

Tyre-derived particles in size-segregated aerosols of urban and alpine areas: occurrence, sources and temporal trends

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In the last decades, rapid urbanization and industrial and economic growth have led to the acceleration of the anthropogenic impact on the planet. The emission in the environment of Chemicals of Emerging Concern (CECs) is consistently increasing, hence their monitoring is of growing interest for the scientific community and policy makers. Among other environmental compartments, the atmosphere is one of the most affected by the growing number of CECs, as they are still poorly regulated and not extensively monitored (Yadav et al., 2021).

Traffic pollution is one of the major contributors to the worsening of air quality, hence understanding how traffic pollution markers can distribute in the environment is of utmost importance. Benzothiazoles (BTHs) are tyre-derived particles often used as markers for traffic pollution based on their high detection frequencies in road runoff (Asheim et al., 2019; Feltracco et al., 2023; Maurer et al., 2023).

BTHs are listed as high production volume chemicals, due to their extensive use in a wide range of industrial and consumer products (Liao et al., 2018). They are mainly used as vulcanization accelerators in rubber manufacturing, but also as fungicides in leather and paper production, corrosion inhibitors in antifreeze formulations, pesticides and ultraviolet light stabilizers in textiles and plastics. BTHs are linked to plastic pollution as they are used as additives; in fact they have been found in plastic leachate (Gunaalan et al., 2020).

The widespread usage of BTHs implies that they will likely be an environmental issue in the future, and according to several studies they exhibit an array of toxic effects in animals and humans (Hornung et al., 2015; Ye et al., 2014), hence research should focus on a comprehensive study of their occurrence and fate in the environment.

This study aims to investigate the presence of eight BTHs in size-segregated aerosols collected in urban (Mestre, Venice) and alpine (Col Margherita, Dolomites) sites in Italy, to study their distribution in different particle-size fractions, to assess regional differences in pollution sources and to observe temporal trends.

Aerosol sampling was carried out using both PM₁₀ and a multi stage cascade impactor. Analytical

determination was performed via UHPLC-MS/MS. NOAA ARL's HYSPLIT model was used to determine the origin of air masses and establish source-receptor relationships.

As expected, the target compounds were found in urban aerosol, with mean concentrations in the order of pg m⁻³. Concentrations were higher in the summer period, and size distribution suggests that BTHs tend to distribute in the finest fraction of aerosols. BTHs were also found in background alpine aerosol, with lower concentrations. These results suggest that their presence is widespread in the atmosphere, even in remote areas.

The present study provides valuable data on the presence of BTHs in the atmosphere in urban settings and an alpine background site, offering a broad view of their size and temporal distributions, that will help for future investigations on the pathways and environmental fate of this class of chemicals.

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