THE 2013 CANADIAN AIR QUALITY MODELLING PLATFORM AND THE BASE AND FUTURE CASES USED FOR POLICY REGULATIONS

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1. INTRODUCTION

The Air Quality Modelling and Applications Section (AQMAS) of Environment and Climate Change Canada (ECCC) has upgraded its 2010-based modelling platform to 2013 base year to efficiently assist Canadian air quality regulators in policy developments. The 2013 Canadian CACs emissions inventory for all anthropogenic sectors were received from the Canada's Air Pollutant Emission Inventory (APEI) of ECCC. The original files were compiled by the Pollutant Inventories and Reporting Division (PIRD) of ECCC using both top-down and bottom-up approaches.

One of the main applications of the updated modeling platform is to support scenario studies for policy regulations. A Unified Regional Air Quality Modelling System (AURAMS) as an off-line chemistry transport model is used to assess the health and environmental benefits.

The new inventory platform contains the base case (2013) and the future scenarios representing a Business As Usual (BAU) projections. This inventory is based on the latest available emission inventories for various sectors including transportation, industrial, residential, open sources and wildfires. In addition, all ancillary data files required to generate the model-formatted emissions are included in this package.

We will first provide an overview of different emissions sectors of 2013 modelling platform, followed by the description of scenario simulations. The evaluation of results for 2013 as base case and projected 2025 BAU scenarios will be finally discussed in last section.

2. 2013 EMISSION INVENTORY PACKAGE

The 2013 modelling platform includes consistent emissions sets for 2013 as base case and future BAU projections in 2025. Scenarios are based on the 2013 emission inventory and the 2015 economic forecast that represent the current federal and provincial regulations without the controls. A description of sectoral-based emissions inventory and scenario simulations is given in the following sub sections.

2-1 Base Case Emission Inventory

This section contains a sector-by-sector description of emissions for updated 2013 emissions inventory as base year.

2-1-1 Transportation

This sector includes emissions from on-road vehicles and off-road engines and machines, commercial marine vessels, rail locomotives and aircrafts.

All on-road emissions are estimated using the MOVES2010b (http://www.epa.gov/otaq/models/moves/index.htm). The on-road emission estimations are at the provincial level except for two provinces (British Columbia and Ontario) with inspection/maintenance (I/M) programs where sub-provincial information are available. 13 road types were also used to improve the spatial allocation.

Emissions estimation for all off-road vehicles and engines are based on the EPA's NONROAD v6.7 tool.

The marine emissions data are originally provided by the transportation division of ECCC in polygon format for the ship routes and database format for the emissions. This sector is an aggregation of a number of classes of vessels (1, 2 and 3) that encompass freighters, tankers, tugs, ferries, passenger boats (inboard), fishing boats, and container ships. The inventory preserves the shipping lanes and allows for the emissions to be elevated above the surface layer within the air quality model. The marine emissions data are used for all the provinces and territories within the 200 nm EEZ.

Locomotive emissions are obtained from the report of Locomotive Emissions Monitoring Program (2010).

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Aircraft sector includes emissions from both Landing/Take-Off (LTO) cycle and in-flight cruise (for all flight above 3000 feet). Emissions estimations for these categories are based on emission factors for all aircrafts and fuel consumption per province/territory reported annually by Statistics Canada (Report on Energy Supply-Demand).

2-1-2 Industrial and Residential

This sector includes emissions from industrial activities divided into facility-level emissions reported by the National Pollutant Release Inventory (NPRI) and emissions from Upstream Oil and Gas (UOG) projected from CLEARSTONE data in year 2010. This sector also includes emissions from other sources such as Electric Generating Units (EGUs), incineration, commercial and residential fuel combustions and general solvent use.

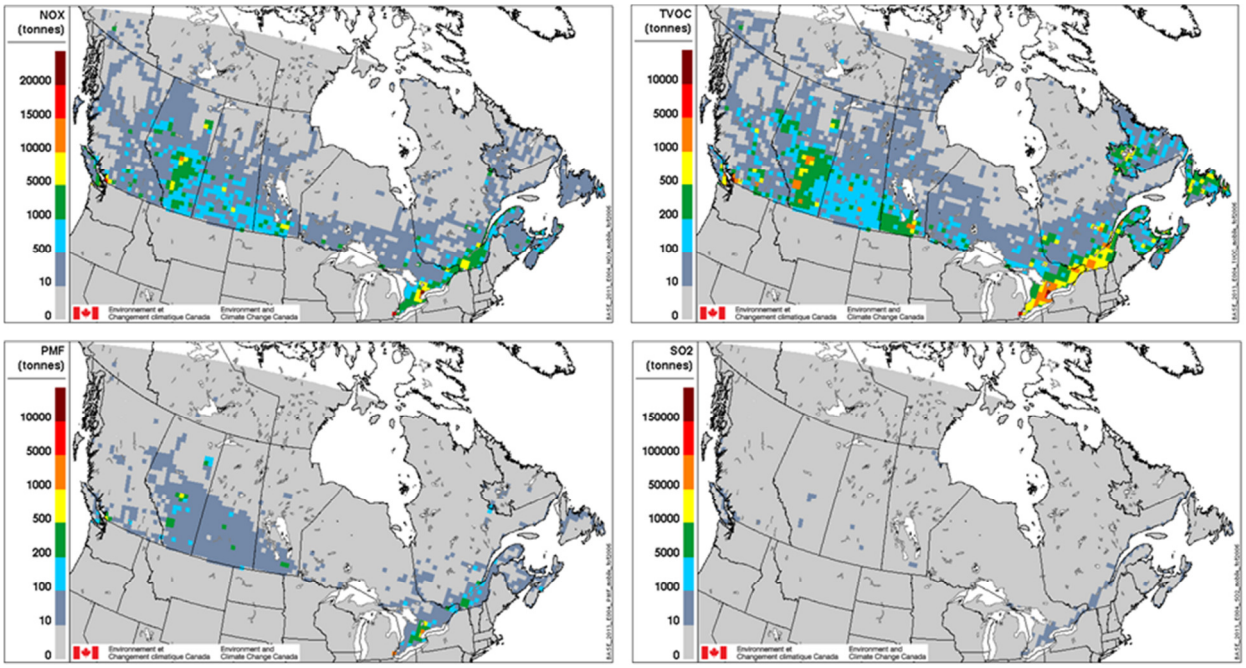

Fig. 1. Annual emission inventory for NOX (top left), VOC (top right), PM2.5 (bottom left) and SO2 (bottom right) for base year (2013) from on-road and off-road mobile sources of transportation sector.

2-1-3 Open Sources

Open sources sector includes emissions from agricultural and fugitive dust sources. The 2013 agricultural emissions inventory contains monthly emissions for NH3 from livestock and agricultural fertilizer which is projected based on 2002 National Agri-Environmental Standards Initiative (NAESI) data. It includes emissions from 54 types of agriculture sources for 282 Canadian census divisions. This inventory data are spatially allocated using a list of 54 new surrogates generated specifically for this sector.

Fugitive dust inventory sector includes dust emitting from buildings and road construction, paved and unpaved roads, agriculture and mine tailing. Dust emissions are processed separately from the other area sources to allow the adjustment based on land use transportable fraction (Pouliot et al., 2010).

2-1-4 Wildfires emissions

The wildfire emissions estimation is based on the information of active wildfires or “hotspots” provided by Canadian Wildland Fire Information System (CWFIS), which is operated by Natural Resources Canada (NRCan). The CWFIS detects active wildland fires using the observations from the NASA MODIS and the NOAA/AVHRR satellite-based detection systems. These data contain daily fire locations by latitude and longitude. Environment Canada’s GEM model forecasts are then used to determine weather conditions at fire locations and estimate the fuel consumption. The daily total emissions for each fire “hotspot” are calculated based on the BlueSky Fire Emission Production Simulator (FEPS) module. More details on FireWork system can be found in Canada’s Economic Action Plan (2011).

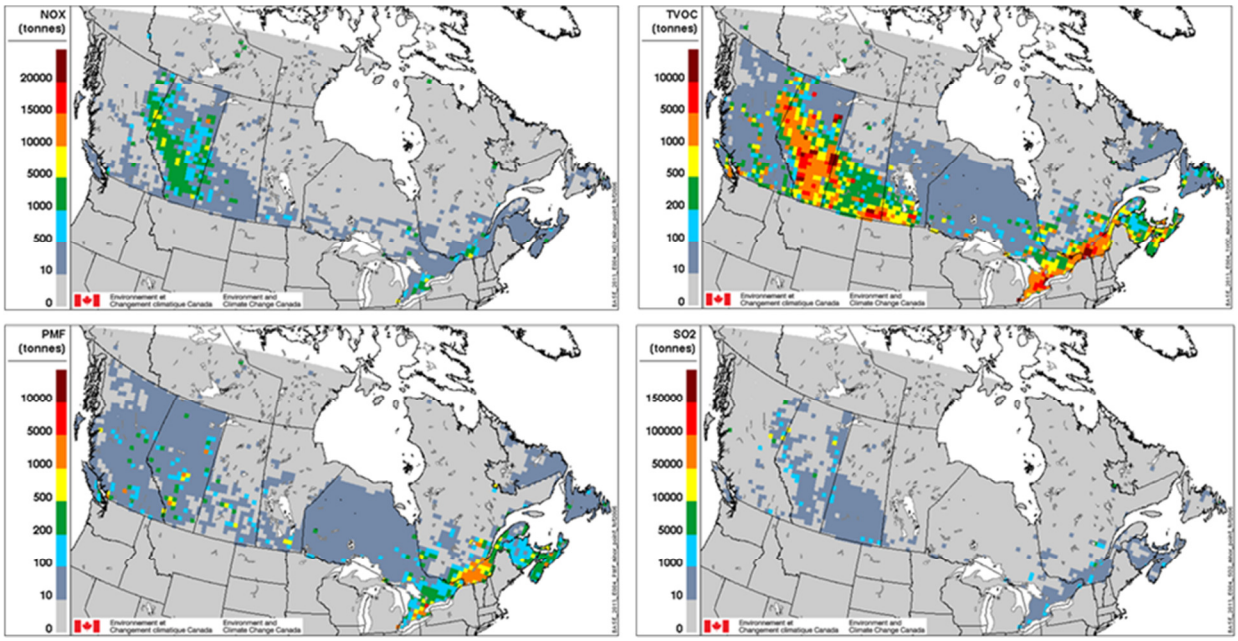

Fig. 2. Annual emissions inventory for NOX (top left), VOC (top right), PM2.5 (bottom left) and SO2 (bottom right) for base year (2013) from industrial and residential sector.

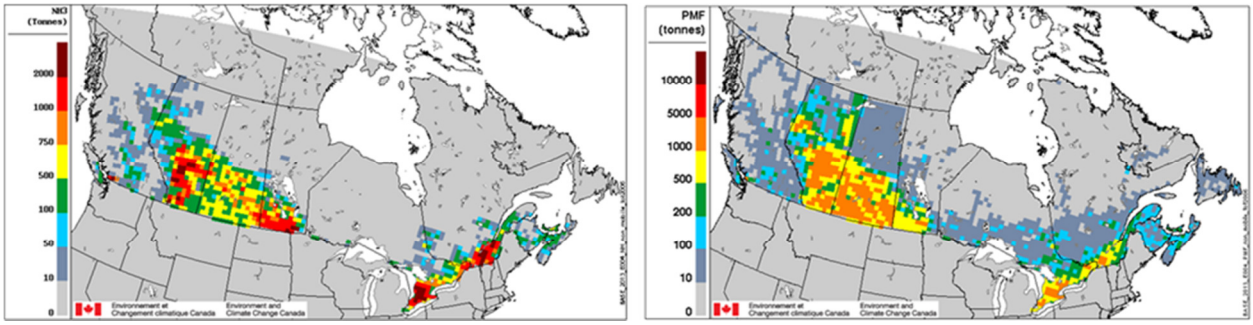

Fig. 3. Annual emissions inventory for NH3 (left) from agricultural sources and PM2.5 (right) from fugitive dust sources for the base year (2013).

2-2 Future Projections

As mentioned above, the 2013 modelling platform includes future scenario simulations in 2025 as well as the base 2013 emissions inventory. The basis for 2025 projections is the energy forecast made by the National Energy Board of Canada released in January 2016 (available at: https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2016/index-eng.html). The energy forecast is then used as input to ECCC's Energy, Emissions and Economy Model for Canada (E3MC) to generate the emissions projections for 2025. Projections represent the Business As Usual (BAU) developments where emissions progress in agreement with regulations in place as of 2013 or which will be in place by 2025 or some of the formally announced measures which would be in place by 2025. Examples are emissions standards for ships from the North American Emission Control Area (ECA) as specified in the Regulations Amending the Vessel Pollution and Dangerous Chemical regulations publications in 2013. ..

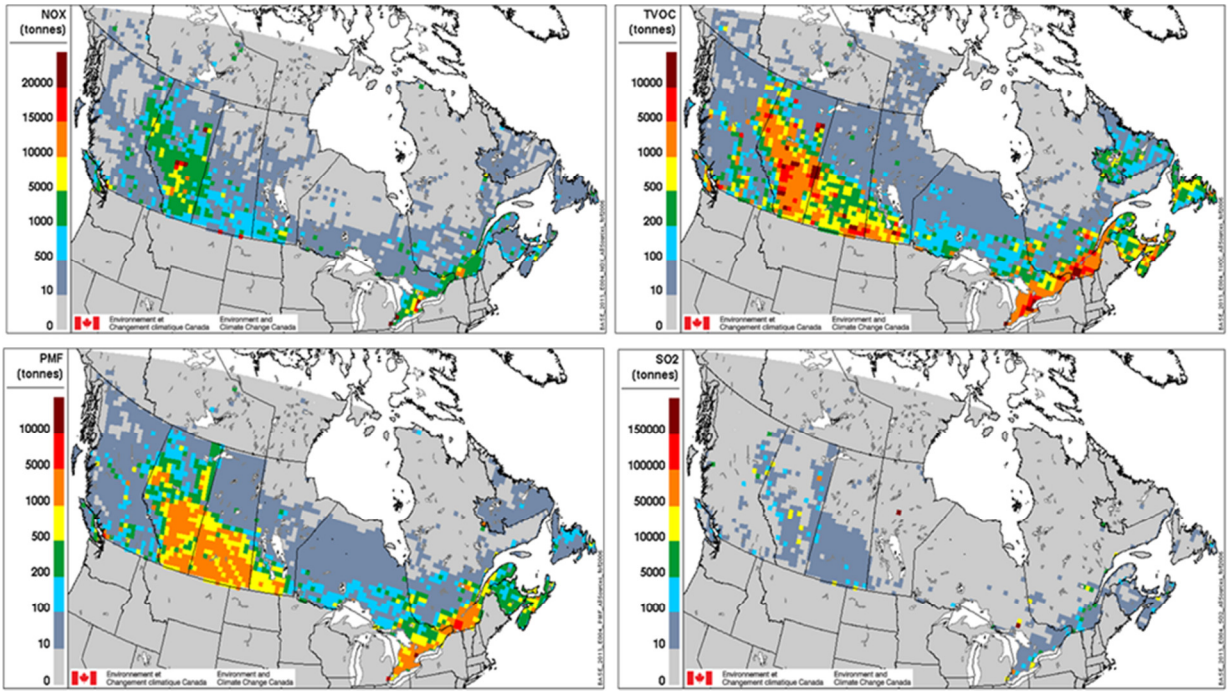

Fig. 4 Total annual emission inventory for NOX (top left), VOC (top right), PM2.5 (bottom left) and SO2 (bottom right) for base year (2013) from all sources described in section 2.1 except for wildfire.

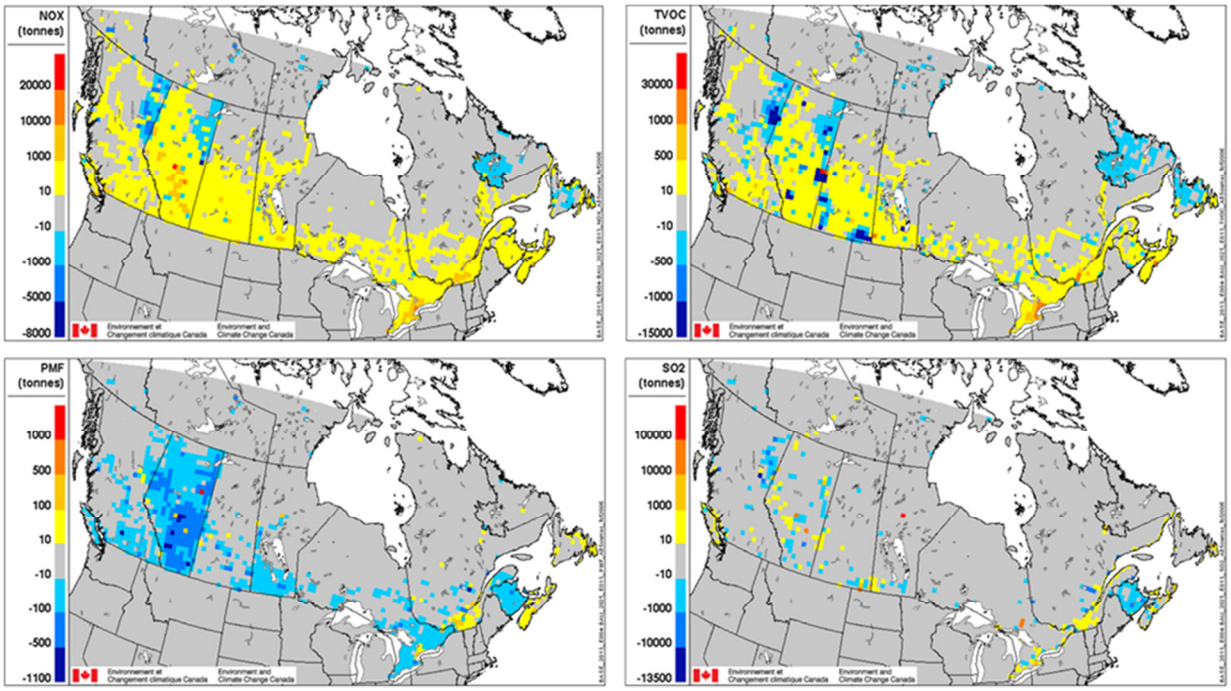

Fig. 5 Differences (2013-2025) between the total annual emissions in year 2025 and base (2013) for emissions form all sources except wildfire.

3. RESULTS AND DISCUSSIONS

Figures 1 and 2 show the annual values for 2013 Canadian NOX, VOC, PM2.5 and SO2 emissions from on-road and off-road mobile sources as part of transportation sector and the industrial and residential sectors, respectively.

Figure 3 shows the annual emissions from open sources including the NH3 from agricultural activities and PM2.5 from fugitive dust sources. Total 2013 annual emissions from all sectors listed in previous section excluding the wildfire is shown in figure 4 for NOX, VOC, PM2.5 and SO2. The corresponding differences between the base and

scenario emissions in 2025 (2013-2025) is presented in figure 5. Difference plots show a decrease in NOX and VOC emissions almost everywhere across Canada which is mainly related to the emissions from marine emissions for NOX and the Light Duty Gasoline Vehicles and Trucks (LDGV and LDGT) emissions from on-road mobile sources for VOC. SO2 emissions show a decrease in response to mining and smelting industries and increase in response to aluminum industries. There is an increase in PM2.5 in 2025 scenario particularly in response to increase in emissions from open sources particularly dust emitting from unpaved roads. Decreases in several locations is related to decrease in residential wood combustion emissions.

4. REFERENCES

Canada's Economic Action Plan, (2011) Backgrounder: Clean Air Regulatory Agenda. Available online at: http://actionplan.gc.ca/en/news/backgrounder-clean-air-regulatory-agenda.

Pouliot, G., H. Simon, P. Bhave, D. Tong, D. Mobley, T. Pace and T. Pierce, (2010), "Assessing the Anthropogenic Fugitive Dust Emission Inventory and Temporal Allocation using an updated Speciation of Particulate Matter", 19th International Emission Inventory Conference, san Antonio, TX. Available online at: http://www.epa.gov/ttn/chief/conference/ei19/session9/pouliot_pres.pdf.

Locomotive Emissions Monitoring Program (2010), Available online at http://www.railcan.ca/assets/images/publications/LEM/LEM_2010/LEM2010eng_rev8.pdf.