October 15, 2019

SPECIFICATION SHEET: OTHPTDUST

Description: Canadian point source dust (othptdust) emissions, for simulating 2016 air quality

1. EXECUTIVE SUMMARY

Canadian point source dust emissions are processed in the othptdust sector using inventories provided by Environment and Climate Change Canada (ECCC) for year 2015. Temporal profiles and spatial allocation are also provided by ECCC. Even though the sources are point sources, they are output to a gridded low-level (2-D) emissions file and do not have plume rise. Consistent with the afdust sector in the US, othptdust 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 point source fugitive dust (othptdust, which means “other point dust”) sector. Emissions for this sector are provided by ECCC for the year 2015 and are used directly (i.e., without projecting) for 2016 modeling. This sector was new for the 2016 beta platform, and therefore does not exist in any other recent modeling cases. No analogous emissions are available for Mexico.

In their inventory package for 2015, ECCC provided six separate inventories for ag, all represented as point sources: animal NH3, animal VOC, harvest, synth_fertilizer, tillage, and winderros (i.e., wind erosion). The harvest, tillage, and winderros inventories each include a single SCC, 2801000001 (land breaking associated with agriculture), and only include PM emissions. (The other three ag point source inventories are included in the othpt sector.) These types of emissions have been part of the othafdust inventory in previous platforms, and so it is appropriate to apply transport fraction and meteorological adjustments to the SMOKE outputs from these three inventories. But, since these emissions are now represented as point sources, they cannot be included in the othafdust sector; they must be processed separately as point sources.

The emissions inventory does not incorporate the application of transport fraction reductions or meteorological impacts, so 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, except that the underlying emissions are point sources instead of area sources. Additional background information on the transport fraction reductions is available in the afdust sector document. Canadian area source fugitive dust emissions are covered in the othafdust sector document.

For 2016v1, the winderros inventory was not included in an effort to reduce the bias related to PM in border areas with the U.S. In addition, the use of the point dust inventory as-is in the beta platform caused an artifact of concentrated emissions in gridded lines due to the rotated 10-km grid on which the inventories were provided. To correct this artifact in v1, a smoothing algorithm was applied prior to processing the emissions through SMOKE.

There is only a single SCC in this sector: 2801000001 (land breaking associated with agriculture).

3. INVENTORY DEVELOPMENT METHODS

ECCC provided the Canadian point source fugitive dust emissions inventory for 2015 in a format that is close to, but not exactly, FF10. 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). Also, accented characters needed to be removed from facility names to facilitate importing the data into EMF. Finally, point source IDs such as the unit_id and rel_point_id were added to the inventory where necessary, since these IDs are required by SMOKE.

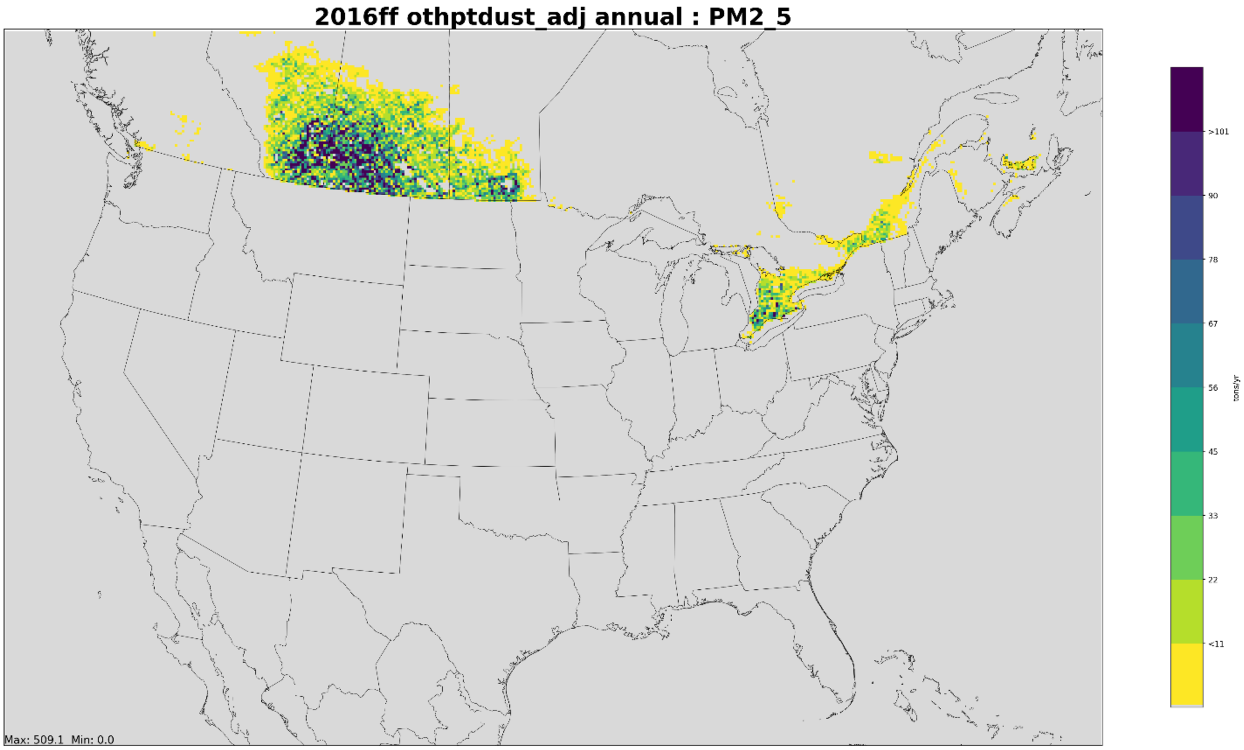
The othptdust emissions inventory includes monthly emissions. Emissions for year 2015 were used directly for year 2016 modeling in the beta and v1 platforms. Point sources are assigned to census division-level FIPS codes.

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] In 2016v1, the othptdust sector includes two of the six ag inventories: harvest and tillage.

A peculiar spatial allocation was discovered in the emissions, in which diagonal lines in a "waffle pattern" have more pronounced emissions. This waffle pattern was due to the ECCC point inventory being allocated on a different resolution grid, 10km in this case, than we use in our emissions modeling platforms. When 10km resolution points are plotted on a 12km resolution grid, the resulting spatial allocation is uneven. This "waffle pattern" is illustrated in Figure 1.

[1] ECCC 2018. Documentation for SMOKE-Ready 2015 Air Pollutant Emission Inventory (APEI) Package version 1. Available from ftp://newftp.epa.gov/air/emismod/2016/v1/reports/A18031_2015_Canadian_CAC_EmissionsInventoryPackage_version1.pdf

Figure 1. 2016ff 12US1 othptdust annual $PM_{2.5}$ emissions with “waffle pattern”



After modeling the 2016ff emissions case, new versions of the 2015 Canada point ag and dust inventories were developed with an improved spatial allocation. Spatial apportionment factors were calculated using the area of overlap between the 10 km Canada Lambert grid and a 4 km resolution grid with the same boundaries and grid projection as the 36US3 modeling domain. The 2015 Canada point ag dust emissions were placed into the 10 km grid cells based on the inventory latitude and longitude and aggregated by province and location. The spatial factors were then applied to allocate the emissions to the 4 km grid cells. Centroid latitude and longitudes for each respective emitting 4 km grid cell were used to fill the location information of the resulting point Flat File. The 4 km resolution inventories were then aggregated to 12 km resolution in order to reduce the size of the inventory. This platform uses the new reallocated point dust inventories.

4. Ancillary Data

Spatial Allocation

Spatial allocation of othptdust emissions to the national 36km and 12km domains used for air quality modeling is accomplished using the latitude and longitude as provided in the point source inventory.

Information on the transport fraction reductions and meteorological reductions is available in the afdust sector document. The procedure is the same for the othptdust 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, transportable fraction and meteorological adjustments are separately applied to gridded emissions for the 12US1 and 36US3 domains. This means post-adjusted othptdust emissions will differ between grid resolutions, especially due to 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 a greater emissions reduction due to meteorological impacts in lower resolution grids.

Temporal Allocation

The othptdust inventory is monthly and is temporalized to hourly within SMOKE using day-of-week and hour-of-day temporal profiles. ECCC provided temporal profiles and an SCC cross-reference. The Canadian temporal profiles used in the beta and v1 platforms differ from those provided by ECCC 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 4.7.
- ECCC's 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 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. The entire sector uses weekly profile 101 and diurnal profile 25.

Chemical Speciation

The othptdust sector includes speciation of PM2.5 emissions using the same profiles and SCC cross-references as in the US. The entire othptdust sector uses PM speciation profile 91101 (Agricultural Soil).

5. EMISSIONS PROJECTION METHODS

ECCC had provided their own future year projections of the harvest and tillage point ag dust inventories, but those inventories exhibited the same waffle pattern as 2015, so we instead decided to project the improved 2015 inventories. ECCC separately provided data from which future year projections could be derived in a file called “Projected_CAN2015_2023_2028.xlsx”, which includes emissions data for 2015, 2023, and 2028 by pollutant, province, ECCC sub-class code, and other source categories. This data was used to calculate 2015-to-2023 and 2015-to-2028 projection factors, which were then applied to the improved 2015 Canada point ag dust inventories to create projections for 2023 and 2028. Emissions values from these in-house projections were found to be close in magnitude to ECCC’s own projections.

Projection factors were applied by province, sub-class code, and pollutant. The ECCC projection workbook included additional source information which provides more detail than do the sub-class codes, but that more detailed information could not be easily mapped to the inventory, and the level of detail offered by the sub-class codes was considered sufficient for projection purposes. For the othptdust sector, there are separate sub-class codes for each of the two inventories (harvest and tillage).

6. Emissions Processing Requirements

Othptdust emissions were processed for air quality modeling using the Sparse Matrix Operator Kernel Emissions (SMOKE[2]) 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). Since the point source inventories are monthly, the onetime step is run once for every month.

Even though the inventories are point sources, land breakage dust emissions are low-level emissions. Therefore, we do not want plume rise applied to these emissions. Also, to apply transport fraction and meteorological reductions, which are done spatially, we must process the emissions as 2-D gridded emissions rather than as inline point source emissions. Thus, for this sector, we omit the Elevpoint program altogether, and process SMOKE with SMK_ELEV_METHOD = 0 and SMK_SPECELEV_YN = N so that all sources are classified as low-level sources and output to the 2-D single layer gridded emissions file. Once a set of gridded 2-D emissions has been generated, emissions reductions can be processed for othptdust the same way as for the afdust and othafdust sectors.

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.

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

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/othptdust 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: "othptdust_adj". Only the othptdust_adj emissions, and not the unadjusted othptdust emissions, should be included in the final sector merge or any downstream modeling. Unlike for other point sources, all emissions from this sector will be included in the 2-D gridded emissions, without a separate inline point source file for CMAQ.

Othptdust emissions were 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.

7. EMISSIONS SUMMARIES

National and province totals by pollutant for the various platform cases are provided here. Plots and maps are available online through the LADCO website[3] and the Intermountain West Data Warehouse[4]. This sector was new for the 2016 beta platform, and therefore does not exist in the earlier cases.

The case descriptions are as follows:

2014fd = 2014NEIv2 and 2014 NATA

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

2016ff, 2023ff, 2028ff = 2016 beta platform

2016fh, 2023fh, 2028fh = 2016 v1 platform

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

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

Table 1. Comparison of Canada national total annual CAPS othptdust emissions (tons/yr)

Pollutant	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
PM10			1,452,013	319,284	1,451,545	319,182	1,451,197	319,097
PM2.5			346,315	119,769	346,203	119,731	346,118	119,698

Table 2. Comparison of province total annual Primary PM10 othptdust emissions (tons/yr)

Province	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Newfoundland			17	3	17	3	17	3
Prince Edward Island			3,075	2,203	3,074	2,202	3,073	2,201
Nova Scotia			600	360	599	360	599	360
New Brunswick			1,602	1,330	1,601	1,330	1,601	1,329
Quebec			24,520	20,678	24,510	20,670	24,503	20,664
Ontario			57,655	48,701	57,644	48,691	57,621	48,672
Manitoba			111,002	54,251	110,965	54,233	110,939	54,220
Saskatchewan			812,975	113,937	812,720	113,901	812,543	113,876
Alberta			433,782	73,933	433,634	73,908	433,526	73,890
British Columbia			6,786	3,887	6,780	3,884	6,775	3,881

Table 3. Comparison of province total annual Primary PM2.5 othptdust emissions (tons/yr)

Province	2014fd	2016fe	2016ff	2016fh	2023ff	2023fh	2028ff	2028fh
Newfoundland			4	1	4	1	4	1
Prince Edward Island			1,109	935	1,109	934	1,108	934
Nova Scotia			200	152	200	152	200	152
New Brunswick			631	577	631	577	631	577
Quebec			9,783	9,015	9,779	9,011	9,776	9,008
Ontario			22,664	20,873	22,659	20,869	22,650	20,861
Manitoba			33,255	21,905	33,244	21,898	33,236	21,893
Saskatchewan			179,821	40,013	179,764	40,000	179,725	39,992
Alberta			96,691	24,722	96,658	24,713	96,634	24,707
British Columbia			2,156	1,576	2,154	1,575	2,152	1,574