Improved eddy covariance flux based transpiration estimates at high relative humidity and comparison to sap flux

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Eddy covariance (EC) directly measures evapotranspiration (ET), which consists of transpiration and evaporation (E) from the soil and other surfaces. For process understanding it is pivotal to separate ET into its components. Yet, its computation is highly sensitive to the methodology used to estimate T. Among the multiple methods proposed in recent years, T has been estimated from EC via the Transpiration Estimation Algorithm (TEA, Nelson et al., 2020), and from the sap flux measurement network SAPFLUXNET (Poyatos et al., 2020). These methods are applicable to a large number of measurement sites worldwide, and can help constrain the global estimates of the ratio of T to ET, T/ET. While EC measures water and carbon fluxes across ecosystems globally, water vapor flux measurements can be underestimated at high relative humidity (Ibrom et al., 2007; Mammarella et al., 2009) causing errors in the measured ET and propagating into the predicted T.

Here we report a method to detect and correct the high relative humidity error caused by attenuation of high frequency in water vapor measurements of a closed-path EC system. Our results of the comparison between present water use efficiency (WUE) with previous TEA-based WUE show that the corrected WUE is lower at high relative humidity than that derived from previous TEA at the sub-daily scale. Besides, we compare the corrected T estimates from EC to concurrent SAPFLUXNET sites to show an improved relationship between sap flux and EC based T, T/ET, and WUE. Finally, we explore the main abiotic factors, such as vapor pressure deficit, air temperature, and precipitation, influencing WUE estimated from different T estimation methodologies. These results provide an improved data-driven approach to the ongoing research on ET partitioning and the factors influencing the WUE across ecosystems globally.

