Comparison of Temperature Differences across Thunderstorm Gust Fronts with Measured Wind Gusts Behind the Front

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Abstract

Studies have shown there is a linear correlation between the strength and depth of the cold pool behind a gust front and the strength of the gust front. In June 2014, a study was done to determine a correlation between the temperature difference across gust fronts and the strengths of ten gust front events in East Central Florida using a single height (2m) instrument. The correlation coefficients showed only a weak correlation between strength of the gust front and temperature difference across it, but did not show a correlation between the temperature difference with time and the strength of the gust front

Introduction

A gust front is the boundary between the cold thunderstorm outflow and the warm environmental air. It is marked by an increase in pressure and relative humidity, a decrease in temperature, and a wind shift. An old gust front may be tens of miles from rain, while a new gust front may be right at the edge of the rain.

In 1982, Kelvin Droegemeir and Robert Wilhelmson conducted a study exploring the correlation between the strength and depth of the cold pool behind the gust front and the strength of the gust front. This study looked at model simulations of gust fronts with a cold pool depth of 1km. Temperature values were assigned every 200m and averaged over a 10km depth. Their study found a nearly linear correlation between the strength and depth of the cold pool and the strength of the gust front.

In June 2014, a modification of the Droegemeir and Wilhelmson study was conducted using a single height instrument and 10 actual gust front cases in East Central Florida. This study was to determine if a linear correlation exists between the temperature difference across the gust front and the strength of the gust front using a single height instrument.

Hypothesis

Strong gust fronts are associated with large temperature differences across the gust front.

Two HOBO U30 Stations were set up to record rain fall, pressure, relative humidity, temperature, mean wind speed, gust speed, and wind direction. One HOBO U30 was set up at the Veterans of Foreign Wars Post 4206 (VFW) in West Melbourne, Florida and the second was set up at Harmony High School in St. Cloud, Florida. The HOBOs logged data of the previous listed parameters every five minutes and transmitted it to the HOBO link website every hour. Ten gust front cases in June 2014 – four from the VFW and six from Harmony – were identified and analyzed. Correlation coefficients were calculated for the following three pairings to determine if there was any correlation between (1) the temperature difference across the gust front and the strength of the gust front and (2) the temperature difference with time across the gust front and the strength of the gust front.

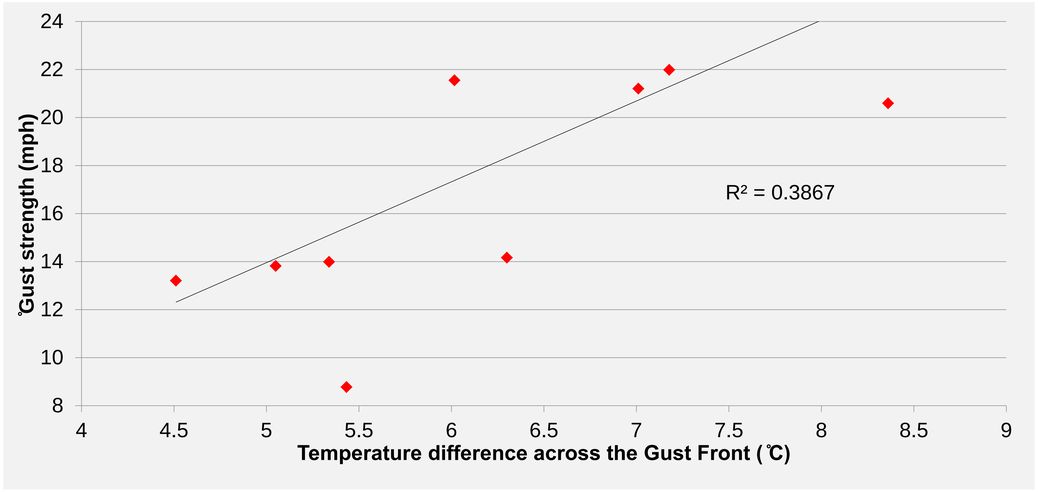

Figure 1. Relationship of temperature differences across the gust fronts and strengths of gust fronts during June 2014 as recorded by two HOBO U30 Stations in Eastern Central Florida.

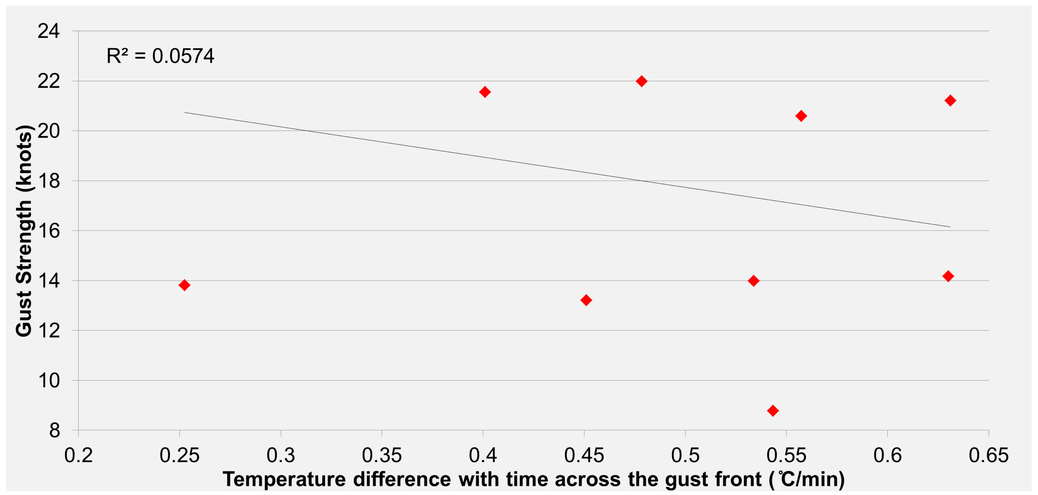

Figure 2. Relationship of temperature differences with time across the gust fronts and strengths of gust fronts during June 2014 as recorded by two HOBO U30 Stations in Eastern Central Florida.

Results

After the ten gust cases were analyzed, a weak correlation was found between the temperature difference across the gust front and the strength of the gust front (see Figure 1). Very weak to no correlation was found between the temperature difference with time across the gust front and the strength of the gust front (see Figure 2).

Conclusions

The relationship between the strength of the cold pool and the strength of the gust front was weak and therefore, the hypothesis was not fully supported. Future research is needed in this area.

Future Research

Future research would address the following:

- Relative air flow around the gust front
- Surface heating and ground friction
- Average temperature from multiple heights from actual gust cases

References

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Acknowledgements

Ms. Scott would like to thank Prof. Carlton Parks and Mr. Jeff Colvin for their advising and support on this project.