Below-cloud scavenging by snow and mixed precipitation events calculated from high temporal resolution *in situ* measurements

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Keywords: snow scavenging, aerosol size distribution, in-situ measurements
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Below-cloud scavenging by snow (snowout) is well identified as an efficient wet deposition process. In case of snow events, accidental releases of pollutants or radionuclides can have serious impacts on biosphere. The recent nuclear accident at the Fukushima-Daiichi Nuclear Power Plant in March 2011 has highlighted the need for snowout coefficient determination when releases of radioactive materials or pollutants occurred in mountainous regions.

Many snowout studies realised till now are laboratories experiments (Knutson et al., 1976, Sauter et al., 1989) whereas few *in situ* studies are available (Kyrö et al., 2009 ; Paramonov et al., 2011). Determination of below-cloud scavenging of atmospheric aerosol particles by snow using *in situ* measurements is needed for a better understanding of this process.

During three winter seasons, optical particle counters were installed on two French sites to record aerosol concentrations from 0.25 to 32 µm with high temporal resolution (a spectra of 31 size classes each minute). Simultaneous use of a PARSIVEL disdrometer at these sites have allowed to identify snow events or events characterized by solid hydrometeors (snowflakes) and liquids (raindrops) coexistence ("mixed events").

For the recorded events (19 snowy and 27 mixed), scavenging coefficient Λ was calculated with the formulation used in previous *in situ* studies (Laakso et al., 2003, Paramonov et al., 2011) :

$$\Lambda(d_p) = \frac{1}{\Delta t}\ln\left[\frac{c_0(d_p)}{c_1(d_p)}\right] \qquad (1)$$

where Δt is the duration of the event, d_p the particle diameter, and c_0 and c_1 the concentration of particle before and after snow or mixed events, respectively. Such method is named "global approach".

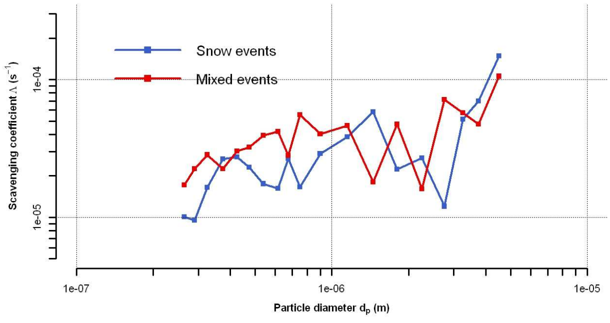

Figure 1. Scavenging coefficient Λ of aerosol according to their size, for snow and mixed events

In the 0.25 to 32 µm size range, mean and median scavenging coefficients Λ were 2.9 10^{-5} and 1 10^{-5} s^{-1} for snow events, and 1.8 10^{-4} and 1.7 10^{-5} s^{-1} for mixed events. These values are similar to those reported by Kyrö (2009) and Paramonov (2011). For the same sizes range, previous work on below-cloud scavenging by rain have shown mean values of Λ which range between 6.2 10^{-5} s^{-1} and 3 10^{-4} s^{-1}, but data were recorded during events with higher intensities. Higher mean scavenging efficiency for mixed events observed here was also shown by Paramonov et al. (2011). As shown in figure 1, no great difference is observed in the distribution of Λ according to the particle diameter between 0.25 and 4.5 µm (no enough data usable below this size).

To improve these results which do not take into account the meteorological conditions variability during snow or mixed events, another similar approach was used. High temporal resolution measurements allowed us to fit decreasing aerosol concentrations to an exponential function for a large number of shorts periods (typical duration of some few minutes). Those for which this fitting is good (relative difference less than few %) were selected, and other processes that scavenging (advection in particular) were considered as negligible. Results were compared with those computed of the "global approach" and with below-cloud scavenging by rain coefficients.

This work was cofunded by Meteo-France and with the financial support of the Water Agency "Rhône Mediterrannée et Corse".

The air quality monitoring Association ATMO-PACA and The staff of the Laboratory of Glaciology and Geophysics of the Environment of Grenoble (LGGE) are also greatly thanked.

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