Dust concentration in PM10 samples and comparison with model results

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It is widely recognized that atmospheric particles are responsible for human health and environment problems. The European Monitoring and Evaluation Programme (EMEP) has been established in Europe for international co-operation to solve transboundary air pollution problems (www.emep.int). In fact, EMEP is a scientifically based and policy driven programme under the Convention on Long-range Transboundary Air Pollution (CLRTAP). Intensive monitoring periods (IMP) at several European sites have been established within EMEP to classify aerosol properties and sources across Europe. Mineral dust was simultaneously determined at 16 regional background sites in spring−summer 2012, and at 15 in winter 2013 within the third EMEP IMP, with the main aim of investigating the variability of the mineral dust composition across Europe. To this end, chemical speciation measurements were performed in PM10 samples. The chemical composition of PM10 samples collected on 2012 at the Mathematical and Physics Department of the University of Salento, at ∼10 m above the ground level, have been analyzed to further contribute to the dust characterization across Europe. Main results on the chemical speciation of PM10 samples collected during the 9-13, July 2012 and the 4-10, August 2012 dust outbreaks, respectively will be presented in this note, as example. A low volume (2.3 $m^3 h^{-1}$) HYDRA-FAI sampler was used to collect 24-h PM10 samples on 47-mm-diameter quartz fiber filters, pre-heated for 1 h at 700°. The thermal optical transmittance technique by means of the Sunset Carbon Analyzer Instrument was used with the NIOSH5040 protocol to determine EC and OC mass concentrations in a 1.5 cm^2 punch of the filter sample [2]. Six trace elements (Ni, Cu, V, Mn, Pb, Cr) were analyzed via Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS, Perkin Elmer PinAAcle Z900). Eight elements (Ca, Mg, K, Na, Fe, Al, Zn and Ti) were analyzed by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES, Varian Liberty 110 spectrometer). The BSC-DREAM (Barcelona Super Computing Center-Dust REgional Atmospheric Model) was used to demonstrate/support the advection of dust particles at the ground level of the monitoring site. The PM10 mass concentrations monitored during the above mentioned Sahara dust outbreaks have also been compared with the dust concentrations retrieved from the BSC-DREAM model (www.bsc.es) for the study area of this study. Figure 1 shows the dust loading over northern Africa and southern Europe provided by the BSC-DREAM8b model for 9 July, 2012 at 12 UTC. Figure 1 reveals that south eastern Italy was affected by dust since 9 July. The evolution with time of the dust concentration at 3940, 2067, 1027 and 86 m above the ground level (a.g.l) from July 8 up to July 14, which has been retrieved from the BSC-DREAM8b model for the monitoring site of this study (40.3°N, 18.1°E), is shown in Figure 2. It is worth noting from Figure 2 that dust particles are firstly advected at high altitudes. The advection of dust particles at 86 m a.g.l. starts on the night of July 10 and lasts up to July 14. Figure 3a and Figure 3b (full dots) show the 24-h PM10 mass concentrations from July 8 to July 14 and from August 4 to August 10, respectively. Open dots show in both figures the 24-h mass concentration of dust particles from the BSC-DREAM8b model at 86 m a.g.l. If we

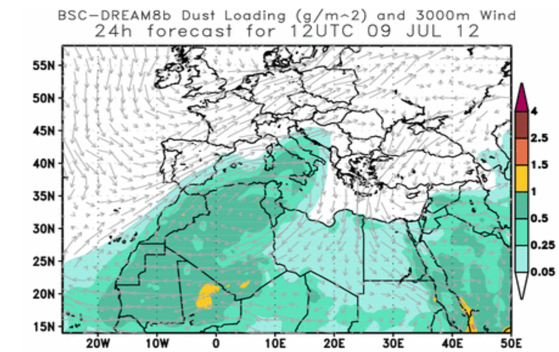

Figure 1. Dust loading (g m^{-2}) from the BSC-DREAM8b model.

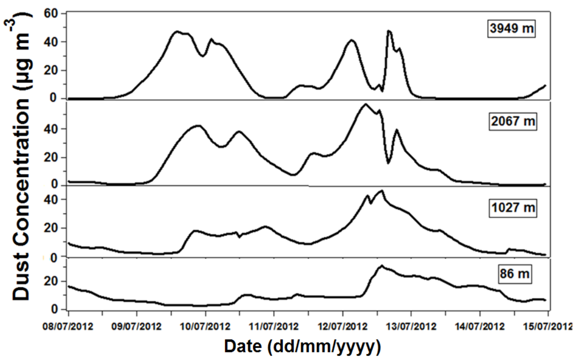

Figure 2. Time evolution of the dust concentration ($\mu g\,m^{-3}$) from 8 to 14 July, 2012 at the monitoring site of this study (40.3°N, 18.1°E) and at selected altitudes above the ground level, from the BSC-DREAM8b model.

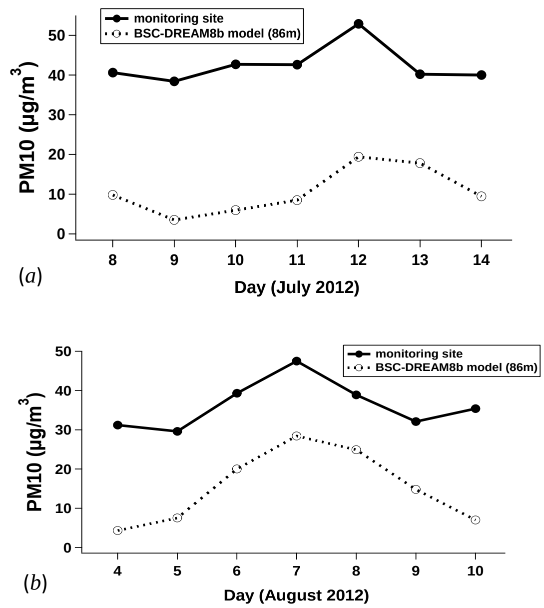

Figure 3. 24-h PM10 mass concentrations (full dots) from (a) 8 to 14 July, 2012 and (b) 4 to 10 August 2012. Open dots show the 24-h mass concentration of dust particles from the BSC-DREAM8b model at 86 m a.g.l.

assume that July 9 was a dust free day (Figure 2), Figure 3a (full dots) reveals that the PM10 mass concentration has increased of $15\mu g\,m^{-3}$ on July 12, as a consequence of the advection of dust particles. This result is in satisfactory accordance with the one provided by the BSC-DREAM8b model (Figure 3a, open dots), which reveals that the dust particle concentration has increased of $16\mu g\,m^{-3}$ from 9 to 12 July, 2012. It is also worth noting from Figure 3b (full dots) that the PM10 mass concentration decreases of $12\mu g\,m^{-3}$ from 7 August (dust day) to 10 August (dust-free day). This last result is in reasonable accordance with the one provided by the BSC-DREAM8b model (Fig. 4b, open dots), which shows that the dust particle concentration decreases of $21\mu g\,m^{-3}$ from 7 to 10 August. Elemental analysis results reveals that the mass percentages of Al, Fe, Na, Mn, K, and Ti were larger in dust-affected samples than in dust-free samples. Conversely, the mass percentages of Cr, Cu, V, Ni, Pb, and Zn which are mainly of anthropogenic origin were similar in dust-free and dust-affected samples. These results are in accordance with previous studies [1]. Ca, OC, and EC mass percentages appear to be not affected by dust outbreaks. In conclusion, paper results have revealed that the advection of dust particles affect both the mass concentration and the chemical composition of PM10 samples. It has also been highlighted that columnar dust loading images as the one of Figure 1 do not provide any information on the impact of dust particles at the ground level. In fact, Figure 1 reveals that the dust loading over south eastern Italy was within the 0.05-0.25 g m^{-2} range at 12:00 UTC of 9 July. However, dust particles do not impact the ground particulate matter concentration at 12:00 UTC of 9 July, in accordance with Figure 2. This comment is further supported by the chemical analysis data, which reveal that the mass percentages of the main elements of crustal origin (Al, Fe, Mn, and Ti) were larger in the 12 July PM10 sample than in the 9 July PM10 sample. Hence, one must be aware that the use of columnar dust loading images, as the ones provided by MODIS or by numerical models (e.g. Figure 1), cannot always be used to support the advection of dust particles at the ground level. Dust particles from desert regions are generally lifted to high altitudes before the advection over Europe and as a consequence, may not affect the ground level.

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