Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04465, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04465
EGU General Assembly 2008

The use of “integrated data fusion” to determine unsaturated flow parameter from geophysical measurements

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Geophysical methods are increasingly being used to provide quantitatively information of subsurface distributions and properties. For hydrological purposes, the geophysical methods bridge the gap between small-scale measurements, such as neutron probe logging or soil sampling, and large-scale measurements, like pumping tests. The reliability of the tomographic images obtained using geophysical methods are, however, highly dependent on the collected data quality, and the applied tomographic inversion routine. Furthermore, uncertainties are also introduced if the tomographic images are converted to hydrological state variables using petrophysical relationships.

Typically, geophysical data are used in a sequential manner, where the data are first inverted to images, before they are converted to hydrological variables. In order to account for varying spatial resolution of the images, random field averaging, apparent petrophysical relations or full-inverse statistical calibration methods, have been suggested. Initial attempts have also been made to jointly invert different data types with complementary resolution properties to help produce more reliable geophysical models.

In this study we use the geophysical data in an “integrated data fusion” approach to estimate unsaturated hydraulic parameters of a 12-m-deep unsaturated soil column. The methodology, which is based on the Generalized Likelihood Uncertainty Estimation (GLUE) method, solely uses the geophysical data in a forward modelling approach to

evaluate a series of plausible hydrological models. In this way the artefacts introduced during conventional geophysical data inversion are avoided and the information content from multiple data sources at multiple measurement scales can, in principle, be evaluated.