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Increase of ice discharge from Greenland's peripheral tidewater glaciers over recent decades

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The Greenland Ice Sheet is losing mass at increasing rates. Substantial amounts of this mass loss occur by ice discharge. The ice sheet is surrounded by thousands of peripheral glaciers, which are dynamically decoupled from the ice sheet, and which account for ~10 % of the global glacier ice volume outside the two main ice sheets. Rather low-lying along the coasts, these peripheral glaciers are also losing mass at increasing, but disputed, rates. The total absence of knowledge about the role and share of solid ice discharge in this mass loss adds to the controversy. Since the quantification of ice discharge is still pending, a full understanding of ice mass loss processes in this globally important glacier region is substantially hampered.

Here, we present the first estimation of ice discharge from Greenland's peripheral tidewater glaciers. For each of these 760 glaciers, we combine an idealized rectangular flux gate cross sections derived from modelling with the Open Global Glacier Model with surface ice flow velocities derived from the ITS_LIVE and MEaSUREs remote sensing datasets to calculate glacier specific ice discharge on both annual and multi-annual time scales over the period 1985 to 2018. For the few glaciers not covered by either of the employed original datasets or modelling methods we use a regression tree-based extrapolation scheme to estimate the necessary input data for our calculation.

Our findings indicate a significant overall increase of ice discharge over the study period although several individual glaciers show contrasting developments. This increase became especially apparent across the southern parts of Greenland. Our results also show that the total of the ice discharge from Greenland's peripheral tidewater glaciers is dominated by few major contributors and that this dominance is completely time-independent.