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An Investigation of the North Atlantic Oscillation's Impact on Extreme Snowfall Events on Mount Washington

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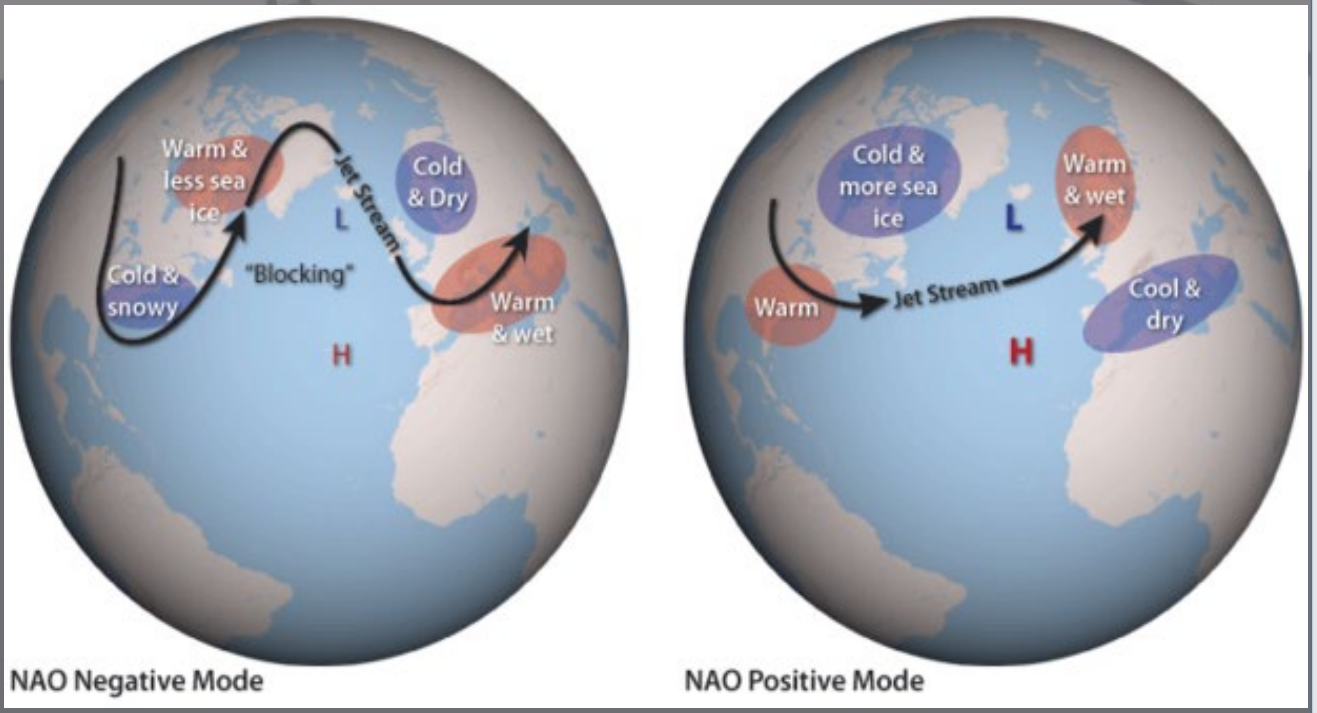
Background Information



North Atlantic Oscillation diagram provided by NOAA's climate.gov NAO website: https://www.climate.gov/news-features/understanding-climate/climate-variability-north-atlantic-oscillation

What is the NAO?

The North Atlantic Oscillation (NAO) is an interannual, global teleconnection split into two phases: positive and negative.

- The positive phase correlates with stronger high and low pressure centers in the Atlantic.
- The negative phase correlates with weaker centers.

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Research Objectives

- *Identify* if there is a statistically significant difference in average snowfall between the most positive and most negative NAO days
- *Analyze* whether the NAO influences the distribution of extreme snowfall

Methods

- Three main methods used in this study:
  - Composite Resampling
  - Extreme Value Modeling
  - Influence of the Covariant

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Methods

- ## Composite Resampling
  - Of the initial snowfall data from **1979-2023**, the **top 3%** of events were filtered out of the data, resulting in a total of **733 snowfall events** that received greater than or equal to 6.3 inches of snowfall
  - Data filtered from **October to April**
  - The NAO indices for the three days prior, three days after, and the day of the snowfall event were compiled to form a **7-day average** of the NAO indices
  - The **top 50** most positive and most negative values of the NAO indices were selected
  - **Mean snowfall** was calculated for each of the positive and negative NAO groups
  - A **Monte Carlo analysis** was then completed by randomly sampling 100 snowfall events without replacement and calculating the difference in the group's means
  - Analysis repeated **10,000** times

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Methods

- ## Extreme Value Modeling
  - The same filtered **top 3%** snowfall events and corresponding NAO indices were used (**October to April**)
  - Categorized the data into three different NAO phases:
    - Strong Negative (NAO ≤ −1.0)
    - Neutral (−1.0 < NAO < 1.0)
    - Strong Positive (NAO ≥ 1.0)
  - For each NAO phase, a **filtered generalized extreme value (GEV) model** was used to create a distribution
- Parameters of analysis:
  - **Location** (shows where the bulk of the data is located),
  - **Scale** (controls the spread of the data (wider or narrower distribution),
  - **Shape** (determines the tail of the distribution and helps understand rare events)

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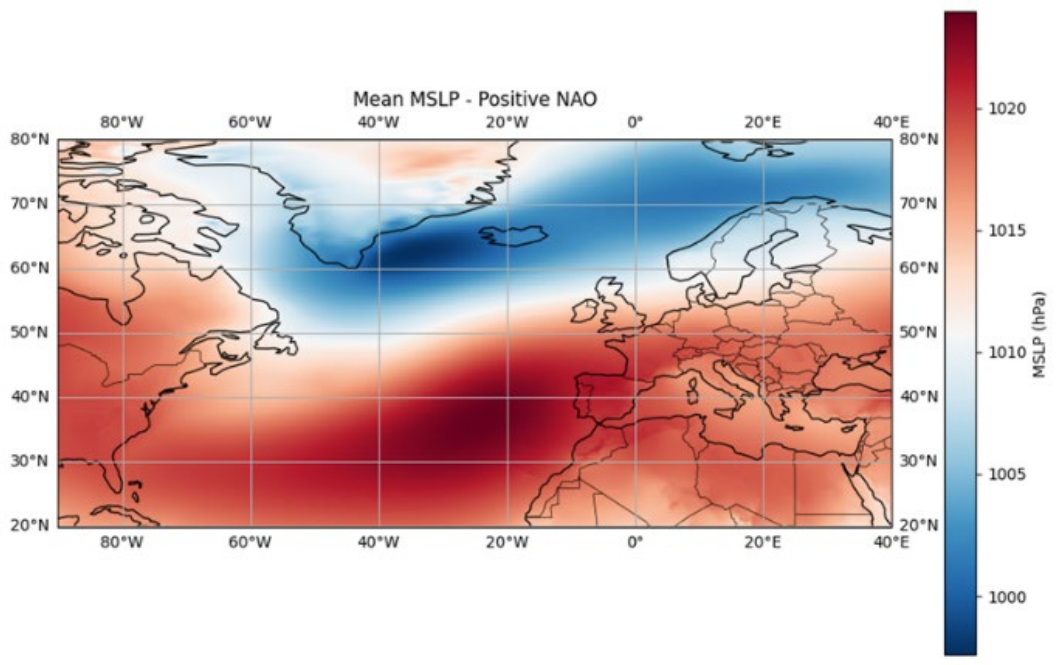
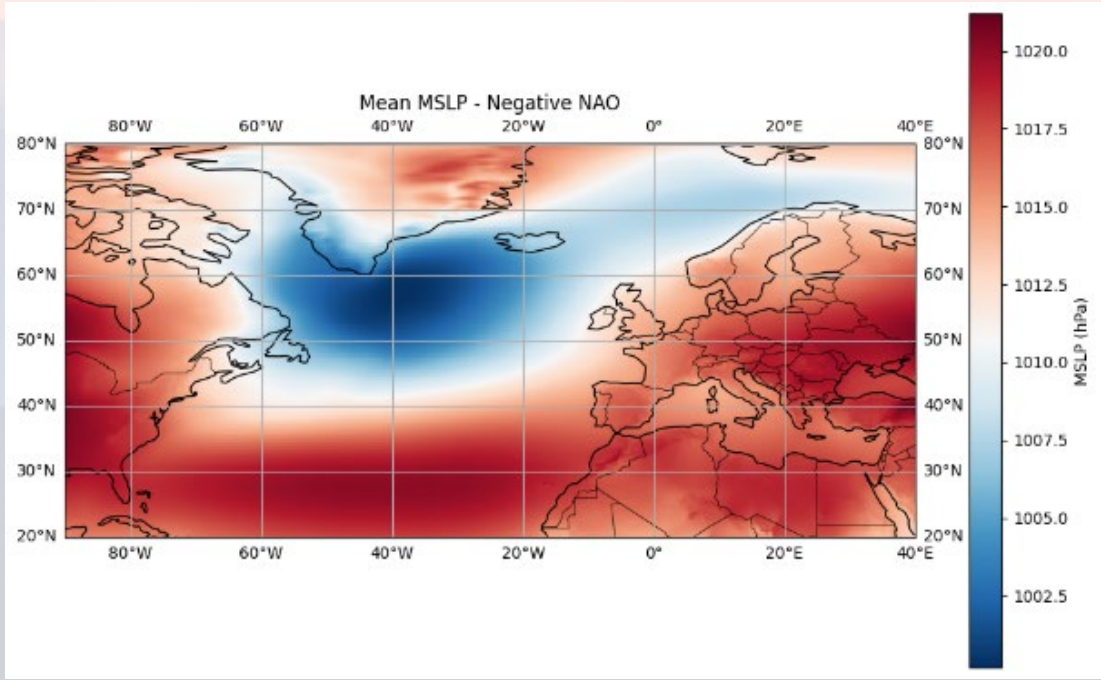
Methods

- Influence of the Covariant
  - An initial climatology was created to show snowfall data and the NAO indices correlations
  - Mean sea level pressure maps were also created using the ECMWF's ERA5 reanalysis data to visually compare the effect of a positive and negative NAO phase on the Atlantic Ocean





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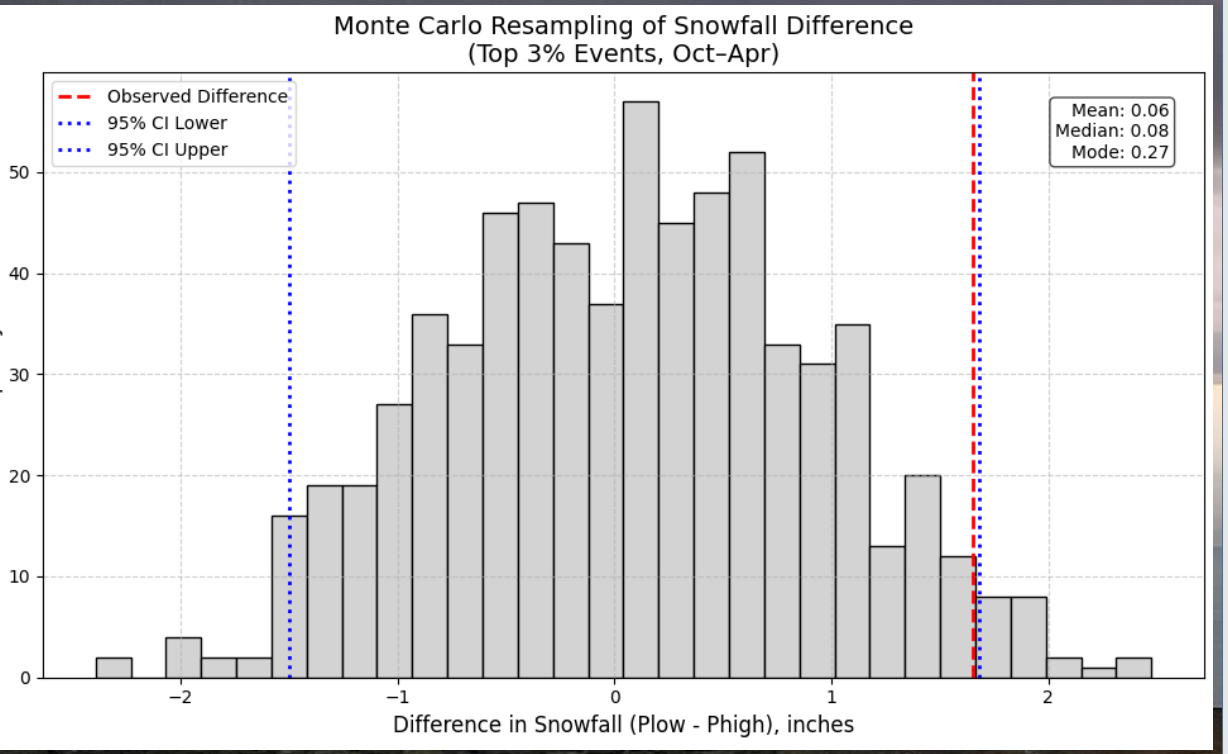
Results and Conclusions



Monte Carlo Results:

- While negative NAO events do appear to produce more snow on average, the difference is not statistically robust.
- Based on **mean values** alone, there is no strong evidence that NAO phase controls the average snowfall during extreme events.

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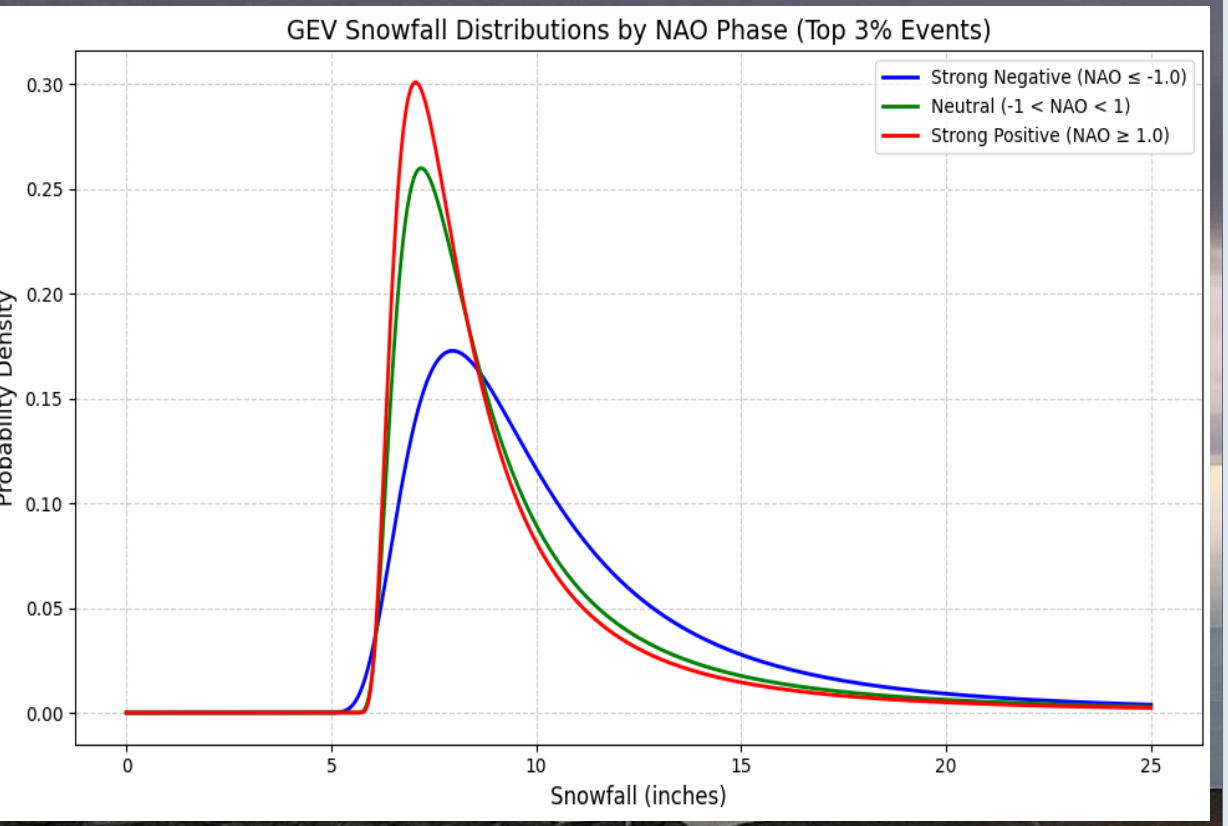
Results and Conclusions



GEV Analysis Results:

- The **location** is highest when NAO is strongly negative, which means there were more extreme snowfall events during the negative NAO phase.
- The **scale** is also larger when there is a negative NAO phase recorded, which means there is greater variability in extreme snowfall.
- The **shape** is less negative for the negative NAO, which indicates there is a heavier upper tail and more extreme maximum snowfall events possible.

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Thank You!