Geophysical Research Abstracts
Vol. 18, EGU2016-7616-1, 2016
EGU General Assembly 2016

Ice thickness estimations based on multi-temporal glacier inventories – potential and challenges

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The ongoing glacier retreat exposes a large number of surface depressions in the former glacier bed that can be filled with water or act as sediment traps. This has already been observed at various sites in Austria and in other mountain areas worldwide. The formation of glacial lakes can constitute an important environmental and socio-economic impact on high mountain systems including water resource management, sediment delivery, natural hazards, energy production and tourism. In general, information on ice thickness distribution is the basis for simulating future glacier change.
We used the approach proposed by Huss and Farinotti (2012) to model the ice thickness distribution and potential locations of subglacial depressions. The study is part of the FUTURELAKE project that seeks to model the formation of new glacier lakes and their possible future evolution in the Austria Alps. The required data on glacier extent, surface elevation and slope were taken from the Austrian Glacier Inventories GI1 from 1969, GI2 from 1998 and GI3 from2006 (Fischer et al., 2015).
The different glacier outlines and surface elevations from the inventories enable us to evaluate (i) the robustness of the modelled bedrock depressions with respect to different glacier settings, (ii) the power of the model to simulate recently formed glacial lakes, (iii) the similarities in calculated ice thickness distributions across the inventories and (iv) the feasibility of simulating observed changes in ice thickness and glacier volume.
In general, the modelled localization of large potential depressions was relatively stable using the observed glacier settings. A number of examples show that recently formed glacial lakes could be detected by the model based on previous glacier extents. The locations of maximum ice depths within different elevation zones appeared to be sensitive to changes in glacier width. However, observed ice thickness changes and, thus, volume changes between the inventories could only partly be reproduced by the model. This may be explained by differences in the dynamical state of the glacier among the considered periods with almost balanced mass balance conditions (GI1 – GI2) and strong disequilibrium (GI2 – GI3).

Huss, M., and D. Farinotti (2012), Distributed ice thickness and volume of all glaciers around the globe, J. Geophys. Res., 117, F04010, doi:10.1029/2012JF002523.

Fischer, A., Seiser, B., Stocker Waldhuber, M., Mitterer, C., and Abermann, J. (2015), Tracing glacier changes in Austria from the Little Ice Age to the present using a lidar-based high-resolution glacier inventory in Austria, The Cryosphere, 9, 753-766, doi:10.5194/tc-9-753-2015.