

# Long-term measurements of ground-level ozone in Windsor, Canada - Part I. temporal variations and trends

Xiaohong Xu<sup>1\*</sup>, Tianchu Zhang<sup>1</sup>, Yushan Su<sup>2</sup>

<sup>1</sup>Department of Civil and Environmental Engineering, University of Windsor, Windsor, Ontario, Canada

<sup>2</sup>Ontario Ministry of the Environment, Conservation and Parks, Toronto, Ontario, Canada

\*Corresponding author: email: [xxu@uwindsor.ca](mailto:xxu@uwindsor.ca)

## Supplemental Material

Figure S1. Long-term trends of NO, NO<sub>2</sub>, and NO/NO<sub>x</sub> in Windsor during 1996-2015.

Figure S2. Long-term trends at various percentile levels in smog season in Windsor, a) O<sub>3</sub>, and b) TO.

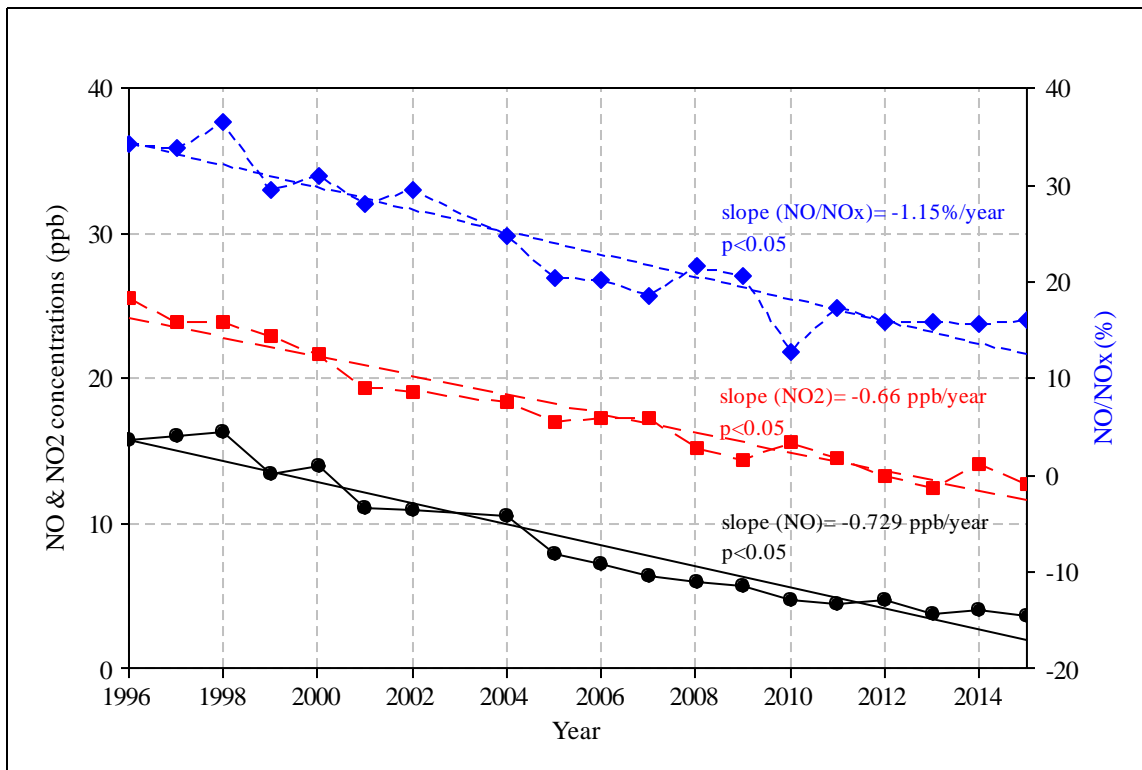
Figure S3. Long-term O<sub>3</sub> trends in the smog and non-smog season in Windsor 1996-2015.

Table S1. Numbers of invalid (flagged) or blank cells, and percentage of valid data in each year during 1996-2015 in Windsor for O<sub>3</sub>, NO, NO<sub>2</sub>, and NO<sub>x</sub>.

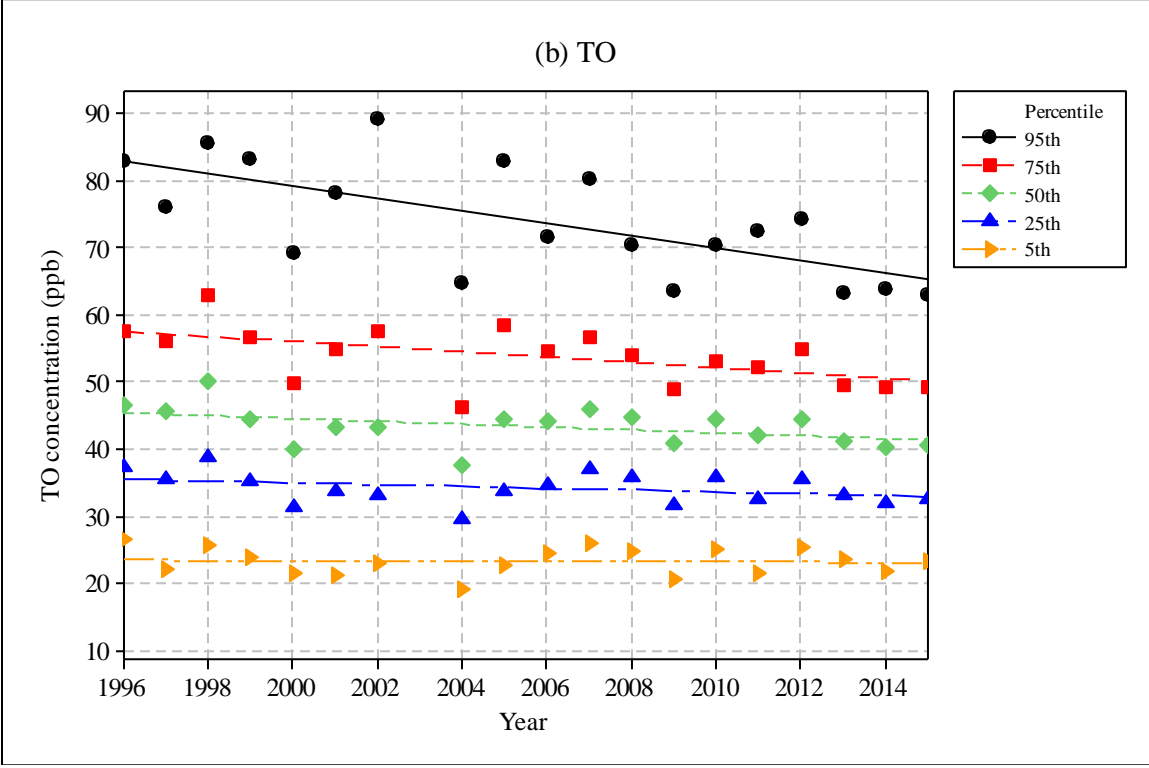
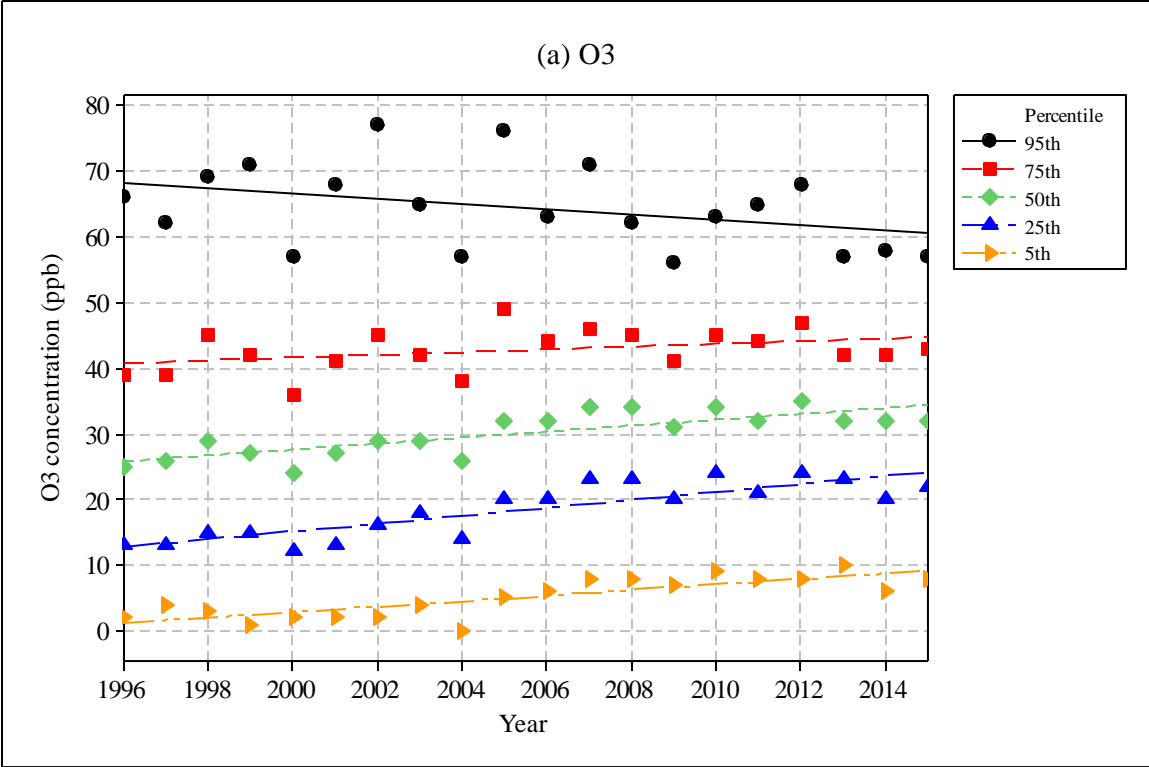
Table S2. Hour-of-day TO, O<sub>3</sub>, and DO<sub>3</sub> in Windsor during 1996-2015, a) concentrations, and b) slopes.

Table S3. Month-of-year TO, O<sub>3</sub>, and DO<sub>3</sub> in Windsor during 1996-2015, a) concentrations, and b) slopes.

Table S4. Slopes of long-term O<sub>3</sub> and TO trends at various percentile levels in all months, the smog season, and the non-smog season in Windsor during 1996-2015.



**Figure S1.** Long-term trends of NO, NO<sub>2</sub>, and NO/NO<sub>x</sub> in Windsor during 1996-2015.



**Figure S2.** Long-term trends at various percentile levels in smog season in Windsor, a) O<sub>3</sub>, and b) TO.

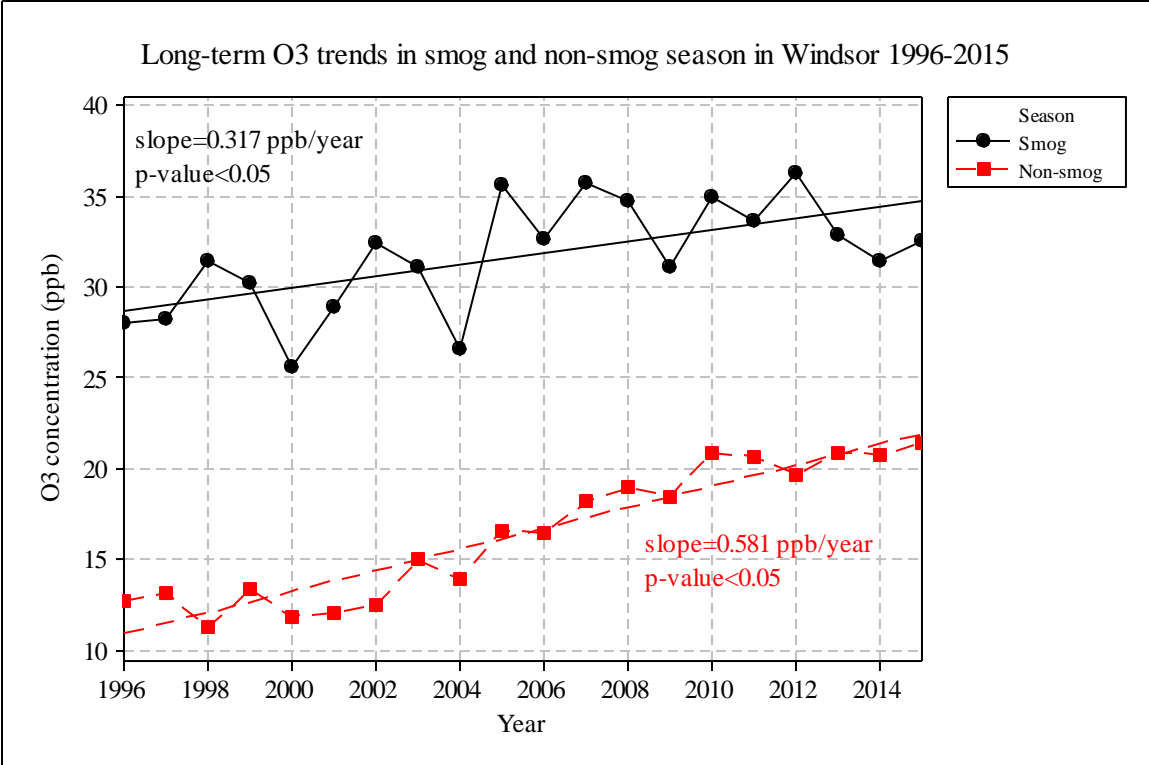


Figure S3. Long-term O<sub>3</sub> trends in the smog and non-smog season in Windsor 1996-2015.

**Table S1.** Numbers of invalid (flagged) or blank cells, and percentage of valid data in each year during 1996-2015 in Windsor for O<sub>3</sub>, NO, NO<sub>2</sub>, and NO<sub>x</sub>. Mark, oversized, reduce col width

Year	O <sub>3</sub>			NO			NO <sub>2</sub>			NO <sub>x</sub>		
	# of flag	# of blank	% valid	# of flag	# of blank	% valid	# of flag	# of blank	% valid	# of flag	# of blank	% valid
1996	9	53	99.3	12	44	99.4	9	53	99.3	6	58	99.3
1997	1	150	98.3	170	145	96.4	170	145	96.4	117	142	97.0
1998	1	89	99.0	87	24	98.7	87	24	98.7	87	24	98.7
1999	97	59	98.2	38	214	97.1	35	119	98.2	36	231	97.0
2000	98	23	98.6	209	23	97.4	209	23	97.4	209	23	97.4
2001	71	1	99.2	170	1	98.0	170	1	98.0	170	1	98.0
2002	153	1308	83.3	167	1308	83.2	167	1308	83.2	167	1308	83.2
2003	235	1	97.3	5320	25	39.0	5320	25	39.0	5343	2	39.0
2004	38	1	99.6	220	1	97.5	220	1	97.5	220	1	97.5
2005	748	7	91.4	205	7	97.6	199	7	97.6	199	7	97.6
2006	18	5	99.7	24	5	99.7	24	5	99.7	24	5	99.7
2007	48	3	99.4	14	3	99.8	14	3	99.8	14	3	99.8
2008	10	62	99.2	19	62	99.1	19	62	99.1	19	62	99.1
2009	48	1	99.4	316	1	96.4	316	1	96.4	316	1	96.4
2010	23	4	99.7	186	4	97.8	186	4	97.8	186	4	97.8
2011	26	0	99.7	20	0	99.8	20	0	99.8	20	0	99.8
2012	41	2	99.5	18	2	99.8	18	2	99.8	18	2	99.8
2013	23	15	99.6	39	15	99.4	39	15	99.4	39	15	99.4
2014	153	39	97.8	36	39	99.1	36	39	99.1	36	39	99.1
2015	31	1	99.6	14	1	99.8	14	1	99.8	14	1	99.8

**Table S2.** Hour-of-day TO, O<sub>3</sub>, and DO<sub>3</sub> in Windsor during 1996-2015, a) concentrations, and b) slopes. (in each column, darker colors indicate larger values). Mark, reformat as other tables

a) Concentrations				b) Slopes			
Hour	TO (ppb)	O <sub>3</sub> (ppb)	DO <sub>3</sub> (ppb)	Hour	TO (ppb/year)	O <sub>3</sub> (ppb/year)	DO <sub>3</sub> (ppb/year)
0	36.6	19.6	16.8	0	0.01	0.62	-0.59
1	35.3	18.7	16.5	1	-0.01	0.55	-0.55
2	34.5	18.2	16.2	2	-0.01	0.50	-0.51
3	33.7	17.5	16.0	3	-0.01	0.50	-0.48
4	32.9	16.4	16.4	4	0.00	0.44	-0.45
5	32.1	14.5	17.5	5	0.00	0.42	-0.44
6	31.9	13.3	18.5	6	0.03	0.40	-0.44
7	32.7	14.1	18.5	7	0.05	0.45	-0.46
8	34.4	17.4	16.9	8	0.05	0.50	-0.46
9	36.6	21.8	14.7	9	0.05	0.50	-0.45
10	39.1	26.1	12.9	10	0.05	0.50	-0.43
11	41.6	29.9	11.6	11	0.03	0.50	-0.42
12	43.8	32.8	10.9	12	0.01	0.44	-0.41
13	45.5	34.7	10.8	13	-0.02	0.40	-0.41
14	46.5	35.5	11.0	14	-0.02	0.42	-0.43
15	47.0	35.3	11.6	15	-0.02	0.46	-0.46
16	46.7	34.2	12.5	16	-0.01	0.50	-0.50
17	46.1	32.4	13.5	17	-0.02	0.53	-0.53
18	44.8	30.0	14.6	18	-0.02	0.57	-0.56
19	43.1	27.1	15.9	19	0.00	0.60	-0.58
20	41.3	24.2	17.0	20	0.00	0.63	-0.62
21	39.8	22.2	17.5	21	0.00	0.64	-0.63
22	38.5	20.8	17.6	22	0.00	0.67	-0.65
23	37.5	20.1	17.3	23	0.00	0.64	-0.63

**Table S3.** Month-of-year TO, O<sub>3</sub>, and DO<sub>3</sub> in Windsor during 1996-2015, a) concentrations, and b) slopes. (in each column, darker colors indicate larger values) Mark, reformat as other tables

a) Concentrations				b) Slopes			
Month	TO (ppb)	O <sub>3</sub> (ppb)	DO <sub>3</sub> (ppb)	Month	TO (ppb/year)	O <sub>3</sub> (ppb/year)	DO <sub>3</sub> (ppb/year)
1	32.4	13.7	18.8	1	0.28	0.63	-0.37
2	37.2	18.3	18.7	2	0.43	0.77	-0.36
3	42.0	25.2	16.5	3	0.15	0.58	-0.43
4	45.1	30.3	14.5	4	-0.10	0.60	-0.57
5	45.7	32.3	13.3	5	-0.18	0.46	-0.50
6	48.5	35.3	13.1	6	-0.39	0.27	-0.53
7	47.5	35.1	12.5	7	-0.24	0.33	-0.45
8	44.0	31.2	12.9	8	-0.21	0.36	-0.47
9	39.6	25.9	13.6	9	-0.34	0.35	-0.57
10	31.7	17.0	14.7	10	-0.17	0.40	-0.53
11	29.5	13.3	16.1	11	0.14	0.60	-0.48
12	28.6	11.5	17.2	12	0.16	0.54	-0.45

**Table S4.** Slopes of long-term O<sub>3</sub> and TO trends at various percentile levels in all months, the smog season, and the non-smog season in Windsor during 1996-2015.

Slope (ppb/year)		5th	25th	50th	75th	95th
O <sub>3</sub>	All months	0.171**	0.731**	0.635**	0.42**	-0.163
	Smog	0.395**	0.548**	0.395**	0.148	-0.447*
	Non-smog	0.124**	0.723**	0.771**	0.631**	0.467**
TO	All months	0.119	0.101	0.0751	-0.149*	-0.736**
	Smog	-0.022	-0.158*	-0.276**	-0.455**	-0.995**
	Non-smog	0.169	0.186**	0.219**	0.144	-0.125

\* significant at p <0.1; \*\* significant at p <0.05