Variability of size distribution measurements of atmospheric aerosol particles observed at Cabauw over the period 2008-2014

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Aerosols particles are important constituents of the atmosphere as they affect the energy balance directly, through scattering and absorption of solar radiation and indirectly by acting as cloud condensation nuclei. Although the ways by which aerosols affect climate are known, understanding the detailed mechanisms is far from complete. A factor that hinders the complete understanding of these mechanisms is the high variability of suspended particulate matter in the atmosphere. Atmospheric particles cover four or five decades in size, while the loading and composition are source and location dependent. Because of this high variability, the long-term monitoring of the aerosols is important for validating and calibrating models with observations.

Here we examine the temporal variability of aerosol size distributions (ranging from 9 to 516 nm) at the CESAR observatory near Cabauw (51°58.223' N, 4°55.575' E) in the Netherlands. The analysis is based on data collected from a Scanning Mobility Particle Sizer (SMPS) situated at the observatory during the period 2008-2014.

Cabauw is a rural site, with only a few pollution sources nearby. However, the wider area is densely populated, with the city of Utrecht (to the North-East) and a dense highway grid being within 25 km distance. The cities of Rotterdam (South-West), The Hague (West) and Amsterdam (North) are situated within a distance of 30 to 50 km. The surface elevation is 0.7 m and it varies from -3 to 5 m within a radius of 30 km. The site is representative of the north-western Europe region. It is influenced by maritime and continental air masses and due to the fact that it is surrounded by several cities it experiences pollution events very often.

Our first results show that for the years 2008, 2010 and 2014, the total particle number concentration was relatively high and ranged from 1.0×10^4 cm^{-3} to 1.2×10^6 cm^{-3}. During the day, the total number concentration starts to increase at around 06:00-07:00 UTC, then it decreases gradually and start to increase again at around 17:00-18:00 UTC before it drops again to reach the background values after midnight. Winds from the East, South and South-West are associated with increased total number concentrations compared to Westerly and Northerly winds.

The data revealed several particle growth events, which occur throughout the year but are more pronounced during springtime. Figure 1 shows aerosol size distributions (top panel; normalized to the maximum value per measurement) for three consecutive days with particle growth and the corresponding total number concentration (lower panel). The events take place between 10:00 and 14:00 UTC mostly under cloud free conditions. The fact that there is no flux of particles in the lower observable size range (lower detection limit 9.6 nm), but the particles we observe have sizes in the range of 17-20 nm, is an indication that they formed further upwind, and grew while they were transferred to the site few hours later. The apparent particle growth rate is 2.5 nm/h which is in line with values reported in the literature.

This work examines the aerosol size distributions from in situ observations at Cabauw and sets the ground for the investigation of aerosol size distributions at different height levels in the future.

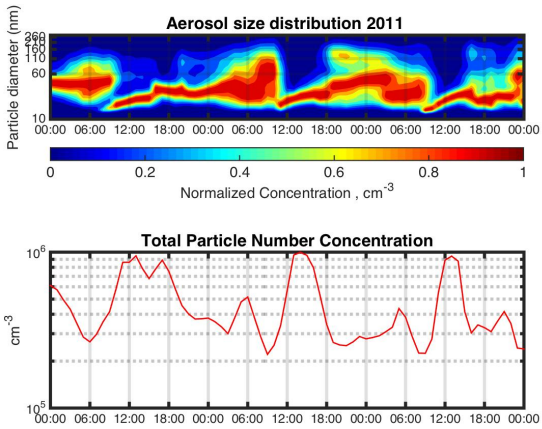

Figure 1. Particle growth events from 01 May 00:00 UTC to 04 May 00:00 UTC

References

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