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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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This paper contains an error in the theoretical development whose correction, although indispensable, should have no affect on the results and conclusions of the article.

The problem has to do with the variation in the "molar volume", defined as the volume occupied by one mole of gas. As is well known, a mole of gas at standard temperature and pressure (STP; 273.15 K and 101300 Pa) occupies 22.4 liters. However, according to the ideal gas law this molar volume is strongly temperature dependent. In combination with any vertical temperature gradients within the so-called "control volume" over which the authors effect spatial integration, this dependence prohibits the extraction of the molar volume from the vertical integral in Equation (2), except for the trivial case of isothermal conditions.

In short, Equation (2) can be valid only under an assumption of incompressibility, and this has been shown to be unacceptable for such applications (see Kowalski and Serrano-Ortiz, 2007, Boundary-Layer Meteorology, 124, 129-141).

There is a simple means of avoiding this conceptual error. Rather than being written in terms of "mass conservation", the boundary-layer budget equations should be formulated in terms of conservation of the CO2 mixing ratio. In this context the molar volume appears, rather than within the integrals on the right-hand side of equation (1), on the left-hand side multiplying the biological NEE term (e.g., see Baldocchi et al., 1988. Ecology, 69(5): 1331 - 1340). Using this approach, the molar volume does not appear in the definition of advection in equation (2), and therefore is consistent with definitions from standard texts on atmospheric dynamics.

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