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Changement climatique Canada

Environment and  
Climate Change Canada

Canada



# **ECCC operations annual update to AQFFGW**

**AQFFGW 2017**

**NCWCP**

**Kasey Thomas, PSD**

**Didier Davignon, CCMEP**

**2016.09.15**

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# SECTION 1

Kasey Thomas presenting on the Canadian air quality program



# Air Quality Health Index (AQHI)

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- Health based formulation
- Uses three pollutants:
  - $O_3$
  - $NO_2$
  - $PM_{2.5}$



# AQHI

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$$AQHI_{PM2.5} = \frac{10}{10.4} * \left( 100 * \left[ \left( e^{(0.000871 * NO_2)} - 1 \right) + \left( e^{(0.000537 * O_3)} - 1 \right) + \left( e^{(0.000487 * PM2.5)} - 1 \right) \right] \right)$$



# Locations



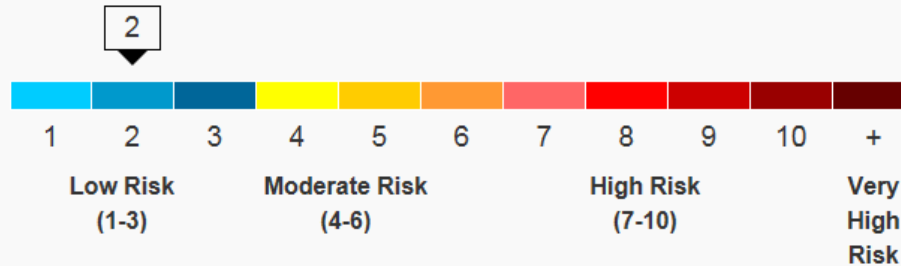
# AQHI City Page

## Halifax - Air Quality Health Index

Current

[Past 24 hr | AQHI by Station](#)

**Calculated at:** 9:00 AM ADT Thursday 18 August 2016



### At-Risk Population:

- Enjoy your usual outdoor activities.
- [Find out if you are at risk](#)

### General Population:

- Ideal air quality for outdoor activities.

### Forecast Maximums

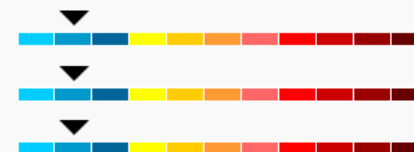
[Next 18 hr | Health Message](#)

**Issued at:** 6:00 AM ADT Thursday 18 August 2016

Thursday 2 - Low Risk

Thursday night 2 - Low Risk

Friday 2 - Low Risk



# AQHI+

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- Used when single pollutants (ie  $PM_{2.5}$ ) are above a certain level based on a one hour average
- The province sets the threshold level
- May be tied to provincial regulations
- The AQHI may still be showing a low or moderate value (<7)
- The AQHI is then manually raised to the high risk category (7 or greater)
- Advisories are issued if required by the province



# Current and Future Air Quality Work

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- Current
  - Implementation of hourly forecast (18 hours) with PAN AM games
  - Forecast by station
- Future
  - 3 day forecast
  - AQHI by map
  - Heat and AQ
  - Allergens





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# SECTION 2

Didier Davignon presenting on Canadian air quality model and operational systems



# Canadian Air Quality Forecast Systems

- **Systems run by ECCC Operations**

- 1) **RAQDPS** (Regional Air Quality Deterministic Prediction System)

- GEM-MACH
    - Emissions & boundary conditions
    - Statistical model (UMOS-AQ)
    - Operational Products
    - Regional Deterministic Air Quality Analysis (RDAQA)

- 2) **FireWork** (RAQDPS with wildfire emissions)

- Emissions
    - Statistical model (UMOS-AQ)
    - Experimental Products
    - Regional Deterministic Air Quality Analysis connected to FireWork (RDAQA-FW)

Now with operational status

- Experimental AQ system versions (ex: GEM-MACH on 2.5km for PanAm games)

- **VAQUM** (Verification of Air Quality Models) System



# Recent changes to RAQDPS

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- Major upgrade to GEM-MACH AQ model and its GEM core dynamic library
- Based on latest weather model GEM v4 (major update).
  - New vertical coordinate (hybrid in *log*-hydrostatic-pressure)
  - New vertical discretization (Charney-Phillips staggering) lowest layer depth is now 40-m;
  - Physics spin-up capability;
  - Global Yin-Yang grid (New LAM grid that align to it);
  - New PBL moist TKE scheme
  - New orographic blocking scheme



# Recent changes to RAQDPS

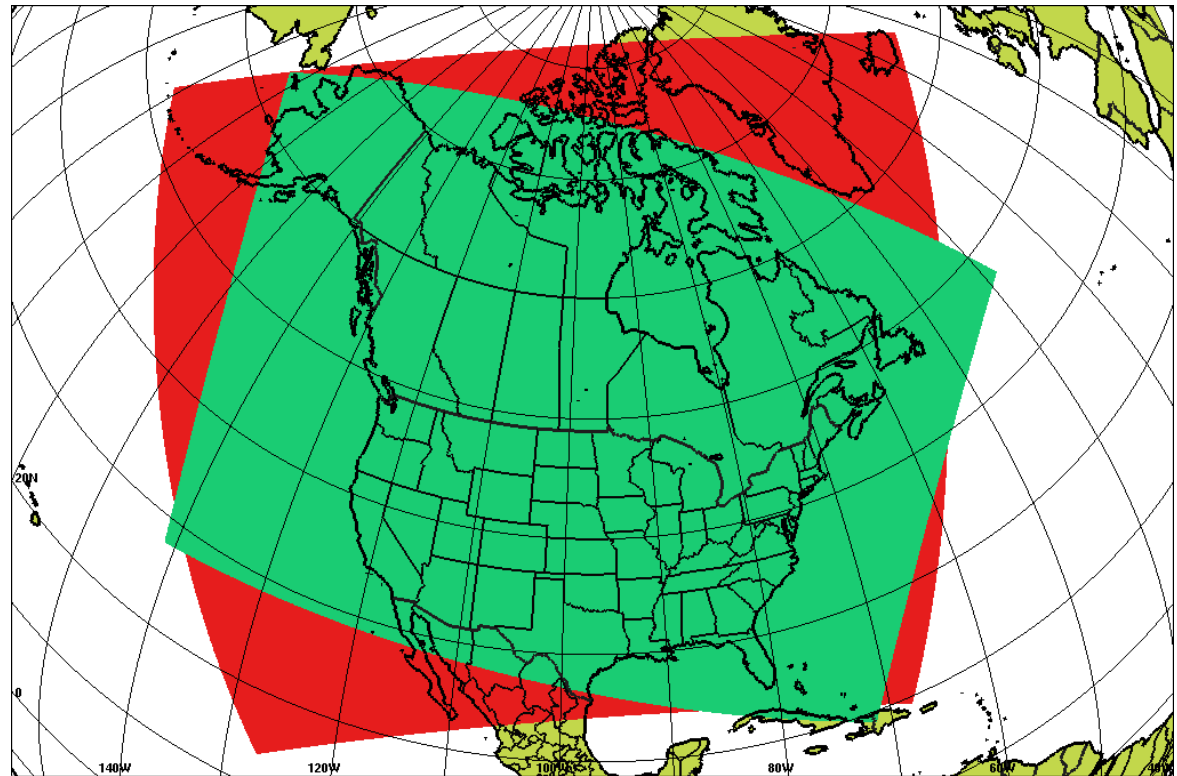
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- Improvements to chemistry modules
  - Native (GEM) vertical diffusion scheme for chemical tracers
  - Comprehensive mass conservation for tracers, designed for LAM
  - Improved below-cloud scavenging
  - Correcting problems with emissions, dry deposition
  - Gas-phase dry deposition with improved LAI scaling
  - New 3D seasonal chemical lateral boundary conditions
  - Sea-salt emissions now precede vertical diffusion (old problem)
  - Various minor corrections

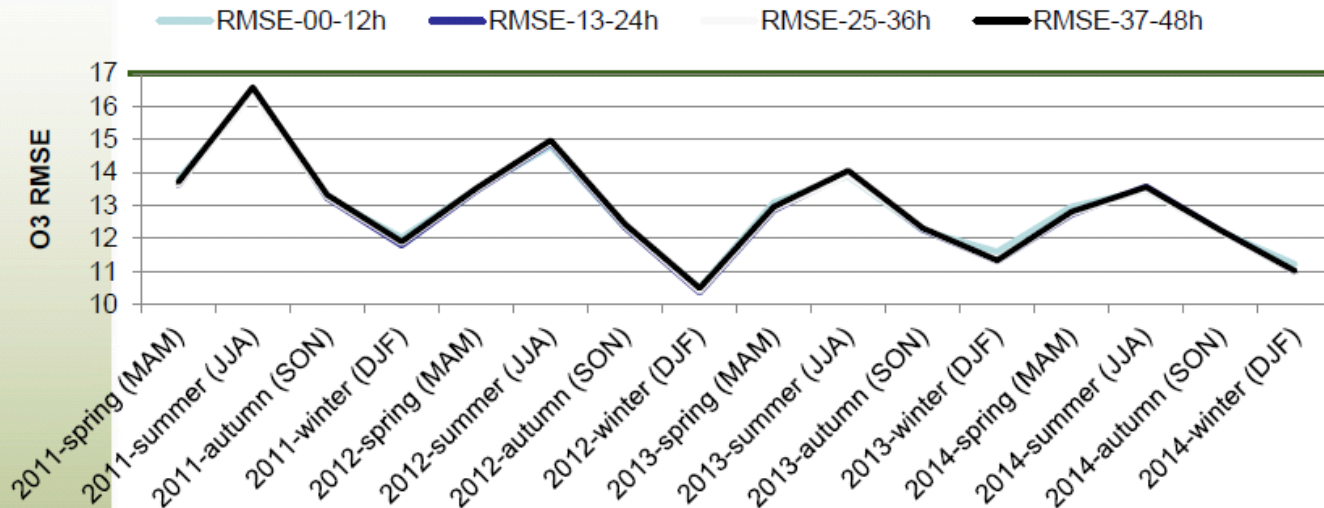


# New RAQDPS domain (Sept 2016)

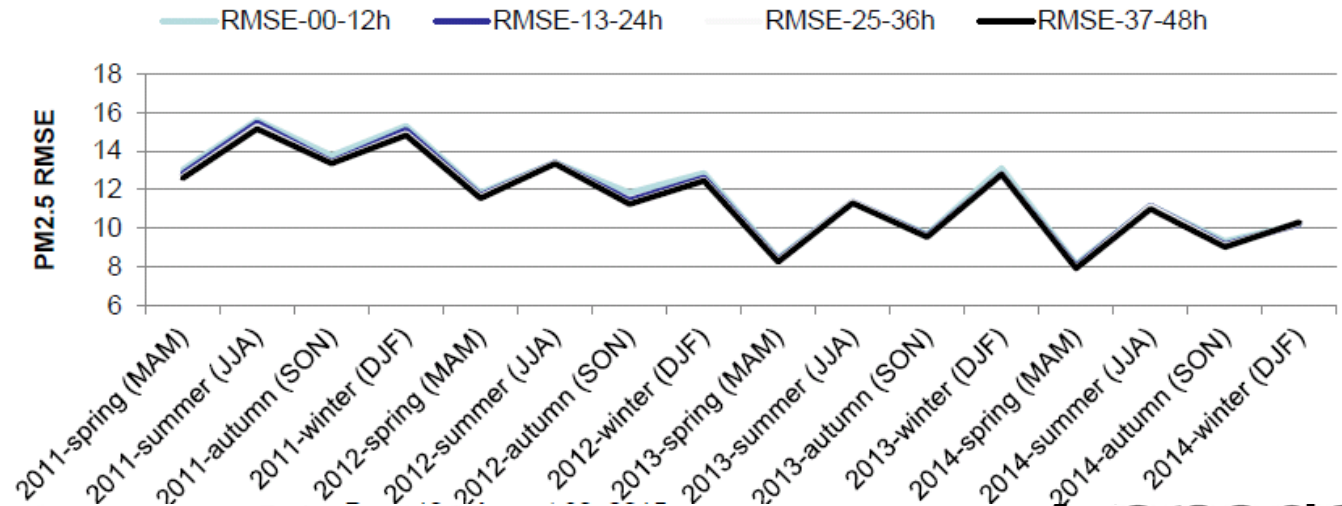
- New RAQDPS\_016 in red



# Performance is steadily improving



**O3 & PM2.5 Root Mean Square Error (RMSE) by Season, 2011-2014**  
(courtesy M. Moran, J. Zhang)



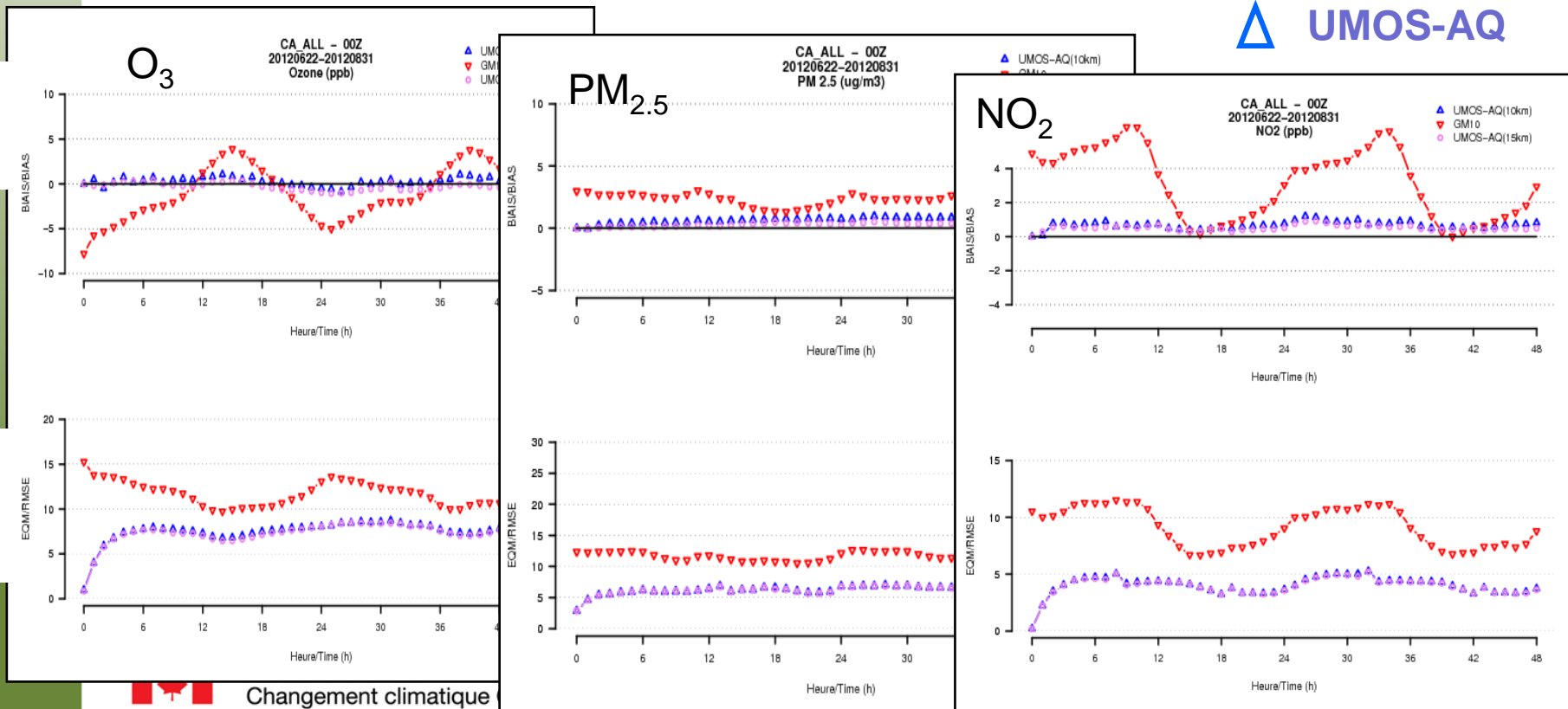
# Statistical Model: UMOS-AQ

- Post-processing applied to GEM-MACH raw model output
- **Reduces model bias and model error at point locations with AQ monitors** through through multi-variate linear regression approach
  - Applied to meteorological variables since 2000
  - Adapted for air quality variables ( $O_3$ ,  $NO_2$ ,  $PM_{2.5}$ ) in 2010
  - Equations are recalculated four times a month

▽ GEM-MACH  
△ UMOS-AQ

BIAS

RMSE



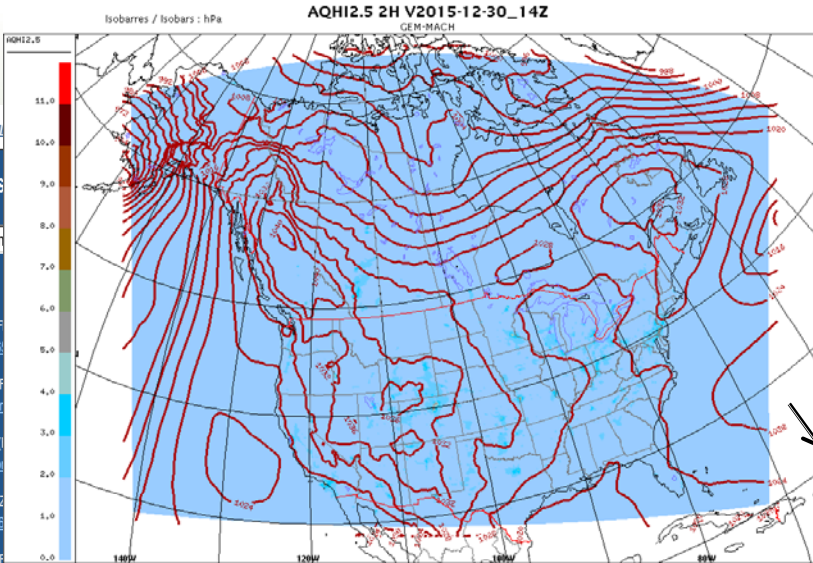
# Products: AQHI Forecaster Resource Site

AQHI Resou

Forecas

Select mor

- Barrie (FAE)
  - Barrie (60304)
- Brampton (F)
  - Brampton (60709)
- Burlington (B)
  - Burlington (60801)
- Dorset (FA2)
  - Dorset (60904)
- Hamilton (FEV)
  - Hamilton Downtown (60512)
  - Hamilton Mountain (60513)
  - Hamilton West (60515)
- Kingston (FEVJR)
  - Kingston (60304)
- London (FCAEN)
  - London (60904)
- Mississauga (FEAKO)
  - Mississauga (60434)
- New market (FDGED)
  - New market (65101)
- Oakville (FOGKZ)
  - Oakville (61603)
- Oshawa (FDMOP)
  - Oshawa (61702)
- Ottawa (FEVNT) & Gatineau (EGLTT)
  - Hull (6) (50204)
  - Ottawa Central (60106)
  - Ottawa Downtown (60101)
- Peterborough (FDGEI)
  - Peterborough (61104)
- Sault Ste. Marie (FDZCP)
  - Sault Ste. Marie (60709)



Interface Field Maps

EM-MACH

- NO<sub>2</sub>
- O<sub>3</sub>
- PM<sub>10</sub>
- PM<sub>2.5</sub>
- AQHI2.5
- AQHI10

Subjective Analysis

- AQHI
- NO
- NO<sub>2</sub>
- O<sub>3</sub>

In case of problems, refer to this document | Français

Observation Maps

AQHI	Hourly
<a href="#">Ontario</a>	<a href="#">Ontario</a>
<a href="#">Toronto</a>	<a href="#">Toronto</a>

Tools

- [24-hour observation summaries](#)
- [Monitoring of incoming air quality observations \(Not operational\)](#)
- [Troubleshooting Guide: Procedures for SPCs](#)

Site / Month	2015-07	2015-08	2015-09	2015-10	2015-11	2015-12
Barrie	100%	99%	95%	93%	91%	100%
Brampton	100%	99%	95%	96%	96%	99%
Burlington	96%	98%	95%	95%	96%	99%
Dorset	99%	99%	92%	96%	93%	99%
Hamilton	100%	99%	96%	96%	96%	100%
Kingston	100%	98%	94%	96%	95%	99%
London	99%	99%	91%	96%	96%	99%



Observation type:  Species:  Domain:  Location type:

24-hour summary table for (AQHI) generated on: Wednesday December 30 18:47:15 (All times in UTC)

Current Conditions

Community	CGNDB	2015 12 30																								Current Forecast	Max Obs
		20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18			
Windsor	FDEGT	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.3	2.3	2.3	2.2	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.2	2.3	3	2.3	
London	FCAEN	1.4	1.3	1.3	1.4	1.5	1.4	1.4	1.4	1.4	1.5	1.6	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.8	1.8	2	1.9	
St. Catharines	FDJFN	1.7	1.6	1.5	1.4	1.4	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.5	1.5	1.6	1.7	1.7	1.8	1.9	2.1	2.2	2.2	2.2	2	2.2	
Hamilton	FEVNS	2.4	1.8	1.6	1.5	1.5	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.9	1.9	2.0	2.0	2.2	2.3	2.3	2.3	2.3	2	2.4		
Burlington	FAMMK	2.6	2.1	1.8	1.7	1.6	1.6	1.7	1.7	1.8	1.7	1.7	1.7	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.3	2.4	3	2.6	
Oakville	FOGKZ	2.2	2.2	1.8	1.5	1.4	1.5	1.6	1.7	1.6	1.6	1.5	1.5	1.6	1.6	1.7	1.8	1.8	1.9	1.9	1.9	1.8	1.8	3	2.2		
Mississauga	FEAKO	1.9	2.2	2.3	2.0	1.7	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.7	1.8	1.9	1.9	1.9	1.0	3	2.3		
Brampton	FALF	2.9	3.1	2.8	2.1	1.6	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.8	1.8	1.9	1.9	1.8	1.8	3	3.1	
Toronto	FEUZZ	2.3	2.5	2.6	3.1	3.1	2.7	2.4	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.3	2.4	2.5	2.5	2.4	2.3	3	3.1	
Oshawa	FDMOP	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.2	2.3	2.4	2.5	2.5	2.5	2.5	3	2.5	
Newmarket	FDGED	1.9	2.1	2.2	2.6	3.1	3.0	2.4	1.6	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	3	3.1	
Barrie	FAFFD	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.3	3	3.1	
Peterborough	FDGEJ	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.5	2.9	3.0	3.1	2.4	2	3.1	
Dorset	FAZKI	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.7	1.6	1.4	1.3	1.2	1.2	1.3	1.5	1.6	2	2.0		
Kingston	FEVJR	1.9	1.9	1.9	1.9	2.0	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	2.0	2.1	2.2	2.4	2.6	2.8	2.9	3.0	3.0	2	3.0		
Ottawa	FEVNT	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.0	1.8	1.8	2.0	2.2	2.3	2.3	2.2	2.3	2.2	2.3	2	2.4	
Sault Ste. Marie	FDZCP	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	2	1.7		

Site / Month	2015-07	2015-08	2015-09	2015-10	2015-11	2015-12
Barrie	100%	99%	95%	93%	91%	100%
Brampton	100%	99%	95%	96%	96%	99%
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Hamilton	100%	99%	96%	96%	96%	100%
Kingston	100%	98%	94%	96%	95%	99%
London	99%	99%	91%	96%	96%	99%
Mississauga	99%	99%	91%	96%	95%	98%
Newmarket	95%	95%	95%	95%	95%	100%
Oakville	94%	96%	96%	96%	96%	99%
Oshawa	96%	92%	96%	96%	96%	96%
Peterborough	99%	100%	100%	100%	100%	100%
St. Catharines	96%	84%	100%	100%	100%	100%
Windsor	95%	96%	95%	95%	95%	95%

Insufficient availability < 85%



# OA: Objective Analysis for Surface Pollutants

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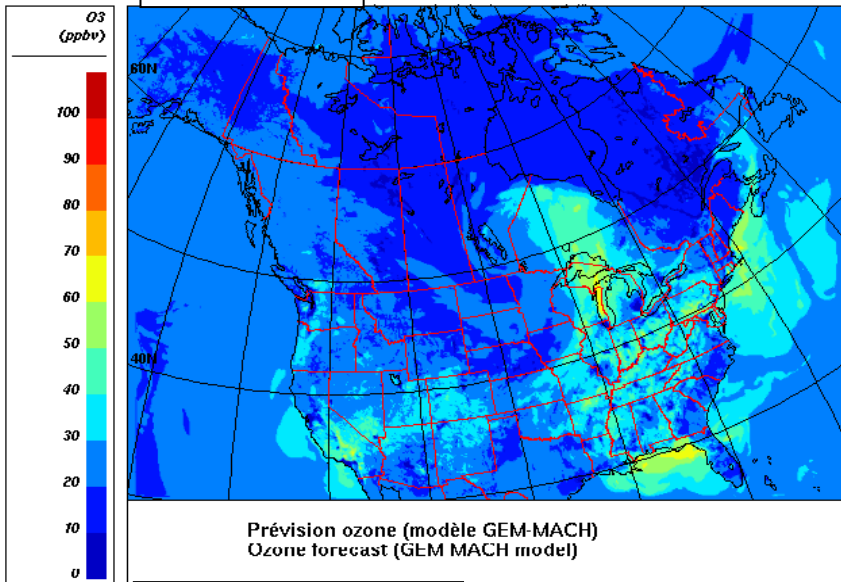
- Operational as of February 2013, called RDAQA
- Blends model forecasts with surface observations from Canadian regional networks and the U.S. EPA's AIRNow observation network
  - Using an optimal interpolation approach
  - Knowledge of the errors of model and observation data is applied to weight each input accordingly
- Products available hourly (2x = early and late analyses):
  - Available for : **PM<sub>2.5</sub>, O<sub>3</sub>, NO<sub>2</sub>, NO, SO<sub>2</sub>, PM<sub>10</sub> and AQHI**
- A new system is under development (basis for 3D assimilation)



# Example of 4-Panel OA Summary for Wed. July 29, 2015, 08 UTC

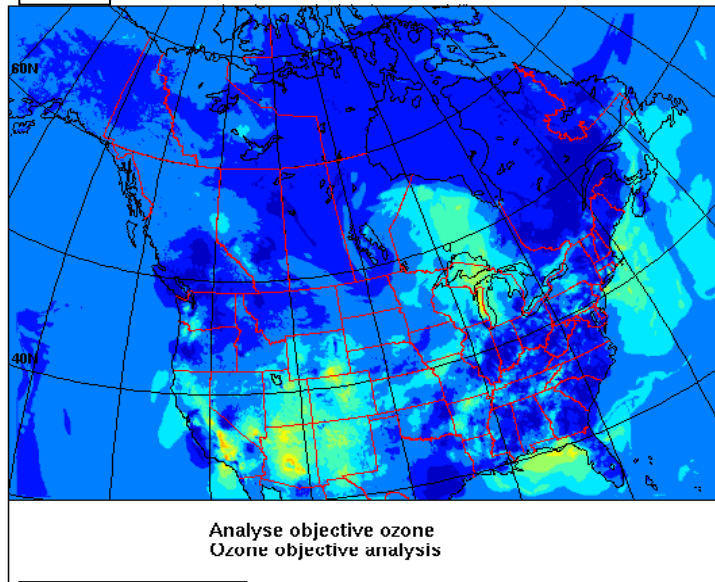
Mercredi 29 Juillet 2015 à 08:00Z / Wednesday July 29 2015 at 08:00Z  
Late Analysis

### GEM-MACH



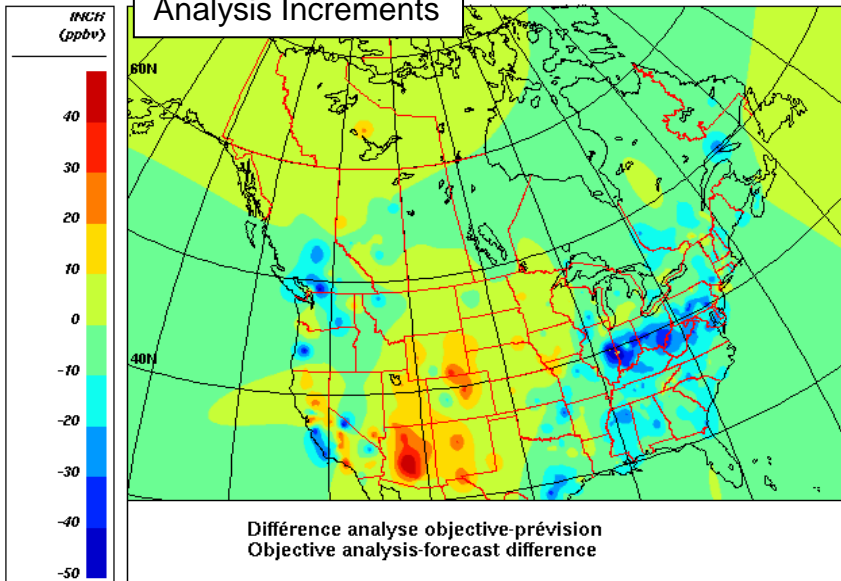
Prévision ozone (modèle GEM-MACH)  
Ozone forecast (GEM MACH model)

### OA



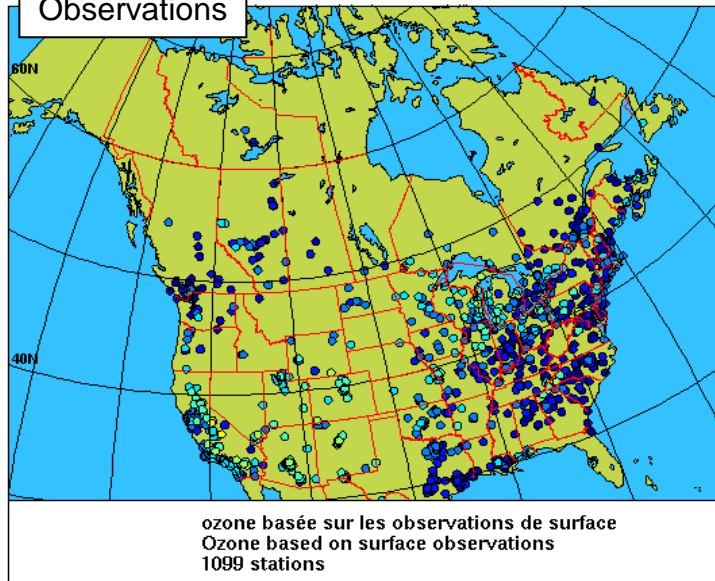
Analyse objective ozone  
Ozone objective analysis

### Analysis Increments



Différence analyse objective-prévision  
Objective analysis-forecast difference

### Observations



ozone basée sur les observations de surface  
Ozone based on surface observations  
1099 stations

# FireWork System

- FireWork has the same configuration as GEM-MACH, the operational AQ model. The only difference is the inclusion of the near-real-time wildfire emissions

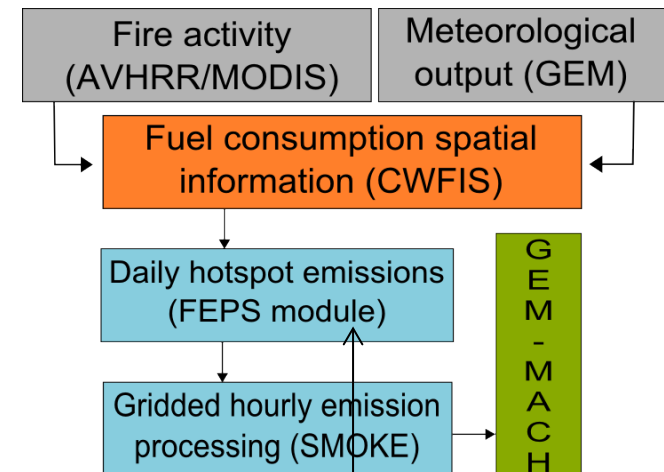
- FireWork:

- Run twice daily (initiated at 00 UTC and 12 UTC)
- Available at approximately at the same time as the operational model

- Additional products

- Alternate AQHI based on FireWork
- PM<sub>2.5</sub>/PM<sub>10</sub> maps and animations based on difference fields (FireWork – GEM-MACH) to isolate plumes
- Total column PM<sub>2.5</sub>/PM<sub>10</sub> sums
- Other specialized products available upon request

## WildFire Emissions Data

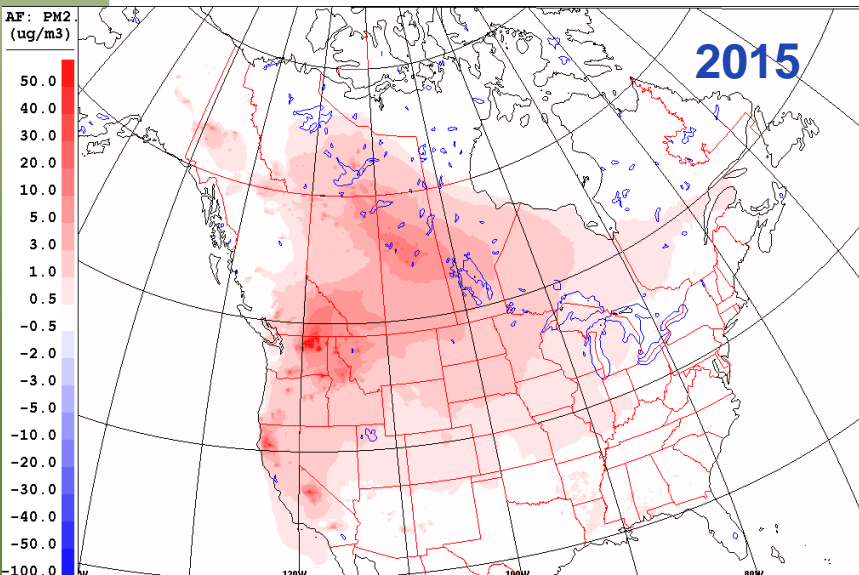
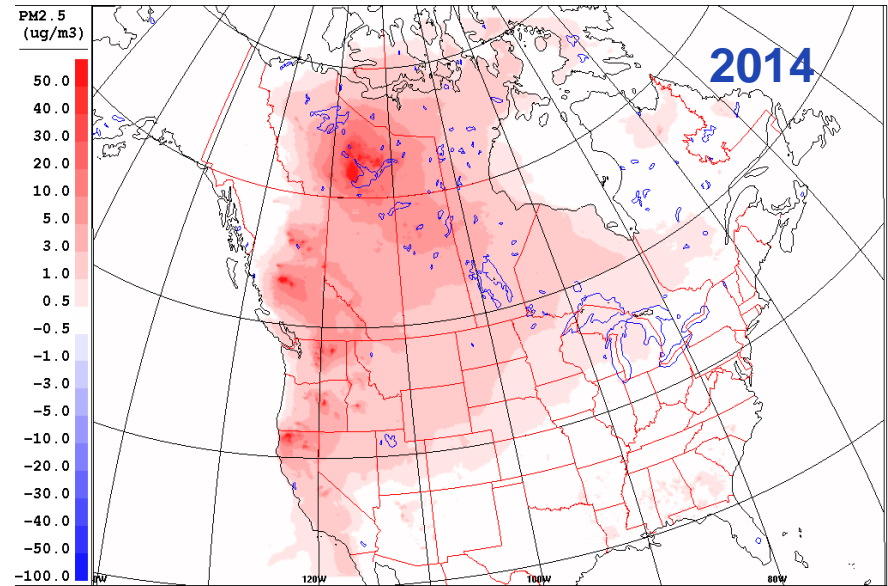
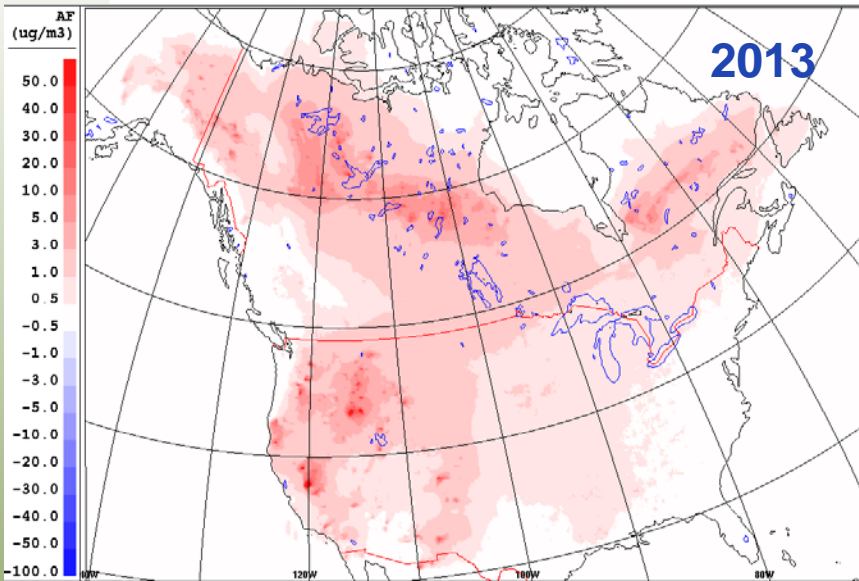


Currently **CFFEPS**, developed by CWFIS, is being tested and will eventually replace the current FEPS module



# How Important are wildfires for AQ?

Forecasted wildfire emissions contribution to average summertime  $PM_{2.5}$  concentrations



**In Canada, the impact of wildfire smoke on air quality is very significant.**

*Forecasted wildfire emissions contribution to the average summertime  $PM_{2.5}$  concentrations (2013-2015) ranges from a few  $\mu\text{g}/\text{m}^3$  to over  $30\mu\text{g}/\text{m}^3$ .*

20 – 5 octobre 2016

and  
nge Canada

Canada

# Products: FireWork Forecaster Resources Site

## EC internal site

### FIREWORK-GEMMACH SITE

Section des Applications en Modélisation de la Qualité de l'Air (SAMQA)  
Air Quality Modeling Applications Section (AQMAS)

AQHI Resources > Prairies and North 2015-07-29 12 UTC

Franca

#### Forecast Report

Select month

#### Nunavut

- Iqaluit (OATRP)
- Waterloo

#### North Territory

- Inuvik (LA)
- Inuvik

#### Yellowknife

- Yellowknife

#### Unassociated

- Snare

#### Alberta

- Calgary (T)
- Calgary
- Calgary
- Calgary

#### Cold Lake

- Cold Lake

#### Drayton Valley

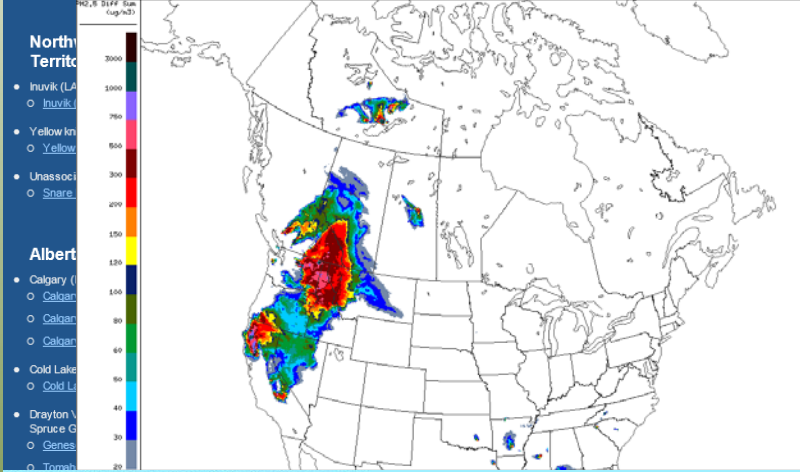
- Drayton Valley
- Spruce Grove
- Genes
- Tromps

#### Active Notices

No active notices available

#### Notice Archive

PM2.5 Difference: Sum / Différences de PM2.5: Somme  
Période / period: 20150803 12UTC - 20150804 12UTC



#### Surface Field Maps

FIREWORK-GEMMACH

- NO2
- O3
- PM10
- PM2.5
- AQHI2.5
- AQHI10

#### Difference Plots

- PM10 surface
- PM2.5 surface
- PM10 column
- PM2.5 column
- Avg over hours 24 - 48
- Sum over hours 24 - 48

#### UMOS-AQ/MIST + Difference Plots

- UMOS-AQ/MIST PM2.5 surface

#### Objective Analysis

- PM2.5
- PM10

#### Observation Maps

AQHI	Hourly
Alberta	Alberta
Baffin Island	Baffin Island
Northwest Territories	Northwest Territories
Southeast PNR	Southeast PNR

#### Tools

- 24-hour observation summaries
- FireWork-GEMMACH summaries for next 24 hours
- Monitoring of incoming air quality observations (Not operational)
- Troubleshooting Guide: Procedures for SPCS
- Current CWFIS hotspot map
- Recent CWFIS hotspot map
- FireWork-GEMMACH output in CSV format

#### AQHI observation availability for the last 6 months

Site / Month	2015-02	2015-03	2015-04	2015-05	2015-06	2015-07
Brandon	87%	82%	49%	96%	51%	76%
Calgary	97%	97%	99%	98%	97%	99%
Cold Lake	73%	85%	81%	85%	78%	82%
Drayton Valley & Spruce Grove	97%	99%	99%	99%	98%	98%
Edmonton	99%	100%	99%	99%	99%	100%
Fort Chipewyan	97%	98%	96%	97%	96%	98%
Fort McKay	96%	98%	97%	98%	97%	98%
Fort McMurray	98%	99%	99%	99%	99%	99%
Fort Saskatchewan	97%	91%	90%	94%	90%	96%
Grande Prairie	74%	97%	98%	98%	96%	98%
Inuvik	95%	97%	93%	33%	76%	85%
Iqaluit	0%	0%	0%	0%	0%	0%
Lethbridge	93%	88%	95%	93%	91%	82%
Medicine Hat	40%	58%	96%	96%	98%	98%
Regina, Alberta	97%	96%	99%	99%	99%	99%

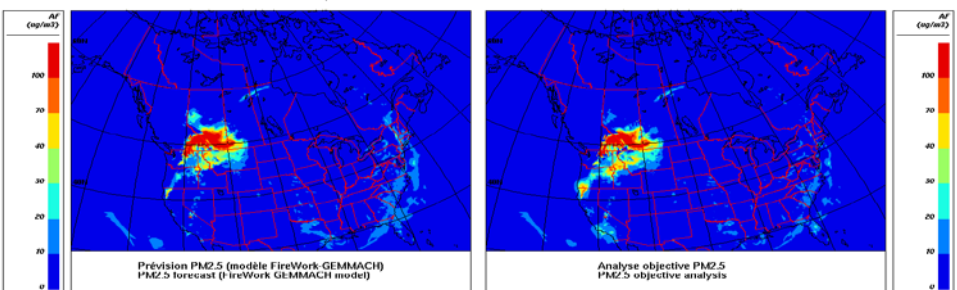
Forecast type: Hourly forecasts | Species: AQHI | Domain: All locations | Location type: Communities | Urban

24-hour FireWork-GEMMACH summary table for (AQHI) for run: 20150729 12Z (All times in UTC)

Community	CGNDB	13	14	15	16	17	18	19	20	21	22	23	24	00	01	02	03	04	05	06	07	08	09	10	11	12	Current Daily Forecast	Maximum	
Calgary	J0A0C	1.0	1.0	1.1	1.2	1.4	1.6	1.7	1.8	1.9	1.8	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.3	1.3	2	1.9	
Central Fraser Valley	J0N00	2.0	2.0	2.0	2.0	2.2	2.5	2.7	2.8	2.8	2.8	2.8	2.7	2.6	2.5	2.2	2.3	2.4	2.6	2.6	2.7	2.6	2.4	2.3	2.3	2.8	2	3.9	
Central Okanagan	J0P0V	1.6	1.7	1.9	2.2	2.6	3.2	3.6	3.9	3.8	3.6	3.2	2.6	2.0	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.5	1.4	1.3	1.3	1.3	2	3.9	
Comox	J0V0Z	1.1	1.1	1.1	1.2	1.3	1.4	1.5	1.7	1.8	2.0	2.1	2.1	2.1	1.9	1.7	1.6	1.4	1.3	1.2	1.1	1.1	1.1	1.1	1.1	1.1	2	2.1	
Duncan	J0B0A	1.4	1.6	1.9	2.0	2.0	2.1	2.3	2.6	2.8	2.9	3.0	3.0	2.9	2.8	2.7	2.7	2.8	3.1	3.6	4.0	4.3	4.3	4.3	4.3	4.3	3	4.3	
Eastern Fraser Valley	J0V0C	1.6	1.6	1.6	1.6	1.8	2.0	2.1	2.2	2.2	2.3	2.3	2.4	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.1	2.0	1.9	1.9	1.9	1.9	3	2.4	
Kamloops	J0P0W	1.8	1.8	1.8	1.8	1.9	2.0	2.2	2.4	2.5	2.5	2.4	2.3	2.2	2.2	2.4	2.5	2.6	2.4	2.3	2.2	2.1	2.0	1.9	1.9	1.9	3	2.4	
Metrol Vancouver - NE	J0V4Z	2.3	2.4	2.6	2.6	2.8	3.2	3.5	3.6	3.6	3.4	3.2	2.9	2.8	2.7	2.7	2.8	2.9	2.9	2.7	2.4	2.2	2.1	2.0	2.0	2.0	3	3.6	
Metrol Vancouver - NW	J0A0F	3.0	3.1	3.3	3.4	3.6	3.8	3.6	3.3	3.1	3.0	3.0	3.0	2.9	2.8	2.8	2.9	2.9	2.9	2.8	2.8	2.6	2.5	2.5	2.5	2.5	3	3.8	
Metrol Vancouver - SE	J0Z0U	2.5	2.6	2.8	2.4	2.2	2.3	2.4	2.6	2.7	2.8	2.7	2.6	2.4	2.3	2.3	2.4	2.6	2.6	2.6	2.6	2.5	2.4	2.3	2.3	2.3	3	3.0	
Metrol Vancouver - SW	J0B0K	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.0	2.9	2.9	2.9	2.9	2.9	2.8	2.7	2.7	2.7	2.8	2.9	3.0	3.1	3.3	3.3	3.3	3.3	3	3.3	
Nanaimo / Parksville	J0G0L	1.6	1.6	1.6	1.6	1.7	1.8	1.8	2.0	2.2	2.5	2.7	2.8	2.8	2.8	2.8	2.6	2.6	2.6	2.6	2.5	2.2	1.9	1.7	1.6	1.4	1.4	2	2.8
North Okanagan	J0C0P	1.5	1.5	1.6	1.8	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7	2	2.0	
Prince George	J0L0S	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.6	1.7	1.8	1.9	2.0	2.0	2.0	1.8	1.7	1.5	1.2	1.2	2	2.0	
Quoniam	J0N0S	1.0	1.0	1.1	1.1	1.1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.0	0.9	0.8	0.8	0.8	2	1.9	
Squamish	J0V0J	1.5	1.5	1.4	1.4	1.5	1.7	1.9	2.0	2.1	2.2	2.2	2.2	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.3	1.3	2	2.2	
Victoria / Saanich	J0C0Q	2.0	2.2	2.4	2.5	2.5	2.4	2.4	2.4	2.5	2.6	2.8	2.9	2.9	2.9	2.7	2.6	2.4	2.2	2.1	2.2	2.4	2.6	2.7	2.8	2.8	3	3.0	
WestShore	J0L0S	1.0	1.0	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.0	3.0	2.9	2.8	2.6	2.4	2.2	2.0	1.9	2.0	2.3	2.6	2.8	2.9	2.9	2	3.0	
Whistler	J0L0E	1.2	1.2	1.2	1.3	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	2	1.7	
Williams Lake	J0T0B	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	2	1.5	



Mercredi 26 Aout 2015 à 00:00Z / Wednesday August 26 2015 at 00:00Z



# Canadian AQ model data access

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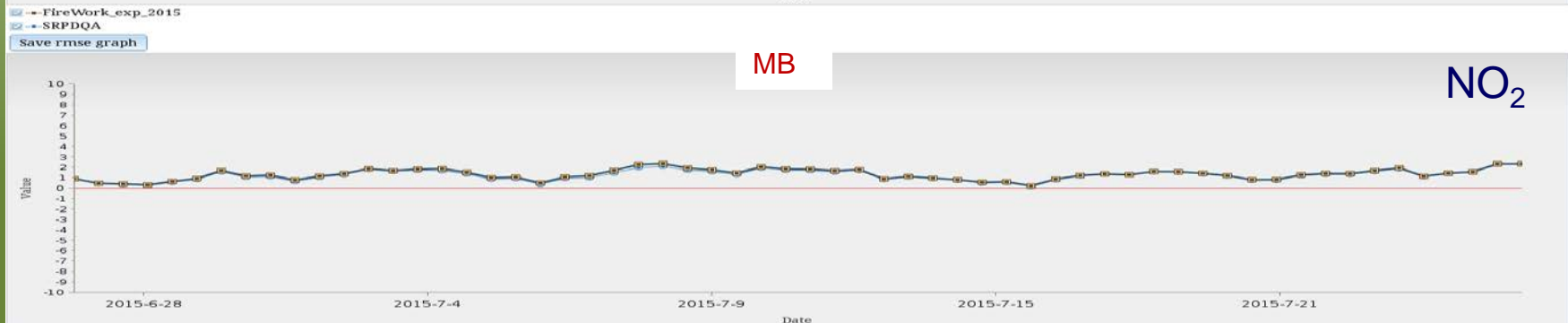
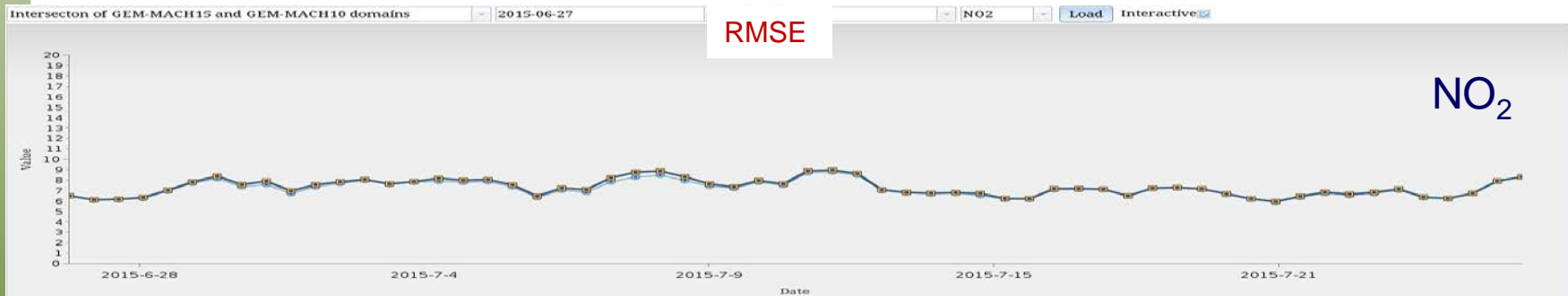
- Two main streams: WMS and GRIB
- GeoMet
  - Updated this fall
  - Geospatial web services (MapServer) solution
  - Open protocols
  - Can deliver data on the fly in numerous formats, such as [WMS](#), [WFS](#), [WCS](#), GeoJSON, csv, etc.
- GRIB
  - NOAA & ECCC are working on mutual operational GRIB data feeds for AQ model forecasts
    - Initially, use internally for model comparison
    - Examine how respective agencies can make use of these new data feeds (with mutual benefits)

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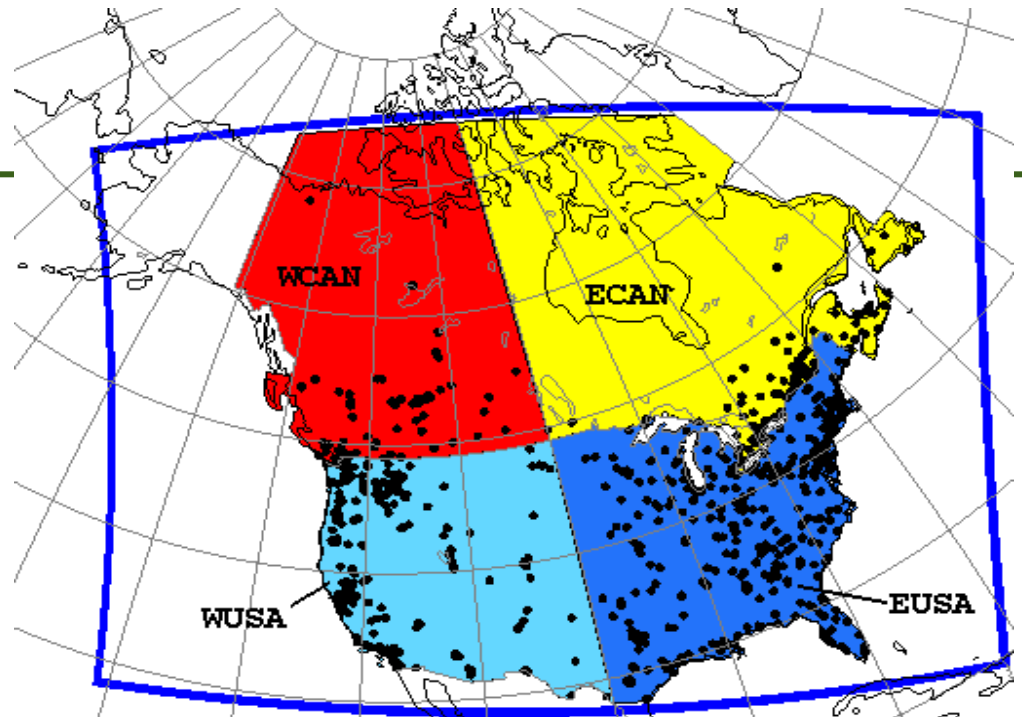


# VAQUM: v erification for Air Q Uality M odels

- Designed a PostGIS database to store AQ observations and corresponding model outputs
  - Can ingest both real time and QC'ed historical datasets
  - Allows to produce various statistics & categorical scores
  - About **1730 stations** (265 CAN, 1465 USA)
  - Collecting data since 2007
- Essential tool to assess the impact of model updates
- Also used to monitor the performance of the operational system

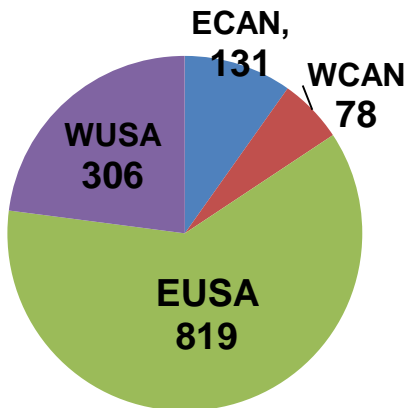


# VAQUM

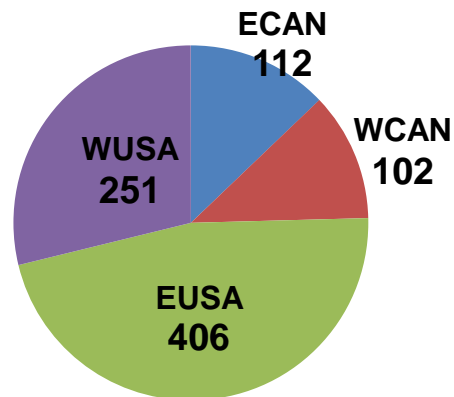


Number of stations with available observations within the GEM-MACH domain

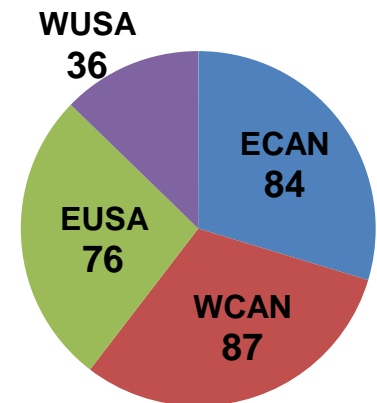
O<sub>3</sub> (1,334 stns)



PM<sub>2.5</sub> (871 stns)



NO<sub>2</sub> (283 stns)



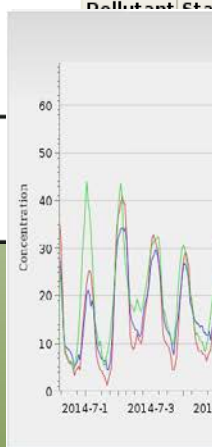


# VAQUM Products

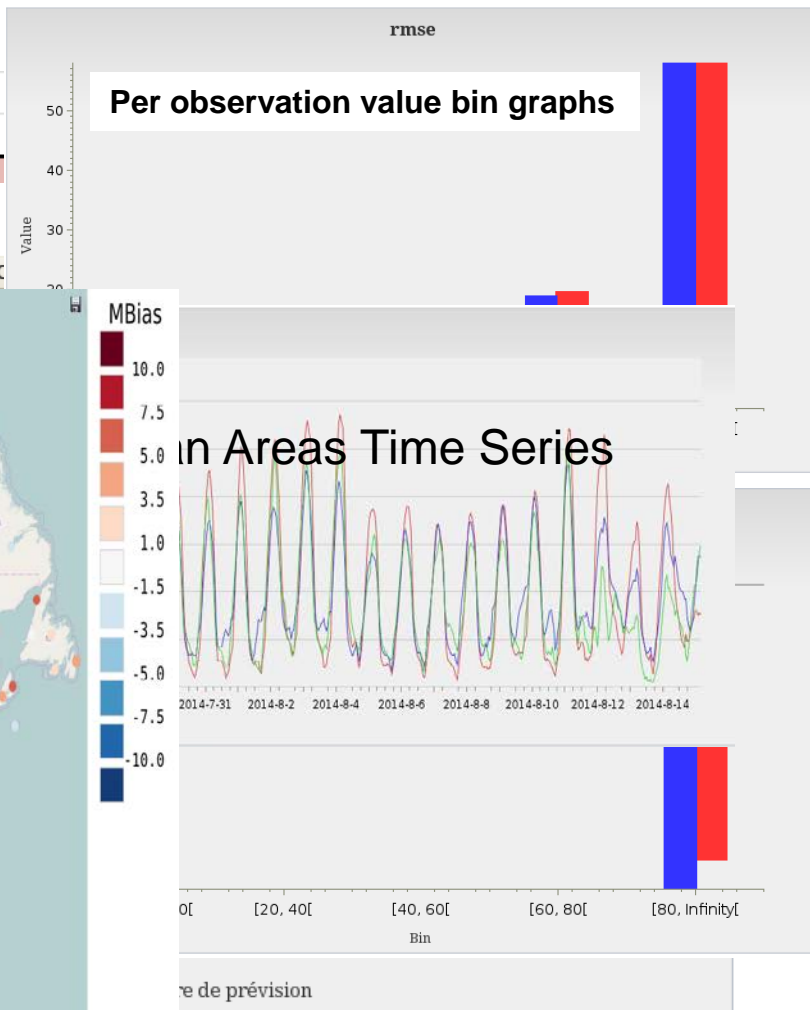
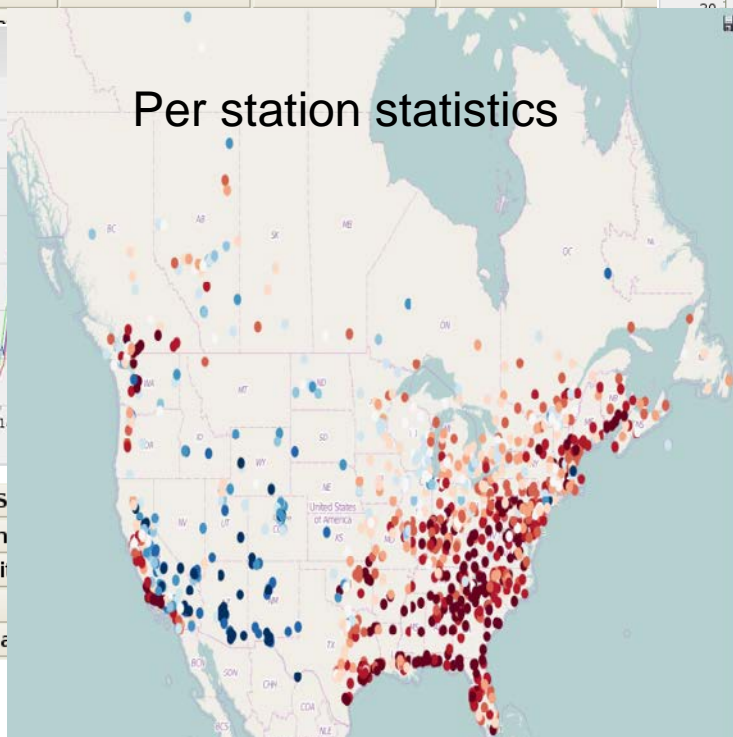
BOOTSTRAPPING		Domaine Complet		Canada		Ouest du Canada		Est du Canada	
Polluant	Statistique	Base	Test	Base	Test	Base	Test	Base	Test

## NO<sub>2</sub> Daily Maximums Statistics

Region	CAN	ECAN	EUSA	C
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## Per station statistics



For further details, please see **poster number 275** (Monday, 11<sup>th</sup> January)  
**Verification Tools for Air Quality Models**

# Next steps

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- Major changes to supercomputing environment.
  - Development to be slower over the next 12 months
  - Hope to gain in performance (and delivery times)
- RAQDPS
  - **72h forecasts** (next 2y)
  - Updated emissions inventories for Canada, U.S. and Mexico (planned for 2017)
  - Developing 2.5km subdomains (next 2y)
- FireWork
  - Improved plume height estimates (2017)
  - Improved wildfire emissions estimates (2017)

