X5.51 | EGU25-10433 | ECS

Env. Pollution

CAUSES OF THE UNREMITTING HIGH AMBIENT LEVELS OF PM_{10} IN A SUBURBAN BACKGROUND SITE IN NE SPAIN

OSPP contest

A. Canals-Angerri[1,2±], M. Via[1*], R. Lara[1], A. Alastuey[1], M.C. Minguillón[1], M. Pandolfi[1], B.L. van Drooge[1], X. Querol[1]

[1]Institute of Environmental Assessment and Water Research (IDAEA), CSIC, Barcelona, Spain

[2]Department of Chemical Engineering and Analytical Chemistry, Universitat de Barcelona, Spain

[*]now at: Centre for Atmospheric Research, University of Nova Gorica, Ajdovščina, 5270, Slovenia

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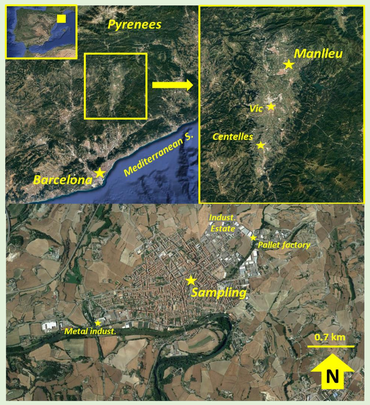
Study Area

Manlleu and the air quality-monitoring site (42°00'12.1"N 2°17'13.5"E).



Introduction

Long- and short-term exposure to $PM_{2.5}$ and PM_{10} is linked to increased respiratory and cardiovascular morbidity, premature mortality [1-3], and substantial health-related costs (4.5% of global GDP) [4]. Despite significant efforts to reduce PM through policies in Europe, 97% of the EU-27 urban population still faces $PM_{2.5}$ concentrations above WHO guidelines (5 μg m^{-3}) [5]. Secondary PM, especially organic aerosols, poses a challenge for abatement. In Spain, Manlleu is a notable PM pollution hotspot, largely due to biomass burning and intensive agriculture. This study analyses long-term PM_{10} and BaP measurements, combined with speciation data, to assess PM sources and impacts, particularly biomass combustion, in urban Europe.

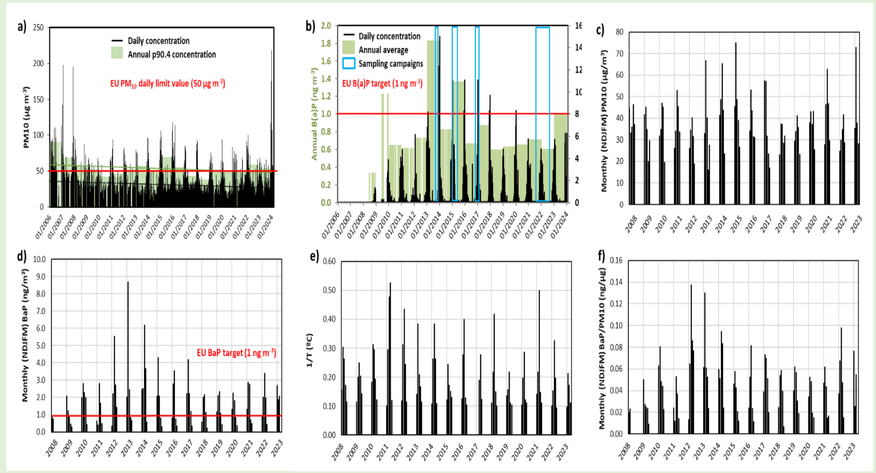


Figure 1.
a) Daily PM_{10} concentrations and annual 90.4 percentile value (should not exceed 50 μg m^{-3}) for 2006-2024. b) Daily BaP concentrations and annual average (should not exceed 1 ng m^{-3}) for 2008-2024. Sampling campaigns and complete chemical analysis of PM_{10} in Blue squares.
Monthly concentrations from November to March (NDJFM) of 2008-2023: c) PM_{10}, d) BaP, e) average 1/T and f) average BaP/PM_{10} ratios.

Methodology

Analysis of air quality data from the official surveillance network in Manlleu, which records hourly concentrations of pollutants like NO, NO_2, SO_2, O_3, and PM_{10}. The last offline PM_{10} speciation campaign was conducted from 2021 to 2022 to analyse inorganic and organic compounds, with techniques such as ICP and GC-MS. Additionally, an online PM_1 speciation campaign was performed from 2016-2017 to monitor hourly variations in pollutants, including black carbon and organic aerosols, focusing on biomass burning sources. This combination of offline and online methods enabled a comprehensive evaluation of PM origins and variations in Manlleu. The receptor modelling analysis was done by applying the Positive Matrix Factorization model, (US-EPA-PMF 5.0) to PM chemical speciation datasets.

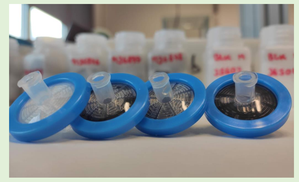


Figure 2. Syringe quartz filters after filtering lixiviates.

Results and conclusions

- PM_{10} levels in Manlleu have exceeded the daily limit since 2006
- BaP concentrations exceeded the EU target and are 3 to 9 times higher than in Barcelona.
- Highest PM_{10} and BaP concentrations are observed in winter months.
- BaP/PM_{10} ratios indicate significant biomass burning, with a clear correlation between colder temperatures and higher pollutant levels.
- Biomass burning significantly contributes to PM_{10} and BaP, with a reduction in BaP due to improved industrial practices after 2015.
- Chemical mass closure indicates high contributions from organic carbon, ammonium, and combustion-related pollutants, with trace metals elevated during heating periods.
- PM_{10} source apportionment revealed four key sources: Secondary Organic Aerosol (SOA), Mineral and Local Industry (MinInd), Agriculture and Fodder Production (AgFo), and Biomass Burning Organic Aerosol (BBOA).
- SOA contributed to PM_{10} mainly in summer months, while BBOA and MinInd were dominant during Winter.

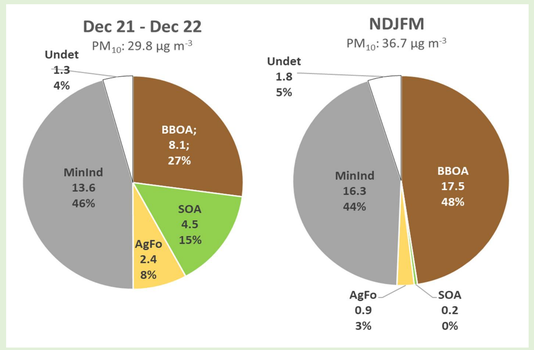


Figure 3.
Contributions (in μg m^{-3} and percentage) of the four main sources identified to the gravimetric PM_{10} concentrations determined in the 2021–2022 period. a) Whole period from December 2021 to December 2022. b) Winter studied period, NDJFM.

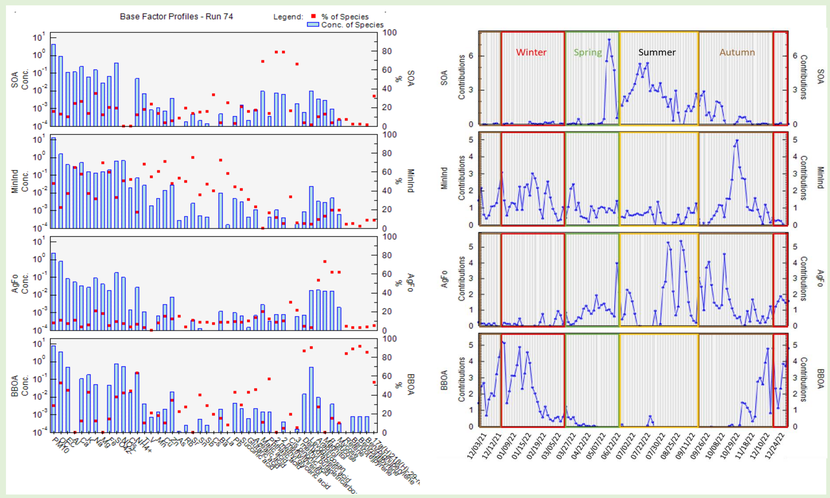


Figure 4.
a) Chemical profiles of the PMF analysis applied to PM_{10} speciation datasets in 2021–2022 (122 samples, 47 species). PM component concentrations of species (y1-axis, blue bars) and total variable percentages (y2-axis, red squares). b) Seasonal evolution of the contribution of main pollution sources.

- Non-refractory PM_1 source apportionment revealed biomass burning, particularly domestic, as the dominant source during winter, with significant contributions from traffic and secondary processes.
- Despite reductions in industrial emissions, regional measures to address biomass burning and NH_3 emissions from agriculture have been ineffective, highlighting the need for stricter controls and continuous monitoring.

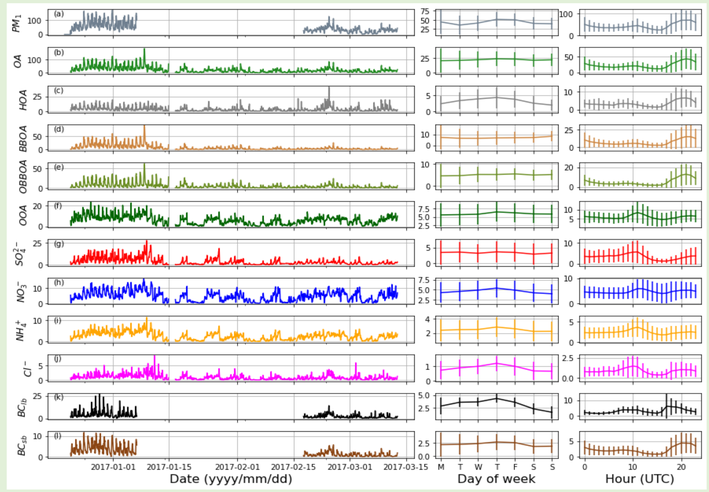


Figure 5. Time series, weekly and diel PM_1 concentrations (a), PM_1 compounds (b, g, h, I, j), OA sources (c, d, e, f) and BC sources (k, l).

References

[1] GBD, 2020. Lancet 396, 1223–1249.
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acageo@cid.csic.es