

## ***Interactive comment on “Three Northern Regions Shelter Forest contributed to long-term increasing trend of biogenic isoprene emissions in Northern China” by Xiaodong Zhang et al.***

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Responses to reviewer's comments Anonymous Reviewer #2

Zhang et al have made MEGAN model simulations of isoprene emissions in China for the period 1982-2010, with special emphasis on the effects of the massive afforestation currently underway in the Three Northern Regions Shelter Forest (TNRSF) area. Model simulations showed an increase of isoprene fluxes over the years in the areas where forested cover also increased, suggesting that the man-made afforestation played a major role in the change of isoprene emissions.

This paper deals with the impact of human activities on the vegetation cover of a big

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land area that in turn impacts the concentrations of isoprene, an atmospherically relevant volatile organic compound that participates in the photochemistry of the atmosphere and can have an active role in the pollution episodes that China has been suffering in recent years. Thus this paper is within the scope of ACP and I would recommend its publication after addressing some concerns. The text needs some rewriting to make it clearer to the reader, especially the part reporting the TVOC measurements and the modeling of fluxes from those measurements.

Response: We thank Anonymous Reviewer#2 for his or her comments and appreciate the constructive criticisms which improve largely the presentations and interpretations in our manuscript. Based on the comments from the Reviewer #2, we have made corresponding revisions to the manuscript. Following are reviewer's comments and our responses

Specific comments:

P2L2: correct the number "R2=0014", there must be a decimal point missing.

Response: Corrected. Thanks!

P2L10: defining reactive BVOCs emitted by plants as "harmful gases" is not appropriate. Authors can argue that they have implications for atmospheric generation of pollutants such as ozone, but not that these gases are harmful.

Response: We agree with the reviewer's comment. In the revised manuscript, we have rewritten text as "they also contribute to air pollution through atmospheric chemistry"

P6L19: Reference to Guenther et al 2006, is it correct? If the MEGAN version was 2.1, should this reference be Guenther et al 2012? Otherwise, MEGAN version should be 2.0.

Response: The reference should be Guenther et al 2012. We have changed '2006' to '2012'. Thanks!

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P9L1: Should L (oxidation rate) be replaced with C (isoprene concentration) in the text? Table S3 does not list L but C, and it is reasonable that L will actually vary with OH and O<sub>3</sub> concentrations, which are also listed in this list.

Response: We agree with the reviewer's comment! The texts have been changed to 'the measured isoprene concentration (C)'.

P10L7: Please write the genus name *Populus* starting with capital letter. Was it only one species of poplars that were planted in the region? If so, please give the scientific name, otherwise list as *Populus* spp and refer to these trees in plural in the text.

Response: Thanks for the suggested changes! We have rewritten 'populus' to 'Populus spp' and referred to these trees in plural in the revised text (e.g., changing 'poplar' to 'poplars').

P10L10: Please list the variety of *P. sylvestris* or otherwise remove the word "var".

Response: We have removed 'var' following the reviewer's comment.

P13L13: The slope of -0.534 applies to northern China without including the TNRSF, according to Fig S5. Please clarify in the text.

Response: The text has been rewritten as '... the relatively strong increasing trend (Fig. 2) in the TNRSF (slope=0.881, R=0.579) has reversed the negative trend (slope=-0.533, R=0.224) of the total annual isoprene emissions in Northern China, which did not take the isoprene emissions in the TNRSF into consideration, to the positive trend (slope=0.347, R=0.118)...'.

P14L14: Did the authors do any statistical analysis to support the statement that the trends of isoprene emissions in the Central-North region are statistically significant whereas those from the other two regions are not?

Response: In the revised manuscript, we added p values for each trend in the three regions. As shown, the p value=0.002 for the isoprene emission trend in the Central-

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North region indicating statistically significant trend. Relatively weak significant trend was found in the Northwestern China region (p=0.012), and no statistically significant trend existed in the Northeastern China (p=0.484). These have been incorporated in the revised paper.

P17L8-P18L2: Please clarify this part of the text. If the surface of a model grid square is not completely covered by vegetation, wouldn't this imply that the calculated MEGAN fluxes do not compare so nicely with the estimates using Eq (1), mainly because the MEGAN fluxes calculated for these sites where TVOC measurements were performed would be higher (more vegetation coverage than the model grid square)?

Response: The reviewer raised a good point! To address the reviewer's question, we have extended discussions on potential reasons causing the difference between MEGAN modeled and TVOC measurements converted fluxes. Except for the reason the reviewer questioned, we also considered an additional cause: in the simplified Gaussian model (Supplementary) we choose the fetch  $\Delta l = 3\text{km}$  which is related directly to the magnitude of the converted emission fluxes which were subject to uncertainties. Nevertheless, overall the converted fluxes from the measured TVOC concentrations using the simplified Gaussian model are about the 2 fold of the modeled fluxes, suggesting the reasonable accuracy of the MEGAN model applied in the present investigation. These discussions have been incorporated into the revised manuscript.

P18L14: was vehicular exhaust the dominant source of atmospheric isoprene? Do the authors want to say that vehicular exhaust was the dominant source of atmospheric VOCs? Same for line 17 of this page.

Response: We have rephrased text in these two sentences. In the revised text, we made clear that 'the atmospheric isoprene during the wintertime was emitted mostly from vehicular exhaust', and 'the summertime isoprene was released from biogenic sources'.

P19L15: Correct *Arneths* to *Arneth*.

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Response: Done! Thanks!

P20L10-13: Please clarify this sentence.

Response: Following the reviewer's comment, we have rephrased this sentence to make our point more clear.

P22L1: This sentence needs more information to make sense. As it currently reads, it may seem that 2007 was a bad year for the trees, but looking at Fig. 2, isoprene emissions are at or near the historical maximum. I suspect the authors have something else in mind that is not clear to me. What is the time span that the authors describe as showing a "considerable decline of forest coverage and isoprene emissions"?

Response: We thank the reviewer to point out this inconsistency. The forests collapse took place since 2007 rather than in 2007 (see Zhang, X., et al., 2015 in the Reference). We have replaced 'in' by 'since' in the revised paper. We further indicated that the mortality of trees since 2007 caused visible decline of the forest coverage and isoprene emissions in this region after 2007.

P22L7-8: the authors assume steady state of the mixed forest of Northeast China, regarding which variable? LAI? If so, have the authors checked whether the LAI information on Fig S6 agree with this assumption?

Response: The LAI data did show no trend in Northeast China. But in the revised manuscript we have deleted 'steady state'. Instead, we added new text, a new Fig. S7b which shows annual temperature averaged over Northeastern China, and corresponding discussions in the revised paper.

P27L10: Please list the year of publication (1996) and the complete list of authors.

Response: Done!

FigS6 (caption): LAT should be LAI?

Response: Yes, 'LAT' is 'LAI'. This error was corrected in the revise paper. Thanks!

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