



Constraining hydrological models by combining ground-based gravimetry and magnetic resonance sounding

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Hydrological models, which simulate natural processes, are prone to uncertainty due to shortcomings such as data being insufficient or incomplete, limited to point scale or the equifinality of the model itself. Using varying data sources to constrain the model can help to overcome these issues and to create more reliable models. As variations in subsurface water storage are equivalent to mass redistributions that are proven to be measurable using modern gravimetry equipment, gravity measurements can advance hydrological modelling. Magnetic resonance soundings (MRS) probe the ¹H spin magnetization of subsurface water molecules and provide vertical water content distributions covering both the saturated and unsaturated zone. The use of gravity and MRS data to improve hydrological modelling is explored in this project. An integrated hydrological model is built, which simulates surface and subsurface flows, and its output is converted into the corresponding changes in gravity on the one hand, and in the MRS response on the other. These numerical results are then compared with real measurements of a high-precision quantum absolute gravimeter as well as of an MRS device with reduced instrumental dead time optimized to provide water content information from the unsaturated zone with increased accuracy. Whereas MRS measurements are point information similar to borehole data, yet non-invasive and thus cheaper than hydrogeological drillings, gravity measurements are beneficial, as they provide integrated information over extended areas. However, they also capture other processes causing mass redistributions, which is why they can produce significant noise. Thus, it is expected that processes in the unsaturated zone, although contributing to the signal, might be difficult to detect by the quantum gravimeter despite of its improved resolution properties. This is why we expect the combination with the additional MRS data might be superior to the usage of hydrogravimetry alone.