The biogeochemical cycle of B and $\delta^{11}B$ in a forest ecosystem

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Boron constitutes an essential nutrient to plant growth with a narrow range between carency and toxicity levels. However, despite its recognized control on the B biogeochemical transfer in forest ecosystems, its biological cycle (soil/plant subsystem) is still poorly studied.

In order to understand the controls and feddbacks of the boron fluxes in forest ecosystems, this study aims at establishing on a year basis the different stocks and fluxes within the soil/plant B pools. The beech forest ecosystem of Montiers (France) has been chosen beacause of the parallel biomass and hydrology models that will provide a strong framework to interpret B data. We thoroughly studied and compared the B biogeochemical cycle from both the soil mineral and aqueous pools as well as beech trees compartments (roots, wood, trunck, branches and leaves) on two of contrasted soil types: deep acid soil (Dystric Cambisol) and shallow calcareous soil (Rendzic Leptosol).

The B inputs (atmospheric wet and dry deposits, soil mineral weathering) vary from $57 g.ha^{-1}.yr^{-1}$ on the rendisoil to $74 g.ha^{-1}.yr^{-1}$ on the alocrisoil while the outputs (drainage and wood exportation) range from $33 g.ha^{-1}.yr^{-1}$ on the calcareous soil and $85 g.ha^{-1}.yr^{-1}$ on the acidic soil. The inputs only represent 20% of the B cycled by vegetation and, out of the remaining 80%, more than 40% of boron originates from the mineralization of organic matter with fluxes varying between $107 g.ha^{-1}.yr^{-1}$ and $167 g.ha^{-1}.yr^{-1}$ in the calcareous and acidic soil, respectively. We also found evidence that the biological cycle controls the dynamics of boron isotopes since the canopy exchange and the mineralization of organic matter tend to favour the release of the heavy isotope ^{11}B while the formation of perenial biomass tend to favour the light isotope ^{10}B. The B uptake by roots doesn't induce any isotope fractionation.

We finally found that the soil type greatly influences the biogeochemical cycle of boron by modifying the stocks and fluxes of boron with globally higher values on the acidic soil. This is also observable from the B isotopic compositions which are systematically higher (about +5‰) in all the compartments of the beech tree developed on the rendisoil. We suggest these observations to result from different physiological functioning linked to a slight boron deficiency on the calcareous soil.