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Towards the assessment of the vertical structure of Saharan dust over the western Mediterranean from rawinsonde data

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African dust particles represent a large fraction of the tropospheric aerosols advected to the western Mediterranean basin. We have studied the radiosounding retrievals at the Murcia station (38.00N 1.17W, 62 m asl, 39 km inland) to further understand the vertical structure of the dust transport to the region. Radiosonde measurements are important for a large variety of meteorological and climate applications and, even though lidars measure with much higher vertical and temporal resolution, the availability of a large radiosonde database should give the opportunity of obtaining information from long term series at many locations around the world.

12UTC rawinsonde data for the period 2000–2006 was utilized to study the vertical structure of the troposphere in the area. We summarize our results concerning:

- A classification of distinct vertical profile types and their relationship to the occurrence of African Dust Outbreaks (ADO). A k-means cluster analysis of the tropospheric profiles of THTA, MIXR and the northern and eastern components of the wind velocity up to 7000 m asl was firstly performed. ADOs are mostly found in three profile types, two of them occurring in summertime and the third in winter and part of spring and autumn.
Mean vertical profiles on days with and without ADO, for each of the seven vertical profile types found, show some differences in the altitude ranges associated to the arrival of African air masses. The synoptic situations corresponding to each profile type on days with ADO are also different. This allows to describe in greater detail the different synoptic scenarios leading to ADO in Spain with respect to previous descriptions reported in the literature.

- A study of the single vertical profiles of all days in the period 2002–2004 with convective conditions and ADO, to attempt to retrieve the mixing height and the African dust layer (DL) heights from the first derivative of THTA. This is inspired in a work by De Tomasi & Perrone (2006) that, aiming to establish the criteria to extract a mixing height (MH) climatology from the lidar signal, found good correlation between the minima of the derivative of the lidar backscattered coefficient and the maxima of the derivative of the potential temperature profiles.
The first maximum in dTHTA/dz was compared to the MH computed from the parcel and bulk Richardson number methods. Then, the nature of the second, third, . . . maxima (possible DLs) was studied by back-trajectory analysis and the output of dust prediction models.
When the first and second maxima in dTHTA/dz are easily identifiable and are well separated from each other, the MH computed by the three methods shows very good agreement. For such cases, the slope of the linear regression of MH(1st max dTHTA/dz) vs. MH(Richardson) is 0.996 with a determination coefficient equal to 0.98. However, on more than a half of the days an aerosol layer appears on top of the PBL coupled to it and computed values show differences, or it becomes difficult to identify a precise height. Thus the procedure is not straightforward and presents some complications. Such kinds of difficulties can be found also in lidar studies of the MH.
The second and third maxima in dTHTA/dz could be associated to African dust layers in 78% and 86% of the cases, according to the back-trajectory analysis. However all days studied were affected by ADO. Dust layers associated to recirculating anthropogenic aerosols, possibly mixed with African dust, correspond to the remaining cases.