Solid Earth Physics Seminar, Harvard University

Friday, 7 August 2015, 1:15 pm
Faculty Lounge, 4th Floor, Hoffman Lab, 20 Oxford Street

Modeling the Migration of Ice Stream Margins

Marianne Haseloff
Atmospheric and Oceanic Sciences
Princeton University

Abstract:

The Siple Coast ice streams are long, narrow bands of ice within the Antarctic ice sheet. They move significantly faster than the surrounding ice ridges, and therefore discharge significantly more ice. Observations suggest that their fast flow is due to sliding along a water-saturated bed, while the bed of the neighboring ridges appears to be frozen. The ice stream velocities and widths vary on decadal to centennial time scales. These variations involve the migration of the ice stream margins, where the fast flow slows down to the speed of the surrounding ridges. In this talk we first show that conventional thin film models, which are used to calculate the evolution of ice sheets on continental scales, are only able to reproduce the inwards migration of ice stream margins and the subsequent shutdown of an ice stream. These processes are the result of insufficient heat dissipation and freezing at the bed. Conversely, we find that the widening of ice streams into regions where the bed is frozen can only be modeled by taking small-scale heat transfer processes in the ice stream margin into account. Previous research has shown that ice stream widening results from an interplay of heating through lateral shearing in the ice stream margin and inflow of cold ice from the adjacent ridges. However, the relative importance of the different effects on the migration speed has not yet been quantified. To account for these processes, we use a newly derived boundary layer model for ice stream margins. The numerical solution of this model provides us with the margin migration speed as a function of large- scale ice stream properties such as ice stream width, ice thickness, and geothermal heat flux. By considering asymptotic solutions in the limit of high heat production rates and high advection velocities, a limit that likely applies in real ice stream margins, we derive a parameterization of ice stream widening that can be incorporated in continental-scale models.