Geophysical Research Abstracts
Vol. 15, EGU2013-8950-1, 2013
EGU General Assembly 2013

Multi-decadal carbon and water relations of African tropical humid forests: a tree-ring stable isotope analysis

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Little is known about the temporal dynamics of the carbon sequestering capacity and dynamics of African tropical humid forest ecosystems in response to various environmental drivers. This lack of knowledge is mainly due to the absence of ecosystem scale flux measurements of gas exchange. However, tree growth often displays itself as alternating pattern of visible rings due to the seasonally varying growth speed of the vascular cambium. Consequently, analysis of tree growth through tree-ring analysis provides us with insights into past responses of the carbon sequestering capacity of key species to abrupt ecosystem disturbances and, while slower, a changing climate.

Not only does the width and density of growth rings reflect annual growth but their isotopic composition of $^{13}C/^{12}C$ and $^{18}O/^{16}O$ isotopes also reveal the environmental conditions in which the trees were growing. In particular, stable isotope ratios in tree-rings of carbon are influenced by fractionation through carboxylation during photosynthesis and changes in leaf stomatal conductance. Similarly, fractionation of oxygen isotopes of soil water occurs at the leaf level through evapo-transipiration. As a consequence, $^{18}O/^{16}O$ ($\delta^{18}O$) values in wood cores will reflect both the signal of the source water as well as that of for example summer humidity. Therefore, both C and O stable isotopes might not only be valuable as proxy data for past climatic conditions but they also serve as an important tool in understanding carbon and water relations within a tropical forest ecosystems.

To this end we correlate long term climate records (1961 – present) with tree ring measurement of incremental growth and high resolution analysis of tree-core stable isotope composition($\delta^{13}C$, $\delta^{18}O$) at a tropical humid forests in the DR Congo. The Yangambi Man And Biosphere (MAB) reserve is located in the north-eastern part of DR Congo, with a distinct tropical rainforest climate. In addition to the tree-core data records and extensive meteorological records collected at both sites, observations on green leaf phenology of key species will provide us with additional information on potential carbon sequestration dynamics. Because, phenology is a first order control on plant productivity. In this unique study, using detailed tree-ring analyses together with auxiliary data, we explore the temporal dynamics of carbon and water relations and the influence on carbon sequestration of key tree species in African tropical humid forests.