

## ***Interactive comment on “A numerical evaluation of global oceanic emissions of $\alpha$ -pinene and isoprene” by G. Luo and F. Yu***

**G. Luo and F. Yu**

ganluo@asrc.cestm.albany.edu

Received and published: 18 December 2009

The authors thank the referee for the constructive comments. Our responses to the comments are given below.

*1. The isoprene concentrations reported by Yassaa et al. are somewhat higher than the observed  $\alpha$ -pinene concentrations. Since  $\alpha$ -pinene has a longer lifetime than isoprene then this means that isoprene emissions must be higher than  $\alpha$ -pinene emissions. So why is the top-down global  $\alpha$ -pinene emission estimate (35.1 Tg) higher than isoprene (2.5 Tg)?*

This is a good point and we have looked into the issue. It turned out that, in

C8672

GEOS-Chem, the outputted concentration of isoprene is in the unit of pptv C while that of  $\alpha$ -pinene is in the unit of pptv  $\alpha$ -pinene. The isoprene concentration in the unit of pptv C has to be divided by 5 to get the isoprene concentration in the unit of pptv isoprene. In the ACPD version of the manuscript, we directly compared the output of isoprene (unit: pptv C) with the ship cruise measurements (unit: pptv isoprene) to assess the top-down global isoprene emission. Thus, the actual simulated isoprene concentration is 5 times lower than that of the measurements along the OOMPH ship cruise. We are grateful to the referee for pointing out the inconsistency.

We have redone all the simulations and obtained new top-down global oceanic  $\alpha$ -pinene and isoprene emissions. The updated top-down global oceanic emissions are 29.5 Tg C yr<sup>-1</sup> for  $\alpha$ -pinene and 11.6 Tg C yr<sup>-1</sup> for isoprene, respectively. As expected, the oceanic isoprene source strength increases. The oceanic  $\alpha$ -pinene source strength decreases due to the changes in the chemistry associated with the increased isoprene emission. The revised  $\alpha$ -pinene emission (29.5 Tg C yr<sup>-1</sup>) is about a factor of 2.5 higher than the isoprene emission (11.6 Tg C yr<sup>-1</sup>). The difference is as a result of larger molecular weight of  $\alpha$ -pinene and slightly short life time of  $\alpha$ -pinene over the Southern Ocean. In GEOS-Chem, the reaction rate of OH (KOH) with  $\alpha$ -pinene is 0.9 of that with isoprene, while the reaction rate of O<sub>3</sub> (KO<sub>3</sub>) with  $\alpha$ -pinene is 5-6 times higher than that with isoprene during the period of ship cruise measurement. Our analysis indicates that the chemical losses of  $\alpha$ -pinene and isoprene due to reactions with O<sub>3</sub> are comparable with those associated with OH over the Southern Ocean and the combined loss rate of  $\alpha$ -pinene is 1-1.4 times larger than that of isoprene.

*2. Is there any reason to assume that the marine species investigated by Yassaa are the source of the  $\alpha$ -pinene observed? Are there other species of plankton that have not been surveyed? The authors should give some indication of what fraction of the total plankton biomass is represented by the species examined by Yassaa et al. If it is a small fraction of the total then it seems likely that the  $\alpha$ -pinene emitting species*

C8673

has not yet been investigated. It should also be noted that Yassaa et al. found that *ocimene* was emitted from marine organisms at a higher rate than  $\alpha$ -pinene. Since *ocimene* was not observed in the ambient air this seems to indicate a high diversity of emission patterns.

Due to the lack of the information about the  $\alpha$ -pinene emitting species and their emission rates, we have to rely on the emission rates of  $\alpha$ -pinene derived from Yassaa et al. (2008) to calculate the global oceanic emission of  $\alpha$ -pinene. It is very likely that there are other species not surveyed by Yassaa et al.. To estimate the fraction of the total plankton biomass represented by the species examined by Yassaa et al. will be difficult due to the lack of data and is out the scope of the present study. Here we use the emission rates derived from Yassaa et al., (2008) and Arnold et al. (2009) to show the spatial and temporal distribution associated with the changes of plankton. By using the “top-down” approach, the differences maybe partially compensated by the prefactors. We agree with the referee that the higher *p*-ocimene emission rate measured in the monoculture experiments but the lower *p*-ocimene concentrations detected in the South Atlantic marine boundary layer (compared to  $\alpha$ -pinene) could indicate a high diversity of emission patterns. We have pointed this out in the revised manuscript.

3. *The authors should provide the details of the top-down and bottom-up approaches for one or more locations along the OOMPH tract (for example, Yassaa et al mentions a “far away”, “distant bloom” and “in-situ bloom” locations. This could be a table of emissions, compound lifetimes, boundary layer height etc. which would provide a clear comparison of the two approaches.*

We have provided the details of the top-down and bottom-up approaches on three selected days: 01-22-2009 (the second day in Region A), 01-26-2009 (the second day in Region B), and 02-01-2009 (the second day in Region C) in the supplement.

C8674

4. *The global terrestrial emission of 127 Tg of  $\alpha$ -pinene estimated (p 20728, line 13) is higher than other reported estimates. How was this estimated?*

The global terrestrial emission of 127 Tg C yr<sup>-1</sup> of  $\alpha$ -pinene estimated is recorded in the output of GEOS-Chem model (ND07: “OC-ALPH”). In GEOS-Chem, the terrestrial emission of  $\alpha$ -pinene is composed by 0.76 of lumped GEIA terpene emissions and 0.05 of GEIA NVOC emissions. There is a huge difference in the reported global terrestrial emission of  $\alpha$ -pinene. The reported  $\alpha$ -pinene emission by Levis et al. (1999) is 33 Tg C yr<sup>-1</sup>, while the reported  $\alpha$ -pinene emission by Guenther et al. (1995) is 127 Tg C yr<sup>-1</sup>.

#### References:

- Arnold, S. R., Spracklen, D. V., Williams, J., Yassaa, N., Sciare, J., Bonsang, B., Gros, V., Peeken, I., Lewis, A. C., Alvain, S., and Moulin, C.: Evaluation of the global oceanic isoprene source and its impacts on marine organic carbon aerosol, *Atmos. Chem. Phys.*, 9, 1253-1262, 2009,
- Guenther, A., Hewitt, C. N., Erickson, D., Fall, R., Geron, C., Graedel, T., Harley, P., Klinger, L., Lerdau, M., McKay, W. A., Pierce, T., Scholes, B., Steinbrecher, R., Tallamraju, R., Taylor, J., and Zimmermann, P.: A global model of natural volatile organic compound emissions, *J. Geophys. Res.-Atmos.*, 100, 8873-8892, 1995.
- Levis, S., Foley, J. A., and Pollard, D.: Potential high-latitude vegetation feedbacks on co2-induced climate change, *Geophys. Res. Lett.*, 26, 747–750, 1999.
- Yassaa, N., Peeken, I., Zöllner, E., et al.: Evidence for marine production of monoterpenes, *Environ. Chem.*, 5(6), 391-401, 2008.

---

C8675

C8676