Understanding Left-Moving Supercells: Environmental Factors and Forecasting Challenges

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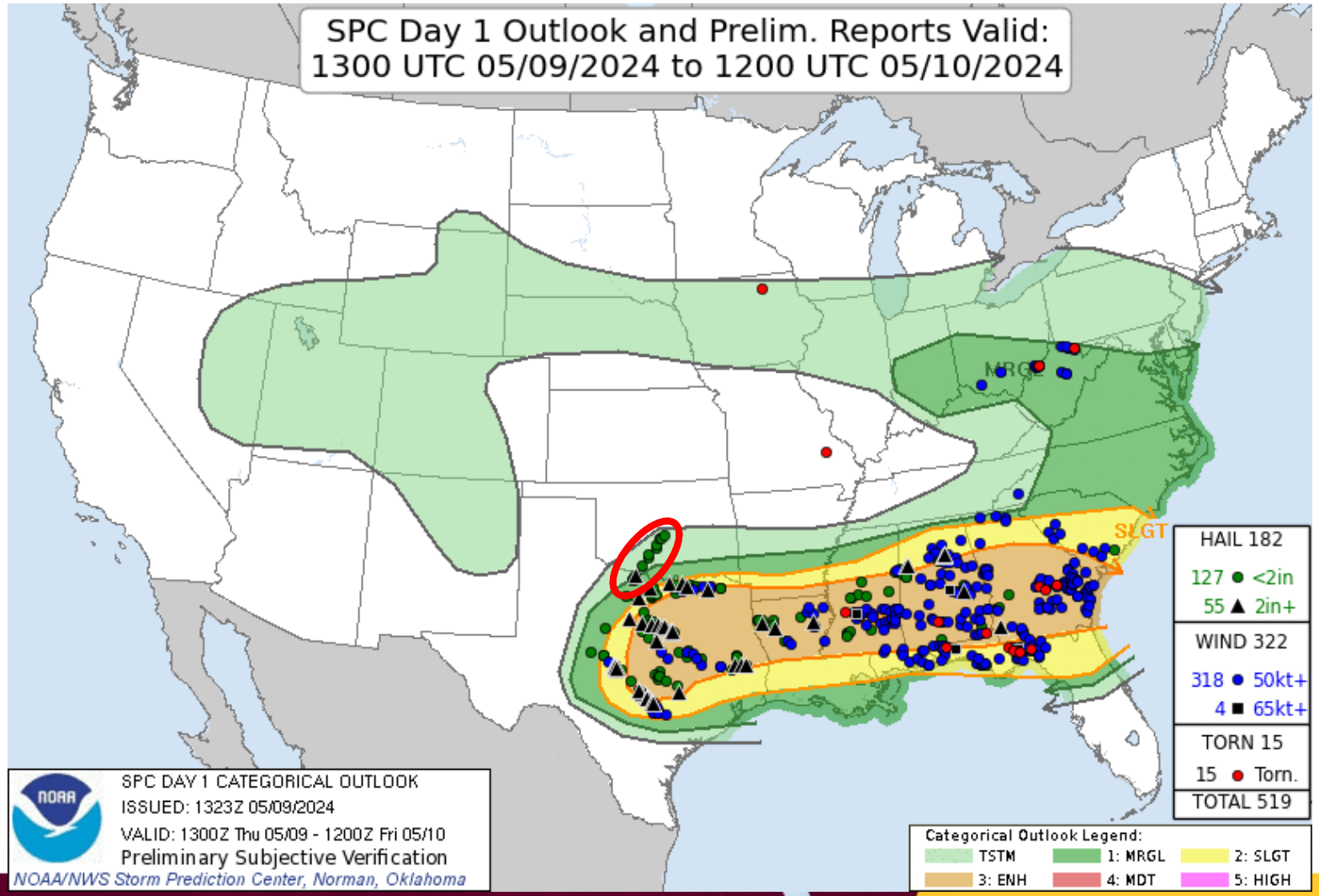
05/10/2024 “Surprise” Left-mover



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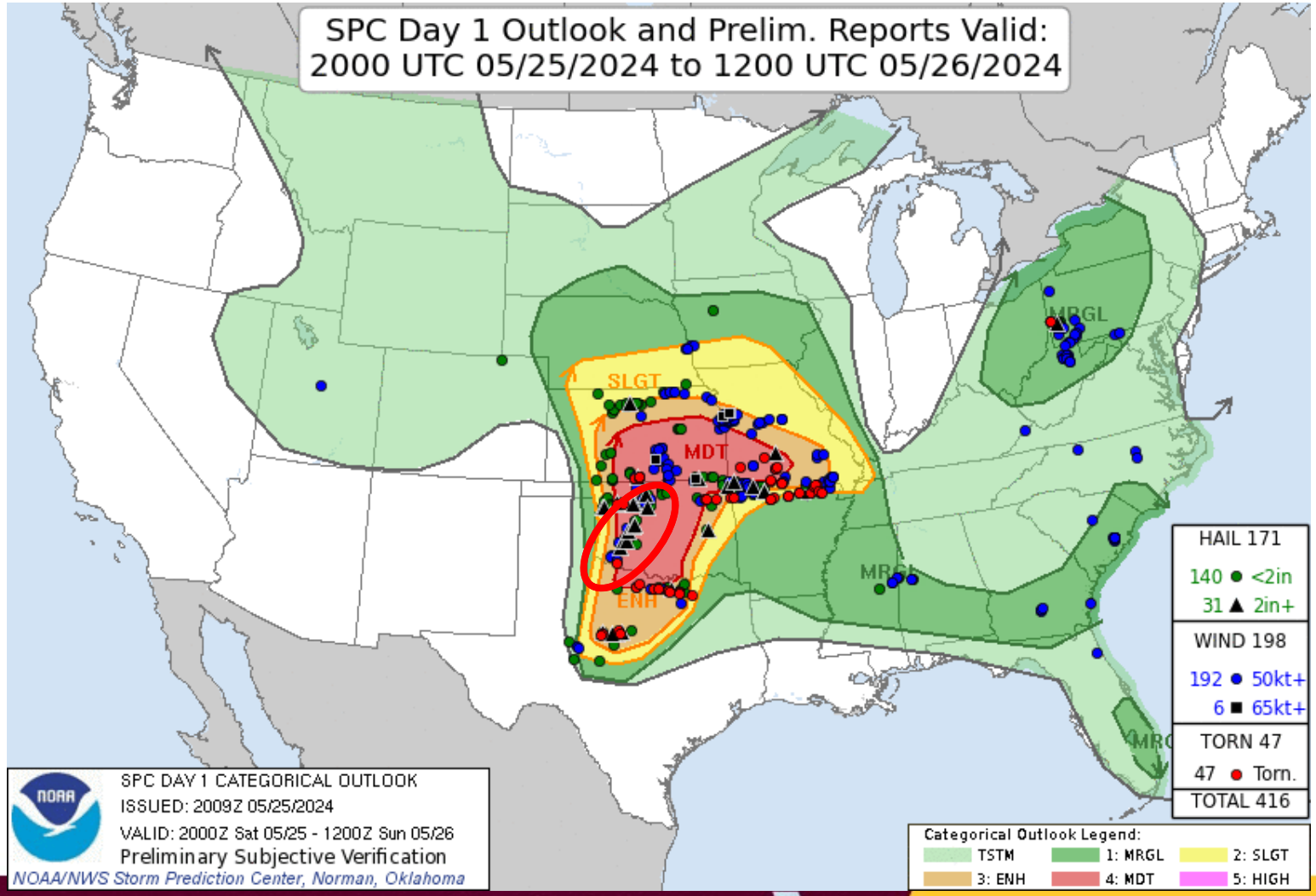
05/25/2024 Disruptive Left-mover



Motivation

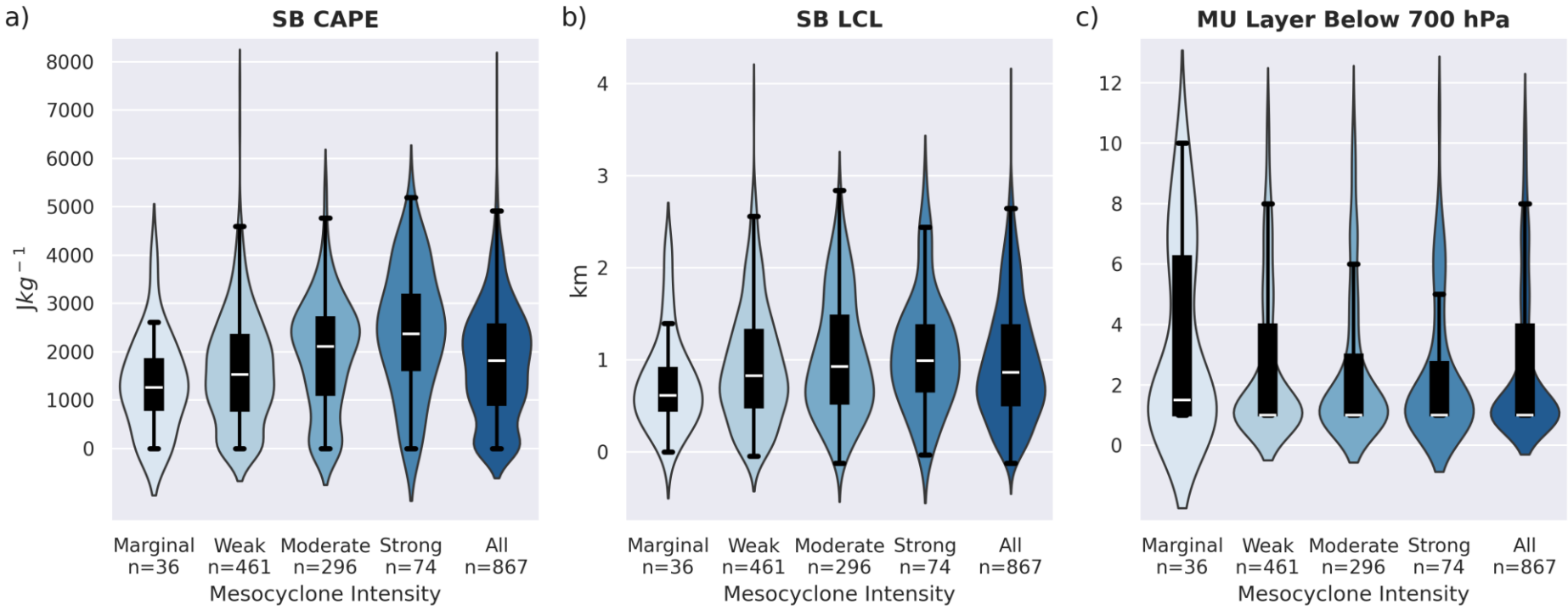
- Left-movers (LMs):
  - Pose a significant forecasting challenge
  - Are perceived as frequent producers of large hail
- There is little research on LMs:
  - Most research are case studies, radar analysis, and basic environmental analysis
    - Largely hodograph and storm motion focused
    - Small datasets
      - <100 LM cases with some exceeding >400 cases
  - No broader research on LM environments and parameter space.

Data

- 889 observed LMs:
  - Manually identified and assigned a mesocyclone strength
    - WSR-88D
      - Maximum mesoanticyclonic rotational velocity in low or mid-levels
      - Storm structure
        - » Strongest gradient on the left flank
        - » Leftward motion relative to nearby convection
  - Manually quality-controlled

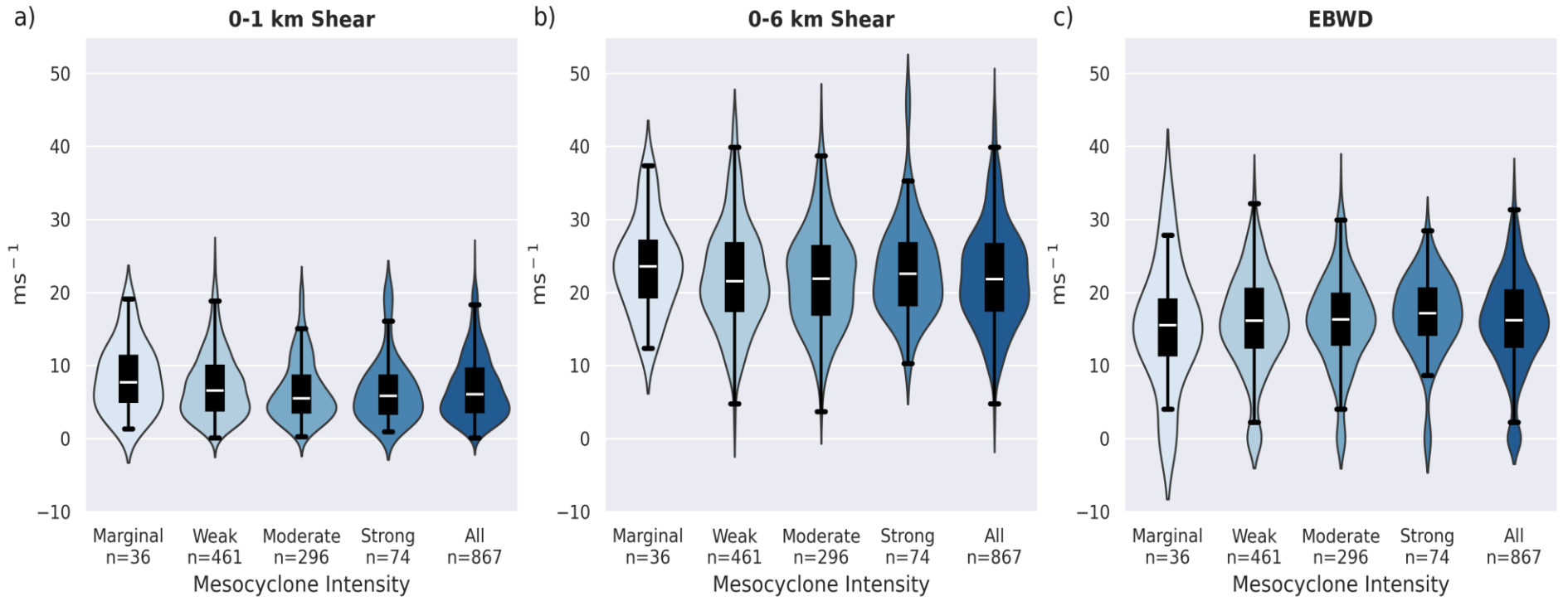
- 867 RUC/RAP sounding profiles:
  - Nearest storm inflow region
  - 22 contaminated profiles
- Mesocyclone strength:
  - Strong: 74 cases (8.54%)
  - Moderate: 296 cases (34.14%)
  - Weak: 461 cases (53.17%)
  - Marginal: 36 cases (4.15%)

Results: Thermodynamics



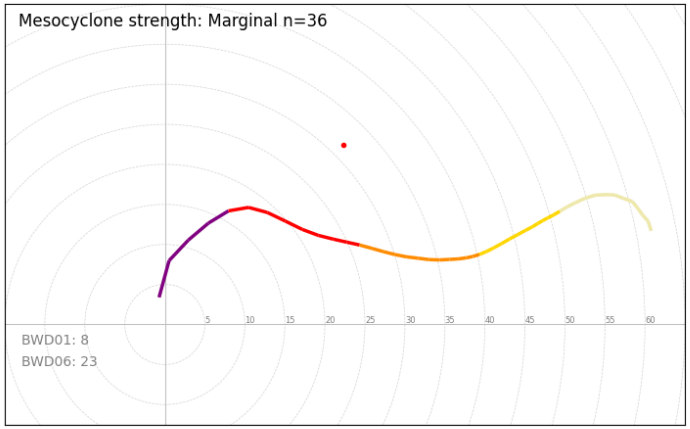
- With increasing mesocyclone strength:
  - Higher CAPE
  - Higher LCLs
  - Decreasing likelihood of being elevated

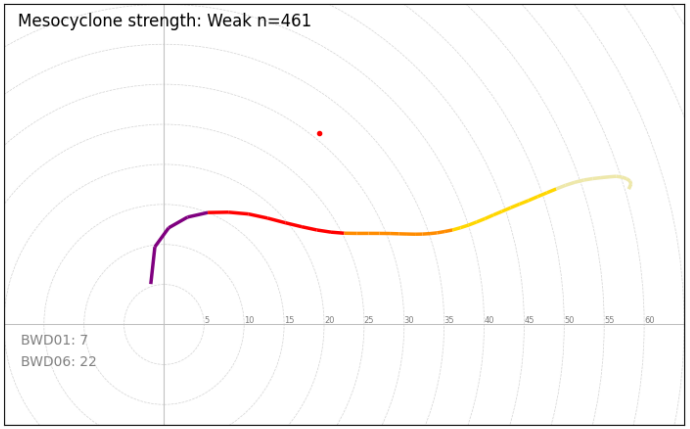
Results: Kinematics

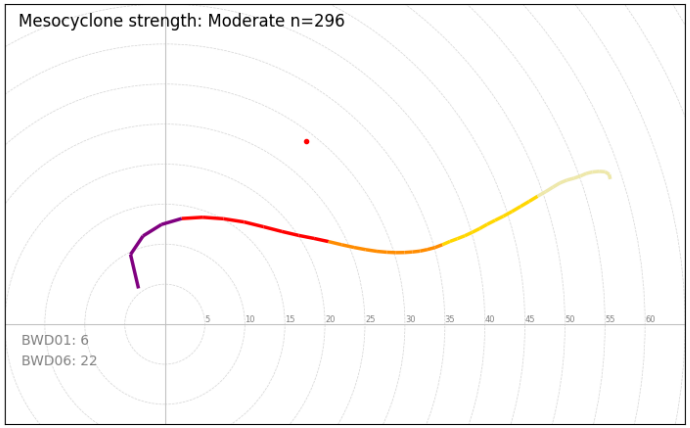


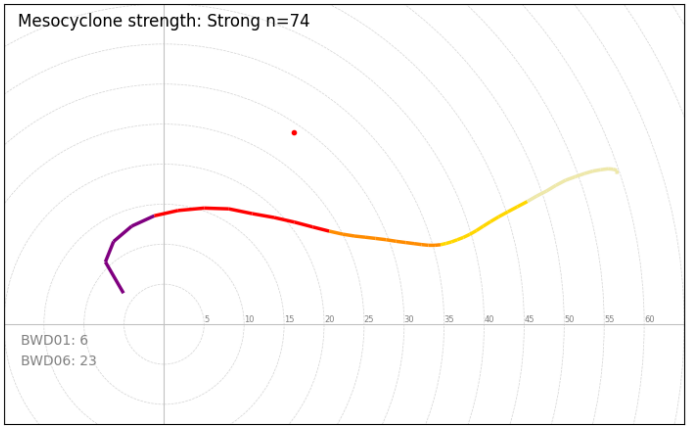
- With increasing mesocyclone strength:
  - Decrease in 0-1 km shear
  - Increase in EBWD

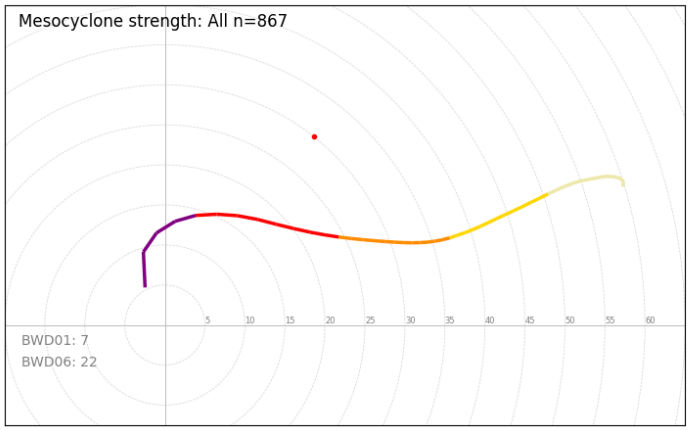
LM Composite Hodographs

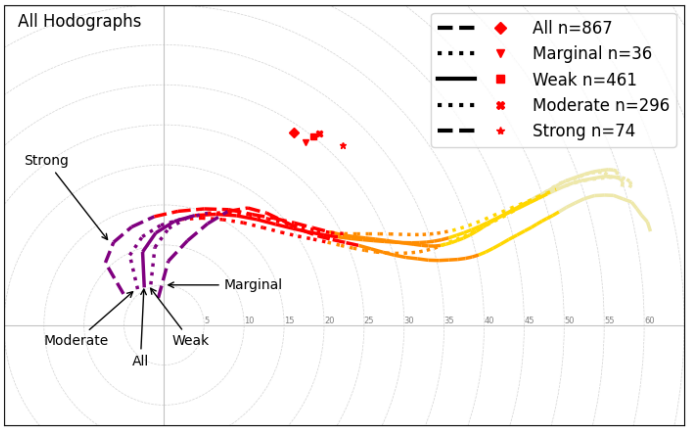






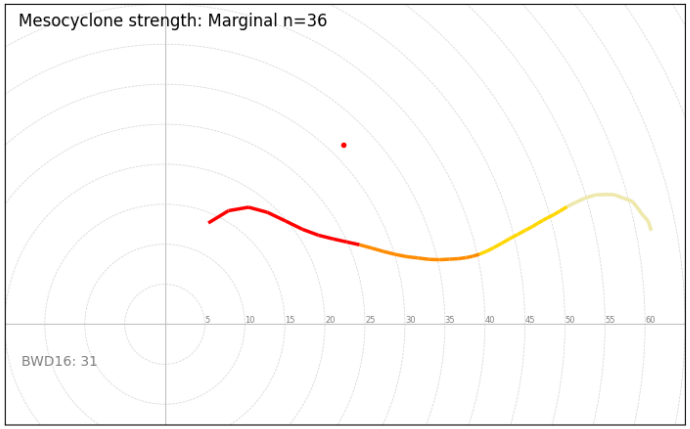


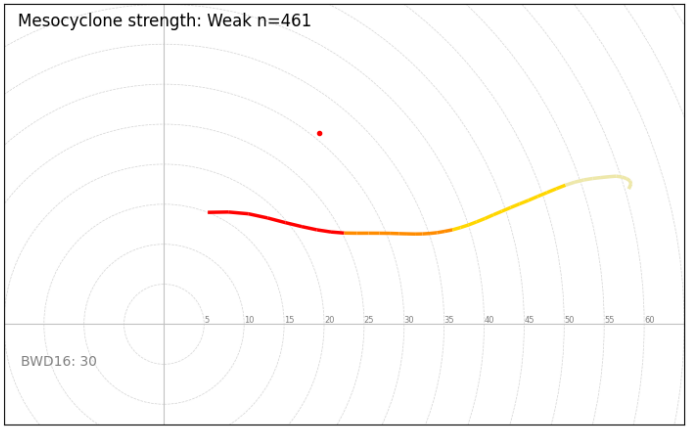


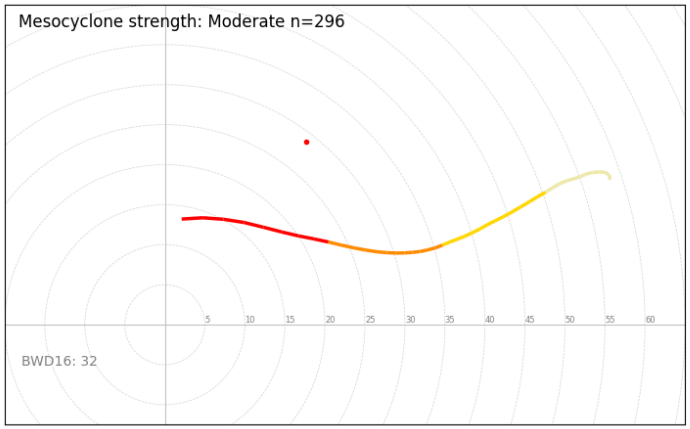


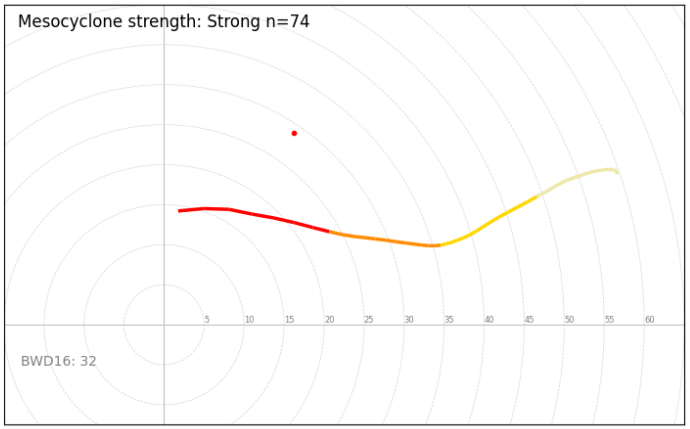
0-1 km 1-3 km 3-6 km 6-9 km 9-12 km

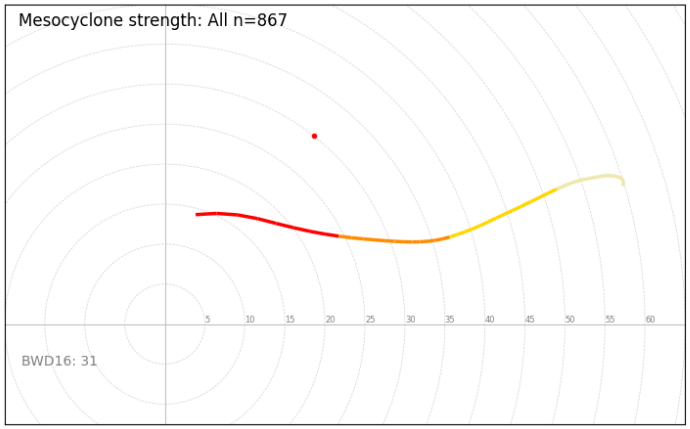
LM Composite Hodographs

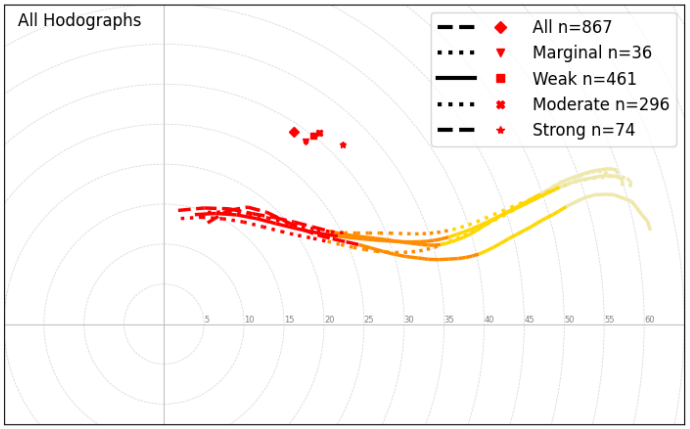






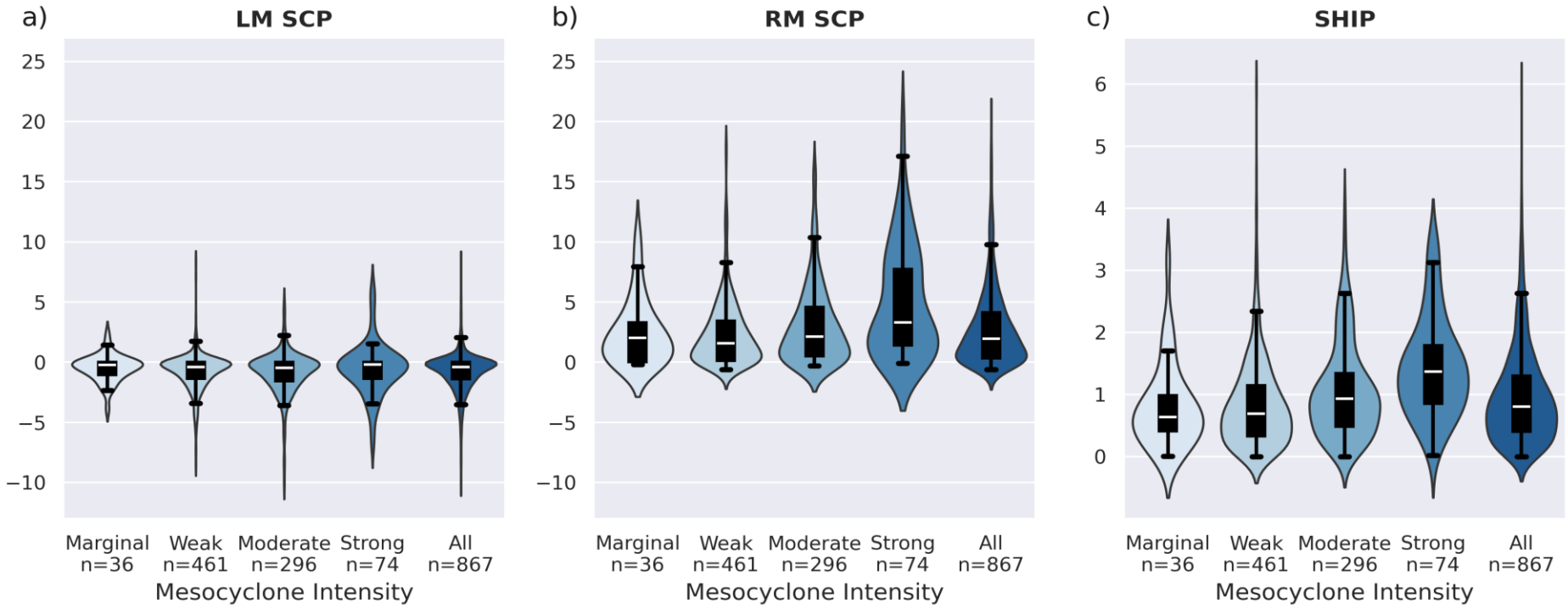






LCL-3 km 3-6 km 6-9 km 9-12 km

Results: Composite Parameters



- The current LM supercell composite parameter has no skill in predicting LMs
  - Environments supportive of both LMs and RMs tend to overlap
- SHIP increases with increasing mesocyclone strength

Key Takeaways

- LMs have different inflow regions than RMs
  - S-shaped hodographs with clockwise curvature in low levels
  - Once restricted to LCL height, the shear profile becomes more favorable
  - LMs rarely have low-level mesocyclones
    - Weak, transient, updrafts with little to no tornado production
- CAPE, LCL height, and hodograph shape (above LCL) may be good predictors of LM strength.
- Commonly used metrics of shear are not useful predictors, and LM SCP has no skill for operational usage.

- Ongoing work is looking at environments to better anticipate LM supercells, particularly those that are severe.

Thank you!

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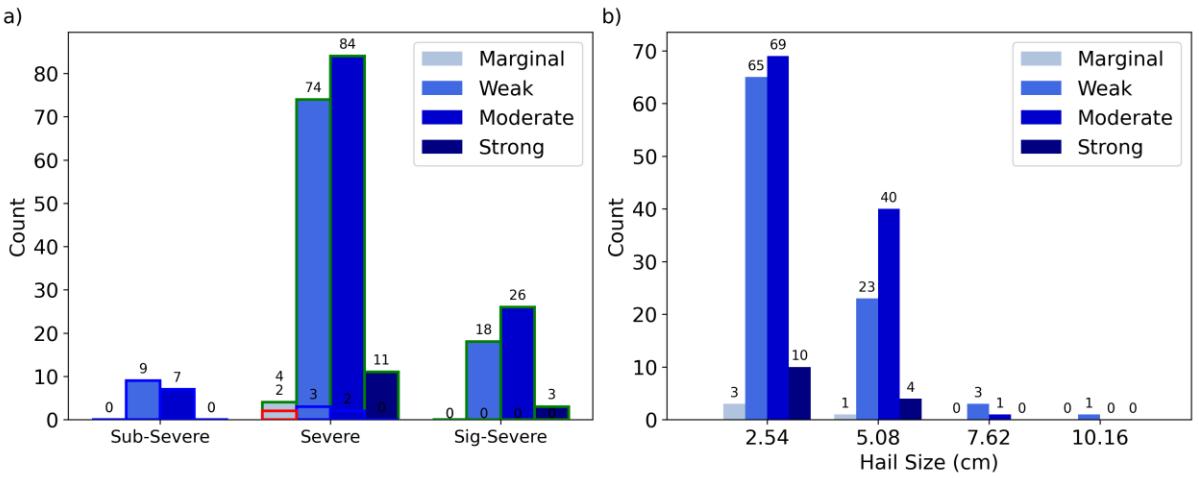
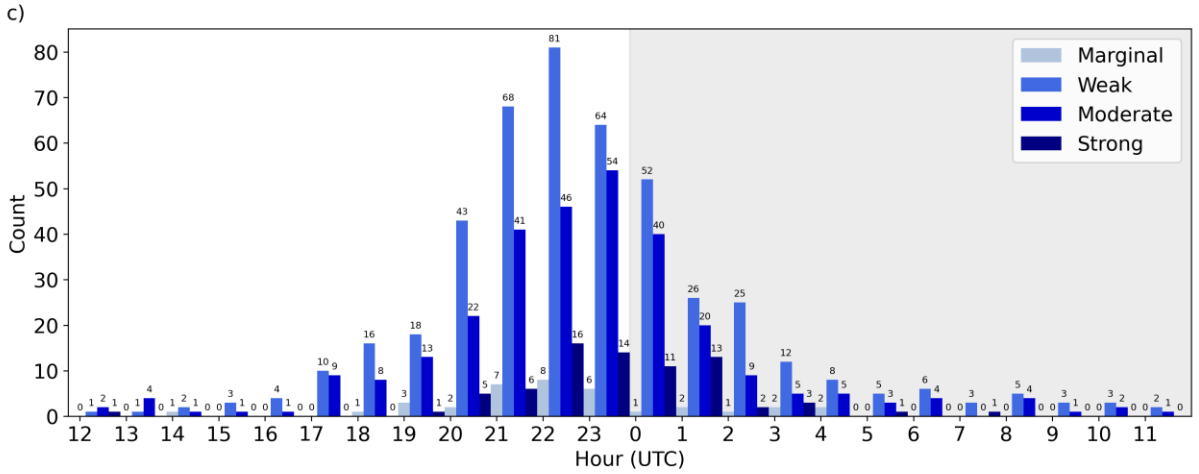
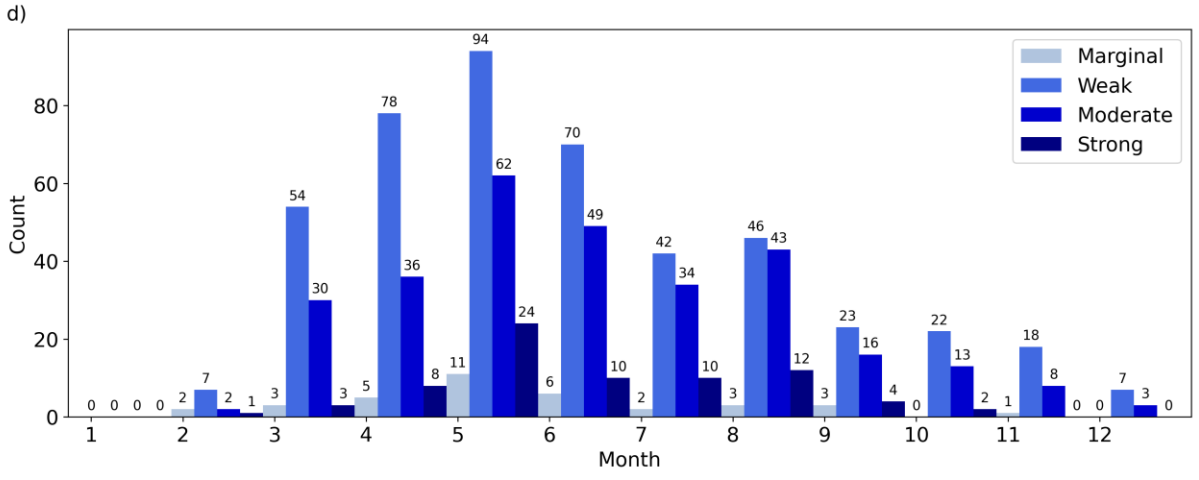
Additional Results







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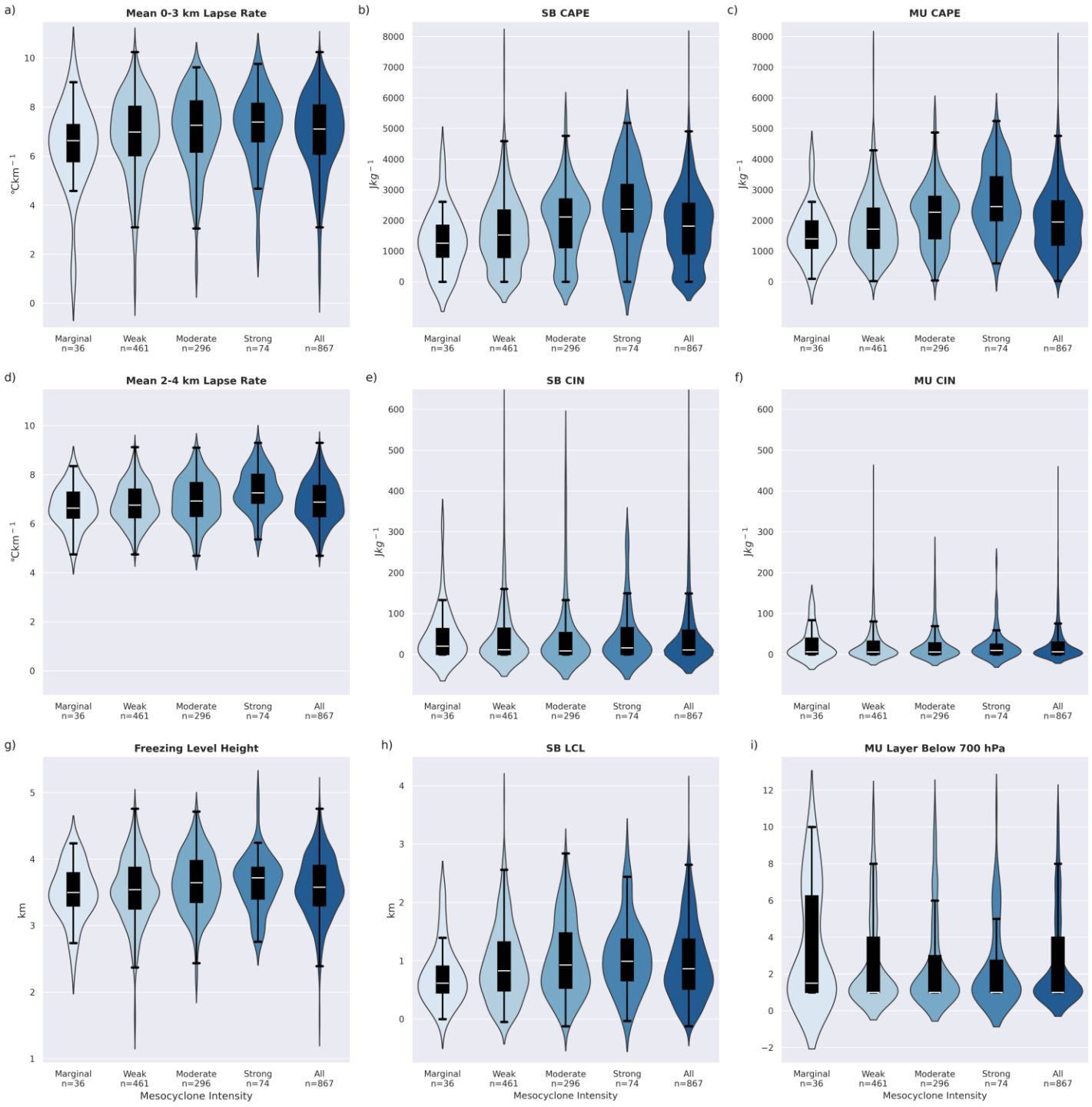
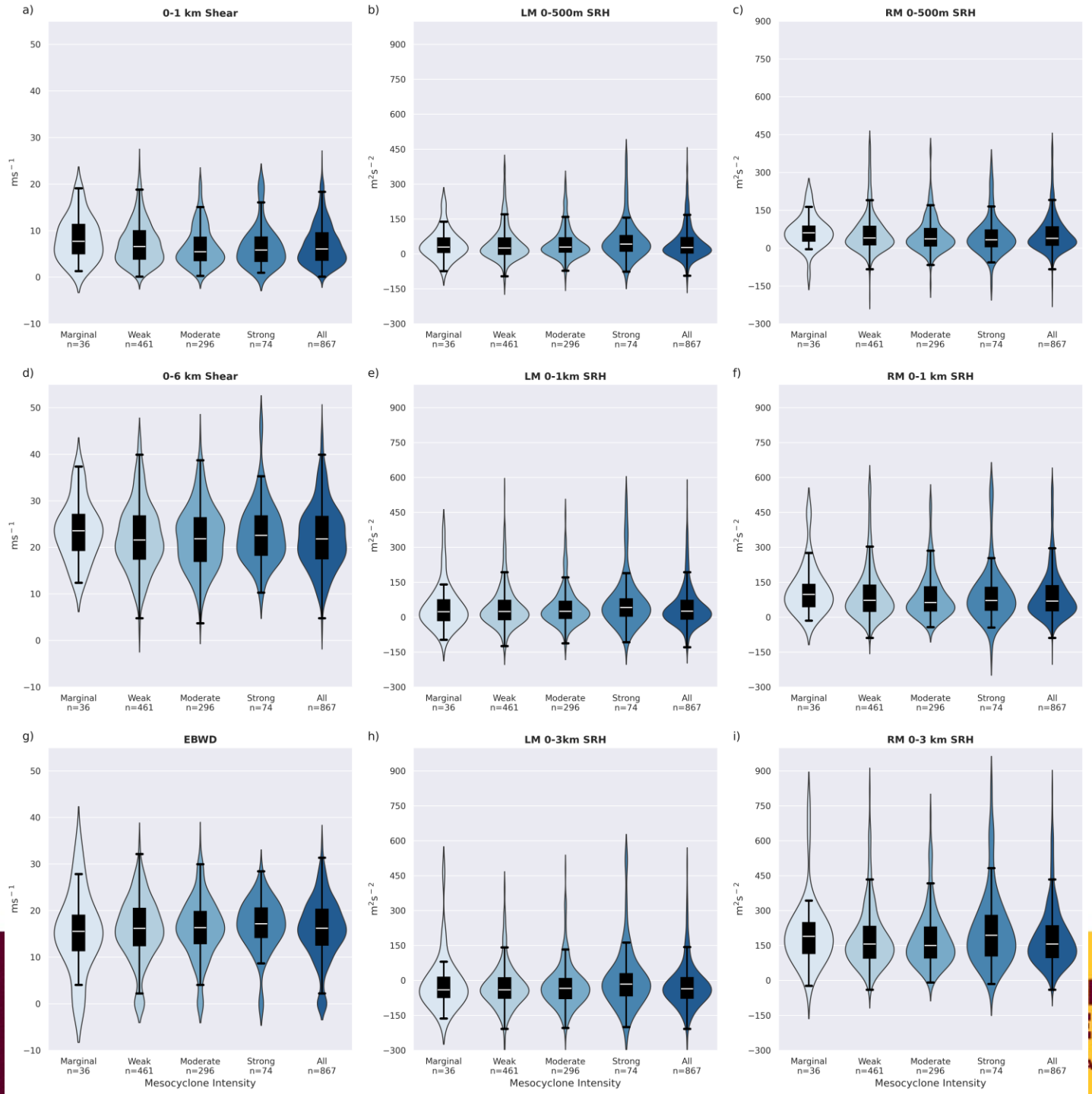

a)
Mean 0-3 km Lapse Rate
°Ckm⁻¹
b)
SB CAPE
Jkg⁻¹
c)
MU CAPE
Jkg⁻¹
d)
Mean 2-4 km Lapse Rate
°Ckm⁻¹
e)
SB CIN
Jkg⁻¹
f)
MU CIN
Jkg⁻¹
g)
Freezing Level Height
km
h)
SB LCL
km
i)
MU Layer Below 700 hPa
Marginal n=36
Weak n=461
Moderate n=296
Strong n=74
All n=867
Mesocyclone Intensity



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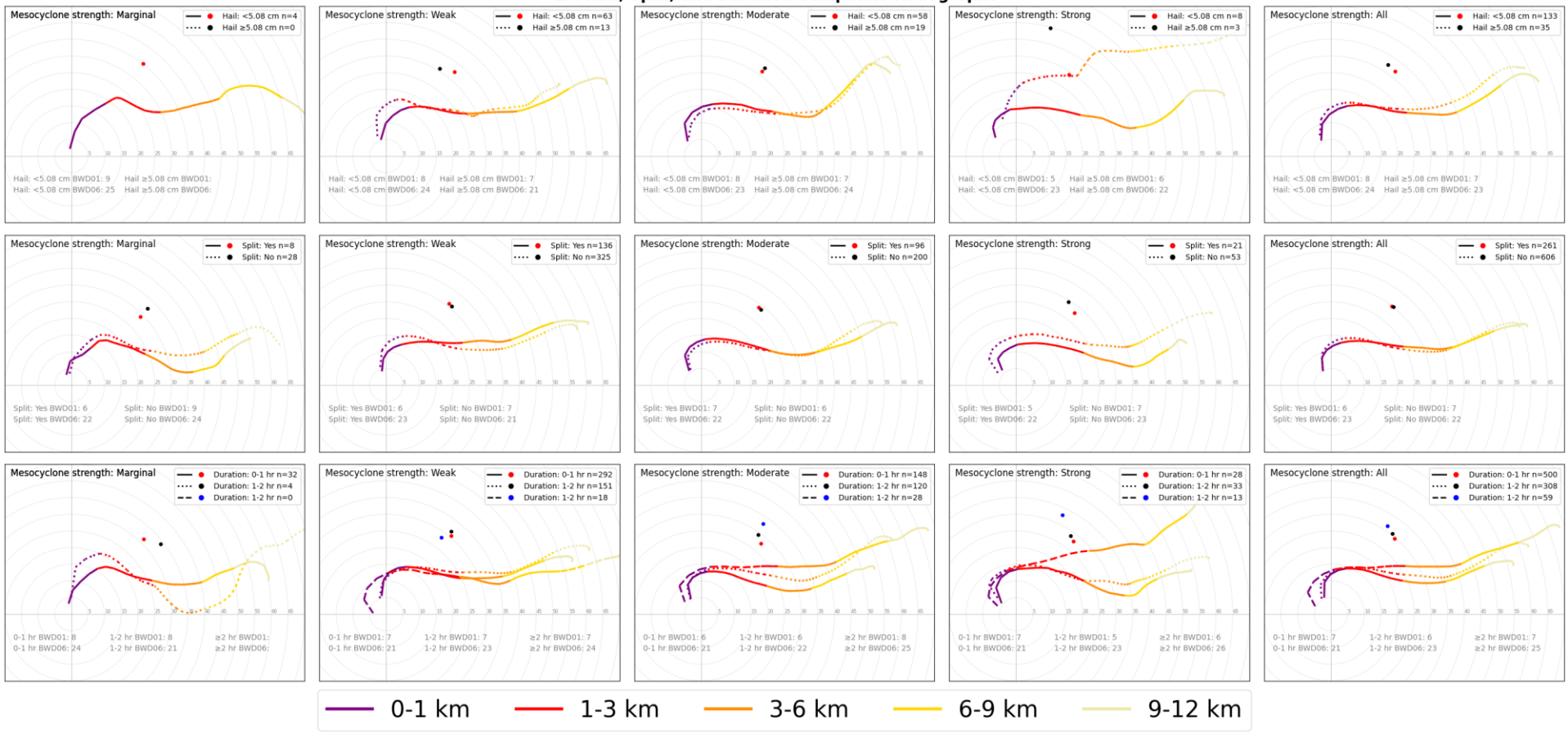
LM Hail, Split, and Duration Composite Hodographs



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