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A dynamic continental runoff routing model applied to the last Northern Hemisphere deglaciation

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We describe and evaluate a dynamical continental runoff routing model for the Northern Hemisphere that calculates the runoff pathways in response to topographic modifications due to changes in ice thickness and isostatic adjustment. The algorithm is based on the steepest gradient method and takes as simplifying assumption that depressions are filled at all times and water drains through the lowest outlet points. It also considers changes in water storage and lake drainage that become important in the presence of large ice dammed proglacial lakes. Although applicable to other scenarios as well, the model was conceived to study the routing of melt water fluxes during the last Northern Hemisphere deglaciation. For that specific application we have simulated the Northern Hemisphere ice sheets with an existing 3D thermomechanical ice sheet model, which calculates changes in topography due to changes in ice cover and isostatic adjustment, as well as the evolution of freshwater fluxes resulting from surface ablation, iceberg calving and basal melt. The continental runoff model takes this input, calculates the drainage pathways and routes the runoff to the surface grid points of an existing ocean model. This results in a chronology of temporally and spatially varying freshwater fluxes from the last glacial maximum to the present day. We analyse the dependence of the runoff routing to grid resolution and parameters of the isostatic adjustment module of the ice sheet model.