December 16, 2019

SPECIFICATION SHEET: AIRPORTS

Description: Airport emissions, for simulating 2016 and future year U.S. air quality

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1. EXECUTIVE SUMMARY

This document details the approach and data sources to be used for developing 2016 and future year emissions for the airport sector, which consists of aircraft and ground support sources. The primary data source is the 2017 draft National Emissions Inventory (NEI) airport inventory, back-projected to 2016 using Federal Aviation Administration (FAA) data. Airport emissions were projected to the years 2023 and 2028 using the FAA's Terminal Area Forecast (TAF) data. Base and future year inventories were processed into a format that can be input to air quality models with the Sparse Matrix Operating Kernel Emissions (SMOKE) modeling system v4.7. National and state-level emission summaries for key pollutants are provided.

2. INTRODUCTION

The airport sector contains emissions of all pollutants from aircraft, categorized by their itinerant class (i.e., commercial, air taxi, military, or general), as well as emissions from ground support equipment. The starting point for the 2016 version 1 (v1) platform airport inventory is

the airport emissions from the 2017 National Emissions Inventory (NEI). The SCCs included in the airport sector are shown in Table 1.

Table 1. 2016v1 platform SCCs for airport sector

SCC	Tier 1 description	Tier 2 description	Tier 3 description	Tier 4 description
2265008005	Mobile Sources	Off-highway Vehicle Gasoline, 4-stroke	Airport Ground Support Equipment	Airport Ground Support Equipment
2267008005	Mobile Sources	LPG	Airport Ground Support Equipment	Airport Ground Support Equipment
2268008005	Mobile Sources	CNG	Airport Ground Support Equipment	Airport Ground Support Equipment
2270008005	Mobile Sources	Off-highway Vehicle Diesel	Airport Ground Support Equipment	Airport Ground Support Equipment
2275001000	Mobile Sources	Aircraft	Military Aircraft	Total
2275020000	Mobile Sources	Aircraft	Commercial Aircraft	Total: All Types
2275050011	Mobile Sources	Aircraft	General Aviation	Piston
2275050012	Mobile Sources	Aircraft	General Aviation	Turbine
2275060011	Mobile Sources	Aircraft	Air Taxi	Piston
2275060012	Mobile Sources	Aircraft	Air Taxi	Turbine
2275070000	Mobile Sources	Aircraft	Aircraft Auxiliary Power Units	Total
40600307	Chemical Evaporation	Transportation and Marketing of Petroleum Products	Gasoline Retail Operations – Stage I	Underground Tank Breathing and Emptying
20200102	Internal Combustion Engines	Industrial	Distillate Oil (Diesel)	Reciprocating

3. INVENTORY DEVELOPMENT METHODS

The 2016v1 airport emissions inventory was created from the 2017NEI airport emissions that were estimated using the FAA's Aviation Environmental Design Tool (AEDT). Additional information about the 2017NEI airport inventory and the AEDT can be found in the 2017 National Emissions Inventory Technical Support Document (https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-technical-support-document-tsd). The 2017NEI emissions were adjusted from 2017 to represent year 2016 emissions using FAA

data. Adjustment factors were created using airport-specific numbers, where available, or the state default by itinerant class (commercial, air taxi, and general) where there were not airport-specific values in the FAA data. Emissions growth for facilities is capped at 500% and the state default growth is capped at 200%. Military state default values were kept flat to reflect uncertainly in the data regarding these sources.

4. ANCILLARY DATA

Spatial Allocation / Vertical Allocation

Spatial allocation of airport emissions to the national 36km and 12km domains used for air quality modeling was based on latitude and longitude data from the point source inventory.

Related to vertical allocation and plume rise, the point source stack replacement parameters (PSTK) file was updated for the v1 platform. This file provides default stack parameters by SCC for sources whose stack parameters are missing or blank in the emissions inventory. In the alpha platform, we discovered that many fugitive point sources, which ideally would remain in Layer 1, have missing stack parameters and were receiving default, stack parameters from the PSTK. These default stack parameters occasionally caused fugitive sources to have plume rise above Layer 1. The PSTK was edited for the v1 platform so that default stack parameters for fugitive SCCs do not cause plume rise above Layer 1.

Temporal Allocation

Reports summarizing total emissions according to the monthly, day-of-week, and hour-of-day temporal profile assignments were developed at the state and county level. They are too large to include in this document. However, plots of the diurnal, weekly, and monthly temporal profiles for airport SCCs are shown in Figures 1 through 3.

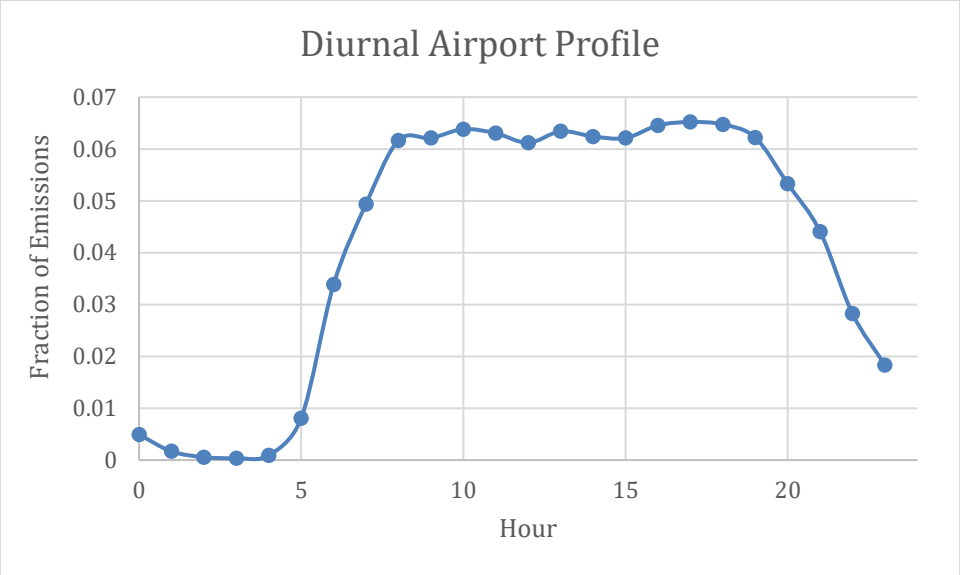

Figure 1. Diurnal Profile for all Airport SCCs

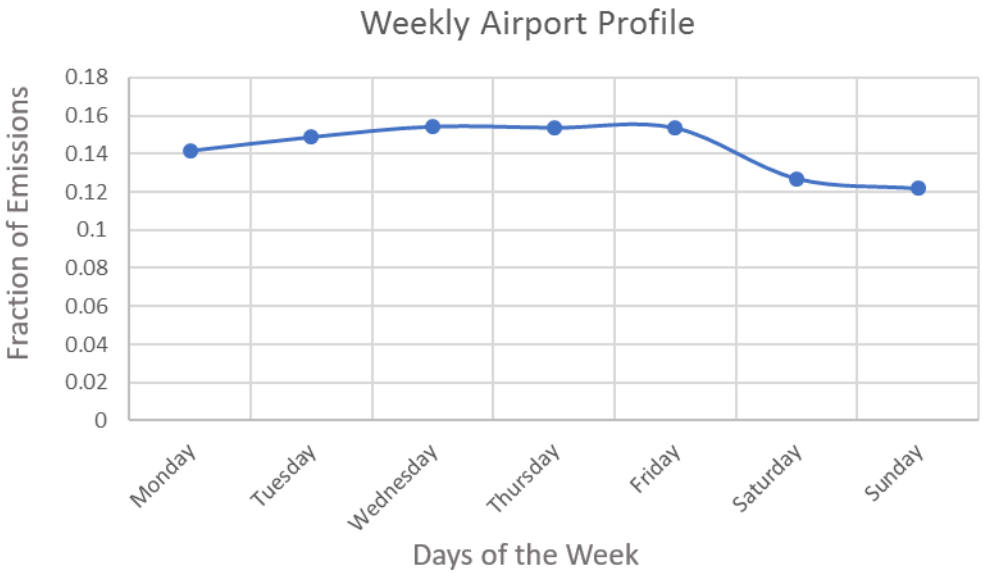

Figure 2. Weekly profile for all Airport SCCs

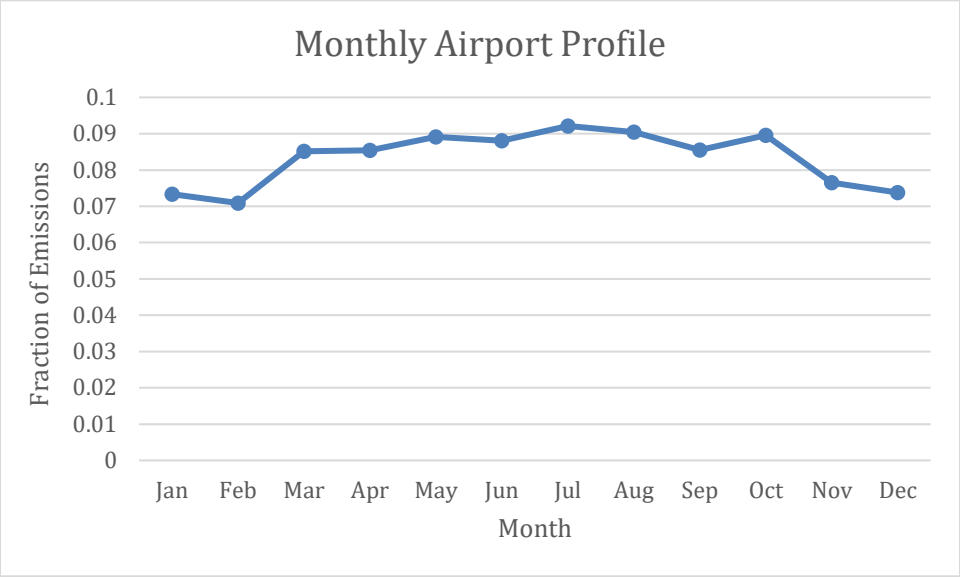

Figure 3. Monthly Profile for all Airport SCCs

Chemical Speciation

The airport sector includes speciation of PM2.5 and VOC emissions, and does not use HAP integration for VOCs. Reports summarizing total PM2.5 and VOC emissions according to speciation profile were developed at the state and county level and are too large to include in this document.

5. Emissions Projection Methods

Airports emissions were projected to 2023 and 2028 mostly using 2018 Terminal Area Forecast (TAF) data available from the Federal Aviation Administration (https://www.faa.gov/data_research/aviation/taf/). Projection factors were computed using the ratio of the itinerant (ITN) data between the base and projection year. For airports not matching a unit in the TAF data, state default growth factors by itinerant class (commercial, air taxi, and general) were created from the collection of airports unmatched. Emission growth for facilities is capped at 500% and the state default growth is capped at 200%. Military state default projection values were kept flat (i.e., equal to 1.0) to reflect uncertainly in the data regarding these sources. Figures 4 and 5 show the absolute and percent differences of NOx between 2028 and 2016 for airports.

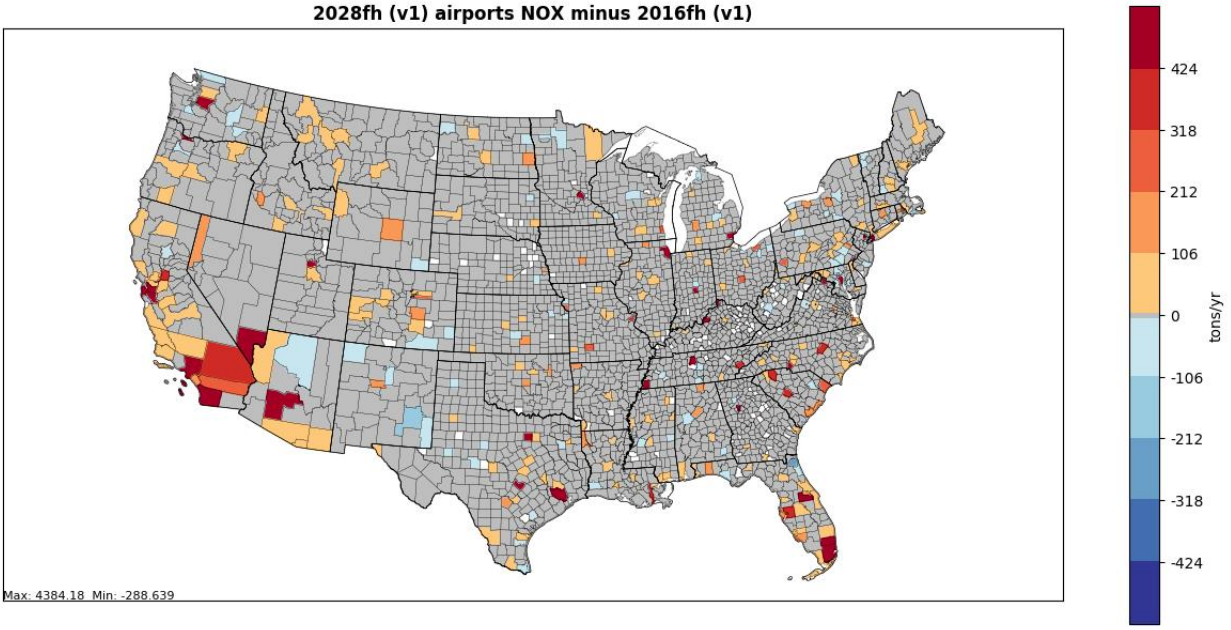

Figure 4. NOx (tons) Airport Sector Emission Differences between 2028v1 and 2016v1

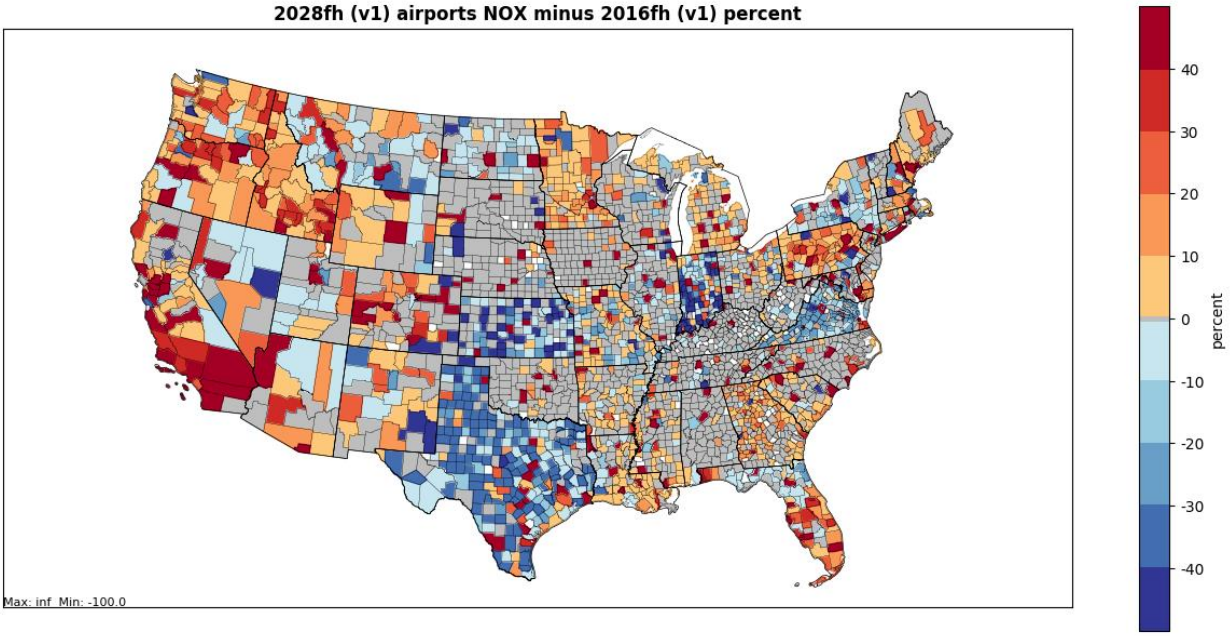

Figure 5. NOx (tons) Airport Sector Emission Percent Differences between 2028v1 and 2016v1

6. EMISSIONS PROCESSING REQUIREMENTS

Airport emissions were processed for air quality modeling using the Sparse Matrix Operator Kernel Emissions (SMOKE[1]) modeling system. As with all point source sectors, this is typically handled with two separate scripts, or "jobs": one which processes time-independent, or "onetime", programs (Smkinven, Spcmat, Grdmat, Smkreport, Elevpoint), and one which processes time-dependent programs (Temporal, Smkmerge).

The airport sector was processed through SMOKE using a PELVCONFIG file that classifies a portion of the sector as "elevated". The criterion for elevated sources is a plume rise of 20 meters or greater, according to the Briggs algorithm[2]. A value of 20 meters was chosen because this is a typical upper bound of Layer 1 in air quality modeling.

Elevated sources are output to an inline point source file for input to CMAQ, and remaining sources are output to a 2-D gridded emissions file. Therefore, one must sum both files together to capture emissions from all airport sources. The 2-D gridded emissions from airports must be included in the 2-D sector merge. The reason is that we do not classify all sources as elevated in airports, pt_oilgas and ptnonipm, as we do with cmv_c3, ptegu, and othpt. This is because we want to limit the size of the inline point source files from these sectors.

7. EMISSIONS SUMMARIES

National and state totals by pollutant for the v1 platform cases are provided here in Tables 2-5. Figures 6-9 show gridded and county-total NO_X and SO_2 emissions for this sector. Additional plots and maps are available online through the LADCO website[3] and the Intermountain West Data Warehouse[4]. The case descriptions are as follows:

2014fd = 2014NEIv2 and 2014 NATA

2016fe = 2016 alpha platform (grown from 2014NEIv2)

2016ff, 2023ff, 2028ff = 2016, 2023, and 2028 cases from 2016 beta platform

2016fh, 2023fh, 2028fh = 2016, 2023, and 2028 cases from 2016 v1 platform

[1] http://www.smoke-model.org/index.cfm
[2] https://www.cmascenter.org/smoke/documentation/4.5/html/ch06s03.html#sect_programs_elevpoint_briggs
[3] https://www.ladco.org/technical/modeling-results/2016-inventory-collaborative/
[4] http://views.cira.colostate.edu/iwdw/eibrowser2016

Table 2. Comparison of national total annual CAPS airport emissions (tons/yr)

Pollutant	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
CO	453,937	453,937	466,580	703,923	513,493	771,488	536,961	837,104
NH3	1	1	1		1		1	
NOX	153,773	153,773	165,422	194,441	198,307	229,229	212,921	254,654
PM10	11,090	11,090	11,267	11,586	11,859	11,906	12,286	12,386
PM2.5	9,815	9,815	10,001	10,288	10,586	10,634	10,989	11,099
SO2	17,272	17,272	18,569	26,679	22,082	31,561	23,695	35,261
VOC	48,845	48,845	50,815	89,463	56,420	96,356	59,032	103,948

Table 3. Comparison of state total annual NOx airport emissions (tons/yr)

State	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Alabama	4,287	4,287	4,279	4,308	4,532	4,681	4,561	4,608
Alaska	3,728	3,728	3,792	4,433	3,440	4,742	3,626	4,383
Arizona	5,532	5,532	5,614	6,290	6,201	6,915	6,552	7,698
Arkansas	1,037	1,037	1,138	1,062	1,306	1,132	1,355	1,253
California	15,544	15,544	17,219	20,297	21,999	25,198	24,287	30,445
Colorado	3,802	3,802	3,979	5,079	5,063	5,946	5,421	6,977
Connecticut	486	486	510	622	586	688	625	778
Delaware	784	784	591	233	599	231	599	259
District of Columbia	0	0	0	0	0	0	0	0
Florida	14,034	14,034	15,710	16,392	17,428	19,071	18,797	20,190
Georgia	6,650	6,650	7,216	8,168	8,105	9,163	8,757	9,684
Hawaii	3,351	3,351	3,406	3,505	3,730	3,574	3,988	4,229
Idaho	399	399	451	490	529	590	568	637
Illinois	6,519	6,519	7,009	9,490	9,628	11,800	10,615	14,195
Indiana	1,366	1,366	1,603	1,693	2,011	2,019	2,163	2,252
Iowa	430	430	528	503	734	640	825	793
Kansas	1,751	1,751	1,712	1,811	1,766	1,776	1,781	1,863
Kentucky	2,532	2,532	3,051	3,249	4,479	4,708	4,812	5,602
Louisiana	2,307	2,307	2,504	1,611	3,092	2,066	3,215	2,319
Maine	315	315	301	365	369	415	384	461
Maryland	4,443	4,443	4,548	3,041	5,124	3,264	5,417	3,721
Massachusetts	2,517	2,517	2,652	3,493	3,340	4,415	3,668	5,028
Michigan	2,786	2,786	3,276	3,603	4,375	4,520	4,708	4,976
Minnesota	2,432	2,432	2,599	3,276	3,231	3,832	3,481	4,314
Mississippi	3,975	3,975	4,062	3,921	4,244	3,968	4,255	4,148
Missouri	1,827	1,827	1,991	2,203	2,758	2,586	2,964	3,193
Montana	372	372	404	491	519	675	557	716
Nebraska	839	839	911	931	1,017	1,055	1,057	1,098
Nevada	3,002	3,002	3,170	3,999	3,622	4,541	3,956	5,096
New Hampshire	302	302	314	625	340	564	356	644
New Jersey	3,042	3,042	3,301	6,099	4,424	7,484	4,868	8,698
New Mexico	1,089	1,089	1,096	1,343	1,113	1,345	1,151	1,267

State	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
New York	7,856	7,856	8,474	10,581	9,955	12,210	10,705	13,135
North Carolina	5,660	5,660	6,014	6,510	7,364	7,950	7,930	8,919
North Dakota	588	588	597	622	704	705	729	819
Ohio	1,668	1,668	1,858	2,088	2,318	2,366	2,461	2,696
Oklahoma	3,428	3,428	3,383	3,431	3,618	3,580	3,650	3,812
Oregon	1,624	1,624	1,718	2,018	1,987	2,535	2,176	2,766
Pennsylvania	3,159	3,159	3,207	4,201	4,117	5,552	4,437	5,575
Rhode Island	267	267	261	365	327	446	338	502
South Carolina	1,821	1,821	1,988	3,042	2,419	4,066	2,523	4,180
South Dakota	241	241	251	332	361	339	394	483
Tennessee	4,595	4,595	5,102	5,243	6,479	6,270	7,032	7,319
Texas	8,765	8,765	9,918	15,492	12,719	18,204	13,943	20,327
Utah	1,109	1,109	1,212	2,051	1,508	2,674	1,624	2,994
Vermont	139	139	131	209	142	215	146	180
Virginia	5,056	5,056	5,594	7,801	6,938	8,950	7,204	9,703
Washington	3,580	3,580	4,102	4,826	4,699	6,034	5,179	6,171
West Virginia	520	520	384	483	422	511	426	606
Wisconsin	951	951	1,015	1,115	1,322	1,414	1,406	1,470
Wyoming	266	266	259	321	321	406	334	475
Puerto Rico	826	826	863	859	748	1,009	779	726
Virgin Islands	133	133	134	189	88	138	91	124
Tribal Data	37	37	19	35	40	50	43	147

Table 4. Comparison of state total annual SO2 airport emissions (tons/yr)

State	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Alabama	427	427	426	449	460	496	464	491
Alaska	405	405	408	578	376	627	395	599
Arizona	586	586	596	787	662	876	701	988
Arkansas	115	115	128	131	151	144	158	163
California	1,640	1,640	1,810	2,805	2,310	3,490	2,547	4,211
Colorado	421	421	438	710	551	825	591	953
Connecticut	58	58	61	89	70	98	74	111
Delaware	54	54	40	23	41	23	41	26
District of Columbia	0	0	0	0	0	0	0	0
Florida	1,478	1,478	1,654	2,347	1,852	2,787	2,002	2,974
Georgia	744	744	810	1,301	913	1,447	988	1,532
Hawaii	336	336	344	525	379	550	406	663
Idaho	50	50	56	74	66	89	71	97
Illinois	660	660	707	1,420	963	1,721	1,060	2,070
Indiana	143	143	167	245	211	285	226	317
Iowa	54	54	67	75	93	94	104	117
Kansas	177	177	172	192	179	189	180	201
Kentucky	263	263	320	452	480	654	517	782
Louisiana	251	251	277	257	356	325	372	364

State	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Maine	38	38	37	47	46	55	48	61
Maryland	470	470	481	389	546	423	579	488
Massachusetts	279	279	293	469	367	592	403	675
Michigan	330	330	388	543	522	664	562	731
Minnesota	281	281	301	467	374	535	403	603
Mississippi	386	386	394	388	415	397	417	417
Missouri	218	218	237	334	334	393	359	486
Montana	47	47	50	72	63	98	68	103
Nebraska	92	92	100	117	115	137	120	145
Nevada	328	328	346	550	395	625	432	703
New Hampshire	33	33	35	82	37	74	39	84
New Jersey	320	320	346	713	457	882	503	1,035
New Mexico	114	114	114	156	118	163	122	160
New York	835	835	895	1,410	1,053	1,616	1,127	1,737
North Carolina	616	616	656	934	809	1,144	873	1,296
North Dakota	68	68	68	79	83	89	87	106
Ohio	211	211	236	318	293	354	310	404
Oklahoma	343	343	340	366	367	390	371	420
Oregon	182	182	190	275	221	350	242	388
Pennsylvania	367	367	373	603	477	767	514	776
Rhode Island	31	31	31	51	38	63	40	71
South Carolina	198	198	219	384	276	540	289	558
South Dakota	30	30	31	46	46	48	50	69
Tennessee	438	438	490	714	647	866	703	1,023
Texas	1,000	1,000	1,126	2,247	1,421	2,648	1,553	2,982
Utah	123	123	133	292	166	379	179	425
Vermont	17	17	16	28	18	31	18	26
Virginia	584	584	637	1,060	779	1,201	805	1,289
Washington	387	387	438	653	504	817	554	838
West Virginia	53	53	41	54	46	55	46	65
Wisconsin	118	118	126	169	163	211	174	219
Wyoming	29	29	29	40	37	50	39	61
Puerto Rico	711	711	757	133	648	153	678	113
Virgin Islands	126	126	134	31	83	23	86	20
Tribal Data	5	5	3	6	5	8	5	22

Table 5. Comparison of state total annual VOC airport emissions (tons/yr)

State	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Alabama	2,141	2,141	2,135	2,192	2,209	2,263	2,216	2,229
Alaska	1,571	1,571	1,540	2,015	1,289	2,186	1,326	1,951
Arizona	1,993	1,993	2,023	2,596	2,099	2,779	2,155	2,997
Arkansas	565	565	593	579	641	570	657	600
California	3,252	3,252	3,419	6,848	4,083	8,177	4,404	9,669
Colorado	1,072	1,072	1,092	2,052	1,340	2,245	1,399	2,596

State	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Connecticut	164	164	176	257	187	267	196	287
Delaware	137	137	111	132	116	133	117	148
District of Columbia	0	0	0	0	0	0	0	0
Florida	4,071	4,071	4,510	6,913	4,726	7,829	4,987	8,194
Georgia	1,588	1,588	1,679	10,059	1,805	9,578	1,899	10,052
Hawaii	842	842	839	1,093	860	1,074	906	1,225
Idaho	224	224	228	324	253	370	269	398
Illinois	1,186	1,186	1,250	3,111	1,593	3,413	1,731	4,021
Indiana	428	428	473	792	565	819	596	897
Iowa	209	209	232	262	279	279	300	313
Kansas	911	911	885	979	890	928	894	959
Kentucky	695	695	817	1,106	1,155	1,423	1,232	1,685
Louisiana	1,022	1,022	1,051	2,004	1,197	2,108	1,224	2,187
Maine	164	164	158	180	170	186	173	193
Maryland	1,352	1,352	1,364	1,264	1,439	1,333	1,483	1,496
Massachusetts	693	693	684	1,233	783	1,439	836	1,620
Michigan	820	820	913	1,392	1,125	1,469	1,192	1,571
Minnesota	594	594	623	1,183	707	1,236	749	1,361
Mississippi	1,983	1,983	2,023	1,967	2,095	1,963	2,099	2,044
Missouri	544	544	592	921	774	1,017	820	1,189
Montana	206	206	210	341	239	416	247	435
Nebraska	387	387	408	448	431	472	440	475
Nevada	713	713	754	1,394	874	1,567	930	1,742
New Hampshire	134	134	134	542	139	507	143	625
New Jersey	653	653	698	2,041	831	2,311	896	2,608
New Mexico	495	495	501	629	485	606	496	555
New York	1,713	1,713	1,832	2,911	2,064	3,143	2,195	3,364
North Carolina	1,795	1,795	1,868	2,767	2,093	3,067	2,186	3,389
North Dakota	325	325	324	374	355	380	365	408
Ohio	750	750	810	1,040	891	1,018	922	1,109
Oklahoma	1,630	1,630	1,611	1,664	1,685	1,702	1,694	1,799
Oregon	599	599	605	962	672	1,195	722	1,315
Pennsylvania	929	929	964	1,653	1,148	1,796	1,223	1,857
Rhode Island	85	85	82	154	92	173	94	189
South Carolina	868	868	894	1,373	1,010	1,600	1,038	1,612
South Dakota	142	142	152	179	186	166	196	202
Tennessee	1,202	1,202	1,298	2,388	1,595	2,697	1,707	3,045
Texas	2,772	2,772	2,959	6,023	3,467	6,567	3,709	7,101
Utah	319	319	347	849	384	1,021	401	1,124
Vermont	68	68	64	103	62	81	63	73
Virginia	2,554	2,554	2,634	6,593	2,874	6,711	2,904	6,924
Washington	1,114	1,114	1,151	1,918	1,298	2,310	1,407	2,366
West Virginia	272	272	204	251	218	258	220	304
Wisconsin	422	422	436	611	492	642	511	662
Wyoming	140	140	131	193	148	223	151	230

State	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Puerto Rico	266	266	271	470	242	531	250	422
Virgin Islands	50	50	46	118	41	92	42	92
Tribal Data	21	21	15	19	22	20	23	40

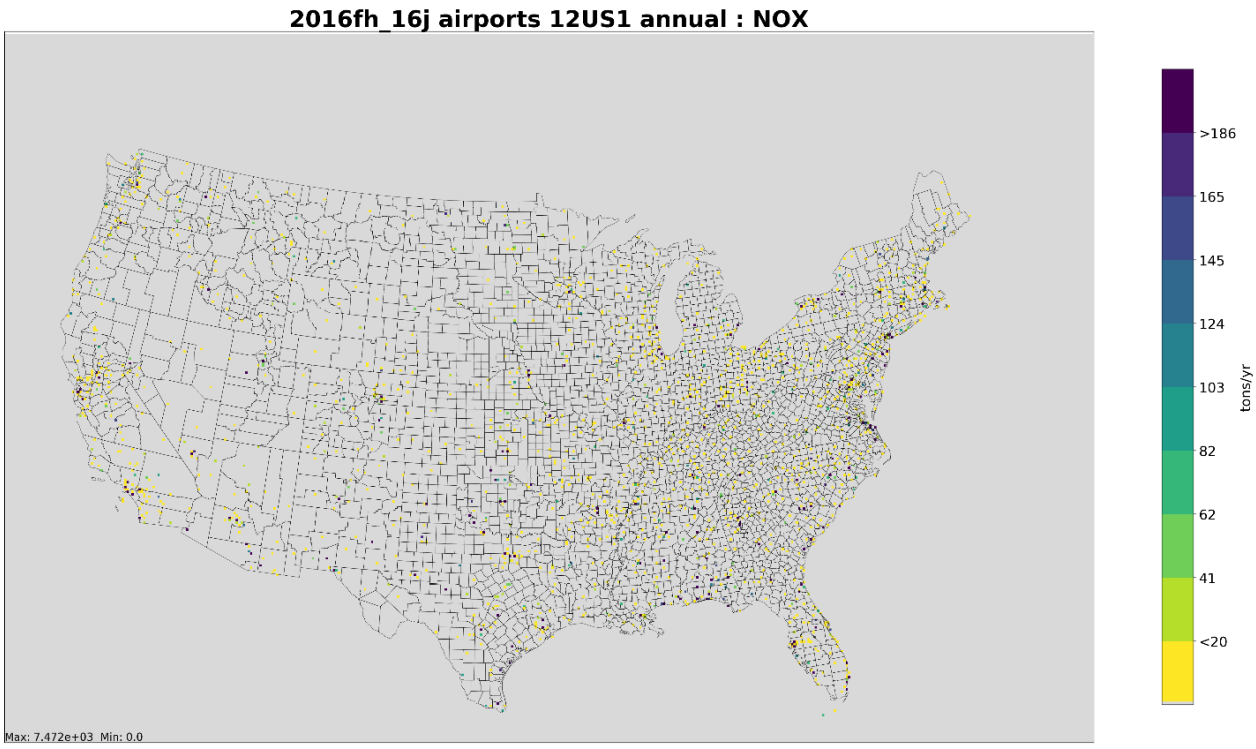

Figure 6. Annual Gridded 2016 airport NOx emissions

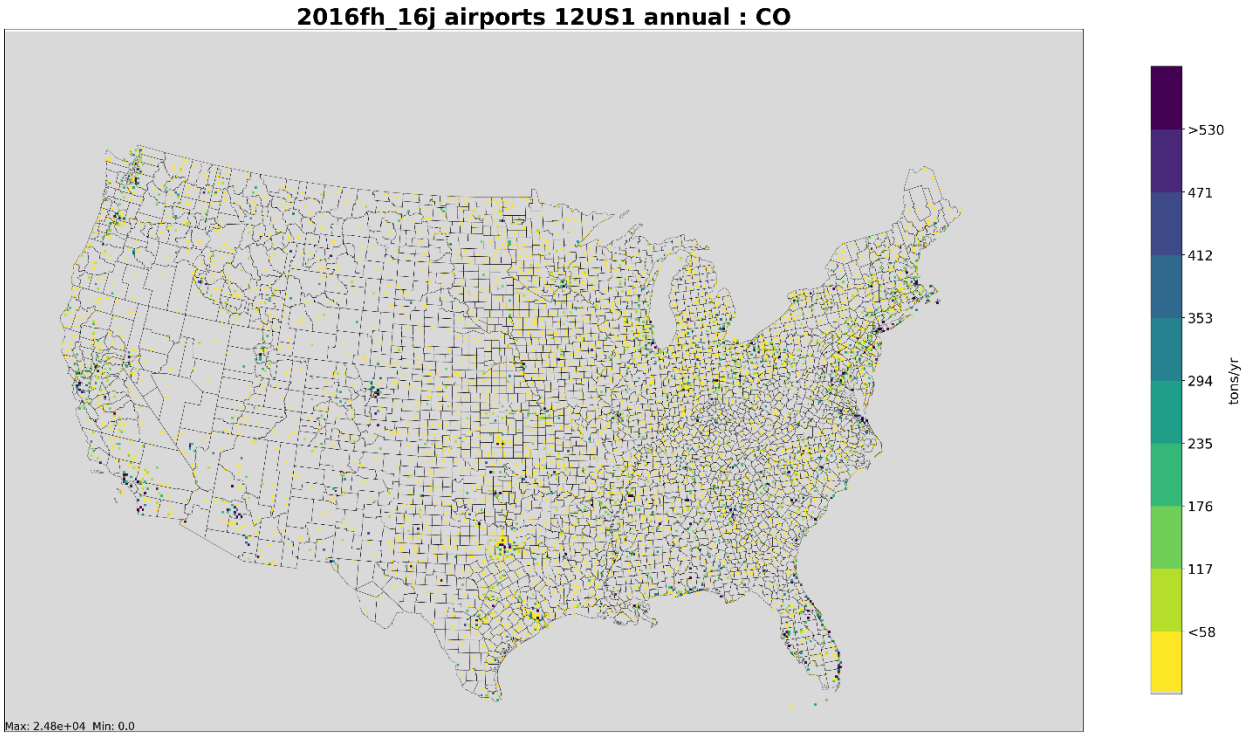

Figure 7. Annual Gridded 2016 airport CO emissions

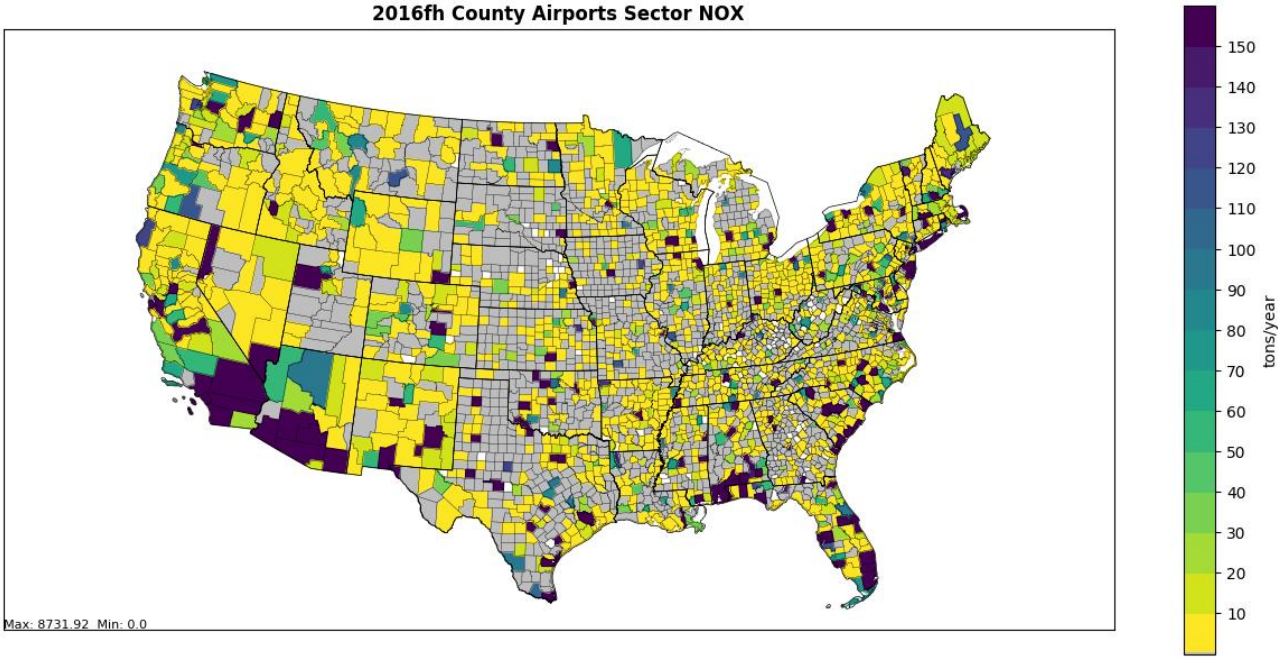

Figure 8. Annual County-total 2016 airport NOx emissions

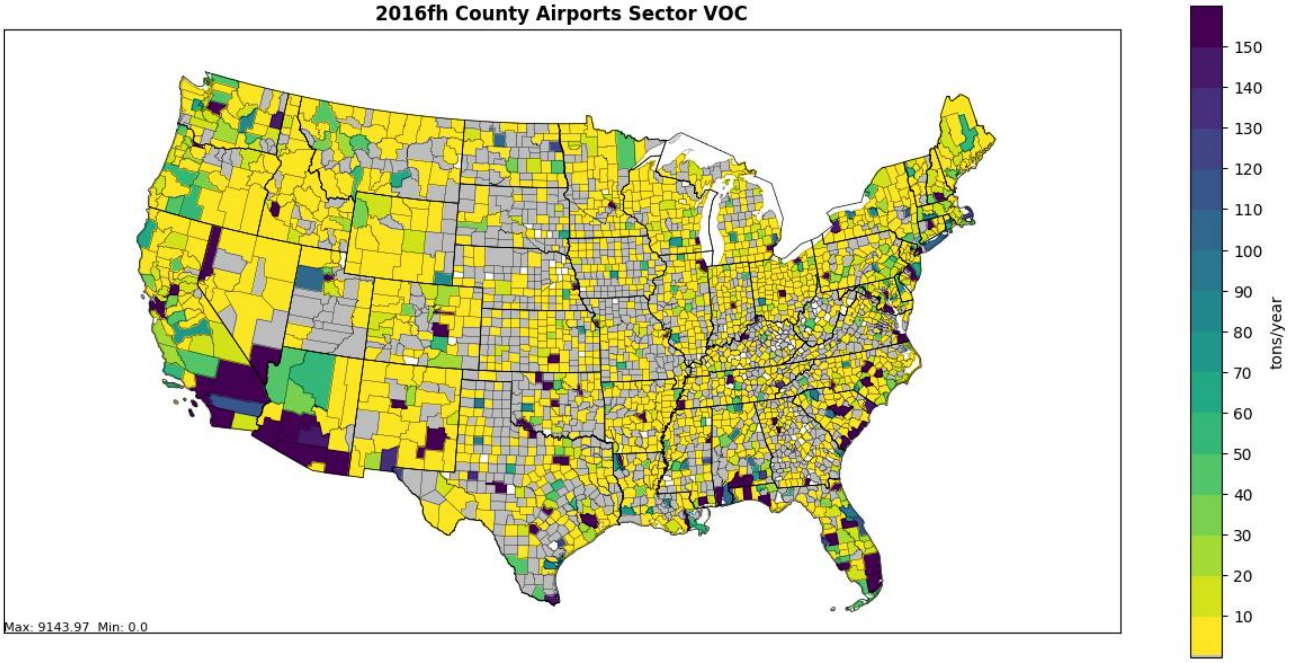

Figure 9. Annual County-total 2016 airport VOC emissions