

# ***Interactive comment on “Modeling of the anthropogenic heat flux and its effect on air quality over the Yangtze River Delta region, China” by M. Xie et al.***

**M. Xie et al.**

minxie@nju.edu.cn

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The details of our changes in manuscript can be found in the supplement file "acp-2015-787-supplement.pdf".

General comments from Referee 3:

1. Is the paper scientifically sound? If "no", please give reason. Yes. This manuscript reported a numerical study of the impact of anthropogenic heat on urban meteorology and air quality as well. This study has high impact as Yangtze River Delta is one of most densely populated city in the world. There are a lot of previous studies which

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study urban heat flux. However, there are few publications that carried out systematic analyses that study the change of urban circulation caused by anthropogenic heat emissions. The WRF/CHEM methodology further allows the authors to study the change in PM and surface ozone concentrations as well. There is an important question asked many times by scientists about whether anthropogenic heat emissions contribute to global warming. Although the answers are negative, the analysis of AH in this manuscript can enhance the understanding of the magnitude of AH emission from megacities and its impact on meteorology and atmospheric chemistry as well. Overall, the paper is well written and the references are quite up to date. Finally, the authors are not native English writers, there are improvements to be made in the choice of words.

[Author's response and changes in manuscript:](#)

[Thanks for the constructive and the affirmative comments. The English is improved according to the suggestions.](#)

2. Is it of sufficient originality and interest to merit publication after attention to matters raised under 3-9? If "no", please give reason. Yes Very few papers studied anthropogenic heat emissions and its impact on urban meteorology and regional air quality at the same time.

3. Are there any errors? No.

[Author's response:](#)

[Thanks for the affirmative comments.](#)

4. Are there any omissions? Yes (1) Section 3.3, The term "monthly averaged differences" should be defined. Is it the difference of two means or is it the mean of two difference ? (2) The sentence "Differences that are non-significant under the 95 percents confidence level (student t test) are masked out." Should be clarified.

[Author's response and changes in manuscript:](#)

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Thanks for the constructive comments.

For (1), the term "monthly averaged differences" means the average value of differences between two simulations. To avoid the misunderstanding, we define it in section 2.2 by providing the calculation expression "(4)". Please see lines 208-213 in the revised manuscript.

For (2), we follow the method used in the work of Zhuang et al. (2013a, 2013b) and Liao et al. (2015). The monthly averaged differences are calculated grid by grid. So, for one grid, there are one data set from NONAH case and one data set from ADDAH case. To guarantee the differences of a variable are statistically significant, student t test is carried out based on the data set from NONAH and ADDAH for each grid. At one grid, if the difference is non-significant under the 95 percents confidence level, we can assert that the AH flux cannot significantly change the meteorology or air quality at this grid. The above words and following references are added in the revised manuscript. Please see lines 213-217 and the reference list.

Reference: Zhuang, B. L., Li, S., Wang, T. J., Deng, J. J., Xie, M., Yin, C. Q., and Zhu, J. L.: Direct radiative forcing and climate effects of anthropogenic aerosols with different mixing states over China, *Atmos Environ*, 79, 349-361, 10.1016/j.atmosenv.2013.07.004, 2013a.

Zhuang, B. L., Liu, Q., Wang, T. J., Yin, C. Q., Li, S., Xie, M., Jiang, F., and Mao, H. T.: Investigation on semi-direct and indirect climate effects of fossil fuel black carbon aerosol over China, *Theor Appl Climatol*, 114, 651-672, 10.1007/s00704-013-0862-8, 2013b.

Liao, J. B., Wang, T. J., Jiang, Z. Q., Zhuang, B. L., Xie, M., Yin, C. Q., Wang, X. M., Zhu, J. L., Fu, Y., and Zhang, Y.: WRF/Chem modeling of the impacts of urban expansion on regional climate and air pollutants in Yangtze River Delta, China, *Atmos Environ*, 106, 204-214, 10.1016/j.atmosenv.2015.01.059, 2015.

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5. Are any sections obscure and what additions or alternations would remove the obscurity? No

[Author's response:](#)

[Thanks for the affirmative comment.](#)

6. Could any sections be omitted or shortened? please be specific. Yes The conclusion looks too long. It could be shorten a bit, especially the first paragraph.

[Author's response and changes in manuscript:](#)

[Thanks for the constructive comments. The conclusion is shorten, especially the first paragraph.](#)

7. Are all the illustrations/tables necessary, clear and suitably captioned? Yes

8. Is the abstract adequate? Yes. The abstract is good.

[Author's response:](#)

[Thanks for the affirmative comments.](#)

9. Are the title and key words appropriate? If not, please suggest alternatives. Yes but I suggest to modify it to "Modeling of the anthropogenic heat flux and its effect on regional meteorology and air quality over the Yangtze River Delta region, China."

[Author's response and changes in manuscript:](#)

[Thanks for the constructive comments. We agree with the reviewer and modify the title. Please see lines 1-3 in the revised manuscript.](#)

Detail comments from Referee 3: Abstract: It is well written.

[Author's response:](#)

[Thanks for this affirmative comment.](#)

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Introduction: Line 28 of page 32370, And is a preposition. It is not appropriate to put “and” at the beginning of a sentence. There are quite a few sentences in the manuscript with the same problem.

[Author’s response and changes in manuscript:](#)

All “and” at the beginning of sentences are deleted. In the revised manuscript, please see the sentences on line 24, line 88, line 188, line 226, line 245, line 268, line 311, line 337, line 387, line 424, line 429, line 458, line 471, line 554, line 580, line 593, line 612, and line 667.

Line 10 of page 32371, delete the word “unfortunately”.

[Author’s response and changes in manuscript:](#)

The word “unfortunately” before “these studies only ……” is deleted. Please see line 99 in the revised manuscript.

Line 15 of page 32371, delete the word “Consequently”.

[Author’s response and changes in manuscript:](#)

The word “Consequently” before “in this paper” is deleted. Please see line 104 in the revised manuscript.

Line 10 of page 32371, delete the word “of” after the word implementing.

[Author’s response and changes in manuscript:](#)

The word “of” after “(2) implementing” is deleted. Please see line 105 in the revised manuscript.

Section 2. Methodology Section 2.1, page 32372 Line 7, the resolution of AH fluxes is 4km, but the domain 3 of WRF/CHEM is 9 km. How do the authors resolve this

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problem?

[Author's response and changes in manuscript:](#)

The resolution of AH fluxes (AHF) used in this study is 2.5 arcmin (about 4km), because the resolution of gridded population data is 2.5 arcmin. The AH fluxes during the period from 1990 to 2010 are all estimated to figure out the changing trend, while only those in 2010 are used in our WRF/Chem simulations of this paper. We estimate them not just for this study. We hope that these AHF data sets can be used in other similar investigations. To some extent, our AHF outputs are something like emission inventories. To fit the resolution of the domain 3 of WRF/Chem in this study (9km), we re-project the 4km AHF data to domain 3 by the latitude and longitude of each grid. Some explanative words are added on lines 261-263 in the revised manuscript to briefly clarify our method.

Section 3.2 Line 7 of page 32380, the word “more than 0.7” could be replaced by “higher than 0.7”.

[Author's response and changes in manuscript:](#)

The words "more than 0.7" are replaced by the words "higher than 0.7". Please see line 354 in the revised manuscript.

Line 5 of page 32381, the word “more solar radiation reaches to urban” could be replaced by “stronger solar radiation reaches urban”.

[Author's response and changes in manuscript:](#)

The word "more" before "solar radiation reaches to urban" is replaced by the word "stronger". Please see line 388 in the revised manuscript.

Section 3.3.1 Line 7 of page 32382, “Differences that are non-significant under the 95

[Author's response and changes in manuscript:](#)

We follow the method used in the work of Zhuang et al. (2013a, 2013b) and Liao et

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al. (2015). The monthly averaged differences are calculated grid by grid. So, for one grid, there are one data set from NONAH case and one data set from ADDAH case. To guarantee the differences of a variable are statistically significant, student t test is carried out based on the data set from NONAH and ADDAH for each grid. At one grid, if the difference is non-significant under the 95 percents confidence level, we can assert that the AH flux cannot significantly change the meteorology or air quality at this grid. These words are added in the revised manuscript on lines 212-217.

Line 17 of page 32382, “the adding AH fluxes” could be changed to “the addition of AH fluxes”.

Author’s response and changes in manuscript:

The word "adding" in "the adding AH fluxes" is replaced by the word "addition". Please see line 428 in the revised manuscript.

The comment “the addition of AH fluxes lead to an increase of SHF in both daytime and nighttime.” is not exactly correct. Figure 7 shows that the SHF is almost the same from midnight 00:00 to 05:00am.

Author’s response and changes in manuscript:

We agree with the reviewer. The description “the addition of AH fluxes lead to an increase of SHF in both daytime and nighttime.” is not proper. So, we rewrite this part as "As illustrated in Fig. 7, the addition AH fluxes lead to an obvious increase of sensible heat flux (SHF) from 07:00 to 21:00, with the daily mean increase of 22 W/m<sup>2</sup> for January and 20.5 W/m<sup>2</sup> for July. The increases at night can be ignored because the AH fluxes are small during these time". Please see lines 427-430 in the revised manuscript.

Line 11 of page 32383, “adding AH fluxes make the PBLH rise up to over 50m” could be changed to “enhanced AH fluxes increase the PBLH by more than 50m”.

Author's response and changes in manuscript:

As suggested above, "the adding AH fluxes make the PBLH rise up to over 50m" is replaced by the words "the enhanced AH fluxes increase the PBLH by more than 50m". Please see lines 467-468 in the revised manuscript.

Line 25 of page 32383, "adding AH fluxes" could be changed to "enhanced AH fluxes".

Author's response and changes in manuscript:

The words "adding AH fluxes" are rewritten as "enhanced AH fluxes". Please see lines 481-482 in the revised manuscript.

Line 6 of page 32384, the word "re-established" is not a good choice of word. May be "modified"?

Author's response and changes in manuscript:

The word "re-established" is changed to "modified" as suggested. Please see line 491 and line 680 in the revised manuscript.

Line 15 of page 32384, the word "ignorable" should be "ignored"?

Author's response and changes in manuscript:

The words "is ignorable" are replaced by "can be ignored" as suggested above. Please see line 499 in the revised manuscript.

Section 3.3.2 Line 20 of page 32384, "an significant" should be "a significant".

Author's response and changes in manuscript:

The indefinite article "an" is changed to "a". Please see line 513 in the revised manuscript.

Section 3.4.1 Line 24 of Page 32385, replace "venting" by "dispersion"?

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Author's response and changes in manuscript:

The words "the venting of air pollution" in the sentence "Adding AH changes spatial and vertical meteorology conditions, and thereby undoubtedly affects the venting of air pollution" are rewritten as "the transportation and dispersion of air pollutants". Please see line 548 in the revised manuscript.

Line 27 of Page 32385, is the PM10 the "surface PM10"? Is it only include the PM10 of the lowest bottom layer or the integrated PBL PM10?

Author's response and changes in manuscript:

All changes of PM10 and O3 caused by the adding AH discussed in section 3.4.1 only include the modeling results from the lowest bottom layer. The changes of other layers in PBL are discussed in section "3.4.2 Vertical changes of PM10 and O3". To avoid misunderstanding, we revise the title of section 3.4.1 to "Changes of surface PM10 and O3", and add some brief explanation in the following paragraph. Please see line 546 and line 553 in the revised manuscript.

Line 4 of Page 32386, (just a comment) a decrease of 29.3  $\mu\text{g}/\text{m}^3$  of PM10 is phenomenal.

Author's response:

Yes, it is remarkable. So, anthropogenic heat fluxes should be considered to better understand the urban atmospheric environment issues.

Line 26 of Page 32386, "increase of O3 causing by AH" should be replaced by "increase of O3 associated with the introduction of AH".

Author's response and changes in manuscript:

The words "increase of O3 causing by AH" are replaced by "increase of O3 associated with the introduction of AH" as suggested above. Please see lines 580-581 in the revised manuscript.

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Furthermore, the article only shows the surface ozone. As the convection is enhanced, it is interesting to show ozone at higher levels such as at 1km altitude.

**Author's response and changes in manuscript:**

Indeed, it is interesting to discuss O<sub>3</sub> at higher levels. In this paper, we not only show the changes of PM<sub>10</sub> and O<sub>3</sub> at the lowest modeling layer in section 3.4.1, but also discuss their vertical changes in section 3.4.2. As shown in Fig. 12e, 12f, and Fig. 13, the decrease of ozone occurs at 1km altitude, which can be attributed to the increase of NO (associated with the introduction of AH) at this layer. Please see lines 627-643 in the revised manuscript.

**Reference section** There are a few references quoted but not found in the reference list. They are Allen et. Al, 2010, Quah Roth 2012, Ryu et. Al, 2013, Yu et. Al, 2014, Grimmer 1992.

**Author's response and changes in manuscript:**

Sorry for these mistakes. The detail information of quoted references is added into the reference list. In the revised manuscript, please see lines 708-709 for Allen et al. (2011), lines 799-800 for Quah and Roth (2012), lines 801-802 for Ryu et al. (2013), and lines 826-827 for Yu et al. (2014). However, we do not cite the reference from Grimmer (1992) in our paper.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/15/C13497/2016/acpd-15-C13497-2016-supplement.pdf>

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 32367, 2015.

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