Surface strain anomaly induced by the drainage of englacial water in Koryto Glacier, Kamchatka, Russia

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The flow of a temperate glacier is significantly influenced by hydrological conditions at the bed. To study the reaction of the flow regime to changes in subglacial conditions, a surface strain measurement apparatus was developed and utilized on a temperate valley glacier during the ablation season.

The apparatus continuously measures the surface strain between two poles installed 5-10 meters apart on a glacier using a metal wire and a displacement transducer. Experiments in a cold room measuring thermal strain of an ice block confirmed measurement accuracy of 10^{-5} strain under ideal conditions.

Field measurements were carried out from August to September 2000 on Koryto Glacier, a maritime glacier located in Kamchatka, Russia. The most interesting observation was an anomalous surface strain triggered by the sudden drainage of water accumulated in a moulin. In late August, one of the most prominent moulins was filled with water presumably because of the closure of a subglacial drainage channel, and then the water subsequently drained within a day. During the event, surface strain measured near the moulin showed strong longitudinal compression followed by extension at a rate of more than 10^{-3} day^{-1}.

The observation suggests that subglacial conditions were spatially non-uniform and the glacier was partly decoupled from the bed during the event. The influence of spatially distributed basal motion on the flow field was investigated using a numerical flow model. Although changes in basal conditions can interpret the surface strain variations qualitatively, the measured strain rate was too large to be reproduced by the flow model. This analysis implies the difficulty of Glen's flow law to model ice deformation near the surface, because it may overrate the viscosity of ice at low deviatoric stresses.