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Density measurements in snow avalanche flow

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In a snow avalanche, force and temperature variations within the avalanche body act on the snow continuously changing its density. Up to now, no density measurements in moving avalanches have been performed. As a consequence, in avalanche dynamics, snow is assumed to be incompressible and its density is estimated to be approximately constant.

In order to quantify the error introduced by this assumption, capacitance sensors have been installed at the Vallée de la Sionne test site to measure density in the avalanche flow starting from the winter season 2006/2007. We describe a sensor geometry specifically designed to measure density in avalanches. The sensors are placed 3 and 6 m above ground on a 20 m high pylon and they are mounted on wedges designed to minimize flow disturbance and flow compression. The sensors record the dielectric permittivity of snow and we calculate density by using an empirical calibration curve. The calibration curve is obtained from a "snow press" applied on representative snow samples collected close to the avalanche path.

We present density measurements performed in the dense, saltation and suspension layers of both dry and wet snow avalanches. Measurements show a complex signal structure, which varies considerably between layers. Large density fluctuations and changes of signal structure are observed inside each layer as well. Thus, as a first result, we show that density varies significantly both in time and space and therefore the assumption of constant density is questionable. We further combine density measurements with velocity, shear rate and pressure measurements and discuss the role of the observed density and structure variations in context of the avalanche flow dynamics.