Geophysical Research Abstracts
Vol. 17, EGU2015-1312, 2015
EGU General Assembly 2015

Soil moisture content estimation from passive temperature measurements

Landon JS Halloran (1), Hamid Roshan (1), Gabriel C Rau (1), Mark O Cuthbert (1,2), Martin S Andersen (1), and Ian Acworth (1)

(1) Connected Waters Initiative Research Centre, UNSW, Sydney, Australia (l.halloran@unsw.edu.au), (2) School of Geography, Earth and Environmental Sciences, University of Birmingham, UK.

Natural temperature variations have increasingly been used to study shallow groundwater; however, the vast majority of studies are limited to saturated conditions. Despite the greater complexity of the unsaturated zone due to the non-linear relationships between moisture content and other physical properties (such as effective thermal conductivity and heat capacity), estimating soil moisture from measurements of natural temperature variations is possible. We have developed fundamental relationships between soil moisture and the diel temperature amplitude ratio and phase-shift. Additionally, we have developed fully coupled thermodynamic and hydraulic finite element (FE) models of temperature and soil moisture response to various boundary conditions. The performance of novel inversion techniques based on existing empirical thermal conductivity models has been evaluated with these results. Two significant empirical models of thermal conductivity of unsaturated sediments were integrated into the approach and compared. We performed a sensitivity analysis of our soil moisture model and determined the feasibility of deriving moisture estimates from temperature data by analysing the required measurement precision for the involved parameters. Inversion of the temperature output from the FE models demonstrates the factors, such as homogeneity and rapidly changing boundary conditions, which may limit the performance of unsaturated zone heat tracing, as well as the benefits of the approach. The use of heat to determine soil moisture content offers the advantages of lower cost; applicability to zones of high pore-water salinity, where inductive electromagnetic measurement methods fail; and the option of high spatial resolution or wide coverage when combined with fibre optic temperature sensing.