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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of bark beetle infestation on monoterpene emissions and secondary organic aerosol formation in Western North America" *by* A. R. Berg et al.

Anonymous Referee #2

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General comments:

The paper presents modeling of bark beetle-induced monoterpene emissions and secondary organic aerosol (SOA) formation in western North America in the areas of recent bark beetle outbreaks. The paper does not give any experimental evidence that bark-beetle attack will cause increases in volatile organic compound emissions. The scale-up factor for pine emissions data is taken from a published paper, but for spruce this information is from an unpublished paper. SOA formation rate in the model is based on the published SOA yields of the major monoterpene compounds in reaction chamber experiments found in literature. SOA in the simulations is calculated by apply-

ing a fixed yield to the first generation oxidation products of the precursors found in the target conifer species. Although this paper does not provide direct evidence that bark beetle-induced terpene emission increase SOA yield above attacked forests, it is timely and present a potential of biosphere-atmosphere feedback mechanisms which might be functional in ecosystem scale under rapid environmental changes such as high latitude climatic warming. As far as I know, this is the first paper reporting evidence that forest insect outbreaks may to have a direct link to atmospheric SOA formation. The paper is appropriate for ACP and should be published with a minor revision following the suggestions given below.

Specific comments:

Page 29767, line 16. It is well-known fact that in deciduous trees the emission rates of volatile compounds from beetle-damaged foliage is much more diverse and in higher level, when compared to healthy foliage, although monoterpenes are among most responsive compounds. Because the focus of this paper is in conifers, it should be also mentioned here that beetle feeding damage on conifer bark may increase emission rates of highly reactive sesquiterpenes even more than that of monoterpenes (e.g. 7-fold vs. 4-fold as shown by Heijari et al. 2011). Sesquiterpenes may have important role in SOA formation (e.g. Tan et al. 2012) although higher volatility monoterpenes still form the majority of VOCs in forests attacked by bark beetles.

Page 29768, Line 22, Beetle mortality? This definitely had to be TREE MORTALITY related to bark-beetle outbreaks

Page 29771. Line 7-8 "...the mortality effect is the decrease in VOC emissions that occurs after trees are killed". Is there a real documented drop in the local emissions levels? How the monoterpene emissions from logging activities, and the remaining dead wood (branches, stumps and root system) and needle litter left in the forest site were implemented in the model? Some reports (e.g. Räisänen et al. 2008) demonstrates that during logging activities there could be even 2 to 3-fold increase in the local

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monoterpene emission rates in pine forests. After the removal conifer trees from a forest site the residual effect may corresponds to about 10% of the monoterpene release detected from intact forests (Haapanala et al. 2012).

Page 29779 Line 2, " ..we have assumed that trees are impacted by beetle attack for a full year,..".

Is there any information available of the annual peak periods of emissions? During warm growing season the emission rates should be relatively high compared to other seasons. During the main attack period of bark beetle females the fresh resin flow from entrance holes should be substantial and the monoterpene emissions rates from fresh resin might be at highest. How these peak emission periods may affect the local SOA levels?

Page 29779 Line 5, Perhaps authors can discuss here about the potential effects of forestry activities and residues on the monoterpene emissions of beetle killed forests in association with the increased surface temperature effect.

Page 29780, Line 9 "Two main effects emerge from this study – the mortality effect and the attack effect". I still wonder how the mortality effect emerges from this study, because I understood that tree mortality was just put as a zero value (reduction of monoterpene emitting area) in the model and not any on mortality site specific monoterpene emission data was not given to support it.

References:

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 29763, 2012.