Local and external sources of sulfate, primary and secondary organic aerosol and submicron particles at urban sites in New York City and Long Island

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In spite of attaining the National Ambient Air Quality Standards, it was estimated that ambient levels of $PM_{2.5}$ in New York City still contribute to more than 3000 deaths every year, 2000 hospital admissions for lung and heart conditions, and approximately 6000 emergency department visits for asthma in children and adults (NYC Department of Health and Mental Hygiene, 2013). Thus air pollution still remains a serious concern for policy-makers and the scientific community in NYC as well as the whole metropolitan area.

This study investigates air pollution at two urban background sites in Queens (NYC metropolitan area) and on Long Island. Particle size distributions were collected over 1 year (2009-2010) at 1 h intervals using a TSI 3031 UFP monitor. Data were processed along with other key air pollutants, including nitrogen oxides (NO, NO_2, NO_x), sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), methane (CH_4), non-methane hydrocarbons (NMHC), total hydrocarbons (THC) as well as $PM_{2.5}$ mass and the $PM_{2.5}$-bound species sulfate (SO_4^{2-}), organic (OC), elemental (EC) and total (TC) carbon.

Primary and secondary OC were estimated using the EC tracer method. A series of tools were thus applied to: (i) study the seasonal, weekly, diurnal cycles of pollutants (Figure 1); (ii) investigate the relationships amongst pollutants through correlation and lagged correlation analyses; (iii) depict the role of atmospheric photochemical processes; (iv) examine the location of the potential sources by mean of conditional bivariate probability function (CBPF) analysis and (v) investigate the role of air mass transport in raising the concentrations of analyzed species using the potential source contribution function (PSCF).

This study has provided direct information on the concentrations and trends of key air pollutants over the highly urbanized areas of NYC and Long Island. Results enable some general considerations that can be summarized as follows:

The seasonal, weekly and diurnal cycles of pollutants primarily emitted by anthropogenic sources (NO, SO_2, CO, NMHCs, EC and 30-100 nm particles) are strongly driven by emission patterns, photochemical processes and meteorology. No significant effects of regional transport of primary species were observed from PSCF analysis. Results of CBPF indicate different potential local sources: road traffic is the most probable source of nitrogen oxides, CO, NMHCs, OC_{pri}, EC and 30-100 nm particles, while building heating burning fuel oil and shipping for SO_2.

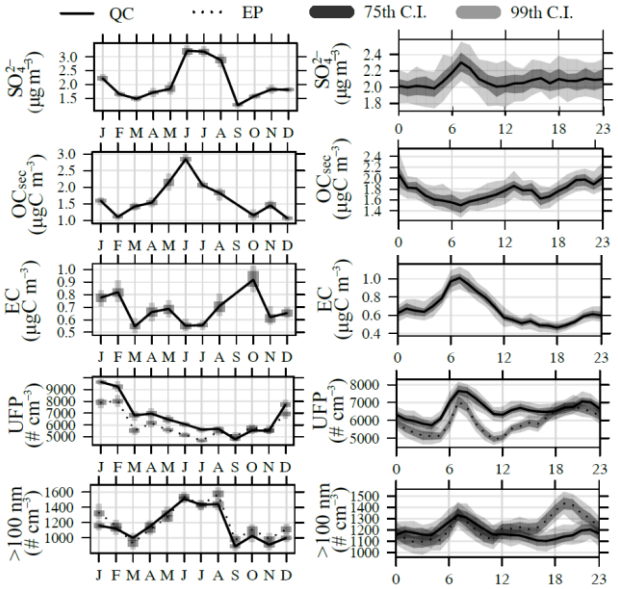

Figure 1. Monthly and daily patterns for some variables.

$PM_{2.5}$ and submicron particle numbers were strongly related to secondary processes. They show comparable seasonal and diurnal profiles, high correlations, and high lagged correlations over long periods (+/- 12 h). CBPF analysis shows that the advection of air masses has a potential effect in raising their levels, while PSCF pointed to the eastern continental U.S. (Ohio River Valley) as most probable source area.

Both local and external sources can be found for UFPs in the nucleation range (<30 nm). Results indicate that LaGuardia airport is a potential local source at the Queens College site, while PSCF analysis does not reveal any dominant remote source area.

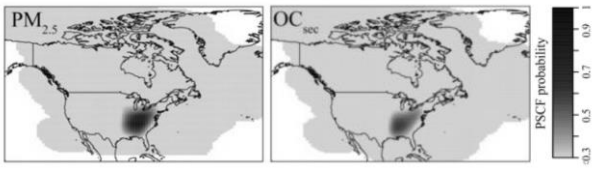

Figure 2. PSCF analysis of $PM_{2.5}$ and OC_{sec}.