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20 years of Black Carbon measurements in Germany

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Black Carbon (BC) is an important short-lived climate-forcing pollutant contributing to global warming through absorption of sunlight. At the same time, BC, as a component of particulate matter (PM) exerts adverse health effects, like decreased lung function and exacerbated asthma. Globally, anthropogenic emission sources of BC include residential heating, transport, and agricultural fires, while the dominant natural emission sources are wildfires.
Despite the various adverse effects of BC, legislation that requires mandatory monitoring of BC concentrations does not currently exist in the European Union. Instead, BC is only indirectly monitored as component of PM10 and PM2.5 (particulate matter with a diameter smaller 10 μm and 2.5 μm). Before the introduction of mandatory PM10 and PM2.5 monitoring in the European Union in 2005 and 2015, respectively, 'black smoke', a surrogate for BC, was a required measurement in Germany from the early 1990s. The annual mean limit value was 14 μg m-3 from 1995 and 8 μg m-3 from 1998 onwards. Many 'black smoke' measurements were stopped in 2004, with the repeal of the regulations obtaining at the time. However, in most German federal states a limited number BC monitoring stations continued to operate.
Here we present a synthesis of BC data from 213 stations across Germany covering the period between 1994 and 2014. Due to the lack of a standardized method and respective legislation, the data set is very heterogeneous relying on twelve different measurement methods including chemical, optical, and thermal-optical methods. Stations include locations classified as background, urban-background, industrial and traffic among other types. Raw data in many different formats has been modelled and integrated in a relational database, allowing various options for further data analysis.
We highlight results from the year 2009, as it is the year with the largest measurement coverage based on the same measurement method, with 30 stations. In 2009 daily average concentrations at 12 background stations ranged from 0.20 to 9.10 μg m-3 BC, while at traffic sites (15 stations) concentrations ranged from 0.30 to 30.60 μg m-3 BC, and industrial sites (3 stations) showed concentrations ranging between 0.30 and 9.4 μg m-3. The seasonal cycle for the year 2009 shows a similar pattern for industrial and background stations with a tendency of higher concentrations in winter. The concentrations at traffic stations are not as clearly coupled to seasons but have a strong weekly cycle with lower concentrations during weekends.
Investigating the trends in BC concentration over at least 10 years was possible for 13 stations. Preliminary results suggest that concentrations have declined at traffic and background stations between 2005 and 2014. This implies that a general reduction of BC has already been achieved. However, preliminary results also show that elevated concentrations still occur during the colder months, most likely linked to residential heating.