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Multivariate distributions of soil hydraulic parameters

Wei Qu (1), Yakov Pachepsky (2), Johan Alexander Huisman (1), Gonzalo Martinez (3), Heye Bogena (1), and Harry Vereecken (1)

(1) Agrosphere Instuitute, Research Center Juelich, Germany, (2) USDA-ARS Beltsville Agricultural Research Center, EMFSL, Beltsville, MD, USA, (3) Andalusian Institute of Agricultural Research and Training, Fisheries, Food and Organic Production (IFAPA), Seville, Spain

Statistical distributions of soil hydraulic parameters have to be known when synthetic fields of soil hydraulic properties need to be generated in ensemble modeling of soil water dynamics and soil water content data assimilation. Pedotransfer functions that provide statistical distributions of water retention and hydraulic conductivity parameters for textural classes are most often used in the parameter field generation. Presence of strong correlations can substantially influence the parameter generation results. The objective of this work was to review and evaluate available data on correlations between van Genuchten-Mualem (VGM) model parameters. So far, two different approaches were developed to estimate these correlations. The first approach uses pedotransfer functions to generate VGM parameters for a large number of soil compositions within a textural class, and then computes parameter correlations for each of the textural classes. The second approach computes the VGM parameter correlations directly from parameter values obtained by fitting VGM model to measured water retention and hydraulic conductivity data for soil samples belonging to a textural class. Carsel and Parish (1988) used the Rawls et al. (1982) pedotransfer functions, and Meyer et al. (1997) used the Rosetta pedotransfer algorithms (Schaap, 2002) to develop correlations according to the first approach. We used the UNSODA database (Nemes et al. 2001), the US Southern Plains database (Timlin et al., 1999), and the Belgian database (Vereecken et al., 1989, 1990) to apply the second approach. A substantial number of considerable (>0.7) correlation coefficients were found. Large differences were encountered between parameter correlations obtained with different approaches and different databases for the same textural classes. The first of the two approaches resulted in generally higher values of correlation coefficients between VGM parameters. However, results of the first approach application depend on pedotransfer relationships not only within a given textural class but also on pedotransfer relationships within other textural classes since the pedotransfer relationships are developed across the database containing data for several textural classes. Therefore, joint multivariate parameter distributions for a specific class may not be sufficiently accurate. Currently PTF may give the best prediction of the parameter itself, but they are not designed to estimate correlations between parameters. Covariance matrices for soil hydraulic parameters present an additional type of pedotransfer information that needs to be acquired and used whenever random sets of those parameters are to be generated.