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Glacier sliding set by self-regulating feedback between friction and drainage efficiency

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Glacier basal sliding accommodates most of glacier motion and is the main process behind glacier dynamic variability, able to substantially modulate glacier response to climate change. In particular, it controls glacier instabilities, surges, ice stream development and flow speeds of most glaciers on Earth. Paradoxically, glacier sliding remains one of the least understood processes in glacier physics due to the difficulty of accessing and observing the sub-glacial environment. In numerical models, sliding of glaciers is traditionally determined by friction laws interlinking basal shear stress, sliding velocity and water pressure. However, assessing the effects of water pressure on sliding remains a challenge due to the sparsity of appropriate data to validate coupled ice-flow/subglacial-hydrology models. We unify here the description of subglacial cavities transient dynamic for basal friction and sub-glacial hydrology and show how it interacts as a self-regulating coupled system. Our results are in striking agreement with observation from a unique multi-decadal record of basal sliding and water discharge in Argentière Glacier (French Alps). We show that sliding speed of hard-bedded glaciers is set by the drainage efficiency necessary to accommodate the melt water supply rather than being driven by water pressure. We suggest that liquid water supply at the glacier base rather water pressure should be used to develop friction laws that include the effect subglacial hydrology. This will make glacier dynamical response to climate change more predictable.