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Slab entrainment and surge dynamics of the 2015 Valleé de la Sionne avalanches

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On 3 February 2015 five avalanches were artificially released at the Valleé de la Sionne test site in the west of Switzerland. The dense parts of the avalanches were tracked by the GEODAR Mark 2 radar system at 111 Hz framerate with 0.75 m down slope resolution.
The data show that these avalanche contain several internal surges and that the avalanche front is repeatedly overtaken by some of these surges. We show that these surges exist on different scale. While the major surges originates from secondary triggered slab releases and occur all over the avalanche. The minor surges are only found in the energetic part of a well developed powder snow avalanche. The mass of the major surges can be as huge as the initial released mass, this has a dramatic effect on the mass distribution inside the avalanche and effects the front velocity and run out. Furthermore, the secondary released snow slabs are an important entrainment mechanism and up to 50 percent of the mass entered the avalanche via slab entrainment.
We analyse the dynamics of the leading edge and the minor surges in more detail using a simple one dimensional model with frictional resistance and quadratic velocity dependent drag. These models fit the data well for the start and middle of avalanche but cannot capture the slowing and overtaking of the minor surge. We find much higher friction coefficients to describe the surging. We propose that this data can only be explained by changes in the snow surface. These effects are not included in current models yet, but the data presented here will enable the development and verification of such models.