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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Variations in time and space of trace metal aerosol concentrations in urban areas and their surroundings" *by* T. Moreno et al.

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We thank the reviewer for the encouraging and positive review, our responses to which are provided below.

1. The very size of the databases and amount of information actually make this a difficult paper to read. I think this could be rectified by having, in addition to the abstract, a more synthesised summing-up towards the end of the paper.

We agree with the reviewer that the manuscript deals with a very large database, and although we tried to provide a clear overview we accept that the text might benefit from further clarification. As suggested therefore we have added a "summing-up" just before

the discussion section to help the reader. The text added is as follows:

"Summarising, the geographic setting of BCN and MSY, linked by the same sea-land breeze recirculation system, results in the transport and dispersion of atmospheric pollutants between the two sites (50 km apart). This results in high concentrations of urban pollutants during the day introduced inland by the sea breeze followed by a reversal of wind direction and a clearing out of pollutants during the night. Among the most obvious tracers for this recirculation system are the metals present in the particulate matter. Highest absolute metal concentrations are shown by Zn and Ti at both BCN and MSY, but when compared with Upper Continental Crust the metallic elements V, Pb, Cu, Zn, Mn, Sn, Bi, Sb and Cd are the most atmospherically enriched. The size of these metaliferous particles is variable, with the finest metals at both BCN and MSY including V, Ni and Cd for both summer and winter, whereas crustal metals (Ti, Sr, Li, Rb) are most abundant in the coarsest inhalable PM size fraction. In general daytime atmospheric metals are greater in size and more abundant than during night at both sites (although some traffic and industrial-related metals are finer during the day in the case of BCN). Hourly data from BCN show metal concentrations differences during the daytime with traffic related metals (e.g. Cu, Sb, Sn, Ba) recording two peaks coinciding with rush hours, whereas industrial and metallurgical metals (e.g. Ni, Mn, Cr) only show an early morning peak produced by contaminated inland valley plumes driven seaward into the city. In MSY, by contrast, most metals show a single concentration peak at midday, heralding the arrival of contaminated urban and industrial air masses from the coast and demonstrating the negative influence of BCN on the air quality of surrounding areas."

2. The bi-directionality of the wind, and therefore re-cycling of the air pollution is very interesting. This seems to be something that can be modelled in more detail, investigating just how many times the particles are 're-cycled'. This has interesting implications for particle age and agglomerations, and also possibly decrease in bioreactivity.

This is an important point. We know, mainly on the base of modelling coupled with

previous experiments with LIDARs in the area under study (Millán et al., 1996; Toll and Baldasano, 2000; Gangoiti et al., 2001; Jorba et al., 2004; Pérez et al., 2004; Viana et al., 2005; Jimenez et al., 2006) that the complex layout of the coast in the Western Mediterranean Basin, with its coastal and pre-coastal mountain ranges, favours the development of small scale thermally driven flows which originate from the upslope winds driven by the sea breeze in the morning and which return back to the sea in the evening, causing the formation of polluted layers with strong levels of subsidence over the coastal area and the sea. Thus, the sea breeze and up-slope winds transport polluted air masses land inwards and inject them up to altitudes of 1-3 km, while at night this air is stored above the marine boundary layer and ready to be drawn back inland again by the sea breeze the next morning. These studies have shown that mainly during summer the layering and accumulation of pollutants such as ozone and aerosols take place along this coast and that the recirculation within the coastal breezes at eastern Iberia can span for more than five days as long as this weather pattern is maintained (Millán et al., 1992; Gangoiti et al., 2001).

However, a closer analysis of this re-cycling driven by the sea/land-breeze or by the summertime convergence of surface winds (and consequently the analysis of how many times the particles are re-cycled as suggested by the reviewer) based only on the experimental data presented in this manuscript is a very difficult task given that the development of some model to study this recycling of pollutants is far beyond the aim of our study and could be the goal of a different manuscript dealing with particle age and (as pointed out) changes in the aerosols bioreactivity.

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Millán et al., 1996. Atmos Environ, 30, 1909–1924.

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Toll and Baldasano, 2000. Atmos Environ, 34, 3069–3084.

Viana et al., 2005. Atmos Environ, 39, 5343-5361.

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