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Impact of Using a Projected 2017 U.S. Inventory on Recent Canadian Air Quality Forecasts

Environment and Climate Change Canada
Environnement et Changement climatique Canada

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1. Introduction

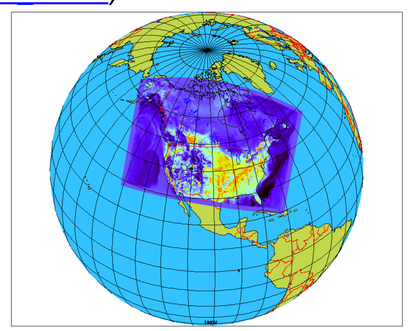
For AQ forecasting, we generally have the problem that available emission inventories are retrospective, that is, representative of a past base year. Hence they do not reflect current emission levels very well, especially given the continued overall decrease of criteria-air-contaminant emissions that has occurred in both Canada and the U.S. since 1990. One way to deal with this mismatch is to use a projected, future-year, business-as-usual (BAU) emission inventory that has been generated by incorporating assumptions about expected changes to the economy, to population and housing, to the on-road and off-road vehicle fleets, etc. along with any emissions changes expected to result from the implementation of existing AQ control legislation.

2. Canadian Operational AQ Forecasts

The Regional Air Quality Deterministic Prediction System (RAQDPS) has been run operationally by Environment and Climate Change Canada (ECCC) since 2001. The current core of the RAQDPS is the GEM-MACH on-line chemical weather model. The model grid covers North America with10-km horizontal grid spacing and 80 vertical levels with lid at 0.1 hPa. (Moran et al., 2016 [1]).

The RAQDPS is run twice daily to produce 48-hour forecasts of hourly ozone (O_3), nitrogen dioxide (NO_2), and particulate matter with aerodynamic diameter smaller than 2.5 μm ($PM_{2.5}$) fields on the model grid. The forecasts are available to the public through ECCC's public-domain weather website (http://www.weather.gc.ca/aqfm/index_e.html).

In addition, these forecasts are combined with hourly AQ surface measurements to generate both point-specific hourly statistical AQ forecasts for Canadian urban centers (UMOS-AQ) and AQ objective analyses (Moran et al., 2014 [2]).

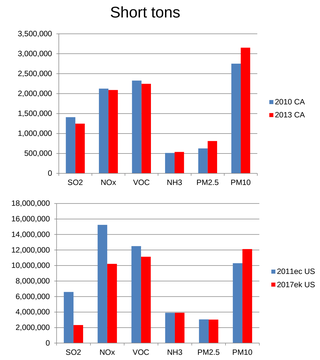


[1] Moran, M.D., S. Gravel, V. Savic-Jovcic, A. Lupu, R. Pavlovic, A. Robichaud, P. Makar, and Q. Zheng. 2016, Recent updates to the Canadian operational Regional Air Quality Deterministic Prediction System. *15th Community Modeling and Analysis System (CMAS) Conference*, Oct. 24-26, Chapel Hill, North Carolina.

[2] Moran, M.D., S. Ménard, R. Pavlovic, D. Anselmo, S. Antonopoulos, P.A. Makar, W. Gong, C. Stroud, J. Zhang, Q. Zheng, A. Robichaud, H. Landry, P.-A. Beaulieu, S. Gilbert, J. Chen, and A. Kallaur, 2014. Recent advances in Canada's National Operational AQ Forecasting System. In: *Air Pollution Modeling and its Application XXII*, DOI 10.1007/978-94-007-5577-2_4, D.G. Steyn, P.J.H. Builtjes, and R.M.A. Timmermans, Editors, Springer, Dordrecht, pp. 215-220.

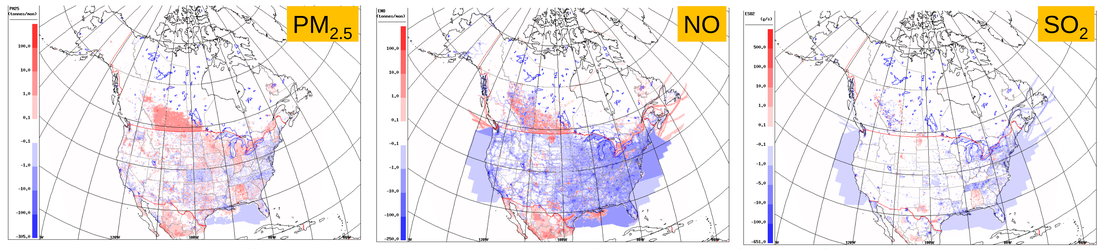
3. Comparison of the New Emissions File Set with the Operational Set

Since 2015 our RAQDPS operational emissions file set has been based on version 1 of the **2010** Canadian Air Pollutant Emission Inventory (APEI), version 1 of the **2011** U.S. National Emission Inventory (NEI), and version 1 of the **1999** Mexican inventory. However, we have recently tested the impact of adopting new emissions files based on the **2013** Canadian APEI, a projected **2017** U.S. inventory based on version 3 of the 2011 U.S. NEI, and the **2008** Mexican inventory. There are significant changes for NO_x, SO_2, and CO emissions between these inventories.



Percentage differences of emissions for Canada and U.S. between the new and old sets.

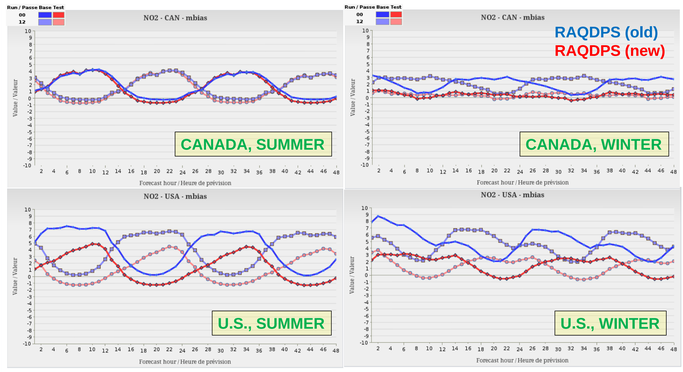
	SO2	NOx	VOC	NH3	CO	PM2.5	PM10
Canada	-12%	-2%	-4%	5%	-31%	30%	15%
US	-65%	-33%	-11%	0%	-26%	-1%	18%



Monthly emission differences (tonnes/month/grid cell, new – old) for July for $PM_{2.5}$, NO, and SO_2

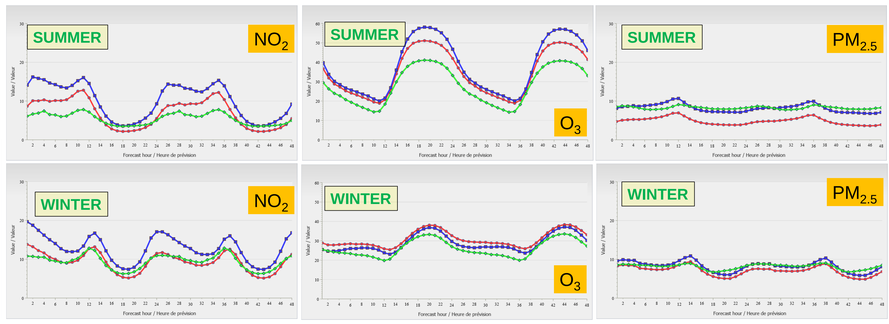
4. Impact of the New Emissions File Set on RAQDPS AQ Forecasts

The RAQDPS was run with both new and old emissions file sets for two 6-week periods: summer 2016 (July 1– Aug. 15) and winter 2017 (Jan. 1–Feb. 18). Hourly model predictions were evaluated using AQ station measurements for North America. NO_2 predictions are improved overall for both summer and winter, while O_3 predictions are improved for summer. $PM_{2.5}$ predictions are mixed.

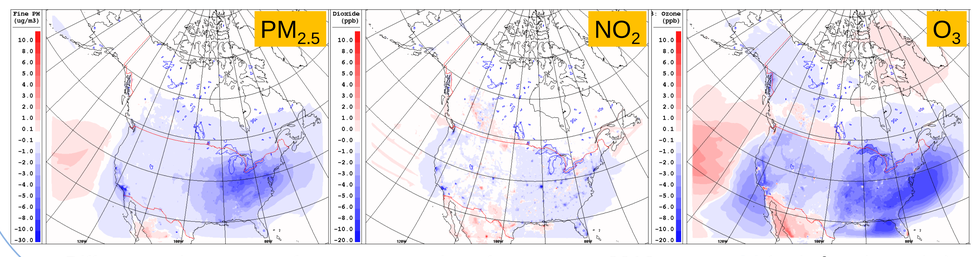


RAQDPS (old)
RAQDPS (new)
Observation

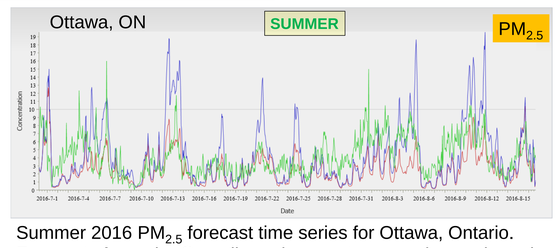
Comparison of 48-hour NO_2, O_3, and $PM_{2.5}$ forecasts for eastern U.S.



NO_2 0-48 hourly mean bias by country for 00 & 12 UTC runs



Differences in mean surface concentrations for **summer** 2016: **new** –**old** (ug/m^3, ppbv, ppbv)



Summer 2016 $PM_{2.5}$ forecast time series for Ottawa, Ontario. Forecasts for major Canadian urban centers are also evaluated with measurements. NO_2 improved for both seasons, especially in western Canada. $PM_{2.5}$ improved in summer but deteriorated in winter.