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Application of statistical and dynamics models for snow avalanche hazard assessment in mountain regions of Russia

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The estimation of extreme avalanche runout distances, flow velocities, impact pressures and volumes is an essential part of snow engineering in mountain regions of Russia. It implies the avalanche hazard assessment and mapping. Russian guidelines accept the application of different avalanche models as well as approaches for the estimation of model input parameters. Consequently different teams of engineers in Russia apply various dynamics and statistical models for engineering practice. However it gives more freedom to avalanche practitioners and experts but causes lots of uncertainties in case of serious limitations of avalanche models.

We discuss these problems by presenting the application results of different well known and widely used statistical (developed in Russia) and avalanche dynamics models for several avalanche test sites in the Khibini Mountains (The Kola Peninsula) and the Caucasus. The most accurate and well-documented data from different powder and wet, big rare and small frequent snow avalanche events is collected from 1960th till today in the Khibini Mountains by the Avalanche Safety Center of “Apatit”. This data was digitized and is available for use and analysis. Then the detailed digital avalanche database (GIS) was created for the first time. It contains contours of observed avalanches (ESRI shapes, more than 50 years of observations), DEMs, remote sensing data, description of snow pits, photos etc. Thus, the Russian avalanche data is a unique source of information for understanding of an avalanche flow rheology and the future development and calibration of the avalanche dynamics models.

GIS database was used to analyze model input parameters and to calibrate and verify avalanche models. Regarding extreme dynamic parameters the outputs using different models can differ significantly. This is unacceptable for the engineering purposes in case of the absence of the well-defined guidelines in Russia. The frequency curves for the runout distance in different avalanche sites were constructed using the field data. It allowed us to assess the probability (return period) of the calculated extreme runout distances using obtained frequency curves. Avalanche zoning is not yet used by land planning authorities to prevent construction in avalanche hazard zones in Russia. Our approach can be used for the future development of avalanche zoning in Russia.