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SPECIFICATION SHEET: OTHAFDUST

Description: Canadian area source dust (othafdust) emissions, for simulating 2016 and future year air quality

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1. EXECUTIVE SUMMARY

Canadian area source dust emissions are processed in the othafdust sector using an inventory provided by Environment and Climate Change Canada (ECCC) for year 2015. Temporal profiles and spatial allocation are also provided by ECCC. Consistent with the afdust sector in the US, othafdust emissions are reduced using a gridded transport fraction file, and then reduced further based on snow cover and precipitation. 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

This document details the approach and data sources to be used for developing 2016 emissions for the Canadian area source fugitive dust (othafdust, which means “other afdust”) sector. Emissions for this sector are provided by ECCC for the year 2015 and are used directly (i.e. without projecting) for 2016 modeling. No analogous emissions are available for Mexico.

The emissions inventory does not incorporate the application of transport fraction reductions or meteorological impacts. Instead, those reductions are applied to the emissions after SMOKE processing is complete. The procedure for applying transport fraction reductions and meteorological reductions is the same as in the US afdust sector. Additional background information on the reductions is available in the nonpoint afdust sector document.

For beta platform, a portion of Canadian fugitive dust emissions is included in the othpdtust sector (point sources). That sector is summarized in a separate document.

A list of all SCCs in the othafdust sector is provided in Table 1. SCC descriptions are not available for the 231108* series of SCCs.

Table 1: SCCs in the othafdust sector

SCC	Tier 1 description	Tier 2 description	Tier 3 description	Tier 4 description
2294000000	Mobile Sources	Paved Roads	All Paved Roads	Total: Fugitives
2296000000	Mobile Sources	Unpaved Roads	All Unpaved Roads	Total: Fugitives
2311010000	Industrial Processes	Construction: SIC 15 - 17	Residential	Total
2311030000	Industrial Processes	Construction: SIC 15 - 17	Road Construction	Total
2311080301	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080302	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080304	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080306	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080307	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080308	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown

SCC	Tier 1 description	Tier 2 description	Tier 3 description	Tier 4 description
2311080309	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080310	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080311	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2311080399	Industrial Processes	Construction: SIC 15 - 17	Unknown	Unknown
2730100000	Natural Sources	Geogenic	Wind Erosion	Total
2805000000	Miscellaneous Area Sources	Ag. Production - Livestock	Agriculture - Livestock	Total
2805020001	Miscellaneous Area Sources	Ag. Production - Livestock	Cattle and Calves Waste Emissions	Milk Cows
2805020002	Miscellaneous Area Sources	Ag. Production - Livestock	Cattle and Calves Waste Emissions	Beef Cows
2805025000	Miscellaneous Area Sources	Ag. Production - Livestock	Swine production composite	Not Elsewhere Classified (see also 28-05-039, -047, -053)
2805030003	Miscellaneous Area Sources	Ag. Production - Livestock	Poultry Waste Emissions	Layers
2805030004	Miscellaneous Area Sources	Ag. Production - Livestock	Poultry Waste Emissions	Broilers
2805030009	Miscellaneous Area Sources	Ag. Production - Livestock	Poultry Waste Emissions	Turkeys
2805035000	Miscellaneous Area Sources	Ag. Production - Livestock	Horses and Ponies Waste Emissions	Not Elsewhere Classified
2805040000	Miscellaneous Area Sources	Ag. Production - Livestock	Sheep and Lambs Waste Emissions	Total
2805045002	Miscellaneous Area Sources	Ag. Production - Livestock	Goats Waste Emissions	Angora Goats

3. INVENTORY DEVELOPMENT METHODS

ECCC provided the Canadian area source fugitive dust emissions inventory for 2015 in a format that is close to, but not exactly the same as the Flat File 2010 format. Some columns that are unused by SMOKE contained metadata that needed to be reformatted or moved prior to importing the data into EPA's Emissions Modeling Framework (EMF), due to restrictions on variables types imposed by the FF10 format (e.g. character values in numeric fields).

The othafdust emissions inventory includes annual emissions. Emissions for year 2015 were used directly for year 2016 modeling in beta platform. The inventory is province-level in all provinces.

Detailed documentation of the ECCC emissions inventories for 2015 is provided in Documentation for SMOKE-Ready 2015 Air Pollutant Emission Inventory (APEI) Package version 1 (ECCC, 2018).¹

The othafdust sector includes the area source “fdust PM” inventory.

4. ANCILLARY DATA

Spatial Allocation

Spatial allocation of othafdust emissions to the national 36km and 12km domains used for air quality modeling is accomplished using spatial surrogates. Spatial surrogates map county polygons to the uniformly spaced grid cells of a modeling domain. For development of spatial surrogates, ECCC did not provide spatial surrogates directly, but instead provided shapefiles and specification files for running the Surrogate Tool. Using those inputs, we ran the Surrogate Tool to create Canadian spatial surrogates for the 36US3 and 12US1 grids.

ECCC provided a cross-reference for mapping SCCs to their surrogates. Reports summarizing total emissions by spatial surrogate at the state and county level are included in the emissions modeling workgroup reports package. A national summary of emissions by spatial surrogate is in Table 2. Note that Canadian surrogate codes are not consistent with US surrogate codes.

Table 2. Othafdust emissions by spatial surrogate (36US3 grid, no transport or meteorological adjustments)

Surrogate	Description	PM10	PM2.5
106	CAN ALL_INDUST	61,097	12,219
212	CAN Mining except oil and gas	2,907	727
221	CAN Total Mining	1,736,053	347,211
222	CAN Utilities	280,364	56,161
940	CAN Paved Roads New	1,332,260	292,838
955	CAN UNPAVED_ROADS_AND_TRAILS	2,640,029	390,862
960	CAN TOTBEEF	5,802	1,289

¹ ECCC 2018. Documentation for SMOKE-Ready 2015 Air Pollutant Emission Inventory (APEI) Package version 1 ftp://newftp.epa.gov/air/emismod/2016/beta/reports/A18031_2015_Canadian_CAC_EmissionsInventoryPackage_version1.pdf

Surrogate	Description	PM10	PM2.5
970	CAN TOTPOUL	1,541	184
980	CAN TOTSWIN	3,566	792
990	CAN TOTFERT	619	321
996	CAN urban_area	6,738	1,348

Information on the transport fraction reductions and meteorological reductions is available in the afdust sector document. The procedure is the same for the othafdust sector, except that emissions for the 36US3 grid are not aggregated from the 12US1 grid, since the 36US3 grid covers a much larger part of Canada than does 12US1. Instead, for the othafdust sector, transportable fraction and meteorological adjustments are applied to gridded emissions independently for 12US1 and 36US3. This means post-adjusted othafdust emissions will differ based on the grid resolution, especially because of the meteorological adjustments. In lower resolution grids such as 36US3, a greater area will have nonzero precipitation or snow cover at any given time, resulting in more emissions reductions due to meteorological impacts in lower resolution grids.

Temporal Allocation

The othafdust inventory is annual and is temporalized to hourly using month-of-year, day-of-week, and hour-of-day temporal profiles. ECCC provided temporal profiles and an SCC cross-reference. The Canadian temporal profiles used in beta platform differ from those provided by Environment Canada in the following ways:

- ECCC provided temporal profiles and cross-references in a format used by older versions of SMOKE (3.5 and earlier). We converted their profiles and cross-reference to the format used by SMOKE 4.6.
- The provided cross-reference included an overall default profile (SCC=000000000) to be used when specific SCCs were not included in the cross-reference. As a standard practice, we do not include an overall default profile in our temporal cross-reference, so we removed that assignment and filled in missing SCCs, with profiles assigned to those for similar SCCs as needed.

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. A national emissions summary by temporal profile is in Table 3.

Table 3. 2016ff othafdust emissions by temporal profile (no transport or meteorological adjustments)

Monthly profile	Weekly profile	Diurnal profile ¹	PM10	PM2.5
262	7	26	874	219
536	103	103	173	43
537	103	103	1,190	298
538	103	103	72	18
539	103	103	216	54
540	103	103	381	95
80001	2002	2013	16,269	3,913
80001	20021	2013	25,998	3,785
80002	2002	2013	5,604	1,346
80002	20021	2013	8,245	1,214
80003	2002	2013	31,544	7,580
80003	20021	2013	46,936	7,039
80004	2002	2013	33,298	7,996
80004	20021	2013	49,374	7,267
80005	2002	2013	143,920	34,713
80005	20021	2013	346,562	50,869
80006	2002	2013	201,182	48,584
80006	20021	2013	582,429	85,575
80007	2002	2013	37,983	9,141
80007	20021	2013	129,130	18,990
80008	2002	2013	17,187	4,196
80008	20021	2013	154,630	22,679
80009	2002	2013	50,057	12,266
80009	20021	2013	1,179,653	176,684
80010	2002	2013	96,762	23,385
80010	20021	2013	110,559	15,851
80011	2002	2013	707	170
80011	20021	2013	2,553	376
80012	2002	2013	537	134
80012	20021	2013	2,217	305
80013	20021	2013	1,745	228
95000	7	26	464	103
95001	7	26	878	195
95002	7	26	1,038	231
95003	7	26	708	157
95004	7	26	34	7
95005	7	26	46	10
95006	7	26	32	7
95007	7	26	6	1
95008	7	26	2,310	513
95009	7	26	287	64

Monthly profile	Weekly profile	Diurnal profile ¹	PM10	PM2.5
95020	7	26	108	13
95021	7	26	60	7
95022	7	26	569	68
95023	7	26	348	42
95024	7	26	32	4
95025	7	26	54	6
95026	7	26	5	1
95027	7	26	15	2
95028	7	26	138	17
95029	7	26	211	25
95030	7	26	789	175
95031	7	26	320	71
95032	7	26	816	181
95033	7	26	1,166	259
95034	7	26	12	3
95035	7	26	4	1
95036	7	26	13	3
95037	7	26	0	0
95038	7	26	422	94
95039	7	26	24	5
95040	101	25	5	3
95041	101	25	400	153
95042	101	25	131	104
95043	101	25	17	14
95044	101	25	10	4
95045	101	25	0	0
95046	101	25	0	0
95047	101	25	0	0
95048	101	25	29	17
95049	101	25	28	26
95051	13	25	2,782,373	556,563

¹ The 2013 temporal profile has different versions for weekdays (2013wd) and weekends (2013we).

Chemical Speciation

The othafdust sector includes speciation of PM2.5 emissions using the same profiles and SCC cross-references as in the US. Reports summarizing total PM2.5 emissions according to speciation profile are included in the emissions modeling workgroup reports package at the state and county level.

5. EMISSIONS PROJECTION METHODS

ECCC provided area stationary source inventories for the years 2023 and 2028. Unlike in their 2015 inventories in which area dust emissions were grouped into a separate file, these sources were not provided as separate inventories for the future years, and so othafdust sector emissions were extracted from that single area source inventory. The othafdust inventory includes PM emissions for all SCCs listed in Table 1. As with 2015, the future year dust emissions are pre-adjusted, so future year othafdust follows the same emissions processing methodology as the base year.

6. EMISSIONS PROCESSING REQUIREMENTS

Othafdust emissions are processed for air quality modeling using the Sparse Matrix Operator Kernel Emissions (SMOKE²) modeling system. Gridded emissions output from SMOKE do not have any transport fraction or meteorological adjustments applied, and so SMOKE outputs are considered “unadjusted” emissions. For this sector, extra steps are needed outside of SMOKE to apply those adjustments.

First, the transport fraction, represented as a gridded file called the XPORTFRAC (see Section 4 of the afdust sector document, Spatial Allocation), is applied to the emissions using a Fortran program called “mult” that multiplies an emissions file by a gridded set of fractions. Output files from this step are placed in the same premerged/othafdust directory, but with “xportfrac” in the file name.

Second, meteorological adjustments are applied to the xportfrac-adjusted emissions, in which emissions are zeroed out whenever there is snow cover or falling precipitation. Output files from this step are assigned a new sector name: “othafdust_adj”. Only the othafdust_adj emissions, and not the unadjusted othafdust emissions, should be included in the final sector merge or any downstream modeling.

Othafdust emissions are processed through SMOKE using representative days: one file for each day of the week per month. Holiday-specific temporalization is not performed in Canada. Transport fractions are not time-dependent, and are applied on a representative day basis. Meteorological adjustments are time-dependent, and so emissions with meteorological adjustments are generated separately for every day of the year.

This is a 2-D sector in which all emissions are output to a single layer gridded emissions file.

² <http://www.smoke-model.org/index.cfm>

7. EMISSIONS SUMMARIES

National and province totals by pollutant for the beta platform cases are provided here. Plots and maps are available online through the LADCO website³ and the Intermountain West Data Warehouse⁴.

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 Canada national total annual CAPS othafdust emissions (tons/yr)

Pollutant	2011en	2014fd	2016fe	2016ff	2023en	2023ff	2028el	2028ff
PM10	8,573,732	8,573,732	8,980,673	6,071,887	10,201,496	6,658,125	6,018,802	7,094,961
PM2.5	1,643,832	1,643,832	1,713,360	1,104,163	1,921,946	1,205,210	938,015	1,280,555

Table 5. Comparison of province total annual Primary PM10 othafdust emissions (tons/yr)

Province	2011en	2014fd	2016fe	2016ff	2023en	2023ff	2028el	2028ff
Alberta	3,689,428	3,689,428	3,939,431	2,775,242	4,689,441	3,012,543	2,542,060	3,235,704
British Columbia	316,144	316,144	336,627	272,228	398,077	332,113	244,323	358,895
Manitoba	415,451	415,451	435,053	254,280	493,858	277,607	329,875	296,812
NW Territories	9,846	9,846	10,567	9,797	12,730	10,345	64,592	10,629
New Brunswick	99,860	99,860	100,938	84,925	104,173	93,803	99,617	99,124
Newfoundland	69,629	69,629	72,761	64,010	82,156	68,793	49,822	72,796
Nova Scotia	92,705	92,705	95,543	80,090	104,056	89,250	95,892	96,221
Nunavut	3,430	3,430	3,849	2,984	5,108	3,374	2,418	3,599
Ontario	1,317,286	1,317,286	1,367,075	1,075,689	1,516,444	1,229,099	1,153,172	1,306,544
Prince Edward Island	19,736	19,736	20,947	14,143	24,579	16,366	19,103	17,683
Quebec	757,644	757,644	784,414	635,274	864,726	695,513	661,758	727,947
Saskatchewan	1,777,722	1,777,722	1,807,904	798,992	1,898,450	824,634	748,518	863,926
Yukon	4,851	4,851	5,563	4,232	7,698	4,685	7,652	5,081

Table 6. Comparison of province total annual Primary PM2.5 othafdust emissions (tons/yr)

Province	2011en	2014fd	2016fe	2016ff	2023en	2023ff	2028el	2028ff
Alberta	675,112	675,112	717,370	498,140	844,144	537,510	398,799	575,120

³ <https://www.ladco.org/technical/modeling-results/2016-inventory-collaborative/>

⁴ <http://views.cira.colostate.edu/iwdw/eibrowser2016>

Province	2011en	2014fd	2016fe	2016ff	2023en	2023ff	2028el	2028ff
British Columbia	61,460	61,460	65,321	52,277	76,904	63,837	46,869	68,959
Manitoba	88,670	88,670	92,162	45,606	102,639	49,393	41,709	52,723
NW Territories	1,872	1,872	2,002	1,851	2,392	1,939	12,537	1,982
New Brunswick	18,865	18,865	19,064	15,715	19,660	17,348	18,144	18,329
Newfoundland	13,092	13,092	13,661	12,049	15,367	12,908	9,165	13,685
Nova Scotia	17,359	17,359	17,883	14,938	19,455	16,646	17,851	17,945
Nunavut	533	533	594	478	778	535	413	566
Ontario	248,277	248,277	256,385	192,686	280,709	219,579	192,411	232,824
Prince Edward Island	4,296	4,296	4,519	2,619	5,188	3,030	3,173	3,274
Quebec	141,835	141,835	146,396	114,612	160,077	125,046	112,919	130,551
Saskatchewan	371,616	371,616	377,037	152,446	393,299	156,615	82,622	163,709
Yukon	845	845	967	742	1,333	821	1,402	889