

We would like to thank the reviewer for their constructive comments and its help to perform our English.

Our response is detailed below.

General Comments

The manuscript describes improvements to the dust aerosol parameterizations employed by the atmospheric model ALADIN. One strength of the manuscript is that it conveniently offers, in one place, a rather complete description of the dust mobilization. This suits the mandate of GMD to enhance the reproducibility of geoscientific models. The primary flaw of the model is its neglect of prior literature and recent developments by Kok. This recent theory has important implications for the mechanisms (like role of parent soil size distribution) analysed and interpreted by this manuscript. Revisions to address the questions that arise would be correspondingly major, yet feasible. On the other hand, the manuscript's revised version of DEAD is clearly an advance within the previous theoretical framework and I congratulate the authors on this progress.

Explicitly, this manuscript describes the improvements made to the Dust Entrainment And Deposition (DEAD) model coupled with the SURFEX scheme. Previous papers cited in this manuscript, describe very well this model. For that, we gave, exclusively, the new elements on whom is based the revised version of DEAD, such as the surface soil size distribution to determine the potential dust sources emission, the saltation dust fluxes, the sandblasting efficiency and the Fecan formulation adapted to the revised DEAD coupled to SURFEX. And we pointed out the references for common parameterizations between the revised and the original version in the interest to shorten this manuscript. These common elements are summarized in table 4.

After the emission, the vertical dust flux is divided into three modes according to AMMA distribution (see Table S1 in the supplement). This distribution is based on the parameterization of Alfaro and Gomes and the AMMA observations obtained during the Special Observation Period (SOP) of June 2006 (Crumeyrole and al. 2011). The measurements taken during this period confirm the existence of a mode of particles centred around 0.64 μm but indicate that almost 99% of the number concentration is included in two other particle modes finer than that centred around 0.64 μm . The AMMA distribution contains: three coarse modes (fitted in one coarse mode see Crumeyrole et al., (2011)), accumulation mode and mode fine. This last being often forgotten in parameterizations of the dusts because it not very active on radiative effect and is often not observed by the measurement system in mass. However the measurement of number made during AMMA showed that this fine mode was very important (on number) and thus act as IN (Ice Nuclei) (Crumeyrole and al 2011). For this reason which we have chooses this tri-modal distribution for the three experiments performed in the 3-D simulation. These three modes are transported by the three-moment lognormal schemes (ORILAM) (Tulet and al. 2005). In ORILAM we choose to forget the biggest mode (20 μm) for mesoscale applications because this type of aerosols has a high sedimentation velocity; so they stay close to the sources.

Concerning the Kok's theory; mainly they reconsider the relation between the size distribution of emitted fluxes and soil texture. This distribution, according to Kok, is independent of the soil texture. However, in our work we were interested to prospect the relation between the soil size distribution and the intensity of emitted dust mass fluxes (not the aerosol size distribution emitted in the atmosphere). So, our conclusion does not disagree with that of Kok.

The concern in the application of the Kok's theory to ORILAM schemes is in the choice of the diameters of these three modes and their geometric standard deviation (σ) into the range “0.2 to 20 μm ” considered by Kok.

Clarification sentences relating to the conclusion of Kok were added in the revised version of the text.

We note that, a supplement for clarify the section 2 is given at the end of these responses. This supplement was introduced in the revised version of the manuscript.

Specific Comments

1. The title does not parse well in English. Adding “model” near the end should suffice, i.e., “Importance of the surface size distribution of erodible material: an improvement of the Dust Entrainment And Deposition (DEAD) Model”.

The reviewer is correct. The revised version of this manuscript will take into account of this correction. The title will be reformulated as follows: “Importance of the surface size distribution of erodible material: an improvement of the Dust Entrainment And Deposition (DEAD) Model”

2. Shannon and Lunt (2011) is a (non-cited) previous GMD article (also reviewed by me) which presents a complete description of the LPJ dust model, and thus the mobilization portion of that paper re-capitulates some of the same parameterizations presented here. This overlap of material between the two papers should at least be noted, possibly used to shorten the present manuscript, and also examined for any ways in which the present manuscript illuminates questions highlighted in Shannon and Lunt (2011). That said, in this age of electronic publications the convenience of having a complete description of a model in one place deserves real weight, and perhaps outweighs the goal of maximal conciseness.

We agree the comments. Important elements are examined in the Shannon and Lunt (2011) paper, such as the effect of the temporal variability in vegetation cover on the dust emissions. This influences the surface of erodible fraction. In our work we consider that vegetation cover and the dust sources emission are invariable in the time. That is a flaw of the revised version of DEAD and could be like prospect for future improvements.

3. Alf Grini implemented the Alfaro and Gomes (2001) sandblasting theory in DEAD c. 2004 Grini and Zender (2004), so there are version of DEAD (e.g., the U. Oslo GCM) which have long had soil-particle size/texture-dependence and sandblasting. Perhaps this should be noted somewhere, with the disclaimer that this manuscript refers, unless otherwise noted, to the original version of DEAD.

Exactly, the version of DEAD coupled to SURFEX is based on the Alfaro and Gomes (2001) sandblasting theory. This theory allows the distribution of emitted fluxes in three modes, according to the friction velocity. Based to the measurement taken during the SOP period of June 2006 of AMMA and the Alfaro and Gomes (2001) sandblasting theory, Crumeyrolle et al. (2011) proposed a new size distribution of emitted dust fluxes (AMMA) for DEAD coupled to SURFEX and since this time, it is this distribution which is used. This remark has been added in the revised version of the manuscript (see the supplement).

4. The sandblasting scheme employed is based on Alfaro and Gomes (2001). This theory holds that faster winds produce (i.e., sandblast) relatively more small particles than slower

winds. Hence the sandblasted size distribution depends strongly on the wind speed at emission. The authors are probably aware of recent challenges by Kok to the sandblasting theory of Alfaro and Gomes. Kok (2010) introduced a new conceptual model where the sandblasting portion of dust generation is treated as the fracturing of brittle materials. Moreover, Kok (2011) argued, based on many published measurements of size-distributed dust flux (not concentration), that the size distribution of mineral dust emissions is independent of the wind speed. Furthermore, Kok (2011) found little sensitivity of the emitted dust size distribution to soil characteristics. Those papers specifically discuss the significance of the differences among size-resolved dust emissions observations and theories.

The sensitivity of dust emissions to wind speed and soil texture is at the heart of this manuscript which makes no mention of Kok's theory. Many assertions made in the manuscript are questionable in light of Kok's work, e.g., f_{xm}

Readers will wonder the extent to which Kok's theory would improve or degrade the dust processes in ALADIN.

(a) Can the authors explain how sensitive their results are to the specific sandblasting formulation utilized?

(b) Would uniform soil textures, coupled to the Kok (2010) size distribution, improve or degrade ALADIN's agreement with AMMA and AERONET measurements?

Could this be performed as Experiment 5?

I specify, through our paper, we proposed a new map of dust source emission based on the surface soil size distribution which replaces the map of the sand fraction utilized in DEAD. And we introduced, in the revised version of DEAD, the Shao (1996) formulation to calculate the sandblasting efficiency (α). The experiments and results exposed in the manuscript show well the interest of these modifications on the intensity of the surface dust fluxes (not emitted size distribution) and its dependence with soil textures. I do not see contradiction between my conclusion and the conclusion of Kok. Rather I find complementarities and to my knowledge, the theory of Kok is an intermediate phase between the emission (mobilization) and transport. The variation of the soil texture is used in our work, only to quantify the saltation dust fluxes, because texture influences much the soil moisture-inhibition effects and the soil potential of fine particles. Thus, influence the saltation dust fluxes. After rising, the emitted dust flux is distributed independently of the soil texture, and we consider a uniform distribution for all textures. And it is the same opinion with Kok not a contradiction. Now, the question which distribution is better, AMMA or Kok? The answer of this question is not the objective of this paper.

Concerning, the sensitivity of our results to the specific sandblasting formulation utilized. The sensitive is very important. Figure S1a and b (see the supplement), shown the sandblasting efficiency calculated, respectively, by MaB95 and Shao et al. (1996). The difference is very well perceptible. And the reason is given in the conclusion page 2913 line 13-20.

Figure S2 shown the size distribution of emitted dust aerosol given by AMMA and Kok. The difference between the Kok's distribution and the AMMA distribution (Fig.S2) is very perceptible and is clear that Kok's distribution is coarser and neglects the fine mode which is confirmed by the AMMA observations. This is related to the fact of this theory which is based on the measurements taking near the surface. However the AMMA distribution is based on the aircraft measurements taking at an altitude around 700 m above mean sea level between Niamey (Niger) and Cotonou (Benin). These regions are far from dust source and the dust fine particles are more dominant, because they have a weak sedimentation velocity and a long atmospheric residence time. For this reason the AMMA distribution is finer than Kok's. This fine mode is very important and thus acts as Ice Nuclei. So, we adopt this distribution for the

revised DEAD version in order to represent well the transportable dust particles in the west Africa.

5. *The finding (whether one believes it or not) by Kok (2011) that dust emitted size distribution is nearly independent of the source soil texture presents an opportunity for this study to emphasize all the reasons source soil texture is important for dust mobilization besides dust size distribution. For examples, fractional coverage by non- erodible pebbles, susceptibility to moisture-inhibition effects, total mass sandblasting efficiency (α). The revised manuscript should emphasize this point so that readers appreciate the oft-neglected subtleties of soil texture which are easier for those (like the authors) with field experience to appreciate.*

Generally, the surface soil size distributions given by literature are very coarse, as our case. And also contain very large soil particles which is not participating in dust transport but it is important for dust mobilization. So, in my opinion it is very difficult to make a corresponding between surface soil size distribution and size distribution of emitted dust aerosol. For this reason in our work, we chose the uniform size distribution of emitted flux for all textures; which is in agreement with kok's theory.

6. *Page 2902 Line 4: This sentence illustrates the manuscript's often poor English translation (of course it's vastly better than my translation of English into French would be), including subject number disagreement with the verb and with adjectives. Please ask a more fluent writer of English to revise the manuscript.*

The sentence will be reformulated as follow: "Different 0-D simulations present the surface dust fluxes evolution, depending on the friction velocity over a specific point are conducted with four different configurations of surface fluxes (EXP1, EXP2, EXP3 and EXP4) defined in table 4". The final version of the manuscript will be revised by an expert in English.

7. *Page 2903 Line 19: wind velocity or wind friction velocity?*

Thanks, it is "wind friction velocity". It has been corrected in the text.

8. *Page 2905 Line 7: We found the same thing. Perhaps this is because Fecan et al. (1999) is more accurate for in situ than for spatially averaged soil moistures?*

Yes, it is the first reason. The second reason is that, Fecan et al. (1999) considers all Sands soil contain 0% of clay, thus $w' = 0\%$. On the other hand, in our work sand soil contains about ~3% of clay, thus $w' = 0.51\%$.

There is no conformity between database on the fraction of sand, clay and silt linked to each soil type.

Technical Corrections

1. *Throughout: "developed" as in "the developed [DEAD, model, version, etc.]" does not translate well into English. Alternatives closer to the intended meaning might be "new", "improved", "updated", "modified", or "revised", as appropriate.*

Revised accordingly

2. *Page 2895 Line 5: "emissions and transport"*

Revised accordingly

3. *Page 2895 Line 24: eliminate "it's important to specify"*

Revised accordingly

4. *Page 2896 Line 1: suggest ". . . 75 mm, the optimal size for saltation"*

Revised accordingly

5. *Page 2896 Line 8: "ignored in the original version of DEAD"*

Revised accordingly

6. Page 2901 Line 3: Place in preceding paragraph. Use ". . . soil particle bins with relative surface areas shown . . .".

Revised accordingly

7. Page 2901 Line 3: disambiguate with ". . . of the suspended dust particles . . ."

Revised accordingly

8. Page 2902 Line 16: "erodible"

Revised accordingly

9. Page 2902 Line 21: "shown"

Revised accordingly

10. Page 2903 Line 16: omit "African"

Revised accordingly

Authors greatly thanks the reviewer for all these syntax or grammatical errors

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Supplement

Importance of the surface size distribution of erodible material: an improvement of the Dust Entrainment And Deposition (DEAD) Model

2. Developed dust emission scheme coded in SURFEX

The representation of dust emission processes is very important in a dust model. It depends on wind conditions, surface characteristics and soil type. The revised DEAD scheme is based on parameterizations of soil aggregate saltation and sandblasting processes. The main steps for this scheme are: the calculation of soil aggregate size distribution for each model grid cell, the calculation of a threshold friction velocity leading to erosion and saltation processes, the calculation of the horizontal saltating soil aggregate mass flux, and finally the calculation of the vertical transportable dust particle mass fluxes generated by the saltating aggregates.

2.1 Soil texture methodology

Soil texture is the result of physicochemical processes acting on rocks and minerals that has decomposed in place or that has been deposited by wind, water or ice, influenced by external factors like climate, topography, and living organisms. The knowledge of the soil texture is necessary to determine the soil potential of the fine particles and to control the soil water contents. In order to characterize the erodible fraction of different types of soils, soil aggregate distributions are provided to the DEAD scheme. These distributions rely upon the USDA (United States Department of Agriculture) textural classification (Table 1), for which different types of soil are classified according to an index referring to the classic sand/clay/silt triangle of texture composition (Fig. 1) (Buckley, 2001). Sand particles range in size from 0.05–2.0 mm, silt ranges from 0.002–0.05 mm, and the clay is made up of particles less than 0.002 mm in diameter. Gravel or rocks greater than 2 mm in diameter are not considered when determining texture. The combined portions of clay and sand in SURFEX scheme are provided by the global FAO database at 10 km resolution (Masson et al., 2003). These portions are shown in Fig. 2a and Fig. 2b, respectively, for the north Africa domain. The silt fraction is the portion which complements the two portions of sand and clay for having the sum of the three portions is equal to 1.

Once, the percentage of sand, clay and silt are known in the soil, the textural class can be read from the textural triangle. For example, a soil with 40% of sand, 40% of silt and 20% of clay would be classified as a loamy soil. Therefore, a map of soil texture can be created (Fig. 3).

The analysis of Fig. 3 shows that North Africa is dominated by a medium texture represented by loamy and sandy loam soil. These types of soil correspond to the Aridisols and Entisols in the Global soil region map classification (USDA/NRCS 1999). In second position, we find sand and loamy sand soil; these soils correspond to shifting sands region in USDA classification (USDA/NRCS 1999). This region, essentially constituted by a continuous substratum of coarse sands producing stable dunes made of coarse sands (median diameter 700 μm) and active dunes made of fine sands (median diameter 250 μm) (Callot et al. 2000). Silt loam occupies the major part of Hoggar and extreme eastern of Egypt toward red sea. Finally, clay and clay loam occupies very limited area in north Africa especially near Nil river and south-east of Sudan.

2.2 Soil aggregate distribution

A three-mode lognormal soil mass size distribution $M^T(D_p)$ is related with each texture class following Zabler (1986):

$$\frac{dM^T(D_p)}{d\ln(D_p)} = \sum_{j=1}^n \frac{M_j^T}{\sqrt{2\pi} \cdot \ln(\sigma_j^T)} \cdot \exp\left(\frac{(\ln D_p - \ln D_{medj}^T)^2}{-2 \cdot \ln^2 \sigma_j^T}\right) \quad (\text{S1})$$

where j refers to the mode, T refers to the texture, M_j^T is the mass fraction of particles for mode j , D_{medj}^T is the mass median diameter, and σ_j^T is the geometric standard deviation.

Table 2 shows the mass fraction of particles M_j^T , the mass median diameter D_{medj}^T , standard deviation σ_j^T , and soil texture composition used to characterize each textural class (Zakey et al., 2006).

Following MaB95, the surface covered by each soil particle is assimilated to its basal surface. Thus a size distribution of the basal surfaces can be computed from the mass distribution, assuming spherical particles with the same density ρ_p :

$$dS^T(D_p) = \frac{dM^T(D_p)}{\frac{2}{3} \cdot \rho_p \cdot D_p} \quad (\text{S2})$$

The total basal surface S_{total} is

$$S_{total} = \int_{D_p} dS^T(D_p) \quad (\text{S3})$$

and the normalized continuous relative distribution of basal surfaces $dS_{rel}^T(D_p)$:

$$dS_{rel}^T(D_p) = \frac{dS^T(D_p)}{S_{total}} \quad (S4)$$

In our study, the process which we adopted to calculate the relative surfaces for each soil particle is based on a soil sample containing 1000 particles with a diameter ranging between $0.01 < D_p < 2000 \mu m$. So, we consider all soil particles which contribute in saltation and sandblasting processes.

In order to increase the computation efficiency of the model and reduce the number of variables which are related to soil particles, we divided the particles of our sample soil into four populations according to their size: a) clay-size $D_p < 2 \mu m$, b) small silt-size $2 \mu m < D_p < 10 \mu m$, c) large silt-size $10 \mu m < D_p < 60 \mu m$ and d) sand-size $D_p > 60 \mu m$. And we calculated the average relative surface of each population according to the relative surfaces of the soil particles in the four size domains considered. The average relative surfaces of each of the four populations $dS_{rel}^T(D_{bin})$ are shown in the Fig.4 superimposed with the cover “COVER004” related to the fraction of erodible surface.

Then, the potential dust source map obtained for the revised DEAD version is represented by the total average relative surface of the four populations (Fig. 5).

2.3 Dust mobilization

The physical basis of the revised DEAD scheme is based globally on the MaB95 scheme, where dust is calculated as a function of saltation and sandblasting. Fine soil particles are not directly mobilized by wind, but they are injected into the atmosphere during the sandblasting caused by saltation bombardment. Following Zender et al. (2003), the optimal size for saltation is $D_0 = 75 \mu m$. So that, the dust mobilization starts when the friction velocity u_* exceeds a threshold value named threshold friction velocity u_{*t} . This threshold friction velocity is parameterized following MaB95 and is obtained for a particle $D_0 \approx 75 \mu m$ of diameter. Following MaB95, we assume all soils in the erodible region contain particles of size D_0 . The threshold friction velocity depends on drag partitioning (MaB95) and soil moisture (Fécan et al., 1999).

The drag partition ratio f_d is calculated following MaB95:

$$f_d = \left[1 - \frac{\ln\left(\frac{Z_0}{Z_{0s}}\right)}{\ln\left\{0.35 \left[\left(\frac{0.1}{Z_{0s}}\right)^{0.8}\right]\right\}} \right]^{-1} \quad (S5)$$

where $Z_0(cm)$ and $Z_{0s}(cm)$ are the roughness length for momentum and the smooth roughness length, respectively.

The smooth roughness length Z_{0s} is estimated following MaB95:

$$Z_{0s} = D_{med} / 30 \quad (S6)$$

where D_{med} is the median diameter of the coarser mode for the twelve soil textures given in the Table 2.

The roughness lengths used by the ISBA scheme are derived from the ECOCLIMAP data bases. The value of Z_0 associated to bare soil (COVER004) is equal to 13 mm (Masson et al., 2003). Value used to quantify the momentum exchanges. But this value is very important and influences considerably the drag partition factor (F_d) and gives very important threshold friction velocity. What penalizes the dust emissions. For that, DEAD adopts a uniform value $Z_0 = 100 \mu m$ and $Z_{0s} = 33.3 \mu m$. However, in our case the smooth roughness length are derived from the relation of MaB95 and varies according to the soil texture of from $33.3 \mu m$ for Sand to $3 \mu m$ for the clay soils. The difference between Z_{0s} derived by MaB95 and Z_0 used in DEAD is significant. What gives important F_d factors. To keep the same value for the F_d factor for both version of DEAD original and new, we chose for the revised version of DEAD a roughness length $Z_0 = 30 \mu m$ which is appropriate for Z_{0s} used.

Soil moisture generates a capillary force which is allowed to suppress dust deflation when the soil gravimetric water content (w) exceeds threshold soil moisture (w'). This threshold is defined in the revised DEAD scheme by the following relationship:

$$w' = b (0.17 M_{clay} + 0.0014 M_{clay}^2) \quad \text{and} \quad 0.053 < w' < 0.15 \quad (S7)$$

It was established, empirically, that setting $b = 3$ in Eq. (S7) is better adapted to w predicted by the Interaction Soil Biosphere Atmosphere (ISBA) scheme (Noilhan and Planton, 1989) and provides a reasonable value of the erosion threshold velocity compared with that obtained by Fecan et al., (1999).

The factor that accounts for the effect of soil moisture content on the threshold friction velocity f_w is calculated following the relationship (Fecan et al., 1999):

$$f_w = \begin{cases} 1 & \text{for } w \leq w' \\ \sqrt{1+1.21[w-w']^{0.68}} & \text{for } w > w' \end{cases} \quad (\text{S8})$$

w and w' having units of kg/kg

The Owen effect is calculated using the following relationship (Zender et al., 2003):

$$u_{*s} = u_* + 0.003(U_{10} - U_{10,t})^2 \quad (\text{S9})$$

where u_{*s} is the corrected friction velocity due to the Owen effect. U_{10} and $U_{10,t}$ are the wind speed and the threshold wind speed at 10 m, respectively.

The total horizontal saltating mass flux G is calculated following MaB95:

$$G = a.E.c.\frac{\rho}{g}.u_*^3\left(1+\frac{u_{*f}}{u_*}\right)\left(1-\frac{u_{*f}^2}{u_*^2}\right)\int_{D_{bin}}dS_{rel}(D_{bin})dD_{bin} \quad (\text{S10})$$

where E is the fraction of the erodible surface is represented by the COVER004, a is the global mass flux tuning factor determined at posterior through the model experiments, $c=2.61$, g is the gravitational constant, ρ is the atmospheric density and $dS_{rel}(D_{bin})$ is the average relative surface for each populations shown in Fig. 4.

In the original DEAD version, the horizontal saltating mass flux G is converted to a vertical dust mass flux F with a sandblasting mass efficiency α which is parameterized following MaB95. This efficiency depends on the clay fraction in the parent soil is restricted to $M_{clay}<20\%$. At the local scale, this parameterization yields reasonable results (Marticorena et al., 1997) but at the global scale, it proves to be overly sensitive to M_{clay} . For this reason, Zender et al. (2003) assigns a constant value for clay fraction ($M_{clay}=20\%$). However, this assumption provides a uniform value of α over all dust source emissions and degrade the representativeness of the spatial variation of this efficiency. In order to turn out of this flaw in the revised DEAD, we adopt the Shao et al. (1996) sandblasting efficiency relationship:

$$\alpha = \frac{F}{G} = \frac{2}{3} \times \frac{\rho_p}{\rho} \times \frac{\beta\gamma g}{[u_{*f}(D_d)]^2} \quad (\text{S11})$$

$$\gamma = 2.5$$

and

$$\beta = [0.125 \times 10^{-4} \ln(D_s) + 0.328 \times 10^{-4}] \exp(-140.7 D_d + 0.37) \quad (\text{S12})$$

where D_d et D_s in mm and $\beta > 0$.

D_s : average diameter of the particles in saltation ($\sim 75\mu m$), D_d : average diameter of the suspended particles ($\sim 6.7\mu m$).

2.4 Size distribution of dust transportable particles

In the original DEAD, the emitted dust flux distribution is parameterized following Alfaro and Gomes (2001) sandblasting theory. This theory allows the distribution of emitted dust fluxes in three modes, according to the friction velocity. The measurements taken during the Special Observation Period (SOP) of June 2006 (Crumeyrole and al. 2011) of AMMA, confirm the existence of a mode of particles centred around $0.64 \mu\text{m}$ but indicate that almost 99% of the number concentration is included in other particle modes finer than that centred around $0.64 \mu\text{m}$. So, based on the AMMA measurement and the Alfaro and Gomes (2001) sandblasting theory, Crumeyrole et al. (2011) proposed a new tri-modal size distribution (AMMA) for the emitted dust fluxes in the DEAD coupled to SURFEX. The parameters related to the AMMA distribution are given in Table S1.

Based on many published measurements of size-distributed dust flux, Kok (2011) argued that the size distribution of mineral dust emissions is independent of the wind speed and found little sensitivity of the emitted dust size distribution to soil textures. Furthermore, Kok (2011) proposed a theoretical emitted dust distribution depend on one median diameter ($D_s=3.4 \mu\text{m}$) and geometric standard deviation ($\sigma_s=3.0$). The difference between the Kok's distribution and the AMMA distribution (Fig.S2) is very perceptible and is clear that Kok's distribution is coarser and neglects the fine mode which is confirmed by the AMMA observations. This is related to the fact of this theory which is based on the measurements taking near the surface. However the AMMA distribution is based on the aircraft measurements taking at an altitude around 700 m above mean sea level between Niamey (Niger) and Cotonou (Benin). These regions are far from dust source and the dust fine particles are more dominant, because they have a weak sedimentation velocity and a long atmospheric residence time. For this reason the AMMA distribution is finer than Kok's. This fine mode is very important and thus acts as Ice Nuclei. So, we adopt this distribution for the revised DEAD version in order to represent well the transportable dust particles in the west Africa.

Dry deposition and sedimentation of dust aerosols are driven by the Brownian diffusivity and by gravitational velocity (see Tulet et al. (2005) and Grini et al. (2006) for details).

Table S1. Log-normal parameters of the AMMA size distribution used in the DEAD coupled to SURFEX.

Dust mode	Mode 1	Mode 2	Mode 3
Number fraction (%)	97.52	1.95	0.52
Mass fraction (%)	0.08	0.92	99
Geometric standard deviation	1.75	1.76	1.70
Number median diameter (μm)	0.078	0.64	5.0
Mass median diameter (μm)	0.20	1.67	11.6

Table S2. Definition of the four configurations tested for five types of soils.

Compared elements	EXP1	EXP2	EXP3	EXP4
Geographic size distribution	Uniform texture	Uniform texture	Uniform texture	USDA textures
Moisture effect	Fecan (1999)	Fecan (1999) with w' is given by Eq.S7	Fecan (1999) with w' is given by Eq. S7	Fecan (1999) with w' is given by Eq. S7
Drag partition effect	MaB95 with $Z_0=100 \mu\text{m}$, $Z_{0s}=33.3 \mu\text{m}$	MaB95 with $Z_0=100 \mu\text{m}$, $Z_{0s}=33.3 \mu\text{m}$	MaB95 with $Z_0=100 \mu\text{m}$, $Z_{0s}=33.3 \mu\text{m}$	MaB95 with $Z_0=30 \mu\text{m}$, $Z_{0s}=D_{med}/30 \mu\text{m}$
Saltation fluxes	White (1979)	White (1979)	White (1979)	MaB95
Sandblasting efficiency $\alpha = F/G$	MaB95 with $M_{clay} = 20\%$	MaB95 with $0 < M_{clay} < 20\%$	MaB95 with $M_{clay} = 20\%$	Shao (1996)
Dust source intensity	M_{sand}	M_{sand}	M_{sand}	Relative surface $dS_{rel}(D_{bin})$ for each of the four populations

Table S3. Threshold friction velocity (u_{*t}) in m/s obtained with EXP1, EXP2, EXP3 and EXP4 configurations over clay soil, loamy soil, sandy loam soil, loamy sand soil and sand soil.

Soil type	EXP1	EXP2	EXP3	EXP4
Clay soil	0.6	0.5	0.5	0.5
Loamy soil	0.55	0.45	0.45	0.45
Sandy loam soil	0.5	0.42	0.42	0.42
Loamy sand soil	0.48	0.37	0.37	0.37
Sand soil	0.43	0.28	0.28	0.28

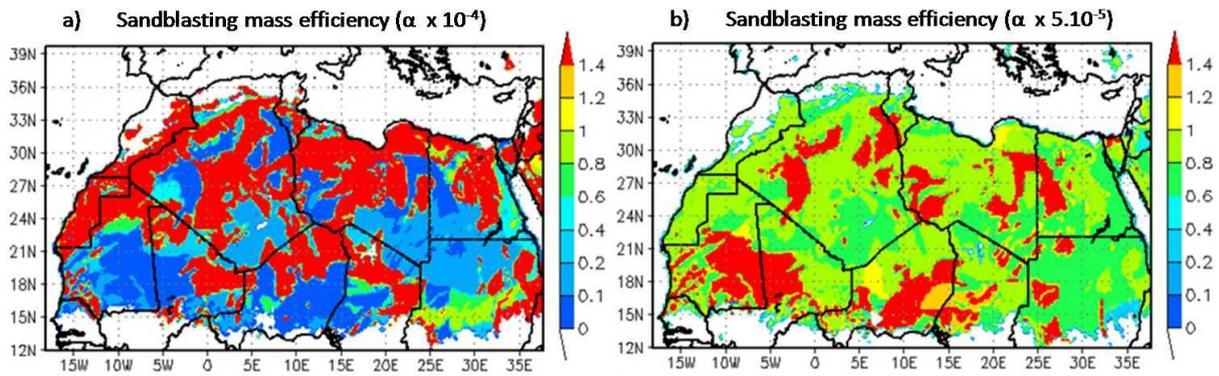


Fig. S1. Sandblasting mass efficiency (α) in m^{-1} calculated by: a) MaB95 with $0 < \% \text{clay} < 20\%$ and b) Shao et al. (1996).

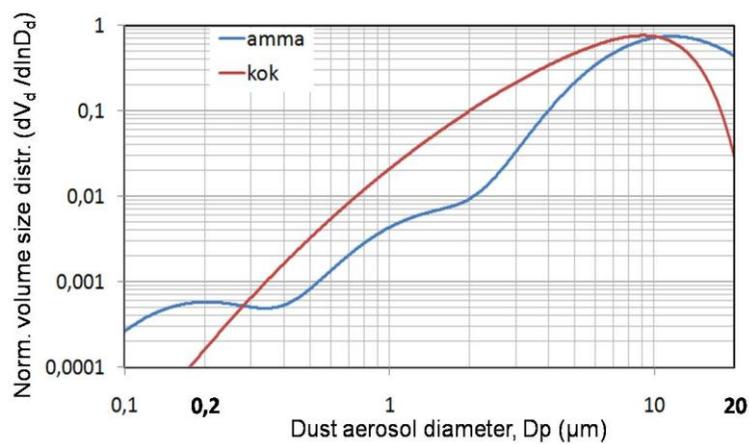


Fig. S2. The normalized volume size distribution of emitted dust aerosol given by: AMMA distribution (blue line) and Kok theory (red line).

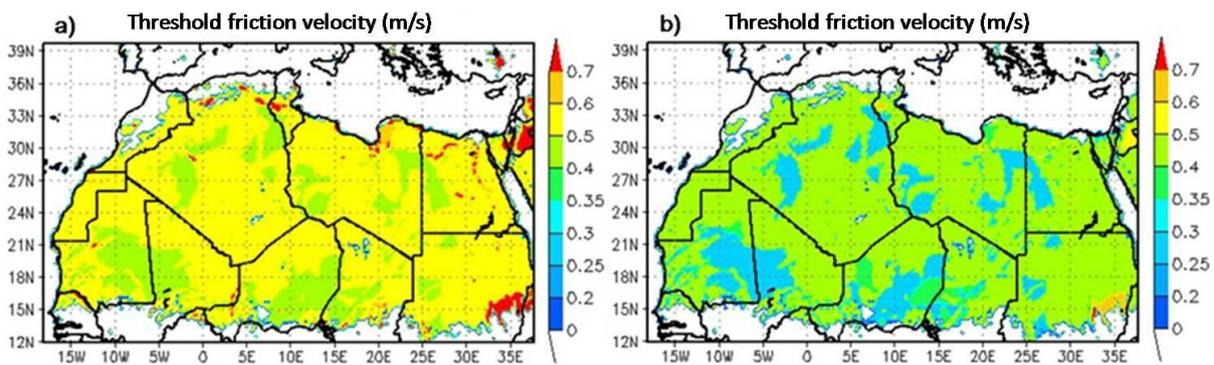


Fig. S3. Threshold friction velocity in m/s calculated by MaB95, introducing the soil moister effect following: a) Fecan et al (1999) and b) adapted Fecan formulation (Eq.S7)