

Interactive comment on “Data assimilation of dust aerosol observations for CUACE/Dust forecasting system” by T. Niu et al.

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(1). There are many different size bin distributions that composing the same DM40, so how do you treat this problem (how do you get the value of each size bin)?

The model simulates the dust aerosols in 12 size bins that contain the DM40. According to the size bin configurations, each size bin has a dust concentration associated with it. For comparison purposes, concentrations from size bin 1 to 8 were used as the PM10. There is a more detail description in the paper (see Section 2.3).

(2). More contents should be described about data assimilation methods how to improve the dust model's forecasting capability.

A detail discussion about how DAS improve the dust model performs has been given in section 4.1. A new figure (Figure 6) was added to show the impact of the DAS on

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the column loading at various dates and locations. Essentially, the DAS corrected the forecasting results by changing the dust column loading in two directions, i.e. positively or negatively, based on the difference between observations and the modeling results.

(3). Page 8313 Section 2.1.1, about $IDDI = T_s - T_{bb}$. More detailed describe should be gave (what IDDI stands for, what we can get from IDDI).

We have added following description in Section 2.1.1:

This data reflecting the dust aerosol column loading was named SDS-IDDI (Infrared Difference Dust Index), a dimensionless quantity between 0 and 50. The temporal resolution of SDS-IDDI is an hour with a spatial resolution of 5 km x 5km. A value of IDDI between 0 and 10 usually indicates a clear sky, 10-20 a floating dust (FD), 20-30 a blowing dust (BD), 30-40 a SDS event and 40-50 a severe SDS event.

(4). Page 8314 Section 2.1.2, the system is using the surface visibility data. Therefore, in most cases, the surface visibility includes effects of anthropogenic air pollution. How do you discriminate between dust-related and air-pollution-related visibility?

Normally the SYNOP visibility includes the effects of both anthropogenic air pollution and dust aerosol and it is difficult to distinguish them. However, during the dust storm events, dust aerosol is the dominant factor which affects the SYNOP visibility. According to the definition issued by WMO, SYNOP visibility determines the class of dust storm except for the period of fog and have no distinguish between air pollution and dust effects. Consequently, the DAS in CUACE/Dust system behaves better in the SDS periods than in the pollution episodes.

(5). Page 8316 Section 2.2.1 Why does the data assimilation produce a negative concentration?

Below is an example where negative concentrations may occur after data assimilation.

Suppose there are a, b, c and d four grid sites of model space with values 100, 50, 10, 20, meanwhile there is an observation site o in the center of the rectangle determined

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by a, b, c, d sites. If $y_o=2$ is observation value, $H(x)=45$ is the corresponding value from model grid to the observation site through the observation operator H. Therefore, $d= y_o - H(x) = 2 - 45 = -43 < 0$. Through minimization a,b,c,d will get negative correction based on background error structure (B) and the value in c-grid maybe turn into negative. This is an example just for explaining the question asked by reviewer. This situation seldom occurs. That is the reason why 3Dvar gives the negative value.

(6). LBFSG should be limited memory BFGS.

It has been changed.

(7). Page 8316-8317 Section 2.2.2, the authors described a method to estimate the background error matrix B from eqs. (2) and (3). But it is very difficult to understand how to establish the B matrix, so more detailed descriptions must be gave here.

More detailed descriptions have been given in Section 2.2.2 with definition of B matrix.

(8). Page 8319 Section 3.2 What are O-B and O-A? How do you define each and what are their units?

O stand for observation PM10 value, B is the model forecasting PM10 value without DAS and A is the analysis forecast PM10 value with DAS. O-B stands for the observation PM10 minus forecasting PM10 without DAS while O-A stands for observation PM10 minus analysis forecast PM10 with DAS. The units all of them are $\mu\text{g}/\text{m}^3$. We have revised the section (3.2).

(9). Page 8321 Section 4.2 Which period dose the TS stander for and how do you define the dust forecast as YES or NO?

This is a daily TS obtained from 24 hr of observations and modeling results. YES or NO is a dichotomous forecast quantifying the performance. Whenever there is a FD, BD, SDS, severe SDS observed in a grid and forecasted by the model, it is a YES otherwise it is a NO. This is what we included in the manuscript:

A daily TS is based on a dichotomous forecast of SDS or non-SDS event. A SDS event includes FD, BD, SDS and severe SDS. Whenever there is a SDS event observed in a grid and forecasted by the model, it is a YES otherwise it is a NO.

(10). About Figure 4(b) more detail should be given, otherwise it is difficult to understand.

The Figure has been revised.

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