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Long-term persistence of throughfall yield assessed by small footprint LiDAR data

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Throughfall (TF) represents an important relocation mechanism for the spatial distribution of intercepted precipitation and hence associated nutrients in wooded ecosystems. To date, a broad range of studies showed that the spatial patterns of TF distribution exhibit a pronounced temporal stability. These studies, however, have examined TF temporal stability at the tree scale or they were computed from event-based data. Here, we seek to evaluate the utility of temporally aggregated TF data at one, three, and six year intervals to determine whether such long-term TF monitoring data could serve as the basis for TF temporal persistence measurements for both beech and spruce forests. In addition, we examine the temporal persistence of TF in relation to small footprint LiDAR data.

In context of the German Science Foundation (DFG) founded “Biodiversity Exploratories” (www.biodiversity-exploratories.de) we studied water-bound nutrient fluxes on a set of three differently managed forest plots (spruce plantation, age class forest beech, unmanaged beech) in central Germany throughout the vegetation periods of 2010 – 2015. For long-term monitoring purposes, TF samples were collected in biweekly routine sampling intervals using X-shaped transects of 20 bulk samplers (axis length 32 m) per experimental plot. In this study, we aim to identify canopy structural parameters explaining the temporal patterns observed. We therefore used small footprint LiDAR (Light Detection And Ranging) data to calculate several canopy structural parameters on base of a gridded canopy model (grid cell resolution = 0.75 m). As LiDAR allows a three-dimensional description of the complex forest canopy structure it might help to extend our understanding of complex canopy processes influencing the spatial dispersal of precipitation water, and hence associated nutrient fluxes, in wooded ecosystems.

Preliminary data analysis reveals that normalized TF values identify a number of TF collectors on each of the three study plots which show significantly lower or respectively higher TF values throughout the whole study period. Time stability plots furthermore exhibit pronounced differences between the two different tree species as well as between different stand ages of beech. In particular, they exhibit a higher temporal variability under spruce as well as a higher spatial variability of TF distribution for the younger even-aged beech stand compared to the unmanaged one. Preliminary analysis further showed that TF amount also is correlated to structural parameters like e.g. slope, aspect or texture of the outer canopy surface and that different structural parameters might be responsible depending on tree species or even growth structure. These preliminary results suggest that long-term throughfall monitoring is useful in establishing the spatiotemporal heterogeneity of TF inputs into both deciduous and coniferous forests.