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Interactive comment on "Impact of climate variability and land use changes on global biogenic volatile organic compound emissions" *by* J. Lathière et al.

Anonymous Referee #1

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General comments:

This paper incorporates well-established biogenic emission schemes within in a global dynamic vegetation model to study how year to year changes in climate and anthropogenic land-use changes impact emissions of biogenic volatile compounds (BVOCs). The authors perform an interesting analysis of the sensitivity of global BVOC emissions to human-induced changes in forest cover in the tropics and Europe that provides an estimate of how emissions may change as the Earth undergoes significant land-use changes in the future. The impact of land-use changes on global BVOC emissions has

not been presented before. Unfortunately, the authors rely heavily on previous modeling estimates of BVOCs and do not make an attempt to evaluate their model results against available measurements. I recommend the manuscript for publication in Atmospheric Chemistry and Physics after the authors have addressed this shortcoming and my specific comments below.

Specific Comments:

There are several sentences throughout the paper that are long and not very clear. In many cases, these could be split into two sentences so that the text reads more clearly. I have noted a few of these sentences and have recommended possible changes.

Page 10615, 2nd paragraph: The 3rd sentence should be split into two as: “Wang and Shallcross (2000) used a global land-surface and chemistry-transport model to show that the inclusion of isoprene emissions has a significant impact on ozone and oxidation products, such as peroxyacetyl nitrate (PAN), in both hemispheres. Their analysis indicated that the response of ozone to isoprene emissions was predominantly governed by the spatial and temporal variations in terrestrial vegetation, with a simulated ozone increase of about 4 ppbv over the oceans and about 8-12 ppbv over mid-latitude continental areas.” Similarly, the 4th sentence beginning with “Sanderson..” should be modified.

Page 10616, 2nd paragraph: The sentence beginning with “On top of the..” should be reworded to begin with “In addition to the..”

Page 10618: 1st sentence should be modified to “Global mean estimates for the 1983-1995 period are given in Sect. 3 and compared to the results of other studies. Analysis of the impact of climate and CO2 interannual variability from 1983 to 1995 on the simulated biogenic VOC emissions is presented in Sect.4.”

Page 10619, Fig. 1: It is also not clear why Loveland et al (2000) is cited in the figure caption. Has the maximum LAI been prescribed based on Loveland et al (2000) data?

ACPD

5, S3919–S3923, 2005

In that case, the reference should be cited on Page 10619.

Page 10620, 1st paragraph: The influence of leaf age on biogenic emissions is mentioned here without any evidence and is then finally described near the end of Sect 2.2. I think it would be useful to either cite the references (MacDonald and Fall, 1993; Guenther et al 2000) here or say that more details are given in Sect 2.2.

Page 10620, 2nd paragraph: 4th sentence should be modified to read as “The atmospheric CO2 levels...and can thus indirectly affect VOC...”

Page 10620, Sect. 2.2: 1st sentence may be written as “In addition to isoprene and monoterpenes, we also explicitly estimate the emissions of methanol, acetoneĚ.which are usually considered as a family of compounds and estimated as bulk emissions.”

Page 10624, Sect.2.3: It is not clear to me whether all the climate/CO2 simulations were performed in static or dynamic mode. If the simulations are performed in static mode then how do changes in CO2 influence the prescribed LAI. For instance, if the LAI for a grid cell is calculated to be more than the maximum prescribed, is it assigned the maximum value associated with the prescribed PFT of the grid cell? In that case, there is a possibility that the model may be underestimating or overestimating the CO2 fertilization effect. It would be useful to clarify this aspect of the simulations.

Page 10624, 1st paragraph: A reference for the annually varying atmospheric CO2 mixing ratios would be appropriate.

Page 10624, Sect.3.1: The authors compare their results with other model results. How do these results compare to available measurements (if there are any)?

Page 10625, 2nd paragraph: Comparison with Naik et al is not very clear and can be modified to read better. Here is a suggestion: “Naik et al (2004) considered a potential vegetation map with no agricultural land, which should lead to higher emissions than ours. However, they assumed that grasses are not a major emitter of isoprene (emission factor of 0) while we use emission factors of 16 and 24 ugC/dgm/h for C3 and C4

ACPD

5, S3919–S3923, 2005

grasses, respectively (Guenther et al 1995), that results in an additional emission of 90 TgC/yr into the atmosphere."

Page 10628, Sect. 3.3: Remove "variability" from the 1st sentence. It would also be helpful to mention the key variables with reference to Equation 1. The effect of increasing leaf temperature on biogenic emissions is described in sentence 4. Since surface temperature is actually used to model the emissions, this may cause some confusion. I would suggest rewording this sentence as - "Increasing the surface temperature (used here as surrogate for leaf temperature) in the biogenic..."

Page 10629, Sect. 4: It is a good idea to perform simulations of constant CO2 and increasing CO2 to understand the driving factor for variability isolate the impact of climate variability from the combined changes in climate and CO2. It would be helpful to clarify what the 1.3% increase in total VOC for "increasing CO2" compared to "constant CO2" simulation signify. Terrestrial vegetation models generally simulate an increase in foliar biomass with increasing CO2, which implies an increase in VOC emissions. Rosenstiel et al 2003, however observe a reduction in isoprene emission despite increases in photosynthesis and biomass accumulation from CO2 increase. The discussion would benefit from a consideration of the findings of Rosenstiel et al.

Page 10630, 2nd paragraph: I think the r2 values shown in Fig. 5 are insignificant to have any meaning. I would recommend removing the figures as they do not add much to the discussion. The regional variability in biogenic emission is best described in Figure 6. It would be useful to explain the cause of the variability in emissions for different regions.

Page 10632, Sect. 5: The deforestation and afforestation results are interesting and show that BVOC emissions would depend considerably on the vegetation species being substituted (high or low emitters). It would be helpful to mention that these results are subject to assumptions made about the extent and type of change in vegetation.

Page 10631, Sect. 5.1: How do the results for deforestation in East Asia compare with

ACPD

5, S3919–S3923, 2005

the results of Steiner et al 2002?

Page 10634, 1st paragraph: On line 4, the units of global annual emissions should be Tg C/yr instead of TgC/an

When citing published studies in the text of the paper it is conventional to list citations by publication date rather than in alphabetical order; this highlights the evolution of research and credits those who pioneered the respective field.

Figures: It would be helpful to increase the size of Figures 2, 3, 7, 8, and 9 as they are extremely small and hard to read. The legibility of these multi-panel plots would also be improved by moving the tickmarks inside the axes - this provides neater plots for publication purposes. Wherever appropriate, use only one colorbar for a panel plot. For example, Figure 2 can be described with only one colorbar. Similarly Figure 3 needs only 4 colorbars.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 10613, 2005.