Geophysical Research Abstracts
Vol. 21, EGU2019-4019, 2019
EGU General Assembly 2019
© Author(s) 2019. CC Attribution 4.0 license.

Accounting for transient effects in water pressure in friction law

Olivier Gagliardini
IGE UGA / CNRS, Grenoble cedex 9, France (olivier.gagliardini@univ-grenoble-alpes.fr)

More than six decades ago, Lliboutry (1958) formulated the role of water pressure in its ability to modulate the friction at the base of glaciers through the opening of water cavities. More recently, from theoretical (Schoof, 2005) and numerical modeling (Gagliardini and others, 2007) frameworks, a water dependent, cavity-modulated friction law has been proposed. Such law reproduces a Weertman-type friction at low water pressure and a Coulomb-type friction for high water pressure. Nevertheless, this proposed friction law still suffer from a number of relatively crude hypotheses and has never been tested against a real setting. Indeed, it was derived assuming (1) perfect sliding at the interface between the hard bed and the ice, (2) a steady state and uniform water pressure inside the cavities and (3) two dimensional geometries. Regarding the second hypothesis, measurements have clearly shown that water pressure is highly variable in time and space, and certainly explain daily to seasonal observed changes in ice flow velocity. In this presentation, the approach by Gagliardini and others (2007) is extended to evaluate the influence of a non-steady water pressure on the form of the friction law obtained assuming steady-sate cavity geometries. It is found that when imposing smooth seasonal variations in water pressure, the obtained friction law does not depart from the steady-sate solution. On the contrary, for daily variations, because the change in water pressure are too fast for the cavity to adapt, the solution strongly depart from the steady-state one. More precisely, the observed decrease of basal shear stress for high water pressure (weakening phase) is never reached and the theoretical Iken's bound is not any more fulfilled. Implications of such friction law behaviour for glacier and ice-sheet basal sliding are discussed.

References:
Gagliardini et al. (2007) Finite-Element Modeling of Subglacial Cavities and Related Friction Law. J. of Geophys. Res., Earth Surface, 112.
Lliboutry (1958) Contribution à la théorie du frottement d'un glacier sur son lit. Compte Rendus à l'Académie des Sciences, pp 317-320.
Schoof (2005) The effect of cavitation on glacier sliding. Proc. R. Soc. A 461