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Calibration of the Voellmy friction parameters from high rate photogrammetric images of an avalanche using a Bayesian approach

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The friction parameters of avalanche dynamic models such as the one commonly used Voellmy friction law must be calibrated from observations. This work aims at achieving this task using a Bayesian approach from high rate photogrammetric images. Application is made to an avalanche artificiality triggered from the Lautared full scale test site on February 13th 2013. Simulated velocities are calculated considering that the avalanche is a sliding block which movement follows the Voellmy law. Then, the simulated velocities are compared with the observed ones to calibrate the friction parameters. We proceed as follows to calibrate the friction parameters: we first calibrate the model, assuming the errors are independent and homoscedastic. Then, from the results of several statistical tests, we propose to fit an ARIMA model for the errors. The Metropolis-Hasting algorithm is applied to estimate the posterior distribution. The results demonstrate that modeling the errors with an ARIMA (autoregressive integrated moving average) model improves the accuracy of the parameters estimation. The statistical approach can readily be applied to other avalanche dynamic model formulations (e.g; based on depth averaged equations), and; potentially, after suitable adaptation on the algorithm, to other friction laws. Finally, the results of the different models and discussion are presented.

Keywords: Avalanche, Voellmy friction parameters, Bayesian approach, Metropolis-Hasting, ARIMA errors model, uncertainty.