Cellular Automata Model for Simulating Wind Transport of Snow and the Interaction with Topography and Alpine Vegetation

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Abstract. A cellular automata model is proposed for simulating the evolution of snow packs in areas in which wind transport of snow and the interactions with terrain and short alpine vegetation are dominant. The model is designed to work at small spatial scales (~1 m) and over weekly time steps. The processes simulated include a layered snowpack formed by accumulating weekly precipitation, a physically based densification scheme that accounts for the compaction of the snow layers, and the interaction between the blowing snow with small-scale topographic features and vegetation. Other features include the possibility of time-variable transport trajectories, space- and time-variable precipitation, and time-variable initial density. The erosion and deposition of particles is determined according to a predefined set of probabilities dependent upon the relative location of the grid cells to aerodynamic obstacles and the vertical angles with such obstacles. The interaction with the vegetation is simulated using a set of probabilities that depend on the height of the vegetation, and a relationship that relates the exposed vegetation height to the vegetation effectiveness. The model is applied to combinations of synthetic topographic and vegetation fields. Results illustrate that the correlation structure of the snow depth fields becomes stronger as the amount of snow transported increases, while the probability distributions of the fields progress from a Gaussian distribution for small transport values to positively skewed probability density functions for high transport values. These results are similar to what we have observed for LIght Detection and Ranging (LIDAR) snow depth fields in alpine and wind dominated environments, for which strong correlation structures and positively skewed distributions have been obtained. Further results regarding the effect of vegetation and dynamic wind patterns on the characteristics of the spatial organization of the fields will be presented.