Response for Referee #1
We thank Referee #1 for the support given to this paper and for the comments to improve it. His comments and remarks are carefully taken into account in the revised version of this manuscript.

General Comments

RC1:

The aim of this paper is to provide a database of dust optical properties, however only the aerosol extinction is discussed. Authors should include some discussions on the single scattering albedo and size distribution which are also key parameters for dust impact and life cycle. As dust optical efficiency strongly depend on the wavelength, the wavelength dependence of these two optical parameters should be analysed.

AC1:

Indeed, in this manuscript, only the optical thickness and the extinction coefficients are discussed and analyzed. We chose these two parameters to validate the optical properties simulated by ALADIN for three reasons: the first reason is the availability of observational data over a fairly long timescale for these two products, covering the total period of simulations, which highly facilitates a comparison. The second reason is the quality of these two products in the data, especially for optical thicknesses. The last reason is that only the extinction climatology is used in the radiative scheme of atmospheric models.

We agree that analyzing the SSA or g distribution and evolution would reinforce the paper particularly to see how these parameters are depending on size distribution (Mallet et al., 2009).

But in addition to that, we analyzed the dust source and deposition areas and the surface concentrations and we have given inter-comparisons with other previous studies.

The ALADIN model does simulate the single scattering albedo (SSA) and particle size distribution. But comparable observational products are not available for the period of simulation. The validation of these two products can be treated for specified case studies such as done in Mallet et al., 2009 or in Crumeyrolle et al., 2008, 2011. These studies use the same aerosol scheme and the same method to retrieve the aerosol optical properties (SSA, g, extinction). These references have been added in the revised paper: (i) to show that the aerosol distribution is correctly modeled over West Africa with the ORILAM aerosol scheme, and (ii) to add comments about the evolution of the two other aerosol optical parameters (SSA and asymetric factor) during their transport over West Africa.

According to the two last remarks, we propose to update the title of the article in order to clarify the subject:
"3D dust aerosol **distribution** and **extinction climatology** over North Africa simulated with the ALADIN numerical prediction model from 2006 to 2010."

RC2:

Discussions are full of vague terms as « compares well », « in good agreement », « reproduces well ». Statistical comparisons between simulations and observations should be added in order to have a better view of the performance of ALADIN in simulating the dust life cycle.

AC2:

In the paper, a qualitative comparison is made for concentrations (Fig. 12), a statistical comparison for optical thicknesses in order to evaluate the representativeness of our

simulation (Fig. 11, and discussion on AOT correlation coefficient, section 4.2). Furthermore, we have used a Z_α factor for the case of extinction coefficients, which gives access to the average vertical profile of extinctions (Fig. 13 and 14). Another quantitative evaluation was for emissions, where we compared the estimated values with those given in previous studies.
We have also introduced in the manuscript the correlation coefficient for the dust surface concentration (see Fig. 1).

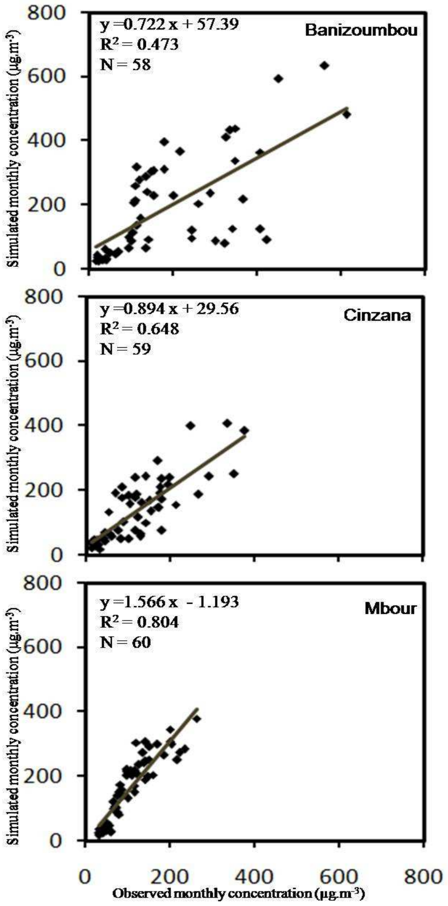

Fig.1: Scatter plot of monthly ALADIN dust surface concentration against observation over Banizoumbou, Cinzana and Mbour from 2006 to 2010. N is the number of averaged monthly surface concentration data available from 2006 to 2010. R is the correlation coefficient.

RC3:

It is stated in Section 3.3 that « we show that the use of a three dimensional NWP model such as ALADIN significantly improves the climatology of wet deposition of dust aerosols. » However, no comparisons with other models are made to support this statement. I suggest to compare the ALADIN statistical scores with the ones published for chemistry-transport models. Does a two-way meteorology-chemistry coupling give a better representation of dust life cycle than a state of the art chemistry- transport model off-line driven by meteorology?

AC3:

Indeed, in the first version of the paper, we have not made any comparison with other models in terms of dust wet deposition. We do believe, as noted in the paper, that the wet deposition simulated by ALADIN is realistic and can compare well with respect to other numerical models, since the ALADIN version used for our simulations is very close to an operational version of the time of this study, therefore overall calibrated. As for the comparison with other CTM models, this would be difficult since values of wet deposition depend on the period of interest, and to our knowledge there are no wet deposition simulations covering this period.

We added in the revised manuscript the intercomparison with other models studies.

Page 5763 line 17: we add after dry deposition. The paragraph below:
"The inter-comparison of dust wet deposition simulated by ALADIN for the year 2006 with models used in the AEROCOM and SDS-WAS programs (BSC-DREAM8b, GOCART-v4Ed.A2.CTRL, GISS-modelE.A2.CTRL and TM5-V3.A2.CTRL, http://aerocom.met.no/cgi-bin/aerocom/surfobs_annualrs.pl) for the same period is given by the Table 1. The results show that the mean wet deposition estimated by ALADIN is much higher than those estimated by AERCOM Model's. As discussed for the seasonal wet deposition, the major part of the wet deposition takes place during the wet season of the African Monsoon.
In terms of spatial distribution, the ALADIN model performs better for the estimation of the dust wet deposition associated with convective systems in the Sahelian regions. For example, the estimates of the BSC-DREAM8b model do not exceed 0.2 $g.m^{-2}.year^{-1}$ for the Sahel and the West African region. Those simulated by TM5-V3.A2.CTRL are less than 5 $g.m^{-2}.year^{-1}$ and those obtained by GOCART-v4Ed.A2.CTRL and GISS-modelE.A2.CTRL varied in the range 20-50 $g.m^{-2}.year^{-1}$. The fact that some part of the total precipitation of ALADIN is resolved can explain that the wet deposition processes in ALADIN are found to be more efficient than in some global models. "

Table 1: Mean dust wet deposition

Models	Wet deposition for 2006 in ($g.m^{-2}.year^{-1}$)
BSC-DREAM8b	0.46
GOCART-v4Ed.A2.CTRL	9.653
GISS-modelE.A2.CTRL	8.301
TM5-V3.A2.CTRL	4.673
This study	21,36

RC4:

Several aerosol climatologies are mentioned in the introduction and are considered by authors as not well adapted due to their coarse resolution. Does the climatology obtain in this study with a finer resolution (20x20 km) give a better estimation?

AC4:

In this paper, we have mentioned other global or regional climatologies for information:

- the one of Tegen et al., (1997) which is a simulated climatology
- the one obtained by combining a modelled and a satellite-derived climatology, from Nabet et al., (2013) and Kinne et al., (2013).

The Tegen climatology is now fairly old and it has low resolution (5° x 4°). We further know that in desert regions, soil characteristics and local meteorological phenomena play an important role in the uprising of dust. Thus, it is very difficult to represent these phenomena and characteristics at this resolution. Therefore, the climatology presented in our paper for North Africa should be of superior quality compared with Tegen (which was used in the operational ALADIN version of that time (see Fig. 2)). Figure 2 shows that the climatology of Tegen is significantly underestimated over North Africa.

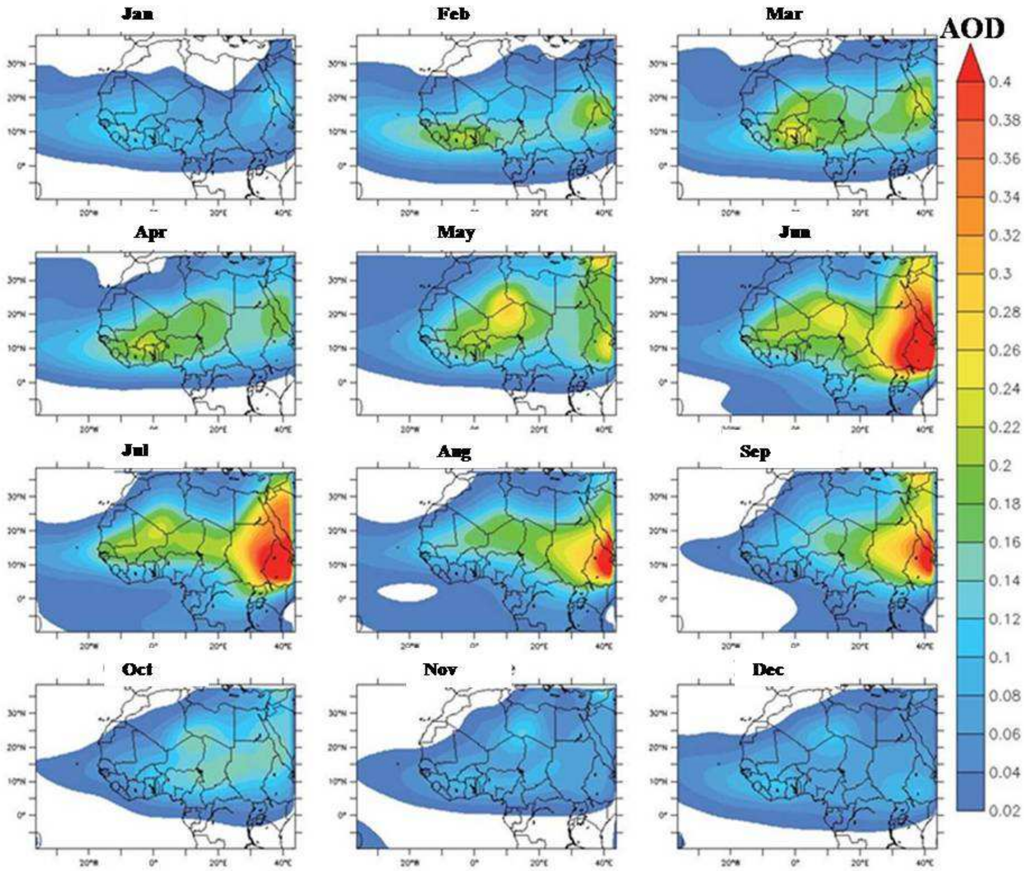

Fig. 2: Monthly climatology of aerosol optical Thickness derived from Tegen et al., (1997) for dust aerosol over North Africa.

We agree with the reviewer that a better resolution will necessary improve the dusts distribution for North Africa. Some sub-scales processes (emission, turbulence, and microphysics) will be resolved explicitly. However, in the end, a compromise between resolution and duration of the simulation is required which led in our case to choosing the resolution of 20 km. The rather long period of simulation of six years was chosen in order to better converge towards an average climate of the area of interest, at the expense of further increasing the horizontal or vertical resolution. The time step of the model and the resolution eventually are close to those of regional climate models.

Specific comments:

RC1:
Page 5753 L 2 : A new IPCC report has been published

AC1:

The reference is updated in the revised manuscript.
Page 5753 line 2-3: the sentence: "Dust aerosol.....(IPCC,2007)." becomes:
"Mineral dust aerosol dominates the aerosol mass over some continental regions with relatively higher concentrations accounting for about 35% of the total aerosol mass (IPCC, 2013)".

Ref:

Boucher, O., D. Randall, P. Artaxo, C. Bretherton, G. Feingold, P. Forster, V.-M. Kerminen, Y. Kondo, H. Liao, U. Lohmann, P. Rasch, S.K. Satheesh, S. Sherwood, B. Stevens and X.Y. Zhang: Clouds and Aerosols. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, doi:10.1017/CBO9781107415324, 2013.

RC2:
Page 5753 L 18 : To identify and quantify

AC2:
The sentence has been rectified in the revised manuscript.
Page 5753, line 17-19: sentence "Therefore, an accurate…….(RCMs)" will be:
"Therefore, an accurate database of aerosol content in this region is crucial to identify and quantify this impact, particularly in Regional Climate Models (RCMs)."

RC3:
Page 5753 L 20-23 : Could you explain this positive impact ?

AC3:
The positive impact of the switch from the Tanré et al. (1984) climatology to the Tegen et al. (1997) climatology was examined in Tompkins et al., (2005). In this study, Tompkins et al., (2005) have performed a couple of 5-day forecasts of the African Easterly Jet (AEJ) with the old and new climatology and the results are compared with high resolution dropsonde data from the JET2000 campaign. The results of these simulations show that the new aerosol climatology significantly improves some aspects of the AEJ structure and strength. In the same study, 4 months of 5-day forecasts was realized and compared using the contrasting aerosol distributions. The results show a clear improvement with the new climatology, with the jet strengthened, elongated to the east, and less zonal, in agreement with the analyses. The new climatology suppresses deep convection by stabilizing the atmosphere, preventing the ITCZ from progressively migrating north during the forecast. A strong reduction of mean equivalent potential temperature at the lowest model level is noted, with the southerly displacement of the ITCZ.
These explanations will be introduced in the final version of the manuscript.

RC4:
Page 5755 L 17-23 : Could you add some details on these initiatives ?

AC4:
Some details have been added in the revised version of the manuscript and the paragraph will be:
Page 5755 line 17-23: The paragraph: "Initiatives have ....capabilities" becomes:
"Initiatives have already been taken to use operational Numerical Weather Prediction (NWP) and regional models at high resolution and short timescales. These efforts include the WMO Sand and Dust Storm Warning Advisory and Assessment (SDS-WAS, http://sds-was.aemet.es) program, whose mission is to achieve comprehensive, coordinated and sustained observations and modeling of sand and dust storms in order to improve the monitoring of such

storms, increase understanding of the dust processes and enhance dust prediction capabilities. SDS-WAS is established as a federation of partners organized around regional nodes (Northern Africa-Middle East-Europe Node and Asian Node). About 16 dust prediction models have been used in SDS-WAS as BSC-DREAM8b, MACC-ECMWF, INCA-LMDZT, CHIMERE, SKIRON, ETA, NGAC, NAAPS….”

RC5:

Page 5757 L 11 : « are explicitly represented « Even at a 20x20 km resolution?

AC5 :

This text was corrected in the revised manuscript.

Page 5757, line 9-11: sentence “Microphysical processes ……. (Lopez, 2002)” becomes:

“Microphysical processes such as auto-conversion, collection, evaporation, sublimation, melting and sedimentation are represented following the parametrization of Lopez (2002).”

RC6:

Page 5757 L 18-23 : The calculation of aerosol optical properties should be described in more details.

AC6:

The method of calculation of aerosol optical properties is described in more detail in Grini et al., (2006). The refraction indexes used have been calculated upon the AMMA data base (Tulet et al., 2008). These references have been added in the revised version of the manuscript.

In the description of ORILAM scheme:

Page 5757, line 20: after “…….(Binkowski and Roselle, 2003).” We add:

“The method of calculation of aerosol optical properties is described in Grini et al., (2006). The refraction indexes used in our work have been calculated following a table of interpolation proposed by Grini et al., (2006). The dust optical properties are calculated from these new indexes in function of lognormal parameter upon the AMMA size distribution (Tulet et al., 2008). ORILAM has been evaluated in several papers for the West Africa region. Crumeyrolle et al., (2008 and 2011) presented a thorough description of the size distribution for the AMMA campaign. Mallet et al., (2009) studied the evolution of the asymmetry factor (g) and the single scattering albedo (SSA) for the dust storm event of March 2006 and studied the radiative balance over West Africa. Such specific studies however only can be carried out for particular situations.”

Ref:

Mallet, M., Tulet, P., Serc, 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 overWest Africa during March 2006, Atmos. Chem. Phys., 9, 7143–7160, doi:10.5194/acp-9-7143-2009, 2009.

Crumeyrolle, S., Gomes, L., Tulet, P., Matsuki, A., Schwarzenboeck, A., and Crahan, K.: Increase of the aerosol hygroscopicity by cloud processing in a mesoscale convective system: a case study from the AMMA campaign, Atmos. Chem. Phys., 8, 6907–6924, doi:10.5194/acp-8-6907-2008, 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.

RC7:
Page 5758 L 17-20 : This part should be rephrased

AC7:
The sentence becomes:

Page 5758, line 17-20: the sentence "Therefore, ECOCLIMAP……ISBA." Will be:
"The ECOCLIMAP database is designed in compliance with the SURFEX "tile" approach: each grid box is composed of four adjacent surfaces for nature (ISBA vegetation classes), urban areas (TEB model), sea or ocean and lake."

RC8:
Page 5766 L 11 : How this combination has been constructed ?

AC8:
We note that the Dark Target (DT) algorithm over land is not designed to retrieve aerosol over bright surfaces, including desert (eg, Levy et al., 2007). This leaves significant holes in global aerosol sampling. However, the Deep Blue (DB) algorithm can retrieve aerosol properties over brighter surfaces like desert and semi-desert areas (Hsu et al. (2004, 2006)). For this reason we used these two products to design a map of AOD over the whole of North Africa.
Over bright arid regions, only DB data are available and no choice is really offered (see Fig. 3a). Conversely, in areas with dense vegetation and ocean, only DT data are available (see Fig. 3b). Thus, we use this product for these areas. However, we have transition areas with low vegetation such as the Sahel (10°N-15°N). For these areas we have both the DB and DT products. These areas are shown in Figure 4 where we display the difference between the monthly aerosol optical thicknesses derived from DB and DT over North Africa for January over 2006-2010. We note that the DT product for the semi-arid region tends to be biased and underestimated. For example, the difference between DB and DT in some areas for this region exceeds 0.3. For this reason, we chose the DB product for the transition regions.
Recently, Levy et al., (2013) proposed another solution for the transition regions, namely to merge the two products and create an AOD product that combines DB and DT products. Levy et al., (2013) used the Normalized Difference Vegetation Index (NDVI) to identify these regions. Unfortunately, this solution has not yet been validated.

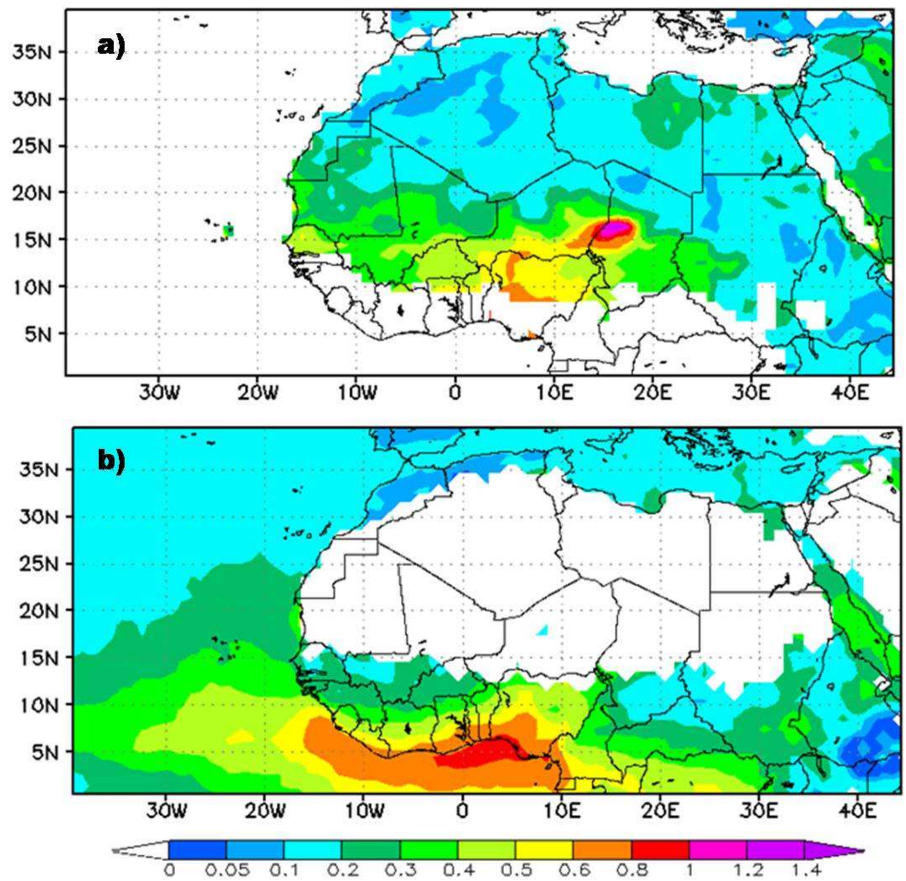

Fig. 3: Monthly aerosol optical thicknesses derived from a) DB and b) DT over North Africa for January over 2006-2010 periods.

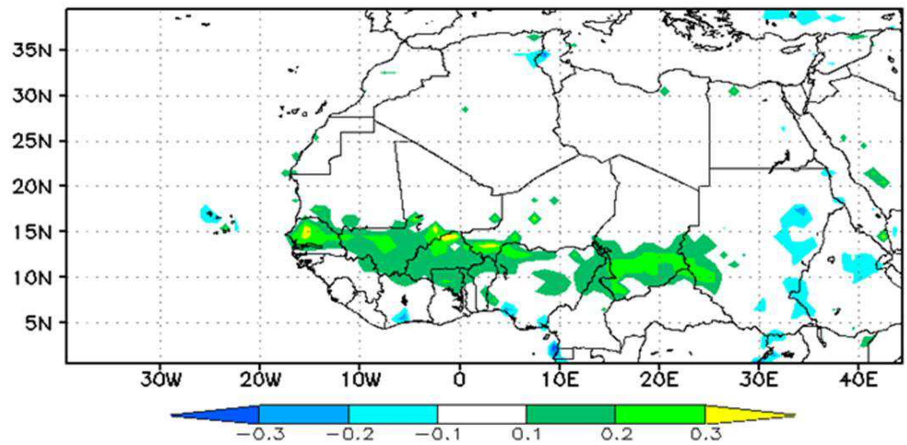

Fig 4: Difference between the monthly aerosol optical thicknesses derived from DB and DT over North Africa for January over 2006-2010 periods.

RC9:

Section 4.1 et 4.2 : Simulations take only into account mineral dust while AERONET and MODIS measurements take into account all possible aerosol species. This could induce a bias in the comparisons. Can you quantify it?

AC9:

We agree that the observations take into account all types of aerosol. In contrary, our simulations only show AOD due to desert aerosol. Then indeed, simulated AODs should be lower than the observed AODs and the bias might be quantified and attributed solely to the missing components. However, there also should be a missing contribution from the unresolved sub-mesh emission and there potentially also can be a systematic error due to the parameterization model controlling the modelled dust aerosol life cycle.
Thus, we do not have any simple way to separate the two sources of bias. In our case, the simulated AOD is overestimated and this is mentioned in the conclusion (page 5774 line 6-14), particularly during the period of biomass fires.

RC10:
Page 5767 : A figure showing the AERONET sites used in the study should be added.

AC10: We agree with the reviewer's proposal.
Page 5759, after sect. 2.3: we added the sub-section 2.4 which describes the observations used in this paper.

2.4 Dataset

2.4.1Ground-based measurement
In this study we use the AERONET AOT product (level 2) and the PM10 measured dust mass concentration (Particulate Matter concentration, particles with diameter of 10 µm or less) in order to evaluate the model-simulated AOT and the surface dust concentration, respectively, from 2006 to 2010.
AERONET (http://aeronet.gsfc.nasa.gov/) is a federation of ground-based remote sensing instruments measuring aerosol and its characteristics (Holben et al., 1998). The AERONET sunphotometers directly measure aerosol optical thickness at seven wavelengths (approximately 0.340, 0.380, 0.440, 0.500, 0.675, 0.870, and 1.02 µm) with an estimated uncertainty of 0.01 – 0.02 (Holben et al., 2001). In the model, the AOT is simulated at 0.55 µm, and it is therefore compared to the AOT measured at the nearest wavelength, 0.440 µm or 0.675 µm. Following Schmechtig et al., (2011) the AOT measured over Banizoumbou, Cinzana and Mbour, at wavelength 0.44 µm and 0.675 µm, are significantly correlated (r^2 =0.99) with slopes ranging from 1.04 in Cinzana to 1.06 in MBour. Thus, in our study, we used the AOT measured at 0.44 µm over the five AERONET sites located in West Africa at: Banizoumbou (Niger), Cinzana (Mali), DMN_Maine_Soroa (Niger), Mbour (Senegal) and Capo Verde (Fig. 5). We note that the AOT measurements only are possible during the day since they are based on measuring the solar radiation attenuation. This characteristic may be affecting the results of the intercomparison if a dust storm event occurred at night-time.

The three stations composing the "Sahelian Dust Transect" (SDT) (Marticorena et al., 2010) located in the Sahelian region at Banizoumbou, Cinzana and MBour are used to validate the surface dust concentration simulated by ALADIN. The SDT provides a continuous monitoring of the atmospheric concentrations PM10 with a 5 minute time step, using a Tapered Element Oscillating Microbalance (TEOM 1400A from Thermo Scientific) equipped with a PM10 inlet. PM10 measurements refer to particulate matter which passes through a size-selective inlet with a 50% effciency cutoff at 10 µm aerodynamic diameter (Marticorena et al., 2010). In terms of sensitivity, the detection limit of the instrument is about 0.06 $\mu g.m^{-3}$ for a one hour sampling time.

2.4.2 Satellite data

The Aqua-MODIS product (Tanré et al., 1997; Levy et al., 2007) was used to evaluate the AOTs simulated by ALADIN. This instrument is a multi-spectral radiometer, designed to retrieve aerosol microphysical and optical properties over ocean and land. Two products of Aqua-MODIS are considered in this study: the MODIS Dark Target (DT) and the MODIS Deep Blue (DB) algorithms (Hsu et al., 2004). The MODIS DT algorithm over land is not designed to retrieve aerosol over bright surfaces, such as the Saharan deserts due to the large values of surface reflectivity (Remer et al., 2005; Shi et al., 2013). This problem leads to large spatial gaps in the aerosol optical thickness recorded in desert regions, although these regions are affected by some of the largest aerosol loadings worldwide. However, the DB algorithm takes advantage of this surface phenomenology by performing aerosol retrievals in the visible blue spectrum (such as the 0.47 μm spectral channel in MODIS) and by utilizing the selected aerosol model in the inversion to generate the AOT (Hsu et al., 2004, 2006; Shi et al., 2013). Thus, a combination between these two products is made to complete the AOT database for the whole of North Africa (ocean and land).

Over bright arid region, only DB data are available, offering no alternative choice. Conversely, in the areas with dense vegetation and ocean, only DT data are available and are therefore used in our study, in these regions. In addition, we have transition areas with low vegetation such as the Sahel (10°N-15°N). For these areas, both the DB and DT products are available. The DT product for the semi-arid regions tends however to be biased and underestimated (Levy et al., 2010). For example, the difference between DB and DT estimated for the transition regions can exceed 0.3. For this reason we chose the DB product for the transition regions. Recently, Levy et al., (2013) proposed another solution for the transition regions, namely to merge the two products and create a combined AOD product. Levy et al., (2013) used the Normalized Difference Vegetation Index (NDVI) to identify these regions. Unfortunately, this solution has not yet been validated.

The CALIOP Level 2 Layer 5 km product was used to evaluate the mean particle vertical distributions simulated by ALADIN over North Africa. The CALIOP instrument (Winker et al., 2007) was launched in 2006 on the Cloud–Aerosol Lidar and Pathfinder Satellite Observations (CALIPSO) spacecraft, and has now provided over 8 years of nearly continuous global measurements of aerosols and clouds with high vertical and spatial resolution at two-wavelength (532 nm and 1064 nm) (Rogers et al., 2014). As part of the "A-train" multisatellite constellation, CALIPSO follows a 705 km sun-synchronous polar orbit, with an equator-crossing time of about 1:30 P.M., local solar time (Stephens et al., 2002). The orbit repeats the same ground track every 16 days. The vertical distribution of aerosols, provided by lidar, is important for radiative forcing (e.g., Satheesh, 2002), air quality studies (e.g., Al-Saadi et al., 2005; Engel-Cox et al., 2006), and model validation (Dirksen et al., 2009; Koffi et al., 2012). The CALIOP instrument and its initial performance assessment are described in Winker et al. (2007) and Hunt et al. (2009).

Fig. 5: Location of the five AERONET sites used in this study to evaluate the ALADIN simulated AOT over West Africa Banizoumbou (Niger), Cinzana (Mali), DMN_Maine_Soroa (Niger), MBour (Senegal) and Capo verde.

Ref:

Levy, R. C., Remer, L. A., Kleidman, R. G., Mattoo, S., Ichoku, C., Kahn, R., and Eck, T. F.: Global evaluation of the Collection 5 MODIS dark-target aerosol products over land, Atmos. Chem. Phys., 10, 10399–10420, doi:10.5194/acp-10-10399-2010, 2010.

Levy, R. C., Mattoo, S., Munchak, L. A., Remer, L. A., Sayer, A. M., Patadia, F., and Hsu N. C.: The Collection 6 MODIS aerosol products over land and ocean, Atmos. Meas. Tech., 6, 2989–3034, doi:10.5194/amt-6-2989-2013, 2013

Winker, D. M., Hunt, W. H., and McGill, M. J.: Initial performance assessment of CALIOP, Geophys. Res. Lett., 34, L19803, doi:10.1029/2007GL030135, 2007.

Hunt,W. H.,Winker, D. M., Vaughan, M. A., Powell, K. A., Lucker, P. L., and Weimer, C.: CALIPSO lidar description and performance assessment, J. Atmos. Ocean. Tech., 26, 1214–1228, doi:10.1175/2009jtecha1223.1, 2009.

Rogers, R. R., Vaughan, M. A., Hostetler, C. A., Burton, S. P., Ferrare, R. A., Young, S. A., Hair, J.W., Obland, M. D., Harper, D. B., Cook, A. L., and Winker, D. M.: Looking through the haze: evaluating the CALIPSO level 2 aerosol optical depth using airborne high spectral resolution lidar data, Atmos. Meas. Tech., 7, 4317–4340, doi:10.5194/amt-7-4317-2014, 2014.

Holben, B. N., Tanre, D., Smirnov, A., Eck, T. F., Slutsker, I., Abuhassan, N., Newcomb, W. W., Schafer, J., Chatenet, B., Lavenu, F., Kaufman, Y., Van de Castle, J., Setzer, A., Markham, B., Clark, D., Frouin, R., Halthore, R., Karnieli, A., O'Neill, N. T., Pietras, C., Pinker, R. T., Voss, K., and Zibordi, G.: An emerging ground-based aerosol climatology: Aerosol Optical Depth from AERONET, J. Geophys. Res., 106, 12067–12098, 2001.

Stephens, G. L., Vane, D. G., Boain, R. J., Mace, G. G., Sassen, K., Wang, Z., Illingworth, A. J., O'Connor, E. J., Rossow, W. B., Durden, S. L., Miller, S. D., Austin, R. T., Benedetti, A., and Mitrescu, C.: The cloudsat mission and the A-Train: a new dimension of space-based observations of clouds and precipitation, B. Am. Meteorol. Soc., 83, 1771–1790+1742, 2002.

Al Saadi, J., Szykman, J., Pierce, R. B., Kittaka, C., Neil, D., Chu, D. A., Remer, L. A., Gumley, L., Prins, E., Weinstock, L., MacDonald, C., Wayland, R., Dimmick, F., and Fishman, J.: Improving national air quality forecasts with satellite aerosol observations, Bull. Am. Meteorol. Soc., 1249–1261, doi:10.1175/BAMS-86-9-1249, 2005.

Engel-Cox, J. A., Hoff, R. M., Rogers, R., Dimmick, F., Rush, A. C., Szykman, J. J., Al-Saadi, J., Chu, D. A., and Zell, E. R.: Integrating LIDAR and satellite optical depth with ambient monitoring for 3-D dimensional particulate characterization, Atmos. Environ., 40, 8056–8067, 2006.

Dirksen, R. J., Boersma, K. F., de Laat, J., Stammes, P., van der Werf, G. R., Val Martin, M., and Kelder, H. M.: An aerosol boomerang: rapid around-the-world transport of smoke from the December 2006 Australian forest fires observed from space, J. Geophys. Res., 114, D21201, doi:10.1029/2009JD012360, 2009.

Satheesh, S. K.: *Letter to the Editor* Aerosol radiative forcing over land: effect of surface and cloud reflection, Ann. Geophys., 20, 2105–2109, doi:10.5194/angeo-20-2105-2002, 2002.

RC11:
Page 5769 L24-25 : Do you have an explanation ?

AC11:
The underestimation of the surface dust concentration from April to June over Banizoumbou is probably related to local dust uprisings that are not well simulated by the ALADIN model. This underestimation is strong in June, which marks the transition between the dry and the wet season monsoon in West Africa. Recently, a study realized by Kocha et al., (2013) shows the existence of two important processes responsible for dust uprising in West Africa, namely: (1) the diurnal variation of surface wind speed modulated by the low level jet occurring after sunrise due to turbulent mixing (Washington et al., 2006), especially in the Bodélé depression; (2) the gust wind associated with the density currents emanating from convective systems occurring in at the afternoon.
We also noted a bias for the values of AOT in the same period but with a less pronounced intensity than for surface concentration.

Page 5769 line 22-25: Sentence "In summer,.....remains high" now reads:
"In summer, the simulated and observed surface concentrations are low for these two stations. In contrast, noticeable differences are seen from April to June at Banizoumbou. For this site, the simulated surface concentration decreases while the PM10 concentration remains high. The model underestimations observed during April to June are probably related to local dust uprisings that are not well simulated by ALADIN model. This underestimation is strong in June, which marks the transition between the dry and the wet season monsoon in West Africa. Recently, a study realized by Kocha et al., (2013) shows the existence of two important processes responsible for dust uprising in West Africa, namely: (1) the diurnal variation of surface wind speed modulated by the low level jet occurred after sunrise due to turbulent mixing (Washington et al., 2006), especially in Bodélé depression; (2) the gust wind associated with the density currents emanating from convective systems occurred at the

afternoon. This second phenomenon generate a strong gust winds can lead to the "dust wall" known "haboob" (Tulet et al., (2010) ; Knippertz et al. (2012)).
We also noted a bias for the values of AOT in the same period but with a less pronounced intensity than for surface concentration.”

Ref:

Washington, R., Todd, M. C., Engelstaedter, S., Mbainayel, S., and Mitchell, F.: Dust and the low-level circulation over the Bodélé depression, Chad: Observations from BoDEx 2005, J. Geophys. Res., 111, D03201, doi:10.1029/2005JD006502, 2006.

Knippertz P., and Todd, M. C., Mineral dust aerosols over the Sahara: Meteorological controls on emission and transport and implications for modeling, Rev. Geophys., 50, RG1007, doi:10.1029/2011RG000362, 2012.

RC12:
Page 5770 L 10 : There is also a model overestimation during July.

AC12:
Thanks, it was a mistake. Rather, “there is also a model underestimation during July”. This is corrected in the final version of the manuscript.
Page 5770 line 9-10: Sentence “Over Mbour.........in August.” Will be “Over Mbour, the monthly simulated surface concentrations are larger than the observations over all months except in July and August.”