The Temporal Evolution of Tornadic and Non-Tornadic VORTEX2 Near-Storm Environments

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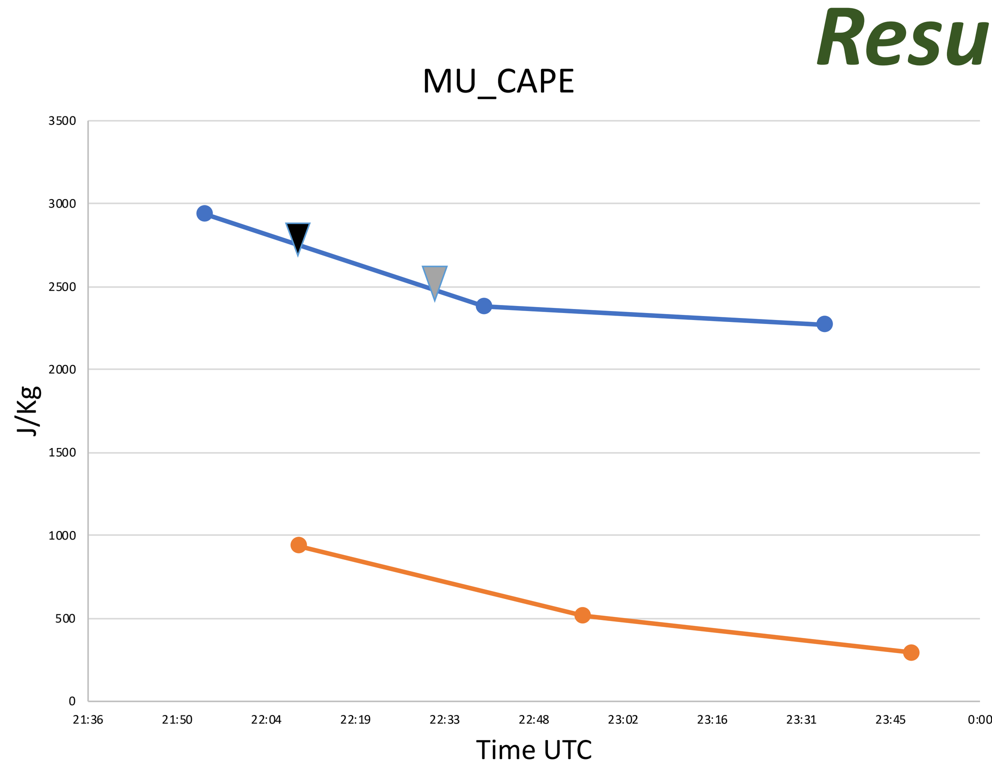
Abstract

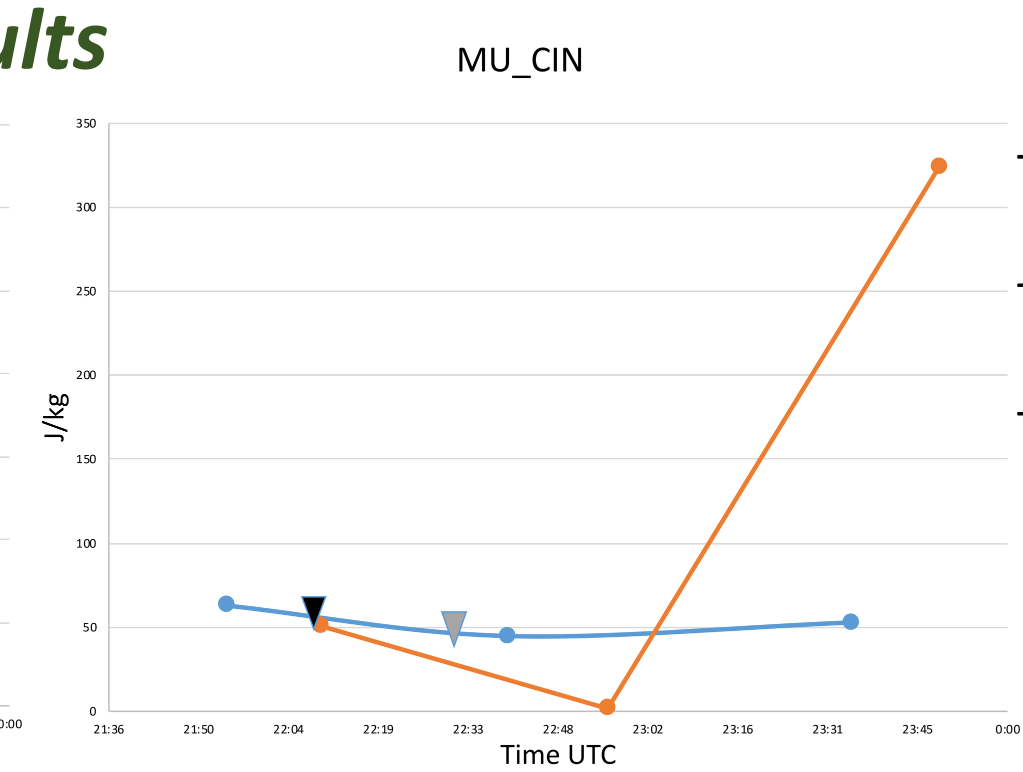
The VORTEX2 field experiment provided a wealth of data on the near-storm environments of tornadic and non-tornadic supercell thunderstorms. While previous research has documented the spatial heterogeneity associated with the environment in the vicinity of the VORTEX2 storms, this study focuses on the temporal evolution of the near-storm environment. Thirty-four supercells are examined, (13 tornadic and 21 non-tornadic), each with at least three inflow soundings launched throughout their lifetime. The evolution of common forecasting parameters (including shear, storm-relative helicity, and instability) are compared among the tornadic and non-tornadic categories. Each parameter is analyzed individually as well as grouped with similar measures to understand potential connections with storm behavior. The timing of associated storm reports is examined to identify relationships between environmental trends and observed hazards. The broad goal of this study is to better understand how supercells respond to near-storm environmental changes, ultimately allowing for better understanding and advancements in forecasting.

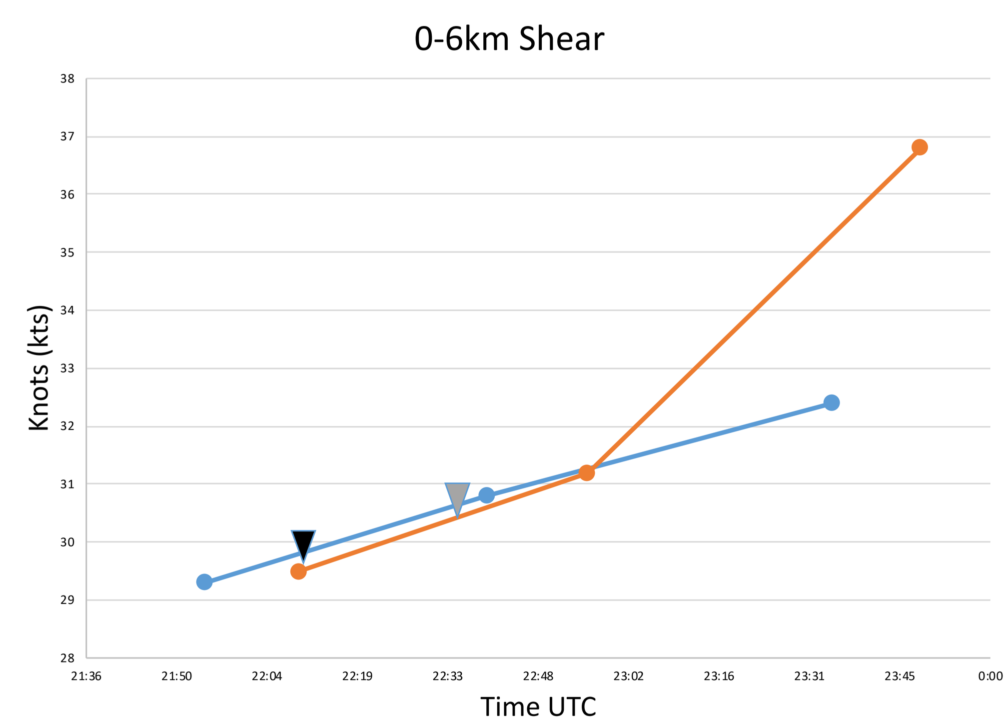
Methodology

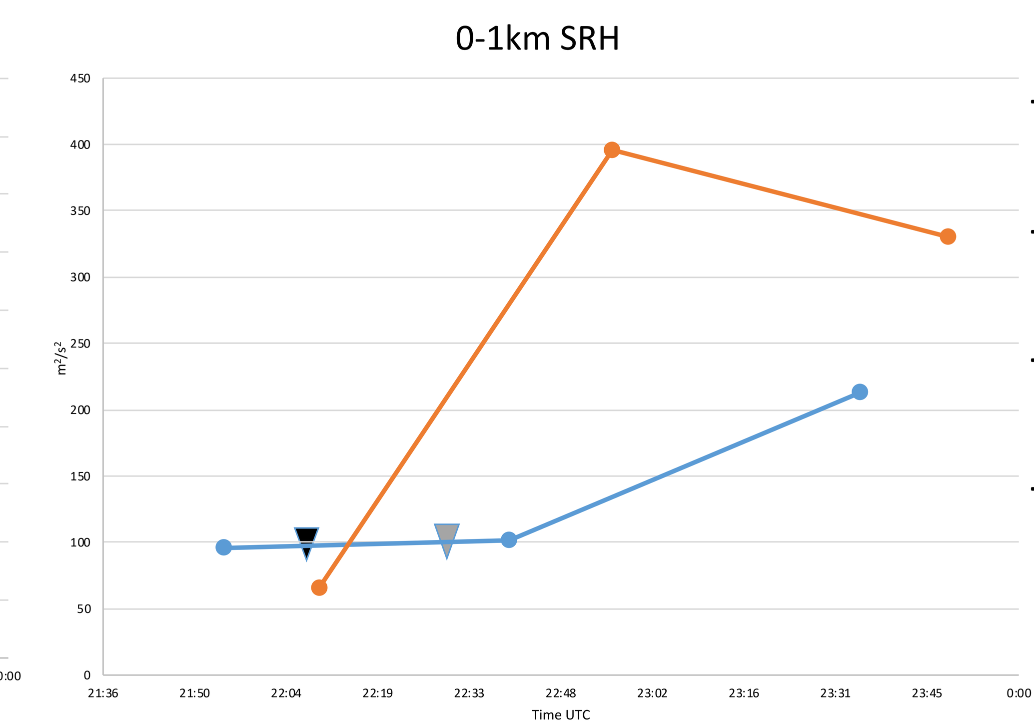
- Use VORTEX2 quality controlled sounding
- Ingest quality controlled sounding data into MetPy for SkewT visualization
- Plot the time series of each parameter/variable (4) calculated and observed to display the progression of each item individually over 3 inflow sounding launch times
- Only a sample comparison between a tornadic and non-tornadic case will be examined here

Results









Tornado genesis (22:07 UTC)

Tornado Dissipation (22:31 UTC)

Tornadic- June 5 2009

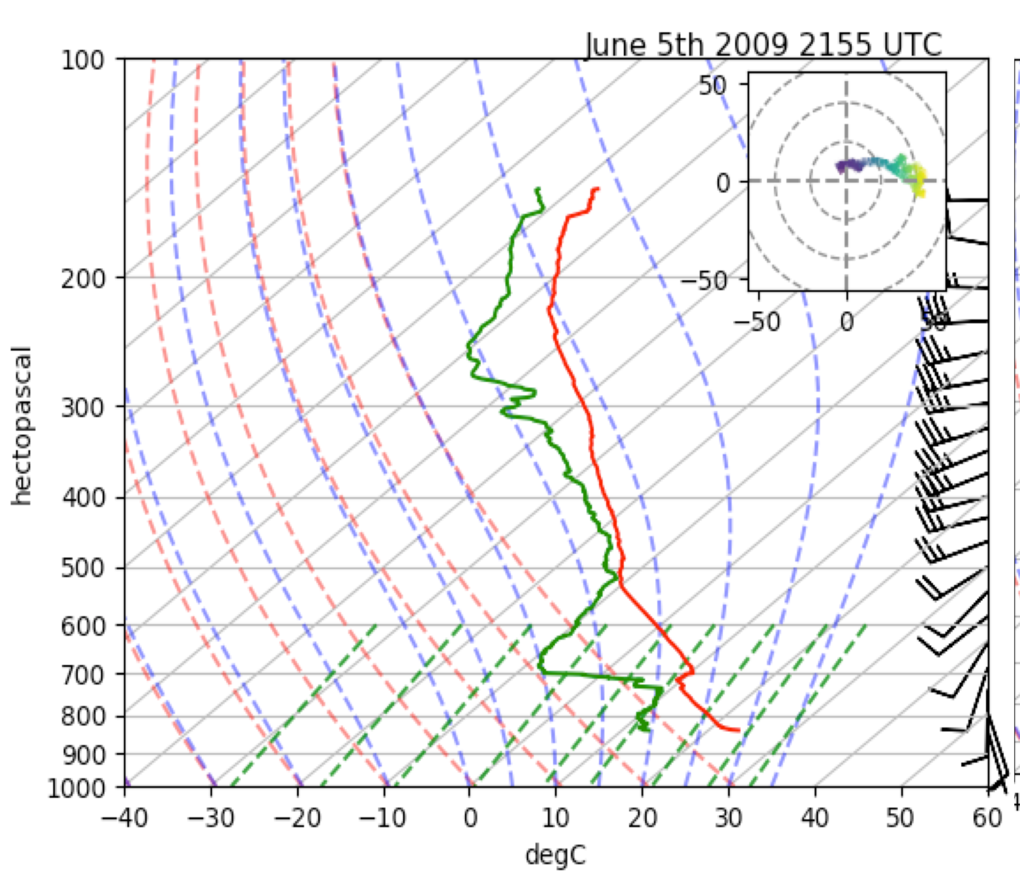
Non-Tornadic- June 6 2010

Findings

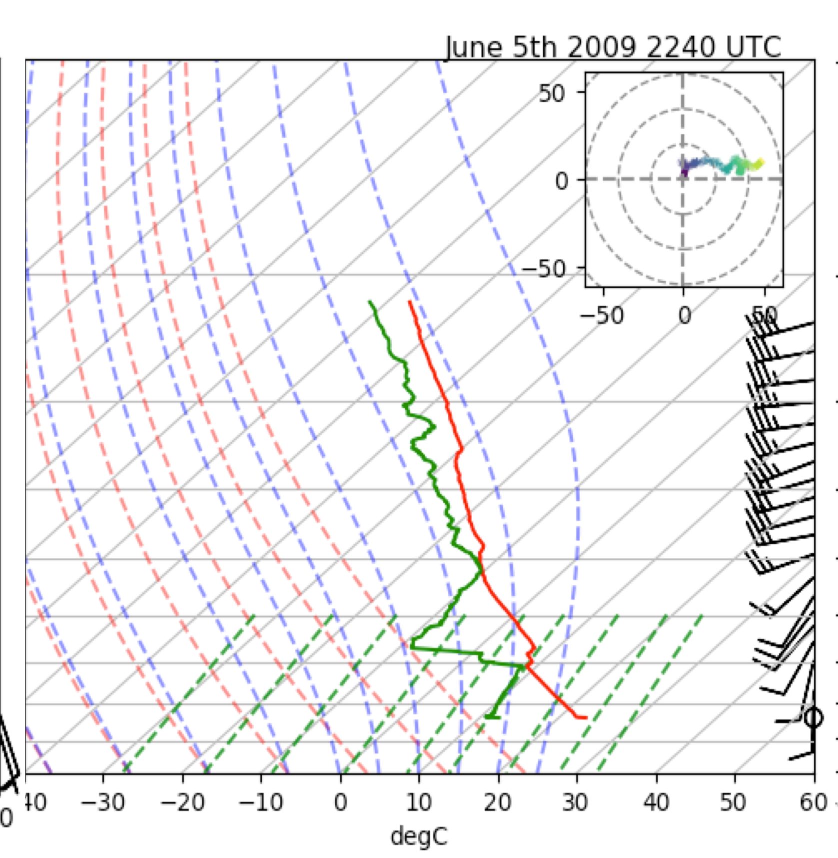
- Similar trends in MUCAPE and MUCIN, though the tornadic case exhibited stronger instability
- Stronger temporal variability in SRH in the non-tornadic case
- Increase in SRH after tornado dissipation

Future Work

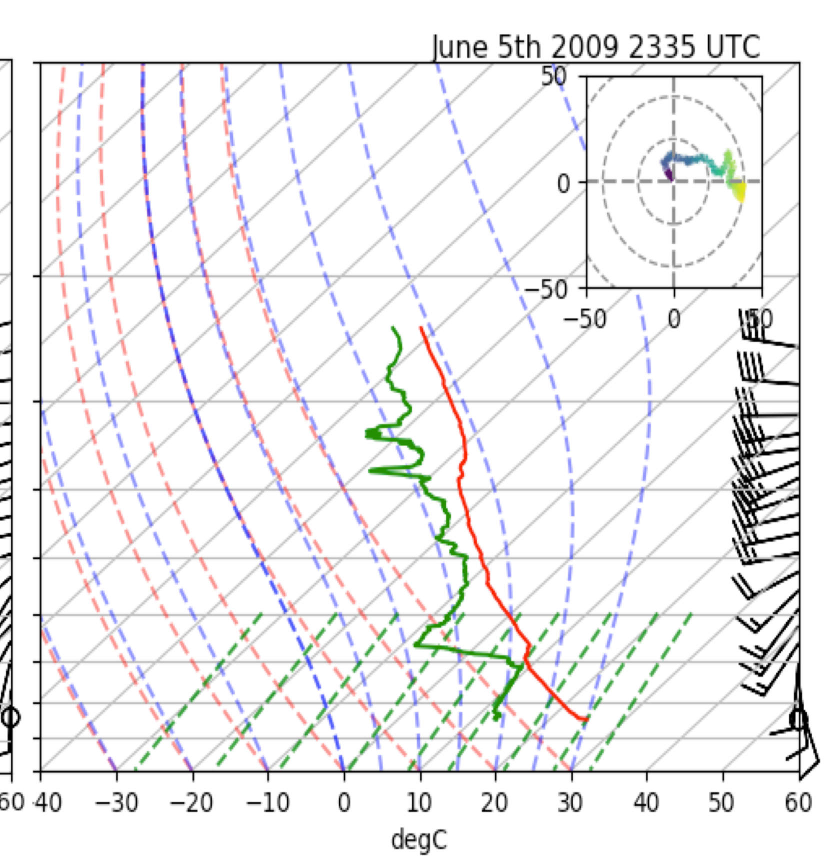
- Transition from a subset of events to the entire distribution of the dataset of 2009-2010 VORTEX2 Inflow Soundings
- Continue to calculate more useful parameters for evaluating temporal evolution of the supercells
- Perform statistical analysis on each event and parameters both individually and grouped based on certain criteria
- Evaluate the change in values for each parameter and compare them to the other events
- Simulate the near-storm environment within a supercell to better forecast the formation and strength of the supercell



Cape: 2935.7 joule / kilogram
CIN 62.9 joule / kilogram
Shear 29.3
LFC 680.1 hectopascal
SRH 95.791 meter ** 2 / second ** 2



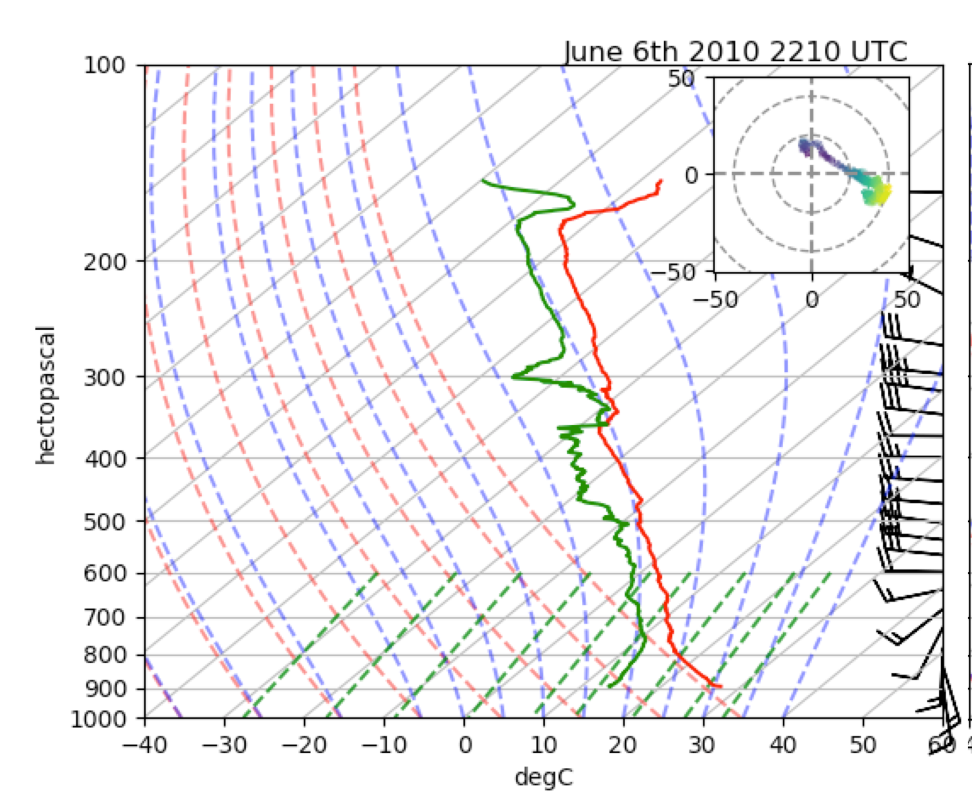
Cape: 2383.5 joule / kilogram
CIN 44.8 joule / kilogram
Shear 30.8
LFC 711.2 hectopascal
SRH 101.279 meter ** 2 / second ** 2



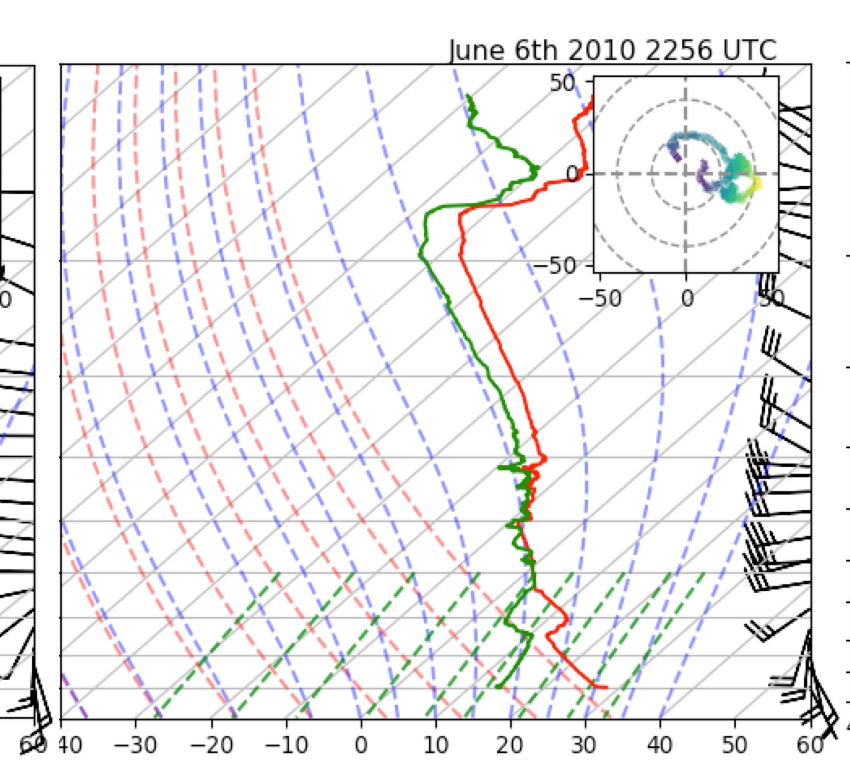
Cape: 2269.6 joule / kilogram
CIN 52.5 joule / kilogram
Shear 32.4
LFC 711.0 hectopascal
SRH 212.862 meter ** 2 / second ** 2

Tornadic 2009 SE Wyoming

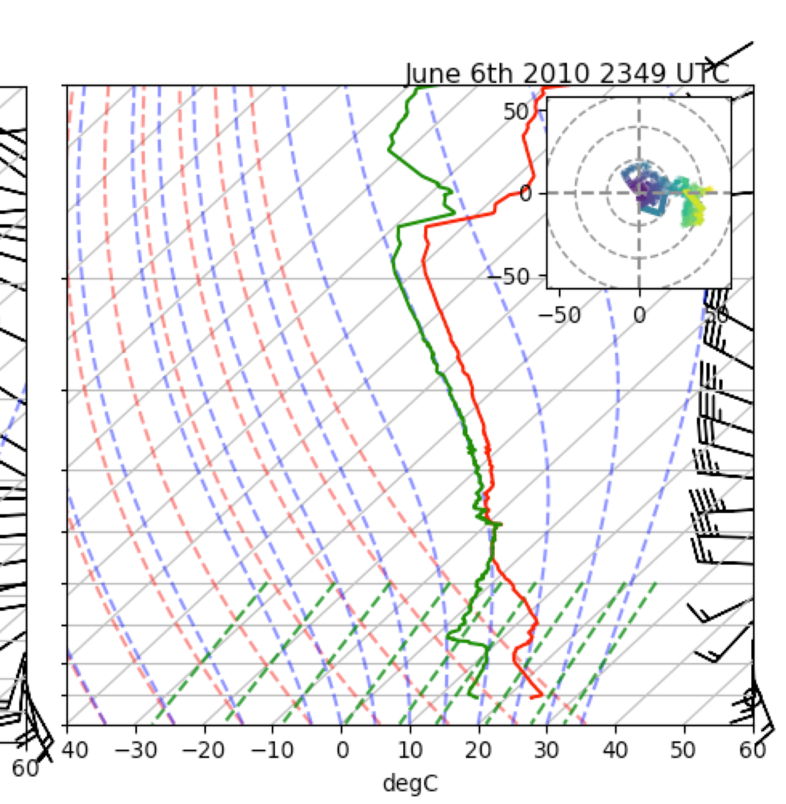
Non - Tornadic 2010 SW Nebraska



Cape: 935.4 joule / kilogram
CIN -51.1 joule / kilogram
Shear 29.5
LFC 631.6 hectopascal
SRH 66.005 meter ** 2 / second ** 2



Cape: 517.6 joule / kilogram
CIN 1.6 joule / kilogram
Shear 31.2
LFC 657.7 hectopascal
SRH 395.893 meter ** 2 / second ** 2



Cape: 295.1 joule / kilogram
CIN -323.9 joule / kilogram
Shear 36.8
LFC 594.7 hectopascal
SRH 330.748 meter ** 2 / second ** 2