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Interactive comment on “A climatology of dust emission events from northern Africa using long-term surface observations” by S. M. Cowie et al.

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The Manuscript entitled “A climatology of dust emission events from northern Africa using long-term surface observations” provides a very good conceptual and a well written study of dust climatology patterns using SYNOP data. I believe that it deserves to be published at the Atmospheric Chemistry and Physics Journal after some minor revisions:

1) Introduction Page 3 Line 4: The authors should expand a little more on the radiative effects of desert dust particles and add a couple more updated refer-

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ences.

Thank you very much for taking the time to read and review this paper. Your comments have been extremely helpful.

We have updated this sentence and added in information from the 2013 IPCC report.

“Once airborne, dust particles from northern Africa can be transported for thousands of kilometres and alter climate by scattering, reflecting and absorbing incoming shortwave and outgoing long-wave radiation at both the surface, and the top of the troposphere (Sokolik et al., 2001). Cooling takes place when absorbing and scattering reduces the amount of energy which reaches the surface (Kaufman et al., 2002; Spyrou et al., 2013) while atmospheric warming takes place when aerosols absorb and re-emit outgoing long-wave radiation (Dufresne et al., 2002). Current radiative forcing estimates of mineral dust are highly uncertain, but an overall negative (atmospheric cooling) effect of $0.1(\pm 0.2)$ W m² is predicted (Stocker et al., 2013)”

2) Introduction Page 4 Line 16: “. . .produces gusty winds and dust emission. . .” should be changed to something like “. . .produces gusty winds which in turn initiate dust emission. . .” just for clarity.

Section now reads: “The morning breakdown of a NLLJ by surface heating produces gusty winds which in turn initiate dust emission. The heating of the surface in the morning expands the boundary layer to the point where it erodes the jet and transports momentum to the surface”

3) Section 2.1.1. Page 7 Lines 10-11: What is meant exactly by time resolution? Please rephrase.

We have reworded this in the following way: “. . . reported at a given time of day or during a certain month, divided by the corresponding total number of observations.

4) Section 2.1.1. Page 7 Line 22: What is the importance of the ratio of day to night observations? Do you assume that during the night the observation of

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dust is hindered, therefore biased? Please explain in the text.

We have added the sentence: “More daytime observations will give extra weight to day-time dust emitting mechanisms. This is a problem for Sahel stations where haboobs commonly occur and are known to uplift dust in the evening and night-time (Marsham et al., 2013)”

5) Section 2.2.1. Page 9 Lines 5-13: The main mechanism for the production of small particles that can travel great distances is the saltation bombardment. When the authors define the threshold of wind speed is it for this process? Please expand.

Our measurements of dust emission are based on a subjective observation made by a station observer. The descriptions of dust emission given by the WMO do not specify the exact mechanism, as this could not be accurately measured considering the expertise and equipment available at WMO SYNOP stations.

We have added the following information to section 2.2.1, P7, Line 1. “. . .the ww codes describing dust emission are 07–09, 30–35 and 98 (WMO, 1995). These descriptions of dust emission weather do not provide information on the physical processes at a particle scale, but simply describe how the dust appears in the atmosphere to the observer.”

6) Section 2.2.1. Page 11 Line 3: End of paragraph. Is there a reference indicating the “. . .fact that emission occurs over a range of wind-speed values.”? Just to strengthen the point made.

We have added the Helgren and Prospero 1987 paper as a reference. They found a range of 6.5 – 13 ms⁻¹ for western Sahara stations using a similar method to ours.

Helgren, D. M., and J. M. Prospero. "Wind velocities associated with dust deflation events in the western Sahara." *Journal of climate and applied meteorology* 26.9 (1987): 1147-1151.

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7) Section 3.1.1. Page 12 Line 12: Can you please add a reference also indicating that the “. . .dust emission is generally more frequent in the semi-arid transition zone between the Sahel and Sahara. . .”?

The following sentence is now included “This is in agreement with the identification of a “Sahel dust zone” by Klose et al. (2010), though their study included transported events.”

Klose, Martina, et al. "Sahel dust zone and synoptic background." Geophysical Research Letters 37.9 (2010).

8) Section 3.1.1. Page 12 Line 19: “. . .proximity to the Mediterranean Sea. . .” Please expand a bit how the Mediterranean has the described effect.

Having looked at the seasonal direction of winds, these stations only show a predominantly north-east direction in summer and this is when dust emission frequency is lowest. We therefore decided to omit this sentence.

9) Section 3.1.2. Page 13 Line 27: Please expand on the physical reasons why Dongola and Abu Hamed in Sudan are prominent outliers.

It is not clear why Dongola and Abu Hamed have much higher annual FDE, but it could be due to local environmental factors such as an easily erodible local source or local orographic circulations, which allow winds to exceed the threshold regularly. A comment on this has been added to the text.

10) Section 3.2.3. Page 18 Line 23: “. . .emission thresholds found in the literature. . .” Can you provide some references?

We have included Helgren and Prospero 1978 and Chomette et al., 1999.

11) Section 4. Page 24 Line17: “. . .Seasonal variations in thresholds are largest in the Sahel and smallest in Sudan.” Can you explain why this happens (a small sentence)?

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This sentence has been included: “In arid Sudan (this work focuses on the northern stations of Sudan) there is significantly less rainfall than in the Sahel. Hence, there will be less seasonal variation in soil characteristics leading to less variable thresholds in Sudan.”

General Remark: I would like to see if this method can be applied to other desert regions of the world (perhaps the Gobbi desert). Can the authors add a paragraph addressing this? I was impressed by the method used and it would be interesting to see the possibilities of applying it to other regions as well.

This method has already been used in the Gobi Desert by Kurosaki and Mikami, 2007 and is currently referenced in 2.2.1.

Kurosaki, Y., and M. Mikami. "Threshold wind speed for dust emission in east Asia and its seasonal variations." *Journal of Geophysical Research: Atmospheres* (1984–2012) 112.D17 (2007).

Figures:

Figure 5: Can the authors create the plot with thicker lines (red, green, blue) so to be more clear?

Done

Figure 7: If the orography is not essential it would be better to omit it from the plot for clarity.

Done

Figure 12: Please write a complete caption like the one on Figure 11.

Done

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