

Interactive comment on “Characterization of individual aerosol particles collected during a haze episode in Incheon, Korea using the quantitative ED-EPMA technique” by H. Geng et al.

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First of all, we deeply appreciate the reviewer's review and very valuable comments on our manuscript, which helped very much to improve our manuscript. Major revisions were done, meeting with all the comments and suggestions from the reviewer. In addition, the content of “Conclusion” was rewritten, more than 20 references were deleted, and other modifications were made in the text, figures, and tables when necessary.

1. Abstract:

Comment 1: It is tedious. The 3 sentences at the beginning are not necessary. Moving them into the introduction will be better.

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Comment 2: It is hard to follow the descriptions of the major results.

Comment 3: The last sentence ‘It is hypothesized that : : ’ does not show any importance of this study. It could be expected without the results of this study.

Reply: We deleted the 3 sentences at the beginning in the original manuscript (lines 2-7 on page 26642) and made a great modification on the descriptions of the major results. The last sentence ‘It is hypothesized that : : ’ in the original manuscript (lines 1-5 on page 26643) was changed.

2. Introduction:

Comment 4: The definition of haze in Korea and more details on the weather and environment conditions for haze occurrence around Incheon will be very helpful for readers to understand the results.

Reply: The reviewer's comment is right. We added the content on the definition of haze in Korea and more details on the weather and environmental conditions for haze occurrence around Incheon. Please see the added sentences in the second paragraph of the modified Introduction.

3. Materials and Methods:

Comment 5: The reason for particles on stage 1 not to be analyzed is necessary.

Reply: We added the reason at the line 17 on page 26645 of the original manuscript. The original sentence was changed to “Particles collected on stages 2 and 3 were analyzed for each sample set since particles in the size range of 1.0-10 μm in diameter have more contributions to haze formation and health damages than particles which are larger than 10 μm . Hence, particles on stage 1 were neglected in the study.”

Comment 6: Haze information needs to be shown in Table 1 in order for reader to remember which samples were from non-haze period and which from haze episode.

Reply: We added a column in Table 1 and describe the weather status for every sample

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to tell the readers which samples were from non-haze period and which from haze episode. Please see the modified Table 1.

Comment 7: The methods are not effective to organic carbon compounds. In this study, criteria and approaches for organic component identification in the analyzed particles are definitely needed.

Reply: It is right. Following the comment, we added the content on criteria and approaches for organic component identification in the second paragraph of the section "2.2 Data measurement and analysis"(page 26646). The added content is "The specification of carbonaceous particles was carried out based on particles' morphologies and the C and O contents. When the sum of C and O contents for a particle was larger than 90% in atomic concentration, it was regarded as an organic or carbon-rich particle (Ro et al., 2005). Although the presence of hydrogen fails to be detected in EPMA, elemental carbon (EC) and organic carbon (OC) can be identified in a somewhat arbitrary way. For EC particles (also called carbon-rich particles), atomic concentration of C is 3 times larger than that of O and the different types of the EC particles such as soot aggregate, tar ball, and char or coal dust can be easily identified by their shape; whereas for OC particles, atomic concentration of C is comparable to that of O, and N signal is often detected."

4. Results and discussion:

General comment: Subsection 3.1 Particle types: This subsection is very tedious.

Comment 8: It is unnecessary to repeatedly to show multiple particles in the same category. One picture for particles before the haze and one picture for particles in the haze are better than several pictures (figure 3). For each category particles, one particle shown as an example is enough.

Reply: In Figure 3, the six pictures about field images of aerosol particles were carefully selected from the large number of pictures. Fig. 3a (the first two pictures) contain

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different size of particles (PM_{2.5-10} and PM_{1.0-2.5}) before the haze (for sample 3 collected at 10:00-12:00 on 14 Oct. 2008); Fig. 3b (the middle two pictures) contain different size of particles (PM_{2.5-10} and PM_{1.0-2.5}) at the beginning of the haze (for sample 6 collected at 18:55-20:30 on 15 Oct. 2008); and Fig. 3c (the last two pictures) contain different size of particles (PM_{2.5-10} and PM_{1.0-2.5}) at the peak of the haze (for sample 8 collected at 19:12-20:34 on 16 Oct. 2008). These figures list all category particles and give the original information on morphology of aerosol particles in PM_{2.5-10} and PM_{1.0-2.5} fractions. It is difficult just to show one picture as an example for each category particles. Thus, we think they need to be kept.

Comment 9: For each category, introduction of the research background is not necessary. The results of this study need to be emphasized in a compacted way. A table summarizing all categories might be a good choice. In addition, many possible sources for the particles are mentioned but no further information is shown to identify the contributions of each possible source. It is likely all possible sources are raised, but readers cannot know where the particles were originated from after reading the paper.

Reply: Respecting the reviewer's suggestion, we deleted the majority of the section "3.1 Particle types", and added a summarizing table (Table 2 in the revised version) to list all particle types, the characteristics of morphology and X-ray spectra, possible sources for particle types, and the corresponding particles shown in Figure 3.

Comment 10: Page 26648 line 3: 'possible due to the electron beam'. This description is vague. Authors analyzed the particles and must have data to make it clear.

Comment 11: Page 26649 line 2-5: Adachi and Buseck (2008) did not discuss water-soluble organic aerosols. Johnson et al. (2008) clearly mentioned that it would be impractical to discuss oxygenated organics with any certainty and did not show any points on water-soluble organics in their samples.

Comment 12: Page 26649 line 7: Adachi et al. (2010) only suggested the condensation without any evidence, and thus the suggestion cannot be applied as a support for the

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conclusion here.

Comment 13: Page 26649 line 18: '[Na]:[Cl]≈1:1'-The low-Z method always overestimates the content of Na in an individual particle. In the case of [Cl] loss caused by nitric acid or organic acid, the loss cannot be identified correctly. In that case, how was the ratio determined? Note that nitrogen compounds and organic compounds are well discussed in following sections.

Comment 14: Page 26650 line 6-7: Geng et al., (2009a; 2009b; 2010) did not report any results of this study.

Comment 15: Subsections 3.1.5 and 3.1.6 contain rare data and information of this study, except the pictures of the particles. They can be largely simplified.

Comment 16: Page 26651 line 26-28: Is the subway system a substantial source for iron particles in a wide range? Evidence is necessary for that the detected particles in this study were from the source.

Reply: These comments result from the content "3.1.1-3.1.6" in the original manuscript. Because these descriptions were deleted in the modified manuscript, we think the response to the comments would not be necessary. The references of Adachi and Buseck (2008), Johnson et al. (2008), and Adachi et al. (2010) were deleted.

General comment: Subsection 3.2 Relative abundances of various types of particles: Important results are reported in this subsection, but more discussions on the reasons of the quantitative results and their implications are anticipated.

Comment 17: Page 26652 line 21-27: These results and conclusions are very important to the understanding of particles of haze phenomenon. Mechanisms or sources responsible for these results need to be discussed clearly in order to make them referentially meaningful. In addition, how did the differences of the contributions of different particles influence the haze properties?

Comment 18: Page 26653 line 15-21: Evidence from this study is necessary to support
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the discussions here. Without the data of this study, the discussion did not increase the readership.

General comment: Subsection 3.3 Possible reasons: : :: The discussions are tedious and they are only published literatures without combining with the situation or conditions of this study. Data and evidence from this study are necessary to show that those discussions are suitable to this study. In particular, authors raised every possibility that could be expected but did not show which possibility was the major one. This leaves me an impression that it is likely that authors have explained their results but I do not understand how the authors did provide a clear answer.

Reply: Thank the reviewer for the valuable suggestions. In the subsection "3.2 Relative abundances of various types of particles" in our revised version, we added more discussions on the reasons of the quantitative results and their implications by combining the content of subsection 3.3 with that of subsection 3.2 in the original manuscript, and deleted some unnecessary contents.

Comment 19: Page 26654 line 4-7: is not cited properly. The weather conditions of Guangzhou must be very different from those at Incheon, and I do not think anthropogenic emissions relevant to haze are comparable at the two cities.

Reply: We deleted the discussion on the haze in Guangzhou without citing the paper of Jung et al. (2009).

Comment 20: Page 26654 -26656: The discussions were not prepared closely in conjunction with the conditions, situations, and aerosol data of this study. Most of the contents are published literatures. How are those elucidation and explanation suitable to the results of this study?

Comment 21: Page 26656 line 17-29: These discussions are suitable to any air parcels arriving at Korea from eastern China. Authors should give evidence of this study to show the links between their results and air parcels from eastern China in this study.

Otherwise, the discussion should be largely simplified.

Reply: The two comments are connected, by asking that elucidation and explanation should be suitable to the results of this study and some unnecessary discussions should be deleted. Following the reviewer's suggestions, we deleted the contents in line 17-29 on page 26656, and added new discussions. Please see the revised manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 26641, 2010.

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