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Beyond friction-velocity thresholds: a new look on eddy-covariance flux filtering and impact on ecosystem C flux estimates

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Global eddy-covariance (EC) flux measurement networks have provided invaluable insights into ecosystem-atmosphere exchanges of gases, energy and momentum. However, EC technique underestimates surface fluxes during periods when the turbulent flow is decoupled from the surface and this deficiency casts a shade on the validity of EC flux networks. The decoupling can happen for instance when strongly stably stratified air layers or thick forest canopies inhibit vertical mixing. These so-called decoupling periods are typically identified using friction-velocity (u*) and periods when u* is below a site-specific threshold are removed from EC flux time series. This approach has at least two weaknesses: 1) it relies on uncertain site-specific threshold values and 2) it does not consider changes in processes hindering the flow coupling to the surface. Furthermore, it can be questioned whether u* is a correct metric for the strength of turbulent mixing. In this study we utilize recently proposed method which overcomes the above-mentioned weaknesses of u* filtering. The method is based on a comparison between vertical wind speed standard deviation and work done against forces (buoyancy and canopy drag) hindering the movement of a downward propagating air parcel. Via this comparison the need for site-specific thresholds is in theory alleviated. We utilize data from various contrasting EC sites to 1) evaluate whether the new method is free from site-specific thresholds also in practice, 2) compare the flux filtering methods in different conditions and 3) assess the effect of these methods on ecosystem respiration, gross primary productivity and carbon (C) balance estimates. These results will help to assess the robustness of ecosystem C flux estimates made in the past with EC and give clues on how to move forward with EC measurements during the decoupled periods.