

March 7, 2019

SPECIFICATION SHEET: NP_OILGAS

Description: Nonpoint oil and gas (np_oilgas) emissions, for simulating 2016 U.S. air quality

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1. EXECUTIVE SUMMARY

The np_oilgas sector consists of non-point (area) source oil and gas emissions. All emissions from this sector are derived from the Oil and Gas Tool, except in California, Colorado, Oklahoma, and Pennsylvania, which use alternative datasets. This sector employs special monthly temporal profiles and spatial allocation specific to oil and gas sources. Base year inventories were processed with the Sparse Matrix Operating Kernel Emissions (SMOKE) modeling system version 4.6. SMOKE creates emissions in a format that can be input into air quality models. National and state-level emission summaries for key pollutants are provided.

2. INTRODUCTION

Nonpoint source emissions from the oil and gas exploration and production sector have gained interest in recent years in the United States as drilling technology has allowed development of unconventional oil and gas plays in areas where there was previously no activity, or where activity had subsided after depletion of the conventional reserves. For example, the areas in and around the Barnett, Haynesville, and Eagle Ford Shales in Texas; the Marcellus Shale in Ohio, Pennsylvania, and West Virginia; and the Bakken Shale/Williston Basin in North Dakota and Montana have all experienced a rapid expansion in activity over the last twelve years. These are referred to as “unconventional” oil and gas plays as the resource must be stimulated through high-pressure, high-volume hydraulic fracturing to release the oil and gas trapped in the source formation (such as shale or tight sands). In EPA’s Oil and Gas Tool, these types of wells are assumed to have been hydraulically fractured when completed, and emissions from the hydraulic fracturing pump engines are included as a discrete source type.

While the major emissions sources associated with oil and gas collection, processing, and distribution have traditionally been included in the NEI as point sources (e.g. gas processing plants, pipeline compressor stations, and refineries), the activities occurring “upstream” of these types of facilities have not been as well characterized in the NEI. In this document, upstream activities refer to emission units and processes associated with the exploration and drilling of oil and gas wells, and the equipment used at the wellsite to then extract the product from the well and deliver it “downstream” to a central collection point or processing facility. The types of unit processes found at upstream sites include separators, dehydrators, storage tanks, and compressor engines.

This document details the approach and data sources to be used for developing 2016 emissions for the nonpoint oil and gas (np_oilgas) sector, which consists of oil and gas exploration and production sources, both onshore and offshore (state-owned only). In 2016 beta platform, these emissions are mostly based on the Oil and Gas Tool, with other data sources in some states. Because of the growing importance of these emissions, special consideration is given to the speciation, allocation, and monthly temporalization of nonpoint oil and gas emissions, instead of relying on older, more generalized profiles.

A list of all SCCs in the np_oilgas sector is provided in Table 1. The table also specifies if SCC is covered by the EPA Oil and Gas Tool or if it was state-submitted. Table 1 also has a column indicating if the SCC is an EXPLORATION or PRODUCTION-related SCC.

Table 1. SCC in the np_oilgas sector for 2016beta inventory

SCC	TOOL OR STATE SCC	PRODUCTION OR EXPLORATION SCC	SCCDESC
2310000000	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; All Processes; Total: All Processes
2310000220	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; All Processes; Drill Rigs
2310000230	STATE	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; All Processes; Workover Rigs
2310000330	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; All Processes; Artificial Lift
2310000550	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; All Processes; Produced Water
2310000660	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; All Processes; Hydraulic Fracturing Engines
2310010100	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Crude Petroleum; Oil Well Heaters
2310010200	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Crude Petroleum; Oil Well Tanks - Flashing & Standing/Working/Breathing
2310010300	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Crude Petroleum; Oil Well Pneumatic Devices
2310011000	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Production; Total: All Processes
2310011201	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Production; Tank Truck/Railcar Loading: Crude Oil
2310011500	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Production; Fugitives: All Processes
2310011501	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Production; Fugitives: Connectors
2310011502	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Production; Fugitives: Flanges
2310011503	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Production; Fugitives: Open Ended Lines
2310011505	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Production; Fugitives: Valves
2310020600	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Natural Gas; Compressor Engines
2310020800	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Natural Gas; Gas Well Truck Loading
2310021010	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Storage Tanks: Condensate
2310021030	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Tank Truck/Railcar Loading: Condensate
2310021100	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Gas Well Heaters
2310021102	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Natural Gas Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP
2310021202	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Natural Gas Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP

Emissions Modeling Platform Collaborative: 2016beta Nonpoint Oil/Gas Sources

SCC	TOOL OR STATE SCC	PRODUCTION OR EXPLORATION SCC	SCCDESC
2310021251	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Lateral Compressors 4 Cycle Lean Burn
2310021300	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Gas Well Pneumatic Devices
2310021302	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Natural Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP
2310021310	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Gas Well Pneumatic Pumps
2310021351	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Lateral Compressors 4 Cycle Rich Burn
2310021400	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Gas Well Dehydrators
2310021450	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Wellhead
2310021500	STATE	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Gas Well Completion - Flaring
2310021501	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Fugitives: Connectors
2310021502	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Fugitives: Flanges
2310021503	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Fugitives: Open Ended Lines
2310021505	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Fugitives: Valves
2310021506	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Fugitives: Other
2310021509	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Fugitives: All Processes
2310021601	STATE	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Gas Well Venting - Initial Completions
2310021603	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Gas Well Venting - Blowdowns
2310021700	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production; Miscellaneous Engines
2310022000	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Off-Shore Gas Production; Total: All Processes
2310023010	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Storage Tanks: Condensate
2310023030	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Tank Truck/Railcar Loading: Condensate
2310023100	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; CBM Well Heaters

Emissions Modeling Platform Collaborative: 2016beta Nonpoint Oil/Gas Sources

SCC	TOOL OR STATE SCC	PRODUCTION OR EXPLORATION SCC	SCCDESC
2310023102	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; CBM Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP
2310023202	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; CBM Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP
2310023251	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Lateral Compressors 4 Cycle Lean Burn
2310023300	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Pneumatic Devices
2310023302	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; CBM Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP
2310023310	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Pneumatic Pumps
2310023351	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Lateral Compressors 4 Cycle Rich Burn
2310023400	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Dehydrators
2310023509	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Fugitives
2310023511	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Fugitives: Connectors
2310023512	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Fugitives: Flanges
2310023513	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Fugitives: Open Ended Lines
2310023515	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Fugitives: Valves
2310023516	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Fugitives: Other
2310023600	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; CBM Well Completion: All Processes
2310023603	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; CBM Well Venting - Blowdowns
2310023606	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; Coal Bed Methane Natural Gas; Mud Degassing
2310030300	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; Natural Gas Liquids; Gas Well Water Tank Losses
2310111100	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Exploration; Mud Degassing
2310111401	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Exploration; Oil Well Pneumatic Pumps

SCC	TOOL OR STATE SCC	PRODUCTION OR EXPLORATION SCC	SCCDESC
2310111700	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Oil Exploration; Oil Well Completion: All Processes
2310121100	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Exploration; Mud Degassing
2310121401	TOOL	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Exploration; Gas Well Pneumatic Pumps
2310121700	TOOL	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Exploration; Gas Well Completion: All Processes
2310321010	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production - Conventional; Storage Tanks: Condensate
2310321400	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production - Conventional; Gas Well Dehydrators
2310321603	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production - Conventional; Gas Well Venting - Blowdowns
2310400220	STATE	EXPLORATION	Industrial Processes; Oil and Gas Exploration and Production; All Processes - Unconventional; Drill Rigs
2310421010	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production - Unconventional; Storage Tanks: Condensate
2310421100	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production - Unconventional; Gas Well Heaters
2310421400	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production - Unconventional; Gas Well Dehydrators
2310421603	STATE	PRODUCTION	Industrial Processes; Oil and Gas Exploration and Production; On-Shore Gas Production - Unconventional; Gas Well Venting - Blowdowns

3. INVENTORY DEVELOPMENT METHODS

Oil and Gas Tool

EPA has developed the 2016 Nonpoint Oil and Gas Emission Estimation Tool (the “tool”) to estimate emissions for the 2016 beta version of the non-point oil and gas inventory. The tool has been previously used to estimate emissions for the 2014 National Emissions Inventory (NEI). Year 2016 oil and gas activity data was supplied to EPA by state air agencies and where state data is not supplied to EPA, EPA populates the 2016 beta inventory with the best available data. The tool is an Access database that utilizes county-level activity data (e.g. oil production and well counts), operational characteristics (types and sizes of equipment), and emission factors to estimate emissions. The tool creates a CSV-formatted emissions dataset covering all national nonpoint oil and gas emissions. This dataset is then converted to FF10 format for use in SMOKE modeling. A separate report named “2016 Nonpoint Oil and Gas Emission Estimation

Tool V1_0 December_2018.docx” was generated that provides technical details of how the tool was applied for the 2016 beta inventory.

Alternative datasets

Some states provided, or recommended use of, a separate np_oilgas emissions inventory for use in 2016 beta platform instead of emissions derived from the Oil and Gas Tool. For example, California developed their own np_oilgas emissions inventory for 2016, and we use that inventory in place of Oil and Gas Tool output in California.

In Pennsylvania, at that state’s request, we used the np_oilgas inventory from 2016 alpha platform instead of emissions from the Oil and Gas Tool. The 2016 alpha platform np_oilgas emissions were projected from 2014NElv2, using the projection factors listed in Table 2 for CO, NOX, and VOC only. These growth factors are based on historical production data released by EIA.

In Colorado, at that state’s request, we performed a projection of 2014NElv2 instead of using data from the Oil and Gas Tool. Here, projections were applied to CO, NOX, PM, and SO2, but not VOC. Projection factors for Colorado are listed in Table 2 and are based on historical production trends.

In Oklahoma, at that state’s request, EPA projected most production np_oilgas emissions from 2014NElv2, except for lateral compressors. Projection factors for Oklahoma np_oilgas production, based on historical production data, are listed in Table 2. For lateral compressor emissions in Oklahoma, the Oil and Gas Tool inventory for 2016 was used, except with a 72% cut applied to all emissions. Exploration np_oilgas emissions in Oklahoma are based on the Oil and Gas Tool inventory for 2016, without modification.

Table 2: 2014NElv2-to-2016 oil and gas projection factors for Pennsylvania, Colorado, and Oklahoma

State/region	Emissions type	Growth	Pollutant(s)
Pennsylvania	Oil	-7.9%	CO, NOX, VOC
Pennsylvania	Natural Gas	+24.8%	CO, NOX, VOC
Pennsylvania	Combination Oil + NG	+8.5%	CO, NOX, VOC
Pennsylvania	Coal Bed Methane	-13.6%	CO, NOX, VOC
Pennsylvania	Natural Gas Liquids	+17.8%	CO, NOX, VOC
Colorado	Oil	+22.0%	CO, NOX, SO2
Colorado	Natural Gas	+3.5%	CO, NOX, PM, SO2
Colorado	Combination Oil + NG	+12.8%	CO, NOX, PM, SO2
Oklahoma	Oil Production	+6.9%	All
Oklahoma	Natural Gas Production	+5.9%	All

State/region	Emissions type	Growth	Pollutant(s)
Oklahoma	Combination Oil + NG Production	+6.4%	All
Oklahoma	Coal Bed Methane Production	-30.0%	All

4. ANCILLARY DATA

Spatial Allocation

The exploration and production of oil and gas has increased in terms of quantities and locations over the last seven years, primarily through the use of new technologies, such as hydraulic fracturing. ERG prepared census-tract, 2-km, and 4-km sub-county surrogate factors for 23 surrogates for EPA to use in 2016 emissions modeling. A technical memo dated December 31, 2018 by ERG provides technical details of how the gridding surrogates were generated.

Spatial allocation of np_oilgas emissions to the national 36km and 12km domains used for air quality modeling is accomplished using the spatial surrogates described in ERG’s technical memo. Spatial surrogates map county polygons to the uniformly spaced grid cells of a air quality modeling domain. All spatial surrogates for np_oilgas are developed by ERG based on known locations of known oil and gas activity for year 2016.

These spatial surrogates, numbered 670 through 699, were originally processed at 4km resolution and without gapfilling. For use in 2016 beta platform, the surrogates were first gapfilled using fallback surrogates. For each surrogate, the last two fallbacks were surrogate 693 (Well Count – All Wells) and 340 (Land Area). Where appropriate, other surrogates were also part of the gapfilling procedure. For example, surrogate 670 (Spud Count – CBM Wells) was first gapfilled with 692 (Spud Count – All Wells), and then 693 and finally 340. After gapfilling, surrogates were aggregated to 12km and 36km resolution. All gapfilling and aggregating was performed with the Surrogate Tool. An additional set of spatial surrogates was provided at 9km resolution for Alaska.

A spatial surrogate cross-reference for each SCC was provided by ERG. Reports summarizing total emissions by spatial surrogate at the state and county level are included in the emissions modeling workgroup reports package. A national emissions summary by spatial surrogate is in Table 3.

Table 3. 2016ff np_oilgas emissions by spatial surrogate

Surrogate	Description	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
670	Spud Count - CBM Wells	0	0	0	0	0	0	113
671	Spud Count - Gas Wells	0	0	0	0	0	0	6,768
674	Unconventional Well	5,124	12	19,127	743	731	9	1,284

Surrogate	Description	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
	Completion Counts							
678	Completions at Gas Wells	1,448	0	274	0	0	6,743	32,577
679	Completions at CBM Wells	14	0	3	0	0	80	395
681	Spud Count - Oil Wells	0	0	0	0	0	0	16,718
683	Produced Water at All Wells	778	0	11	0	0	0	47,204
685	Completions at Oil Wells	1,343	0	254	0	0	763	27,822
687	Feet Drilled at All Wells	9,696	0	38,373	1,420	1,391	27	2,785
691	Well Counts - CBM Wells	45,240	0	32,341	481	481	12	27,342
692	Spud Count - All Wells	1,930	0	8,884	272	253	99	353
693	Well Count - All Wells	0	0	0	0	0	0	159
694	Oil Production at Oil Wells	21,449	0	4,165	0	0	15,385	1,060,803
695	Well Count - Oil Wells	216,752	0	143,918	3,105	3,099	34	600,255
696	Gas Production at Gas Wells	36,628	0	16,562	1,871	1,871	166	431,037
698	Well Count - Gas Wells	396,278	0	298,879	6,193	6,173	248	645,169
699	Gas Production at CBM Wells	3,574	0	2,413	312	312	25	7,612

Temporal Allocation

Monthly temporalization of np_oilgas emissions in 2016 beta platform is based primarily on monthly factors provided by ERG. These temporal profiles are described also in the December 31, 2018 Technical Memo. Factors were provided specific to each county and SCC. For use in SMOKE, each unique set of factors was assigned a label (OG0001 through OG6323), and then a SMOKE-formatted ATPRO_MONTHLY and an ATREF were developed.

This dataset of monthly temporal factors included profiles for all counties and SCCs in the Oil and Gas Tool inventory. Because we are using non-tool datasets in some states, this monthly temporalization dataset did not cover all counties and SCCs in the entire beta platform inventory. To fill in the gaps in California, Colorado, Oklahoma, and Pennsylvania, state average monthly profiles for oil, natural gas, and combination sources were calculated from EIA data and assigned to each county/SCC combination not already covered by the ERG monthly temporal profile dataset. Coal bed methane (CBM) and natural gas liquid sources in those four states were assigned flat monthly profiles where there was not already a profile assignment in the ERG dataset.

Because these monthly profiles are based on data that is specific to the year 2016, it may or may not be appropriate to use these profiles for other modeling years, such as 2014 or 2017. These same profiles are used in modeling of future years projected from 2016, however.

In the np_oilgas sector, all day-of-week and hour-of-day temporalization is flat.

Reports summarizing total emissions according to the monthly, day-of-week, and hour-of-day temporal profile assignments are included in the emissions modeling workgroup reports package at the state and county level.

Chemical Speciation

The np_oilgas sector includes speciation of PM_{2.5} and VOC emissions, and uses partial HAP integration for VOCs. All PM_{2.5} emissions in the np_oilgas sector use speciation profile 91145 (Petroleum Industry Average). VOC speciation relies in part on a combination GSREF file which assigns multiple profiles for certain FIPS and SCCs. Reports summarizing total PM_{2.5} and VOC emissions according to speciation profile are included in the emissions modeling workgroup reports package at the state and county level.

5. EMISSIONS PROJECTION METHODS

Future year projections for the 2016 beta platform have not yet been finalized at the time this was written.

6. EMISSIONS PROCESSING REQUIREMENTS

Np_oilgas sector emissions are processed for air quality modeling using the Sparse Matrix Operator Kernel Emissions (SMOKE¹) modeling system version 4.6. All np_oilgas sector inventories are annual. Since all day-of-week temporalization is flat, we could model this sector with a single representative day per month. However, to be consistent with the nonpt sector, we process this sector with seven representative days per month (one for each day of the week), plus holidays. This is a 2-D sector in which all emissions are output to a single layer gridded emissions file.

7. EMISSIONS SUMMARIES

National and state totals by pollutant for the beta platform cases are provided here. Plots and maps are available online through the LADCO website² and the Intermountain West Data Warehouse³.

¹ <http://www.smoke-model.org/index.cfm>

² <https://www.ladco.org/technical/modeling-results/2016-inventory-collaborative/>

³ <http://views.cira.colostate.edu/iwdw/eibrowser2016>

The case descriptions are as follows:

2011en, 2023en, 2028el = Final 2011, 2023, and 2028 cases from the 2011v6.3 platform

2014fd = 2014NElv2 and 2014 NATA

2016fe = 2016 alpha platform (grown from 2014NElv2)

2016ff = 2016 beta platform

Table 4. Comparison of national total annual CAPS np_oilgas emissions (tons/yr)

Pollutant	2011en	2014fd	2016fe	2016ff	2023en	2028el
CO	637,716	664,161	645,039	743,189	691,797	822,234
NH3		15	15	12		
NOX	668,418	690,642	678,563	567,292	672,243	744,504
PM10	17,819	17,798	17,798	14,434	24,815	31,700
PM2.5	16,368	17,532	17,532	14,347	21,821	28,822
SO2	17,430	39,025	39,025	23,636	49,905	42,785
VOC	2,611,994	3,058,936	3,012,127	2,933,607	3,094,534	2,174,463

Table 5. Comparison of state total annual NOx np_oilgas emissions (tons/yr)

State	2011en	2014fd	2016fe	2016ff	2023en	2028el
Alabama	10,823	9,113	7,889	8,792	6,853	6,960
Alaska	1,349	2,348	2,364	2,090	1,348	1,348
Arizona	15	15	3	9	14	25
Arkansas	11,419	7,168	5,720	5,521	7,312	8,864
California	2,282	2,274	2,518	1,877	1,599	1,663
Colorado	37,008	34,088	36,605	36,645	53,977	45,555
Florida	55	16	15	20	47	72
Idaho		5	5	12		
Illinois	8,495	8,495	7,732	23,478	7,039	15,983
Indiana	6,187	4,916	4,065	3,516	5,358	13,182
Kansas	56,387	61,891	50,981	49,832	36,901	44,876
Kentucky	24,056	11,467	10,695	15,903	18,763	46,907
Louisiana	45,871	31,746	27,894	28,442	29,248	52,810
Maryland	12	2	3	1	10	18
Michigan	11,048	10,137	8,637	11,665	7,157	24,751
Minnesota	0				0	0
Mississippi	3,394	9	7	2,806	2,603	3,843
Missouri	17	236	143	536	13	16
Montana	4,422	4,421	3,612	2,237	4,481	7,269
Nebraska	896	3	2	520	615	681
Nevada	19	11	10	3	14	28
New Mexico	41,430	37,018	37,573	33,143	42,987	34,742
New York	605	636	420	627	350	293

State	2011en	2014fd	2016fe	2016ff	2023en	2028el
North Dakota	18,687	35,597	38,963	14,572	38,001	27,198
Ohio	319	5,195	11,853	1,668	1,347	488
Oklahoma	66,436	73,204	76,957	56,046	56,318	50,493
Oregon	41	33	27	15	31	29
Pennsylvania	40,563	19,573	22,441	22,441	60,965	61,553
South Dakota	243	218	163	98	243	425
Tennessee	1,548	1,163	846	757	1,267	3,004
Texas	222,695	256,090	246,300	179,392	220,657	218,243
Utah	13,558	15,340	12,168	8,300	15,287	21,746
Virginia	9,577	9,934	8,602	10,199	6,437	9,707
West Virginia	21,472	25,734	32,183	29,249	36,130	29,175
Wyoming	7,491	22,540	21,161	16,882	8,870	12,556

Table 6. Comparison of state total annual VOC np_oilgas emissions (tons/yr)

State	2011en	2014fd	2016fe	2016ff	2023en	2028el
Alabama	21,312	17,909	15,356	15,600	15,764	14,265
Alaska	128,138	25,670	25,838	25,211	128,138	53,144
Arizona	68	62	10	47	69	49
Arkansas	12,553	12,420	10,132	12,539	7,708	5,197
California	14,278	110,267	100,936	7,505	15,209	12,810
Colorado	250,483	83,334	86,637	83,334	305,879	137,343
Florida	2,514	926	833	916	2,443	2,022
Idaho		9	9	514		
Illinois	27,437	27,437	24,833	117,342	22,784	19,683
Indiana	10,799	17,391	13,233	13,373	9,971	11,188
Kansas	93,310	97,094	77,213	89,595	61,692	33,325
Kentucky	29,912	28,363	25,270	40,564	25,273	43,866
Louisiana	112,560	67,314	57,030	57,592	75,078	80,656
Maryland	10	4	6	1	10	29
Michigan	31,712	25,217	21,105	22,656	21,384	41,586
Minnesota	0				0	0
Mississippi	23,665	11	10	11,382	19,726	17,735
Missouri	57	533	328	1,165	45	17
Montana	45,926	49,941	39,337	40,619	50,813	56,229
Nebraska	2,524	4	3	2,774	1,769	887
Nevada	448	219	194	169	311	527
New Mexico	125,358	173,068	190,403	180,794	160,310	78,540
New York	8,205	6,718	4,409	6,571	4,603	8,173
North Dakota	186,604	474,440	456,283	450,336	430,153	297,903
Ohio	10,178	14,658	30,475	15,559	47,927	12,379
Oklahoma	182,577	181,350	191,091	179,035	168,238	80,363
Oregon	53	44	36	32	43	17
Pennsylvania	18,618	118,844	145,977	145,977	38,438	39,610

State	2011en	2014fd	2016fe	2016ff	2023en	2028el
South Dakota	2,981	2,904	2,232	2,282	3,183	3,565
Tennessee	3,057	4,065	2,951	2,058	2,653	3,015
Texas	980,334	1,087,020	1,072,820	1,136,375	1,147,192	826,898
Utah	120,944	111,880	86,705	78,696	121,332	93,196
Virginia	8,354	12,161	10,579	11,736	5,354	11,981
West Virginia	46,863	100,782	127,204	108,456	104,163	129,133
Wyoming	110,160	206,876	192,649	72,803	96,880	59,131
Tribal Data		0	0			