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Heavy metals in atmospheric deposition in Málaga (SE Spain) and the influence of African dust intrusions

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This study reports information on deposition samples collected weekly at a coastal sampling site (Málaga, SE Spain) as part of a research project focused on the impact of atmospheric deposition on the Alborán Sea (W-Mediterranean). This semi-enclosed basin is a transitional area between the Atlantic Ocean and the Mediterranean. Moreover, due to its geographical location the area is frequently affected by intrusions of air masses loaded with high concentrations of atmospheric particulate matter. Major and trace metal analysis of filters and filtrates were aiming at finding the dissolved and non-dissolved fractions of the deposited material. The origin of the air masses reaching the study region was interpreted based on back-trajectories and principal component analysis was performed to find out the groups of elements with similar behaviour. Deposition fluxes at this site were marked by meteorological conditions and the external influence of other sources on a regional scale and the frequency and magnitude of African dust intrusions.

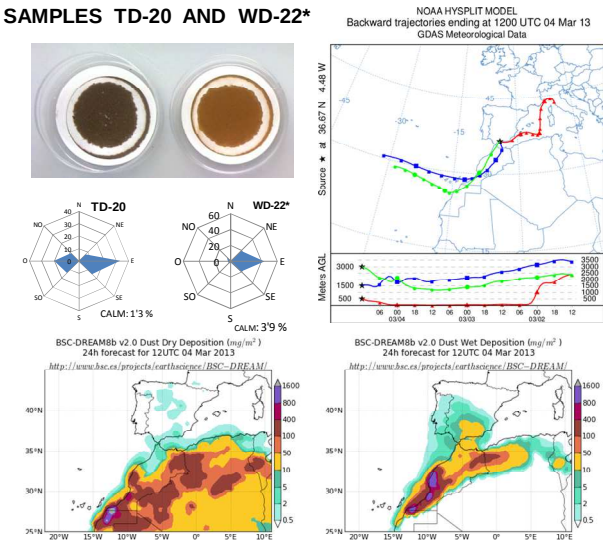
Keywords: Atmospheric deposition, major and trace metals, African dust intrusions, Mediterranean Sea

Mineral dust plays an important role in the optical, physical and chemical processes within the atmosphere while dust deposition adds exogenous mineral and organic material to land and ocean surfaces, having a significant impact on ecosystems and biogeochemical cycles (Jickells et al., 2005). Metals contained in atmospheric particles can reach the Earth's topsoil surface, the continental surface waters as well as the surface of the ocean via dry and wet deposition processes, and eventually become absorbed by biota. Different studies (i.e. Guerzoni et al., 1999; Guieu et al, 2002; Sandroni and Migon, 2002) have found atmospheric transport to be the main form of pollutants transportation from the continent to the sea. The Alborán Sea (Western Mediterranean area) is a semi-enclosed basin in the transitional area between the Atlantic Ocean and the Mediterranean Sea. Regarding the atmospheric input, it is a very interesting case study because the atmospheric chemistry is dominated by the influences of both natural (mainly from the Sahara) and human activity due to the relative proximity of land-based sources, densely populated shores and high ship traffic area.

This study reports information of deposition samples collected at a coastal sampling site at the NW-Alboran Sea, in the city of Málaga (36° 43′ 40″ N; 4° 28′ 8″ W). This Mediterranean city is surrounded by mountains, which causes a special wind regime. Prevailing wind directions are from the NW, generally bringing dry air, and from the SE, bringing maritime, humid air. Due to its geographical proximity to the African continent, our study area is frequently affected by intrusions of air masses loaded with high concentrations of atmospheric particulate matter. Samples of bulk deposition (wet + dry) (TD) were collected on a weekly basis using a standard rain collection gadget. Using the bulk deposition collector, dry deposition samples were collected during dry periods (dry deposition samples, DD). The wet-only deposition was concurrently measured with a standard automatic rain collector (wet

deposition samples, WD). The samples were filtered to separate the dissolved and the suspended fractions and filtrates and filters were analyzed by ICP-MS for selected heavy metals (Al, Cd, Cr, Cu, Fe, Ni, Mn, Pb, V and Zn) to evaluate their presence under different meteorological scenarios.

Average daily heavy metal flux deposition rates for the dissolved and suspended fractions were calculated and the contribution of the soluble fraction in deposition fluxes were usually greater for all the metals except for Al, Fe and Pb. Maximum values in soluble and insoluble forms were mainly recorded in the WD samples. Wet deposition rates were much more significant than the dry deposition rates on a daily basis. However, the relative contribution of dry and wet deposition for the supply of elements from the atmosphere was, to some extent, depending on the precipitation regime in the area. Some meteorological factors like wind speed, wind direction as well as relative humidity can also determine the chemical composition of the atmospheric deposition of heavy metals in this coastal area of the Mediterranean.



In order to investigate the influence of African dust intrusions on the amount and chemical composition of bulk, dry and wet atmospheric deposition, we compared mean values between the different samples sorted depending on the presence or not of African dust outbreaks. The identification of African events during the sampling period was confirmed by means of back trajectory analysis (at 500 m, 1500 m, 3000 m a.g.l.) using the HYSPLIT model and BSC-Dream8b dust images. The figures, where some examples are depicted, clearly show that during the sampling period the origin of these events was mainly from the North and West Sahara. The results of the present study show that the monitoring of atmospheric deposition at this coastal site gives useful information on the potential significance of atmospheric inputs of the dissolved and non-dissolved fractions of major and trace metals to this area.

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