

Diagnosing Environmental Conditions Using Python During the December 10, 2021 Tornado Outbreak

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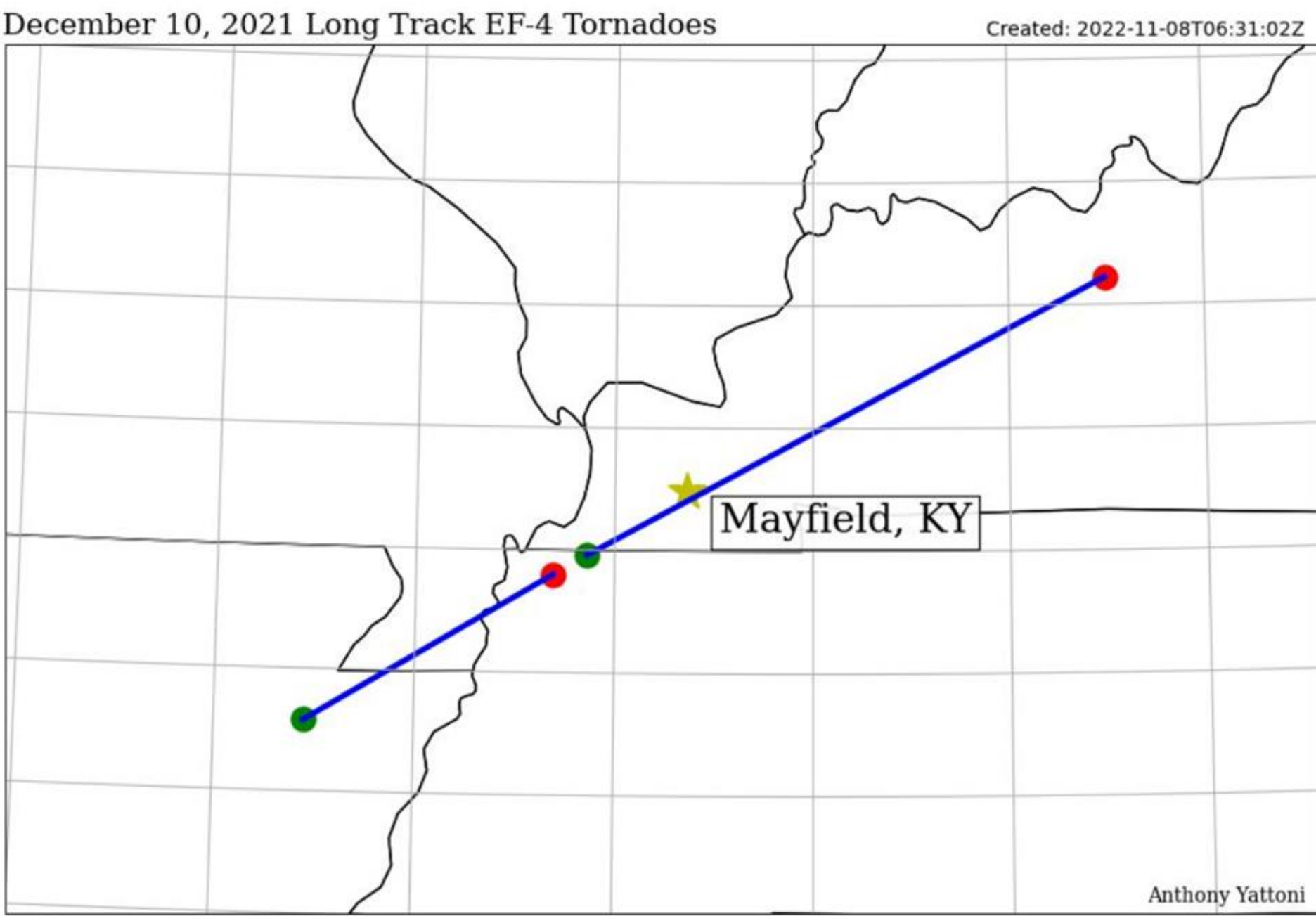
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Introduction

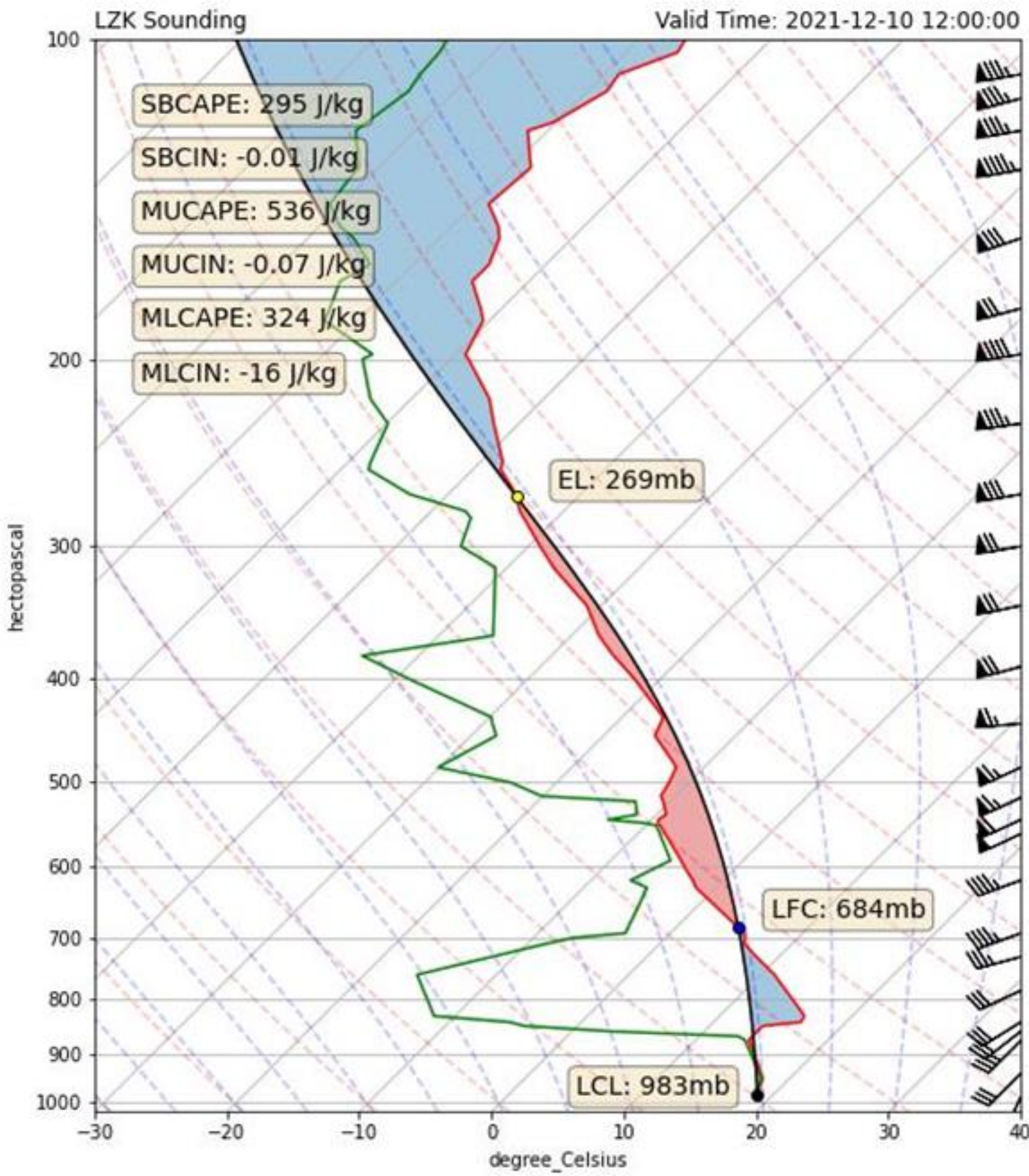
This tornado outbreak was the largest outbreak for December (71) until later in the month when 121 tornadoes occurred. The hardest hit area was Mayfield, KY. This was a long track supercell which spanned over 165 miles. Most people thought this was going to be longer than the tri-state tornado in 1925, but the National Weather Service (NWS) survey found a brief lift in the tornado. This tornado was rated a high-end EF-4 (190 mph). In this Python case study, I look at the Mayfield, KY tornado and analyze the environment that was present using upper air soundings and looking at radar signatures.

Study Area

Mayfield, KY is in Western Tennessee and has a population of just under 10,000 people. Mayfield is located in Paducah's County Warning Area (CWA). Although Paducah's radar is 25 miles away from Mayfield, upper air observations are much further. The closest upper air station is Nashville, TN with Little Rock being nearby as well. This day had mesoscale (local) conditions that enhanced the storm's environment. Upper air observations nearby could have picked up on the environmental conditions, but only surface observations were available.

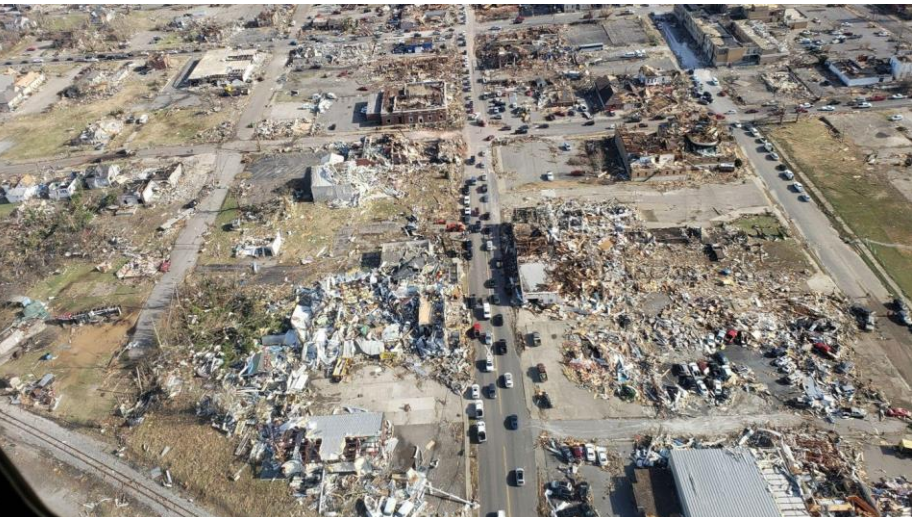


The path of the log track tornado as shown with the town of Mayfield, KY

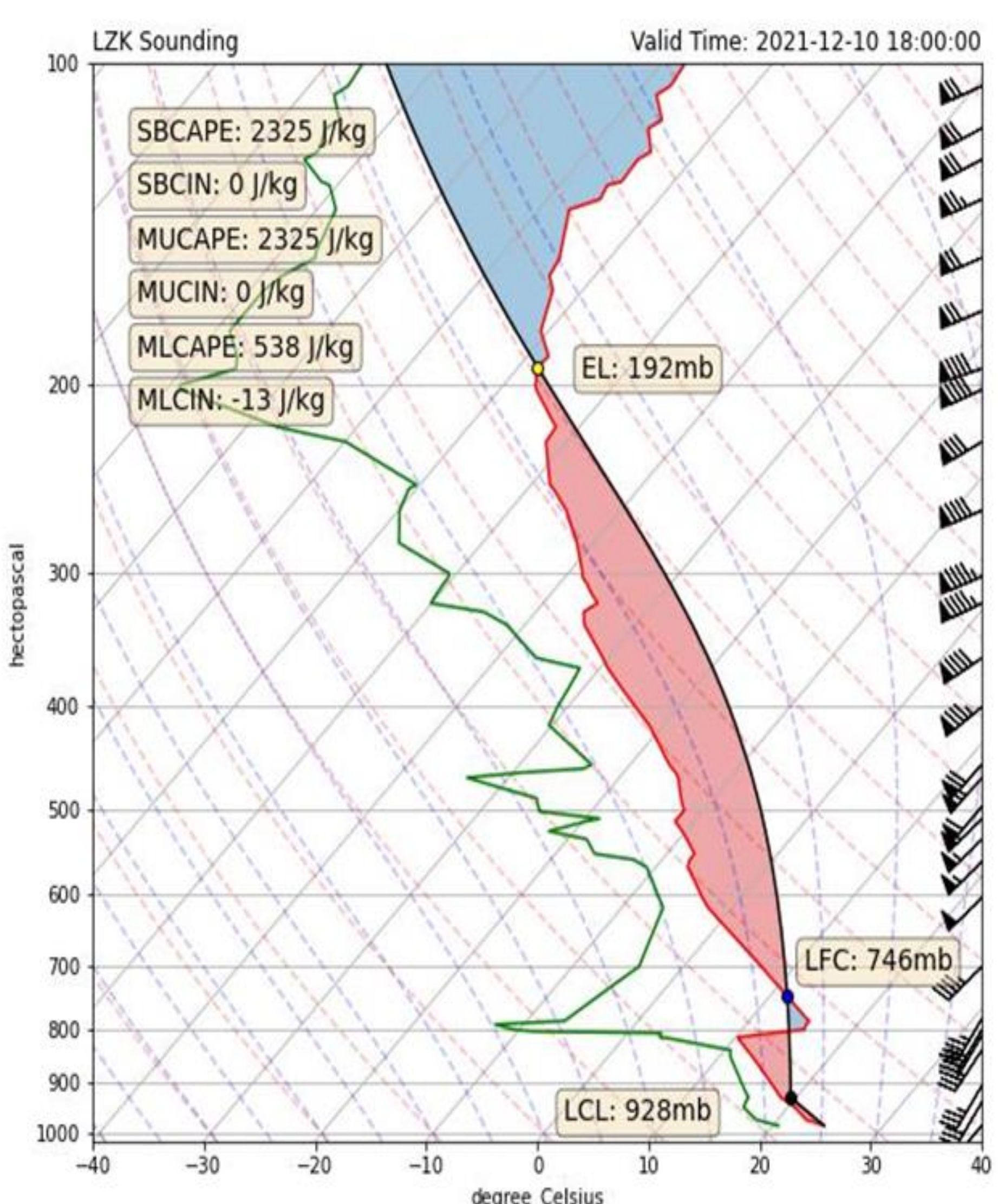


Synoptic Overview

The synoptic overview for this event is impressive. At 9 pm, a 992 mb low was centered over the tri-state region of Iowa, Missouri, and Illinois. The attendant cold front lagged across the Ozark region. Upper-level ascent was noted in the 300 mb jet across Kentucky. 0-1 km SRH was near 350 m2/s2, while 0-3 km SRH had an area of 300-400 km SRH. Although on the lower end, the significant tornado parameter was 3, with higher amounts to the SW of Mayfield at 9 pm. There was also an adequate amount of CAPE not only for the time of the year, but for the time of day with around 1000 J/kg of MLCAPE.



Storm damage in central Mayfield
(NWS Survey)



Partial Code

```
Partial Sounding Code

In [ ]: from datetime import datetime

import matplotlib.pyplot as plt
import numpy as np
import metpy.calc as mpcalc
from metpy.plots import SkewT
from metpy.units import pandas_dataframe_to_unit_arrays, units
import numpy as np
from siphon.simplewebservice.wyoming import WyomingUpperAir

In [ ]: dt = datetime(2021, 12, 10, 18)
station = 'LZK'

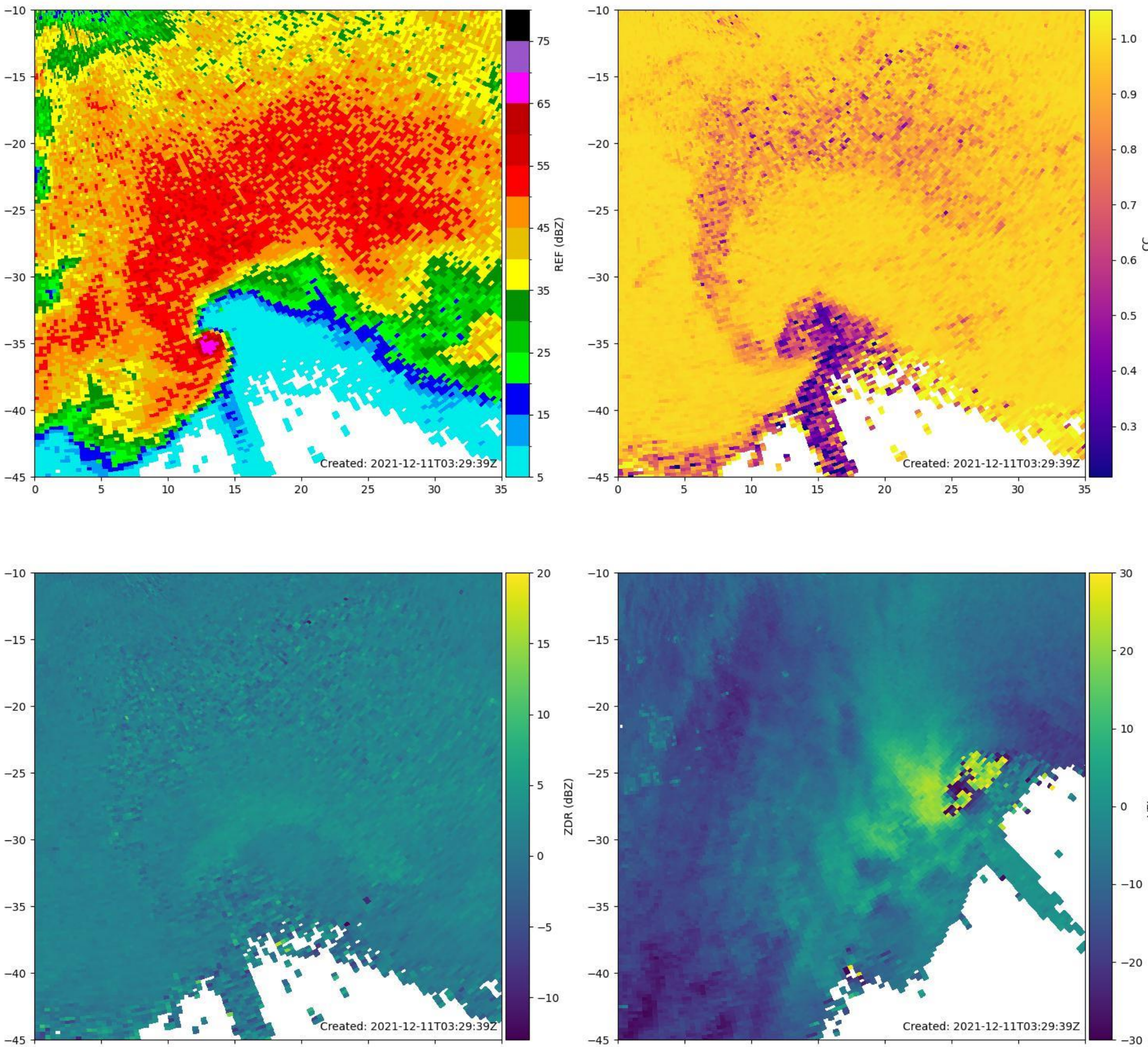
In [ ]: # Read remote sounding data based on time (dt) and station
df = WyomingUpperAir.request_data(dt, station)

# Create dictionary of united arrays
data = pandas_dataframe_to_unit_arrays(df)

In [ ]: # Isolate united arrays from dictionary to individual variables
p = data['pressure']
T = data['temperature']
Td = data['dewpoint']
u = data['u_wind']
v = data['v_wind']

In [ ]: mpcalc.lcl(p[0], T[0], Td[0])
mpcalc.lfc(p, T, Td)
mpcalc.el(p, T, Td)
mpcalc.surface_based_cape_cin(p, T, Td)
mpcalc.most_unstable_cape_cin(p, T, Td)
mpcalc.mixed_layer_cape_cin(p, T, Td)
```

KPAH December 10th, 2021 Tornado Outbreak



Full Code

To access the full code, visit my GitHub repository:
<https://github.com/ayatt0485/MetPy-Monday-Ind-Study>

Data

Data for this project was collected through Siphon and the use of Wyoming Upper Air to create the soundings. Radar data came from the AWS bucket and was downloaded to copy the time key to be pulled out through code.

Future Studies

In future studies, use of Satellite would be useful in diagnosing convection. More parameters such as upper-air analysis and model sounding parameters could be useful in determining how volatile the atmosphere was.