

The Implementation of Regional Deterministic Air Quality Analysis for Surface NO₂, PM₁₀, SO₂ observations at the Canadian Meteorological Center

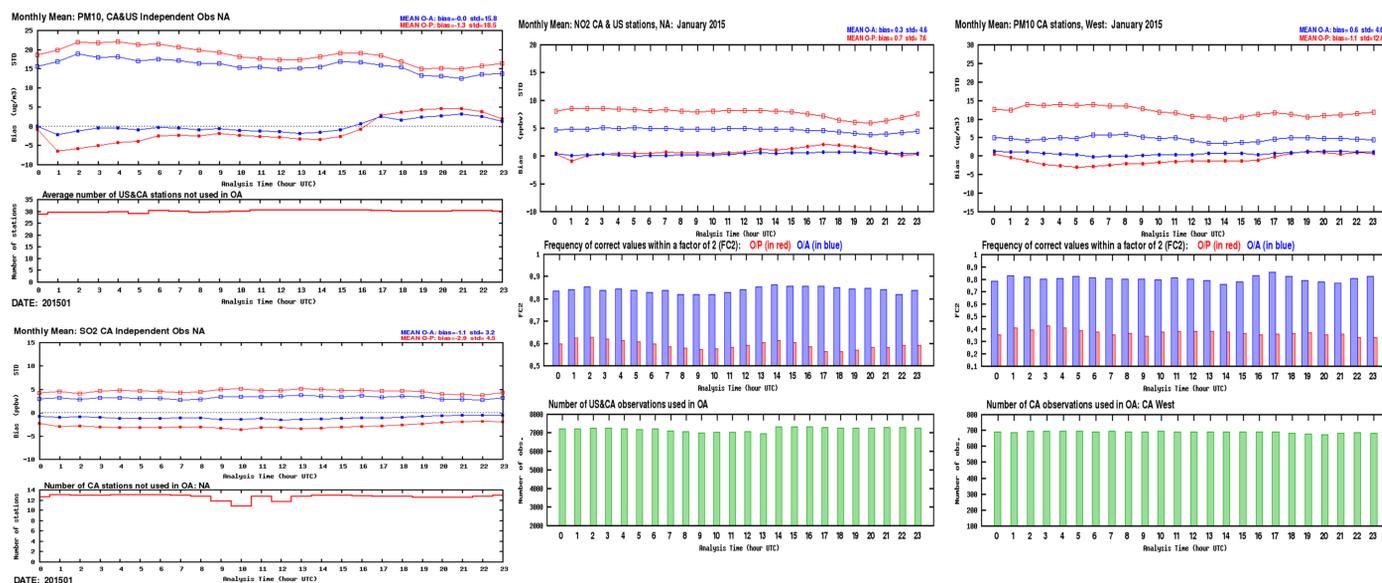
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INTRODUCTION

In April 2015, in collaboration with the Air Quality Research Division, the Canadian Meteorological Centre (CMC) upgraded the Regional Deterministic Air Quality Analysis (RDAQA) for air quality surface pollutants. Since February 2013, surface analyses have been generated for ozone and PM_{2.5} and RDAQA is now upgraded by including new pollutants: nitrogen dioxide (NO₂), coarse particulate matter (PM₁₀) and sulfate dioxide (SO₂). Currently, the RDAQA System is connected to two slightly different configuration of the same model (operational GEM-MACH and experimental FireWork-GEM-MACH respectively). The two RDAQA analyses (early and late) are produced hourly using the two model configurations (trial fields), surface observations (from Canadian regional data providers and the US EPA/AIRNow Program). The solver which blends model and observations is an improved version based on the classical optimal interpolation approach with a semi-empirical bias correction algorithm. The RDAQA and RDAQA-FW systems are presently running an "off-line" mode meaning that the resulting analyses do not serve as input for the models in the subsequent integration.

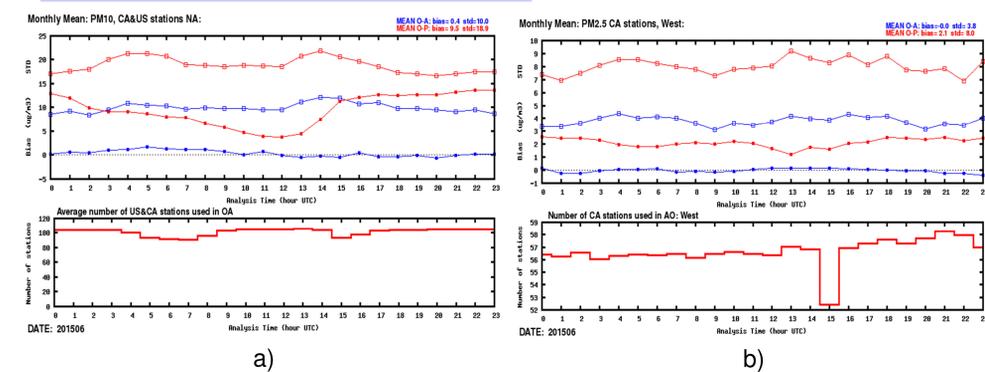
METHODOLOGY, EVALUATION AND AIR QUALITY SURFACE DATA PROCESSING

Objective Analysis (OA) method is based on the optimal interpolation scheme adapted to air quality. Here it uses a linear combination of the background field and observations and optimized by minimizing the error variance using error statistics computed off line. Estimates of error statistics are obtained for each hour, pollutant and surface station for the four seasons. Two types of verification scores have been computed: internal and external. The internal verification means that the analysis is created using all the observations, whereas in the case of external verification (or cross-validation), independent data is not seen by the analysis, is used to verify the final product. The operational run task sequencer (MAESTRO) was used to create a modular suites for the RDAQA and RDAQA-FW as part of the larger ensemble of operational suites. Each module represents a particular process in two systems for supporting the air quality database for observations and gridded data files containing the trial fields, analyses and increments.



Examples of external verification (cross-validation test) for PM₁₀ (for all stations) and SO₂ (just Canadian stations) independent observations for January 2015 over North America using GEM-MACH model.

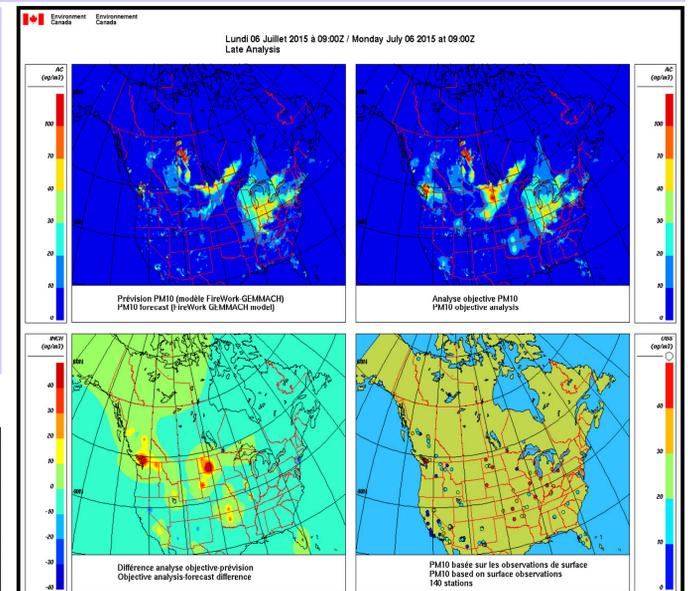
These figures show the results of the monthly verification scores for NO₂ (for all reporting stations over North America) and PM₁₀ (for Canadian stations, western of Canada). A separate categorical score called the frequency correct within a factor of 2 (FC2) shows that the analysis is more reliable than the GEM-MACH model output for all hours of the day.



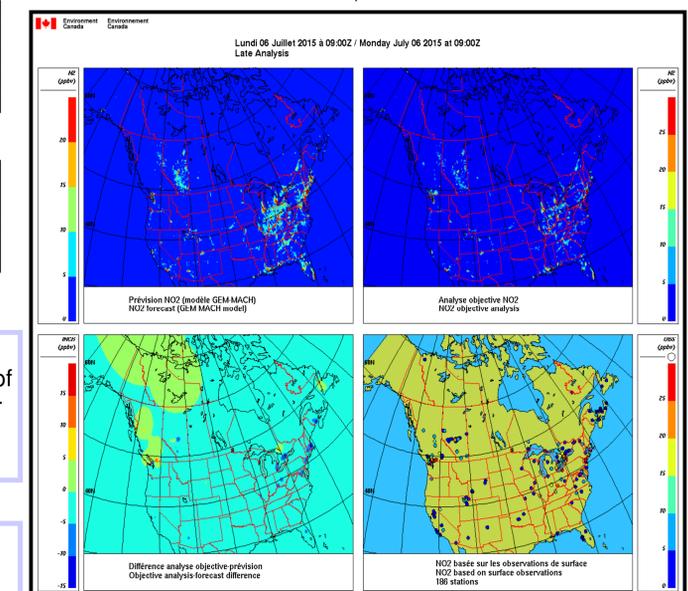
a)

b)

Examples of monthly mean O-P & OA statistics which include the bias, standard deviation and average number of stations per UTC hour for June 2015 (RDAQA-FW system):
 a) PM₁₀ for all reporting stations over North America.
 b) PM_{2.5} for Canadian stations, western of Canada.



a)



b)

Examples of the final product from a) RDAQA-FW (connected to FireWork model) and b) RDAQA (connected to operational GEM-MACH model). The product contains 4 images: model trial field in the top left corner, objective analysis in the top right, analysis increments (or correction to the model) in the bottom left corner, and observations used to generate the analysis in the bottom right.

FUTURE

The RDAQA and RDAQA-FW are the novel products that fill a gap as far as surface pollutants analyses are concerned. The information about and access to the final products are available on an internal Environment Canada website. The daily and monthly monitoring products, as well as cross-validation tests show that the error variance is reduced in a very significant way. The monitoring procedures help to evaluate the quality of the data for all the stations as a group or the quality of the data for individual stations. This enables the detection of problems for particular station which provide valuable feedback to the data provider. The future development includes using the analysis to initialize the GEM-MACH and FireWork-GEM-MACH models as well as adding other species to the RDAQA & RDAQA-FW systems.

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