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# A 3-years full-scale mechanical ice deformation test from the artificial drainages of the Tête Rousse cavity

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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, a pressurised water-filled cavity of at least $50\,000$ m$^3$ was again discovered within the glacier. To avoid a repetition of the 1892 disaster, an unprecedented initiative has been risen up to drain the water cavity under this high altitude glacier. This procedure was further repeated in Autumns 2011 and 2012 since the cavity was permanently refiled in-between two drainages. However, as the cavity was decreasing in size due to the creep of ice when the water level was low, the total water volume drained out of the cavity was decreased each Autumn.

At the same time, a dense network of stakes was deployed to survey the glacier surface displacements above the cavity during the pumping. Record of the water level evolution within the cavity together with the surface displacement measurements along an almost 3-years period constitute a very well documented full-scale experiment to characterise ice deformation. When the water level is low, the cavity is shrinking, whereas when the cavity is full of pressurised water, the cavity is growing. Because of the density ratio between ice and water, closing is approximately 9 time faster than opening.

This dataset is completed by recently acquired surface and bedrock DEMs, as well as an image of the cavity geometry from sonar and radar measurements. This unique dataset was then used to constraint the finite-element ice flow model Elmer/Ice and perform transient simulations over the 3-years period. Both the evolution of the surface displacements and of the cavity volume are compared to measurements. We show the importance of accounting for ice damage to reproduce the observed surface displacements.