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Ice velocity and ice elevation changes at Fleming Glacier, Antarctic Peninsula

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The Antarctic Peninsula is one of the hot spots in climate warming with air temperature trends well above the global average. Ice shelves in the region are known to have retreated and collapsed during the last decades with the retreat of Wordie Ice Shelf in the 1980s as one of the first well-documented events. Since then, the retreat has continued reducing the original surface area of about 2000 km^2 in the 1960s to less than 100 km^2 in 2010 that still survive as two small and isolated ice tongues. Fleming Glacier, the largest glacier draining into Wordie Bay, has lost all its floating part and its glacier front is situated upstream of its 1996 grounding line. We investigate Fleming Glacier in order to determine how the change in the buttressing force at its terminus affects the flow behaviour. Ice velocities at the lower reaches of the glacier were determined using image correlation techniques applied to optical and radar satellite data acquired between 1989 and 2010. The results show an acceleration of the glacier of between 30 and 60 % within this time span. During the summer season 2008/2009 GPS measurements were conducted at an altitude of about 900 m a.s.l. and a distance of 40 km from the glacier front where velocity data from the 1970s are available. The data demonstrate that acceleration also affects the upper reaches. A detailed analysis of 10 month of continuous GPS data reveals an acceleration signal even within this short time period. A comparison of airborne laser scanning data acquired in 2004 and 2008 revealed a surface lowering all along a longitudinal profile starting at an elevation of 1100 m down to the ice front where maximum elevation change rates of -4.1 m per year were detected. Elevation trends determined from ICESat data confirm the former result. In summary, negative ice elevation trends together with the acceleration of the ice flow indicate that Fleming Glacier has not yet reached a new equilibrium and is still losing mass due to enhanced ice flow.