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Monitoring glacier mass change in northern Sweden from 2003 to 2023 using satellite altimetry data

Global warming is a recognized global issue, with glacier changes serving as sensitive climate change indicators. Glacier mass balance is one of the most important features in estimating glacier change. Traditionally, field observations have been the primary method for measuring glacier mass balance. These in situ measurements are mainly based on pits, stakes, and cores. Field measurements, however, can be very expensive due to the need for repeated manual measurements and are constrained by limited spatial coverage across glacier regions. Modern remote sensing technology has revolutionized the study of glacier mass change by providing global coverage of remote sensing data at varying spatial and temporal resolutions.

The analysis of glacier mass changes in northern Sweden from 2003 to 2023 utilized data from satellite altimetry data ICESat and ICESat-2, along with Swedish national DEM and RGI v7.0 glacier boundary. The total volume decreased by -2.78 ± 0.58 km³, corresponding to a total mass loss of 10.41 ± 6.60 m w.e. over the past two decades. These changes contribute approximately $6.52 \cdot 10^{-3}$ mm to global sea-level rise. The study reveals a general trend of glaciers losing mass throughout the observation period.

Additionally, in-situ measurements in northern Sweden were obtained to evaluate the results from the altimetry remote sensing method. The results are all reasonable compared to the in-situ measurements. Except for Storglaciären, the in-situ measurements of the other glaciers exhibit more negative mass balances compared to those measured by altimetry data. The relationship between glacier mass changes and temperature changes was also analyzed by comparing the average temperature during the glacier melt season with the annual average glacier mass balance obtained from the results. As the average temperature of melt season increases, the glacier mass changes increase.

Keywords: Altimetry, Climate change, Glaciology, ICESat, ICESat-2, Mass change, Satellite, Sea-level rise, Sweden

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