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High Resolution Alpine Glacier Modelling: Do Ice Dynamics Matter?

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We investigate the role of ice dynamics in simulations of alpine glacier evolution driven by high resolution climate data. To quantify the importance of ice dynamics within such models, we compare the results from four different model realizations: (I) fully coupled mass balance with ice dynamics; (II) non coupled mass balance and ice dynamics; (III) instantaneous, mass balance driven steady-state; (IV) mass balance only. These models require good initial and final ice geometry data in combination with downscaled, high resolution climate forcing to create a benchmark experiment which allows such a comparison. We present model results for all three cases from glaciers in southern British Columbia (Canada) and northern Washington State (USA). Glacial extents from 1985 serve as the initial state for all models and 2005 extents as the final target geometry. To drive our models we use high resolution mass balance estimates based on downscaled data from the North American Regional Reanalysis. Ice dynamics are implemented using a two-dimensional (x,y) finite volume discretization of the shallow ice approximation, modified for use in an alpine setting. The models run on a 200 m spatial resolution and the forcing is based on daily temporal resolution climate data. These high resolutions capture as much complexity in the system as possible from the available input data. To further investigate the importance of ice dynamics in large scale models, we perform our benchmark experiment for both well studied individual target glaciers, and within the regional glacier model of our research domain, spanning 916000 km^2.