Windward Snow Drift

What wind speed are required to create snow compaction in a windward snow drift

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Abstract

In collaboration with the Alaska Future Farmers of America (FFA) Delta Junction Chapter and the NASA remote sensing technology program, our task was to document changes in a snow drift located next to Delta Junction High School. Our research concentrated on a specific site to evaluate snow depth and the liquid equivalent of snow melt, alongside examining the impact of wind on snow compaction within a windward snow drift at the southern end of the Delta Junction FFA/High School Complex in Delta Junction, Alaska.

Using various measurement techniques, we systematically gathered data from November 2024 to February 2025, adhering to the GLOBE land cover and snow protocols. Unexpected chinook winds occurred from late January to early February, leading to significant snowpack loss and prompting greater attention to the internal physics of the snow drift. While collecting GLOBE snow samples, our team observed unique formations, including ice bubble lenses, melt clusters, and snow ribs.

The team shifted its primary investigation to the question: "What wind speeds are necessary to cause snow compaction in a windward snow drift?" Student researchers determined that wind does impact snow compaction within the 6-8 mph range, influencing factors such as temperature control, which subsequently contributes to further compaction.

This research period revealed that the volume of meltwater retained in the snow drift is crucial for supporting agriculture and managing natural resources in the interior of Alaska marked by diminished snowpack during a mid-winter chinook event.

Introduction

The Delta Junction FFA High School was offered to join the Snow View GLOBE photos of snow in clouds, trees, and on land intensive observation. (IOP) Through GLOBE training to learn globes protocols for land cover about observing snow on the ground which can be compared to NASA remote sensing technology records to see if they get the same reading.

Potential questions and factors the team considered when collaborating on the “What causes snow compression?”

15 topic ideas were narrowed down to the hypothesis of What wind speeds are required to create snow compaction in a windward snow drift?

Snow is part of the local and global water cycle that impacts agriculture and natural resources within the interior region of Alaska. The purpose was to see how much water equivalent is in the snow for agricultural and natural resources. Sharing of data with citizen scientists around the world about snow drift accumulation due to wind occurrences helps with this purpose. Research found that as the intermittent wind increased the windward drift increased in height.

Delta High School windward drift.

Figure 1. (Above) Showing *snow drift, loss of snow pack, and bare ground during Chinook event at Delta Junction High School south field.*

Hypothesis

What wind speeds are required to create snow compaction in a windward snow drift?

Materials and Methodology

- Globe and landcover snow measurements (snow collection sampling were utilized.)
- From November to February 2025, the windward snow drift at the Delta Junction High school was surveyed for snow ed monitoring.
- Protocol sites selected from toe of the drift to the peak of the drift
- High school students collected and measured snow and melt water samples at each incriminated site.
- Used measuring devices:

1. Meter stick for snow or the lack of snow
2. Rain gauge to measure liquid of total snow (Also known as snow water melt equipment in mm)
3. Snowboard during snow event to measure depth, amount of water, and ph of new snow
4. Weather station to collect wind data

Ice layers on drift; showing of icicle creation/layers.

Figure 2. Showing of Icicle creation/Ice layers on toe of drift- while taking a STELLA meter readings.

Data

- Later on in our research, a Chinook (warm tropical wind) occurred January 24th to February 9th, losing 2000 mm of snowpack .
- Was reported to be high 39 degrees and average 19 degree with wind clocked at 60mph.
- Height of snow drift was 2500 mm tall before Chinook, after it went down to 1524 mm.
- From monitoring before and after the Chinook, estimated a total of 680 mm of snow melt occurred.
- Was reported from Ft. Greely Garrison source.

Data Imagery

Temperature and Wind Speed Data

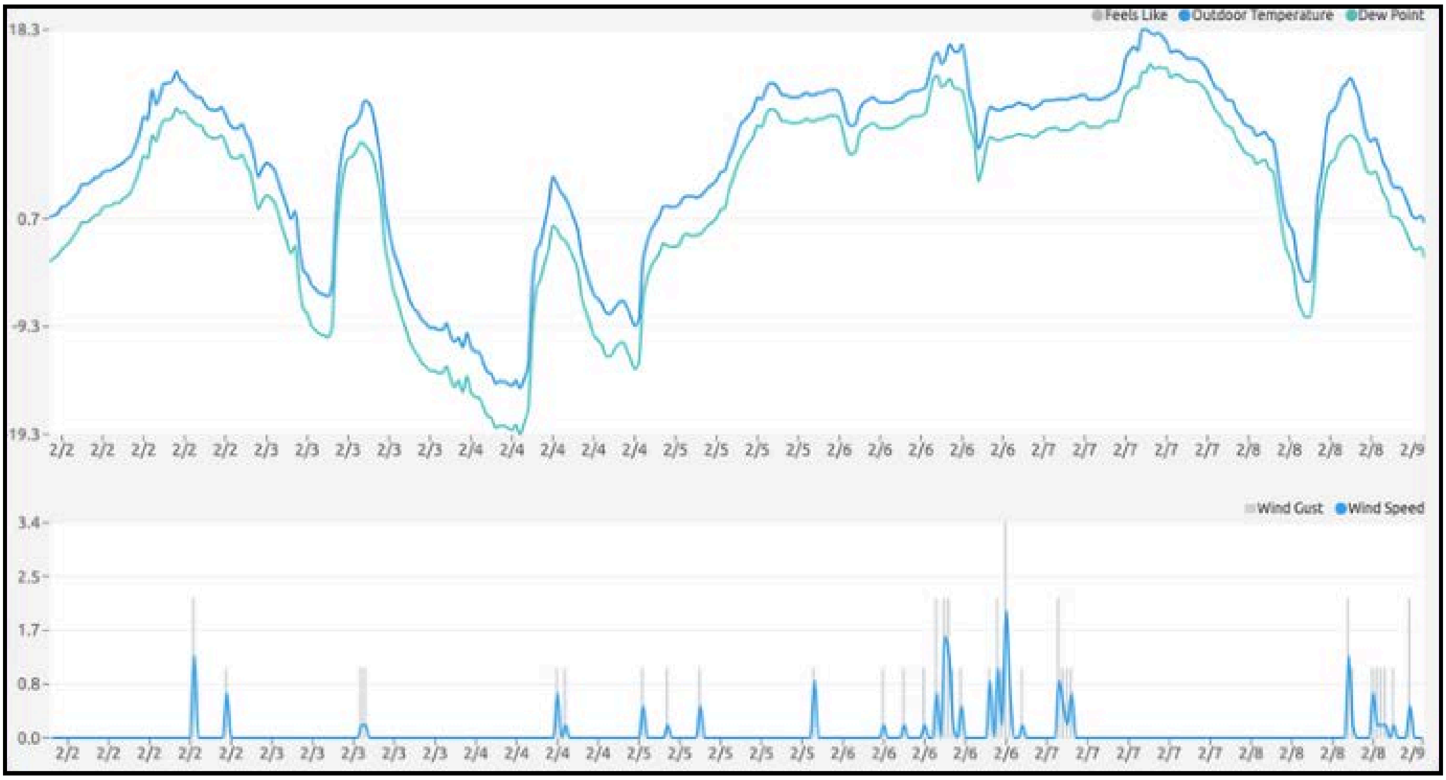

Figure 3. Chart showing temperature(fahrenheit), dew point, wind gust and wind speed form the Delta Junction High School weather station. A new weather station was purchased and installed by the school IT department over christmas break to support our class's Globe Snow View intensive observation IOP region research. The top graph illustrates the outdoor temperature and dew point, and the bottom graph records wind gust as well as wind speed.

These two were taken side by side as to show correlation between temperature and wind as we can clearly see the chinook when both graphs are at their peak.

Windward Snow Drift Depth Measurements.

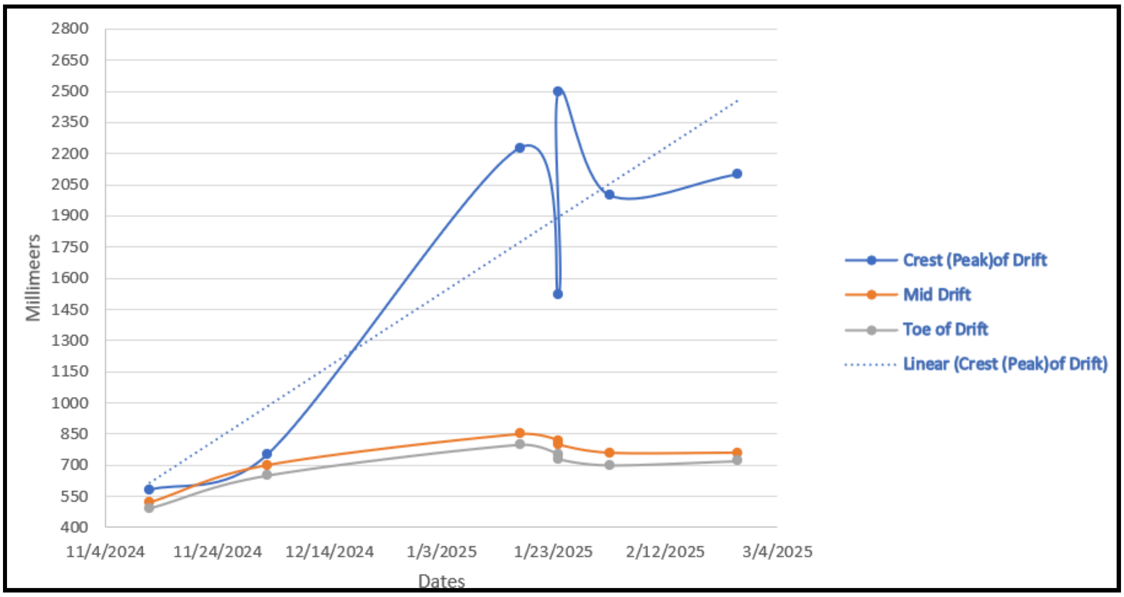

Figure 4. Snow depths for toe, Mid, and crest(peak) snow drift depth measurements in millimeters demonstrates a upward trend in snow drift compaction until the Chinook. Showing direct correlation between wind and compaction ice layers.

Toe of Drift vs. Melt Water

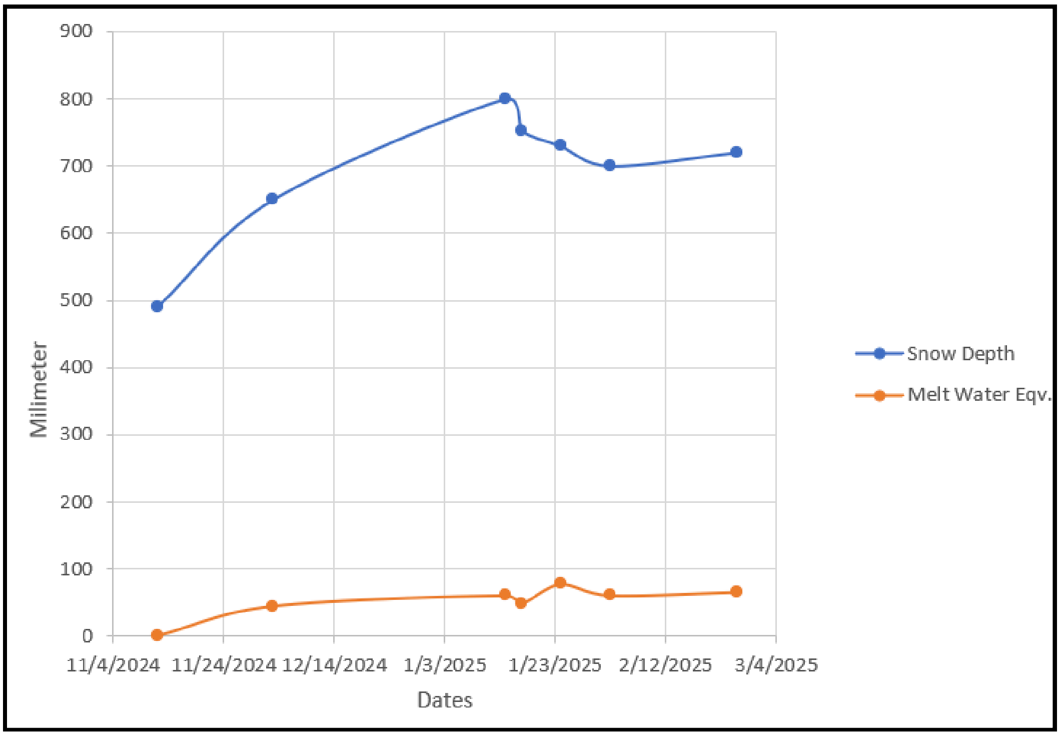

Figure 5. Comparison of the toe of the drift and melt water equivalent in millimeters showing two graph lines mirror the chinook occurrence.

Mid Drift vs. Melt Water

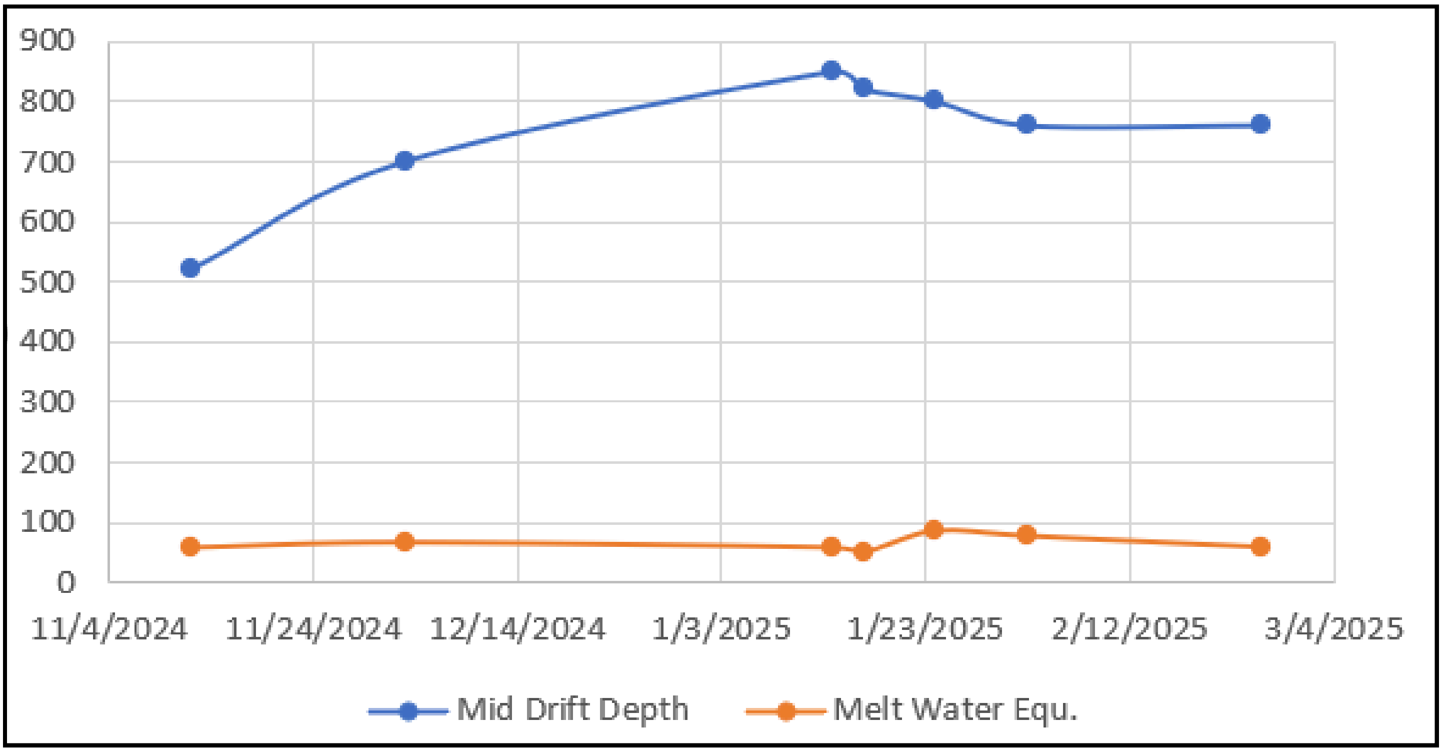

Figure 6. The above graph shows that the amount of melt water held in the mid drift was nearly the same as in the toe of the drift after the Chinook event.

Crest (peak) of Drift vs. Melt Water

Figure 7. The greatest amount of melt water held in the drift was in crest after the Chinook event and is evident by the thin ice layers found when taking the snow sample.

Documentation Dates

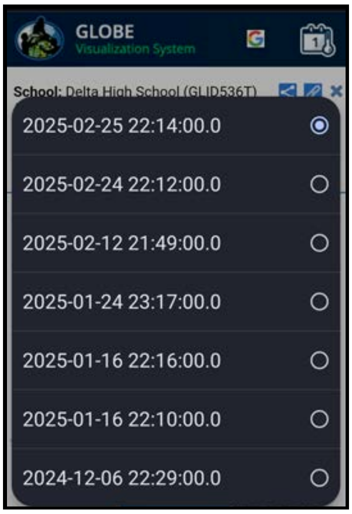

Figure 8. Documentation of using the Globe landcover app.

Global Protocol usage

Figure 9. Using Global protocols to use atmospheric data.

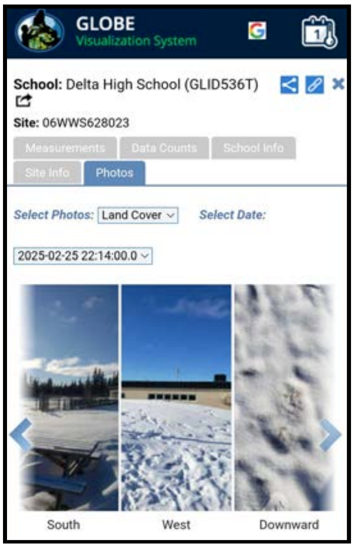

Figure 10. Cardinal photos of the windward snow drift were captured while collecting atmosphere data for Snow View (IOP) in the month of February 2025.

Results

After a few weeks of measuring, we had discovered it was a complete ice layers at the bottom of the snow drift and we were no longer able to measure physically along the snow drift entirely because of the ice lens layer. During this, we had found melt clusters as well when looking around the drift after the Chinook, we discovered ice ribs (snow layer that when heated due to rain, warm weather, etc. melts down). It is uncommon to see a Chinook during this time.

When heat rose, and our melt water started to spread through the snow ribs/boundary layers (percolate), it would then further compact once the atmosphere's heat lowered, made a new layer, as well as fortified the snow ribs.

Weathered down ice layer

Figure 11. Showing of melt clusters.

First site on Drift

Figure 12. Discovery of the ice that completely covered the bottom of drift.

Discussion

Originally, the intention was to compare differences between snow depth and melt water equivalent within a snowdrift to support NASA SnowEx. Intern in collecting data for SWE observations. However, the student researchers witnessed wind affected drift action throughout the season. Over the course of 4 months that we had collected data, we had taken note of pH levels (from 5.89-6.43) using the globe snow pH salt methods by adding salt to melt water (EC). We swiftly changed our focus once the chinook appeared during our research. The aftermath of the chinook completely turned our drift into ice (being unable to measure its full depth), clear showing of ice lenses, and an Ice bubble within the drift. The width of our drift was originally measured 4 ft wide by 3.5 ft tall. As winter storms and intermittent wind continued throughout the time of study, our snow drift rose up to 8 ft at crest and was 15 ft wide. The student researchers observed the degradation and creation of melt clusters, which seem to melt and form a new, compact layer once the water from the water froze.

Next steps for continued monitoring within the windward snow drift:

- Weather station data uploaded to Globe data base in the coming weeks as the snow drift continues to melt during the spring months.
- Students will become familiar with STELLA data collection and comparison of albedo throughout the snow drift- as Mrs. Kovalenko provides modeling lessons and leadership from Oregon State University.
- Student research will also, be share at the Alaska FFA State Convention this coming April.

Conclusion

We had discovered that the wind, specifically lower wind speeds (such as 6-8 mph) can help with snow compaction when it came to our windward snow drift. The wind typically blows it in a leapfrog manner called saltation, helping create a new outer layer. However, it doesn't just do this to the drift. Since wind helps with temper control, the harsher the winds (60-90 mph), the further pressure and compaction is created when it eventually freezes over. The data in the graphs reflect evidence for the ice lenses and layers directly correlating with the chinook winds. The graphs demonstrate a big drop from 2200 mm of snow depth before the chinook, to 1500 mm. We see the crest of the drift building, having an upward trend before the chinook happens, the warm winds causing a drop, then saltation of the drift resumes shortly after. The melt water becoming trapped infiltrating within the drift creating ice layers. The hydrofracturing within the drift forms melt cluster crystal formations.

Airs in crest snow SWE for crest graph

We have replicated our snow swe collection and will be sending you the photos to show you the data. Rain tube full of snow 30 mm, swe for volume 95mm

Second, the other snow collection tubes were 3mm smaller in diameter than the rain gage. One of the issues validated.

Research will continue through 2025 until snow has dissipated and water findings can be fully calculated

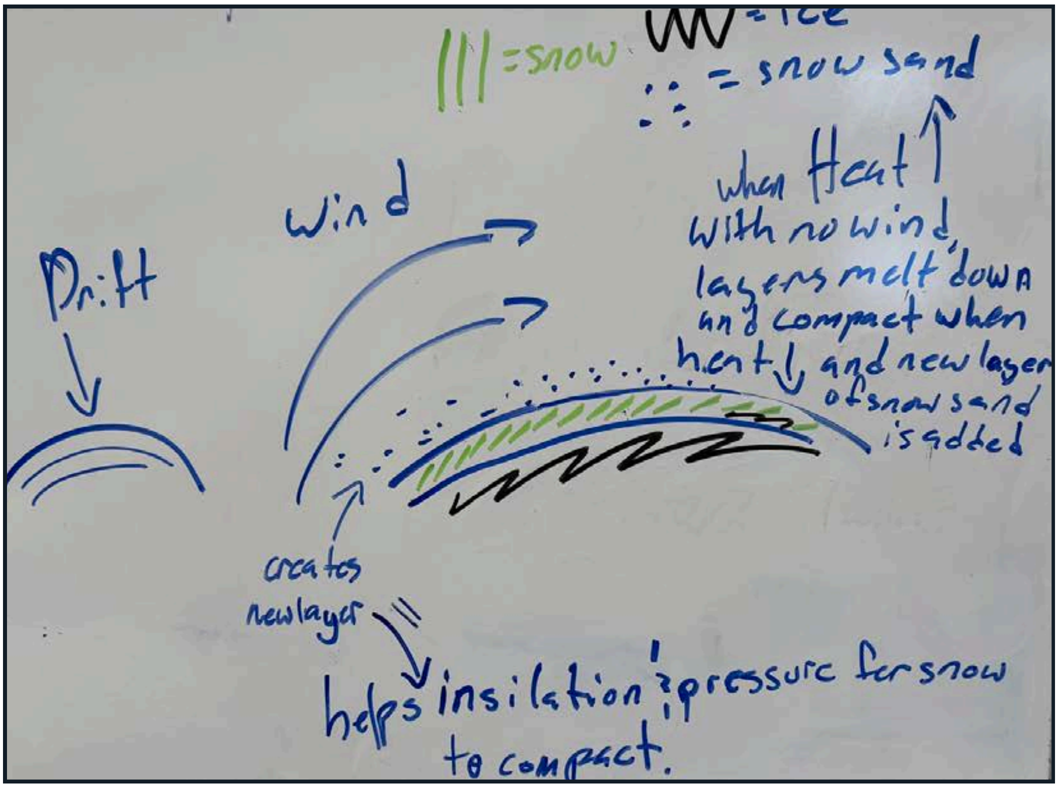

Figure 13. The student drawn diagram of findings and observation regarding wind and snowdrifts compaction.

Badges & Description

STEM Storyteller:

Fianna Rooney presented the research findings and story about the windward snow drift at meet the scientists snow view IPP (international event) with various countries and states, Delta High School was the host site for meet the scientist. In addition, the same data was presented to the delta Greely school district school board.

Data Scientist:

This study had collected data from Globe and land cover measurements as well as examining the local Delta High school weather station for further information. By doing this we learned to take scientific protocols and data which will support a NASA interns project. The students thoroughly compared snow depth to melt water as well as engaged learners from around the state by presenting the teams data, collaborating with science and education specialists, program manager and geographic network of Alaska faculty in measuring snow and water equivalent in snow drifts.

Student Researcher:

In this study, my team of classmates and I collected various data using Globe on land observations (sampling) and information from the weather station. During this, I had played a key role leading the group under the guidance of my teacher and our Globe mentor in collecting snow measurements. As a team, we have and will continue to collect the snow data and observations in order to come to a full conclusion on our current research question.

References

Sturm, M. (2010). *Apun*. University of Alaska Press.

Globe Alaska and NASA SnowEx: Reciprocal

Julia White, NASA SnowEx. Intern University of Alaska Fairbanks, MS Earth Systems Science , Geophysical Institute, Alaska Satellite Facility.

Christina Buffington, UAF mentor University of Alaska Fairbanks, Geophysical Institute, Geographic Information Network of Alaska(PI*)

Graham Rooney SGM, Senior Enlisted Adviser, Arctic Regions Test Center, U.S. Army

Globe Program "Meet the NASA Snow and Data Scientist" February 28, 2025; Meet the NASA Snow and Data Scientist .Presenters Dr.Carrie Vuyovich, NASA Lead SnowEx

Scientist, Julia White, NASA SnowEx. Intern, Delta Junction Junior and Senior High School students and FFA, and Tammie Kovalenko, Globe Educator