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Sensitivity studies of ice flow acceleration in response to increased ice shelf melting in the region of Pine Island Glacier

Eric Larour[†]; Eric Rignot; Michael Schodlok; Dimitris Menemenlis; Mathieu Morlighem; Helene Seroussi
[†] Jet Propulsion Laboratory, USA
Leading author: eric.larour@jpl.nasa.gov

The acceleration of Pine Island Glacier in the last decade correlates significantly with an increase in ocean temperatures in the Amundsen Sea during the same period. Although studies have been carried out to try and link both phenomenons, the demonstration of a significant link between sub-cavity ice shelf melting and ice flow acceleration remains an open question. Here, we present a new coupled ocean circulation/ice flow model, based on the MITgcm (within the ECCO2 project) and the Ice Sheet System Model (ISSM), that includes significant coupling between the sub-ice shelf cavity ocean circulation and the glacier ice flow. Computed melting rates are used to constrain ice flow, which in turn is used to constrain geometry of the sub-ice shelf cavity. The model is applied to the Amundsen Sea/Pine Island Glacier, to try and assess the sensitivity of ice flow acceleration to a scenario of increased melting under the ice shelf. The results show significant sensitivity of ice flow acceleration on a short term basis (10 to 100 years), as well as modification of the ocean circulation under the ice shelf, in response to a changing sub-ice shelf cavity geometry. They also demonstrate a strong influence of the bed roughness in controlling the rate of grounding line retreat. These results indicate that there are significant links between changing ocean circulation patterns in the Amundsen Sea and sudden ice flow acceleration of Pine Island Glacier in the last decade. This work was performed at the California Institute of Technology's Jet Propulsion Laboratory under a contract with the National Aeronautics and Space Administration's Cryosphere Science Program.