Analysis of Variation in Thermodynamic and Kinematic Properties within Supercell Inflow using Balloon-Borne Radiosondes

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1. Purpose

A large amount of research has been devoted to analysis of pre-storm environments in relation to severe hazards. However, much less work has been done investigating how supercells modify their environmental inflow. The recent studies that investigated tornadic versus non-tornadic supercell inflow environments showed conflicting results over changes in storm relative helicity (SRH) and anvil shading effects (Parker 2014; Wade et al 2018).

In the summer of 2023, a prototype project employing miniature radiosondes was undertaken to measure inflow at varying distances from the updrafts of a tornadic and non-tornadic supercell. This study aims to analyze how these two supercells modified their inflow environments as distance from the updraft decreased.

2. Cases/Deployments

The goal for each case was to obtain a preconvective sounding followed by three soundings in the inflow of the supercell at 30 km, 20 km, and 10 km from the updraft.

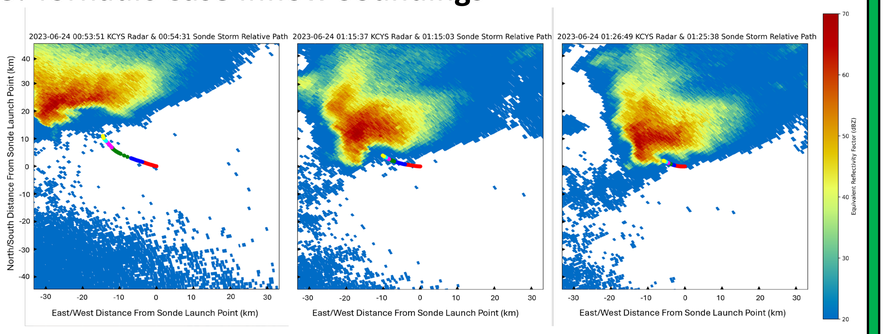
1.Tornadic Case: Chugwater, WY – Scottsbluff, NE Supercell 06/23/23

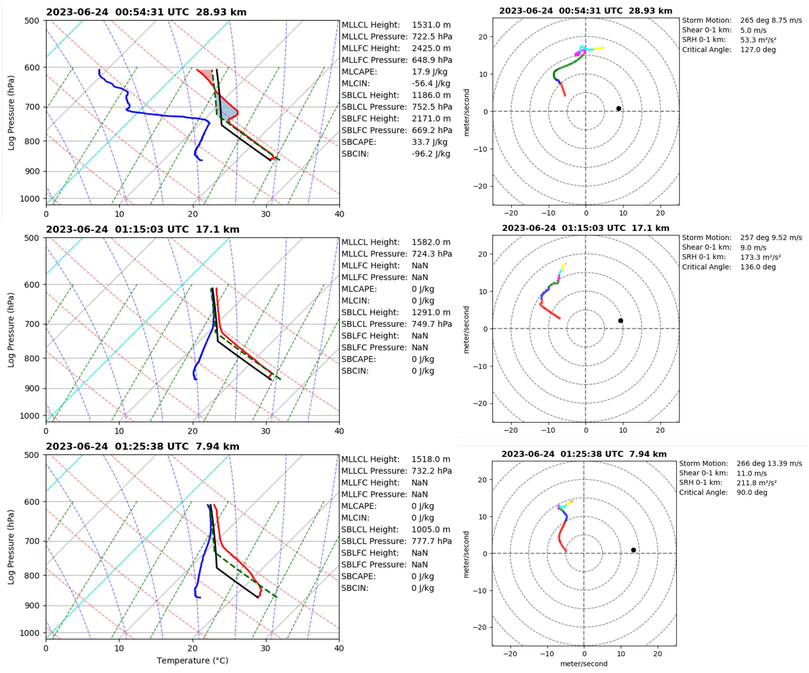
- •No preconvective sounding
- •Obtained soundings at 28.93 km, 17.1 km, and 7.94 km from updraft
- •Additional sonde drifted into forward flank

2. Non-Tornadic Case: Sykeston, ND Supercell 07/18/23

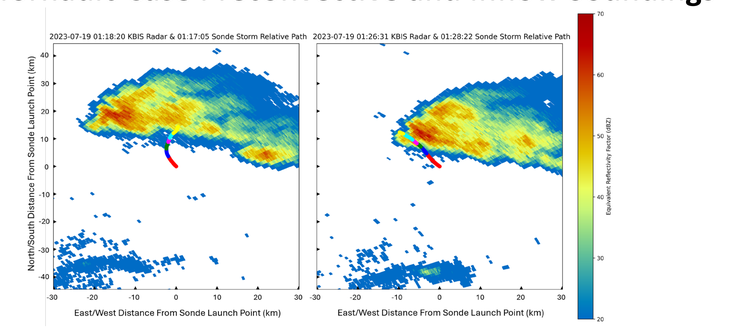
- •Obtained preconvective sounding
- •Obtained soundings at 22.8 km and 11.37 km from updraft

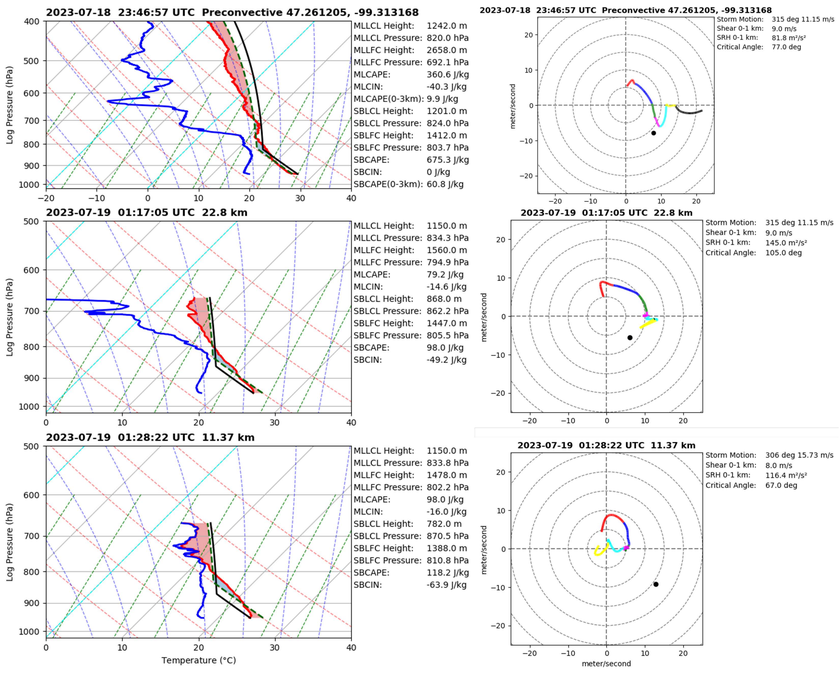
3. Tornadic Case Inflow Soundings





4. Non-Tornadic Case Preconvective and Inflow Soundings



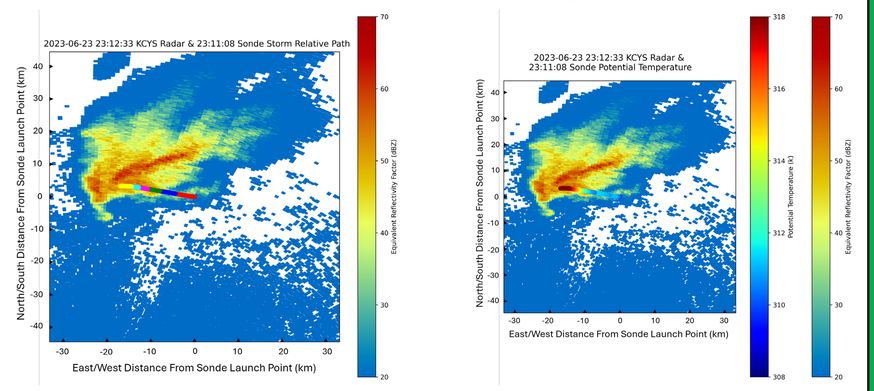


Altitude Key (All Storm Relative Paths and Hodographs):

= 0-500 m = 500-1000 m = 1000-1500 m = 1500-2000 m

= 2000-2500 m = 2500-3000 m = 3000-3500 m

5. Tornadic Case Forward Flank Sounding



6. Conclusions

- Tornadic case inflow features large elongation and reorientation of both the 0-500 m and 0-1 km shear vectors resulting in an increase in SRH (non-tornadic doesn't).
- Tornadic case inflow soundings show noticeable near-surface inversion, potentially a sign of radiative cooling due to anvil shading (Frame and Markowski 2010).
- Tornadic case inflow thermodynamics profiles begin to follow adiabats in final two soundings, likely linked to updraft width/strength.

7. Future Work

- With field and analysis procedures established, a next step would be to markedly expand the number of cases to achieve statistical significance of the kinematic/thermodynamic changes if present.

References

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