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## ***Interactive comment on “The emission factor of volatile isoprenoids: caveats, model algorithms, response shapes and scaling” by Ü. Niinemets et al.***

**Ü. Niinemets et al.**

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Received and published: 12 April 2010

It is great to see that many comments and pertinent suggestions on the paper. We thought to respond to all comments point-by-point simultaneously, and still intend to do this in due course as well. However, we wanted to clarify two things right now. First, the general philosophy of parameterization of emission models for atmospheric chemistry. It is certainly sure that overall biomass in the pixel, the way we aggregate this foliage, i.e. the way we let the biomass harvest light and be coupled to atmosphere can play very important roles. We do not expect that just multiplying ES with the amount of foliage in the pixel will do a good job. In fact, reasonably good approaches of within-

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canopy light propagation have been used in Guenther et al. models applied in regional and global scales. MEGAN even offers two ways to cope with within-community heterogeneity, so active development in this field is going on. There is always room for improvement, but I am not sure that when the modeller comes from upstairs and asks, can there be a factor of 3 problem somewhere (Peter Harley), that the answer will be that canopy model is performing not well. It might be biomass, which means bad pixel parameterization, it might be ES, which refers to some of the issues highlighted here (e.g., induced emissions that can introduce more than a factor of 3). It might be also that OH/NO<sub>x</sub> are wrong or some other problems with the chemistry model. Probably, if one were to make a chemistry model best predicting O<sub>3</sub> over relatively short periods of time, and having access to past O<sub>3</sub> data, inverse modelling to predict plant VOC source strength would result in best agreement with the predicted and measured O<sub>3</sub> levels. People doing plant VOC measurements, may have a problem with the inverse-modelled VOC emission rate, but this value certainly removes the factor 3 problem and over short period of time likely provides reliable O<sub>3</sub> estimates. Although performing the best over short periods of time, such non-data based modelling has several disadvantages. The most severe likely being non-generality, i.e., impossibility of transferring the model algorithm to other areas of interest. The second problem is that our predictions necessarily will be short-sighted. Making long-term predictions, including prediction to future climates, requires inclusion of processes, such as effects of CO<sub>2</sub> considered in this MS, that affect the VOC source strength. So, I believe that there are good reason to make as best VOC source strength model as possible. Well, we certainly must be in a position to say that it is not VOC part that needs fixing by a factor of 3. I found it difficult to say this here given all the marvellous work done by Alex Guenther, Peter Harley and Thomas Karl in improving the VOC emission models and emission estimates. The second question we wanted to clarify is that if we measure say isoprene emission rate at 30 C and 1000 micromol m<sup>-2</sup> s<sup>-1</sup>, will this value be an emission factor? Alex Guenther says “the use of emission factors is a common practice in the air quality modelling community where it is widely recognized as a modelling concept”. Well, was it so in

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the original Guenther et al. 1991, 1993 papers? I am not sure that people today going out in the field or working in the lab and reporting the emission factors measured under standardized conditions are reporting something that reflects a modelling concept. On the other hand the way these measured values are further processed, aggregated and summarized in models often results in a modelling concept, i.e., with a value that has no correspondence in the nature. To our understanding, this is not that widely recognized within the VOC measuring and modelling community. As said above, sometimes such modelled values are absolutely needed for practical purposes. Nevertheless, the main view put forward in this paper is that we should try to keep measured and modelled values apart. We need measurements to parameterize and verify the models. If we do not do this, our models will not reflect the processes in nature. In this MS we refer to VOC models only. Clearly, in complex chemistry models, it is not only VOC flux that needs to be precise and accurate. It is also true that our MS deals mainly with the leaf scale measurements. However, this is the scale where most VOC measurements so far have been done and the scale that has been traditionally used to parameterize larger scale models using scaling up algorithms. We realize that there are now possibilities to conduct whole canopy VOC flux measurements. However, we argue that in reactive atmospheres, we principally cannot measure the plant VOC source strength with none of the large-scale techniques available so far. There are ways to estimate the deposition and decomposition fluxes, but this again leads to a non-measured estimate of VOC source strength. This is much different for more inert CO<sub>2</sub> and H<sub>2</sub>O fluxes, which reflect true plant performance. In summary, the main emphasis in this MS is that we must keep measurements and models apart (opinion part), and also highlighting the main caveats and dangers one can make using constant response shapes, not considering some of the responses, using wrong scale etc (review part). So we believe that this paper serves as a roadmap for modellers to make an educated guess of either to use or not use certain leaf-level subtleties that are out there in the literature and also as a summary for experimentalists to fill the gaps in the knowledge to avoid “factor 3 problems”. It is clear that we need to make these aspects more clear in the revised

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MS and also emphasize that we do not criticize previous work, but rather provide our viewpoint of how we feel that models and data should be combined. We believe that we all want to improve VOC emission estimates, albeit the opinions likely differ in where we believe to be the weakest link in the chain.

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Interactive comment on Biogeosciences Discuss., 7, 1233, 2010.

**BGD**

7, C509–C512, 2010

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