March 7, 2019

SPECIFICATION SHEET: PTFIRE_OTHNA

Description: Canadian, Mexican, and other non-US wildland and agricultural burning emissions, for simulating 2016 air quality

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1. EXECUTIVE SUMMARY

The ptfire_othna emissions inventory contains wildland and agricultural fire emissions in areas outside of the United States. The emissions are derived from the Fire INventory from NCAR (FINN) fire inventory data for most non-US regions. Wildland fire emissions from Environment and Climate Change Canada (ECCC) were available for select dates and used in place of the FINN where applicable. 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 province-level emission summaries for key pollutants are provided.

2. INTRODUCTION

The ptfire_othna inventory sector contains daily wildland fires and agricultural burns in regions outside of the United States, but within the regional modeling domains. The countries in this sector include Canada, Mexico, Cuba, Dominican Republic, Bahamas, Haiti, Jamaica, and portions of Central America. Due to the nature of the input data prescribed fires are not differentiated from wildfires.

Table 1. The SCCs included in the ptfire_othna sector for the 2016 beta inventory

SCC	Description
2810001000	Miscellaneous Area Sources; Other Combustion – as Event; Forest Wildfires; Total (Smoldering + Flaming) for Wildfires
2801500000	Miscellaneous Area Sources; Agriculture Production – Crops – as nonpoint; Agricultural Field burning – whole field set on fire; Unspecified crop type and Burn Method

3. INVENTORY DEVELOPMENT METHODS

FINN

Open biomass burning makes up an important part of the total global emissions of greenhouse gases, reactive trace gases, and particulate matter. Although episodic in nature and highly variable, open biomass burning emissions can contribute to local, regional, and global air quality problems and climate forcings. The Fire INventory from NCAR (FINN) model provides high resolution, global emission estimates from open burning; these emissions have been developed specifically to provide input needed for modeling atmospheric chemistry and air quality in a consistent framework at scales from local to global. The inventory framework produces daily emission estimates at a horizontal resolution of ~1 km2. The product differs from other inventories because it provides a unique combination of high temporal and spatial resolution, global coverage, and estimates for a large number of chemical species.

FINN emission estimates are based on the framework described by Wiedinmyer et al. [2006; 2011]. FINN uses satellite observations of active fires and land cover, together with emission factors and estimated fuel loadings to provide daily, highly-resolved (1 km) open burning emissions estimates for use in regional and global chemical transport models.

Canada

Environment and Climate Change Canada's FireWork air quality (AQ) forecast system for North America includes the development of near-real-time biomass burning emissions for the Canadian wildfire season since 2013. Biomass burning emissions are based on the Canadian Wildland Fire Information System (CWFIS). The CWFIS is a computer-based fire management information system (http://cwfis.cfs.nrcan.gc.ca/home) that monitors fire danger conditions across Canada. Daily weather conditions are collected from across Canada and used to produce fire weather and fire behavior maps. In addition, satellites are used to detect fires.

ECCC provided output wildland fire emissions and location data from FireWork for 1 April through 22 December, 2016. All fires in the ECCC dataset are assigned the wildfire SCC, 2810001000. A facility ID is created from the BlueSky fire ID. The EC emissions are aggregated and reformatted to annual and daily point inventory flat files. Canada fire emissions outside of the provided dates come from the FINN fires database.

Other non-US

The other non-US wildland and agricultural fire emissions are derived from the Fire Inventory from NCAR (FINN). Inventories are created from this dataset for Canada (1 January through 31 March; 23 December through 31 December), Mexico, Cuba, Dominican Republic, Bahamas, Haiti, Jamaica, and portions of Central America. The FINN fire emissions are processed from remote sensed data into a location-based emissions inventory (See https://www2.acom.ucar.edu/modeling/finn-fire-inventory-ncar). For the 2016 beta inventory the SAPRC99 FINN v1.5 release from 3 Sep 2018 was used. Fire detects below 50 square meters in size were assumed to be false detects and dropped. A preprocessor was run to prepare the FINN data for emissions processing. The preprocessor converted mole values to mass in tons. The heat flux of the burn is used to determine plume rise. Heat flux was calculated using the $PM_{2.5}$ mass emissions value, an assumed heat content value for woody biomass, and a relational factor as shown in the equation below:

*Heat Flux (BTU) = $PM_{2.5}$ (tons) * 139.76 (tons fuel/tons $PM_{2.5}$) * 8000 (BTU/lb) * 2000 (lb/tons)*

Locations were geocoded from the location of the detect in order to differentiate the country and, where applicable, province or state. The vegetation landcover type is provided in the GENVEG field of the FINN data. Fires with types 1 (grasslands or savanna) or 9 (croplands) are over agricultural vegetation type and assigned the agricultural burning SCC. Fires associated with vegetation types other than 1 or 9 are assigned the wildland fire burning SCC in Table 1. The preprocessor outputs annual and daily point flat files for each country.

4. ANCILLARY DATA

Temporal Allocation

The ptfire_othna sector emissions are daily and do not need allocation from the annual values. A single diurnal profile is used for wildfires, 210, which has a slight daytime peak. The agricultural burns use profile 500, which allocates all emissions to the daytime hours. A plot of these two diurnal profiles is in Figure 1. A table of emissions assigned to each diurnal profile is in Table 2.

Figure 1. Ptfire_othna diurnal profiles

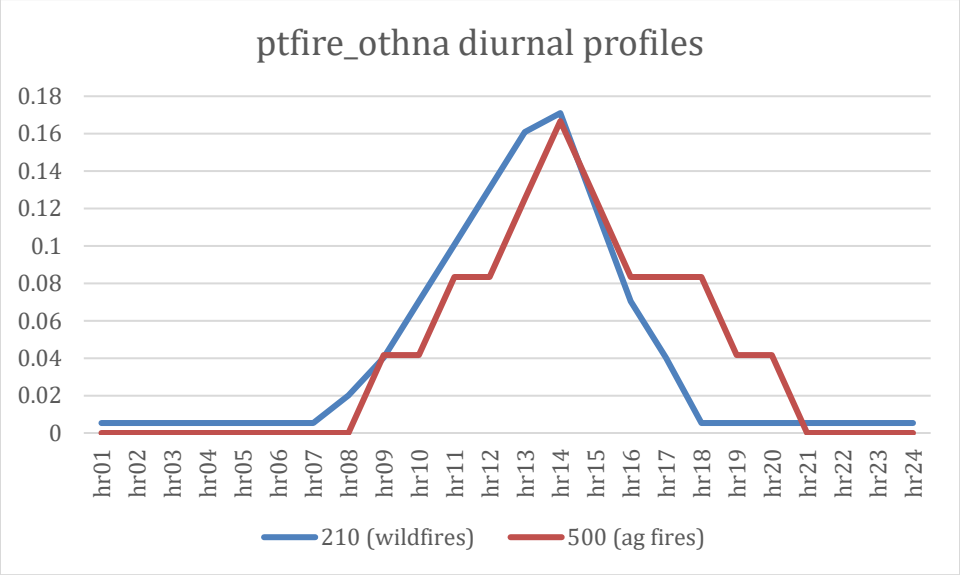

Table 2. Ptfire_othna emissions by diurnal profile

Diurnal profile	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
24[1]	108	2	1	10	9	1	25
210	19,887,519	334,139	746,816	2,966,088	2,053,547	151,370	5,454,680
500	1,658,987	28,616	95,046	131,499	104,813	8,061	764,560

[1] *This is an erroneous profile assignment affecting Nunavut province only and will be corrected for the 2016 version 1 platform.*

Chemical Speciation

SMOKE was used to support Carbon Bond version 6 (CB6) TOG speciation for the 2016beta inventory. Additionally, aerosols under 2.5 microns are speciated using AERO6. VOC speciation was applied using profile 5560 for wildfires (Biomass Burning – Extratropical Forest) and profile 8746 for ag fires (Straw Burning). PM2.5 speciation was applied using profiles 91102 (Wildfires) and 91103 (Agricultural Burning).

5. Emissions Projection Methods

Wildland and agricultural burning emissions are year-specific and not projected.

6. Emissions Processing Requirements

Ptfire_othna sector emissions are processed for air quality modeling using version 4.6 of the Sparse Matrix Operator Kernel Emissions (SMOKE[1]) modeling system. Point fires are output to daily inline emissions files. A complementing daily stack groups file is output to provide fire locations.

The sector is 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.

The heat flux value derived from fuel consumption and heat content is 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, province, and state totals by pollutant for the beta platform cases are provided here, and some example plots. 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. Note that the same emissions for this sectror are used in all the 2011 platform cases.

2014fd = 2014NEIv2 and 2014 NATA

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

2016ff = 2016 beta platform

[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

Table 3. Comparison of Canada national total annual CAPS ptfire_othna emissions (tons/yr)

Pollutant	2011en	2014fd	2016fe	2016ff
CO	4,838,557	43,544,545	10,320,204	10,440,419
NH3	82,363	6,233	181,018	183,314
NOX	83,249	720,846	262,129	267,341
PM10	520,561	4,539,922	1,186,167	1,204,195
PM2.5	441,110	3,847,441	1,006,574	1,021,633
SO2	35,769	362,961	93,762	94,819
VOC	1,175,210	10,344,472	2,612,317	2,637,828

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

Pollutant	2011en	2014fd	2016fe	2016ff
CO	11,991,507	452,048	7,959,701	7,952,377
NH3	181,167	8,348	121,178	121,030
NOX	563,043	19,550	348,519	348,266
PM10	1,867,913	51,628	1,159,000	1,157,982
PM2.5	1,154,701	42,719	748,427	747,684
SO2	67,518	3,090	45,385	45,339
VOC	3,415,491	151,850	2,273,114	2,270,393

Table 5. Comparison of province total annual NOx ptfire_othna emissions (tons/yr)

Province	2011en	2014fd	2016fe	2016ff
Alberta	20,186	21,545	114,802	114,588
British Columbia	24,560	219,594	60,560	60,448
Manitoba	1,870	5,442	7,733	7,749
NW Territories	6,232	428,316	32,136	36,074
New Brunswick	13	46	209	213
Newfoundland	3	2,636	384	382
Nova Scotia	0	40	197	199
Nunavut	0	46	1	1
Ontario	24,720	1,322	7,393	7,365
Prince Edward Island	0	0	17	17
Quebec	261	3,352	2,570	2,577
Saskatchewan	4,203	38,232	32,259	32,150
Yukon	1,200	273	3,866	5,578

Table 6. Comparison of state total annual NOx ptfire_othna emissions (tons/yr)

State	2011en	2014fd	2016fe	2016ff
Aguascalientes	64	15	163	161
Baja Calif	0	639	823	809
Campeche	90,933	41	64,890	64,910
Chiapas	64,150	261	57,347	57,330

State	2011en	2014fd	2016fe	2016ff
Chihuahua	11,614	2,861	4,492	4,468
Coahuila	3,314	184	317	310
Colima	1,125	21	1,825	1,808
Distrito Federal	273	0	46	46
Durango	14,743	3,094	4,332	4,269
Guanajuato	2,240	453	3,716	3,716
Guerrero	22,497	71	16,930	16,811
Hidalgo	3,871	85	1,744	1,784
Jalisco	16,927	163	23,653	23,657
Mexico	2,949	3	1,396	1,407
Michoacan	14,976	394	13,502	13,541
Morelos	731	50	478	466
Nayarit	5,863	383	5,539	5,524
Nuevo Leon	2,782	332	729	729
Oaxaca	50,785	272	41,455	41,479
Puebla	3,434	23	1,465	1,510
Queretaro	611	20	818	813
Quintana Roo	95,086	32	23,507	23,456
San Luis Potosi	8,217	110	2,256	2,328
Sinaloa	11,848	4,924	6,525	6,471
Sonora	3,838	1,449	1,952	1,961
Tabasco	8,258	227	7,071	6,981
Tamaulipas	12,949	2,850	4,300	4,344
Tlaxcala	235	2	208	207
Veracruz	22,703	297	15,462	15,564
Yucatan	85,545	13	40,993	40,813
Zacatecas	481	280	585	593

Table 7. Comparison of province total annual VOC ptfire_othna emissions (tons/yr)

Province	2011en	2014fd	2016fe	2016ff
Alberta	323,394	244,642	1,034,905	1,033,989
British Columbia	178,244	2,250,229	496,597	495,834
Manitoba	39,754	59,262	75,776	75,999
NW Territories	149,720	7,152,565	457,482	475,300
New Brunswick	172	387	2,074	2,137
Newfoundland	87	25,845	4,256	4,252
Nova Scotia	13	540	2,516	2,528
Nunavut	17	2,179	25	25
Ontario	369,328	17,984	60,168	59,984
Prince Edward Island	0	4	172	171
Quebec	5,544	32,364	23,875	23,956
Saskatchewan	89,258	554,465	417,955	417,298
Yukon	19,680	4,005	36,517	46,353

Table 8. Comparison of state total annual VOC ptfire_othna emissions (tons/yr)

State	2011en	2014fd	2016fe	2016ff
Aguascalientes	587	152	1,457	1,431
Baja Calif	0	5,443	7,986	7,832
Campeche	583,949	175	429,992	430,766
Chiapas	366,579	1,775	325,182	324,892
Chihuahua	54,333	23,811	35,987	35,686
Coahuila	10,881	696	1,655	1,550
Colima	6,736	53	13,465	13,201
Distrito Federal	1,230	0	331	331
Durango	81,527	22,195	30,712	30,098
Guanajuato	19,283	4,267	37,154	37,101
Guerrero	105,815	292	98,648	97,671
Hidalgo	23,884	547	10,463	10,742
Jalisco	89,541	1,167	180,889	180,667
Mexico	14,227	8	10,211	10,302
Michoacan	60,676	2,931	79,611	79,846
Morelos	3,638	244	3,371	3,196
Nayarit	33,200	3,161	38,020	37,827
Nuevo Leon	15,649	1,902	4,360	4,365
Oaxaca	301,494	1,343	249,161	249,140
Puebla	20,064	59	8,742	9,005
Queretaro	4,100	191	6,358	6,338
Quintana Roo	554,908	178	135,316	134,917
San Luis Potosi	54,453	838	14,285	14,717
Sinaloa	91,794	40,764	52,935	52,528
Sonora	23,018	10,685	15,109	15,218
Tabasco	64,120	2,068	51,567	51,064
Tamaulipas	87,302	21,869	31,005	31,414
Tlaxcala	1,730	5	1,967	1,962
Veracruz	182,187	2,859	117,469	118,259
Yucatan	556,782	124	276,105	274,663
Zacatecas	1,802	2,048	3,599	3,665

8. REFERENCES

Wiedinmyer, C., S. K. Akagi, R. J. Yokelson, L. K. Emmons, J. A. Al-Saadi, J. J. Orlando, and A. J. Soja. "The Fire Inventory from Ncar (Finn): A High Resolution Global Model to Estimate the Emissions from Open Burning." Geoscientific Model Development 4, no. 3 (2011): 625-41. (http://www.geosci-model-dev.net/4/625/2011/gmd-4-625-2011.html)

Wiedinmyer, Christine, Brad Quayle, Chris Geron, Angle Belote, Don McKenzie, Xiaoyang Zhang, Susan O'Neill, and Kristina Klos Wynne. "Estimating Emissions from Fires in North America for Air Quality Modeling." Atmospheric Environment 40, no. 19 (2006): 3419-32.