Atmos. Chem. Phys. Discuss., 14, C8922–C8927, 2014
www.atmos-chem-phys-discuss.net/14/C8922/2014/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spatio-temporal variations in PM_{10} concentrations over Seoul estimated using multiple empirical models together with AERONET and MODIS data collected during the DRAGON-Asia campaign" *by* S. Seo et al.

S. Seo et al.

jkim2@yonsei.ac.kr

Received and published: 8 November 2014

Anonymous Referee #2

General comments: This paper evaluates the performance of empirical models for studying spatio-temporal variability of PM10 concentration over Seoul using AERONET and MODIS AOD, and other ancillary data including boundary layer height (BLH), rela-

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

tive humidity (RH), and effective radius (Reff) of the aerosol size distribution during the DRAGON-Asia campaign in 2012. The methods/results are well documented and summarized. The topical area is also suitable for the special issue ("Meso-scale aerosol processes, comparison and validation studies from DRAGON networks") in ACP journal. I favor publication of this paper in ACP with some clarifications and minor changes.

–> We reflected all the comments by the reviewer. The comments and suggestions by the reviewer were appropriate and improved the scientific quality of our manuscript. We sincerely appreciate such efforts.

Specific comments:

1. The title appears to be a bit descriptive and awkward. Reword it to be concise.

Ans.) As suggested by the reviewer, we changed the title as "Estimation of PM10 concentrations over Seoul using multiple empirical models with AERONET and MODIS data collected during the DRAGON-Asia campaign".

2. Making scatter plots of measured PM10 against major parameters (e.g., AOD, BLH, RH, Reff, AE, and their combinations) may give some insights of the relationship between them. And linear fits can be added as well.

Ans.) The following sentences and figures have been inserted on pages 21719, lines 4 in the revised manuscript as: "To gain insights of the relationship between PM10 and major predictors, all PM10 concentration was plotted against AOD, BLH, RH, and Reff, which were used in this study for development and validation of PM10 estimation as shown in Fig 4. The correlation coefficient (R) between PM10 and AOD was 0.5 and that of Reff was 0.32. As expected, BLH showed negative correlation with PM10 (-0.36). However, RH did not show any significant relationship with PM10."

(Please see attached figure)

Figure 4. Scatter plots of the various parameters including (a) AOD, (b) BLH, (c) effective radius, and (d) RH against the dependent variable of PM10 concentration. The

ACPD
14, C8922–C8927, 2014

regression line is shown as a blue dashed line.

3. In Table 5, results were well summarized by various statistical measures, however, I wonder if they are statistically significant among models. Are their performances significantly different among models (M1∼M6)?

Ans.) As the reviewer pointed out, there might be no statistically significant differences between the performances of models in some cases. However, the main purpose of this study is to evaluate the performances of various empirical models by incorporating different parameters. For this reason, we tested various models and provided correlation coefficient, RMSE etc., which makes possible to determine important factors in PM10 estimation.

4. R2 (coefficient of determination) is a more appropriate quantity than R (correlation coefficient) in explaining the performance of empirical linear models throughout this paper. Refer to a statistics textbook.

Ans.) As suggested by the reviewer, we added the R2 (coefficient of determination) values in Table 5, 6 and 7.

5. What empirical models are best for estimating PM10? And Why? These things need to be clearly discussed and stated in abstract and conclusion. I expect the best performances from M3 and M5 because they look close to the form of equation 3. If not, explain why. Even the best performance of M5 during the winter season (R=0.81, R2 = 0.66) in Table 7 shows remaining 34% variance is not explained by the model. What other factors should be taken into account for future improvement?

Ans.) As suggested by the reviewer, we inserted some sentences in the revised manuscript to emphasize the empirical model which derives the best result in PM10 estimation. The following sentence has been revised in abstract [P21711, L11-13] in the revised manuscript as: “Among various empirical models, the model which incorporates both BLH and Reff showed the highest correlation, which indicates the strong

ACPD
14, C8922–C8927, 2014

influence of BLH and Reff on the PM10 estimations. Meanwhile, the effect of RH on the relationship between AOD and PM10 was appeared to be negligible during the campaign period (spring) when RH is generally low in Northeast Asia." The following sentences have been inserted in conclusion [P21729, L21] in the revised manuscript as: "The improved performances were found when the vertical correction on AOD using the BLH was applied in both AERONET and MODIS datasets (M2) compared to the simplest model (M1). These empirical model performances were further enhanced by additionally including the effective radius for size correction (M3, M5). However, not meaningful improvements were found when RH was considered additionally (M4). Among different empirical models based on the physical relationship between AOD and PM concentration (M1-M5), model M5 which follows the nearest form of that relationship with the largest number of parameters showed the best performance." We discussed about other factors which should be considered for future improvement in conclusion in the revised manuscript. Please refer to answers to comments 6 of Referee #2.

6. Page 21730, lines 20-24: it does not necessarily support that AOD at a finer spatial resolution from such as GOCI or MODIS would help to improve the predictability of PM10. In general, the accuracy of MODIS AOD from a higher spatial resolution of 3km is not better than that from a standard product of a 10 km resolution, especially in urban areas due primarily to inadequate characterization of surface properties (Refer to the paper, "MODIS 3 km aerosol product: applications over land in an urban/suburban region", L. A. Munchak, R. C. Levy, S. Mattoo, L. A. Remer, B. N. Holben, J. S. Schafer, C. A. Hostetler, and R. A. Ferrare, Atmos. Meas. Tech., 6, 1747-1759, 2013). Moreover, very accurate point measured AOD data from AERONET after additional cloud screenings were already tested in this study. Further in-depth discussion about possible factors and mechanism other than AOD for improving the predictability of PM10 is expected to enhance the quality of this paper.

Ans.) As the reviewer pointed out, AOD products at a finer spatial resolution didn't show

ACPD
14, C8922–C8927, 2014

better performances over urban areas than those at a lower spatial resolution (Munchak et al., 2013). To mention a limitation in application of the finer resolution AOD data for improving the PM10 estimation and difficulties of surface reflectance characterization, we inserted following sentences in P21727, L24 in the revised manuscript as: “In order to understand smaller scale features of the air quality, higher spatial resolution AOD products such as a MODIS 3km product are under development. Although this high resolution product has been expected to explain aerosol gradients in detail at a small scale, the 3km product showed poor performances compared to the 10 km product due to improper characterization of the urban surfaces (Levy et al., 2013; Munchak et al., 2013). This bias in surface reflectance of MODIS algorithm indeed resulted in misfit between column AOD and surface PM concentration, as discussed in Escribano et al. (2014). Thus, estimated spatial characteristics of surface PM concentrations are reliable when aerosol products are satisfied with both higher quality and finer resolution.”

Also, to suggest other factors needed to be considered for improving the predictability of PM10, sentences in P21730, L20-24 have been revised as: “For better estimating surface PM concentrations by satellite remote sensing, especially in urban areas where diverse aerosol sources are distributed, aerosol products with a higher quality and a finer resolution are required. Additionally, accurate and detailed information about aerosol vertical distribution, size distribution, and composition will contribute to improve empirical models.”

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/14/C8922/2014/acpd-14-C8922-2014-supplement.pdf

---

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 21709, 2014.

ACPD
14, C8922–C8927, 2014

Interactive Comment

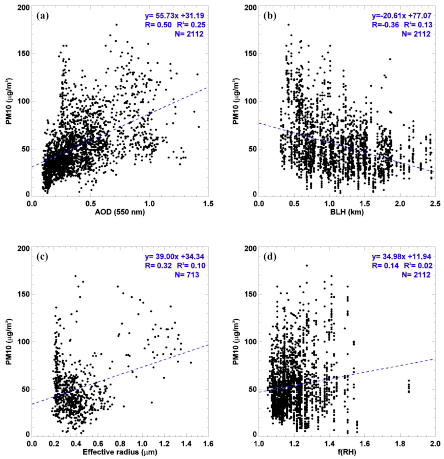

Figure 4. Scatter plots of the various parameters including (a) AOD, (b) BLH, (c) effective radius, and (d) RH against the dependent variable of PM10 concentration. The regression line is shown as a blue dashed line.

Fig. 1. Flg. 4

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper