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Sources and atmospheric aging processes of submicron aerosols in Cairo Megacity.

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Over the last few decades, Greater Cairo Megacity has experienced rapid population growth and expansion of its industrial activity. Hosting more than 20 million people, Cairo is considered one of the most polluted megacities in the world. Concentration levels of fine particulate matter ($PM_{2.5}$) are several times higher than those recommended by the World Health Organization (WHO). Although actions have been designed recently to improve air quality in the framework of a "Pollution Management and Environmental Health program" (PMEH) supported by the World Bank, observational studies assessing the main sources leading to this PM pollution are missing, making difficult to implement and monitor the efficiency of local mitigation strategies.

The aim of our study is to investigate atmospheric concentrations levels, temporal variability, as well as major sources, and atmospheric aging of PM in Cairo megacity with a focus on the submicron aerosol fraction (PM_1) to better assess human-made activities with lower interference from natural (dust) emissions. A comprehensive suite of on-line and off-line instruments has been set-up to monitor PM_1 chemical composition and reactive trace gases (i.e. Volatile Organic Compounds) as a part of the POLCAIR campaign that took place during winter 2019-2020, at an urban background site in Greater Cairo. Chemical composition of PM_1 and source apportionment analysis via Positive Matrix Factorization (PMF) on both Q-ACSM (Aerosol Chemical Speciation Monitor, Aerodyne, US) organic mass spectra and co-located filter samples, attributed exceptionally high concentrations of compounds to traffic emissions and diverse combustion sources with pronounced diurnal variability. Two severe pollution episodes were recorded, with hourly mean PM_1 concentrations reaching values as high as 300 $\mu g/m^3$ and lasting for 2 consecutive days favored by low dispersion conditions. Pollutant variability is directly associated with the meteorological conditions, including wind patterns and air mass origins. This helps in

recognizing emission hot spots of major anthropogenic PM_1 sources. Additionally, the effects of the relative humidity and the role of heterogeneous oxidation reaction mechanisms was investigated. Finally, the multi-variable analyses performed, helped us to better investigate the complex urban atmospheric chemistry in Cairo megacity and to highlight the dynamics of Secondary Organic Aerosol formation.