Geoscientific
Model Development
Discussions

Interactive comment on "The new implementation of a computationally efficient modeling tool (STOPS v1.5) into CMAQ v5.0.2 and its application for a more accurate prediction of Asian dust" *by* Wonbae Jeon et al.

Anonymous Referee #1

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Please see the supplementary PDF for a better version *

Reviewing "The new implementation of a computationally efficient modeling tool into CMAQ and its application for a more accurate prediction of Asian Dust" by Jeon et al.

This study by Jeon et al. implemented a new hybrid Lagrangian-Eulerian model, STOPS, into CMAQ, to improve the air quality forecasting. Jeon et al. use the STOPS modeling framework with constrained PM from geostationary satellite AOD to improve the Asian dust event that occurred in South Korea on Feb 22-24, 2015. It demonstrates well how STOPS could be useful in air quality forecast, particularly for the unusual air

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quality events such as Asian dust transport. The merit of using STOPS is on low computational burden compared to CMAQ, which can be critical for emergency forecasting.

The manuscript is well within the scope of GMD. However, the manuscript requires some revisions. Please see my comments below. In addition to those comment, I believe science writing in this manuscript should be improved, with focus on reducing the redundancy and increasing coherence within a paragraph. I have listed several places that need such improvement, but please try to improve throughout the manuscript (not limited to my list). When these comments/suggestions are addressed in the manuscript, I recommend this manuscript to be published in GMD.

Major comments

1. I encourage the authors to clarify the following point carefully throughout the manuscript. In my understanding, the STOPS model seems to be a great modeling tool, mainly due to less computational burden. It might be particularly useful when it needs to explore several possibilities. However, I don't think STOPS itself improves any air quality prediction. Also, the authors already stated that STOPS simulation results are relatively similar to CMAQ. I think the significant improvement in simulated PM10 was contributed by constraining PM10 based on GOCI AOD, not by using the STOPS model. CMAQ with the constrained PM10 from GOCI-AOD should also simulate a more accurate Asian dust. In short, I think STOPS does not contribute to "more accurate" forecasting but could help for "quicker" forecasting. If the authors agree with me, please change any relevant parts throughout the manuscript.

2. I suggest adding more detailed information of STOPS in Section 2.1. It is not easy to picture what exactly the STOPS model does (why is it a hybrid Lagrangian-Eulerian model?). I found the short description on the abstract (line 21-23) and the Figure 1 in Czader et al. (2015) quite helpful, which could be added to Section 2.1. Please clarify model domain and dispersion process used in STOPS: 1) does STOPS accounts for vertical and horizontal dispersion as it transport, like FLEXPART, which

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means it changes the number of grids carrying by STOPS over time?; 2) does STOPS carry a couple of grids in the defined STOPS domain or STOPS moves the defined STOPS domain over time (e.g., 61x61 gridcells in Section 4.1)?

3. I agree with the authors that the main reason for the PM10 underprediction in CMAQ is very likely missing dust emissions, as the threshold friction velocity calculation indicates. However, I don't agree with the authors on how to draw a conclusion that the model meteorology is accurate, mainly because the evaluation results, shown in Figure 3, are not comprehensive. Here are more specific questions related to the evaluation. First of all, why do the authors choose averaged values of 20 sites? I'd strongly prefer to see individual site evaluations. Alternatively, the individual site evaluation can be provided in supplementary material. Secondly, given that the long-range transport of Asian dust to influence South Korea, it is important to simulate correct meteorology from source regions to receptor regions. Would it be possible to include meteorological evaluations in Chinese source regions? Lastly, I encourage including more meteorological variables (such as precipitation, if there is any precipitation event during the event).

4. Please provide a brief description of the CMAQ dust emission parameterizations used in your forecast modeling. It will help readers to understand what the underpredicted threshold friction velocity affects to dust emissions.

Minor comments:

Title

I'd suggest changing a title. What about "Computationally efficient air quality forecasting tool: implementation of a hybrid Lagrangian-Eulerian model into CMAQ v5.0.2"?

Abstract

I'd strongly suggest re-writing this section. Overall abstract seems to sound quite redundant. Please consider taking the suggestions below.

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Page 1; line 17-19 – Please consider moving this to the end of Abstract and either delete or modify this phrase ("for a more accurate prediction of Asian dust event in Korea"): see the major comment above. Page 1; line 20-21 – I'd suggest deleting sentence. It is mentioned in line 31-33. Page 1; line 24-27 – Please consider deleting this as well. Next a few sentences basically say the same information. Having this sentence, it sounds too redundant. Page 1; line 29-31 – I'd suggest modifying this. The following is my suggestion: "The underestimated PM10 concentration is very likely due to missing dust emissions in CMAQ rather than incorrectly simulated meteorology as the model meteorology agrees well with the observations." Page 1; line 32 – Please delete "we use the STOPS modeling system inside the CMAQ model, and", and please modify "we run several STOPS simulations using" to "we used the STOPS model with". Page 2; line 2-4 – Please shorten the sentence. "The simulated PM10 from the STOPS simulations were improved significantly and closely matched to surface observations". Page 2; line 5-9 – Please see my major comment 1.

Introduction

Page 2; line 18-21 - I'd suggest changing "Severe PM events . . . Gobi Desert" to "Dust emissions from Mongolia and Gobi Desert". Page 2; line 23 – please change "become" to "are". Page 2; line 29 – Please rephrase "the numerous factors such as meteorology and emissions ... PM concentrations". It sounds a bit unclear. Page 2; line 21 – Add "modeling" in front of "studies"; change "described" to "shown" and delete "simulation". Page 3; line 31 to Page 3; line 9 – This paragraph should be rewritten in order to deliver the key point clearly, which, I think, improving meteorology and emission inventory do not help better Asian dust forecasting due to the uncertainty in dust emission modeling. Besides, please delete the last sentence (Therefore, ∼): the first part is too obvious to mention, and the second part is somewhat debatable (especially "primarily") and contradicts with "accurate meteorology" above. Page 3; line 25 – This "(STOPS, hereafter)" should be moved above, where STOPS is mentioned in the first time. Page 3; line 22-35 – I found this paragraph This paragraph doesn't sound coherent. Please use

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present tense to state goals and objectives and past tense for methods. Please also modify the paragraph based on my major comment 1. It is incorrect to say that STOPS enhance the PM predictions. Page 3; line 23 – Delete "simulated"; add "to" in front of "determine". Page 3; line 24 – Delete "particularly", as this study focuses on Asian dust event only.

2.2. Modeling system and experimental design

Page 5; line 4-5 – I think this sentence fits better in the end of next paragraph. Page 5; line 10 – why do you mean by "refer to the CAPPS emissions"? Page 5; line 18 – delete "for the simulation" Page 5; line 18-23 – Please shorten the sentences. Page 5; line 24 – Please remove "listed in Table 1" and list the date here.

2.3. In-situ and satellite measurements

Page 5; line 29 – "referred to" to "use" Page 5; line 36 – what is this "500 m resolution" for? Why is it different from AOD's 6 km resolution? Page 6; line 1 – "550 nm AOD" to "AOD at 550nm"

3.1 Comparison with surface measurement

Page 6; line 20-22 – Please define RMSE, IOA and MBE and explain what each measure indicates briefly. Page 6; line 26-29 – Please see the major comment 3. Page 6; line 30-36 – CMAQ dust emission modeling should be explained before this result. Please add the brief description in method section.

3.2 Comparison with satellite-based observation

Page 7; equations 4-6 – It looks like empirically derived method. Does the method by Roy et al. (2007) tested over the Korea as compared to more theoretical-based (Mie theory) optical properties? Is it reasonable to use it for Korea? Also, why isn't there no water uptake by organic aerosol [OM] in Eq 5? Figure 4 – It is good that the CMAQ AOD field shows removed areas with GOCI bad pixels. However, it would be also helpful to present CMAQ AOD without removing any areas in the supplementary

materials. It could show what GOCI might miss in those areas. Page 7; line 32 – delete "the same results" Page 7; line 34 – Do you actually mean "PM precursor" or "PM and its precursor"? If it is indeed specifically "PM precursor", please provide further explanation. Next sentence about meteorology should be re-considered (see major comment) Page 8; line 3 - please add year: Feb 22-24, 2015. Please make the same corrections throughout the manuscript, if possible.

Page 8; line 15-16 – please change "the high amounts of dust particles" to "the high dust concentrations". Page 8; line 19-20 – This should be modified with my major comment 1. I'd suggest changing to this: "We use STOPS to explore how to improve PM10 simulation."

4.2. PM10 forecasting using STOPS

Page 9; line 6-8 – This sentence is unnecessarily long. Please remove "that is, the . . . failed". Page 9; line 8-9 – This should be rephrased, esp. "the most recent and accurate input data". It makes me think about meteorology, emissions, initial and boundary conditions. If the constrained PM10 derived from GOCI AOD is only read in the first time, it is considered initial concentration and thus "input data". However, the way you used the constrained PM10 derived from GOCI AOD in Section 4.2.2 seems more than initialization and close to nudging. Page 9; line 13-18 – Please remove this part. This is out of placed and doesn't have much new information, in my opinion. If the authors want to make a point that the CMAQ with constrained PM using GOCI AOD is less desirable as a forecasting tool due to their long simulations, perhaps do it elsewhere (maybe the end of the paragraph). Page 9; line 18 – what do you mean by "dust core"? center of dust storm? Page 9; line 26- do you actually mean "on the STOPS domain"? Perhaps it is "on the STOPS results"? Also, perhaps "would be diminished" is better than "would be mitigated"?

4.2.1. Satellite-adjusted PM concentrations

This section is particularly confusing. Please re-write them and use figure or diagram

to help readers to understand the method.

Page 9; line 31 – Please remove "To provide ~ AOD into account," and clarify "at the beginning of the updated forecast". Page 9; line 34 – Perhaps "as a constraint" is correct? Page 10 – Isn't the second paragraph better to move? Page 11; line 2-3 – Fix line break

4.2.2. Enhanced PM10 forecasting using STOPS

Page 11; line 22 - why did you said "were assumed to"? Page 11; line 29-30 – please shorten to "Figure 8 exhibits clear..." Page 11; line 27 – please add ", shown in Fig. 8," after using STOPS Page 11; line 32 – please change to "because of the poor dust emission modeling in CMAQ". Page 11; line 36~ - Isn't this already mentioned in Line 30? Page 12; line 32 – Remove "changed" in "To verify the changed horizontal"

Summary

Please revise the summary section if it is subject to the major comments.

Page 13; line 22 – "but with" to "but used" Page 13; line 24 – add comma between "dust events" and "we"

Tables & Figures

Table 2 – "Without Dust Events" to "Without dust events" Figure 1 – It is hard to find the site location. I was able to find only 17 sites. Can you use color symbol for sites? Figure 2 – It would be nice, if the dust event days were shown in the figure. Figure 6 – Does white space shown in the map represent for very low AOD or does it also include areas with missing pixels? Just in cases missing areas should be shown in white. Figure 7 – Please double check the caption. It says standard and constrained CMAQ runs, while "constrained CMAQ run" is never discussed in the main text.

Please also note the supplement to this comment:
http://www.geosci-model-dev-discuss.net/gmd-2016-180/gmd-2016-180-RC1-

supplement.pdf