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A seven year record of Saharan dust outbreaks over the Central Mediterranean Sea:chemical characterization, size distribution and optical properties

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Saharan dust largely affects air pollution and climate. This study aims at determining the mineral contribution to PM10 in the Central Mediterranean Sea based on 7 years of PM10 chemical composition measurements at the island of Lampedusa (35.5°N, 12.6° E). Total content and soluble fractions of selected elements and metals are used to characterize the dust events. The soluble + insoluble contribution is determined by PIXE, (Particles Induced X-ray Emission), while the composition of the soluble fraction by ICP-AES, (Inductively coupled plasma – atomic emission spectroscopy) after extraction with HNO_3 at pH1.5. The solubility of each element and its size distribution are analyzed with the aim of obtaining information on their sources, mixing processes, and availability for the environment.

The Saharan dust contribution to the total PM was estimated by considering Al, Si, Ca, non-sea-salt Na, K and Fe oxides. During strong Saharan dust events PM10 is often higher than 50[U+F06D]g m-3, and the dust contribution is about 50%. The crustal aerosol amount and contribution to PM10 shows a very small seasonal dependence; conversely, the dust optical depth displays an evident annual cycle, with a strong summer maximum (monthly average aerosol optical depth at 500 nm as large as 0.28 in June-August). We found that only 49% of the events identified from optical properties over the air column display a high dust content at the ground level, demonstrating that Saharan dust transport frequently occurs above the marine boundary layer, with negligible or small impact on the surface aerosol properties.

The average size distribution obtained by Optical Particle Counter during the days with high mineral content comprises three modes, whose median radii are at about 0.29 um, 2.2 um, and 7.2 um, respectively.

Solubility of each elements present a large variability in the condition of extraction, but usually in Saharan dust events the solubility is lower than in non-Saharan dust events. Markers of crust present two relative maxima in the size range 2.1-3.3 um and 5.8-9 um, generally characterized by low solubility. Conversely, elements having also anthropic source present a maxima in the finest fraction, characterized by highly soluble components. For instance Fe, K and Co present a very low solubility in the coarse fraction (8 % in the size range 2.1-3.3 um for Fe), on the contrary the finest fraction is characterized by high solubility (69 % in the size range 0.4-0.7 um for Fe).