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Partitioning Carbon Dioxide Fluxes with Flux-Variance Similarity: Recent Advances

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Flux-variance similarity theory has previously been applied to eddy covariance data to partition CO_2 fluxes into gross photosynthesis and ecosystem respiration and, simultaneously, to partition water vapor fluxes into transpiration and direct evaporation. The approach is based on the assumption that stomatal fluxes (i.e. photosynthesis and transpiration) lead to perfectly negative correlations, while non-stomatal fluxes (i.e. ecosystem respiration and direct evaporation) lead to perfectly positive correlations between the CO_2 and water vapor high frequency time series measured above vegetated surfaces. Here, some recent advances are reviewed, including the development of an analytical expression that greatly simplifies that application of the partitioning procedure. The only input needed for this partitioning approach is leaf-level water use efficiency (WUE), but it is acknowledged that accurate estimates of this variable often can be difficult to obtain, and that the partitioning results can be sensitive to the estimated value. Therefore, stomatal optimization theory is applied to the solution space of the partitioning results, generating a most likely estimate of WUE. These eddy covariance-based estimates of WUE are shown to agree well with leaf-level measurements from an Ameriflux site (Morgan-Monroe State Forest). The resulting partitioned CO_2 fluxes are compared with those yielded by traditional approaches, and ecosystem respiration fluxes are shown to be more sensitive to surface wetness. Opportunities for merging this theory with other developing approaches (e.g. COS and stable isotopes) are discussed.