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Biogeosciences Discussions

Interactive comment on "Dependence of CO_2 advection patterns on wind direction on a gentle forested slope" *by* B. Heinesch et al.

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The authors are correct in determining that the relative error induced by the inappropriate assumption of incompressibility is of order 0.7% regarding the total height of integration. However, one must correctly interpret the consequences of such an error in order to appreciate its significance. Specifically, the authors estimate NEE based on the conservation of mass inside a control volume, and it is to this quantity (the CO2 mass inside the control volume) that the relative error of 0.7% in height applies.

For a 40-m tower such as that at Vielsalm and a background temperature of 288K as posited by the authors, and with completely calm conditions (no winds or turbulence) and 350 ppm of CO2, a 0.7% change in the CO2 mass inside the control volume can be achieved by a half-hour of surface exchange at a rate of 2.3 micromol m-2 s-1.

This is certainly not negligible in a biological context - whether in terms of relative or absolute error - and highlights the errors associated with an incorrect assumption of incompressibility. However, the point of the original comment is not to suggest that the authors have made such grave errors, because the final version of their equation (2) is in fact correct (i.e., contains no error).

Rather, the point is that the means by which this equation has been derived is indefensible. It appears that this is because the authors have committed similar, but canceling errors in their derivation. First, in the derivation of equation (1), the continuity equation has been applied in its (inappropriate) incompressible form, leaving equation (1) incorrect. Then, in the integration from equation (1) to the final version of equation (2), a similar error is committed. The net effect of these mutually annulling errors is to obscure the correct path to equation (2). Meanwhile an appropriate approach exists for justifying the final version of the authors' budget equation: for such a compressible medium as air, it is far simpler to begin the derivation by writing an expression for conservation of the mixing ratio, from which equation (2) can be derived handily.

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Interactive Comment