AEROSOL CONCENTRATION DURING A THERMAL INVERSION FOLLOWED BY RAIN IN NORTHWESTERN IBERIA

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INTRODUCTION

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. In addition, in the 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 critical to allow a good vertical dispersion of the contaminants in the air because it determines the rate and the range of dispersion of substances formed or emitted near the ground (Schäfer et al., 2006; 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), and study the effect of rain event after thermal inversion.

STUDY AREA

- **Aerosol particles distribution**, **Black Carbon** concentration (BC) and **raindrop spectrum** were measured in the Campus of **University of León** during a period that includes a thermal inversion and a precipitation event.

42° 36' 50" N 5° 33' 38" W | **Altitude: 846 m** | **20th October 2016** → **10th November 2016**

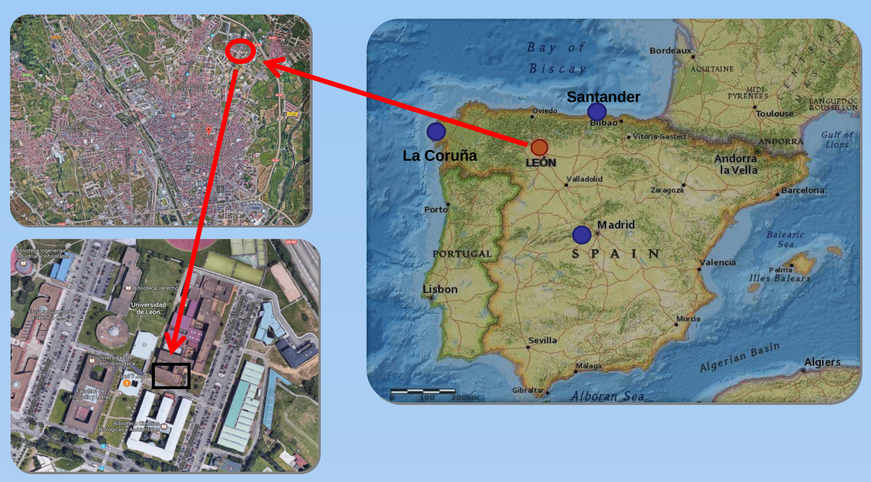


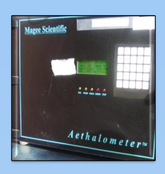
Figure 1. León city in the NW Iberian Peninsula and surroundings of the sampling site.

METHODOLOGY

Optical particle counter (PCASP-X) → Aerosol size distribution between **0.1 and 10 µm** in 31 channels

High resolution nanoparticle sizer (TSI-SMPS Model 3938)

→ Aerosol size distribution between **14.3 and 661.2 nm** in 107 channels



AE31 Aethalometer → **eBC_{ff}** and **eBC_{bb}** (eBC from fossil fuel and biomass burning), AAE (Absorption Ångström Exponent)

Laser Disdrometer LPM

→ **Number and size of raindrops**

Davis Weather Monitor II Station → **T, RH (%) and wind** speed and direction

We analyze radiosoundings (data provided by AEMET)

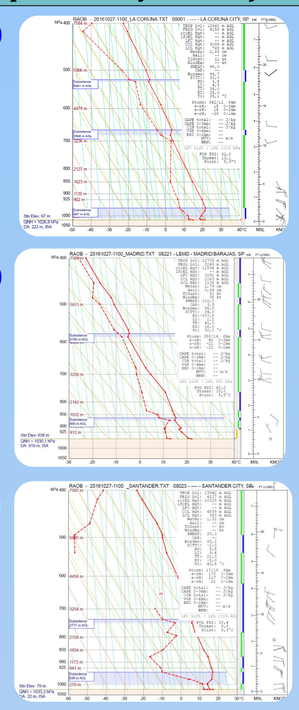
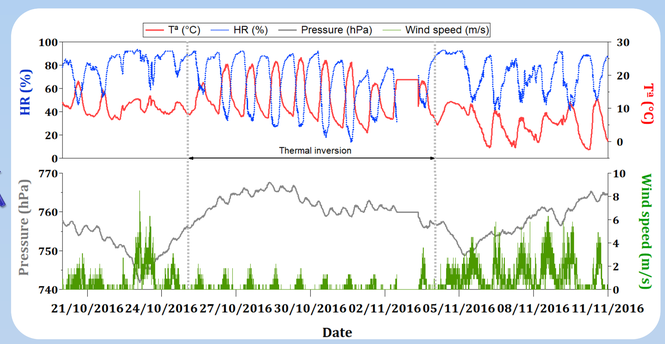


Figure 2. Radiosoundings of day 27/10/2016 at 1100 UTC up to the pressure of 400 hPa in: a) La Coruña; b) Madrid; c) Santander.

RESULTS and CONCLUSIONS



WEATHER STATION

Figure 3. Evolution of the meteorological parameters in thermal inversion occurred. Pressure (gray line), wind speed (green line), HR (blue line) and Tª (red line).

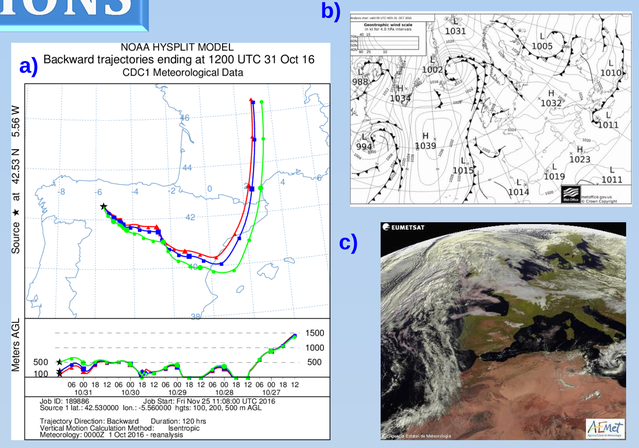
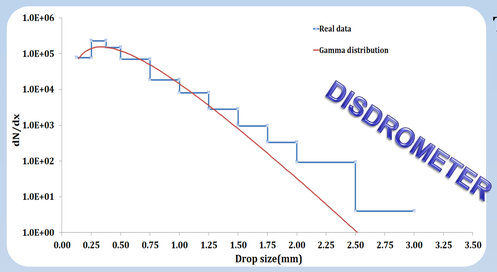


Figure 4. a) Hysplit back trajectories at 500, 1000 and 1500 m; b) Synoptic map of 31st October 2016. Data obtained from: http://old.wetterzentrale.de; c) Visible image of 29st October 2016. Data obtained from: http://www.aemet.es/es.

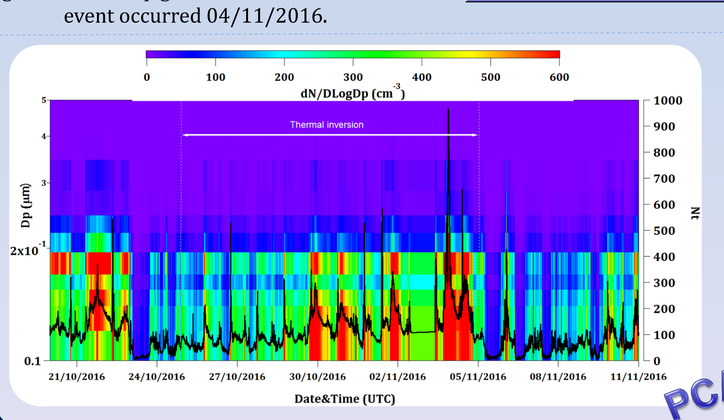


DISDROMETER

Figure 5. Raindrop gamma distribution of rain event occurred 04/11/2016.

Table 1. Characterization of rain event occurred 04/11/2016 with data compiled by the LPM.

Total precipitation (mm)	1.92
Total number of drops recorded per m^2	$1.81\ 10^7$
Mean drop size (mm)	0.46
Variance of mean size (mm)	0.06
A (alpha parameter)	3.64
β (mm^{-1}) (beta parameter)	7.93

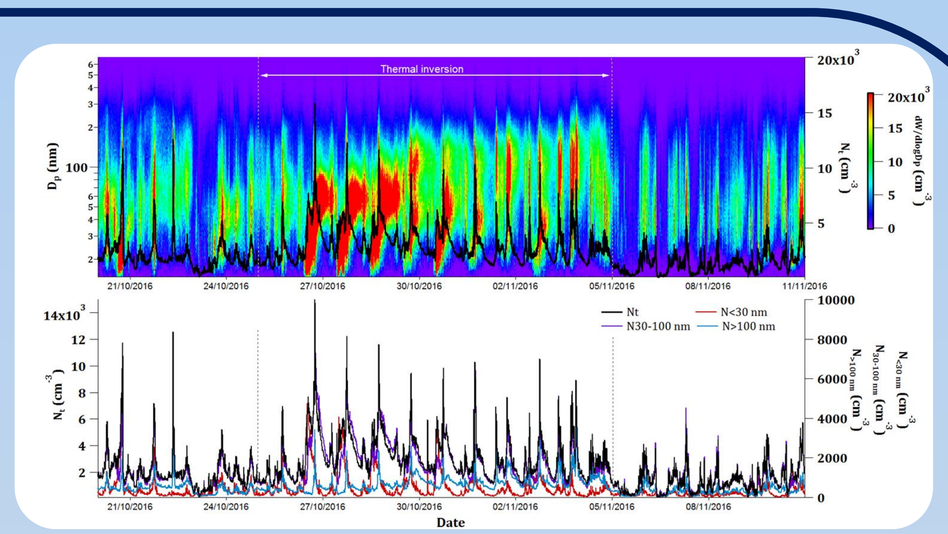


PCASP

Figure 6. Evolution of the number of aerosol particles (0.1-10 µm) in thermal inversion occurred between 25th October 2016 and 4th November 2016.

CONCLUSIONS

- Thermal inversions by subsidence produces an **increase in the UFP concentration** in nucleation, Aitken and accumulation mode, between the days before inversion and the days during inversion, of **30, 55 and 46%,** respectively.
- During thermal inversion, hourly mean **eBC** concentration are reached values of **8.0 µg/m³**, with very clear **increases** over periods without inversion, both in **eBC_{ff} and eBC_{bb}**, of **39%** and **78%**, respectively.



SMPS

Figure 7. Evolution of the number of aerosol particles (14.3-661.2 nm) in thermal inversion occurred between 25th October 2016 and 4th November 2016.

Table 2. Summary of mean and standard deviation of BC, eBC_{ff}, eBC_{bb}, $AAE_{470\text{-}950nm}$ and BB (% biomass burning BC) before, during and after thermal inversion.

Thermal inversion		Mean ± SD (µg/m³)
BEFORE	**eBC**	0.96 ± 0.82
	eBC_{ff}	0.77 ± 0.73
	eBC_{bb}	0.19 ± 0.17
	$AAE_{470\text{-}950nm}$	1.12 ± 0.14
	BB (%)	24 ± 16
DURING	**eBC**	1.55 ± 1.25
	eBC_{ff}	1.10 ± 1.08
	eBC_{bb}	0.44 ± 0.45
	$AAE_{470\text{-}950nm}$	1.18 ± 0.17
	BB (%)	31 ± 20
AFTER	**eBC**	1.10 ± 1.03
	eBC_{ff}	0.76 ± 0.80
	eBC_{bb}	0.35 ± 0.39
	$AAE_{470\text{-}950nm}$	1.18 ± 0.26
	BB (%)	33 ± 23

AETHALOMETER

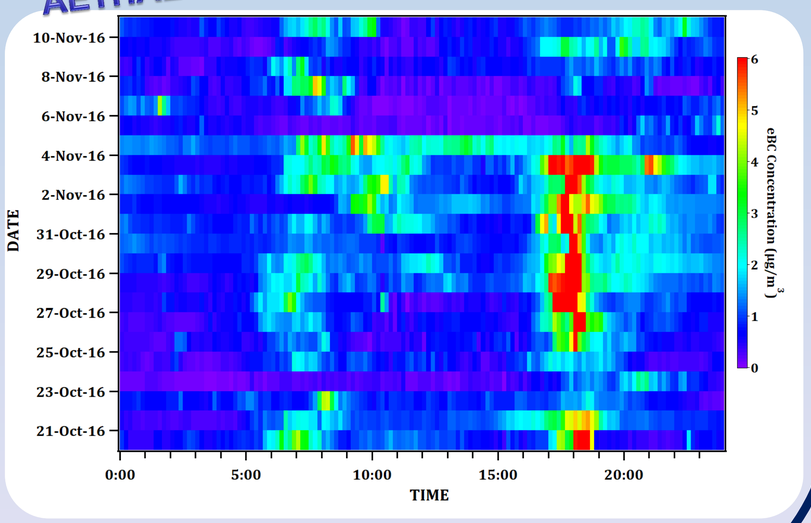


Figure 8. Temporal variations of [eBC] in thermal inversion occurred between 25th October 2016 and 4th November 2016.

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