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Alpine glacier instabilities
Processes and early warning perspectives

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Alpine glacier instabilities are gravity-driven rupture phenomena. Three different types of instabilities can be identified according to the thermal properties of the ice/bed interface. If cold (1), the maturation of the rupture is shown to be associated with a typical time evolution of surface velocities and seismic activity generated by the glacier. A prediction of the final break-off is possible by using these precursory signs. For the other types of instabilities, water plays of key role in the initiation and the development of the instability. If the ice/bed interface is partly temperate (2), the presence of melt water at the interface reduces its basal resistance which promotes the instability. No clear and easily detectable precursory signs could be evidenced in this case, and the only way to infer a possible instability initiation is to monitor the time and spatial evolution of the thermal regime at the interface. The last type of instability (3) concerns steep temperate glacier tongues switching for a couple of days/weeks during the melting season into so called ”active phases” followed in rare cases into a major break off event. Although such an event prediction remains far from being realizable yet, we could identify critical conditions promoting the final instability with a newly developed numerical modeling including water flow in a subglacial drainage network.