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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ion concentrations of $PM_{10-2.5}$ and $PM_{2.5}$ aerosols over the eastern Mediterranean region: seasonal variation and source identification" *by* H. Kouyoumdjian and N. A. Saliba

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1. In the introduction, give some information on the typical wind directions at the sampling site during the different seasons, and specify if there are any important local sources that might affect the PM in these directions

The suggested information reads as follows: "Eastern Mediterranean region is subject to several inputs of natural and anthropogenic pollutants that are generated from several regional and local sources. Seasonal dust storms coming from the Arabian (SE) and Saharan deserts (S/SW) constitute the major source of mineral elements in

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the region (Kubilay2000). The Saharan dust storms generally occur in spring and are commonly associated with the passage of a low pressure system towards the east (Goudie and Middleton, 2001), whereas, Arabian dust storms occur in autumn (Alpert et al., 1990; Dayan, 1986; Kubilay et al., 2000). First, African sandy storms cause a significant increase in PM levels and influence the chemical composition of aerosols in the region (Dayan et al., 1991; Goudie and Middleton, 2001; Kubilay et al., 2000). Second, long-range transport of pollutants from central Europe have been the cause of high SO2 levels as determined in Israel and Greece (Ganor et al., 2000; Luria et al., 1996; Sciare et al., 2003; Tsitouridou et al., 2003; Zerefos et al., 2000), and third, marine aerosols (sea spray), which are considered a major contributor to the eastern Mediterranean aerosols. Local sources are also major contributors to high levels of HNO3, H2SO4 and NH3 which are derivatives of oxides of nitrogen, sulfur dioxide and ammonia, respectively (Danalatos and Glavas, 1999; Erduran and Tuncel, 2001; Kassomenos et al., 1999)".

2. In section 2.2.1 you write that out of the five filters collected each month (one filter every 6 days) only one filter was taken for anion analysis and one for cation analysis. This means that there was at least 6 days difference between the collection of these two filters. Have you considered the effect of differences in meteorological conditions during the two sampling times and the possible artifact this may introduce to their interpretations of the data? It is clear that at this stage the sampling can not be redone, but the authors should mention in the paper why they chose to do it this way and comment on the problems it may rise. The author agrees with the referee that cation and anion speciations were done using PM filters collected in two different days and so a correlation between cations and anions will need to take into account the meteorological variations. With the exception of the sampling days in March and November, the percent difference in the relative humidity within each month ranged between 0.5 and 15% and the percent difference in temperature did not exceed 6%. Using the AIM2 model, it was found that the measured cations and anions were done above the deliquescence relative humidity (DRH) of the major salts (calcium nitrate and sulfates) and

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so all nitrates and sulfates are considered in the aqueous phase. To answer the above inquiry, Ţ a “sampling artifact” paragraph has been added to the manuscript Ţ the discussion has been changed to highlight the variations of the anions and cations among each other and not between anions and cations Ţ Less emphasis has been given to the correlation between cations and anions.

3. Why only two filters a month were used for ion analysis? Were the other three used only for total PM? Do the authors have any estimation of how well does one filter represent a whole month? The other filters were used for PIXE and XRD analysis; data that is still under analysis. No estimation on how well one filter represent a whole month has been assessed and so the discussion in the manuscript has been changed to focus on the sampling dates rather than the extrapolation of these sampling days to represent the whole month.

4. FTIR analysis: line 14- How did you press the filters against the ATR to ensure even and repeatable readings? Since this method has not been widely used for aerosol analysis, you might want to add few more details on how it was done. This method has been introduced in a separate manuscript (Atmospheric Environment 2004, volume 38, p 523) as referenced, but more details will also be added in here to clarify the technique. The new paragraph reads: Nicolet AVATR Multibounce HATR 360 FTIR spectrometer equipped with a DTGS-detector and ZnSe horizontal crystals (45 angle of incidence). Teflon filters were gently pressed against the ZnSe crystal using a regulated pressure exerted by a Teflon coated plate to ensure even and repeatable readings. Spectra were collected by averaging 1250 co-added scans at wavenumbers ranging from 750 to 4000 cm-1 at a resolution of 1 cm-1. All spectra were ratioed against the spectrum of an empty cell. ATR spectra show peaks that are more intense at lower wavenumbers.

5. The numbers in Table 1 and in figure 2 don’t agree with each other. Based on the data from the table the “other species” contribution is 74 percent and 63 percent for the fine and coarse PM Figure 2 has been changed completely to show the normal-

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ized cation and anion concentrations in each sampling day and Table 1 was corrected accordingly.

6. Figure 2 does not seem to contribute much new information to what is shown in table 1. You might want to consider adding two columns of the amount of unidentified species (fine and coarse PM) in the table and omit figure 2. As discussed in (5), Figure 2 was completely changed.

7. Increase in PM during dust storms (Section 3.1, line 23)- can you be more quantitative? By how much has it increased? What was the dust storm contribution to the fine PM? The increase in the PM mass concentration was assessed and was included in the ms to read as follows: Lower PM concentrations were recorded in the rainy season (November-January), whereas highest PM concentrations were determined during dust storms episodes where an increase by 170% was recorded during the month of February.

8. In general, in several point in the paper you mention significant effect of dust storms on the PM composition. However, no specific analysis of such storm event is provided, such as dates and back trajectories or other meteorological data to support the origin of such dust. Furthermore, basic mineralogical information regarding the dominant rocks in the local area and the Saharan and Arabian dust would also be beneficial to the data interpretation. The dates and the wind vectors during dusty storms were included in the text to read as follows: Lower PM concentrations were recorded in the rainy season (November-January), whereas highest PM concentrations were determined during dust storms episodes where an increase by 170% was recorded during the month of February. This increase was correlated with wind vectors originating from Egypt as deduced by the application of the HYSPLIT air mass trajectory model on the dust-storms days (i.e. February 24th and 25th of 2004).

9. In the coarse particles there is very large amount of Cl-, any ideas in what form is it present? (not enough of any of the measured inorganic cations to neutralize

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the Cl- charge). The amount, charge balance and possible sources and forms of Cl- concentration were discussed in the two paragraphs i)PM10-2.5 Coarse Particles and ii)Sources of PM particles.

10. Section 3.2.1, end of line 14: Any explanation to the high Ca2+ levels measured in this site compare to the other eastern Mediterranean sites References reporting a high Ca2+ due to the nature of the rocks in Lebanon were added. The paragraph reads as follows: In the coarse mode (Figure 3A), almost constant high levels of Calcium were determined due to the calcitic nature of the rocks in Lebanon (Abdel-Rahman and Nader, 2002).

11. Figure 4: 1) Need to increase the font sizes. 2) The dates of the data points for the fine and coarse particles in this figure don't overlap, wasn't the ionic analysis done on the same filters for the fine and coarse particles? The font sizes are corrected The answers to part 2) was addressed in question 2.

12. Section 3.3, line 10-show on the figure when were these dust storms or give in the text their dates. Example dates of dust storms were reported: Lower PM concentrations were recorded in the rainy season (November-January), whereas highest PM concentrations were determined during dust storms episodes where an increase by 170% was recorded during the month of February. This increase was correlated with wind vectors originating from Egypt as deduced by the application of the HYSPLIT air mass trajectory model on the dust-storms days (i.e. February 24th and 25th of 2004).

Technical corrections: 1. In section 2.1 would have changed the order of the two paragraphs. Starting with the general information on the location of the sampling site and then discuss the sampling procedure The order to the two paragraphs has been changed.

2. Section 3.2.1, lines 15-20: is it necessary to give some references to a commonly used assumption The number of references has been reduced

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3. Section 3.2.1, end of line 22: instead of “so the attribution to” change to “thus attributed to”. In the next sentence (line 23) take out the word “Other” The sentence was completely changed

4. Figure 3-Better to name the Y-axis “absorbance” rather than “intensity” and to give a reference bar for demonstrating the absorbance magnitude The Y-axis was changed into absorbance

5. Section 3.2.2, line 10: better to use “supported” instead of “confirmed” Corrected as suggested

6. Section 3.2.2, line 15: add “in the form of” between “were” and “water soluble” Corrected as suggested

7. Section 3.3, line 5- move the “in the coarse mode particles” to line 3 after “it is apparent that” Corrected as suggested

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