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African dust outbreaks over the Mediterranean Basin during 2001-2011: concentrations, phenomenology and trends

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Concentrations, phenomenology and trends of African dust outbreaks over the whole Mediterranean Basin werestudied on an 11-year period (2001-2011). This work has been performed in the context of the MED-PARTICLES (LIFE programme, EU) project, devoted to quantify short-term health effects of particulate matter over the Mediterranean region by distinguishing different particle sizes, chemical components and sources, with emphasis in the effects of African dust. In order to evaluate conduct this investigation, PM10 data from 19 regional and suburban background sites West to East in the Mediterranean area were compiled. After identifying the daily occurrence of African dust outbreaks, a methodology for estimating natural dust contributions on daily PM10 concentrations was applied.

Our findings point out that African dust outbreaks are sensibly more frequent in southern sitesacross the Mediterranean, from 30 to 37 % of the annual days, whereas they occur less than 20% of the annual days in northern sites. The central Mediterranean emerges as a transitional area, with slightly higher frequency of dust episodes in its lower extreme when compared to similar latitudinal positions in western and eastern sides of the Basin. A decreasing south to north gradient of African dust contribution to PM10, driven by the latitudinal position of the monitoring sites at least 25ºE westwards across the Basin,is patent across the Mediterranean. From 25ºE eastwards, higher annual dust contributions are encountered due to the elevated annual occurrence of severe episodesof dust but also because of inputs from Middle Eastern deserts.

Concerning seasonality patterns and intensity characteristics, a clear summer prevalence is observed in the western part, with low occurrence of severe episodes (daily dust averages over 100 μg m-3 in PM10); no seasonal trend is detected in the central region, with moderate-intensity episodes; and significantly higher contributions are common in autumn-spring in the eastern side, with occurrence of various severe episodes throughout the year. Overall, African dust emerges as the largest PM10 source in regional background southern sites of the Mediterranean (35-50% of PM10), with seasonal peak contributions to PM10 up to 80% of the total mass in the eastern side.

The multi-year study of African dust episodes and their contributions to PM10 concentrations displaysa consistent decreasing trend in the period 2006/2007 to 2011 in 4 of the 17 studied regions, all of them located in the NW of the Mediterranean. Such decrease is almost parallel to that of NAO (North Atlantic Oscillation) index for the summer period, being progressively more negative since 2006. As a consequence, a sharp change in the atmospheric circulation over the last 5 years (a similar negative NAO period occurred in the 1950 decade) have affected the number of African dust episodes and consequently the annual dust inputs to PM10observed in the NW part of the Mediterranean. By investigating mean temperatures and geopotential height maps at 850hPa it is evident a displacement of warm air masses accomplishing African dust towards the central Mediterranean in the 2007-2008 period, and towards the NW African coast and the Canary Islands in the 2009-2011 period.

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