The authors thank the reviewer for his precious time and the constructive comments. The detailed responses to the editor and referee comments are given below.

## General comment

1) The authors report the sensitivity of WRF (v3.3.1)-MEGAN (v2.1) calculated BVOCs emissions to land cover and LAI inputs over the Beijing area in 2013. The results were compared with previous studies and related to regional air quality. This material is original and suitable for ACP.

Response: The authors appreciate your precious time and effort to improve the quality of our manuscript. The aim of our studies is to investigate the natural effect on air quality, and the future work will focus on the air quality simulation to quantitatively investigate its effect on air pollution. This manuscript is the first step of this topic and we concentrated on the MEGAN model and its sensitivity to different inputs. Considering the comments from two reviewers, we will adjust the content of our manuscript, and the data and results from a recent published paper concentrated on same topic by Ren et al. (2017) would be added in the revised manuscript to further discuss this topic.

2) The methodology section needs to be significantly expanded to include more descriptions on experiment setup (see my specific comments below). Any novel settings should be highlighted.

Response: The authors thanks for your comments. We have replied the reviewer's specific comments below and will add more details of the configuration of the experiments in the revised manuscript and supplement.

3) The paper can benefit from careful language editing, preferably with help from a native English speaker. I recognize that the authors made some efforts to address this issue brought up during the ACPD quick report phase. However, the current version still contains many grammar mistakes and awkward sentences. References are often inaccurate/inappropriate. Transitions from one sentence to another, from one paragraph to another are not smooth. Also, when one paragraph ends and a new one begins, the authors should either indent the first line of the new paragraph, or leave a line space between the two paragraphs. Here are some suggested edits to the first sentences of your abstract.

P1, L11: air quality pollution -> air pollution

P1, L12: delete "still", and also requires other emission inventories. A sentence saying BVOC emissions are sensitive to land and met conditions should be placed here.

P1, L15-16: "based on" -> "using"; add "the" before "Model of ….."; delete "model" after v2.1

P1, L19: "are used to design five experiments, as E1-E5, to calculate and test the sensitivity of the model" -> are used in five model sensitivity experiments, as E1-E5

P1, L20: "Based on the meteorological conditions from Weather Forecasting and Research (WRF) model, this inventory is an hourly inventory with 3-km spatial resolution."->These sensitivity calculations were driven by hourly, 3 km meteorological fields from the Weather Forecasting and Research (WRF) model.

Response: The authors thanks for your constructive suggestion. The language issue was mentioned by two reviewers and we would take some measures like inviting native speakers to help embellish the language, and the professional language editing has been called before the revised manuscript submitted.

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**To whom it may concern**

The paper "Sensitivity of Biogenic Volatile Organic Compounds Emissions to Leaf Area Index and Land Cover in Beijing" by Hui Wang, Qizhong Wu was edited by Elsevier Language Editing Services.

Kind regards,

**Elsevier Webshop Support**

**Specific suggestions and comments:**

1) Novelty: The authors argue that using spatially and temporally varying meteorological fields output from WRF is advantageous, compared with the approaches in some previous studies. Using WRF fields to drive MEGAN calculations is not at all a novel approach and has been widely used in a large number of studies, including some cited by the authors. As the authors are already aware, the uncertainty in their WRF simulation contributed to the estimated BVOC emission biases. There is no need to emphasize the benefit of driving MEGAN using WRF. Rather, if any novel configurations were applied to your WRF simulation, which helped reduce errors in the modeled T2, radiation, moisture, etc, they should be highlighted. See also my next comment.

Response: The authors appreciate your constructive comments. The authors agree to the reviewer's point of " driving the MEGAN model by mesoscale meteorological model is not a novel approach", indeed, multiple studies have adopted same methodology(Carlton and Baker, 2011;Shuping et al., 2010;Wang et al., 2011;Li and Xie, 2014). In this study, we emphasizing this part is to explain the different consideration of meteorological conditions compared with some previous studies. Compared with some previous studies (Klinger et al., 2002;Zhihui et al., 2003), this method could be the more reasonable way to explain the meteorological effect on the BVOCs emission. And the accuracy of the meteorological conditions is helpful to diminish the uncertainties of BVOCs emission from meteorological conditions. And we adopted default MODIS land cover provided by WRF-official group in our previous simulation. Therefore, considering reviewer's suggestion, we re-simulated the WRF model with updated land cover by using MODIS 12Q1 data for the summer in 2013. As showed in Table 1, the simulation results were validated by hourly in-situ temperature observation. The average *R* has a slight increase from 0.82 to 0.83, but the Root-Mean-Square-Error (RMSE) and Mean Error is ***increased*** from 2.67 ℃ and 3.34 ℃ to 3.07 ℃ and 3.70 ℃, which means updating land cover of MODIS is not beneficial to improve the model performance under this situation. And the specific sites like Tong Zhou, Da Xing and Fang Shan still have the underestimation of temperature simulation, which could not be solved by the updating the land cover. Since the work mainly focus on the sensitivity of LAI and LC, the more effort would be paid on discussing the effect of LAI and LC inputs.

Table 1. The meteorological validation with in-situ observation. MB, ME and RMSE is the abbreviation of Mean Error, Mean Bias and Root-Mean Square Error, and the *R* is the correlation coefficient.

| Default MODIS land cover in WRF | | | | |
|---|---|---|---|---|
| ID | ME(°C) | MB(°C) | *R* | RMSE(°C) |
| Beijing | 2.07 | 0.68 | 0.83 | 2.76 |
| Hai Dian | 2.16 | 0.93 | 0.83 | 2.93 |
| Chao Yang | 2.09 | -0.48 | 0.82 | 2.67 |
| Shun Yi | 2.02 | -0.35 | 0.84 | 2.61 |
| Huai Rou | 2.13 | 1.4 | 0.84 | 2.95 |
| Tong Zhou | 4.26 | -4.03 | 0.78 | 4.9 |
| Chang Ping | 2.3 | 0.75 | 0.79 | 3.19 |
| Yan Qin | 3.7 | 3.36 | 0.79 | 4.64 |
| Feng Tai | 2.31 | -1.19 | 0.82 | 2.88 |
| Shijing Shan | 2.09 | -0.25 | 0.81 | 2.68 |
| Da Xing | 4.53 | -4.42 | 0.81 | 5.12 |
| Fang Shan | 3.9 | -3.63 | 0.79 | 4.48 |
| Mi Yun | 1.94 | 0.46 | 0.83 | 2.52 |
| Mentou Gou | 1.92 | 0.44 | 0.83 | 2.6 |
| Ping Gu | 2.57 | -1.77 | 0.85 | 3.1 |
| Avg | ***2.67*** | -0.54 | 0.82 | ***3.34*** |
| MODIS 12Q1 land cover in 2013 | | | | |
| ID | MB(°C) | ME(°C) | *R* | RMSE(°C) |
| Beijing | 2.93 | 2.64 | 0.85 | 3.59 |
| Hai Dian | 3.23 | 2.97 | 0.83 | 3.99 |
| Chao Yang | 1.96 | 0.02 | 0.83 | 2.53 |
| Shun Yi | 1.87 | -0.22 | 0.85 | 2.41 |
| Huai Rou | 3.67 | 3.56 | 0.83 | 4.39 |
| Tong Zhou | 4.14 | -3.92 | 0.8 | 4.73 |
| Chang Ping | 2.89 | 2.54 | 0.81 | 3.8 |
| Yan Qin | 5.34 | 5.33 | 0.8 | 6.04 |
| Feng Tai | 2.15 | -0.94 | 0.83 | 2.68 |
| Shijing Shan | 2.35 | 1.39 | 0.82 | 2.97 |
| Da Xing | 4.47 | -4.38 | 0.82 | 5.01 |
| Fang Shan | 3.89 | -3.67 | 0.8 | 4.46 |
| Mi Yun | 1.93 | 0.78 | 0.85 | 2.48 |
| Mentou Gou | 2.67 | 2.14 | 0.82 | 3.36 |
| Ping Gu | 2.6 | -1.92 | 0.85 | 3.13 |
| Avg | ***3.07*** | 0.42 | 0.83 | ***3.70*** |

2) More information regarding your WRF simulation and evaluation approach should be provided in Section 2.2.1. These should include:

Response: The authors are grateful for your valuable suggestions. As mentioned above, we have supplemented the description about configuration and evaluation of the model in the revised manuscript. And corresponding questions or comments would be replied point to point as following:

*-introduce the initialization time for each domain.*

Response: The model is initialized at 12:00 UTC every day, and initial and boundary conditions are provided by the FNL(Final) Operational Global Analysis data(National Centers for Environmental Prediction, 2000); the boundary conditions are updated every 6 hours. The first 12 hours are treated as the spin-up time. And we cut and merged the medium 24 hours, from 00:00 A.M. UTC to 23:00 P.M. UTC, to drive the MEGAN model to estimate the BVOCs emission.

*-introduce the vertical spacing for each domain.*

Response: The three domains in model all contain same 27 vertical layers above the ground and 4 vertical layers under the ground, and the sigma values of model vertical layers are:

1, 0.993, 0.983, 0.97, 0.954, 0.934, 0.909, 0.88, 0.8295757, 0.7791514,0.7287272, 0.6783029, 0.5917439, 0.5136936, 0.4434539, 0.3803751, 0.3238531, 0.2733261, 0.228273, 0.18821, 0.1526888, 0.1212943,0.09364247, 0.0693781, 0.04817315, 0.02972473, 0.01375316, 0.

*-introduce your physics options for each domain and their suitability for the Beijing area (based on literature and/or any sensitivity simulations the authors may have conducted)*

Response: The authors appreciate your previous comments. The physical options would be presented in the supplement.

*-introduce the land cover and vegetation dynamics (e.g., green vegetation fraction) input data, including the year of these input data represented, and discuss how they may have contributed to biases from your WRF simulation.*

Response: The land cover of WRF simulation was using default MODIS land cover datasets. The discussion of impact on meteorological simulation by updating the land cover or vegetation fraction is focused on the WRF simulation, which is out of the scope of this study mainly concentrated on. In addition, we also did the sensitivity simulation to test the impact of updating the land cover by the MODIS 12Q1 land cover data in 2013, and hourly temperature validation indicated that such measure didn't significantly help to improve the meteorological simulation. The further discussion about the optimize physical schemes or parameters may out of the object of this study, and the meteorological validation has demonstrated the reasonability of our meteorological simulation on the key condition like temperature and radiation.

*- P4, L23: Skamarock et al., 2005 is for WRF version 2. Please cite WRF version 3 documentation.*

Response: We have modified this reference from Skamarock et al. (2005) to Skamarock et al. (2008).

*- P4, L27: justify "we considered the second day as the reasonable results", for example, compare the 1-day and 2-day model performance.*

Response: As mentioned above, the 2-day simulations of WRF were done day by day, and the model is initialized at 12:00 UTC. The simulation lasts 48 hours and first 12 hours are as the spin-up time. The data of the period from 00:00 A.M. UTC to 23:00 P.M. UTC of the second day was cut and collapsed to estimate the BVOCs emission. The "reasonable" part means the simulation without the spin-up time, but such configuration was not expressed clearly by this sentence. Therefore, we modified this paragraph as following to verify the processing of WRF data:

"The WRF model was initialized at 12:00 UTC, and the first 12 hours were spin-up time. The data of the period from 00:00 A.M. UTC to 23:00 P.M. UTC in the second day was cut and merged to estimate the BVOC emissions. The merged file was processed by the Meteorology-Chemistry Interface Processor (MCIP) (Otte and Pleim, 2010) tool to provide meteorological conditions for MEGAN model."

- P4, L29: explain why daily T2 was evaluated, instead of hourly T2? Change "among" to "within";

Response: Considering the observation of radiation is daily, in order to evaluate the two variables at the same level, daily T2 was used to evaluate the simulation ability of model to daily variance of whole year meteorological conditions. We also did the validation with the hourly T2 as presented in Table 2. The validation results are similar

with the previous validation with daily temperature. Therefore, there is no obvious difference to use daily or hourly temperature data to validate the simulation and they all illustrate the reasonability of our meteorological simulation.

Table 2. The meteorological validation with hourly T2 in-situ observation.

| ID | ME(°C) | MB(°C) | R | RMSE(°C) |
|---|---|---|---|---|
| Beijing | 1.9 | -0.13 | 0.97 | 2.48 |
| Hai Dian | 2 | 0.1 | 0.97 | 2.67 |
| Chao Yang | 2.35 | -1.07 | 0.96 | 2.91 |
| Shun Yi | 2.32 | -1.3 | 0.97 | 2.93 |
| Huai Rou | 2.12 | 0.28 | 0.96 | 3.13 |
| Tong Zhou | 4.91 | -4.77 | 0.96 | 5.5 |
| Chang Ping | 2.03 | -0.4 | 0.97 | 2.73 |
| Yan Qin | 3.11 | 1.88 | 0.94 | 4.3 |
| Feng Tai | 2.9 | -2 | 0.96 | 3.55 |
| Shijing Shan | 2.34 | -0.98 | 0.96 | 2.86 |
| Da Xing | 5.22 | -5.04 | 0.95 | 5.92 |
| Fang Shan | 4.73 | -4.44 | 0.94 | 5.6 |
| Mi Yun | 2.61 | -0.36 | 0.94 | 3.66 |
| Mentou Gou | 2.01 | -0.5 | 0.97 | 2.57 |
| Ping Gu | 3.3 | -2.53 | 0.95 | 4.25 |
| Avg | 2.92 | -1.42 | 0.96 | 3.67 |

- P5, L1/L4: unit is missing for these biases. Why was the MB of -1.5 degree mentioned twice?

Response: Thanks for your precious comments. We have followed the reviewer's suggestion and added the unit of biases in the article. The MB mentioned twice is for emphasizing the general cooling bias of the temperature simulation.

- P5, L9: which single station?

Response: It's Beijing Station, No. 54511. The information will be added in the revised manuscript.

3) Issues regarding satellite products:

- P6, L22: "Because of the highest spatial resolution of the FROM LC product, the experiment using FROM PFT and GLASS LAI as inputs is the baseline experiment (E1)". I don't understand the logical connections between resolution and choice of the baseline experiment.

Response: The authors appreciate your precious comments. According to the description of MEGAN(Guenther et al., 2012), the emission factor is decided by the distribution of Plant Function Types (PFTs). The sub-grid categories in the specific gird are presented by calculating the area fraction of different PFTs, which means the high-resolution can provide more details of PFTs distribution and calculate more accurate fractions of PFTs. Therefore, we treated the Fine Resolution Observation and Monitoring of Global Land Cover (FROM-GLC) land cover datasets with 30m spatial resolution as the baseline experiment.

- Although the land cover datasets used in this study differed by at least a factor of ten in resolution (30m vs 500/300m), they are all at much finer resolution than the 3 km WRF-MEGAN grid. It would be helpful to explain how these data were regridded to your WRF-MEGAN model grid. This would help us understand how the original data resolution may have affected your results. Approach used to reproject the original 1 km LAI data should also be provided. Missing a "respectively" in P5, L25.

Response: The authors agree with the reviewer. The WRF-MEGAN grid is coarser than the land cover grids, and we used the Preprocessing Tools of MEGAN to regrid the grids by calculating the area fractions of different landscapes

or PFTs) in WRF grid. Furthermore, the original LAI data was also regridded to WRF-MEGAN grid through the calculating the area mean LAI.

- P5, Section 2.2.2: The land cover and LAI data citations are not helpful. For each dataset, please cite the corresponding algorithm/validation paper, and provide the dataset doi or/and accurate links to retrieve the data. MOD15 is not an accurate description for the used MODIS LAI data. I assume the correct format should be MCD15A2H, Collection/Version XX. Same issue exsits in Table 4.

Response: The authors thank your constructive comments. We have cited the relevant papers and added the doi of the datasets to help readers to retrieve the data, and the name of MODIS LAI data has been modified. The availability of datasets and code is added as an independent section in revised manuscripts as following:

"The source code of WRF model V3.3.1 and MEGAN v2.1 is available at http://www2.mmm.ucar.edu/wrf/users/ and https://bai.ess.uci.edu, respectively. The FROM-GLC can be downloaded from the website of Department of Earth System Science, Tsinghua University, at http://data.ess.tsinghua.edu.cn/index.html. The CCI-LC can be downloaded from the website of Climate Change Initiative Program at https://www.esa-landcover-cci.org. The GLASS LAI can be obtained through the website of National Earth System Science Data Sharing Infrastructure at http://www.geodata.cn/thematicView/GLASS.html or the website of Global Land Cover Facility, University of Maryland, at http://glcf.umd.edu/data/lai/. The GEO v2 LAI is available on the website of the Copernicus Global Land Service at https://land.copernicus.eu/global/products/. The MODIS MCDQ12 LC and MODIS MCD15A2 LAI, Version 5, are available on the website of Land Process Distributed Active Center at https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table."

- Did the author screen the LAI data and if so, based on what criteria? What values were used for grids with missing data/unrealistic (e.g., extremely high) LAI? Previously studies have reported MEGAN sensitivity to PFT and LAI, so it'd be helpful to compare your findings with theirs.

Response: The authors appreciate your comments. In this study, the LAI datasets are the level 4 satellite products, and the GEOv2 as well as GLASS LAI products have adopted some measures to remove and fill the unrealistic or unreasonable value (Verger et al., 2014;Xiao et al., 2014). The MODIS LAI products adopting vegetation canopy radiation models of diverse plants type to produce LAI products, and if the canopy model is not available for the pixel, the backup algorithm of estimating LAI by using Normalized Difference Vegetation Index (NDVI) would be used (Knyazikhin et al., 1999). And the MODIS products also provided the quality flags to distinguish the quality of products, and the remain missing values are the pixel mixed with no-vegetation types like water. Considering the characters of the MODIS LAI, we checked all the available values to make sure that they are in reasonable range of LAI (0-7), and used all available values. We didn't use interpolating method to fill the missing value to avoid extra uncertainty and will further compare the effect of LAI products by considering two aspects, masking area and LAI value discrepancy. And we will follow the reviewer's suggestion to compare our results with other publications.

5) The uncertainty section (3.5) is not well written, and the current discussions are very qualitative and not informative.

Response: The authors thank for your comments. We have removed this section and added more informative as well as quantitative results in the Discussion section.

6) P2, L25-27: Please provide the source for "the statistical data from the Nation Forest Resources Survey (NFRS) reported that the forest coverage rate in Beijing rose from 20.6% to 35.8% during 1998-2013". This is also the right place to mention the impact of different met conditions during the earlier periods and 2013.

Response: The authors thank for the reviewer's comments. The data of forest coverage rate of China and specific provinces came from the website of the China Forestry Database (http://data.forestry.gov.cn/lysjk). We also followed the met conditions effect on this period at the same position.

7) P1, L14; P2, L28; P3, L1: “new” is not accurate. Previous estimates of BVOCs emissions introduced by the authors are not for 2013.

Response: Thanks for your comments. We have modified it in the revised paper and removed the word “new”.

8) P5, L25: Shouldn’t the last sentence belong to Section 2.2.1? Define MCIP, and use the correct link for MCIP.

Response: The authors appreciate your comments. We have move the last sentence of this paragraph to Section 2.2.1, and the abbreviation of MICP was extended to the full name, Meteorology-Chemistry Interface Processer, with citing the corresponding paper from Otte and Pleim (2010).

8) P5, L28: four species -> four groups

Response: Thanks for your precious comments. We have followed the review’s comments and modified this error.

9) P9, Section 3.3: Method of this sensitivity test should be first introduced in Section 2.

Response: Thank you for the comments. The introduction of the contribution calculation has been moved to supplement of the manuscript.

10) To comply with the ACP policy, data availability should be included in the “Acknowledgements” section.

Response: Thank you for the comments. We have followed the reviewer’s comments and added data availability in the revised manuscript as following:

“The source code of WRF model V3.3.1 and MEGAN v2.1 is available at http://www2.mmm.ucar.edu/wrf/users/ and https://bai.ess.uci.edu, respectively. The FROM-GLC can be downloaded from the website of Department of Earth System Science, Tsinghua University, at http://data.ess.tsinghua.edu.cn/index.html. The CCI-LC can be downloaded from the website of Climate Change Initiative Program at https://www.esa-landcover-cci.org. The GLASS LAI can be obtained through the website of National Earth System Science Data Sharing Infrastructure at http://www.geodata.cn/thematicView/GLASS.html or the website of Global Land Cover Facility, University of Maryland, at http://glcf.umd.edu/data/lai/. The GEO v2 LAI is available on the website of the Copernicus Global Land Service at https://land.copernicus.eu/global/products/. The MODIS MCDQ12 LC and MODIS MCD15A2 LAI, Version 5, are available on the website of Land Process Distributed Active Center at https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table.”

11) Captions of Figures 4, 6, 7: specify which experiment these were based on.

Response: Thank you for the comments. We would modify these figures and make them more clear and informative.

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