# Significant Late Season Snow and Precipitation Events in the White Mountains

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## 1. Introduction

- Winter storms impact millions of people
- Late season events catch many off-guard
- Multiple modeling studies found such systems would continue at the same or an increased rate going forward in the Northeastern U.S despite shortening winters

**Research Goals:**

- Identify the frequency, intensity, and duration of such systems for the years 1995-2024
- Analyze observational trends in the data to confirm changes in late-season winter storm behavior

## 2. Data & Methodology

- Daily precipitation and snowfall from MWOBS B16 Archives and Northeast Regional Climate Center (CLIMOD 2)
- Defined "late season" as March 1st to June 30th
- Calculated 90th percentiles for non-zero daily precipitation and snowfall for the 30-year period
- Defined "significant event" to be one which was greater than or equal to this percentile
- Utilized 3- and 5-day running averages to filter for multi-day events to prevent overcounting
- Wrote python scripts to clean and organize data, perform calculations, and create visualizations
- Gathered surface analysis and radar imagery to confirm event duration and analyze development

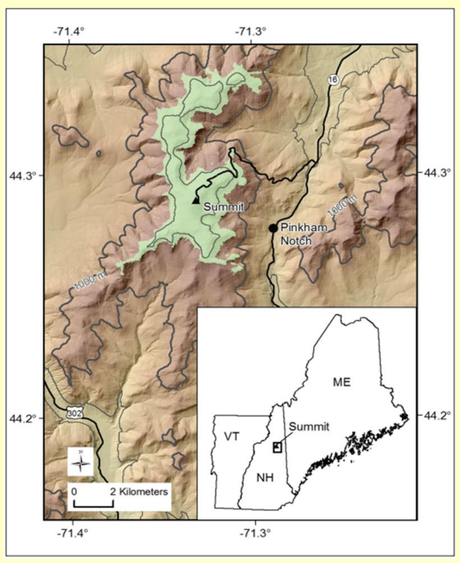



**Figure 1: Topographic map outlining the area of study for this study including the location of both stations. Green shading designates the protected alpine zone**

## 3. Results

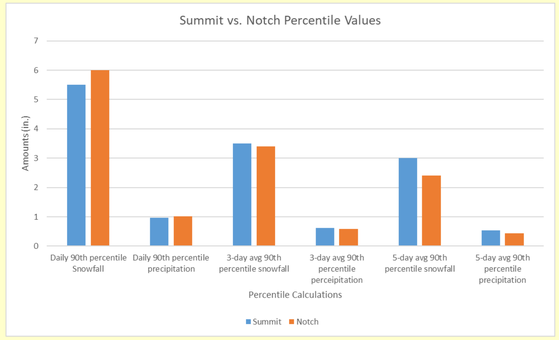



**Figure 2: 90th Percentile comparisons between MWOBS and the Notch**

- MWOBS records higher running averages but slightly lower 90th percentiles than Pinkham Notch
- Reveals Pinkham Notch is potentially influenced by windblown snow
- Valleys experience similar degree of precipitation during significant events
- Orographic influence for the MWOBS is clear

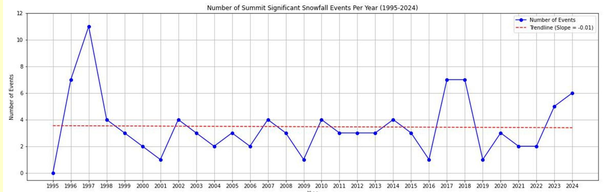



**Figure 3: Frequency of Significant Snowfall Events at MWOBS**

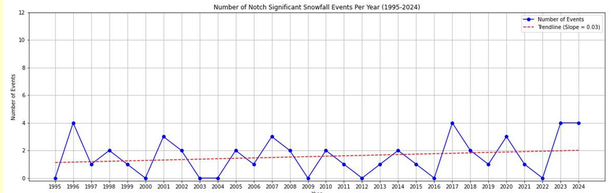



**Figure 4: Frequency of Significant Snowfall Events at Pinkham Notch**

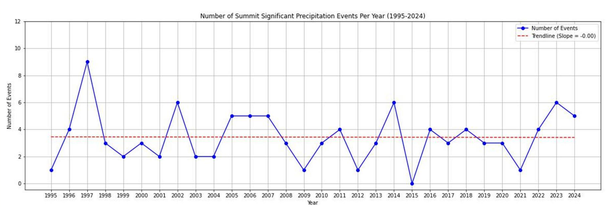



**Figure 5: Frequency of Significant Precipitation Events at MWOBS**

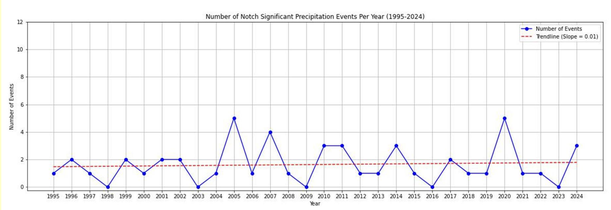



**Figure 6: Frequency of Significant Precipitation Events at Pinkham Notch**

- MWOBS Snow: Peaks in 1997, 2017, 2018, 2024
- Consistent amount of significant events
- More outlier events with less spread in intensity
- Notch Snow: Peaks in 1997, 2002, 2014, 2024
- Consistent amount of significant events
- Higher maximum with increased intensity variation
- MWOBS Precip: Peaks in 1996, 2017, 2023, 2024
- Slight increase in significant events by about 1 event
- Notch Precip: Peaks in 2005, 2007, 2020
- Consistent amount of significant events

| Statistic | Summit (in.) | Notch (in.) |
|---|---|---|
| Max | 23.7 | 32.0 |
| Q3 | 9.9 | 11.0 |
| Median | 7.5 | 9.0 |
| Q1 | 6.3 | 6.2 |
| Min | 5.5 | 6.0 |

**Table 1: Box & Whisker plot statistics from significant snow events at MWOBS and Pinkham Notch**

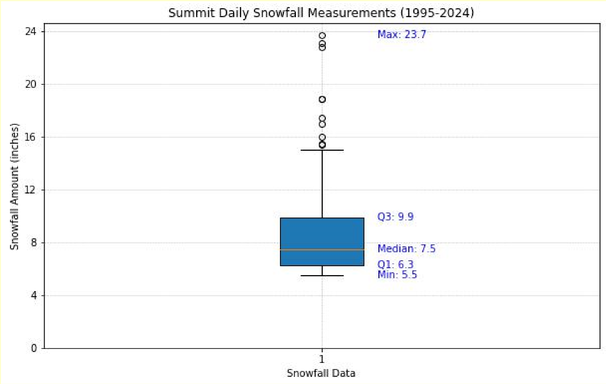



**Figure 7: Quantity of daily snowfall from significant events at MWOBS**

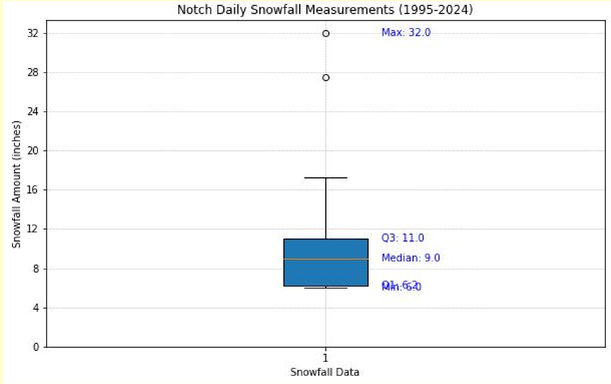



**Figure 8: Quantity of daily snowfall from significant events at Pinkham Notch**

## 4. Conclusions

- Majority of significant snowfall events result in 6-11 inches of snow over a 24-hour period
- There has been a steady rate of 3-4 significant late-season snowfall and precipitation events at the Mt. Washington summit
- Significant snowfall events have been slowly increasing at Pinkham Notch
- The last 2-3 years have seen a surge in significant snowfall and precipitation events
- Large variation in number of events per year
- Higher probability that significant events will last longer in years that have higher event frequency
- It is likely that such events will continue to occur regularly going forward

## 5. Future Work

- Identify causes for year-to-year variability
- Explore mesoscale processes that contribute to increased late-season snowfall in the region
- Investigate affects of windblown snow on Pinkham Notch's measurements
- Increase the range of years studied to include the full MWOBS and Pinkham Notch dataset
- Utilize alternative methods for finding events

## Acknowledgements

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## References

[1] Chen, G., W. Wang, C. Cheng, and H. Hsu, 2021: Extreme Snow Events along the Coast of the Northeast United States: Potential Changes due to Global Warming. J. Climate, 34, 2337–2353, https://doi.org/10.1175/JCLI-D-20-0197.1.

[2] McCray, C. D., Schmidt, G. A., Paquin, D., Leduc, M., Bi, Z., Radiyat, M., et al. (2023). Changing nature of high-impact snowfall events in Eastern North America. *Journal of Geophysical Research: Atmospheres*, 128, e2023JD038804. https://doi.org/10.1029/2023JD038804

[3] Murray, G., Colgan, A., Nelson, S., Kelsey, E., & Kimball, K. (2021). Climate trends on the highest peak of the Northeast: Mount Washington, NH. *Northeastern Naturalist*, *28*(11). doi:10.1656/045.028.s1105

[4] Vose, R. S., and Coauthors, 2014: Monitoring and Understanding Changes in Extremes: Extratropical Storms, Winds, and Waves. Bull. Amer. Meteor. Soc., 95, 377–386, https://doi.org/10.1175/BAMS-D-12-00162.1.

[5] Zarzycki, C. (2018). Projecting Changes in Societally Impactful Northeastern U.S. Snowstorms. *Advancing Earth and Space Sciences*, *45*(21). doi:10.1029/2018gl079820

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