Response to Editor and reviewers

Dear Professor Xavier Querol:

Thanks so much for providing us a chance to revise and resubmit our manuscript, when one reviewer clearly misunderstood the key innovation and contribution of this research. As supported by the other three reviewers during the first and second round of review process, this research provided new visions for the communities on the strong temporal effects on pollutant-meteorology associations across China, which has rarely been investigated before due to the lack of high-resolution temporal data. The other three reviewers all agreed that this research was novel and presented some interesting findings. Specifically, when previous scholars suggested that pollutant-meteorology associations could present large variations at different temporal scales, yet no quantitative research has been conducted to prove or further interpret this issue. This research revealed that the temporal effects might be even stronger than expected, characterized with more than 50% of cities presented different dominant meteorological factor for specific pollutant at 3h and 24h scale. We also noticed that the role of some meteorological factors, such as wind and precipitation, may be largely underestimated at the 3h scale. This research also found that the temporal effects were stronger in those less polluted regions. As a team which has published many papers concerning pollutant-meteorology associations, we guarantee these findings are new and have yet been discussed by us or other scholars before. All these conclusions suggest that we should be careful to attribution airborne pollution from both the anthropogenic and meteorological perspectives by choosing temporal scale carefully and better employing the combination of multiple-scale data.

The reviewer mentioned that some content was similar to previous studies. I think this is a major misunderstanding. Actually, this type of content only accounted for a very small proportion and simply served as the introduction of related studies. As you can see in the similarity report, the similarity between this research and previous studies was very low, indicating the findings from this research are quite different from previous studies and we mainly focus on the difference of pollutant-meteorology associations at 3h and 24h (the

temporal effects), instead of pollutant-meteorology associations at one specific time scale. As one can see in the abstract and conclusion part, all the major findings from this research were completely new and none part of that was revealed before.

Although the lack of new findings and the confusion of the major purpose of this research is purely a misunderstanding, we are still willing to make substantial efforts to address this confusions. We have added more references to the introduction and discussion part to further emphasize the importance of revealing the temporal effects on pollutant-meteorology associations, which can highlight the innovation and major contributions of this research. We have further added much more content to the results part, especially the spatial patterns of temporal effects on pollutant-meteorology associations. In total, we added around more than 800 words to further illustrate our research. In this case, we believe the purpose and value of this research can be better understood.

Thanks again for processing our manuscript and keeping giving us chances to improve it. I believe that as an top scholar and editor in the field of atmospheric pollution research, you can fully understand the value of this research after you checked the revised version and above explanation.

Please feel free to contact us if additional revisions are requested and we are more than willing to conduct further revisions.

The very best

Ziyue

To Reviewer 1:

Thanks so much for providing us some many general and detailed comments, which helped us so much improve this manuscript. We have advised this manuscript according to your constructive comments. We are more than willing to conduct further revisions if you have additional comments.

Thanks again for your time and help.

It is clear that the methodology is innovative, but despite the exhaustive review made previously, the purpose of this methodology is not expressed or detailed, nor what applications it may have. In fact, many of the results shown are obvious and consistent with what is already known by the scientific community, as for example paragraph starting in line 147 and lines starting in 167 and 319 (pressure associated discussion). Additionally, figures have not been improved and neither are self-explanatory.

R: Thanks so much for your comments. Actually, I think there is a misunderstanding and we are sorry that we did not make it clearer here. The use of CCM, which has been frequently employed by us and other scholars, is not innovative and the major contribution of this research. Instead, as supported by the other three reviewers during the first and second round of review process, the major highlight and contribution of this research is to provide new visions for the communities on the strong temporal effects on pollutant-meteorology associations across China, which has rarely been investigated before due to the lack of high-resolution temporal data. Specifically, when previous scholars suggested that pollutant-meteorology associations could present large variations at different temporal scales, yet no quantitative research has been conducted to prove or further interpret this issue. Based on the rare national 3h meteorological data sources (the major highlight and innovation of this research, which to our best knowledge, the highest temporal-resolution national data sources ever employed), this research revealed that the temporal effects might be even stronger than

expected, characterized with more than 50% of cities presented different dominant meteorological factor for specific pollutant at 3h and 24h scale. We also noticed that the role of some meteorological factors, such as wind and precipitation, may be largely underestimated at the 3h scale. This research also found that the temporal effects were stronger in those less polluted regions. As a team which has published many papers concerning pollutant-meteorology associations, we guarantee these findings are new and have yet been discussed by us or other scholars before. All these conclusions suggest that we should be careful to attribution airborne pollution from both the anthropogenic and meteorological perspectives by choosing temporal scale carefully and better employing the combination of multiple-scale data. And we believe this is the key purpose, major findings and interpretation (applications) of this research. These introduction, findings and discussion are all made on the temporal effects on pollutant-meteorology associations across China, instead of the causation model CCM.

You mentioned that some content was similar to previous studies. Actually, this type of content only accounted for a very small proportion and simply served as the introduction of related studies. As you can see in the similarity report, the similarity between this research and previous studies was very low, indicating findings from this research are quite different from previous studies and we mainly focus on the difference of pollutant-meteorology associations at 3h and 24h (the temporal effects), instead of pollutant-meteorology associations at one specific time scale. Furthermore, you can see in the abstract and conclusion part, all the major findings from this research were completely new, which are all about the difference between 24h and 3h, and none part of that was revealed before.

Thanks again for pointing out you concerns. To address the potential confusions, we are still willing to make substantial efforts to address this confusions. We have added more references to the introduction and discussion part to further emphasize the importance of revealing the temporal effects on pollutant-meteorology associations, which can highlight the innovation and major contributions of this research. We have further added much more content to the results part, especially the spatial patterns of temporal effects on pollutant-meteorology associations. In total, we added around more than 800 words to further

illustrate our research. In this case, we believe the purpose and value of this research can be better understood.

Meanwhile, according to your suggestion, the locations of "Yangtze River Delta" and "Shandong Peninsula" have been indicated on the map. The legend is indicated in the second small image in Figure 2, 3, and 4. The Yangtze River Delta region has a green border, while the Shandong Peninsula has a blue border. Enlarged figure s can provide a clearer view.

Thanks again for your continuous help during two rounds of review. Please feel free to contact us if additional revisions are requested and we are more than willing to conduct further revisions.

List of all relevant changes made in the manuscript:

Line 23: ‘From the spatial perspective, pollutant-meteorology associations at 3h and 24h were more consistent in those heavily polluted regions, while extracted dominant meteorological factors for pollutants demonstrated more difference at 3h and 24h in those less polluted regions.’ has been added to the revised manuscript.

Line 50: ‘Fu et al. (2020) used integrated empirical mode decomposition (EEMD) to decompose the time series data of $PM_{2.5}$, five other atmospheric pollutants and six meteorological types. On the daily scale, $PM_{2.5}$ was positively correlated with O_3 and daily maximum and minimum temperature, and negatively correlated with air pressure, while $PM_{2.5}$ presented an opposite association with these factors at the monthly scale.

Despite massive studies conducted, notable inconsistence of dominant meteorological and anthropogenic drivers for airborne pollutants was observed between findings from previous studies. Even if some studies revealed different pollutant-meteorology association at multiple temporal scales, such research conducted in isolated cities, cannot reflect the spatiotemporal variations of temporal effects across China.’ has been added to the revised manuscript.

Line 62: ‘Due to’ → ‘More importantly, due to’.

Line 63: ‘at the daily scale and many scholars’ → ‘at the daily scale, while many scholars’.

Line 120: ‘We obtained the 3h meteorological data sources from China Meteorological Administration.’ has been added to the revised manuscript.

Line 160: ‘summer and autumn’ has been removed.

Line 188: ‘High temperature promotes photochemical reactions and produce more $PM_{2.5}$, PM_{10} and other precursors of secondary pollutants, leading to higher concentrations of $PM_{2.5}$ and PM_{10}. High temperature may also lead to increased evaporation loss of $PM_{2.5}$ and PM_{10}, including NO^{3-} salt and other volatile or semi-volatile components, resulting in decreased concentrations of $PM_{2.5}$ and PM_{10}.’ has been added to the revised manuscript.

Line 206: ‘at 3h scale’ → ‘at 3h scale in summer’.

Line 213: ‘This may be attributed to existence of the Asian monsoon system, which includes the strong southeast and southwest summer monsoon in China.’ been added to the revised manuscript.

Line 234: ‘Based on the extracted pollutant-meteorology associations at 3h scale, which have rarely been discussed, we found some interesting differences of pollutant-meteorology association between 3h and 24h in some major regions across China. For the heavily polluted Beijing-Tianjin-Hebei Region, the dominant meteorological factor for O_3 in spring was temperature at 3h scale. Meanwhile, the dominant factor was wind speed at the 24h scale. For $PM_{2.5}$, the dominant factor for $PM_{2.5}$ in spring was temperature at the 3h scale and wind speed at the 24h scale. The dominant meteorological factor for PM_{10} in summer was temperature at the 3h scale and precipitation at 24h scale.

For the Yangtze River Delta, the dominant meteorological factor for O_3 in spring was temperature at the 3h scale and the combination of temperature and precipitation at the 24h scale. In summer, the dominant meteorological factor for O_3 was temperature at the 3h scale and wind speed at the 24h scale. The dominant factor of $PM_{2.5}$ in spring was temperature at the 3h scale and the combination of temperature and precipitation at the 24h scale. The dominant factor of PM_{10} in spring was mainly temperature at the 3h scale and wind speed at the 24h scale. For the Pearl River Delta, the dominant meteorological factor for O_3 in winter was temperature at the 3h and precipitation at the 24h scale.

For Sichuan Basin, the dominant meteorological factor for O_3 in all four seasons was constantly temperature at the 3h time scale, while it was precipitation, atmospheric pressure and wind speed in summer, autumn and winter respectively at the 24h scale. The dominant meteorological element for $PM_{2.5}$ was temperature in all four seasons at the 3h scale, while it was precipitation in summer and winter at the 24h scale. The dominant meteorological element for PM_{10} in spring and winter was temperature at the 3h scale, while it was atmospheric pressure for spring and winter at the 24h scale. Compared with other regions, the unique basin terrain led to stronger temporal effects on extracted pollutant-meteorology associations.

Our previous (Chen et al., 2018; 2020) revealed that meteorological influences exerted a stronger influence on PM pollutants when PM concentration was higher. This might be the reason that the difference of PM-meteorology associations between 3h and 24h was relatively small in heavily polluted winter and large in less-polluted spring. Meanwhile, we found that the role of wind speed and precipitation may be largely underestimated at the 3h scale. Compared with the generally consistent pollutant-meteorology associations in these heavily polluted regions, the dominant factor for PM and O_3 demonstrated significant variations in those coastal cities, such as Shenzhen, Zhuhai, Zhanjiang.' has been added to the revised manuscript.

Line 298: 'pointed out the difference' → 'pointed out the notable differences'.

Line 299: 'few studies have actually conducted the quantitative analysis due to the lack of data.' → 'and the great importance to better understand the temporal effects, few studies actually conducted a comparative analysis due to the lack of data, especially the high temporal resolution meteorological data.'

Line 307: 'we got several interesting and useful findings as follows' → 'we got some major conclusions as follows'.

Line 309: 'difference' → 'differences'.

Line 313: 'The role of wind speed and precipitation, which may be recognized as dominant meteorological factors at the 24h scale, can be largely underestimated at 3h scale.' has been added to the revised manuscript.

Line 371: 'From the spatial perspective, pollutant-meteorology associations at 3h and 24h were more consistent in those heavily polluted regions, while extracted dominant meteorological factors for pollutants demonstrated more differences at 3h and 24h in those less polluted regions.' has been added to the revised manuscript.

Line 373: 'for the' → 'of the'.

Line 374: ‘scale’ → ‘scales’.

Line 376: ‘**Acknowledegement** This work was supported by the National Natural Science Foundation of China (Grant No.42171399)’ has been added to the revised manuscript.

Line 402: ‘Fu, H., et al. 2020. Investigating PM2. 5 responses to other air pollutants and meteorological factors across multiple temporal scales. Scientific reports, 10(1), 1-10.’ has been added to the revised manuscript.