Long-term size-segregated particle (PM_{10}, $PM_{2.5}$, PM_1) characterization study in the rural background of Germany – influence of air mass inflow and season

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Long-term studies allow quantifying the influence of decreasing emissions to the concentrations. The particle mass concentration is also influenced by particle formation from precursors and long-range transport. The rural-background site Melpitz (12°56' E, 51°32' N, 86 m asl.) is located in Germany in the Saxon lowlands near Torgau in the glacial valley of the river Elbe (Spindler et al. 2013). The Melpitz station is integrated in ACTRIS and EMEP and representative for a large area in central Europe.

High-Volume (HV) quartz filter samples for particles < 10 µm aerodynamic-diameter (PM_{10}) were collected daily (since November 1992). Particles $PM_{2.5}$ and PM_1 were collected daily respective every six days (since January 2003). The determination of the particle mass was done gravimetrically. Main water-soluble ions (NO_3^-, SO_4^{2-}, Cl^-, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) were analyzed by ion chromatography. The determination of OC and EC (available since 2003) performed by a two-step thermographic method (according to VDI 2465 part 2). PAH and n-alkanes were determined by CPP-GC-MS (Curie point 510°C) for PM_{10} samples in 2012.

Daily samples were evaluated at first as yearly means and quarterly means (per year), at second for spatial and seasonal discrimination days were sorted for air mass transport from a western sector (W, 210-320°, mostly maritime influenced) and a broad eastern sector (E, 35-140°, continentally influenced) using backward trajectories (96 h) Days with a strong change in transport direction (often more local influenced by inversion) were excluded here. A seasonal discrimination was done for winter (Wi, November-April) and for summer (Su, May-October). The result are the four categories WiW, WiE, SuW and SuE in which 68% of the whole time (November 1992 until December 2014) can be sorted (53.3% for W, 15.1% for E).

PM_{10} show a decreasing trend (1993-2000) followed by a second period without clear trend (2001-2014) with a mean mass concentration of about 22.3 ± 2.9 µg/m³ (variation 13%). The absolute sulphate and calcium concentration (1993-2014) as well as the EC-concentration (2003-2014) decrease by about 50, 75 and 30% for PM_{10}, respectively. Reasons are decreasing anthropogenic emissions, especially from coal burning. The nitrate concentration remains more constant all the time, because the emission of NO_x from traffic does not decrease significantly. For all quarterly periods highest values found in the winter (JFM: January, February and March). The highest particle mass and EC-concentrations were found for WiE. EC shows generaly a decreasing trend. The PAH concentration is much higher in winter as in summer and higher for WiW compared to WiE. The higher particle mass, sulphate, EC and PAH concentrations for WiE are caused by long-range transport of anthropogenic emissions from source regions inside and outside the EU in eastern direction of the Melpitz site.