

## Response to Referee #2

The study by Wang and co-workers investigates the impact of satellite-based land use changes on biogenic VOC emissions in China over 16 years (2001-2016). They report positive emission trends of 1-1.5% per year over the whole country, which are attributed, for a major part, to changes in vegetation. The strongest BVOC trends are reported in Qinling mountains and in south China, where the BVOC emissions increased by more than ~60% in 2016 relative to 2001. Further comparison of BVOC interannual variability with HCHO columns from the OMI instrument over the studied period in summertime exhibited positive temporal correlation over forested regions. This study addresses an interesting subject for Atmospheric Chemistry and Physics journal. However, there are weaknesses and limitations in the present study, which raise doubts regarding the validity of the conclusions. Furthermore, the presentation is often difficult to follow, mostly due to insufficient mastery of the English language. To my view, the manuscript will need a major revision before it becomes suitable for publication. My main concerns are listed below:

Response: Thank you so much for your precious time and we really appreciate your comments. Since we haven't finished the revision of paper, right now we will only response the discussion of ACP and introduce our direction of revision. The final response will be submitted with the revised paper. We will try to address the problems you mentioned about uncertainty of this study by taking following measures:

1. We will further analyze the role of meteorology on the trend of BVOC emission.
2. Extra experiments will be added to illustrate the contribution of LAI on trends of BVOC emission. In addition, we will conduct some experiment to discuss the uncertainty induced by the PFT product and its classification system.
3. We will compare our estimations with the results by other studies to discuss the potential reasons of discrepancy between them.
4. We will invite some native speakers to improve the language of the revised paper.

(i) Important input datasets required for calculating BVOC emissions using MEGAN model (e.g. PFTs) are not shown. Annual maps of the MODIS PFTs and LAI should be provided, as well as their trends. Without such information, it is impossible to assess the driving factors for the changes and therefore for the validity of the claims. Furthermore, it is not clearly mentioned whether a unique emission factor per PFT has been used (Table 2 of Guenther et al. 2012) or if a map of standard emission factors has been used.

Response: Thank you so much for your comments. We will present the annual change of MODIS PFTs and LAI and their trends in the revised paper or the supplement. The emission factor is coming from the Table 2 of Guenther et al. 2012, and we will also mention that in the revised paper.

(ii) I have my doubts regarding the almost negligible isoprene trends due to meteorology suggested by Figure 3 (simulations S3 and S4). The scale in this figure does not allow to see any changes elsewhere than in the Tibetan Plateau. Elsewhere, the color (grey) corresponds to no value. In order to explain the emission trend in S3 and S4, trends of the main drivers of the BVOC emission trends, namely, air temperature, solar radiation and leaf area index should be analysed. In addition, the simulated trend in surface temperature and radiation should be compared to the corresponding trends of the in situ temperature and solar radiation data used for the evaluation of the WRF model

simulation in Section 2.3.

Response: Thank you so much for your comments. We will add more analysis regarding the meteorological impact on BVOC emission as you suggested. We will also analyze the trend of meteorological fields of WRF simulation and in-situ observation separately as you suggested.

(iii) There is not convincing evidence for the very low monoterpene emission derived in this study compared to previous work (Table 3). The invoked reasons, e.g. interannual variations, horizontal resolution, etc. (page 7, lines 81-20) are not convincing. The reasons of the discrepancy should be investigated through detailed comparisons e.g. with the MEGAN inventory and similar studies e.g. Sindelarova et al. (2014). These datasets are accessible via the ECCAD database (<https://eccad.aeris-data.fr>).

Response: Thank you so much for your comments. We agreed to your suggestion and will compare our results with other datasets of BVOC emission from ECCAD database. Another reviewer also mentioned it and asserted that the misclassification of PFTs of MODIS may be the potential reason of low monoterpene. Therefore, we will also do some experiments to investigate the impact of different land cover classification system of MODIS products.

(iv) The strong trends inferred over the Qinling mountains and over Southern China need further discussion. Can you put compare this result to past studies? What is the respective roles played by LAI and PFT cover trends?

Response: Thank you for your comments. We will compare our results with other studies to further investigate the strong trend over the Qinling Mountains. In addition, extra experiments will also be added to investigate the role played by LAI and PFT, respectively.

Specific comments/Language corrections

p.2, l.3-7: The sentence is too long, considering splitting into two and rephrasing.

Response: Thank you for your comments. This sentence has been re-written as:

“Besides the climatic factors, the land cover change also plays a key role in the variability of BVOC emission (Stavrou et al., 2014; Unger, 2011; Chen et al., 2018). For instance, cropland expansion has been estimated to dominate the reduction of isoprene, the dominant BVOC species, in last century (Lathière et al., 2010; Unger, 2013) although there are large uncertainties associated with these estimates.”

p.2, l.5: add space between '2014' and 'Chen'

Response: Thank you. We have followed your advice.

p.2, l.12: 'a corresponding impact', replace by 'changes'

Response: Thank you. We have followed your advice.

p.3, l.10: remove 'observed'

Response: Thank you. We have followed your comments.

p.3, l.10: 'regional ecosystem isoprene emission', change to 'isoprene emission at regional to global scales'

Response: Thank you. We have followed your advice.

p.3, l.11: 'reported the', change to 'reported an'

Response: Thank you. We have followed your advice.

p.3, l.12: read 'detected by the Ozone'

Response: Thank you. We have followed your advice.

p.3, l.14-15: rephrases as follows: 'Here we used the long-term OMI 2005-2016 record to estimate the interannual isoprene variability in China'

Response: Thank you. We have followed your advice.

p.3, l.19: add reference Guenther et al.(2012)

Response: Thank you. We have followed your advice.

p.3, l.20: add more references, e.g. Bauwens et al.(2018) and Messina et al.(2016)

Response: Thank you. We have added these references.

p.3, l.23: read 'uses the fundamental'

Response: Thank you. We have followed your advice.

p.4, l.1: read 'the standard emissions factor, and the emission activity factor for the chemical species i'

Response: Thank you. We have followed your advice.

p.4, l.3: '(PFT) distribution from the Community Land...'

Response: Thank you. We have followed your advice.

p.4, l.5: replace 'expresses it as' by 'can be written as'

Response: Thank you. We have followed your advice.

p.4, l.8: 'equal to 1 at standard conditions (Guenther et al. (2006)'

Response: Thank you. We have followed your advice.

p.4, l.9: please specify the source of the LAI dataset

Response: Thank you. We have added the link of website of MODIS LAI products (<https://lpdaac.usgs.gov/products/mcd15a2hv006/>) in this sentence.

p.4, l.9: replace 'and the leaf age in MEGAN' by a new sentence: 'It is used to define the leaf age response function as described in Guenther et al.(2012).'

Response: Thank you. We have followed your advice.

p.4, l.10: the text should read 'Guenther et al. (1991, 1993, 2012)'

Response: Thank you. We have followed your advice.

p.4, l.14: remove 'factor'

Response: Thank you. We have followed your advice.

p.4, l.18: 'adopted', change to 'used'

Response: Thank you so much. We have followed your advice.

p.4, l.18: 'in this study', missing reference for the LAI datasets used

Response: Thank you so much. We have followed your advice and added the reference of MODIS LAI product.

p.4, l.20: missing reference for the dataset

Response: Thank you so much. We have followed your advice and added the reference of MODIS VCF product.

p.4, l.22: change 'data' to 'dataset'

Response: Thank you. We have followed your advice.

p.4, l.22: 'land cover product' missing reference.

Response: Thank you so much. We have followed your advice and added the reference of MODIS land cover product.

p.4, l.24: 'described in'

Response: Thank you. We have followed your advice.

p.4, l.24: using the climatology of ERA-interim dataset', change to 'using the ERAInterim climatology'

Response: Thank you. We have followed your advice.

p.5, l.1: 'during 2001-2016', change to 'over 2001-2016'

Response: Thank you. We have followed your advice.

p.5, l.5: 'The meteorological simulation is', change to 'The model was'

Response: Thank you. We have followed your advice.

p.5, l.10: 'using the in-situ', change to 'using in-situ'

Response: Thank you. We have followed your advice.

p.5, l.13: 'monthly averaged'

Response: Thank you. We have followed your advice.

p.5, l.15: -2 in Wm-2 should be superscript

Response: Thank you. We have followed your advice.

p.5, l.15: among 98 sites, and the overestimations', change to 'for 98 studied sites. The

overestimation'

Response: Thank you. We have followed your advice.

p.5, l.17: 'the lack of aerosol radiation effect and cloud simulation', not clear what is meant here

Response: Thank you so much for your comments. We have modified this sentence as:

“The overestimation of DSW simulation is a common issue in multiple simulation studies and may be induced by the lack of physical processes for aerosol radiation effect (Wang et al., 2011; Situ et al., 2013; Wang et al., 2018).”

p.5, l.23: 'Our', change to 'The'

Response: Thank you. We have followed your advice.

p.6, l.1: 'Observations'

Response: Thank you. We have followed your advice.

p.6, l.3: 'and was retrieved'

Response: Thank you. We have followed your advice.

p.6, l.4-5: 'The detailed...De Smedt et al. (2015)'. Please remove sentence (repetition)

Response: Thank you. We have followed your advice.

p.6, l.6: 'temporally stable', what about the row anomaly? This effect should be mentioned.

Response: Thank you. We will follow your advice and add the discussion about the row anomaly of OMI.

p.6, l.9: change 'anthropogenic source' to 'anthropogenic VOC'

Response: Thank you. We have followed your advice.

p.6, l.10: 'in the forest regions without obvious anthropogenic impact', replace by 'over forests in summertime'

Response: Thank you. We have followed your advice.

p.6, l.21: 'between 2001 to 2016', change to 'between 2001 and 2016'

Response: Thank you. We have followed your advice.

p.6, l.25: This has been already mentioned, please avoid repetitions

Response: Thank you. We have followed your advice and removed that sentence.

p.6, l.26-27: sentence not clear

Response: Thank you. We will rephrase or extend this sentence to let it clearer.

p.7, l.6-8: what do you mean by 'results' and corresponding results'? State clearly what you did

Response: Thank you. We have followed your advice.

p.7, l.15: 'S1...conditions', repetition

Response: Thank you. We have followed your advice and removed the sentence.

p.7, l.18: 'other estimations', missing references

Response: Thank you. We have followed your advice and added the reference in Table 3 to the sentence.

p.7, l.24: 'increasing rates of these species', replace by 'trends'

Response: Thank you. We have followed your advice.

p.7, l.25: 'despite the direct impact of meteorological conditions', not clear

Response: Thank you so much. We will rewrite this sentence in the revised paper.

p.8, l.11: Rewrite as 'The average annual total BVOC emission over 2009-2016 is by 50% higher than over 2001-2008.' Is that what you mean?

Response: Thank you so much for your comments. That's what we mean, and we have rewritten this sentence following your suggestion.

p.8, l.13: 'are by 11.3%'

Response: Thank you. We have followed your advice.

p.8, l.21: 'S4 is 23.5%', change to 'S4 is by 23.5%

Response: Thank you. We have followed your advice.

p.8, l.23: 'by 29.9%'

Response: Thank you. We have followed your advice.

p.8, l.25-26: poor language

Response: Thank you. We will rephrase this sentence.

p.9, l.15: 'landcover', change to 'land cover'

Response: Thank you. We have followed your advice.

p.9, l.15: read 'contribute up to 20%, and taken together more than 30% to the estimated...'

Response: Thank you. We have followed your advice.

p.10, l.6: 'driven', change to 'driven'

Response: Thank you. We have followed your advice.

p.10, l.10-12: Sentence could be removed

Response: Thank you. We have followed your advice.

p.10, l.15: superscripts for m-2 y-1

Response: Thank you. We have followed your advice.

p.10, l.20: read 'broadleaf trees, needleleaf trees and other vegetation'

Response: Thank you. We have followed your advice.

p.10, l.25: 'percent', replace by 'percentage'

Response: Thank you. We have followed your advice.

p.10, l.13-24: too many numbers in this paragraph make the reading difficult, consider removing some of the numbers and rewriting

Response: Thank you so much for your suggestion. We will rephrase this paragraph.

p.11, l.4-7: too many numbers in the text, consider introducing them in a table

Response: Thank you. We will consider your advice and add a suitable table or graph.

p.11, l.11: 'in (Figure 3)', change to 'in Figure 3'

Response: Thank you. We have followed your advice.

p.11, l.23: 'dominate factor', read 'dominant factor'

Response: Thank you. We have followed your advice.

p.12, l.2: 'suffering from poor air quality'

Response: Thank you. We have followed your advice.

p.12, l.2: add space between 'years' and 'Yang'

Response: Thank you. We have followed your advice.

p.12, l.13: 'in rural regions with minimal anthropogenic influence', change to 'over forests'

Response: Thank you. We have followed your advice.

p.12, l.18: 'summer-average isoprene emission estimated in our study to evaluate our estimation of interannual variability of isoprene emission', poor wording.

Response: Thank you. We will rephrase this paragraph.

p.13, l.1: 'anthropogenic sources', missing reference

Response: Thank you. We will add the reference in the revised paper.

p.13, l.5: 'correlation can be found', change to 'correlation is found'

Response: Thank you. We have followed your advice.

p.13, l.10: 'anthropogenic sources', missing reference

Response: Thank you. We will add the reference in the revised paper.

p.13, l.20: 'greatest increasing trend', change to 'strongest positive trend'

Response: Thank you. We have followed your advice.

p.14, l.4: 'the mega-city areas', read 'in megacities'  
Response: Thank you. We have followed your advice.

p.15, l.1: read 'from 2001 to 2016'  
Response: Thank you. We have followed your advice.

p.15, l.1: read 'as inputs in the MEGAN'  
Response: Thank you. We have followed your advice.

p.15, l.1: 'the long-term', remove 'the'  
Response: Thank you. We have followed your advice.

p.15, l.11: here and elsewhere in the manuscript, use one instead of two decimals  
Response: Thank you. We have followed your advice.

p.15, l.18: 'there'?  
Response: Thank you so much for your comments. We will rephrase this sentence.

p.15, l.21: 'during 200-2010', missing reference  
Response: Thank you. We will add the reference in the revised paper.

p.15, l.22: 'there has been in a increasing trend', do you mean 'showed an increasing trend'?  
Response: Thank you for your comments. We have revised this sentence as your suggestion.

p.15, l.24: read 'assess'  
Response: Thank you. We have followed your advice.

p.16, l.6: remove the references (they are already mentioned before)  
Response: Thank you. We have followed your advice.

p.16, l.6-10: repetition of l.20-25 of page 14, not necessary  
Response: Thank you. We have followed your advice and removed this sentence.

p.23: Table 3, the estimates reported in Li et al. are in TgC, not in Tg, please correct  
Response: Thank you so much. We have corrected this in the revised paper.

p.26: Difficult to read, I suggest splitting into a figure with 4 panels (a, f, k, p) and another figure with the trends. The regions in panel (r) are barely visible. Please improve.  
Response: Thank you. We will follow your suggestion and find a better way to present the results.

p.27: It is very difficult to distinguish the colors corresponding to broadleaf and needleleaf trees, please adapt. In the caption, please correct typos for the names of provinces.  
Response: Thank you. We will follow your suggestion and improve the figure as well as caption.