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Occurrence, spatial pattern, and influence of atmospheric deposition on top- and subsoil water repellency in a beech forest

Joerg Bachmann, Jürgen Böttcher, Jiem Krüger, and Susanne K Woche
Institute of Soil Science, University of Hannover, Hannover, Germany (bachmann@ifbk.uni-hannover.de)

It is well known that enhanced solute input due to stemflow infiltration causes enhanced soil acidification near the tree base. Infiltration-driven alteration of chemical soil properties like pH, and carbon to nitrogen ratio (C/N) may also affect soil wettability (quantified as contact angle, CA) with a trend to increased soil water repellency (SWR) with decreased pH. Objective of this study was to analyze the impact of tree location on top- and subsoil wettability and selected soil chemical parameters on two large-scale transects (length [U+F040] 50 m, sampling depths 0.1-0.2 m). The transects were about 50 m apart from each other, time of sampling was in July 2013 and July 2015. To analyze subsoil wettability in the vicinity of selected trees, three transects (lengths =3 m, sampling depths = 0.1 – 2.0 m) were additionally sampled in June 2013. Sampling site is a 100 years old beech forest (Fagus sylvatica L.). Soil type is a well-drained sandy Dystric Cambisol in northern Germany with moderate to locally extended acidification. According to standard statistics, the total variance of chemical soil properties and SWR was independent of stemflow infiltration pattern. Results of spectral variance analyses, however, showed that the spatial variability of acidification (pH, Al content) as well as SWR in the soil horizon close to the surface was strongly affected by the pattern of patches with and without stemflow infiltration on both large-distance transects, no matter if sampling took place in 2013 (mean CA = 40°, SD = 12°) or 2015 (mean CA = 110°, SD = 14°). Regarding subsoil wettability on the smaller transects, CA were always in the range $0° < CA < 90°$. A significant impact of the distance to the tree on SWR was observed for none of the transects, indicating that the impact of tree canopy is restricted to surface-near soil layers. Specific chemical surface properties analyzed via X-ray photoelectron spectroscopy (XPS) showed specific chemical alteration of the particle interfaces with corresponding impact on the CA, i.e. expressed by linear relationships between O/C ratio and CA (r2=0.78), the amount of non-polar C species and CA (r2=0.77), and the amount of Al and CA (r2=0.87). For C/N ratio, sulfate, and oxalate-soluble Fe content no significant relations to SWR or soil acidity were found. We conclude that our study provides a link between chemical soil quality and physical behavior with respect to SWR and, accordingly, water infiltration in a beech forest soil.