Recent unpinning and calving front retreat of Pine Island Glacier documented by new bathymetric and satellite data

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Abstract

Pine Island Glacier currently experiences the largest negative ice sheet mass balance in comparison to other outlet glaciers in Antarctica and hence is the largest contributor to modern sea-level rise. Ice loss of this glacial outlet and neighbouring ones has increased greatly over the recent decades through ice thinning and flow acceleration that also resulted in rapid grounding line retreat, most likely as a result of basal melting induced by the inflow of warm Circumpolar Deep Water onto the shelf. Due to the glacier's topographic setting, a bed that deepens beyond the grounding line to the deep interior basin of the West Antarctic Ice Sheet (WAIS), it has been suggested that this increased ice loss may be a precursor of WAIS collapse. Despite the increased mass loss, however, the calving front of Pine Island Glacier remained more or less stable in a position west of a pinning point located at the northern part of the glacier and its orientation remained similar (10-30° east of north) since the earliest observations in the mid-20th century. Large icebergs where calved at intervals of a few years, e.g. the B-31 calving event (720 km²) in November 2013, but subsequently the calving front re-advanced close to or even beyond its former position. In 2015 this pattern changed with a calving event initiated by a large rift oriented 55° east of north and the calving front for the first time retreated east of the pinning point. The rifts that initiated this calving event were proposed to have formed by expansion of basal crevasses due to ocean forcing.

In 2017 we were able to access the formerly ice-shelf covered area during RV Polarstern expedition PS104. Bathymetric data from this area revealed a bathymetric knoll with minimum water depth of ~375 m that was the former pinning point of the glacier. A new rift 8-9 km upstream of the calving line that may initiate the next calving event within a year was visited by helicopter. Satellite data acquired in the last decades suggest that unpinning from the bathymetric knoll likely took place in 2006. We use these data collected during expedition PS104 in combination with the satellite data to investigate the impact of glacier unpinning on Pine Island Glacier calving dynamics.

Keywords: Pine Island Glacier, Pinning Point, Ice Shelf Calving, Remote Sensing