**Title**

Detecting Alpine glacier changes from a combination of ICESAT-2 and GEDI data

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**Abstract**

The melting of mountain glaciers worldwide contributes significantly to global sea level rise, and is considered an indicator of climate change. The accurate modelling of glacier heights is crucial for determining their past, current and future state. The new lidar altimeters ICESAT-2 and GEDI were launched in 2018, which could provide valuable new data in this regard. ICESAT-2 uses a novel photon counting technique that delivers elevation data at an unprecedented 0.7 m along-track resolution. This also poses questions about how such data should be processed. GEDI uses a more conventional full waveform sensor, which creates a vertical profile of surface returns every 60 m representing a footprint with a 30 m diameter. In this thesis the potential of ICESAT-2 and GEDI for detecting glacier changes in Austria is examined. The vertical errors on the Austrian glaciers of the ATL03 geolocated photons and ATL06 Land ice elevation data products of ICESAT-2 were found to be 1.94 and 1.72 meters respectively, which outperforms most alternative sensors. The GEDI L2A product provides an error of 5.80 m for the same area. For both sensors, the horizontal geolocation error was found to be relatively large, which results in a strong relation between the surface gradient and the vertical error. The high resolution and accuracy of ICESAT-2 can provide valuable detailed information about glacier height differences worldwide. The inclusion of GEDI data can help provide observations in sparsely sampled areas, but considering its relatively poor resolution and accuracy better alternatives may be available. The satellite observations were confined to glacier inventory outlines and compared to a high quality Digital Elevation Model of Austria. The results show an average glacier height loss of 5.85 m for ICESAT-2 and 4.86 m for GEDI, with the majority of observations representing the period 2010-2019. The height differences were compared with their local elevation, slope, orientation and their distance to the glacier edge, in order to find what features could assist in extrapolating the observations. All features show some relation with the glacier height differences, but the elevation and distance to glacier edge were found to contribute the most information.
Spaceborne lidar data is confined to narrow profiles of the surface, so they require extrapolation to make conclusions about the total state of the glaciers. The total mass difference of Austria was estimated first by simply applying the average height difference to the total glacier area, and secondly by ordinary cokriging with the elevation. Both techniques agree on a total mass loss of 1.59 gigatons, while the cokriging method additionally results in a more detailed image of mass loss for individual glaciers. For the Ötztal region a mass loss of 77.07 megatons annually was estimated for the period 2010-2019.