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The instantaneous velocity response of Petermann Glacier, northern Greenland to ice tongue loss

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Dynamic ice discharge from marine-terminating outlet glaciers is an important component of recent mass loss from the Greenland Ice Sheet. In recent years, Petermann Glacier in northern Greenland has lost large sections of its floating ice tongue, including two major calving events in 2010 and 2012, which were the largest recorded from Greenland in the past two decades. Petermann is fast flowing ($\sim$1000 m a-1) and has a catchment area of 6% of the GrIS, meaning that it could contribute substantially to sea level rise. However, Petermann has shown limited dynamic response to these major calving events, and it is unclear how sensitive it is to future ice tongue losses. We aim to assess this sensitivity using the state of the art, finite element numerical ice flow model (Úa). Specifically, we use remotely sensed data to set up the model and to ensure that it replicates the limited change in ice velocities observed after the 2010 and 2012 calving events. We then assess the instantaneous velocity response of Petermann Glacier to the calving of further sections of its floating ice tongue.

First, we use the inversion capabilities of Úa to assess the stress conditions beneath Petermann Glacier. We present results from three experiments used to replicate the buttressing forces and lateral resistive stresses acting on the floating ice tongue. Using initial model velocities pre-2010, and estimates of basal characteristics we perform diagnostic experiments; we perturb to the terminus, removing successive splices, approximately similar sized to calving events in 2010 and 2012 back to the grounding line, and examine the immediate velocity change. Initial estimates suggest inland ice flow is insensitive to the removal of floating ice up until $\sim$12 km seaward from the grounding line, after which large calving events (8 km) contribute to an instantaneous velocity increase of $\sim$700 m a-1 at the grounding line. Future work will incorporate transient simulations estimating the future ice discharge contribution of Petermann Glacier once its entire ice tongue is lost.