Geophysical Research Abstracts
Vol. 18, EGU2016-10516, 2016
EGU General Assembly 2016

Relating soil pore geometry to soil water content dynamics decomposed at multiple frequencies

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Soil structure is a critical factor determining the response of soil water content to meteorological inputs such as precipitation. Wavelet analysis can be used to filter a signal into several wavelet components, each characterizing a given frequency. The purpose of this research was to investigate relationships between the geometry of soil pore systems and the various wavelet components derived from soil water content dynamics. The two study sites investigated were located in the state of São Paulo, Brazil. Each site was comprised of five soil profiles, the first site was situated along a 300-meter transect with about 10% slope in a tropical semi-deciduous forest, while the second one spanned 230-meter over a Brazilian savanna with a slope of about 6%. For each profile, between two to four Water Content Reflectometer CS615 (Campbell Scientific, Inc.) probes were installed according to horizonation at depths varying between 0.1 m and 2.3 m. Bulk soil, three soil cores, and one undisturbed soil block were sampled from selected horizons for determining particle size distributions, water retention curves, and pore geometry, respectively. Pore shape and size were determined from binary images obtained from resin-impregnated blocks and used to characterize pore geometry. Soil water contents were recorded at a 20-minute interval over a 4-month period. The Mexican hat wavelet was used to decompose soil water content measurements into wavelet components. The responses of wavelet components to wetting and drying cycles were characterized by the median height of the peaks in each wavelet component and were correlated with particular pore shapes and sizes. For instance, large elongated and irregular pores, largely responsible for the transmission of water, were significantly correlated with wavelet components at high frequencies (40 minutes to 48 hours) while rounded pores, typically associated to water retention, were only significantly correlated to lower frequency ranges (48 hours and two months). These results will be further discussed in the context of the location of the soil horizons within the toposequence.