Dry deposition velocity measurements onto urban surfaces using atmospheric beryllium 7: development of a methodology and results

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Context and objectives

During the Fukushima nuclear plant accident, dry deposition has contributed to transfer particulate radionuclides (Katata et al., 2011). However, only few data on dry deposition in urban environment exists in the literature and very little is known (Fowler *et al.* 2009). The dry deposition transfer is quantified with the deposition velocity V_d (m s^{-1}), ratio between the aerosol dry deposition flux F (particles m^{-2} s^{-1}) and the aerosol concentration in the air C (particles m^{-3}). V_d depends on aerosol and deposit surface characteristics, and on meteorological conditions. Beryllium 7 (^7Be) is a natural radionuclide that can be used as a tracer to quantify V_d of the accumulation mode of the atmospheric aerosol.

The aim of the study is to develop and acquire an experimental method to measure V_d with urban surfaces, and onto ^7Be as a tracer, and to measure associated meteorological parameters. Results will be analysed and compared to the data of the literature to put in evidence the principal physical phenomena of deposition on urban surfaces.

Material and method

The experimental device is set up in the suburban of Nantes (France). It is composed of an assembly support equipped with urban surfaces (vertical glass and cement facing; horizontal asphalt and synthetic grass; slate, tile and zinc angled at 30°) directly exposed to the atmospheric aerosol to sample its deposits and to measure deposition fluxes. A roller blind protect it against precipitations. A Partisol® samples atmospheric aerosol on filter to measure the concentration of atmospheric ^7Be. An ultrasonic anemometer measures the wind speed at 1 m from the assembly support. Meteorological parameters are measured with a meteorological station. Each experiment was carried out for one month to sample quantifiable ^7Be deposits. Experiments are led during 15 consecutive months. ^7Be is measured by gamma spectrometry at the LRC. Filters containing atmospheric aerosol are put in geometries (cylindrical boxes) and directly measured. ^7Be deposit on urban surfaces must be recovered by washing with an acidic solution and put in geometries (50 mL container) to be measured. A method is developed to make corrections on measured activities that are underestimated with the washing method.

Results and discussions

Fig.1 shows the results of experiment. They are in the same order of magnitude than those measured by Roed (1987) using Tchernobyl radionuclides as tracers. However, for glass and cement facing, deposition velocities are higher than those measured by Maro *et al.* (2010) for the same surfaces with a generated fluorescein aerosol on 1 hour duration.

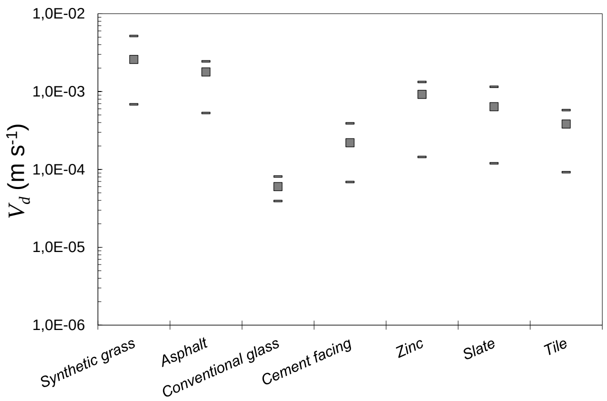

Fig. 1: V_d mean, minimum and maximum measured on each surface.

This highlights the role of additional physical phenomena on the long durations (1 month). The proposed hypothesis is the growing of atmospheric particles by water vapor condensation during dew episodes. Dry deposition velocities could be higher because of deposition rises by impaction and settling.

Conclusions

A measurement method of V_d using atmospheric ^7Be as a tracer has been developed. It permits to quantify V_d for real urban surfaces and to measure associated meteorological parameters. Results show differences in the order of magnitude between V_d measured on short duration expositions (~1 h) and on long duration expositions (~1 month). This involves an additional physical phenomenon contributing to the dry deposition on long durations. Further experiments will be necessary to explain differences between short and long durations. Particularly, continuous measurements of the atmospheric aerosol distribution will allow to verify the growing of particles and to measure their diameters during the dew episodes.

D. Fowler *et al.* (2009) *Atm. Env.* 43, 5193-5267.
G. Katata *et al.* (2011) *Jour. of Env. Rad.* 111, 2-12.
D. Maro et al. (2010) *Int. Aero. Conf*, Helsinki.
J. Roed (1987) *Rad. Prot. Dos.* 21, 33-36.