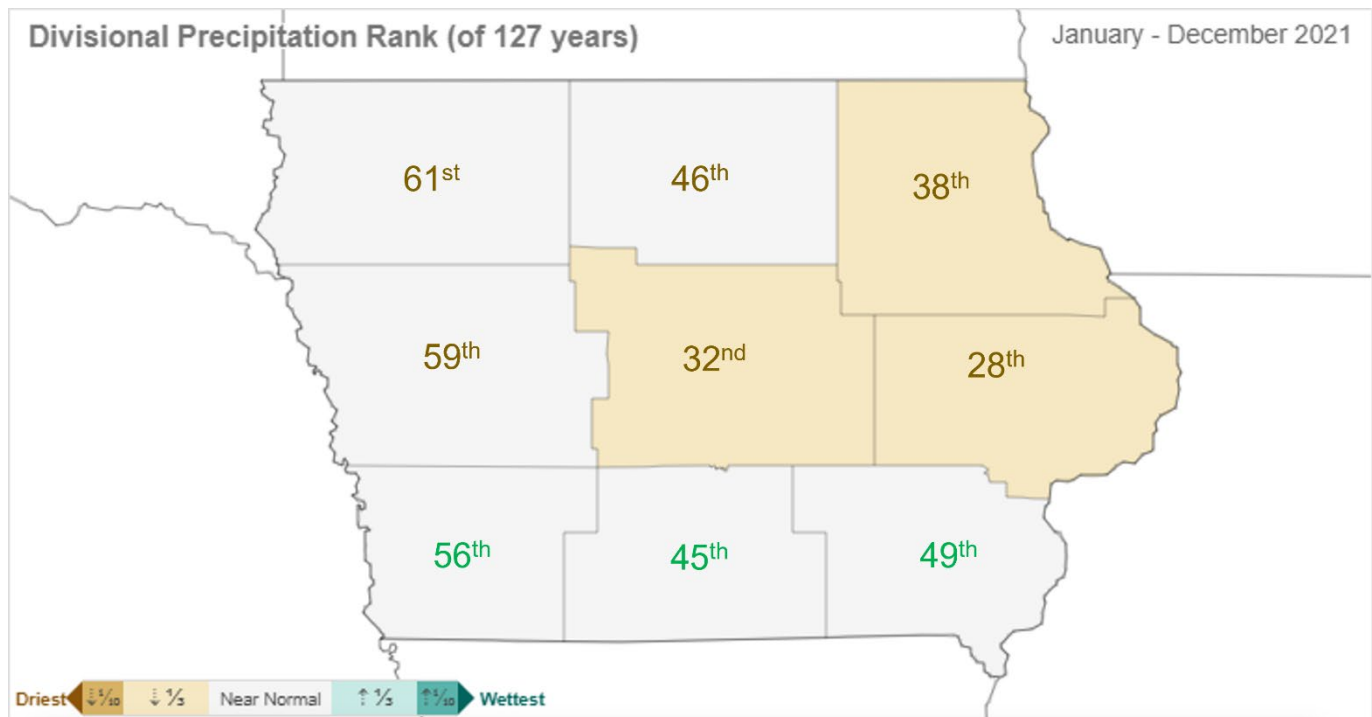
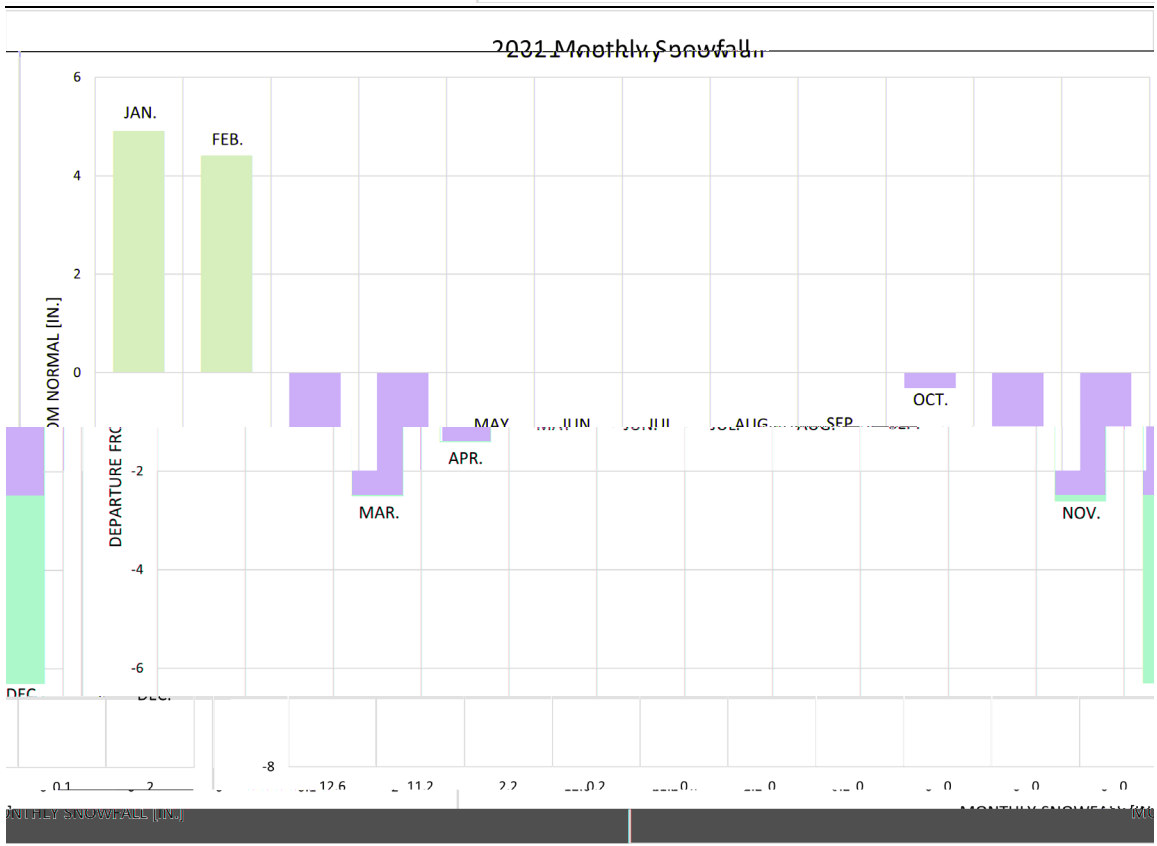
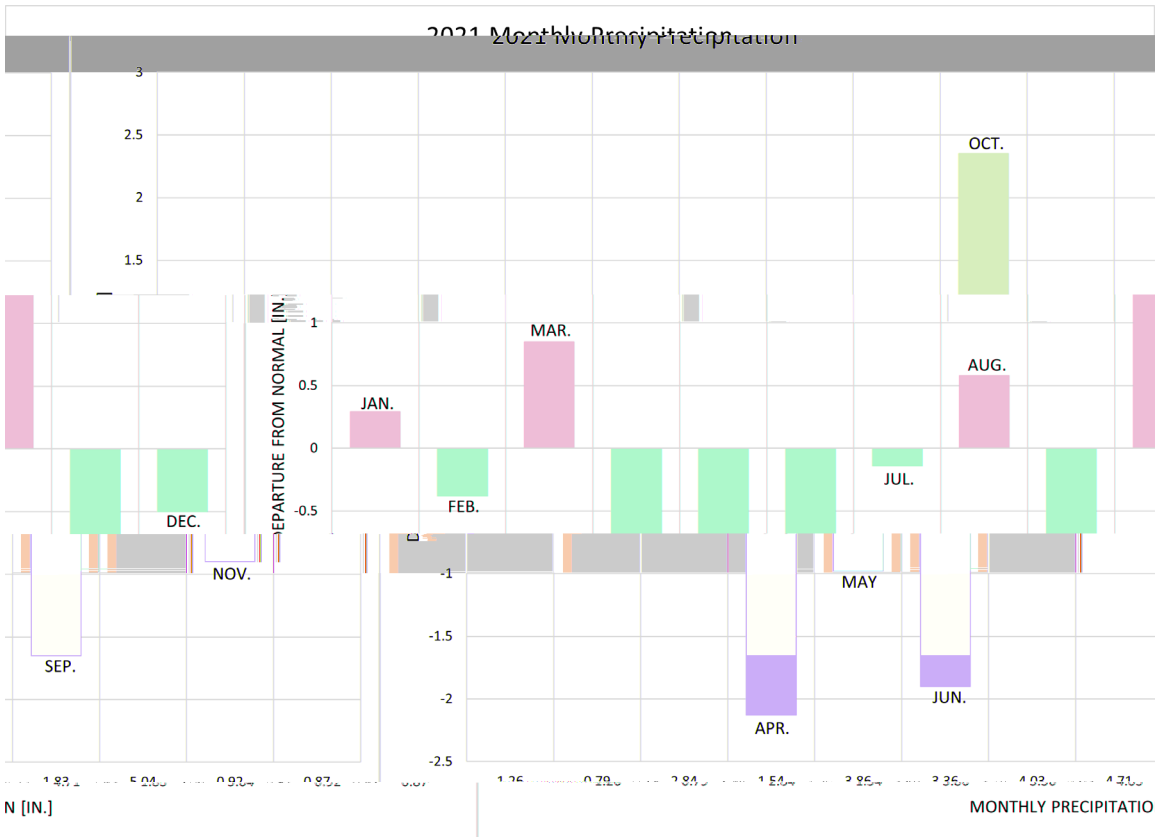


IOWA ANNUAL WEATHER SUMMARY – 2021

General Summary: Iowa temperatures averaged 50.0 degrees or 1.6 degrees above normal while precipitation totaled 31.06 inches or 4.49 inches more than normal. This ranks as the 16th warmest and 57th driest year on record. A warmer year was last recorded in 2014 while a drier year occurred in 2020. This is also the 57th least snowy calendar year among 134 years of records with 28.3 inches, 4.1 inches above average; 2017 saw less snow.



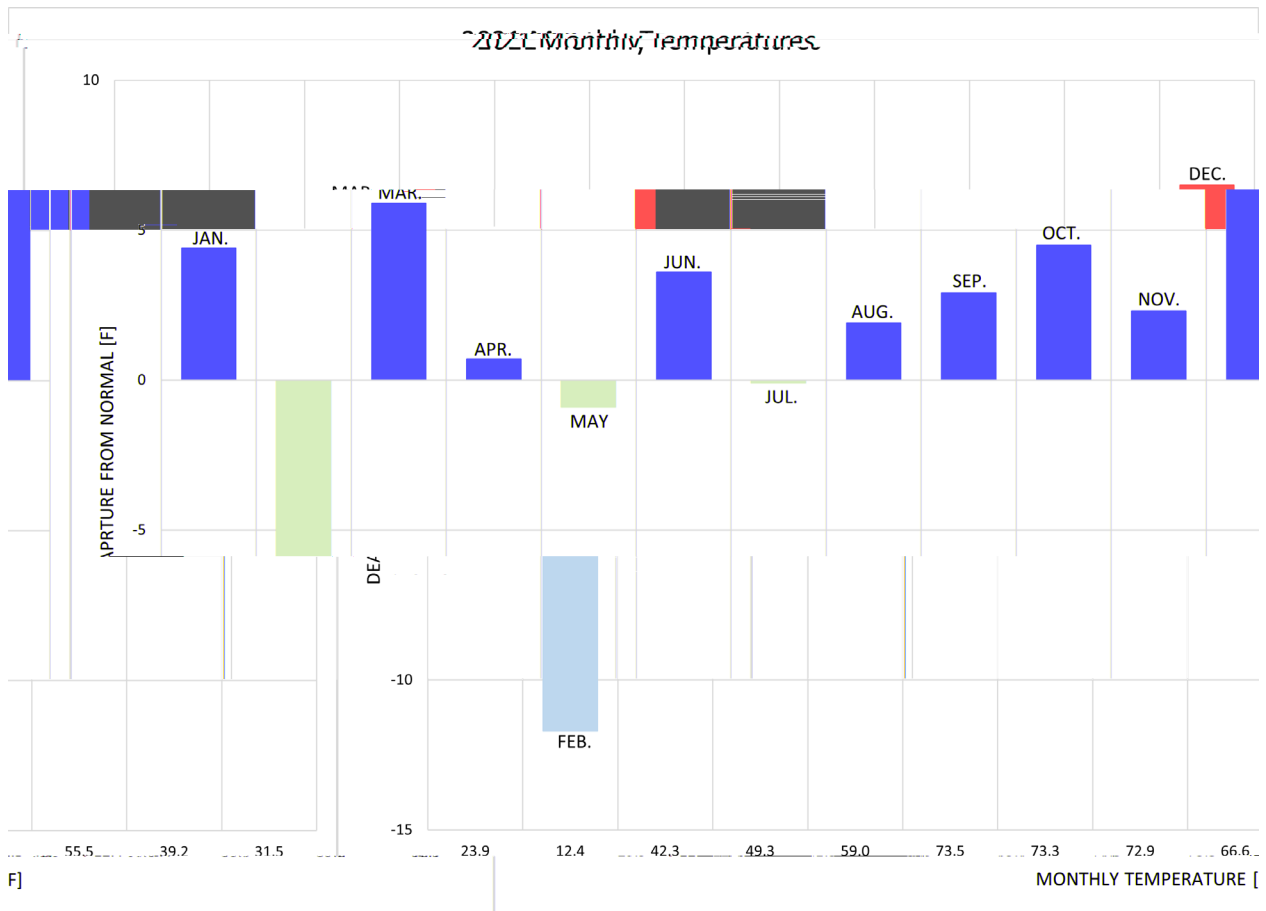
Precipitation: In 2021 precipitation was below normal for eight of the 12 months of the year and was significantly below normal during late spring and early summer. On the opposite side of the meteorological spectrum, October 2021 was the 8th wettest October on record, with 2.88 inches of above average rainfall. The distribution of precipitation was not uniform across Iowa in 2021. There were pockets of near to above-average precipitation totals around the four corners of the state. Much of Iowa's interior experienced precipitation deficits of four to six inches; pockets of eight to twelve-inch precipitation deficits were found in central, north-central and northwestern Iowa.



Temperature: Iowa experienced warmer-than-average temperatures for nine months of the year with January starting off 4.4 degrees above average. Arctic air gripped much of the first half of February, as a destabilization in the Polar Vortex led to an intrusion of high-latitude frigid air. The Polar Vortex is a large low pressure system over the Arctic basin that dams off frigid air from the mid-latitudes. When the vortex weakens and begins to wobble, meanders (dips) form that allow bulges of cold air to intrude into the Midwest. Typically, after a burst of Arctic air, unseasonably warm conditions follow from west to east over the next several days. While there was a rebound in the statewide average temperature behavior given warmer-than-normal temperatures at the end of the month, average temperatures for February were anywhere from eight to 16 degrees below normal. The coldest period of the month was between February 7th and 16th when the average temperature was -5.2 degrees, 27.2 degrees below normal. Unseasonably warm temperatures blanketed Iowa during March with positive departures of up to eight degrees reported in western Iowa. The remaining portions of the state observed monthly averages between two to six degrees. In a rebound from February, March 2021 was the 12th warmest March on record.

Temperatures for the three spring months of March, April and May averaged 50.2 degrees, 1.9 degrees above normal. This spring ties 1902, 1911, 1936 and 2006 as the 29th warmest on record; Spring 2016 was warmer. Precipitation totaled 8.08 inches or 2.42 inches below normal. This ties 1935 as the 52nd driest May in 149 years of records with a drier spring last occurring in 2000. The first half of June saw very warm temperatures across the Midwest with daytime high temperatures in the upper 80s and 90s along with sporadic triple-digit days; the first 16 days were the 7th warmest, dating back 149 years. With a return of an active weather pattern, clouds and rain helped moderate temperatures during the month's second half. Overall, June ended as the 13th warmest on record at 3.5 degrees above normal. Temperatures for the three summer months of June, July and August averaged 73.3 degrees, which is 1.9 degrees above normal, tying 1900 and 1947 as the 35th warmest summer on record.

Temperatures over the three autumn months (September-October-November) averaged 53.8 degrees or 3.4 degrees above normal tying 1947 as the 13th warmest fall among the period of record. September ranked as the 24th warmest while October ended as the 21st warmest, 3.0 degrees and 4.6 degrees above average, respectively. The year ended with an anomalously warm December as positive departures ranged from five to eight degrees statewide; southern Iowa reported the warmest conditions. Nearly 100 National Weather Service (NWS) co-op stations tied or broke their December record highs on December 15th in advance of a potent low pressure system advancing towards Iowa from Colorado. Oskaloosa (Mahaska County), Muscatine (Muscatine County), Iowa City (Johnson County) and Ottumwa (Wapello County) reported the month's high temperature of 75 degrees on the 15th, on average 39 degrees above normal. This reading also breaks the December record high temperature of 74 degrees that was observed at Thurman (Fremont County) on December 6, 1939.



2021 Statewide Monthly Temperature Extremes							Statewide Monthly Rank*	
Month	Max. Temp.	Day	Location	Min. Temp.	Day	Location	Temperature	Precipitation
January	52	20th	Clarinda Shenandoah Sioux City A.P.	-14	29th	Elkader	29th warmest	63rd wettest
February	59	27th	Centerville Donnellson	-35	16th	Battle Creek 2NE Mapleton No. 2	8th coldest	45th driest
March	78	29th	Desoto	7	2nd	Elkader	12th warmest	34th wettest
April	93	26th	Desoto	11	1st	Estherville A.P. Battle Creek 2NE	71st warmest	16th driest
May	97	1st	Spencer A.P.	26	11th	Estherville A.P.	53rd coldest	64th driest
June	104	17th	Little Sioux	40	22nd	Belle Plaine Elkader Estherville A.P.	13th warmest	28th driest
July	99	28th	Spencer A.P.	48	8th	Estherville A.P.	58th coldest	64th wettest
August	98	24th	Multiple south-central stations	45	14th	Forest City Webster City	49th warmest	42nd wettest
September	95	28th	Red Oak	32	25th	Atlantic Audubon Guthrie Center	24th warmest	22nd driest
October	87	1st	Davenport A.P.	23	23rd	Elkader Mason City A.P.	21st warmest	8th wettest
November	73	6th	Lake Park	8	26th	Several northern stations	43rd warmest	41st driest
December	75	15th	Several southern stations	-8	29th	Postville	13th warmest	47th driest

Drought Monitor: Iowa began the year already in drought conditions, especially in the northwest part of the state. As shown in the figure below, those early 2021 drought conditions held mostly steady through the winter months and into the spring. By the middle of April D3 – Extreme Drought had disappeared from the state, and drought conditions continued to improve until the middle of June, when drought coverages began to expand. Extreme Drought reappeared in early August and was present in the state until the end of that month. After the rains of October, D2 – Severe Drought disappeared from the state

in early November, and conditions remained generally steady for the remainder of the year. Iowa ended 2021 with roughly half of the state free from any dryness or drought, and about 12 percent of the state with D1-Moderate Drought conditions.

Severe Weather:

Weather-wise, Iowa experienced its 1st and 4th largest tornado outbreaks on record and the first serial derecho to occur in December in United States history.

July 14th, 2021: This event developed with a broad area of thunderstorms moving into northwestern Iowa around 3:00 am on the 14th, which would turn out to be a significant weather day. The first wave of rainfall was heavy across northern and eastern Iowa, along with some strong to severe thunderstorms; these storms did not use up all of the atmospheric instability allowing a second, and much stronger, area of severe supercell thunderstorms to form in central Iowa during the afternoon. Within a stretch of four hours, several supercells produced tornadoes from Sac City (Sac County) to Canton (Jones County). Most of the tornadoes were rated EF-1 but a strong EF-3 tornado produced crop and property damage along a 10-mile stretch through Lake City (Calhoun County); wind speeds were estimated between 135-145 mph. Preliminarily, there were 26 tornadoes across Iowa, the 4th highest count for a day since records started. Thankfully, no injuries or fatalities were reported.

December 15th, 2021: Unseasonably warm and record-setting air and dewpoint temperatures produced unstable conditions in advance of a potent Colorado low pressure system on December 15th. Temperatures across the state were 30 to 40 degrees above average, creating an explosive spring-like thunderstorm environment. Readings were so warm that several stations reported the month's high temperature of 75 degrees, on average 39 degrees above normal. This broke, by one degree, December's record high temperature of 74 degrees set at Thurman on December 6, 1939.

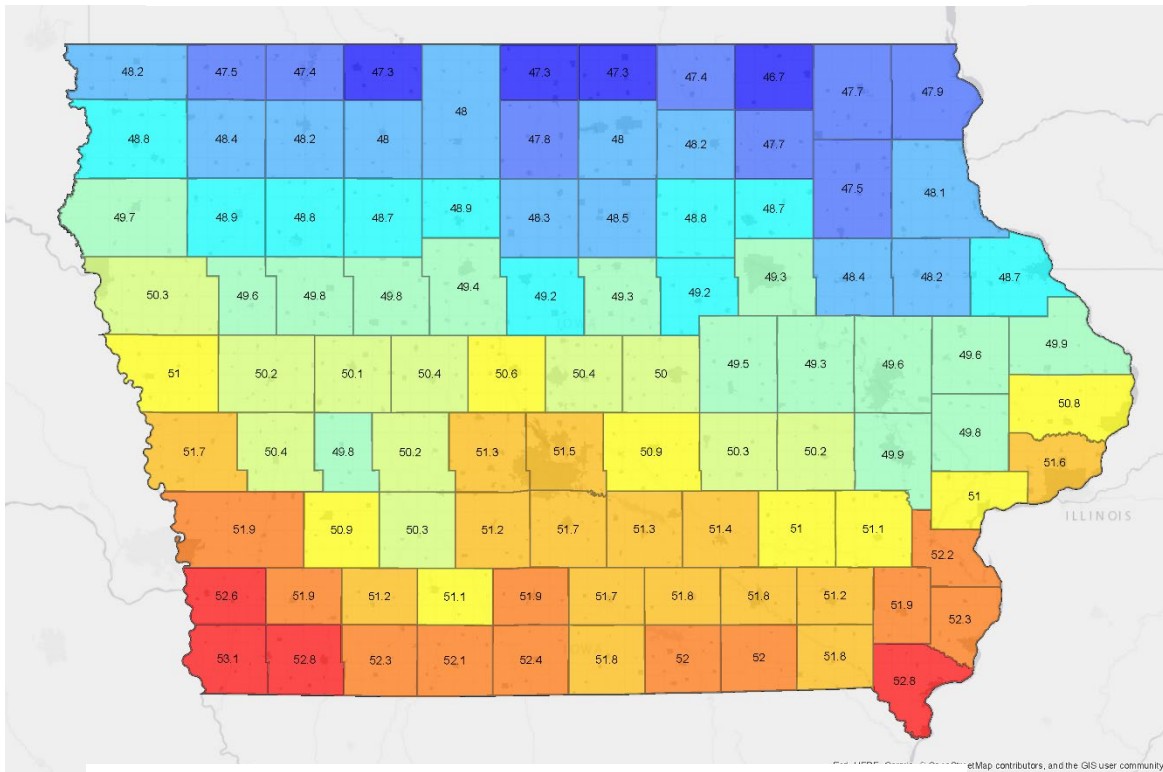
Coupled with very strong gradient winds that produced southwesterly flow in the 40 to 50-mph range, a squall line developed in eastern Nebraska and propagated into Iowa during the late afternoon and evening hours. This squall line was classified as a Quasi-Linear Convective System (QLCS) and had unique features known as Line Echo Wave Patterns (LEWPS); these structures produce bows or divots along the length of the QLCS line and are associated with strong to severe thunderstorms embedded within. These bow echo features, combined with strong ambient flow, produced multiple tornadoes across the northwestern half of Iowa. Non-tornadic wind gusts associated with these thunderstorms were in excess of 80 mph with 88 mph observed in Audubon (Audubon County). After the QLCS line passed through Iowa, strong gradient winds approaching 70 mph formed on the backside of the low pressure system. The highest non-thunderstorm wind gusts were reported at Decatur City (Decatur County; 83 mph), Marshalltown (Marshall County; 81 mph) and Johnston (Polk County; 80 mph).

The preliminary tornado count as of early 2022 for this event stands at 63, breaking Iowa's all-time highest tornado outbreak that occurred on August 31st, 2014; 35 tornadoes were reported in that event. Twenty-one of the tornadoes were rated EF-2 with peak winds between 111-135 mph. The multi-state tornado outbreak is the highest December outbreak in recorded history as well. Given the path length of the QLCS system and with wind gusts of 55 mph or greater along a majority of the system path, the

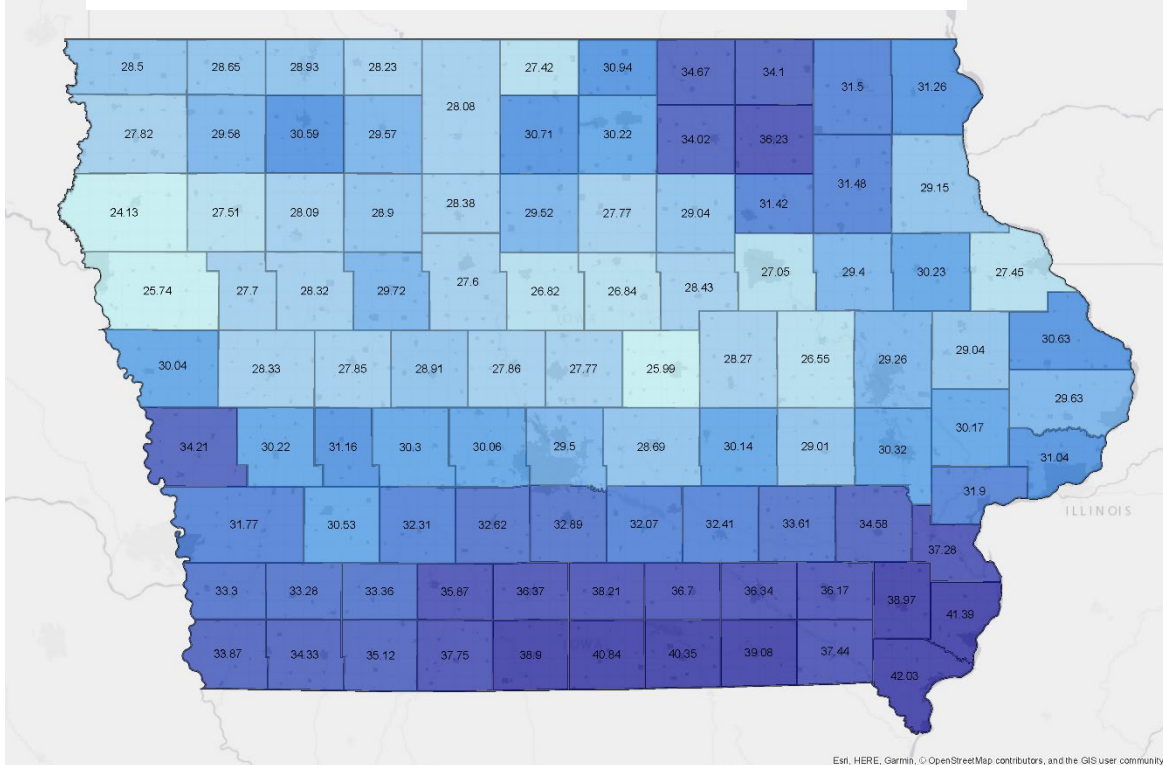
December 15th event is classified as a serial derecho; the first of which to ever occur in December. A serial derecho typically occurs in conjunction with a strong and well-organized low pressure system. This derecho differs from the August 10, 2020, Midwest derecho – the costliest thunderstorm in United States history – which was a “progressive” derecho. Progressive derechos are dominated by self-sustaining thunderstorms that produce downbursts/microbursts and travel along a generally west-to-east-oriented surface boundary with strong, unidirectional steering winds. These derechos have a smaller footprint, longer path length and typically occur in the summer. Serial derechos have a larger footprint and smaller pathlength. Overall, the 55+ mph wind gust count from the serial derecho outnumbered those from the August 10 progressive derecho, however, the progressive derecho produced widespread and catastrophic damage.

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2021 County-Level Average Temperatures (°F)



2021 County-Level Precipitation Totals (inches)



2021 County-Level Precipitation Totals, Departure from Normal (inches)

