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Glacier changes in northern Sweden since 2003

Global warming is a recognized global issue, with glacier changes serving as sensitive climate change indicators. The rate of warming has accelerated significantly since 1980s. Glaciers worldwide show evident retreat, including reduced area, decreased mass, and rising boundaries. Glacier mass balance is one of the most important features in estimating glacier changes. Traditionally, field observations have been the primary method for measuring glacier mass balance. Researchers measure glacier melt by monitoring stakes ablation and snow accumulation from pits and cores in study areas. 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. In Sweden, most glaciers are small and dispersed. The total glacier area in Sweden amounts to only 261.38 km², representing only 0.37% of the global glacier area.

This master's thesis aims to monitor glacier mass changes in northern Sweden from 2003 to 2023, addressing the gap in measuring Swedish glacier changes using satellite data. The total volume decreased by -2.78 ± 0.58 km³ 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. 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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