Role of Grounding Zone processes in Ice Sheet stability

S Anandakrishnan[1], RB Alley[1], B Parizek[1], K Christianson[1], L Peters[1], A Muto[1]

[1]*Department of Geosciences and the Earth and Environmental Sciences Institute, Penn State University, University Park, PA USA*

It has become increasingly clear that ice-ocean interactions are the critical zone for controlling stability criteria for marine ice sheets like the West Antarctic Ice Sheet and for over-deepened glaciers such as Jakobshavn Isbrae in Greenland. The flow of glaciers across the grounding line is dependent on a balance between inflow of ice from inland and spreading of the floating ice shelf to seaward. Ocean processes are particularly critical to ice shelf thinning, which can lead to a reduction in buttressing of interior ice. Work on Pine Island Glacier shows that ocean circulation under the ice shelf is vigorous and important in the melting of basal ice. High salinity water from the ocean (produced during sea ice formation) descends towards the grounding line, where, because of the higher pressure, it's temperature is above the melting point for ice. This melting at the grounding line thins the ice and reduces the back pressure of the ice shelf. In the case of an over-deepened glacier, a retreat of the grounding line leads to a rapid thinning of the floating ice shelf, which is generally not immediately replaced by flow from the interior, thus leading to a steepening at the grounding line. This process is likely fundamentally unstable for the ocean-terminating Thwaites Glacier, one of the largest glaciers in West Antarctica. I report on recent modeling and observational work on Thwaites Glacier that suggests the glacier has begun to retreat at an increasingly rapid rate. However, models of future mass balance depend critically on the details of the sliding law of the glacier. As noted, if the interior ice cannot replace the lost ice at the grounding line, the attendant steepening will lead to an instability. However, if the flow law is highly non-linear, it is possible that ice will flow rapidly enough to minimize the effects of grounding-zone thinning. I report on recent results from Thwaites Glacier and Pine Island Glacier, which are in the most critical sector of West Antarctica