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Changes in ice flow regime after formation of proglacial lakes in Rhonegletscher, Swiss Alps

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Alpine glaciers in the world have been retreating significantly under the influence of recent climate change. In some of these glaciers, new proglacial lakes have formed. If a lake forms at the glacier terminus, increase in subglacial water pressure accelerates ice flow. Speed-up of glacier flow might cause acceleration of glacier retreat.

To investigate changes in ice flow regime at the glacier terminus due to proglacial lake formation, ice flow speed and subglacial water pressure were measured in spatial resolutions of 100 m. The measurements were carried out at Rhonegletscher in the Swiss Alps during the summer seasons of 2007-2009. At this glacier, two proglacial lakes have formed since late 1990s as a result of glacier retreat.

Ice thickness near the terminus is thinning in a rate of -3.44 m a^{-1} from 2008 to 2009. Horizontal flow velocity at the glacier terminus increased twofold from 2006 to 2007. Water level in boreholes drilled to the bed was approximately equal to the lake level in the range of 200 m up-glacier from the terminus, suggesting that a subglacial drainage system was well developed. Subglacial water pressure exceeded ice overburden pressure in the lake shore. It is suggested that high water pressure enhanced basal sliding and caused the acceleration of glacier flow. Acceleration of ice flow at the terminus changed the flow regime in the longitudinal direction from compressive to tensile. This change was responsible for a part of the glacier thinning. Huge surface uplift associated with formation of crevasse was observed in the region where water pressure exceeded the overburden pressure. These observations suggest that if the glacier continues to thin, the entire part of the terminus may get afloat and disintegrate over the next few years.

Keywords: proglacial lake, glacier flow, Alpine glacier, Switzerland