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Using remote sensing data to automatically calibrate a groundwater model

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Abstract:

Calibration is a necessary and critical step in groundwater modelling. A lack of observation data during model calibration may result in an over-parameterized model with little or even no predictive value. However, recent developments in remote sensing techniques make it possible to obtain both data required to set up, as well as to verify a groundwater model in an arid or semi-arid environment where normally the observation infrastructure is poor.

Direct evaporation from an aquifer takes place if the groundwater table gets close enough to the ground surface. In regions with non-zero evaporation from groundwater, we can compare the evaporation rates from simulation and from observation with remote sensing in the model calibration process: On one hand evapotranspiration and from it evaporation can be computed from remote sensing data e.g. NOAA-AVHRR images; on the other hand evaporation from groundwater can be calculated in a groundwater model. The advantage of using evaporation data in addition to or alternatively to head measurements is the complete areal coverage of these data compared to usually limited point data.

In this study, two methods of incorporating evaporation data into the groundwater model calibration process were taken into account. The first method is to calibrate the groundwater model with absolute evaporation values directly. In the second one, two

mathematical transforms were considered individually to convert the absolute evaporation values from spatial domain to frequency domain. One is the discrete Fourier transform and the other is the discrete wavelet transform. The transformed results, both from observation and calculation, were compared in the model calibration process. In both methods, the code PEST, based on the least square method, was used as an automatic calibration tool.

The results show that the areally distributed data yield a converging solution for the conductivities. Using the evaporation data is a valid alternative to using the point values of depth to groundwater. Both methods lead to very similar results concerning the parameters, however with different estimation errors.

Key Words: model calibration; evaporation; remote sensing; PEST