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A novel experiment for measuring infiltration into seasonal frozen soil

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Large parts of the northern hemisphere have at least seasonal frozen soils. Depending on the initial soil water content infiltration capacity can be reduced through pore blockage of ice. Many studies dealing with this topic used numerical modelling for estimating the effect of frozen soils on infiltration. Only a few studies investigated the influences of seasonal frozen soils on infiltration and runoff generation in field experiments. Some authors point out that preferential flow can be an important factor under frozen conditions, but only qualitative information are available so far. A missing methodology makes it hard to measure and quantify infiltration into frozen soils, especially the role of preferential flow. Therefore, a novel multi-method approach for measuring the influences of seasonal frozen soil on infiltration is presented. Sprinkling experiments with a rate of 50 mm/h were performed at frozen soil plots under wet and dry initial conditions in a grassland field site in the Black Forest, Germany. Additionally, two different water temperatures were used for the sprinkling experiments ($\sim$2°C and $\sim$10°C). Thermal infrared imagery was tested for continuous, in-situ monitoring of the spatiotemporal soil thermal state during infiltration and the possibility to derive information on water flow. A dye tracer (Brilliant Blue FCF) was added to the infiltrating water and analyzed by image analysis for flow patterns and depth distribution. Thermal infrared imagery and dye tracer were used for the first time in field experiments in frozen soils and were tested for their potential to show the effect of preferential flow under frozen conditions. These information were related to observed soil moisture and temperature profiles measured with capacitance probes in five depths. Furthermore timing and amount of surface runoff was examined for all plots. Brilliant Blue flow patterns and surface runoff were compared against unfrozen soils with similar initial conditions. Preliminary results are presented and analyzed regarding to initial water content and thermal state.