Aerosol concentration during a thermal inversion followed by rain in northwestern Iberia

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Thermal inversion events, with high levels of atmospheric pollution, have become particularly important in recent years due to their effects on human health and natural environment. Additionally, in big cities there are restrictions to human activities (mainly traffic-related) when such events occur, affecting the economic activity and daily life of the population (Viard and Fu, 2015). The mixing height is the critical parameter governing vertical dispersion of the pollutants in the air because it determines the rate and the range of dispersion of substances formed or emitted near the ground (Gramsch et al., 2014). Thus, episodes of thermal inversion (frequent in winter) are usually related to the most serious pollution events. The weather conditions of thermal inversions cause the aerosol particles (mainly PM_{10}) to be trapped under the atmospheric mixed layer. These conditions produce high concentrations of pollutants, often higher than World Health Organization (WHO) standards.

The aim of this study is to analyse the relationship between thermal inversions and the concentration of aerosol particles in León (Spain). For this purpose, a monitoring campaign was carried out at the university campus of León (42° 36' 50" N, 5° 33' 38" W, 846 m asl), located in Northwestern Iberia, with a Mediterranean Pluviseasonal-Oceanic bioclimate.

An event of thermal inversion was studied between 25th October 2016 and 2th November 2016. This period was characterized by the typical meteorological conditions of a thermal inversion: clear days with low wind speeds (maximum of 0.46 m/s), low pressures (maximum of 766.2 hPa) and large daily temperature ranges (between 9.8 and 19.8 °C).

The campaign involved different instruments: i) an optical particle counter (PCASP-X) for determining aerosol size distributions between 0.1 and 10 μm size in 31 channels; ii) a high resolution nanoparticle sizer (TSI-SMPS Model 3938) for the continuous monitoring of particle size distributions (between 14.3 and 661.2 nm in 107 channels); iii) an AE31 Aethalometer (Magee Scientific) for measuring Black Carbon (BC) concentration; iv) a laser disdrometer Thies LPM which registered raindrops between 0.125 and 8 mm size in 20 channels; v) a Davis Weather Station, used for continuously registering the temperature, humidity, wind speed and wind direction. To detect thermal inversion, we have used the radiosounding data from La Coruña, Santander and Madrid.

Preliminary results reveal a progressive increase (about 57%) in aerosols number concentration during the thermal inversion, mainly for Aitken mode (particles between 30 and 100 nm) with an increase of 63 %. In accumulation mode (particles larger than 100 nm) there was an increase of 49 %. In nucleation mode (particles less than 30 nm) there was an increase of 52 %. As a consequence, an 8% increase in the median particle size has been observed. BC values increased during the inversions by 33%. Furthermore, a change in air mass and a rain event (1.91 mm with a mean intensity of 0.38 mm/h, with raindrop sizes between 0.13 and 2.5 mm) occurred after the inversion and caused a decrease of 63% in the number of particles smaller than 1 μm. Besides, the rain event produced a decrease of 78% in BC values between before and after rain.

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