Review of the manuscript
Implementation of aerosol assimilation in Gridpoint Statistical Interpolation v. 3.2 and WRF-Chem v. 4.3.1
by M. Pagowski et al.
GMDD 7, 2483-2500 (2014)

General comments

In this manuscript, the authors present an extension of the GSI assimilation tool which allows for the assimilation of aerosol PM2.5 and PM10 concentrations from surface measurements and aerosol optical depth from satellite measurements.
Given the importance of having accurate aerosol representation in air-quality studies, this extension is certainly useful for forecast models. In addition to that, the proposed package also provides statistics and conversion tools which are helpful for model users.

The manuscript, however, should be improved before publication in GMD.
In particular:

- some technical terms needs to be explained;
- more accuracy is desirable in Section 3 and 3.1;
- the figures need to be improved;
- language can be improved (e.g., the use of articles).

Please find more detailed comments below.

Major remarks

P2484-L17: I understand that this is a technical paper, but I would try to rephrase this sentence in a more positive way (e.g., "Scientific aspects are also briefly discussed").

P2484-L21: it is not clear to me what you mean by "continuously recycled". Please clarify.

P2485-L2: please explain what 3-D and 4-D refers to. I guess that 3-D is for time, latitude and longitude, whereas 4-D also includes the vertical coordinate. How is such vertical coordinate defined?

P2485-L2: provide a definition for "ensemble Kalman filters".

P2486-L13: if possible, provide a reference for the BUFR format.

P2487-L2: in case observation values are not available in some grid boxes, how are these treated in the assimilation procedure? Are they simply ignored or are they interpolated from the nearest valid gridboxes?

P2487-L9-26: this paragraph needs to be extended with a more detailed

explanation. Methods like "recursive filters" and "incremental approach" are not explained at all and just providing a reference is not sufficient. The terms in Eq. (1) are listed but the actual meaning of some of them (e.g., the observation operator *H*) is not explained. I would recommend to add a few sentences to make this paragraph easier to understand, especially for non-experts.

P2488-L9-10: please specify the values of the size bins used for dust and sea-salt.

P2488-L18: the factors that account for the size cut-off at 2.5 micron requires an assumption on the size distribution of dust and sea-salt particles. Is that the case? If so, please provide more information on such assumption.

P2488-L25: here aerosol size modes are mentioned (lognormal modes, I guess), while in the previous paragrah size bins for dust and sea-salt are mentioned. This is a bit confusing. Is the model using size modes or size bins?

P2489-L5: the parameters ρ_{dk} is not defined and the value of k_{top} is not given.

P2489-L19: the default value 0.5 for the parameter α is somewhat arbitrary. What does it actually represent and how should it be chosen?

P2489-L23-24: the reason for this thresholds is not clear. Why are such cut-off values applied?

P2490-L4: what is meant by *thinning*? Is this a regridding to a coarser resolution? Please clarify.

P2490-L13: why can variance and correlation length only vary zonally and vertically? Is there no dependence on time and/or longitude?

P2492-L9: as an alternative, the *diffv* operator from the CDO package is also very useful (https://code.zmaw.de/projects/cdo).

Figure 1: on the vertical axis, I would provide the actual pressure or altitude coordinate.

Figure 2 and Figure 3: units are missing

Minor remarks

P2484-L3: please provide in brackets the country of the National Centers for Environmental Predictions (USA?).

P2484-L4: "the implementation" (article missing)

P2484-L8: "make" → "to be made"

P2484-L20: "meteorological assimilation was only applied to meteorology"; this sounds like a repetition, I would delete "meteorological".

P2486-L3: the URL seems to have changed to airnowapi.org. Please check and update.

P2486-L8: "and rural" → "and on rural".

P2486-L19: "both aerosol" → "both PM aerosol".

P2488-L4: "The forward models" (article missing).

P2488-L8: I guess P_{25} is a typo for $PM_{2.5}$.

P2488-L8: "(BC_1, BC_2)" → "(BC_1 and BC_2, respectively)".

P2488-L9: "(OC_1, OC_2)" → "(OC_1 and OC_2, respectively)".

P2489-L15: "A representativeness error" (article missing).

P2489-L25: "distance" → "difference" or "deviation".

P2490-L4: "the volume" (missing article).

P2490-L9: "section on background error" → "the next section".