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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Boreal forest BVOCs exchange: emissions versus in-canopy sinks" *by* Putian Zhou et al.

Anonymous Referee #1

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Zhou et al. have developed a multi-layer gas dry deposition model and present its implementation and application in a one-dimensional chemical transport model in order to quantify source and sink processes of twelve biogenic volatile organic compounds (BVOCs) or BVOC groups in the Hyytiälä forest canopy in July 2010. The explicit description of dry deposition of different gases to vegetation surfaces and soil surfaces is an important extension of the column model SOSAA that helps to disentangle the interactions of biogenic emissions, chemistry, and transport as controlling factors of BVOC concentration changes in and above forest canopies. The study is fully within the scope of Atmospheric Chemistry and Physics and should be published after language-editing and revising the manuscript by taking into account the following comments:

a) One of the main results of the study is the classification of selected BVOCs into

different categories corresponding to the dominant source and sink terms. I recommend to add more discussion about the general validity of the classification of each compound, and to give more guidance about possible changes of this classification in different canopies.

b) I had difficulties following the discussion of many results because of the separation of turbulent transport and gas dry deposition, which is only briefly explained in the appendix. When used to parameterize canopy-scale flux measurements, dry deposition is typically a combination of these processes. Then, the deposition velocity is expressed as the inverse of the quasi-laminar sublayer resistance and the canopy resistance (rb and rc), AND the aerodynamic resistance (ra) derived from the turbulent diffusivity of the scalar of interest. The separation of turbulent transport and gas dry deposition should be clarified in the beginning of section 3.2, and the budget of sources and sinks should be introduced. Also, the definition of a deposition flux by Eq. 1 leads to some ambiguity throughout the manuscript. For example, in Figure 4 on p. 18 fluxes at the canopy top are discussed which are obviously not the deposition flux according to Eq. 1. Also, a downward turbulent flux (e.g. p. 20, line 20) is obviously defined as positive because it is a source with respect to the canopy. However, by micro-meteorological convention a downward turbulent flux (= deposition) would be negative. For clarity, these differences should be clearly pointed out throughout the manuscript.

c) Figures 5-7 seem to indicate that the budget of in-canopy sources and sinks are balanced for almost all compounds for most of the time (when there is no white part in the bar charts). Then, according to Eq. A1 the in-canopy concentration tendency would be zero. Is this true?

d) On page 21, line 6 it is stated that emission sources shift upward during the day, "which implies that PAR and leaf temperature play a comparable role in emission rates besides the LAD". Why does the shift imply a comparable role?

e) In my opinion, there is no additional benefit from the summary in Chapter 5. I

recommend to revise this chapter, removing the purely summarizing parts and focusing on conclusions and synthesis.

Additional minor and technical comments:

p.1, line 15: "Most of the simulated sources and sinks were located...": Without knowing the forest geometry, e.g. the canopy height, absolute heights are not very helpful. I recommend using the height above ground level relative to the canopy height, height/hc (similar to the presentation of Figure 2a and b) throughout the manuscript, and in particular also in Figures 8 and 9 and their discussions.

p.1, line 21: "in-canopy" instead of "in-caonpy"

p.1, lines 22/23: I recommend to divide the last sentence of page 1 into two sentences.

p.2, line 16: A comma is missing after methanol.

p.2, line 19: Revise "... or partly transported into higher atmosphere".

p.2, line 24: "leaf-scale" instead of "leaf-sale"

p.2, line 29: You may also add a reference to Bamberger et al. (2011) Deposition fluxes of terpenes over grassland. J. Geophys. Res. 116, D14305, doi:10.1029/2010JD015457.

p.3, line 10: Could you please add a reference for the GECKO-A model?

p.3, lines 22/23: What do you mean by: "Both of them motivated this study"?

p.3, line 29: "complementary" instead of "complementory"

p.4. line 29: I cannot follow the explanation of the data filtering: A one month-data set of 45-minute averages would consist of almost 1000 data points for each time series. Why did you filter out one data point "from 164 measurement data points"?

p.6, Table 1: In the first and second columns, "delta3-pinene" should read "delta3-carene"

p.11, line 31: Remove "." after "BVOCs"

p.12, Table 3: In the first column, "delta3-pinene" should read "delta3-carene"

p.13, Table 4: In the first column, "delta3-pinene" should read "delta3-carene"

p.14, line 10: The statement that in "the sub-canopy (0.6 m) the incoming PAR was only about 1/4 of that at the canopy top" is not evident from Figure 1b. Is this statement with respect to maximum values or daily sums or something else? Just by looking at Figure 1b, most subcanopy values seem to be around 1/3.

p.14, line 9: Is the accuracy of the precipitation measurement good enough to give a value of 34.64 mm for the accumulated precipitation?

p.15, line 8: "due to the buoyancy" instead of "due to buoancy"

p.15, line 11: "occurrence" instead of "occuring"

p.15, line 16: Is this reference to Section 4.4 pointing to line 26 on page 20? I couldn't find a true demonstration of the potentially important role of leaf wetness in Section 4.4. Also, it should be acknowledged that leaf wetness may play a role at rH < 70 %, e.g. depending on the deliquescent behavior of salts deposited on the vegetation surfaces.

p.16, line 8: Remove "from the ecosystem".

p.17, line 5: I would assume that the standard deviation of the measured data shown in Figure 4b is not only due to measurement uncertainties but also due to day-to-day variability over the course of the month. If this is the case, please rephrase "measurement uncertainties".

p.19, line 4: Revise "still keep similar".

p.19, line 17: "In the second..." instead of "While in the second..."

p.21, line 9: "... inside the canopy compared to the vertical..." instead of "... inside the canopy compared to the effect of vertical..."

p.21, line 21: "most" instead of "a majority portion of"

p.22, line 1: "chemical sources" instead of "chemical productions"

p.22, line 4: "phenomenon" instead of "phenomena"

p.23, lines 5/6: Revise "...need of the application of canopy exchange modelling system..."

p.23, line 15: "causing a slight upward flux" instead of "causing slightly upward flux"

p.24, lines 2-5: This sentence basically repeats p.23, lines 5-7.

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