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# The influence of snow cover thickness on the thermal regime of Tête Rousse Glacier (Mont Blanc range, 3200 m a.s.l.): consequences for water storage, outburst flood hazards and glacier response to global warming

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Tête Rousse Glacier (French Alps) was responsible for an outburst flood in 1892 that devastated the village of St Gervais-Le Fayet close to Chamonix, causing 175 fatalities. In 2010, geophysical surveys of this glacier revealed a subglacial lake that was subsequently drained artificially. The processes controlling the thermal regime of the glacier have been investigated on the basis of measurements and snow cover and heat flow models using meteorological data covering the last 200 years. Temperature measurements show a polythermal structure with subglacial water trapped by the cold lowest part of the glacier (-2°C). The modeling approach shows that the polythermal structure results mainly from changes in the depth of the snow cover with time at the glacier surface. Paradoxically, periods with negative mass balances, associated with warmer air temperature, tend to cool the glacier because the warmer temperatures reduce the snowpack depth and extent, thereby decreasing the insulation of the glacier from the cold and the amount of latent heat introduced by meltwater refreezing. Conversely years with colder temperatures, associated with positive mass balances, tend to increase the glacier temperature by maintaining a thick snowpack all year round at the glacier surface. The thermal effect of the subglacial lake is evaluated and suggests that the lake existed before 1980. Modeling shows that the glacier will cool again in the future. This study provides insight into the thermal processes responsible for water storage inside a small static glacier which can lead to catastrophic outburst floods such as the 1892 event or potentially dangerous situations as in 2010.