# Contribution and impact of desert dust outbreaks for a long-term period in a site of the Western Mediterranean Basin

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The desert dust (DD) aerosols are a key player in the Earth's planetary system and, therefore, their influence is still an open topic. There are different terms to refer to the change on the aerosol load or properties during DD outbreaks, but they are related in greater or lesser extent. The fraction of the total aerosol load caused by DD outbreaks is known as DD contribution, meanwhile the DD impact is similar but it means the produced change in a time window used as reference (e.g., moving 30-day averages). The main aim of this study is to analyse both quantities in order to provide a comprehensive characterization of the DD episodes in a background region placed around 1000 km to the North of the Saharan and Sahel desert. The identification of DD episodes for this area is presented by Cachorro et al. (2016).

The database used in this study includes both columnar and surface aerosol data for a long-term database of 12 years (2003-2014). The formers are obtained from Palencia site (41.99ºN, 4.52ºW, 750 m a.s.l.) belonging to AERONET (Aerosol Robotic Network). The surface measurements are those from Peñausende site (41.28ºN, 5.87ºW, 985 m a.s.l.) of the EMEP (European Monitoring and Evaluation Programme) network. The distance between the columnar and surface sites (~100 km) plays a minor role due to the absence of any large landforms between them and the clean atmospheric background conditions.

The DD inventory used in this study is evaluated with the joint interpretation of columnar and surface aerosol loads and other ancillary information (Cachorro *et al*, 2016).

The impact of DD episodes is addressed using the average daily variations (δX) of AOD (aerosol optical depth) and $PM_{10}$ (particulate matter of diameter below 10 μm) with respect to their inter-annual monthly mean. Those intrusions strongly/weakly modifying the aerosol behavior in the study area are highlighted, since the influence of background levels and other episodes of high turbidity are minimized in our results. With respect to the aerosol load, three months highlight by a strong impact (>0.3 and >30 μg $m^{-3}$) both at the surface and entire column: March-2004, July-2004, and August-2010. On the contrary, the least intense events, simultaneously observed at the surface and the entire column, occur on June-2009, January-2012, and August-2013, with an impact close to zero on both quantities. However, there are other events with large δAOD but with a weaker impact on $PM_{10}$: July-2003, August-2003, August-2004, and October-2008. In these months, whereas δAOD is always larger than 0.25, $\delta PM_{10}$ barely reaches 20 μg $m^{-3}$. The opposite situation (large $\delta PM_{10}$ and a weaker AOD impact) takes place in: November-2003, March-2005, April-2005, August-2005, and June-2012.

The DD contribution to AOD and $PM_{10}$ is addressed at seasonal (annual) scale obtained as the difference of the multi-annual monthly (yearly) means considering all days and the corresponding value without including the desert dust cases. This method assumes the entire daily aerosol load (both surface and columnar) due to DD aerosols, being included the contribution of regional background aerosols. As a result, the annual cycle peaks in March, decreases in April-May, notably increases during summer months and experiences a progressive decline after summer towards minimum values in winter. The maximum DD contribution to AOD occurs in June and August close to 0.03, while the $PM_{10}$ maximum DD contribution reaches 2.4 μg $m^{-3}$ in August. The inter-annual variability of the DD contribution to aerosol load is maximum in 2004 for AOD with 0.03 and 2006 for $PM_{10}$ with 2.4 μg $m^{-3}$, and minimum in 2013 (0.004 for AOD and 0.4 μg $m^{-3}$ for $PM_{10}$).

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