# 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 #1,

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:** This paper explores the impact of different land cover data sets on biogenic emissions and its contribution to ozone and secondary organic aerosol in China with the Model of Emissions of Gases and Aerosols from Nature (MEGAN) v2.1 employing a further developed version of the Community Multiscale Air Quality Modelling System (CMAQ). For that, a set of experiments with three different leaf area index (LAI) and plant functional type (PFT) input were conducted to show the impact of the different input to BVOC emissions, extreme ozone and SOA. The BVOC emissions estimated from all simulations are within the reported range of literature values whereas, however, only the changes of LC data lead to a significant impact on BVOC emissions and related air quality.

This investigation will be valuable, also on a global scale to assess further the uncertainty of the input data to BVOC emissions and their products and finally improve the model representation of air quality. Besides the following suggestions, I advise the authors to improve the manuscript regarding the language and the structure, adapt the visualization more to the analysis purpose and strengthen the conclusion.

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

Comments:

1. Abstract: In particular, the beginning is a bit unstructured. Some sentences don't have enough content to understand the link between different aspects see the following points. If you structure it more following a red line it may also lead to more comprehension of the text.

1.1 Time period of 'greening impacts in China'? Which role does this play for BVOC emissions? How does BVOCs act for O3 and SOA? Why are these important species to study? – air quality/health impact. How is the BVOC estimation based on inventories, and how does this link to satellites? If you want to mention the uncertainty of satellites include a relative estimate.

**Response**: Thanks for pointing out these important issues. The period of 'greening impacts in China' is from 2000 to 2017 (Chen et al., 2019). The greening impacts increase the vegetated area, further increasing the biogenic volatile organic compounds (BVOC) emissions. Since BVOCs are the important precursor for ozone ($O_3$) and secondary organic aerosol (SOA), the increase in BVOC emissions further changes concentrations of $O_3$ and SOA. In this study, the BVOC emissions are estimated by the Model of Emissions of Gases and Aerosols from Nature (MEGAN) and the satellite datasets are necessary inputs for the MEGAN model. The sentences in the abstract were modified and shown below.

**Changes in manuscript:**

**Abstract (Lines 11-14 in the revision):** The greening impacts in China from 2000 to 2017 led to an increase in vegetated areas and thus enhanced biogenic volatile organic compounds (BVOC) emissions. BVOCs are regarded as important precursors for ozone ($O_3$) and secondary organic aerosol (SOA). As a result, accurate estimation of BVOC emissions is critical to understanding their impacts on air quality.

1.2 A more general formulation of the results would make the abstract more appealing. Also, including relative changes helps the reader to judge the impact order of your changes.

**Response**: Thanks for your suggestions. The results were modified to be more general and the differences between cases were presented with the relative difference in 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. Introduction: It's confusing that some sentences are lacking scientific background and with some you go in very detail as can be seen in the following points. In particular the last paragraph could be more conclusive by linking the mentioned studies more together:

2.1 'wide range of warming and cooling climate pollutants' (l.39) is to unspecific. The different radiative forcing/role in climate between aerosols and greenhouse gases like O3 should be mentioned.

**Response**: The pollutants and their effects on climate were determined in the manuscript and listed below.

**Changes in manuscript:**

**Introduction (Lines 38-41 in the revision):** In addition, changes in emissions of BVOCs will alter the capacity of a wide range of warming and cooling climate pollutants, such as $O_3$, methane ($CH_4$) and aerosols. $O_3$ and $CH_4$ can warm the climate, while the aerosols have a cooling effect by scattering solar radiation (Unger, 2014b, a).

2.2 (l.51) The role of emission and activity factors for BVOC emissions need to be explained before. In general, I suggest to describe in short how BVOC emissions are calculated by the model.

**Response**: Thanks for your suggestion. The calculation of BVOC emission was added in the manuscript and explained below.

**Changes in manuscript:**

**Introduction (Lines 49-51 in the revision):** The model determined the vegetation types according to model inputs and then use the activity factor multiplied with the emission factor to calculate emissions for each vegetation type (Guenther et al., 2012).

2.3 (l. 69) which CTM was used in the cited study?

**Response**: The specific name for the chemical transport model (CTM) of the cited study was written in the manuscript and shown below.

**Changes in manuscript:**

**Introduction (Lines 69-72 in the revision):** Fu and Liao (2012) used the Goddard Earth Observing System chemical transport model (GEOS-Chem) to quantitate the impact of biogenic emissions on $O_3$ in China over the year 2001-2006 and found that the difference in $O_3$ concentrations induced by interannual variability of BVOCs could be 2-5%.

2.4 (l. 71 f.) Why is the particular SOA concentration in Sichuan mentioned here? Is this a high number?

**Response**: Yes, it is. The sentence was modified to clear its point in the manuscript and shown below.

**Changes in manuscript:**

**Introduction (Lines 76-77 in the revision):** Qin et al. (2018) investigated the biogenic SOA (BSOA) during summertime in 2012 and found that a high level of BSOA concentration appeared in Sichuan Basin.

3. Section 2: I suggest to re-structure this section (Model description: CMAQ, MEGAN, WARF; Data description, experiments) to improve readability. Along this, I have some question:

**Response**: Thanks for your suggestions. The structure of the section 'Methodology' was changed from Data description, Model description, and Model application to Model setup, and Data description.

3.1 (Line 100/101) According to which maps are the PFT classified?

**Response**:

The plant function type (PFT) scheme used in the MEGAN is classified based on Community Land Model v4.0 (CLM4) (Guenther et al., 2012). The sentence was modified and Figure R1 (named as Figure S2 in the revision) was added to the manuscript to make it clear.

**Changes in manuscript:**

**Methodology (Lines 142-145 in the revision):** PFTs used in the MEGAN model adopt the scheme used for Community Land Model v4.0 (CLM4) (Guenther et al., 2012). Three LC maps are first re-gridded to the CMAQ domain (Fig. S2). Secondly, LC types are categorized into eight vegetation types according to legend descriptions of LC maps. Lastly, eight vegetation types are further reclassified into CLM-15 PFTs based on the climate rules described in Bonan et al. (2002).

**Changes in supplementary material:**

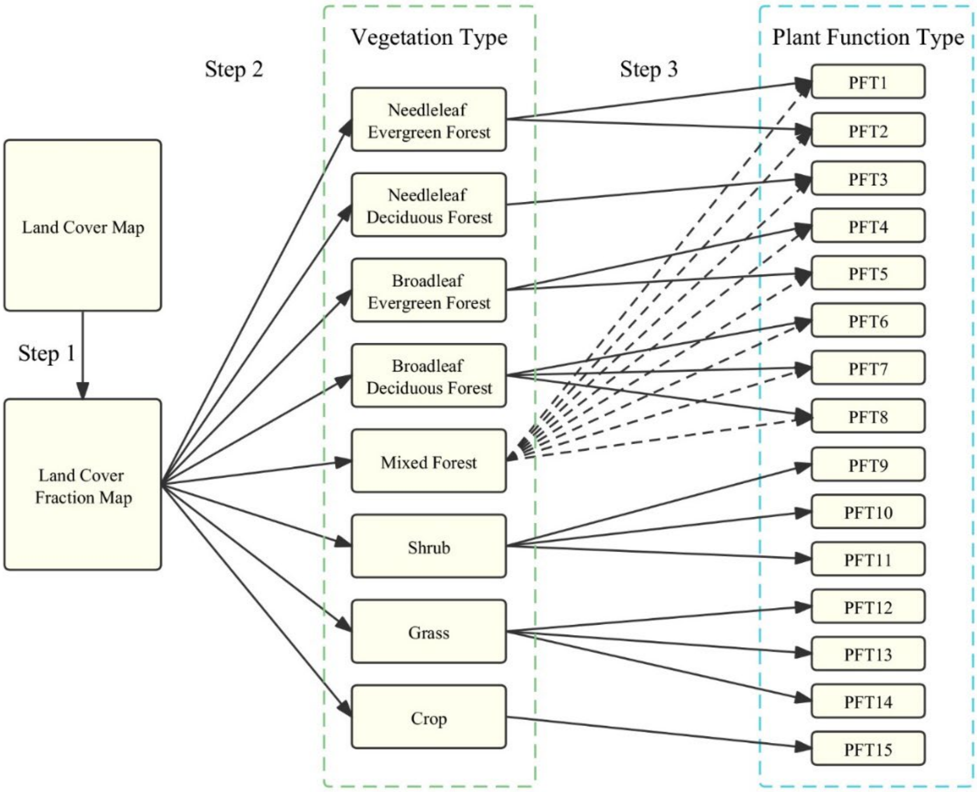


Figure R1. The flow chart for making plant function type (PFT). The dashed line represents the complementary classification for PFT1 to PFT8.

3.2 (l.112) To which LAI maps does GLASS show better consistency?

**Response**: In leaf area index (LAI) satellite products, the Global LAnd Surface Satellite (GLASS) products show better consistency than the MODIS MOD15A2H version 6 (MOD15) products according to the study in Xiao et al. (2016), while the accuracy of the Copernicus Global Land Service (CGLS) products are slightly less than MOD15 products (Fuster et al., 2020). Therefore, GLASS products have a better consistency than MOD15 products and CGLS products.

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

3.3 140-153 belongs to 'Model description'

**Response**: Thanks for your comments. The subheading 'Model description' was changed to 'Model setup' and sentences in line140-153 were moved to 'Model setup'.

3.4 150 f. Difficult sentence structure. Is MEIC based on EDGAR?

**Response**: No, it is not. The modelling domain in CMAQ was 36 km × 36 km in horizontal spatial resolution, which covers China and its surrounding countries in East Asia (Fig. S1). Since Multiresolution Emission Inventory for China (MEIC) only provided anthropogenic emissions for China, while anthropogenic emissions for regions excluding China were provided by the Emissions Database for Global Atmospheric Research (EDGAR) v4.3. The sentence was modified to make it clear and shown below.

**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).

3.5 147: The chemistry does not impact the meteorology, right?

**Response**: The chemistry does not impact the meteorology. We made it clear in the manuscript that chemistry has no effect on meteorology.

**Changes in manuscript:**

**Methodology (Lines 171 in the revision):** The model chemistry has no effect on meteorological conditions when simulating.

4. Section 3: The statistical analysis is useful, but in the later analysis I often miss the conclusion/interpretation of the simulation results instead the authors often only describe the figures. What can we learn from the data/results?

**Response**: In this study, we concluded that changing the MEGAN inputs has an impact on BVOC estimates, and this further influences the formation of $O_3$ and secondary organic aerosol (SOA). Besides, changing land cover datasets for the model shows more conspicuous differences in BVOC emissions than using different LAI datasets.

4.1 158: criteria -> uncertainty? How is the uncertainty calculated?

**Response**: The criterion is a way of evaluating the model performance and is obtained based on the observations. Simulations with different parameter schemes will generate uncertainties that can lead to bias between predictions and observations, hence, the need to use the criterion to measure model performance. The criteria of 2 is a benchmark value for wind speed. The criteria for other meteorological conditions and calculation methods are described by Emery et al. (2001).

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

4.2 170/171: The day-to-day variability in Fig S2 are hard to see. Think about another visualization when you want to show this.

**Response**: Thanks for your advice. We changed the line chart of day-to-day variability for 2 m temperature into the scatter chart, which is Figure R2 (named as Figure S3 in the revision).

**Changes in supplementary material:**

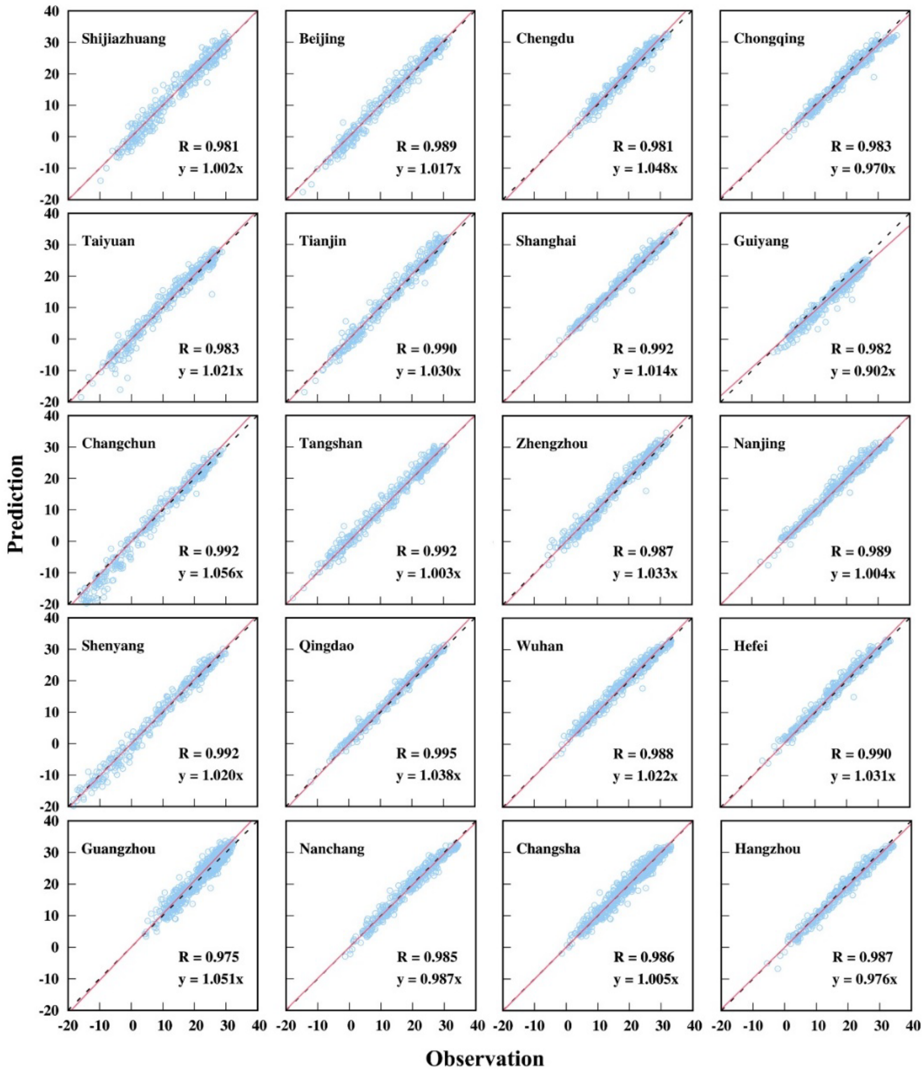


Figure R2. Comparison of observed and predicted daily averaged 2m temperature in each city.

4.3 172 f.: The MB and he GE of the T2 exceeds the 'benchmark', you have to explain this, and why the model performance is still acceptable. Temperature is a crucial driver of BVOC emissions.

**Response**: The result of the mean bias and the gross error of temperature at 2 m (T2) exceeding the benchmark is possible due to the overestimation of cloud coverage in the WRF model leading to an underestimated T2 (Wu et al., 2020). These biases of T2 are relatively small compared with previous studies with a yearly long WRF simulation in China (Wu et al., 2020;Wang et al., 2018a). The reasons were explained in the manuscript and shown below.

**Changes in manuscript:**

**Results and discussion (Lines 178-181 in the revision):** It is possible due to the overestimation of cloud coverage in the WRF model leading to an underestimated T2 (Wu et al., 2020). These biases are relatively small compared with previous studies with a yearly long WRF simulation in China (Wu et al., 2020;Wang et al., 2018a).

4.4 179: What is your motivation to investigate both, MDA1O3 AND MDA8O3?

**Response**: The maximum daily averaged 1h (MDA1) $O_3$ and maximum daily averaged 8h (MDA8) $O_3$ are different indicators for $O_3$ in the National Ambient Air Quality Standard (NAAQS) proposed by EPA (1997, 2015). They are used to represent concentrations for the short-term (1 to 3 hours) and the prolonged (6 to 8 hours) exposures to $O_3$ according to the NAAQS. They differ spatially and temporally due to differences in calculation methods (Bell and Ellis, 2003). China, the study area in this study, also uses them to evaluate the $O_3$ pollution (MEP, 2012). Therefore, they are both important and need to be investigated.

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

4.5 181: What are cut-off concentrations?

**Response**: The cut-off concentration is a minimum threshold value used to restrict observations to mitigate the bias of the model performance analysis (Emery et al., 2017). The 60 ppb as the threshold for $O_3$ is suggested by EPA (2007) to focus bias and error statistics on times of higher $O_3$.

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

4.6 199: I wouldn't say that air quality is not correlated to LAI input only because of this result. Not only BVOC emissions rely on LAI input (also e.g. dry deposition)

**Response**: The dry deposition is a process modelled by the Community Multiscale Air Quality Modelling System (CMAQ). Although this process will be influenced by the satellite-derived land use and vegetation products (Pleim and Ran, 2011), these parameters provided by Weather Research and Forecasting model (WRF) remain unchanged in this study. According to the scope of this paper, only inputs for the Model of Emissions of Gases and Aerosols from Nature (MEGAN) were changed, which did not have impacts on the WRF model, and thus the dry deposition would not be influenced. We modified the sentence to make it appropriate.

**Changes in manuscript:**

**Results and discussion (Lines 211-213 in the revision):** Although C1, C2, and C3 adopt LAI satellite products with different accuracies, the accuracies of these products have no significant impact on the model performance due to similar statistics values.

4.7 214: definition or reference for LAIv=2

**Response**: LAIv means the average LAI for vegetated areas, which is estimated by dividing the grid average LAI by the fraction of the grid that is covered by vegetation (Guenther et al., 2006). The related sentence was modified.

**Changes in manuscript:**

**Results and discussion (Lines 224-225 in the revision):** The BVOC emissions in C1 are about 5 Tg higher than C2.

4.8 215: In which figure can this be seen?

**Response**: The remarkable difference in isoprene between C1 and C2 can be seen in Table 2. The related sentences were modified.

**Changes in manuscript:**

**Results and discussion (Lines 224-225 in the revision):** The BVOC emissions in C1 are about 5 Tg higher than C2.

4.9 220 and before: Are these findings in agreement with other studies?

**Response**: Yes, these findings agreed with the study of Wang et al. (2018). Wang et al. (2018) used three different land cover datasets to run the MEGAN model, which were the Finer Resolution Observation and Monitoring of Global Land Cover (E1), Moderate-Resolution Imaging Spectroradiometer (MODIS) MCD12Q1 PFT products (E4), and the Climate Change Initiative Land Cover (CCI LC) products (E5) in his study. The higher fractions of broadleaf tree in E4 resulted in higher isoprene emissions than E1 and E5, but the lower fractions of needleleaf tree and shrub in E4 resulted in lower monoterpene and sesquiterpene emissions than E1. We added the reference to the sentence and showed below. Figure R3 (named as Figure S3 in the revision) was added to the supplementary material.

**Changes in manuscript:**

**Results and discussion (Lines 227-230 in the revision):** Although the total BVOC emissions in C5 are 1.29 Tg higher than those in C1, the emissions of monoterpenes, sesquiterpenes, and other VOCs are lower than in C1. This is induced by the discrepancy in the distribution of needleleaf tree and shrubs between C1 and C5, which is in agreement with the result in Wang et al. (2018) (Fig. S3 and Fig. S5).

**Changes in supplementary material:**

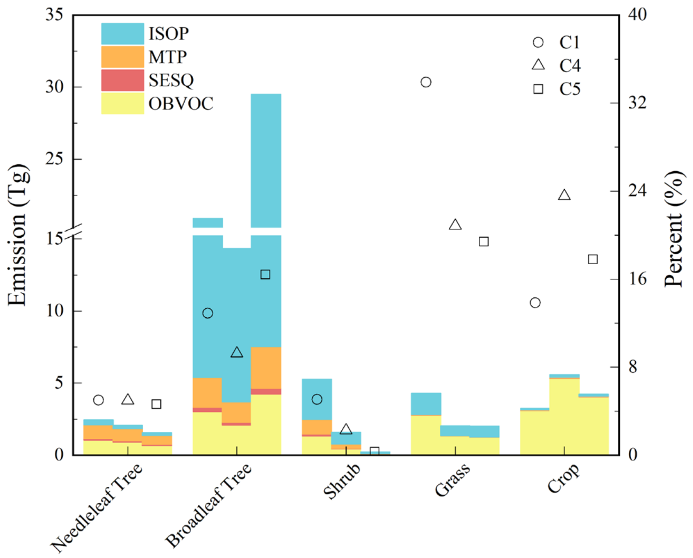


Figure R3. The BVOC emissions and vegetation fractions of needleleaf tree, broadleaf tree, shrub, grass, and crop in the C1, C4 and C5. ISOP is isoprene, MTP is monoterpene, SESQ is sesquiterpene and OBVOC is other BVOCs.

4.10 221: seasonal variations are not easy to see in Fig. 3. I suggest to show/add the annual cycle

**Response**: Thanks for your suggestion. We changed the Figure R4 (named as Figure 3 in the revision) from the histogram to the stacked column chart to represent the annual emissions of BVOC as shown below. As shown in the Figure R4, the BVOC emissions are mainly concentrated in summer, accounting for 60.9%~63.8% of total emissions compared to 2.9%~3.4% in winter.

**Changes in manuscript:**

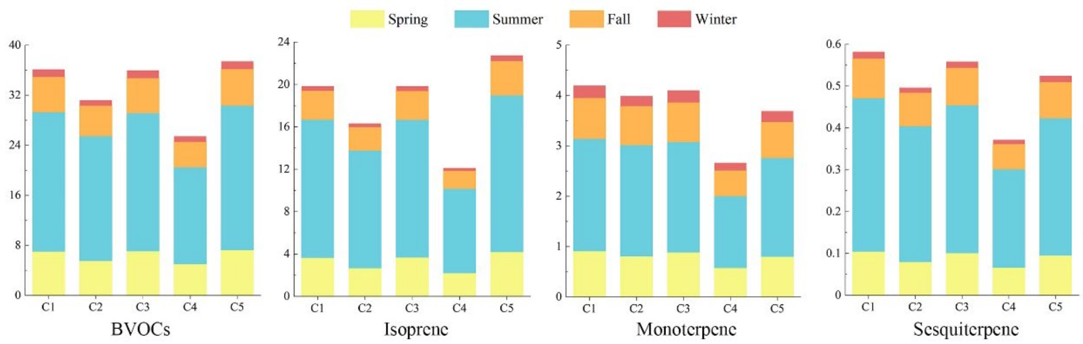

Figure R4. Seasonal emissions of isoprene, monoterpenes, sesquiterpenes, and total BVOCs of each case in China. Unit is Tg.

4.11 224-226: the two sentences are contradicting.

**Response**: These two sentences were corrected in manuscript and shown below.

**Changes in manuscript:**

**Results and discussion (Lines 233-235 in the revision):** In general, using different LAI and LC products does have an impact on the temporal variability in the BVOC emissions. The BVOC emissions show similar seasonal variations in all cases, which are mainly concentrated in summer, accounting for 60.9%-63.8% of total BVOC emissions compared to 2.9%~3.4% in winter

4.12 225 'seasonal change trend'. What do you mean? You do not consider multiple years

**Response**: We wanted to express that the different cases showed similar seasonal change characteristics. The expression was corrected and shown below.

**Changes in manuscript:**

**Results and discussion (Lines 233-235 in the revision):** In general, using different LAI and LC products does have an impact on the temporal variability in the BVOC emissions. The BVOC emissions show similar seasonal variations in all cases, which are mainly concentrated in summer, accounting for 60.9%-63.8% of total BVOC emissions compared to 2.9%~3.4% in winter

4.13 228: Is this in agreement with other findings?

**Response**: Yes, it is. In the study of Ibrahim et al. (2010), the sesquiterpene emitted from birch and aspen increased faster than monoterpene with temperature rising. And Bai et al. (2015) concluded that the increasing rates of isoprene with temperature were much higher than for monoterpenes. These references were added to the sentence.

**Changes in manuscript:**

**Results and discussion (Lines 238-241 in the revision):** The percentage of winter monoterpenes in the total monoterpenes is higher than that of isoprene and sesquiterpenes, probably because isoprene and sesquiterpenes are more sensitive to temperature changes than monoterpenes (Ibrahim et al., 2010;Bai et al., 2015).

4.14 230/31: Are the different species emitted by different PFTs? (Could also be a reason for the difference). What is the temperature coefficient?

**Response**: No, they aren't. In the MEGAN model, different PFTs can emit all BVOC species with different emission factors. The emission ($\boldsymbol{F_i}$) of chemical species *i* from vegetation type *j* according to

$$\boldsymbol{F_i = \gamma_i \sum \varepsilon_{i,j}\chi_j}$$

Where $\boldsymbol{\varepsilon_{i,j}}$ is the emission factor at standard conditions for different vegetation type *j* with fractional grid box areal coverage $\boldsymbol{\chi_j}$.The emission activity factor ($\boldsymbol{\gamma_i}$) accounts for the processes controlling emission responses to environmental and phenological conditions (Guenther et al., 2012). The temperature coefficient is an empirical coefficient used to determine the light-independent fraction, and the light-independent is a part of the temperature activity factor in the MEGAN model (Guenther et al., 1993;Guenther et al., 2012;Helmig et al., 2006).

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

4.15 233/234: Why have the monoterpenes only little sensitivity to LAI sensitivity

**Response**: We made a mistake here and the sentence was deleted.

**Changes in manuscript:**

**Results and discussion (Lines 241 in the revision):** C4 used the C3S LC and GLASS shows the lowest emissions in total BVOCs and its main species among each season.

4.16 240 and before: I suggest to show the emission change per each PFT which would make it easier to interpret and draw general conclusions

**Response**: Thanks for your suggestion. The figure about the BVOC emissions of main PFT was added in the supplementary material (Figure R3, named as Figure S3 in the revision). In Figure R3, the highest fraction of broadleaf trees in C5 contributing large BVOC emissions. Although grass areas are higher than broadleaf tree areas, it does not contribute significantly to the BVOC emissions due to its lower the emission factor.

**Changes in supplementary material:**

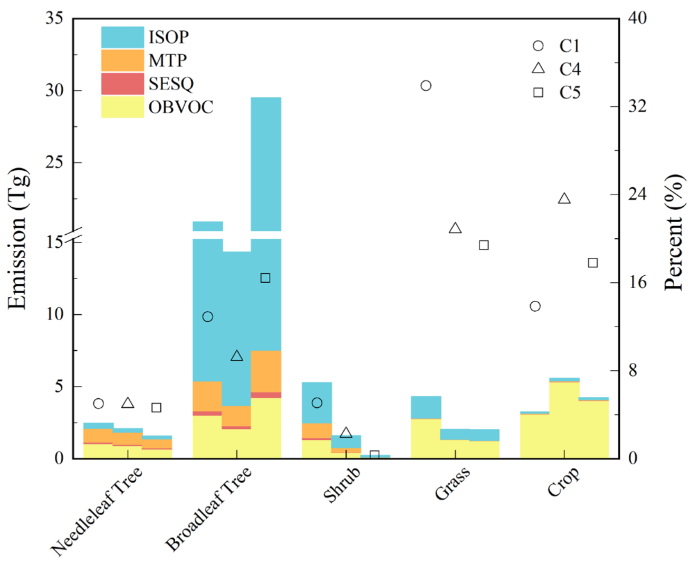


Figure R3. The BVOC emissions and vegetation fractions of needleleaf tree, broadleaf tree, shrub, grass, and crop in the C1, C4 and C5. ISOP is isoprene, MTP is monoterpene, SESQ is sesquiterpene and OBVOC is other BVOCs.

4.17 Table 4: It would make more sense to compare the emission estimates from approximately the same time period. Also, adding one more column in the table with the average LAI value would improve the clarity or alternatively list the BVOC emission estimates normalized by the LAI. Why is the estimate for 2018, which is quite close to your study period, almost double?

**Response**: Many thanks for your comments. We changed the study comparison with Li et al. (2013) to a comparison with Li et al. (2020). This column about the LAI could not be added because the LAI data from previous studies were not available. The reason for the last question is that Li et al. (2020) produced the basal emission rates for 192 plant species and categorized them into 82 PFTs for China resulting in more BVOC estimates.

**Changes in manuscript:**

**Results and discussion (Lines 280-283 in the revision):** There is a considerable difference in BVOC emissions between this study and those of Li et al. (2020). The difference is mainly due to the combined effect of emission rate and PFTs. Liu et al. (2020) produced the basal emission rates for 192 plant species and categorized them into 82 PFTs for China resulting in more BVOC estimates.

4.18 Line 286: How do you estimate the BVOC emissions only formed from O3? (Information could be added to the Methods section

**Response**: The concentrations of $O_3$ from different VOC sources (henceforth $\mathbf{O_3\_VOC_i}$) were determined by the source-oriented method (Ying and Krishnan, 2010). Based on the method, the non-reactive $O_3$ tracer is used to track $O_3$ attributed to BVOCs, which is tagged as $\mathbf{O_3\_VOC_{bio}}$ and directly predicted. The descriptions of $O_3$ source apportionment see detailed in Wang et al. (2019).

**Changes in manuscript:**

**Methodology (Lines 105-108 in the revision):** The concentrations of $O_3$ from different VOC sources (henceforth $\mathbf{O_3\_VOC_i}$) were determined by the source-oriented method (Ying and Krishnan, 2010). Based on the method, the non-reactive $O_3$ tracer is used to track $O_3$ attributed to BVOCs, which is tagged as $\mathbf{O_3\_VOC_{bio}}$ and directly predicted. The descriptions of $O_3$ source apportionment see detailed in Wang et al. (2019).

4.19 6: The seasonal variation is hardly visible and might be better displayed by seasonal cycles (with uncertainty bars)

**Response**: Thanks for your suggestion. The seasonal histogram charts contain information not only on seasonal changes but seasonal differences between cases. Therefore, using the seasonal cycles will not get any better.

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

4.20 327: Why don't you use the same unit as in the Fig. 7?

**Response**: Ppb and μg $m^{-3}$ are both the commonly used units (Wang et al., 2021;Zhang et al., 2021;Hu et al., 2016).

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

4.21 352/53: Do you want to say that changing the MEGAN inputs has a large impact on isoprene emissions and since isoprene is the main contributor to BVOCs this also impact BVOC emissions?

**Response**: We want to express that changing the MEGAN inputs has a large impact on isoprene emissions, which are the main contributor to BVOCs. And this impact further changes the concentration of secondary organic aerosol (SOA). The sentence was modified to make it clear and shown below.

**Changes in manuscript:**

**Results and discussion (Lines 348-349 in the revision):** Changing the MEGAN inputs has a large impact on isoprene emissions, which are the main contributor to BVOC emissions. This further impact the formation of SOA.

4.22 364: Why is summer BSOA in C1 2.5 times higher than in C4?

**Response**: This is due to the higher BVOC emissions in the C1. The reason was added to the manuscript. Figure R5 (named as Figure S8 in the revision) was added to the supplementary material.

**Changes in manuscript:**

**Results and discussion (Lines 357-358 in the revision):** This is because that the summer BVOC emissions in C1 are higher than those in C4 in the YRD (Fig. S8) and thus formed more BSOA.

**Changes in supplementary material:**

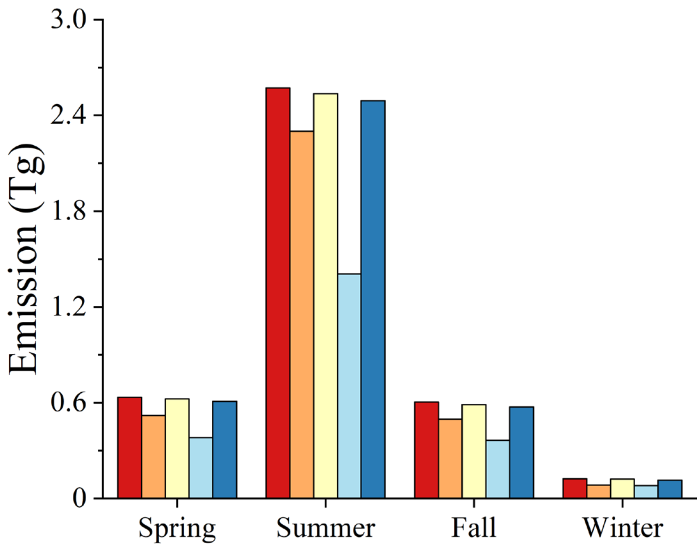


Figure R5. Seasonal spatial variation of BVOCs in the YRD.

4.23 From Fig. 4 you found that BSOA changed for different LAI as well as for different PFT inputs although the BVOC emissions (analyzed before) don't change much with different LAI. Why is that?

**Response**: BVOC is an important contributor to SOA, so changing BVOC emissions will have an impact on the formation of SOA, and the magnitude of the impact depends on the amount of change in BVOC emissions. In this study, although changing the LAI for the MEGAN model has little effect on BVOC estimates, it could be amplified in BSOA through complex chemical process involving gas-particle reactions (Mahilang et al., 2021).

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

4.24 267: For which year did the studies, which are referred here, estimate the emissions?

**Response**: The study estimated the BVOC emissions in 2018. The study year for the reference was added to the sentence.

**Changes in manuscript:**

**Results and discussion (Lines 270-271 in the revision):** However, results in this study are lower than 58.9 Tg for 2018 estimated by Li et al. (2020).

**Technical corrections:**

1. Abstract: introduce abbreviations LAL and LC.

**Response**: Revised accordingly.

2. 49: as in PRD …

**Response**: Revised accordingly.

3. Grammar and tense issues: l.52/53: ‘quantifi(ed)/determine(d)’, l. 55 ‘affect(ing)’, l.99&l.111 &l.145&l.122 ‘were’ -> are

**Response**: Revised accordingly.

4. 104 ‘major(ity)’

**Response**: Revised accordingly.

5. Sentence in line 62 f. (‘Wang et al. (2018a) misses one verb

**Response**: Revised accordingly.

6. Sentence in l. 71 has a complicated sentence structure, integrate the last part in the main sentence

**Response**: Revised accordingly.

7. -(l.100) ‘of each LC type […] and [this]’

**Response**: Revised accordingly.

8. 158 ‘based on five different cases’ -> with 5 different sets of LC input data for MEGAN

**Response**: Revised accordingly.

9. Footnote in Table S3 not found, in caption: ‘The values are bolded without meeting the benchmarks’ -> ‘The values without meeting the benchmarks are bolded’

**Response**: Revised accordingly.

10. S3: scale could be improved

**Response**: Revised accordingly.

11. Table S5: units are not given in the caption, information on benchmarks in the table, distinction between MDO3 and MDA8 could be clearer

**Response**: Revised accordingly.

12. 252: are occurred -> occur

**Response**: Revised accordingly.

13. 260: shouldn't be the sentence refer to Fig. S4 ?

**Response**: Revised accordingly.

14. 344/45: the plots from the three different species are hard to compare since they have different scales

**Response**: The sentence was deleted.

15. 347: Reformulate

**Response**: The sentence was deleted.

16. 350: attribute -> be attributed

**Response**: Revised accordingly.

17. 355: delete 'amount of'

**Response**: Revised accordingly.

18. 359: 'temporal trend' -> seasonal cycle ?

**Response**: Revised accordingly.

19. 369: sometimes you mean both LAI and PFT when you write LC datasets

**Response**: We corrected the mistakes.

20. 374-76: More comprehensive formulation needed for the conclusion

**Response**: Revised accordingly.

## Reference

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