

Actuarial Weather Extremes Series

Hurricane Ian 2022: October 3 Follow-Up

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Hurricane Ian Events Snapshot over the period September 26 to October 2-3, 2022

As noted in the SOA Research Institute report published on 9/30/2022 [1], Hurricane Ian caused tornadoes, significant rainfall and flooding, and record-breaking tide levels in Florida. This report provides a more focused, detailed look at the extreme observations and historical significance of some of the observed perils.

The figures in the following analysis illustrate the difficulty of relying upon observed, historical extremes to predict future extremes. For several United States Geological Survey (USGS) stations, the water level exceeded the flood stage by several feet more than had been previously recorded in the stations' history. The estimated probabilities of these extreme observations are often less than 1% and should add caution to any peril planning in the region that relies upon traditional methods of a "1-in-100 floodplain". As a technical note, the observed data were fitted to a Gamma Distribution using the SciPy library in Python.

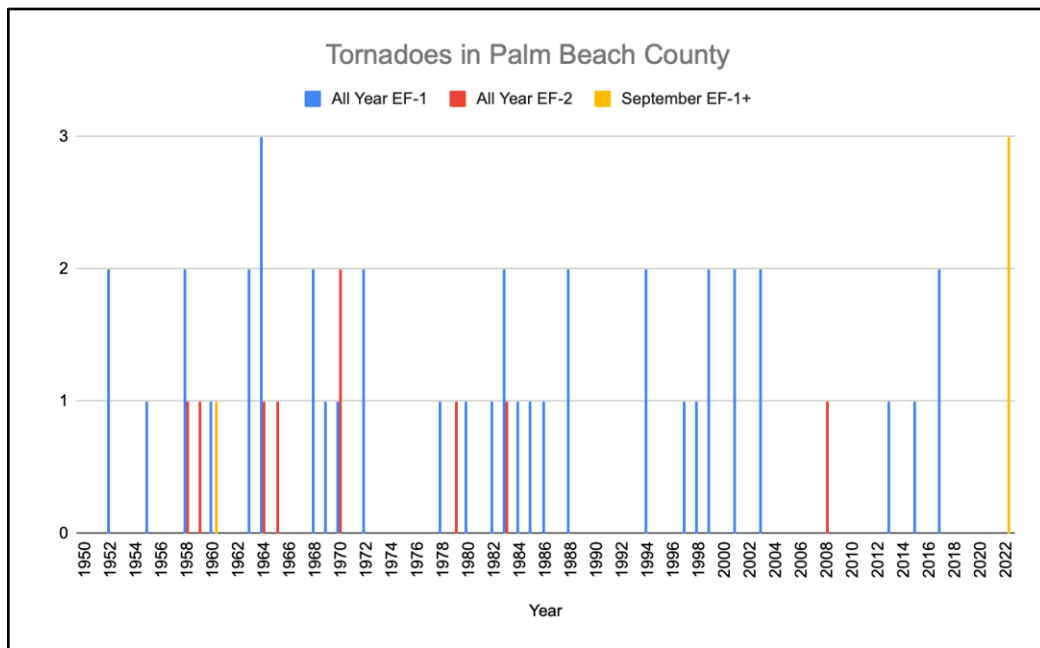
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Tornadoes

Palm Beach County, Florida recorded two EF-1 tornadoes and one EF-2 tornado¹ [2]. Such an outbreak is not unprecedented for Florida and certainly not for an area hit by a hurricane. However, this county has recorded only one tornado of at least EF-1 strength in September since 1950, as shown in Figure 1 below [3].

Figure 1
TORNADOES IN PALM BEACH COUNTY, FLORIDA SINCE 1950



The graph above illustrates that it would be unusual to see this many EF-1+ tornadoes any time in the year, but particularly in September. This historical context emphasizes the risk of extreme hurricane events. Two people were injured by the EF-2 tornado, and the roof was torn off an apartment complex [4]. Fortunately, no fatalities have been recorded from these tornadoes.

Flooding

Four USGS stations in Florida recorded gauge heights at least 7 feet above flood level. Figures 2-5 below show time series plots for each station and that each station hit its historical maximum gauge height after Hurricane Ian made landfall [5]. From these time series, we then fit the data to a Gamma distribution and estimated the implied probability of the historical maximum occurring for each station.

In each Gamma Estimation graph, the red bar represents the maximum observed values. While the Gamma fits are imperfect, the maximum values are clearly extreme, low-probability events for these stations.

¹ EF refers to the Enhanced Fujita Scale of tornado damage intensity. [The Enhanced Fujita Scale \(EF Scale\) \(weather.gov\)](https://www.weather.gov/eas/easfaq)

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Figure 2
MAXIMUM FEET ABOVE FLOOD STAGE OF PEACE RIVER AT ARCADIA, FL

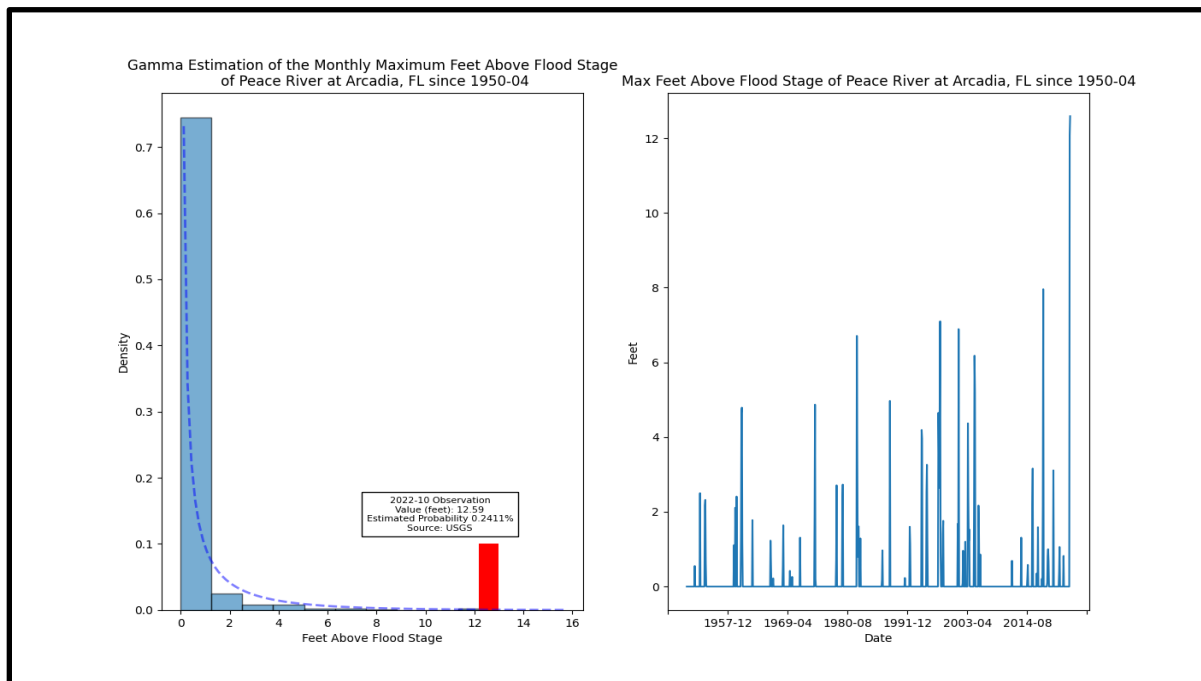
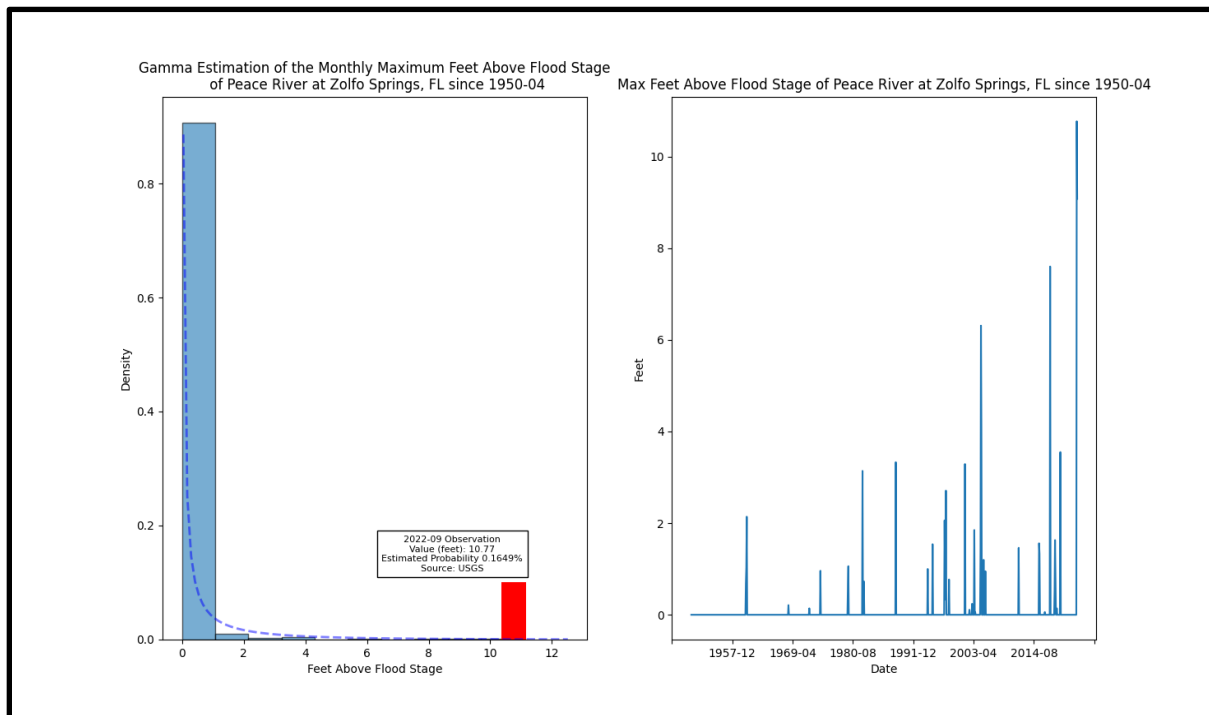


Figure 3
MAXIMUM FEET ABOVE FLOOD STAGE AT PEACE RIVER AT ZOLFO SPRINGS, FL



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Figure 4
MAXIMUM FEET ABOVE FLOOD STAGE OF HORSE CREEK AT ARCADIA, FL

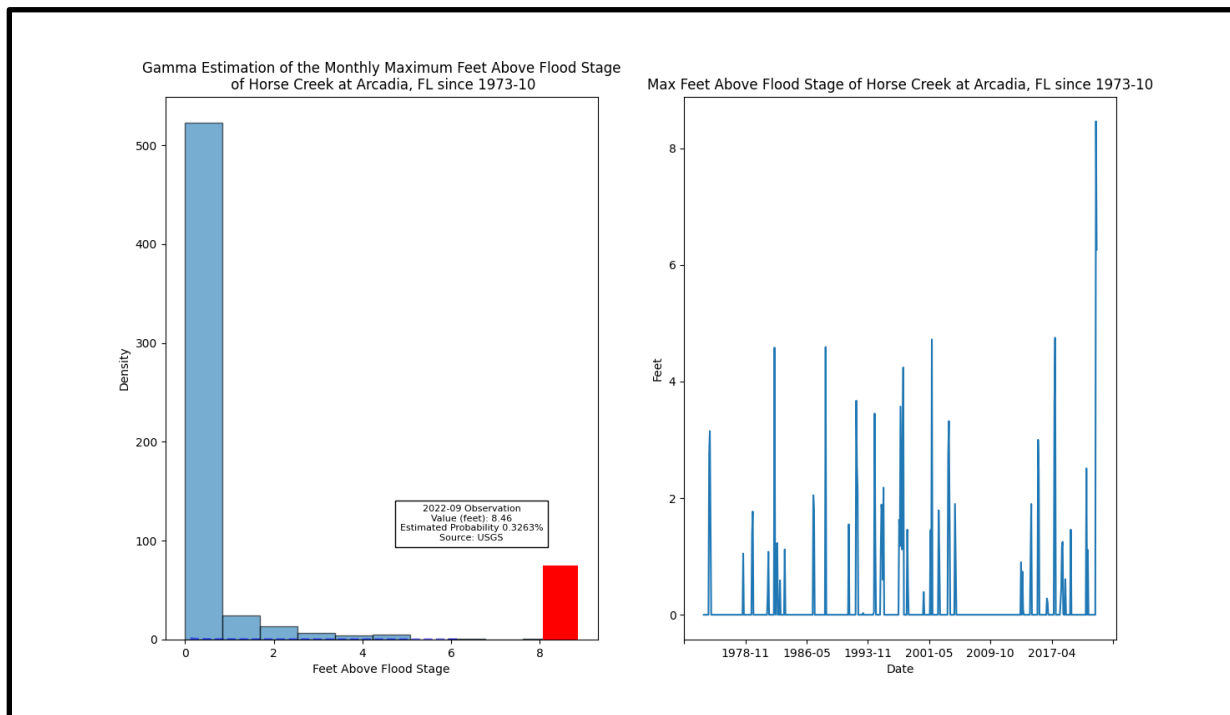
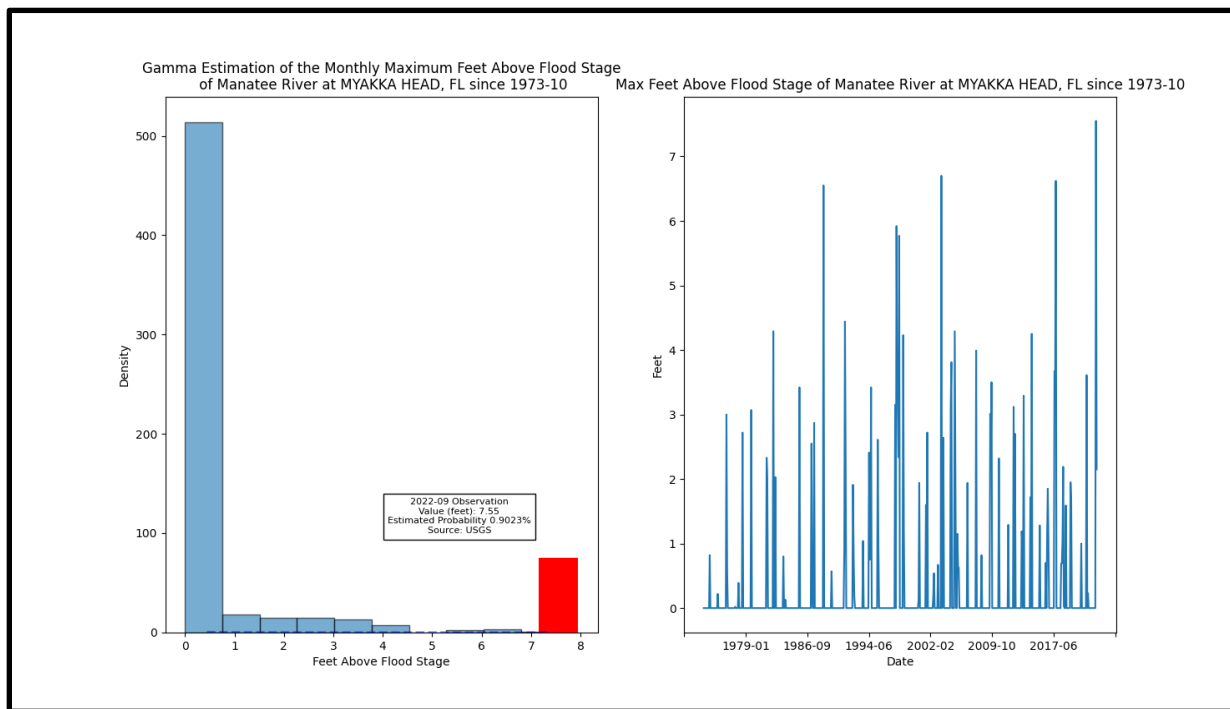


Figure 5
MAXIMUM FEET ABOVE FLOOD STAGE OF MANATEE RIVER AT MYAKKA HEAD, FL



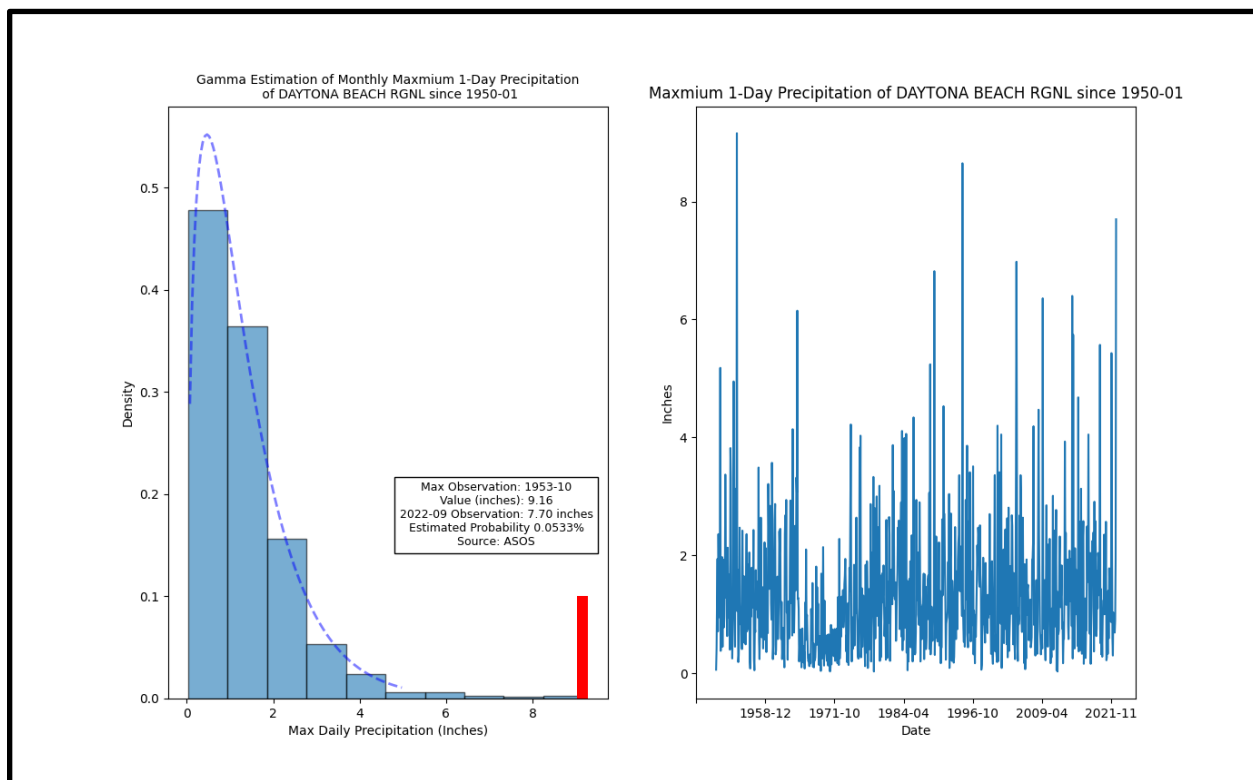
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Precipitation

Two Automated Surface Observing System (ASOS) stations in Eastern Florida recorded daily precipitation over 7 inches [6]. Station Daytona Beach RGNL recorded its third highest daily total since 1950, with 7.7 inches shown in Figure 6. Station Sanford/Orlando recorded a new maximum record of 9.5 inches, with a record going back to 1992, shown in Figure 7. These figures evaluate the maximum one-day precipitation total in each month.

Figure 6
MAXIMUM 1-DAY PRECIPITATION IN EACH MONTH AT DAYTONA BEACH, FLORIDA INTERNATIONAL AIRPORT

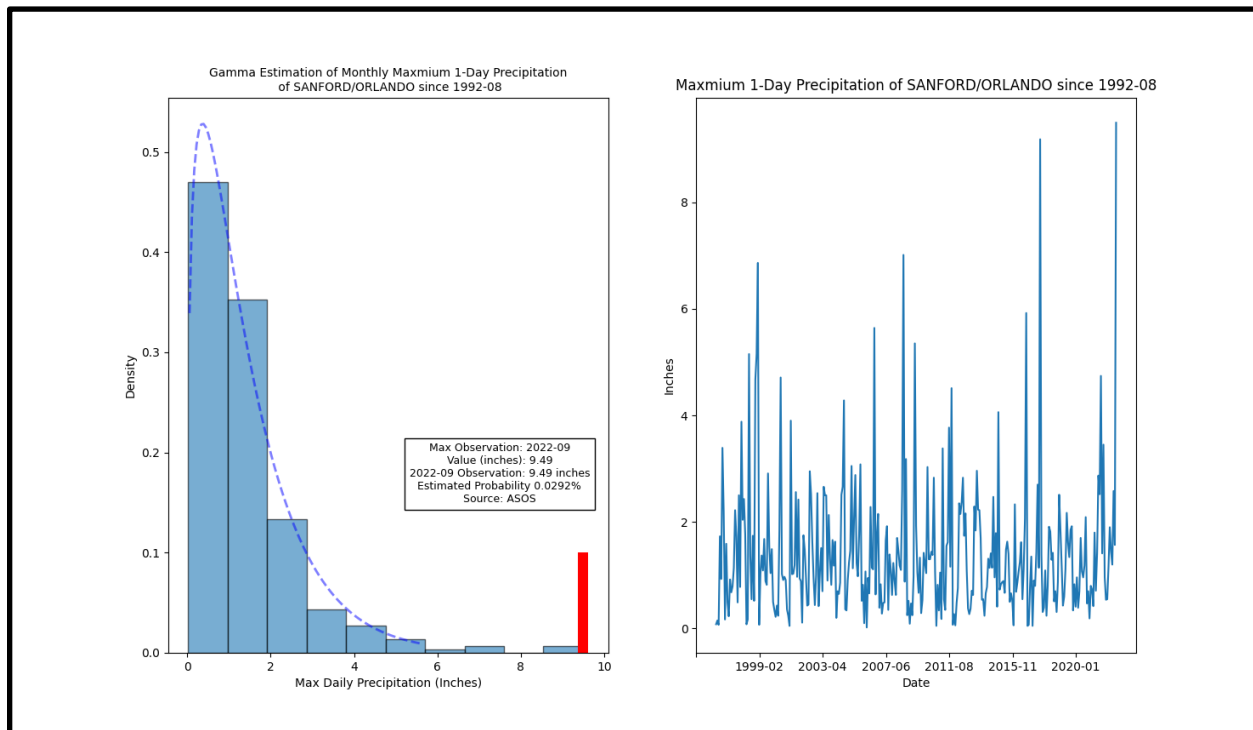


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Figure 7

MAXIMUM 1-DAY PRECIPITATION IN EACH MONTH AT ORLANDO SANFORD INTERNATIONAL AIRPORT, FLORIDA



Sources

- [1] Society of Actuaries Research Institute Actuarial Weather Extremes Series: Hurricane Ian September 26-29, 2022
 - <https://www.soa.org/4a8283/globalassets/assets/files/resources/research-report/2022/weather-extremes-sept-2022.pdf>
 - Date Published: 9/30/2022
- [2] Palm Beach County Tornadoes
 - National Weather Service Damage Survey
 - <https://mesonet.agron.iastate.edu/wx/afos/p.php?pil=PNSMFL&e=202209301542>
 - Date Accessed: 10/3/2022
- [3] Palm Beach Historical Tornadoes
 - NOAA Storm Events Database
 - <https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28%29+Tornado&beginDate mm=06&beginDate dd=01&beginDate yyyy=1950&endDate mm=06&endDate dd=30&endD>

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[ate_yyyy=2022&county=PALM%2BBEACH%3A99&hailfilter=0.00&tornfilter=1&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA](https://www.weather.gov/pal/afos?date=2022&county=PALM%2BBEACH%3A99&hailfilter=0.00&tornfilter=1&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA)

- Date Accessed: 10/3/2022
- **[4] NWS Damage Survey**
 - National Weather Service (NWS)
 - <https://mesonet.agron.iastate.edu/wx/afos/p.php?pil=PNSMFL&e=202209301542>
 - Date Accessed: 10/3/2022
- **[5] Gauge Height Daily Values**
 - United States Geological Survey (USGS)
 - <https://waterservices.usgs.gov/rest/DV-Test-Tool.html>
 - Date Accessed: 10/3/2022
- **[6] Precipitation Totals**
 - Automated Surface Observing System (ASOS): Iowa State Mesonet
 - https://mesonet.agron.iastate.edu/request/asos/hourlyprecip.phtml?network=FL_ASOS
 - Date Accessed: 10/3/2022

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