AQHI Program Status and Future Development

NOAA Air Quality Forecaster Focus Group Workshop
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Meteorological Service of Canada
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Part 1 - Overview

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

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

\[
AQHI_{PM_{2.5}} = \frac{10}{10.4} \times \left[ 100 \times \left[ e^{0.00087\times NO_2} - 1 \right] + e^{0.00053\times O_3} - 1 \right] + e^{0.00048\times PM_{2.5}} - 1 \]

• 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
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
# AQHI+ Pollutant Thresholds

<table>
<thead>
<tr>
<th>AQHI+ Pollutant</th>
<th>Alberta</th>
<th>British Columbia</th>
<th>Ontario</th>
<th>Northwest Territories</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (ppb)</td>
<td>13500</td>
<td></td>
<td>30501.5</td>
<td></td>
</tr>
<tr>
<td>NO₂ (ppb)</td>
<td>159.5</td>
<td></td>
<td>201</td>
<td></td>
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<tr>
<td>O₃ (ppb)</td>
<td>82.5</td>
<td></td>
<td>81</td>
<td></td>
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<tr>
<td>PM₂.₅ (μ/m³)</td>
<td>80.5</td>
<td>60</td>
<td></td>
<td>80.5</td>
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<tr>
<td>SO₂ (ppb)</td>
<td>172.5</td>
<td>71*</td>
<td>251</td>
<td></td>
</tr>
<tr>
<td>H₂S (ppb)</td>
<td>1000.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRS (ppb)</td>
<td>1000.5</td>
<td></td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

*proposed
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 $\mu g/m^3$) 3 hour rolling average
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
*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.
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.
Part 2 - Overview

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

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

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

- Systems run by ECCC Operations
  - **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 2$^{nd}$ 00-24UTC**
Canadian Operational Air Quality Forecast Systems

Con't

• 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.
Improving Performance

$O_3$ (ppb) CANADA

2010-2016 average monthly concentrations

- Observed trend
- Summertime
Improving Performance

$O_3 \text{ (ppb)} \text{ CANADA}$
Pollution in Major Canadian Cities

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
July 2016 - NO$_2$ (ppb)

UMOS-AQ/MIST greatly improves AQ forecasts
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.
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)