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Measurements of particulate matter and pollen in the city of Berlin

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ABSTRACT

A six week pilot study campaign of parallel measurements of particulate matter (PM10) and pollen has been carried out during the pollination season of grass pollen in May/June 2011 in the city of Berlin. The measurements run as 24 h daily samplings at three monitoring sites, characterized as inner-city, suburban and traffic locations with different vegetation influences. The results show the highest burden for urban public health at the traffic hot-spot, both for PM10 and grass pollen. Furthermore, for both good correlations were found between the sites. Sound correlations have been determined between concentrations and daily maximum temperature. On several days grass pollen concentration in densely populated parts of the city reached health relevant threshold values that are required to initiate allergenic symptoms. Official statistics identified peak grass pollen burden for Berlin and the Eastern part of Germany during the study campaign.

1. Introduction

Pollen allergy has a remarkable clinical impact all over Europe. There is evidence suggesting that the prevalence of respiratory allergic reactions induced by pollen has been an increase in the past

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decades in some (D'Amato et al., 1998, 2007; European Community Respiratory Health Survey, 1996; The International Study of Asthma and Allergy in Childhood, 1998; Lee et al., 2004; Maziak et al., 2003; Selnes et al., 2005) but not all countries (Braun-Fahrländer 2004; Anderson, 2004; Asher et al., 2006).

The life-time prevalence of hay-fever in the German adult population between 18 and 79 years has been recently estimated to be in total 14.8%, in females 16.5% and in males 13.0% (Langen et al., 2013).

There is a link between an increase in the prevalence of allergic airway diseases and an increase in air pollution. The World Health Organization recently has compiled latest study results which have shown the evidence of adverse effects of ambient air pollution on respiratory health (WHO, 2013).

With regard to air pollution some studies indicated that pollinosis is found more frequently in urban areas than in rural environments (Riedler et al., 2000; Braun-Fahrländer, 1999).

Exposure to pollen and to pollen allergen loaded fine particles is related to allergic airway response in pollen-sensitized children and adults suffering on rhinitis and/or asthma bronchiale. Recent reports indicated links between global climate change and altered local pollen counts (Ziello et al., 2012). From public health perspective a warmer climate will lead to an earlier and longer pollination season and more days with peak pollen counts. Furthermore it will increase the risk of proliferation of neophytes with well-known allergenic pollen grains, such as ragweed, which would increase the number of vulnerable people suffered by this burden (Bergmann and Jäger, 2010).

Burkard pollen traps are used in network of 45 monitoring sites distributed all over Germany to sample and analyze qualitative and quantitative data on pollen flight. This pollen network is operated by the Foundation German Pollen Information Service (http://www.pollenstiftung.de), which provides measurement data for pollen broadcast, clinical studies and other scientific projects. Pollen measurements are not part of continuous ambient air measurements provided by the responsible air quality monitoring networks in Germany.

Most pollen traps in Germany and other countries are located in cities, but spatial variability of pollen count at the city level is poorly known. There is a need to improve the understanding on small scale distribution and variation of pollen and their contribution to fine particulate matter in a city, as well as to ameliorate assessments of exposure and health impacts of aeroallergens in an urban population.

The biogenic contribution to urban PM can be of relevance concerning human health aspects, as fragments of pollen or fungi can also be found in the fine PM fraction (Taylor et al., 2004; Elbert et al., 2007). Recent study results have shown that primary biogenic emissions in Berlin to reach up to 33% of organic carbon in the PM_{10} fraction in late summer and autumn months (between 0.7 and 0.2 $\mu g/m^3$ Carbon in PM_{10} and 0.1 $\mu g/m^3$ Carbon in PM_1) (Wagener et al., 2012a,b).

Therefore, we were interested to measure both airborne materials which may influence hay-fever in cities, namely pollen and PM_{10} which may include allergenic particles from pollen.

A comparative pilot study was planned and conducted by the Federal Environment Agency (Umweltbundesamt/UBA) in co-operation with the Foundation German Pollen Information Service (Stiftung Deutscher Polleninformationsdienst/PID) to investigate the spatial distribution and burden of fine particulate matter (PM_{10}) and various pollen species (during the grass pollen season) in ambient air of Berlin.

2. Methods

PM_{10} and pollen measurements took place as 24 h daily samplings carried out in parallel during a period of six weeks between 12 May and 23 June 2011 at three monitoring sites in the city of Berlin. They are characterized as inner-city park ('*Tiergarten*'; sampling site in a distance of about 50 m from the nearest road with around 34,000 vehicles per 24 h), suburban ('*Adlershof*'; sampling site in a distance of about 50 m from nearest road with around 4500 vehicles per 24 h) and traffic-related hot spot located nearby residences ('*Stadtautobahn*/*Westend*'; sampling site in the immediate vicinity of the inner city motor highway 'BAB 100' with approximately 155,000 vehicles per 24 h passing this section). All three sites are influenced by different vegetation conditions (Fig. 1). At '*Adlershof*' and '*Stadtautobahn*/*Westend*' the pollen traps were situated at roof level, at Tiergarten in about 1.5 m.

PM_{10} was daily sampled by UBA with three low-volume samplers (Kleinfiltergerät LVS3.1 Derenda; flow rate of 2.3 m^3/h). Particles were collected on glass fiber filters (Pallflex, Tissuquartz, 2500QAT-UP, 47 mm) and gravimetrically determined at UBA laboratory.

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