

## ***Interactive comment on “Aerosols optical and physical characteristics and direct radiative forcing during a “Shamal” dust storm, a case study” by T. M. Saeed et al.***

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We thank referee #1 for taking the time to read the manuscript. Although his/her comments disappointed us, the quality of scientific work can only be improved through constructive criticism. Here we address the issues raised by referee #1. For the sake of clarity the commentator's paragraph have been pasted between parenthesis while the response is stated below each paragraph.

General

“The paper presents the impact of a severe dust storm on the radiation budget. The

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case occurred already ten years ago and was already presented in the literature.”

The “age” of the case study is not, to our best understanding, a factor upon which the related research work can be published or not. If that is the case, then please let me know the “threshold” time span between the occurrence of certain phenomena and its discussion in literature. Moreover the timing of the dust storm is not our concern. It is considered as an example of an intense dust activity for which its meteorology is described and its radiative impact is estimated. Regarding the publication of the work, to our best knowledge, we haven't seen any publication on this particular case study and if we had missed it then please provide us with the reference. However if the anonymous referee #1 was referring to Saeed and Al-Dashti (2010) publication then, yes, there are similarities but they are certainly not the same work. Saeed and Al-Dashti (2010) does not discuss radiative forcing, radiative heating and does not simulate dust height. It is quite common to find in literature authors that have used the same techniques to investigate aerosol properties on different study sites at different seasons over different time spans. Also authors can focus on certain region and investigate optical and physical properties and discuss source and sink regions over a number of publication using either satellite based observation or/and ground based observation. The best example is the list of references posted by H. El-Askary in the interactive comment on the current publication (refer to our response to H. El-Askary). You'll find that the same technique is applied at different sites and the same site is investigated for different aspects such as atmospheric pollution or mixing of dust with local pollutants.

“The paper is lengthy and does not contain any new aspect of dust research.”

The length of the paper is well within the limits of ACPD. The topic needs to be covered adequately without worrying about its length. I agree that there isn't any new aspect of dust research but the work sheds light on the optical, physical and radiative aspects of an intense dust loading in a region that is considered as one of the five major source regions of dust around the globe (Prospero et al. 2002). There are not many published studies from the Arabian Peninsula and very few, if any, discuss such an extreme case.

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"The very general way how to use dust optical data to compute radiative properties and fluxes is outlined only. I personally learned nothing from the paper. The only exotic point is the rather high dust load and the corresponding high dust optical depth of 3.7. But does this aspect (already presented in the literature!!) justify publication? I vote for rejection."

The reviewer states that the manuscript is lengthy (see comment above), but at the same time requests more information on a well documented subject of calculating radiative properties. We agree that this is an essential part of the study and believe that the optical data and radiative properties of dust for this episode are described in adequate detail.

"1 Introduction: The introduction is very lengthy, very general, and thus very boring. No information on important dust field campaigns like 2004 United Arab Emirates Unified Aerosol Experiment (UAE2) or the Saharan dust campaigns SAMUM 2006 and 2008."

The United Arab Emirates Unified Aerosol Experiment (UAE2) is discussed in chapter 6 (P. 23911, line 11). In the introduction we tried to reference work conducted under similar conditions and hence the references stated. Following the recommendations of anonymous referee #2 the SAMUM experiment is referenced in the revised manuscript.

"2 Study site The instruments, techniques, models, and corresponding uncertainties should be presented in section 2. I would like to know how one can measure an aerosol optical depth larger than 3 with a hand-held photometer? The uncertainty must be rather high."

Structuring of the paper was based on sections, with each section discussing the instrumentation, accuracy and techniques used. However following the recommendation of anonymous referee #2 some sections are merged and subdivided. As regards the AOT reading, this is the instantaneous reading of the Microtops sunphotometer during the dust storm hour. If such a value surprises the reviewer then please refer to Sabbah et al. (2001) where you would find in Plate 2 that had exceeded 3 during a Khamaseen

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storm of March 1998. Table 3 of the paper states selected instantaneous values of AOT and on two occasions, 15 and 31 March 1998, were 6.06 and 6.76 respectively. Also keep in mind that they used a hand held sunphotometer similar to the one used for this work.

"3 Synoptic description The meteorological description is very length and cumbersome (sounds like a field campaign report) and is not needed for the direct radiative forcing discussion on which the paper is obviously focusing."

We believe that the synoptic description is needed for the radiative forcing of dust. As the reviewer is aware the life cycle of dust particles depends on the synoptic conditions in the area. The description covered the evolution of the low pressure system, its outbreak over Kuwait and its stall afterward, which was the key for this intense dust episode.

"4 Ground-based versus satellite-based data Again a very lengthy description of like-wise simple observations. But again, no word to uncertainties in the observations of aerosol optical depths around 4.15 with handheld photometer. One may even speculate, the other way around: May be the aerosol optical depth was 8 or even higher (which fits to visibilities of the order of 300m, dust mass concentrations of about 5000 micrograms per m<sup>3</sup>, and 3-6 km high dust layers), but only AODs up to 4 can be estimated from such questionable photometer measurements."

The uncertainty in AOT measurement is stated in P. 23902, lines 6-7. The uncertainty in is stated in the same page lines 17-19.

"5 Vertical distribution of the dust layer Again a very lengthy discussion of model details which we do not need here in this paper. On the other hand: Models usually do a bad job regarding the vertical distribution of dust outbreaks. How large are the uncertainties in the model results here?"

We reduced the description of the model used, as per the reviewer's suggestion. The

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reviewer states that models do a bad job regarding the vertical distribution of dust, but he does not support his claim with a reference or a study. Of course we are aware that the parameterizations used in an atmospheric system are not perfect and are updated constantly, but give an adequate representation of dust life cycle. Also in this case the results of the model agree satisfactory with other sources (e.g. satellite images). More information on the capabilities of the SKIRON model is presented in Spyrou et al., 2010 and Spyrou et al., 2013. As for the uncertainties in the results of the model we do not have vertical dust distribution measurements in order to calculate statistical variables for this case. This is the main reason why we make use of an atmospheric model. If there was such data available the model vertical distribution would be obsolete. Finally keep in mind that this is not a modeling study. The model profile is used in context with other data sources.

“6 Direct radiative forcing Again: A very lengthy (unnecessary) description of the radiative transfer model and input parameters. Obviously many dust parameters for Saharan dust are assumed, but are the ones for Arabian mineral dust not significantly different from the Saharan parameters (as Schuster et al, 2012, ACP) found? All in all, even this chapter does not present any new or surprising aspect. No comparison with all the comprehensive radiation measurements and computations performed in the frame of SAMUM-1 for example.”

The discussion of the input parameters to the radiative transfer model is crucial to elucidate the role that each parameter plays in altering the radiative flux at top of atmosphere and at ground level. As regards to the input parameter, actually non of the assigned values were based on the Saharan dust properties, otherwise it would have been referenced, but instead were obtained from in-situ measurements of the scattering and absorption coefficients of dust under similar conditions, P. 23910 lines 1-4 and lines 11-13. Comparisons of the radiative forcing results were with studies that involved dust carried from the Arabian Peninsula and/or reported similar conditions of high dust loading. The UAE2 field campaign that you mentioned earlier is one of them.

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General comment: The anonymous referee #1 often uses words such as “lengthy”, “boring” and “cumbersome”. We believe that such descriptions are non-scientific and in fact quite subjective. What one finds “boring” might be quite interesting to another especially if they want to compare results under similar conditions. Moreover we do not find any set of rules for what is considered the “right length” of a piece of work or the right length of different sections within the work.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 23895, 2013.

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