Future sea-level rise from Greenland's major outlet glaciers in a warming climate

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Mass loss from the Greenland Ice Sheet has increased rapidly over the past decade, as a result of both increased ice discharge to the ocean and increased surface melting and runoff. The recent dynamic changes seem to be parallel to oceanic and climatic warming but the linking mechanisms and forcings are still poorly understood and, furthermore, large-scale ice sheet models are currently unable to realistically simulate such changes, which provides a major limitation in our ability to predict dynamic mass losses. Therefore quantifying the future dynamic contribution of such glaciers to sea-level rise remains a major challenge.

Here we present model simulations that include a fully dynamic treatment applied to four major ocean-terminating outlet glaciers, Jakobshavn, Helheim, Kangerdlugssuaq and Petermann glaciers. We first validate the model and calibrate forcing parameters in the model by reproducing the recent observed velocity, flux and glacier front position, then run the model for future warming scenarios. We have produced a first estimate of sea level contribution from four major Greenland marine outlet glaciers that fully accounts for effects of dynamic retreat and is driven by specific emission scenarios (A1B and RCP8.5). At 19-50 mm SLR contribution by the year 2200 our estimate is consistent with the upper-bound estimate of a recent semi-empirical model study, but lower than previous estimates based on extrapolation of current trends. Further model development and application to other marine terminating outlet glaciers are essential to improve these projections.