

Review 3 :

General Comments:

The article is about the implementation of an Ensemble Optimal Interpolation (EnOI) method in the numerical chemistry weather prediction system GRAPES_Meso5.1 / CUACE to improve PM2.5 and visibility forecasts of pollution episodes in China. EnOI of PM2.5 improves the model's initial field and forecasting of PM2.5 and visibility to a certain degree. The interesting point of this work is the EnOI's use in the application of PM2.5 involving over 1500 surface observation stations and visibility in China mainland, such a large domain. Particularly the improvement in visibility forecasting is a new attempt and scientific means.

Every comment by the first reviewers is taken seriously, some new experiments are conducted, essential figures and text are added and the article has been substantially revised according to the reviewers' suggestions. The revised manuscript fits the level and scope of GMD. I suggest publication after corrections of the following minor errors:

Response: Thank you very much for taking the time to read our paper. Sincerely thanks for the positive general evaluation and the detailed and professional comments and this is valuable for the paper improving, all the comments have been carefully addressed. Enclosed below are our point-to-point responses to these comments.

Minors:

Line 16: "to do" may be replace by "in" ?

Response: "to do" has been replaced by "in". (Line 16 in the revised manuscript)

Line 25: "than in the heavy pollution period," should be "than that in the heavy pollution period." ?

Response: The sentences have been completed. (Line 25 in the revised manuscript)

Lin 25-26: "Since visibility is much more affected by humidity during the heavy pollution period accompanied by low or extreme low visibility, To get", should be replaced by "Considering the large contribution of humidity low or extreme low visibility during the heavy pollution period, to get"

Response: In conjunction with the fourth reviewer's comment the sentence has been removed. (Lines 25 to 28 in the revised manuscript)

Line 32: "all developing" should be "most developing"

Response: Words have been corrected. (Line 32 in the revised manuscript)

Line 34: delete "including"

Response: The words have been removed. (Line 34 in the revised manuscript)

Line 36: "effectively absorb and scatter solar radiation", "absorb and scatter solar radiation effectively" maybe better

Response: The sentence has been revised. (Line 36 in the revised manuscript)

Line 42: “in CTM or CCMM,” change to “by CTM or CCMM”

Response: The sentence has been revised. (Line 42 in the revised manuscript)

Line 67: “the previous studies” change to “previous studies”

Response: Removed "the" from the sentence. (Line 68 in the revised manuscript)

Line 79: References should be sorted by the time series, please examine and revised the references order here and the whole manuscript.

Response: The order of the references has been adjusted. (Line 80 in the revised manuscript)

Line 168: “The model system consists of two main components, which are called GRAPES_Meso and CUACE, respectively” should revise as “The model system is established by online coupling the Chinese Unified Atmospheric Chemistry Environment model (CUACE) with meteorology model GRAPES_Meso5.1 ”, corresponding delete the full name of CUACE on line 177 should be deleted.

Response: Deleted "consists of two main components, which are called GRAPES_Meso and CUACE, respectively". Corrected to "The model system is established by online coupling the Chinese Unified Atmospheric Chemistry Environment model (CUACE) with The model system is established by online coupling the Chinese Unified Atmospheric Chemistry Environment model (CUACE) with meteorology model GRAPES_Meso5.1', and the corresponding content in line 177 has been deleted. (Lines 168 to 170, Lines 178 to 179, Lines 188 to 189 line in the revised manuscript)

Line 182: “ aerosols.. ” should be “aerosols. ”

Response: Removed extra spaces. (Line 183 in the revised manuscript)

Line 187: delete the phrase “GRAPES_Meso and CUACE are online fully-coupled”

Response: Deleted. (Lines 188 to 189 in the revised manuscript)

Line 192: “less than 10km, according to” should be “ less than 10km according to ”

Response: Removed comma. (Line 193 in the revised manuscript)

Line 204: “Fig. -2. ”, Fig. and Figure are both used in the whole manuscript, please uniform Fig. or Figure (use the same one)

Response: Checked the whole text and used "Figure" at the beginning of sentences and "Fig." in sentences. (Line 205 in the revised manuscript)

Line 212, 216, 217 and etc: “0000 UTC” or “00:00UTC” ??? please make sure and examine the similar words in the whole manuscript.

Response: We checked the expressions in the full text and they are all uniformly "0000 UTC".

Line 233: section 3.1 title “Sensitivity experiments of localization length-scale” is better? Similar to section 3.2.

Response: Changed to "Sensitivity experiments of localization length-scale" and "Sensitivity

experiments of ensemble size". (Line 234 and 269 in the revised manuscript)

Line 259: "m-3,MB" revised as "m-3, MB"

Response: Added space between "m-3" and "MB". (Line 260 in the revised manuscript)

Line 272: "m.s-1" should be "m s-1"?

Response: Removed "!' ". (Line 273 in the revised manuscript)

Line 274: "in A and B.." is "in A and B. "

Response: Removed the redundant "!' ". (Line 275 in the revised manuscript)

Line 319: "days 3 to 7 as", please offer the specific date here, also "the last two days" and "the first two days"

Response: The sentences have been completed. (Lines 319 to 322 in the revised manuscript)

Line 340: 3.4 The title "EnOI's Impact on forecast" may be better

Response: Removed "fields". (Line 344 in the revised manuscript)

Line 341: delete "fields"

Response: Removed "fields". (Line 345 in the revised manuscript)

Line 375: "than 0000 UTC" please revised it as "than that at 0000 UTC"

Response: The sentences have been completed. (Line 378 in the revised manuscript)

Line 398: "3.4.2 Impact on Visibility forecast fields", delete "fields"

Response: Removed "fields". (Line 400 in the revised manuscript)

Review 4:

This paper develops an efficient and quick-update data assimilation system based on ensemble optimal interpolation (EnOI) for an operational online regional atmospheric chemistry model. The possibility of the practical application of the EnOI is shown and the key problems related to the approach are discussed. In particular, the data assimilation system can provide more accurate initial fields of PM_{2.5} and better forecasts of visibility. It is found that the EnOI scheme provide a cost-effective alternative to the use of an ensemble of forecasts, and that is very promising for real-time operational air quality forecast. The topic is well within the scope of GMD.

The revised manuscript has been modified and significantly improved with corresponding revisions according to the former reviewers' comments. The method and results are well structured and clearly presented. Proper credit to related work and this study contribution to air quality forecast have been given. The writing is fluent and clear. Therefore, I recommend the paper is suitable for publication in GMD.

Response: Thank you very much for taking the time to read our paper. Sincerely thanks for the

positive general evaluation. Enclosed below are our point-to-point responses to these comments.

Minor comments:

Line 79: references should be cited in order of time.

Response: The order of the references has been adjusted. (Line 80 in the revised manuscript)

Line 97: "PM2.5" should be "PM_{2.5}".

Response: 2.5 has been corrected to subscript form. (Line 98 in the revised manuscript)

Line 121 and 128: please make sure the second level of parenthesis in Eq. (8) and Eq. (9) is necessary or not.

Response: Removed extra parentheses from the formula. (Line 123 and 129 in the revised manuscript)

Line 272: "m.s-1" should be "m s⁻¹".

Response: Removed '!'. (Line 273 in the revised manuscript)

Line 457: please add a few more sentences about limitations of this study and the planned further research.

Response: The limitations of this study and future perspectives are extended.. (Lines 430 to 433 in the revised manuscript)