

Comment on “The potential influence of Asian and African mineral dust on ice, mixed-phase and liquid water clouds”, by A. Wiacek , T. Peter , and U. Lohmann

John Marsham¹, Peter Knippertz² and Doug Parker²

¹National Centre for Atmospheric Science (NCAS), University of Leeds, UK

² University of Leeds, UK

The paper presents an interesting study on the potential for dust from Africa and Asia to reach locations where it will affect clouds.

The conclusions are based on trajectories derived from ECMWF fields. In the discussion of the limitations of this approach, although deep moist convection is mentioned, deep dry convection is hardly discussed. Deep dry convection is of particular importance in many dust source regions.

The atmosphere of the Sahara exhibits the deepest dry convection on Earth – dust is routinely observed to be mixed by dry convection to 5 or even 6 km (~500 hPa, e.g. Cuesta et al 2009, Knippertz et al. 2009 and references therein). The dust in the Saharan boundary layer is then exported out over neighbouring cooler boundary layers in the Saharan Air Layer (e.g. Cuesta et al 2009, as you say “the Saharan Air Layer is confined to 5 to 6 km altitude”). Since it does not account for dry convection, Figure 3 only shows air ascending to these heights after it has travelled westwards away from the African continent. Other deserts also have deep dry convective boundary layers. Therefore, for this study it would be more realistic to start the trajectories from all heights between the surface and the expected top of the boundary layer (as done and discussed in Knippertz et al. 2009), rather than simply from 770 hPa (or 700 hPa on line 7 page 4052?). Boundary-layer top is a parameter analyzed by the ECMWF routinely and could be used in this study (although we have not evaluated these values for the Sahara). Care must be taken to account for the strong diurnal cycle in the boundary layer over deserts that creates differential advection during the night and deep vertical mixing during the day (see Knippertz et al. 2009 for a discussion of this matter). If this is not done, we recommend that this limitation of the method should be stated in Section 3.2, the conclusions and the abstract. Currently this limitation is only referred to briefly in section 4.3,

“While the mixed boundary-layer depth above the hotter African continent routinely reaches 5 km, the melting level and the tropopause altitude above this low-latitude desert are correspondingly higher than in Asia.”

“Our analysis may underestimate both the ascent of bare mineral dust by clear-air turbulent processes and the ascent of cloud-processed mineral dust via convective system”

The role of dry convection in the vertical transport of dust in arid regions also means that very limited conclusions can be drawn from Figure 2, which shows zonally and annually averaged potential temperatures. The longitudinal, seasonal and diurnal variations in this field are so large that this does not give a realistic picture of dust transport; in the tropics the vertical gradient in potential temperature is sufficiently small that in some regions (eg the Sahara where the atmosphere is often dry adiabatic to almost 6 km), as discussed, dry convection routinely results in significant vertical transport of dust over the source regions and their surrounds.

Given the more mid-latitude and less tropical locations of the Asian dust sources compared with the African sources it is unsurprising that the ECMWF trajectories show greater vertical transport for the Asian sources. Only synoptic scale ascent will be captured by the trajectories and this is comparatively more important in the mid-latitudes compared with the tropics, where convection is expected to play a larger role.

References

Dynamical mechanisms controlling the vertical redistribution of dust and the thermodynamic structure of the West Saharan Atmospheric Boundary Layer during Summer, J. Cuesta, J. H. Marsham, D. J. Parker, C. Flamant, *Atmos. Sci. Lett.*, **10**(1), 34-42, DOI: 10.1002/asl.207, 2009.

Knippertz, P.; Ansmann, A.; Althausen, D.; Müller, D.; Tesche, M.; Bierwirth, E.; Dinter, T.; Müller, T.; von Hoyningen-Huene, W.; Schepanski, K.; Wendisch, M.; Heinold, B.; Kandler, K.; Petzold, A.; Schütz, L.; Tegen, I., 2009: Dust mobilization and transport in the northern Sahara during SAMUM 2006 – A meteorological overview. *Tellus*, 61B, 12–31. [doi:10.1111/j.1600-0889.2008.00380.x](https://doi.org/10.1111/j.1600-0889.2008.00380.x)