Evaluating Vehicle Emission Control Policies using on-Road Mobile Measurements and Continuous Wavelet Transform: a Case Study during the Asia-Pacific Economic Cooperation Forum, China 2014

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Supplemental Materials

S1. Solving the problem of the negative components in the high frequency signal decomposed from the on-road air pollutant concentrations by the Continuous Wavelet Transformation (CWT).

Using CWT to decomposed instantaneous concentrations of air pollutants from on-road measurements, we always have negative components (Figure S1 (a)), this is caused by the principle of CWT. To adjust the negative component, we used 1-minute moving average and 0-percentile of the instantaneous concentration line as a reference (REF-line in Figure S1 (b)). By subtracting REF-line we were able to move the instantaneous concentrations (black line) up with no negative component (Figure S1 (c)). If we subtract the background (red line in Figure S1 (a)) with the REF-line, then we get a new background (red line in Figure S1 (d)). Apparently, Figure S1 (d) provides reasonable decomposing results of the instantaneous and background concentrations of air pollutants. We applied the same routine as described above for the CWT decomposing the concentrations of on-road air pollutants measured in this study.

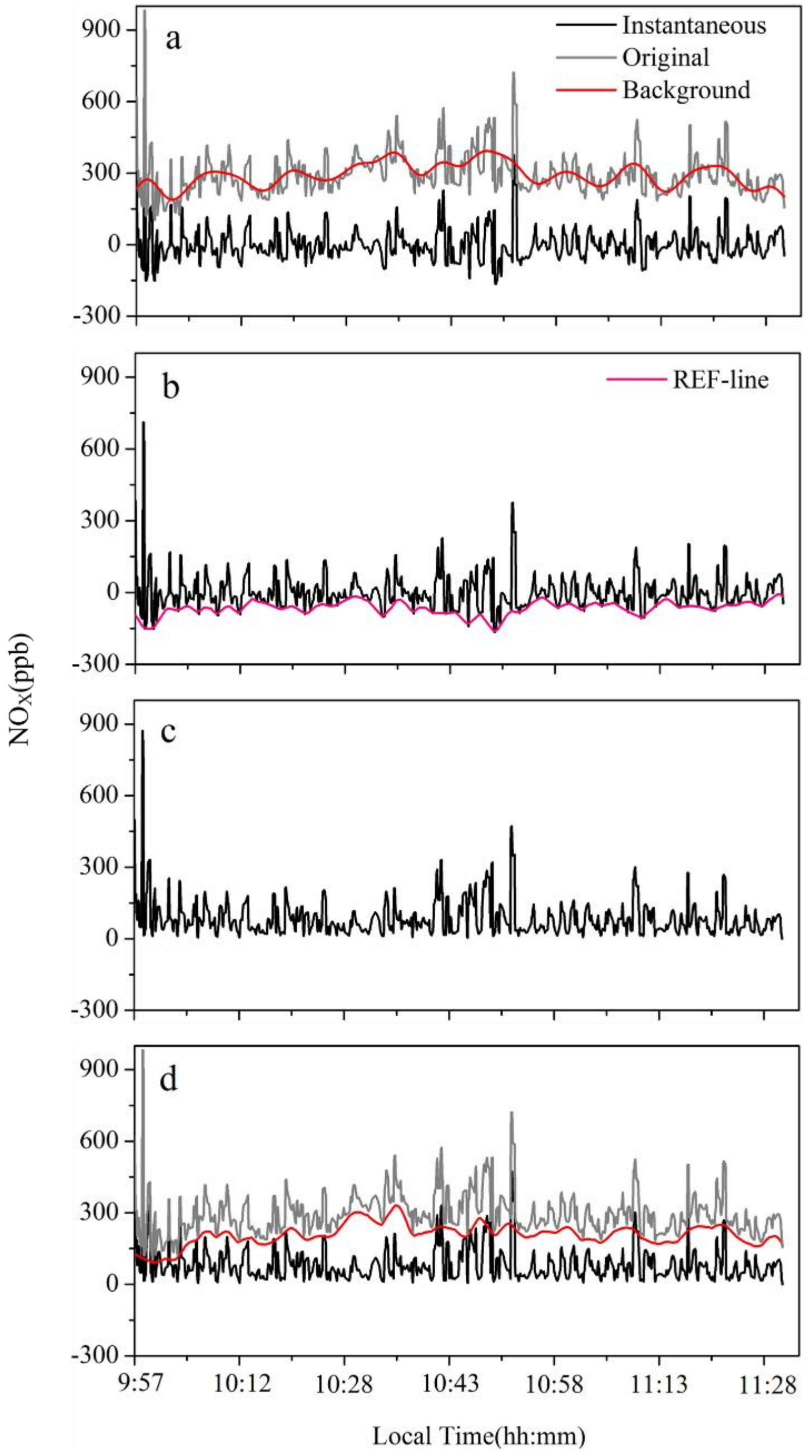

Figure S1. The decomposing of the concentrations of on-road air pollutant by the CWT method: (a) the gray line represents original mobile monitoring result, the black line represents instantaneous concentration decomposed by CWT, the red line represents on-road background concentration decomposed by CWT; (b) the 1-minute moving average and 0-percentile of the instantaneous concentration can be used as a reference (REF-line); (c) subtracting REF-line to move the instantaneous concentrations (black line) up with no negative component; (d) the decomposed instantaneous and background concentrations of air pollutants after adjusting the negative components.

S2. Comparison of the monitoring results of the mobile research platform and a stationary site in the campus of Peking University.

Figure S2 shows that the temporal variations of the concentrations of air pollutants measured with our mobile research platform are almost the same as those measured at a stationary site in the campus of Peking University (PKU station). NO_x concentrations measured with mobile research platform were higher than those measured at the PKU station, reflecting the high NO_x emission from vehicles, while O_3 was lower, due to the titration of NO directly emitted from vehicles.

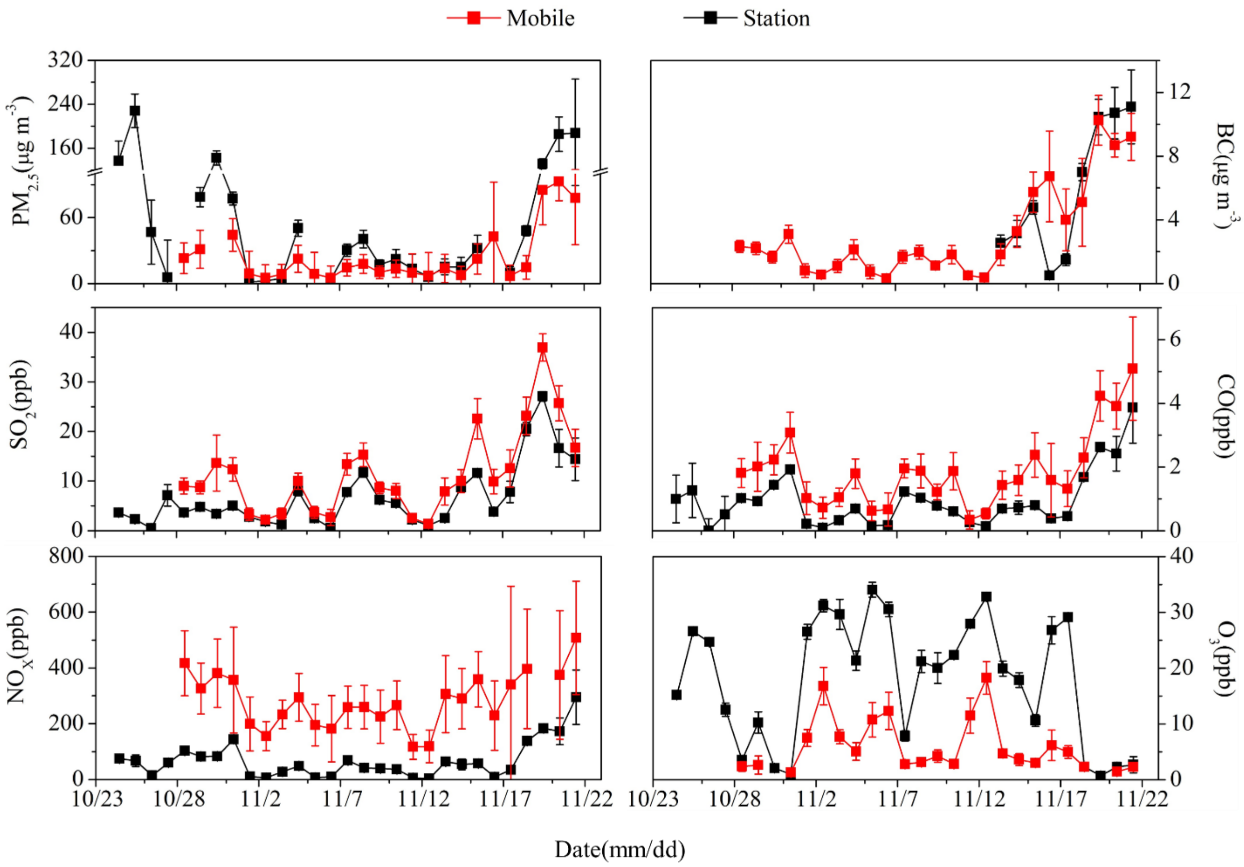

Figure S2. The comparison between the concentrations of air pollutants measured with mobile research platform (Mobile, red dot) and a stationary station in the campus of Peking University (Station, black dot). The pollutant concentrations from mobile research platform measurements were averaged over each measurement trip on each day, while the pollutant concentrations from PKU station measurements were averaged over the same period as the mobile measurements.

S3. A test of the decompose efficiency of CWT.

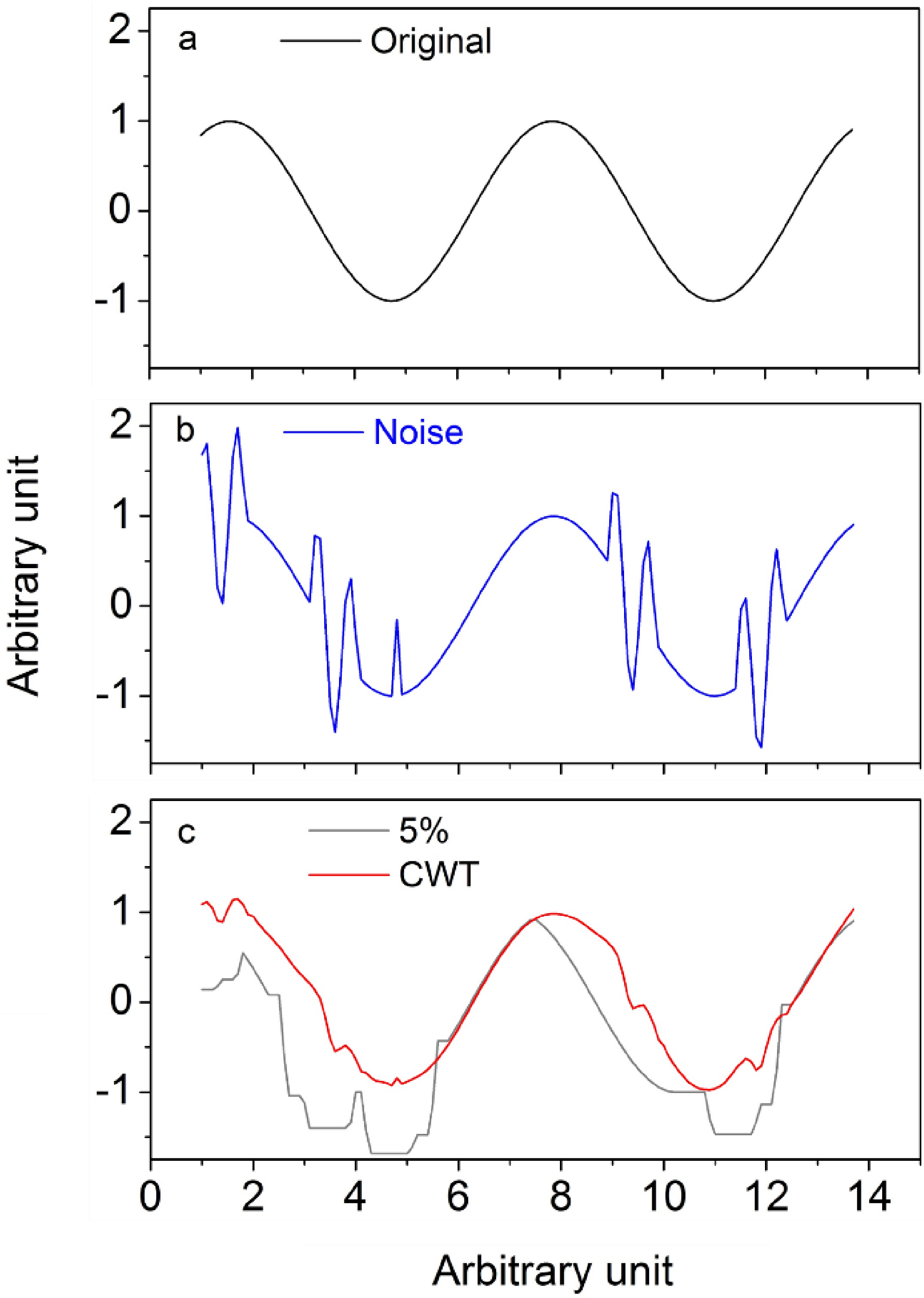

Figure S3. A test of the decomposition efficiency of CWT method using a simulated signal: the black line in (a) represents low frequency signal; the blue one in (b) represents the low frequency signal added with a random high frequency signal; the red one in (c) represents the decomposed results by CWT; the gray one in (c) represents the decomposed result by moving 5-minute 5%-percentile method.

S4. The correlation coefficient of on-road NO_x concentrations averaged along each measurement trip, and decomposed by CWT and moving 5-minute 5%-percentile method.

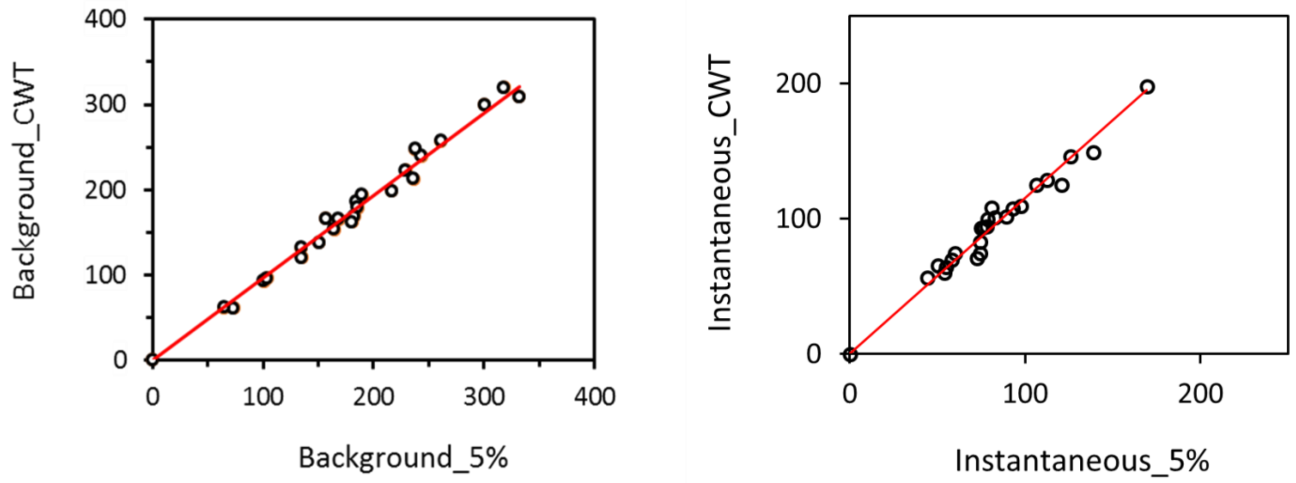

Figure S4. The correlation between on-road background NO_x concentration (left, $R^2 = 0.99$, slope = 0.97) and instantaneous concentrations (right, $R^2 = 0.97$, slope = 1.1) decomposed by CWT (Background_CWT, Instantaneous_CWT) and moving 5-minute 5%-percentile method (Background_5%, Instantaneous_5%).

S5. The CWT decomposed result of SO_2 and O_3 on-road concentrations measured along the route shown in Figure 1.

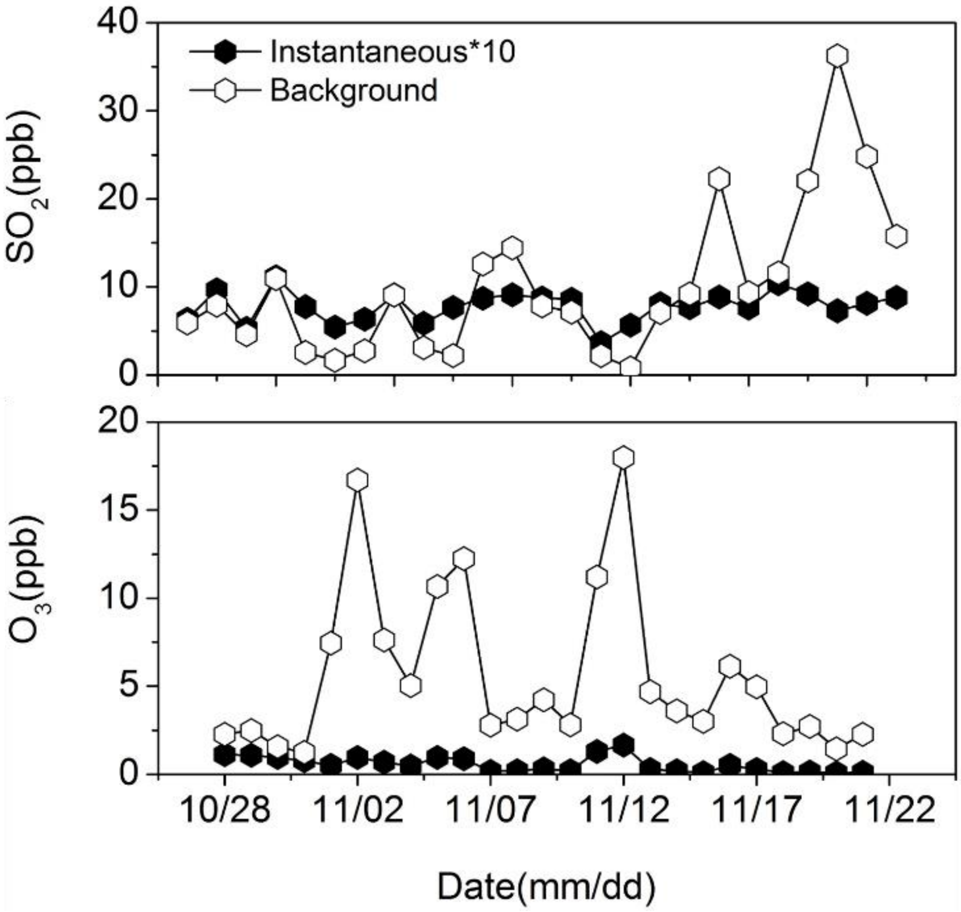

Figure S5. The CWT decomposed results of SO_2 and O_3 on-road concentrations measured along the route. The instantaneous concentrations of SO_2 and O_3 are very low, mainly because vehicle emissions are not major source of these two pollutants.

Table S1. The correlation coefficients (r) between results of CWT decomposed air pollutants: (a) the correlation coefficients between the on-road instantaneous concentrations; (b) the correlation coefficients between the on-road background concentrations.

(a) The correlation coefficients between the on-road instantaneous concentrations of air pollutants.

r (Spearman)	CO	NO_x	SO_2	BC	$PM_{2.5}$
CO	1	0.770**	0.444*	0.319	0.285
NO_x		1	0.590**	0.313	-0.180
SO_2			1	0.399*	-0.139
BC				1	0.255
$PM_{2.5}$					1

(b) The correlation coefficients between the on-road background concentrations of air pollutants.

r (Spearman)	CO	NO_x	SO_2	BC	$PM_{2.5}$
CO	1	0.846**	0.886**	0.838**	0.878**
NO_x		1	0.652**	0.743**	0.863**
SO_2			1	0.864**	0.695**
BC				1	0.771**
$PM_{2.5}$					1

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table S2. The percentage declines of the total concentrations and the background concentrations (decomposed by CWT method) of traffic-related air pollutants measured with our mobile research platform during APEC period relative to the periods before and after APEC.

	Compared period	CO (%)	NO_x (%)	BC (%)	$PM_{2.5}$ (%)
Total	Before APEC	32.6	29.3	33.3	59.8
	After APEC	54.6	35.3	79.7	70.8
Background	Before APEC	33.3	35.0	40.8	69.5
	After APEC	56.3	33.3	83.4	79.3