Supplemental Information for:

Air pollution inequality in the Denver metroplex and its relationship to historical redlining

Alexander C. Bradley.[1, 2]; Bart E. Croes[2]; Colin Harkins[2, 3]; Brian C. McDonald[3]; and Joost A. de Gouw*[1, 2]

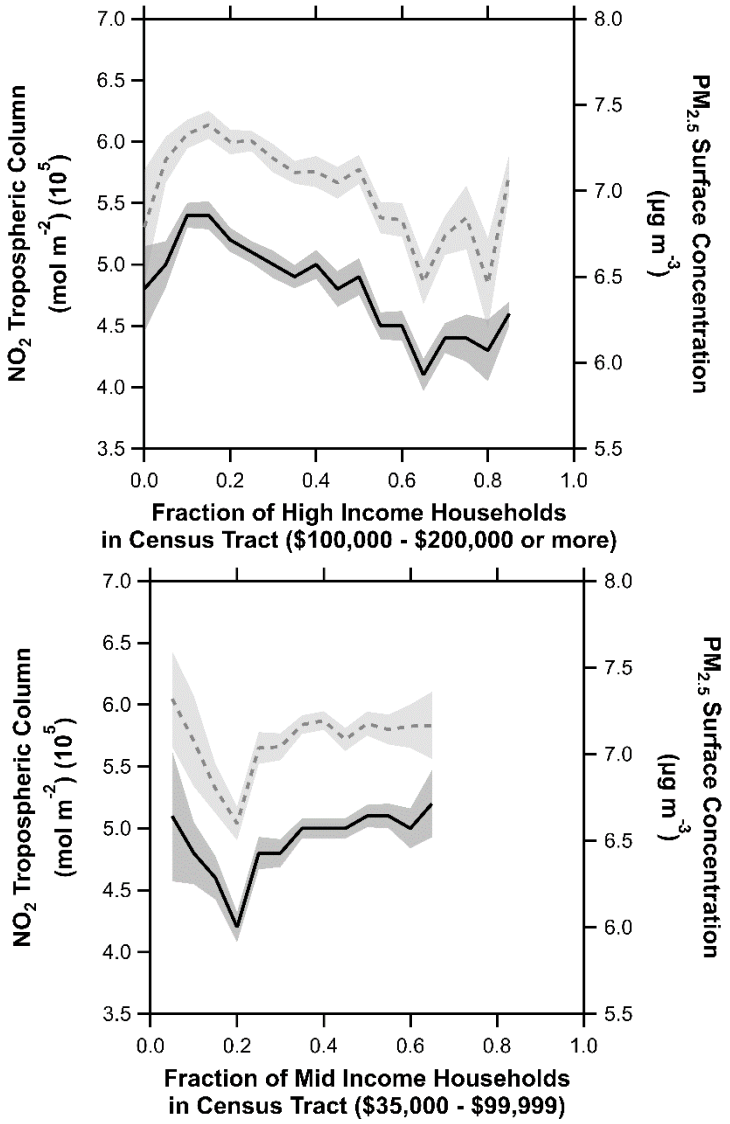
1. University of Colorado Boulder, Boulder, CO 80309, USA
2. Cooperative Institute for Research in Environmental Sciences, Boulder, CO 80309, USA
3. Chemical Sciences Laboratory, National Oceanic and Atmospheric Administration, Boulder, CO 80305, USA

*Joost.deGouw@colorado.edu

Contents:

Figure S1. Pollution inequality based on income plots:

Values for the fraction of low/mid/high income households were calculated using 2020 census data at the census tract level. NO_2 tropospheric column averages were calculated using 0.01º x 0.01º physically oversampled TROPOMI data, $PM_{2.5}$ surface concentration averages were calculated using a satellite-derived model produced by van Donkelaar et. al. Income brackets were determined following federal poverty guidelines for a family of 4 (~$35,000 / year) and an even split between the remaining population for mid and high income.



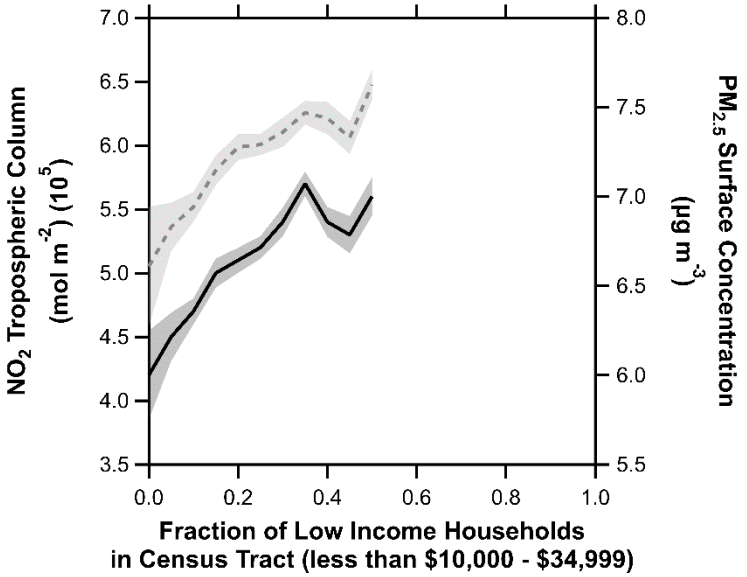


Table S2. Pollution inequality based on income table:

Spearman rank-order correlations were calculated for the low, mid, and high income groups described previously and summarized in the table below. Total household (Hshld) count and fraction of total are also presented.

	Spearman Coefficients		Pop. Stats	
Income Level	**NO_2**	**$PM_{2.5}$**	**Tot. Hshld.**	**Hshld. Frac.**
Low	0.44	0.39	190,336	18.8%
Mid	0.19	0.14	420,453	41.4%
High	-0.39	-0.32	403,755	39.8%

Table S3. Spearman coefficients for all redlined cities.

Spearman coefficients were calculated using NO_2 tropospheric column data for every city that underwent the practice of redlining. This distribution of this data is presented in **Figure 3** in the main text, but the authors believed the raw data would be of interest.

Urbanized Area	Number of Census Tracts	NHW	BAA	AAA	AIAN	NHPI	SOR	TMR	HL
Akron, OH	103	-0.72	0.68	0.28	0.10	-0.10	0.46	0.27	0.67
Albany--Schenectady, NY	102	-0.25	0.32	0.18	-0.11	-0.15	-0.19	-0.26	0.08
Altoona, PA	13	0.63	-0.63	0.45	-0.08	-0.15	-0.37	-0.49	-0.27
Amarillo, TX	38	-0.75	0.61	0.15	0.04	-0.32	0.40	-0.15	0.74
Dallas--Fort Worth--Arlington, TX	1143	-0.21	-0.03	-0.06	-0.14	-0.13	-0.01	-0.30	0.16
Asheville, NC	16	-0.25	0.74	0.13	-0.41	0.04	0.45	-0.06	-0.57
Atlanta, GA	1039	-0.37	0.47	-0.36	0.06	-0.08	-0.17	-0.26	-0.29
Atlantic City, NJ	13	-0.74	0.46	0.04	0.33	0.32	0.38	-0.23	0.43
Chicago, IL--IN	1850	-0.45	0.29	-0.34	0.02	-0.03	-0.01	-0.22	0.07
Austin, TX	225	0.01	0.04	-0.08	-0.10	0.03	-0.04	-0.24	-0.01
Baltimore, MD	477	-0.08	0.05	-0.30	0.34	-0.01	-0.10	0.13	0.17
Battle Creek, MI	10	-0.66	0.67	-0.59	0.43	0.50	0.79	0.59	0.77
Bay City, MI	9	-0.63	0.58	-0.38	0.48	0.00	0.43	0.43	0.47
Beaumont, TX	22	-0.58	0.39	-0.62	-0.46	0.16	-0.32	-0.25	0.66
Boston, MA--NH--RI	786	-0.34	0.34	0.15	0.10	0.03	0.08	0.17	0.24
New York--Newark, NY--NJ--CT	4210	-0.30	0.10	0.19	0.13	0.14	0.29	0.27	0.05
Allentown, PA--NJ	81	-0.47	0.38	-0.13	0.18	0.08	0.30	-0.19	0.43
Binghamton, NY--PA	23	-0.56	0.53	0.35	0.51	-0.16	0.04	0.02	0.52
Birmingham, AL	133	-0.15	0.12	-0.01	-0.15	-0.13	-0.12	-0.11	-0.11
Buffalo, NY	208	-0.77	0.78	0.48	0.14	0.10	0.42	0.15	0.59
Philadelphia, PA--NJ--DE--MD	1172	-0.43	0.35	-0.05	0.13	0.03	0.20	-0.08	0.27
Canton, OH	48	-0.61	0.65	-0.37	0.40	-0.05	0.58	0.43	0.52
Charleston, WV	17	-0.62	0.68	-0.36	0.22	-0.02	0.56	0.55	0.06
Charlotte, NC--SC	274	-0.37	0.43	-0.15	0.08	0.03	-0.20	-0.35	0.09
Chattanooga, TN--GA	50	-0.60	0.60	-0.36	0.05	-0.08	0.06	-0.43	0.31
Cleveland, OH	446	-0.58	0.53	-0.24	0.18	-0.04	0.15	-0.06	0.11
Columbia, SC	90	0.10	-0.07	-0.06	-0.31	-0.28	-0.30	-0.15	-0.22
Columbus, GA--AL	46	-0.69	0.72	-0.54	-0.13	-0.02	-0.06	-0.47	-0.38
Columbus, OH	311	-0.51	0.60	-0.51	0.25	0.04	0.25	0.26	0.25
Omaha, NE--IA	177	-0.35	0.02	-0.48	0.43	0.09	0.12	-0.09	0.71
Cincinnati, OH--KY--IN	320	-0.20	0.28	-0.25	-0.04	-0.23	0.08	-0.02	-0.11
Dallas--Fort Worth--Arlington, TX	1143	-0.21	-0.03	-0.06	-0.14	-0.13	-0.01	-0.30	0.16
Davenport, IA--IL	58	-0.34	0.16	-0.01	-0.28	0.07	0.12	-0.19	0.42
Dayton, OH	129	-0.14	0.13	-0.09	0.36	0.21	0.21	0.46	0.42
Decatur, IL	17	-0.42	0.35	-0.23	-0.10	0.24	-0.19	0.16	0.30
Denver--Aurora, CO	530	-0.22	0.16	-0.39	0.34	-0.12	-0.02	-0.33	0.31
Des Moines, IA	69	-0.60	0.57	0.13	0.41	0.10	-0.01	0.43	0.57
Detroit, MI	1051	-0.46	0.45	-0.51	0.14	-0.04	0.14	-0.09	-0.19
Dubuque, IA--IL	11	-0.41	0.56	-0.42	0.13	-0.08	0.17	0.28	0.56
Duluth, MN--WI	17	-0.49	0.42	0.52	0.54	0.08	0.31	0.49	0.03
Durham, NC	53	-0.49	0.63	-0.50	-0.11	0.07	-0.13	-0.35	0.14
St. Louis, MO--IL	415	-0.63	0.63	-0.26	0.09	-0.13	0.22	-0.32	-0.11
El Paso, TX--NM	107	-0.60	-0.45	-0.58	-0.07	-0.11	-0.35	-0.64	0.62
Elmira, NY	2	1.00	-1.00	1.00	-1.00	0.00	1.00	-1.00	-1.00
Evansville, IN--KY	32	0.05	-0.10	0.35	-0.16	0.09	0.06	-0.21	-0.07
Flint, MI	68	0.18	-0.21	0.47	0.07	-0.06	0.09	0.47	0.33
Fort Wayne, IN	59	0.27	-0.22	-0.02	0.04	-0.07	0.07	0.10	-0.32
Fresno, CA	127	-0.51	0.29	-0.35	0.30	-0.10	-0.19	-0.57	0.67
Grand Rapids, MI	97	-0.31	0.09	0.29	-0.03	-0.06	-0.06	-0.13	0.40
Greensboro, NC	60	-0.29	0.29	-0.38	0.16	0.28	-0.22	-0.05	0.21
Harrisburg, PA	62	-0.29	0.20	-0.13	0.04	0.10	0.24	-0.03	0.39
Hartford, CT	168	-0.46	0.43	-0.01	0.19	-0.11	0.23	-0.44	0.42
Springfield, MA--CT	87	-0.40	0.64	-0.07	0.24	0.05	0.30	-0.15	0.32
Huntington, WV--KY--OH	33	-0.31	0.31	-0.18	0.26	0.01	0.01	0.27	0.25
Indianapolis, IN	271	-0.28	0.28	-0.59	0.28	-0.09	0.09	0.17	0.37
Jackson, MI	13	-0.76	0.70	-0.32	0.47	-0.41	0.14	0.37	0.23
Jackson, MS	48	-0.43	0.42	-0.54	0.21	0.07	-0.19	-0.11	-0.25
Johnstown, PA	9	-0.25	0.30	0.42	0.27	0.01	-0.07	-0.22	0.20
Kalamazoo, MI	38	-0.02	-0.04	-0.53	0.34	0.04	-0.05	0.27	0.45
Kansas City, MO--KS	333	-0.43	0.39	-0.25	0.04	0.02	0.00	-0.22	0.25
Kenosha, WI--IL	24	0.37	-0.19	0.27	-0.05	-0.15	-0.21	-0.57	-0.33
Knoxville, TN	82	-0.48	0.62	0.02	0.23	-0.08	0.11	0.11	0.12
Lancaster, PA	34	-0.67	0.64	-0.15	0.22	-0.01	0.38	0.34	0.69
Lansing, MI	69	-0.35	0.21	-0.44	0.32	0.11	0.30	0.62	0.57
Lexington-Fayette, KY	55	-0.31	0.34	-0.50	0.23	-0.07	0.06	0.02	0.23
Lima, OH	15	-0.38	0.33	-0.55	-0.01	-0.50	0.11	0.31	0.02
Lincoln, NE	54	-0.51	0.59	0.17	0.71	0.18	0.39	0.37	0.57
Little Rock, AR	51	-0.32	0.41	-0.41	0.12	0.18	0.07	0.09	-0.02
Lorain--Elyria, OH	28	0.42	-0.05	0.32	-0.05	0.10	0.27	0.30	-0.56
Los Angeles--Long Beach--Anaheim, C	2769	-0.62	0.02	-0.16	0.03	-0.13	-0.24	-0.53	0.48
Louisville/Jefferson County, KY--IN	213	-0.06	0.00	0.15	0.06	0.16	0.17	-0.20	0.00
Lynchburg, VA	19	-0.30	0.49	-0.28	0.14	0.14	-0.35	0.53	0.06
Macon, GA	21	-0.12	0.05	-0.17	0.18	0.04	-0.03	0.11	0.22
Madison, WI	52	0.08	-0.15	-0.11	0.19	0.11	0.00	0.17	-0.16

Urbanized Area	Number of Census Tracts	NHW	BAA	AAA	AIAN	NHPI	SOR	TMR	HL
Manchester, NH	26	0.27	-0.17	0.14	-0.14	-0.13	-0.28	-0.30	-0.32
Medford, OR	11	-0.17	-0.16	0.37	0.01	0.62	0.17	0.57	0.16
Memphis, TN--MS--AR	203	-0.47	0.40	-0.34	-0.05	-0.17	-0.18	-0.41	-0.07
Miami, FL	1283	-0.55	-0.15	-0.29	-0.12	-0.14	-0.16	-0.37	0.47
Milwaukee, WI	336	-0.46	0.38	-0.23	0.27	-0.01	0.24	0.01	0.35
Minneapolis--St. Paul, MN--WI	590	-0.24	0.19	-0.18	0.35	0.14	0.17	0.16	0.37
Mobile, AL	71	-0.34	0.37	-0.56	-0.24	-0.01	-0.12	-0.33	-0.38
Montgomery, AL	33	-0.26	0.33	-0.73	0.00	-0.31	-0.38	-0.20	-0.19
Muncie, IN	14	-0.10	0.17	-0.72	0.12	-0.43	0.13	0.42	-0.42
Muskegon, MI	14	0.18	-0.23	0.29	0.56	-0.17	-0.25	-0.03	-0.07
Nashville-Davidson, TN	169	-0.40	0.41	-0.28	0.22	0.00	0.15	-0.06	0.26
Hartford, CT	168	-0.46	0.43	-0.01	0.19	-0.11	0.23	-0.44	0.42
New Haven, CT	79	-0.28	0.32	0.23	0.21	0.04	0.09	-0.10	0.14
New Orleans, LA	276	0.39	-0.29	0.01	0.09	0.05	-0.17	0.23	0.08
Virginia Beach, VA	308	-0.17	0.19	-0.20	0.06	-0.16	-0.03	-0.26	-0.06
San Francisco--Oakland, CA	671	-0.30	0.41	-0.06	0.28	0.39	-0.21	-0.11	0.25
Ogden--Layton, UT	69	0.18	0.05	0.19	-0.02	0.48	0.17	0.24	-0.27
Oklahoma City, OK	231	-0.44	0.08	-0.34	0.19	-0.14	-0.11	-0.24	0.29
Omaha, NE--IA	177	-0.35	0.02	-0.48	0.43	0.09	0.12	-0.09	0.71
Oshkosh, WI	9	-0.43	0.32	0.62	0.15	0.00	0.44	0.48	-0.47
Providence, RI--MA	179	-0.48	0.39	0.20	0.26	0.04	0.14	-0.13	0.43
Peoria, IL	34	-0.51	0.51	-0.27	0.14	-0.05	0.30	0.15	0.41
Philadelphia, PA--NJ--DE--MD	1172	-0.43	0.35	-0.05	0.13	0.03	0.20	-0.08	0.27
Phoenix--Mesa, AZ	753	-0.63	0.49	-0.18	0.45	-0.07	0.08	-0.29	0.61
Pittsburgh, PA	386	-0.46	0.39	0.06	0.08	-0.02	0.25	0.15	0.33
Detroit, MI	1051	-0.46	0.45	-0.51	0.14	-0.04	0.14	-0.09	-0.19
Port Arthur, TX	23	-0.32	0.28	-0.14	-0.51	0.04	-0.12	-0.46	0.00
Portland, OR--WA	377	0.10	0.19	-0.28	0.01	-0.16	0.26	0.30	-0.10
Poughkeepsie--Newburgh, NY--NJ	49	-0.25	0.04	-0.20	0.04	0.05	-0.12	-0.43	0.45
Providence, RI--MA	179	-0.48	0.39	0.20	0.26	0.04	0.14	-0.13	0.43
Pueblo, CO	25	-0.42	0.24	-0.14	0.62	-0.11	0.07	0.38	0.38
Racine, WI	16	0.51	-0.45	0.44	0.32	-0.02	0.02	-0.24	-0.64
Richmond, VA	182	-0.32	0.41	-0.45	0.00	-0.12	0.00	-0.06	-0.18
Roanoke, VA	34	-0.67	0.70	-0.33	0.32	0.15	0.33	0.44	0.58
Rochester, MN	12	0.01	-0.31	0.06	-0.15	0.27	-0.01	-0.33	0.15
Rochester, NY	153	-0.51	0.57	-0.13	0.18	0.00	0.19	0.17	0.56
Rockford, IL	55	0.01	-0.13	0.52	-0.10	-0.12	0.07	0.02	0.27
Sacramento, CA	336	-0.44	0.42	0.18	0.11	0.30	0.13	-0.12	0.49
Saginaw, MI	23	-0.80	0.78	-0.51	-0.38	-0.09	-0.09	0.06	0.11
Salt Lake City--West Valley City, UT	203	-0.54	0.68	0.30	0.62	0.38	0.24	0.17	0.50
San Antonio, TX	328	-0.45	-0.31	-0.52	-0.04	-0.32	-0.20	-0.55	0.47
San Diego, CA	585	-0.46	0.67	0.06	0.18	0.39	-0.19	-0.24	0.51
San Francisco--Oakland, CA	671	-0.30	0.41	-0.06	0.28	0.39	-0.21	-0.11	0.25
San Jose, CA	332	-0.50	0.40	-0.16	0.31	0.32	-0.14	-0.48	0.61
Savannah, GA	39	-0.30	0.30	-0.27	0.12	-0.44	-0.22	-0.51	-0.17
Seattle, WA	627	-0.17	0.40	-0.19	0.36	0.33	0.03	0.17	0.27
Shreveport, LA	45	-0.24	0.21	-0.45	0.00	-0.20	-0.21	-0.04	-0.25
Sioux City, IA--NE--SD	9	0.02	-0.22	-0.47	-0.30	0.40	0.30	0.55	-0.15
South Bend, IN--MI	59	-0.60	0.62	-0.28	-0.16	-0.26	0.10	0.19	0.59
Spokane, WA	71	-0.43	0.37	-0.01	0.51	0.23	0.31	0.27	0.28
Springfield, IL	33	-0.45	0.47	-0.52	0.14	0.24	0.29	0.53	0.32
Springfield, MO	46	0.16	-0.12	0.27	-0.07	-0.09	0.14	-0.29	-0.26
Springfield, OH	15	0.25	-0.25	0.32	0.46	-0.07	-0.01	0.10	-0.51
St. Joseph, MO--KS	12	-0.06	-0.28	-0.74	0.02	-0.17	-0.24	0.30	0.38
Minneapolis--St. Paul, MN--WI	590	-0.24	0.19	-0.18	0.35	0.14	0.17	0.16	0.37
Tampa--St. Petersburg, FL	482	-0.71	0.59	0.08	-0.07	-0.03	0.30	-0.15	0.63
Stockton, CA	68	0.01	0.07	-0.59	0.22	-0.59	0.13	-0.07	0.43
Syracuse, NY	83	-0.15	0.14	0.45	0.01	0.05	0.07	0.05	0.13
Terre Haute, IN	11	-0.20	0.19	-0.30	-0.12	-0.12	0.25	0.01	-0.15
Toledo, OH--MI	147	-0.54	0.43	-0.63	0.26	0.00	0.08	0.42	0.59
Topeka, KS	25	-0.31	0.30	-0.30	0.17	0.29	0.34	0.17	0.32
Trenton, NJ	43	-0.19	0.16	-0.14	0.12	-0.09	-0.28	0.04	0.06
Albany--Schenectady, NY	102	-0.25	0.32	0.18	-0.11	-0.15	-0.19	-0.26	0.08
Tulsa, OK	138	-0.23	0.25	0.01	0.05	0.13	0.15	-0.10	0.40
Utica, NY	30	-0.35	0.16	0.64	-0.36	0.06	0.20	0.12	0.20
Waco, TX	18	-0.39	0.29	-0.60	-0.42	-0.52	0.23	-0.05	0.24
Youngstown, OH--PA	75	-0.66	0.65	-0.23	0.22	0.04	0.21	-0.05	0.74
Waterbury, CT	30	-0.43	0.27	0.03	0.39	0.03	0.20	0.18	0.44
Waterloo, IA	17	-0.53	0.50	0.52	0.09	0.41	0.19	0.03	0.47
Wheeling, WV--OH	8	-0.19	0.02	-0.50	0.33	-0.26	0.38	0.45	-0.10
Wichita, KS	88	-0.65	0.54	-0.02	0.07	0.19	0.18	0.17	0.58
Scranton, PA	63	0.05	-0.20	0.46	0.08	-0.11	0.21	-0.17	-0.16
Winston-Salem, NC	61	-0.67	0.67	-0.55	0.11	-0.12	-0.25	-0.17	0.44
York, PA	34	-0.59	0.53	-0.19	0.17	0.15	0.30	0.35	0.61
Youngstown, OH--PA	75	-0.66	0.65	-0.23	0.22	0.04	0.21	-0.05	0.74

Figure S4. FIVE weekend emission plots

Weekend emissions map and plots for non-Hispanic white (top) and Hispanic or Latino (bottom) racial and ethnic groups. NOx emissions were obtained from the Fuel-based Inventory of Vehicle Emissions (FIVE).