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The influence of topographic feedback on a coupled mass balance and ice-flow model for Vestfonna ice-cap, Svalbard

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Using a coupled simulation set-up between a by statistical climate data forced and to ice-cap resolution downscaled mass balance model and an ice-dynamic model, we study coupling effects for the Vestfonna ice cap, Nordaustlandet, Svalbard, by analysing the impacts of different imposed coupling intervals on mass-balance and sea-level rise (SLR) projections. Based on a method to estimate errors introduced by different coupling schemes, we find that neglecting the topographic feedback in the coupling leads to underestimations of 10–20% in SLR projections on century time-scales in our model compared to full coupling (i.e. exchange of properties using smallest occurring time-step). Using the same method it also is shown that parametrising mass-balance adjustment for changes in topography using lapse rates is a - in computational terms - cost-effective reasonably accurate alternative applied to an ice-cap like Vestfonna. We test the forcing imposed by different emission pathways (RCP 2.4, 4.5, 6.0 and 8.5). For most of them, over the time-period explored (2000-2100), fast-flowing outlet glaciers decrease in impacting SLR due to their deceleration and reduced mass flux as they thin and retreat from the coast, hence detaching from the ocean and thereby losing their major mass drainage mechanism, i.e. calving.