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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of dust on West African climate during 2005 and 2006" *by* M. Camara et al.

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Interactive comment on "Impacts of dust on West African climate during 2005 and 2006" by M. Camara et al. Anonymous Referee #2 Received and published: 26 March 2010 Review of Impacts of dust on West African climate during 2005 and 2006. By Camara et al.

Question 1: The paper deals with the radiative and climatic impact of dust aerosol over west Africa. This topic has received much attention recently notably through studies based on experimental field campaigns as well as global and regional modelling. A better understanding of dust aerosol processes (emission, transport, physical properties) and their effect in the western African climate system is an important goal of the AMMA experimental program. The paper is thus in line with ACPD and particularly with

the AMMA special issue. However I suggest important revisions before publication.

General comments and suggestions: The goal of the paper is to quantify and discuss the dust impact on west African environment. The authors discuss both JAS seasonal averages (based on a two year simulation 2005-2006) and a case of intense dust outbreak occurring in September 2006: i) The discussion of the mean dust impact on WAM contains some interesting elements but is based only on two years simulation which is quite short in order to assess climatic significance of dust induced anomalies. Beside, as outlined by the author themselves, the results and analysis highlighted in this section are essentially similar to Konaré et al., 2008 which uses the same model but over a much longer time period. ii) The discussion and the analysis of specific cases is potentially interesting, especially because it is uses specific AMMA measurements to evaluate the model. However the discussion is a bit fast and it is difficult to really figure out the effect of dust bases on these results. Overall it is a bit difficult to understand the strategy and the link between these two parts. If one looks at the literature dealing with dust impact modeling on weather and climate, one find essentially some studies based on global climate simulation with multi-year integrations, or some studies studies based on detailed meso-scale models and focusing on some specific episodes and/or processes (several of these studies have been proposed as part of the present ACPD AMMA special issue). Even if the authors have partially discussed it, I believe that, using a regional climate model, there is an opportunity to study in more detail the intra-seasonal scale. This could in my opinion bring some originality to this work. Ideally the validation of the model should take a bigger advantage of AMMA SOP and LOP data as well as previous publications dealing with these period (suggestions in reference list). It is for example possible to look at how different observed period in 2006 (e.g. dry season and wet season SOPs, use of seasonal lidar data) are captured within a same continuous regional climate run and assess the robustness of the regional climate model to realistically simulate a suit of individual dust events in different seasonal conditions. The authors could then discuss how dust impact climatic variables, weather system (e.g. Harmattan, Heat low, AEW, ..) and monsoon seasonal

evolution. They could also outline more the significance of these impacts (e.g. compared to sources of uncertainty, model biases, natural variability), as well as sensitive processes/factors. Some suggestions are also given in the specific comments.

Response 1: In the revised version, we focus more on the intraseasonal variability of dust characteristics and its impacts on West African. 4 periods have been considered: Mean December to February –DJF (winter), Mean March to May – MAM (spring), June to August –JJA (Summer) and September to November –SON (Autumn). We clearly stated in the introduction the objectives and originality of this work after a strong literature review of regional and global climate modeling as well as observational studies linked to the goal of this paper. We compare our results with publications focusing on dust spatio-temporal characteristics and its impacts on West African climate during the AMMA SOP period.

Question 2: Specific comments: p3056 In the introduction some recent references to global studies are missing (e.g. Lau et al.,2009 + see list of detailed references at the end of my review). These references are important since they conclude on a strengthening of continental WAM by dust which is basically opposite to the results of this study. The author should also include the works and conclusions of studies performed at the scale of dust specific events (especially in the context of AMMA, see references section). A remark: The link between dust / WAM/ and hurricane might not be as straightforward as the author suggest in the introduction since SST cooling effect should also be balanced by diabatic warming effects and possible microphysical impacts.

Response 2: Thanks for your contribution; We took into consideration these references in your specific comments and the remark concerning the link between DUST/WAM/ and Hurricane in the revised version

Question 3: p3057 Model description: The author should give more information on the dust optical properties used in their model version. How do these optical properties

compare with measurements made during AMMA ? Response 3: We gave more information about the dust optical properties used in this study by producing a seasonal simulated single scattering albedo plot and some comparison with other studies have been done.

Question 4: p3058 L 15 : Modis deep blue AOD could also be used here and bring a more quantitative information.

Response 4: Thanks for this contribution

Question 5 L20 : Why just focusing on JAS months when a two year continuous run has been done. In the perspective of intra-seasonal variability studies, showing other seasons would be valuable

Response 5: In the revised version, we focus on the intraseasonal variability. Thanks for the contribution

Question 6: p3059 L12 :vertical and seasonal evolution. I think this is interesting, but I understand that the vertical / month plots at the 4 stations in fig 3 are from the model. It would be very interesting to compare these profiles with Lidar profiles measured during AMMA (see references list) and check the consistency of simulated vertical dust distribution.

Response 6: We compared the vertical profile of aerosol extinction coefficient obtained at the 4 stations to other studies including lidar observation.

Question 7: p3060 L1:What could explain the discrepancy over Dakar ? Is it a problem of transport or sources (e. g. the Mauritanian source over estimated). Can we identify some causes from satellite observations. L8: Todd et al., 2008 points out such an underestimation of the Bodele source by RegCM, which could be linked to local surface wind speed underestimation in the Bodele basin. Is this underestimation also visible on model/satellite comparison for the dry season ?

L 16: The sentence is not very clear. Again is it a problem of source (occurrence of the

event) or aerosol transport over Dakar ?

Response 7: We compare the model dust to the NCEP/NCAR reanalysis and effectively found an underestimation of surface wind over the bodélé depression region by the RegCM3 during the dry season (SON, DJF, MAM) in coherence with Todd et al (2008) Dakar is located upstream of the main dust source which means that the underestimation is probably due to a transport problem.

Question 8: p3061 It would have been useful to display the clear sky TOA radiative forcing for comparison with other studies. Surface and dust single scattering albedo variations are critical factors for dust diabatic heating which can modulate the precipitation anomaly pattern.

Response 8: DONE : Thanks for the contribution

p : 3063 I think the discussion about a possible dust impact on WAM via the the Saharan heat low (co-located with dust source and larger burdens) is interesting and should more be developed. How much could this effect contribute to the signal in addition to the reduction of moist convection over the Sahelian zone ? P3065. L5: The author should also mention and discuss recent studies (e.g. lau et al.; 2009).

Response: DONE p3065-end. Cf general comments Technical remarks: The legend and graphs have been mixed in a number of figures.

Response: FIXED

Thanks for providing these below references

Here is a (non exhaustive) list of references possibly useful to this study: Lau, K. M., Kim, K. M., Sud, Y. C., and Walker, G. K.: A GCM study of the response of the atmospheric water cycle of West Africa and the Atlantic to Saharan dust radiative forcing, Ann. Geophys., 27, 4023-4037, 2009. Sud, Y. C., Wilcox, E., Lau, W. K.-M., Walker, G. K., Liu, X.-H., Nenes, A., Lee, D., Kim, K.-M., Zhou, Y., and Bhattacharjee, P. S.: Sensitivity of boreal-summer circulation and precipitation to atmospheric

aerosols in selected regions – Part 1: Africa and India, Ann. Geophys., 27, 3989-4007, 2009. Mallet, M., Tulet, P., Serça, D., Solmon, F., Dubovik, O., Pelon, J., Pont, V., and Thouron, O.: Impact of dust aerosols on the radiative budget, surface heat fluxes, heating rate profiles and convective activity over West Africa during March 2006, Atmos. Chem. Phys. Discuss., 9, 2967-3006, 2009. Léon, J.-F., Derimian, Y., Chiapello, I., Tanré, D., Podvin, T., Chatenet, B., Diallo, A., and Deroo, C.: Aerosol vertical distribution and optical properties over M'Bour (16.96_ W; 14.39_ N), Senegal from 2006 to 2008, Atmos. Chem. Phys., 9, 9249-9261, 2009. Kim, S.-W., Chazette, P., Dulac, F., Sanak, J., Johnson, B., and Yoon, S.-C.: Transport and vertical structure of aerosols and water vapor over West Africa during the African monsoon dry season, Atmos. Chem. Phys. Discuss., 9, 1831-1871, 2009. Raut, J.-C. and Chazette, P.: Radiative budget in the presence of multi-layered aerosol structures in the framework of AMMA SOP-0, Atmos. Chem. Phys. Discuss., 8, 12461- 12528, 2008. Rajot, J.-L., Formenti, P., Alfaro, S. C., et al.: AMMA dust experiment: An overview of measurements performed during the dry season special observation period (SOP0) at the Banizoumbou (Niger) supersite, J. Geophys. Res., 113, doi:10.1029/2008JD009906, D00C14, 2008. Tulet, P., Mallet, M., Pont, V., Pelon, J., and Boone, A.: The 7–13 March 2006 dust storm over West Africa: Generation, transport, and vertical stratification, J. Geophys. Res., 113, D00C08, doi:10.1029/2008JD009871, 2008. Mallet, M., Pont, V., Liousse, C., et al.: Aerosol direct radiative forcing on Djougou (northern Benin) during the African Monsoon Multidisciplinary Analysis dry season experiment (SOP-0), J. Geophys. Res., 113, D00C01, doi:10.1029/2007JD009419, 2008. Flamant,C., C. Lavaysse, M. C. Todd, J.-P. Chaboureau, J. Pelon Multi-platform observations of a springtime case of Bodélé and Sudan dust emission, transport and scavenging over West Africa. Quarterly Journal of the Royal Meteorological Society Volume 135, Issue 639, Date: January 2009 Part B, Pages: 413-430

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3053, 2010.