**Atmospheric
Measurement
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Discussions

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Interactive comment on "A tethered-balloon PTRMS sampling approach for rapid surveying of landscape-scale biogenic VOC fluxes" by J. P. Greenberg et al.

Anonymous Referee #1

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General comments

Greenberg et al. have measured VOC fluxes with PTR-MS at four sites using two different approaches: the surface layer gradient technique and the mixed layer variance technique. In addition, results have been compared to the MEGAN model. The authors have used a tethered-balloon for vertical profile measurements without permanent measurement site installations.

The tethered-balloon approach has been used only few times for on-line VOC measurements before and the research is worth of publishing. However, the authors should

describe their methods better and have more discussion about their results before the manuscript can be accepted for publication. The authors should also check the results with care and do recalculations if needed.

Major comments

Chapter 2.4.2

Generally, the chapter should be written more carefully and some corrections are also needed. I can see at least the following problems:

- The measurements have been done at six heights (5, 20, 40, 60, 80 and 100 m). Are you sure that the highest measurement level is still inside the constant flux layer and can be used for the flux calculations?

The lowest level is a slightly problematic as well because the gradient technique does not work properly inside a canopy, therefore, data from the lowest measurement level should not be used in the case of Prades (that is covered by a forest). In addition, the zero displacement height d should be taken to account above a forest and use a value $z - d$ for the calculations instead of z. Trees are also generating a roughness sublayer where the flux gradient law tends to break down. To avoid the effect, you could e.g. calculate the fluxes without using data from the lowest measurement levels (5 and 20 m, see e.g. Simpson et al., 1998).

Montseny site could also have the same problems because it is surrounded by a forest. How large was the meadow where the measurements were done? This would be good to mention in the text.

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- Eddy diffusivities have been calculated using the formula

$$K = 0.4 \cdot u^* \cdot z. \tag{1}$$

However, the equation works basically only in hydrostatically neutral conditions. In unstable and stable conditions, the eddy diffusivities should rather be calculated by the equation

$$K = \frac{0.4 \cdot u^* \cdot z}{\phi_h(z/L)}, \tag{2}$$

where ϕ_h is the dimensionless universal stability function, z the measurement height and L the Obukhov length (e.g. Dyer 1974; Simpson et al., 1998).

- I do not fully understand Eq. (3). It seems that you have calculated flux values between all levels. Which one of the values has been used later? How the gradients have been approximated? Please explain the calculation procedure in a more explicit way.

Chapter 3

Results should be handled in a more precise way. From the point of a reader, some important information is currently missing:

- I have understood that the MLV method defines only the absolute value of a flux, not a sign. If this is true, how have you figured out whether the fluxes were positive or negative?

- The comparison between the measurements and MEGAN is presented mainly in the Fig. 3. However, this needs more discussion in the text as well. It would be e.g.

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interesting to know if there were any significant correlations or systematic differences between the methods. If the negative flux values have been removed from the analysis, it should be mentioned in the text.

- Methanol fluxes are positive in the Tab. 1 and mainly negative in the Fig. 4. Could you explain this? In addition, I can see only two SLG values from Prades. What is the reason for that?

- Monoterpene emissions vary enormously between some sites: e.g. median monoterpene emissions from Prades and Montseny are 740 μgm^{-2}h^{-1} and 140 μgm^{-2}h^{-1}, respectively. Do you think that this is caused by the different measurement sites or is it rather random variation? How about some negative Q1-values of isoprene and terpenes, are they realistic values or random noise?

The table contains also some strange things, such as a median value that is not between the quartiles. I prefer the authors to check all values with care.

- I cannot fully follow the analysis of errors and uncertainties. What is e.g. the total error of SLG (and MLV) method? Some kind of table about the error sources and their effects might be one solution to make the analysis more clear.

Chapter 4

You conclude that the SLG and MLV techniques are suitable solutions to obtain flux measurements without permanent measurement infrastructure. From your point of view, which one of the method performed better? It would be also good to discuss what are benefits of the MLV technique compared to the SLG method and vice versa.

Specific comments

- Page 982, lines 8–12: This sentence would fit better to conclusions.

- Page 982, lines 22–25: Is the instrument equipped with a quadrupole mass analyzer (PTR-QMS)? This should be mentioned.

- Page 983, lines 4–6: How often did you calculate the sensitivities?

- Page 983, lines 6–8: A citation is needed.

- Page 986, lines 12–14: This sentence is not clear enough. How long did you obtain measurements at 100 m (I suppose 10 minutes)? Besides, 10 Hz sampling frequency sounds pretty high for normal quadrupole PTR-MS. What has been the used sampling/integration time for the studied compounds?

- Page 986, lines 20-21: The protonated masses could be written down as well.

- Page 986, lines 22-24: Is r^2 a squared (Pearson's) correlation coefficient? How have you chosen the criteria $r^2 > 0.5$?

- Page 987, Eq. (3): Minus sign is missing from the equation.

- Page 987, line 5: Please define variable $[x]_i$.

- Page 988, lines 18–19: This needs a citation

- Page 988, lines 26–28: This needs a citation

- Page 989, line 2: Would there be more recent reference available?

- Page 989, lines 5–7: Can this bring an additional error? What kind of?

- Page 989, lines 7–8: Explain the sentence. Why the contribution of the smallest eddies was excluded?

- Page 989, lines 13–15. The sentence needs more explanations. What is in the order of 10%?

- Tab. 1: Does 'terpene' mean same as monoterpenes? Terpene is a more general term including also e.g. sesquiterpenes.

- Tab. 1: What are Q1 and Q3 for acetaldehyde in Montseny?

- Fig. 4: The title is slightly misleading because 'emission' means positive flux. It would be better to use the title 'Methanol flux' instead. What is the unit of the y-axis?

Technical corrections

- Page 985, line 20: Please fix the parenthesis.

- Figs. 2 and 3: Could you use different markers for different variables? Otherwise it is difficult to separate the variables (especially without colour printing).

- Fig. 3: Could you enlarge the figures? It is very difficult to read them in a moment. Unit of the y-axis has been also typed wrong, please fix that.

References

Dyer, A. J. 1974. A review of flux-profile relationships. *Boundary-Layer Meteorology*, **7**, 363 - 372.

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Simpson, I. J., Thurtell, G. W., Neumann, H. H., Hartog, G. D. & Edwards, G. C. 1998. The validity of similarity theory in the roughness sublayer above forests. *Boundary-Layer Meteorology*, **87**, 69-99.

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