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The effect of LAI on the representativeness of eddy covariance estimates of ecosystem respiration during turbulent conditions at night across a range of sites

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Calm conditions at night cause eddy covariance (EC) systems to underestimate ecosystem respiration due to poor mixing of the canopy air allowing for advection, a term which is not usually measured. However, turbulent conditions do not always result in reliable nighttime measurements either and leaf area index (LAI) may play a role. This study investigated the effect of LAI on the representativeness of EC measurements of ecosystem respiration (REC) at night in turbulent conditions in a wide range of vegetation types, climates, and topographies. Representativeness of REC was evaluated by its agreement with alternative estimates of ecosystem respiration (RALT). This was tested at a simple grassland site that allowed for minimal uncertainty in RALT estimates. We then tested the trend of REC representativeness with changes in LAI over time to investigate the effect of vegetation type. For this, we used 8 sites, including 2 herbaceous fields, 2 peatlands, a deciduous broadleaf forest, a mixed forest and 2 evergreen needleleaf forests. There was a significant correlation of REC underestimation with LAI ($p = 0.06$) at the simple semi-arid grassland site, a nearly significant correlation at a Mediterranean forest ($p = 0.11$), and no correlation at the remaining 6 sites ($p > 0.10$). This indicates that REC representativeness is not commonly affected by LAI within any of the 4 vegetation types tested but suggests that climate may play a role. Lastly, we tested general REC representativeness across 15 sites around the world and found no indication of bias in REC relative to RALT (0.90 ± 0.99 μmol m-2 s-1 underestimate) and no significant trend with LAI ($p \gg 0.10$). This suggests that while REC in turbulent conditions may underestimate at some sites, it generates realistic approximations of ecosystem respiration when sites are pooled.