THE EXPECTED INTENSITY OF SUMMER THUNDERSTORMS ALONG THE FLORIDA PANHANDLE

Sydney Goldberg

INTRODUCTION

The Florida Panhandle is a 16-county region of Florida known for its white-sand beaches and blue-green waters of its barrier islands along the Gulf of Mexico, making it a popular summer vacation destination. However, the warmer months do not only attract tourists but also bring about afternoon thunderstorms. The combination of heat, humidity, and Gulf winds along the Florida Panhandle makes it an ideal breeding ground for thunderstorms, especially during the summer months.

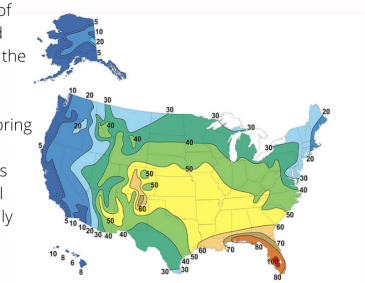

Figure 1: The figure above shows the average number of thunderstorm days each year throught the United States (NOAA).

Florida is notorious for its high numbers of thunderstorms and lightning fatalities in the United States. **Figure 1** shows the average number of thunderstorm days per year throughout the United States.

THUNDERSTORM 101

The three main ingredients for thunderstorm production are moisture, an unstable environment, and a lifting mechanism. The instability of the atmosphere is also referred to as convective available potential energy or CAPE is described by the National Weather Service (NWS) as "the amount of fuel available to a developing thunderstorm. A higher value of CAPE means the atmosphere is more unstable and would therefore produce a stronger updraft" leading to a more severe storm (NWS, 2015).

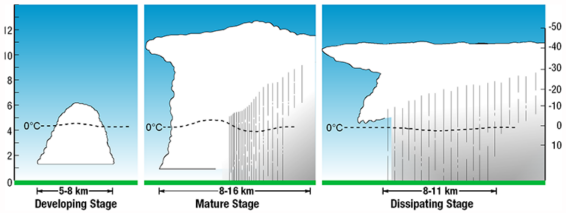

Figure 2: The three stages of thunderstorm development (NOAA National Severe Storms Laboratory)

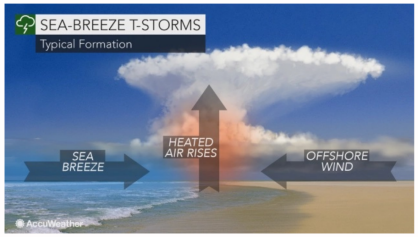

Figure 3: The figure above demonstrates how the convergence of sea breezes and offshore winds lead to the development of afternoon thunderstorms along the Florida panhandle (AccuWeather, 2019).

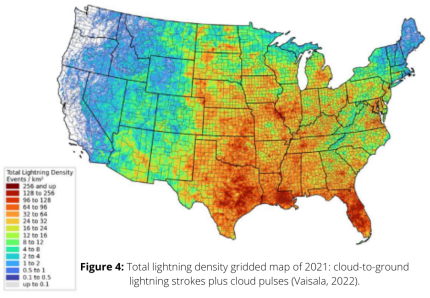

Figure 4: Total lightning density gridded map of 2021: cloud-to-ground lightning strokes plus cloud pulses (Vaisala, 2022).

Lightning, torrential rain, wind gusts, hail, tornadoes, derechos, downbursts, and flash flooding are associated with thunderstorms. The most severe storms can result in a variety of hazardous weather conditions. Lightning, however, is the one of the most concerning hazards produced by thunderstorms in the Florida Panhandle. **Figure 4** shows areas where lightning is most prone within a single year.

WARMING CLIMATE

A change in average weather patterns, referred to as climate change, could potentially further increase thunderstorm intensity. **Figure 5**, known as the Keeling Curve, represents monthly the overall global increase of CO2 since the first recording of 1958. As greenhouse gases such as CO2 continue to increase, results in climbing average global temperatures. **Figure 6,** created by NASA's Goddard Institute for Space Studies illustrates the change in global surface temperature relative to 1951-1980 average temperatures, with the year 2020 tying with 2016 for warmest on record. Global surface temperatures are increasing, and the state of Florida is noticing these warming temperatures. In fact, in 2016, The Environmental Protection Agency reported that "the Florida peninsula has warmed more than one degree Fahrenheit during the last century" (EPA, 2016).

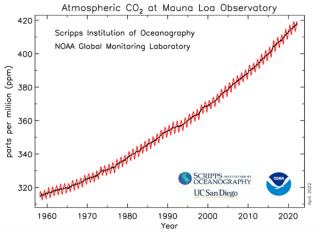

Figure 5: The graphs show monthly mean carbon dioxide measured at Mauna Loa Observatory, Hawaii starting in 1958 (NOAA Global Monitoring Laboratory, 2022)

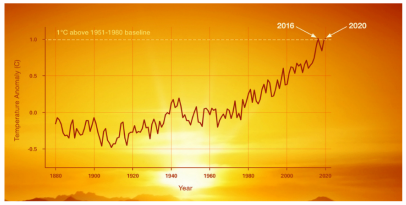

Figure 6: This graph illustrates the change in global surface temperatures relative to 1951-1980 average temperatures, within the year 2020 (NASA, 2022)

CLIMATE CHANGE AND THUNDERSTORMS

A study by Trapp et al. (2007) suggested that global warming should increase convective available potential energy (CAPE) by warming the Earth's surface and therefore increasing the amount of moisture in the air through evaporation (Trapp et al. 2007). **Figure 7** demonstrates how convective potential energy environments in the United States are expected to significantly increase in the future and how it directly correlates to an increase in severe thunderstorm environment days. A study by Jacob Steeley and David Romps concluded that with a warming climate "the growing consensus that there will be more annual severe-thunderstorm-favorable combinations CAPE and wind shear in a warm future United States (Seeley and Romps, 2015).

Total Rainfall Pensacola, FL	
Year	Inches of Rainfall
2007	57.76
2008	56.69
2009	88.33
2010	62.96
2011	48.68
2012	66.63
2013	74.61
2014	83.17
2015	75.69
2016	64.62
2017	91.91
2018	90.01
2019	52.56
2020	76.49
MEAN	70.72

Figure 8: The annual mean rainfall and total annual rainfall in inches (in) for Pensacola, FL information from NOAA database (O'connor, 2021).

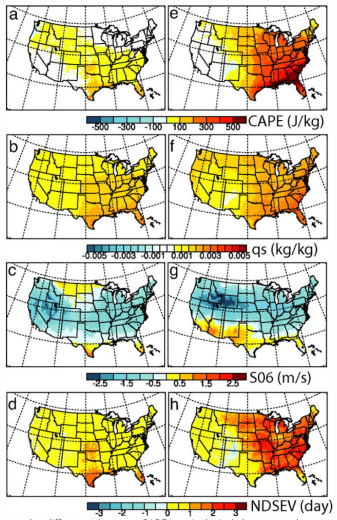

Figure 7: This figure shows the difference in mean CAPE, vertical wind shear over the surface to 6 km layer (S06), mean surface specific humidity (qs), and severe thunderstorm environment days (NDSEV) The RF integration period is 1962–1989, and the A2 integration period is 2072–2099 (Trapp et al. 2007).

Research conducted by Trenberth et al claims that global warming directly influences precipitation. (Trenberth et al. 2003). An anticipated increase in atmospheric water vapor is coupled with warming temperatures, leading to intensified precipitation and a higher frequency of extreme precipitation events. According to Rick O'Connor a Sea Grant Extension Agent in Escambia, reported that the western Florida panhandle has "a mean annual rainfall of 64.4 inches" (O'Connor, 2021). **Figure 8** shows the total rainfall for Pensacola, FL from 2007 to 2020. According to the table, the annual mean rainfall for this panhandle city over 14 years is 70.72 inches, which is 6.32 inches higher.

THUNDERSTORM CONCERNS AND MITIGATION

As thunderstorms along the Panhandle are expected to intensify, coastal communities should protect themselves and their property through mitigation. The Federal Emergency Management Agency (FEMA) defines mitigation as "a sustained action to reduce or eliminate risk to people and property from hazards and their effects" (FEMA, 2021).

POPULATION IN 2002 AND PROJECTED (2010 THROUGH 2030) (IN THOUSANDS)

COUNTY	Estimate 2002	2010	2015	2020	2025	2030
ESCAMBIA	299.5	347.2	375.4	404.7	434.9	465.5
OKALOOSA	177.0	219.6	245.7	273.2	301.7	330.8
SANTA ROSA	61.1	80.9	93.5	107.1	121.4	136.2

Figure 9: Population in 2002 and projected population 2010 through 2030 in thousands (Truma et al. 2011)

Figure 9 estimates projected population of residents with Florida panhandle counties. Due to the high population and the "many outdoor activities taking place during the afternoon and evening, a prime time for summer thunderstorms, it is easy to see why [thunderstorms] can be so dangerous," according to the National Weather Service of Melbourne, FL (NWS Melbourne Lighting Rules, 2015).

Flood Mitigation:
-improve stormwater drainage system capacity
- elevating structures and utilities
-restore natural features, such as sand dunes along the barrier islands
-clean gutters

Lightning Mitigation:
-lightning rods
-surge protections
-lightning horns

Severe wind Mitigation **(Figure 10)**:
-regulate construction sites
-regular maintenance of power lines and utilities
-shutters
-hip roofs
-tie down loose items
-roof-to-wall connection

Figure 10: Severe wind mitigation efforts applied to residential home (Tallahassee Real Estate Inspections LLC)

CONCLUSION

Data suggests that afternoon thunderstorms could intensify as the climate warms due to increasing anthropogenic greenhouse gas emissions. Coastal beach community residents on the Florida panhandle should expect more dangerous storms in the summertime and will need mitigation efforts to combat increasing storm intensity. As beach communities along the Panhandle experience a surge in tourist during the summer months, efforts should be made to educate those unaware of thunderstorm hazards to reduce fatalities.

REFERENCES

2022: Overview: Weather, Global Warming and climate change. NASA. https://climate.nasa.gov/resources/global-warming-vs-climate-change/ (Accessed April 29, 2022).
O'Connor, R., 2021: The changing climate; part 4 (The Florida Panhandle). Panhandle Outdoors. https://nwdistrict.ifas.ufl.edu/nat/2021/10/13/the-changing-climate-part-4-the-florida-panhandle/ (Accessed May 2, 2022).
Sosnowski, A., 2019: Why Florida ranks highest for lightning fatalities in the US. AccuWeather. https://www.accuweather.com/en/weather-news/why-florida-ranks-highest-for-lightning-fatalities-in-the-us/350561 (Accessed April 12, 2022).
Thunderstorm basics. NOAA National Severe Storms Laboratory. https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/ (Accessed April 12, 2022).
Trapp, R. J., N. S. Diffenbaugh, H. E. Brooks, M. E. Baldwin, E. D. Robinson, and J. S. Pal, 2007: Changes in severe thunderstorm environment frequency during the 21st century caused by anthropogenically enhanced global radiative forcing. Proceedings of the National Academy of Sciences, 104, 19719–19723, doi:10.1073/pnas.0705494104.
US Department of Commerce, N. O. A. A., 2022: Global Monitoring Laboratory - Carbon Cycle Greenhouse Gases. Trends in Atmospheric Carbon Dioxide. https://gml.noaa.gov/ccgg/trends/ (Accessed April 12, 2022).
Wind mitigation. Tallahassee Real Estate Inspections. https://inspectally.com/wind-mitigation/ (Accessed April 29, 2022).