A Climatology of Solid-to-Liquid Ratio on Mount Washington (1980-2024)

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Introduction

Why it's important:

- Critical variable for Quantitative Precipitation Forecasts (QPFs).[1,2]
- Many forecast models assume a national average value of SLR = 10 but studies suggest this may be inaccurate.[1,2,4]
- Eastern SLR is critically understudied, especially within the White Mountains.[1,2]
- SLR is important in forecasting road safety and avalanche danger.[4,5]

Objectives:

- Create a comprehensive climatology of SLR for winters of 1980-2024
- Understand what atmospheric variables impact SLR on Mount Washington
- Assess the impact of estimating SLR values on the climatology

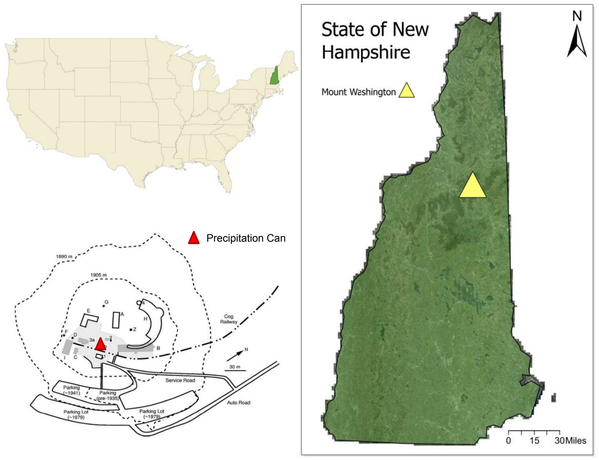

Figure 1. Study area, Mount Washington Observatory. Summit of Mount Washington NH

Data and Methodology

Data:

- Daily data, spanning 1980-2024 from in-situ precipitation can.[3]
- Variables: average daily wind, average daily temperature, 24-hr accumulated solid precipitation, 24-hr accumulated liquid equivalent
- Converted to "Snow Year" – starting in October and continues through to the May of the next year

Filtering:

- Only included instances where accumulated solid precipitation > 0.5 inches
- Excluded any instance where liquid equivalent > solid precipitation
- Recorded any instance of SLR being estimated

Results and Discussion

Histograms:

- Mount Washington Summit SLR varies greatly, and is significantly different to SLR = 10
- Estimates are reflective of real data
- There are no particular conditions under which estimates are made

Variable	K-S Test (95% CI)
SLR	Fails
Wind	Fails
Temperature	Fails

Table 1. Results of the Kolmogorov-Smirnov comparison test between histograms including and excluding estimated data to assess the impact of estimates on data. Three variables are assessed: SLR, Wind, Temperature.

Climatology:

- SLR has a seasonal cycle through the snow year
- SLR approaches 10 in Jan, Feb, and March, but are significantly different from 10 at the shoulder seasons
- SLR correlates with temperature but not wind

Variable	R-Square Value	P value < 0.05
Wind	0.03	False
Temperature	0.55	True

Table 2. Assessing the correlation between Solid-to-Liquid Ratio and variables wind and temperature. It was found that SLR does not correlate significantly with wind. It was found that SLR does correlate significantly with temperature.

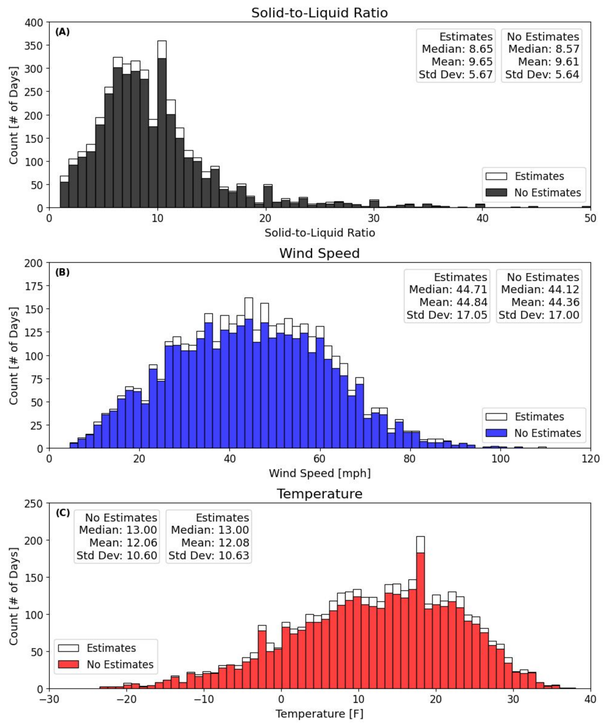

Figure 2. Histogram showing the distribution of Solid-to-Liquid Ratio (A), Wind Speed (B), and Temperature (C) for the period 1980-2024. Histograms show data with (white bar) as well as without estimates (colored bar).

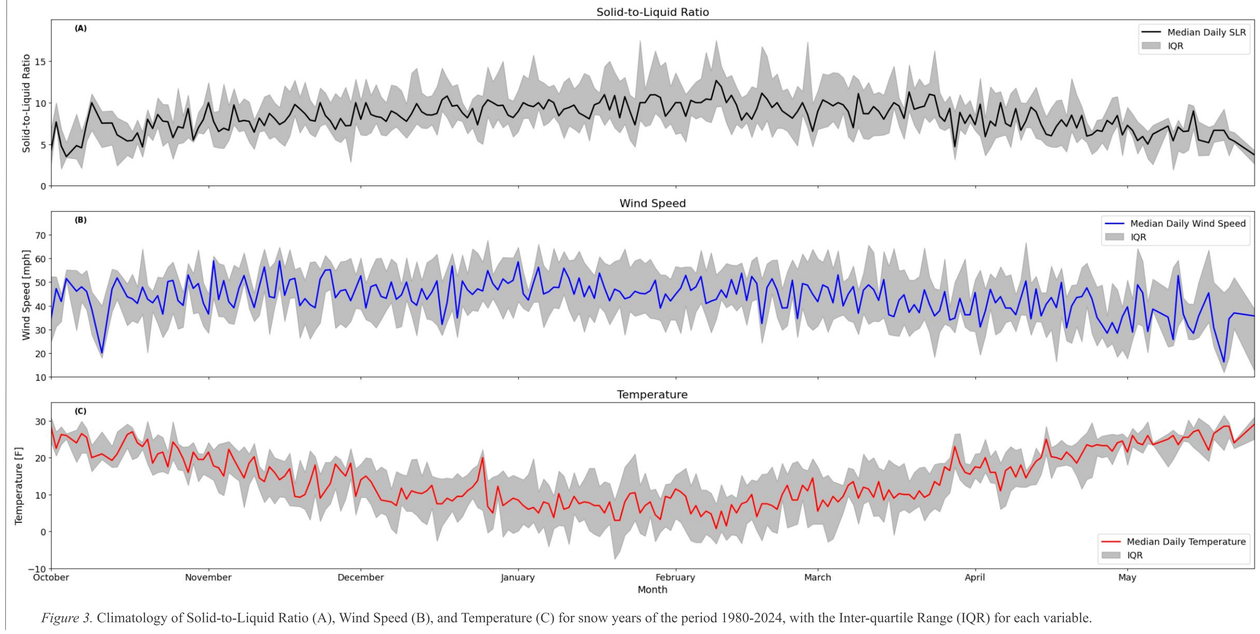

Figure 3. Climatology of Solid-to-Liquid Ratio (A), Wind Speed (B), and Temperature (C) for snow years of the period 1980-2024, with the Inter-quartile Range (IQR) for each variable.

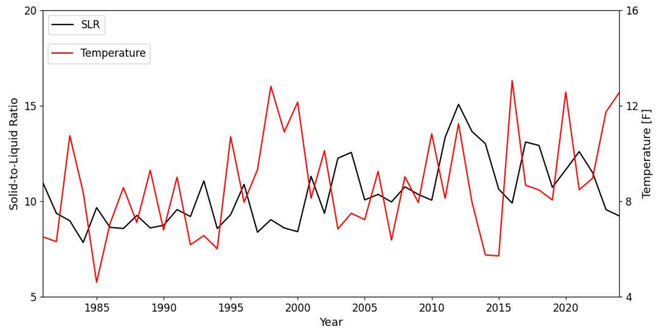

Figure 4. Median "Deep Winter" Daily SLR and temperature as a time series over the period of record (1980-2024). Trend lines for the data are plotted as dashed lines in their respective colors.

Variable	Trend (dec^{-1})	R-Square
SLR	0.76 ± 0.17	0.32
Temperature	0.58 ± 0.24	0.121

Table 3. Trend line of SLR and Temperature with respect to time, for the period 1980-2024 only including median "Deep Winter" values across years.

Temporal Trend:

- Both Temperature and SLR increase significantly over time.
- SLR and temperature exhibit opposite relationship to climatology in interannual trends
- SLR and temperature correlate on an individual year basis

Main Conclusions

- SLR on the summit of Mount Washington is distinct from the standard 10:1 assumption.
- SLR is found to be dependent on temperature, but not wind [1,2]
- Estimates have no effect on SLR data. And there are no particular conditions under which estimates are made.

Further Work

- Case study analysis, how do particular synoptic setups influence SLR[5]
- Elucidate what is driving the temporal increase in SLR
- Differentiate between solid precipitation and snow events, to find a Snow-to-Liquid ratio.

Acknowledgements & Sources

Thanks to the Mount Washington Observatory and Mount Washington Avalanche Center for their support throughout this project and to Synoptic for funding this project.

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