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Water stable isotope shifts of surface waters as proxies to quantify evaporation, transpiration and carbon uptake on catchment scales

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Comparison of water stable isotopes of rivers to those of precipitation enables separation of evaporation from transpiration on the catchment scale. The method exploits isotope ratio changes that are caused exclusively by evaporation over longer time periods of at least one hydrological year. When interception is quantified by mapping plant types in catchments, the amount of water lost by transpiration can be determined. When in turn pairing transpiration with the water use efficiency (WUE i.e. water loss by transpiration per uptake of CO_2) and subtracting heterotrophic soil respiration fluxes (R_h), catchment-wide carbon balances can be established. This method was applied to several regions including the Great Lakes and the Clyde River Catchments ...(Barth, et al., 2007, Karim, et al., 2008). In these studies evaporation loss was 24 % and 1.3 % and transpiration loss was 47 % and 22 % when compared to incoming precipitation for the Great Lakes and the Clyde Catchment, respectively. Applying WUE values for typical plant covers and using area-typical R_h values led to estimates of CO_2 uptake of 251 g C m^{-2} a^{-1} for the Great Lakes Catchment and CO_2 loss of 21 g C m^2 a^{-1} for the Clyde Catchment. These discrepancies are most likely due to different vegetation covers. The method applies to scales of several thousand km^2 and has good potential for improvement via calibration on smaller scales. This can for instance be achieved by separate treatment of sub-catchments with more detailed mapping of interception as a major unknown. These previous studies have shown that better uncertainty analyses are necessary in order to estimate errors in water and carbon balances. The stable isotope method is also a good basis for comparison to other landscape carbon balances for instance by eddy covariance techniques. This independent method and its up-scaling combined with the stable isotope and area-integrating methods can provide cross validation of large-scale carbon budgets. Together they can help to constrain relationships between carbon and water balances on the continental scale.

References

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