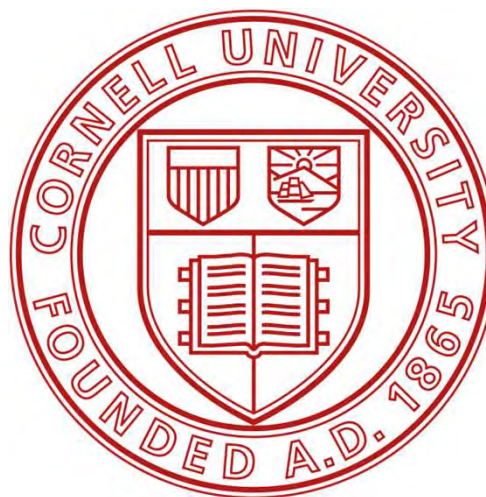
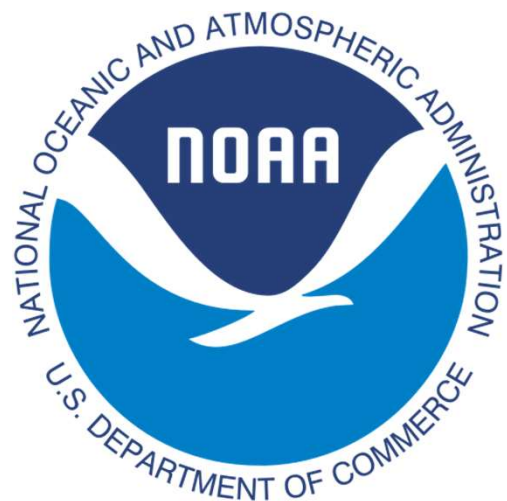




First-Ever, Observationally-Based, Snowpack Climatology in the Northeastern United States

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Importance of Snowpack in the Northeast:



Economy:

- Winter tourism generates billions of dollars
- Hundreds of thousands of jobs



Hydrology:

- ***Snow Water Equivalent (SWE)***
most important
- Altered water supply
 - Shifted spring streamflow
 - Increased winter/spring flood threat
 - Drought planning/agriculture
 - Delayed/Advanced streamflow timing

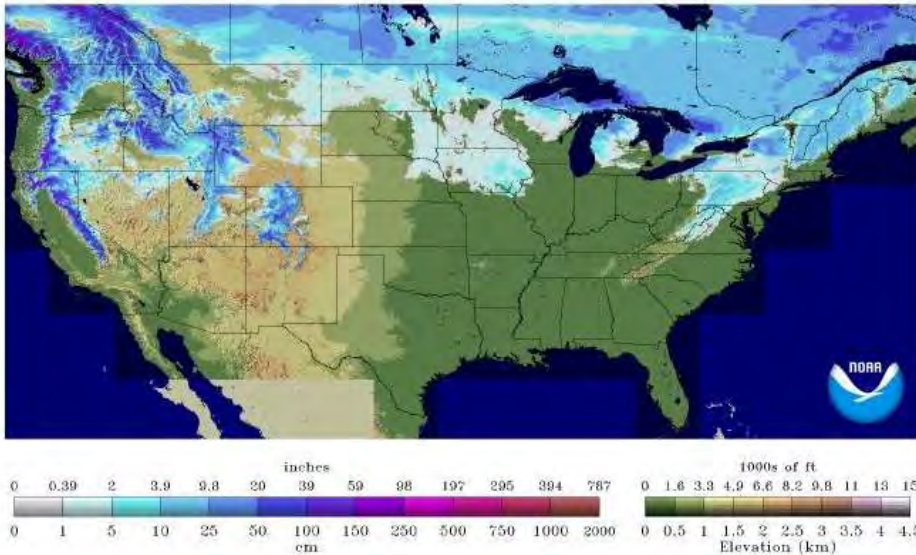


Ecosystems:

- Freeze-thaw cycles harm exposed trees/plant roots
- Decreased snow cover extends season for fungal/vector diseases
- Northward expansion of invasive species

Background:

Snow Depth
2024-12-16 06 UTC



- **National Weather Service (NWS) collects snow depth and SWE measurements**
 - Observers
 - Cooperative Observer Program (COOP)
 - Automated Sensors
 - Mesonets
- **Snow Data Assimilation System (SNODAS) via National Operational Hydrologic Remote Sensing Center (NOHRSC)**
 - High-resolution (1km) gridded analysis
 - Observations, remote sensors, and RAP/GFS model input
 - **Began in 2003; no products available prior**
 - More complete estimation of snowpack and SWE

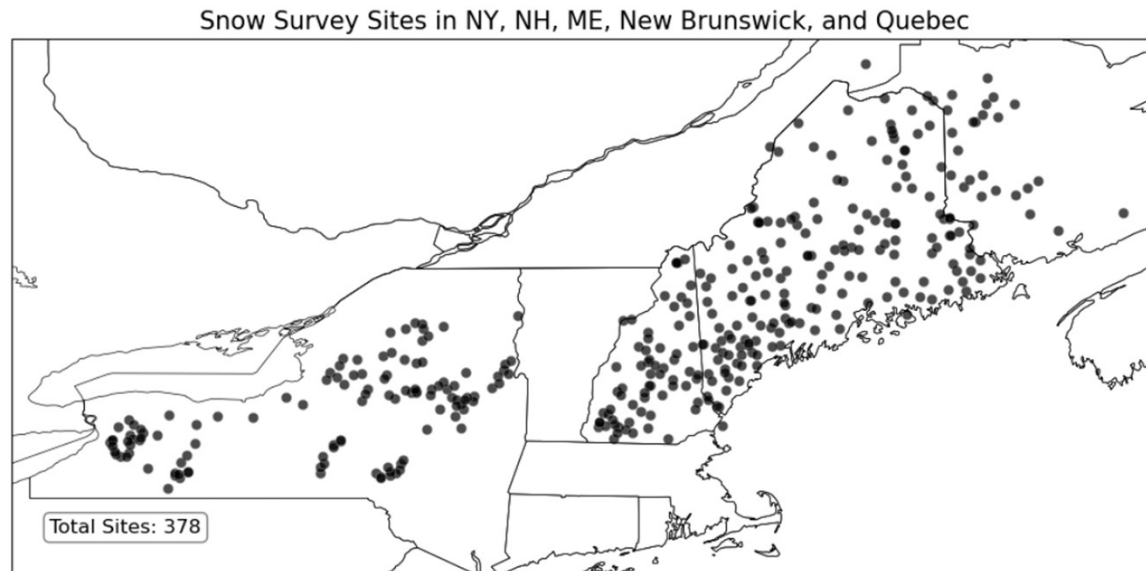
Goals:

- Address the absence of **observationally-based**, climatological products
- Leverage decades of snowpack data to develop one
 - Data sources include:
 - US Army Corps
 - Various hydropower companies
 - NWS community observers (CoCoRAHS and COOP)
 - Hubbard Brook Experimental Forest
- Contribute to broader understanding of snow depth and SWE
 - Inform water resource management of drought and flood risk assessment



Methodology:

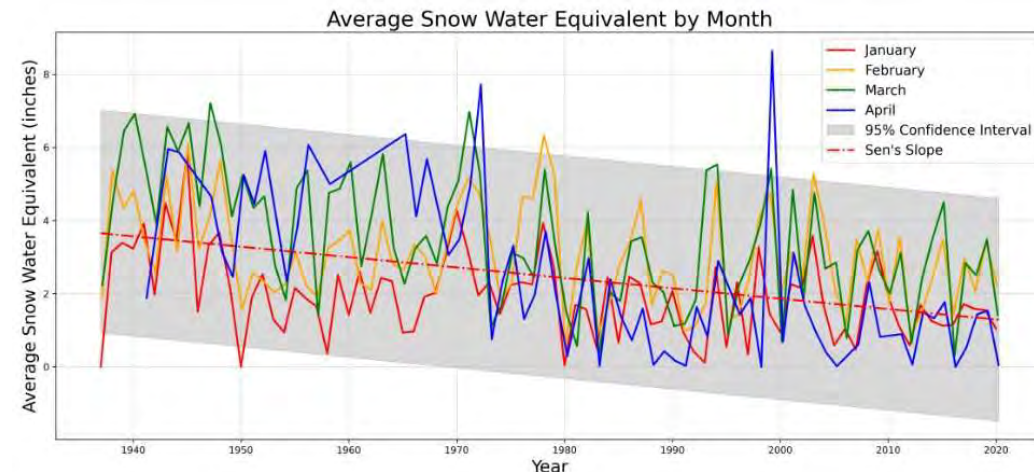
- Quality Assurance (QA) and Quality Control (QC)
- Utilize Python to remove erroneous values such as:
 - $SWE > Depth$
 - Negative Depth/SWE values
 - Rounding differences (depth to nearest tenth and SWE to nearest hundredth)



Methodology Continued:

- Create Metadata files for all data
 - National Weather Service Location Identifier (NWSLI), State-specific ID number, Station Name, Latitude, and Longitude
 - *New York sites include elevation above sea level (ft)*
- Analyze data on large time scales

	NWSLI	ID Number	Station Name	Latitude	Longitude	Elevation
0	GBON6	12E	GREENBORO	43.649167	-75.842783	1473.0
1	OSCN6	24E	NORTH OSCEOLA	43.57945	-75.750883	1550.0
2	HGMN6	32E	HIGHMARKET	43.6167	-75.5333	1844.0
3	NaN	04F	BIG MOOSE	43.82	-74.87	1867.0
13	LVLN6	19F	LOWVILLE	43.8167	-75.4833	738.0



Methodology Continued:

~50% of years contain no snow-out date

- Defined as “last measurement of the year that is 0.0”

Gap-Filling Strategies

- Median used over mean
- Found median snow out dates and melt rate (inches/day)
- Curves tested:
 - LOWESS (Locally Weighted Scatterplot Smoothing)
 - Linear
 - Exponential
 - Quadratic
 - Polynomial (2-4 order)
- ***Snow out dates are calculated every week; may occur in previous six days***

Best Curve for Gap-Filling:

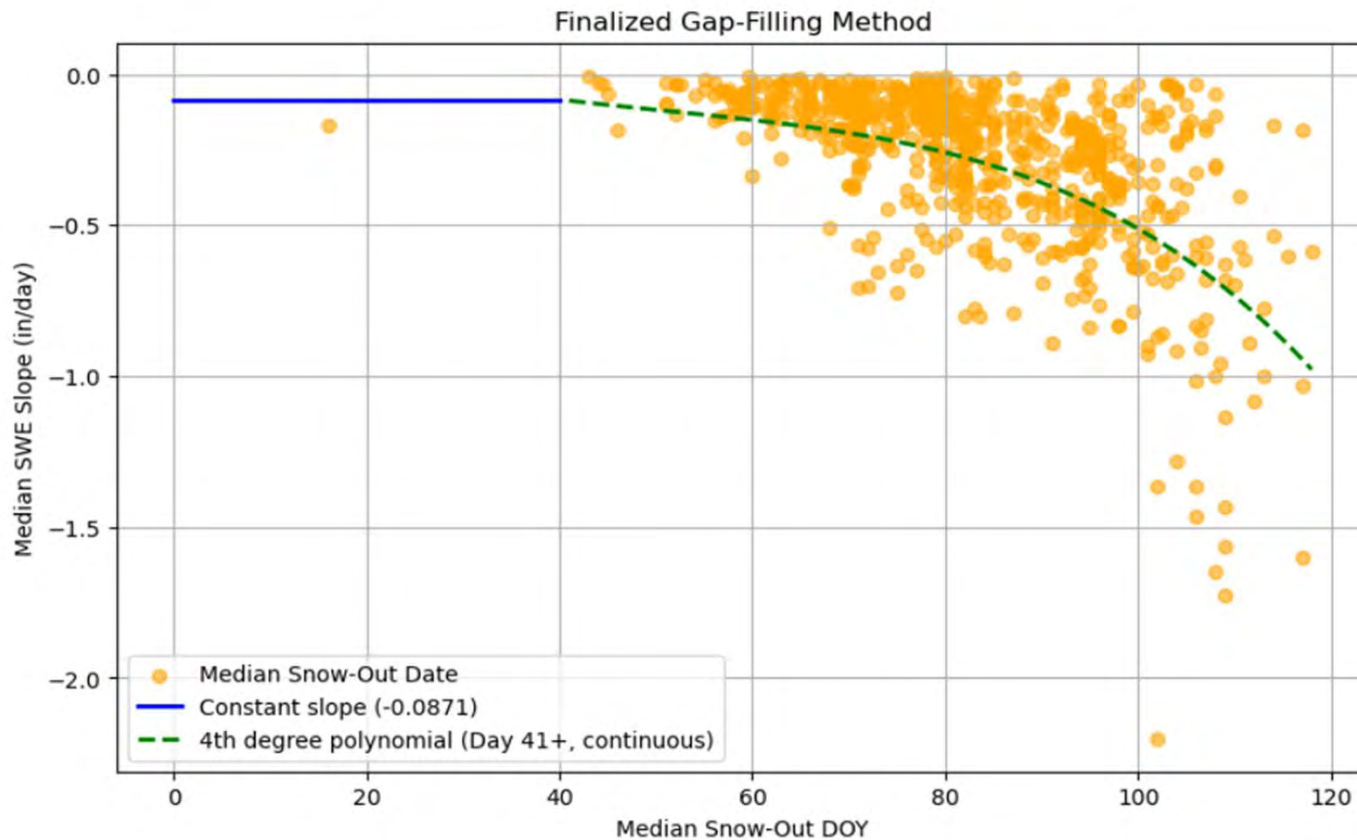
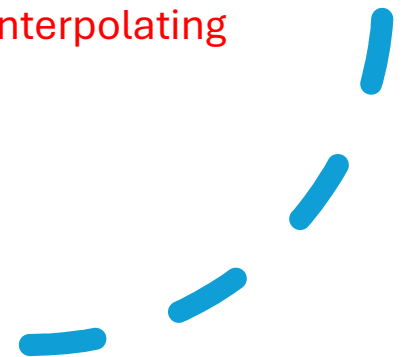


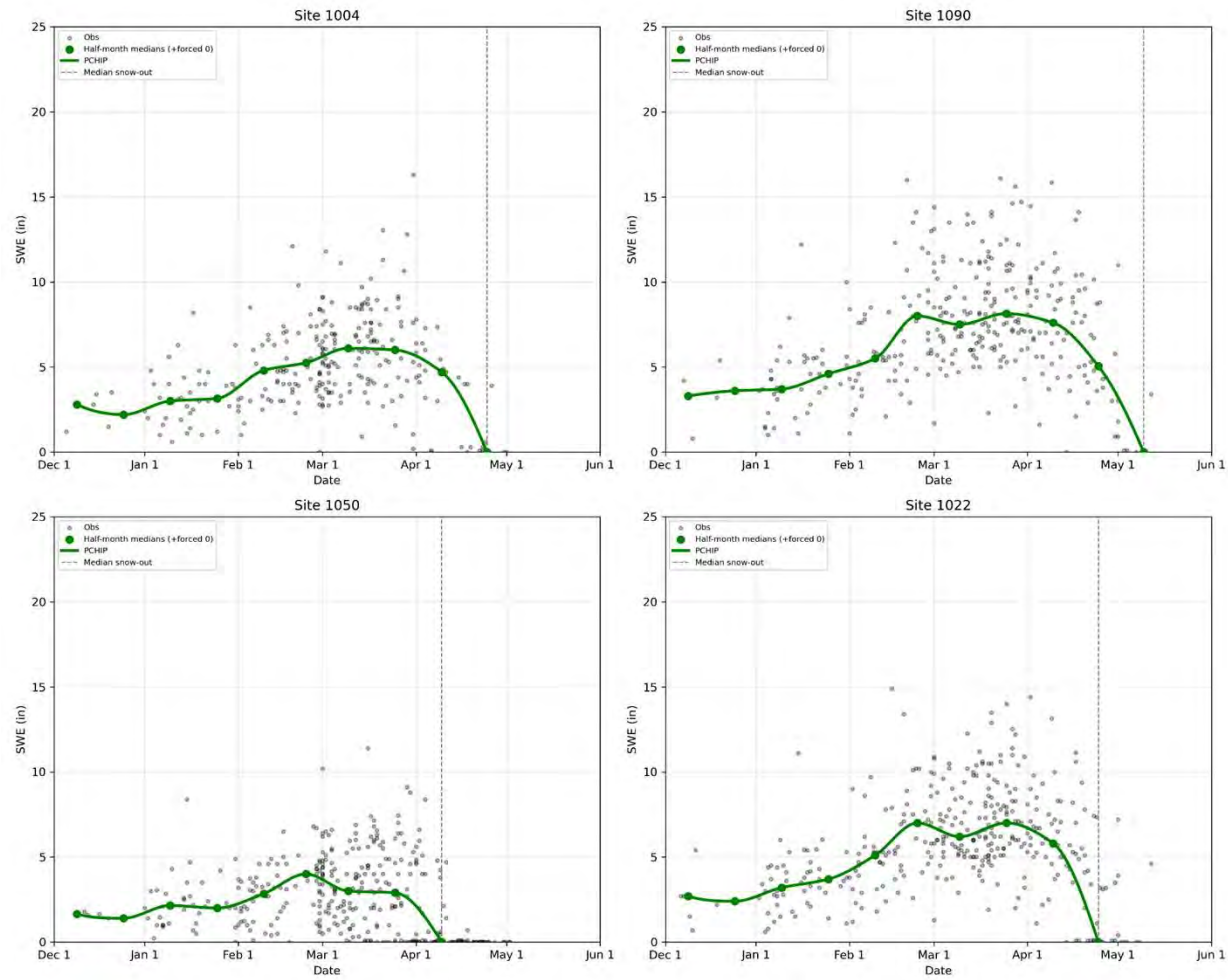
Fig. 1: The curve of best fit for gap-filling missing snow-out dates contains a *constant slope of -0.0871* until day 40, followed by the *fourth-order polynomial curve* from day 41 until melt out.

Methodology Continued:

- Climatological curve fit to gap-filled dataset
 - Curves tested:
 - LOWESS (Locally Weighted Scatterplot Smoothing)
 - Linear
 - Exponential
 - Quadratic
 - Polynomial (2-4 order)
 - PCHIP (Piecewise Cubic Hermite Interpolating Polynomial)



Example PCHIP Curve:



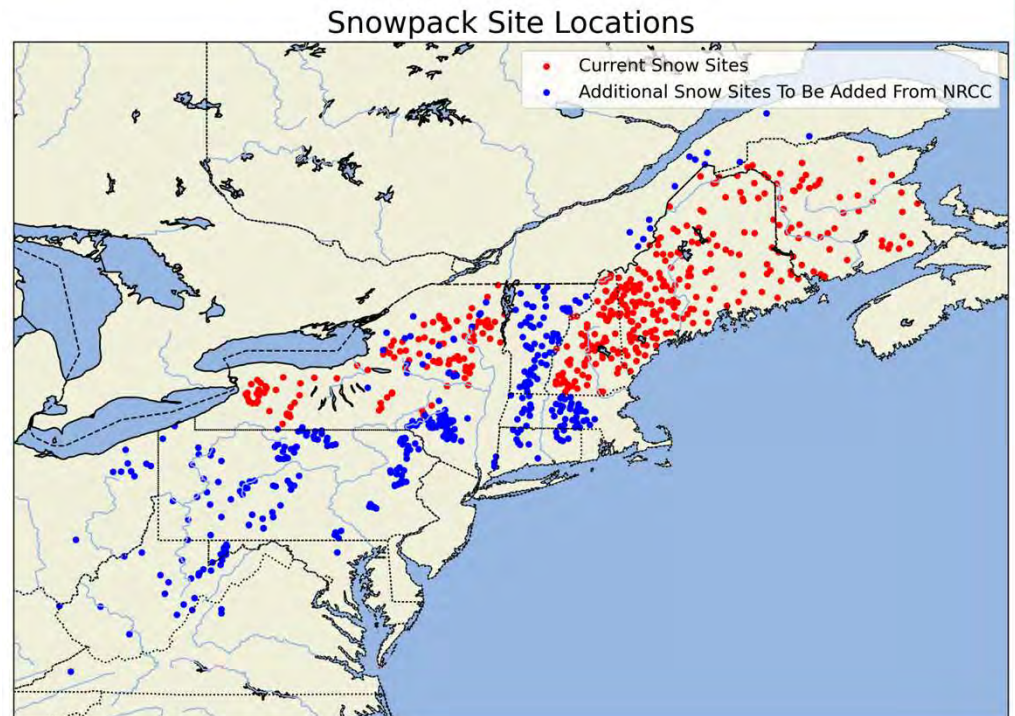
Future Work:

- **Expand to other states**

- Massachusetts
- Rhode Island
- Connecticut
- Downstate New York
- Pennsylvania
- Northeast Ohio
- West Virginia/Virginia

- **Products planned to add:**

- Print daily climatological normals of depth and SWE
- Snow drought index
- Snowpack trends



Future Work Continued:

- Publish products on National Integrated Drought Information System (NIDIS), Northeast Regional Climate Center (NRCC), and Plymouth State websites

RESEARCH AND LEARN

Developing a Northeast Snowpack Climatology



NIDIS-Supported Research

The Northeast Regional Climate Center is working with Plymouth State University to develop a Northeast snowpack climatology that expands our understanding of the seasonal contribution of snow melt to water availability and potential drought in the region. The research team will validate and quality control NOAA/National Weather Service snow course data and associated metadata from across the Northeastern U.S. The team will then curate this quality controlled snow course dataset and format it for the National Weather Service's and the Northeast Regional Climate Center's (NRCC) hydrometeorological needs. The researchers will analyze the data and produce numerous climatological and operational products, including (but not limited to) a Snow Drought Index, daily mean snow depth and snow water equivalent (SWE) conditions for each site, and mean snow-out dates (i.e., when snow has melted out for the season).

These products will provide the necessary climatological context for National Weather Service staff to evaluate how real-time snowpack conditions will impact near-term, medium-range, and seasonal drought and flood risk. These improved hydrometeorological forecasts and seasonal outlooks will help stakeholders, state and local officials, and the public make timely and informed decisions regarding drought and flood risk, water resource management, and all other hydrometeorological operations.

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- Amber Rochon – PSU Graduate



Northeast Regional
Climate Center



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