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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Harmattan, Saharan heat low and West African Monsoon circulation: Modulations on the Saharan dust outflow towards the north Atlantic" *by* Kerstin Schepanski et al.

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The authors would like to thank the reviewer for the time spend on the manuscript, and for providing helpful and constructive comments and suggestions. We have considered carefully all comments made; please find our detailed reply (italic) below.

Anonymous Referee 2

The present manuscript investigates the atmospheric circulation pattern over North Africa about its role favouring dust emission and dust export towards the tropical North Atlantic. The focus of the study is in Summer 2013 (June to August) when it took

place the field campaign SALTRACE (Saharan Aerosol Long-range TRansport and Aerosol-Cloud interaction Experiment). While the results of the study are interesting to be published, their presentation and discussion are not yet sufficient to be published in Atmospheric Chemistry and Physics in the current form. Therefore, it is worth to be published after addressing major revisions which are explained below along with a few other details.

Major comments:

One of my main concerns is related to the study period, i.e. in summer 2013. This is justified because of the SALTRACE experimental campaign. However, I couldn't find any model comparison within the exceptional observational database from this experimental campaign which includes among others aerosol vertical profiles neither any link to other publications related to this campaign and the link with your results. Then, why are you limiting your analysis to summer 2013? If you include more years, the results would be more representative. If not, it would be reasonable that in the discussion of the results, you also consider to include a description of the vertical dust structure associated with the North Atlantic dust transport (and its associated dust sources) and the relation with the dust concentrations measured in the Caribbean.

The study is motivated by and carried out in the framework of the SALTRACE project. During SALTRACE, measurements were obtained over the Caribbean. Following a holistic approach accounting for the full atmospheric life-cycle of mineral dust, dust sources and emission as well as the transport pathways are required to be considered in order to assess dustiness and dust involving atmospheric processes over the Caribbean. To provide a concise manuscript despite the broad extent of the topic and the aims of SALTRACE, we decided to present the study by two manuscripts: One examining the origin of dust (in particular dust sources and emission processes) and transport pathways towards the north Atlantic (this manuscript), and one presenting the dust transport across the Atlantic and deposition over the Caribbean (the companion paper by Heinold et al. (in preparation). Although being companion papers, both

manuscripts are self-contained.

Otherwise, it would be good that you reinforce the performance of the model results because the evaluation sounds qualitative. You don't include any performance skill score with the AERONET database neither comparison with satellites. Meanwhile, your analysis of the dust emission is based on satellites; you only use the model results for the analysis of the dust transport. In this sense, how is the agreement between the dust emission fields between satellite and model results? Can the model reproduce the results (timing and spatial distribution) obtained from MSG? For example, from the model evaluation against AERONET is clear that haboobs are missing in your simulations (see Cinzana and Banizoumbou in late July in Figure 3). Then, in your discussion about the results based on the model simulations. Are haboobs negligible?
Many thanks for your suggestion on validating COSMO-MUSCAT dust source regions against these obtained from MSG. We will include this in the revised version of the manuscript. Please be referred to Schepanski et al. (2016) for a more thorough comparison of the model fields against satellite observations. Haboobs are embedded in the West African Monsoon circulation, which provides the moisture reservoir necessary to form deep convection. Thus, the propagation of the monsoon front relates to the formation of deep convection, an essential precondition for Haboobs. The scope of this manuscript is on the general role of the atmospheric circulation regimes on dust source activation and transport pathways. Local-scale processes are of minor importance here compared to the overall strength of the regime.

Minor comments:
Page 3 Line 19: A reference to CV-Project (from University of Aveiro, link) is missing.
Many thanks for drawing our attention on this activity at Cape Verde. Unfortunately, we could not find any peer-reviewed reference of this activity that we can refer to.

Page 3 Line 34: Please, you include further information about the referenced companion paper.
We have included the reference for the companion paper: Heinold, B., K. Schepanski, D. Gieseler, and I. Tegen, Mixing and Deposition Processes during Transatlantic Transport of Saharan Dust, in preparation for Atmos. Chem. Phys.

Page 5 Line 19: Numeric labelling in the title of the section is missing.
Many thanks for spotting this. It will be corrected in the revised version of the manuscript.

Page 10 Line 7: How is the agreement between the dust emission fields between satellite and model results?
Many thanks for this suggestion. A discussion on this will be added to the revised version of the manuscript. The agreement between dust source activation frequency (DSAF) calculated from COSMO-MUSCAT and these inferred from MSG SEVIRI generally show similar spatial patterns. Both distributions identify a hot spot in terms of DSAF for the source region south of the Hoggar Massif and in between the Adra and Air Mountains. Also, frequent dust emission over southern Mauritania are evident in both data sets.

Page 10 Line 23: What AERONET dataset are you using? Quality-assured?
We are using AERONET coarse mode level 2.0 respectively level 1.5 where level 2.0 is not available. Level 2.0 data are available for Santa Cruz and Dakar, level 1.5 data are available for Cape Verde, Cinzana, and Banizoumbou. This information is added to the revised version of the manuscript.

Page 11 Line 6: In the AERONET comparison, what about the model overestimations

observed in Cinzana and Banizoumbou in early August? Could you include spatial verification of the model outputs based on satellites such as MISR or MODIS?
The focus of the manuscript is on the general impact of atmospheric circulation regimes on dust export towards the tropical north Atlantic. Thus, daily case studies are beyond the scope of the manuscript. Please be referred to Schepanski et al. (2016) for a more thorough comparison against satellite data.

Page 12 Line 22: Add a reference to Figure 6.
A reference to Figure 6 is added (Fig. 7 in the revised version of the manuscript).

Page 16 Line 2: As you indicate, "maybe there is a temporal lag at which the Harmattan winds and the SHL act on the dust export". Have you been tried to correlate NAFDI/LLAT and dust flux introducing delayed days between them?
Indeed, we have calculated the correlation between NAFDI respectively LLAT and the dust export flux, including lags of a varying number of days. However, the correlations are not significant (r=[-0.2,0.2] for lag correlations). This is also discussed in Section 7: "Generally, the Pearson correlation r between NAFDI respectively LLAT and eastward or westward dust flux is close to zero (r(NADI, eastward dust flux) = -0.04, r(NAFDI westward dust flux) = -0.3, r(LLAT, eastward dust flux) = 0.3, r(LLAT, westward dust flux) = -0.1) and thus not significant".

Figure 4: Correct NADI by NAFDI.
Many thanks for spotting this. Corrected.

Figure 11: Indicate in the caption the order of the month for each panel.
The time axis is chronological and is clearly labeled by day and month. We think that no additional description in the caption is necessary.

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