Stability and drainage of subglacial water systems

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Subglacial drainage plays an important role in controlling dynamics between the overlying ice and underlying bed. Deeper and spatially distributed water systems favor decoupling of ice and bed and enhance slip rates along this interface. Shallow or coalescent water systems favor strong coupling and lower slip rates along the bed. In this work, we examine the effects of subglacial water drainage resulting from spatially distributed water sheets. In our model, the weight of overlying ice is supported by both water pressure and various sizes of bed protrusions that penetrate the water sheet. Each of the various sizes bears a different magnitude of the overlying ice based on a linear stress recursion that balances forces at the bed. Previous results [e.g., ?] have shown that water depth can be a multi-valued function of both effective pressure (ice overburden minus water pressure) that drives sheet closure and hydraulic gradient that drives water flow. Curvature and structure of this multi-valued water depth function depend on the protrusion size distribution. Switches between different branches of the water depth relationship correspond to either the establishment or shutdown of a ‘connected’ (or efficient) drainage system. We build upon and extend previous work to show how along-path discharge affects water depth and switches from one state to another. We conclude by relating state behavior to subglacial conditions beneath Antarctica.