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Seasonal ice velocity variability of Western Antarctic Peninsula tidewater glaciers from high temporal resolution Sentinel-1 imagery

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In Antarctica dynamic ice loss dominates the continent's contribution to sea level rise and the magnitude of dynamic ice loss depends in part on the ice speed at marine-terminating glacier grounding lines. Long term dynamic ice speed variations in Antarctica have been observed on multi-year timescales, most notably in ice speed increases in the Amundsen Sea sector, Getz basin and Antarctic Peninsula. Glacier and ice sheet speed can also be variable on seasonal timescales, due to surface meltwater-induced variations in basal water pressure and changes in the force balance at the terminus due to terminus advance and retreat. While these seasonal changes are well documented on the Greenland Ice Sheet, observations of seasonal ice speed changes in Antarctica are sparse and poorly resolved.

In this study, we show widespread seasonal ice speed fluctuations near the termini of 106 tidewater outlet glaciers across Western Antarctic Peninsula North of 70° S by exploiting the full Sentinel-1 record from 2014 to 2021. The seasonal speed variations were consistent each year, and are characterised by a summertime speed-up, with speed variability on average 13 ± 6.5% of the annual mean. There is good agreement between our observations of seasonal ice speed changes and time-series of potential forcing mechanisms, including surface water flux, terminus position change and reanalyses of ocean temperature. Our results demonstrate that the glaciers of the Western Antarctic Peninsula are sensitive to forcing in the ice-ocean-atmosphere system on seasonal timescales.

By observing widespread seasonal ice speed variations on the Antarctic Peninsula for the first time, we demonstrate a previously unknown sensitivity of part of the Antarctic Ice Sheet to external forcing over short timescales. This is particularly relevant for mass balance calculations by the input-output method, which typically rely on annual estimates of ice speed that do not capture these seasonal changes. Our dataset covers the Sentinel-1 epoch (2014-present), however the Antarctic Peninsula has undergone the greatest warming of any Southern Hemisphere terrestrial area in the latter twentieth century and atmospheric temperatures are projected to rise further in a 1.5°C warming scenario. Therefore, it is essential to understand the historic prevalence of seasonal speed changes on the Peninsula and to determine the impact of these seasonal variations on annual ice motion, to improve future projections of the Antarctic response to continued warming and its contributions to sea level rise.