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Dynamic Hydrological Discharge and Lake Modelling for Coupled Climate Model Simulations of the Last Glacial Cycle

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The continually evolving large ice sheets present in the Northern Hemisphere during the last glacial cycle caused significant changes to river pathways both through directly blocking rivers and through glacial isostatic adjustment. Associated with these changing river pathways was the formation and evolution of large glacial lakes such as Lake Agassiz. Studies have shown this changing hydrology had a significant impact on the ocean circulation through changing the pattern of freshwater discharge into the oceans. A coupled Earth system model (ESM) simulation of the last glacial cycle thus requires a hydrological discharge and lake model that uses a set of river pathways and lakes that evolve with Earth's changing orography while being able to reproduce the known present-day river network given the present-day orography. Here, we present a method for dynamically modelling rivers and lakes by applying predefined corrections to an evolving fine-scale orography (accounting for the changing ice sheets and isostatic rebound) each time the river directions and lakes basins are recalculated. The corrected orography thus produced is then used to create a set of fine-scale river pathways and these are then upscaled to a coarser scale on which an existing present-day hydrological discharge model within the JSBACH land surface model simulates the river flow. The associated glacial lakes are delineated from the same corrected fine scale orography; lake inflow and outflow being linked to the river flow model.