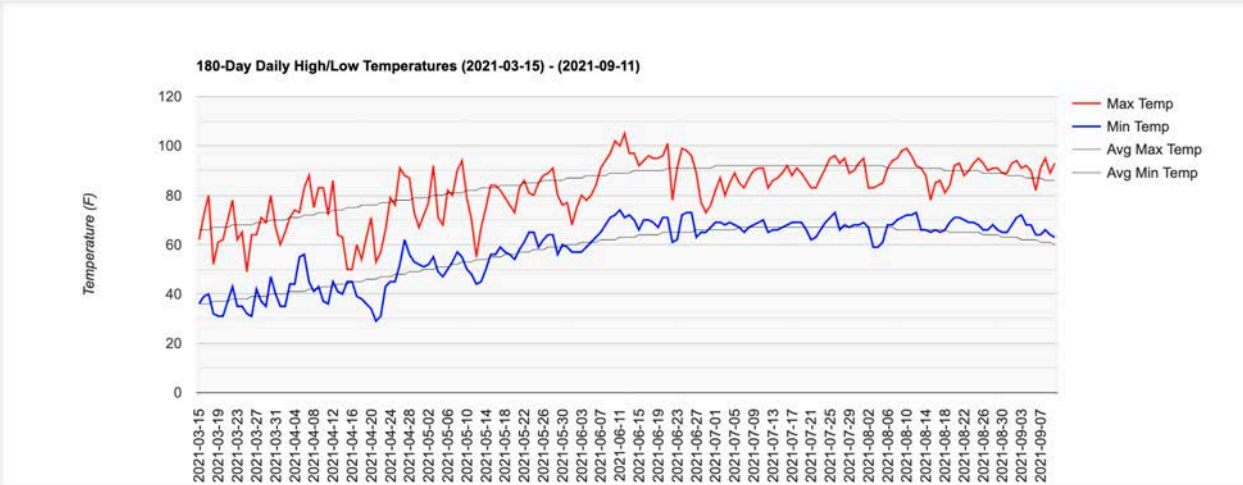


14 Aug 2021 ~7 AM till 13 Sep 2021 ~7 AM Average Temperature Ranks by Climate District  
 Based on IEM Estimates, 1 is hottest out of 129 total years (1893-2021)

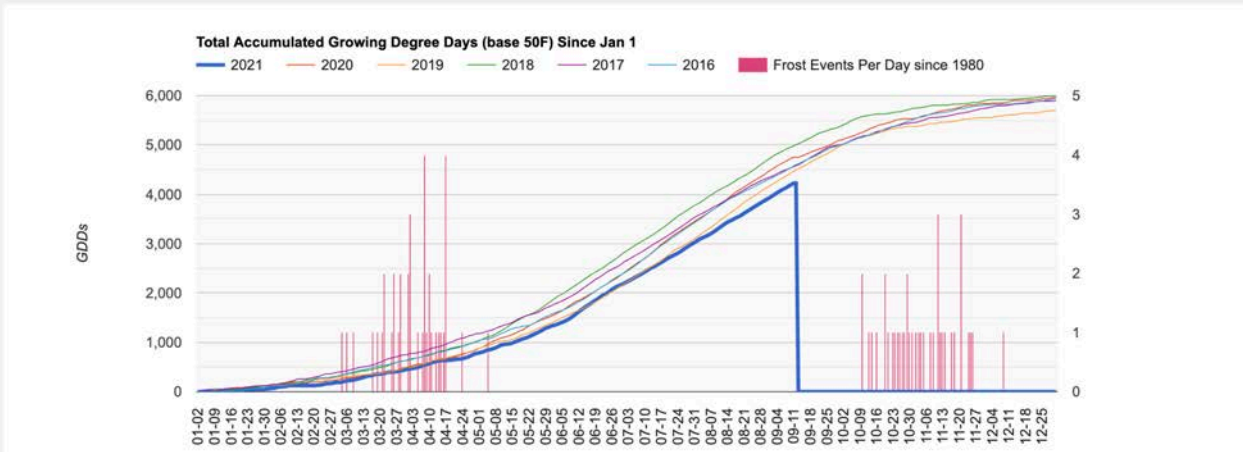


# Lubbock, TX

PRISM 180-Day High/Low Temperatures (2-day lag)

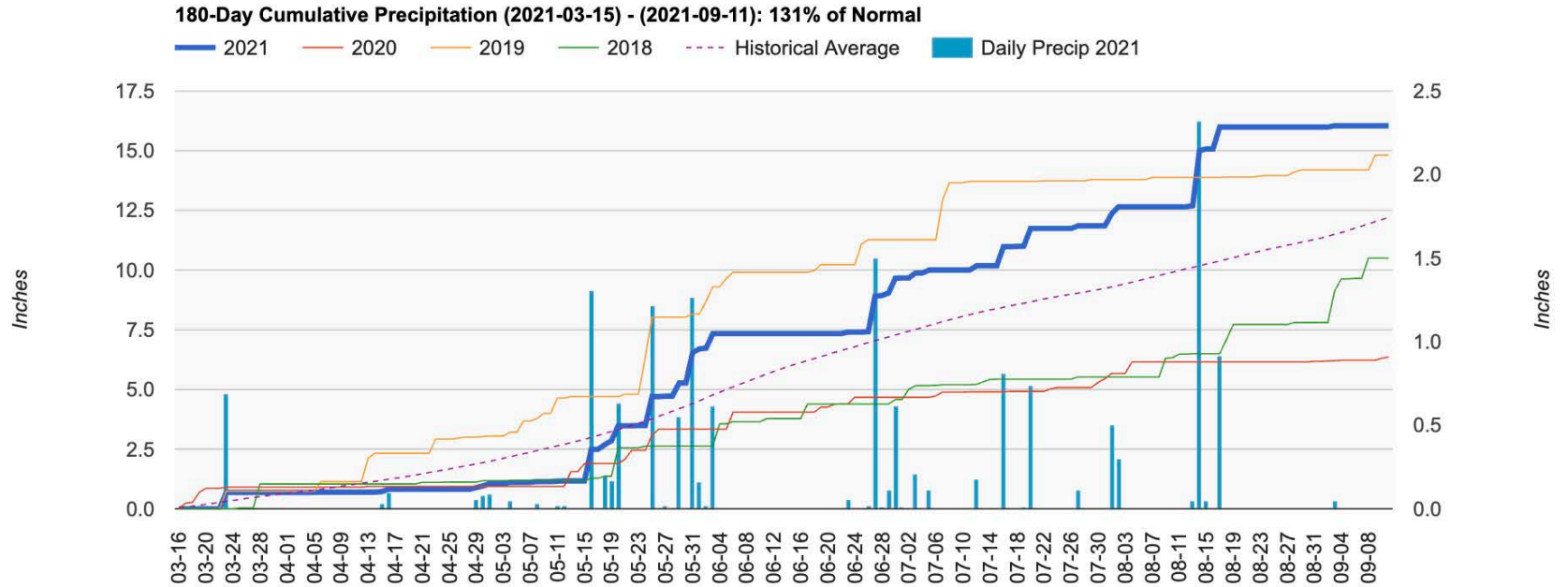


PRISM Year-to-Date Total Accumulated Growing Degree Day and Historical Frost Dates (2-day lag)



# Lubbock, TX 180-day Precipitation History

PRISM 180-Day Cumulative Precipitation (2-day lag)

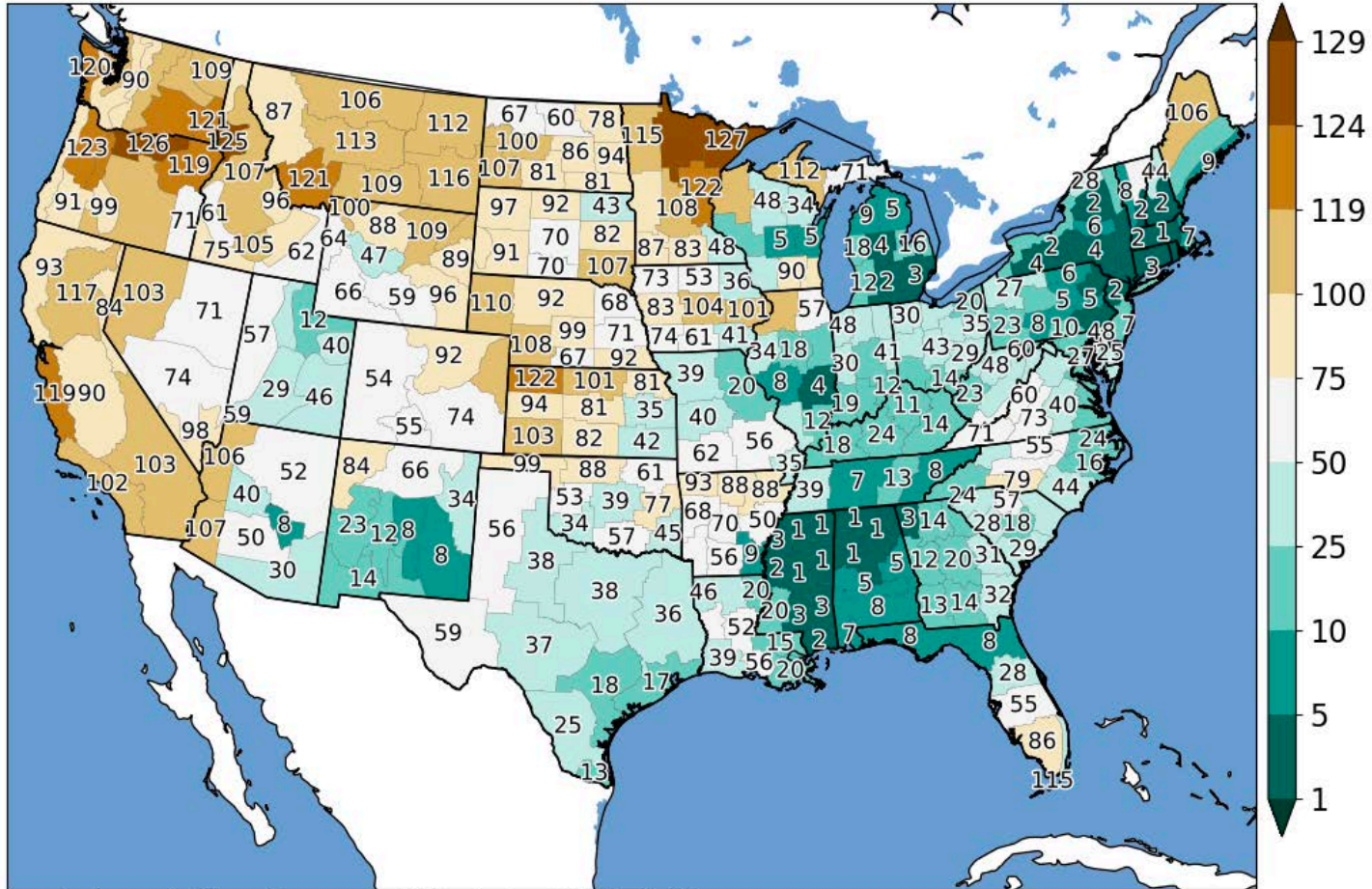


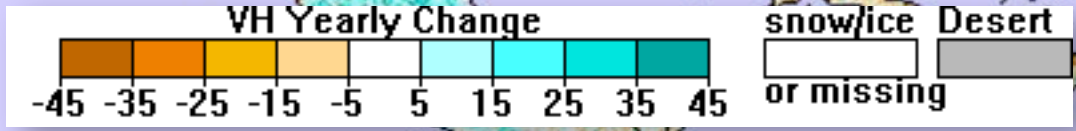
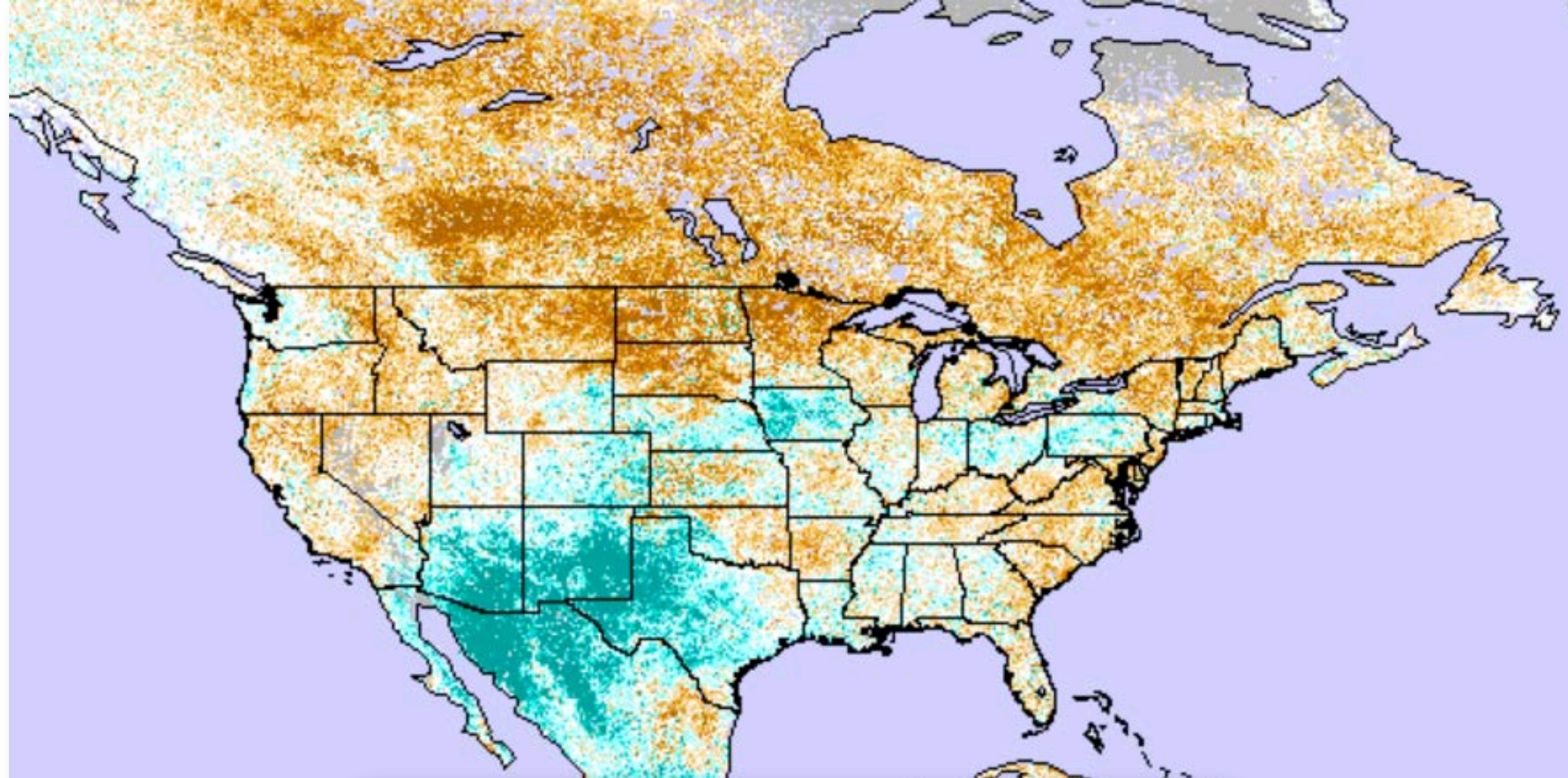




# 31 May 2021 ~7 AM till 13 Sep 2021 ~7 AM Total Precipitation Ranks by Climate District

Based on IEM Estimates, 1 is wettest out of 129 total years (1893-2021)



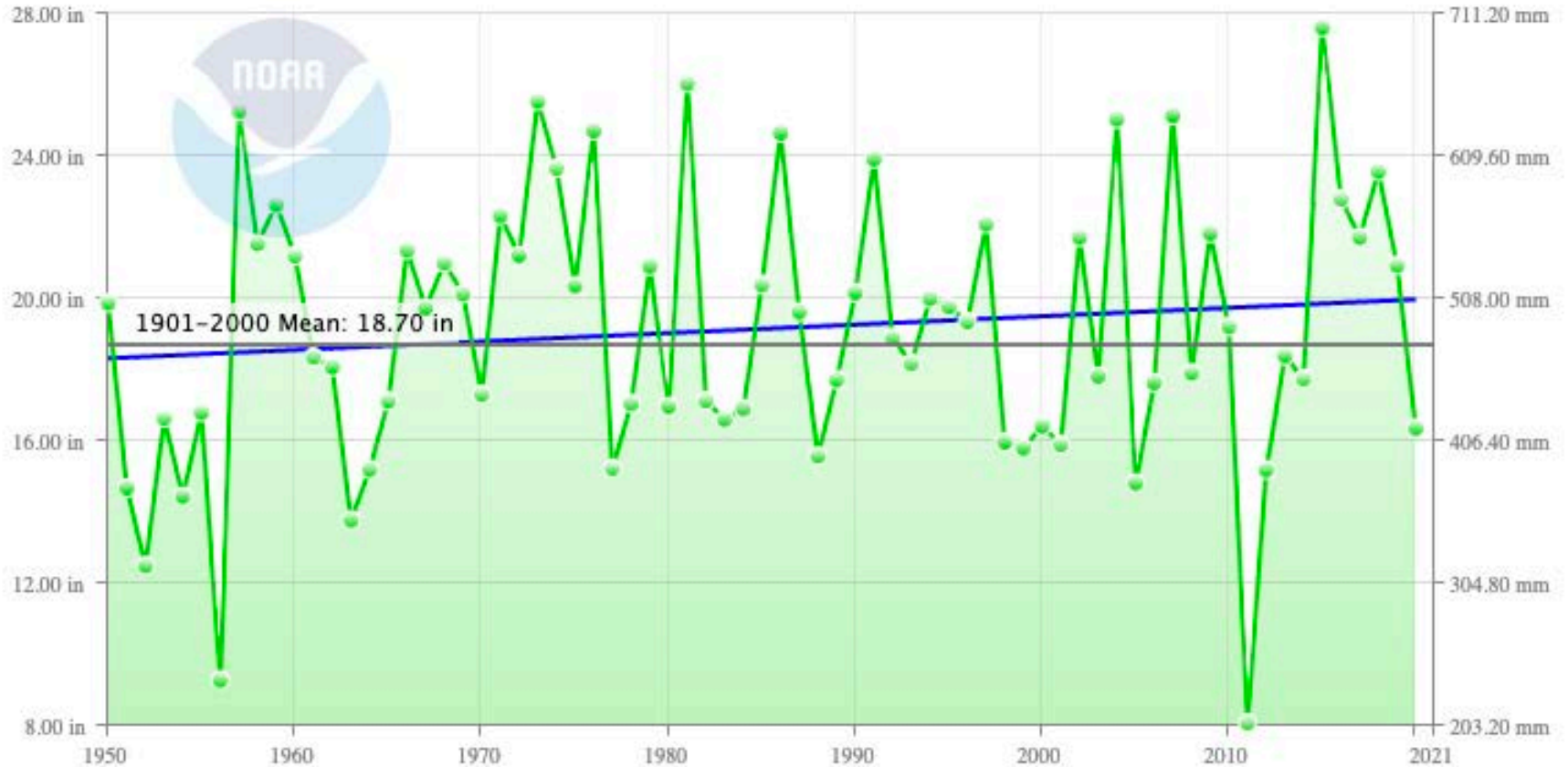


# Texas Precipitation

April–October

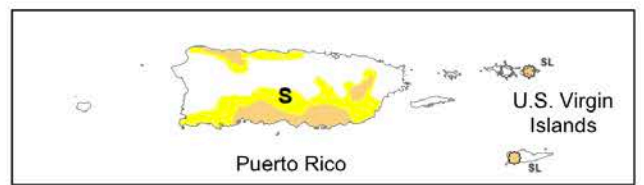
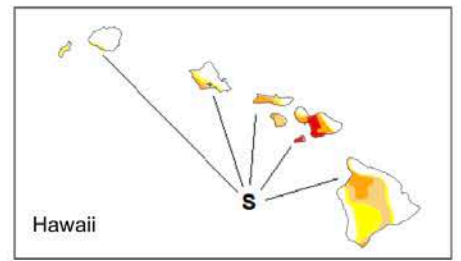
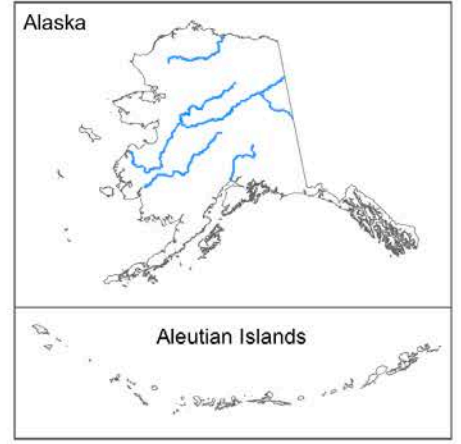
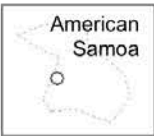
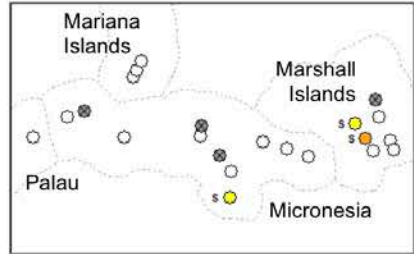
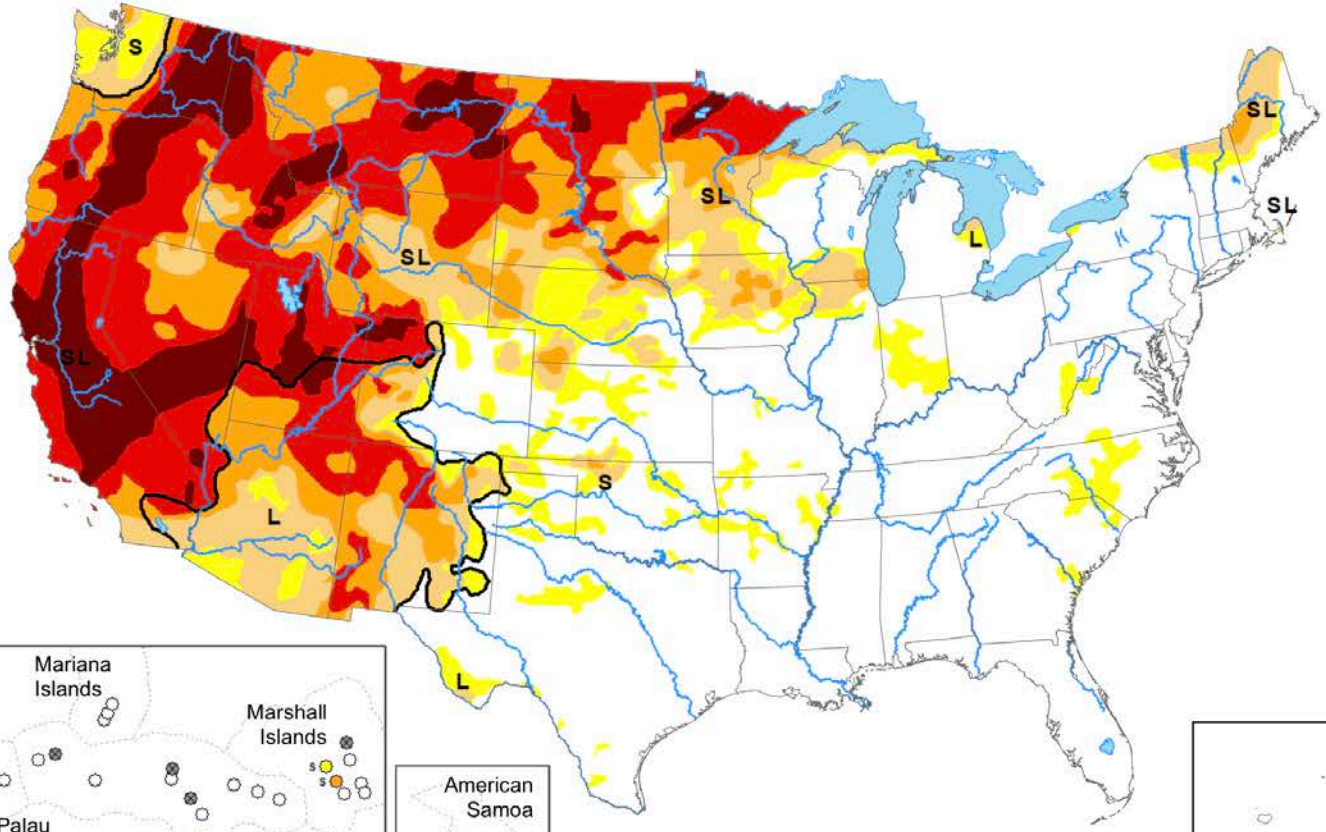
+2 inches since 1950 (+1/4 inch per decade)

1950–2020 Trend  
(+0.24 in/Decade)

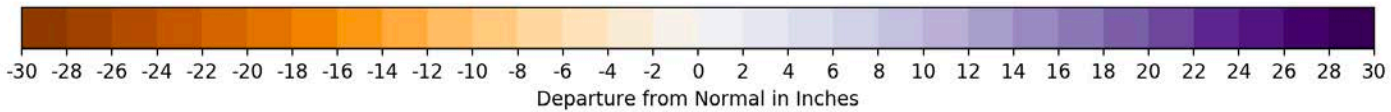
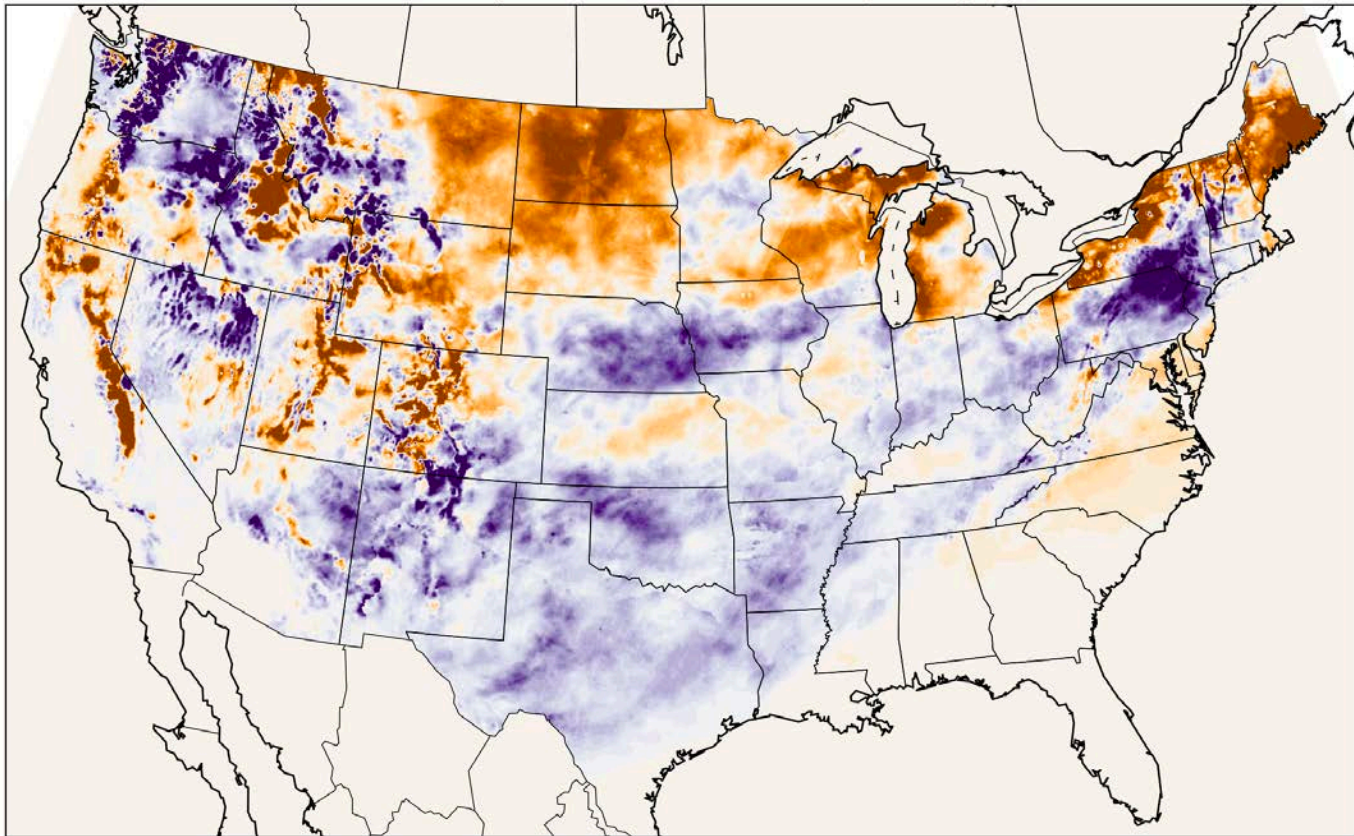


# Map released: September 9, 2021

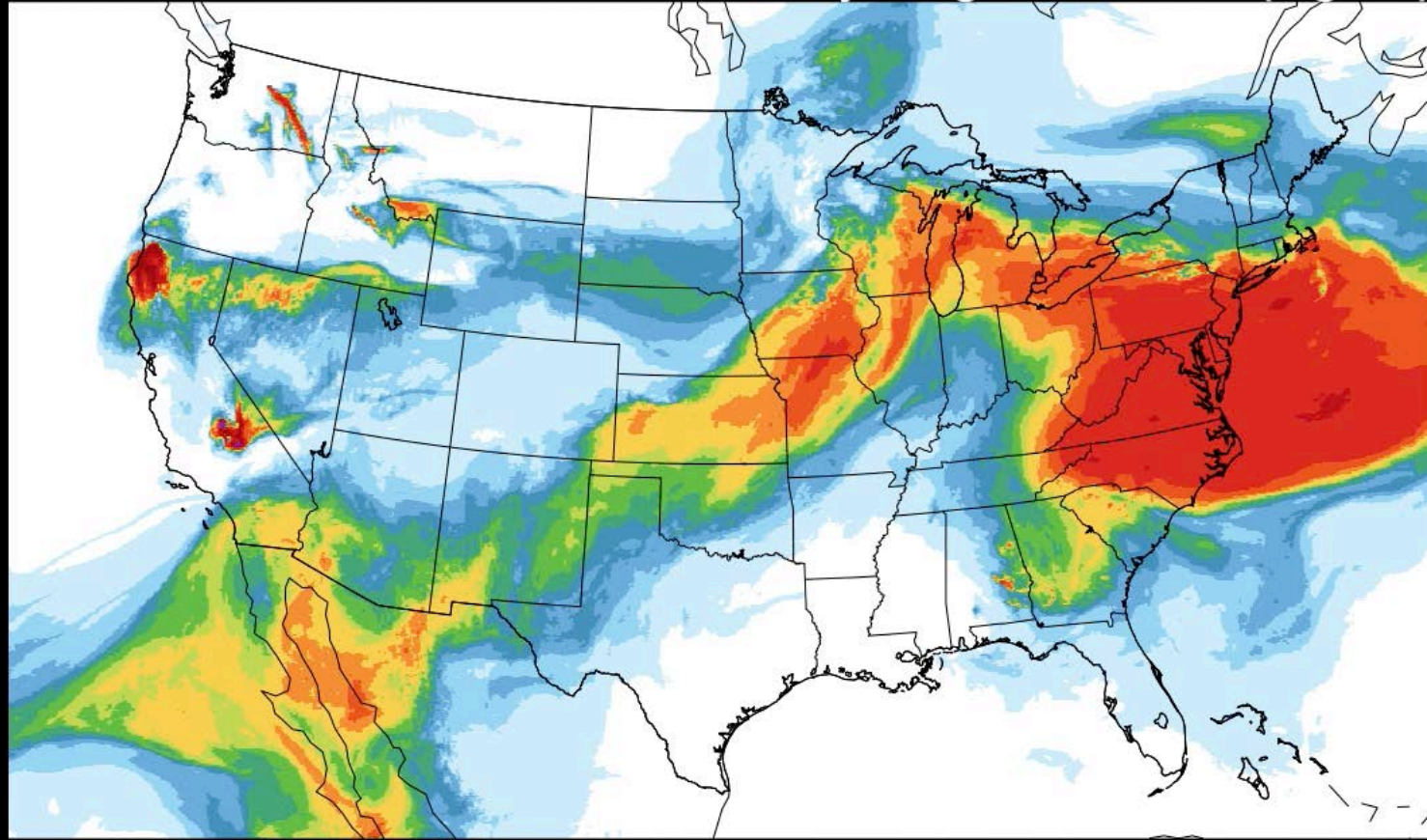
Data valid: September 7, 2021



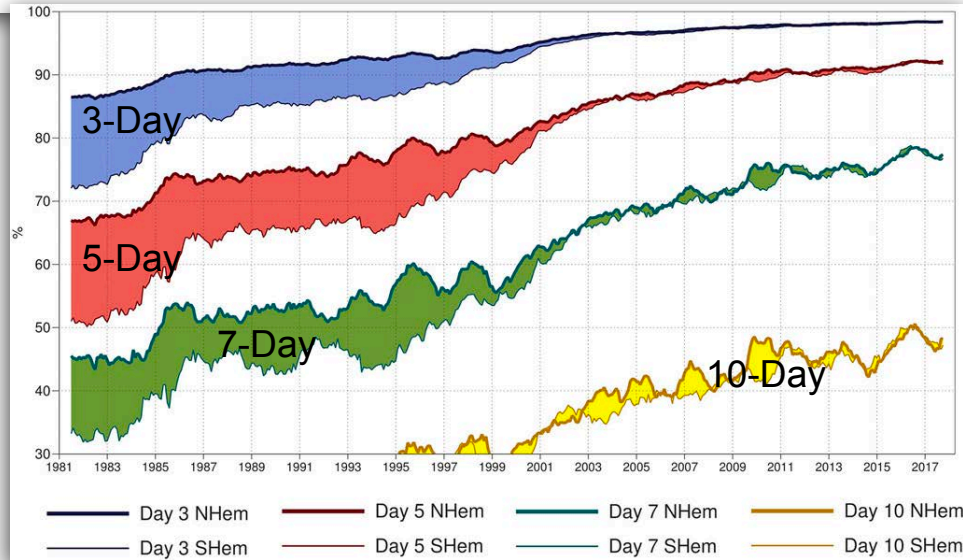
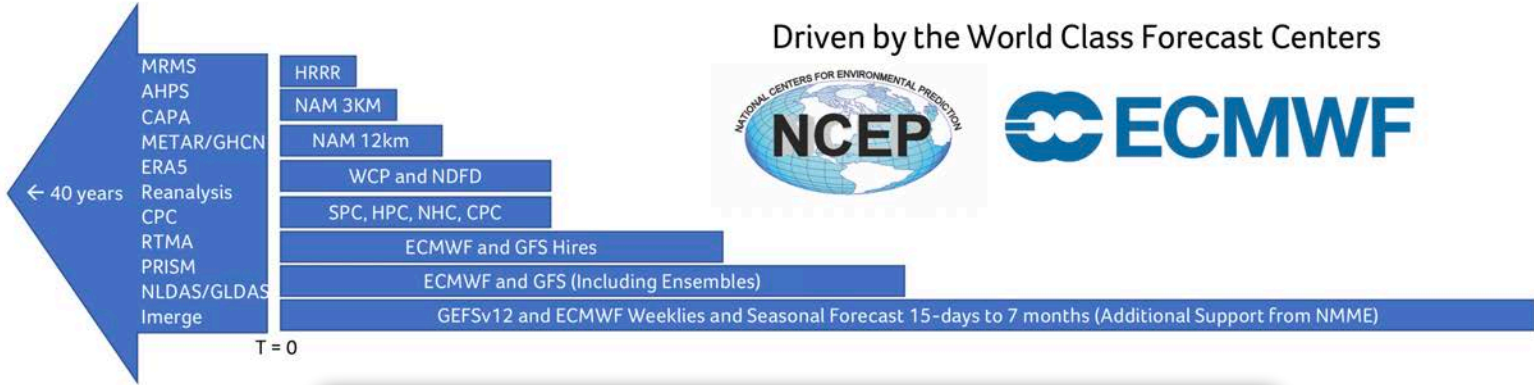
# Accumulated Snowfall Departure from 2008-2019 Average through March 1, 2021

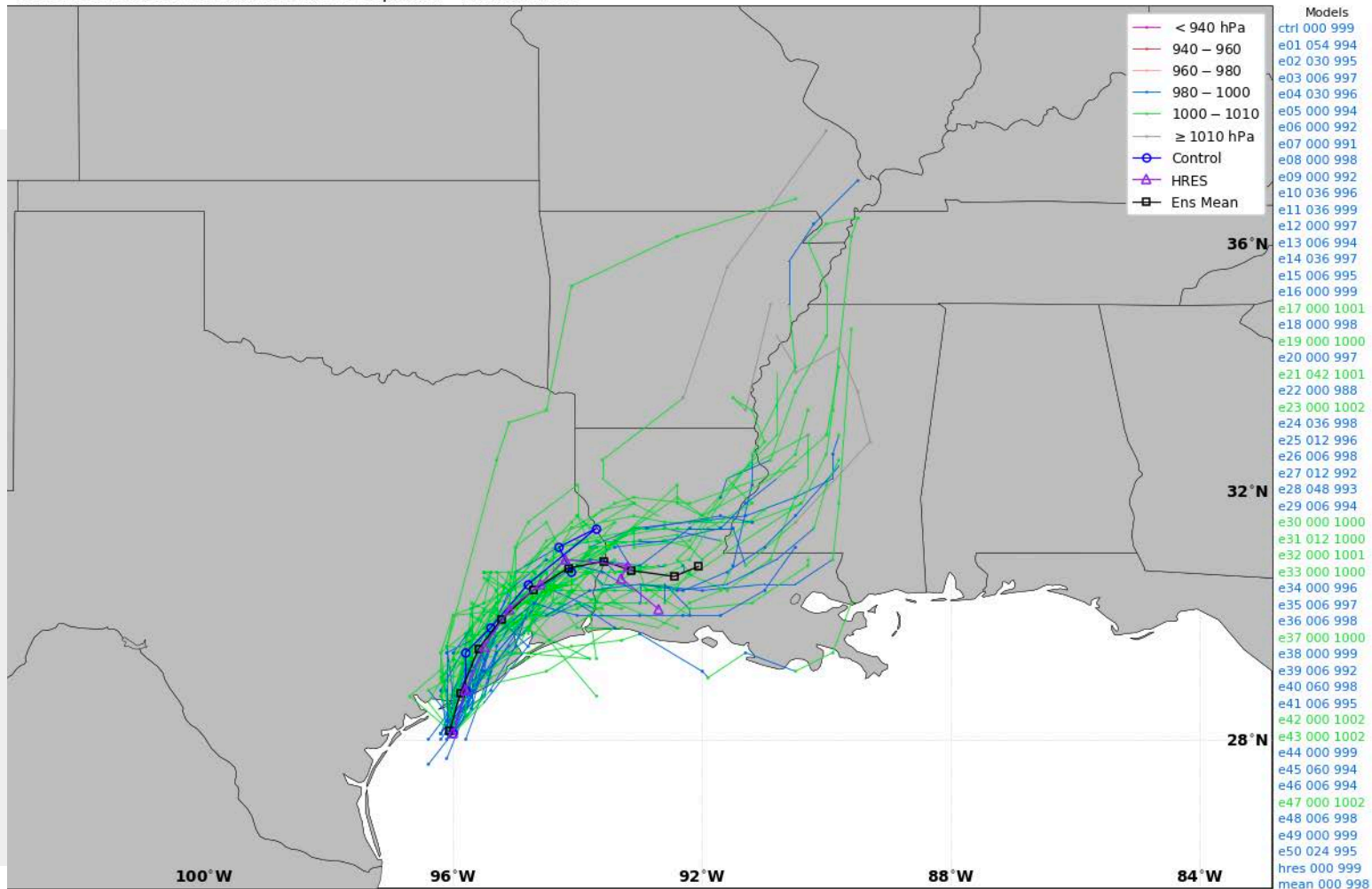


# Vertically Integrated Smoke (mg/m<sup>2</sup>)



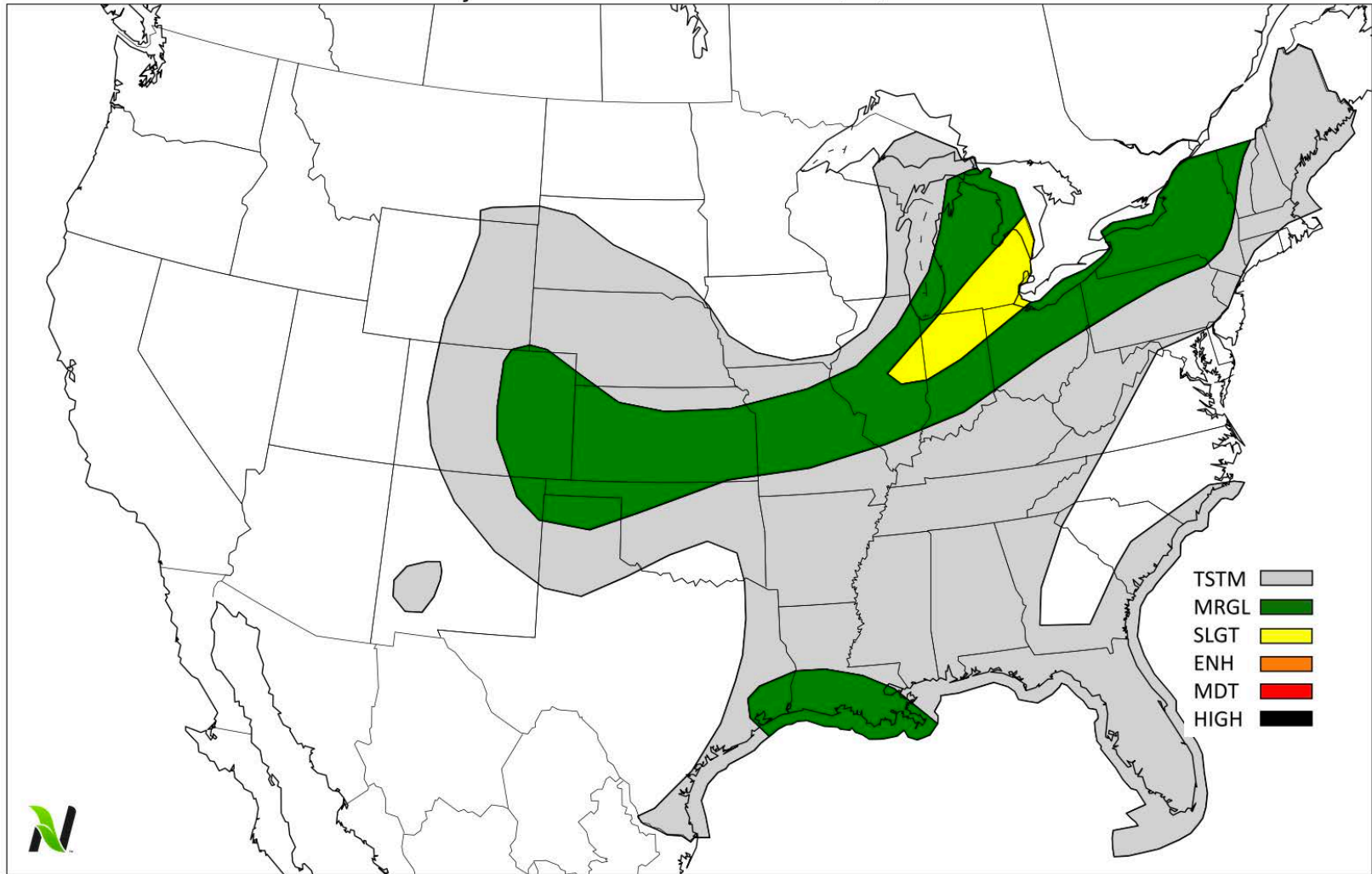
## Driven by the World Class Forecast Centers











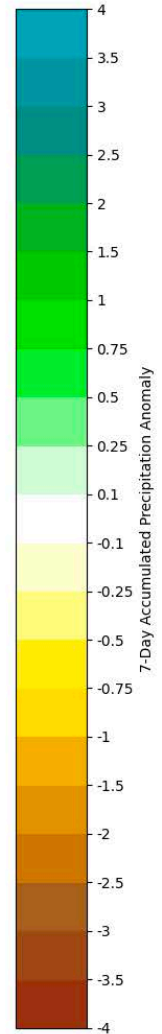
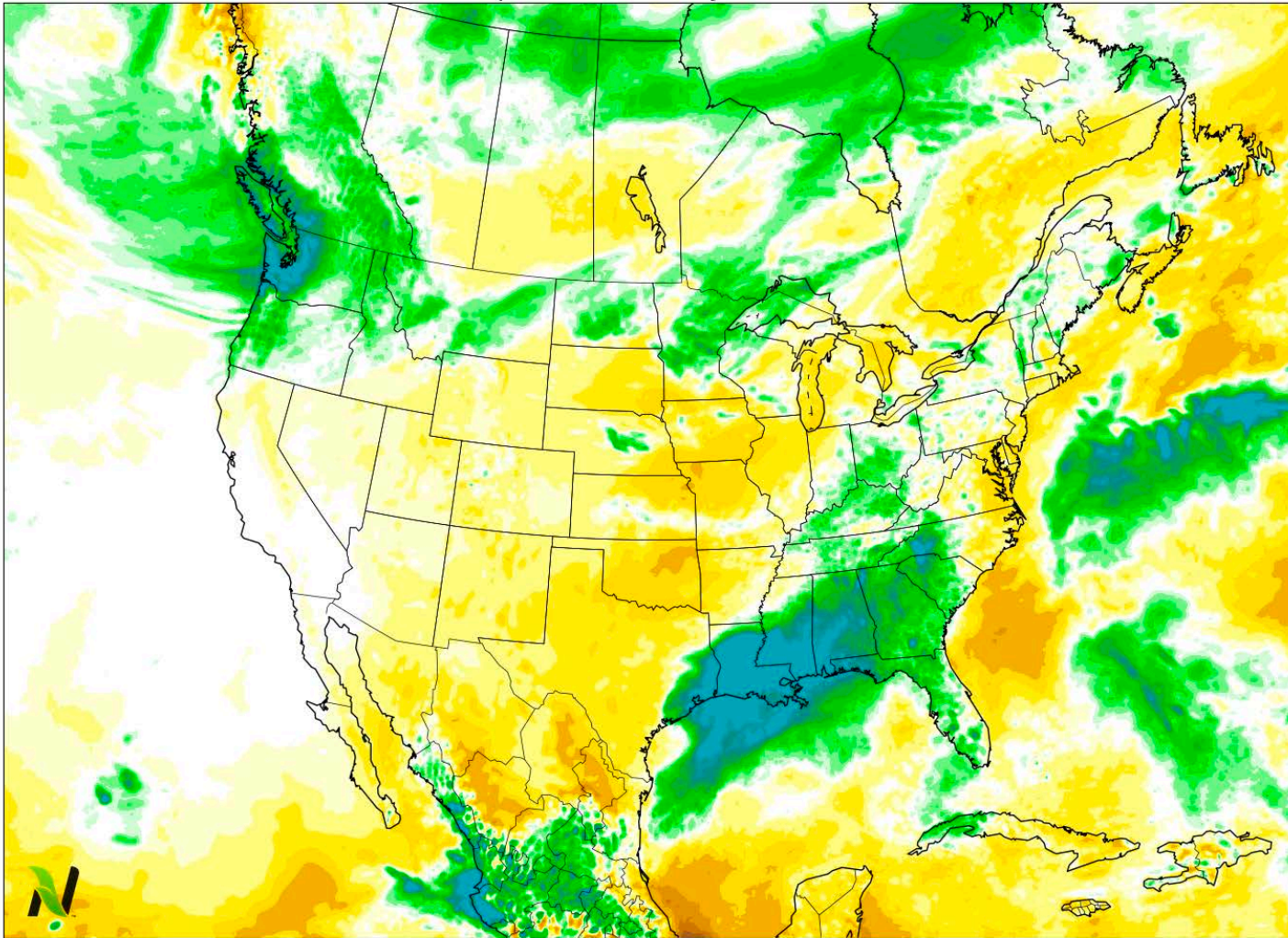


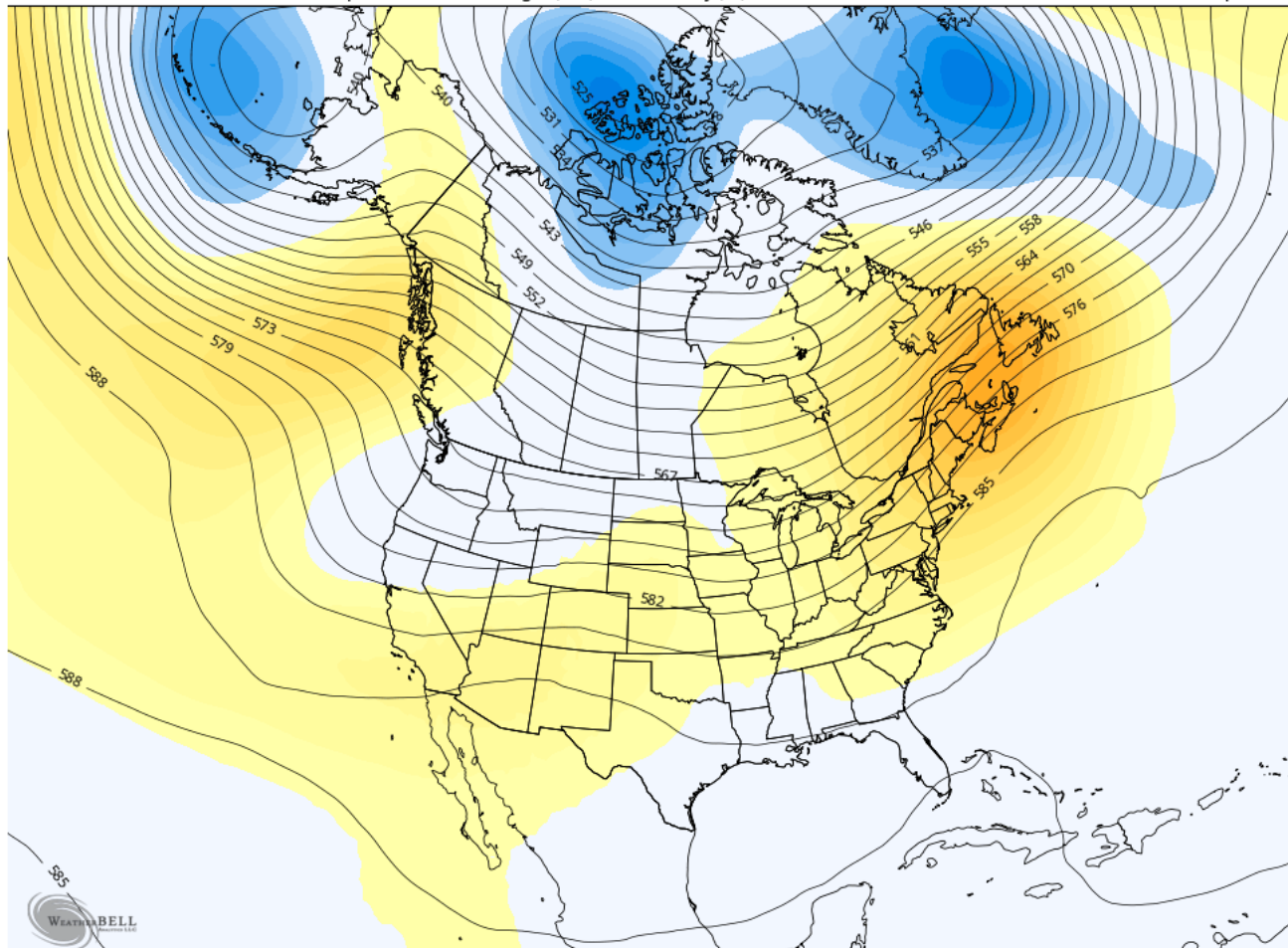
# Day 1 SPC Convective Outlook 09/14/2021



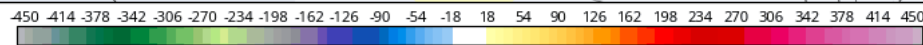
- TSTM 
- MRGL 
- SLGT 
- ENH 
- MDT 
- HIGH 

# Week #1 ECMWF Precipitation Anomaly from the 00Z Init.20210914

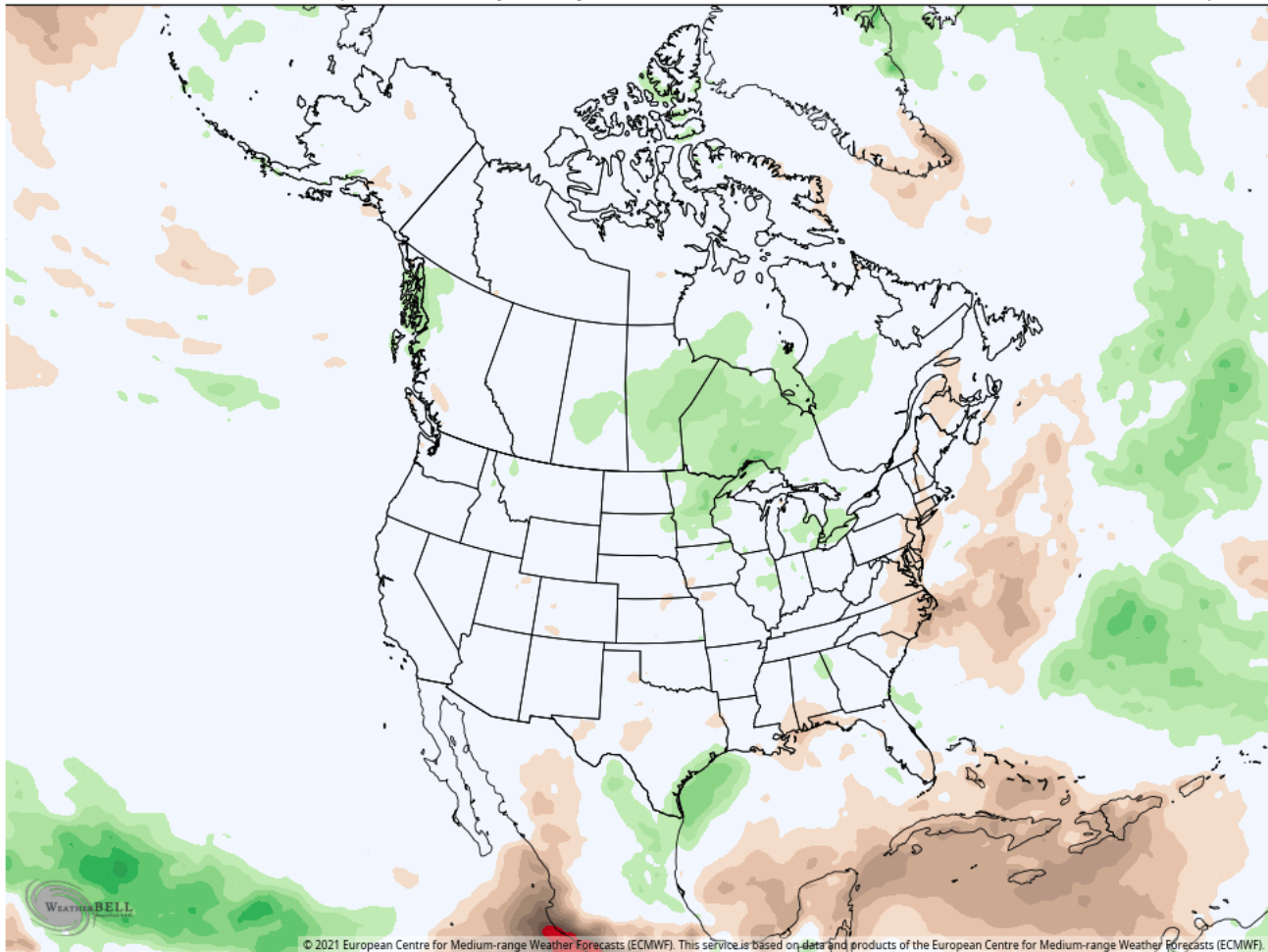




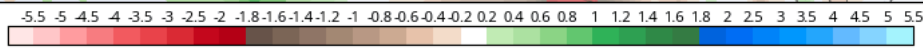
© 2021 European Centre for Medium-range Weather Forecasts (ECMWF). This service is based on data and products of the European Centre for Medium-range Weather Forecasts (ECMWF).



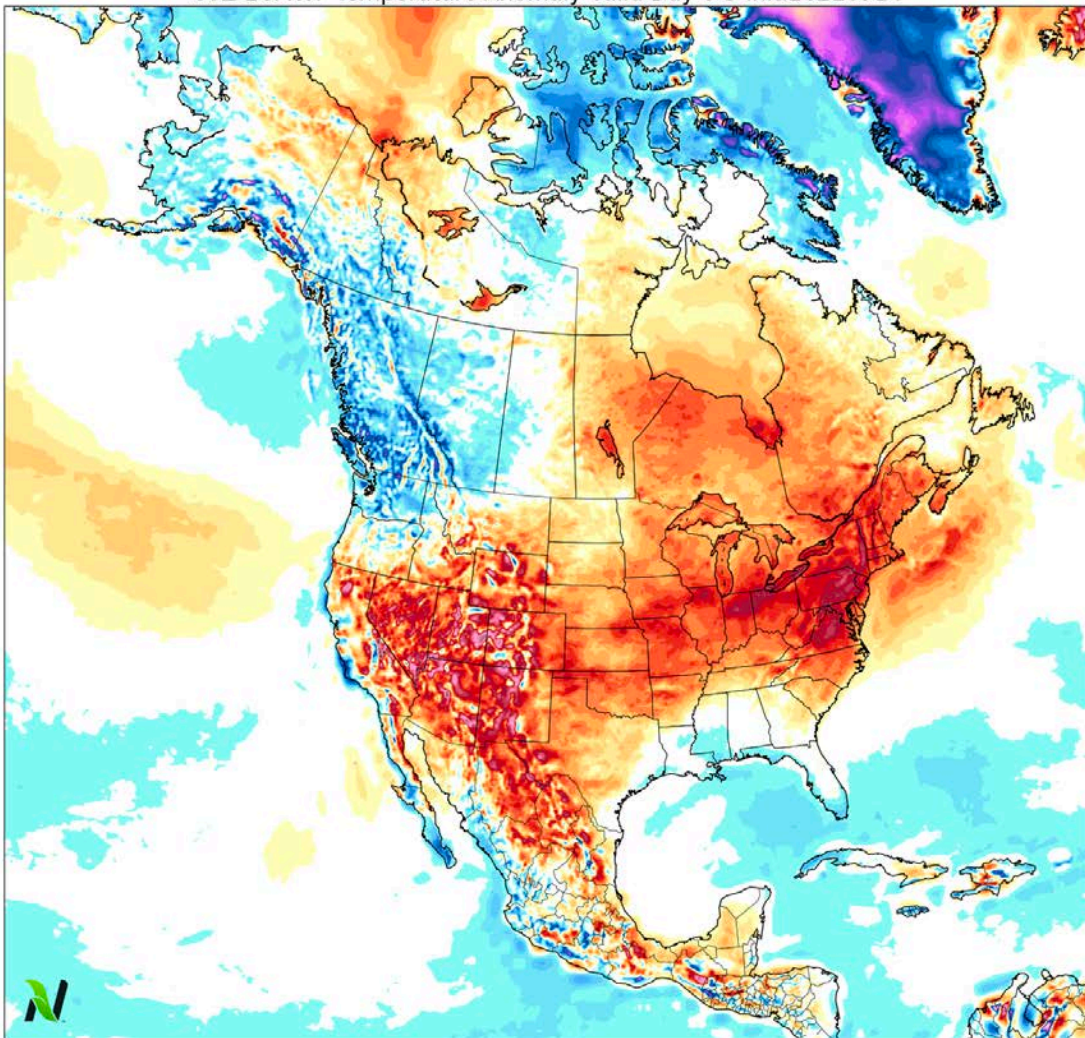
Max: 123.2 • Min: -78.1

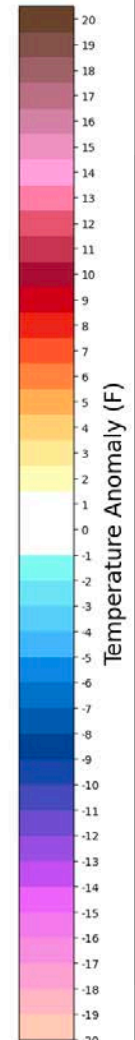
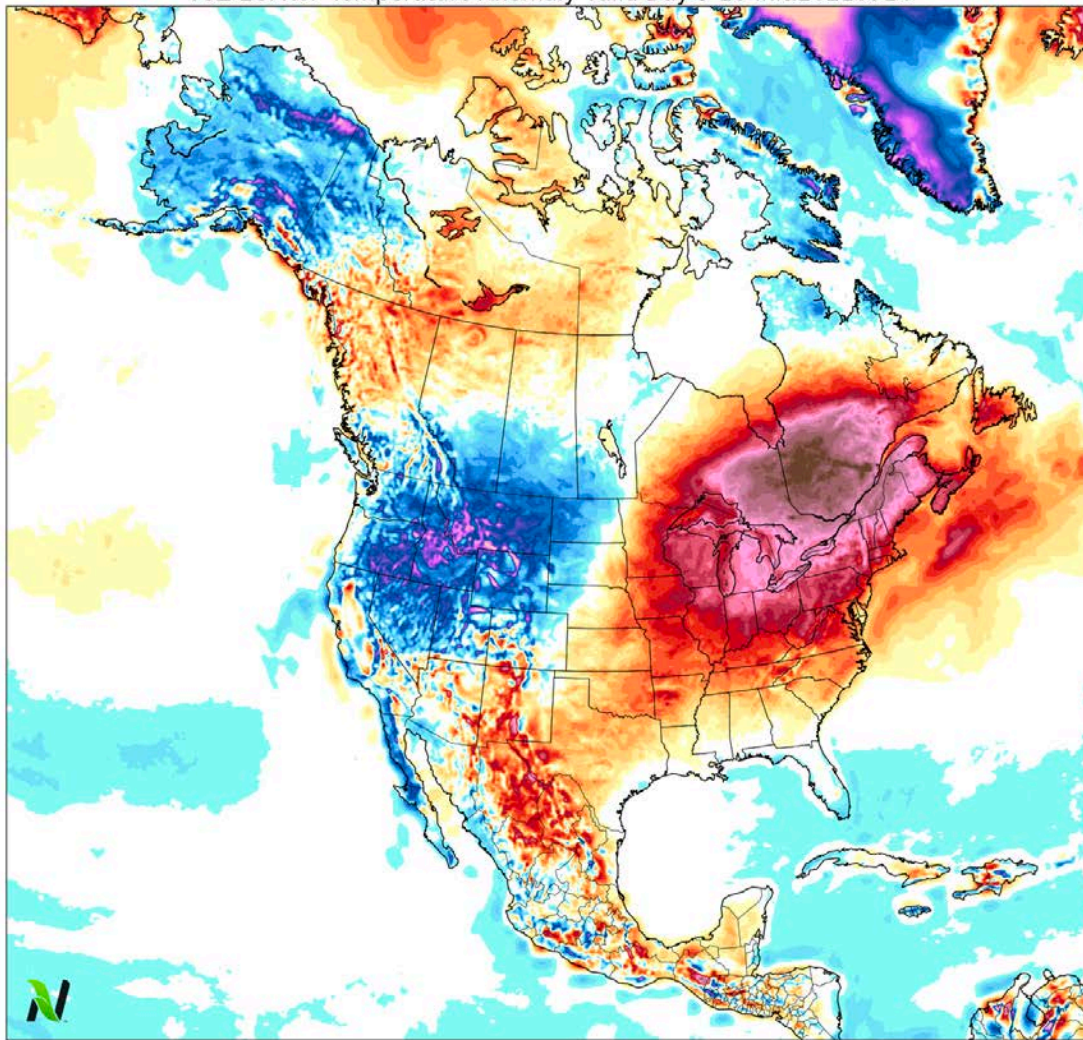


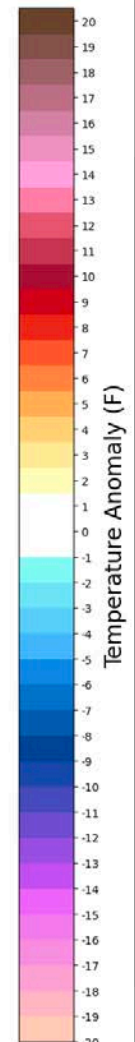
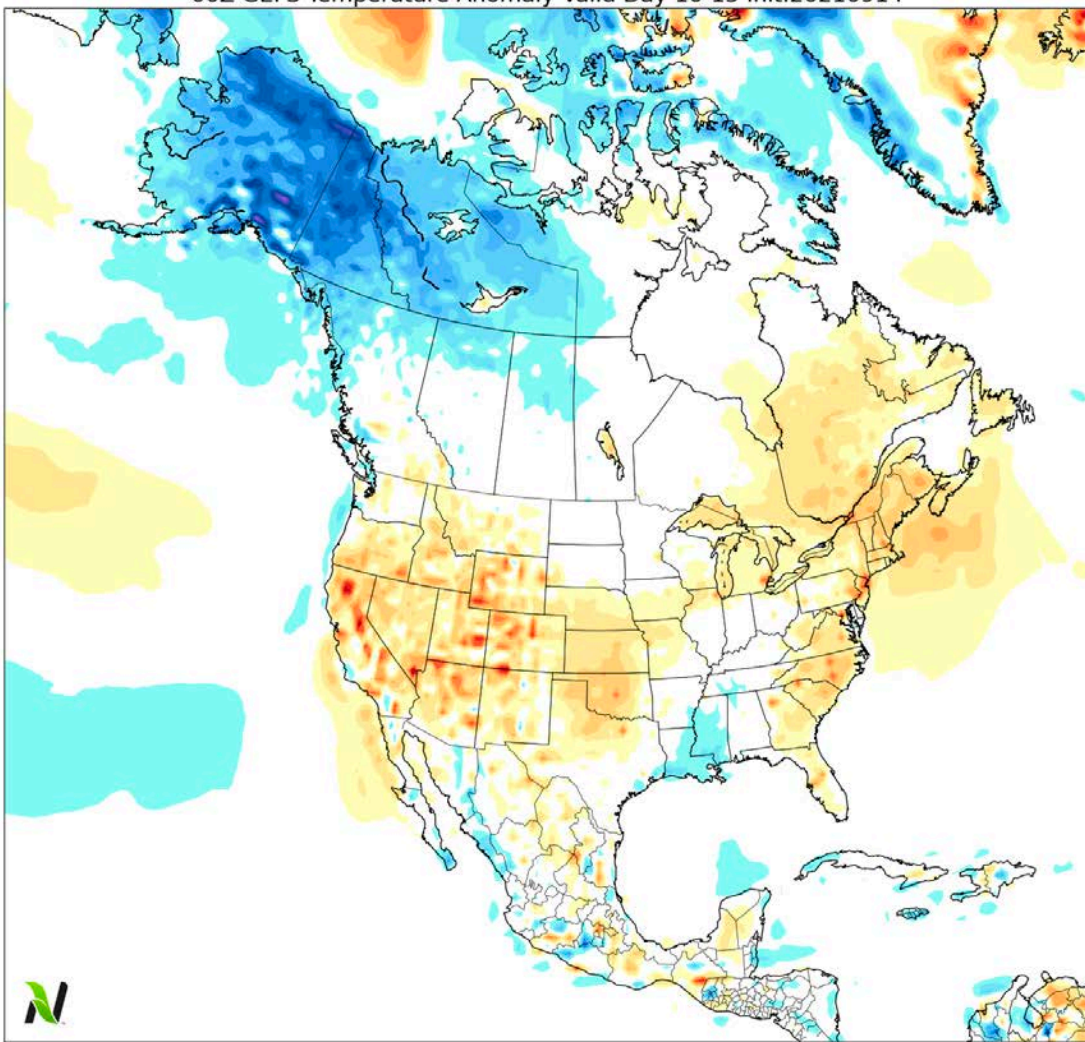
© 2021 European Centre for Medium-range Weather Forecasts (ECMWF). This service is based on data and products of the European Centre for Medium-range Weather Forecasts (ECMWF).



Max: 1.3 • Min: -2.4







# Average Date of First Freeze of Season (Starting Aug 1)



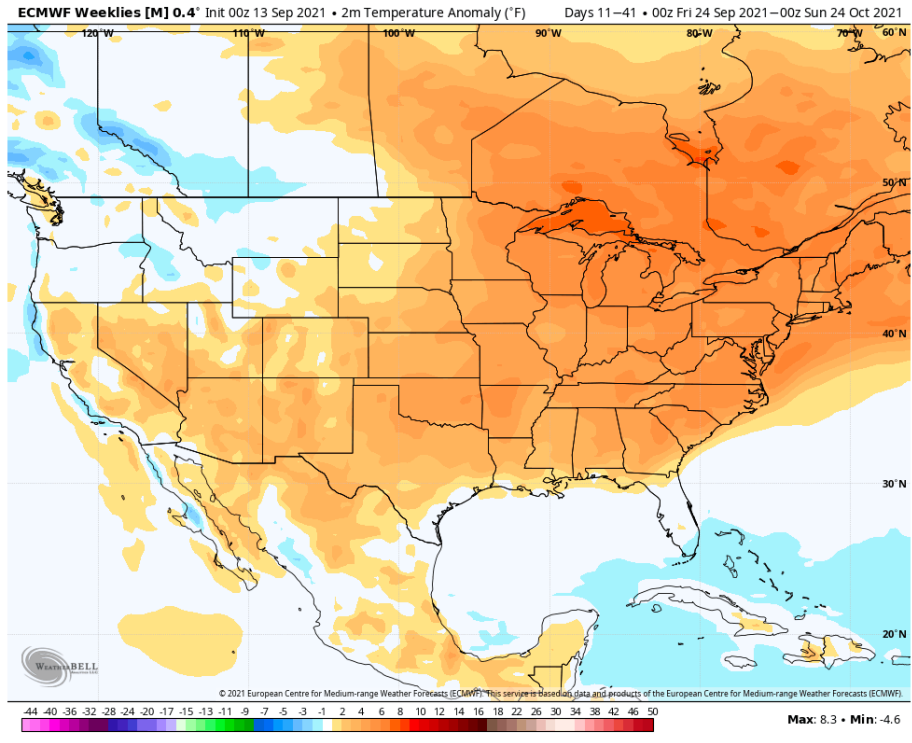
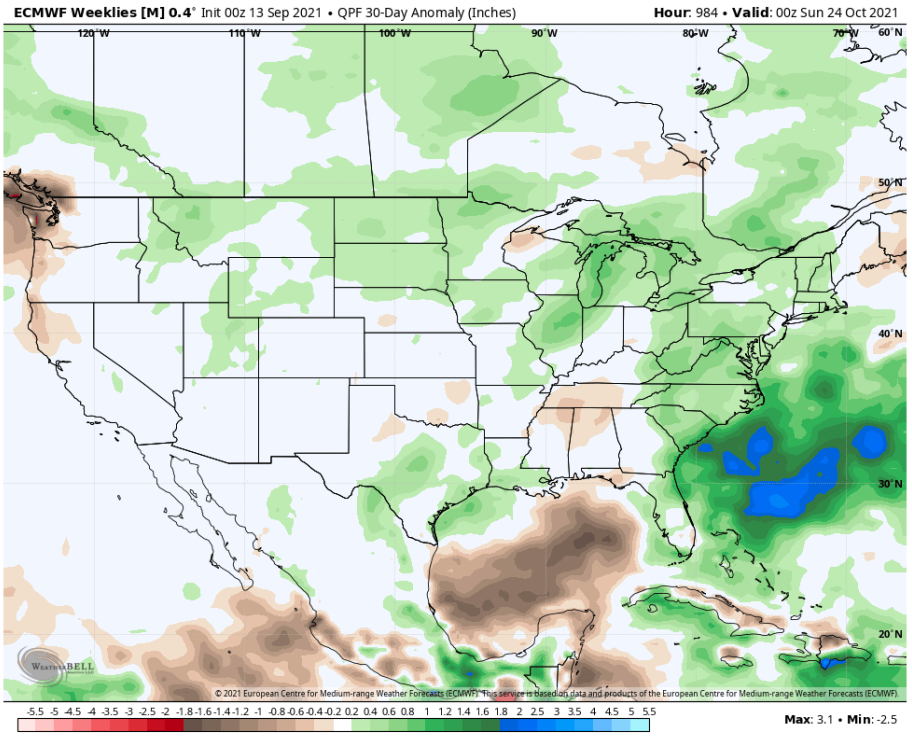
Source: GHCN-D

© Brian Brettschneider

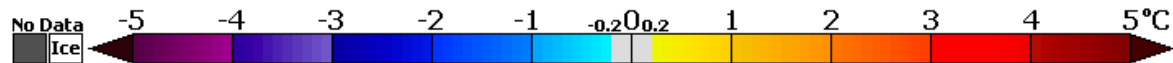
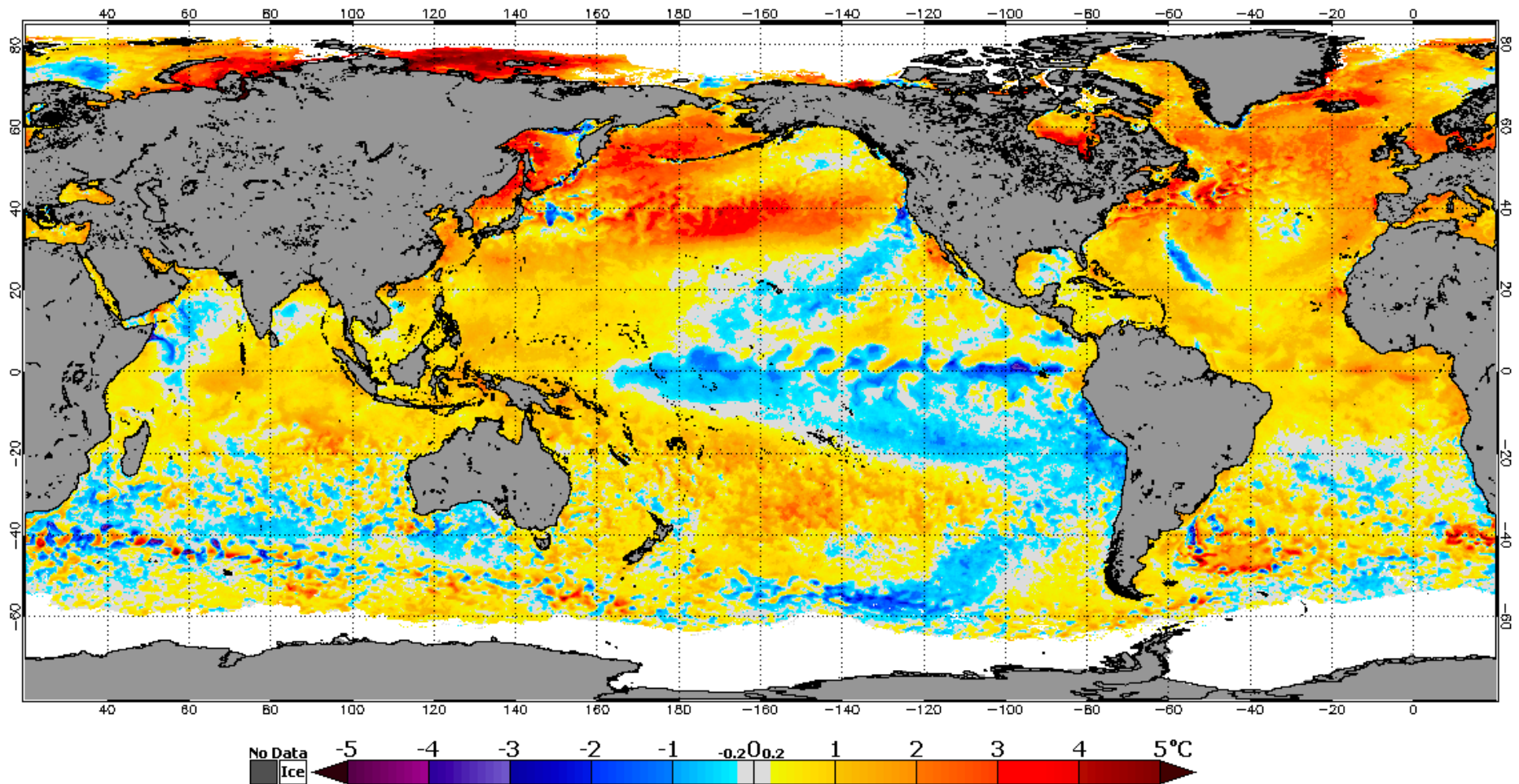
After Jan 1 or Freeze  
< 25% of Years



# September 24 - October 24, 2021 ECMWF “Weeklies”

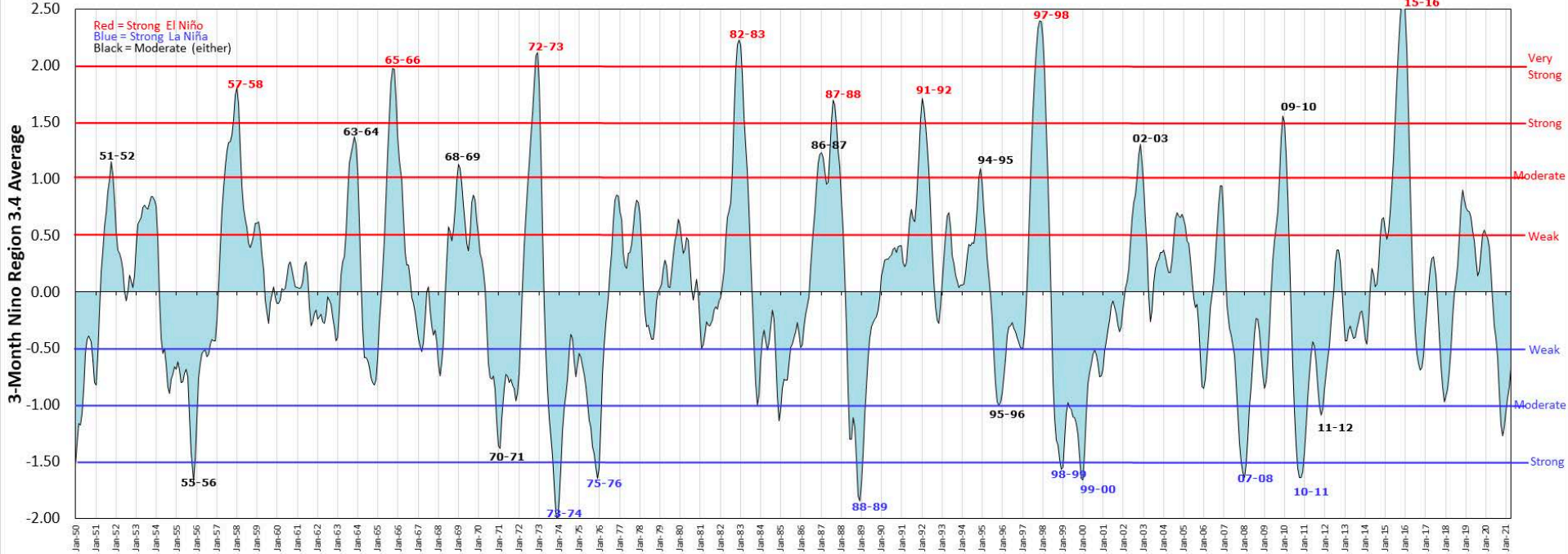


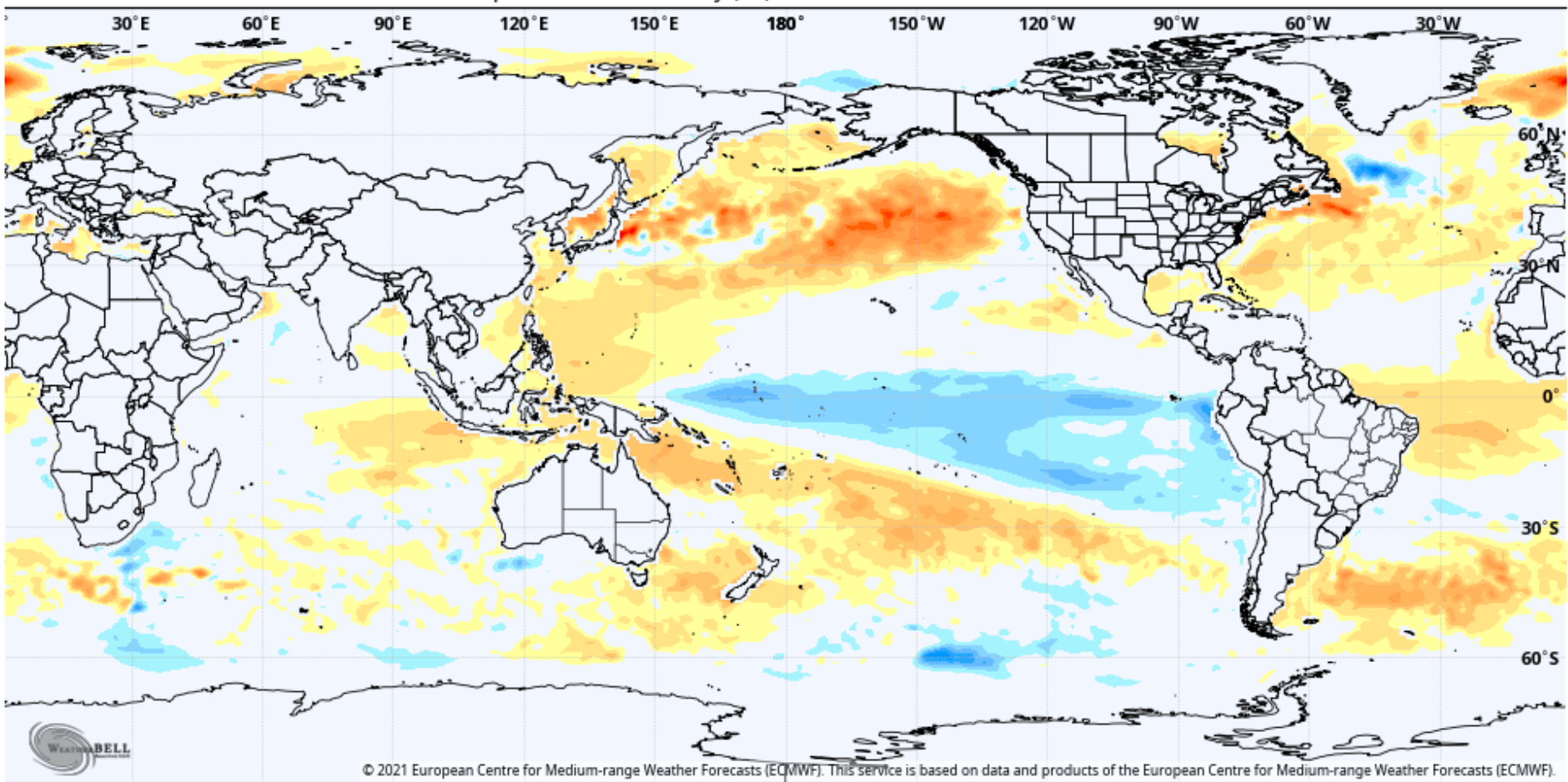
NOAA Coral Reef Watch Daily 5km SST Anomalies (Version 3.1) 12 Sep 2021



# Oceanic Niño Index (ONI)

[https://origin.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensostuff/ONI\\_v5.php](https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php)





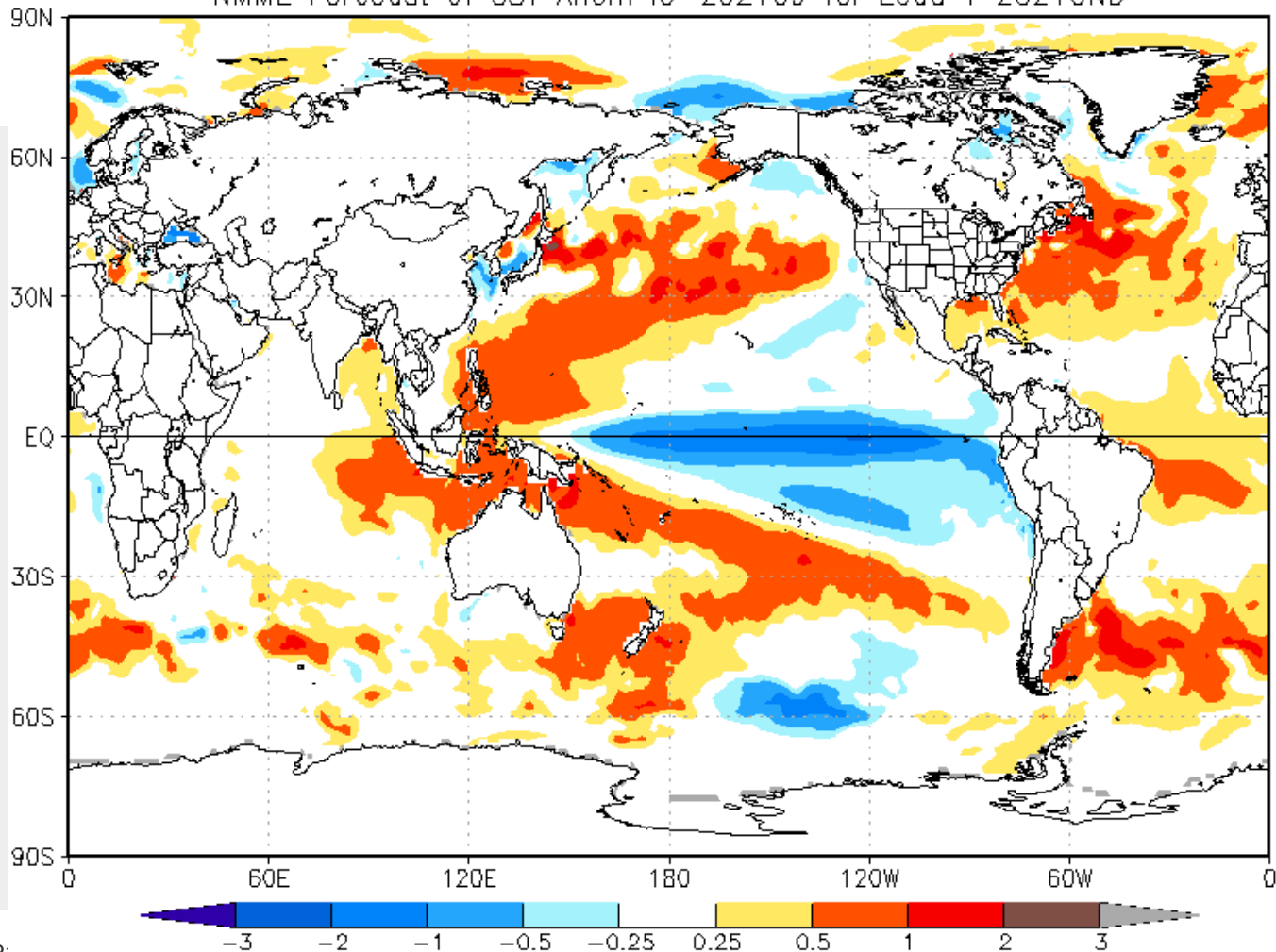
© 2021 European Centre for Medium-range Weather Forecasts (ECMWF). This service is based on data and products of the European Centre for Medium-range Weather Forecasts (ECMWF).

-9.5 -8.5 -7 -6.5 -6 -5.5 -5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 8 9



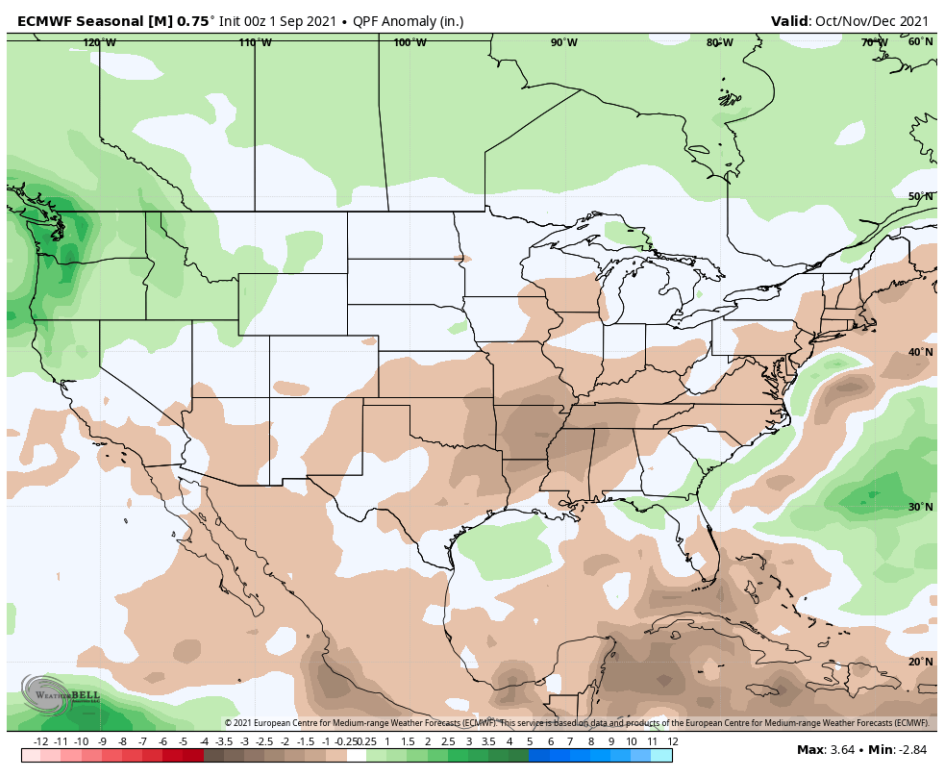
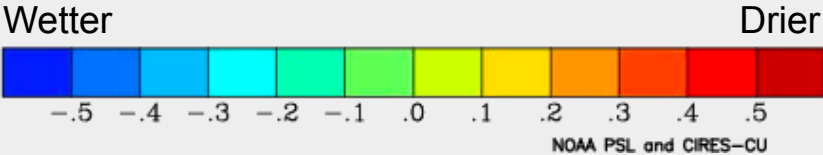
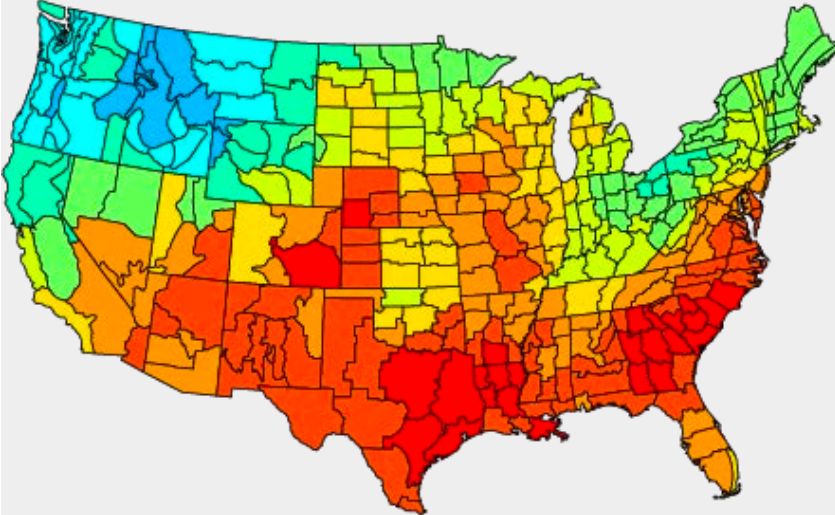
Max: 3.1 • Min: -1.6

NMME Forecast of SST Anom IC=202109 for Lead 1 20210ND



# La Nina Harvest Weather (October-November-December)

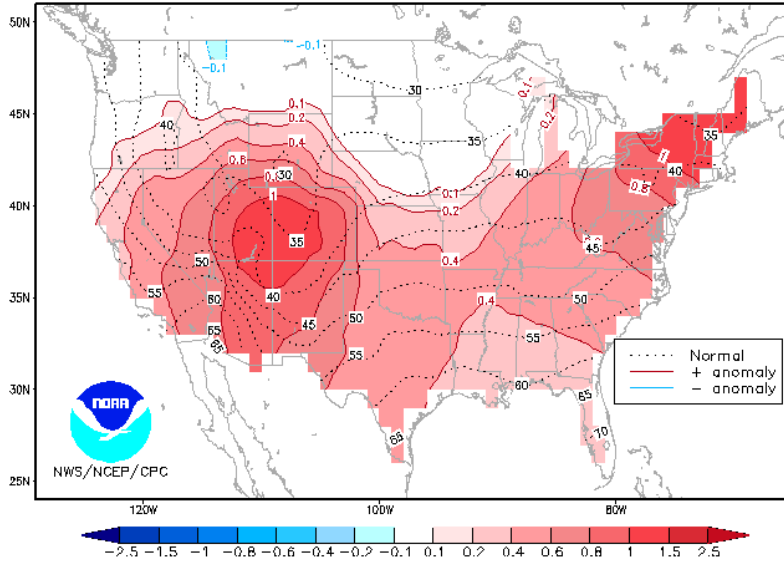
Correlation Precipitation Oct to Dec  
With Oct to Dec Nino3.4  
1948 to 2019



# CPC Guidance: October - December

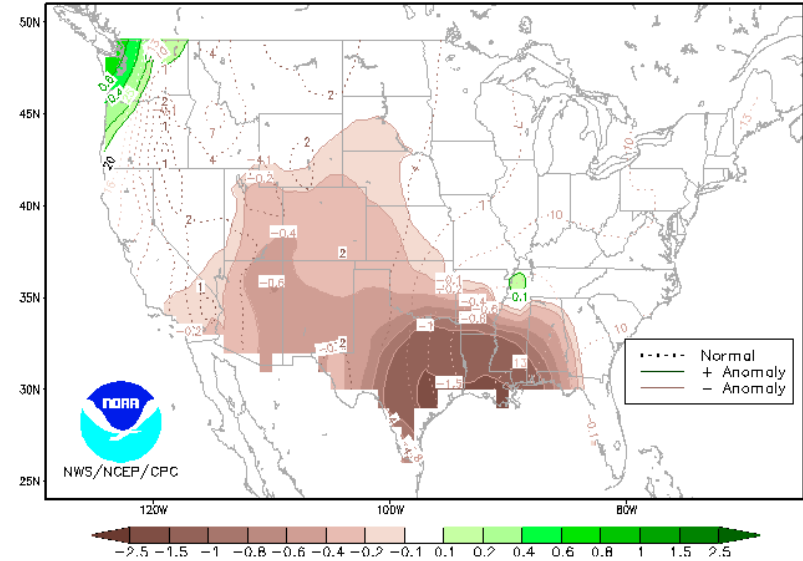
## Anomaly (deg F) of the Mid-value of the 3-Month Temperature Outlook Distribution for OND 2021

Dashed lines are the median 3-month temperature (degrees F) based on observations from 1991-2020. Shaded areas indicate whether the anomaly of the mid-value is positive (red) or negative (blue) compared to the 1991-2020 average. Non-shaded regions indicate that the absolute value of the anomaly of the mid-value is less than 0.1. For a given location, the mid-value of the outlook may be found by adding the anomaly value to the 1991-2020 average. There is an equal 50-50 chance that actual conditions will be above or below the mid-value. Please note that this product is a limited representation of the official forecast, showing the anomaly of the mid-value, but not the width of the range of possibilities. For more comprehensive forecast information, please see our additional forecast products.



## Anomaly (inches) of the Mid-value of the 3-Month Precipitation Outlook Distribution for OND 2021

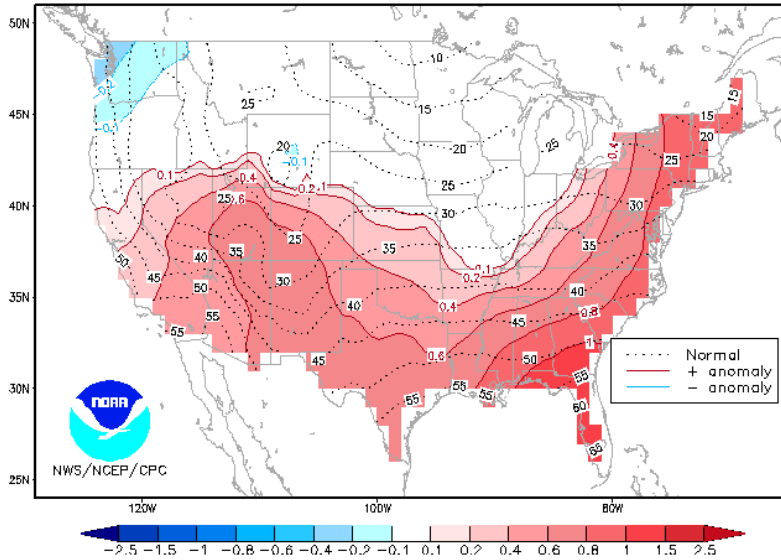
Dashed lines are the median 3-month precipitation (inches) based on observations from 1991-2020. Shaded areas indicate whether the anomaly of the mid-value is positive (green) or negative (brown) compared to the 1991-2020 average. Non-shaded regions indicate that the absolute value of the anomaly of the mid-value is less than 0.1. For a given location, the mid-value of the outlook may be found by adding the anomaly value to the 1991-2020 average. There is an equal 50-50 chance that actual conditions will be above or below the mid-value. Please note that this product is a limited representation of the official forecast, showing the anomaly of the mid-value, but not the width of the range of possibilities. For more comprehensive forecast information, please see our additional forecast products.



# CPC Guidance: December - February

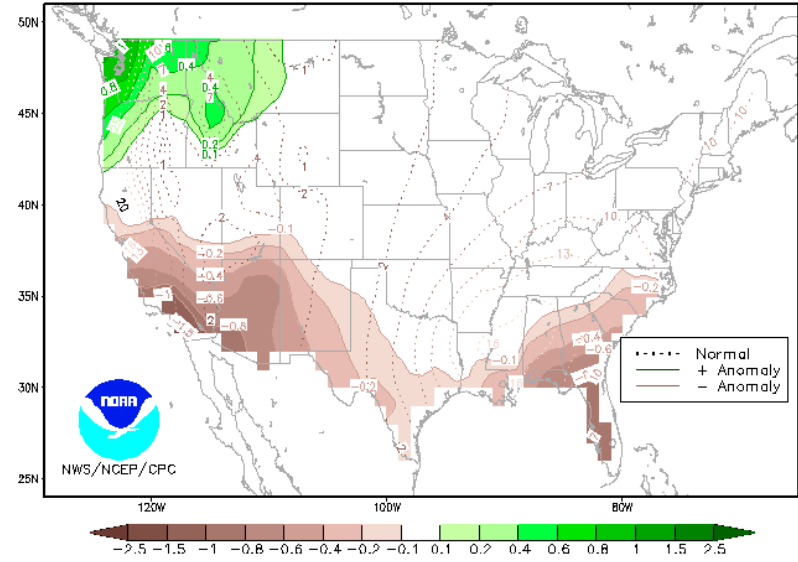
## Anomaly (deg F) of the Mid-value of the 3-Month Temperature Outlook Distribution for DJF 2021-22

Dashed lines are the median 3-month temperature (degrees F) based on observations from 1991-2020. Shaded areas indicate whether the anomaly of the mid-value is positive (red) or negative (blue) compared to the 1991-2020 average. Non-shaded regions indicate that the absolute value of the anomaly of the mid-value is less than 0.1. For a given location, the mid-value of the outlook may be found by adding the anomaly value to the 1991-2020 average. There is an equal 50-50 chance that actual conditions will be above or below the mid-value. Please note that this product is a limited representation of the official forecast, showing the anomaly of the mid-value, but not the width of the range of possibilities. For more comprehensive forecast information, please see our additional forecast products.



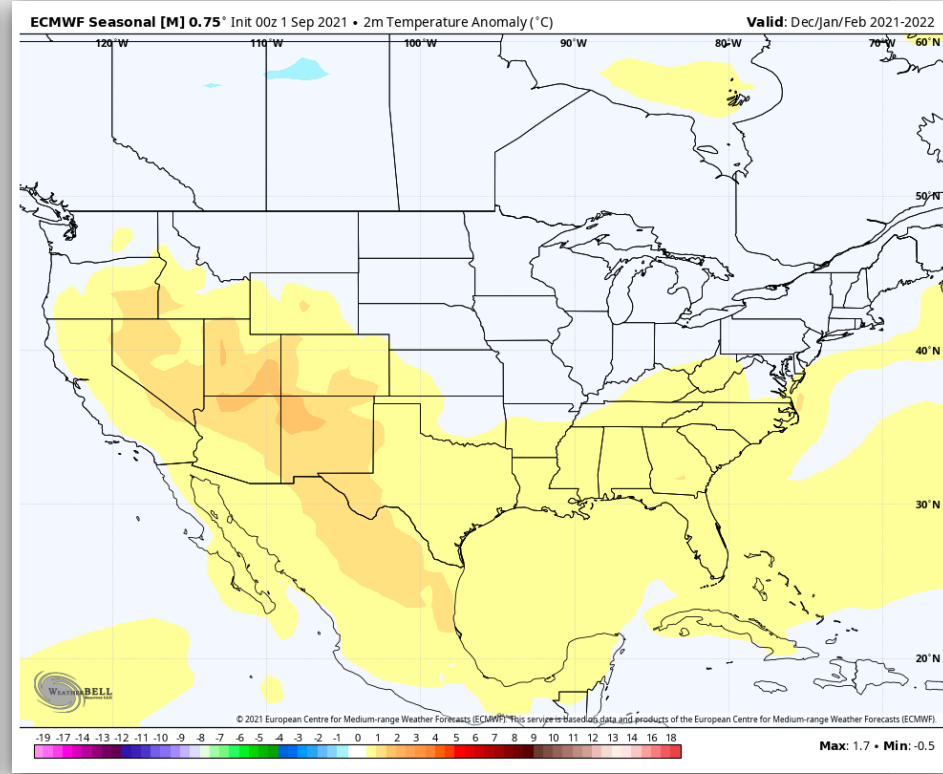
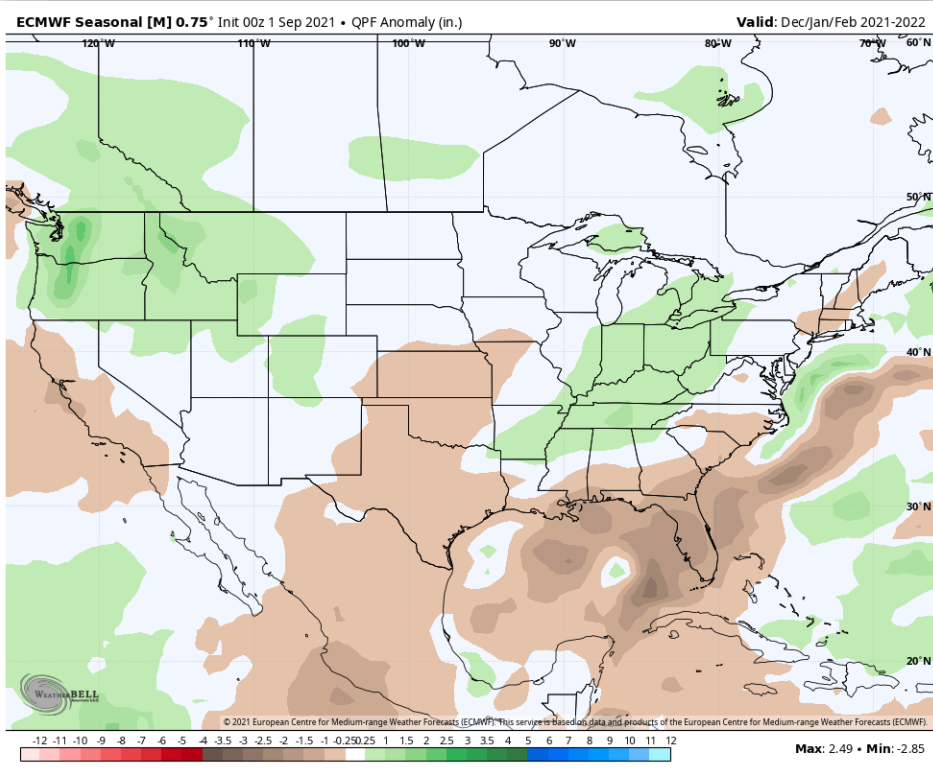
## Anomaly (inches) of the Mid-value of the 3-Month Precipitation Outlook Distribution for DJF 2021-22

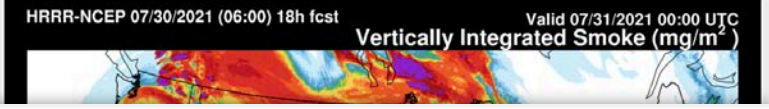
Dashed lines are the median 3-month precipitation (inches) based on observations from 1991-2020. Shaded areas indicate whether the anomaly of the mid-value is positive (green) or negative (brown) compared to the 1991-2020 average. Non-shaded regions indicate that the absolute value of the anomaly of the mid-value is less than 0.1. For a given location, the mid-value of the outlook may be found by adding the anomaly value to the 1991-2020 average. There is an equal 50-50 chance that actual conditions will be above or below the mid-value. Please note that this product is a limited representation of the official forecast, showing the anomaly of the mid-value, but not the width of the range of possibilities. For more comprehensive forecast information, please see our additional forecast products.



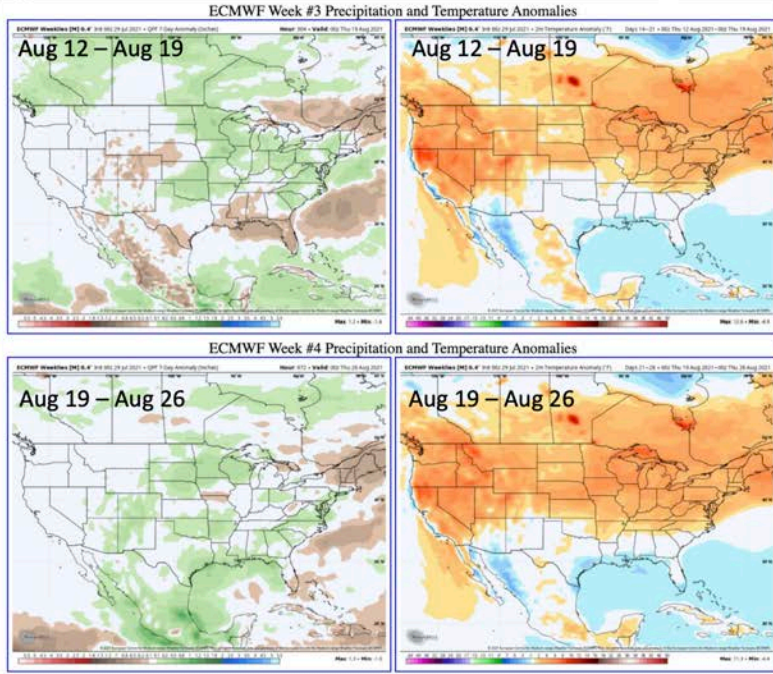


# Winter 2021-22 (Preliminary ideas from ECMWF)



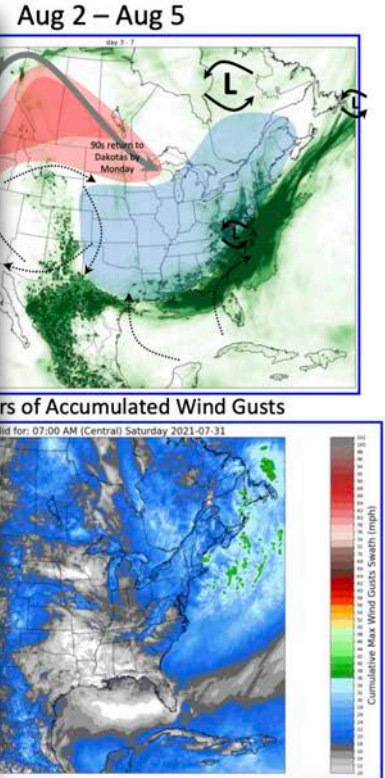
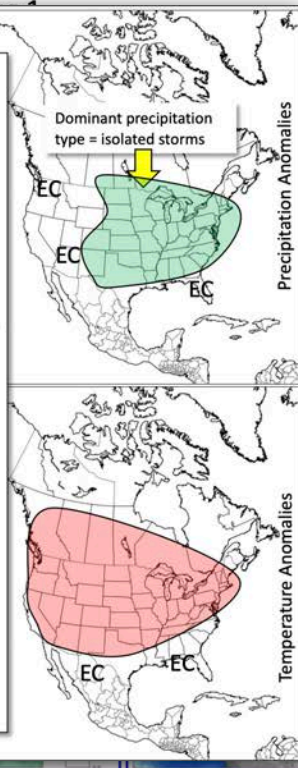


**Nutrien** ECMWF Week 3-4 Forecast + Day 16-30 Composite Analysis  
 Ag Solutions **No change to my analysis from Tuesday.**



After showing some alignment last week, the CFSv2 and ECMWF are **not** in agreement on the August temperature and precipitation patterns. Shown to the left is the ECMWF forecast which has been more consistent. Thoughts:

- The CFSv2 is significantly hotter in week #3 over the Great Lakes and Upper Midwest and much drier over the Plain due to the placement of a large Ridge over the Red River Valley of the North. The ECMWF favors the persistent westward trend of the ridge (which we have seen all summer)
- The ECMWF has projected above normal rains for the Canadian Prairie.
- I have low confidence in the week 3-4 forecast primarily due to low momentum in the Northern Hemisphere jet stream pattern and the MJOs weak return to Phase 1-3 (Africa to India).
- There just aren't strong signals so the model defaults to persistence and climatology. So excessive heat stays primarily in the west, the Gulf stays open, high evapotranspiration rates add additional moisture for storms east of the Rockies, but regions with drier soils and crops will likely stay drier.



patterns. The 6th map shows the week #2 precipitation anomalies trough moving through the Central US, the favors more storms in map.