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# *Interactive comment on* "Differentiating local and regional sources of Chinese urban air pollution based on effect of Spring Festival" *by* Chuan Wang et al.

**Chuan Wang et al.**

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General comments: The paper presents an assessment of the effect of the Chinese Spring Festival on urban air quality in a southern China city. Various trace gases and aerosols were measured over three consecutive winters (2014-2016), including both the Spring Festival (SF) and non-Spring Festival (non-SF) periods, at an urban site of Shenzhen city. By comparing the concentrations of these pollutants in different periods, the authors show that the decreases for some pollutants are significant (by 50%-80%) in the SF with respect to the non-SF while the decreases of others pollutants are smaller. They suggest that such differences in the reduction extent of pollutant



concentrations be used to judge their sources, i.e., predominantly from local emissions or from regional transport. This study, together with a valuable dataset, should be a welcome addition to the literatures on the holiday effects on air quality. The manuscript can be accepted for publication after the following issues have been well addressed.

As the main purpose of the study is to distinguish the sources of urban pollution between the local emissions and regional transport, the local and regional pollution sources should have been clearly defined. It would be great if the authors could provide a map showing the geographical distributions of emissions rates of major air pollutants in Shenzhen city and its surrounding areas during wintertime. It is also suggested that if possible, the geographical extent of pollution reduction during the SF in relative to the non-SF period be identified, perhaps by using population density or satellite product.

The study identifies the primary source of each pollutant, i.e. the local or regional origin, using the reduction extent of a pollutant (in relative percent) from the non-SF to SF period. This methodology is fine for primary pollutants (such as NOx and BC), and it may also work for some secondary pollutants (perhaps SO42-); but it might not entirely applicable to O3 since ozone production changes non-linearly with an increase (or a decrease) of NOx. A stronger evidence is needed before a conclusion on the origin of ozone is given in the manuscript.

Specific comments:

1. Line 12 and Line 49-53: During the SF, the power plants are generally not shutdown in the megacities of China. Are there any power plants in Shenzhen? Where the industrial area of Shenzhen located in reference to the measurement site? Are the wind roses of various pollutants in the SF different from those in the non-SF period?

REPLY: There are few power plants in Shenzhen. We now cite a paper (Zheng et al., 2009b) in section 2.1 to describe the relative location of the sampling site in terms of pollutant emissions in PRD, as below: "A highly resolved temporal and spatial emission inventory for PRD indicates that the sampling area is characterized by lower SO2

emissions but higher NOx and VOCs emissions in comparison with other areas in PRD (Zheng et al., 2009b)." Since the data points on each wind direction are limited, wind rose analysis may not be a solid evidence. However, the analysis of relationship between pollutant concentrations and wind speeds during SF and NSF in section 3.3 can already well reveal that Group LD was highly influenced by wind speed.

2. Line 19-21: Here it might not be suitable to say "decreasing of regional pollutants" since there is an increase of O3 by 6%.

REPLY: We rephrased the sentences by"The concentration variation of species mostly from regional or natural sources, however, is found to be much less, such as for bulk PM2.5."

3. Line 47: It might not be fully suitable to say so. The reported emission reductions could be verified by comparisons of different approaches, e.g., ground measurements, satellite observations, and model simulations with different emission inventories.

REPLY: ". . .so the reported emission reductions cannot be verified" changed to ". . .so the air quality monitoring campaigns cannot be repeated."

4. Line 77-79: Figure S1 provides only geographical position of measurement site. How far away from the main traffic roads the site is? How about regional distributions of pollutants' emissions?

REPLY: We have provided the relevant information in the revised text as below: "PKUSZ is located in the western urban area of Shenzhen, and there are no significant anthropogenic pollution sources nearby except a local road $\sim$100 m far from the sampling site. A highly resolved temporal and spatial emission inventory for PRD indicates that the sampling area is characterized by lower SO2 emissions but higher NOx and VOCs emissions in comparison with other areas in PRD (Zheng et al., 2009b)."

5. Line 135: Figures S3-S5 provide more detailed information and can be moved into the formal part of the manuscript.



REPLY: After careful consideration, we still believe that Figures S3-S5 are too large to be moved into the main text. Therefore, supporting information could be a better choice when considering that ACP is freely available on the internet.

6. L174: CO is NOT a typical SECONDARY regional air pollutant as most of CO in the urban and polluted areas are mostly probably to be primarily emitted.

REPLY: It is a typo. "secondary" is now deleted.

7. L183-184, L252-253, L261-267, L309-312 and L337-340: According to the study, isoprene and DMS measured in Shenzhen have anthropogenic sources. But they are repeatly described as "natural" gases; on the other hand, sometimes they are classified as "pollutants". These vague expressions should be corrected.

REPLY: We have checked all the manuscript and rephrased the words to say that they are "mainly emitted by natural sources"

8. Line 191-192: It should noted that there is an increase of O3 to a small extent.

REPLY: We have rephrased the sentences as below: "The group of pollutants with smallest decrease in concentration (hereinafter called "SD") includes SO2, PM0.8–2.5, and O3 (8h) in the case of comparison with NSFM. The magnitude of the average percent change is less than 20% relative to the two NSF periods. It is interesting to note that there was even concentration increase in other O3–related cases."

9. L195-202: Are there any power plants in Shenzhen and nearby areas? A plot of the regional emission distributions of SO2 would be helpful for the reader to follow the discussion here. It would also be great if the wind rose or trajectory analysis result could be given.

REPLY: There are few power plants in Shenzhen. We now cite a paper (Zheng et al., 2009b) in section 2.1 to describe the relative location of the sampling site in terms of pollutant emissions in PRD, as below: "A highly resolved temporal and spatial emission inventory for PRD indicates that the sampling area is characterized by lower SO2

emissions but higher NOx and VOCs emissions in comparison with other areas in PRD (Zheng et al., 2009b)." Since the data points on each wind direction are limited, wind rose analysis may not be a solid evidence. However, the analysis of relationship between pollutant concentrations and wind speeds during SF and NSF in section 3.3 can already well reveal that Group LD was highly influenced by wind speed.

10. L212-215 and L300-301: The sentence "meteorology has only a small impact on their concentrations" is misleading. Note that only for the period average values are the result consistent.

REPLY: To be more rigorous, this sentence is changed to: "The decreasing ratios of various species during SF when compared with the NSFT and NSFM periods are similar, which suggests that the meteorological variations might not be the dominant reason for the species decreasing during SF."

11. L231, Figure 2: Ticks for 10 nm and 1000 nm could be given.

REPLY: Our instrument (SMPS) determined the particle number size distribution in the size range of 15–615 nm.

12. L288-289: In-depth analysis should be performed if you insist that the lack of NOx at noon during the SF period hinders the generation of O3. Figure 3B shows that the levels of NOx in the SF and NSFM at noon are comparable. It seems that the difference in VOCs might play an important role.

REPLY: We agree that based on limited VOCs measurements, it is not reasonable to get the conclusions that whether the O3 formation is NOx-sensitive or VOCs-sensitive. Therefore, in the revised manuscript, we only state as below: "As a result, although the reduction in emissions of urban anthropogenic sources leads to a significant decline of NOx and VOCs, this reduction does not mitigate the average ambient O3 concentration, which implies that the concentration ratio VOC/NOx plays an important role in controlling O3 concentration."



13. L300: What are the wind fields look like? It might be more appropriate to say the wind field patterns are the same.

REPLY: The wind rose plots can be seen in Figure S2. We take this suggestion to use "wind field patterns"

14. L368-370: The concept of regional air pollutants is unclear. How are they defined? Even for NOx, it can also result in regional pollution.

REPLY: In this study, we studied urban air quality and urban emissions, and thus regional pollutants refer to species from outside the urban areas. Yes, NOx can also be from regional transport. However, based on our results, NOx is found to be mostly from local urban emissions. In the revised text, we have added the words like "air pollutants mostly from regional or natural sources" to be more rigorous.

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