Responses to interactive comments

Journal: Atmospheric Chemistry and Physics

Manuscript ID: acp-2022-739

Title: "Impacts of land cover changes on biogenic emission and its contribution to ozone and secondary organic aerosol in China"

Dear Referee #2,

We appreciate your comments to help improve the manuscript. We tried our best to address your comments and detailed responses and related changes are shown below. Our response is in blue and the modifications in the manuscript are in red.

Comments: In the manuscript titled "Impacts of land cover changes on biogenic emission and its contribution to ozone and secondary organic aerosol in China" the authors have analysed the impact of LAI and LC datasets on biogenic VOCs emission over China. The study has further attempted to understand its contribution to O3- and secondary organic aerosols by performing five different set of simulations using MEGAN and WRF-CMAQ models.

This study provides an interesting insight into the uncertainties in regard to the biogenic VOC emission input data and the impact it can have on air quality. However, there are a few minor comments which the authors can address in the revised manuscript.

Response: Thanks for the recognition of our study. Below is the response to each specific comment.

Minor Comments:

1. Page 1 Abstract Section: The results from the study should be stated for each experimental design before drawing out the inference as to which input dataset is best suited for the study region along with a sentence on the significance/impact of this study in the concluding statement of the abstract.

Response: Thanks for your comments. A brief summary of model validation and the sentence about the significant of this study were added to the Abstract.

Changes in manuscript:

Abstract (Lines 23-31 in the revision): Changing the LC inputs for the MEGAN model has a more significant difference in BVOC estimates than using different LAI datasets. The C4 case has better model performance, indicating that it is the better choice for BVOC estimations in China. Changing the MEGAN inputs further impacts the concentrations of O_3 and SOA. The highest O_3 and biogenic SOA (BSOA) concentrations appear in the C1 (using GLASS and MCD12Q1 LC) simulation, which can reach 12 ppb and 9.8 μg m^{-3}, respectively. Due to the combined effect of local BVOC emissions and the summer monsoon, the relative difference between C1 and C4 is over 52% and 140% in O_3 and BSOA in central and eastern China. The BSOA difference between C1 and C4 is mainly attributed to the isoprene SOA (ISOA), which is a major contributor to BSOA. Particularly, the relative difference in ISOA between these two cases is up to 160% in eastern China. Therefore, our results suggest that the uncertainties in MEGAN inputs should be fully considered in future O_3 and SOA simulations.

2. Page 1 Line 17: Define LAI, LC, SOA and BSOA abbreviation in the Abstract.

Response: The abbreviations of these terms were added to the Abstract.

Changes in manuscript:

Abstract (Lines 14-15 in the revision): "In this study, Model of Emissions of Gases and Aerosols from Nature (MEGAN) v2.1 was used to investigate the impact of different leaf area index (LAI) and land cover (LC) …"

3. Page 1, Line 44 and 45: Change "isoprene emission ranged" and "monoterpene emissions ranged" to "isoprene emissions are ranged" and "monoterpene emissions are ranged":

Response: Revised accordingly.

Changes in manuscript:

Abstract (Lines 45-47 in the revision): Global annual inventories of the isoprene emission are ranged from 500 to 750 Tg yr-1 (Guenther et al., 2006) and those of monoterpene emissions are ranged from 74.4-157 Tg yr-1 (Guenther et al., 2012;Messina et al., 2016).

4. Page 1 Line 52 and 53: Either "quantified" to "quantify" and "determined" to "determine" or rephrase the sentence accordingly to fit the tense.

Response: Revised accordingly.

Changes in manuscript:

Introduction (Lines 53-54 in the revision): Therefore, it is necessary to quantify the influence of those factors and determine the bias in BVOC emissions.

5. Page 1 Line 55: Remove 'that'.

Response: Revised accordingly.

Changes in manuscript:

Introduction (Lines 56-57 in the revision): Land cover (LC), including leaf area index (LAI) and plant function types (PFTs) fractions, is a major factor affecting the BVOC emissions in the MEGAN model.

6. Page 3 Line 93: Remove "land cover" from "land cover (LC)". Abbreviation only needs to be defined at its first instance in the manuscript, authors need not define it again for every section.

Response: Revised accordingly.

Changes in manuscript:

Methodology (Lines 136 in the revision): "Three LC datasets were applied as PFTs inputs…".

7. Page 4 Section 2.1 Data description: Mention of supplementary material Table S2 and Fig S2 comes before the Table or Figure S1. To ensure a chronical order to the flow of figures and tables in text and supplementary, authors should renumber the supplementary figures and tables as it appears in the manuscript.

Response: Revised accordingly.

Changes in manuscript:

Methodology (Lines 118, 122, 142, and 143 in the revision):

"…China and its surrounding countries in East Asia (Fig. S1) …"

"… Table S1 briefly lists the physical options used for the WRF model."

"Sources of these products were listed in Table S2."

"Three LC maps are first re-gridded to the CMAQ domain (Fig. S2)."

8. Page 4 Line 100-101: The text mentions the 16 PFTs classifications whereas, Figure 1 only shows 15 classifications. Correct accordingly.

Response: Revised accordingly.

Changes in manuscript:

Methodology (Lines 144-145 in the revision): Lastly, eight vegetation types are further reclassified into CLM-15 PFTs based on the climate rules described in Bonan et al. (2002).

9. Supplementary Table S2 lists the sources of the LC and LAI datasets. The table should include more information to better describe all the datasets used in the study such as temporal resolution spatial resolution and years for which data is available etc.

Response: Thanks for your suggestions. The temporal resolution, spatial resolution and available years for satellite datasets used in this study were added to the Table R1 (named as Table S2 in the revision).

Changes in supplementary material:

Table R1. The sources of datasets.

Datasets	Year	Temporal Resolution	Spatial Resolution	Source
MODIS MCD12Q1	2001-2021	Yearly	500 m	Available at https://search.earthdata.nasa.gov/, last access: 10 April 2022
C3S LC	1992-2021	Yearly	300 m	Available at https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=form, last access: 21 March 2022
CGLS LC	2015-2019	Yearly	100 m	Available at https://land.copernicus.eu/global/products/lc, last access: 15 April 2022
MODIS MOD15	2000-2021	8 days	500 m	Available at https://search.earthdata.nasa.gov/, last access: 10 April 2022
GLASS	2000-2021	8 days	500 m	Available at http://www.glass.umd.edu/LAI/MODIS/, last access: 11 April 2022
CGLS	2014-2021	10 days	300 m	Available at https://land.copernicus.eu/global/products/lai, last access: 10 April 2022

10. Page 4 Line 106: The description of Figure S2 in text seems to be Figure S4 in supplementary material. Check and correct.

Response: Revised accordingly.

Changes in manuscript:

Methodology (Lines 148-150 in the revision): Although MCD12Q1 and CGLS LC both show a large area of broadleaf tree in central and southern China, the area fraction of broadleaf tree in CGLS LC is higher than that in MCD12Q1 (Fig 1 and Fig. S3).

11. Page 5 Line 145: States the physical schemes adopted in WRF model. Authors are suggested to support the choice of these WRF physical parameterizations through literature review for the same study region.

Response: Thanks for your suggestions. The references were added to the manuscript.

Changes in manuscript:

Methodology (Lines 121-122 in the revision): The model configurations are similar to the previous studies (Wang et al., 2018;Wang et al., 2020;Zhu et al., 2021) and Table S1 briefly lists the physical options used for the WRF model.

12. Page 5 Line 148: Number of grid cells of CMAQ model are given. Is the CMAQ model running at the same resolution as the WRF model? Provide horizontal spatial resolution for CMAQ model too.

Response: Yes, it is. The horizontal spatial resolution for the Community Multiscale Air Quality Modelling System (CMAQ) model was added to the sentence and shown below.

Changes in manuscript:

Methodology (Lines 125-126 in the revision): The CMAQ model used the same horizontal resolution as WRF with a horizontal domain of 197 × 127 grid cells. This domain covers China and its surrounding areas (Fig. S1).

13. Page 5 Lines 150-153: The sources of anthropogenic emissions used for China and other countries is provided. Few sentences on MEIC and EDGAR emission inventories should be added to understand the reason behind selection of these inventories.

Response: Thanks for your comments. The reasons for choosing MEIC and EDGAR were added to the manuscript.

Changes in manuscript:

Methodology (Lines 127-134 in the revision): The anthropogenic emissions of China used the datasets from Multiresolution Emission Inventory for China (MEIC; available at http://www.meicmodel.org, last access:3 May 2022). Since the MEIC only provides anthropogenic emissions for China, anthropogenic emissions from foreign countries were provided by the Emissions Database for Global Atmospheric Research (EDGAR) v4.3 (available at http://edgar.jrc.ec.europa.eu/overview.php?

v=_431, last access: 10 May 2022). The MEIC inventory is widely used in air quality studies in China (Li et al., 2017;Hu et al., 2016;Wu et al., 2020). It had an improvement in a vehicle emission inventory with high resolution (Zheng et al., 2014), and a non-methane VOC mapping approach for different chemical mechanisms (Li et al., 2014). The EDGAR is a grided emissions inventory with a high horizontal resolution of 0.1°×0.1° (Saikawa et al., 2017).

14. Table S4 gives the benchmarks for some statistical indices for meteorological parameters. It is suggested to provide the reference of these benchmarks. Similarly, provide the reference for O3 benchmark as well.

Response: The references for the benchmarks were added to the Table S4 and Table S5.

Changes in supplementary material:

"Note: * are benchmarks limits suggested by (Emery et al., 2001)."

"Note: * are criteria suggested by EPA (2007)."

15. Page 7 Line 212: Define the term 'LAIv'.

Response: LAIv means the LAI of vegetation covered surface, which is calculated by dividing the grid average LAI with the fraction of grid that is covered by vegetation (Guenther et al., 2006). This term has been explained in the manuscript in Line 161.

Changes in manuscript: No changes were made for this comment.

16. Page 9 Line 260: "Fig S3" should be "S4".

Response: Revised accordingly.

Changes in manuscript:

Results and discussion (Lines 261-263 in the revision): The spatial distribution of isoprene emission in C5 is conspicuously different than in C1, which is consistent with a difference in the broadleaf tree distribution in the inputs (Fig. S5).

17. Page 11 Lines 323-325: The results analyzed in Section 3.4.1, have a special mention to the BSOA concentrations noted over Sichuan basin. As it is also stated in the Conclusion Section on Page 12, it would be nice to mark the location of Sichuan basin on the spatial figures of both main manuscript and supplementary material.

Response: Thanks for your comments. We marked the location of the Sichuan basin in the Figure R1 (named as Figure S1 in the revision).

Changes in supplementary material:

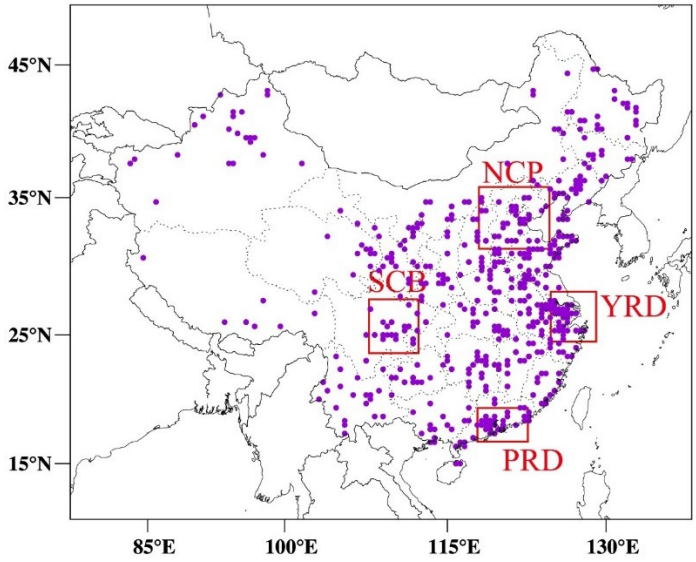

Figure R1. Model domain with the key city clusters (North China Plain, NCP; Yangtze River Delta, YRD; Pearl River Delta, PRD; Sichuan Basin, SCB). Purple-filled circles show locations of air quality monitoring sites (1381 sites in total).

Reference

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