AQHI Program Status and Future Development

NOAA Air Quality Forecaster Focus Group Workshop

College Park, Maryland

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Meteorological Service of Canada

September 27-28, 2017

Part 1 - Overview

- AQHI Current Status
- AQHI+
- AQHI Advisory Program
- SO$_2$ Exceedances
- Future Developlments (Day 3 forecast, AQHI Map, Health impact based forecasting, aero-allergens)

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AQHI Current Status

- Multi-pollutant health based index (O_3, $PM_{2.5}$, NO_2)

$$AQHI_{PM\,2.5} = \frac{10}{10.4} * \left(100 * \left[\left(e^{(0.000871*NO_2)} - 1\right) + \left(e^{(0.000537*O_3)} - 1\right) + \left(e^{(0.000487*PM\,2.5)} - 1\right)\right]\right)$$

- As of Oct 3rd, 2017 AQHI forecasts available for:
  - 104 Communities across Canada
  - 13 additional station forecasts in larger cities
- This covers approximately 80% of the Canadian population
- Continue to support the Info-Smog program in Quebec

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AQHI communities

Inuvik
Whitehorse
Yellowknife
Fort Smith
Fort Chipewyan
Smithers
Terrace
Fort St. John
Grand Prairie
Spruce Grove
Fort McKay
Prince George
Fort McMurray
Cold Lake
Quesnel
Williams Lake
Fort Saskatchewan
Kamloops
Comox/Courtenay
Drayton Valley
Edmonton
Whistler
Red Deer
Prince Albert
Nanaimo/Parksville
WestShore
Calgary
Saskatoon
Duncan
Castlegar
Victoria /Saanich
Okanagan Valley
Regina
Brandon
Vancouver and Lower Fraser Valley
Squamish
Swift Current
Winnipeg
Medicine Hat
Lethbridge
Thunder Bay
North Bay
Sault Ste. Marie
Sudbury
Petawawa
Ottawa
Gatineau
Cornwall
Montréal
Québec
Labrador City
Grand Falls-Windsor
Corner Brook
St. John's
Burin
St. Peters Bay
Charlottetown
Summerside (Wellington)
Sydney
Bathurst Cambellton
Port Hawkesbury
Edmunston
Pictou
Miramichi
Kentville
Halifax
Greenwood
Moncton
Saint John
Fredericton

Parry Sound
Dorset
Kingston
Belleville
Barrie
Peterborough
Newmarket
Oshawa
Tiverton
Toronto
Brampton
Mississauga
Oakville
St. Catharines
Guelph
Burlington
Kitchener
Hamilton
Grand Bend
Brantford
London
Sarnia
Port Stanley
Chatham
Windsor

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AQHI+

- Activates based on single pollutant thresholds
  - Set by province/territory
  - Single pollutant AQHI formulation used while above threshold
  - Threshold linked to high risk AQHI category (7 or more)
  - Can be used for non-AQHI pollutants
- Generally based on 1-hr average
  - More responsive to changing conditions
  - More vulnerable to bad data
  - BC has special case
- Acts as a support to health messaging during single pollutant events
  - e.g. Forest fires

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AQHI+ Pollutant Thresholds

AQHI+ Pollutant	Alberta	British Columbia	Ontario	Northwest Territories
CO (ppb)	13500		30501.5	
NO_2 (ppb)	159.5		201	
O_3 (ppb)	82.5		81	
$PM_{2.5}$ (μ/m^3)	80.5	60		80.5
SO_2 (ppb)	172.5	71*	251	
H_2S (ppb)	1000.5			
TRS (ppb)	1000.5		28	

*proposed

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Advisory Programs

- Ontario:
  - Smog and Air Health Advisory for AQHI 7 or more (incl. AQHI+)

- Alberta/Northwest Territories
  - Air Quality Advisory for AQHI 7 or more (incl. AQHI+)

- British Columbia
  - Advisories issued by province
  - Provincial advisories are disseminated by ECC via Special AQ Statement

- Quebec
  - Smog Warning based on AQI
  - Triggered by:
    - O_3 (82 ppb) for at least 3 consecutive hours
    - $PM_{2.5}$ (35 μ/m^3) 3 hour rolling average

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SO$_2$ Exceedances

- Ontario and British Columbia looking for additional messaging for SO$_2$ events

- Nature of the pollutant is such that exceedances occur with very little warning and are often short lived

- Pollutant is detectable by public due to pungent smell, but as it is not part of AQHI formulation, the observed AQHI does not reconcile with user experience

- Proposal -> A canned message will display on AQHI page automatically when SO$_2$ exceeds threshold
  - Message will be short, not too technical and direct users to provincial/territorial website for more details

- May result in removing SO$_2$ from AQHI+ in some cases

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Ottawa - Air Quality Health Index

Current

Calculated at: 9:00 AM EDT Wednesday 17 May 2017

2*
▼

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | + |

| **Low Risk** (1-3) | **Moderate Risk** (4-6) | **High Risk** (7-10) | **Very High Risk** |
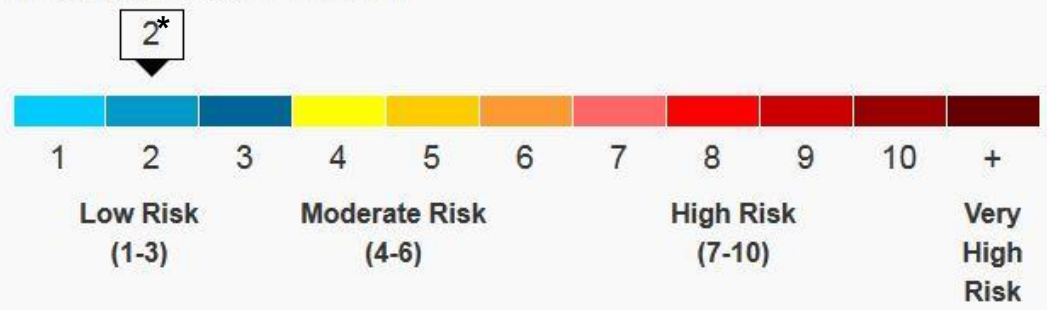
*Air Quality Note:
- A strong odor may be present due to elevated levels of air pollutants. For more details please consult your provincial ministry of the environment.

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

Issued at: 6:00 AM EDT Wednesday 17 May 2017

Wednesday	3 - Low Risk	▼
Wednesday night	3 - Low Risk	▼
Thursday	3 - Low Risk	▼

Future Developments

- Development of 72hr or more GEMMACH model will allow longer range AQHI forecasts (Day 3+)

- Map based service will allow users to easily find AQHI observations and forecasts for their area

- Forecasting of aero-allergens

- Evaluating the feasibility of staffing a smoke desk that would monitor forest fire smoke for the whole country

- Longer term -> Moving towards an all hazards, health impact based forecast product which could combine Air Quality with Heat/Cold, UV, etc.

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Part 2 - Overview

- Short description of operational AQ systems
- A few performance metrics
- Next steps

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Canadian Operational Air Quality Forecast Systems

- **Systems run by ECCC Operations**
  - 1) **RAQDPS** (**R**egional **A**ir **Q**uality **D**eterministic **P**rediction **S**ystem)
    - GEM-MACH
    - Emissions & boundary conditions
    - Statistical model (UMOS-AQ)
    - Operational Products
    - Regional Deterministic Air Quality Analysis (RDAQA)

http://meteo.gc.ca/mainmenu/airquality_menu_e.html

Different PM$_{2.5}$, PM$_{10}$ and O$_3$ charts are available
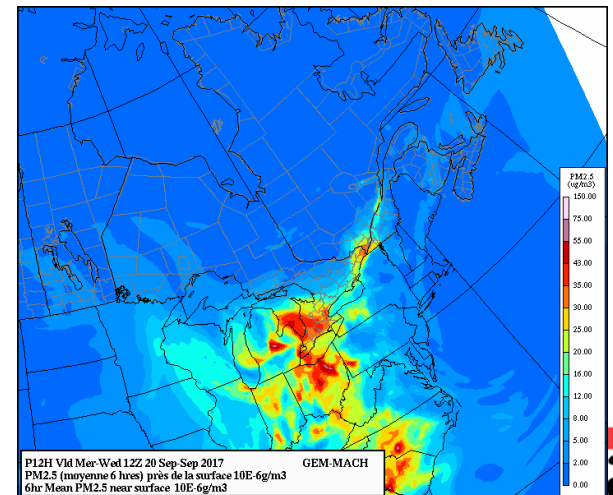
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Canadian Operational Air Quality Forecast Systems

- **Systems run by ECCC Operations**

  2) FireWork (RAQDPS with wildfire emissions)

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

  http://weather.gc.ca/firework/index_e.html

Hourly, max and average fire-PM$_{2.5}$ concentrations over FireWork domain and/or zoomed Canadian sub-domains
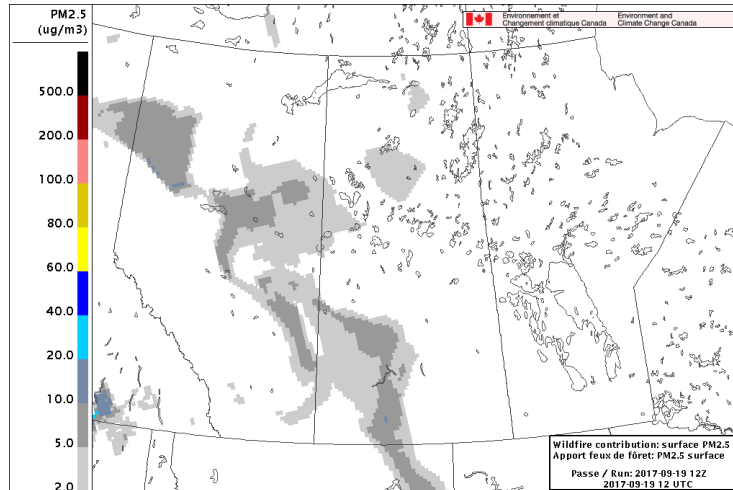
Exemple: MAX hourly PM$_{2.5}$ (ug/m^3)
*Period covered: **Sept 2nd** 00-24UTC*
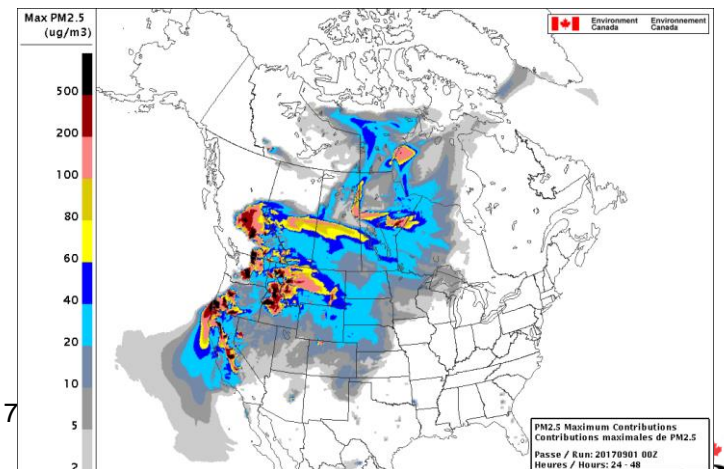
Canadian Operational Air Quality Forecast Systems

- **Systems run by ECCC Operations**

  2) FireWork (products available via password-protected web page)

http://collaboration.cmc.ec.gc.ca/cmc/air/FireWork-GEMMACH/

Many additional products and tools such as:

- ➢ *Objective Analysis*
- ➢ *Wildfire event related products*
- ➢ *Client-specific products*
- ➢ *Interactive Webmap*
- ➢ *UMOS-AQ/MIST 2D fields*
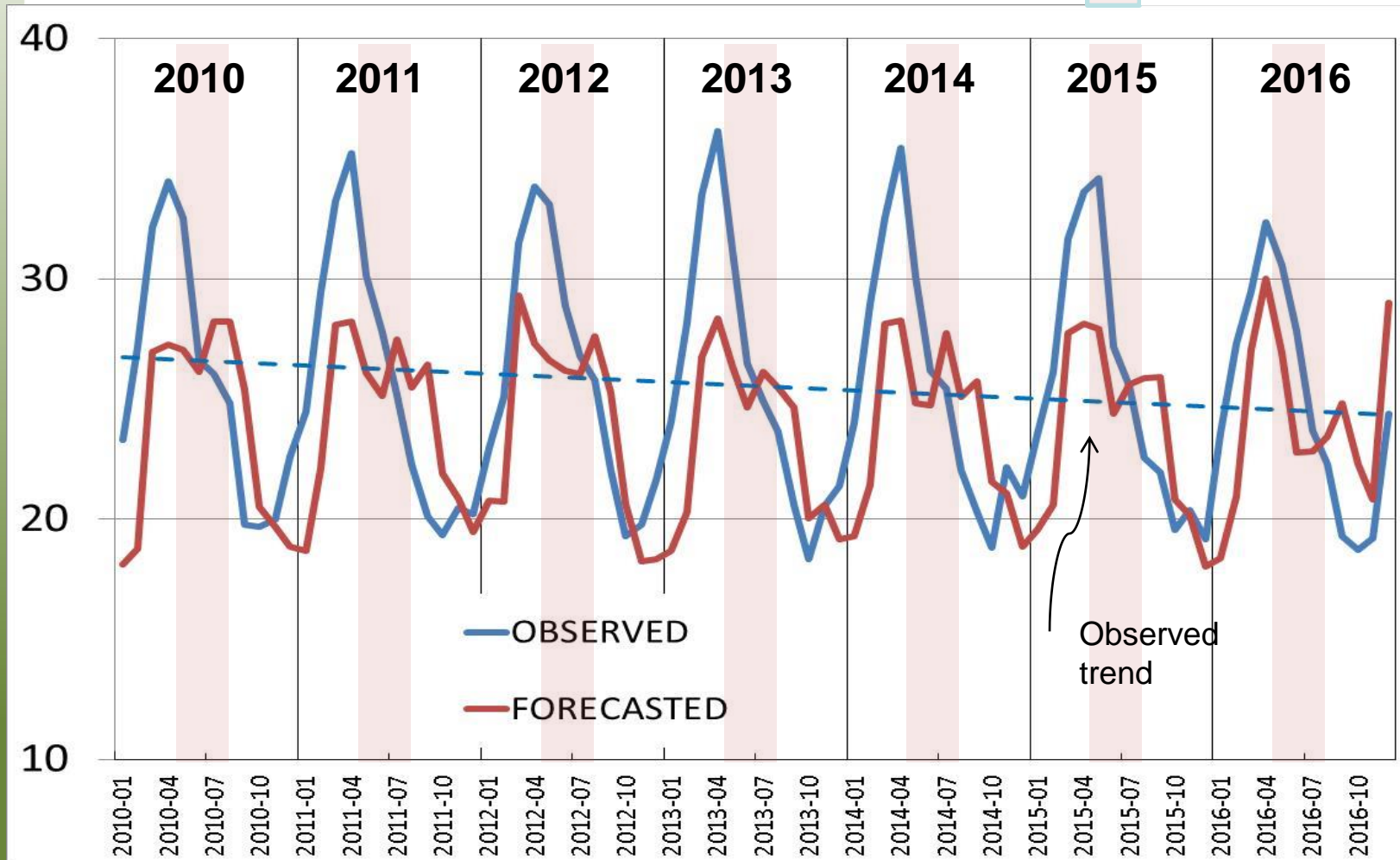- ➢ *Etc.*

– October-3-17
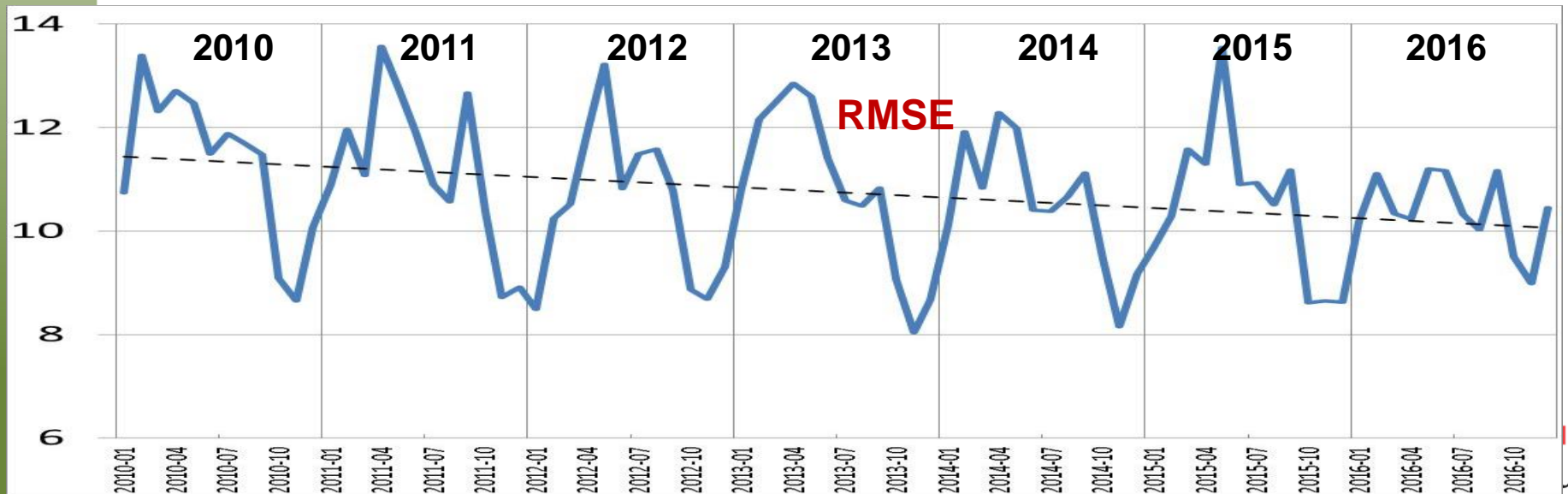
anada

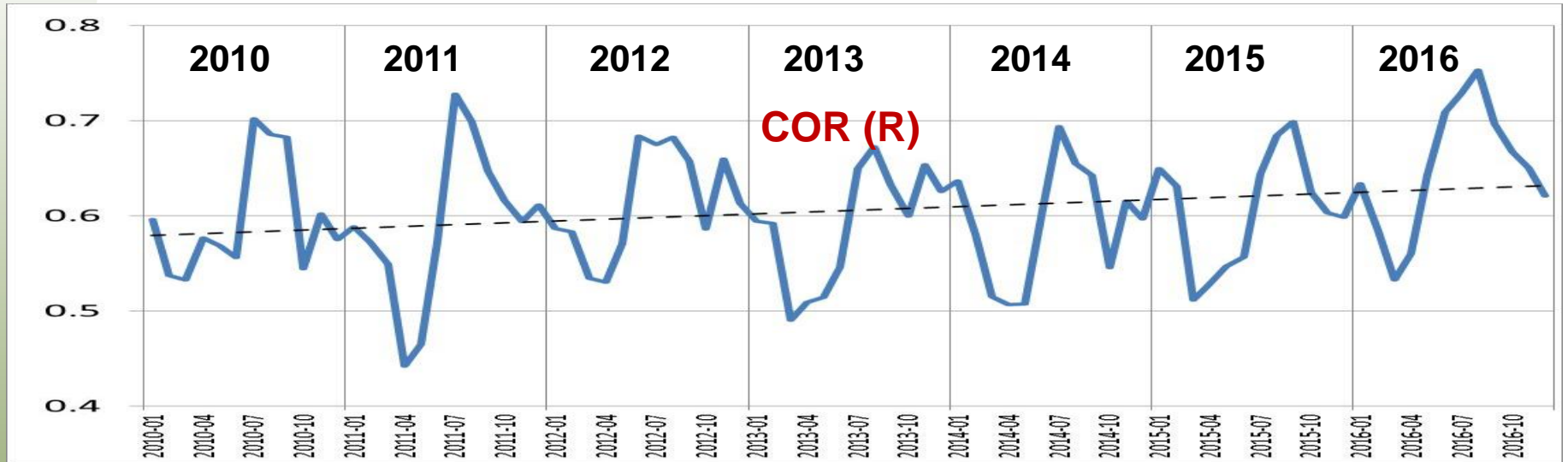# Improving Performance
O_3 (ppb) CANADA

2010-2016 average monthly concentrations

Improving Performance
O₃ (ppb) CANADA

Pollution in Major Canadian Cities
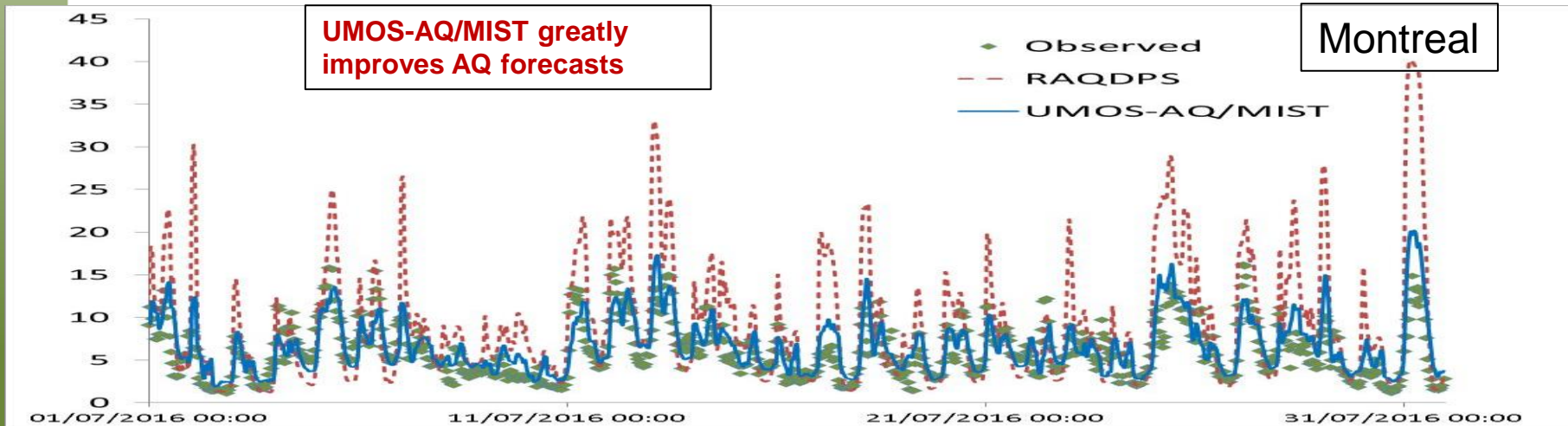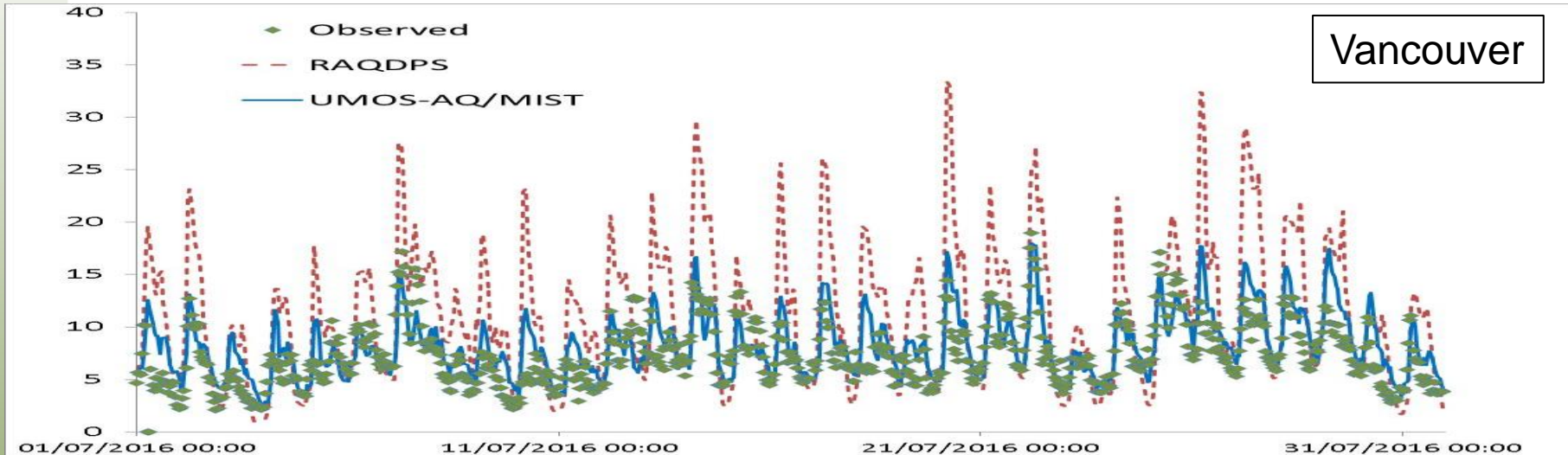

MONTREAL

VANCOVER

TORONTO

● AQ Station

Nearly 13 million people, or more than a third of the Canadian population, live in these three metropolitan areas (Statistics Canada, 2015)

✓ In Canada, SMOG episodes are generally attached to large urban areas
✓ The pollution field may be non-homogeneous near urban areas
✓ The performance of UMOS-AQ / MIST, especially in cities, is a key factor in **improving urban forecasting** capabilities

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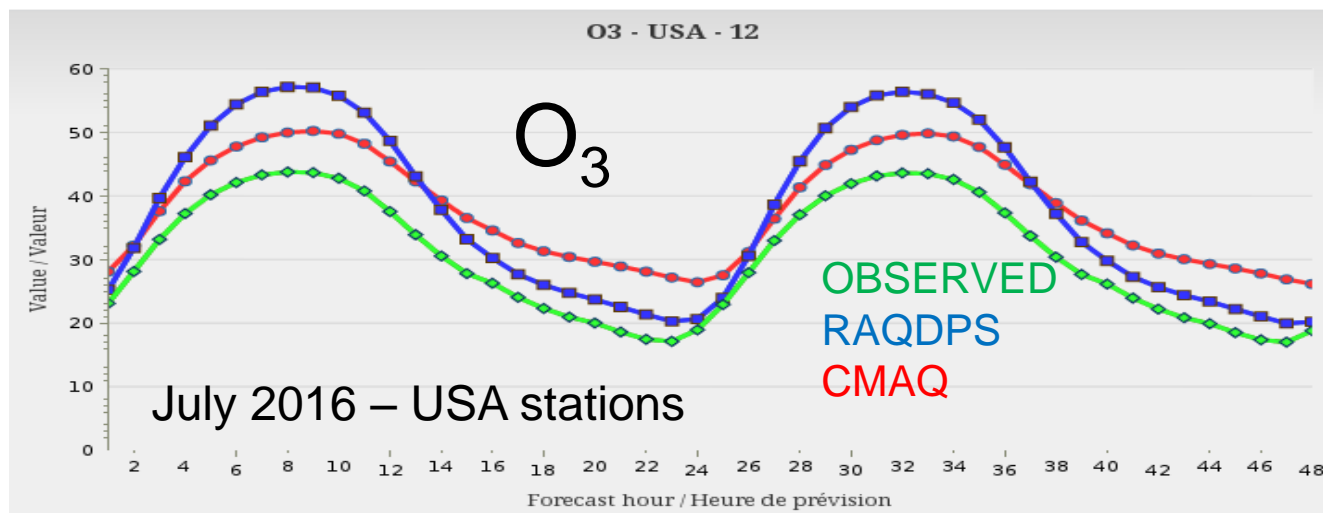Changement climatique Canada

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July 2016- NO$_2$ (ppb)

Operational Monthly Verifications

The Canadian Meteorological Centre regularly performs AQ Model performance comparisons. So far, online verification is done using RAQDPS, FireWork (ECCC's systems) and CMAQ (USA NOAA system).

Starting this fall, the ECMWF global chemistry model will be added to monthly verifications.

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Next Steps

- RAQDPS
  - Updated emissions inventories for Canada, U.S. and Mexico (fall 2017)
  - **72h forecasts** (early 2018)
  - New, improved GEM core dynamic library (early 2018)
  - Developing 2.5km subdomains (experimental)
- FireWork
  - On top of the RAQDPS updates:
    - Improved plume height estimates (tested this year, delivery planned for 2018 wildfire season)
    - Improved wildfire emissions estimates (tested this year, delivery planned for 2018 wildfire season)

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