Point-by-point reply to the reviewer's comments

The authors would like to thank the reviewers for the time they 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.

Review #2

General remarks:
The present manuscript search to aim for an assessment on atmospheric circulation patterns that determine dust source activation and dust transport toward the western Mediterranean basin with regard to the ChArMEx/ADRIMED special observation period in June and July 2013. EOF analysis is used to identify different modes of variance of dust simulations using the atmosphere-dust model COSMO-MUSCAT. While the results of the study are interesting to be published, their presentation and discussion are not yet sufficient to be published at Atmospheric Chemistry and Physics in the current form. The present manuscript is focusing on the meteorological synoptic patterns that determine the dust transport towards the western Mediterranean basin by means a regional dust model, the COSMO-MUSCAT. The main problem is that the authors do not clearly provide evidence of the performance of the meteorological-dust model for the study period to provide support for the conclusions. ChArMEx project proposes a multi-scale model-observation integrated strategy with satellite and field observations. During the Charmex short observation periods (SOP) detailed process studies are performed during intensive campaigns (for summer 2012 and 2013); studies include continental plume transport and aging and chemical and optical closures in the column. In this sense, I would suggest a comparison with satellite aerosol products observations (as MODIS or SEVIRI/AERUS) or ground-based lidar stations (such as EARLINET) in addition to reanalysis (such as MACC reanalysis and ERA-Interim) to demonstrate the ability of the COSMO-MUSCAT model to reproduce the dust transport during summer 2013 over the Mediterranean.

Many thanks for the time you spend on the manuscript and for your assessment. We have acted on your suggestions and have included a comparison to MODIS aerosol products. Furthermore, the revised version of the manuscript also includes a discussion of the June-July 2013 period with regard to a longer time period using ERA-Interim reanalysis data.

Finally, I would suggest to include in the discussion of the results some recent references as the following:

- Cuevas, E., Gómez-Peláez, Á. J., Rodríguez, S., Terradellas, E., Basart, S., García, R. D., García, O. E., and Alonso-Pérez, S.: Pivotal role of the North African Dipole Intensity (NAFDI) on alternate Saharan dust export over the North Atlantic and the Mediterranean, and relationship with the Saharan Heat Low and mid-latitude Rossby waves, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-287, 2016. In this manuscript it is revised the index that quantifies the North African Dipole Intensity (NAFDI), and explain its relationship with the Saharan Heat Low (SHL) and mid-latitude Rossby waves. If you check the results of this work, you will see similar results to your negative phase associated of the dust transport and meteorological patterns associated with the negative NAFDI phase.

Many thanks for your suggestion. As the paper is still under review and following the discussion some changes to the final paper can be expected during the review process, we decided to not include the manuscript at this stage.

- Menut, L., Rea, G., Mailler, S., Khvorostyanov, D., and Turquety, S.: Aerosol forecast over the Mediterranean area during July 2013 (ADRIMED/CHARMEX), Atmos. Chem. Phys., 15, 7897-7911, doi:10.5194/acp-15-7897-2015, 2015. This work is also covering the same study period using the CHIMERE model and it would desirable to compare your results with those included in this analysis.

Many thanks for your suggestions. We now refer to this work in the introduction section.

Minor errors:

Page 2 Line 28. You could include the following reference: Gkikas, A., Basart, S., Hatzianastassiou, N., Marinou, E., Amiridis, V., Kazadzis, S., Pey, J., Querol, X., Jorba, O., Gassó, S., and Baldasano, J. M.: Mediterranean intense desert dust outbreaks and their vertical structure based on remote sensing data, Atmos. Chem. Phys., 16, 8609-8642, doi:10.5194/acp-16-8609-2016, 2016.

Many thanks for the suggestion. We now refer to the reference at a later point in the manuscript (see suggestions below).

Page 2 Line 33. If you check Ginoux et al. (2012) you will see that there are some desert dust anthropogenic sources that affects the Mediterranean.

- Ginoux, P., Prospero, J. M., Gill, T. E., Hsu, N. C., & Zhao, M. (2012). Global scale attribution of anthropogenic and natural dust sources and their emission rates based on MODIS Deep Blue aerosol products. Reviews of Geophysics, 50(3).

This may be a misunderstanding here. We do not say that dust from anthropogenic dust sources is not affecting the Mediterranean. The sentence rather means that dust emitted from human-induced source can be controlled by legislative regulations, whereas dust from natural sources, in particular from North African deserts, is rather controlled by weather.

Page 3 Line 14. You could add Gkikas et al. (2016).

Many thanks for the suggestion.

Page 3 Line 26. Could you give any detail about the radiative module implemented in the model?

The radiation scheme developed by Ritter and Geleyn (1992) is implemented in COSMO. Dust-radiation interactions are computed online at solar and thermal wavelength bands and account for variations in the simulated size-bin resolved aerosol concentrations (Helmert et al., 2007). It can impact on the meteorology and consequently implicitly feed back on dust emission and dust transport. This information is added to the manuscript.

Page 4 Line 32. Does the model include any soil moisture or drag partition correction in the calculation of the threshold friction velocity?

The influence of soil moisture on the dust emission flux is considered following Tegen et al. (2002) (cf. their Equation 3). Formally, drag partition in our dust module follows Marticorena & Bergametti (1995).

Page 5 Line 26. You could add Gkikas et al. (2016).

Many thanks for the suggestion. We have added the publication to the list of references.

Page 6 Line 8. Could you include any other information about the model configuration used in the present study? As the meteorological initial and boundary conditions, and the dust initial conditions (does the model include data assimilation?)

Many thanks for spotting this lack of information! We have added the following information to the manuscript: Only dust sources located in North Africa are considered here. Initial and lateral boundary fields are provided by the Deutscher Wetterdienst (DWD, German weather service) global model GME at six-hourly resolution. To keep the meteorology close to the analysis fields, model runs are re-initialized every 48 hours. Following a 24-hour spin-up for the COMSO model, MUSCAT is coupled to COSMO and aerosol processes are computed. Dust concentration fields from the previous cycle are used to initialize atmospheric dust loading in the following cycle. No initialization of the atmospheric dust loading takes place for the first cycle.

Page 6 Line 17. For the coarse-mode AOD comparison with AERONET, are you are taking the coarse fraction of the simulated dust fields (i.e. r > 1microm)?

Dust concentrations from all size bins are taken to calculate the dust AOD as described by Equation 4.

Page 7 Line 16. You could add the work of Rodríguez, S., Querol, X., Alastuey, A., Kallos, G., and Kakaliagou, O.: Saharan dust contributions to PM10 and TSP levels in Southern and Eastern Spain, Atmos. Environ., 35, 29 2433–2447, 2001.

Many thanks for the suggestion. The paper is added to the list of references.

Page 8 Line 2. You could add the work of Basart, S., Pérez, C., Cuevas, E., Baldasano, J. M., and Gobbi, G. P.: Aerosol characterization in Northern Africa, Northeastern Atlantic, Mediterranean Basin and Middle East from direct-sun AERONET observations, Atmos. Chem. Phys., 9, 8265-8282, doi:10.5194/acp-9-8265-2009, 2009.

Many thanks for the suggestion. We have added the publication to the list of references.

Page 8 Line 10. For the Eastern Mediterranean region, you should consider the Middle East desert dust sources particularly in spring.

The focus of the present study is on North African dust transport toward the western Mediterranean basin. Discussing the contribution of dust originating from the Middle East is an interesting topic, no doubt, but beyond the scope of the manuscript. The model setup used here accounts for dust originating from North African dust sources only.

Page 8 Line 16. Could you quantify "significantly stronger"?

Calculating the correlation between 10m wind speed and wind speed at 850hPa and 700hPa respectively, the fraction of grid cells which represent a correlation coefficient of 0.4 or larger shows a large difference:
fraction correl (10m wind, 850hPa wind) > 0.4: 68.47%
fraction correl (10m wind, 700hPa wind) > 0.4: 2.71 %
The considered domain is chosen as limited by 20-40N, 20W-30E. This information has been added to the manuscript.

Page 9 Line 13. You should indicated that they are the dust sources predicted by the model.

This is clarified now.

Section 5.1. In addition to AERONET comparison, you should include the spatial comparison of your model results using other aerosol observational datasets as MODIS, SEVIRI/AERUS and EARLINET.

Many thanks for your suggestion. We have added a comparison with MODIS AOD products.

Figure 1. Include the locations of Sirtra and Biscaia Gulf.

Bay of Biscay and Gulf of Sidra are now highlighted in Figure 1.