Balancing the water budget of the Whillans Ice Plain: Implications for the nature of the subglacial hydrologic system

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The subglacial water system of the Whillans Ice Plain (WIP) contains numerous connected subglacial lakes contained in three distinct hydrological regimes: a north basin containing Subglacial Lake Engelhardt (SLE), a central basin containing Subglacial lake Whillans (SLW), and southern one containing Subglacial Lake Conway (SLC) and Subglacial Lake Mercer (SLM). We use surface elevation data from the ICESat mission combined with a subglacial water model to investigate how water produced in the upper Whillans and Kamb ice stream catchments is distributed among these regimes. We show that for a brief period in 2006 when at least one subglacial lake in each of the three regimes is observed to be filling that the combined filling rates are approximately equal to the sum of the predicted basal melt water production and subglacial lake discharge from upper Kamb, Whillans and Mercer Ice streams. This suggests that previous methods used to estimate basal meltwater production are reasonably accurate on basin-wide scale, and that ñsealò mechanism prevents water from escaping downstream when a lake is filling. The systems by which water is distributed and seals are breached however may be more complicated than first thought. i) During the course of several simultaneous floods from lakes further upstream in 2005-06, ~85% of the water previously directed toward the southern regime became rerouted towards the central basin, resulting from a small increase in ice thickness that changed the hydropotential, indicating that subglacial waterways in a deltaic system can change course over time frames of less than a year. ii) Balancing the water budget of the Southern Basin required that water overflow SLC into SLM while its volume was still increasing, suggesting that the growth of the flow mechanism breaching the seal was limited by some factor of which our current understanding is incomplete. These initial results demonstrate that even within the relatively small area surrounding the WIP contains a myriad of dynamic subglacial environments, that could possibly serve as a microcosm for the greater ice sheet.