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 #1:

General comments:

This paper aims at characterizing the dust aerosol radiative effects over the Mediterranean. The focus is done over a specific period, the summer 2012, in which in-situ measurements were made as part of the campaign TRAQA/CHARMEX. This paper addresses several different questions: (i) the ability of a model dust emissions scheme to produce realistic fluxes and then aerosols concentrations, (ii) the impact of these dust concentrations on the daily radiation variability, (iii) the impact of the use of a deterministic scheme in place of a climatology, (iv) climatological differences between 'dusty' or not days, (v) a comparions between several AOD satellite products.

This leads to a very long paper, mixing several concepts: climate and a specific studied case, model sensitivity tests, model comparisons (with MACC), data comparisons, impact of aerosols on radiation, comparisons between model outputs and measurements. The result is sometimes not very clear and several issues has to be corrected before publications. Removing unnecessary parts could make the article more clear and precise.

Authors: We have prepared a revised version of the paper answering the different points mentioned above. The detailed replies to the different points are presented below. As a general rule, we have tried to make the paper clearer and shorter, and for this reason we have reorganized the previous sections 3, 4 and 5 inside the two following sections :

- Section 3 (the evaluation part) is clearly separated into the following subsections (3.1) for the spatial evaluation of total AOD, (3.2) for the temporal evaluation of AOD, (3.3) for the evaluation of the contribution of aerosol species to AOD, (3.4) for the evaluation of dust extinction vertical profile and (3.5) for the evaluation of the dust mass size distribution at different altitudes.

- Section 4 is the section devoted to the estimation of the radiative and climatic effects of aerosols : (4.1) for the direct radiative forcing, (4.2) for the impacts of aerosols at the daily scale, (4.3) for the composite study, (4.4) for the impact of using a prognostic aerosol scheme on the summer average and (4.5) for a discussion that takes into account the reviewers' remarks.

As a consequence, all the other elements (text and figures) have been removed.

Regardless of long or unnecessary parts, there is critical issues:

1. the paper is presented as a study of 'aerosol-climate' interactions. There is a confusion between meteorology and climatology. And this is all along the paper. The aerosols hourly interact with the meteorological variables, leading, after a long time, to a climate change. But you can not claim that, with a study of three months, you are able to characterize the 'aerosol-climate' interactions over a region.

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

2. The comparison between an aerosol climatology and a deterministic calculation of dust emissions has no sense in the framework of a case study. Knowing the large variability of daily emissions, it is obvious that a climatology of aerosols is not adaptated. This part of the paper should be removed because the confusion between hourly meteorology and climate does not highlight the entire study.
Authors: We are aware that an aerosol monthly climatology is not adapted to the study of daily dust events over the Mediterranean, but many regional climate models do not include daily aerosol variations (e.g. Artale et al., 2010; Herrmann et al., 2011; L'Hévéder et al., 2012). In this paper, we aim first at showing the ability of a new aerosol scheme, included in the ALADIN-Climate model, to reproduce the main aerosol physical and optical properties, as well as the vertical profiles of the TRAQA/ChArMEx experiment. Secondly, we have investigated the consequences of the aerosol radiative effect on the regional climate (SW radiation, temperature, etc.) by using this interactive aerosol scheme instead of a monthly climatology, not only in terms of daily variables but also in terms of seasonal means, which has never been done before over the Mediterranean region to our knowledge. One of the goal of the paper is to question the current practices of the RCM community. The results, now presented in a separated section (4.3), show the impact of this choice on the summer means of surface radiation and temperature.

3. the modelled domain is not adaptated to the studied problem. For a study about mineral dust long-range transport, this is surprising to make simulations with a large part of missing African dust emissions potential sources: the lowest latitude of the domain is 8N (domain is not explained in the text and figures are small), when a latitude of 0 is a minimum to be sure to catch all possible events.
Authors: Compared to previous studies carried out with the ALADIN-Climate model using aerosol climatologies, here our domain has been extended to include all the sources of aerosols affecting the Mediterranean area. In particular, it covers the whole Saharan desert up to 14°N and the whole Arabian peninsula. It has also been extended westward over the Atlantic ocean, to allow dust transport in this area that could reach the Mediterranean region after few days when passing over Spain. With this domain, we include all the dust sources that can affect the Mediterranean area (Middleton and Goudie, 2001; Israelevich et al., 2012): North African sources (Morocco, Algeria, Tunisia), the Hoggar mountains, the Tibesti Mountains, the Bodele depression, Libya, Egypt as well as sources near the Red Sea (northeast Sudan, Djibouti). All these sources are clearly visible in Figure 1, which presents the total dust emission simulated by CNRM-RCSM5 during summer 2012. In addition, this domain is wider than the one used

in a previous modelling study of dust aerosols over the Mediterranean basin (Nabat et al., 2012). The justification of the model domain has also been added in the revised version of the paper.
Page 3 Line 218: As far as dust particles are concerned (Middleton and Goudie, 2001; Israelevich et al., 2012), the following sources are notably included in the domain: North African sources (Morocco, Algeria, Tunisia), the Hoggar mountains, the Tibesti Mountains, the Bodele depression, Libya, Egypt as well as sources near the Red Sea (northeast Sudan, Djibouti). No aerosol is indeed included in the lateral boundary forcing.

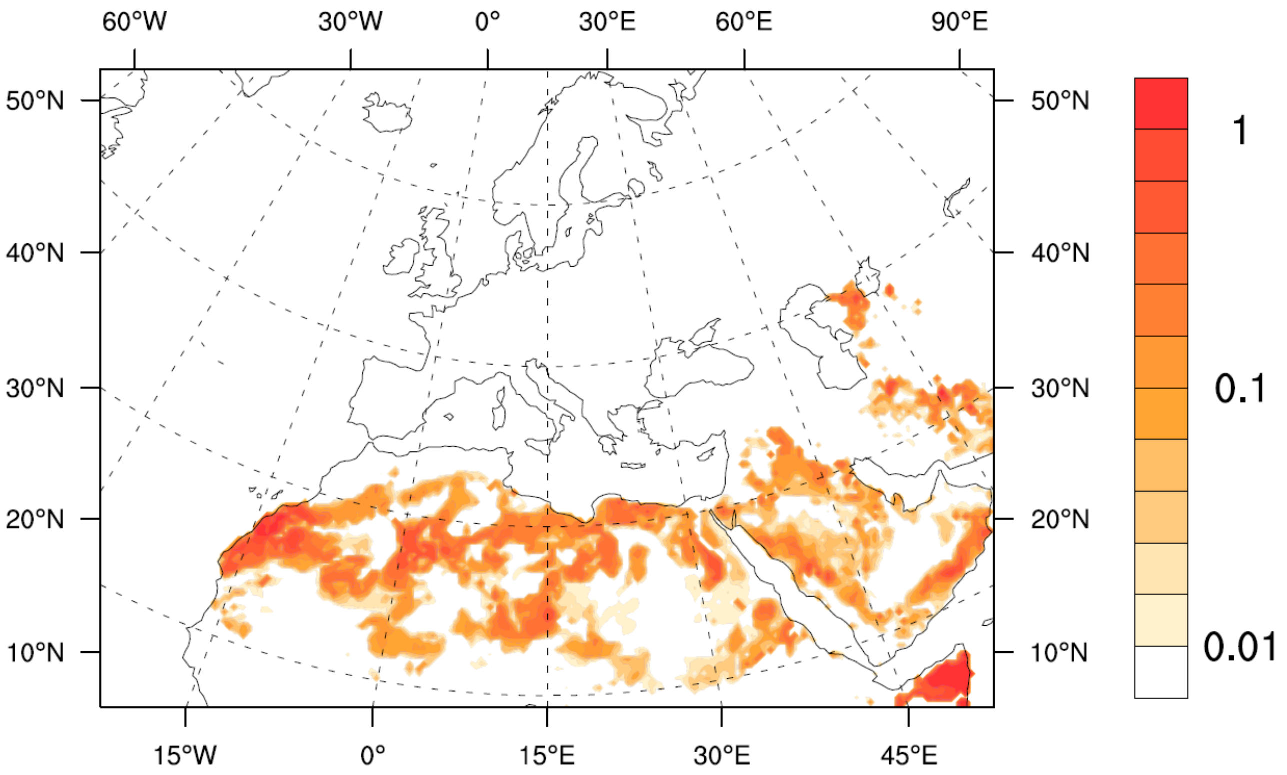

Figure 1 : Total dust emission during summer 2012 (kg/m²)

4. The use of MACC outputs does not provide significant added value to the article and should be removed.
Authors: We agree that the comparison is not very useful for the evaluation of total AOD, as we already have observations from both satellites and ground-based measurements. However, with regards to the evaluation of the contributions of the different aerosol types to AOD, no direct observation is available. Therefore, MACC is an interesting product, since it includes AOD assimilation from the MODIS sensor. Moreover, MACC is more and more considered as a reference in the aerosol modelling community. In the revised version of the paper, we have removed from the text the part concerning the comparison between simulated total AOD and MACC AOD (but MACC has been kept in the figures as an information for the reader), but kept MACC in the evaluation of the contribution of aerosol species to AOD.

5. The criterion used to select the 'dusty' days seems to be inappropriate. The use of a number (10%) of dusty days to select them as well as the use of AOD in place of Angstrom coefficient to select dust periods make results difficult to understand.
Authors: We admit that the method used to select the dusty days could be difficult to understand. We have now taken into account the simulated dust AOD (instead of total simulated AOD) and a unique threshold for all the stations (see more details in the reply to specific comments below). Unfortunately it was impossible to take into account the Angstrom

coefficient in the criteria to select the dusty days, because (1) for some stations in the composite study where daily AOD observations are given by AERUS-GEO (the two buoys, Fès, Ajaccio and Nice), we do not have the Angstrom coefficient; (2) the Angstrom coefficient is not directly computed in the model.

Specific comments:
1. Introduction:
- the term 'interactive dust scheme' is not clear. Do you mean 'dust production scheme'? - Dust particles are not from 'desert sources' but from 'arid areas'
Authors: Interactive has been replaced by prognostic, and the different processes (emission, transport, deposition) have been clearly mentioned.
Page 2 Line 90: models need prognostic dust schemes (emission, transport, deposition) to uplift dust particles from arid areas and transport them in the atmosphere.

2.2 The aerosol scheme
p. 25359 l.2: The dust emission scheme is a keypoint for this study, the results being directly compared to a climatology. But the scheme itself appear to be an old scheme, not up to date compared to the model development on dust emissions these last ten years. Mainly: the Marticorena and Bergametti uses constant values to estimate the vertical dust flux from the horizontal one. But these constant values were primarily fitted over the Sahara and sahel region. p. 25359 l. 7 and 17: Finally, these fluxes are integrated in 3 bins (whereas others aerosols are over 12 bins?). For hourly regional studies, 3 bins are not sufficient, leading to errors in transport, sedimentation and deposition. If the model is limited in computer resources, it is better to use lognormal modes for dust. p. 25359 l. 21: The aerosol scheme is not complete and certainly useful for some climate studies. But is it really adaptated for this specific study, focussing on a real event during three months? What about the nitrate?
Some references discussing these points: - Mahowald, N., et al. The size distribution of desert dust aerosols and its impact on the Earth system. Aeolian Research 2013), 10.1016/j.aeolia.2013.09.002 - Knippertz and Todd, 2012, Mineral dust aerosols over the Sahara: meteorological controls on emission and transport and implications for modeling, Reviews of Geophysics, 50, RG1007. - Simpson et al, The EMEP MSC-W chemical transport model - technical descriptions, Atmos. Chem. Phys., 12, 7825-7865, 2012. - Shao et al., 2011, Dust cycle: An emerging core theme in Earth system science, Aeolian Research, 181-204.
Authors : First, we would like to mention that our objective was to set up a coupled regional climate model where aerosols are one of the components of the climate system, for a low numerical cost. For example, a coupled simulation over a period of thirty years only needs one month to be carried out. In this framework, we present here the aerosol scheme of CNRM-RCSM, which is indeed a simplified aerosol scheme compared to chemistry-transport models. This scheme first needs to be evaluated against case studies, before being used in multi-annual simulations.
The dust scheme has been upgraded compared to the version used in the MACC reanalysis. It is based on the work of Marticorena and Bergametti (1995) and Kok (2011). The vertical dust flux is calculated from the horizontal one in function of the clay content, so that it is not constant over the domain. Using three dust aerosol bins to represent the whole size distribution is indeed a limitation of our study. However we had to find a compromise between the computational cost for a regional climate model (the need to perform multi-annual simulations) and the representation of the dust radiative effects. Using three bins for dust aerosols enables us to distinguish the effects of submicronic particles which have an important contribution to the aerosol shortwave extinction, from those of larger particles (coarse mode), important for deposition processes and longwave-radiation interactions. Many other global and regional climate models have a similar number of bins (3 for MACC, 4 for RegCM, 5 for COSMO-MUSCAT, between 2 and 8 for AEROCOM models, see Huneeus et

al., 2011), which is also mentioned by Mahowald et al. (2013). Besides, there are still many uncertainties in dust emission (Shao et al., 2011; Knippertz and Todd, 2012), partly due to the lack of observations, notably under convective clouds in dust-emitting regions. Finally, the evaluation of our model against different observations in summer 2012 (AOD, size distribution, vertical profile) has shown that it was able to correctly reproduce dust outbreaks over the Mediterranean basin despite the limitations mentioned above (and now clearly stated in the revised version of the paper). All these points have been added in the paper, in the introduction and in the discussion part.
Page 2 Line 103: large uncertainties remain in the characterization of dust properties and the resulting impact on climate (Huneeus et al., 2011; Mahowald et al., 2013)
Page 3 Line 281: The complexity of this aerosol scheme is similar to the one used in RegCM, but it does not include detailed chemical processes that can be found in COSMO-ART (Vogel et al., 2009). However it enables our model to keep a low cost of calculations, so that multi-annual simulations could be carried out for aerosol-climate studies.
Page 19 Line 977: Finally, the low complexity of the aerosol scheme used in the present work could constitute another limitation. In particular, it does not take into account the detailed processes of the formation of secondary aerosols mainly because of too large numerical cost, nor does it consider the second indirect effect of aerosols because of the huge uncertainties in their parameterizations (Quaas et al., 2009).

Besides, we admit that the absence of nitrate aerosols in our model is regrettable, it is now clearly mentioned in the paper. However, for our study which is especially based on the radiative effects of dust aerosols, the presence of nitrate aerosols is not compulsory. This aerosol species has to be effectively taken into account for future climate simulations as shown by Bellouin et al. (2011).
Page 4 Line 287: Note also that nitrate aerosols are not considered in this model.

3. Evaluation of the simulated aerosols.
p. 25364-25365: This section is dedicated to the model scores. For that, AOD are compared to AERONET measurements. In fact there is also a comparison between several satellite products. This reduces the understanding of the section. The conclusion is the model is better than the satellites compared to aeronet stations: but in this section, the comparisons is done between very different products: sun-photometers high-frequency time resolution, two models, and satellite known to be time-averaged to give realistic aerosols patterns. Thus, the comparisons are really between tomatoes and potatoes and the conclusion that the model is better than the satellite is erroneous. I suggest to remove the comparison to MACC, not useful, and to discuss separately the comparison with the satellites products and the models outputs by adaptating the time average to the products.
Authors: In order to get the evaluation part of the paper clearer, we have now separated the evaluation against satellites (section 3.1 Total AOD: spatial evaluation) from the evaluation against AERONET used for the temporal evaluation (section 3.2) as well as from the evaluation against MACC reserved for the evaluation of the contribution of each aerosol type to AOD (section 3.3). We think that the evaluation against MACC in Table 1 is useful insofar as it provides AOD separately for each aerosol type contrary to observations from satellites and ground-based measurements. Moreover, even if this is not the main objective of the paper, the comparison between MACC, satellites and AERONET provides interesting information for data users and modellers. This point is now discussed in a specific paragraph to get the whole section clearer.

Page 7 Line 464: Besides, the daily values for the satellite products have been added in Figures 3 and 4 as information for data users. It is indeed important to note that in terms of daily variability, (1) MODIS and AERUS-GEO have a higher temporal correlation with AERONET (resp. 0.73 and 0.76) than MISR (0.15), probably because of a reduced number of available retrievals with this instrument, (2) AERUS-GEO has the best scores among the satellite products, (3) MODIS and AERUS-GEO have however respectively 5 and 3 stations with RMSE higher than 1.25, and (4) all these products have a higher mean bias than CNRM-RCSM5.

4. Aerosol radiative effect: Apart to prove that a climatology of aerosols is not adaptated to this kind of study, the interest to have the PROG-M simulation is not useful and should be remove. This is the same than for NO simulation. To study aerosols variablity, the use of no aerosols or climatological aerosols is not suitable and it is just obvious. This leads here to a very long section, given numerous quantification of detailed scores, but based on tools not adaptated to the scientific question.

Authors : In order to get this long section clearer and better highlight the main results, we have reorganized this part in four subsections. The direct radiative forcing of aerosols is studied in paragraph 4.1. The 4.2 part is dedicated to the effect of aerosols at the daily scale on surface radiation and temperature, with results based on the comparison between daily series in the different stations where observations are available. The 4.3 part deals with the composite study, which is necessary to better identify the effect of dust aerosols on daily temperature. Finally, the 4.4 part deals with the consequences of these daily effects on the average for summer 2012, and puts forward the differences between PROG-M and PROG at the seasonal scale. Indeed, while the differences between PROG-M and PROG in terms of daily values could be expected, the differences between these simulations at the seasonal scale are much more unexpected. That is the reason why we think that it is necessary to keep the PROG-M simulation in the paper. Besides, most of the regional climate models over the Mediterranean regions use only monthly AOD fields (e.g. Herrmann et al., 2011; L'Hévéder et al., 2012).

With regards to the NO simulation, NO is essential to be able to calculate the effect of aerosols on meteorological variables such as temperature and radiation. NO also enables us to estimate the "weather" effect in the composite study.

Page 4 Line 298: 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.

5. Composite analysis: In this section, a threshold in AOD is estimated to select between 'dusty' days or not. The following sentences is not clear to me: p.25374 l.16: 'A threshold in AOD has been chosen for each stations in order to have 10% of dusty days'. This means that a 'dusty' days is not defined considering the AOD absolute values, for the 10% of the highest recorded values for one site? What is the physical meaning of this choice? In addition, high AOD are not only due to long-range transport of dust but may be the effect of local intense particulate matter resuspension, long-range transport of other sources (fires for example). To select 'dusty' days, the use of the ratio between fine and coarse mode, angstrom coefficient over the aeronet stations would give more realistic results. After this selection using the data, the study could quantify the ability of the model

to retrieve the same type of scores. But, to have different treshold between stations, using AOD only (in place of Angstrom coefficient) can not give physical answers to the question. This part has to be redone and rewritten taken into account these remarks.
Authors: In order to reinforce the robustness of the criterion to define a dusty day, we have recalculated the composites by fixing a unique threshold of 0.2 for dust AOD in the simulations, and of 0.2 for total AOD in the observations (indeed we have to use total AOD for observations as dust AOD is not measured). As a consequence, the number of days is more variable between the different stations (see the corresponding column in Table 5, which has been updated), but this choice is more physical and easier to understand for the reader. Figures 11 and 12 (previously 13 and 14) have also been redone. The results are generally similar to the previous calculation, and the conclusions remain identical.

Technical corrections:
- sulphate (not sulfate) - Enlarge the legends figures, sometimes very small and difficult to read. - Many informations on the figures, with text often superimposed and thus unreadable (Fig. 5) or symbols too small (Fig. 4) or colors difficult to distinguish (fig.7). Please correct.
Authors: Corrected. Legends have been enlarged as far as possible.

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: This confusion between meteorology and climate has been clarified (please see the answer to the first reviewer).

Particular comments:
The abstract must be rewording taking in mind the comment on the confusion about meteorology and climate previously mentioned.
Authors: Please see the answer to the first reviewer. 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.

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