Simplified Models of West Antarctic Ice Streams with Differing Boundary Conditions

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Abstract

Ice streams discharge ice from the interior of the Antarctic Ice Sheet into ice shelves and the ocean, contributing to the mass balance of the ice sheet, and resulting in changes in sea level (Joughin *et al.* 2014). The Amundsen Sea and the Ross Sea sectors of West Antarctica, have large ice stream systems feeding in to the Amundsen Sea and the Ross Ice Shelf, respectively. Currently, many physical processes of ice streams, their natural variability, and their response to changing environmental factors (e.g. climatic conditions, geothermal heat flux), are not well understood. In the Ross Sea sector two ice streams, Whillans and Kamb, have either decelerated their flow (Whillans) or stagnated (Kamb). The cause of this behaviour is hypothesised to be changes in basal properties (Anandakrishnan & Alley, 1997).

Ice streams are likely dependent on the water volume and thermal regime at the basal interface, and are postulated to develop as a result of mechanical plastic failure of subglacial till (Schoof, 2006). Modelling the variability of basal boundary conditions in ice streams can therefore help understand these complex systems. Through modelling, a better understanding of what processes, environmental conditions, and basal mechanisms regulate the flow of ice streams can be obtained. In turn, this will result in a better understanding of the future West Antarctic Ice Sheet response to climatic changes (Paolo *et al.* 2015).

Here we present results from Parallel Ice Sheet Model (PISM) simulations that investigate ice stream variability under a range of perturbed boundary conditions. PISM is a three-dimensional, thermodynamic, open-source, coupled ice-sheet/ice shelf model, which utilises the shallow-shelf approximation for ice shelves, and for ice sheets a combination of the shallow-shelf and shallow-ice approximation equations (Bueler & Brown, 2009). We vary climatological conditions (air temperature, precipitation rate), geothermal heat flux, and basal substrate rheology (till friction angle, saturation, deformation behaviour) to quantify the impact of each of these components on ice stream velocity, discharge, and grounding line location. Generic findings from these experiments will help to provide a regional-scale context to inferences from field-based geophysical surveys.

Keywords: Ice stream, Ross Sea, Amundsen Sea, PISM

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