Role of Foehn winds in snow sublimation and land-ice changes

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The Pine Island Glacier (PIG), currently Antarctica's single largest contributor to sea-level rise, has recently experienced increased ice loss that has mostly been attributed to basal melt and ocean ice dynamics. However, atmospheric forcing also plays a role in the ice mass budget, as besides lower latitude warm air intrusions, the steeply sloping terrain that surrounds the glacier promotes frequent Foehn winds. An investigation of 41 years of ERA-5 reanalysis data reveals that Foehn occurs more frequently from June to October, with Foehn episodes typically lasting about 5 to 9 h. An analysis of the surface mass balance indicates that their largest impact is on the surface sublimation, which is increased by about 1.43 mm water equivalent (w.e.) per hour with respect to no-Foehn events. Blowing snow makes roughly the same contribution as snowfall, around 0.34-0.36 mm w.e. hr-1, but with the opposite sign. The melting rate is two orders of magnitude smaller than the surface sublimation rate. The negative phase of the Antarctic Oscillation and the positive phase of the Southern Annular Mode promote the occurrence of Foehn at PIG. A particularly strong event takes place on 9–11 November 2011, when 10-m winds speeds in excess of 20 m s-1 lead to downward sensible heat fluxes higher than 75 W m-2 as they descend the mountainous terrain. Surface sublimation and blowing-snow sublimation dominate the surface mass balance, with magnitudes of up to 0.13 mm w.e. hr-1. Satellite data indicate an hourly surface melting area exceeding 100 km2. Our results stress the importance of the atmospheric forcing on the ice mass balance at PIG.