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Deformation response to ocean tidal forcing at the 79°N Glacier, Greenland

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Understanding the buttressing of floating ice tongues is important to better evaluate the contribution of grounded ice streams to sea-level rise. In Greenland only few floating tongues still exist, such as the one of the 79°N Glacier, an outlet glacier fed by the North East Greenland Ice Stream. Within the project Greenland Ice Sheet Ocean Interaction (GROCE) a team of glaciologists, oceanographers, geophysicists, geodesists, and atmospheric scientists combine measurements and model studies to investigate the dynamics of the 79°N Glacier. We present a glaciological study focusing on the deformation response to ocean tidal forcing by means of observations and modeling. GPS measurements on the 79°N Glacier realized in 2017-2018 allow to analyze vertical and horizontal displacements of the glacier and its ice tongue due to ocean tides. In the hinge zone, i.e. the transition between grounded and floating ice, the tidal forcing leads to bending of the ice and a movement of the grounding line. Observations at stations situated on the fully grounded part reveal phase shifts of horizontal displacements caused by tidal forces in a distance of more than 35 km to the grounding line. In order to model the measured displacements a viscoelastic material is required using the observed vertical displacement at the ice tongue as external forcing. In a purely viscous material model the phase shift of horizontal displacements due to tides cannot be described. Using AWI's new ultrawideband radar, geometries are obtained which form the data basis for the finite element simulations. The results obtained by the viscoelastic Maxwell material model with a nonlinear Glen-type viscosity show the measured phase shift of horizontal displacements on the fully grounded part. This material model combines the typical long-term viscous behavior of ice with the short-term elastic response. Nonlinearities of basal sliding and viscous deformation result in a modified ice outflow across the grounding line and are also included in the model.