Geophysical Research Abstracts
Vol. 21, EGU2019-14012, 2019
EGU General Assembly 2019

Dynamic of soil water availability and soil aeration as factors for urban road trees

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Urban trees have to cope with restricted growing conditions like a specific microclimate, soil contaminants, restricted rooting space and soils of artificial materials. Due to ongoing urbanization and to climate change, it is of crucial importance to find solutions for a sustainable urban tree management and to learn how to improve trees site conditions in case of planting.
To quantify the soil water induced stress, we monitored soil water content and availability as well as O_2- and CO_2-concentration at six established trees (Quercus robur and Acer pseudoplatanus), and additionally the soil water availability at 17 freshly planted trees (seven species) along roads in the city of Hamburg. For the established trees, during the vegetation period also sap flow measurements were conducted. As the climatic conditions in the vegetation periods 2016 – 2018 were quite different, the monitoring data allow to quantify the tree water stress and to distinguish between the climatic and the soil impact.
During summer, the ratio of dry soil (pF > 3.3) below a large Q. robur canopy varied between 0 and 36 % of the days for the three summer season. In contrast, below another Q. robur tree even in the low rainfall season 2018 the soil never dried out > pF 3.3. Soil CO_2 showed significant annual trends with summerly high and wintery low concentrations. High CO_2 contents of > 6 % correspond with soil surface compaction and likely cause the restricted root density below some road trees. The constant moist soil condition below one tree thus indicates a limited root water uptake.
In the below-canopy soil of freshly planted road trees long periods of soil drought have been observed even in moist summer seasons. Here, the low water holding capacity of the planting substrate guarantees the mechanical load as well as the aeration, however leads to highly dynamic water availability courses.