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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Vertical advection and nocturnal deposition of ozone over a boreal pine forest" *by* Ü. Rannik et al.

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The authors choose to define "concentration" in their manuscript as a synonym for constituent density, and consequently to write budget equations in terms of mass conservation. Given such choices, certain allowances must be made for the non-conservative nature of such a variable.

It is certainly true that the boundary-layer budget equation "most frequently presented in the literature" uses scalar densities to define a mass balance. However, this does not make such an approach necessarily preferable. In fact, as has been recognized only very recently, the use of a mass conservation approach implies the need for very accurate determination of the the mean vertical velocity, beyond the measurement limits of simple sonic anemometry. In fact, rather than being directly measured

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against a coordinate system determined by planar fitting to anemometer measurements, such mean vertical velocities must be modelled in terms of the "density effects" acting on the entire control volume. For a more precise means of estimating these vertical velocities, see Finnigan, J.J., Response to comment by Dr. A.S. Kowalski on "The storage term in eddy flux calculations". Agric. Forest Meteorol. (2008), doi:10.1016/j.agrformet.2008.10.012, and equation (10) in particular.

Also, given the authors' definition of "concentration" the statement at line 9 of page 18444, regarding a "concentration gradient which drives the flux" is demonstrably false. Since temperature gradients exist in the near viscinity of stomata, one can see readily that gradients in the concentration of inert Argon must also exist, but should in no way be interpreted as driving fluxes of Argon to or from the plant surface. With such a definition of "concentration" (as absolute density, rather than a relative definition such as the molar fraction or mixing ratio), it simply not true that the concentration drives the flux.

These unfortunate micrometeorological complications can be avoided completely by simply writing budget equations in terms of conservation of the ozone mixing ratio (defined as the mass fraction with respect to dry air). With such a relative definition of "concentration", only sources/sinks of ozone can represent sources/sinks of the scalar variable, and the relationship between fluxes and gradients is preserved. Such a definition represents the simplest of all solutions for correcting the manuscript: by specifying the variable "c" as the ozone mixing ratio, all of the fluxes in equations (1), (2), and (4) simply represent kinematic fluxes, which must be scaled by the dry air (molar) density in order to yield results with units as presented in the Figures of the manuscript.

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