

Answer to the comments of Reviewer 2

[We are grateful to the referee for the constructive comments that helped to improve the clarity of the manuscript. Please find below our replies to each comment.](#)

General comments

The manuscript introduces a method to assess the spatial scales of local aerosol production in boreal forest and agricultural ecosystem. Following the footprint estimation via Lagrangian dispersion modelling to assess flux footprints they develop a source contribution function for aerosol particles in the size range of 2-2.3 nm which can be related to the local sources of needed precursor gases and the favorite atmospheric conditions.

The manuscript has some aspects that may need a bit deeper explanations. As example, the prerequisite of a neutral stratification and the limit to this conditions is mentioned but it remains unclear why that limitation was chosen.

[The aims of this study were twofold: 1\) to outline the processes contributing to local aerosol formation in forests and agricultural fields and suggest a method for quantification of the relevant horizontal scales, and 2\) to estimate how different horizontal scales of local aerosol formation we could expect in a closed-canopy forest versus open vegetation areas. The main reason to choose neutral stratification conditions was to use the simplest possible setup. Stratification inside the forest might not always be well coupled to the stratification above the forest, and therefore to avoid too many complexities, the simplest case was to use neutral stratification conditions.](#)

[We have modified the second aim to read:](#)

[‘To quantify horizontal spatial scales corresponding to the growth of ions from 1.7 to 2 nm size linked to a local ecosystem via VOC emissions for a simple case of neutral stratification’](#)

Specific comments

page 1, line 5: "to produce small particles predominantly from own emissions." It is not immediately clear what these "own emissions" are. You speak about "an ecosystem" therefore I assume the "own" relates to this ecosystem, in that case I would at least write "its own emissions".

[Thank you for the comment, we have modified the text as suggested.](#)

page 1, line 10: What do you mean with "below-canopy forest"? Is that the understory layer? Is it a suppressed canopy layer?

[We apologize for being unclear, we meant below-canopy air layer in the forest. We changed wording throughout the text as suggested.](#)

page 1, line 11: "For the distribution close to measurements, the contribution of the nearby 100-500 m is approximately 30% in agricultural fields." What distribution do you refer to? It leaves me thinking what if that distribution is not near to measurements? Why the 100-500 m, that are a feature of the forest (in the sentence before), are now some fraction of the agricultural field?

[We apologize for being unclear. We meant aerosol distribution which we used in the model, and which is consistent with measurements. In the manuscript, we report also results of modelling with an unlikely aerosol distribution in order to understand what the consequence of changing distribution parameters would be. This is, however, not very important for the abstract. We have reformulated this sentence which now reads:](#)

'Under the same conditions in the agricultural field, the contribution of the nearby 100-500 m to the aerosol concentration is approximately 30% while the total contributing area is few km'.

page 6, line 178ff: You emphasize that the footprint function is itself not time depended? Where do you get this statement from? I ask because later in the manuscript (page 8, line 240) you tell that your Lagrangian dispersion model calculates according the travel time of air parcels. Furthermore you tell in Appendix B that the model used Gaussian distributions of velocity fluctuations. Velocities usually have a unit of m/s, so an explicit relation to time.

The footprint function is the sum of the contributions from the air parcels with different travel times (they are shown schematically in Fig. 2 and for one of our calculations in Fig. 3a). Calculation of these contributions from the different air parcels does involve time-dependent functions, as the reviewer mentions. However, their sum is a converging function: the longer the travel time is, the smaller and wider the contributions become, and their sum converges. So, if the travel time is chosen sufficiently long, the footprint function does not change anymore and is time-independent. For this reason, there is no dependence on the upper limit of integration T in eq (1).

page 6, line 184ff: The two subsequent sentences "Our concept of the source contribution function of local aerosol production is related to the concentration footprint for non-inert trace gases as we consider also the time scales of aerosol dynamics. Our concept of the source contribution function of local aerosol production is related to the concentration footprint for organic vapours (inert scalar) but considers also the time scales of aerosol dynamics." seem to tell the same thing. Maybe that remained accidentally while revising or, as AI helpers become more popular, these tend to repeat text with slightly different wording over and over. Maybe decide which version to retain.

In writing this manuscript, we have not used AI helpers for any other purposes than converting references to BibTeX format. The double sentence appeared when one of the co-authors suggested a better formulation of this sentence, which was copy-pasted in the manuscript instead of replacing the old one. We are grateful to the referee for noticing and we removed the extra sentence:

~~Our concept of the source contribution function of local aerosol production is related to the concentration footprint for organic vapours (inert scalar) but considers also the time scales of aerosol dynamics.~~

page 10, line 310 and page 11, line 327: Figure number reference not resolved in the text.

Thank you for noticing, it should be Fig. 8, now resolved.

page 11, line 349: "the concept of the footprint of the turbulent transport," I am not sure if I understand that statement. Turbulent transport "determines" the footprint (the field of view of the sensor). Why the "concept"?

Thank you for the comment, the formulation is indeed awkward. We have rephrased the statement to read:

'based on the concept of the footprint, and accounting for turbulent transport...'

page 12, line 358: "Above the canopy, the behaviour seems..." I would add like so " Above the canopy, the behaviour of forests seems..."

We have changed as suggested.

page 14, line 438: You tell that you are using the forward trajectory method. Can you explain why that choice was taken? Backward method is reported (e.g., Vesala 2008) to allow efficient application in case of inhomogenous terrain which is more apparent than homogenous terrain.

Regarding forward and backward Lagrangian stochastic simulations, it does not matter for our turbulence model which approach is used. In case of horizontally homogeneous turbulence (which we assumed), the most straightforward approach is to use forward simulation. Backward approach can be applied efficiently under horizontally inhomogeneous conditions. But we did not use more realistic inhomogeneous fields because we do not have a model to simulate turbulence statistics under inhomogeneous conditions.