EFFECT OF A THERMAL INVERSION ON ATMOSPHERIC PARTICULATE MATTER IN NORTHWESTERN SPAIN

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INTRODUCTION

Thermal inversions are usually related to serious atmospheric pollution events. This is caused by the weather stagnating conditions consequence of a reversal of the normal temperature vertical gradient in the troposphere that produces the smallest aerosol particles to be trapped under the atmospheric mixed layer. Thus, the presence of thermal inversions in urban/industrial areas directly impacts on human health, economic activity and daily life of the population (e.g. traffic restrictions). The aim of this study is to examine the relationship between thermal inversions and the concentration of aerosol particles and black carbon (BC) in León (Spain).

STUDY AREA

Data were collected between 20th December and 10th January 2017 at the university campus of León, Spain:

- 42° 36' 50" N
- 5° 33' 38" W
- 846 m asl

FIG. 1. León city in the NW Iberian Peninsula (green) and radiosounding sites (red).

METHODOLOGY

SAMPLING

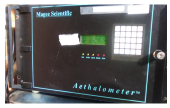
Optical particle counter (PCASP-X)

Aerosol size distribution between 0.1 and 10 μm in 31 channels

High resolution nanoparticle sizer (TSI-SMPS Model 3938)

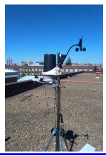
Aerosol size distribution between 14.3 and 661.2 nm in 107 channels

AE31 Aethalometer



Black carbon mass concentration.

Davis Weather Monitor II Station



Temperature, relative humidify and wind speed and direction

RESULTS and CONCLUSIONS

Between 25th December 2016 and 4th January 2017 an intense subsidence thermal inversion was observed in León (Fig. 2).

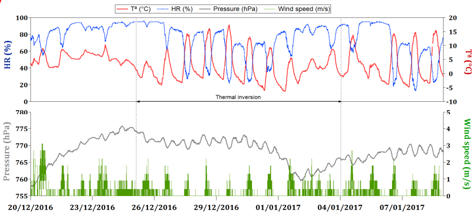


FIG. 2. Evolution of the meteorological parameters before, during and after the thermal inversion.

After the thermal inversion, a decrease of **52%** in the number of particles larger than 0.1 μm was observed.

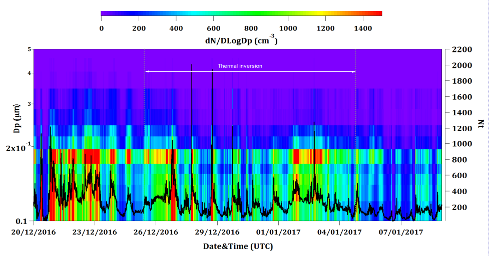


FIG. 3. Evolution of the number of aerosol particles (0.1-10 μm) before, during and after the thermal inversion.

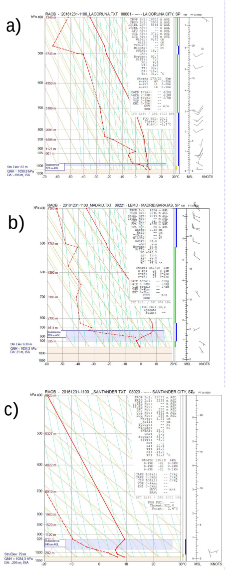


FIG. 3. Radiosoundings of 31/12/2016 at 1100 UTC corresponding to:
a) La Coruña; b) Madrid; c) Santander.

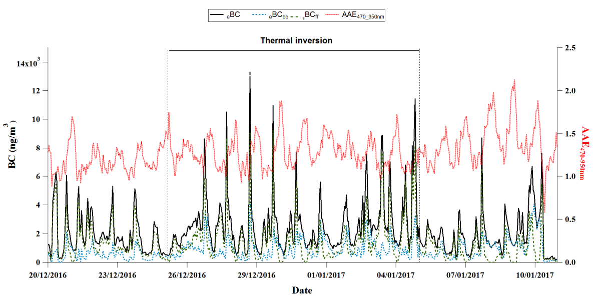


FIG. 4. Evolution of the $_eBC$ (equivalent BC), $_eBC_{ff}$ ($_eBC$ from fossil fuels), $_eBC_{bb}$ ($_eBC$ from biomass burning) and $AAE_{470\text{-}950nm}$ (Absorption Ängstrom Exponent) before, during and after the thermal inversion.

An increase in the number of particles of **15**, **52** and **41%** in the Aitken (10-30 nm), accumulation (30-100 nm) and coarse modes (>100 nm), respectively, has been observed during the thermal inversion.

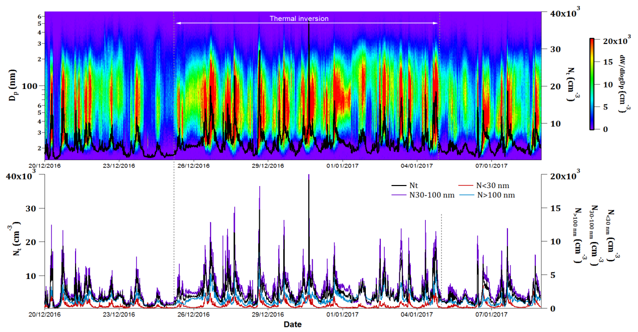


FIG. 5. Evolution of the number of aerosol particles (14.3-661.2 nm) before, during and after the thermal inversion.

CONCLUSIONS

1. During the subsidence thermal inversion an important increase in the particle number concentration was registered (30% increase in the Aitken mode, 55% in the accumulation mode and 46% in the coarse mode).
2. The concentration of particles larger than 0.1 μm suffers an increase greater than 20% during the thermal inversion. This increase is specially remarkable during the afternoon (between 1700 and 2200 UTC).
3. During the thermal inversion, hourly mean $_eBC$ concentrations reached values up to 13.290 μg/m³, with a clear increase with respect to the periods without inversion for both $_eBC_{ff}$ and $_eBC_{bb}$ (higher than 40%).
4. AAE took values of 1.190±0.179 before and 1.277±0.180 during the thermal inversion.

TABLE 1. Mean and standard deviation of $_eBC$, $_eBC_{ff}$, $_eBC_{bb}$ and $AAE_{470\text{-}950nm}$ and BB (percentage of $_eBC_{bb}$) before, during and after the thermal inversion.

THERMAL INVERSION		*Mean ± St.Dev. (μg /m³)*
BEFORE	$_eBC$	1.658 ± 1.387
	$_eBC_{ff}$	1.127 ± 1.057
	$_eBC_{bb}$	0.532 ± 0.603
	$AAE_{470\text{-}950nm}$	1.190 ± 0.179
	BB (%)	32 ± 21
DURING	$_eBC$	2.512 ± 1.921
	$_eBC_{ff}$	1.565 ± 1.528
	$_eBC_{bb}$	0.947 ± 0.697
	$AAE_{470\text{-}950nm}$	1.277 ± 0.180
	BB (%)	43 ± 23
AFTER	$_eBC$	1.389 ± 1.346
	$_eBC_{ff}$	0.715 ± 0.992
	$_eBC_{bb}$	0.673 ± 0.703
	$AAE_{470\text{-}950nm}$	1.321 ± 0.271
	BB (%)	48 ± 30

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