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On the role of buoyant flexure in glacier calving

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Interactions between glaciers and the ocean are key for understanding the dynamics of the cryosphere in the climate system. Here we investigate the role of hydrostatic forces in glacier calving. We develop a mathematical model to account for the elastic deformation of glaciers in response to three effects: (i) marine and lake-terminating glaciers tend to enter water with a nonzero slope, resulting in upward flexure around the grounding line; (ii) horizontal pressure imbalances at the terminus are known to cause hydrostatic in-plane stresses and downward acting torque; (iii) submerged ice protrusions at the glacier front may induce additional buoyancy forces that can cause calving. Our model provides theoretical estimates of the importance of each effect and suggests geometric and material conditions under which a given glacier will calve from hydrostatic flexure.We find good agreement with observations. This work sheds light on the intricate processes involved in glacier calving and can be hoped to improve our ability to model and predict future changes in the ice-climate system.