Process Book: Exploring Snowfall Data Captured by the Differential Emissivity Imaging Disdrometer

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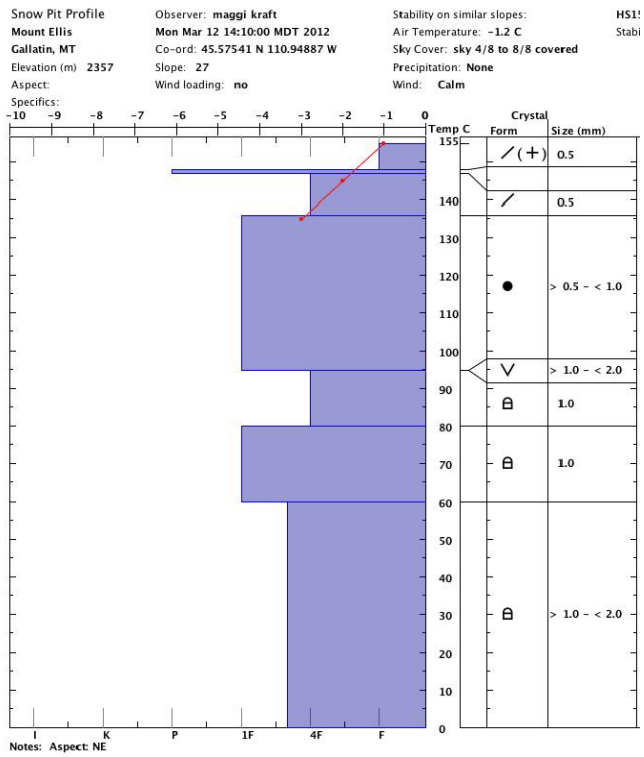
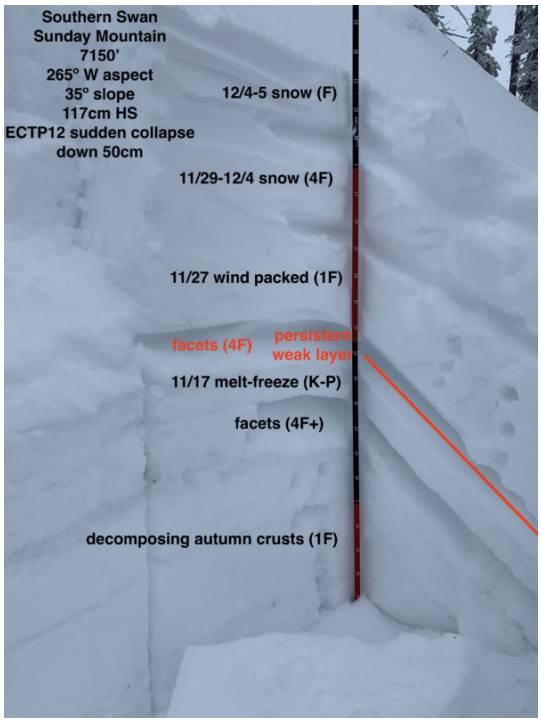
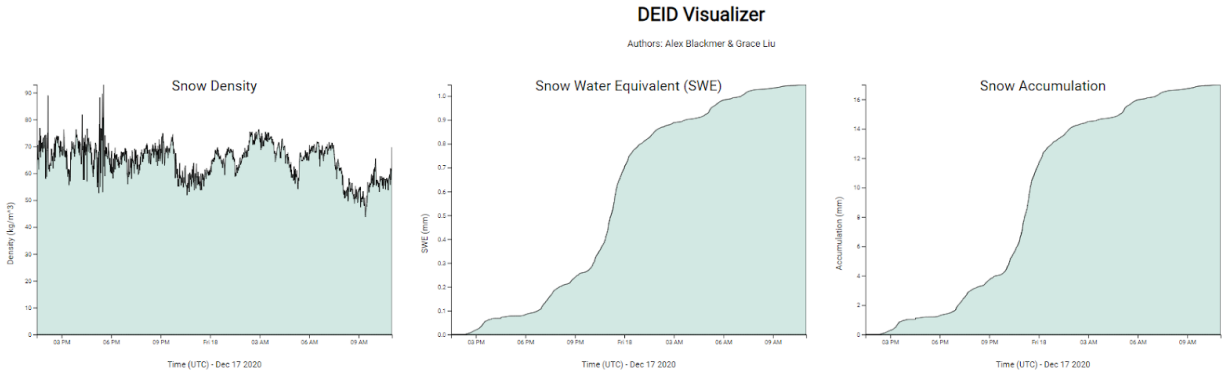
The primary goal for this visualization is to provide an interactive tool to understand parameters critical to snow science and avalanche dynamics as captured by the Differential Emissivity Imaging Disdrometer (DEID), a novel instrument developed in Dr. Tim Garrett's group. Those parameters are snow density, snow water equivalent (SWE), accumulation total, and accumulation rate. They describe the physical characteristics of a snowpack and are especially useful for avalanche forecasting.

The density visualizations are heavily influenced by snow pit profiles collected by snow and avalanche professionals. The figure on the left is the graphical representation of data physically collected in snow pits like the one shown on the right. Since snow density and vertical layering is a critical component of determining slabs and weak layers in the snowpack, density is plotted against height from the ground. We created a graph that visualizes density over height in a similar fashion to provide a clear visual analogy between the two.

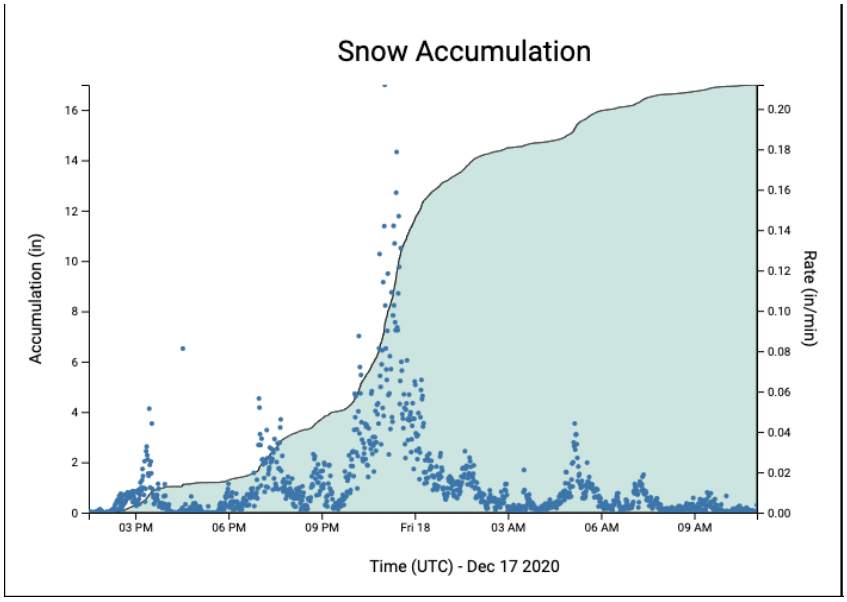




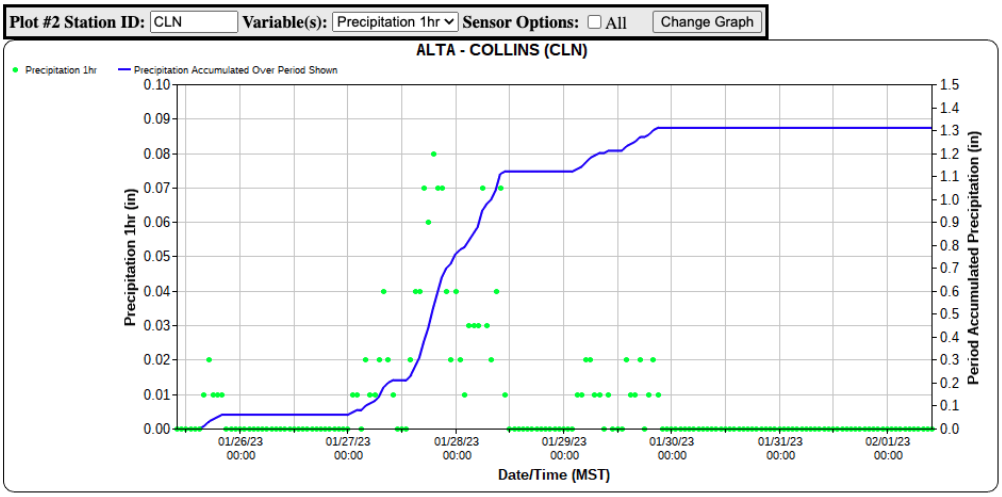
We started by creating a few simple area graphs with brushable zooming features. The first was the snow density over time, followed by SWE and snow accumulation. Since both variables are derived from the same DEID data, the trends are the same. Consolidating these graphs is the ultimate goal, as representing them as two is redundant.



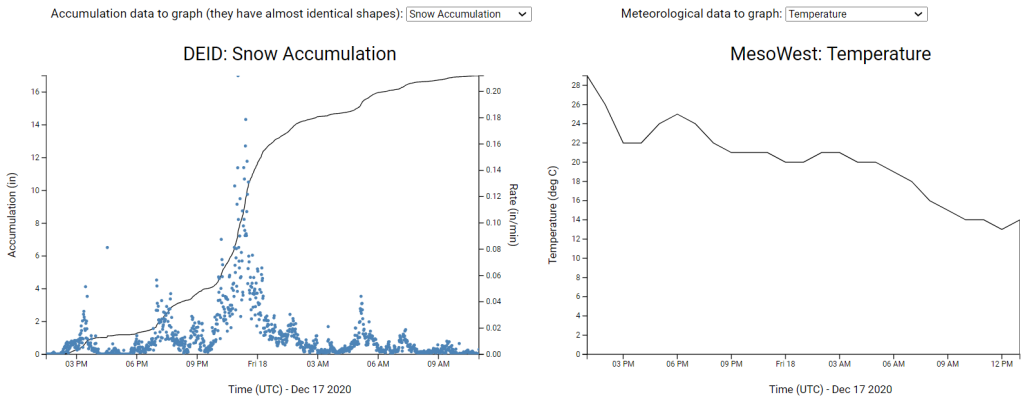
Following that, we decided to calculate the accumulation rate of both SWE and snow to plot with the accumulation figures. This gives an idea of when the snow fell the hardest.



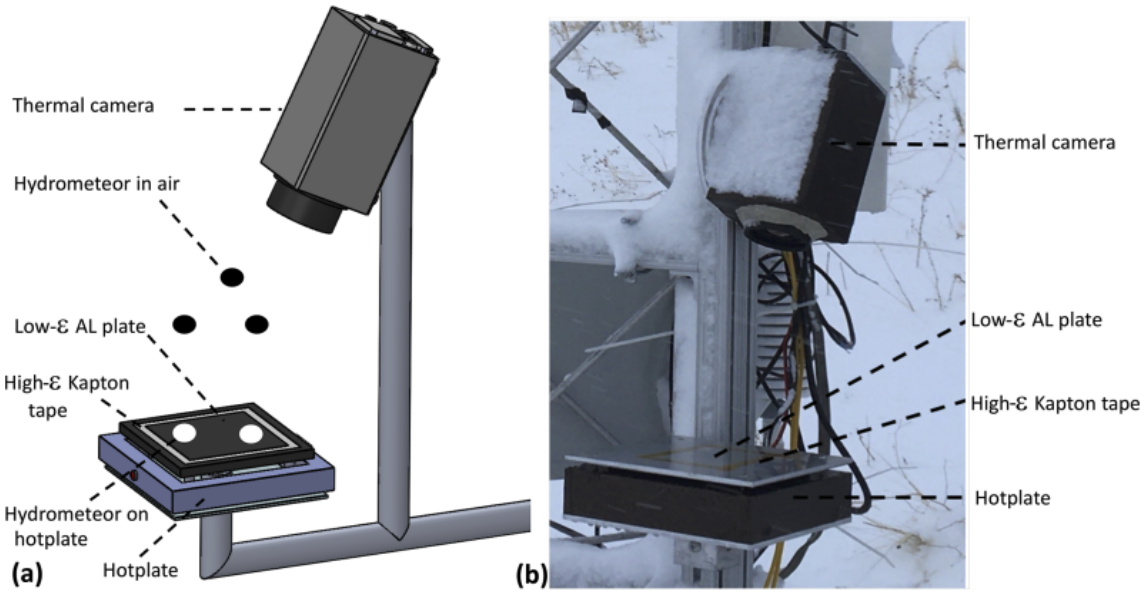
We also intend to create a graph comparing the weather data collected from MesoWest. Illustrating the comparisons between the meteorological site and the DEID will allow for visual validation of the DEID data. The parameters of interest will be snow accumulation rate and total accumulation.



Result:



Since the data is from a novel meteorological instrument, it will be important to provide the pertinent background information to readers of our visualization. We embedded a sample of the DEID's video data as part of that explanatory section. Adding a picture of the DEID will also provide more context behind the data.

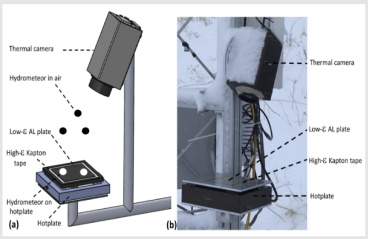


This is a visualization of snowfall data collected by the Differential Emissivity Imaging Disdrometer (DEID).

Data was collected at the Alta-Collins observation plot in Little Cottonwood Canyon, Utah. In addition to DEID data, the co-located weather station reported the following data to MesoWest; temperature, overall snow depth, hourly snow interval, and hourly snow water equivalent accumulation rate. The captured storm event occurred December 17-18 2020.

The DEID consists of a thermal camera focused on a hot plate. Viewed from a thermal camera, the surface of the roughened heated aluminum plate is dark due to its low infrared emissivity. Hydrometeors have large emissivity values at high temperatures, appearing as bright regions on the hot plate. From these outlines the hydrometeor's size and area can be measured by counting pixels.

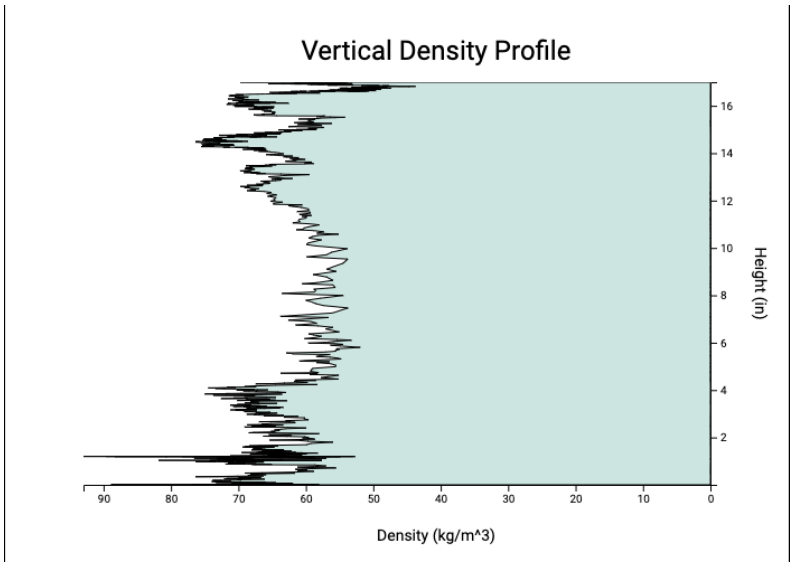
Data courtesy of Dr. Tim Garrett
Read more about the DEID here



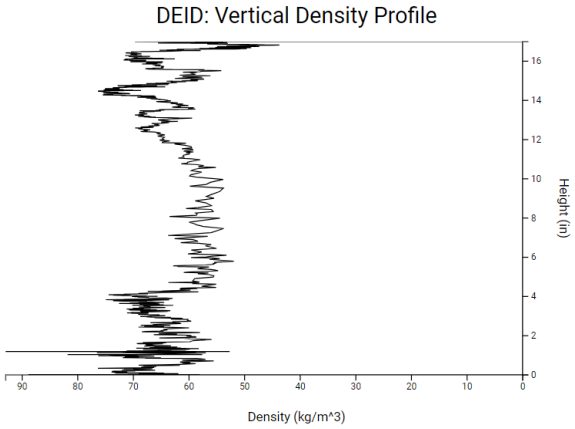
(a) Schematic of the DEID.
(b) Photograph of the DEID after deployment in field experiments.

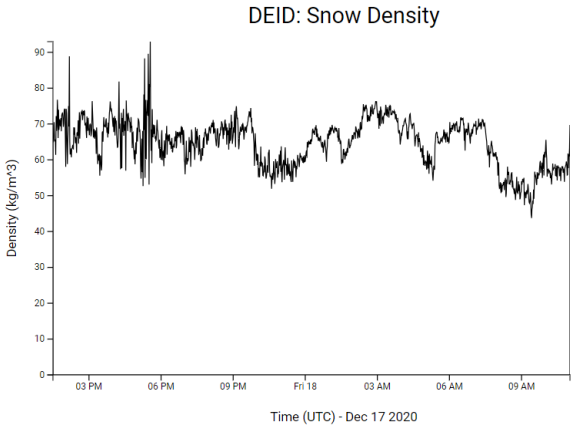
Above is a raw video collected by DEID of snowflakes falling and melting atop the hot plate.

The most practically important visualization we can create is the density versus snow accumulation. It will be useful to snow science professionals who have purchased the DEID. What we have done so far is a fantastic starting point, but we would ultimately like to further flesh it out. One idea is to color-code the area graph by average density to further emphasize the differences in density layers. This will be done by preprocessing the density data with smoothing and finding the most abrupt changes in density to define layer boundaries.



Result:





Milestone Notes

Steps for project milestone

- ~~Plot other DEID variables as brushable graphs (copy and paste)~~
    - ~~Alex~~
- ~~Orient density graph vertically~~
    - ~~Alex~~
- ~~Plot MesoWest variables on one graph, toggle between vars~~
    - ~~Use Grace assignment3 for variable dropdown~~
- ~~Embed sample video in website~~
    - ~~Alex access video; try to embed~~
- Explanations
    - Start by copying background from proposal; add NWS links for scientific vars
- Bind graphs by time (DEID, DEID and MesoWest)
    - Toggle for binding
    - Grace. Don't worry about toggling at first
- Work on process book (screenshots below)
    - Alex describe data collection and preprocessing
- ~~Get accumulation rates to plot (differentiate accumulated depth)~~, ~~plot on acc graph~~
    - ~~Grace~~

Future

- Make it pretty
    - Standardize css styles
- Toggle for orientation?
- Add text to cursor
    - Alex has already developed a cursor class, it just isnt working right
- Video file, bind to brushable area
    - Get to lower resolution if needed
    - Speed up? Toggle for speed?
- Plot layers color coded by density (or position by density)
- Drop down between different storm events
- Make met graph x-axis same as DEID