We thank the reviewer for his/her comments, and below is our general reply to the concerns. We will revise the ms to clarify issues that clearly have been unclear or confusing.

First, it is necessary to clarify the motivation of this study. It focuses on a key dataset which shows that the seasonality is a major factor in monoterpene emission potentials in evergreen forests. It emphasises the need for addressing such fine scale processes when upscaling and modelling across regions and plant functional types.

There exists a large variety of important biosphere-atmosphere models of different scales that have different purposes and aims, but that all try to answer questions within the categories of air quality, climate, atmospheric composition and more. Not all models are global. It is correct that global models utilise emission potentials for plant functional types, but many of the models that are not global models don't, even though they still contain e.g. the full version of MEGAN or only the emission response algorithms from e.g. MEGAN. Independently, when modelling boreal forests, one should be aware of the discrepancy that an exclusion of the enhanced emissions from new Scots pine foliage can result in. This is where we see our ms having the main contribution.

Unfortunately, in our manuscript it was not – and still is not – possible to suggest a better value for the coefficients in the expression for the leaf age emission activity factor (as also pointed out in Sec 4.1), since no other boreal species than Scots pine was studied and since it is not transparent how models attain the emission potentials of their plant functional types. Hence, we only studied Scots pine, because to our knowledge, there does not exist sufficient measurements from other boreal species for such an investigation. Nowhere in the manuscript do we claim, nor assume, that other boreal forest species – or all tree species in Finnish forests - behave in a similar way as Scots pine.

In this manuscript there are very evident reasons for using Finland as a case study, e.g. the great data availability on tree species and tree age distributions, because the model to simulate the seasonal development of Scots pine needle mass has been validated using data from Finland and because the only comprehensive ecosystem scale flux measurements from Scots pine forest during spring have been conducted at the SMEAR II station. Nowhere have we stated that SMEAR II is representative of forests in southern Finland nor than SMEAR I is representative of forests in northern Finland (not to say that they are not). Observations from SMEAR I and II are utilised in order to provide results across a latitudinal gradient and due to data availability.

Intra-species variability in emission responses in combination with practical limits with respect to measurements is the constant headache of researchers in our fields of science. Thus it seems strange that the referee is indicating that we consider an insufficient amount of data for our analysis. We have utilised data from Aalto et al. (2014) because there exists no other continuous long-term measurements of monoterpene emissions from different needle age classes simultaneously. Our results are compared to, and found to be in agreement with, ecosystem scale observations. Since we are very aware of intra-species variations, we have therefore also composed Fig. 4, which includes, if not all, then at least by far most, reported monoterpene emission factors from Scots pines. Though they are included for comparison, none of the values in Fig. 4 (except Aalto et al., 2014 values, of course) are suitable for our analysis, as they do not concern emission factors from new and mature needles individually, during spring, growing on trees that are not seedlings. Though the issue of plant-to-plant variation has also been pointed out other places in the manuscript, we can potentially add a sentence along the lines of "Our analysis is based on observations from one tree, and since measurements show large intra-species variations in emission responses (add relevant references), it is not certain that a similar seasonal pattern would be observed from other Scots pine individuals." in Sec. 2.3.

The comment about our reference to Räisänen et al. study is unfortunately not clear to us: The referee is firstly referring to Räisänen et al. (2005), but we do not know of such a paper. Do you mean Räisänen et al. (2009)? In that case, the authors report that European pine sawfly was noticed at the measurement site at the same time as the high emission rates from mature needles were observed and that some of the trees used for measurements of mature needles were also infested with the larvae. Since previous measurements (e.g. Ghimire et al., 2013) have shown inductions of both localized and systemic monoterpene emissions during European pine sawfly feeding on Scots pines, it seems very likely that the observed difference between emissions measured from mature needles is caused by the presence/absence of herbivory stress. At any rate, it seems unreasonable that we should point out this difference when even the authors have suggested another reason than needle age and because the paper only includes few data points from which it is difficult to draw a solid conclusion on the seasonal behaviour of mature needles.

Although Scots pine is a widely distributed tree species, dominating ~65 % of forest land in Finland, we do not want to extrapolate from pine to whole forest area of Finland. The estimate of an annual increase of 27 Gg monoterpenes/year from Finnish forests only considers enhanced emissions from Scots pines and no other tree species as the referee incorrectly indicates. This annual value is provided in order to put our results in perspective as previous estimates of the emissions of VOCs from Finnish forests only report annual values. The referee calculates that an increase of 27 Gg monoterpenes/year from Finnish forests would lead to an increase of <0.02% in the total global emissions of monoterpenes. Such an exercise seems largely unnecessary as the forest area of Finland only makes up a small fraction of the total boreal forest area, while Scots pine is found across large parts of Europe, Canada, US and northern Asia, and naturally within the Eurasian taiga. It is the most widely distributed pine species in the world and it is one of the most dominant evergreen tree species globally. Due to lack of measurements, we can naturally not prove that all Scots pine individuals in the world show a similar seasonal behaviour as the measurements utilised in this study, but it also seems unlikely that this trait should be specific to Finnish Scots pine trees. Due to lack of measurements, our best current guess must therefore be that new Scots pine needles in general have a significantly higher potential to emit monoterpenes than mature needles. Further, as no data so far exists from other species, it is possible that many if not all new flushing leaves/needles have similar higher emission potentials, which in some ecosystems where seasonality is less pronounced and constant new flushes occurs, may not be as evident as in the boreal forest with clear seasonal flushing period for new foliage.

The referee then calculates that an increase of 25% in the emissions of monoterpenes from all boreal evergreen ecosystems would lead to an increase of 1% in global monoterpene emissions or a 0.15% increase in total bVOC emissions. Such a calculation seems equally unnecessary as it is very well known that boreal forests globally is a small emitter (see e.g. Guenther 2013 or Guenther et al., 2012) and based on Guenther et al. (2012) Needleleaf Evergreen Boreal Tree PFT contributes to only about 4% of the global monoterpene emissions. However, individual VOCs have different physiochemical properties and thus different roles and faiths in the atmosphere, and the ambient blend of VOCs impacts those faiths too (which you should know since you also refer to Kiendler-Scharr et al., 2009 and McFiggans et al., 2019). Thus, production of new particles, from oxidised biogenic trace gases and subsequent gas to particle conversion, is frequently observed in boreal forest. Previous studies from sites in the boreal forest indicate for example that 12–50% of aerosol mass and 50% of the climatically relevant cloud condensation nuclei originate from forest sources (Tunved et al., 2008; Sihto et al., 2010). In the specific case of Finland, it has been estimated that particle formation causes a local radiative perturbation of between −5 and −14 Wm^{-2} (global mean −0.03 to −1.1 Wm^{-2}) (Kurten et al., 2003).

One key word with respect to our enhanced emissions is timing. Almost all of those ~27 Gg monoterpenes/year is emitted during spring. Thus if these enhanced emissions are considered in calculations, a larger local and regional perturbation in the radiative effect would be estimated, since spring is the time during which new particle formation is observed most frequently and intensively in boreal forests (which has also been pointed out many times in the manuscript). Though tropical PFTs account for ~80% of global monoterpene emissions and ~70% of global total BVOC emissions (Guenther et al., 2012), NPF has not been observed in e.g. the Amazon.

Finally to clarify the reviewer's view: Nowhere in the manuscript do we claim that the discrepancy between observations and predictions of NPF is entirely due to an under-estimation of total monoterpene emissions. Our calculations of the potential impacts on the predictions of NPF and growth are order-of-magnitude calculations (which is also very clear from Sec. 4.3) – too rough to even consider the different potentials of individual monoterpenes to participate in aerosol processes. The complete set of equations used for these calculations are provided in Sec. 4.3 and from there it is possible to do the re-calculations using the input values provided in the manuscript and get the same results as listed in Table 3.