The dynamic response of Pine Island Glacier to a calving event inferred from Elmer/Ice

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Pine Island Glacier is known as the weak underbelly of the West Antarctic Ice Sheet. During the last 30 years, it has undergone a dramatic acceleration along with a retreat of its grounding line. In the ice shelf, the ice shrink and the rift boarding the main ice stream extended upstream to reach the grounded part of ice. Since records are performed on Pine Island Glacier, calving events have been taking place frequently, however the recent enlargement of the crevasses area questions the possibility of larger calving events to occur in the future. Pine Island Glacier being potentially unstable as it lies below sea level on an upward sloping bedrock, is thus of high importance to assess the potential impact of calving events on the ice stability.

In this presentation, the 3D full-Stokes model Elmer/Ice is used to investigate the dynamic response of Pine Island Glacier, West Antarctica, to various calving scenarios. The flow problem takes into account surfaces evolution, migration of the grounding line, and an inverse analysis to infer basal drag and ice viscosity. Various mesh refinement were tested showing that such modeling require sub kilometric resolution at the grounding line to compute consistently its migration in a short time scale of a few decades. We show that the current calving event initiated at the end of 2011 will not induce any significant acceleration of ice or a retreat of the grounding line. However, the model predicts that a calving event taking place further upstream would rapidly induce large dynamic changes, since doubling the amount of ice loss is sufficient to result in a significant increase of the ice discharge, along with a fast retreat of the grounding line.