Scale-Dependent Spatiotemporal Patterns of fine PM concentrations

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Exposure to fine particulate matter (PM) is known to levy a substantial burden of disease, with adverse outcomes even below 10 $\mu g \cdot m^{-3}$ of $PM_{2.5}$. Hence, much research is dedicated to assess the variation of fine and ultrafine (UF) PM in urban environments. Ambient concentrations of fine PM result from dynamic processes that occurs at different spatiotemporal scales, including local and remote emissions, transport and aging processes. We hypothesized that analyzing fine temporal scales of PM records can spatially resolve local short-term processes from regional phenomena, as has been demonstrated for UF PM (Sabaliauskas *et al.*, 2014).

A network of relatively low-cost optical particle counters (OPCs) was deployed in an urban residential neighborhood for six months. Five nodes were set 150-300 m apart and measured number concentrations of fine particles >0.5 µm. The extremely long time-series (1 min sampling frequency) facilitated a frequency analysis for studying PM patterns at selected spatiotemporal scales. Specifically, we used continuous wavelet decomposition (CWT) to resolve periodic cycles (e.g. diurnal) and transient phenomena (e.g. synoptic events, local emissions).

The spatial variability, i.e., inter-nodal differences, in the study area was found mostly in the 95 percentile of PM concentrations, and in the corresponding skewness of the concentration distribution, leading to overall 19.5–33.6% RMS, in comparison to 8-16% RMS among collocated nodes. The variation seems to be related to anthropogenic activity (commute, commerce). Applying CWT, we identified synoptic events (e.g. dust storms) and diurnal cycle of PM concentrations. We then isolated and reconstructed the short-lived transient component. The different temporal scale events are demonstrated in the wavelet scalogram shown in Figure 1.

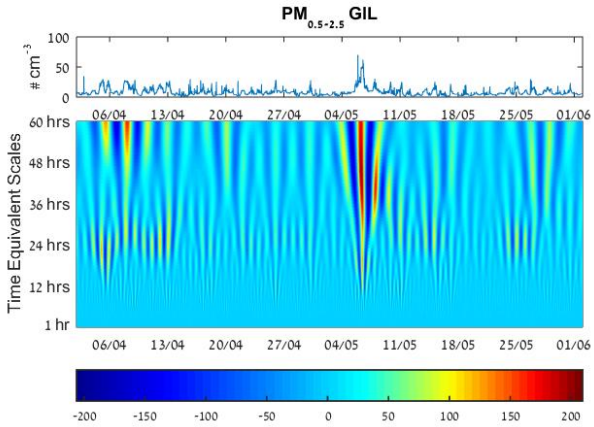

Figure 1. Time series measured by a mini-OPC at one of the measurement sites (code name GIL) during April-June 2014 (Top), and its continuous wavelet decomposition (Bottom). The color bar represents the magnitude of the wavelet coefficient in every decomposition level, which corresponds to a specific temporal scale.

We characterized various spatiotemporal contributions to the ambient fine PM levels in the study area, including local traffic and commerce. Our results demonstrate that by using the CWT we can distinguish between inter and intra neighborhood contributions to observed PM, and hence improve exposure estimation at the individual level.

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Sabaliauskas, K., Jeong, C. H., Yao,,X. and Evans, G. J. (2014) *Atmos. Environ.***95**, 249–257.