Geophysical Research Abstracts
Vol. 14, EGU2012-3435, 2012
EGU General Assembly 2012

Catchment-scale reconstruction of glacier mass balance using observations and global climate data: case study of the Hailuogou catchment, south-eastern Tibetan Plateau

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Debris-covered glaciers are common in the Tibetan Plateau, where ablation zones are mantled in a supraglacial debris cover that influences glacier mass balance, runoff, and response to climate change by affecting the melt rate of the underlying ice. The impact of debris cover has not yet been taken into account in regional- or global-scale assessments of glacier mass balances and freshwater resources by using physically based numerical models. Here, a surface energy-mass balance model that accounts for the significance of debris cover and its effect on the ice melt rate is applied to reconstruct the glacier mass balance of Hailuogou catchment, which is located in the south-eastern Tibetan Plateau and contains three debris-covered and four debris-free monsoonal maritime glaciers. According to our calculations, the glaciers in Hailuogou catchment show a mean annual balance of –0.42 m water equivalent (w.e.) for the period 1952–2009. A comparison of summer temperature- and precipitation-mass balance/ELA relations indicates that the glaciers in the catchment are much more sensitive to temperature change. In the last 20 yrs, increasing summer temperature is the main cause of rapid wasting of the glacier mass in the catchment. Meanwhile, the presence of supraglacial debris markedly accelerates glacier mass loss, resulting in the unstable termini of debris-covered glaciers in Hailuogou catchment. This highlights the importance of debris cover for understanding glacier mass balance in the Tibetan Plateau.