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The role of longitudinal stresses on the dynamics of tidewater outlet glaciers

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The recent rapid changes of marine based Greenland outlet glaciers is in its nature very similar to the known unstable retreat behaviour of calving tidewater glaciers. The latter is often explained as an effect of basal topography and calving and has been reproduced using simple shallow ice approximation (SIA) models. Observations of the former however, indicate that the acceleration and upstream thinning are initiated by a reduction of buttressing at the glacier front and longitudinal stresses seem to play a crucial role in transferring these perturbations upstream. The aim of this study is to investigate the role of longitudinal stresses for rapidly changing tidewater outlet glaciers. We use a suite of simple time-dependent numerical flowline-models of different mechanical complexity (SIA, higher-order mechanics) and apply them to the situation of marine outlet glaciers, similar as Helheim Glacier or Jakobshavn Isbrae in Greenland. We compare their response to perturbations in the frontal region (calving events, thinning) and evaluate the role of longitudinal stresses for the dynamics of such outlet glaciers, in particular their role in the retreat-thinning feedback. Such a comparison gives us important insights on the requirements for numerical models to improve our ability to predict future ice sheet change.