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Changes in ice dynamics along the northern Antarctic Peninsula

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The climatic conditions along the Antarctic Peninsula have undergone considerable changes during the last 50 years. A period of pronounced air temperature rise, increasing ocean temperatures as well as changes in the precipitation pattern have been reported by various authors. Consequently, the glacial systems showed changes including widespread retreat, surface lowering as well as variations in flow speeds. During the last decades numerous ice shelves along the Antarctic Peninsula retreated, started to break-up or disintegrated completely. The loss of the buttressing effect caused tributary glaciers to accelerate with increasing ice discharge along the Antarctic Peninsula. Quantification of the mass changes is still subject to considerable errors although numbers derived from the different methods are converging. The aim is to study the reaction of glaciers at the northern Antarctic Peninsula to the changing climatic conditions and the readjustments of tributary glaciers to ice shelf disintegration, as well as to better quantify the ice mass loss and its temporal changes.
We analysed time series of various satellite sensors (ERS-1/2 SAR, ENVISAT ASAR, RADARSAT-1, ALOS PALSAR, TerraSAR-X/TanDEM-X, ASTER, Landsat) to detect changes in ice dynamics of 74 glacier basins along the northern Antarctic Peninsula (<65°). Intensity feature tracking techniques were applied on data stacks from different SAR satellites over the last 20 years to infer temporal trends in glacier surface velocities. In combination with ice thickness reconstructions and modeled climatic mass balance fields regional imbalances were calculated. Variations in ice front position were mapped based on optical and SAR satellite data sets.
Along the west coast of the northern Antarctic Peninsula an increase in flow speeds by ∼40% between 1992 and 2014 was observed, whereas glaciers on the east side (north of former Prince-Gustav Ice Shelf) showed a strong deceleration. Nearly all former ice shelf tributaries showed similar reactions to ice shelf disintegration, with a significant acceleration and frontal retreat after ice shelf break-up and a subsequent deceleration and front stabilization. In total an ice discharge of 17.93±6.22 Gt/a was estimated for the study region in the period 2010-2014. Regional mass balance estimates indicate nearly balanced mass budgets in the period 1992-1996 and positive imbalances in more recent years (2010-2014), dominated by the clearly positive mass balances along the west coast due to high climatic mass balances.
The detailed multi-mission time series analysis of glacier changes supports the interpretation of the ongoing processes in this region and allows multi temporal imbalance estimates.