For the Love of Snow: Snow Monitoring with Community Science

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1 | Appalchian Mountain Club 2 | Plymouth State University

Introduction

The Appalachian Mountain Club has been recording snow depth at Joe Dodge Lodge since the 1930s, and more recently at 3 mountain huts, however spatial distribution of snow in the complex terrain of the White Mountains is generally unmonitored. In 2022, AMC and partner organizations joined efforts with Community Snow Observations (CSO) to engage winter recreationists in crowdsourcing mountain snow depth measurements, filling in gaps where traditional measurements are scarce. More complete information improves the understanding of snow depth variability in mountainous terrain, allowing for more precise estimates of avalanches, floods, agriculture impacts, and ecosystem science.

These efforts demonstrate the effectiveness of different outreach strategies & illuminates gaps in current modeling practices.

Methods

Engagement:

AMC, Partners, and CSO ambassadors in the Northeast have been promoting the CSO program to expand participation in this region through:

- Outreach tabling at winter recreation-focused events and AMC facilities
- Informational webinars
- Teacher trainings
- Hosting hands-on workshops
- Self-guided walks with provided ruler and instructions
- Youth-oriented story-based guides
- Print materials distributed that walk volunteers through how to take snow depth measurements and point towards more resources
- Focused "snow-blitzes" events, recruiting for a weekend or day of intensive sampling

Data Collection and Analysis:

CSO snow depth measurements are reported using the Snow Scope app and a ruler or avalanche probe by volunteers. The field observations come with geolocation information and are displayed and accessible for download on the CSO website https://communitysnowobs.org. We downloaded 2457 observations made in the Northeast region from 2017-2025. Raster values for elevation were extracted from USGS 3DEP 1m DEM Mosaic in ArcPro. The predicted snow depth from CSO's model[1], available through a public Google Cloud storage bucket, was extracted on the same date and location as the observations where possible. Of the 2457 observations, only 576 observations were within the time and geographic frame of the model domain established over the White Mountains. From this group of observations, microtopography was derived for 404 observations from a 1m dem using the Geomorphon tool in ESRI ArcPro. Micro-topography was split into 10 distinct features, and then grouped into 4 larger categories – concave, convex, sloped and flat – as some features did not have enough data to be significant.

Concave	Pit, Valley, Hollow	n = 79
Convex	Ridge, Peak	n = 24
Sloped	Footslope, Shoulder, Slope, Spur	n = 295
Flat	Flat	n = 6

[1] For more info on model data sources: https://www.mountainsnow.org

Citizen science observations are key in improving predictive models for snow depth

Join Community Snow Observations

1 **Download** the **Snow Scope** app for iOS or Android

2 **Measure** snow depth to the nearest centimeter, 3 or 4 times in a small radius, in undisturbed snow

3 **Record** the average of your measurements with the "Snowpack Height" feature in the **Snow Scope** app

Scan to download the free Snow Scope app

Visit communitysnowobs.org to learn more

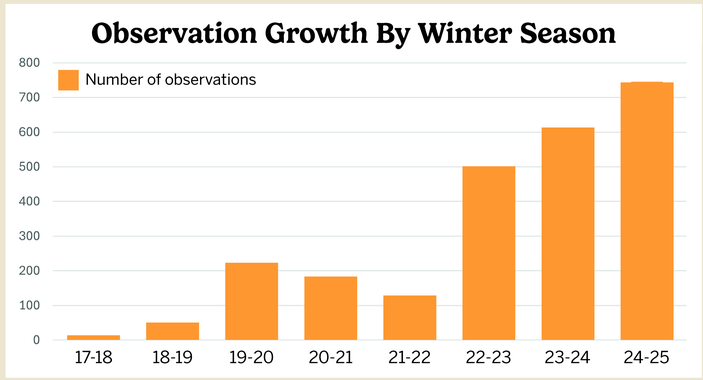

Fig1: *Number of observations submitted to the Snow Scope app within a winter season within the northeastern region, defined as Oct-Apr.*

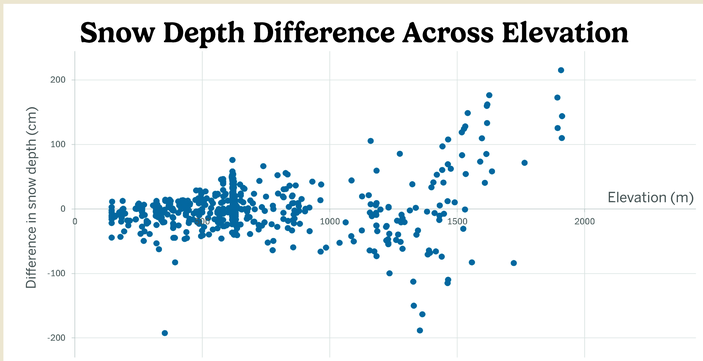

Fig2: *Difference between Snow Scope observations and modeled snow depth at that location and date across elevation (m) within the NH model domain. Positive average values represent an overestimation by the model, and negatives an underestimation.*

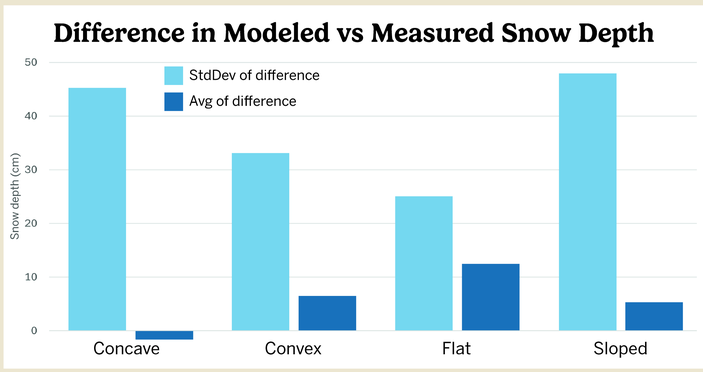

Fig3: *Within grouped landforms, in cm, the standard deviation and average of the difference between Snow Scope observations and modeled snow depth at that location and date within the NH model domain. Positive average values represent an overestimation by the model, and negatives an underestimation.*

Results

Engagement:

Between November 2022 and March 2025, **AMC conducted 30 outreach events, reaching over 1020 winter recreationists.** This effort, combined with the passive distribution of print materials and efforts from partners, has led to an increase in observations season after season since AMC became involved. Just over 75% of all observations are from November 2022 onward, aligning with the timing of AMC and partners promotion of the program.

Data Collection and Analysis:

The average difference of observed vs modeled snow depth is 25cm, with the largest difference being a 215cm overestimation from the model at the summit of Mount Washington. The model underestimated snow depth in concave landforms by 2cm on average, while overestimating all other groups of landforms by 5-12cm on average. **All landform categories had high variability in model accuracy, with standard deviation positively correlated with the number of observations in the model, varying from 25-48cm.**

Discussion

Engagement:

Focusing on the strength rather than the size of the volunteer network may see a higher return on investment for outreach efforts.

Over 50% of observations come from just 14 people, 5.5% of all participants, and over 90% of observations come from just under 50% of observers. Additionally, **PSU's successful weekend Snow Blitz** in March of 2025, seeing 75 observations over 3 days, provides a framework for future outreach events.

Data Collection and Analysis:

The high level of variation between modeled and actual snow depth shows the gaps in current snow modeling in the Northeast. Our results show that convex landforms are prone to overestimation, consistent with the effect wind plays in the locations of snow accumulation in mountainous terrains. The limited number of both snow monitoring and wind measuring sites in these regions amplifies the need for citizen science to take in situ measurements to improve models, similar to Crumley et al. 2021. **Further, this work informs the Northeast Snow Survey feasibility study,** a project that aims to monitor snowpack, and other variables, across elevational gradients to better understand the impacts of climate change on regional snowfall and snowpack.

Contact

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