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Preferential water flow and ice layer formation in the snowpack: insights from measurements and SNOWPACK simulations at an alpine site

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Water percolation through snow is a critical and challenging process to understand the evolution of the snowpack. Recent advances in measurement methods and modelling have given new insights into the development of preferential flow in a stratified snowpack. In particular, they led to the implementation of a water transport scheme representing preferential water flow in the one-dimensional snow cover model SNOWPACK. Using this new modelling approach, our study aims at better identifying the occurrence and effects of preferential flow in a natural alpine snowpack, particularly the formation of deep ice layers within dry snowpacks. A comprehensive observation dataset was collected at the Weissfluhjoch study plot during winter 2017, including weekly detailed snow profiles, measurements from an upward-looking ground penetrating radar, runoff measurements, as well as daily SnowMicroPen measurements of the penetration force in snow. This detailed dataset offers new perspectives to identify the occurrence of percolation and ice layer formation. It was then compared to SNOWPACK simulations with different water transport schemes. The preferential flow scheme represents well the wetting of snow layers at capillary barriers, suggesting that vertical preferential flow is the most likely cause of the observed deep ice layers, but fails to form ice and produces too strong runoff.