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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global isoprene emissions estimated using MEGAN, ECMWF analyses and a detailed canopy environment model" *by* J.-F. Müller et al.

J.-F. Müller et al.

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We would like to thank the anonymous referees for their helpful comments and suggestions for improvement. Their general and specific comments are adressed below.

Referee 1

General comments

Section 2.1: The MEGAN EFv2.0 doesn't provide distinct dataset for the geographical distribution of evergreen broadleaf trees and deciduous broadleaf trees. Which dataset did the authors use for this purpose and was this distinction also made concerning *emission factor allocation?*

The distinction between evergreen and deciduous broadleaf trees is based on the global ecosystem database of Olson et al. (1985). This is clarified in the revised manuscript.

Section 2.2: Could the authors give a few words about the canopy environment model capacity to calculate radiation and leaf temperature? It is indeed important to make sure that by going into more detailed processes, we do not add more uncertainty on biogenic emissions.

Evaluating the performance of the canopy environment model is an important, but demanding task. Note that the model parameterizations are generally based on measurements. A limited validation of has been provided in Wallens (2004) for the parameterization adopted for PPFD attenuation in the canopy, with fairly good results. Although a more comprehensive validation appears desirable, there currently are no above canopy VOC flux measurements accompanied by detailed canopy environment data (i.e., leaf temperature and solar radiation on sun and shade leaves at different canopy levels). We recommend that the scientific community make it a priority to get such data, so that MOHYCAN and other canopy environment models can be thoroughly compared and validated.

Section 3.1: Considering the impact of soil moisture change on isoprene emission, the reduction in emission calculated in this study (20%) is much higher than the one calculated by Guenther et al. (2006) (7%). Different datasets are used in the two studies to provide soil moisture, which can explain the results. The approach used to calculate the soil moisture activity factor is strongly linked to the difference between the soil moisture and the wilting point, and to how this difference compares to 0.06 m3/m3. It would be interesting to know how the difference between the soil moisture and the *wilting point compares to 0.06 m3/m3 for both studies and to discuss if this limit can be used for any case or if it is not rather strongly dataset-dependent.*

It is difficult to answer this question, due to the lack of appropriate measurements. As already mentioned in our manuscript, it is important that the value for the wilting point used in the soil moisture stress activity factor matches the value employed in the meteorological analyses. Still, the impact of soil moisture stress presented in this manuscript should be considered as indicative, firstly because its parameterization is unfortunately based on measurements from only one study (Pegoraro et al., 2004), and secondly because soil moisture is not directly constrained by measurements in meteorological analyses. These limitations are now mentioned in the revised manuscript.

Section 3.2: Monthly climatological LAI, derived from MODIS LAI from 2000 to 2006, are used over the 1995-1999 period. Could the authors specify how this could affect the interannual variability calculated for isoprene emissions and estimate how much of the emission variability is linked to the LAI variability? Is the MODIS LAI characterized by a strong interannual variability over the 2000-2006 period?

The interannual variability of LAI has only a small impact on the variability of emissions. Using the actual MODIS LAI for a specific year, instead of the climatology, leads to emission changes not exceeding 5% at most locations, in particular over Tropical forests and over temperate and boreal forests during summer. The impact of LAI variability is larger at mid- and high latitudes during Fall and Spring, but this has a rather small influence on annual emissions. For example, the coefficients calculated for the correlation between annual emissions and the ONI Index are only slighly higher when the climatological LAI data are used for calculating the emissions over the whole period (1995-2006), compared with the case presented in the manuscript.

Specific comments

Page 15375, line 4: replace "a decreased oxidizing capacity" by "decreased oxidizing capacity" and "a substantial contribution" by "substantial contribution".

Page 15376, line 11-12: replace "the MOHYCAN (...) model, including" by "MOHYCAN (...), including".

Page 15376, line 15-16: replace "Secondly, this model coupled with MEGAN is used to calculate" by "Secondly, this model is coupled with MEGAN to calculate".

Page 15378, line 7: replace "The number of layers is taken to" by "The number of layers is set to".

Page 15381, line 15: replace "till" by "until".

Page 15382, line 25: replace "is neglected in the calculations" by "is neglected".

Page 15383, line 4: check the emission reduction when the impact of soil moisture change is considered (20% given in the abstract and conclusion and 25% given in the text).

Page 15385, line 18: replace "campaigns measurements" by "campaign measurements".

Page 15388, line 9: replace "data from a satellite" by "data from satellite".

Page 15392, line 21: replace "for better constraining" by "for improved constraining".

Figures: in figures 1, 2 and 3, use a lighter-colored purple so that it appears more clearly on the map, especially in the figure 1.

We accept the suggestions proposed by the referee. The corresponding changes are made in the revised manuscript.

Referee 2

Specific comments

Page 15375, line 11: Change the sentence to "It has also been shown that"

Page 15377, line 16: Replace "a factor adjusted so that" with "an adjustment factor so that"

Page 15378, line 8: Change the sentence "is taken to eight.." to "is taken to be eight.." and "associated to vertical discretization" to "associated with vertical.."

These changes will be made in the revised manuscript.

Page 15378: Are the parameterizations of alpha and Cp based on data? It would be helpful to give a source/reference for equations 5 and 6.

The reference for equations 5 and 6 is the MEGAN model, described in Guenther et al. (2006). The fact that MEGAN, i.e. Guenther et al. (2006) is the basis for Equations 1 through 11 is made more clear in the revised manuscript. The parameterization for the influence of past temperatures and light levels is based on several experimental studies, in particular Petron et al. (2001), Monson et al. (1994), Sharkey et al. (2000), Geron (2000), Hanson and Sharkey (2001).

Page 15379: What is Eqn 11 based on? Is the emission response to soil moisture stress based on field measurements? Do all pfts respond to soil moisture stress in the same manner? A reference would be helpful here too.

As indicated in Guenther et al. (2006), the response to soil moisture stress is based on the measurements by Pegoraro et al. (2004) for a deciduous species (poplar). We do not know whether other plants react similarly to soil moisture stress, although it appears very likely that isoprene emission (like photosynthesis) stops at or below the wilting point, because water is a necessary ingredient to photosynthesis.

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Page 15383, line 4: It is stated here that inclusion of soil moisture stress reduces emissions by 25% while in the Abstract, reduction in emissions from soil moisture is stated to be 20%. Reconcile the numbers.

The numbers are corrected in the revised manuscript.

Page 15384, section 3.2: Does the use of annual varying MODIS LAI for the period 2000 to 2006 induce any interannual variability in emissions?

The interannual variability of LAI has only a small impact on the variability of emissions. Using the actual MODIS LAI for a specific year, instead of the climatology, leads to emission changes not exceeding 5% at most locations, in particular over Tropical forests and over temperate and boreal forests during summer. The impact of LAI variability is larger at mid- and high latitudes during Fall and Spring, but this has a rather small influence on annual emissions. For example, the coefficients calculated for the correlation between annual emissions and the ONI Index are only slighly higher when the climatological LAI data are used for calculating the emissions over the whole period (1995-2006), compared with the case presented in the manuscript.

Page 15384, line 12: Change "emissions about twice lower in.." to "emissions about a factor of two lower in..".

Corrected.

Page 15384, line 25: Which latitude bands are included in the calculation of "annual tropical isoprene emissions"?

The latitude band (23°S - 23°N) is now mentioned.

Page 15385, lines 3-5: How significant are the correlation coefficients shown in Figure

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6?

Due to the small number of samples (N = 12), the null hypothesis (i. e. absence of correlation) cannot be ruled out at any specific location (except at a very few ones where the correlation coefficient is larger than 0.5). However, the simple fact that the distributions shown in Fig. 6 aren't chaotic, i. e. the existence of large-scale features (such as the large negative values in the Southeastern US in the left panel of Fig. 6) clearly demonstrates the significance of the correlations at the scale of these large regions.

Page 15385, lines 18-19: It would be helpful to mention that the authors used for comparison, model results for the year in which observations were conducted.

This is now mentioned in the revised manuscript (first paragraph of Section 4).

Section 4.1 and 4.2: What is the uncertainty in measurements? Is the model bias within the level of this uncertainty?

The uncertainty is estimated to be about 30% (Rinne et al., 2002; Goldstein et al., 1998). This is now mentioned in the revised manuscript. The model/data bias is only slightly higher at Harvard forest. The measurement uncertainty is much larger than the model/data bias at Tapajós.

Page 15392, lines 1: Provide the reference after "previous study,.."

Reference provided.

References:

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