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A semi-automatic method to create central glacier flow lines: A pilot study with Alaskan glaciers

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Glacier length is an important, but largely missing parameter in digital glacier inventories as it has to be digitized by hand (with the related variability). Length changes of glaciers are key indicators of climate change, but can only be measured in the field for a few hundred selected glaciers globally. Its vector representation (a central flow line) is a most important input for modelling future glacier evolution, but only seldom available from digital databases. Hence, there is an urgent need to generate such flow lines for a large number of glaciers from automated methods. The study describes a new method to automatically create central flowlines of glaciers along with an application to a study site where its suitability to automatically derive changes in glacier length is demonstrated. Our new method will likely strongly facilitate the number of available data on both issues (length values and changes) and thus help to improve the assessment and modelling of climate change impacts on glaciers.

This new algorithm is based on Python scripting and additional libraries (GDAL / OGR) and requires only a DEM and glacier outlines as an input. The core of the method is based on a glacier axis concept that is combined with geometry rules such as the k-d Tree, Nearest Neighbour and crossing test theory. We have applied the method to 400 glaciers located in Western Alaska, where a new glacier inventory was recently created. The accuracy of the method was assessed by a quantitative and qualitative (outline overlay) comparison with a manually digitized data set for 20 glaciers. This comparison revealed for 17 out of the 20 glaciers a length value that is within the range of the manual digitizations. Other potential methods to determined glacier length performed less good. Combined with previous glacier outlines from the same region we determined and analysed length changes for 390 glaciers over a c. 50 year period.