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Evidence of uplift at Argentière glacier (Mont Blanc area, France)

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Understanding basal processes is a prerequisite for predicting the overall motion of glaciers and its response to climate change. Although a number of studies have shown that subglacial hydrology affects glacier's basal sliding motion, the involved mechanisms remain poorly known. Several studies suggested that glacier velocity increases with englacial and subglacial water storage, but observational quantification of subglacial water storage and associated velocity changes are challenging to make due to uncertainties on velocity measurements and on vertical straining.

Here we tackle this observational challenge through analyzing numerous field measurements from the surface and from the subglacial observatory on the Argentière Glacier (French Alps). We analyze specifically the relationships between daily sliding velocities (measured continuously at the glacier base), surface horizontal and vertical velocities from DGPS observations and ice thickness changes over years 2018 and 2019. We find strong upward surface movements of about 0.5 m during the winter until the beginning of May that cannot be explained by longitudinal strain rate changes. We support that it is caused by water volume increase in subglacial cavities.

Further analyzing the relationships between cavity growth, sliding and surface velocities, we find that unlike in previous studies bed separation variations are not synchronous with sliding speed variations. Surface uplift starts in winter, which is long before the spring sliding acceleration, and surface drop occurs mid-summer, which is long before the end of summer sliding deceleration. These findings support that the link between subglacial water storage and sliding speed may not be as direct as previously thought.

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