

Interactive comment on “Large estragole fluxes from oil palms in Borneo” by P. K. Misztal et al.

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We thank Prof. Monson for his overall positive evaluation and his constructive criticism and reply to all the comments below:

Pg. 7 line 24 CO₂ and H₂O are exchanged across leaf surfaces, not from leaf surfaces.

This has now been corrected.

Pg 8 line line 15 Why do you refer to monoterpene concentration gradients? Monoterpenes are not the topic of this paper.

Thank you for drawing attention to this typing error. The word “monoterpenes”

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has been replaced by “BVOC” because this comment applies to all emitted compounds, on the basis that the concentration gradient from inside the leaf to ambient air will be less than the gradient from inside the leaf to charcoal-filtered air.

Pg 8 lines 15-18 I don't buy your argument that we should ignore concern about differences in the ambient-to-leaf concentration gradients when using charcoal-filtered air.

You seem to suggest that because the influences on leaf-to-air concentration gradients are complex, we should assume that the influences will tend to average out to be negligible. In the end, you really don't know what the effect of using charcoal-filtered air is on your emissions measurements, and you should simply state that, along with the assumption you have used that other factors are larger. That assumption may be wrong, but you have to go with it given your design. Don't stretch to try to convince the reader that this assumption is valid, because you really don't know if that's true.

See reply to comment above. Text has been simplified, and referenced later (3.1.1) with the comment that even with a measurement system that would tend to overestimate emission fluxes, no significant emission from leaves was observed.

Pages 11-13. The modeling seems quite uncertain

We agree that there are different uncertainties associated with modelling floral emissions compared with foliage emissions. Please note, however, that this is the first modelling study of a floral emission and therefore we were not expecting to provide a finished modelling solution but rather that there was value in exploring how simple models based on leaf-level emissions but used

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with empirical parameters obtained from canopy data perform with respect to floral emissions. The general problem is that there are no available data or models for modelling any floral emission so there must be a starting point somewhere if we want to progress further. Our approach is one way of starting and we now provide additional comments on the modelling uncertainties in an added paragraph in the revised version.

I'm not sure which coefficients were borrowed from Guenther et al. (2006) for the temperature and light dependence curves, but there appears to be an assumption in this approach that the coefficients transfer with similarity from terpenoid compounds to estragole.

All the coefficients are derived through fitting to our measurement data – only the formalism of Guenther's approach has been used. The text has been altered to make this clear. We were surprised that we could achieve such a good agreement despite the differences between floral and foliar biochemistries and emission triggers. The model has sufficient degrees of freedom to accommodate any such differences. The model's dependence on historical PAR and temperature data may help to accommodate differences between foliar and floral emission processes, but the resultant equation is purely empirical. We have added clarifying sentences to indicate the exploratory nature of floral modelling and the uncertainties associated with this approach.

Within the scope of this paper we show that a simple empirical model can simulate the canopy flux reasonably well, albeit with a disproportional representation of the two daily emission peaks. This suggests that the current algorithm lacks a parameter related to potential thermogenesis or some other floral release mechanism(s)/process(es) that differ from those of foliage.

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We feel that the presentation of an empirical formulation that reproduces the observed flux well, is a worthwhile contribution to the paper. It does not greatly lose in mechanistic description compared with the Guenther algorithm for monoterpenes, which is a mixture of plant physiological and empirical response curves and therefore also not fully mechanistic, yet useful.

The uncertainties carried in this assumption are then transferred to the calculation of the deposition velocity, and from there to the calculation of the canopy conductance to estragole emission.

The assumption (that estragole behaves like a monoterpene) was not made (see above). In addition, current modelling of monoterpene exchange does not account for its potential deposition.

The aerodynamic conductance of the canopy is likely to carry considerable uncertainties, as approaches to derive this term from wind profiles carries inherent uncertainties.

The aerodynamic resistances / conductances are not calculated from wind profiles but from wind speed (u), the friction velocity (u^*) and atmospheric stability, all of which are determined directly from the sonic anemometer measurements of turbulent flux. The use of these resistances is standard practice in deposition modelling.

Additionally, the leaf boundary layer conductance is estimated for a 'standard' leaf assuming diffusive exchange. Within-canopy turbulence is ignored, with also introduces high uncertainties into the modeling of the transport resistances. When all of this is considered, the modeling comes across as more of 'back-of-the-envelope' stuff than a rigorous effort to understand the controls over exchange. I just don't think

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the modelling can carry much legitimacy.

It is true that the deposition model applied here is based on the big-leaf modelling approach, rather than a multi-layer model. However, we strongly reject the criticism that this would lead to a 'back-of-the-envelope' estimation of the exchange. Firstly, most deposition models use a big-leaf approach or, possibly, separate out the soil interface as a second layer. We do not have any information on exchange at this layer. Secondly, and more importantly, the emission parameterisation applied here (and that of Guenther et al.) is also based on a big-leaf approach and does, for example, not account for the vertical profile of T and PAR within the canopy. Therefore the complexity of the deposition parameterisation is consistent with the complexity of the emission scheme and in line with the current state-of-the-art.

This said, we concede that the inclusion of the deposition parameterisation improves the model fit only very slightly and that constant deposition velocities, here selected to provide the best model fit to the measurements, is highly uncertain. In the revised version we have decided to omit deposition element in the modelling, but the discussion of the relative importance of deposition is made at the end of Section 3.6.

Overall, the paper provides some very interesting and valuable data on estragole emission observations. The modeling summarized in Figure 10 is so uncertain as to be of low utility for interpretation. I recommend eliminating Figure 10 and the section on deposition modeling. This aspect of the study should await a future, more nuanced approach to this issue of emissions versus deposition, and the issue as to how the Guenther models for isoprene line up with regard to the temperature and PAR dependence of estragole emission.

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One would not expect to model floral emissions as perfectly as foliar emissions, because floral emissions may not be directly dependent on environmental variables, but indirectly (e.g. by correlation with previous history of temperature and PAR). Undoubtedly, a 'more nuanced approach' (a new model) would be better, but as an exercise, the degree to which an algorithm based on foliar emissions (and shown to work well for a range of BVOCs) actually applies to floral emissions at the canopy scale is of interest. The deficiencies are clear from Figure 9; the model is constrained by the whole dataset, and so overestimates morning emissions at the expense of evening emissions. Estragole may be important for regional chemistry and it can be approximately modelled using the modified Guenther algorithm despite the many difficulties faced in previous attempts at modelling flower emissions from other species. Figure 9 (now without deposition) presents a first comparison of measurement and model for floral emissions based on field measurements at the canopy scale.

We would like to thank the referee for reviewing the article and for providing comments that have led to clarification and improvement of the manuscript.

With kind regards,

Pawel Misztal

On behalf of other authors

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