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Operational ice-flow modelling at Tête Rousse glacier, French Alps

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Impact of global warming onto glaciers may lead to an increase of local risks related to outburst floods that would follow the breaking-off of an ice dam or the purge of a sub glacier water-filled cavity. History of the city of Saint Gervais Mont Blanc, in the french Alps, is deeply marked by the 1892 disaster which killed 175 persons, after the unexpected release of $100\,000$ m^3 of water contained in a hidden cavity inside the Tête-Rousse glacier. During summer 2010, the presence of a pressurized water-filled cavity of $50\,000$m^3 was confirmed, jeopardizing again residents down the valley. To avoid a repetition of the 1892 disaster, an unprecedented initiative has been rise up to drain the water cavity under a high altitude glacier. However, the contingent release of pressure within the cavity during its artificial drainage may precipitate its collapse and potentially flush out the remaining water. The risk associated with the drainage initiative had to be rapidly and accurately evaluated. We therefore model the flow of the entire glacier and evaluate the impact of the water drainage on the stability of the cavity. We found that the maximum tensile stress in the cavity roof was below the rupture value, indicating a low risk of collapse. Post draining survey of the surface glacier deformation confirms the accuracy of the model prediction. In a general perspective, this demonstrates that ice flow models have reached a sufficient maturity to be operational and assist policymakers when faced with glaciological hazards.