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Hydrology & isotope tools to quantify carbon sources and sinks

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Vegetation is fundamental for carbon uptake and usually assumes the largest portion in the evapotranspiration term. While interception can be separated by mapping various plant types in a catchment, the water isotope method yields numbers for pure evaporation. The latter causes enrichment of the heavier isotope in the remaining water phase, while transpiration leaves the isotope signal of water unaltered over longer time periods. Evaporation can thus be quantified in an integral manner over large areas by measuring water stable isotopes at points of river discharge and by comparing them to incoming precipitation. This method has been applied on scales of several thousand square kilometres and its calibration on scales of few square kilometres will allow to better constrain uncertainties. This necessitates comparison with hydrometric methods of well-instrumented catchments in several climatic regimes. Innovative small-scale methods involve determination of effective rainfall by time series analyses of hydrological data. This in turn requires temporal resolution of daily to hourly values to apply methods such as runoff recession or principal component analyses. It is also known that continental water fluxes are related to carbon fluxes through photosynthesis that in turn recycles large amounts of water via transpiration. This is usually described by the water use efficiency (WUE) term that quantifies how many moles of water transpire to accumulate one mole of CO2. However, so far only few empirical numbers are available for the spatio-temporal variability in WUE of plants and plant communities and further field experiments combined with isoscape approaches are necessary to constrain this term on a regional scale and its dependencies on factors such as light, temperature, water availability, plant type and height. Combined data can then serve to determine catchment-wide carbon uptake via the transpiration rates. Carbon accumulation can also be determined with eddy covariance methods, which usually yield local information. Furthermore, eddy covariance methods yield valuable information about ecosystem respiration. The latter needs to be subtracted from carbon uptake to determine net ecosystem CO2 exchange and to define sources or sinks. Eddy covariance and their upscaling combined with area-integrating water isotope methods thus provide cross validation of large scale carbon budgets with independent approaches. This combination may therefore provide new insights into relations between carbon and water balance of the biosphere as affected by various environmental conditions.