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Geoscientific Model Development Discussions

Interactive comment on "Aerosol effects modeling using an online coupling between the meteorological model WRF and the chemistry-transport model CHIMERE" *by* Régis Briant et al.

Anonymous Referee #2

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General Comments:

This paper describes the development of an on-line coupled chemistry-weather model using the WRF weather forecasting model and CHIMERE chemical transport model, coupled for the first time using OASIS –MCT. The authors then assess the impact of the coupled system on the regional simulation of aerosols over Northern Africa and Europe and the feedback of the aerosols due to the direct and semi-direct effect on model radiation fields, surface temperature and wind fields. Observations of aerosol optical depth and temperature profiles are used to evaluate the performance of the

three different test cases (offline, online coupling of meteorological fields to CHIMERE only, and online coupling of met fields and aerosol between CHIMERE and WRF).

While the development of the online coupled chemistry-weather models and impact on weather forecasts is of increasing interest in both the weather and atmospheric composition communities, I find this paper poorly written and lacking in a substantial discussion of what are the principle aims of the paper. Evaluating the impacts of the inclusion of aerosol-radiation-interactions on the radiation balance in the model and other meteorological fields is of interest to the community but it is not new, particularly when the authors focus on a dust specific case and make no mention of the role of anthropogenic emissions, even though CHIMERE simulates more than just dust aerosol. The current evaluation does nothing but confirm the findings of many other dust specific studies already published in the literature (not all of which are referenced here). What the paper is crucially lacking is a discussion on what are the potential benefits (or not) of having a fully online coupled chemistry-weather system for (a) aerosol performance (as assessed through Online Case 1) and (b) weather forecast skill (as assessed in Online Case 2) versus the offline model. There is no clear statement on these points. The paper would strongly benefit from a Discussion section summarizing the results and putting them into context of the aims of the paper. This is highlighted by the authors use of language such as "may result" a number of times (such as in the discussion of temperature impacts and AOD). There should be no ambiguity in the results and the authors should be able to clearly demonstrate their findings with confidence in order to draw conclusions.

I would not publish this paper in this current form but it would be publishable if substantial improvements were made in terms of both presentation and scientific content. Major revisions are requested as outlined below.

Specific Comments:

Abstract, Line 3: "several distinct models are involved" . Do you mean parameteriza-

tions? It would be more correct to highlight the inherent uncertainty in the processes involved.

Abstract, line 7: “This is mainly due to some additional computations made within the models such as more frequent calls to meteorology...” – what about the additional cost due to the additional number of tracers in the CTM? How significant is this cost?

Paper Layout: I would recommend putting the model descriptions described in Section 3 before the Coupling description section. It is very difficult to follow the coupling description without some knowledge of the individual models.

I would also strongly recommend the inclusion of a Discussion section before the Conclusions to bring the evaluation presented in Section 5 into context in terms of the main aims of the paper.

The main aims of the paper should be clearly stated in the Introduction.

Introduction: There are much more appropriate references for the direct and indirect aerosol effects, please update. Use of the word “effects” to describe aerosol feedback as opposed to “interactions” – CMIP5 did update this terminology for the direct and indirect effects to be aerosol-radiation interactions and aerosol-cloud-radiation interactions. I would recommend updating the terminology to what is now routinely used in the literature.

Introduction, page 2 line 2: The statement that aerosol effects are neglected by offline models, is this strictly true? Do these models not have a climatological representation of aerosols or even just use some fixed numbers? If so then they do not neglect them but just have a very (possibly overly) simplified approach to representing them.

Coupling Methods and Assessment of Computational Performance: How can you assess the impact of the coupled system on the computational performance of the model without appropriate load balancing? The results presented here are therefore not a correct representation of what an optimally load balanced system would look like, severely

affecting the WRF wait time for instance. It is well known that CTMs are very computationally intensive and require appropriate load balancing and I am surprised the authors have not done this. I find this a major flaw in the scientific methods and recommend redoing the computational analysis on an appropriately load balanced system.

The authors refer in a number of places (in the Abstract, Section 2.4 and Conclusions for instance) on the additional computational time requirements of CHIMERE “due to more frequent calls to meteorology treatment routines” when in ONLINE mode. Can the authors please expand on this ? What routines need to be called more frequently and why? Section 5: I would include in the section title that this is a dust specific case study.

In the WRF-CHIMERE online simulations covering the May to July 2012 period, is WRF free-running? I assume it is being driven by an analysis. If this is the please include details of how WRF is driven and how frequently. If it’s not the case then a free-running model is very quickly going to diverge from the true meteorological conditions which will severely impact the simulation and distribution of aerosols and associated biases.

Impacts on radiation would benefit from a link to the spatial distribution of the dust. Inclusion of a spatial AOD plot in Figure 7 or dust AOD if possible would highlight the impacts better.

Figure 7: Are these all-sky fluxes? The increase in net SW at the surface is linked to cloud changes, is this just a surmise or have the authors evaluated this? For example, did the authors assess the impact on the SW cloud forcing? Please improve this discussion and wording.

End of Section 5.1 – what is the impact of the aerosol feedback on dust emission? A plot would be informative or even a statement of the regional % change.

Technical Corrections:

Figure 7 has no caption or figure labels

All figures are missing appropriate labels (a), (b), (c) etc.

Figure 11: it is much clearer if (model-obs) is plotted rather than (obs – model) , in the former a negative value is associated with a negative bias or underestimation which is much clearer than vice versa with the former.

Page 1, line 21: The aerosol effects processes –> ?? see my earlier comment on updating the terminology of aerosol effects –> interactions.

Page8, line16: Please include appropriate references for WFR and CHIMERE configurations.

Page 9, line 8: planeray –> planetary

Page 9, line 12 – put link in parentheses

Page 9, line 11: Anthropic –> Anthropogenic

Page 10, line 2: Tests consist in –> Tests consist of

Page 10, line 2: 64 cores computer –> 64 computer cores

Page 14: Line 12: The perturbation is dominated by dust “as observed” – what observations are you referring to here?

Page 18 line, second last line: Above 1000 meter each of the two simulations perform better alternatively – badly phrased sentence which doesn’t make sense, reword.

Page 19, first paragraph and in other areas of the manuscript the authors use the phrase “difference among models” –> difference between models. Change all occurrences.

Section 5.4, last paragraph: There is no discussion here of the contribution of anthropogenic source to the AOD observed at particularly more northern European stations. There is very little difference between the 3 test cases really in terms of rmse and bias and correlations. Can the authors draw a conclusion on the role of the more highly

resolved meteorology on improving AOD simulations.

PM10 evaluation: a plot or a table summarizing the PM10 results would be useful. The authors should acknowledge that there is a lot more at play here than just the online coupling, in terms of aerosol size distribution, transport and removal processes of in particular dust and sea salt will play a large role in PM10.

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