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Combining sprinkling experiments and superconducting gravimetry in the field: a qualitative approach to identify dominant infiltration patterns

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Hydrological process research at the plot to catchment scale commonly involves invasive field methods, leading to a large amount of point data. A promising alternative, which gained increasing interest in the hydrological community over the last years, is gravimetry. The combination of its non-invasive and integrative nature opens up new possibilities to approach hydrological process research. In this study we combine a field-scale sprinkling experiment with continuous superconducting gravity (SG) measurements. The experimental design consists of 8 sprinkler units, arranged symmetrically within a radius of about ten meters around an iGrav (SG) in a field enclosure. The gravity signal of the infiltrating sprinkling water is analyzed using a simple 3D water mass distribution model. We first conducted a number of virtual sprinkling experiments resulting in different idealized infiltration patterns and determined the pattern specific gravity response. In a next step we determined which combination of idealized infiltration patterns was able to reproduce the gravity response of our real-world experiment at the Wettzell Observatory (Germany). This process hypothesis is then evaluated with measured point-scale soil moisture responses and the results of the time-lapse electric resistivity survey which was carried out during the sprinkling experiment.

This study demonstrates that a controlled sprinkling experiment around a gravimeter in combination with a simple infiltration model is sufficient to identify subsurface flow patterns and thus the dominant infiltration processes. As gravimeters become more portable and can actually be deployed in the field, their combination with sprinkling experiments as shown here constitutes a promising possibility to investigate hydrological processes in a non-invasive way.