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Seasonal leaf and soil water isotope dynamics obtained from the δ^{18}O signals of CO_2 fluxes

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The oxygen isotope composition of CO_2 fluxes such as photosynthesis and respiration carry important information on the dynamics of ecosystem water pools. Chamber-based field measurements of total CO_2 and $CO^{18}O$ fluxes from foliage and soil can help evaluate and refine our models of isotopic fractionation by plants and soils and validate the extent and pattern of isotopic enrichment within terrestrial ecosystems. This is highly desirable as the oxygen isotope composition of atmospheric CO_2 is among a very limited number of tools available to constrain estimates of the biospheric gross CO_2 fluxes, photosynthesis and respiration at large scales. Due to sampling limitations in the past, such measurements have been very rare and covered only a few days. In this study, we coupled automated branch and soil chambers with tuneable diode laser absorption spectroscopy techniques to continuously capture for the first time the oxygen isotope signals of foliage and soil CO_2 exchange at a FLUXNET site (Maritime pine forest) in southern France. Over the growing season we observed seasonally persistent isotopic differences between the oxygen isotope signatures of net CO_2 fluxes from leaves and soils, except during rain events when the isotopic imbalance between the two became temporarily weaker. These variations were driven dynamically by variations in evapotranspiration and precipitation inputs over the growing season. Variations in the oxygen isotope composition of water pools and CO_2 exchanged between leaves, soil and the atmosphere were also modelled following theory describing changes in the oxygen isotope composition of ecosystem water pools in response to changes in leaf transpiration and soil evaporation. The results of this modelling and the implications for larger scale CO_2 and $CO^{18}O$ mass balance studies will be discussed in this presentation.