Toronto Neighbourhood Air Quality Studies and **Upcoming Monitoring Plans**

Christopher Ll. Morgan

Environment & Energy Division

Clean Air Council - June 22nd 2018

Monitoring + Modelling + Mental-ing "the times they are a changing"

REVISED CONTENT

- Introduction
- Present & Future AQ Modelling
- Present & Future AQ Monitoring
- Conclusion
- Monitors and Models are Adequate when Alone
- But both are Better when Combined
- + the "Mental" part is always Essential

.... Intertwined



INTRODUCTION

- I have to begin by admitting:-
- I was once a big AQ modeling supporter & a bit of a monitoring denier
- I am now less of a modelling supporter & a stronger supporter of new monitoring (i.e., not so much of the old - albeit it is still necessary)
- Modelling has improved greatly but hasn't conceptually moved too much in recent years re: understanding or acceptance ... or to a <1km grid scale</p>
- But monitoring has improved, changed & become much more useful !!
 With new equipment & new capabilities
 - But the mental component is still (& always will be) the most important and the most necessary !!

Monitors & Models (i) cf.

- Monitors monitor the "present" & store "historical" data +
- Monitors (generally) cannot ID the sources
- Most people have <u>faith</u> in monitored data

+

+

+

- Models can model the "past, present or <u>future</u>"
- Most people have <u>less faith</u> in modelled results
- Models input the sources and ID the <u>culprits</u>
- Models can ID space <u>between</u> the monitoring stations ++
- Model the benefits of improvement <u>scenarios</u>

BUT best to combine modelling, monitoring, analyzing
 AND thinking !!

Monitors & Models (ii) cf.

conferatur

Established Old Standard – Fixed Stations

- MOE Stations
- \triangleright O₃ PM_{2.5} NO₂ SO₂ CO TRS

New Standard – No Fixed Stations

- ▶ UofT, PHO + EED & TPH
- ► BC UFP NO₂
 - BC & UFP = diesel exhaust signature
 - NO₂ = traffic volume indicator

(unregulated mobile)

(regulated industrial)

- AQ Models not refined enough? (albeit R-LINE / MUNICH in future?)
- NB New TRAP Focus across the GTAH (less of an industrial focus)
- Industrial emissions are easy to model TRAP much less so

Toronto's AQ Neighbourhood Studies & AQ City-Wide Studies

- We were perhaps the first out of the gate in the GTAH
- LOCAL Riverdale Leslieville (CALPUFF)
- LOCAL South Etobicoke (CALPUFF)
- LOCAL other areas (political resistance)
- CITY WIDE = Problems ... because we were told to change course in midstream
 - Problem = 3 model grid cell layers were legitimately apportioned by consultants for specific ward groups but couldn't be "controlled" when spatially linked (esp. with trace sources from USA – led to showing max and min concentrations without anything between.
 - Since when others have done it much better (eg Peele & Hamilton using CMAQ)

PM₁₀ Annual Average

LEGEND pm10-aa-v3 19.61 - 21.69 Particulate Matter 10 - Annual AAQC (µg/m3) = N/A 21.7 - 23.77 ANALYSIS MAP -11 28 - 13 36 23.78 - 25.85 ANNUAL AVERAGE CONCENTRATION

25.86 - 27.93

27.94 - 30.01

30.02 - 32.09

ARTICULATE MATTER <10µm ANNUAL AVERAGE

ONCENTRATIONS FROM ALL EMISSION SOURCES

FIGURE: C-22

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13 37 - 15 44

15.45 - 17.52

17.53 - 19.6

Projection: Lambari Contornal Conto: Datum 140 83 Countrale System US EPA LCC

NEFENENGE

Benzene Annual Average





AADTs – Vehicle Volumes > 15,000 = adverse health significance

Mean & Max daily traffic Volumes on Pro	v. Hwys. &	City Expwys.
Expressways & Highways	Mean	Maximum
Highway 401 (Renforth Dr. to Kingston Rd.)	331,246	410,000
Highway 427 (South of the 401 only)	364,550	382,200
Highway 404	255,600	285,100
Highway 400	141,800	231,000
Gardiner Expressway	150,662	222,894
Don Valley Parkway	148,286	180,303
Queen Elizabeth Way <mark>(QEW)</mark>	171,900	175,000

Mean and Max daily traffic Volumes on City Arterials (major & minor)

Major Arterial Roads in Toronto	Mean	Maximum
Average of 27 major arterials	35,066	62,180
Average of 116 minor arterials	26,332	38,214

Traffic Volumes can be a better Policy Driver than Model Maps Output!!!!

PLAUDITS to Region of PEEL (aka Louise Aubin !!)

- They use CMAQ (assisted by RWDI)
- **5 year contract** connection (produce and maintain) + second 5-yr phase to start soon
- **Their model covers the GTAH** (from Hamilton to Oshawa etc. in high-def resolution)
- They really are doing it the right way!
- Better yet they are willing to share to other regions in GTAH (for a fee tbd)
- Details to be explored and agreed upon. Kudos!!
- This can also potentially reverse-link to AQ monitoring data (MOECC + UofT + PHO etc.)
- E.G., for Hwy 401 TRAP from west to east (from coast to coast)
- Though R-LINE (or similar) might also be interesting there!

Present /FUTURE AQ Models

AERSCREEN / AERMOD

CALPUFF

- SMOKE (Sparse Matrix Operator Kernel Emissions input to CMAC)
- Models 3 / CMAC (Community Multiscale Air Quality Modeling System)
- R-LINE (Research) // C-LINE (Community)
- MUNICH
- The street-network model is the Model of Urban Network of Intersecting Canyons and Highways (MUNICH), which consists of two main components: a street-canyon component and a street-intersection component.

Models are not single entities - but combinations

- To 3 Dimensional Dynamic PHYSICAL Model (CALPUFF)
 - CALMET + CALPUFF + CALGRID (MESOPUFF & RIVAD/ARM3) + CALPOST
- To 3 Dimensional Dynamic CHEMICAL Model (CMAQ)
 - WRF + MCIP + SMOKE + CMAQ-CTM (aka CCTM)



MOECC's 4 (main/standard) AQ Monitoring Stations in TO

27 17 (404) 38 73 STEELES 17 **MOECC** monitors MALVERN 72 THORNHILL 400 401 CONCORD 53 to provide AQHI 7 HIGHLAND AGINCOURT CREEK 407 PORT UNIC BAYVIEW SCARBOROUGH WOODBRIDGE VILLAGE YORK WILLOWDALE WEST HILL 401 UNIVERSITY BENDALE 50 HEIGHTS NORTH YORK The "Big Six" 0 Don Valley Pkwy 07 JANE AND FINCH SMITHFIELD 401 DOWNSVIEW $\begin{array}{ccc} O_3 & PM_{2.5} & NO_2 \\ SO_2 & CO & TRS \end{array}$ REXDALE **GOLDEN MILE** MALTON 401 Allen Rd 427 CLIFFSIDE Toronto Pearson 409 YORK International Airport 0 Toronto Toronto ERINGATE THE BEACH East West CENTENNIAL Toronto WEST DEANE Toronto Brampton 14 Downtown (410) Mississauga ENTERTAINMENT 427 Gardiner Expv DISTRICT Oakville 17 **ISLINGTON - CITY** 403 **CENTRE WEST** Burlington 23 ETOBICOKE Hamilton West (11)7 Hamilton Pawntawn 4 NEW TORONTO *lountain*

Previous AQ Monitoring

- Old AQ Monitoring was/is not supposed to be political
- BUT it seems to always have been!
- e.g., monitors downwind of concerned citizens (angry voters)
- Original 6 in TO dropped to 4 post amalgamation
- Old Standard MOE Stns
 - \triangleright O₃ PM_{2.5} NO₂ SO₂ CO TRS (industrial focus)
- Provincial Reporting Requirements
- Clarkson Air-shed Study (CASS)
 - Much money to monitor CASS
 - Too little money to model CASS

Halton adopted 2 Air Pointers to support modelling & policy etc.

Present / FUTURE AQ Monitoring

- Uot Research (BC & UFP)
 - Greg E & Cheol on the GO (in coach adjacent to engine)
 - Greg E & Cheol re: Brunel (new school) & Bentway
- PHO & UofT re: TRAP near schools & day-cares

- New MOE Monitoring Locations (Kudos!)
- a) Next to 401

show pictures of installation

b) University & Front

show pictures of site

New Monitoring – adjacent to TRAP near Highways & in Canyons













Upcoming Monitoring Plans

-- to satisfy the title Gabby gave me

- We (EED & TPH) persuaded a willing PHO to help monitor TRAP in Toronto and especially in respect to Day Cares, Schools and Seniors LTC Homes
- PHO began "trial-ing" the concepts and practices of monitoring TRAP outside 15 Schools in 2017
 - problems of location selections and access were evident
 - 15 minute data samples at 15 schools between 10:00am and 4:00pm
 - Excluded drop off but captured pick up
 - measured BC UFM and NO2
- In 2018 PHO linked with UofT (people and equipment support and model)
 - Begun recently and ongoing through the summer focus is on Day Cares
- In 2019
 - ► ?

Corrected Pollution Scores, by School (2017)



BC

UFP

"Pollution Scores" reflect proximity of location to Higways & Parkways.

Schools were frequently closer to the Hwys and Pkwys than the mobile monitoring platform could be.

1 = on avg. (indicates) greater values than at MOE's OLD downtown comparison site

What we Need ...

- Better regional generalities
- Better Regional General Perspective from better combining and integrating new Regional AQ Models with new Regional AQ Monitoring (e.g., add BC and UFB to NO₂ monitoring)
- Better local details
- Better Locale Specific Perspectives from developing, adopting, combining and integrating models such as R-LINE and MUNICH linked to traffic volume and flow characteristics ... and urban structure constraints
- ► More detailed focus (such as ...)
- Near side Far side ... monitor and model intersection emission vtns.
- Steady flow Congestion ... monitor and model emission vtns.
- Urban canyon vtns. ... model and monitor air flow and emission diffusion vtns.
- Overlapping Intersections (i.e., not connected) e.g., 401 and arterial underpasses)
- Integrate regional and local
- Higher confidence, better policy and better improvements
- **Better health for all** (including drivers)

Neither Model nor Monitor are perfect for <u>all</u> purposes !!

- Everything is Improved when Each informs the Other
- And that includes Regional and Local
- And that relies on the Mental



Present & Upcoming

- Backpack Monitoring
- Private Monitoring Apps (integrated to reflect spatial area variations)
- Drones (vertical & horizontal)
- Integrating Everything Appropriately (the "mental" part again!)
- Better Addressing Time & Space
 - Present & Future (not just industry include traffic as well)
 - Regional & Local (not just generalities include site-type specifics)