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Enhanced basal lubrication and the contribution of the Greenland ice sheet to future sea level rise

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We assess the effect of enhanced basal sliding on the flow and mass budget of the Greenland ice sheet (GrIS) using a newly developed parameterization of the relation between meltwater runoff and ice flow. A wide range of observations suggest that water generated by melt at the surface of the ice sheet reaches its bed by both fracture and drainage through moulins. Once at the bed, this water is likely to affect lubrication, although current observations are insufficient to determine whether or not changes in subglacial hydraulics will limit the potential for the speed up of flow. An uncertainty analysis based around our best-fit parameterization admits both possibilities; continuously increasing or bounded lubrication. We apply the parameterization to four higher-order ice sheet models in a series of experiments forced by changes in both lubrication and surface mass budget, and determine the additional mass loss brought about by lubrication in comparison to experiments forced only by changes in surface mass balance. We employ forcing from a regional climate model, itself forced by output from the ECHAM5 global climate model run under scenario A1B. While changes in lubrication generate widespread effects on the flow and form of the ice sheet, they do not affect substantial net mass loss; increase in the ice sheet's contribution to sea-level rise from basal lubrication is projected by all models to be no more than 5% of the contribution from surface mass budget forcing alone ($\sim$8 mm by 2200).