Aerosol impact on fog microphysics

M. Mazoyer[1], F. Burnet[1], G.C. Roberts[1], M. Haeffelin[2], J.C. Dupont[2] and T. Elias[3]

[1]Météo-France/CNRS, CNRM/GAME, Toulouse, France
[2]Institut Pierre Simon Laplace/UVSQ, Palaiseau, France
[3]HYGEOS, Lille, France

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Presenting author email: frederic.burnet@meteo.fr

The occurrence and development of fogs result from the non-linear interaction of competing radiative, thermodynamic, microphysical and dynamical processes. To better understand relationships between such processes comprehensive field campaigns dedicated to fog life cycle observation were conducted during winters of 2010-2013 at the SIRTA observatory in the Paris suburb area (Elias et al., 2015, Dupont et al., 2015).

State of the art in situ measurements of particle size distribution were performed. They reveal large variability of both aerosol background before the fog onset and number concentration and size of fog droplets. In situ microphysical measurements collected during 23 fog events are examined here to document their properties with the objective to evaluate the impact of the aerosol on the fog microphysics.

To derive accurate estimation of the actual activated fog droplet number concentration (*Nact*) we determine the hygroscopicity parameter (κ), the dry and the wet critical diameters and the critical supersaturation for each case by using an iterative procedure based on the kappa-Kohler theory that combines cloud condensation nuclei (CCN), dry particle distribution from an SMPS and composite wet particle size distribution at ambient humidity derived from WELAS and FM-100 measurements (Mazoyer et al., 2016). These data are averaged over one hour time periods before and during the fog onset to characterize the air mass and the fog properties, respectively.

Resulting values of $\kappa = 0.17 \pm 0.05$ were found typical of continental aerosols. This study reveals low values of the derived critical supersaturation with median of 0.043 %, and large values of both the wet and the dry activation diameters with median of 0.39 µm and 3.8 µm, respectively. Consequently the corresponding *Nact* values are low with a median concentration of 53.5 cm^{-3} and 111 cm^{-3} within the 75th percentile.

Mean values of *Nact* are reported on Fig. 1, as function of *N** the concentration of activable aerosols, for the 23 fog cases. *N** is defined as the number concentration of aerosol particles with diameter ≥ 200 nm which corresponds to the smallest derived mean dry diameter. Figure 1 reveals that almost no relationship exists between *Nact* and $N*$. In contrast the CCN data at SS=0.1 % exhibits a strong correlation with these aerosol concentrations. We therefore conclude that the actual supersaturations reached in these fogs are too low to observe a simultaneous increase of both aerosols > 200 nm and droplet concentrations.

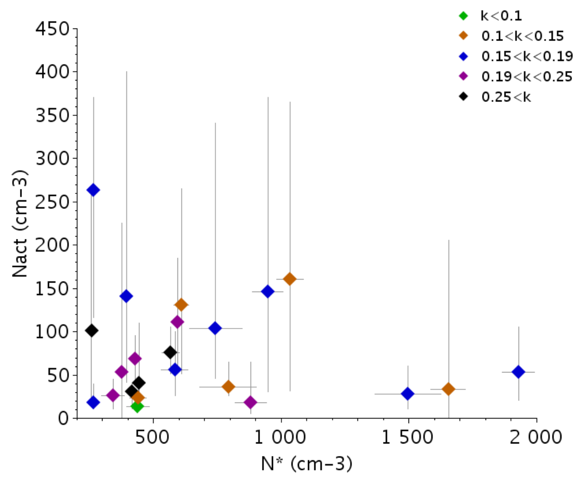

Figure 1. Number concentration of activated particles Nact as function of N the concentration of aerosol particles with diameter > 200 nm for the 23 fog cases. Colour as function of the hygroscopic parameter κ as indicated in the legend.*

Moreover our analysis suggests that an high aerosol loading limits the supersaturation values. It is also found that the activation fraction mainly depends on the aerosol size while the hygroscopicity appears to be of a secondary importance.

Over the 23 fog events analysed, 13 are radiation fog and 10 are stratus lowering fog. Radiative fogs are associated to higher aerosol loading compared to stratus lowering events, but the *Nact* values are similar for both fog type. Evolution of the droplet concentration during the fog life cycle in contrast indicates significant differences between both types of fog.

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