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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.

Anonymous Referee #2

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General Description

This paper describes the contribution of three major Asian industrial regions on PM2.5 concentrations in Taiwan in January and June 2017. WRF and CMAQ models were used to simulate the transport of pollutions from the Asian industrial regions and also the chemical reactions in these plumes. The performance of the model in capturing temperature, wind speed, and direction, and PM2.5 was evaluated in multiple stations located in Taiwan covering north to south of the island. The authors used the process analysis technique in CMAQ to identify the dominant physical and chemical processes for the production and removal of PM2.5 in different locations in the domain. In gen-

eral, the topic is suitable for ACP journal and the paper makes interesting conclusions about the contribution of long-range transport under different transport patterns to the air quality of Taiwan. However, the authors need to address some scientific issues discussed in the comments section below. The paper needs major English proofreading, major technical corrections, better quality for figures. I would not recommend this paper for publications unless these issues are addressed.

Please note that I reviewed the updated version of the paper after the comments from reviewer 1 were addressed.

General Comments

1) The contribution of local emissions was discussed very briefly in the last section of the paper. I believe adding a discussion about the contribution of local emission to the measured PM2.5 can be beneficial for drawing fair conclusions.

2) I recommend adding backtrajectory analysis using HYSPLIT when discussing transport patterns on specific days. I added more details in the specific comments section.

3) The paper misses a lot of important information such as the main configurations of the model, details on the emission inventory used, and information about the location of measurement sites and equipment. I highly recommend adding these to the paper for the purpose of reliability and reproducibility of the work.

4) Were there any seasonal or diurnal cycle in the emissions? Are January and July emissions different?

5) Major changes are required for the figures. The texts are too small in many of them, the color bar can be improved. I added more comments about each figure in specific comments.

6) I did not make comments on the grammatical mistakes, incomplete sentences, and inconsistencies as there were too many.

Specific Comments Introduction: 1. The first two paragraphs in the Introduction section need to be re-written with better English.

2. L69. The reference at the end of the sentence (Byuan and Schere, 2006) does not match the reference at the beginning of the sentence (Kwok et al. (2013)).

3. L65. Consider starting a new paragraph when describing the AM method.

4. L65-75. After reading this section I was under the assumption that the AM method performs better and was used in this study. At the end of this paragraph please mention that you did not use the AM method and used the BFM method instead.

5. L86...nitrate and sulfate... Please be consistent and either use the chemical formula or the name in the paper or both.

6. L99. When is the northeast monsoon period? Which season/months?

7. L111. Change Brir to BRIR . . .same for other emission regions.

8. L115. What do you mean by "meandering movement"? You can here refer to previous studies that showed this.

9. L120. I suggest moving the discussion of monsoon seasons earlier in the introduction section.

Methods:

10. L128. In addition, year 2017 . . .. I don't understand this sentence.

11. 2.1. Geographical location of meteorological . . . Are stations with the same names (for example #5 and #13) in the same locations? In the text, you use the station names but in Fig 1, you used the numbers. To find the location of each station in Fig 1 readers must go back and forth between section 2.1, fig 1 and the text. Please be consistent and either use numbers or names in figures, tables, and text.

12. 2.1. Geographical location of meteorological . . . Please provide more information

about the measuring equipment, the temporal resolution of data and reference to the measurement data used.

13. L142. . . .NCEP diagnostic fields. Please use a reference for this data set. There is doi available for this data set.

14. L142. Which nesting method did you use? One or two-way?

15. L144. What is the model's top?

16. L145. What is the temporal and special resolution of the emission inventories used? Is there a diurnal or seasonal variability?

17. L150. Why different biogenic inventories were used for different domains?

18. 2.2 Models and modeling configuration Please add a table (can be in SI) with all main WRF and CMAQ configurations and schemes such as PBL scheme, LSM, cumulus scheme, ... How long was the spin-up? What did you use for chemical initial and boundary conditions?

19. 2.2 Models and modeling configuration Did you do any nudging or re-initialization of the model? Please add details to this section.

20. L161. Is there any RH data available? If yes then adding discussion on model performance in capturing RH can be very beneficial for the paper.

21. L167. . .which is due to the smoother terrains. . . In Fig 1, HC is located very close to the sea. Is there a complex terrain in that region? It is not very clear in the figure. Can smoother terrain in the model impact other stations as well?

22. L169. Are other stations influenced by buildings?

23. L173. Please use better quality plots for figure S2.3. Also, be consistent in the title of subplots.

24. Table 1 and table 2. Please add mean model and observed values to these tables.

C4

This can help better compare January and June values and values in different stations.

25. L173. 2.3.2. Evaluation of CMAQ chemical modeling... Please add an emission map. Are any of the stations close to major emission sources?

26. L173. 2.3.2. Evaluation of CMAQ chemical modeling... Please mention that PM2.5 values are very low in HC compared to other stations (Fig S2.4)

27. L173. 2.3.2. Evaluation of CMAQ chemical modeling... Is there a significant difference between PM2.5 values in January compared to June?

Results and Discussion 28. L185. How did you calculate 5%? Is this for the whole island or 5% is the maximum value?

29. Fig 2. Please consider using a better color bar. Why negative values for the color bar? Use more colors for 0-2ug/m3 (right column) and 0-5% (left column).

30. L186. Fig 3 only shows three stations, not seven. Why did you use only these stations? How far are they from major local emission sources?

31. L187. This is not true for PRDIB contribution which is higher in central and southern Taiwan (C-2 and C-3) compared to northern Taiwan (C-1).

32. L189. January 8th or 9th? 14th or 13th? In Fig 3 column a 9th, 14th, 20th, in column b 9th, 13th, 20th had the highest PM2.5 concentrations and contribution from BRIB and YRDIB. Why did you pick 9th and 13th? Throughout the text, different days were mentioned which can be confusing for the readers. Please be consistent and clearly justify your choice of Jan 9th and 13th.

33. L 195. What do you mean by almost the same? Please be more specific.

34. L196. ...could reach ... In which stations? 6-8 ug/m3 and 9-12ug/m3, why giving a range?

35. L200. Please show where Fujian and Guangdong are in Fig 2.

36. L202. Fig. 4. There are two red lines in Fig. 1. Did you use both of them? Please clearly mention this in the text.

37. L214. Locations #17-20 are missing from the updated Fig 1.

38. L 214. Please mention that you did not evaluate model performance (transport and chemistry) in these locations.

39. L224. The positive and negative . . . I don't understand this sentence

40. Fig. 5. What does column 1 represent? What do you mean by contribution of total emission? Do you mean the base case?

41. Fig. 5. Please add titles to the subplots. Or at least put titles for each row and column. It is very difficult to interpret this figure.

42. L226. Can you be more specific about the evaporation of ammonium nitrate in PM2.5 when moving from high latitude to low latitude regions?

43. L245. I cannot distinguish between ZADV and CHEM in Fig 5. Use different colors

44. Fig 5e-1. Any comment on why the daily concentration change is much higher in BQ (#10) than others? Does this mean a high contribution of local emissions? Please discuss this.

45. L247. The removal process of . . .. This sentence is unclear.

46. L250. . . . the PM2.5 of ZM. . . I don't understand this sentence.

47. L259. For CY. . . Please mention that CY (#14) and ZM (#13) are closer to each other than BQ (#10).

48. 3.2. The physical . . . Please justify why you chose to only use #10, #14, and #13 in this section. Please provide a more detailed discussion on the contribution of local emissions.

49. L266. The section number is not correct. Why Jan 13th was discussed before Jan

9th? How did you classify Jan 13th as a severe episode and Jan 9th as a moderate episode?

50. L274 Fig. 8. Please add the altitude of each layer to the figure.

51. L275. The arrival of LRT haze on Jan 14-15 can also be seen in Fig 3.

52. Fig 8. Again I don't understand why Jan 13th was chosen for this discussion. The contribution of LRT was small on this day compared to Jan 14th or 15th. Maybe using these days for Fig 8 would be more helpful?

53. L296. Downstream not upstream.

54. L266 Analysis of ... Adding Hysplit back-trajectories released from locations discussed in this section can be very helpful. It can reveal the trajectory and the origin of the plumes arrived at each of the locations and add confidence to this discussion.

55. L309. What is vv?

56. 3.5 Analysis of the moderate ... I think it is worth discussing this event further (similar to Jan 13th) especially with the high values in BQ at lower levels.

57. L316 ...for all cities. Cities or stations

58. L325. Why July 18th? I don't see high PM2.5 concentrations for July 18th in any of the subplots in row a (Fig. S2.8).

59. L325. The positive and negative contribution ... Does this refer to July 18th? This is not shown in any figure.

60. Fig 2.9 and L330. Please use a better color bar. More colors between 0-20 ug/m3.

61. How much is the local emission contribution in July and how does this compare with January?

62. L225. Where is Fig 15?

63. L338. According to the main content. . .. Are you referring to Fig 8? If yes then your statement is incorrect, BRIR and YRDIR did not have a contribution to #19 (c-2 and c-3) and #20 (d-2 and d-3). Looks like Jan 13th is not the best day to pick for this discussion. Is this measurement available on Jan 9th or 20th?

64. Fig 11. OC and NH4+ colors are very similar.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-762, 2019.