Depth-specific scaling properties of soil water storage

Dr. Asim Biwas[1,2], Dr. Henry Wai Chau[3], Dr. Bing Cheng Si[4], Dr. Hamish Cresswell[5]
[1]University of Guelph, [2]Mcgill University, [3]Lincoln Unversity, [4]University of Saskatchewan, [5]CSIRO

Knowledge of the spatial distribution of soil water over a range of spatial scales and time has important hydrologic applications. Data intensive measurement of surface soil water using remote sensing approaches have established that the spatial variability of soil water can be described using the principle of self-similarity (scaling properties) or fractal theory. This information can be used in determining land management practices provided the surface scaling properties are retained in the deep layers. The objectives of this study were to examine the scaling properties of sub surface layers and their relationship with surface layers at different initial soil water conditions over time. Soil water storage (SWS) down to 1.4 m depth at seven equal intervals was measured along a transect of 576 m for 5 years in Saskatchewan, Canada. The surface SWS showed multifractal nature only during the wet period (from snowmelt until early summer) indicating the need for multiple scaling indices in transferring soil water variability information over multiple scales. However, with increasing depth, the SWS became monofractal in nature indicating the need for a single scaling index to upscale/downscale soil water variability information. In contrast, all soil layers during the dry period (from early summer to the end of the growing season in the fall) were monofractal in nature, possibly resulting from the high evapotranspirative demand of the growing vegetation. This strong similarity between the scaling properties at the surface layer and deep layers provides the possibility of inferring soil water dynamics in the whole profile using the scaling properties of the easy-to-measure surface SWS data.