Geophysical Research Abstracts
Vol. 19, EGU2017-16353, 2017
EGU General Assembly 2017

A confined-unconfined aquifer model for subglacial hydrology

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Modeling the evolution of subglacial channels underneath ice sheets is an urgent need for ice sheet modellers, as channels affect sliding velocities and hence ice discharge. Owing to very limited observations of the subglacial hydraulic system, the development of physical models is quite restricted. Subglacial hydrology models are currently taking two different approaches: either modeling the development of a network of individual channels or modeling an equivalent porous layer where the channels are not resolved individually but modeled as a diffusive process, adjusted to reproduce the characteristic of an efficient system.

Here, we use the latter approach, improving it by using a confined-unconfined aquifer model (CUAS), that allows the system to run dry in absence of sufficient water input. This ensures physical values for the water pressure. Channels are represented by adjusting the permeability and storage of the system according to projected locations of channels. The evolution of channel positions is governed by a reduced complexity model that computes channel growths according to simple rules (weighted random walks descending the hydraulic potential). As a proof of concept we present the results of the evolution of the hydrological system over time for a simple artificial glacier geometry.