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CLIVAR-SPAIN contributions: Establishing an aerosol climatology for the Mediterranean basin

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Modelling systems based on state-of-science chemistry transport models (CTMs) are fundamental elements to investigate the transport and chemistry of pollutants behaviour at different scales and to assess the impact of emissions in aerosol levels and composition (Silibello et al., 2008). Therefore, this study aims to summarise the results on the levels and chemical composition of aerosols along the Mediterranean basin, highlighting the marked gradient between the western-central-eastern coasts. Special attention is paid to the analysis of the seasonality of PM composition and levels. For this purpose, the regional modelling system MM5-CHIMERE-EMEP has been implemented for conducting a full transient simulation for the ERA-Interim period (1989-2008) using year-to-year changing EMEP emissions (Vestreng et al., 2007). The domain of study covers Europe with a horizontal resolution of 25 km and a vertical resolution of 23 layers in the troposphere; however the analysis focuses on the Mediterranean area. The PM levels and composition are compared to the measured values reported by Querol et al. (2009), showing a good agreement with observations for both western and eastern Mediterranean. The modelling results for the Mediterranean basin indicate that the aerosol levels follow a seasonal pattern with summer maximum concentrations caused by an increased secondary activity and the lower precipitation in the area, together with the contribution of Saharan dust outbreaks. The eastern Mediterranean is characterized by higher levels of sulphate, ammonium and OM EC compared to the western part of the basin. Nitrate presents much differentiated levels between winter (DJF) and summer (JJA) periods, with maxima during colder months in northern Italy and the Netherlands and lower levels in the warm season. This can be related to the thermal instability of the ammonium nitrate in summer ambient conditions, favouring the gas phase prevalence of nitrate. Sulphate levels at both parts of the basin increase progressively from April-May to reach maximum levels in mid-summer, due to enhanced photochemistry, low air mass renovation at regional scale, the increment of the summer mixing layer depth favouring the regional mixing of polluted air masses, and the possible higher summer contribution of marine secondary sulphate from DMS oxidation. The levels of sulphate are higher in the eastern Mediterranean and are highly correlated to ammonium levels. OM EC concentrations are maxima in JJA in the whole basin, because of the higher formation of secondary organic aerosols (SOA) from different natural and anthropogenic sources. Secondary peaks are usually observed in spring (MAM) and autumn (SON) and are associated with winter anticyclonic pollution episodes. For sea-salt aerosols the modelling results indicate a non-uniform behaviour in the Mediterranean basin, showing a strong seasonality and gradient. A higher concentration of marine aerosol is estimated for the western Mediterranean (Alboran Sea and Gulf of Lion) during summertime, related to the increasing sea breeze circulation over the coast, which intensifies in the mid-summer. On the eastern Mediterranean, no large differences are found seasonally; here the sea spray clearly follows the wind speed variation. The results confirm the capability of the modelling strategies to reproduce the particulate matter levels, composition and variation in the Mediterranean area. This kind of information is useful for establishing improvement strategies for the prediction aerosols and to achieve the standards set in European Directives for modeling applications. Keywords: CLIVAR-SPAIN, climate variability and change, southwestern Europe.