Approaches to characterize an elevated PM episode in Graz, Austria

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Exposure to particulate matter (PM) is of special concern because of proven negative effects to human health (Rohr and Wyzga 2012; WHO 2013; Wu, Jin, and Carlsten 2018). Many European countries still report violations of limit values set by the European Union. In 2017 a high pollution period of PM occurred over mid-Europe strongly influencing PM concentrations in large parts of Europe (EEA 2019).

Within this study we focus on the characterization and source contributions of $PM_{2.5}$ samples from an urban sampling station in Graz, Austria. During a time period from January to March 2017 the daily PM_{10} limit value of 50 µg/m^3 was exceeded on 34 days, with maximum concentrations above 100 µg/m^3. Already 21 exceedance days occurred during January, with PM accumulation driven predominantly by the ambient meteorological conditions. Previous studies have shown that elevated PM concentrations in the region of Graz can be dominated by both local and regional sources, with pronounced, but variable contributions of secondary inorganics (SIA) and aerosol related to woodsmoke (WS) or traffic (Gomiscek et al. 2004; Bauer et al. 2007). To identify major aerosol sources samples were comprehensively characterized. Analyses included inorganic ions as well as the carbonaceous fraction, characterized by elemental and organic carbon as well as selected compounds like polycyclic aromatic hydrocarbons or levoglucosan. Different approaches were used to characterize the pollution episode. It could be shown that all of these rather simple approaches, which only rely on data and samples collected within the local air quality network, are capable of distinguishing periods of local pollution and regional or long-range transport. The results agree with the time periods given by the EEA for the European-wide winter episodes with high background concentrations (EEA 2019).

The comparison of PM_{10} ratios of the urban sampling site and a background site showed two scenarios: 1) PM_{10} ratios >1.5 representing higher pollution at the urban station i.e. an incremental increase of PM within the urban environment 2) PM_{10} ratios <1.5 representing similar PM concentrations on the urban and background station and thus pointing to long-range or at least regional transport.

Source apportionment was conducted using the macro tracer (MT) model, which is based on concentration of tracer substances and appropriate conversion factors which have been optimized for Austrian situations (Schmidl et al. 2008; Bauer et al. 2007). Table 1 summarizes PM_{10} concentration ratios of the urban sampling station and background stations and major contributors of time periods violating the PM10 limit value. Again, two different periods are distinguished: A) higher PM_{10} ratios correspond to rather low contribution of SIA (18.7% of $PM_{2.5}$ mass) pointing towards a local pollution episode; B) lower PM10 ratios are reflected by elevated contribution of SIA (41.8 – 44.1% of $PM_{2.5}$ mass) pointing to a pollution episode of at least regional origin. WS contributions show similar contributions.

Evaluation of meteorological data showed that high pollution episodes in Graz can be linked to weather conditions resulting in local temperature inversions and confirms the source apportionment with the MT model.

Table 1. PM_{10} ratios of urban and background sampling station, contributions of major aerosol sources

	PM10 ratio urban/back-ground	%SIA of $PM_{2.5}$	%WS of $PM_{2.5}$
11.01. – 12.01.2017	2.6	18.7	32.4
22.01. – 23.01.2017	1.1	44.1	30.4
31.01. – 02.02.2017	1.5	41.8	34.1

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