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Dynamics of grounding zones under tidal forcing

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We combine the dynamics of ice, bed and ocean in a new elastic model for the tidal-timescale migration of grounding lines on deformable foundations. Previous interpretations of tidal flexure using models of elastic ice shelves with fixed grounding lines were found to be inconsistent, suggesting an elasticity of ice that varies spatially and temporally and that is significantly smaller than measured experimentally. We argue that, with our model, a consistent, purely elastic interpretation can be made. Combining this new approach with remote-sensing measurements, we show that the grounding line migrates several kilometers during a tidal cycle, that we can infer the effective elastic properties of the bed, and that the elastic pressure of the ice leads to a hydrological barrier near the grounding line and controls subglacial hydrology. Our findings imply that subglacial lubrication and melting induced by the ocean thermal forcing can increase substantially during high tide. Consequently, these processes can combine to accelerate the mass transfer from ice sheets to the ocean, and contribute to sea level rise.