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Estimating daily evapotranspiration at the field scale from superconducting gravity and eddy covariance measurements: pitfalls and uncertainties

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Understanding individual hydrological processes and dynamics at different scales is essential for achieving a more complete quantification of the water budget at the catchment scale. Gravimetry, with its integrative nature of monitoring, facilitates the observation of these individual or combined hydrological dynamics at different scales. Depending on the data available for correcting gravity observations for undesired components (e.g. global hydrology outside of catchment), gravimetry can be used to quantify water storage changes from field up to catchment scales with a high temporal resolution.

In this study, we examine the feasibility to extract water storage changes caused by local evapotranspiration from relative gravity measurements. For this purpose, we set up a superconducting gravimeter (iGrav) in a dedicated field enclosure at a well instrumented crop field in mid-west Germany (Merzenhausen). Besides different methods of measuring precipitation, an eddy covariance tower is located only 100 m from the gravimeter. In order to extract evapotranspiration, gravity observations are corrected for all other gravity relevant signal components. This approach is repeated for all combinations of the available data (precipitation, discharge, other gravity components) and the resulting time series are compared to the evapotranspiration data measured directly by the eddy covariance tower. In this way, we assess the uncertainties in resolving the signal of interest (here field-scale evapotranspiration rates at different temporal scales) from the integrative gravity observations. We also discuss challenges in running short-term gravity experiments in the field and the the high potential of the hydro-gravimetric field method for improving scale-independent quantification of water storage changes.