

MONITORING OF THE TRANSPORT OF CHEMICALS TO THE
EASTERN MEDITERRANEAN AND THE BLACK SEA THROUGH THE ATMOSPHERE

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ABSTRACT

Chemicals, both natural and man-made, reach the oceans by a number of routes, including rivers, direct dumping and via the atmosphere. The first two paths have been studied for several decades, but it has only recently become possible to estimate the amount of material entering the oceans from the atmosphere. The atmospheric route seems to have gained importance especially for the open ocean regions where the influence of riverine inputs is often not detectable. To evaluate the importance of the atmospheric transport and deposition, and to identify sources of trace elements and ions we collected daily aerosol samples on the Mediterranean coast of Turkey and on board ship during an oceanographic cruise at the Black Sea.

The analyses of aerosol measurements during August 1991 - December 1992 at Erdemli (36N, 34E) located on the Turkish coast of the Eastern Mediterranean has shown higher concentration of dust and total deposition during transitional seasons (spring and autumn) compared to summer and winter seasons. Comparison of the trace metal data with those obtained over the western Mediterranean basin has demonstrated that the eastern basin is under the influence of crustal material derived mainly from North African deserts rather than anthropogenic emissions. The data, coupled with three-dimensional (3-D) air mass back trajectories, suggest that North African and Middle East desert derived dust particles are transported to the region during the transitional seasons. Horizontal transport and sources derived from the trajectories are in good agreement with the satellite observations. The vertical motion inferred from trajectories at different final barometric levels confirm long - range transport of dust from Africa into the eastern Mediterranean. Transport events in the last part of March 1992 and early October 1992 are studied through combined analyses of ground based and satellite observations and modelling results. It is shown that dust transport constitutes a large fraction of the annual atmospheric deposition in the eastern Mediterranean, with two deposition events of short duration accounting up to 30 % of the total annual flux. Therefore, the dissolved and particulate species associated with dust could be extremely variable in the mixing layer during large deposition events that could easily be missed in a short- term sampling program. The possible impact of large pulses on biological productivity of the sea also warrants consideration.

An extreme atmospheric transport event distributing Sahara desert dust in an area extending from the American to the Eurasian continent in early April 1994 is studied in depth. The strong atmospheric blocking shown in this hemispherical case exemplifies the often-overlooked role of large-scale atmospheric dynamics creating a particular transport pattern. A synoptic-scale stable vortex dipole characterised the Atlantic blocking, corresponding to the positive phase of the North Atlantic Oscillation (NAO).

Aerosol sulfate and nitrate concentrations were relatively low during winter months due to scavenging by frequent precipitation. Maximum non-sea-salt sulfate (nss-SO_4^{2-}) concentrations were measured during June 1992 ($21.78 \pm 8.49 \times 10^{-6} \text{ g/m}^3$) and July 1992 ($19.81 \pm 6.49 \times 10^{-6} \text{ g/m}^3$) whereas the highest nitrate (NO_3^-) concentrations were observed in April 1992 ($7.74 \pm 4.02 \times 10^{-6} \text{ g/m}^3$). Case studies, using back trajectories of aerosol samples combined with high nss-SO_4^{2-} and low NO_3^- concentrations reveal biogenic sources of nss-SO_4^{2-} in the Levantine basin of the eastern Mediterranean. In July 1992, the coincidence of an enhanced coccolithophorid bloom in the Black Sea with high levels of nss-SO_4^{2-} suggests biogenic dimethylsulfide (DMS) to be a dominant source of nss-SO_4^{2-} transport from this region.

The elemental compositions of the atmospheric aerosols over the Black Sea have been shown to vary by an order of magnitude in association with the synoptic scale weather system. It has also been shown that mineral aerosol originating from the Sahara can reach the Black Sea and alter the elemental concentrations of trace metals. It has been estimated that the atmospheric input of oxidised nitrogen ($\text{NO}_3 + \text{NO}_2\text{-N}$) can reach 13% of the total inorganic nitrogen input of the Danube. Lead (Pb) input reaches 39 % of this riverine input. Such loads can play an important role in the present state of the sea.

The results obtained from this study form an important contribution towards understanding the eastern Mediterranean and the Black Sea aerosols and would emphasize the importance of the future participation of riparian states in an atmospheric sampling program.

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ABSTRACTS

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