Geophysical Research Abstracts
Vol. 13, EGU2011-3540, 2011
EGU General Assembly 2011

Prediction of the water retention curve in dry soils

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The Knowledge of the water retention curve (WRC) is essential to predict the water transport in soils. Various empirical pedo-transfer functions have been established to predict water retention under humid condition. However, these relationships are not able to predict water retention under conditions dryer then the wilting point.

So far only one pedo-transfer function based on 8 soils by Campbell et al. has been established for the dry region. Here we present an improved pedo transfer function (PTF) that predicts the WRC for dry soils based on the clay content of the soils at ambient air temperature. For the calibration data set we measured WRC data for 18 soils with clay contents from 2% to 61%. Data for 32 soils from the literature were used for validation. In general the predictions of the WRC from the clay mass fraction were very good if the clay content was higher than 7% and if the clay fraction was dominated by 2:1 clay minerals. The water content of soils rich in the 1:1 clay mineral kaolinite could not be predicted by the presented approach. In addition to the extended calibration data set we also we also revised theoretical endpoint at the dry end of the WRC which further improved the prediction as compared to the endpoint that has been used in the literature before.

In addition the temperature dependence of the water retention curve under dry conditions was investigated for 8 soils. The absolute value of the adsorption enthalpy of water, ΔH_{ads}, which reflects this temperature dependence, increased with decreasing water content and thus deviated from the condensation enthalpy of a pure (unbound) water phase, ΔH_{cond}. The observed temperature dependence of WRCs varied only little between the studied soils. Therefore, an average empirical equation derived from our experimental data may serve as a good approximation of ΔH_{ads} for soils in general. This allows the temperature extrapolation of WRCs received from the pedo-transfer function at 20˚C to temperatures between 5˚C and 40˚C without the need for additional experimental information.