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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the segregation of chemical species in a clear boundary layer over heterogeneous land surfaces" *by* H. G. Ouwersloot et al.

Anonymous Referee #1

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General Comments

Overall this is a very nice paper. It addresses a very valuable question of the impact of heterogeneous land surfaces on the mixing/segregation of chemical species and how this affects the rate of reaction between them. This is highly pertinent to the reaction of isoprene with OH and has consequences for the impact of OH on tropospheric chemistry from the local to global scales. Consequently the paper focuses on these two chemical species.

This paper describes the results of a study with a Large Eddy Simulation (LES) model. The complexities of the impacts of surface heterogeneity and the various sensitivity

forcings are, on the whole, described clearly. The results are very interesting and have implications for future modelling studies.

My main concern with the paper is the lack of evaluation/validation against observational data. I would have thought that the campaigns that have taken place in Amazonia in recent years should provide some data that could be used to validate some aspects of the model performance.

For example, the HET simulation, suggests that the highest concentrations of isoprene in the boundary layer (BL) are to be found above the savannah landscape as opposed to the forested landscape (Fig. 4). This finding is initially surprising, as one might expect the highest concentrations to be observed above the actual source region, i.e. the forest. Although this result is explained by the heterogeneity in the surface buoyancy flux leading to a mesoscale circulation that transports isoprene in the surface layer from the forest to the savannah, before being transported upwards, it would be good to show that these types of features have been observed in the atmosphere, if indeed they have. The model results are shown to differ with different forcings (e.g. scale of heterogeneity and background wind), which would have to be considered in any comparison with observations.

As well as the data collected over Amazonia, aircraft observations over W. Africa have shown a link between the land surface characteristics (forest/shrubland) and isoprene concentrations in the BL (Garcia-Carreras et al, JGR, 2010). Furthermore Garcia-Carreras et al discuss the observed relationship between areas of surface convergence and upper BL divergence and surface heterogeneities, and to the isoprene distribution.

Specific Comments

On a first read, I found the Abstract hard to understand and appreciate. After having read the paper it made more sense. I would suggest that some mention of LES modelling is required and a brief comment on its set up is made earlier (i.e. the simulations of heterogeneity using “a cool, wet forest patch ... and a warm, dry, patch ...”).

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The results for lambda $\geq$ 16 hBL are discussed, but not shown. I would have thought that these length scales would be relevant for many situations in Amazonia and elsewhere so think it might be helpful to show these, perhaps in the form of Figures 3 and 4.

It is not clear to me from any of the figures, for any of the simulations, how the isoprene concentrations near to the surface differ for the forest and savannah (e.g. Fig. 4). Several references are made to the surface layer, but this layer is never really defined.

Technical Corrections

p. 18932, l. 16-17, "The number of grid points of these patches" is rather odd phraseology, please re-phrase.

p. 18933, l. 12, "with 6x" should be "by 6x".

p. 18933, l. 19, "Next to" perhaps should be "As well as".

p. 18933, l. 29, "Constant initial" is an odd phrase. If something is constant, it is unnecessary to refer to initial.

p. 18934, l. 10, "periodic boundary conditions". Please explain.

p. 18934, l. 24, "initial profiles", what does this refer to?

p. 18939, l. 11, "Please note that in case". No need for "Please". Also it should be "in the case". This latter correction needs to be made in several places in the manuscript.

p. 18941, l. 12 and 14 "halfway the boundary layer" should be "halfway up the boundary layer".

p. 18941, l. 26. "in numerical" should be "in the numerical".

p. 18943, l. 20-21. "forcing" should be "forcings".

p. 18944, l. 3. I was confused by the statement that "the entrained air that is transported towards the savannah areas" as this seems at odds with the statement on p.

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18941, l. 21-22. “The entrained air is horizontally advected towards the forest patches”. I seem to have mis-understood something, so please clarify.

p. 18944, l.11. Why use “1+ IS”?

p. 18944, l. 24. “For numerical” should be “For the numerical”.

p. 18945, l. 6. and elsewhere. I found use of the word “spread” a little ambiguous. I would prefer “variability”.

p. 18945, l. 18-19. In reference to Figure 5a and b, it states “The intensities .... all are different from the intensity of total boundary layer segregation.”. This is not very apparent to me in the figures. Perhaps this is due to the scales of the x-axes.

p. 18946, l. 2. Suggest changing “isoprene and OH producing compounds” to “OH producing compounds and isoprene” to avoid it sounding like “isoprene producing compounds”.

p. 18946, l. 9. The change in correlation factor doesn’t seem very “gradual” to me.

p. 18946, l. 14-28. There are several relative terms such as “increase” and “smaller”, when it is not immediately clear exactly what they are comparing with.

p. 18949, l. 22. Suggest “lower length” should be “shorter length”.

p. 18950, l. 16-17, “transport of the warm air from the savannah areas divided by the size of the forest areas”, please explain.

p. 18951, l, 25. “The heterogeneity of isoprene emissions does not affect boundary layer dynamics”. Is this known? If isoprene impacts aerosols, which in turn affect cloud formation, may be it can? Perhaps not in the model.

p. 18952, l, 4-6. “This segregation is caused by the transport of isoprene from the forest to the savannah by the induced mesoscale circulations. During transport, isoprene is depleted by OH. Consequently, high isoprene concentrations are found over the sa-

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vannah and low isoprene concentrations over the forest." These sentences appear to me to be contradictory. If the isoprene is being transported from the forest to the savannah and being depleted by OH along the way, then I would expect the concentrations of isoprene to be higher over the forest. I had understood the lower concentrations over the forest to result from the mesocale circulation that was set up, bringing air, depleted in isoprene, down over the forest.

p. 18952, l, 8. "In case the" should be "In the case where the".

In the Conclusions the length scales of heterogeneity greater than the BL height are discussed twice in two separate places. Perhaps these could be joined.

Table 1. I would suggest that the title of the table and the heading for the first column needs changing to accommodatd "vegetation-atmosphere interactions" and "surface heterogeneity".

Table 1 – a few other suggestions: Clouds impact on photosynthetically active radiation and subsequently biogenic emissions (e.g. isoprene); Precipitation on soil moisture and subsequently latent heat and biogenic emissions (e.g. NOx from soils).

Table 3 – first line of title, suggest "kept constant to the control" should be "kept the same as the control".

Fig. 1 – caption, suggest "kept constant to" should be "kept the same as".

Fig. 2 – The last sentence does not seem to be applicable to the 1st hour values for the maximum gradient method.

Fig. 3 – the wind vectors are hard to see in plot a.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 18927, 2011.