THE AIRBORNE TRANSPORT OF SAHARAN DUST: A REVIEW

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Abstract. The extent of the short and long-range transport, and the atmospheric residence time of airborne Saharan dust are dependent on factors like the initial size distribution of the dust and the type of weather systems raising dust and creating different kinds of dust storms.

The paper discusses these factors. It further reviews a number of investigations of long-range transport of Saharan dust out from the Sahara, and shows how eolian dust can be monitored with the help of meteorological SYNOP and METAR observations.

1. The size distribution of eolian desert dust and the relation to its atmospheric residence time and distance from the source

As soon as dust has been raised by the wind and lifted up in the troposphere, the coarser particles begin to be removed from the atmosphere by gravitational forces. Relatively big particles with a radius of more than 100 μm will have an atmospheric residence time of the order of minutes to hours, while particles of radii of 1 μm or less might remain in the atmosphere for up to weeks and be transported several thousands of kilometers. Figure 1 gives a schematic picture of how an original (idealized) sand distribution is fractionated as a function of distance from the source. Figure 2 shows the size distribution of Saharan dust after it has been transported by the winds to Cape Verde (the right curve), and to Barbados (left curve), which it reaches after 10 to 20 days. The mass median radius changes from about 3 μm to 1 μm during the transport over the Atlantic, as a consequence of sedimentation removal in transit.

The vertical extent of Saharan dust plumes varies considerably, depending on the geographical position of the plumes. Observations or estimates of tops from 1500 m to above 6000 m have been reported (Bertrand et al., 1974; Carlson and Prospero, 1972; Kalu, 1979; Morales, 1981). In the USA, the top of a dust layer over Texas in connection with a dust storm in February 1977, was between 4000 and 5000 m (McCauley et al., 1981).
2. Dust raising weather systems

Since the wind is a prerequisite for the mobilization of dust into the atmosphere, and since the wind is caused by meteorological factors, I will now go on to these factors, with particular reference to the Sahara.

Figure 1. Sand fractionation processes by wind, schematic. The original sand distribution is fractionated into major fraction 2, 3, 4 as a function of the distance from the source. Curves 5, 6 and 7 depict the change in concentration due to both wet and dry removal from the atmosphere. The sum of curve 2, 3 and 4 should be equal to the original curve 1. (From Junge, 1979. Reproduced with permission of John Wiley and Sons, Chichester. Copyright 1979 by SCOPE).