Dry deposition velocity of sub-micron aerosol over a rural area: a parametrization with turbulent parameters onto homogeneous surfaces.

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In order to evaluate the impact of accidental or chronic atmospheric pollutant releases on ecosystems, dry deposition velocity of aerosols, in rural areas, is a key parameter. It is obtained by dividing the deposit flux by the aerosol concentration measured in the air. The aim of this study is to parameter the aerosol dry deposition velocity with turbulent parameters, substrates, aerosol sizes on homogenous rural area.

Deposition flux can be calculated from the covariance between fluctuations of the vertical wind velocity and fluctuations of the atmospheric aerosol concentration. In our measurements, the aerosol concentration was measured with an Electrical Low Pressure Impactor (ELPI, Dekati, Inc.) and the vertical wind velocity, by an ultrasonic anemometer for 30 minutes at high frequency (> 1 Hz). In order to validate measurements quality tests were checked. Spectral analysis and a spectral correction were performed to calculate fluxes (Damay *et al.* 2009). Four experimental campaigns were achieved in southwestern France on several homogenous rural substrates (maize, grass and bare soil).

Measurements provided values of dry deposition velocities (Vd) of submicronic aerosols. The friction velocity (U*) and the heat sensible flux (H) have simultaneous effect on the deposit phenomenon, because they influence the atmospheric turbulence. These effects can be taken into account simultaneously by parameterizing Vd/U* as a function of the inverse of Monin-Obukov length (See Fig 1). Thus, whatever the substrates, results obtained are conformable to previously published data. (Wesely, 1985)

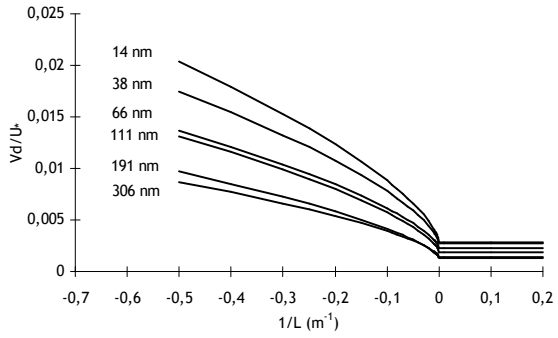

Figure 1. Normalized values of the measured Vd versus stability parameter (L^{-1}) for six ranges of particle diameter from the ELPI.

For neutral and stable atmospheric stability conditions, the dry deposition velocities normalized by U* are constant. However, in unstable conditions the ratio Vd/U* depending of the Monin-Obukhov length by the formula:

$Vd/U^* = (Vd/U^*)_{neutral\text{-}stable}.(1+(-B/L)^{2/3})$.

This parametrization have been used by Lamaud *et al.* (1994) and Nemitz *et al.* (2004). They quantify empirically the B parameter respectively by the inversion base height (z_i) and the particle diameter. In our cases, we have not observed any consistent Vd/U* variation versus z_i. On figure 2, Vd/U* is plotted versus of the aerosol size for neutral and stable conditions (white circles) and unstable conditions (black triangles).

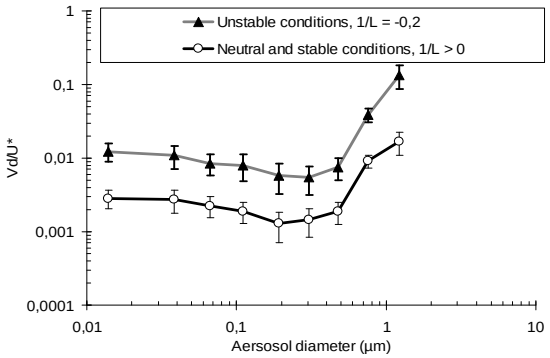

Figure 2. Vd/U* versus particles diameter on rural canopies (two cases of atmospheric stability)

Results show the effect of the friction velocity, the sensible heat flux and the atmospheric stability on the dry deposition velocity. Finally, the parameterization of Vd as a function of the turbulent data enables us to quantify the dry deposition velocity in stable, unstable and neutral atmospheric condition. The perspectives are to apply this method on other substrates (urban, forest or other rural substrates) to futher document measurements comparison.

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