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Solid-ice flux indicators from Petermann glacier, north Greenland: interannual to decadal variability

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The outlet glaciers of Greenland can drain large volumes of solid ice, via calving of iceberg and bottom melting from floating ice tongues. The contribution of these solid-ice fluxes is controlled by ice dynamics, such that it had been generally believed to have a relatively slow response to climate forcing or changes in boundary conditions. However, this assumption has recently been questioned and observations of one surging glaciers in Greenland suggest relatively large and rapid changes in flux are possible. The magnitude of solid ice entering the ocean can be determined ideally by deriving the ice flux crossing line of calving glaciers, using remote-sensing data and ancillary data. Here, our research goal here is to identify the spatial-temporal variability and possible trends in indicators of calving fluxes for the Petermann glacier in northern Greenland, which is relatively unknown. The methodology approach is based primarily on analysis of repetitive satellite data over a period starting from 1990, together with sporadic earlier observations. Different satellite image data has been acquired and explored to estimate the interannual to decadal mean and variability of frontal position and ice-surface velocity (indicators of solid ice fluxes). The multi-sensor data range from high-resolution optical images from declassified satellite data, Landsat, SPOT and Terra ASTER and high-resolution SAR images from ERS and ENVISAT. The SAR data are useful to readily delineate the calving front, regardless of cloud cover. The SAR data include ERS-1/-2, and ASAR ENVISAT. These disparate data have been imported, geo-registered and analysed within a Geographic Information System. Two analysis methods have been used: 1) Delineating the calving front of the glacier and 2) Estimating the surface velocity using sequential satellite images.

We have found from our decadal+ series of image measurements, the surface velocity of the Petermann glacier, below the grounding line is around 800 m per year in early 1990s and slightly greater than 1 km per year in 2002. The calving-front position variability is more episodic, with two main mass discharges from the glacier to the open water in 1991 and 2001.