Analysis of 210Pb peak values at Mt. Cimone (1998 - 2011)

Abstract:
The present study analyses the peak 210Pb activity concentrations observed all over the 1998-2011 period at the WMO-GAW high altitude site of Mt. Cimone (44.18N, 10.7E, 2165 m asl; Italy) in terms of meteorological conditions, links with other atmospheric species and population dose rate associated with this radiotracer. Events with 210Pb concentrations above the 95th percentile were selected with this aim. The highest 210Pb events mainly occurred in the warm period and were associated with prolonged anticyclonic conditions, high temperatures, and low relative humidity values. A correlation with the seasonal pattern of the mixing height was also observed, suggesting the importance of thermal convection promoting uplift of warm air from the atmospheric boundary layer (ABL), transporting high concentrations of 222Rn and thus 210Pb. The main sources of high 210Pb concentrations were identified by means of clusters of back trajectories applied at three different heights (1400, 2200 and 3000 m asl), chosen to better represent the meteorology and the dynamics above and below the measurement site. Sources located at east (central Europe), at west (Spain and France) and south (north of Africa) of Mt. Cimone were determined. The results obtained at the three heights were compared in order to study the extent between ABL and free troposphere during the highest 210Pb events: a wide influence of the strong coupling on 210Pb activity concentrations was demonstrated. The link between the highest values of 210Pb and different atmospheric substances, such as ozone, carbon dioxide, 7Be, PM10, and the ratio 7Be/210Pb revealed different relationships according to the different air masses. The annual effective dose from the potential inhalation of this radionuclide was also calculated comparing the average 210Pb concentration measured during the peak concentration episodes with the 1998-2011 average (with and without the highest 210Pb events). Even though the average dose increase during the selected events with respect to the whole period represents only a small fraction of the total dose from all sources, our analysis might still be useful in the context of emergency situations, e.g., to correctly evaluate the areas that need to be evacuated in the case of nuclear emergencies.

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