Thunderstorm Morphologies With Mountain Interactions in New England

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NEPARS — Hobart and William Smith Colleges — Plymouth State University — NSF REU

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1. Introduction

- Forecasting in northern New England comes with many challenges due to the topographic features of the region
- Studies on mountain terrains' impacts on thunderstorms are limited
- Previous studies on severe weather showed that terrain affects the location of thunderstorms (Wasula *et al.* 2002)
- Another study looked at thunderstorm intensities over the mountains (Rinehart 2019)
- Research Goals:
  - **Identify shifts in thunderstorm morphologies when they interact with mountains**
  - **Investigate how the storm environment changes as a result**

2. Methodology

- METAR from Iowa State Mesonet used to identify thunderstorm days for 2011 to 2015 warm seasons (Fig. 1)
  - METARs containing TS, LTG, or LTG DSNT were counted as thunderstorm days
- NCEI using the NEXRAD Level 2, Level 3, and the National Reflectivity Mosaic to subjectively identify thunderstorm morphologies based on Gallus *et al.*, 2002 (Fig. 2)
- Morphology shifts after interacting with mountainous terrain were recorded with coordinates taken from the leading edge of the storm
- To capture the storm environment as best as possible, storms were analyzed at the closest hour
- RUC hourly analyses were used to collect sounding parameters

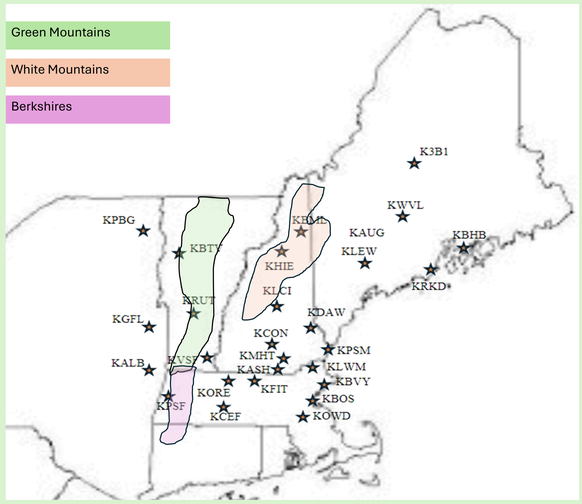


Figure 1: METAR stations utilized in study

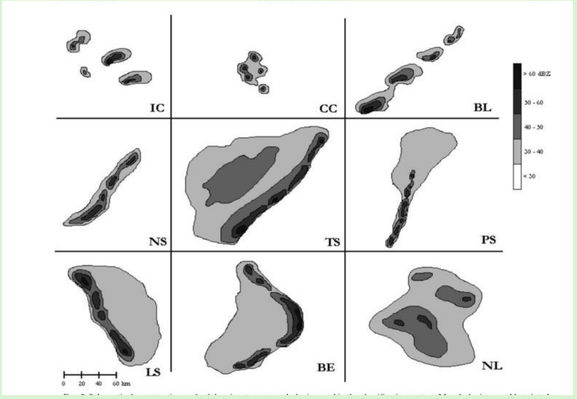


Figure 2: Morphologies referenced (Gallus *et al.*, 2002)

Example

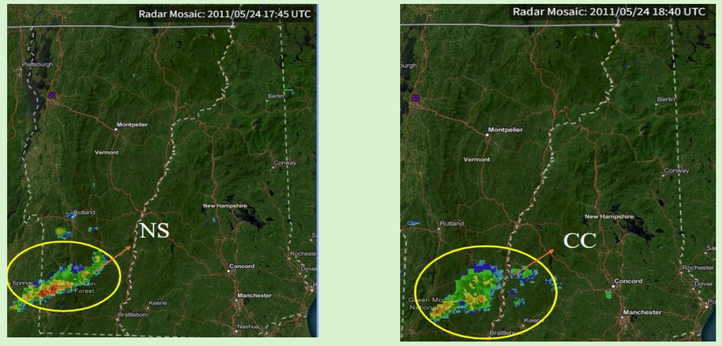


Figure 3: Example of morphology identifications. A no stratiform cell shifting to a clustered cell over the Green Mountains.

3. Results

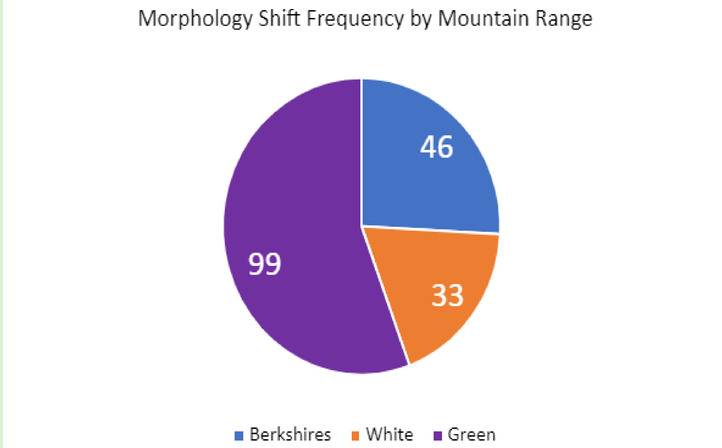


Figure 4: Morphology shift frequencies by mountain for 2011 to 2015

- Morphology shifts over the Green Mountains were most common with 99 occurrences (~56%)
- White Mountains were the least frequent with 33 occurrences (~18%)

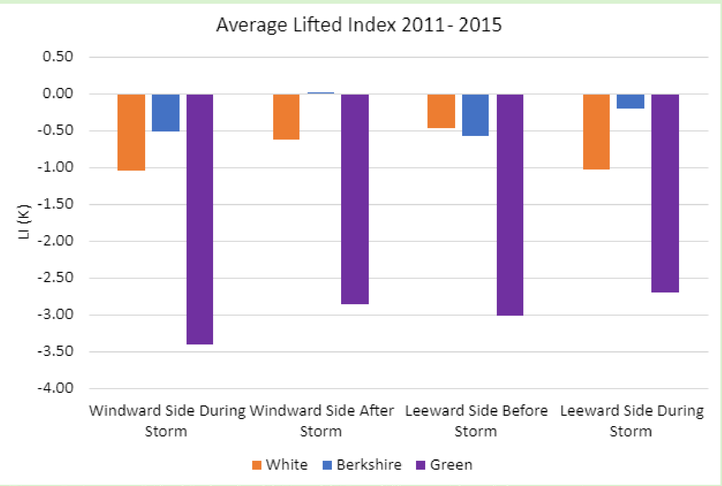


Figure 5: Average Lifted Index for 2011 to 2015 at different sides of the mountain

- Green Mountains LI values are significantly lower compared to other mountain ranges
- Berkshires have more stable LI values on both sides of the mountain regardless of storm position

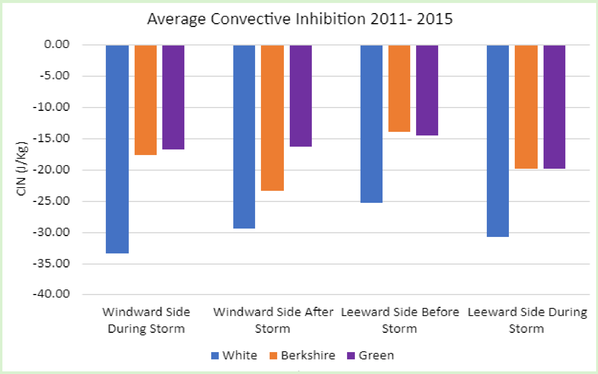


Figure 6: Average convective inhibition at the surface for 2011 to 2015 at different sides of the mountain

- White Mountains have the most CIN for both sides of the mountain
- The Berkshire and Green Mountains have similar average CIN values leeward of the mountain during the storm

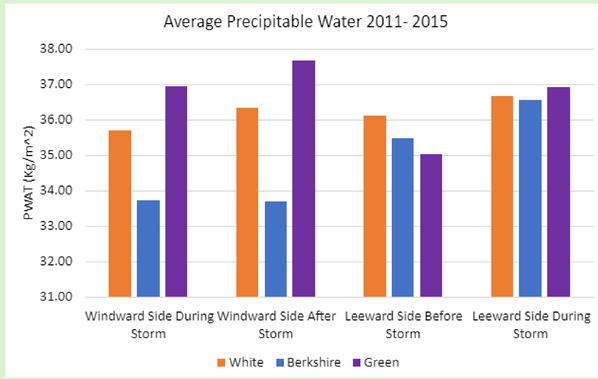


Figure 7: Average Precipitable Water for 2011 to 2015 at different sides of the mountain

- Berkshire PWAT values are minimal on the windward side of the mountain regardless of storm position
- Leeward side has more available moisture for both the White and Berkshire Mountains
- Both sides of the Green Mountains have similar available moisture

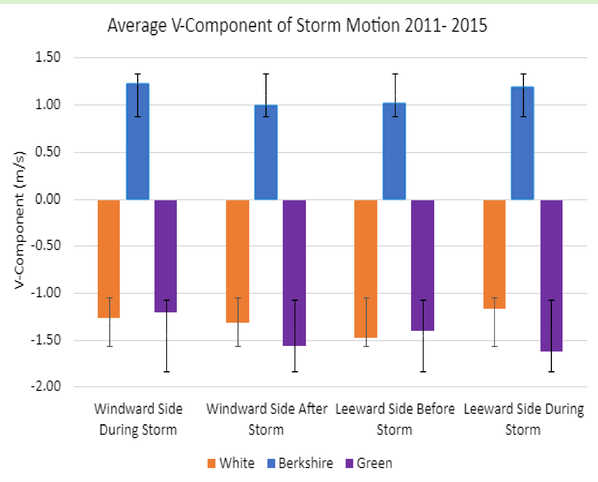


Figure 8: Average V-Component of storm motion at different sides of the mountain

- Storms over the Berkshires have a positive V-Component for both sides of the mountain no matter the storm positions

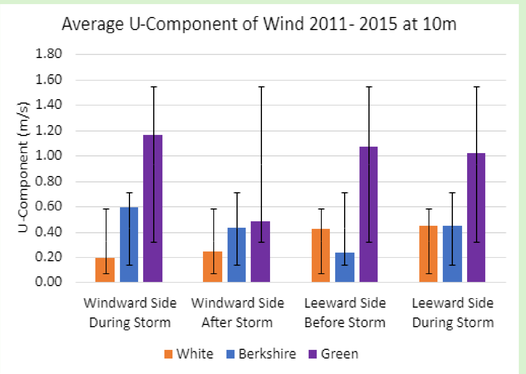


Figure 9: Average U-Component of Wind at different sides of the mountain

- The Green Mountains have an increased, positive U-Component of the wind
- The windward side of the Green Mountains has decreased wind after the storm passes

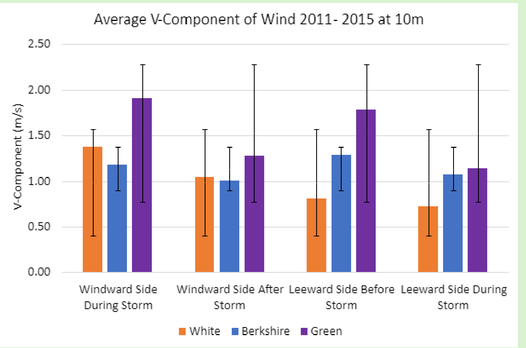


Figure 10: Average V-Component of Wind at different sides of the mountain

- All 3 mountains have a positive V-Component
- The Green Mountains have faster winds compared to the other mountains

4. Conclusions

- The White Mountains have minimal morphology shifts occur compared to the Green or Berkshire Mountains
- Storms over the Berkshires move quickly and have a southerly component while storms over the other mountains move with a northerly component
- The Green Mountains have a significant amount of instability
- The Berkshires have less available moisture to sustain storms

5. Future Work

- Examine storm morphology shifts away from the mountains
- Collect wind data to investigate vertical shear
- Look at surface analysis to understand synoptic patterns that may play a role in the shifts

6. References & Acknowledgments

- Wasula, C.W., L. F. Bosart, K. D. LaPenta, 2002: The Influence of Terrain on the Severe Weather Distribution across Interior Eastern New York and Western New England. *Wea. and Forecasting*, **17** Issue 6, 1277-1289.
- Rinehart, E., 2019: A Climatological Study of Linear Convective Systems in Northern New England. M.S. thesis, Dept. of Atmospheric Science and Chemistry, Plymouth State University, 127 pp.

- This research was done as part of the 2024 NEPARS REU summer research program. Funding was provided from the National Science Foundation with AGS-1947706.
- Further support provided by Plymouth State University and Hobart & William Smith Colleges