March 11, 2019

SPECIFICATION SHEET: PTAGFIRE

Description: US agricultural burning emissions, for simulating 2016 U.S. air quality

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1. EXECUTIVE SUMMARY

The ptagfire emissions inventory was derived from the year 2016 specific Hazard Mapping System (HMS) fire activity over agricultural land. The emissions were calculated using crop-specific emissions factors. Base year inventories were processed with the Sparse Matrix Operating Kernel Emissions (SMOKE) modeling system version 4.6. The same inventories are used for base and future years. 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

Biomass burning is an important contributor to the degradation of air quality because of its impact on ozone and particulate matter. To implement and modify National Ambient Air Quality Standards (NAAQS) under the Clean Air Act in an effective and efficient manner, EPA's Office of Air and Radiation (OAR), EPA regional offices, and the States rely on robust emission inventories and modeling platforms. In the first step in the inventory process, the EPA estimated this emission source using remote sensing data. These estimates were then reviewed by the states and revised as resources allow. However, many states do not have the resources to estimate emissions for this sector. Therefore, remote sensing is necessary to fill in the gaps for regions where there is no other source of data. Crop residue emissions result from either pre-harvest or post-harvest burning of agricultural fields. The crop residue emission inventory for 2016 is day-specific and includes geolocation information by crop type. The method employed and described here is based on the same methods employed in the 2014 National Emissions Inventory (NEI). However, it should be noted that grassland fires were moved from "agricultural burning" sector to the prescribed and wildland fire sector for 2016beta inventory. This was done to prevent double-counting and because the largest fire (acres burned) in 2016 was a wild grassland fire in Kansas.

The ptagfire inventory sector contains daily agricultural burning emissions. Daily activity was derived from HMS fire activity data. The agricultural fires sector includes SCCs starting with '28015'. The first three levels of descriptions for these SCCs are: 1) Fires - Agricultural Field Burning; Miscellaneous Area Sources; 2) Agriculture Production - Crops - as nonpoint; and 3) Agricultural Field Burning - whole field set on fire. The SCC 2801500000 does not specify the crop type or burn method, while the more specific SCCs specify field or orchard crops and, in some cases, the specific crop being grown. The source category codes (SCCs) for this sector are in Appendix A.

3. INVENTORY DEVELOPMENT METHODS

Daily year-specific agricultural burning emissions are derived from HMS fire activity data, which contains the date and location of remote-sensed anomalies. The activity is filtered using the 2016 USDA cropland data layer (CDL). Satellite fire detects over agricultural lands are assumed to be agricultural burns and assigned a crop type. Detects that are not over agricultural lands are output to a separate file for use in the ptfire sector. Each detect is assigned an average size of between 40 and 80 acres based on crop type. The assumed field sizes can be found at http://www.epa.gov/sites/production/files/2015-06/draft_2014_ag_grasspasture_emissions_nei_may62015.xlsx.

Another feature of the database is that the satellite detections for 2016 were filtered out to exclude areas covered by snow during the winter months. To do this, the daily snow cover fraction per grid cell was extracted from a 2016 meteorological simulation (WRF). The location of fire detections was then compared with this daily snow cover file. For any day in which a grid cell has snow cover, that fire detection was excluded. Due to the inconsistent reporting of fire detections from the Visible Infrared Imaging Radiometer Suite (VIIRS) platform, any fire detections in the HMS dataset that were flagged as VIIRS or SUOMI were excluded. In addition, certain crop types (corn and soybeans) have been excluded from these specific midwestern states: Iowa, Kansas, Indiana, Illinois, Michigan, Missouri, Minnesota, Wisconsin, Ohio.

Emissions factors were applied to each daily fire to calculate criteria and hazardous pollutant values. These factors vary by crop type. In all prior NEIs for this sector, the HAP emission factors and the VOC emission factors were known to be inconsistent. The HAP emission factors were copied from the HAP emission factors for wildfires in the 2014 NEI and in the 2016 beta modeling platform. The VOC emission factors were scaled from the CO emission factors in the 2014 NEI and the 2016 beta modeling platform.

Heat flux for plume rise was calculated using the size and assumed fuel loading of each daily fire. This information is needed for a plume rise calculation within a chemical transport modeling system. In prior NEIs including the 2014 NEI, all the emissions were placed into layer 1 (i.e. ground level).

The daily agricultural and open burning emissions were converted from a tabular format into the SMOKE-ready daily point flat file format. The daily emissions were also aggregated into annual values by location and converted into the annual point flat file format.

State-specific data

Participating federal, regional, state, local and tribal agencies were encouraged to submit their own fire activity data for year 2016. Several agencies provided data and all data were incorporated into the 2016beta in some manner. The state of Georgia provided their own estimates of agricultural crop residue burning and completely replaced the emission estimates by the EPA. Idaho and the Nez Perce tribe (Idaho) provided daily activity data. The HMS information was replaced with the state-supplied activity data and the emissions were recomputed for this state.

Some additional fire detections from Minnesota were identified as agricultural fires that were originally identified as wildfires. These additional fires were added to the crop residue burning

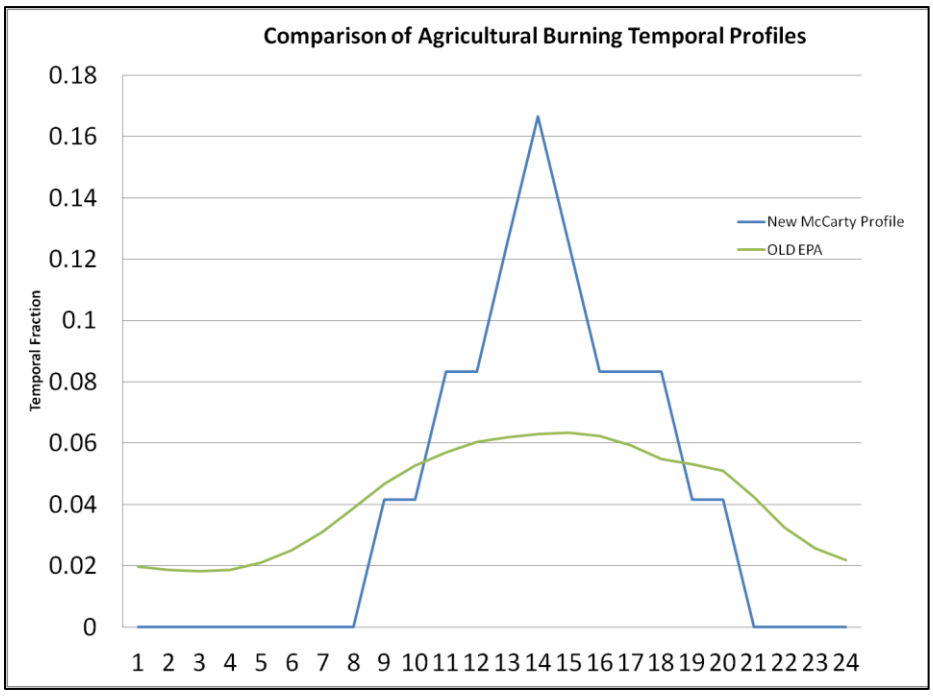
inventory for Minnesota. The state of Washington provided a month-specific supplemental agricultural burning inventory that was also used in the 2016 beta inventory.

4. ANCILLARY DATA

Temporal Allocation

The ptagfire sector emissions are day-specific and do not need allocation from the annual values. Agricultural burns use profile 500, which allocates all emissions to the daytime hours to reflect the workday as shown in Figure 1.

Figure 1. Agricultural burning diurnal temporal profile



Chemical Speciation

SMOKE was used to support Carbon Bond version 6 (CB6) TOG speciation for the 2016beta inventory. The speciation profiles are based on composite straw burning values. Additionally, aerosols under 2.5 microns are speciated using the AERO6 mechanism which is described in the Technical Support Document Preparation of Emission Inventories for the 2014 Emissions Modeling Platform (EPA, 2018). The PM2.5 speciation profile used is shown in Table 1.

Table 1. Speciation Profile for PM2.5 for the ptagfire sector

Specie	Factor
PAL	0.0003
PCA	0.00033
PCL	0.0905
PEC	0.109
PFE	0.0001
PK	0.0704
PMG	0.000806
PMOTHR	0.0239
PNA	0.00655
PNCOM	0.2717
PNH4	0.018
PNO3	0.0035
POC	0.3882
PSI	0.00015
PSO4	0.0165
PTI	0.00001

5. EMISSIONS PROJECTION METHODS

Agricultural burning emissions are year-specific and not projected to a future-year.

6. EMISSIONS PROCESSING REQUIREMENTS

The ptagfire sector emissions were processed for air quality modeling using version 4.6 of the Sparse Matrix Operator Kernel Emissions (SMOKE[1]) modeling system. Point fires were output to daily inline emissions files. A complementing daily stack groups file was output to provide fire locations. Plume rise may be calculated in SMOKE from the heat flux by providing meteorology and running laypoint. The resulting files are 3-dimensional gridded emissions files rather than inline.

The sector was run in two parts. The first job runs the smkinven for the annual inventory, defines the gridded matrix, and sets up the speciation cross-reference. The second job processes the daily emissions inventory through smkinven by month, applies diurnal temporal profiles, and outputs daily stack groups and inline emissions files.

[1] http://www.smoke-model.org/index.cfm

The heat flux value derived from fuel consumption and heat content was used to calculate plume rise. The model uses a modified version of the Briggs algorithm to calculate plume rise based on the heat flux with an assumed stack height of zero.

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 website[2] and the Intermountain West Data Warehouse[3]. The case descriptions are as follows:

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

2014fd = 2014NEIv2 and 2014 NATA

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

2016ff = 2016 beta platform

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

Pollutant	2011en, 2023en, 2028el	2014fd	2016fe	2016ff
CO	1,040,236	569,166	592,980	278,701
NH3	3,469	90,763	80,344	54,442
NOX	46,441	19,734	18,294	10,824
PM10	154,750	85,962	96,328	35,206
PM2.5	103,148	63,411	68,096	24,561
SO2	17,933	6,188	5,635	3,908
VOC	81,299	38,630	36,114	18,323

Table 3. Comparison of state total annual Primary PM10 ptagfire emissions (tons/yr)

State	2011en, 2023en, 2028el	2014fd	2016fe	2016ff
Alabama	714	1,269	890	394
Arizona	842	93	311	219
Arkansas	9,775	2,534	4,131	3,055
California	4,196	2,611	7,814	5,412
Colorado	5,941	47	826	319
Connecticut	10			
Delaware	26	0	15	13
Florida	3,513	19,775	4,679	2,951
Georgia	5,889	5,912	2,279	
Hawaii	1,567			
Idaho	922	1,607	1,808	1,313

[2] https://www.ladco.org/technical/modeling-results/2016-inventory-collaborative/

[3] http://views.cira.colostate.edu/iwdw/eibrowser2016

State	2011en, 2023en, 2028el	2014fd	2016fe	2016ff
Illinois	1	146	250	32
Indiana	56	79	81	12
Iowa	5	51	730	62
Kansas	23,904	15,410	26,324	2,349
Kentucky	1,648	402	499	276
Louisiana	8,798	1,866	2,469	1,695
Maine	4	0	3	3
Maryland	281	2	27	21
Massachusetts	14	2	1	1
Michigan	0	27	52	28
Minnesota	3,760	427	493	311
Mississippi	6,976	1,349	1,369	838
Missouri	12,111	2,246	3,239	623
Montana	3,208	1,450	2,093	932
Nebraska	3	643	1,718	907
Nevada	1,120	20	65	5
New Hampshire	32			
New Jersey	185	177	13	12
New Mexico	1,073	205	409	72
New York	728	25	48	34
North Carolina	1,358	872	591	382
North Dakota	16,048	2,932	4,905	3,335
Ohio	0	41	51	9
Oklahoma	2,326	8,439	13,248	1,532
Oregon	869	1,971	1,348	696
Pennsylvania	553	20	72	46
Rhode Island	1			
South Carolina	1,896	2,494	404	221
South Dakota	20,281	678	1,445	799
Tennessee	1,303	430	570	260
Texas	6,759	6,120	8,154	2,164
Utah	978	56	63	39
Vermont	60	0	3	2
Virginia	484	192	212	111
Washington	2,962	3,109	1,934	3,527
West Virginia	109	18	23	7
Wisconsin	0	85	109	36
Wyoming	1,114	128	559	149
Tribal Data	346			

Table 4. Comparison of state total annual Primary PM2.5 ptagfire emissions (tons/yr)

State	2011en, 2023en, 2028el	2014fd	2016fe	2016ff
Alabama	466	912	632	268
Arizona	557	69	224	156

State	2011en, 2023en, 2028el	2014fd	2016fe	2016ff
Arkansas	7,292	1,706	2,743	1,965
California	3,933	2,469	5,686	3,919
Colorado	3,166	35	580	207
Connecticut	5			
Delaware	26	0	8	7
Florida	2,800	15,527	3,676	2,391
Georgia	3,583	4,073	1,587	
Hawaii	1,441			
Idaho	876	1,079	1,269	899
Illinois	0	83	182	21
Indiana	31	38	59	9
Iowa	2	37	539	45
Kansas	14,253	10,861	18,389	1,536
Kentucky	977	256	328	169
Louisiana	8,278	1,398	1,879	1,288
Maine	3	0	2	2
Maryland	156	2	16	12
Massachusetts	9	2	1	1
Michigan	0	20	37	20
Minnesota	2,189	300	350	215
Mississippi	4,568	912	915	526
Missouri	7,421	1,640	2,369	436
Montana	2,084	1,040	1,506	653
Nebraska	1	475	1,077	487
Nevada	811	15	48	4
New Hampshire	18			
New Jersey	185	176	8	8
New Mexico	585	151	294	45
New York	411	16	31	22
North Carolina	1,290	560	380	232
North Dakota	10,002	1,964	3,238	2,116
Ohio	0	30	37	7
Oklahoma	1,373	6,124	9,546	937
Oregon	869	1,437	974	494
Pennsylvania	314	14	46	27
Rhode Island	1			
South Carolina	1,896	1,831	274	141
South Dakota	11,480	424	934	463
Tennessee	829	294	385	159
Texas	3,963	4,401	5,815	1,418
Utah	631	40	43	25
Vermont	38	0	2	2
Virginia	291	136	148	74
Washington	2,923	2,705	1,333	3,013
West Virginia	73	13	16	5

State	2011en, 2023en, 2028el	2014fd	2016fe	2016ff
Wisconsin	0	63	80	26
Wyoming	719	90	408	107
Tribal Data	328			

Appendix A:

Table A-1. The SCCs included in the ptagfire sector for the 2016 beta inventory

SCC	Description
2801500000	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Unspecified crop type and Burn Method
2801500100	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crops Unspecified
2801500112	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Alfalfa: Backfire Burning
2801500130	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Barley: Burning Techniques Not Significant
2801500141	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Bean (red): Headfire Burning
2801500150	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Corn: Burning Techniques Not Important
2801500151	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Double Crop Winter Wheat and Corn
2801500152	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;DoubleCrop Corn and Soybeans
2801500160	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Cotton: Burning Techniques Not Important
2801500170	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Grasses: Burning Techniques Not Important
2801500171	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Fallow
2801500182	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Hay (wild): Backfire Burning

SCC	Description
2801500202	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Pea: Backfire Burning
2801500220	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Rice: Burning Techniques Not Significant
2801500250	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Sugar Cane: Burning Techniques Not Significant
2801500262	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Field Crop is Wheat: Backfire Burning
2801500263	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;DoubleCrop Winter Wheat and Cotton
2801500264	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;DoubleCrop Winter Wheat and Soybeans
2801500300	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Orchard Crop Unspecified
2801500320	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Orchard Crop is Apple
2801500350	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Orchard Crop is Cherry
2801500410	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Orchard Crop is Peach
2801500420	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Orchard Crop is Pear
2801500500	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Vine Crop Unspecified
2801500600	Miscellaneous Area Sources;Agriculture Production - Crops - as nonpoint;Agricultural Field Burning - whole field set on fire;Forest Residues Unspecified