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Interactive comment on "Study the impact of three Asian industrial regions on $PM_{2.5}$ in Taiwan and the process analysis during transport" *by* Ming-Tung Chuang et al.

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Dear reviewer#1 and editor:

On behave of all co-authors, we are really grateful to reviewer#1 who spent much time reviewing the original manuscript. I know we have made some misleading narratives and have modified those in the revised manuscript. After all reviewers' comments are replied, the authors will an English language editing company to revise the manuscript. We know it is impossible but we hope the final manuscript could be an article written by a native English writer. In this response, we have attached three files: the manuscript of the main context, the supplement, and the one-to-one reply. We welcome any further

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Discussion paper

comments from reviewer#1. Thanks.

Best regards.

Ming-Tung Chuang

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Response to Reviewers

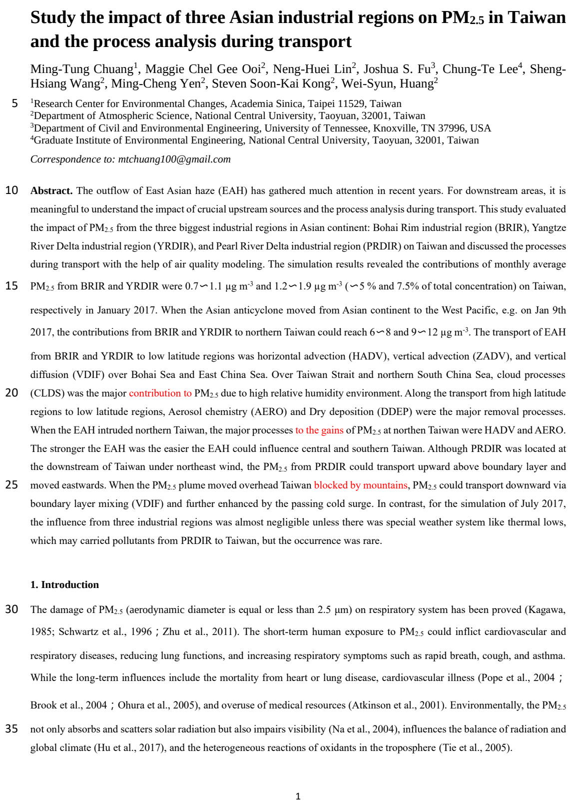
Manuscript *acp-2019-762*

We greatly appreciate the insightful comments and suggestions of the reviewers. Below please find a list of the Reviewers' remarks in contrast to our responses to them:

Review #1

Major Concerns	Responses
1) The manuscript shows the analysis both for January and July. However, the impacts of three industrial regions on Taiwan in summer (July) is quite small, almost negligible even in the last few days when the impacts were relatively large. I don't think it is worthwhile spending much space for the July analysis, rather focusing on winter case would make the paper more concise and scientifically focused.	First, the authors really appreciate the reviewer spend much time and efforts reviewing this manuscript carefully and giving valuable opinions. They are truly grateful for the reviewer's comments which are very helpful to make this manuscript better. The authors admitted that they accidentally used non-precise and inappropriate words and so as to make misleading narratives. They promised that they will ask an English language editing company to revise the manuscript after all reviewers' comments are responded. Yes, the authors agree with the reviewer's suggestions and have cut down the contents of July analysis. They only keep the original Fig. 6 (Fig. 10 in the revised manuscript) in the main content and moved original Fig. 7 and Fig. 8 to Fig. S2.6 and Fig. S2.8 in the supplement of revised manuscript), and delete original Fig. 12, Fig. 13, Fig. 14, and Fig. 16.
2) The results of process analysis was described and discussed in 3.2, 3.4, 3.5, and 3.6, which formed a main part of this paper. However, the descriptions in these sections were not firmly reasoned. In these sections, the author argued "dominant" contribution of three industrial regions at some locations. For example, in	Yes, the authors have written several misleading narratives in the original manuscript. After careful checking, first, they have modified the arrangement of the manuscript such that they combined the section 3.3, 3.4 and 3.6 of the original manuscript to section 3.5 of the revised manuscript in order to cut down the content of July analysis, and separate section 3.5 of the original manuscript into section 3.4 and 3.5 in the revised manuscript. Therefore, Fig. 11 of the original manuscript was changed to Fig. 9 and Fig. 14 was deleted. Now the main part is section 3.2, 3.4, and 3.5 for the revised manuscript. Second, they revised misleading narratives in order to avoid the

Fig. 1. one-to-one reply



Study the impact of three Asian industrial regions on $PM_{2.5}$ in Taiwan and the process analysis during transport

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Abstract. The outflow of East Asian haze (EAH) has gathered much attention in recent years. For downstream areas, it is meaningful to understand the impact of crucial upstream sources and the process analysis during transport. This study evaluated the impact of $PM_{2.5}$ from the three biggest industrial regions in Asian continent: Bohai Rim industrial region (BRIR), Yangtze River Delta industrial region (YRDIR), and Pearl River Delta industrial region (PRDIR) on Taiwan and discussed the processes during transport with the help of air quality modeling. The simulation results revealed the contributions of monthly average $PM_{2.5}$ from BRIR and YRDIR were 0.7∽1.1 μg m^{-3} and 1.2∽1.9 μg m^{-3} (∽5 % and 7.5% of total concentration) on Taiwan, respectively in January 2017. When the Asian anticyclone moved from Asian continent to the West Pacific, e.g. on Jan 9th 2017, the contributions from BRIR and YRDIR to northern Taiwan could reach 6∽8 and 9∽12 μg m^{-3}. The transport of EAH from BRIR and YRDIR to low latitude regions was horizontal advection (HADV), vertical advection (ZADV), and vertical diffusion (VDIF) over Bohai Sea and East China Sea. Over Taiwan Strait and northern South China Sea, cloud processes (CLDS) was the major contribution to $PM_{2.5}$ due to high relative humidity environment. Along the transport from high latitude regions to low latitude regions, Aerosol chemistry (AERO) and Dry deposition (DDEP) were the major removal processes. When the EAH intruded northern Taiwan, the major processes to the gains of $PM_{2.5}$ at northen Taiwan were HADV and AERO. The stronger the EAH was the easier the EAH could influence central and southern Taiwan. Although PRDIR was located at the downstream of Taiwan under northeast wind, the $PM_{2.5}$ from PRDIR could transport upward above boundary layer and moved eastwards. When the $PM_{2.5}$ plume moved overhead Taiwan blocked by mountains, $PM_{2.5}$ could transport downward via boundary layer mixing (VDIF) and further enhanced by the passing cold surge. In contrast, for the simulation of July 2017, the influence from three industrial regions was almost negligible unless there was special weather system like thermal lows, which may carried pollutants from PRDIR to Taiwan, but the occurrence was rare.

1. Introduction

The damage of $PM_{2.5}$ (aerodynamic diameter is equal or less than 2.5 μm) on respiratory system has been proved (Kagawa, 1985; Schwartz et al., 1996；Zhu et al., 2011). The short-term human exposure to $PM_{2.5}$ could inflict cardiovascular and respiratory diseases, reducing lung functions, and increasing respiratory symptoms such as rapid breath, cough, and asthma. While the long-term influences include the mortality from heart or lung disease, cardiovascular illness (Pope et al., 2004；Brook et al., 2004；Ohura et al., 2005), and overuse of medical resources (Atkinson et al., 2001). Environmentally, the $PM_{2.5}$ not only absorbs and scatters solar radiation but also impairs visibility (Na et al., 2004), influences the balance of radiation and global climate (Hu et al., 2017), and the heterogeneous reactions of oxidants in the troposphere (Tie et al., 2005).

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Fig. 2. revised manuscript

Supplement S1. Formulas for statistical evaluation indexes

1. Mean Bias

$$\mathrm{MB} = \frac{1}{\mathrm{N}} \sum_{1}^{N} (\mathrm{Sim} - \mathrm{Obs})$$

2. Mean Average Gross Error

$$\mathrm{MAGE} = \frac{1}{N} \sum_{1}^{N} |Sim - Obs|$$

3. Root Mean Square Error

$$\mathrm{RMSE} = \sqrt{\frac{1}{N} \sum_{1}^{N} (Sim - Obs)^2}$$

4. Index of agreement, IOA

$$\mathrm{IOA} = 1 - \frac{\sum_{i=1}^{N} (Sim - Obs)^2}{\sum_{i=1}^{N} (|Sim - \overline{Obs}| + |Obs - \overline{Obs}|)^2}$$

5. Wind Normalized Mean Bias

$$\mathrm{WNMB} = \frac{\sum_{i=1}^{N} (Sim - Obs)}{N \times 360°} \times 100\%$$

3. Wind Normalized Mean Error

$$\mathrm{WNME} = \frac{\sum_{i=1}^{N} |Sim - Obs|}{N \times 360°} \times 100\%$$

6. Mean Fractional Bias

$$\mathrm{MFB} = \frac{2}{N} \sum_{1}^{\mathrm{N}} \left(\frac{Sim - Obs}{Sim + Obs} \right)$$

7. Mean Fractional Error

$$\mathrm{MFE} = \frac{2}{N} \sum_{1}^{\mathrm{N}} \left| \frac{Sim - Obs}{Sim + Obs} \right|$$

8.Correlation coefficient (R)

$$\mathrm{R} = \frac{1}{N} \sum_{i=1}^{N} [\frac{(Sim - \overline{Sim})(Obs - \overline{Obs})}{S_p S_o}]$$

$$S_P = [\frac{1}{N} \sum_{i=1}^{N} (Sim - \overline{Sim})^2]^{\frac{1}{2}}$$

$$S_o = [\frac{1}{N} \sum_{i=1}^{N} (Obs - \overline{Obs})^2]^{\frac{1}{2}}$$

Fig. 3. revised supplement file

ACPD

Interactive comment

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