Relating Delta T and Stability to Eclipse Occlusion in Oklahoma for 21 August 2017 Total Eclipse

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Abstract

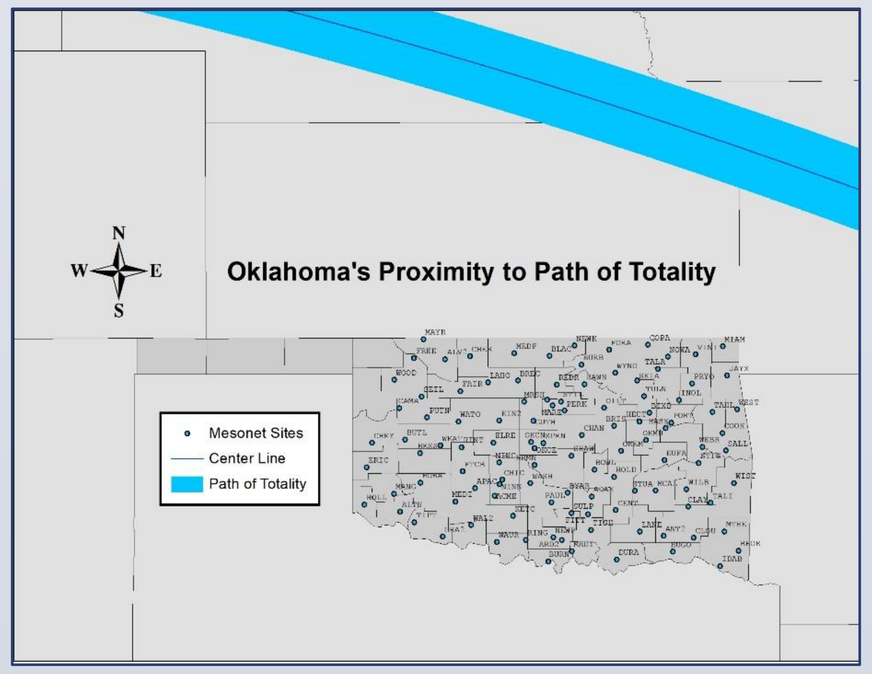
A total eclipse traversed from Oregon to South Carolina on 21st August 2017. The atmospheric response to the total eclipse was observed as a partial eclipse by the Oklahoma Mesonet at 120 automated weather stations across the state of Oklahoma. The observations were recorded by the Mesonet in 1-Minute intervals. The maximum and minimum temperature values were determined for each site at 1.5 m and 9 m. The maximum and minimum temperature was determined by finding the minimum temperature and establishing a maximum temperature that occurred before the minimum. A maximum temperature change was then calculated for each site and plotted on a map of Oklahoma. Additionally, the stability was quantified for each site and plotted on a map of Oklahoma. The temperature change and stability was found to be related to levels of occlusion.

Materials and Methods

The Data

- Special one minute data was requested from the Oklahoma Mesonet for all 120 sites for the day of the eclipse.

Variable Name	Variable Description
TA1M	1.5m Aspirated Air Temperature
SR1M	Incoming Short Wave Solar Radiation
T91M	9m Unaspirated Air Temperature
TS1M	1.5m Unaspirated Air Temperature



R Studio

- One minute data was imported into R Studios.
- The data was filtered for the time frame of the solar eclipse.
- The difference between 2 and 9 meters was calculated.
- The maximum and minimum of the difference was found for all 120 sites.
- The maximum and minimum temperature was found for both 2 and 9 meters for each site.
- The difference between maximum and minimum temperature was calculated for each 2 and 9 meters.

Methods (Continued)

ArcMap

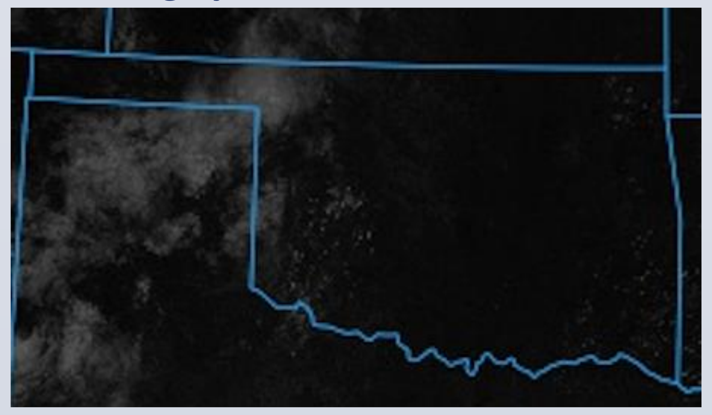
- The temperature difference for both 2 and 9 meters was plotted on a map of Oklahoma.
- Inverse Distance Weighing (IDW) interpolation was used to turn the point data sets into raster layers.
- The values within the raster layers were grouped into defined categories and colored accordingly.
- Next, the greatest vertical temperature difference for the timeframe for each site was plotted on a map of Oklahoma.
- All sites less than zero were colored blue to distinguish sites that experienced an eclipse related inversion.
- Inverse Distance Weighing (IDW) interpolation was used to turn the point data sets into raster layers.
- The values within the raster layers were grouped using Natural Breaks and colored accordingly.

Objectives

- Find the temperature response to the total eclipse observed as a partial eclipse for each Mesonet site in Oklahoma
- Quantify the greatest stability achieved for each Mesonet site as a result of the eclipse.

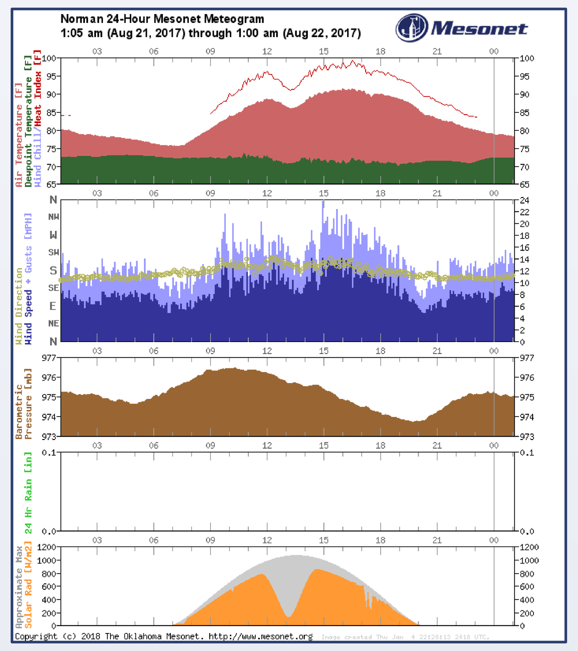
Results

An eclipse traversed across the country from Oregon to South Carolina on 21st August 2017. Although the eclipse did not traverse across Oklahoma, the Center of Totality was only 290 Km away from Miami, the closest Oklahoma Mesonet site. The Miami site experienced 92.7% occlusion while the furthest sites experienced roughly 78.5% occlusion.

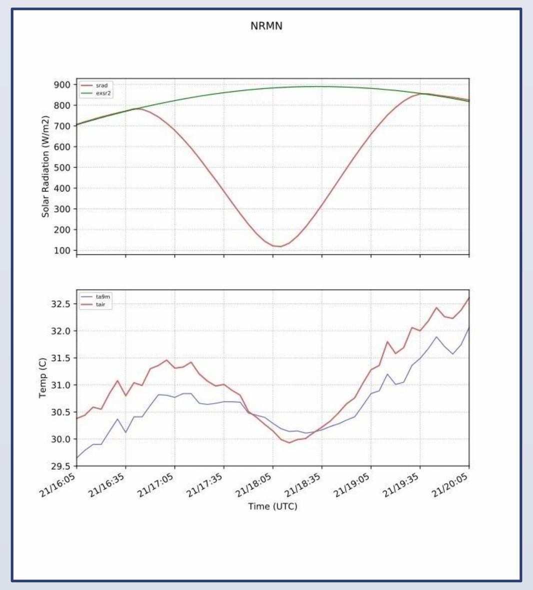


Fortunately, near ideal atmospheric conditions existed for most of the continental portion of Oklahoma. Far Northwestern Oklahoma into the Oklahoma Panhandle experienced adverse viewing conditions. In these areas, NWS radar detected scattered showers and thunderstorms. The GOES-16 satellite showed an area of cumulus clouds in the Panhandle and North Western Oklahoma. It was also noted that there were scattered stratus clouds in parts of Western Oklahoma. The quality of the data in these areas were affected by adverse conditions. Therefore, the data for the Panhandle of Oklahoma was excluded in the study Some sites in Western Oklahoma have notable reduction in data quality but not enough to be excluded.

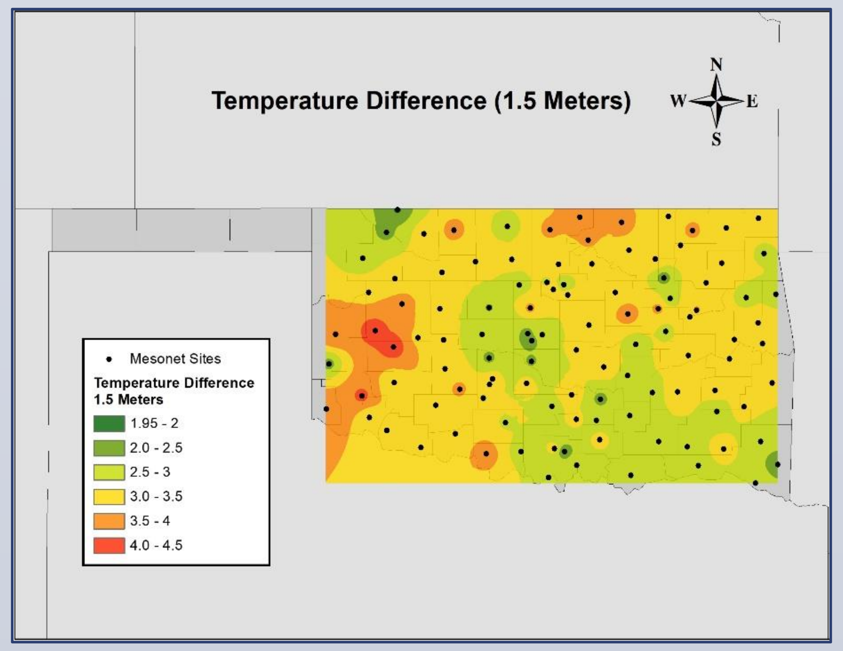
Results (Continued)



After examining the observations, the Norman Mesonet site had a similar response to the eclipse as other sites. The Norman Mesonet site experienced 84.2% occlusion. As seen in the Meteogram, the solar radiation had a 770 Wm^{-2} departure from normal. The winds at both 10 meters and 2 meters dipped by a few miles per hour during the eclipse. After the peak of the eclipse, the wind speeds returned to pre-eclipse speeds. The variable of most concern for this study is temperature. The eclipse caused the Norman Mesonet site to decrease by 2.43 °C at 1.5 meters and 1.7 °C at 9 meters before returning to normal temperature.

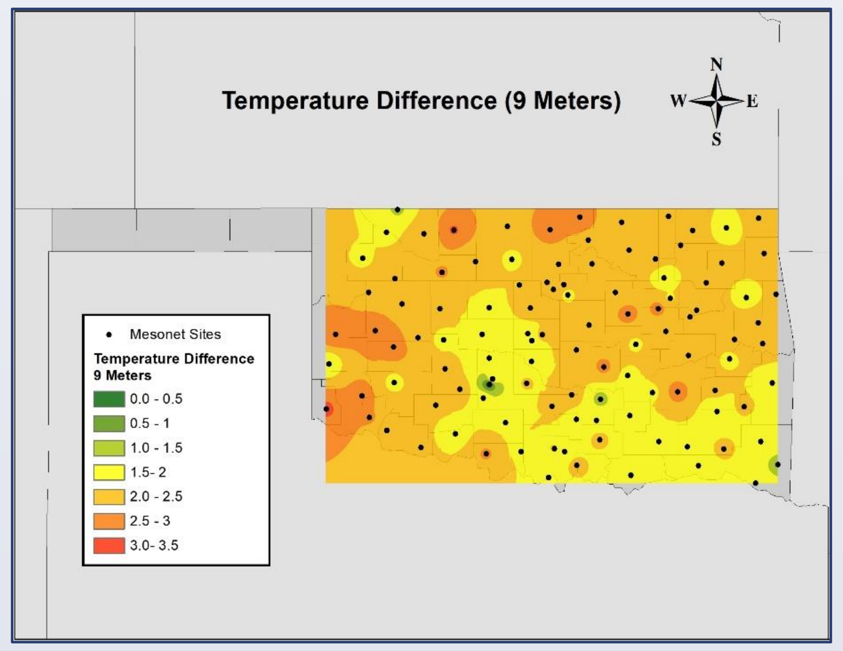


Taking a look at all the continental sites within the state, the influence of the eclipse is most notable with the temperature taken at 1.5 meters but the 9 meter sensor also had a notable temperature decrease. The greater temperature delta found at the lower height level is likely due to a decrease in sensible heat from the surface as a result of the occlusion. The influence of decreased sensible heat also affected the temperature delta at 9 meters but to a lesser extent.

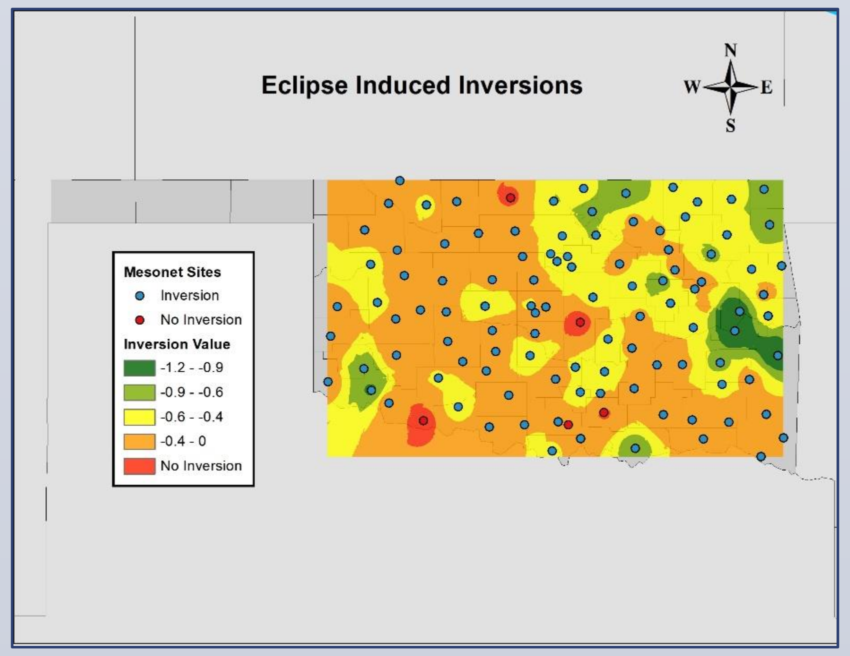


Results (Continued)

The influence of sensible heat decreases with height. Meaning the temperature at 9 meters was less affected by the decreased levels of solar radiation reaching the surface. By looking at the decrease in temperature across the state, a slight pattern emerged. The sites with the greatest occlusion values noticed a greater temperature decrease. This was expected due to a greater decrease in sensible heat. These results were greatly influenced by the topography within the state. Additionally, other factors such as wind and cloud cover in the Western part of the state may have impacted the results.



The Inversion Map shows if there was an inversion caused by the eclipse or not. The map also shows the magnitude of the inversion. It was noted that that the closer the location was to the eclipse totality, the more likely it was to have an inversion and it was more likely to have a strong inversion. The effect of the landscape and weather can enhance or hinder the effects of the eclipse in respect to the formation of an inversion. For example LeFlore, Haskell, and Muskogee county in South Central Oklahoma, which is an area of hills and valleys, have a considerably string inversion for this event between -0.9 and -1.2. Additionally, people in Central Oklahoma noted as the eclipse progressed, small cumulous clouds that existed in the area dissipated and returned after the eclipse ended. This is likely due to the eclipse induced inversion causing temporary absolute stability.



Conclusion

On 21st August 2017 an eclipse traversed across the United States. Although the path of totality did not pass over Oklahoma, it's affects were observed across the state. The temperature difference found for each site during the eclipse was plotted on a map. A weak but noticeable relationship can be established between the temperature delta and occlusion percentage. The greatest affect was noticed by the decrease in solar radiation. The decrease in solar radiation caused a decrease in irradiated sensible heat from the surface. The decrease in sensible heat affected both thermistors at 1.5 meters and 9 meters. The affects of sensible heat irradiated from the surface decreases with height. As the eclipse progressed, the temperature difference found at 9 meters was much less than the temperature at 1.5 meters. The uneven vertical affects of sensible heat caused a surface inversion at most sites across the state. The surface inversion was quantified for each Mesonet site across the state.

References

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