New methods to quantify the contributions of rainout, washout and dry deposition to the total deposition flux of atmospheric aerosol on horizontal urban surfaces

P. Laguionie[1], D. Maro[1], P. Roupsard[1], S. Percot[1], L. Solier[1], V. Ruban[2], M. Rozet[1], D. Hébert[1] and O. Connan[1]

[1]Institut de Radioprotection et de Sûreté Nucléaire (IRSN), PRP-ENV/SERIS/LRC, Cherbourg-Octeville, 50130, France

[2]Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux (IFSTTAR), GER7, Bouguenais, 44344, France

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Presenting author email: philippe.laguionie@irsn.fr

In the event of accidental or chronic atmospheric pollution, knowing the total deposition flux of atmospheric aerosol is fundamental to estimate risks for the population and the environment. Deposition flux differs between rural and urban area as the latter has higher surface roughness and type heterogeneities. Although urban areas are continuously growing both in terms of spatial coverage and number of inhabitants, urban aerosol deposition flux remains poorly studied. More urban data sets are now needed as underlined by the scientific community (Fowler *et al.*, 2009; National Research Council, 2012) and is the focus of this study.

The total deposition flux of atmospheric aerosol is made of both dry and wet contributions. Pollutant wet deposition occurs through either washout or rainout processes, which respectively correspond to below-cloud and in-cloud aerosol particle scavenging by the rain droplets. For the first time, this study estimates the respective weighting of these three deposition processes over urban substrates. Data are based on natural radioactive Beryllium-7 (^{7}Be) submicron aerosol tracer. ^{7}Be (53.2-day half-life) comes from cosmic ray spallation in the upper atmosphere. Therefore, ^{7}Be is naturally present in the environment and representative of the atmospheric aerosol accumulation mode.

Experiments were conducted in the suburban area of Nantes (65 km², 282 000 inhabitants) in France, between 9/9/2010 and 1/12/2011. The method developed by Roupsard *et al.* (2012) was used to determine the dry deposition flux over horizontal urban substrates such as asphalt. The rainout and washout components of the wet deposition were estimated using a new method that will be presented during the conference. Overall this method requires (1) monthly-integrated data of ^{7}Be concentration in rainwater at ground level and in atmospheric aerosol particle sampled by Partisol™, (2) scavenging coefficients for ^{7}Be aerosol particle size as a function of rainfall intensity (Laguionie *et al*, 2011), (3) local atmospheric ^{7}Be reload rate, and (4) meteorological parameters.

Over 13-month average, rainout, washout and dry deposition contributed to respectively 72±21%, 12±10% and 16±13% of the total deposition flux of atmospheric aerosol on horizontal surfaces (Figure 1), with meteorological conditions representative of oceanic climate. The rainout contribution was dominant due to ^{7}Be stratospheric origin. The rainout process intra-annual variability was linked to seasonal changes in both rainfall and ^{7}Be production rate. In terms of washout process, intra-annual change was due to monthly-variations in both rainfall duration (as the scavenging process mainly occurs at the onset of the rainfall) and 7Be atmospheric reloading during dry periods. Washout and dry deposition contribution temporal variations both depend on ^{7}Be concentration within the atmospheric boundary layer and may display similar trend over given periods.

These results will be further discussed during the conference.

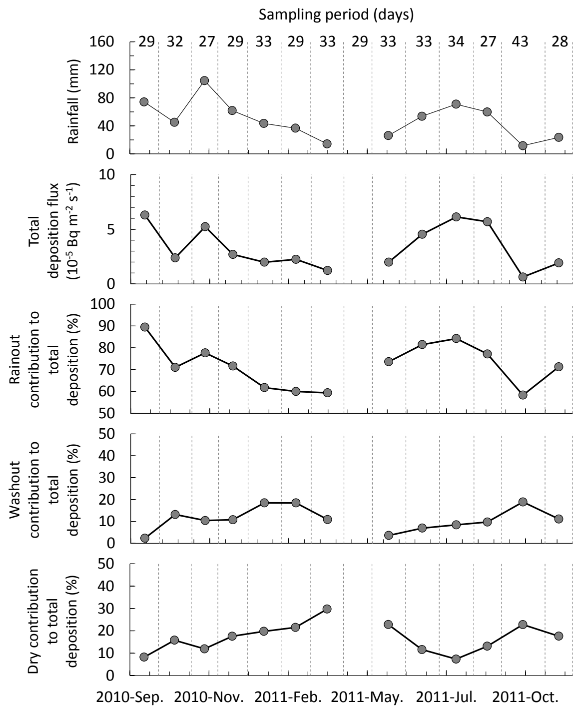

Figure 1. Rainfall and contribution of rainout, washout and dry deposition to total deposition flux in time.

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