Review of « Dust aerosol radiative effects during summer 2012 simulated with a coupled regional aerosol-atmosphere-ocean model over the Mediterranean »

Authors: We would like first to thank the reviewers for the evaluation of our work and their positive comments and interesting suggestions. We have addressed all the comments and questions in detail, and clarified the mentioned points. Please find below our point-by-point replies highlighted in bold. Corrections in the text are indicated in italics (page and line numbers refer to the revised manuscript).

Report #2:

General comments:
According to the tittle the manuscript deals with the simulation of dust aerosol and its radiative effects by means of a coupled regional aerosol-atmosphere-model. In order to test the success of the modeling scheme the authors apply it to the Mediterranean basin during summer 2012. The model results are tested against experimental data on aerosol optical depth, total solar irradiance and temperature at surface level. In fact the selected study case corresponds to the whole summer with intensive measurements of some variables during short periods. The study is interesting and the results obtained are relevant in the framework of atmospheric aerosol studies and their role in the Earth energy balance and through this on the evaluation of the aerosol climate effect. Nevertheless, the manuscript includes some errors that the author must correct before the manuscript will be publishable in ACP. Mainly there is some confusion on terminology concerning the climate and meteorology scales. Especially the abstract is confusing using terms like "Mediterranean climate daily variability". In fact, although the results of the study are relevant for climate studies the study in itself only tests the modeling scheme against a study case, although the study case covers in fact a period of a whole summer. The success of the modeling is tested using different time scales, since the daily scale at particular stations to the summer average at the regional level. Due to the broad cover of the paper sometimes these facts are not clearly stated.
Authors: The distinction between climate and meteorology is effectively not obvious in our case. We admit that a study of three months is not long enough to characterize the aerosol-climate interactions and that this study deals with the impact of dust aerosols on daily radiation and temperature, which could be important for numerical weather forecast. However, our study is not limited to the meteorological time scale (about a few days). As defined by WMO and IPCC, climate refers to the "the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from <u>months</u> to thousands or millions of years". The identification of dusty days through a composite study is closer to climate than to weather forecast. The section dealing with the impact of using a prognostic aerosol scheme instead of a monthly climatology on the summer average is also closer to climate, as well as the use of the ocean model and the study of SST.
Finally, we have moderated our words in the revised version of the paper, and mentioned the necessity of a longer period of study in the discussion (Section 4.5). Note also that the world climate is not in the title of the paper.
Page 1 line 1: The present study investigates the radiative and climatic effects of dust aerosols in the Mediterranean region during summer 2012.
Page 2 line 149: Thus the present work aims at studying the radiative and climatic effects of dust aerosols in the Mediterranean area during summer 2012. The question of the difference between the use of climatological and prognostic aerosols in this model will also be raised, notably to study the consequences of this choice both on the daily and seasonal (for summer) variability of different meteorological parameters (radiation, temperature, cloud cover).
Page 19 line 958: the composite study and the analysis of the utility of prognostic aerosols should be redone on a longer period

Particular comments:
The abstract must be rewording taking in mind the comment on the confusion about meteorology and climate previously mentioned.
Authors: The abstract has been corrected.

Also the introduction requires a depth review in order to avoid expressions like: "A particularly intense dust event has been measured at the end of June with different observation means (balloons, aircraft, surface and remote-sensing measurements), and consequently represents a documented case to evaluate the ability of climate models to reproduce this kind of events and their effects on climate". As I said before you can test the capability of the coupled regional aerosol–atmosphere–ocean model to reproduce a particular event but you can't evaluate the effect on climate of a particular event, is a matter of scales.
Authors: The introduction has been modified to better explain this question of scales.
Page 2 Line 77: consequently represents a documented case to evaluate the ability of regional climate models to reproduce this kind of events and the associated radiative and climatic effects of aerosols. Indeed the evaluation of regional climate models is possible through case studies, made possible by the use of a reanalysis as lateral boundary forcing which provides the real chronology of these events.

Since the beginning the purpose of running the simulations SN-PROG, SN-PROG-M and SN-NO must be clearly stated. The utility of SN-NO to capture the variability in the analyzed fields due to other elements different of the aerosol is interesting, must be clearly formulated since the beginning. The utility of SN-PROG-M is not so clear to me and must be justified. It is obvious that using monthly values for the aerosol field will not capture effect of the daily variability of this component so likely this part of the study can be excluded.
Authors: The utility of PROG-M and NO has been clarified in the revised version of the paper.
Page 4 Line 292: First of all, the PROG simulation includes the whole aerosol prognostic scheme described previously. Secondly, in order to estimate the effect of aerosols on meteorological variables such as temperature and radiation, a simulation without aerosols is needed : the NO simulation does not include aerosols. Thirdly, as the objective of this study is also to discuss the choice of using climatological or prognostic aerosols, another simulation, called PROG-M, uses monthly AOD provided by PROG, so that PROG and PROG-M share the same average aerosol content at the monthly scale. Comparisons between these simulations will enable to estimate the aerosol effects on the radiative budget and regional climate, and the implications of using a prognostic aerosol scheme instead of monthly climatologies. While an improvement on daily SW radiation variability is expected with the use of prognostic aerosols, it is more difficult to answer a priori for other daily parameters (2m-temperature, SST), and more generally for consequences on the summer average.

Concerning the presentation of results it is necessary to include the uncertainties associate to both the experimental values and the model outputs. This is especially interesting for the daily comparison and for the particular cases like the aerosol extinction coefficient profiles. The uncertainties on the retrieval of the extinction coefficient from elastic lidar using the Klett algorithm would lead to large uncertainties in spite of using the AERONET aerosol optical depth as a constrain that must be included.
Authors: Uncertainties concerning the AOD measurements have been added both for ground-based measurements (AERONET, ±0.01) and satellite retrievals (±0.05).
Page 6 Line 428: Indeed AERONET measurements benefit from a higher temporal resolution than data from moving satellites and their accuracy is generally higher, about ±0.01 (Holben et al., 1998) against about ±0.05 for satellites (Kahn et al., 2010; Levy et al., 2010).
Page 19 Line 973: With regards to the uncertainties of the model outputs, they will be more

deeply evaluated in a multi-model exercise currently carried out in the framework of the TRAQA/ChArMEx campaign.

Concerning the capability of the modeling scheme to simulate the aerosol profile, the authors are really optimistic in their comment on the success of this simulation, specially looking at the results over Barcelona. Anyway the use of only two profiles is too poor to extract conclusions on the effectivity of the modeling scheme to reproduce the aerosol vertical structure.
Authors: The comments on the performance of the model for simulating the aerosol vertical profiles have been moderated. The use of only two profiles here is due to the difficulty of evaluating the vertical distribution of dust as simulated by a model for a specific dust case. Indeed, this exercise requires to find a case where the model simulates the dust plume at the exact place and moment where and when observations are available.
Page 9 Line 527: In summary, the comparison between these lidar profiles and the dust extinction simulated profiles has shown that CNRM-RCSM5 was able to simulate the different altitudes of dust aerosols, even if it should be mentioned that two profiles are not sufficient to conclude. This kind of comparison would need to be done for other places and situations, but it is a difficult exercise as evaluating only the aerosol vertical distribution implies to find cases where adequate observations are available and where the model correctly simulates the transport of dust aerosols.

Looking at figure 1 it seems that some AERONET stations in southern Iberian Peninsula are missing, there is any reason for this?
Authors: We have given priority to stations which provide the highest number of observations as possible. Some stations from Iberian Peninsula have gaps in summer 2012.

All the discussions on numeric results require including the uncertainties associated to modeling and experimental measurements and in addition due to the approach used, checking summer averages of regional fields or daily averages of the atmospheric variables in a particular site, an indication of data spreading through standard deviation values is required.
Authors: A discussion part (see section 4.5 in the revised version of the paper) has been added to deal with the question of uncertainties in observations and in the model, the choice of the approach and the period of time.

The quality of figures must be improved, especially concerning the size of labels and scales. Any axis must include the appropriate units used that in some cases are missed, see for example Figure 6
Authors: Corrected.

References:

Holben, B. N., Eck, T. F., Slutsker, I., Tanr´e, D., Buis, J. P., Setzer, A., Vermote, E., Reagan, J. A., Kaufman, Y., Nakajima, T., Lavenu, F., Jankowiak, I., and Smirnov, A.: AERONET-A Federated Instrument Network and Data Archive for Aerosol Characterization, Remote Sens. Environ., 66, 1–16, doi:10.1016/S0034-4257(98)00031-5, 1998.

R. A. Kahn, B. J. Gaitley, M. J. Garay, D. J. Diner, T. F. Eck, A. Smirnov, et B. N. Holben. Multiangle Imaging SpectroRadiometer global aerosol product assessment by comparison with the Aerosol Robotic Network. Journal of Geophysical Research, 115 :D23209, 2010. doi : 10.1029/2010JD014601.

Levy, R. C., Remer, L. A., Kleidman, R. G., Mattoo, S., Ichoku, C., Kahn, R., and Eck, T. F.: Global evaluation of the collection 5 modis dark-target aerosol products over land, Atmospherics, Chemistry and Physics, 10, 10 399–10 420, doi:10.5194/acp-10-10399-2010, 2010.