COAL COMBUSTION EMISSIONS: IMPACT ON AIR QUALITY IN NW SPAIN

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INTRODUCTION

Emissions from coal combustion represent a serious environmental problem. As a result of this activity, in some megacities of China an increase in the concentrations of NO_x, SO_2, CO_2 and toxic trace elements has been observed, which negatively impacts human health and the ecosystems (Xie et al., 2006). For many years, León (Spain) has been the principal producer of primary energy from coal in Castilla y León (Antolín, 1996). According to the Junta de Castilla y León, in 2016, León produced 20.6% of the total national coal-based energy. Furthermore, in 2014, 22% of the total energy consumption in the region came from coal combustion, increasing in 2015 to 24%. The emissions from coal burning increase during coldest months due to the use of domestic heating devices. The objective of this paper is to study the emissions from burning coal during a two-month sampling campaign in León, through the evolution of gases and aerosol particles, highlighting the behavior of the main coal combustion markers (As, Se and S).

STUDY AREA

The sampling campaign was carried out in the Campus of the University of León, at León city, Spain (42º 36′ N, 05º 35′ W and 838 m a.s.l.) at 24 hour intervals (Fig. 1), in a sampling period between 1 December 2016 and 30 January 2017.

Fig. 1. Map of Iberian Peninsula and location of León.

Sampling

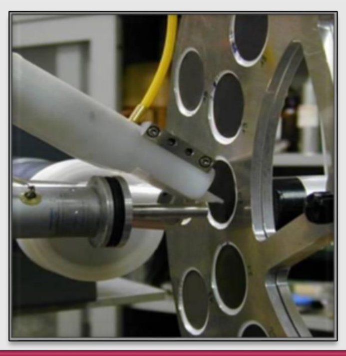
Automatic weather station recorded temperature (T), wind speed and direction, and relative humidity (RH)

Low volume sampler (TECORA, ECHOPM): Collection of PM10 (47 mm diameter teflon filters)

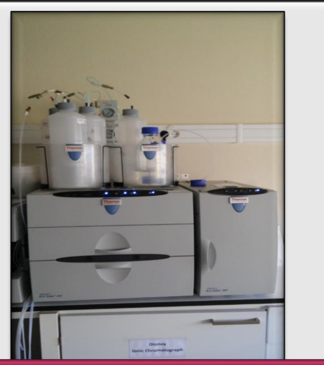
High volume sampler (CAV-A/Mb): Collection of PM10 (150 mm diameter quartz filters)

High resolution nanoparticle sizer (SMPS): Continuous monitoring of particle size distributions (0.018-1 µm)

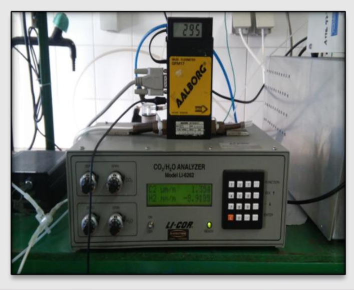
Analysis



PIXE (Particle-Induced X-ray Emission): analysis of major and trace elements



Thermo Scientific Dionex™ ICS-5000 Ion Chromatography: water soluble ions



Organic (OC) and elemental (EC) carbon analysis by termal-optical technique

Fig. 2. Sampling and analytical instrumentation.

Additional data provided by the regional air quality network (www.medioambiente.jcyl.es) related to SO_2 was also taken into account. The evolution of the mixing-layer thickness was also analyzed, by using the data from NOAA database (https://www.ready.noaa.gov/READYamet.php).

RESULTS AND CONCLUSIONS

High concentrations of As and Se were obtained between 20 December 2016 and 10 January 2017, with a maximum of 4.0 ng/m³ for As and 22.9 ng/m³ for Se, observed on 26 December 2016, coinciding with a slight decrease in the minimum temperatures (T_{Min}) registered in León (Fig. 3).

As and Se concentrations showed a negative significant correlation with the temperature (*r* < -0.4, *p*< 0.01), and a positive correlation with the relative humidity (*r* > 0.2, *p*< 0.01).

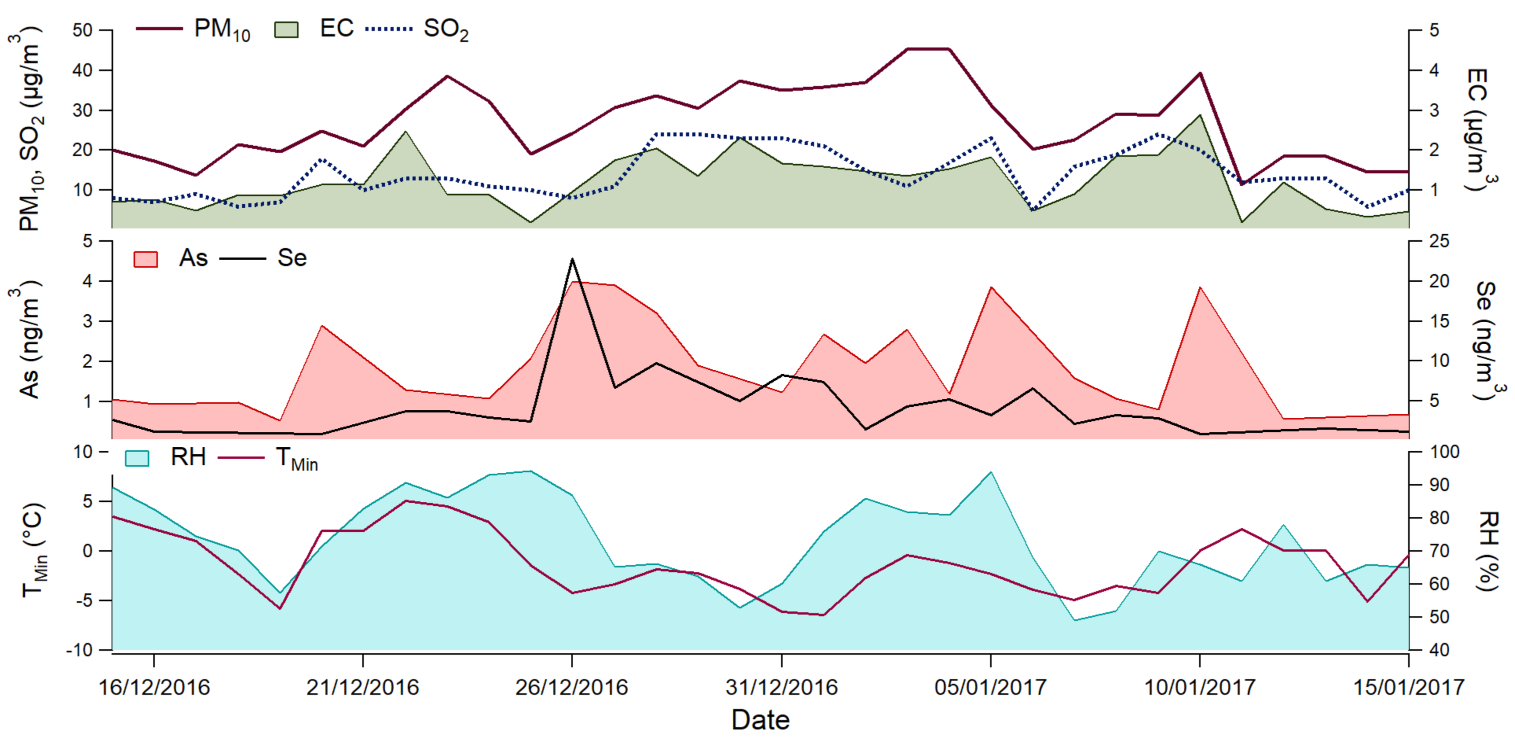


Fig. 3. Daily evolution of PM_{10}, SO_2, EC, As, Se concentrations, minimum temperature (T_{Min}) and relative humidity (RH), between 15 December 2016 and 15 January 2017.

An increase in the EC concentrations during the same period was also observed, going from 0.9 µg/m³ to 2.7 µg/m³. A simultaneous enhancement of the SO_2 values was recorded in the urban air quality station LE01 (urban station), from 8 µg/m³ to 24 µg/m³ on 27 December 2016 (Fig. 3).

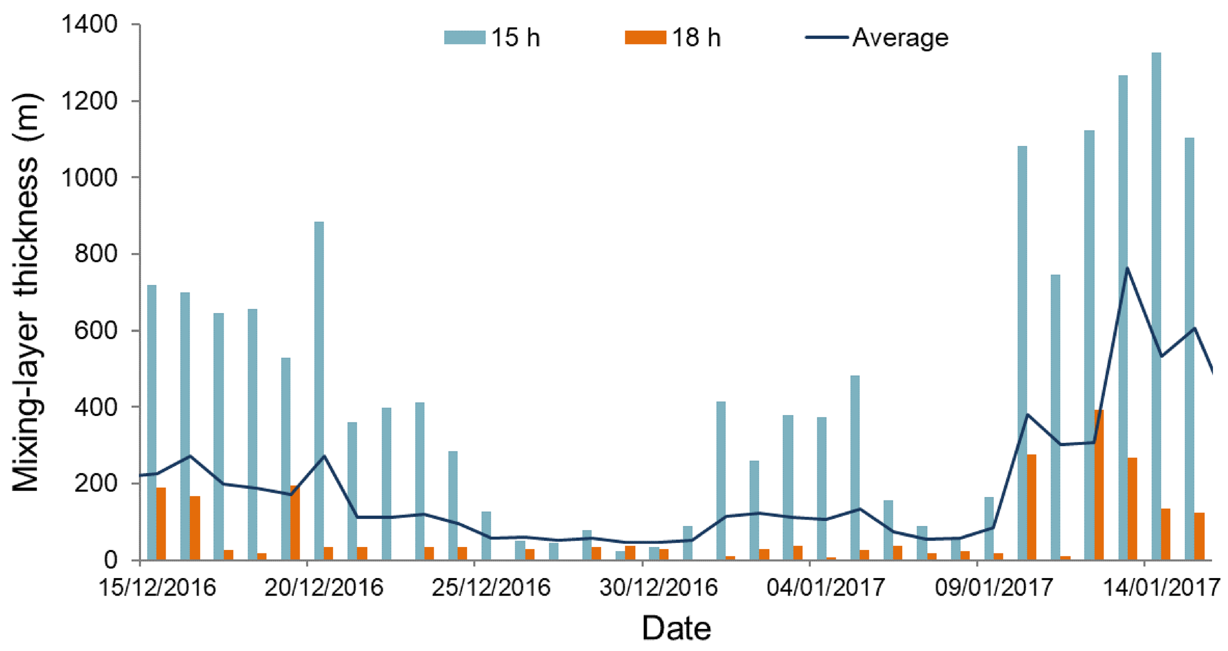


Fig. 4. Daily evolution of the mixing-layer thickness at 1500 UTC, 1800 UTC and the daily average value.

There was a decrease in the mixing-layer thickness between 21 December 2016 and 10 January 2017, causing a low dispersion of the pollutants (Fig. 4).

Two peaks in NH_4^+, SO_4^{2-} and NO_3^- concentrations were observed during the sampling period. The first increase was observed between 22 and 26 December 2016, and the second between 31 December 2016 and 4 January 2017, coinciding with the increase in the coal combustion markers. The maximum values were reached on 22 December 2016, with 4.5 µg/m³ for NH_4^+, 5.8 µg/m³ for SO_4^{2-} µg/m³ and 7.4 for NO_3^- (Fig. 5).

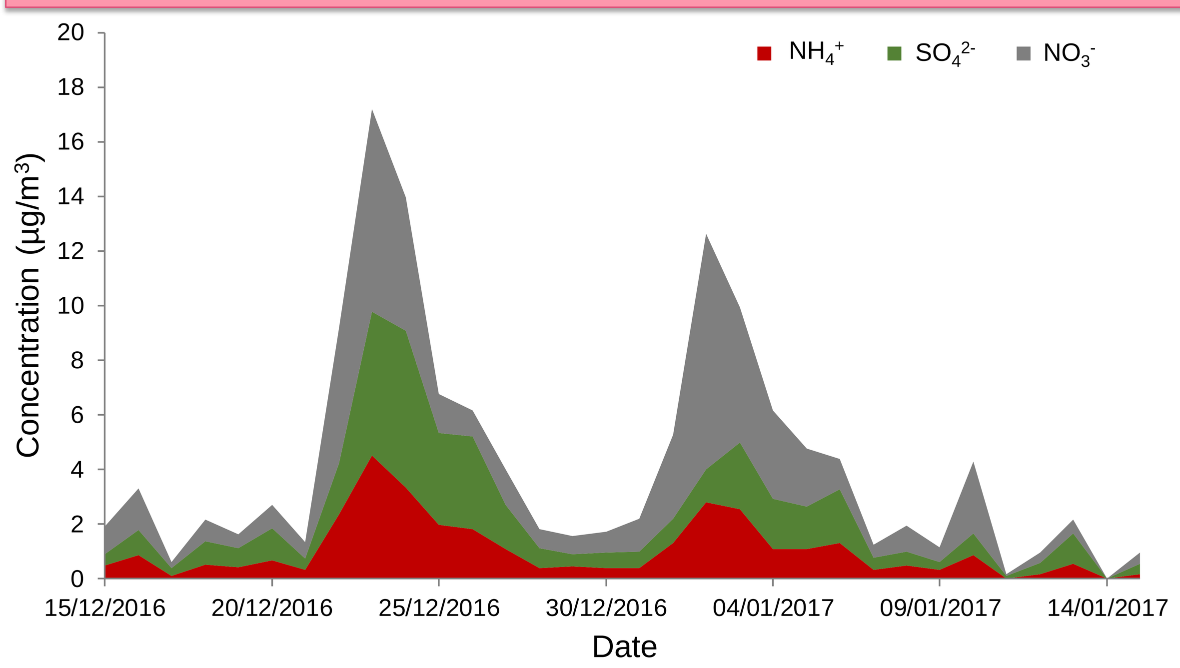


Fig. 5. Daily evolution of ammonium, sulfate and nitrate concentrations between 15 December 2016 and 15 January 2017.

There was an increase of total particle number concentration (N_t) between 21 December 2016 and 10 January 2017, reaching maximum mean concentration of particles with aerodynamic diameters < 30 nm on 27 December 2016 with 1006 particles cm⁻³ (Fig. 6).

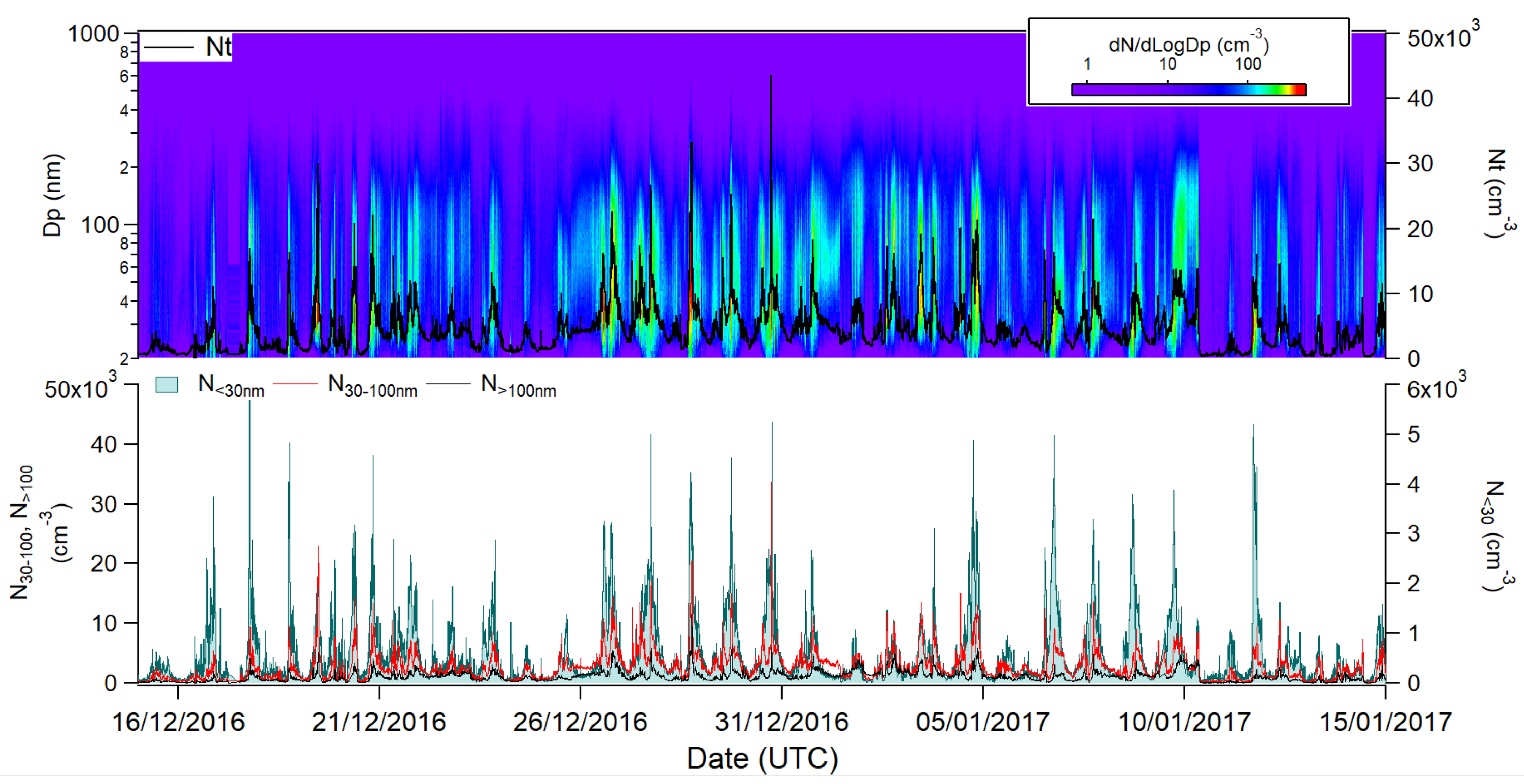


Fig. 6. Evolution of the aerosol size distributions, total particle number concentration (N_t) and particle concentration for each of the three modes: nucleation ($N_{<30nm}$), Aitken ($N_{30\text{-}100nm}$) and accumulation ($N_{>100nm}$) between 15 December 2016 and 15 January 2017.

As the combustion of coal in domestic devices is still frequent in León, mainly during the colder months, air pollution from this source becomes more noticeable. In addition, weather conditions can contribute to a low dispersion of pollutants due to a narrow mixing layer.

ACKNOWLEDGEMENTS

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