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Influence of snow temperature on avalanche impact pressure

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The properties of the snow entrained by an avalanche during its motion (density, temperature) significantly affect flow dynamics and can determine whether the flowing material forms granules or maintains its original fine-grained structure. In general, a cold and light snow cover typically fluidizes, while warmer and more cohesive snow may form a granular denser layer in a flowing avalanche. This structural difference has a fundamental influence not only in the mobility of the flow but also on the impact pressure of avalanches.

Using measurements of impact pressure, velocity, density and snow temperature performed at the Swiss Vallée de la Sionne full-scale test site, we show that, impact pressure fundamentally changes with snow temperature. A transition threshold of about -2°C is determined, the same temperature at which snow granulation starts.

On the one hand warm avalanches, characterized by temperatures larger than -2°C, move as a plug and exert impact pressures linearly proportional to the avalanche depth. For Froude numbers larger than 1, an additional square-velocity dependent contribution cannot be neglected.

On the other hand cold avalanches, characterized by a temperature smaller than -2°C, move as dense sheared flows, or completely dilute powder clouds and exert impact pressures, which are mainly proportional to the square of the flow velocity. For these avalanches the impact pressures strongly depend on density variations within the flow.

We suggest that the proposed temperature threshold can be used as a criterion to define the transition between the impact pressures exerted by warm and cold avalanches, thus offering a new way to elude the notorious difficulties in defining the differences between wet and dry flow, respectively.