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On the validity of depth-averaged models in avalanche simulations

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A complete description of avalanche motion must consider three flow zones based on the velocity distribution through the depth: (1) a starting zone where the mass begins to move, followed by (2) rapid motion, and finally (3) a run out zone where the mass comes to rest in the deposit. For avalanche flows down topography with a smooth base, the velocity perpendicular to the base can be neglected in the rapid flow zone. In this case, the velocity distribution is relatively homogeneous through the depth, which enables depth-averaged models to effectively describe that part of the avalanche. However, as soon as the avalanche encounters an obstacle, or when the initiation and run out zones are considered, the velocity component perpendicular to the base cannot be neglected, and the velocity component parallel to the base is no longer constant with depth. Therefore, only a limited description of these cases is possible with depth-averaged models. We address this lack of an adequate model by performing small-scale laboratory experiments in which we measure the velocity field of the granular flow in an inclined chute. These experiments provide data for understanding the flow processes and a act as a basis for the development of new non depth-averaged theoretical and numerical models. We present a comparison of the experimental data with a simulation based on a depth-averaged model. This allows us to estimate the error produced by the depth-averaging and to determine regions, in which a non depth-averaged model should be used.