Interactive comment on "3D-Var versus Optimal Interpolation for Aerosol Assimilation: a Case Study over the Contiguous United States" *by* Youhua Tang et al.

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Thank you for your comments. We revised this manuscript accordingly. Here are the answers to your specified questions.

First, the purpose of data assimilation is to improve forecast. However, this paper presents mainly the impact of data assimilation on the simulation at the assimilation time window. It does show impact on prediction, but it was a only one-hour forecast from 18 to 19 UTC on 07/01/2011 (Figure 8). Additionally, it is unclear to the reviewer if the time-series plot (Figure 9) showed forecast results or adjusted results from assimilating data on the same time window. Second, the data used for verification is not

clearly described. Are they the same PM data used in the assimilation? Please note that the data used for assimilation should not be used in the verification of data assimilation process. Otherwise, the verification is cheating by checking self-consistency.

The data assimilation methods used in study are mainly about adjusting initial condition. So, its immediate impact is the change of initial condition, which was discussed in Figures 4-7. Its impact on next-hour forecast was discussed in Figure 8. All thereafter impacts were shown in figure 9 and table 2, for one-month performance in 4-cycle per day. The data used in verification are not those used in data assimilation. For 18UTC data assimilation and forecast, the verification starts from 19UTC to 00UTC, and 00UTC cycle's verification is done from 01UTC to 06UTC. We added this clarification in the manuscript.

1.Treatments on observation and prior errors need a better justification. Error characterization on observation and background are essential to data assimilation. Observation error was simply assumed as constant (0.1) for both PM2.5 and AOD. This needs to be justified with error covariances

Thank you for your comments. We added some justification about the observation error.

2. The data assimilation system should be described in more detail. In particular, the OI system needs a detailed description, so that readers does not need to go to Tang et al 2015 for essential information about the method. Also, it is not clear how CMAQ and GSI 3D-Var get coupled

Thank you for your suggestion. We added more detailed about the OI and how CMAQ and GSI 3D-Var get coupled.

3. A brief description and references of the PM2.5 data are needed. How many number of sites are used? Were all sites used for both data assimilation and model evaluation.

Good suggestion. We added this information

4. A brief description of MODIS AOD is also necessary with references. It shall include which MODIS product is used (e.g., level 2 or level 3, which collection, on which wavelength) and why 18Z data assimilation is applied, etc.

We added the information about MODIS AOD data

5. Page 6, line 34: Do those mass scaling factor vary with time and location? If they are constants, please provide here.

The mass allocation factors of PM25AT, PM25AC, and PM25CO are varied with time and location, which depends on the aerosol size distributions in the three modes. We added the clarification

6. Figure 2: It is not clear to the reader which wavelength is for these AODs. I could only confirm that the Reconstruction AOD (panel b) is at 550 nm

All of the AOD are in 550nm. We added the clarification

Figure 4: Arrangement of panels in Figure 4 is confusing and please make them clear and consistent. The figure caption says GSI is on the left and OI on the right, but OI is found in the middle row for both columns and GSI is found at the bottom row for both columns too. According to the text, I think those panels should be arranged like Figure 6: (a) GSI_PM, (b) OI_PM, (c) GSI_AOD, (d) OI_AOD, (e) GSI_All, (f) OI_All

You are right. We re-arranged the plot panels.

Figure 7: Again, please specify the used spectral wavelength for AODs.

We added

Evaluation of model predictions needs further quantitative statistically analysis. For instance, bias, RMSE and RĚĘ2 for predictions of PM2.5 against observation should be reported.

The statistics of bias, RMSE and R are listed in table 2

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Font size in almost every plot needs to be increased, especially for color-bar axes

We increased the fonts of those figures.

Thank you again for your comments

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-147, 2017.