Atmos. Chem. Phys. Discuss., 12, C9443–C9448, 2012
www.atmos-chem-phys-discuss.net/12/C9443/2012/

Atmospheric Chemistry and Physics Discussions

ACPD

12, C9443–C9448, 2012

Interactive Comment

Interactive comment on "A novel approach to emission modelling of biogenic volatile organic compounds in Europe: improved seasonality and land-cover" *by* D. C. Oderbolz et al.

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Received and published: 16 November 2012

The reviewer comments are very much appreciated. In the following we will address the issues rose by both reviewers.

1 Reviewer 1

(1) We agree that the title might be a bit too ambitious. Nevertheless, as also noted by the reviewers, we present some new aspect for improving the modeling of BVOC

emission from the earth surface. Further, the inventory we compiled is very comprehensive. Therefore we change our title to: A comprehensive emission inventory of biogenic volatile organic compounds in Europe: improved seasonality and land-cover.

(2) We did not explicitly refer to basal emission rates of emission capacities in the methods section. In fact basal emission rates or emission factors are needed and used for the modeling approach. We now are more specific in the method section. Further, we discuss the variability of emission factors also addressing the literature suggested by the reviewer. The corresponding paragraphs now read like this:

"This paper focuses on constitutive BVOC, that is BVOC emissions which occur under normal and stress conditions, but which are limited to specific emitting plants (as defined in Niinemets et al. 2010a). We do not treat stress-induced emissions of BVOC, which have been shown to occur from a broader range of plants, which are, however, difficult to quantify" (3rd sentence of 2.1)

We have also added a new section 2.3.1 dedicated to the discussion of the basal emission rates, which we acknowledge was missing:

"2.3.1 Basal emission rates e_0
The basal emission rates are a crucial input to this kind of model because we assume that a given plant species produces a constant known emission of a given BVOC at standard conditions (30° C leaf temperature and $1000\,\mu\mathrm{mol\,m^{-2}\,s^{-1}}$ incident quantum flux density = PAR). The authors are well aware that this is a simplification, because many abiotic (for example draught) but also biotic factors (for example genetic disposition) are known to have an influence on the basal emission rates of plants (Niinemets et al., 2010b). However, in detail those effects are not very well studied and it would be an enormous endeavor out of the scope of this paper to determine the effect of all known and yet unknown factors on the emission behavior of more than 100 species living in the different climatic zones of Europe. Recently, for example, Baghi et al (2012) showed that flowering considerably contributes to the overall load of BVOCs. However,

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it would be an enormous endeavor just to add flowering and BVOC emission of the main European tree species– if this is currently possible at all. Therefore we decided to accept this limitation of our model. The correct derivation of basal emission rates, but also of the environmental correction factors γ is very challenging. Niinemets et al. (2011) provide an extensive overview of potential experimental problems but also problems related to data analysis (averaging or integration). It is, for example, of vital importance that plants with specialized storage tissue are not mechanically stressed, otherwise, the BVOC emissions can raise by two or more orders of magnitude. The authors list ten recommendations to ensure a future standard in BVOC measurements. In the selection of emission factors or basal emission rates used for compiling the emission inventory we focus on studies where plants were not impacted by stress. Due to increasing experimental challenges associated with high reactivity and stickiness, the quantitative determination of basal emission rates of sesquiterpenes is challenging and error-prone (Niinemets et al., 2011). Thus, only for a few plant species some information on sesquiterpene emission exists. Based on the knowledge available, with the current constraints in the analysis of sesquiterpenes in air samples, we assume that all plant species considered in our inventory emit sesquiterpenes. Further, we assume that this compound group is emitted temperature controlled only as also shown by, for example Fares et al. (2011), despite some information exist that sunlight, beside stress, might be another controlling factor (Hansen and Seufert, 2003). The situation for oxygenated VOC is similar to that of sesquiterpenes. In a recent study on BVOC emission from Mediterranean vegetation, Brancho-Nunez et al. (2011) highlighted the uncertainty associated with the emission of oxygenated VOC including the difficulties to model this emission type. However, the authors demonstrated that oxygenated VOC are a key compound class in the total BVOC emission of the plants studied, with methanol as major compound. In the presented inventory we follow a rather pragmatic approach when modeling oxygenated VOC emission from vegetation, similar to that of the sesquiterpenes assuming a temperature only emission. In a study on orange, Fares et al. (2011) show that methanol emission from branches is very well

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parameterized by a temperature-only algorithm. "

(3) We agree with the reviewer that our current knowledge on biogenic compound emissions other than isoprene and monoterpenes is rather limited. Estimates of such emissions have therefore, high uncertainties. However, these emissions are needed for the air quality model to treat their chemical pathways at least with some good estimates of default values. One has to keep in mind, however, the high uncertainty in such emissions (as well as others) which will hopefully decrease in future with more available measurements. We discussed that in more detail in the revised version, highlighting also the high uncertainty of the estimates presented. The corresponding text reads now like this:

"As already discussed in section 2.3.1, the uncertainty of the basal emission rates for SQT and OVOC are higher than for ISOP and MT, this uncertainty enters the expression for the total emissions in a linear fashion." (3rd sentence of section 3)

(4) The reviewer appreciates the work we presented but raise some concern whether it is appropriate for publishing it in ACP. The aim of the paper is to support atmospheric chemists and physicists with latest developments on estimating the terrestrial surface source strength of BVOC, globally as well as in remote regions the major compound class triggering the reactivity of the atmosphere. Furthermore, main topics in ACP are biosphere interactions (as our BVOC emissions) and atmospheric modeling (as our chemistry-transport modeling). Finally, then the focus on emissions in relation to Chemistry-Transport Modeling (CTM) is highly relevant as emissions are considered among the largest uncertainties with respect to regional scale CTM modeling. It has a number of times been demonstrated, that high spatial and temporal resolution in emissions is crucial for model performance (e.g. Hertel et al, 2006, Skjøth et al, 2011). In fact Menut and Bessagnet (2010) have recently stated that improved knowledge on the formation of secondary organic aerosols are limited by the inventories of biogenic emissions and how they are treated in the CTM models. Thus, we think the topic of our paper is well within the scope of the ACP Journal.

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2 Reviewer 2

We agree that the importance of seasonality and land-cover in emission modeling are already recognized but we still think that the concept how we include the seasonality of land-cover and emission factors in the model is new and leads to an improved estimate of BVOC emission from the terrestrial earth surface. However, we changed the title -as given above- to emphasize more the improvements. The suggested technical corrections are considered in the revised document.

3 References

Baghi, R., Helmig, D., Guenther, A., Duhl, T., and Daly, R., 2012, Contribution of flowering trees to urban atmospheric biogenic volatile organic compound emissions: Biogeosciences, 9, 3777-3785

Bracho-Nunez, A., Welter, S., Staudt, M., Kesselmeier, J. (2011), PlantâĂŘspecific volatile organic compound emission rates from young and mature leaves of Mediterranean vegetation, Journal of Geophysical Research, 116, D16304, doi:10.1029/2010JD015521.

Fares, S., Gentner D.R, Park J.-H., Ormeno, E., Karlik,J., Goldstein, A.H. (2011), Biogenic emissions from Citrus species in California, Atmospheric Environment 45, 4557-4568.

Hansen, U., Seufert, G., (2003), Temperature and light dependence of ïĄć-caryophyllene emission rates, Journal of Geophysical Research, 108 (D24), 4801, doi:10.1029/2003JD003853.

Hertel, O., Skjøth, C. A., Løfstrøm, P., Geels, C., Frohn, L. M., Ellermann, T., and Madsen, P. V., 2006, Modelling Nitrogen Deposition on a Local Scale - A Review of the

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Current State of the Art: Environ. Chem., 3, 317-337.

Menut, L. and Bessagnet, B., 2010, Atmospheric composition forecasting in Europe: Ann. Geophys., 28, 61-74.

Niinemets, U. et al. (2010a), Mild versus severe stress and BVOCs: thresholds, priming and consequences, Trends Plant Sci., 15(3), 145-153.

Niinemets, U. et al. (2010b), The emission factor of volatile isoprenoids: caveats, model algorithms, response shapes and scaling, Biogeosciences, 7, 1809-1832.

Niinemets, U., et al. (2011), Estimations of isoprenoid emission capacity from enclosure studies: measurements, data processing, quality and standardized measurement protocols, Biogeosciences, 8, 2209-2246.

Skjøth, C. A., Geels, C., Berge, H., Gyldenkærne, S., Fagerli, H., Ellermann, T., Frohn, L. M., Christensen, J., Hansen, K. M., Hansen, K., and Hertel, O., 2011, Spatial and temporal variations in ammonia emissions - a freely accessible model code for Europe: Atmospheric Chemistry and Physics, 11, 5221-5236.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 19921, 2012.