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2-D modelling of water flow in snow

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The amount of liquid water and its interaction with snow stratigraphy is related to wet-snow instability. Layers with a high amount of liquid water show reduced shear strength. Observations have shown that a large amount of water reaching the bottom of the snowpack causes instability and can be associated with wet-snow avalanche activity. Quantifying liquid water content in snow under field conditions is difficult, time consuming and prone to errors as most measurement devices do not allow capturing the evolution over time and even may influence the water flow itself. Modelling of water flow in snow is an alternative, but complicated by the fact that water flow in snow is a highly transient phenomenon with direct feedbacks on the surrounding ice matrix and thus the water flow itself. Therefore, only very few attempts were made to model water flow in snow. We model water flow through a snowpack with an adapted cellular automaton model in 2 D. Within our model we use a randomly generated snowpack with a certain density, grain size, and layering. Water flows into the snowpack from the top, as it may happen due to melting of the uppermost layer or during rain-on-snow events. During the flow process water may refreeze and parts of the ice matrix may melt according to stochastic cellular automaton rules. We studied the flow patterns for different amounts of water, various grain sizes and layering of the snowpack. First results indicate that the model well reproduced general flow characteristics in porous media. With small grain size water tended to flow in a uniform wetting front, while with large grain size preferential flow fingers were more often triggered. With coarse-grained snow water flow was fast with few, but large preferential flow channels routing large amounts of water deep into the snowpack.