4.013 Abundance of light-absorbing anthropogenic iron oxide aerosols in the urban atmosphere and their emission sources.

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Abstract:

Light-absorbing iron oxide (FeO_X) aerosols such as magnetite contribute to shortwave atmospheric heating and possibly affect the biogeochemical cycle. However, their atmospheric abundance and emission sources are poorly understood. In this study, we quantified the abundance and mixing states of FeO_X at two urban sites in Tokyo and Chiba, Japan, using a modified single-particle soot photometer and filter-based instruments. At both sites, the majority of the FeO_X were of anthropogenic origin in the form of aggregated magnetite nanoparticles, and their concentrations generally correlated with those of black carbon (BC) and carbon monoxide. In Chiba, where the observatory was located near an integrated steel plant, we observed distinctly high FeO_X concentrations and high FeO_X/BC concentration ratios when the air mass passed through the plant. From the observed FeO_X plumes with the mass equivalent diameter range of 170–2100 nm, we estimated their emission flux to be approximately 0.012% of the crude steel production. Meanwhile, in Tokyo, where the observatory was 20–40 km northwest of steel plants, the FeO_X concentrations and FeO_X/BC ratios showed clear diurnal variations and depended little on wind direction. This indicates that other human activities also locally produce FeO_X aerosols in Tokyo. Our data imply that, although steel plant activities emit a large amount of FeO_X, emissions from other anthropogenic sources, e.g., motor vehicles, have a major contribution to the abundance of FeO_X aerosols at the regional and global scales.