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Evaluating Petermann Gletscher ice-shelf basal melt and ice-stream dynamics from high-resolution TanDEM-X elevation data.

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Petermann Gletscher drains 4% of the Greenland Ice Sheet that contains an estimated volume of ice equivalent to a 0.5 m global sea-level rise. It terminates in the longest floating ice shelves in the Northern Hemisphere. A significant portion of the glacier's drainage basin is grounded below sea level on a downsloping bed, hence prone to rapid retreat if the glacier was pushed out of equilibrium by climate warming. Previous studies documented near-zero mass balance and a steady grounding line position during the last three decades. However, more recent observations revealed the transition to a new phase characterized by rapid grounding line retreat and accelerated ice flow after 2016. Increased basal melt due to warming ocean temperatures has been identified as the physical mechanism driving the retreat process. Nonetheless, a comprehensive evaluation of the magnitude and spatial variability of basal melt has not been performed yet. Its contribution to the ice mass loss remains, for this reason, poorly constrained.

In this study, we achieve this goal by employing high-resolution digital elevation models acquired by the German Aerospace Centre (DLR) TanDEM-X mission between 2011 and 2021. We derive basal melt estimates from ice elevation changes computed in a Lagrangian framework. The extended temporal coverage provided by TanDEM-X data allows mapping changes in basal malt over different temporal scales with unprecedented resolution and highlights increased melt rates during the second part of the observation period. The melt rate spatial distribution is consistent with the recent inland migration of the grounding line with peak values above 60 meters per year measured along with the western, central, and eastern sectors of the grounding zone.