

## Supplementary Materials:

Keelan McHugh<sup>1\*</sup>, Thomas Cummins<sup>1</sup> and Julian Aherne<sup>2</sup>

**Table S1.** Annual mean O<sub>3</sub> concentrations (µg/m<sup>3</sup>) at ambient air quality monitoring stations in Ireland for the period 2015–2019.

Station	2015	2016	2017	2018	2019	Average
BFT	43.2	41.3	45.0	41.3	40.8	42.3
CBR	57.7	50.9	55.7	57.7	56.3	55.7
CSK	53.7	47.1	52.7	53.8	49.0	51.3
CSL	42.9	31.7	34.7	40.4	46.8	39.3
EMO	54.2	49.8	57.0	56.7	51.3	53.8
KKT	59.6	57.1	57.7	58.8	58.0	58.2
LNV	54.4	46.9	48.5	50.3	53.5	50.7
MHD	76.0	71.8	75.8	74.8	73.9	74.5
RTM	42.6	36.3	44.2	47.1	46.7	43.3
SVL	54.8	43.5	52.4	55.5	54.4	52.1
VAL	71.3	69.1	65.7	67.5	72.4	69.2
Ireland	55.5	49.6	53.6	54.9	54.8	53.7

**Table S2.** Seasonal mean O<sub>3</sub> concentrations 2015–2019.

Station	Winter DJF	Spring MAM	Summer JJA	Autumn SON
BFT	37.8	54.6	41.9	35.3
CBR	56.4	68.4	51.0	47.1
CSK	51.8	61.2	48.2	43.8
CSL	36.2	51.6	34.6	34.3
EMO	57.1	65.4	48.3	45.2
KKT	58.3	71.8	51.0	51.8
LNV	53.6	59.7	46.6	43.0
MHD	78.4	84.9	64.7	69.9
RTM	43.7	52.6	39.1	36.9
SVL	54.4	62.7	46.7	44.4
VAL	74.4	79.6	57.7	65.6
Average	54.7	64.8	48.2	47.0
Median	54.4	62.7	48.2	44.4

**Table S3.** Monthly mean values for the period 2015–2019.

	BFT	CBR	CSK	CSL	EMO	KKT	LNV	MHD	RTM	SVL	VAL
Jan	35.9	55.8	50.9	32.5	56.8	52.9	55.2	78.4	41.3	54.7	74.8
Feb	44.5	60.3	54.4	39.3	61.3	64.5	56.3	80.5	46.8	57.2	76.5
Mar	48.6	67.0	60.5	48.1	67.3	70.4	58.4	85.1	52.1	61.9	78.9
Apr	58.1	69.2	61.7	55.6	66.6	74.8	60.1	86.3	52.9	65.0	81.2
May	57.4	69.1	61.4	51.2	62.2	70.1	60.6	83.3	53.0	61.1	78.6
Jun	47.0	59.6	54.2	45.2	52.2	59.5	52.0	71.5	45.2	54.4	66.6
Jul	41.1	46.8	45.3	32.2	46.1	46.9	44.6	59.4	34.6	43.3	51.1
Aug	38.0	46.7	45.1	26.3	46.5	46.6	43.2	63.3	37.5	42.4	55.3
Sep	38.8	47.4	43.9	32.8	43.7	49.9	41.6	67.5	37.4	42.8	60.8
Oct	35.2	47.1	43.5	33.7	45.6	53.3	43.8	70.0	36.6	43.7	69.1
Nov	32.2	46.8	44.0	36.4	46.2	52.0	43.7	72.3	36.7	46.6	66.9

Dec	32.8	53.2	50.2	36.8	53.1	57.5	49.4	76.3	42.9	51.3	71.9
-----	------	------	------	------	------	------	------	------	------	------	------

**Table S4.** Long-term trends using Mann-Kendall test during 10-year period (2005–2019), for chosen percentiles of data for each station, the p-value with significance is shown.

Percentile	2	5	10	25	50	75	90	95	98
<b>BFT</b>	0.30	0.19	0.15	0.15	0.24	0.19	0.08	0.19	0.19
<b>CBR</b>	0.24	0.43	0.24	*0.04	0.07	**0.01	**0.01	0.08	0.08
<b>CSK</b>	0.15	0.15	0.24	0.30	0.24	0.19	0.36	0.43	0.30
<b>EMO</b>	*0.04	*0.02	*0.02	0.08	*0.02	*0.02	0.15	0.30	0.36
<b>KKT</b>	0.24	0.36	0.36	0.36	0.24	0.30	0.24	0.36	0.50
<b>LNV</b>	0.11	0.15	0.19	0.36	0.24	0.30	0.50	0.43	0.15
<b>MHD</b>	0.19	0.03	0.36	0.43	0.15	*0.04	0.08	0.15	0.19
<b>RTM</b>	0.24	0.03	0.08	***0.00	**0.01	*0.04	0.05	0.08	0.19
<b>VAL</b>	0.43	0.36	0.30	0.50	0.19	0.15	0.19	0.24	0.24

**Table S5.** Long-term trends using Mann-Kendall test during 15-year period (2005–2019), for chosen percentiles of data for each station, the p-value with significance is shown.

Percentile	2	5	10	25	50	75	90	95	98
<b>BFT</b>	*0.05	0.19	**0.01	*0.03	0.30	0.46	0.77	0.32	0.59
<b>EMO</b>	**0.01	*0.02	*0.05	0.12	0.06	0.11	0.66	0.84	1.00
<b>KKT</b>	0.73	0.84	0.62	0.65	1.00	0.77	1.00	1.00	0.84
<b>LNV</b>	0.11	0.07	*0.02	0.84	0.09	0.32	0.23	0.14	0.37
<b>MHD</b>	***0.00	*0.04	0.32	0.62	0.88	1.00	0.69	0.55	0.46
<b>RTM</b>	0.23	0.16	0.18	0.06	0.46	0.80	0.84	0.92	1.00
<b>VAL</b>	0.43	0.52	1.00	0.92	0.84	1.00	0.43	0.32	0.37

**Table S6.** Monthly long-term trend slope with significance for 10-years (2010–2019).

	<b>BFT</b>	<b>CBR</b>	<b>CSK</b>	<b>EMO</b>	<b>KKT</b>	<b>LNV</b>	<b>MHD</b>	<b>RTM</b>	<b>VAL</b>
<b>Jan</b>	0.88	1.95	1.07	1.70+	0.00	0.43	0.99*	0.80	2.22
<b>Feb</b>	1.36*	1.21+	1.60	1.36*	1.01+	0.51+	0.63	1.74*	1.80*
<b>Mar</b>	0.50	1.66*	1.56*	2.00	-0.05	0.69+	0.95+	1.40+	1.21
<b>Apr</b>	0.45	-0.59	-0.14	0.07	-0.53	-0.20	-0.28	0.69	0.87
<b>May</b>	-0.26	0.36	-0.69	0.64	0.10	-0.77	0.06	0.64	1.35
<b>Jun</b>	0.25	1.21***	0.68	0.97	0.55	-0.16	0.71	0.50	0.82
<b>Jul</b>	0.31	0.37	-0.08	1.20	0.03	-0.52	-0.06	-0.42	-0.40
<b>Aug</b>	0.58	-0.12	-0.10	0.68	-0.14	-0.41	0.10	-0.23	-0.39
<b>Sep</b>	-0.21	-0.42	-0.67	0.03	-0.55	-1.25	-0.39	-0.22	-1.25+
<b>Oct</b>	0.31	0.38	-0.51	0.81	0.45	0.01	0.42	0.28	-0.48
<b>Nov</b>	-0.61	0.02	-0.34	0.36	0.02	-0.48	-0.63	-0.10	-0.81*
<b>Dec</b>	0.06	0.99	1.13	0.94	-0.05	0.15	0.34	0.68	0.35

**Table S7.** Monthly long-term trend slope with significance for 15-years (2005–2019).

	<b>BFT</b>	<b>EMO</b>	<b>KKT</b>	<b>LNV</b>	<b>MHD</b>	<b>RTM</b>	<b>VAL</b>
<b>Jan</b>	0.82	0.77	-0.12	0.64	0.60	0.21	0.68
<b>Feb</b>	1.03***	1.20*	0.83***	0.96***	0.52*	0.84	0.71
<b>Mar</b>	0.06	0.30	-0.03	0.22	0.06	0.17	-0.30
<b>Apr</b>	-0.12	-0.25	-0.31	0.00	-0.41	-0.12	-0.33
<b>May</b>	-0.08	0.22	-0.12	-0.16	-0.23	-0.13	-0.42
<b>Jun</b>	-0.01	0.27	-0.14	-0.05	-0.16	-0.22	-0.13
<b>Jul</b>	0.09	0.38	-0.30	-0.27	-0.32	-0.44	-0.67
<b>Aug</b>	0.58+	0.75***	0.40	0.26	0.41	0.43	0.34
<b>Sep</b>	0.06	0.05	-0.19	-0.03	-0.09	-0.09	-0.05
<b>Oct</b>	0.25	0.48	0.14	0.43+	0.12	0.30	-0.10

Nov	-0.31	0.07	-0.46	-0.42	-0.29	-0.13	-0.35
Dec	0.50	0.98*	0.26	0.77	0.62*	0.89	0.39

Table S8. Significance values for 10-year long-term trends.

	BFT	CBR	CSK	EMO	KKT	LNV	MHD	RTM	VAL
January	0.35	0.13	0.17	0.07+	0.93	0.38	0.05*	0.22	0.14
February	0.03*	0.08 +	0.17	0.01*	0.01+	0.07+	0.48	0.02*	0.03*
March	0.41	0.04*	0.02*	0.11	0.96	0.06+	0.05+	0.05+	0.36
April	0.73	0.34	0.78	0.90	0.15	0.20	0.26	0.40	0.60
May	0.64	0.64	0.79	0.22	0.78	0.26	0.84	0.34	0.49
June	0.17	0.00***	0.47	0.11	0.17	0.89	0.22	0.70	0.25
July	0.45	0.19	0.90	0.10	0.97	0.22	0.77	0.77	0.35
August	0.41	0.97	0.97	0.14	0.90	0.47	0.91	0.73	0.48
September	0.75	0.24	0.30	0.95	0.33	0.10	0.70	0.71	0.07+
October	0.62	0.71	0.43	0.21	0.14	0.92	0.60	0.41	0.54
November	0.59	0.84	0.83	0.40	0.99	0.20	0.66	0.99	0.01*
December	0.73	0.55	0.42	0.39	0.91	0.82	0.58	0.64	0.55

Table S9. Significance values for 15-year long-term trends.

	BFT	CBR	CSK	EMO	KKT	LNV	MHD	RTM	VAL
January	0.35	0.13	0.17	0.07+	0.93	0.38	0.05*	0.22	0.14
February	0.03*	0.08 +	0.17	0.01*	0.01+	0.07+	0.48	0.02*	0.03*
March	0.41	0.04*	0.02*	0.11	0.96	0.06+	0.05+	0.05+	0.36
April	0.73	0.34	0.78	0.90	0.15	0.20	0.26	0.40	0.60
May	0.64	0.64	0.79	0.22	0.78	0.26	0.84	0.34	0.49
June	0.17	0.00***	0.47	0.11	0.17	0.89	0.22	0.70	0.25
July	0.45	0.19	0.90	0.10	0.97	0.22	0.77	0.77	0.35
August	0.41	0.97	0.97	0.14	0.90	0.47	0.91	0.73	0.48
September	0.75	0.24	0.30	0.95	0.33	0.10	0.70	0.71	0.07+
October	0.62	0.71	0.43	0.21	0.14	0.92	0.60	0.41	0.54
November	0.59	0.84	0.83	0.40	0.99	0.20	0.66	0.99	0.01*
December	0.73	0.55	0.42	0.39	0.91	0.82	0.58	0.64	0.55

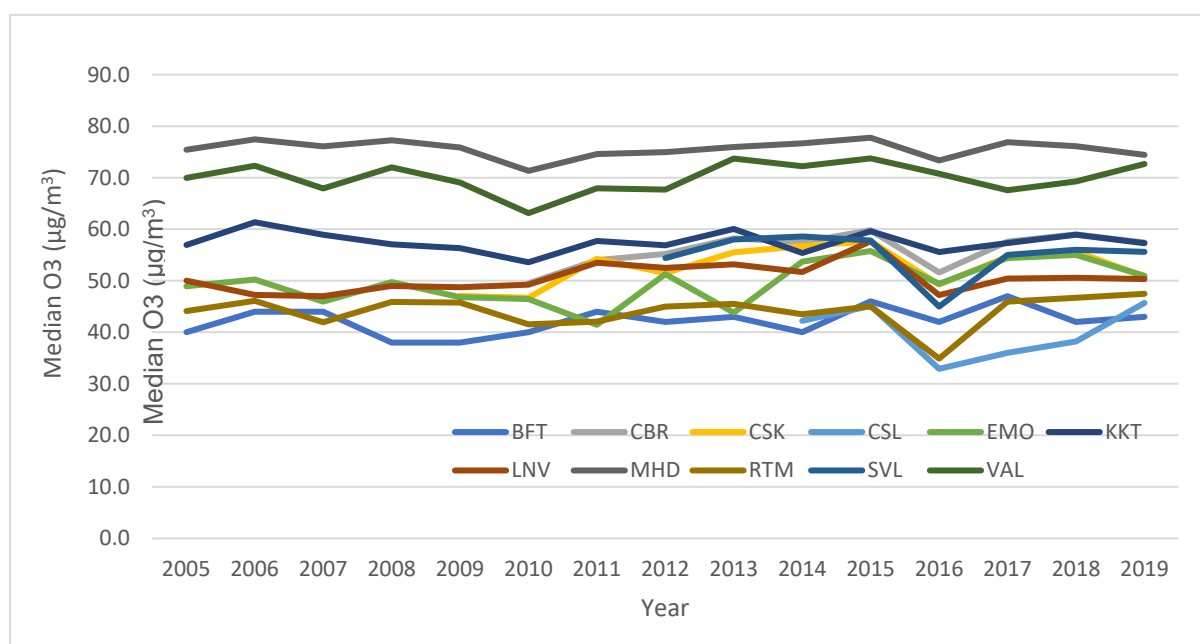
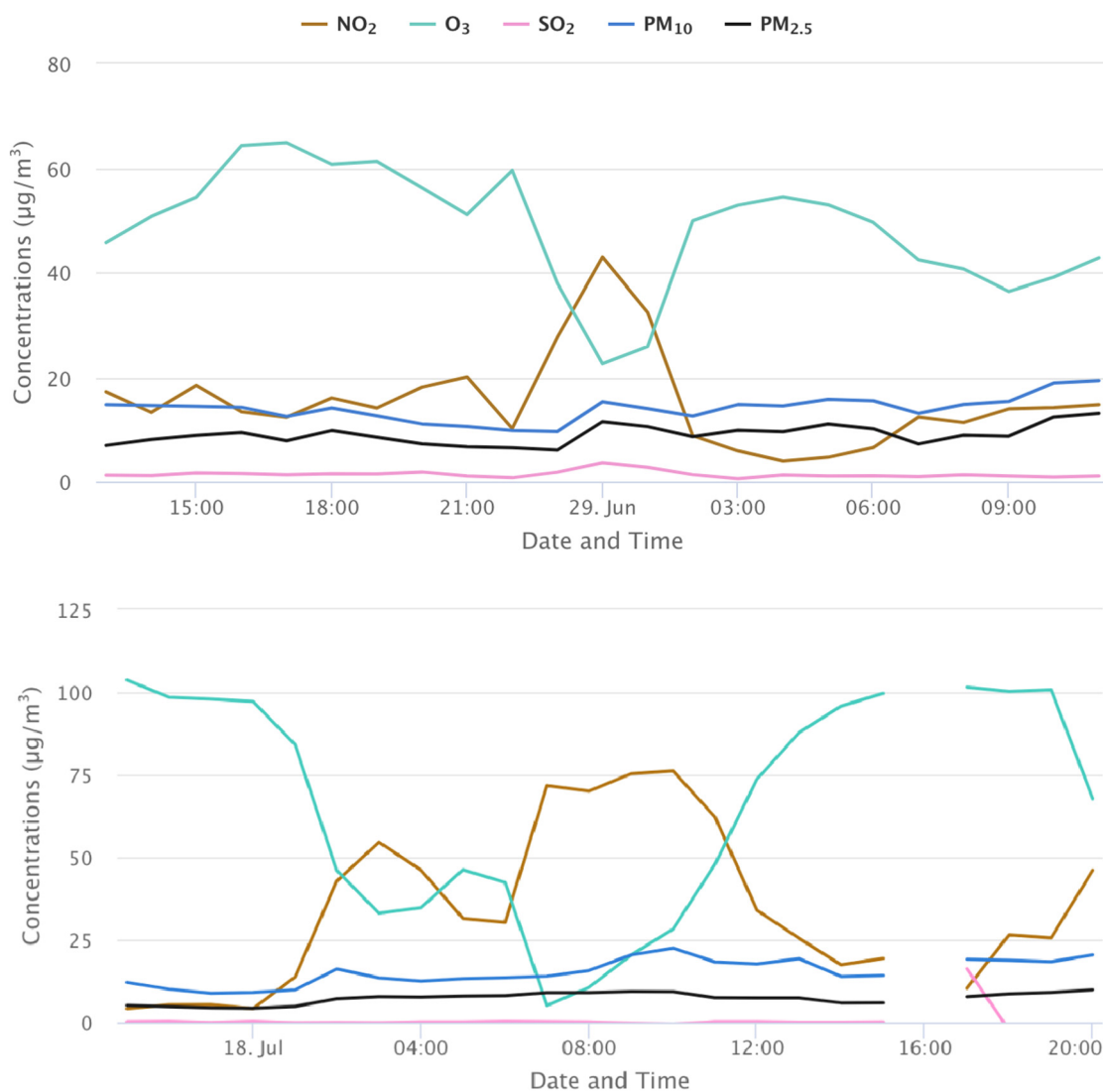


Figure S1. Annual median O3 concentrations for all stations over 2005–2019.51.



**Figure S2.** Gaseous and particulate concentrations for the urban station RTM, during summer 2021 (top graph 28–29 of June; bottom graph 17–18 July). Negative relationship between NO<sub>2</sub> and O<sub>3</sub> visible (screenshot source: <https://airquality.ie/station/EPA-22>).