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3D surface velocity variations of the Argentière glacier (French Alps) monitored with a high resolution continuous GNSS network

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Five continuous GNSS stations monitor the Argentière glacier surface motion on a longitudinal profile at 2400 m altitude over a full melt season, from April to November 2019. High precision data analysis is enabled by a close-by reference station on the bedrock. This GNSS survey is part of the SAUSSURE project 2019-2022 that aims at increasing our knowledge on the physics of glacier basal sliding, by improving friction laws and validating them in a natural environment. The Argentière glacier is particularly interesting due to its long-term subglacial observatory measuring basal sliding velocity and subglacial discharge. The SAUSSURE project furthermore includes seismic, tiltmeter and piezometer measurements. The bedrock topography is obtained from a Ground Penetrating Radar.

The dense GNSS station setup permits to validate individual antenna movements. We then retrieve horizontal and vertical surface velocities on daily and sub-daily time scales. We can deduce strain rates in between the stations and their evolution in time, and relate this observable with the vertical surface motions. The confrontation of the GNSS data with independent observations allows analyzing the surface motions searching for glacier surges that combine horizontal speed-ups combined with uplift due to bed separation of the ice sheet. These events could give indications about cavity growth in spring. We will also try to investigate sub-daily motions that seem to occur in daily cycles in summer, as hinted at by the basal sliding measurements. These daily cycles are usually also seen in the seismic activity. The phase of the different features varies with respect to the daily cycles of temperature and sub-glacial water pressure. These phase offsets can give us indices on eventual mechanisms of sliding at the bedrock interface. The GNSS measurements represent a rare in situ data set that can contribute to

better apprehend mechanisms of basal sliding and to provide high-resolution 3D constraints on physical models of glacier flow.

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