A First-Ever Observational-Based Snowpack Climatology for the Northeastern United States

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1. Motivation

- Snowpack plays a critical role in the hydrology, ecosystems, and economy of the northeastern United States.
- Accurate snow depth and snow water equivalent (swe) measurements are collected by various organizations across the United States such as the National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), and National Operational Hydrologic Remote Sensing Center (NOHRSC).
- While real-time observations are valuable for forecasting and decision-making, a climatological baseline is essential for placing these measurements into a long-term context
- This project addresses the absence of a current climatological product by leveraging decades of snowpack data to develop one.

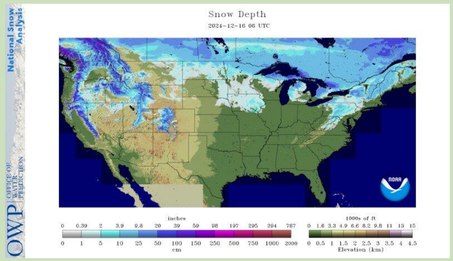


Fig. 1: "SNODAS" is a modeling and data assimilation system developed by NOHRSC to provide the best possible estimates of snow cover and associated parameters to support hydrologic modeling and analysis.

2. Data and Methods

- Datasets containing bi-weekly snow depth and swe measurements from January to May were obtained from local NWS offices and the Northeast Regional Climate Center (NRCC).
  - ➢ Various organizations such as the US Army Corps, hydropower companies, Community Collaborative Rain, Hail and Snow Network (CoCoRAHS), Cooperative Observer Program (COOP), and Hubbard Brook experimental forest contributed to the data collection efforts.
- Python was used to implement quality control (QC) procedures, removing erroneous values and ensuring data accuracy.



Fig. 2: A snow sampler consists of a snow tube and spring scale. The snow tube is pushed down through the snowpack to the ground surface. Snow Sampling Equipment (2024). From usda.gov

3. Early Findings

- At completion of QC, over 400 individual sites across New England and New York remained (Fig. 3)
- Preliminary analysis on a state-by-state basis shows decreasing depth and swe trends from January to April since measurements began in the early 1900s.
  - ➢ Sens slope and 95% interval plots verify this thinking across New York (Fig. 4)

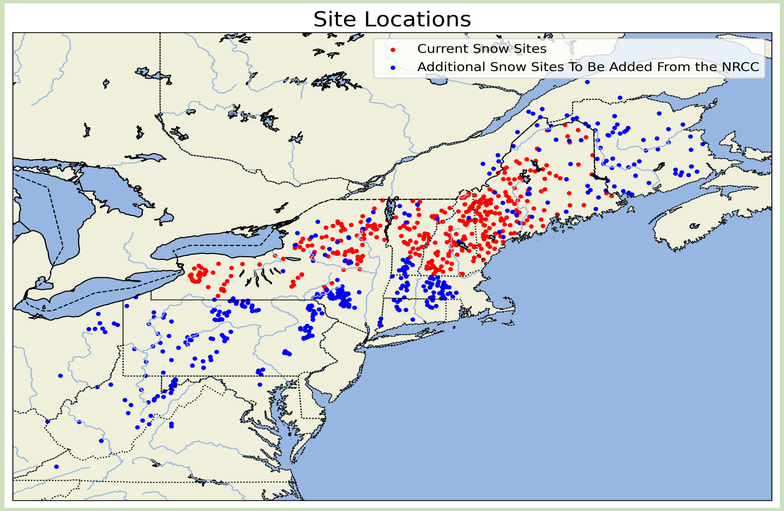


Fig. 3: Sites (red) in the current dataset and new sites to be added from the NRCC (blue). Most new sites continue south into the Mid-Atlantic.

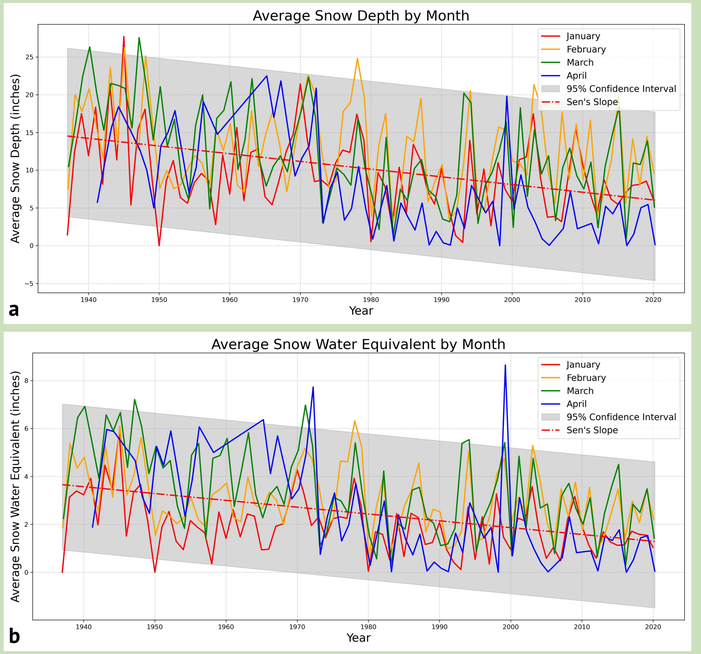


Fig. 4: The average a) snow depth and b) swe for all sites across New York. Sens slope and a 95% interval are applied to the plot, which shows a decrease in both depth and swe with time.

4. Future Work

- The project will expand to include measurements from Massachusetts, Rhode Island, Connecticut, downstate New York, Pennsylvania, Northeast Ohio, and the Virginias.
- Products produced will include:
  - ➢ Snow drought index
  - ➢ Median snow-out dates
  - ➢ Snowpack trends
  - ➢ Snowpack variables at 1km resolution
  - ➢ Daily climatological normal of depth and swe
- We will use self-organizing maps to objectively identify the modes of variability of swe and depth.

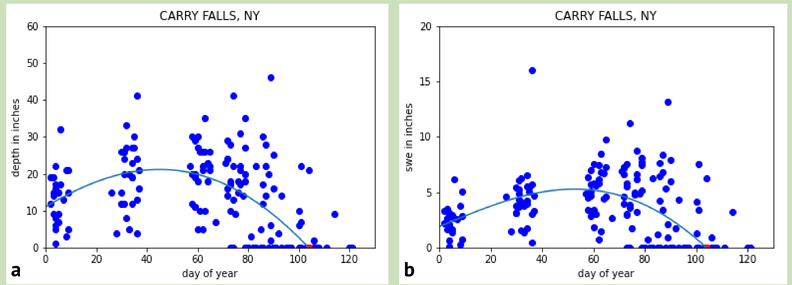


Fig 5: 4th polynomial regression maps are shown above for snow depth a) and swe b) at Carry Falls, NY. Day 0 represents January 1st while the red dot shows mean snow-out dates. All sites will have similar graphs.

5. Acknowledgements

- This project is funded by NOAA-NIDIS, in collaboration with Cornell University
- Margaret Curtis and Nikki Becker - NWS Gray, ME: provided data and metadata, helped troubleshoot metadata issues
- Stephen Barron - PSU Graduate: completed QC on data across New Hampshire; also made a blueprint for data analysis.
- Amber Rochon - PSU Graduate: completed QC on data across Maine.

6. References

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