Geophysical Research Abstracts
Vol. 20, EGU2018-4879-3, 2018
EGU General Assembly 2018

The microscopic insight into calving process in grounding tidewater glaciers - the Discrete Element Method numerical approach

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If a glacier is fed by enough snow to flow out of the mountains down to the sea, we call it a tidewater glacier. These types of glaciers will break off or calve into saltwater at sea level. As water undermines some ice fronts, great blocks of ice break loose and crash into the water. Processes governing calving in tidewater glaciers are complex and are relatively little explored theoretically as well empirically.
Numerical modelling offers a new approach to study a bahavior of such glaciers and is the alternative to field and laboratory efforts in discovering the secrets of glaciers. Numerically studied glacier dynamics is usually based on the classical continuum-based methods. However, fracturing and fragmentation processes - the most important for glacier calving are rather difficult to describe within such approaches. For these reasons we propose to use the Discrete Element Method (DEM). In this method the material is represented as an assemble of interacting particles. Depending on the application of interest, many thousands (or even millions) of particles may be used and simulations may consist of up to millions of timesteps.
However, the history of DEM application to glacier dynamics is relatively short due to heavy computational burden of this method. Most of the research papers with DEM appeared in recent several years, usually with two-dimensional approach. Meanwhile, big-scale polar phenomena required large computations. Therefore, in our research we take advantage of Okeanos Supercomputer of the Interdisciplinary Centre for Mathematical and Computational Modelling, Warsaw University to carry out some test simulations.
In this presentations we report results obtained with a sophisticated numerical model of glacier which consists of randomly distributed clusters imitating ice poli-crystals. The essential point of the model is that the bonds between particles inside “crystals” differs from bonds between different crystals-domain. Moreover, macroscopic properties of whole material are adjusted to fit the macroscopic properties of the ice. Additionally, complicated surface topography of the glacier is taken into consideration. This DEM approach is used to study the process of ice masses fracturing in grounded tidewater glacier from microscopic point of view. It was possible to estimate acoustic emission connected with the impact of the ice block on the water during glacier calving in order to asses mass loss during calving process.