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Inverse problems and rheology of gravity-driven flows.

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Natural gravity-driven flows are frequent phenomena in the Alps. Typical examples include snow avalanches, debris flows, rock avalanches, and so on. These flows of bulk materials threaten man's activities and life and consequently the rising demand for higher safety measures has given impetus to the development of models for predetermining the flow features and the probability of their occurrence. A key point in the development of these models is the constitutive equation. Most current models speculate the form of the constitutive equations; the parameters involved in the resulting equations of motion are then adjusted from field data. However, this does not provide evidence that the assumed constitutive equation is appropriate and therefore, when applying the model to a new site (e.g., for engineering applications), the model outcomes may be questionable. Another approach is to directly derive the constitutive equation (or, more precisely, rheological properties) from field data similarly to what is done in fluid rheometry. Exemplifying this approach with real snow avalanches and granular flow experiments (in the laboratory), we show that the rheological properties cannot properly be interpreted. Notably, we provide evidence that the Coulomb frictional model is a suitable model for describing the motion of snow avalanches, but the status of the friction coefficient is unclear: is it a genuine friction parameter or does it reflect a complex combination of various processus (including bulk deformation, slipping, mass variation, etc)? Bayesian inference techniques were used to determine the probability distribution of the friction coefficient and revealed that, for snow avalanches, there is no universal law for this coefficient.