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Coupling hydraulic and gravity information for improved aquifer characterization

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We consider the ability of coupling hydraulic data and observations of temporal dynamics of gravity to determine redistribution and changes of the mass of water within unconfined aquifers subject to pumping. The unprecedented development of high precision technology and data analysis techniques to detect gravimetric responses of the earth system suggests the possibility of transferring these types of geophysical information into groundwater flow hydrological models to improve our ability to characterize the underground environment. This would allow fusing hydraulic data (e.g., hydraulic head and/or drawdown, water content, hydraulic conductivity, and porosity) and gravity information within a unique predictive model of groundwater circulation. Here, we consider the groundwater flow field induced by a partially penetrating well operating in a compressible unconfined aquifer. We rely on the analytical solution of Mishra and Neuman (2010, 2011), which accounts for horizontal as well as vertical flows in the saturated and unsaturated zones. We investigate the effect of aquifer parameters, including wellbore storage, on the ability of numerical methods adopted to model temporal gravity incremental distributions to assess the water storage changes in the two regions of the groundwater system. Computation of gravity effects is performed upon relying on the discretization of the aquifer system through a set of prisms. The analysis is performed relying on local and global sensitivity quantities and highlights the potential usefulness of these geophysical data to characterize such complex saturated/unsaturated flow fields.

References

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