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The Kulikovskiy–Sveshnikova–Beghin Model of Powder Snow Avalanches: Development and Application

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A simple theoretical model, the Kulikovskiy–Sveshnikova–Beghin (KSB) model, is outlined describing the motion of a particle cloud moving down an incline. This model includes both the entrainment of surrounding ambient fluid and the entrainment of particles from the slope and is equally valid for Boussinesq and non–Boussinesq flows. Improvements to the model are described which are particularly relevant for high density flows such as powder snow avalanches. With the updated model, physically realistic mean densities are predicted which have a significant impact on the Richardson number–dependent ambient entrainment. The improvements are illustrated by comparing analytical solutions to the original and the updated KSB equations for the case of a particle cloud travelling on a slope of constant angle and with constant ambient and particle entrainment. Solving the updated model numerically, predictions are compared with data from several large powder snow avalanches at the Swiss Vall\'ee de la Sionne avalanche test site. The updated KSB model appears to capture the dynamics of the avalanche front well, however problems remain with relating the theoretical geometry to a real avalanche geometry and the model is non–predictive with regard to snow entrainment from the track. The success of this model in capturing the front dynamics shows that, with careful assumptions that reflect the physics, it is possible to describe aspects of complex flows such as powder snow avalanches with simple models.