Size-dependent aerosol activation properties measured in radiation and stratus lowering fog during the ParisFog 2012/13 field campaign

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Fog causes tremendous hazards in road traffic, maritime navigation, as well as in air traffic and railway traffic. There is a great demand, e.g. from airports, for more reliable fog forecasts to prevent such accidents. Improved fog forecasts require a better understanding of the numerous complex mechanisms during the fog life cycle.

During winter 2012/13 a field campaign called ParisFog aiming on fog research has taken place at SIRTA (Site Instrumental de Recherche par Télédétection Atmosphérique). SIRTA is about 20 km south of Paris in a semi-urban environment. It hosts active and passive remote sensing instruments to continuously quantify cloud and aerosol properties, as well as key atmospheric parameters (Haeffelin et al., 2005).

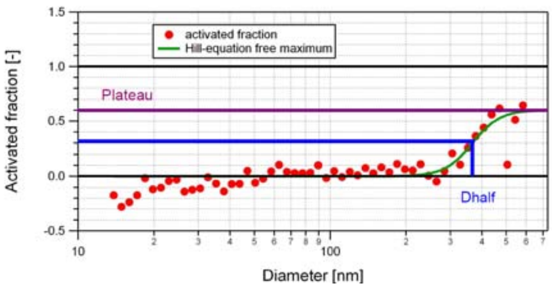

Figure 1. Activated fraction with a hill-equation fit for an hourly average.

From October 2012 to January 2013 a scanning mobility particle sizer (SMPS) has been installed at SIRTA to measure the particle number size distribution. The device has been connected to a switching valve that switched between the total and the interstitial inlet. The total inlet was heated. Thus, all particles can be measured including the fog residuals, since the water evaporates from the fog droplets and leaves the dry residual particles behind. On the interstitial inlet system an aerodynamic size discriminator was attached. The cut-off size was 1 µm. This inlet samples only the non-activated aerosols, as the aerosols larger than 1 µm are expected to be activated to cloud droplets. To monitor and quantify fog events a particle volume monitor (PVM-100; Gerber, 1991) has been installed which measured the liquid water content and the effective radius of the fog droplets.

For the selected fog events, based on the PVM-100 data, the activated fraction has been calculated which is defined as (Verheggen et al., 2007):

$$F_N\left(D_p\right)=\frac{\left(N_{tot}\left(D_p\right)-N_{\text{int}}\left(D_p\right)\right)}{N_{tot}\left(D_p\right)} \qquad (1)$$

Where $N_{tot}(D_p)$ is the number concentration of the total particles with diameter D_p and $N_{int}(D_p)$ is the number concentration of the interstitial aerosols with diameter D_p. Figure 1 shows an example for an hourly average on the 10/10/2012 05:30 where D_{half} has been retrieved as the middle between the lowest (i.e. 0) and highest plateau value.

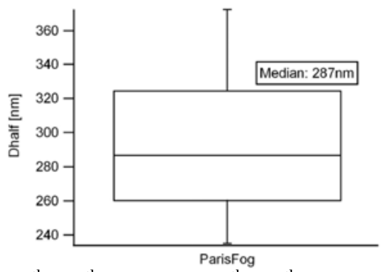

Figure 2. 10th, 25th, median, 75th, 90th percentiles of the activation diameters (D_{half}) for all classified fog events during ParisFog2012/13.

It has been observed that the activation plateau is quite often below 1 with a considerable fluctuation within the different fog events. This is likely due to entrainment of drier air into the fog.

The median of the activation diameters (D_{half}) during the 10 fog events ranges from 252 nm to 400 nm (see Figure 2). The median over all fog events is 287 nm.

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