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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Dust emission size distribution impact on aerosol budget and radiative forcing over the Mediterranean region: a regional climate model approach" *by* P. Nabat et al.

Anonymous Referee #2

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Review of the manuscript entitled "Dust emission size distribution impact on aerosol budget and radiative forcing over the Mediterranean region: a regional climate model approach" by P. Nabat, F. Solmon, M. Mallet, J. F. Kok, and S. Somot, with reference no.: acp-2012-337.

This manuscript deals with the application of a new parameterization scheme of the dust size distribution to the emitted vertical flux in the RegCM-4 model, in order to estimate the aerosol budget, and radiative forcing over the Mediterranean region. Calculations of aerosol budget (load, dry and wet deposition), properties (e.g. Aerosol

Optical Depth, AOD, asymmetry factor, single scattering albedo) and radiative forcing are carried out with the coupled-chemistry regional climate model RegCM-4.

The total radiative effect of dust aerosols on the Earth's energy budget still remains a source of uncertainty in simulating present climate and predicting future climate changes. This uncertainty is induced from the high spatial and temporal variability of aerosols amount and properties due to their short lifetime, which is strongly determined by the size distribution of atmospheric particles. Therefore, the realistic representation of dust size distribution in climate and air quality models is of great importance.

The main originality of the submitted work is the application of a new method, proposed by Kok (2011), parameterizing the size distribution of the emitted dust vertical flux, in the RegCM-4 aerosol module. In order to investigate the improvements resulted from the use of the new scheme, a comparison between simulations with the mew method and the one already used by RegCM, is performed by authors. Additionally, a comparison with observational data is made for some calculated aerosol properties such as AOD. The new dust size distribution scheme results in more realistic estimates compared to measurements.

In the framework of the main objective, the submitted work treats too many things. For instance, simulations are performed on different time scales: daily (episodic), seasonal (intra-annual variability) and long-term (decadal) scale. Simulation of dust events allows the assessment and the evaluation of emission and transport processes whereas, long-term simulations present climate interest. Moreover, estimation of the aerosol radiative forcing over the Mediterranean region over a relative longer time scale (2000-2009) with a coupled-chemistry regional climate model (RegCM 4) constitutes another originality of the present work.

In overall, the submitted paper is interesting, well written and organized and it can be published in the ACPD Journal after taking into account the following comments.

The Taylor diagram, as authors note in the text, is a useful tool that allows a quick

and concise statistical evaluation of how well different patterns correspond each other. Indeed, the comparison-validation that is performed in the paper between the spatial distribution of simulated and MODIS AOD along with Taylor diagram, clearly proves the improvements in model estimations resulted from the use of the new parameterization scheme. However, authors could attempt a more detail and thorough comparison between simulated and MODIS AOD. For instance, they could calculate the differences (absolute of relative) between simulated (both REF and NEW) and MODIS AOD for each grid-cell. This kind of comparison can be performed at least for the seasonal means of AOD for the year 2008. Such a comparison allows a very detail and accurate evaluation of model outputs taking always into account the error of MODIS AOD data, and mostly would reveal the improvement in the spatial distribution of AOD, induced by the new parameterization scheme. Since the manuscript is already extended enough as it contains a lot of results, there is no space to insert additional figures. Authors could however, give in the discussion the range of the calculated differences and how these are reduced for the NEW simulations.

In general, in the results discussion authors do not insist so much on the quantitative comparison of simulations with observations and even the statistics presented through Taylor diagrams is not discussed. For instance, in section 4.1 (case study 1) only numbers for standard deviation are given whereas the improvement of RMS with the NEW simulation is noted without giving any number. Respectively, in section 4.2 (case study 2) it is pointed out the amelioration of the correlation coefficient for the NEW simulation, again without cite the respective numbers.

In tables 1 and 2 authors can add next to the "total" AOD value the corresponding mean AOD value issued from MODIS data, averaged over the study domain.

In the section 2.2, second paragraph, authors should clearly state that they have used the MODIS-Aqua Deep Blue data and specify which collection (5.0 or 5.1), which Level and with what spatial resolution.

Page 17851, section 4.3, line 15, authors write: "Three stations have been chosen in different places over the Mediterranean basin, ...". The stations should be added in parenthesis, e.g. (Blida (Algeria), representing a location in the vicinity of dust sources, Barcelona located in the west Mediterranean and Crete in the eastern basin).

In Fig. 9 and 10, colour bars indicating the scale of AOD values are missed.

In Fig. 11, clarify if values of aerosol concentration (mg m-3) are averages over the year of 2008.

At the end of page 17854 (lines 17-28) authors state "In contrast, with the new size distribution, the column burden of the larger dust (> 1.0μm) is substantially increased.". According to Fig. 11, this increase is particularly strong for the dust bin 2.5 – 5 μm. This could be pointed out in the discussion.

Specify what the temporal resolution of the simulations performed over the year of 2008 and the period 2000-2009, is.

Authors could attempt a comparison of the intra-annual variability of SW radiative forcing with the one reported by Benas et al. 2011 (Benas et al.: Aerosol shortwave daily radiative effect and forcing based on MODIS Level 2 data in the Eastern Mediterranean (Crete). Atmospheric Chemistry and Physics, 11, 12647-12662, 2011) noting however that this work refers to Crete AERONET station and calculations are performed with a radiation transfer model based on Terra and Aqua MODIS data.

In section 5.2 (page 17856, lines 15-16) authors cite "During the dry period, namely from June to October, the absence of rain favours a strong aerosol maximum.". Actually, it is the synoptic conditions prevailing over the Mediterranean this period of the year that favour the accumulation of aerosol particles in the atmosphere. Specifically, during this period, the subtropical Atlantic high (Azores) prevails over the Mediterranean basin being enhanced and causing subsidence. It results thus, in an extremely stable atmosphere and in absence of rainfall, conditions that favour the aerosol accumulation

in the atmosphere.

Authors underline in the text that one of the objectives of this work is to estimate the aerosol direct SW and LW radiative forcing, with estimations on a decadal scale (2000-2009) being important for climate reasons. Additionally, they note that it is the first time that such calculations are performed for the Mediterranean basin with a coupled-chemistry regional climate model. For the above reasons, I suggest authors to summarize in a table the calculated values of aerosol direct SW and LW radiative forcing averaged over the period 2000-2009 and at least, over the whole study area (meaning that they could give values for Africa, Mediterranean Sea and Southern Europe separately and/or for each season depending on the paper extent). This could be helpful for the readers and easier to make comparisons with other studies.

In section 5.2 (page 17857, lines 10-18) authors compare the calculated SW aerosol radiative forcing for the whole study area over the period 2000-2009 with respective estimations from the work of Papadimas et al. (2011) noting the exact region considered in the work of Papadimas et al. (2011) and that they use MODIS data. They should additionally specify that this work refers to the period 2000-2007, it uses MODIS Terra (collection 5 and 5.1) Level-3 data and computations are performed with a spectral radiative transfer model. Finally, the reference to this work should be corrected since it is now available to ACP (Papadimas et al.,: The direct effect of aerosols on solar radiation over the broader Mediterranean basin, Atmos. Chem. Phys., 12, 7165–7185, 2012).

Though authors in the abstract and the introduction emphasize the impact of the new parameterization method on the dust deposition due to its effect on marine biochemical activity, the respective discussion is not equivalent. Specifically, the information that I miss is the validation of the model deposition estimates with measurement, in case that these are available for the study area. Such a comparison could show how realistic are the deposition values resulted from the NEW scheme. The same is valid for the revealed seasonal cycle though it seems completely normal.

At the last paragraph of the section 5.3 (page 17858, lines 18-19) authors state "Its seasonal cycle, similar in the three regions, ...". Focusing on decadal simulation since it can be considered more representative, the seasonal variation over the southern Europe is single with maximum in February indicating the important role of winds, whereas for the other two regions a secondary maximum in autumn can be noticed (early in autumn (September) in Africa and late autumn (November) over the Mediterranean Sea). The secondary maximum seems consistent with the dust episodes in autumn and the respective maximum of the wet deposition.

Conclusions are rather qualitative and they miss some numerical results. For instance, it can be cited what is the improvement in AOD values with the new size distribution scheme always compared to the previous one and MODIS measurements. Also, the estimated increase in dust deposition can be mentioned, and finally the computed with the REgCM-4, aerosol SW and LW radiative forcing over the Mediterranean can be reported since it is one of the main findings of this work.

Some minor remarks

Stay consistent with the full name (RegCM-4) of the current version of RegCM especially in the discussion part of the paper, where some times it is cited as RegCM and some others as RegCM-4. In section 4.1, page 17849, line 26 you cite the SSA. Define the acronym in section 2.2, page 17843, line 8, where the single scattering albedo is cited for first time.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/12/C6907/2012/acpd-12-C6907-2012-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 17835, 2012.