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Limitations of eddy covariance measurements in Amazonian forest towers: implications to the energy balance and carbon fluxes

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In this work, a review of the most important limitations to the application of the eddy covariance method (EC) in forest flux towers in Amazonia is given. In nearly all towers in complex terrain, the energy balance does not close and nighttime carbon fluxes seem to be underestimated. Using data collected at Manaus K34 and Rebio Jaru flux towers, a review of some issues that may explain the lack of energy balance closure is given, namely: (i) sources of errors and uncertainties in all the terms of the energy balance; (ii) the choice of averaging time used in EC calculations; (iii) the spatial variability of turbulent processes. A basic assumption of the EC method is that the averaged product of temporal fluctuations in the wind and scalars measured at the tower is equivalent to the spatially averaged exchange by turbulent eddies carried with the mean flow. It is also usually assumed that the flow field is horizontally homogeneous and flux divergences and advection are negligible. Over complex surfaces, however, frequently the lower portion of the boundary layer (surface layer) is affected by slowly-passing "large eddies" or local circulations due to topographical or surface cover heterogeneity, which weaken the validity of these assumptions. To better understand the influence of these large eddies on the flux measurements, it is studied how turbulence statistics depend on different time scale and spatial scale classes, decomposing the turbulence signals using multi-resolution (wavelets). Results show that, although largest contributions to measured fluxes occur in turbulent scales (structures with length scales up to 1000 m and time scales up to 15 min), larger eddies can contribute with up to 30 % to the total exchange.