



## **35 years of satellite observations document several flow-regime changes for a North Greenland glacier**

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Hagen Glacier is a major marine-terminating outlet-glacier that drains 6 % of the Northern part of the Greenland ice sheet. This part of the part of the ice sheet is critically understudied, and here we show that the dynamics of the glaciers in the region can be highly variable, potentially impacting the total mass budget of the whole northern sector.

We present 35 years of ice velocity measurements derived from both synthetic aperture radar (Sentinel-1) and optical satellite data (Landsat). In conjunction with satellite observations of glacier area change and surface elevation change, the data document the surge of Hagen Glacier starting in 2002 in high detail, and reveal both prior and subsequent dramatic changes in flow regime and geometry. During the past 35 years, Hagen Glacier has experienced three distinct flow regimes: i) a long period of 'stagnant' flow causing a general thickening, ii) a period of fast flow with speed-up occurring over winter and iii) a deceleration with constant flow velocities during the winter and a marked summer speed-up. We investigate the possible drivers and controls of the observed changes in the context of atmospheric and ocean forcings, and discuss the future of glacier.