Thanks to the reviewer for their critical evaluation of our manuscript. Please find a point-to-point reply below where we will explain our approaches and a possible way of dealing with the serious concerns. We hope that we can convince the reviewer from the proposed procedure as we think these approaches will provide reliable data. Please find the reviewer's comments in bold, our reply as plain text.

The manuscript by Lee at al. reports measurement of VOCs from forest soil and compares them between compacted waterlogged and well drained microsites. The focus of the manuscript is interesting as there is relatively little known on the effects of human disturbances to the soil VOC emission.

However, I find the measurement methodology and emission calculations to be inadequate. This methodology and data processing can only give semi-quantitative results. The chamber used is referred to as "dynamic chamber". However, the size of the chamber (10 L) compared to the low flow through the chamber (200 mL/min) leads to e-folding time of 50 minutes. Thus, during the two-hour emission measurement, starting at the moment of chamber closure or very soon after this, the concentrations inside the chamber has not reached steady state, a prerequisite for reliable quantification of exchange rates by dynamic chamber method. This can easily lead to nearly a 40% systematic underestimation of fluxes.

We agree that the term "dynamic" chamber might not be adequate since the air flow through our large chambers (10 L) is quite low (200 mL/min). As the reviewer mentions correctly, it takes ca. 150 minutes (considering volume and flow rate) until a steady state is reached. Due to very low exchange rates expected (low µg/m2/h – range), we decided to design the chamber with a large soil surface area (0.08 m2, open bottom) (at a height of only 10 cm); this of course leads to the large volume. *In a revised version of the manuscript, we propose to skip the term "dynamic", and only describe the chamber system used in the study.*

The very low exchange rates and consequently small concentration differences between chamber inlet and outlet need a highly sensitive analytical device to allow quantification of concentrations at relevant scales (typical concentration ranges are between ca. 50-300 ppt, max 800 ppt, depending on the trace gas considered). Concentration differences between chamber inlet and outlet are therefore very small. Even a highly sensitive online instrument (such as a PTR-TOF-MS) would not be able to determine such small differences. Increasing the flow rate through the chamber would dilute the gas concentration in the chamber, hence, further decreasing the concentration differences.

For this reason, we had to accumulate the exchanged gases (i.e. VOCs) on adsorption tubes. However, to sample sufficient amounts of these gases (masses of some ng), the sampling duration had to be adjusted to 120 min, resulting in 24 L of air sucked over the adsorption tubes. Waiting for longer time until an equilibrium establishes would have caused changes within the chamber (mainly condensation problems and therefore unreliable data since some VOCs would solve into the water droplets). With our approach, we were able to avoid such issues. *In a revised version, we would explain our approach more detailed*.

Furthermore, the equation used to calculate the emission is incorrect for both the dynamic and static chamber. For dynamic chamber the calculated exchange rate should be proportional to the air flow rate through the chamber (e.g. Breuningen et al., 2012), but this term does not appear in the Eq. on page 6 of the manuscript. In static chamber the exchange rate should be proportional to the rate of change of concentration in time inside the chamber, which is also not measured nor does not appear in the equation.

Our equation uses the masses of a given VOC entering the chamber and exiting the chamber. The mass difference had to be emitted by the soil surface within the chamber and during the time of VOC accumulation. Because the whole gas flow out of the chamber is channeled through the sampling tubes, there is no further dilution which has to be considered. Hence, calculating with masses instead of 'concentrations multiplied with an air flow', seems mathematically correct.

However, we fully agree with the reviewer that our calculation ignores that the steady state is not reached in our approach. I.e., particularly at the beginning of sampling, we mainly accumulate VOCs from ambient air present in the chamber and only with ongoing time, we collect larger amounts of VOCs emitted from the soil. Hence, the reviewer is fully correct when stating that we underestimate the true fluxes from/into the soil with our approach. We regret that we have overseen this before.

However, we are sure that with an adjusted equation, we can precisely calculate the true emission rates from the soil. Considering that reaching the steady state concentration follows a saturation curve, we can apply an equation which takes into account (i) that reaching the steady state follows a saturation curve, (ii) the concentration of a VOC of interest in the chamber at time when the sampling is started (which is the same as its concentration in ambient air) and the dilution of this VOC in the chamber from inflowing ambient air and (iii) the mass of this VOC accumulated over the 120 min of sampling on the adsorbent tube (and of course the soil surface area and the sampling duration).

To calculate the exchange rate [µg m^{-2} h^{-1}] accordingly, the following equation can be applied:

$$Echange\ rate = \frac{mass_{outlet} \times Q \times Conc_{inlet} \times sampling\ time}{sampling\ time - \ \times (1 - e^{\frac{sampling\ time}{\tau}})}$$ (subsequently the exchanging area is taken into account, and the time unit is changed from min to h)

In the equation:
mass $_{outlet}$: accumulated mass (µg) of the VOC of interest at the chamber outlet (measured)
Q: flow rate through chamber (0.2 L min^{-1})
$Conc_{inlet}$: concentration of the VOC of interest at the chamber inlet (µg L^{-1}) (i.e. entering the chamber) (measured)
Sampling time: the duration of accumulation (120 min)
τ = exchange time of the chamber: V/Q = 50 min

The denominator is constant: $120\ \text{min} - 50\ \text{min} \times (1 - e^{-\left(\frac{120\ min}{50\ min}\right)})$ = 74.5 min.

If we get the chance to revise the manuscript, we would like to apply this equation to precisely calculate the exchange rates between soil and the atmosphere and revise all respective figures and calculations. Noteworthy, the re-calculated patterns will be very similar to the ones presented in the original version, but the fluxes are underestimated as mentioned before.

Not measuring the ambient air in the point of inlet to the chamber adds even more uncertainty, as any nearby source of VOCs would make the mixing ration in the incoming air to differ from that measured in the ambient air.

The reviewer understand that the reviewer expresses concern regarding the point where we measured the concentration of the air entering the chambers, therefore, assuming wrong concentration differences and, hence, wrong flux rates. This is most relevant for the seasonal exchange rates of toluene and p-cymene presented in figure 6. Before conducting the measurements of the present study, we analyzed concentrations of some aromatics in different heights (10, 60, 120 cm) above soil surface. Their concentrations in different heights were comparable and usually did not differ. This might be beacuse the forest site is located at the top of a hill and moderately exposed to wind. As we did not see consistent concentration differences for these aromatics, we decided to do the ambient measurements in 120 cm distance from the soil. *In a revised version of the manuscript, we would add more details on this procedure.*