Supplementary information

Climate Change Penalty to Ozone Air Quality: Review of Current Understandings and Knowledge Gaps

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Table S1 Model projections of changes in summertime or annual mean ozone air quality due to climate change only, adapted and updated from Jacob and Winner [1] and Fiore et al. [2] to report results from studies since 2015

Notation in Figure 1[a]	Reference	Domain	Climate scenario [b]	Time horizon and averaging period	Metric reported	Surface ozone change [ppb] [c]
A	Fann et al. [3]	US	RCP6.0, RCP8.5	(2025-2035) vs (1995-2005)	May-September mean MDA8 [d]	Midwest US and the Great Plains: 0~2.6 (RCP6.0), 0~5.4 (RCP8.5) Southwestern US: 0~1.64 (RCP6.0), 0~0.8 (RCP8.5)
B	Garcia-Menendez et al. [4]	US	POL3.7, POL4.5	(2035-2065) and (2085-2115) vs (1980-2010)	Population-weighted annual mean MDA8	US (2035-2065): ~0.5 (POL3.7), ~0.5 (POL4.5) US (2085-2115): ~0.7 (POL3.7), ~0.5 (POL4.5)
C	Gonzalez-Abraham et al. [5]	US	A1B	(2045-2054) vs (1995-2004)	JJA MDA8	Northwestern US: -1 Southwestern US: 0.4 Central and Southern US: 4.3-4.5 Midwest US: 7.2 Northeastern US and Southeastern US: 6.1-6.6
D	Val Martin et al. [6]	US	RCP4.5, RCP8.5	2050 decadal mean vs 2000 decadal mean	Annual mean MDA8	Northeastern US: ~2.5 (RCP4.5), ~4 (RCP8.5) Southern and Southeastern US: ~1.5 (RCP4.5), ~3 (RCP8.5) Midwest US: ~2 (RCP4.5), ~1 (RCP8.5) Western US: ~1 (RCP4.5), ~1.5 (RCP8.5)
E	He et al. [7]	US	A1B, A1Fi	(2048 to 2052) vs (1995 to 1999)	JJA MDA8 [e]	Northeastern US: -0.5 (A1B), 4.2 (A1Fi) Southeastern US: 1.6 (A1B), 4 (A1Fi) Midwest US: 0.9 (A1B), 5.8 (A1Fi) California: -0.9 (A1B), 2.5 (A1Fi) Texas: -0.6 (A1B), 3.4 (A1Fi)

F	Nolte et al. [8]	US	RCP4.5, RCP6.0, RCP8.5	(2025-2035) vs (1995-2005)	JJA MDA8	All US: 0.2 (RCP4.5), 0.1 (RCP6.0), 1.1 (RCP8.5) Northeastern US: 0.6 (RCP4.5), 0.5 (RCP6.0), 1.8 (RCP8.5) Southern and Southeastern US: -0.4 (RCP4.5), -0.5~-0.4 (RCP6.0), 0.2~0.4 (RCP8.5) Midwest US: 0.2~0.7 (RCP4.5), 0.4~1.0 (RCP6.0), 2.1~2.9 (RCP8.5) Western US: -0.2~1.3 (RCP4.5), -0.1~0.5 (RCP6.0), 0.2~2.0 (RCP8.5)
G	Rieder et al. [9]	Eastern US	RCP4.5	(2026-2035), (2046-2055), and (2091-2100) vs (2006-2015)	JJA MDA8	Eastern US (2026-2035): 1 Eastern US (2046-2055): 1 Eastern US (2091-2100): 2
H	Rieder et al. [10]	US	RCP4.5, RCP8.5	(2096-2100) vs (2001-2005)	JJA MDA8	Northeastern US: ~2 (RCP4.5), +1-4 (RCP8.5) Western US: ~-1 (RCP4.5), ~-2 (RCP8.5) Southeastern US: ~-3 (RCP4.5), ~-4 (RCP8.5)
I	Lee et al. [11]	Northern East Asia	A2	(2046-2055) vs (2016-2025)	Annual MDA8	Northern East Asia: -8.1~-1.3
J	Pommier et al. 2018	India	RCP8.5	(2045-2055) vs (2006-2015)	Annual mean	Northern India: +2 Southern India: -1.4
K	Lacressonniere et al. [12]	Europe	+2°C (reached along 2031-2080 under RCP4.5)	(2031-2080) vs (1971-2000)	SOMO35 [f]	Europe: -200~1000 [ppb · day] [g]
L	Fortems-Cheiney et al. [13]	Europe	+2°C (reached	(2028-2057) vs (1971-	Annual mean	Europe: -1.1 (2°C), 2.2 (3°C)

			along 2028-2057 under RCP4.5), +3°C (reached along 2040-2069 under RCP8.5)	2000), (2040-2069) vs (1971-2000)		
M	Schnell et al. [14]	Global	RCP8.5	2100 decadal mean vs 2000 decadal mean	JJA MDA8	Western North America: -2.1~5 [h] Eastern North America: -2.2~7.1 [h] Northern Europe: -3.9~2 [h] Southern Europe: -1.3~9.3 [h] Northern East Asia: -2.5~3.1 [h] Southern East Asia: -4.7~-0.8 [h]
N	Glotfelty et al. [15]	Global	A1B	2050 vs 2001	Annual MDA8	Western North America: 0 ~ 3 Eastern North America: -0.8~0 Northern Europe: -1.4 ~ 1.6 Southern Europe: 0.4 ~ 2 East Asia: 0~3 South Asia: 0.8 ~ 1.6 Global: 0.6

[a] Results are shown in Figure 1 and denoted with alphabets.

[b] RCP4.5, RCP6.0, and RCP8.5, are different climate scenarios by which the global mean radiative forcings reach 4.5, 6.0, and 8.5 W m^{-2}, respectively, in the year 2100 [16]. POL3.7 and POL4.5 denote stabilization scenarios that assume a uniform global carbon tax to achieve total radiative forcings of 3.7 and 4.5 W m^{-2} by 2100, respectively [4]. A1B, A1FI, and A2 are socio-economic scenarios for GHG emissions used in the IPCC Fourth Assessment Report [17] that represented rapid economic growth and efficient introduction of new technologies, with differences in technological emphasis.

[c] Concentration changes reported in ppb unless otherwise specified.

[d] Maximum daily 8-h average ozone concentration.

[e] JJA denotes June, July, and August.

[f] SOMO35 is defined as the cumulative exceedance of the daily maximum 8-h averaged ozone over 35 ppb integrated over a year.

[g] Ranges reported is the range projected by four regional models.

[h] Ranges reported are the ranges projected by four global models.

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