



Investigating Flash Drought After a Hurricane with the Parameters of Evaporative Demand and Volume of Precipitation



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Introduction

- I use the term **flash drought** very frequently in my research. **Flash drought** describes the rapid onset of a drought. For example, if the conditions in the region become drastically drier over a time of about three months this can be described as a flash drought.
- In my research I will determine if flash drought occurred after the landfall of a hurricane. The parameters that I will use to define drought are evaporative demand in the atmosphere and volume of precipitation accumulation. I will use the magnitude of change in evaporative demand over time and the magnitude of the volume of precipitation accumulation at landfall to determine if the hurricane spurred the flash drought.
- My research mentor and I hypothesized that due to the intense downdrafts and down currents in the atmosphere for a prolonged time during the landfall of a tropical cyclone, the atmosphere will compensate in the next few weeks and months with drier conditions. Furthermore, we hypothesized that the more rainfall volume accumulated in the region, the more intense the atmospheric drying would be. In other words, the evaporative demand would be stronger.
- This topic is a gap of knowledge within the meteorological community. There has been little to no research concerning if tropical cyclones can act as a trigger for flash drought. There has been prior research about flash drought, but that research centered mainly on the areas where flash drought would be most common in the United States and how flash drought could affect agriculture in the United States. This research mainly focused on how farmers could see the signs of flash drought and prepare for it.

References

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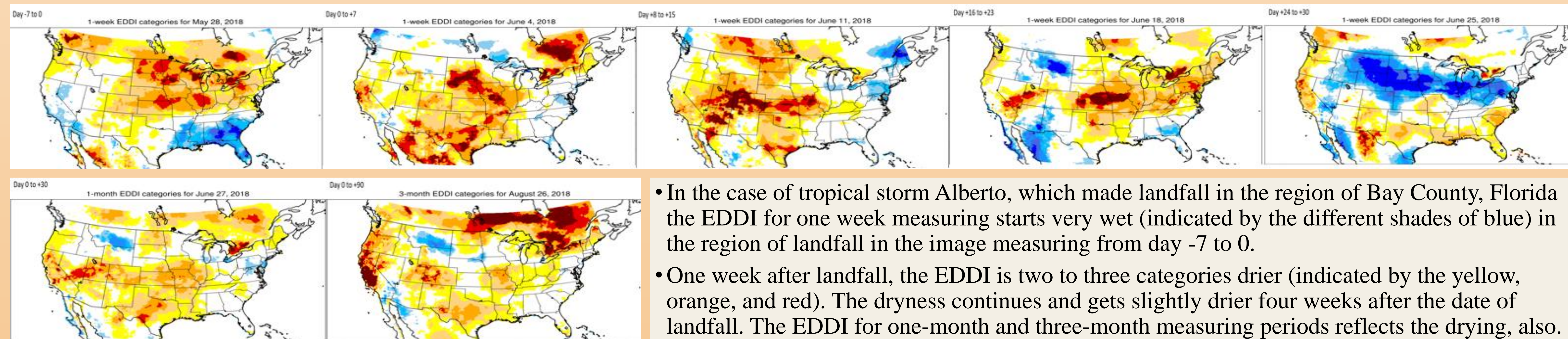
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Methods

- The process to determine if flash drought occurred in the region of landfall started with obtaining evaporative demand drought index (EDDI) pictures for the continental United States and compiling the pictures on PowerPoint. I investigated named tropical cyclones for the 2001 to 2021 Atlantic Hurricane Seasons.
- Before each series of EDDI pictures I included a tropical cyclone information slide which included landfall location, name of the tropical cyclone, time of landfall (in UTC), and intensity information (Saffir-Simpson category, minimum central pressure at landfall, and maximum sustained winds at landfall).
- EDDI timestamps take the date on the image and go backwards in time from that date. For example, hurricane Dolly made landfall on the date July 23rd, 2008. If I use a weekly timestamp, I am analyzing the average evaporative demand conditions from July 16th to July 23rd.
- I used weekly timestamps for the first month after landfall. Day -7 to 0 (first week), day 0 to +7 (second week), day +8 to +15 (third week), and so on until day +24 to +30 (final week). Additionally, I used monthly timestamps. Day 0 to +30 (one month) and 0 to +90 (three months).
- The next step to determine if a flash drought had occurred in the region of landfall is to construct a code to analyze the volume of rainfall accumulation in the region during the landfall of each named tropical cyclone in each Atlantic Hurricane Season (2001 to 2021).
- The region of analysis is defined by a box with sides of approximately 1100 km where the center of the box is the center of circulation of the named tropical cyclone (the "eye" of the hurricane).
- To compute the volume of precipitation that accumulated in the region I first had to compute the average rainfall that accumulated over an area defined by the box. The average rainfall was measured only for a 30-minute run time (starting at the time of landfall and ending 30 minutes later) however, the unit is in mm/ hour. Second, I used the area average rainfall value to compute the volume of precipitation that would accumulate in the box over a period of one day. (Area average rainfall mm/hour) * (1.1 * 10⁹ mm) * (1.1 * 10⁹ mm) * (24 hours/ day) = (Volume of precipitation accumulated mm³/ day)
- Next, I must compile the data in an Excel table for the volume of precipitation, tropical cyclone name, intensity in wind speed, time of landfall (in UTC), landfall location (latitude, longitude) for each tropical cyclone in each Atlantic Hurricane Season (2001 to 2021)
- Finally, I must compare the results of these two parts (evaporative demand drought index and volume of precipitation during landfall) to determine if a named tropical cyclone can spurn a flash drought in the weeks and months after the landfall. Furthermore, I will determine if there is a correlation between higher volume of precipitation accumulated at landfall and greater atmospheric drying (greater atmospheric demand)

Results



- In the case of tropical storm Alberto, which made landfall in the region of Bay County, Florida the EDDI for one week measuring starts very wet (indicated by the different shades of blue) in the region of landfall in the image measuring from day -7 to 0.
- One week after landfall, the EDDI is two to three categories drier (indicated by the yellow, orange, and red). The dryness continues and gets slightly drier four weeks after the date of landfall. The EDDI for one-month and three-month measuring periods reflects the drying, also.

The table below shows the volume of precipitation (in m³/day), the landfall location (in degrees latitude and longitude), the time of landfall (in UTC), the intensity (category at landfall and wind speed at landfall), and the name of the tropical cyclone for each named tropical cyclone landfalling in the continental United States

	A	B	C	D	E	F
1	2018 Atlantic Hurricane Season					
2	Tropical Cyclone Name	Time of landfall (UTC)	Location of Landfall (lat, lon)	Intensity (Category at landfall)	Intensity (wind speed at landfall)	Total volume (m ³ /day)
3	Alberto	05/28/2018 2100 UTC	(30.30, -86.00)	Tropical Storm	40 knots	16755893697.73865 m ³ /day
4	Florence	09/14/2018 1100 UTC	(34.20, -77.80)	Category 1 Hurricane	80 knots	26891107478.141785 m ³ /day
5	Gordon	09/05/2018 0300 UTC	(30.40, -88.50)	Tropical Storm	60 knots	11813487632.27463 m ³ /day
6	Michael	10/10/2018 1730 UTC	30.00, -85.50)	Category 5 Hurricane	140 knots	27808125801.08643 m ³ /day

Conclusions

- My data has not been finalized, but we have found evidence of at least four landfalling named tropical cyclones in the continental United States in the last two decades that exhibit strong drying post-landfall: Hurricane Humberto (2007), Hurricane Isaac (2012), Hurricane Matthew (2016), and Hurricane Harvey (2017).
- We find that in many of these instances, the mitigative impact of rainfall from the landfalling tropical cyclone make the appearance of the flash drought milder than typical droughts. However, the absence of rainfall and increased temperature in the post-landfall period exacerbates drought like conditions.