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Identification of a synergistic effect between the occurrence of african dust outbreaks and atmospheric pollutants levels in the madrid metropolitan area

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Introduction

The Mediterranean region is frequently affected by African dust outbreaks from the Sahara desert, the largest dust source in the world. The SINERGIA project main goal is the evaluation of the impact of long-range transport of African dust events on the levels of both particulate matter and gaseous pollutants within the Madrid urban area. These events are expected to increase both in frequency and intensity due to climate change.

Methodology

In this work, we have analysed a database composed by estimated values of daily contribution of African dust to the PM_{10} and $PM_{2.5}$ levels (particulate matter with aerodynamic diameter $<$10 and 2.5 μm, respectively) for each African dust event, created from a specific methodology developed ad hoc, in order to obtain a list of identified events with impact in the Madrid urban area classified by its intensity. For those events, we have estimated the midday mixing layer height in Madrid from radiosondes launched at the Madrid airport and multiwavelength Raman lidar lidar station installed at CIEMAT site (40.45^{o}N, 3.73^{o}W, 663 m asl), located 13.5 km westward. Intensive aerosol optical properties derived from the lidar profiles, such as backscatter-related Angstrom exponents, allow the identification of the different atmospheric layers as dust and mixing boundary layers. Finally, variability of levels of atmospheric pollutants at urban-traffic and urban-background monitoring sites of the Madrid air quality network, was correlated with the occurrence of African events of variable intensity.

Conclusions

Our study indicates that when these events take place, the mixing layer height, the depth of the lower troposphere layer through which air pollutants can be effectively dispersed, is reduced due to compression by the aloft warm African air mass. As a consequence, the mean PM_{10}, $PM_{2.5}$, NO, NO_2 and CO levels increased at urban-traffic locations in correlation with the intensity of the event. There is a twofold explanation for the increase in the mean PM_{10} levels: not only the dust load contributed to increase the PM_{10} concentrations but also the observed reduction favored the accumulation of PM_{10} emissions from local sources. Furthermore, these events increased the concentrations of several substances that affect human health and the environment. Hence, the exacerbation of these long-range transport events due to a changing climate must be monitored in terms of human health. The potential increase on mortality during African dust episodes of increasing intensity in Madrid is presently under evaluation.

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