Using ICESat-2 Altimetry to Derive Snow Depth over the Boreal Forests and Tundra of Alaska in Support of the SnowEx 2022/2023 Campaign

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ABSTRACT

The SnowEx 2022/2023 campaign was conceived to address questions about snow water equivalent (SWE), snow depth, and albedo in boreal forest and tundra environments. A series of field and airborne missions were conducted to accomplish these objectives through snow pit measurements, synthetic aperture radar (SAR), and lidar, among other methods. There has also been an emerging interest in using surface elevation measurements from the Ice, Clouds, and Land Elevation Satellite-2 (ICESat-2) mission for snow depth estimates. In this work, we present preliminary snow depth retrievals as derived from a combination of ICESat-2 data and snow-off digital elevation models (DEMs). We compare the ICESat-2 results to snow depths gathered from airborne lidar in March and October 2022 over five field sites in Alaska (Bonanza Creek, Caribou Creek, Creamer's Field, Toolik Station, and the Arctic Coastal Plain). Our results show general agreement between ICESat-2 and lidar-derived snow depths, particularly when the terrain is flat, and vegetation is accounted for. The mean bias in ICESat-2 snow depth relative to airborne lidar is -0.08 m We will expand upon these results in future work, using comparisons with field data, SAR, and stereographic imagery.

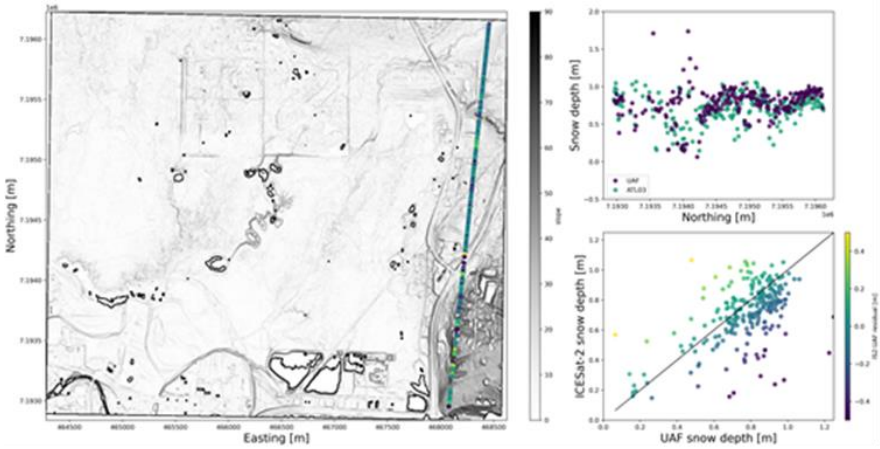

Figure 1. (Left) A slope map of Creamer's Field in Fairbanks, AK, derived using airborne lidar. The line is an ICESat-2 track that passed the field site on 21 March 2022, with the colors representing snow depth residuals between ICESat-2 and airborne lidar. (Top right) Along-track snow depth estimates for the ICESat-2 ATL03 product (green) and the UAF airborne lidar (purple). (Bottom right) Scatter plot of snow depths, with points colored by the snow depth residuals.

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