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Rising Temperatures and Heat Waves in the CSRA

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ABSTRACT

Temperatures are gradually rising at the CSRA, to study this we compared temperature data from the CSRA from the 1970s and the 2010s. We discovered that the 2010 decade was hotter than the 1970s.

A heat wave is a period of more than two days when the temperature is abnormally hot. However, heat waves involve more variables than just temperature-high pressure-and low soil moisture are also common. Also, the heat island effect- urban areas tend to be hotter than rural areas-affects the wave.

I chose to study two heat waves, June 2015 and May 2019. The high temperatures in the heat wave were related to high pressures and low soil moistures. We compared SRS and Daniel Field and Bush Field Airport temperatures. Daniel Field was in the city and showed higher temperatures during the wave.

INTRODUCTION

1-Rising Temperature

Rising temperature over the years is no secret and global warming is the cause. (Herring et al 2022) We have seen much change in the Earth's temperature since the Industrial Revolution. We wanted to look at the Savanah River Site and what tests we could provide that would prove this. We compared summer and winter months for daily maximum and minimum temperatures from the 1970s to the 2010s.

We also looked at Cooling Degree Days and Heating Degree Days to determine if air conditioning was necessary more in the 1970s vs 2010s. A Cooling Degree Day is the number of degrees in one day's average temperature that are above 65°F, and is a measurement designed to show how much energy is needed to cool buildings. For example, if the maximum temperature for a certain day is 85°F, the minimum is 60°F, then the average temperature would be 72.5°. Subtract 65 from this value to get 7.5, the number of CDD for that day. CDD is a measurement designed to show how much energy is needed to cool buildings. In contrast, a heating degree day is number of degrees in one day's average temperature that are below 65°F. This means that heating the building would be necessary. For HDD, you subtract the 65 from the average temperature of that day.

Wet Bulb Temperature is the lowest temperature where air can be cooled by evaporation of water. When temperature is high as well as wet bulb temperature it causes a problem for body temperature because it forces less evaporation meaning that sweat cannot cool you off. When a person is outside and they are sweating, the evaporation of the sweat is what cools them off, but having high wet bulb temperature negates this effect, leading to the body overheating no matter how much water you drink. This can cause heat exhaustion in the body and heat stroke. A WBT above 26°C is where fatalities begin to occur. (Mora 2017)

We also looked at how easily it was to break 100 in the 1970s versus how easily in the 2010s. This can show us if it is getting hotter more regularly and if it is getting easier to break temperature records in the CSRA. As well as compared the summer average temperatures of

2-Heat Waves

A heat wave is a period for more than two days when temperature is abnormally hot. This is usually combined with high humidity and pressure. The Savanah River Site has had some long waves in the past and continues to have them, some even lasting up to eighteen days. We've chosen two waves to study, one from June 2015 and the other from May 2019. For both, the NOAA Forecast made a 6-10 prediction that there would be above average temperatures in the Southeastern Region, with Augusta and the site being dead center of the area we were bound to experience these abnormal temperatures. We wanted to study the waves and get a feel for how they look when viewing the data. Temperature, dew point, soil moisture, pressure, soil temperature, and rainfall were all variables that were took into consideration during the waves. How the temperature and dew point during the wave? What does soil moisture look like during the wave, before, and after? Are these variables reinforcing each other?

One thing that could potentially affect the heatwave is the urban heat island effect. This effect shows that urban areas get and absorb more heat due to man-made features. These include buildings, metal, cars, and pavement. This was taken into consideration when analyzing the wave to see if the heat wave amplified the heat island effect.

METHODS

1-Rising Temperatures

We wanted to confirm if temperatures were indeed rising at the site. We gathered temperature daily maximums and minimums from 1970s to the present. We then compared

summer and winter month highs and lows from the 1970s and 2010s decades to compare. I compared each month separately. We checked the top 53 Temperatures recorded at the site for the past 50 years to see if there was correlation to any particular year or decade. To look at possible factors of the hotter summers we compare rainfall data to show whether these summers have a correlation with drier weather.

We also wanted to find if there was a relation between consistency of WBT being above 26 for the 1990s and the 2010s. We did this by comparing the number of hours in each decade that the wet bulb temperature was above 26°C.

2-Heatwaves

Time Period

We chose June 14th through the 21st of 2015 for the intensified heat wave and looked at fifteen-minute intervals for temperature, dew point, soil temperature, pressure, soil moisture, and rainfall. This was a period where the temperature exceeded 96 degrees consistently at some point in the day. We collected the daily maximum and minimum temperatures for June 2015 and May 2019 to find a correlation between heat wave and regular day temperatures within the month.

Reinforcing Variables

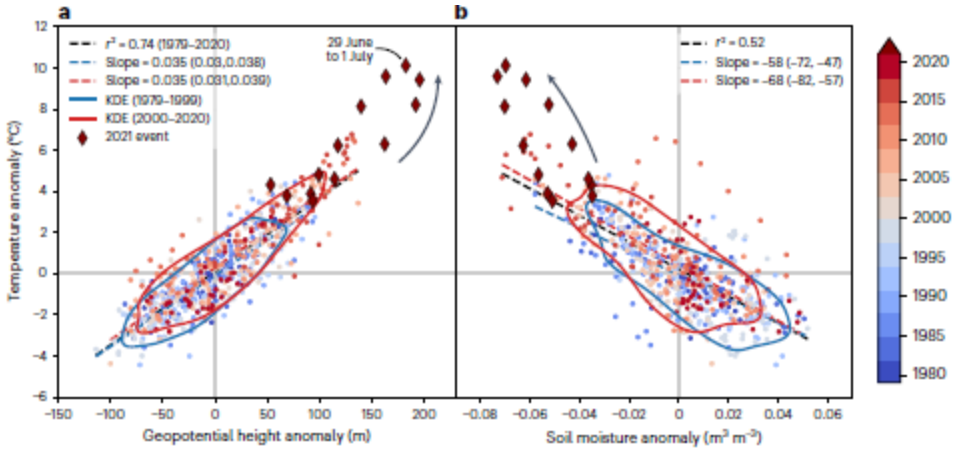
We gathered the max temperatures for the whole June 2015 month as well as May 2019. We collected 15 min pressure and soil moisture data for those months as well but only specified at 14:00 EST. We chose that time, inferring that the maximum of variables usually occurs then. We then compared the maximum daily temperature with the pressure and soil moisture at 14:00. We singled out the days of the heat wave for each month.

The Heat Island Effect

We chose to compare Daniel Field, located in the city of Augusta, and Bush Field Airport, located in a more rural part of Augusta. We then compared these two airports to the Savanah River Site to discover the strength of the heat island effect.

We then gathered the same data for a 2019 heatwave during May 24th through the 29th and ran the same tests to compare them.

For reference we did an experiment like (Bartusek et al, 2021) where they compared the soil moisture anomaly to the temperature anomaly and saw a correlation in high temperature anomaly and low soil moisture anomaly. The anomaly is defined as the difference from the average of that variable, whether positive or negative. Those red diamonds were those in the 2021 Pacific Northwest Heat Wave.



Rather in our experiment we compared daily max temperature of May 2019 with soil moisture at 18:00 UTC or 14:00 EST each day to get a similar result. We concluded that this time was a good estimate when max temperature generally is, so it was safe to grab other variables from this time.

RESULTS

1-Rising Temperatures

HDD and CDD

There were more Cooling Degree Days in the 2010s than the 1970s, demonstrating that people need more energy for cooling their buildings now than in the past. Contrarily, Heating Degree Days were lower in the 2010s than in the 1970s, demonstrating that there is less energy needed to heat buildings when it is cold. This confirms that on the CSRA hot and cold times are getting warmer.

Record Breaking Trends

The 2010s reached 100 degrees 50 times, while the 1970s reached it around 25 times. As the temperature increased, so did the difference in number of breaks in each decade. The 2010s showed the highest temperature breakage with a 109°F max temperature recorded.

Wet Bulb Temperature

The 2010s had roughly 4,000 more hours spent with wet bulb temperature above 26°C than the 1990s. this gives evidence that heat is getting more humid and deadly.

2-Heat Waves

In the June Heat Wave Temperatures were there highest during the wave, June 14th through June 21st. The Heat Wave days were picked out from the month and correlation of higher pressure and lower soil moisture within the days of the wave. The same applied for the variables of the May 2019 and the wave.

Heat Island Effect

The heat island effect was greater at Daniel Field Airport, while Bush Field was weaker during the 2019 and 2015 wave.

CONCLUSION

In conclusion, we can clearly recognize the increase in temperature at the site with the number of record breaks being higher in the 2010s compared to the 1970s. The heat is also getting more deadly as wet bulb temperature hours increasing from the 1990s.

I found that heat waves have more variables than high temperature. These variables include high pressure and low soil moisture. Secondly the urban heat island effect was evident during both heat waves in the Augusta area. Daniel Field Airport, the city airport, was warmer during both waves compared to Bush Field Airport, a rural airport.

REFERENCES

-Trends in record-breaking temperatures for the conterminous United States

-Global risk of deadly heat

-*"2021 North American heatwave amplified by climate change-driven nonlinear interactions"*

2015 Heat Wave Test Plan

-I chose June 14th through the 21st of 2015 for the intensified heat wave and looked at fifteen-minute intervals for temperature, dew point, soil temperature, pressure, soil moisture, and rainfall. This was a period where the temperature exceeded 96 degrees consistently at some point in the day. I chose to compare Daniel Field, located in the city of Augusta, and Bush Field Airport, located in a more rural part of Augusta. I then compared these two airports to the Savanah River Site to discover the strength of the heat island effect.

-I then gathered the same data for a 2019 heatwave during May 24th through the 29th and ran the same tests to compare them.

Different Test

-I gathered the max temperatures for the whole June 2015 month as well as May 2019. I collected 15 min pressure and soil moisture data for those months as well but only specified at 14:00 EST. My

mentor, David Werth, chose that time, inferring that the maximum of variables usually occurs then. I then compared the maximum daily temperature with the pressure and soil moisture at 14:00. I singled out the days of the heat wave for each month.

Rising Temperatures

- I wanted to confirm if temperatures were indeed rising at the site. I gathered temperature daily maximums and minimums from 1970s to the present. I then compared summer and winter month highs and lows from the 1970s and 2010s decades to compare. I compared each month separately.
- I checked the top 53 Temperatures recorded at the site for the past 50 years to see if there was correlation to any particular year or decade.
- To look at possible factors of the hotter summers we compare rainfall data to show whether these summers have a correlation with drier weather. Also looking at Wet Bulb Temperature Change. WBT is lowest temperature where air can be cooled by evaporation of water. A WBT above 26 degrees is where fatalities occur. We found if there was a relation between consistency of WBT being above 26 for the 90s and the 2010s decade.
- Another thing we looked at were how fast new record high temperatures were being broken and how easily it was to break a previous stationary record. For example, how easily it was to break 100 in the 80s versus how easily today.