Geophysical Research Abstracts
Vol. 20, EGU2018-683, 2018
EGU General Assembly 2018

Basal ripple formation in seasonally forced simulations of ice shelves and plumes

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The flow of ice sheets into the ocean can be impeded by buttressed ice shelves, and hence ice shelf dynamics are important for understanding future sea level rise. Ice shelf stability can be altered by the presence of channels inscribed into the base of the ice. While there is a well-understood mechanism thought to be responsible for the formation of channels running parallel to the ice flow, the origin of recently observed channels running transverse to the flow remains unclear. Based on the annual spacing of these features on Pine Island Glacier, it has been suggested that seasonal variability may be responsible for their formation. Here, we investigate the impact of seasonally-varying forcing on ice shelf geometry using nonlinear, vertically integrated 1-D simulations of a coupled ice shelf and plume. Whilst seasonal variability leads to ripples in the ice thickness, a purely 1-D simulation is unable to produce features of the magnitude seen under Pine Island Glacier, suggesting an additional feedback mechanism would be needed for them to grow. Accounting for the transverse component of the plume velocity may provide such a mechanism by allowing channelisation of the plume flow, focusing melting in the apex of a channel.