

Black Carbon source apportionment from fossil fuel and biomass burning in a suburban area near Lisbon during the COVID-19 pandemic

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Black Carbon (BC) is emitted from the incomplete combustion of fossil fuels and biomass burning. It is a large contributor to global warming and has a significant impact on human health (Manohar et al., 2021).

Seixal comprises a heavy industrial park and is crossed by highways with intense commuting traffic to Lisbon. This communication is part of a more global study concerning PM_{2.5} source apportionment in the area (Gamelas et al., 2023), but here we aim to determine, for the first time, the contribution of fossil fuel combustion (BC_{ff}) and biomass burning (BC_{bb}) to BC concentrations at this suburban site.

PM_{2.5} samples were collected in 128 sampling days, in winter (December 2019-March 2020), summer (June-August 2020) and autumn (September-November 2020), spanning from pre-pandemic to pandemic context. PM_{2.5} was chemically analyzed by PIXE and ion chromatography (Gamelas et al., 2023).

BC concentrations were determined using a Multi-wavelength Absorption Black Carbon Instrument (MABI, by ANSTO). The light transmission is measured through unexposed (I₀) and sampled (I) filters, for seven wavelengths (λ) and these values are used to determine the mass absorption coefficients (ε) and the BC concentrations at each wavelength (Manohar et al., 2021). The determined ε values are comprised from 4.649 to 7.518 m².g⁻¹, and the Angstrom exponent (α) calculated by fitting ε versus λ to a power law, is 0.495, suggesting the predominance of fossil fuel combustion particles (Manohar et al., 2021).

A chemical mass balance was performed, including the contributions of BC, NO₃⁻, NH₄⁺, non-sea salt sulphate (nssSO₄²⁻), mineral dust, sea salt and trace elements, to the total PM_{2.5} mass (Figure 1), calculated as in Faria et al. (2022). BC was the main constituent of PM_{2.5}, representing 19.9% in the whole period. BC concentrations decreased by 46.1% from the pre- to the post-confinement.

The smoke indicator (BC_{λ405}-BC_{λ1050}) is used to differentiate the BC source, since for BC_{ff} the module of this indicator is ≤50 ng.m⁻³ and when the indicator is >500 ng.m⁻³, BC_{bb} is present (Manohar et al., 2021). BC dominated by fossil fuel has been identified in 123

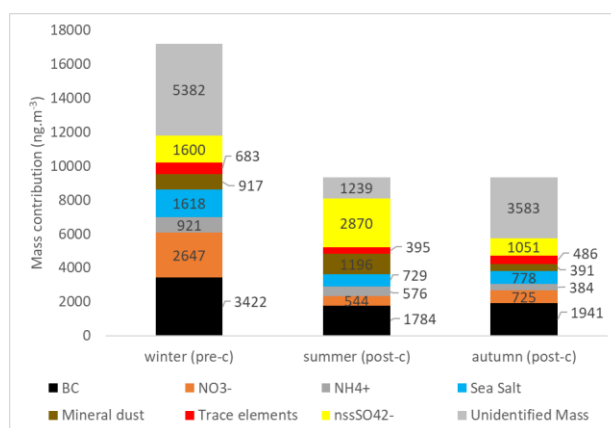


Figure 1. Mass contributions (ng.m⁻³) to the total PM_{2.5}, determined by mass balance. “Pre-c” and “post-c” mean pre- and post-confinement, respectively.

sampling days and biomass burning was representative in only 5 sampling days. In the winter/pre-confinement, BC_{ff} represented 97.5% of the total BC (Table 1), showing that the study area is mostly exposed to traffic. BC_{bb} concentration more than tripled, from winter/pre-confinement to autumn/post-confinement and this is presumably due to the increased frequency of biomass burning in fireplaces in the post-confinement, due to the increased time spent at home by the population.

Table 1. BC concentrations (BC₆₃₉), BC due to fossil fuel combustion (BC_{ff}) and biomass burning (BC_{bb}) (mean±s.d.).

	BC ₆₃₉	BC _{ff}	BC _{bb}
	(ng.m ⁻³)		
whole period	2510±2011	2389±2059	123±166
winter/pre-c	3448±2515	3361±2555	87±125
summer/post-c	1784±766	1748±770	36±101
autumn/post-c	1936±1514	1681±1586	265±180
post-c	1859±1197	1715±1242	149±185

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Faria et al. (2022) *Sci. Total Environ.*, 823, 153745.

Gamelas et al. (2023) *Urban Clim.*, 49, 101446.

Manohar et al. (2021) *Atmos. Pollut. Res.*, 12(4), 133.