ATMOSPHERIC ^{210}PB FLUXES DUE TO SAHARAN DUST INPUT TO THE NORTHWESTERN MEDITERRANEAN SEA

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Abstract

One of the fundamental parameters needed in geochemical models of ^{210}Pb, a well known radiotracer of particle transport in the marine environment, is its atmospheric flux. The Mediterranean Sea is an area affected by events that inject large amounts of Saharan dust to the atmosphere that can significantly contribute to the atmospheric flux of nutrients, metals and other substances, including ^{210}Pb. In this work we have evaluated the annual flux of ^{210}Pb due to Saharan dust events registered in bulk deposition in the Montseny area, north of Barcelona, yielding a value of ca. 26 Bq·m^{-2}. This flux represents a fraction of about 20% of the total atmospheric deposition of ^{210}Pb in the area.

Keywords: 210Pb, atmospheric flux, Saharan dust, Northwestern Mediterranean

The Mediterranean area is globally affected by events that inject large amounts of dust originated in North Africa to the atmosphere. Saharan dust introduces large quantities of nutrients (N, P, Fe), key elements (C) and pollutants (metals, organic compounds, radionuclides) in the water column that can alter the biogeochemical processes of this ecosystem (1). These events ("red rain") are relatively frequent: it is estimated that, in average, their frequency is 3 events per year in NE Spain (2). The source regions providing this dust are, by order of importance, the Moroccan Atlas, the Western Sahara and central Algeria.

^{210}Pb ($T_{1/2}$ = 22.3 y) is a member of the ^{238}U decay series widely used as a tracer of biogeochemical processes in the oceans (3, 4). It is introduced to the Earth surface after decay of ^{222}Rn exhaled from the continental crust, mainly by wet deposition. The atmospheric flux of ^{210}Pb in the Northwestern Mediterranean is estimated to range between 80 and 130 Bq·m^{-2}·y^{-1} (5, 6, 7 and unpublished data). Saharan dust inputs may significantly contribute to the ^{210}Pb atmospheric flux. In this work we have evaluated the fraction of ^{210}Pb due to Saharan dust events that has been deposited in the Montseny area (north of Barcelona) during the period 1983-2000. Bulk deposition was sampled weekly by using open collectors consisting of 4 polyethylene funnels of 19 cm diameter connected each to a 10 L polyethylene bottle. A total of 110 samples were identified from the filtration of bulk deposition during red rain events. Dust deposition was highly variable from year to year. Indeed, five events accounted for 70% of total dust deposition in the 17-yr record. Avila *et al.* (8) determined the annual dust deposited in the area to be, in average, 5.3 g·m^{-2}·y^{-1}. This value is low if it is compared with areas where dust storms are more important, such as Central and Eastern Mediterranean Sea where the average deposited annual mass fluxes are estimated to be 12 and 35 g·m^{-2}·y^{-1}, respectively (1)

The ^{210}Pb specific activities ranged from 0.77 ± 0.07 to 8.0 ± 0.5 kBq·kg^{-1}, with a mean value of 4.8 kBq·kg^{-1}. Calculated ^{210}Pb fluxes vary from 0.25 ± 0.05 to 153 ± 8 Bq·m^{-2} per event. The average of the annual atmospheric flux of ^{210}Pb associated to Saharan dust inputs was estimated to be about 26 Bq·m^{-2}·y^{-1}. In a companion paper (this volume) we show that total ^{210}Pb inventories in soils collected in the Western Mediterranean correlate with rainfall. Using that, we estimated that ^{210}Pb deposition in the Montseny area is of the order of 120 Bq·m^{-2}·y^{-1}. Therefore, the ^{210}Pb flux associated to Saharan dust deposition accounts for about 20%.

Some of the implications of this finding are:

i. ^{210}Pb atmospheric deposition studies in the Mediterranean area should take into account large time intervals as Saharan dust events are highly irregular.

ii ^{210}Pb atmospheric deposition due to dust in areas where precipitation is very low and there are large fluxes of Saharan dust (such as Central and Eastern Mediterranean Sea) is relevant.

iii. Large inputs of ^{210}Pb associated to individual dust events have to be considered when using ^{210}Pb as biogeochemical tracer in the water column.

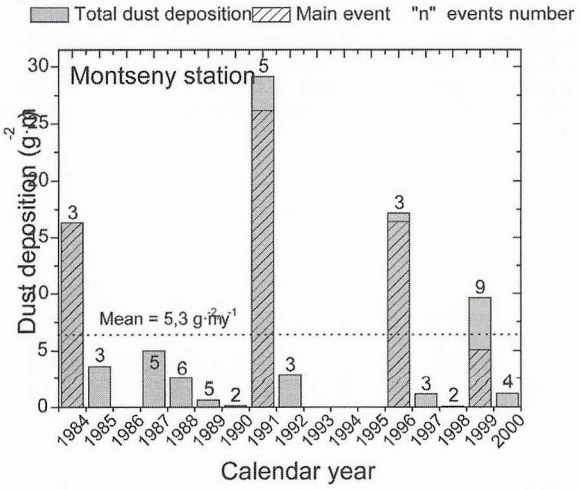

Fig. 1. Dust deposition per year during the studied period 1983 -2000.

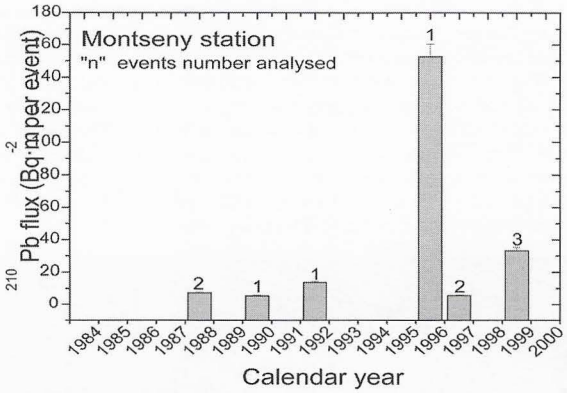

Fig. 2. ^{210}Pb fluxes on atmospheric samples analysed.

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