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Mapping snow depth in the Arctic with public satellite elevation datasets, a case study in Iceland with ICESat-2 and the ArcticDEM

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Satellite datasets are especially useful to monitor the cryosphere in vast and remote environments, such as the Arctic, where seasonal snowpack controls permafrost distribution, surface runoff, plant growth and animal survival rate. The recent availability of free, high-precision and high-resolution elevation datasets show promises to map snow depth on a large scale, a key bulk variable of the snowpack. Here, we mapped the snow depth distribution across Iceland (65°N) using elevation data from ICESat-2, a photon-counting laser altimetry satellite, and the ArcticDEM, a large set of digital elevation models from satellite stereoimages. The snow depth was retrieved through comparison of acquisitions with snow-on conditions (ICESat-2, ArcticDEM) and snow-free (summer ArcticDEM). Despite the heterogeneous spatial coverage of the two datasets, negative impacts of clouds, polar night and a shallow snowpack often close to the limit of detection, we successfully retrieved snow depth from 2018 to 2023, at monthly resolution. By leveraging large publicly available datasets, this approach is promising to further monitor the snowpack in other regions of the Arctic.