Integration of high-resolution glacier modelling with geomorphological data for the reconstruction of past glacier fluctuations in the European Alps

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ABSTRACT

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Several studies have reconstructed the extent and evolution of specific Alpine glaciers using geomorphological, geochronological and modelling tools. In this study, we integrate detailed geomorphological data with high-resolution and high-order glacier modelling to reconstruct past glacier fluctuations in the Alps. We will use the AlpIce database (Kamleitner et al., in prep.) to reconstruct glacier extent from the Younger Dryas to the present. This database contains dated moraines and ice margin positions, peat bogs, rockfall deposits and bedrock exposure ages. The Instructed Glacier Model (IGM), a highly efficient 3D ice-flow model with a deep learning emulator, will allow us to simulate transient glacier behaviour with a resolution of 50 metres. This high resolution is essential to capture the intricate geomorphological features that characterise Alpine valleys. To achieve this goal, we have developed a new workflow tool that automatically reads the AlpIce database, compares it with model output, and scores the simulations based on temporal and spatial accuracy. This approach is first tested and evaluated in a small example region, the results of which are presented here. Subsequently, the tool will be extended and applied to the whole Alps. The scoring involves comparing the modelled ice margin positions and deglaciation times with the dated geomorphological features. This integrated approach will ensure a better fit between model results and observational data (e.g. geomorphological landforms). The combination of a comprehensive geomorphological database with high-resolution glacier modelling allows a consistent reconstruction of glacier fluctuations across the Alps. Using long-term climate history as an input, the modelling ultimately aims to produce a fully transient, high-resolution (50 m) reconstruction of glacier fluctuations from the YD to the present that is consistent with the geological record.