Top-down estimate of surface flux in the Los Angeles Basin using a mesoscale inverse modeling technique: Assessing anthropogenic emissions of CO, NOx and CO2 and their impacts

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Supplement material

Along with NEI 2005 and the posterior estimates, a CARB 2010 projection is also used in the WRF-Chem v3.4 Eulerian model simulations of tropospheric chemistry (See section 4 for details). To downscale the CARB 2010 projection to a 4x4km inventory, the NEI-05 emission

inventory is modified for 6 counties in Southern California according to the CARB (California Air Resources Board) 2010 projected emissions available at: http://www.arb.ca.gov/app/emsinv/fcemssumcat2009.php. The modified counties are Los Angeles, Orange, Riverside, San Bernardino, Ventura and San Diego. Modifications are based on the CARB grown and controlled projected emissions for a summertime day by modifying emission sums of 20 categories based on the U.S. source classification codes (SCCs) within the NEI. These categories and their corresponding assignments to the CARB classifications are listed in Table 1. The NEI categories chosen for modification are based on the major sources of criteria pollutants (reactive VOC, NOx, CO, SO_2, and $PM_{2.5}$) for Southern California counties within the 2 inventories. "Point" sources within NEI-05 are not modified in this version. These generally represent a minor contribution to the county totals for most criteria pollutants, and more recent, monitoring based emissions estimates of "point" sources would be the most appropriate choice for inclusion. Only emissions for the "mobile onroad", "mobile nonroad", and "nonpoint" emission sectors within the NEI-05 are modified. Modification factors for the 20 categories within Table 1 were determined by ratioing CARB published emissions to the July monthly averages in the NEI-05 for each county. The total emissions in each inventory that are not in the 20 categories are also determined, and the CARB-10 to NEI-05 ratio is used to adjust the "nonpoint" emissions within the uncategorized class. By maintaining the original "point" emissions, the modified NEI-05 inventory is not quantitatively identical to the CARB-10 inventory. However, the disagreement is within 24% for all species and counties, which is well within the uncertainties of the inventories. Further partitioning within SCC category limits, weekday/weekend and hourly temporal allocations, 4-km grid spatial partitioning, and species allocation for reactive VOC and PM2.5 are kept unchanged within the NEI-05.

Most categories have well defined or obvious category assignments between the 2 inventories. However, a few individual source categories do not have 1-to-1 assignments, and some explanation is necessary:

1) The CARB inventory only reports "natural gas" sources (in their offroad equipment category) whereas the NEI05 splits natural gas sources into "LPG" or "CNG". The CARB natural gas sources are split between the two NEI-05 sources using the NEI-05 relative fractions of LPG and CNG.

2) The NEI-05 inventory splits airport emissions between "point" emissions and "nonpoint" emissions, and only the "nonpoint" fraction is modified here. For Los Angeles county, the NEI-05 airport emissions are ~85% of the total, so only ~15% would undergo modification from ratios of the totals shown in Table 1. Since the NEI-05 and CARB-10 airport emissions are quite similar for Los Angeles county, there are only minor modifications. For the other 5 counties, the "nonpoint" airport sources dominate, and airport emission modifications more directly reflect the CARB-10 inventory.

3) Some very minor sources in the mobile on-road and non-road NEI categories are not modified. This includes railway maintenance equipment and diesel powered recreational boats.

Table 1. Emission categories and Source Classification Code ranges within the NEI-05 inventory that are modified according to CARB 2010 projected emissions. The CARB classifications used to derive the modification factors are in column 3. Summertime emissions of 5 criteria air pollutants, and a designation of their source for Los Angeles county are in the last 6 columns. Units of emissions are in short tons per day.

NEI-2005 descriptor	SCC range	CARB categories	VOC	NOx	CO	SO_2	$PM_{2.5}$	Source
Onroad Diesel	2230000000-	light heavy duty diesel trucks-(1&2)	7.41	98.90	37.11	0.83	2.87	NEI05
	2239999999	medium heavy duty diesel trucks	8.93	136.57	39.53	0.16	5.06	CARB
		heavy heavy duty diesel trucks						
		heavy duty diesel urban buses						
Onroad Gasoline	2200000000-	light duty- passenger, trucks (1&2)	176.33	176.61	1717.2	1.66	2.73	NEI05
	2209999999	medium duty trucks	105.80	106.45	1039.1	1.15	5.89	CARB
		gas trucks – light heavy duty (1&2),						
		medium and heavy heavy duty.						
		motorcycles, school buses, other						
		buses and motor homes						

Offroad Diesel	2270000000- 2270099999	Diesel – off-road equipment, farm equipment, recreational vehicles	6.90 13.84	59.02 100.75	30.79 72.43	.409 .096	4.94 5.23	NEI05 CARB
Offroad Gas 2-stroke	2260000000- 2260999999	2 stroke – off-road equipment, farm equipment, recreational vehicles	31.32 15.29	0.37 0.28	68.24 32.19	.001 .019	1.768 0.088	NEI05 CARB
Offroad Gas 4-stroke	2265000000- 2265999999	4 stroke – off-road equipment, farm equipment, recreational vehicles	21.29 6.16	12.40 8.76	1614.1 313.5	.034 .028	0.410 0.700	NEI05 CARB
Offroad LPG	2267000000- 2267999999	Natural gas off-road equipment	6.164 0.132	22.664 5.005	105.28 32.229	.028 0.00	0.129 0.070	NEI05 CARB
Offroad CNG	2268000000- 2268999999	Natural gas off-road equipment	0.035 <.001	2.167 0.479	12.32 3.771	.003 0.00	0.016 0.009	NEI05 CARB
Pleasurecraft 2-stroke (Offroad)	2282000000- 2282009999	Recreational boats – 2stroke	6.533 19.928	0.202 2.002	11.761 31.202	.0003 .006	0.104 2.030	NEI05 CARB
Pleasurecraft 4-stroke (Offroad)	2282010000- 2282019999	Recreational boats - 4 stroke	0.797 8.031	0.484 4.846	9.292 111.47	.0003 .008	.004 .047	NEI05 CARB
Commercial Marine and Harborcraft Diesel	2280002000- 2280002999	Ocean going Vessels – Diesel Commercial Harbor Craft - Diesel	4.017 1.686	120.80 34.94	21.43 6.15	25.98 0.82	4.706 0.886	NEI05 CARB
Commercial Marine and Harborcraft Residual	2280003000- 2280003999	Ocean going Vessels – residual fuel Commercial Harbor Craft - residual	0.809 1.237	21.75 28.64	2.83 2.67	11.87 29.57	0.948 3.102	NEI05 CARB
Aircraft/Airport	2275000000- 2275999999	Other Mobile - Aircraft	5.642 5.814	13.720 14.739	45.891 40.968	.6171 1.399	0.433 0.616	NEI05 CARB
Railroad	2285000000- 2285999999	Other Mobile - Trains	1.202 1.498	24.201 11.956	3.97 4.51	1.230 0.096	0.557 0.468	NEI05 CARB
Architectural Coatings	2401001000- 2401003999	Architectural Coating and related Process solvents	32.695 17.398	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	NEI05 CARB
Miscellaneous nonindustrial solvents	2460000000- 2465999999	Consumer products	70.878 65.208	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	NEI05 CARB
Petroleum products storage and transport	2500000000- 2509999999	Petroleum Marketing Other mobile-fuel store and handle	42.802 27.872	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	NEI05 CARB
Livestock	2805000000-	Areawide Sources – Farming	0.536	0.00	0.00	0.00	0.020	NEI05

	2805059999	Operations	0.308	0.00	0.00	0.00	0.000	CARB
Commercial cooking	2302002000	Areawide Sources - Cooking	0.747	0.00	0.18	0.00	7.269	NEI05
	2302003299		1.223	0.00	0.00	0.00	8.776	CARB
Fugitive dust –	2294000000-	Areawide Sources –	0.00	0.00	0.00	0.00	3.018	NEI05
paved roads	2294015999	Paved road dust	0.00	0.00	0.00	0.00	10.96	CARB
Fugitive dust –	2296000000-	Areawide Sources –	0.00	0.00	0.00	0.00	2.880	NEI05
unpaved roads	2296005999	Unpaved road dust	0.00	0.00	0.00	0.00	2.783	CARB
NEI-05 Total	All	All	580.32	605.74	3727.6	78.73	45.23	NEI05
CARB-10 Total		All	367.60	506.01	1789.7	50.01	64.83	CARB
Modified NEI-05 Total	All	All	384.31	505.79	1777.4	60.59	61.63	

Note: Aircraft emissions for NEI-05 include the “point” emissions in addition to the “nonpoint” SCC categories listed here.