Geophysical Research Abstracts
Vol. 19, EGU2017-12402, 2017
EGU General Assembly 2017

As above, so below? How the interplay between overstory species and edaphic factors influences the magnitude and mechanisms of belowground carbon cycles.

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The choice of overstory species in relation to soil properties is one of the most important management decisions in forestry, especially when deciduous or mixed stands are replaced by coniferous monocultures. When assessed in relation to climate change, conversion effects are mainly studied in terms of total carbon stocks. These are generally considered to evolve linearly, according to similar stabilization processes across ecosystems. Here we show that the belowground carbon cycle is subject to ecosystem-specific stable process domains. The process domains are separated by steep thresholds, or even tipping points, where a small increase in environmental forcing can cause a drastic change in the way the ecosystem processes carbon. These effects are demonstrated in detail for the old-growth forest complex of the Gaume in Belgium. This forest spans a lithological gradient and mixed-species stands occur next to stands recently converted to Norway spruce (Picea abies) monocultures, creating a setting of paired plots that allow to address the magnitude of management choices relative to intrinsic natural potential. Vegetation descriptions, litter samples and soil samples at different depths were compared for above- and belowground functional biodiversity, litter layer characteristics, soil properties, nutrient status, bioturbation, soil carbon stocks and soil carbon functional pools. Results show that in soils with limited remaining buffer capacity, overstory-induced acidification under spruce causes a shift to an acid aluminum buffered environment, with a collapse in variability of abiotic and biotic soil properties. This entails a shift in soil fauna and depth relations, with a clear decoupling of the litter layer from the topsoil and the subsoil in terms of biological communities, carbon input and stochastic constraints. Finally, this study indicates that although spruce conversion increases the total soil carbon stocks, this extra carbon is stored in more labile carbon pools. Sustainable management strategies should therefore recognize the importance of aboveground species diversity and identity, and the corresponding litter characteristics for driving carbon cycles, especially in systems near a pedological threshold.