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The role of basal roughness on the flow dynamics of Pine Island Glacier

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The degree of coupling between ice and bed is of fundamental importance in controlling the amount of basal motion experience by an ice body. This coupling is controlled by bed roughness and subglacial water pressure, however, bed roughness is often completely ignored, usually because of difficulties in measuring this quantity.

Pine Island Glacier is one of the largest glaciers in West Antarctica and recent thinning and retreat has suggested it may be particularly vulnerable to climatic warming. However, understanding the mechanisms behind recent changes has (until recently) been difficult due to a lack of data and knowledge of conditions at the bed. Here we present a detailed assessment of basal roughness beneath Pine Island Glacier, in West Antarctica, derived from a new airborne radio-echo sounding data-set. These data were collected as part of a major aero-geophysical survey of the Amunsden Sea Sector of West Antarctica, in the austral summer of 2004/05 by the British Antarctic Survey (BAS) and the University of Texas (supported by the National Science Foundation (NSF) of the United States).

Our methodology successfully identifies smooth regions of bed located within fast-flowing tributaries of the glacier. A smooth bed in these regions either facilitates basal motion and/or is a consequence of past/present basal motion. Identifying regions of low roughness beyond the current limits of rapid flow may reveal important information about the stability of Pine Island Glacier, and also perhaps the maximum extent of basal motion at times in the past when the ice sheet was larger and/or more dynamic.