Using wavelet transform to analyse on-road mobile measurements of air pollutants: a case study to evaluate vehicle emission control policies during the 2014 APEC summit

Yingruo Li[1, 2#], Ziqiang Tan[1#], Chunxiang Ye[1], Junxia Wang[1], Yanwen Wang[1], Yi Zhu[1], Pengfei Liang[1], Xi Chen[1], Yanhua Fang[1], Yiqun Han[1], Qi Wang[1], Di He[3], Yao Wang[3], and Tong Zhu[1*]

[1]BIC-ESAT and SKL-ESPC, College of Environmental Sciences and Engineering, Peking University, Beijing 100871, China
[2]Institute of Urban Meteorology, China Meteorological Administration, Beijing, 100089, China
[3]Environmental Meteorology Forecast Center of Beijing-Tianjin-Hebei, China Meteorological Administration, Beijing, 100089, China

[#]These authors contributed equally to the paper.

[*]*Correspondence to*: tzhu@pku.edu.cn

Supplement

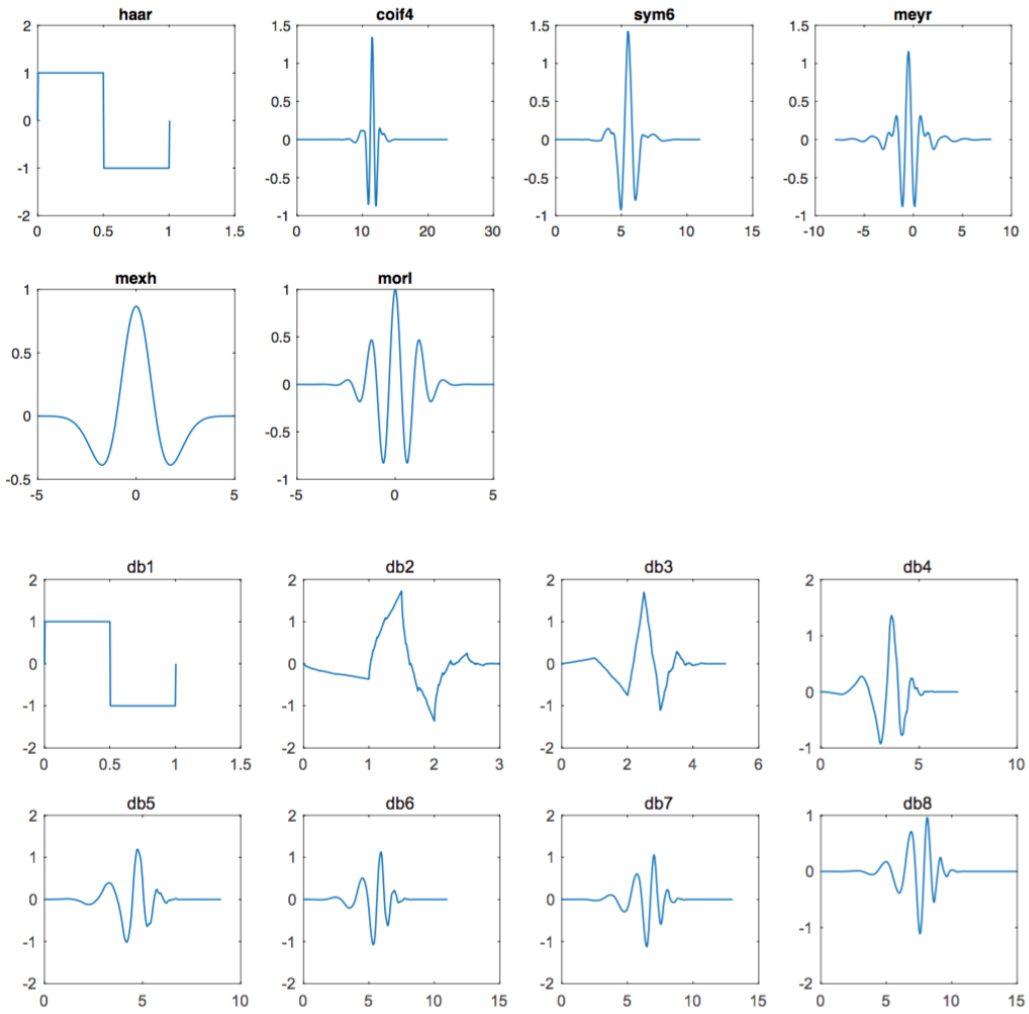

Figure S1. The commonly used mother wavelet functions and the "dbN" family wavelet functions used in this study.

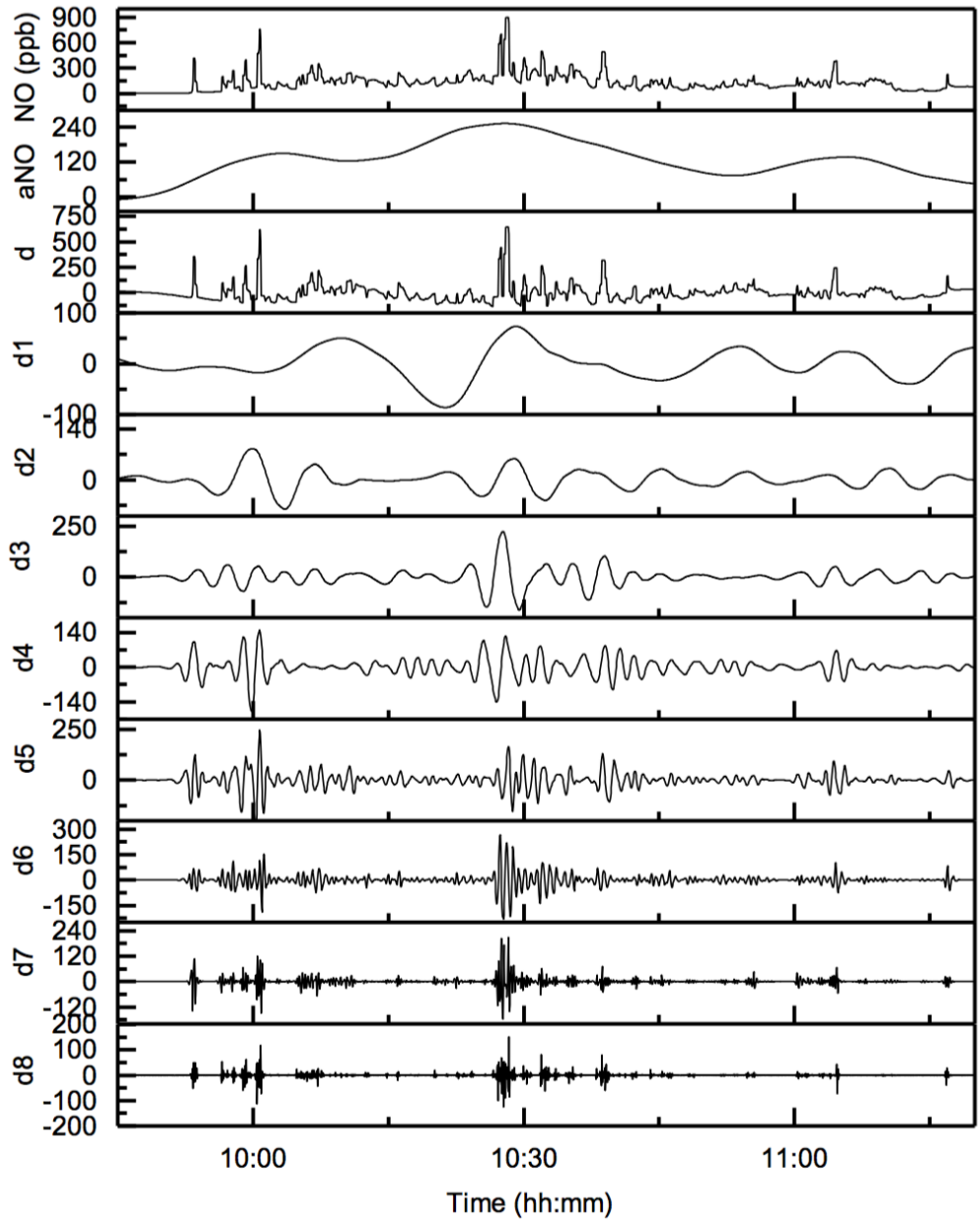

Figure S2. The original decomposition results of the WTM using db6 and eight decomposition levels for 6 November 2014. NO is the on-road mobile measurement concentration, aNO is the decomposed signal representing the trend in the background, and d (= d1 + d2 + … + d8) is the decomposed signal representing trends in vehicle emissions. d1–d8 are the decomposed signals representing variations at different frequencies.

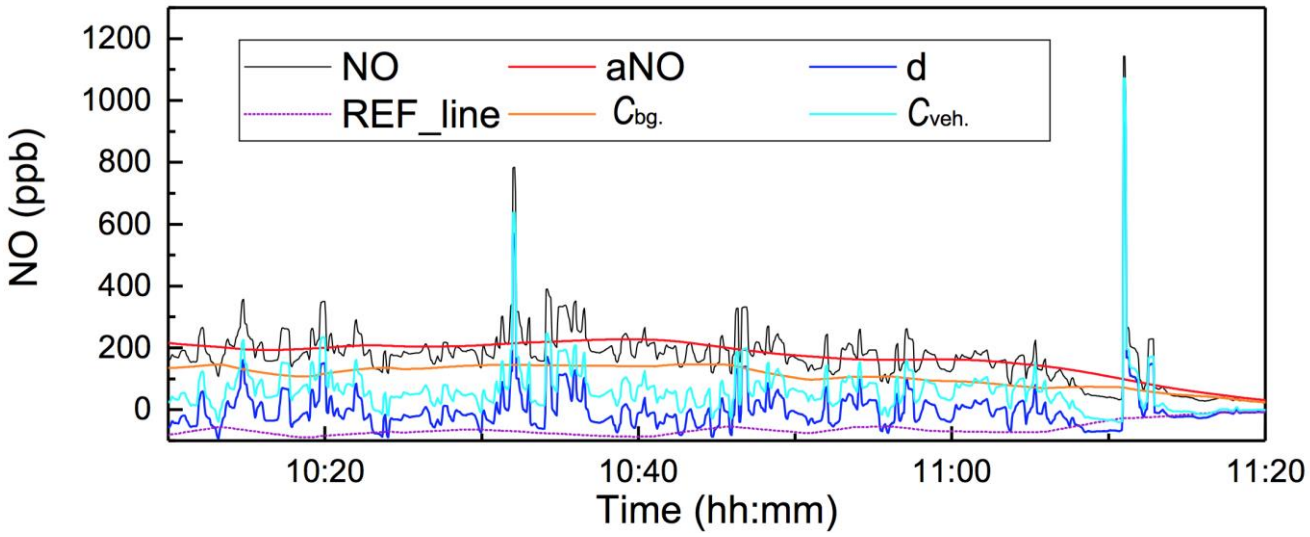

Figure S3. Moving the decomposed result of the WTM by taking REF_line as the reference line (example data from 8 November 2014). The black line represents the original measured on-road NO concentrations, the red line represents original high-frequency concentrations decomposed by the WTM, and the blue line represents original low-frequency concentrations decomposed by the WTM. The purple dotted line represents a moving reference line, which is a 5 min moving minimum of line "d". The orange line represents $C_{bg.}$ and was obtained by adding "aNO" to "REF_line", and the cyan line represents $C_{veh.}$ and was obtained by subtracting "REF_line" from "d". The principle of the selection of the REF_line is to keep the original shape of "aNO" and "d" but avoid negative values as much as possible.

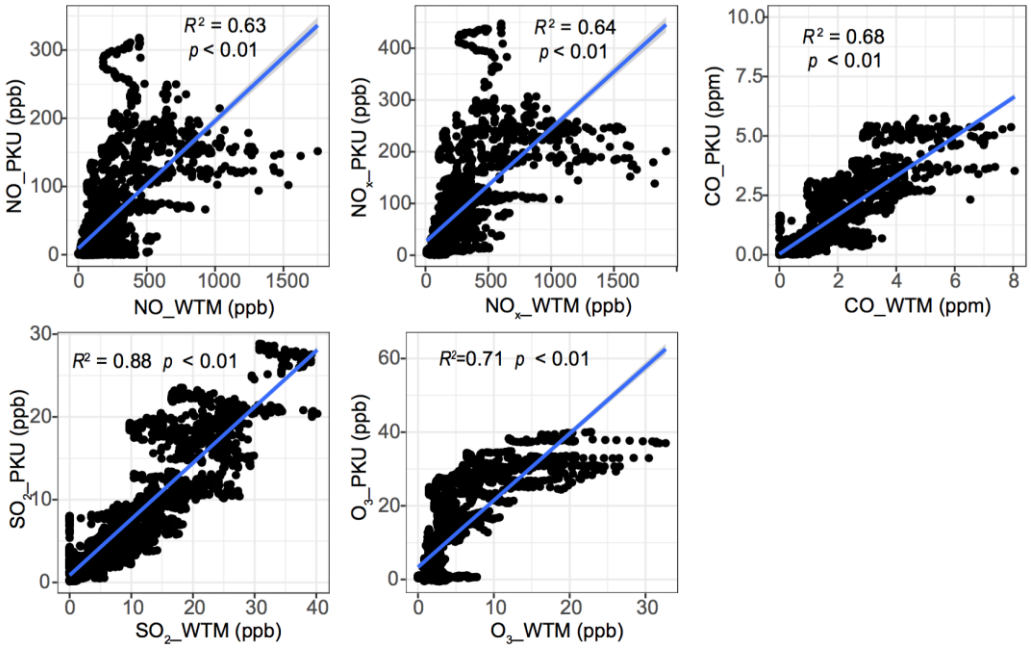

Figure S4. Correlations between the on-road background concentrations obtained by the wavelet transform method (WTM) and observations at the PKU site for NO, NO_x, BC, CO, SO_2, and O_3.

Table S1. Timing of on-road measurements made around the 4th Ring Road of Beijing.

Date (MM/DD_Night, Day)	Start time[a] (hh:mm)	End time[b] (hh:mm)	Driving duration[c] (h)
10/28_Day	10:17	11:55	1.63
10/29_Day	09:52	11:20	1.47
10/30_Day	20:06	21:13	1.12
10/31_Day	10:09	11:28	1.32
11/01_Day	09:53	11:18	1.42
11/02_Day	09:56	11:24	1.46
11/03_Day	10:05	11:17	1.20
11/04_Night	00:58	02:06	1.13
11/04_Day	09:56	11:29	1.55
11/05_Night	00:58	02:12	1.23
11/05_Day	09:56	11:10	1.23
11/06_Night	01:10	02:22	1.20
11/06_Day	09:58	11:10	1.20
11/07_Night	01:04	02:05	1.02
11/07_Day	09:58	11:08	1.17
11/08_Night	00:56	02:05	1.15
11/08_Day	09:58	11:12	1.23
11/09_Night	00:58	02:07	1.15
11/09_Day	09:58	11:07	1.15
11/10_Night	00:59	02:07	1.13
11/10_Day	09:59	11:08	1.15
11/11_Night	00:59	2:09	1.17
11/11_Day	10:01	11:12	1.18
11/12_Night	00:59	02:11	1.20
11/12_Day	09:58	11:06	1.13
11/13_Night	00:58	02:08	1.17
11/13_Day	09:57	11:18	1.35
11/14_Night	00:58	02:08	1.17
11/14_Day	09:57	11:45	1.80
11/15_Night	00:58	02:08	1.17
11/15_Day	10:00	11:28	1.47
11/16_Night	00:58	02:10	1.20
11/16_Day	10:02	11:19	1.28
11/17_Night	00:58	02:08	1.17
11/17_Day	09:57	11:29	1.53
11/18_Night	00:59	02:08	1.15
11/18_Day	10:03	12:03	2.00
11/19_Night	00:58	02:06	1.13
11/19_Day	09:57	011:16	1.32

11/20_Night	00:59	02:09	1.17
11/20_Day	09:57	11:38	1.68
11/21_Night	00:58	02:10	1.2
11/21_Day	10:02	11:59	1.95
11/22_Night	00:58	02:06	1.13

[a]Start-time is when the monitoring vehicle entered the 4th Ring Road.

[b]Start-time is when the monitoring vehicle left the 4th Ring Road.

[c]Driving duration is the length of time when the monitoring vehicle driving along the 4th Ring Road.