Occupational
Health Clinics
for Ontario Workers

Centre de Santé
des Travailleurs(ses)
de l'Ontario

OCC-DISEASE PREVENTION

"Where there's smoke…":
Understanding Particulate
Hazards Indoors and Out

FEATURING

Dr. Dave Stieb,
Health Canada Physician
and Epidemiologist

in **conversation** with

John Oudyk,
OHCOW Occupational
Hygienist

A WEBINAR

JULY 21, 2023 | 1:30 - 3:00

OHCOW

Wed
28 Jun

25°C

Smoke

Tonight

10°C

Smoke

Access city | Weather Topics

↻ Last updated 12:38 PM EDT Wed 28 Jun 2023

Brantford, ON

⚠ **SPECIAL AIR QUALITY STATEMENT** ▶

▾ Current Conditions

Past 24 hours | Weather Radar | Satellite | Lightning

21°C

°C | °F

Observed at: **Brantford Municipal Airport**
Date: **12:00 PM EDT Wednesday 28 June 2023**

Condition: **Not observed**	Temperature: **21.1°C**	Wind: **NW 17 km/h**
Pressure: **101.5 kPa**	Dew point: **11.2°C**	Humidex: **23**
Tendency: **Rising**	Humidity: **53%**	

▾ Forecast

Hourly Forecast | Air Quality | Alerts | Jet Stream

Wed 28 Jun	Thu 29 Jun	Fri 30 Jun	Sat 1 Jul	Sun 2 Jul	Mon 3 Jul	Tue 4 Jul
25°C	27°C	26°C 40%	27°C 60%	25°C 40%	26°C 30%	29°C
Smoke	Smoke	Chance of showers	Chance of showers	Chance of showers	Chance of showers	A mix of sun and cloud
Tonight	**Night**	**Night**	**Night**	**Night**	**Night**	
10°C	16°C	18°C 40%	17°C 40%	17°C 30%	17°C	
Smoke	Cloudy	Chance of showers	Chance of showers	Chance of showers	Cloudy periods	

▾ Forecast issued: 11:00 AM EDT Wednesday 28 June 2023

Climate change perspective

Climate change - forest fire feedback loop

1 Increased global CO_2 emissions lead to higher temperatures and more droughts

2 Increase in temperatures, decrease in humidity and a lack of moisture in potential fuel for fires, such as shrubs, grasses, and forest debris can help fires catch and spread, leading to longer and more active fire seasons

3 Larger areas burn as fires become more frequent and intense, leading to higher CO_2 emissions, which enter the atmosphere and contribute further to climate change, restarting the cycle

https://factcheck.afp.com/doc.afp.com.33JY44F

Sources: Global Forest Watch, World Resource Institute, NOAA

AFP

"Unprecedented" environmental exposures

Smoke from wildfires in Canada was detected across a large part of the U.S. on June 7, 2023. Dark purple (brown?) dots indicate hazardous air quality; purple indicates very unhealthy air; red is unhealthy; orange is unhealthy for sensitive groups; and yellow indicates moderate risk. AirNow.gov

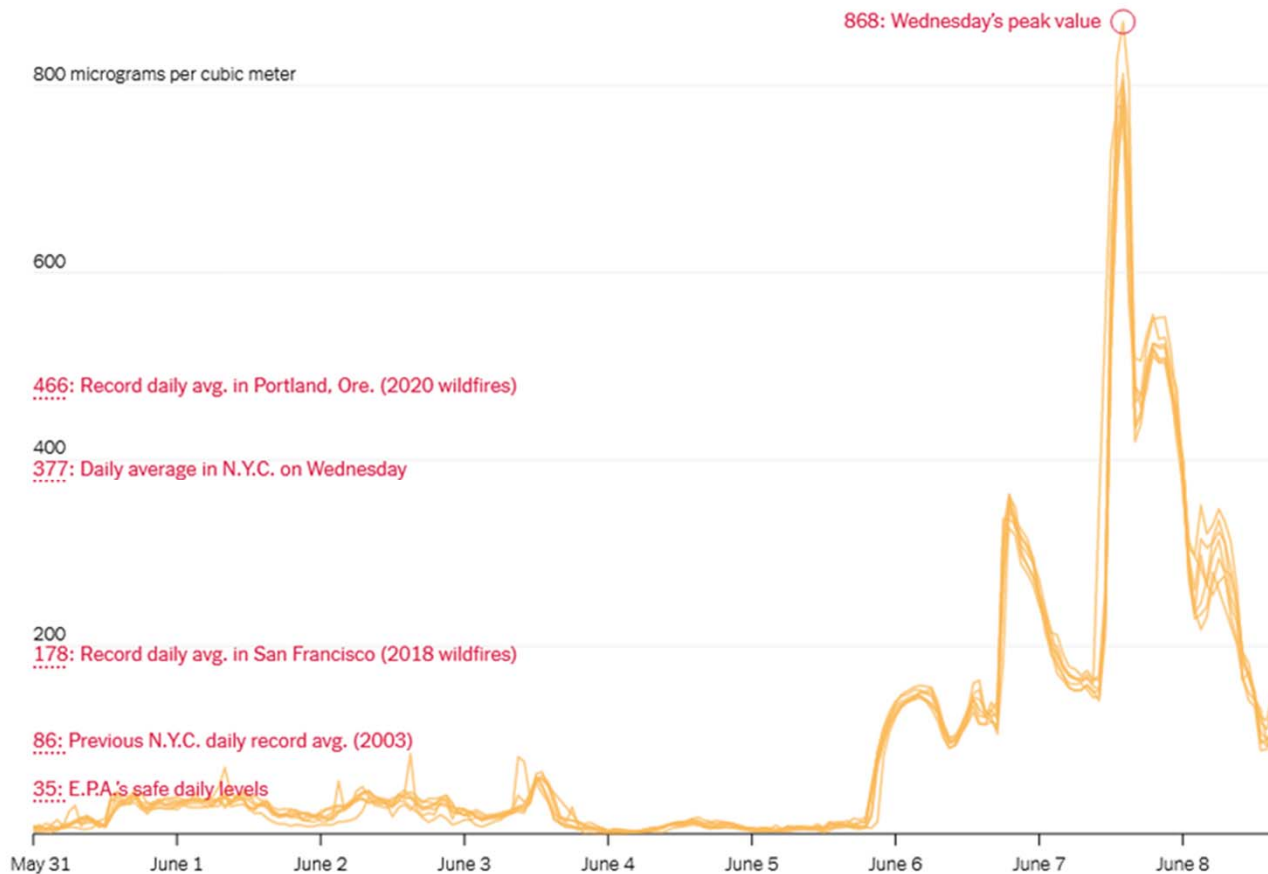https://www.pbs.org/newshour/science/how-wildfire-smoke-can-threaten-human-health-even-when-the-fire-is-hundreds-of-miles-away
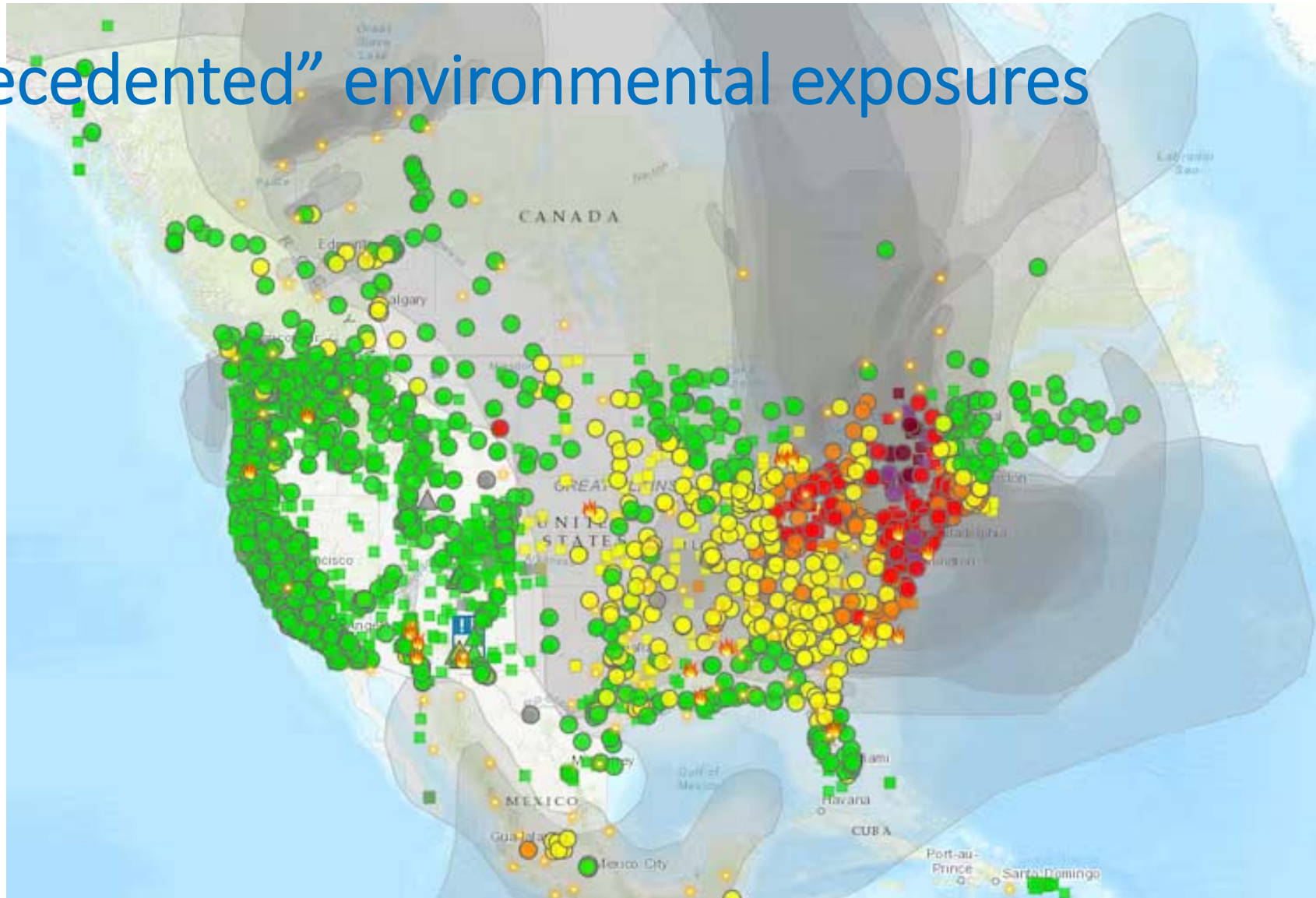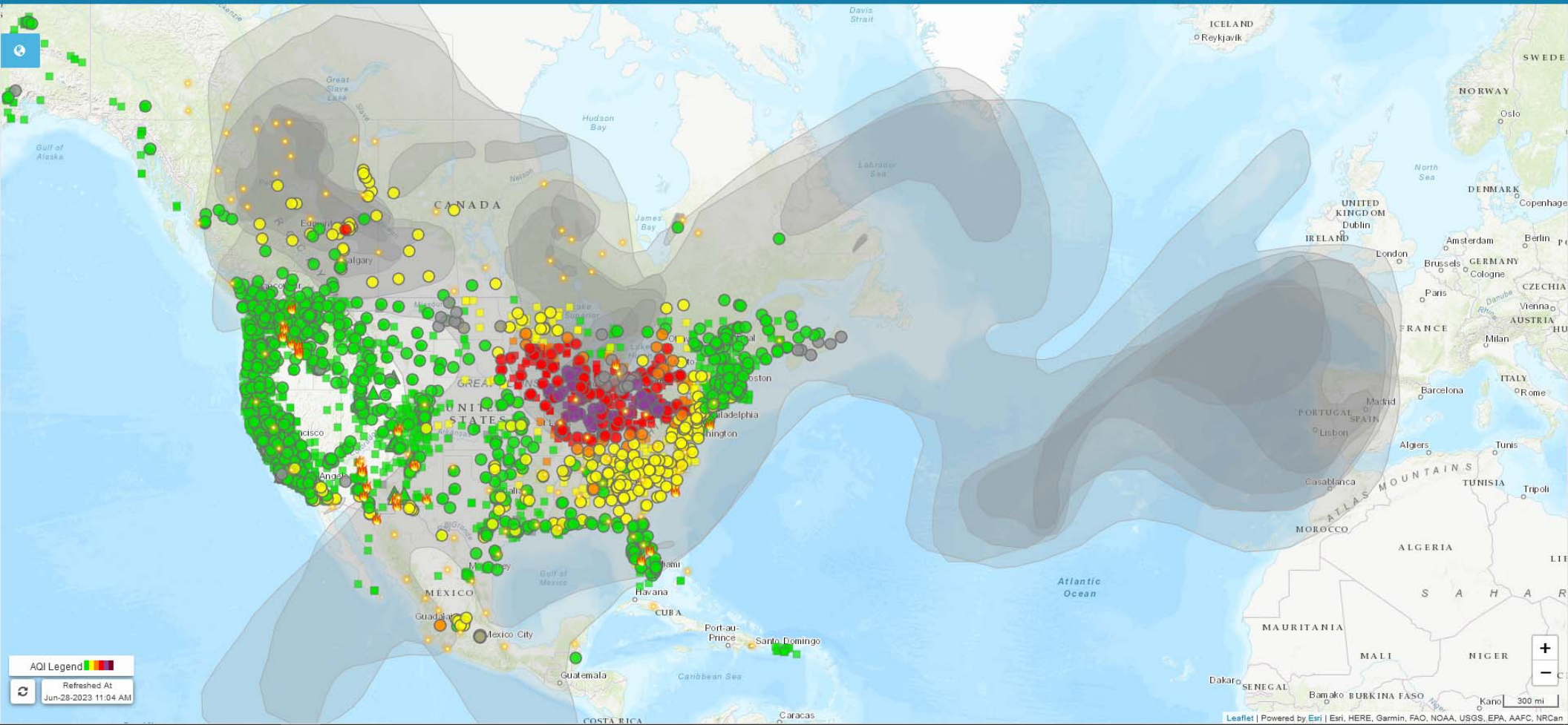
Just How Bad Was the Pollution in New York?

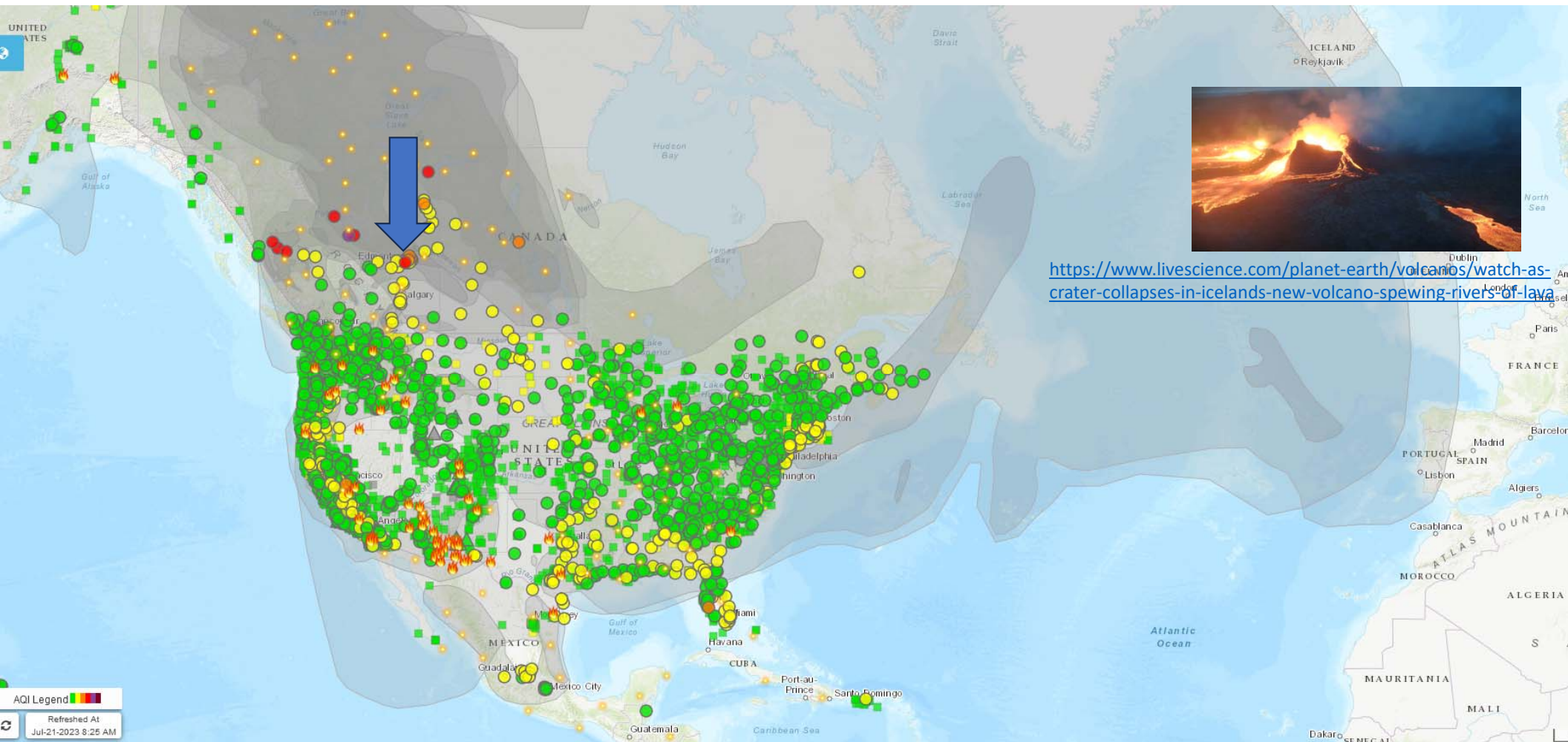By Aatish Bhatia, Josh Katz and Margot Sanger-Katz   June 8, 2023

https://www.nytimes.com/interactive/2023/06/08/upshot/new-york-city-smoke.html

Fine Particle Pollution at Seven Locations in New York City

868: Wednesday's peak value

800 micrograms per cubic meter

600

466: Record daily avg. in Portland, Ore. (2020 wildfires)

400
377: Daily average in N.Y.C. on Wednesday

200
178: Record daily avg. in San Francisco (2018 wildfires)

86: Previous N.Y.C. daily record avg. (2003)

35: E.P.A.'s safe daily levels

May 31   June 1   June 2   June 3   June 4   June 5   June 6   June 7   June 8

https://fire.airnow.gov/#

https://www.livescience.com/planet-earth/volcanos/watch-as-crater-collapses-in-icelands-new-volcano-spewing-rivers-of-lava

https://fire.airnow.gov/#
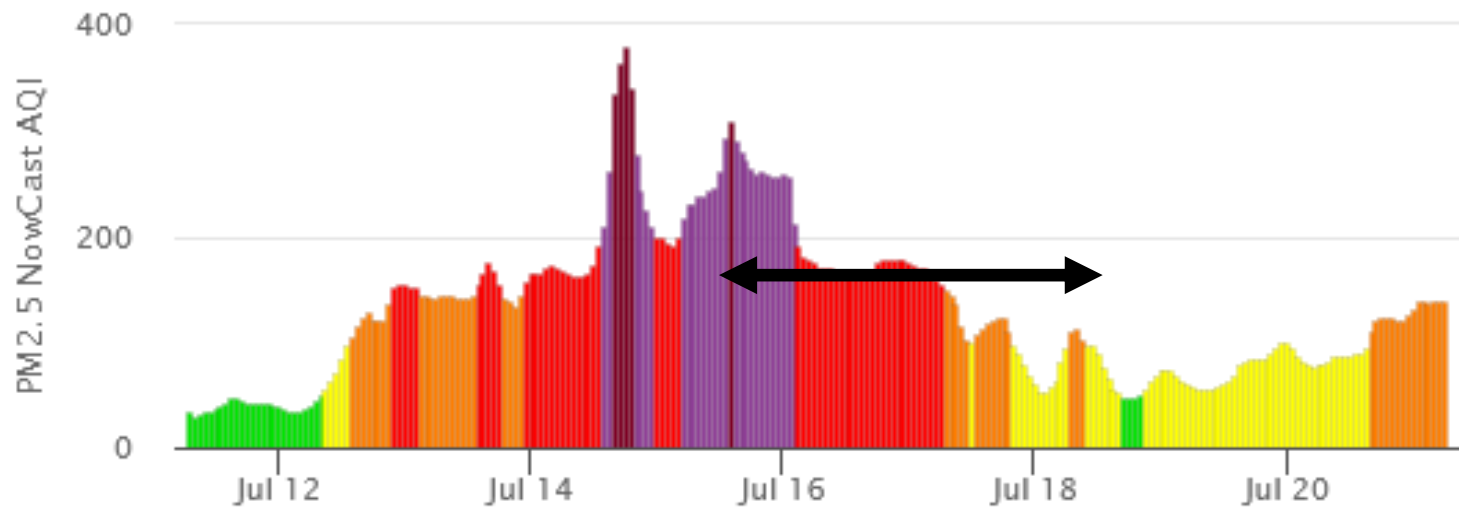
Edmonton - Air Quality Health Index

https://weather.gc.ca/airquality/pages/abaq-001_e.html

AQHI

Observed Conditions

Calculated at: 5:00 AM MDT Friday 21 July 2023

| 5 |

| 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**
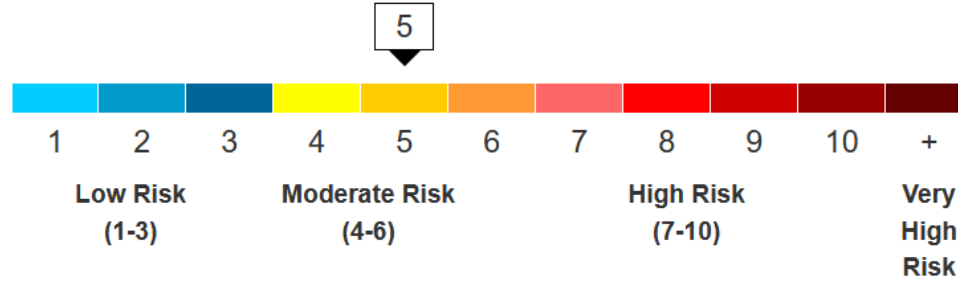
At-Risk Population:

- Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.
- Find out if you are at risk

General Population:

- No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.

Forecast Maximums   Next 24 hr | Health Message

Issued at: 6:00 AM MDT Friday 21 July 2023

Friday	**5 - Moderate Risk**
Friday night	**5 - Moderate Risk**
Saturday	**5 - Moderate Risk**
Saturday night	**5 - Moderate Risk**

But where did this AQHI come from?

A New Multipollutant, No-Threshold Air Quality Health Index Based on Short-Term Associations Observed in Daily Time-Series Analyses

David M. Stieb and Richard T. Burnett
Healthy Environments and Consumer Safety Branch, Health Canada, and Department of Epidemiology and Community Medicine, University of Ottawa, Ottawa, Ontario, Canada

Marc Smith-Doiron, Orly Brion, and Hwashin Hyun Shin
Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario, Canada

Vanita Economou
Department of Epidemiology and Community Medicine, University of Ottawa, Ottawa, Ontario, Canada

If you're wondering how to calculate the AQHI:

Equations 4 and 5 summarize the final index formulations derived from the analysis described above:

$$PM_{2.5}AQHI = 10/10.4*(100*(e^{(0.000871*NO_2)} - 1 + e^{(0.000537*O_3)}$$
$$- 1 + e^{(0.000487*PM_{2.5})} - 1)) \qquad (4)$$

$$PM_{10}AQHI = 10/11.7*(100*(e^{(0.000871*NO_2)} - 1 + e^{(0.000537*O_3)}$$
$$- 1 + e^{(0.000297*PM_{10})} - 1)) \qquad (5)$$

Spreadsheet:

B6 | fx =10/10.4*(100*((EXP(0.000871*$B$5)-1)+(EXP(0.000537*$B$3)-1)+((EXP(0.000487*$B$4)-1))))

	A	B
1		
2	pollutant:	value
3	O_3 (ppb)	10
4	$PM_{2.5}$ ($\mu g/m^3$)	45
5	NO_2 (ppb)	3
6	$PM_{2.5}$ AQHI	3

Conditional Formatting Rules Manager

Show formatting rules for: Current Selection

New Rule... | Edit Rule... | Delete Rule | Duplicate

Rule (applied in order shown)	Format	
Cell Value < 1.5	AaBbCcYyZz	
Cell Value < 2.5	AaBbCcYyZz	
Cell Value < 3.5	AaBbCcYyZz	
Cell Value < 4.5	AaBbCcYyZz	
Cell Value < 5.5	AaBbCcYyZz	
Cell Value < 6.5	AaBbCcYyZz	
Cell Value < 7.5	AaBbCcYyZz	
Cell Value < 8.5	AaBbCcYyZz	
Cell Value < 9.5	AaBbCcYyZz	
Cell Value < 9.5	AaBbCcYyZz	=$B$6
Cell Value > 10.49999999	AaBbCcYyZz	=$B$6

Colors

Standard | Custom

Colors:

Color model: RGB

Red: 0
Green: 204
Blue: 255
Hex: #00CCFF

New

Current

OK | Cancel

OK | Close | Apply

AQHI Advice:

The following table provides the health messages for 'at risk' individuals and the general public for each of the AQHI Health Risk Categories.

Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population*	**General Population**
Low	1 - 3	**Enjoy** your usual outdoor activities.	**Ideal** air quality for outdoor activities.
Moderate	4 - 6	**Consider reducing** or rescheduling strenuous activities outdoors if you are experiencing symptoms.	**No need to modify** your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7 - 10	**Reduce** or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	**Consider reducing** or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High	Above 10	**Avoid** strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	**Reduce** or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

* People with heart or breathing problems are at greater risk. Follow your doctor's usual advice about exercising and managing your condition.

https://link.springer.com/article/10.17269/s41997-019-00237-w

QUANTITATIVE RESEARCH

Assessment of the Air Quality Health Index (AQHI) and four alternate AQHI-Plus amendments for wildfire seasons in British Columbia

Jiayun Yao[1] · Dave M. Stieb[2] · Eric Taylor[3] · Sarah B. Henderson[1]

1-h PM$_{2.5}$Only

Take the ceiling values (the closest integer greater than or equal to a given value) of the 1-h PM$_{2.5}$ concentration divided by 10.

=10/10.4*
(100*((EXP(0.000871*B5)-1) +
    (EXP(0.000537*B3)-1) +
      ((EXP(0.000487*B4)-1))))

Wildfire smoke version
(1-hr PM$_{2.5 \text{ Only}}$ AQHI)

=ROUND(B4/10,0)

	A	B
1		
2	pollutant:	value
3	O$_3$ (ppb)	10
4	PM$_{2.5}$ (µg/m^3)	45
5	NO$_2$ (ppb)	3
6	PM$_{2.5}$ AQHI	3

	A	B
1		
2	pollutant:	value
3	O$_3$ (ppb)	10
4	PM$_{2.5}$ (µg/m^3)	45
5	NO$_2$ (ppb)	3
6	1-hr PM$_{2.5 \text{ Only}}$ AQHI	5

Dave Stieb

Public Health Physician,
Health Canada

David Stieb is a Public Health Physician with Health Canada's Environmental Health Science and Research Bureau and an Adjunct Professor in the School of Epidemiology, Public Health and Preventive Medicine, and member of the School of Graduate and Postdoctoral Studies at the University of Ottawa. In addition to conducting primary research, including linking national administrative cohort data and exposure surfaces, and key systematic reviews and meta-analyses of epidemiological studies of air pollution and health, he has made notable contributions to knowledge translation, working with federal, provincial and municipal public health and NGO partners. These include acting as health science lead in the development of Canada's Air Quality Health Index, a public health risk communication tool (www.airhealth.ca). He also co-developed the Air Quality Benefits Assessment Tool and other applications that translate knowledge to estimate the human health impacts and costs/benefits of changes in ambient air quality resulting from proposed regulatory or other initiatives.

MENU

Air Quality Benefits Assessment Tool (AQBAT)

Version 3 now available with updated air quality, health and census data!

The Air Quality Benefits Assessment Tool (AQBAT) is a computer application developed by Health Canada which is designed to estimate the human health impacts of changes in Canada's ambient air quality. It is used to estimate the benefits (positive impacts) or damages (negative impacts) of proposed regulatory initiatives related to outdoor air quality as mandated by the Treasury Board Cabinet Directive on Regulatory Management.

AQBAT:

- allows the user to define a wide range of scenarios combining pollutants, health endpoints, geographic areas and scenario years
- consists of a Microsoft Excel file with numerous controls to enable the user to define, run, examine and save the inputs and outputs for specific scenarios
- contains sheets of historical and projected population data, pollutant concentration data, annual baseline health endpoint occurrence rates, and Health Canada endorsed concentration-response functions and health endpoint valuations
- utilizes the @Risk add-in software to perform Monte Carlo simulations, which allow the user to examine the effects of uncertainties on estimated health impacts
- new in version 3: A non Monte Carlo mode can be run in Excel without installing add-ins. Full functionality for Monte Carlo mode still requires installation of @Risk add-in

https://science.gc.ca/site/science/en/blogs/science-health/air-quality-benefits-assessment-tool-aqbat

Files

This application consists of a macro-enabled spreadsheet (file size 51 MB) along with 31 data files in csv format (total 514 MB) and a user guide in pdf format (6 MB).

For more information please contact Guoliang Xi.

Search website 🔍

MENU ⌄

🌐 Help   ➜ Log in | Register

Dave Stieb, MD, MSc, FRCPC

🪪 Public Health Physician/ Epidemiologist
👥 Health Canada
📍 Sinclair Centre, Vancouver BC

Contact

Contact Dave Stieb, MD, MSc, FRCPC

Expertise

Health › Environmental Health

Health › Epidemiology

Affiliations

School of Epidemiology and Public Health, University of Ottawa

Current research and/or projects

- Epidemiologic studies of effects of air pollution, primarily using large administrative datasets
- Application of epidemiology to risk analysis, modeling, economic evaluation and risk communication
- Application of systematic review and meta-analysis methods to risk assessment

Research and/or project statements

- Examining effects of air pollution on risks of death, hospital admissions and birth outcomes such as preterm birth and low birth weight using national data on air pollution exposures and health
- Applying findings from these and other studies to quantify public health impacts from air pollution, in cost-benefit analyses and to communicate with the public using tools like the Air Quality Health Index (AQHI)
- Working with risk assessors to more systematically evaluate the worldwide evidence in developing air quality standards

Education and awards

MD (Queen's)

MSc (Health Research Methods, McMaster)

FRCP (Public Health, McMaster)

Key publications

Lavigne E, Lima I, Hatzopoulou M, Van Ryswyk K, van Donkelaar A, Martin RV, Chen H, Stieb DM, Crighton E, Burnett RT, Weichenthal S. Ambient ultrafine particle concentrations and incidence of childhood cancers, Environ Int 2020; 145 https://doi.org/10.1016/j.envint.2020.106135.

Stieb DM, Evans GJ, To TM, Brook JR, Burnett RT. An ecological analysis of long-term exposure to PM2.5 and incidence of COVID-19 in Canadian health regions. Environ Res. 2020 Aug 26;191:110052. doi: 10.1016/j.envres.2020.110052.

Trieu J, Yao J, McLean KE, Stieb DM, Henderson SB. Evaluating an Air Quality Health Index (AQHI) amendment for communities impacted by residential woodsmoke in British Columbia, Canada. J Air Waste Manag Assoc. 2020 Aug 19:1-13. doi: 10.1080/10962247.2020.1797927.

Liu X, Bertazzon S, Villeneuve PJ, Johnson M, Stieb D, Coward S, Tanyingoh D, Windsor JW, Underwood F, Hill MD, Rabi D, Ghali WA, Wilton SB, James MT, Graham M, McMurtry MS, Kaplan GG. Temporal and spatial effect of air pollution on hospital admissions for myocardial infarction: a case-crossover study. CMAJ Open. 2020 Oct 9;8(4):E619-E626. doi: 10.9778/cmajo.20190160.

Stieb DM, Zheng C, Salama D, Berjawi R, Emode M, Hocking R, Lyrette N, Matz C, Lavigne E, Shin HH. Systematic review and meta-analysis of case-crossover and time-series studies of short term outdoor nitrogen dioxide exposure and ischemic heart disease morbidity. Environ Health. 2020 May 1;19(1):47. doi: 10.1186/s12940-020-00601-1.

Matz CJ, Egyed M, Xi G, Racine J, Pavlovic R, Rittmaster R, Henderson SB, Stieb DM. Health impact analysis of PM2.5 from wildfire smoke in Canada (2013-2015, 2017-2018). Sci Total Environ. 2020 Jul 10;725:138506. doi: 10.1016/j.scitotenv.2020.138506.

https://profils-profiles.science.gc.ca/en/profile/dave-stieb-md-msc-frcpc

https://www.sciencedirect.com/science/article/pii/S0048969720320192

Health impact analysis of PM$_{2.5}$ from wildfire smoke in Canada (2013–2015, 2017–2018)

Carlyn J. Matz [a,*], Marika Egyed [a], Guoliang Xi [b], Jacinthe Racine [c], Radenko Pavlovic [c], Robyn Rittmaster [d], Sarah B. Henderson [e], David M. Stieb [f]

[a] Air Health Effects Assessment Division, Health Canada, 269 Laurier Ave W, PL 4903C, Ottawa, ON K1A 0K9, Canada
[b] Population Studies Division, Health Canada, 101 Tunney's Pasture Dr., PL 0201A, Ottawa, ON K1A 0K9, Canada
[c] Canadian Meteorological Centre Operations, Environment and Climate Change Canada, 2121 Rte Transcanadienne, Montreal, QC H9P 1J3, Canada
[d] Economic Health and Analysis Division, Health Canada, 269 Laurier Ave W, PL 4904B, Ottawa, ON K1A 0K9, Canada
[e] Environmental Health Services, British Columbia Centre for Disease Control, 655 W 12th Ave, Vancouver, BC V5Z 4R4, Canada
[f] Population Studies Division, Health Canada, 445-757 West Hasting St., Federal Tower, Vancouver, BC V6C 1A1, Canada

HIGHLIGHTS

- Wildfire smoke impacts air quality and population health in Canada.
- Hundreds to thousands of premature deaths per year attributable to wildfire-PM$_{2.5}$.
- Mortality and morbidity health impacts had an economic value of billions of CDN$.
- Health impacts greatest in populations in close proximity to the wildfire activity.
- Population at distance also impacted due to long-range transport of wildfire-PM$_{2.5}$.

GRAPHICAL ABSTRACT
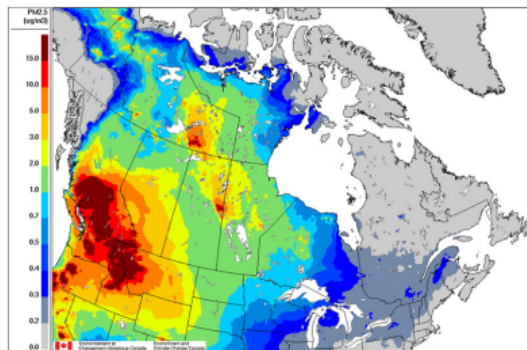
Highlights

- Wildfire smoke impacts air quality and population health in Canada.

- Hundreds to thousands of premature deaths per year attributable to wildfire-PM$_{2.5}$.

- Mortality and morbidity health impacts had an economic value of billions of CDN$.

- Health impacts greatest in populations in close proximity to the wildfire activity.

- Population at distance also impacted due to long-range transport of wildfire-PM$_{2.5}$.

… he also spent some time working at OHCOW

… turn it over to Dr. Stieb ….

Wildfire smoke: Occupational Hygiene reflections

John Oudyk MSc, CIH, ROH
Occupational Hygienist

July 21, 2023

AQHI in table format along with forecasts ...

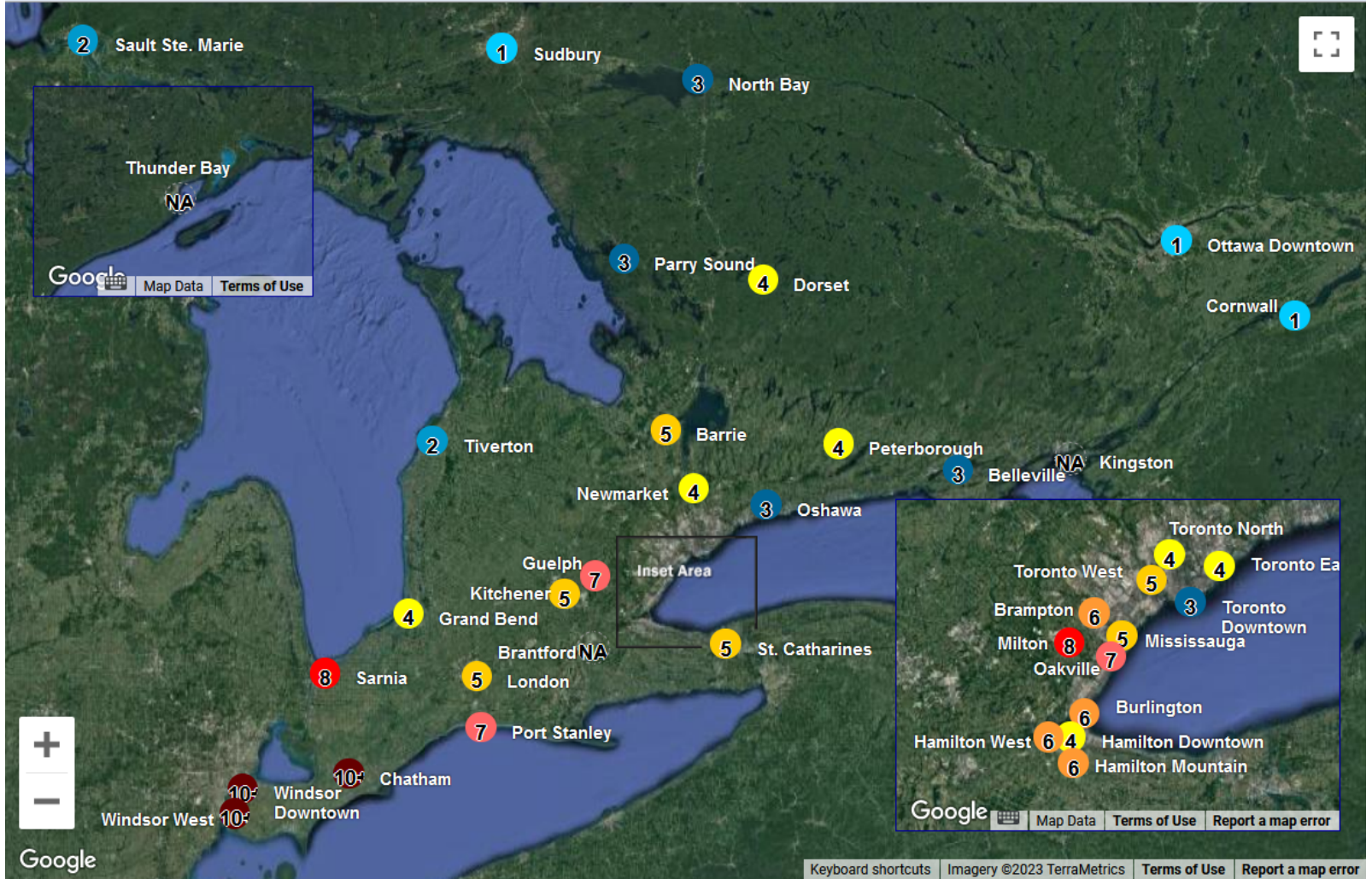https://www.airqualityontario.com/aqhi/index.php

AQHI Observations and Forecasts

- Current AQHI calculated at 6:00 pm EDT June 27, 2023
- Environment Canada location AQHI forecasts updated at 5:00 pm EDT June 27, 2023

Current and Forecast Air Quality Health Index for Ontario

Location	Current	Forecast Maximums	
	Tuesday, 6:00 pm	Tuesday Night	Wednesday
Barrie	5 Moderate Risk	7 High Risk	9 High Risk
Belleville	3 Low Risk	5 Moderate Risk	7 High Risk
Brampton	3 Low Risk	6 Moderate Risk	9 High Risk
Brantford	4 Moderate Risk	6 Moderate Risk	9 High Risk
Burlington	2 Low Risk	6 Moderate Risk	9 High Risk
Chatham	10+ Very High Risk	10+ Very High Risk	10+ Very High Risk
Cornwall	3 Low Risk	3 Low Risk	6 Moderate Risk
Dorset	2 Low Risk	7 High Risk	9 High Risk

AQHI data:

https://www.airqualityontario.com/aqhi/locations.php?pol=251

AQHI Observations:

Observation or Forecast	Day	Month	Year	Hour	Show as Table	
Observations	28	June	2023	10:00 AM	☐	Update

PM$_{2.5}$ data:

Air Quality Ontario > Pollutants > Fine Particulate Matter > Air Monitoring Stations https://www.airqualityontario.com/aqhi/locations.php?pol=124

Fine Particulate Matter PM$_{2.5}$:

Day	Month	Year	Hour	Pollutant	Show as Table	
28	June	2023	6:00 AM	PM2.5 (µg/m3)	☐	Update

7 Sault Ste. Marie
4 Sudbury
70 North Bay
10 Ottawa Downtown
97 Parry Sound
64 Dorset
Cornwall 5
55 Tiverton
84 Barrie
49 Peterborough
NA Kingston
23 Belleville
Newmarket 103
57 Oshawa
Guelph 83
Inset Area
Kitchener 85
71 Grand Bend
Brantford 128
102 St. Catharines
214 Sarnia
84 London
101 Port Stanley
313 Chatham
217 Windsor Downtown
216 Windsor West

Toronto North
97 104 Toronto Ea
Toronto West 105 68 Toronto Downtown
Brampton 87
Milton 108 90 Mississauga
Oakville 116
113 Burlington
Hamilton West 118 67 Hamilton Downtown
126 Hamilton Mountain

Ontario

MINISTRY OF THE ENVIRONMENT, CONSERVATION AND PARKS

ONTARIO.CA | MINISTRY OF THE ENVIRONMENT, CONSERVATION AND PARKS | ACCESS ENVIRONMENT

Air Quality Ontario > Pollutants

Ontario

> **Pollutant Map (Table)**

Pollutant Concentrations

▸ **Current Pollutant Concentrations**

▸ **Map: Pollutant Concentrations**

▸ **Table: Pollutant Concentrations**

▸ **Search: Pollutant Data**

Air Quality Ontario: Home Page

▸ **Air Quality Health Index (AQHI)**

Pollutant Concentrations for July 14, 2023, 5:00 am EDT

Choose Date Options:

Day	Month	Year	Hour	
14 ⌄	July ⌄	2023 ⌄	5:00 am ⌄	Update

Air Pollutant 1-Hour Concentrations For July 14, 2023, 5:00 am EDT

Station	O_3 (ppb)	$PM_{2.5}$ (µg/m³)	NO_2 (ppb)	SO_2 (ppb)	CO (ppm)
Barrie	11	9	4.1		
Belleville	16	5	5.7		
Brampton	14	6	4.1		
Brantford	9	8			
Burlington	9	9	17.7		
Chatham	20	6	7		

Exposure measurement: Visual Cues

just look up!

1.2 Visual cues – "calibrated eyeballs"

- Looking at the sky (better with no/few clouds) the **colour of the sky** can be a visual cue of the air quality – if people regularly check their perceptions of the haze against the hourly MOE pollutant data they can consciously (or even unconsciously) "calibrate" themselves into estimating (guessing) the rough range of air pollution (in the 1970's people were trained to be "calibrated eyeballs" for plume opacity http://eprijournal.com/wp-content/uploads/2016/01/1978-Journal-No.-8.pdf p.23)

- Modern technics have been developed by **using cell phones** and taking pictures of the sky – software is needed to provide the comparison with pictures of clear skies, but such techniques have been used to crowd-source pollution data (https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2014GL061462) – it will likely be just a matter of time before these crowd-sourcing pollution measurement apps become widely available (especially after these wildfire episodes)

Geophysical Research Letters®

Mapping atmospheric aerosols with a citizen science network of smartphone spectropolarimeters

Frans Snik ✉️, Jeroen H. H. Rietjens, Arnoud Apituley, Hester Volten, Bas Mijling, Antonio Di Noia, Stephanie Heikamp, Ritse C. Heinsbroek, Otto P. Hasekamp, J. Martijn Smit, Jan Vonk, Daphne M. Stam, Gerard van Harten, Jozua de Boer, Christoph U. Keller, 3187 iSPEX citizen scientists

entrance slit
polarization optics
collimator lens
transmission grating

camera lens
detector chip

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2014GL061462
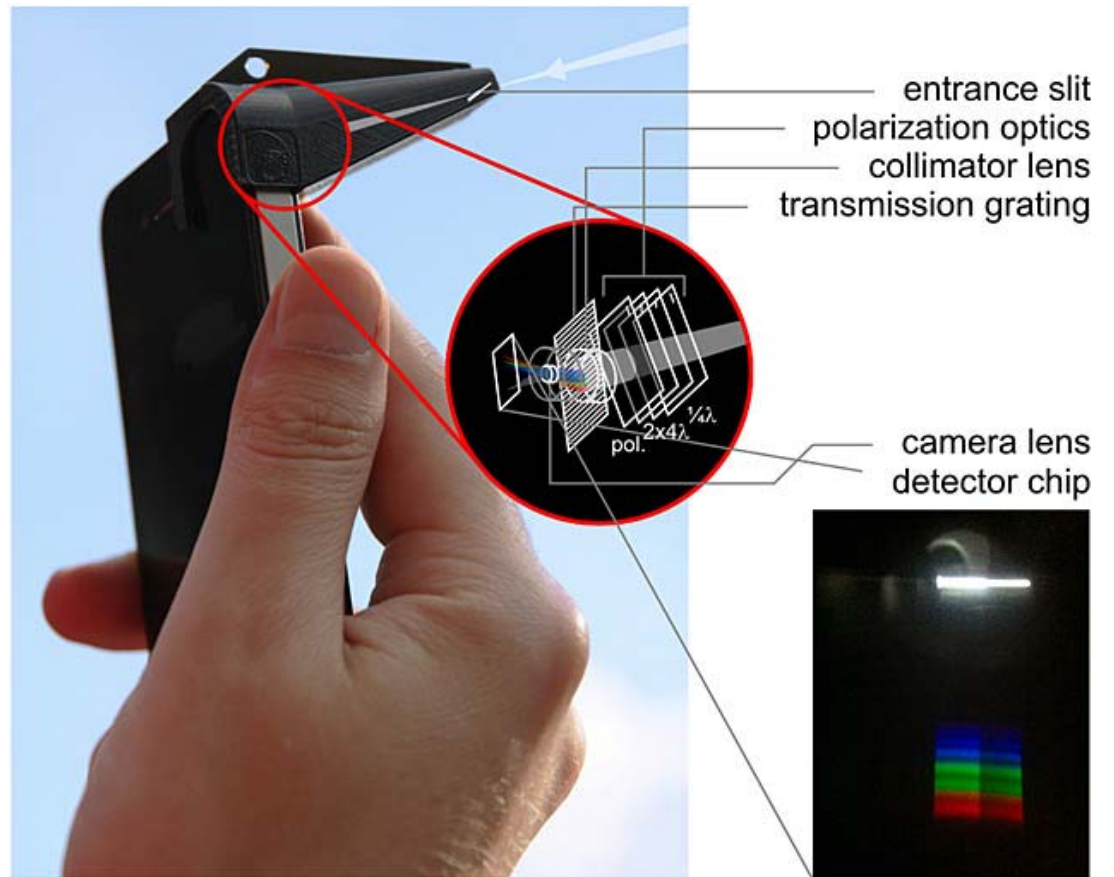
Original AQHI colour scheme was supposed to reflect the colour of the sky

Air Quality Health Index
Moncton, New Brunswick

0 1 2 (3) 4 5 6 7 8 9 10 +

Currently
July 7, 2006
8:00 AM EST

3 **Low Risk**
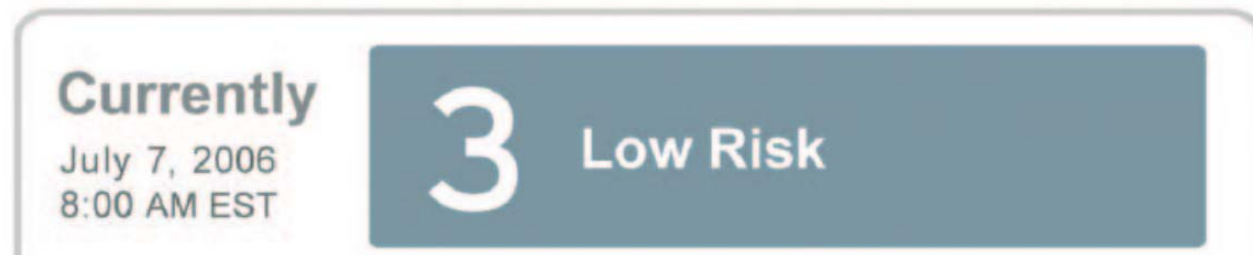
ment. The color scale gradient ranging from light blue at low AQHI values to brown at high AQHI values was intended to mimic a clear sky to a polluted one. Red was used for values exceeding 10. Materials were designed to

Criteria for evaluating the accuracy of particle meters:

EPA/600/R-20/280 | February 2021

Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors
USE IN AMBIENT, OUTDOOR, FIXED SITE, NON-REGULATORY SUPPLEMENTAL AND INFORMATIONAL MONITORING APPLICATIONS

Office of Research and Development
Center for Environmental Measurement and Modeling

Table 4-2. Base and Enhanced Testing – Recommended Performance Metrics and Target Values for PM$_{2.5}$ Air Sensors Used in Ambient, Outdoor, Fixed Site NSIM Applications

Performance Metric		Target Value		Associated Section Describing Calculation
		Base Testing	**Enhanced Testing**[*]	
Precision	Standard Deviation (SD)	$\leq 5\ \mu g/m^3$		3.1.3 and 3.2.3
	-OR-			
	Coefficient of Variation (CV)	$\leq 30\%$		3.1.3 and 3.2.3
Bias	Slope	1.0 ± 0.35	No target values recommended; report results	3.1.4 and 3.2.4
	Intercept (b)	$-5 \leq b \leq 5\ \mu g/m^3$		3.1.4 and 3.2.4
Linearity	Coefficient of Determination (R^2)	≥ 0.70		3.1.4 and 3.2.4
Error	Root Mean Square Error (RMSE) or Normalized Root Mean Square Error (NRMSE)	RMSE $\leq 7\ \mu g/m^3$ or NRMSE $\leq 30\%$[†]		3.1.5 and 3.2.5

[*]No specific target values are recommended due to limited feasibility, lack of consensus regarding testing protocols, and inconsistency in sensor evaluation results that can result due to the limited amount of data that will be collected and variation in the tester's choice of PM surrogate. See Appendix D for further discussion.
[†]A sensor will meet this target if either the RMSE or NRMSE meet this criterion. See Appendix D for further discussion.

South Coast AQMD

AIR QUALITY   INCENTIVE PROGRAMS   RULES & COMPLIANCE   PERMITS   NEWS, WEBCASTS, & CALENDAR   TECHNOLOGY ADVANCEMENT   RESOURCES   MEETING AGENDAS & MINUTES

AQ-SPEC
## Air Quality Sensor Performance Evaluation Center

PM Sensor Evaluations

South Coast AQMD's AQ-SPEC program aims at being the testing center for low cost air monitoring sensors to establish performance standards by which sensors are evaluated. The program evaluates sensors in both controlled laboratory conditions and in the field. In the field, sensors are tested alongside one or more of South Coast AQMD's existing air monitoring stations using traditional federal reference/equivalent method instruments to gauge overall performance. Sensors demonstrating acceptable performance in the field are then brought to the AQ-SPEC laboratory for more detailed testing in an environmental chamber under controlled conditions alongside traditional federal reference/equivalent method and/or best available technology instruments.

PM Sensors							
Sensor Image	Make (Model)	Est. Cost (USD)	Pollutant(s)	*Field R^2	*Lab R^2	*Field MAE ($\mu g/m^3$)	*Lab MAE ($\mu g/m^3$)	Summary Report

PM Sensors

Sensor Image	Make (Model)	Est. Cost (USD)	Pollutant(s)	*Field R^2	*Lab R^2	*Field MAE ($\mu g/m^3$)	*Lab MAE ($\mu g/m^3$)	Summary Report
	Plume Labs (Flow 2)	$199	$PM_{1.0}$	0.01 to 0.14				
			$PM_{2.5}$	0.01 to 0.13		7.3 to 10.6		
			PM_{10}	0 to 0.04		19.3 to 28.3		
	PM Monitor (iMonPM)	$1,995	$PM_{1.0}$	0.77 to 0.89	0.98	2.2 to 3.8	1.1 to 2.4	PDF (756 KB)
			$PM_{2.5}$	0.76 to 0.89	0.98	3.4 to 4.3	2.7 to 4.1	
			PM_{10}	0.38 to 0.62	0.99	12.0 to 17.8	8.2 to 9.4	
	PurpleAir (PA-I)	$150	$PM_{1.0}$	0.93 to 0.95	0.95			PDF (1,072 KB)
			$PM_{2.5}$	0.90 to 0.92	0.99			
			PM_{10}	0.32 to 0.44	0.97			
	PurpleAir (PA-I-Indoor)	$180	$PM_{1.0}$	-	0.99		5.1 to 9.5	PDF (772 KB)
			$PM_{2.5}$	0.75	0.99		18.7 to 27.7	
			PM_{10}	0.36 to 0.46	0.97		4.1 to 20.1	
	PurpleAir (PA-II)	$200	$PM_{1.0}$	0.96 to 0.98	0.99		11.7 to 15.9	PDF (1,328 KB)
			$PM_{2.5}$	0.93 to 0.97	0.99		1.7 to 4.2	
			PM_{10}	0.66 to 0.70	0.95		15.6 to 20.5	
	PurpleAir (PA-II-FLEX)	$299	$PM_{1.0}$	0.91 to 0.94		1.4 to 2.2		
			$PM_{2.5}$	0.78 to 0.88		3.4 to 3.8		
			PM_{10}	0.21 to 0.39		15.3 to 24.8		
	Qingping (Air Monitor)	$135	$PM_{2.5}$	0.86 to 0.90		1.8 to 2.3		
	Qingping (Air Monitor Lite)	$96	$PM_{2.5}$	0.85 to 0.93		1.8 to 3.6		
			PM_{10}	0.37 to 0.43		16.2 to 20.1		

http://www.aqmd.gov/aq-spec/evaluations/criteria-pollutants/summary-pm

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Sensor Description

Manufacturer/Model:
PurpleAir PA-II

Pollutants:
PM_1, $PM_{2.5}$, PM_{10}

Measurement Range:
0 - 500 µg/m³

Type: Optical

Evaluation Summary

- Overall, the three PurpleAir PA-II sensors showed moderate to good accuracy, compared to the reference instrument for PM_1, $PM_{2.5}$, and PM_{10}, for a concentration range between 0 to 250 µg/m³.
- The three PA-II sensors exhibited high precision for most of the tested T/RH combinations.
- PA-II sensors showed low intra-model variability as well as good sensor a and b correlation in each node.
- PA-II sensors had good data recovery (95%).
- For PM_1 and $PM_{2.5}$, the PA-II sensors had very strong correlations with the reference instrument from both the field ($PM_{1.0}$ $R^2 > 0.96$, $PM_{2.5}$ $R^2 > 0.93$) and laboratory studies (PM_1 $R^2 > 0.99$, $PM_{2.5}$ $R^2 > 0.99$). For PM_{10}, the PA-II sensors did not always follow the concentration change recorded by FEM instrument in the field (PM_{10} $R^2 > 0.66$), however in the laboratory, the PA-II sensors followed the concentration ramping (increasing) change, reporting (PM_{10} $R^2 > 0.95$).

Laboratory Evaluation Highlights

Accuracy

$$A\ (\%) = 100 - \frac{|\bar{X} - \bar{R}|}{\bar{R}} * 100$$

Steady State (#)	Sensor mean (µg/m³)	GRIMM (µg/m³)	Accuracy (%)
1	19.7	13.5	54.3
2	44.3	35.7	75.7
3	80.8	84.1	96.1
4	134.7	155.1	86.8
5	186.3	233.5	79.8

Accuracy was evaluated by a concentration ramping experiment at 20 °C and 40%. The sensor's readings at each ramping steady state are compared to the reference instrument.
Negative % means sensors' overestimation by more than two fold. The higher the positive value (close to 100%), the higher the sensor's accuracy.

Precision (PM$_{2.5}$)
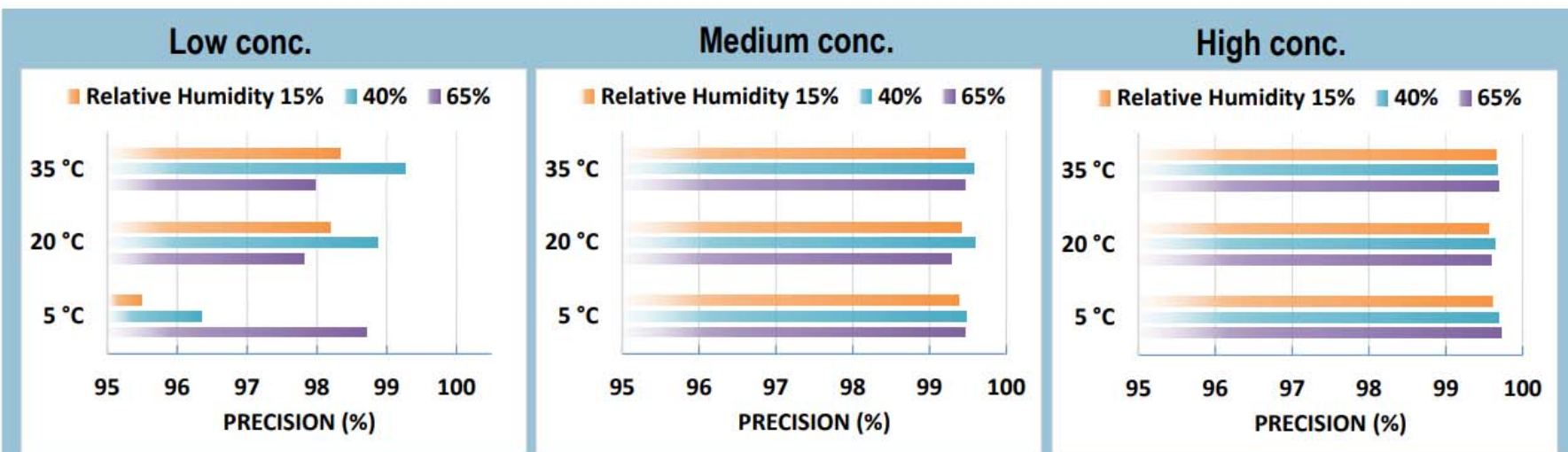
South Coast AQMD

AIR QUALITY   INCENTIVE PROGRAMS   RULES & COMPLIANCE   PERMITS   NEWS, WEBCASTS, & CALENDAR   TECHNOLOGY ADVANCEMENT   RESOURCES   MEETING AGENDAS & MINUTES

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Share: f 🐦

Home / AQ-SPEC / Evaluations / Criteria Pollutants / Field

Field Evaluations

http://www.aqmd.gov/aq-spec/evaluations/criteria-pollutants/field/page/2

Field

AQ-SPEC Home

Plume Labs Flow 2 - Field Evaluation
PDF, 2.82 MB

PM Monitor iMonPM - Field Evaluation
PDF, 14.52 MB

PurpleAir PA-I - Field Evaluation
PDF, 3.87 MB

PurpleAir PA-I Indoor - Field Evaluation
PDF, 1.40 MB

PurpleAir PA-II - Field Evaluation
PDF, 5.42 MB

PurpleAir PA-II-Flex - Field Evaluation
PDF, 27.01 MB

Qingping - Air Monitor Lite - Field Evaluation
PDF, 10.58 MB

Qingping - Air Monitor - Field Evaluation
PDF, 7.77 MB

QuantAQ MODULAIR-PM - Field Evaluation
PDF, 14.96 MB

Discussion

- The three **Purple Air PA-II** sensor nodes (two raw sensors in each node) were very reliable (data recovery was between 95 and 99% for all units tested) and were characterized by very low intra-model variability
- $PM_{1.0}$ sensor data correlated very well ($R^2 > 0.96$) with the corresponding values collected using a substantially more expensive particle instrument (GRIMM) and were quite accurate
- $PM_{2.5}$ sensor data correlated very well with the corresponding FEM GRIMM and FEM BAM values ($R^2 > 0.93$ and $R^2 > 0.86$, respectively) and were quite accurate
- PM_{10} sensor measurements correlated well with the corresponding GRIMM and FEM BAM values ($R^2 > 0.68$ and $R^2 > 0.60$, respectively) (1-hr average)
- The designs of the raw sensor inlet/outlet and node housing in PA-II (PMS5003) are both different than those in PA-I (PMS1003)
- Two raw sensors are attached to each other in PA-II compared to one raw sensor in PA-I
- The user manuals for PMS5003 as well as for PMS1003 (PA-I) can be found in: http://www.aqmd.gov/aq-spec/resources#&MainContent_C001_Col00=1
- No sensor calibration was performed by SCAQMD Staff prior to the beginning of this test
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors over different / more extreme environmental conditions
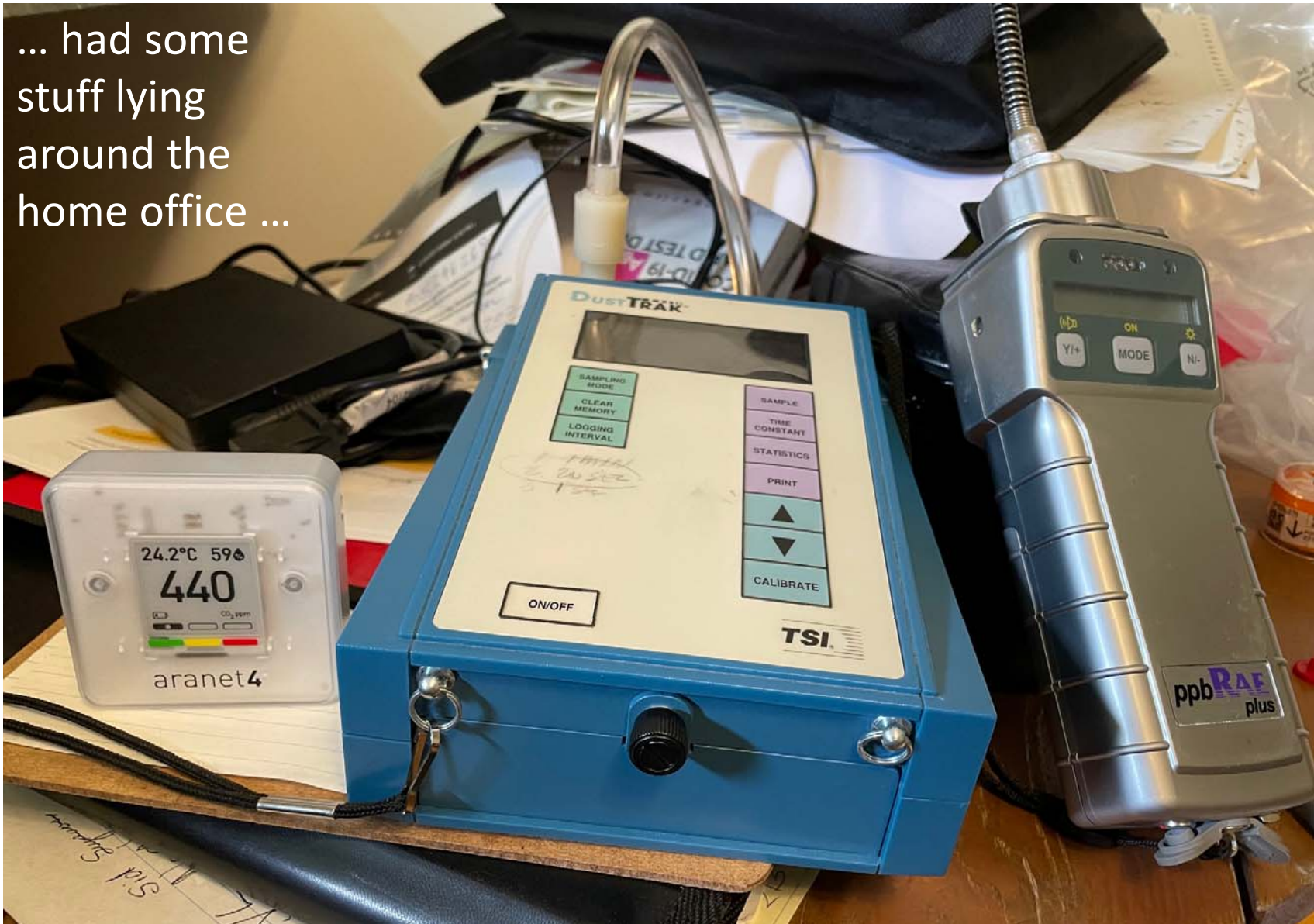
- All results are still preliminary

31

ONTARIO.CA | MINISTRY OF THE ENVIRONMENT, CONSERVATION AND PARKS | ACCESS ENVIRONMENT

Air Quality Ontario > Pollutants > Brantford: Hourly Fine Particulate Matter Concentrations

Choose Station: Brantford
Pollutants: Fine Particulate Matter (PM2.5)
Day: 26
Month: June
Year: 2023
Chart: ☑
Table: ☐
Refresh Page
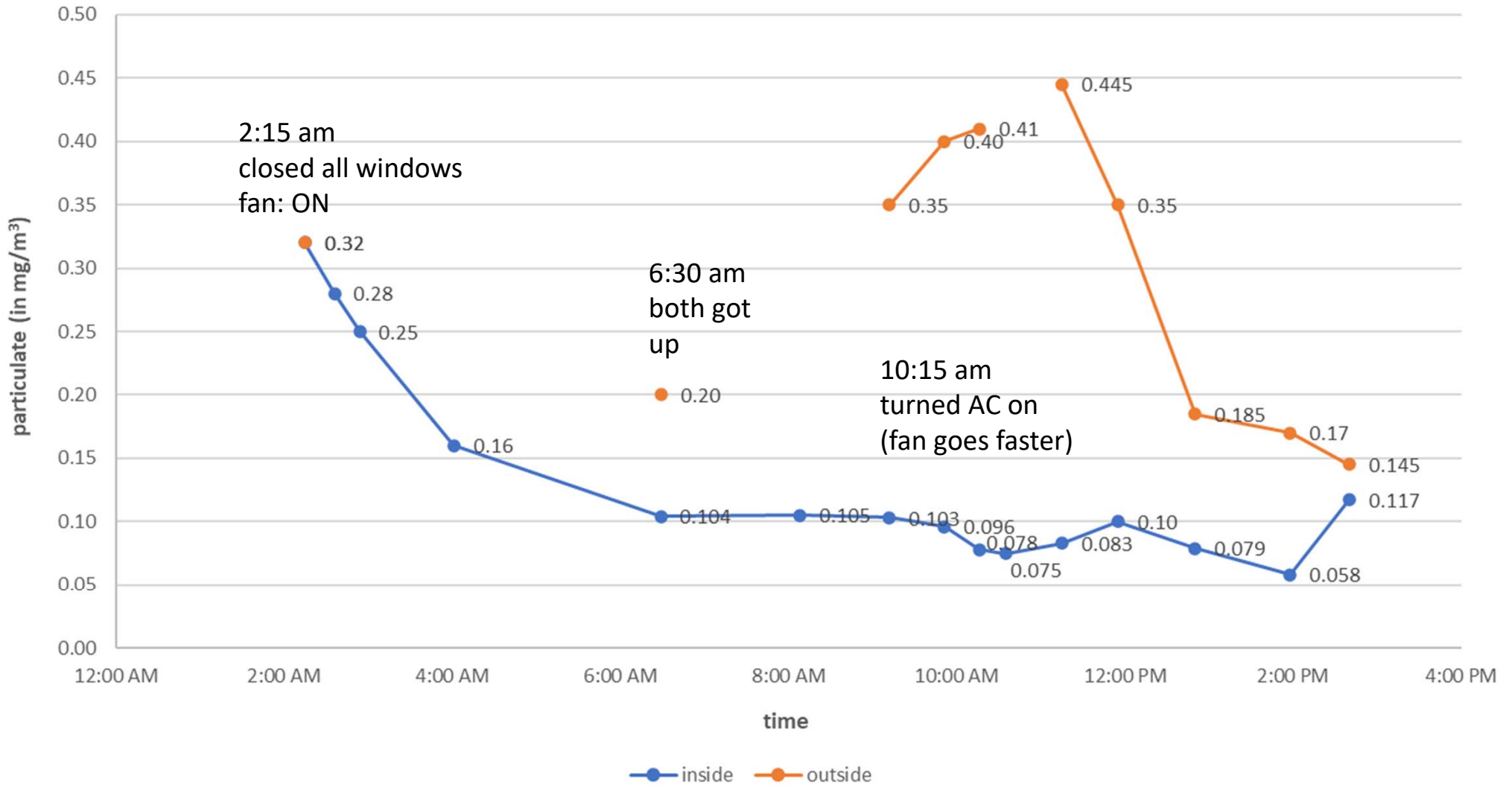
Brantford: Hourly Fine Particulate Matter Readings

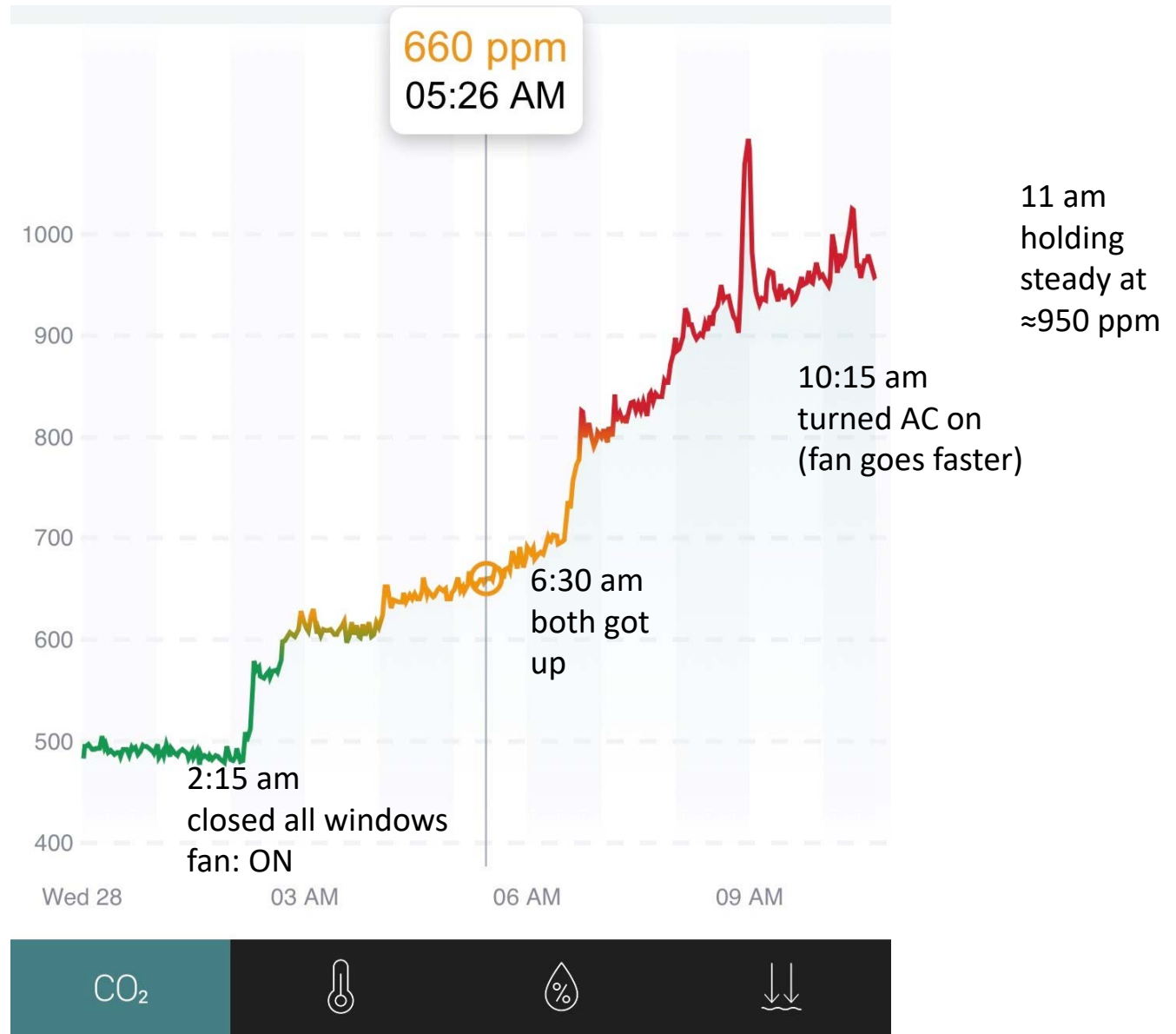From Jun-26-2023 EDT to Jun-28-2023 EDT.
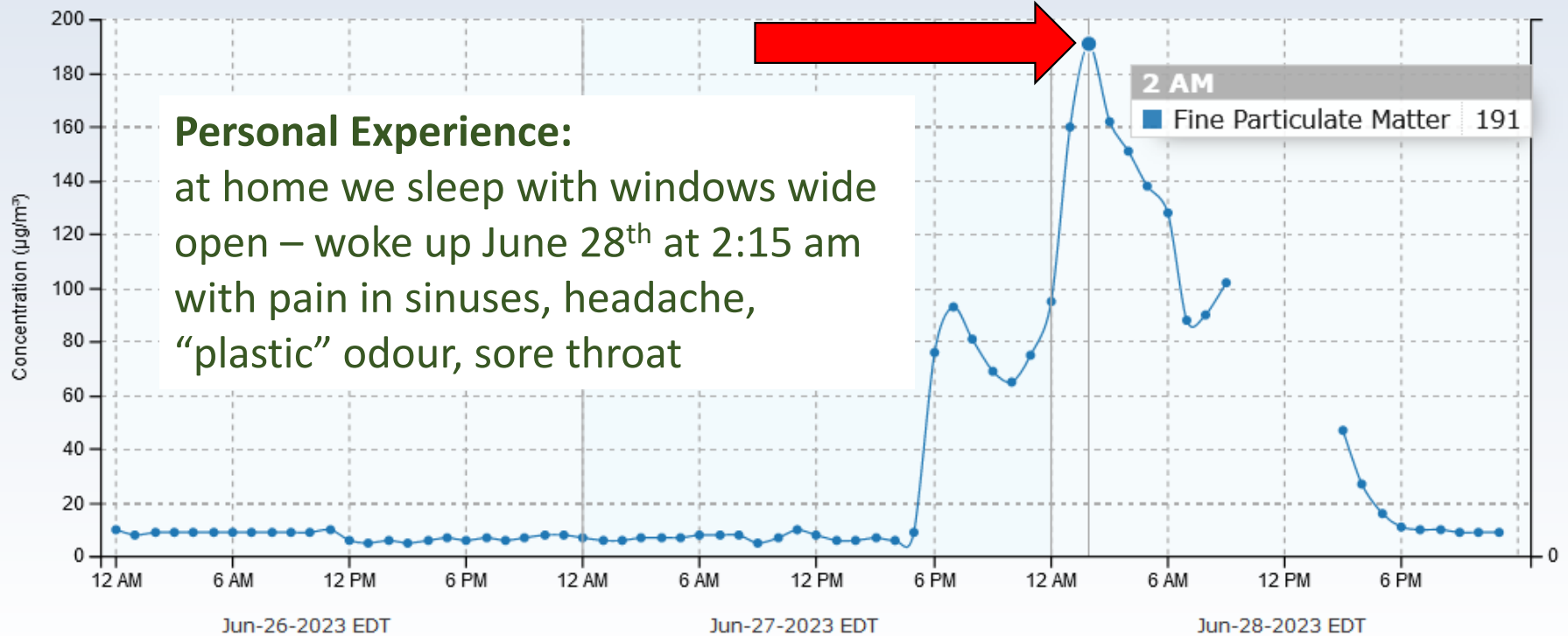
2 AM
■ Fine Particulate Matter   191

Personal Experience:
at home we sleep with windows wide open – woke up June 28th at 2:15 am with pain in sinuses, headache, "plastic" odour, sore throat

June 28, 2023 (at home)

ASHRAE 62.1-22
Outdoor air quality requirements:

4. OUTDOOR AIR QUALITY

Outdoor air quality shall be investigated in accordance with Sections 4.1 and 4.2 prior to completion of ventilation system design. The results of this investigation shall be documented in accordance with Section 4.3.

4.1 Regional Air Quality. The status of compliance with the National Ambient Air Quality Standards (NAAQS) shall be determined for the geographic area of the building site.

4.1.1 In the United States, compliance status shall be either in "attainment" or "nonattainment" with the NAAQS. In the United States, areas with no U.S. Environmental Protection Agency (U.S. EPA) compliance status designation shall be considered "attainment" areas.

Informative Notes:
1. The NAAQS are shown in Informative Appendix E, Table E-1.
2. The U.S. EPA list of nonattainment areas can be found at www.epa.gov/green-book.
3. Air quality data collected at outdoor monitors across the U.S. can be found at www.epa.gov/outdoor-air-quality-data.
4. Internet links to detailed information on the NAAQS and contaminant levels for other select counties and regions can be found in Informative Appendix E.

4.2 Local Air Quality. An observational survey of the building site and its immediate surroundings shall be conducted during hours the building is expected to be normally occupied to identify local contaminants from surrounding facilities that will be of concern if allowed to enter the building.

4.3 Documentation. Documentation of the outdoor air quality investigation shall be reviewed with building owners or their representative and shall include the following as a minimum:
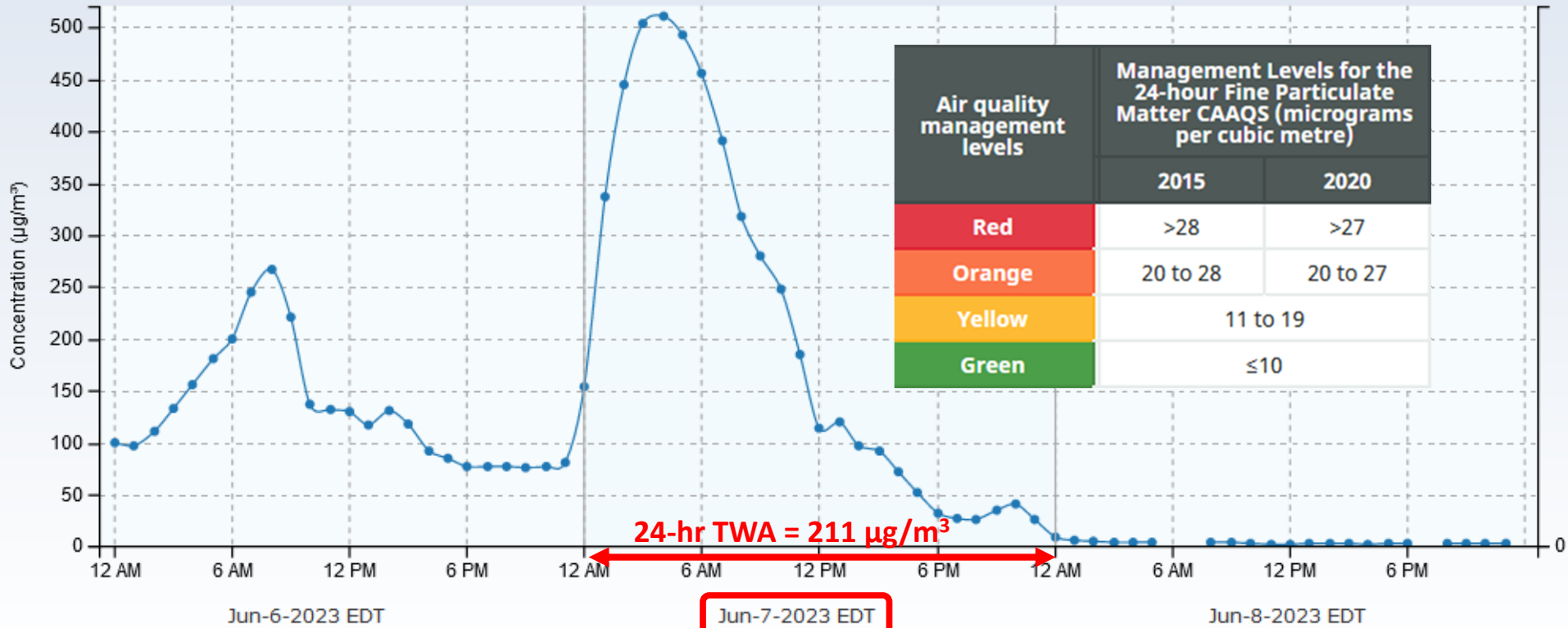
Ottawa Downtown: Hourly Fine Particulate Matter Readings

From Jun-6-2023 EDT to Jun-8-2023 EDT.

Environmental exposures compared to Occupational OELs

Ottawa Downtown PM$_{2.5}$ 24-hr averages

Ontario 8-hr TWA OEL (3000 µg/m^3)

Xerox 8-hr TWA OEL (400 µg/m^3)

1-hr PM2.5 Only AQHI = **10** (95 µg/m^3)

CAAQ 24-hr (27 µg/m^3)

Ottawa's record-setting 24-hr TWA environmental exposure (211 µg/m^3)
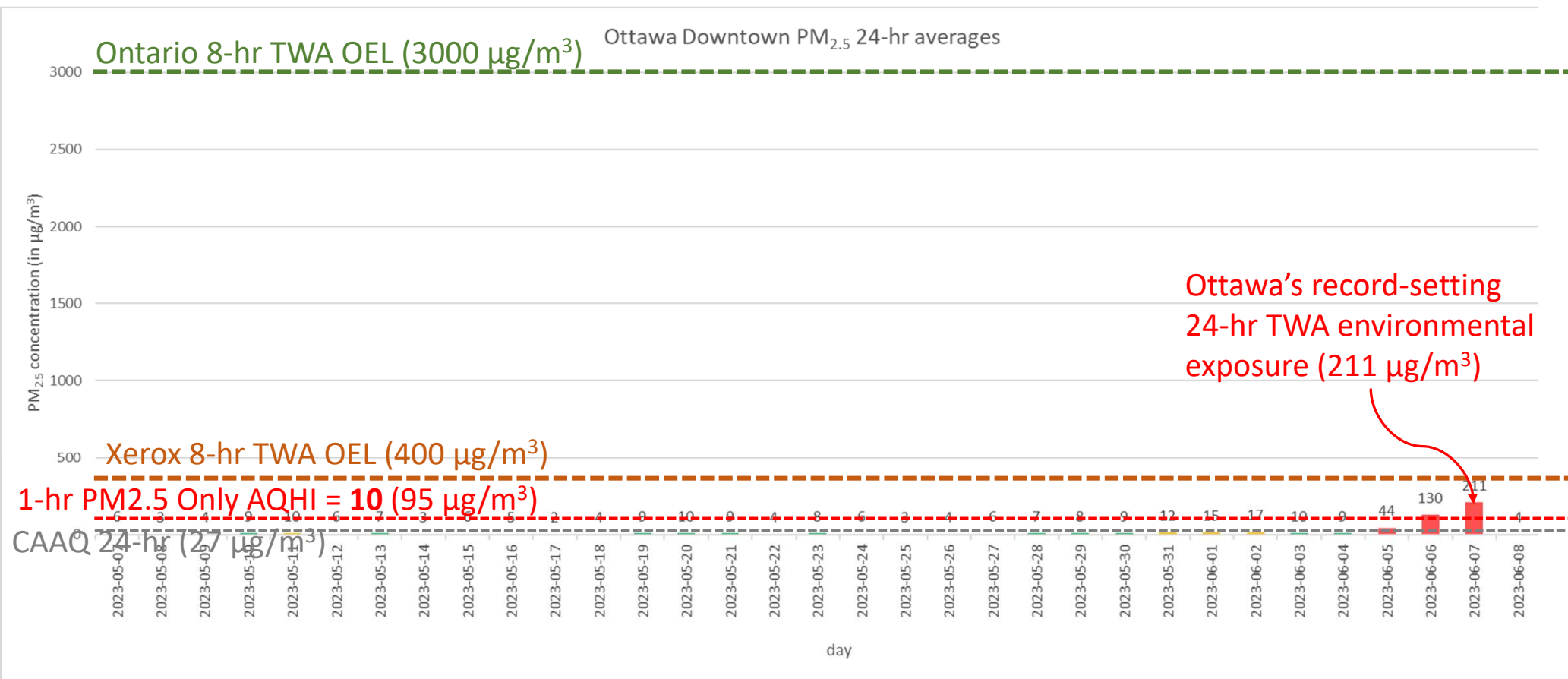
Systematic Review

Environmental and Occupational Short-Term Exposure to Airborne Particles and FEV$_1$ and FVC in Healthy Adults: A Systematic Review and Meta-Analysis

Alan da Silveira Fleck [1,2], Margaux L. Sadoine [1,2], Stéphane Buteau [3], Eva Suarthana [4,5], Maximilien Debia [1,2] and Audrey Smargiassi [1,2,3,*]

1   Department of Environmental and Occupational Health, School of Public Health, University of Montreal, 2375 Chem. de la Côte-Sainte-Catherine, Montreal, QC H3T 1A8, Canada; alan.da.silveira.fleck@umontreal.ca (A.d.S.F.); margaux.sadoine@umontreal.ca (M.L.S.); maximilien.debia@umontreal.ca (M.D.)

2   Centre for Public Health Research (CReSP), 7101 Av du Parc, Montreal, QC H3N 1X9, Canada

3   Institut National de Sante Publique du Québec (INSPQ), 190 Boul Crémazie E, Montreal, QC H2P 1E2, Canada; Stephane.Buteau@inspq.qc.ca

4   Research Institute of the McGill University Health Center, 2155 Rue Guy, Montreal, QC H3H 2L9, Canada; eva.suarthana@gmail.com

5   Centre de Recherche de l'Hôpital du Sacré-Coeur de Montréal (CRHSCM), 5400 Boul Gouin O, Montreal, QC H4J 1C5, Canada

*   Correspondence: audrey.smargiassi@umontreal.ca

check for updates

For a similar exposure increment ($10 \, \mu g/m^3$), the associations with fine particles in healthy adults are an order of magnitude greater in environmental studies as compared to occupational studies. Even if PM exposure in occupational settings were from very diverse settings, the estimate for FEV_1 was relatively consistent considering the varied exposure contexts.

5. Conclusions

This systematic review and meta-analysis show that environmental and occupational short-term exposures to fine particles are associated with reduced FEV_1 and FVC in healthy adults. A lower meta-estimate was found in occupational studies than environmental studies for a similar exposure increment; however, exposure levels were substantially greater in occupational studies. This may reflect a potentially nonlinear relationship linking PM exposure to certain lung functions parameters, with a steeper slope at lower concentrations. Differences in meta-estimates may also be, in part, due to differences across occupational and environmental study design and methods. Future meta-analyses would benefit from greater standardization of study design and methods, notably in terms of the metric used to express the lung function parameters and the fraction of particles measured.

Hierarchy of Controls

Most effective
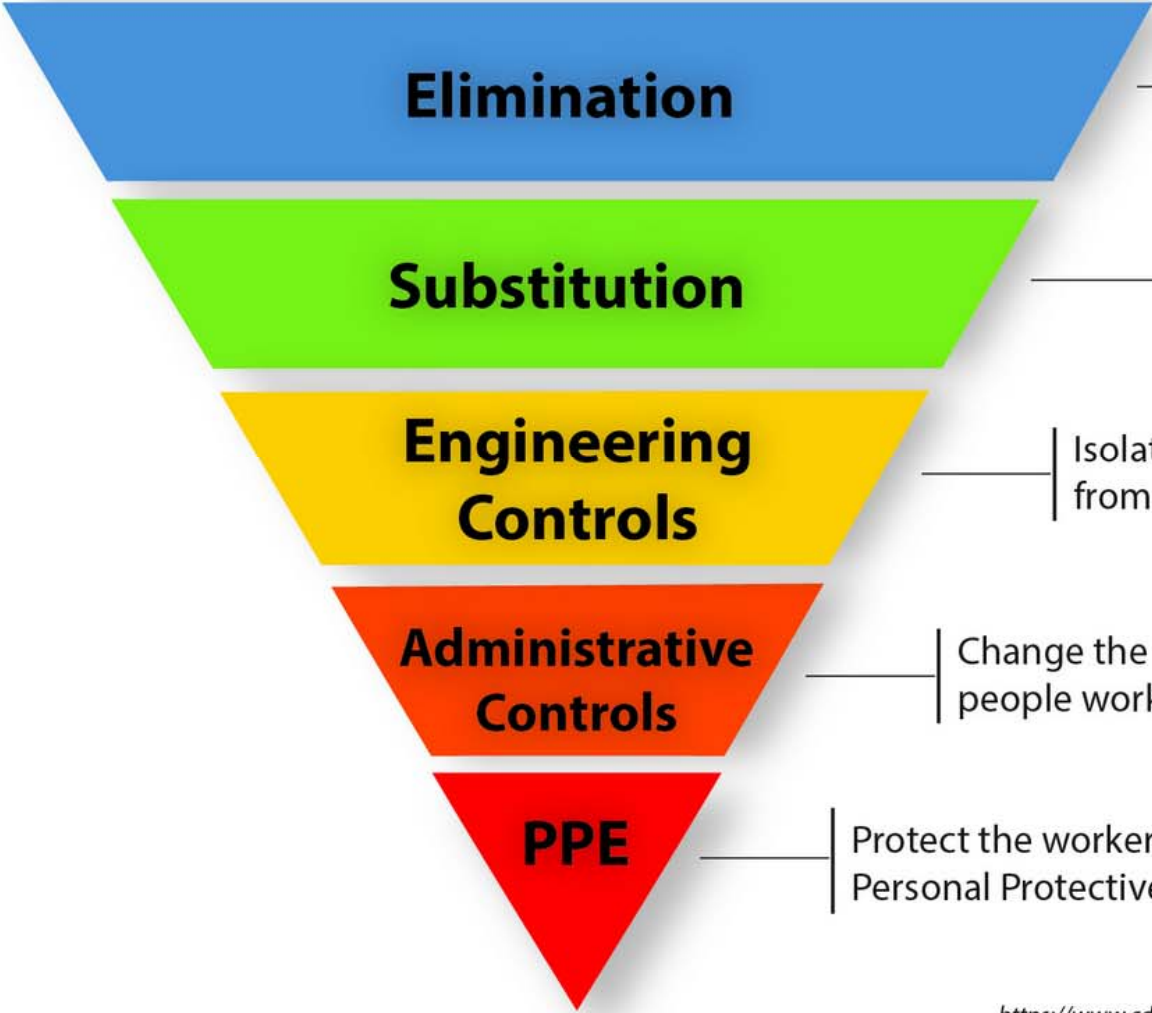
Elimination — Physically remove the hazard

Substitution — Replace the hazard

Engineering Controls — Isolate people from the hazard

Administrative Controls — Change the way people work

PPE — Protect the worker with Personal Protective Equipment

Least effective

filters

reschedule

mask

Image by NIOSH
https://www.cdc.gov/niosh/topics/hierarchy/default.html

Filters: go look on the roof ...

make sure you look inside

Check the filters –

Check the filters:

MERV 4

MERV Rating	Air Filter will trap Air Particles size .3 to 1.0 microns	Air Filter will trap Air Particles size 1.0 to 3.0 microns	Air Filter will trap Air Particles size 3 to 10 microns	Filter Type ~ Removes These Particles
MERV 1	< 20%	< 20%	< 20%	Fiberglass & Aluminum Mesh
MERV 2	< 20%	< 20%	< 20%	~
MERV 3	< 20%	< 20%	< 20%	Pollen, Dust Mites, Spray Paint,
MERV 4	< 20%	< 20%	< 20%	Carpet Fibres
MERV 5	< 20%	< 20%	20% - 34%	Cheap Disposable Filters
MERV 6	< 20%	< 20%	35% - 49%	~
MERV 7	< 20%	< 20%	50% - 69%	Mold Spores, Cooking Dusts,
MERV 8	< 20%	< 20%	70% - 85%	Hair Spray, Furniture Polish
MERV 9	< 20%	Less than 50%	85% or Better	Better Home Box Filters
MERV10	< 20%	50% to 64%	85% or Better	~
MERV 11	< 20%	65% - 79%	85% or Better	Lead Dust, Flour, Auto
MERV 12	< 20%	80% - 90%	90% or Better	Fumes, Welding Fumes
MERV 13	than 75%	90% or Better	90% or Better	Superior Commercial Filters
MERV 14	% - 84%	90% or Better	90% or Better	~
MERV 15	% - 94%	95% or Better	90% or Better	Bacteria, Smoke, Sneezes
MERV 16	95% or Better	95% or Better	90% or Better	
MERV 17	99.97%	99% or Better	99% or Better	HEPA & ULPA
MERV 18	99.997%	99% or Better	99% or Better	~
MERV 19	99.9997%	99% or Better	99% or Better	Viruses, Carbon Dust, <.30 pm
MERV 20	99.99997%	99% or Better	99% or Better	

gaiter mask

cloth mask

exhaling

inhaling

N95 respirator

N99 respirator

Illustration Provided by LakeAir / www.lakeair.com

Conversion factors:

Portable air filters:

- Not to be used in place of supplying outdoor air (i.e., to reduce heating/cooling costs)

- Need to be **sized properly** taking into account the amount of noise that is tolerable (variable speed units)

- **Need to be maintained** (poorly maintained units will eventually put out more particles than they take in)

- Filters age and lose their electrical properties for particle collection

Things to watch out for when buying air purifiers

	Low	Mid	High
Air Purifier	Levoit LV-H134	Blue Pure 121	Medify MA-112
Image			
CADR	312 cfm 460 ft²	400 cfm 570 ft²	560 cfm 800 ft²
AHAM Verification	✖	✔	✖
Maximum Noise Level	54 decibels	56 decibels	70 decibels
Rated Power	45W	61W	95W
Pros & Cons	✓ 100% ozone-free ✓ 360-degree air intake ✗ Not AMAM approved	✓ Minimalist design ✓ Washable pre-filter ✗ No true HEPA filter	✓ Very high CADR ✓ Large filter surface ✗ No air quality monitor on V2.0
In-depth Review	-	Blueair Blue Pure 121 Review	Medify MA-112 Review
Customer Ratings	★★★★⯪	★★★★⯪	★★★★⯪
Prime Status	✓Prime	✓Prime	-
Current Price	$407.82	$439.99	Price not available

Clean Air Delivery Rate (CADR): need roughly a CADR (dust) of **70 cfm per 100 ft² of floor space**

recommended background noise level: **≈40 dBA**

DIY air cleaner

five 20x20x2 MERV-11

Face Masks for Wildfire Smoke

The best way to protect your health from wildfire smoke is to seek cleaner air. Use a portable air cleaner at home, find an indoor environment with filtered air, or relocate to an area with less smoke. If you cannot access cleaner air, some face masks can provide protection from wildfire smoke. However, it is important to be aware of the limitations and potential risks.

Well-fitted respirators offer the most effective protection from fine particulate matter (PM$_{2.5}$).

- Respirators are marked with letter and number combinations, such as N95, KN95, and KF94. These products are very similar, but the markings indicate different standards used to test them.
- A good fit is the most important thing for filtration of PM$_{2.5}$. Inhaled air must pass through the material of the mask, not around it.
- A well-fitted respirator will reduce PM$_{2.5}$ concentrations by more than 90%.

If you chose to wear a respirator or mask for wildfire smoke, you should be aware of the limitations and potential risks.
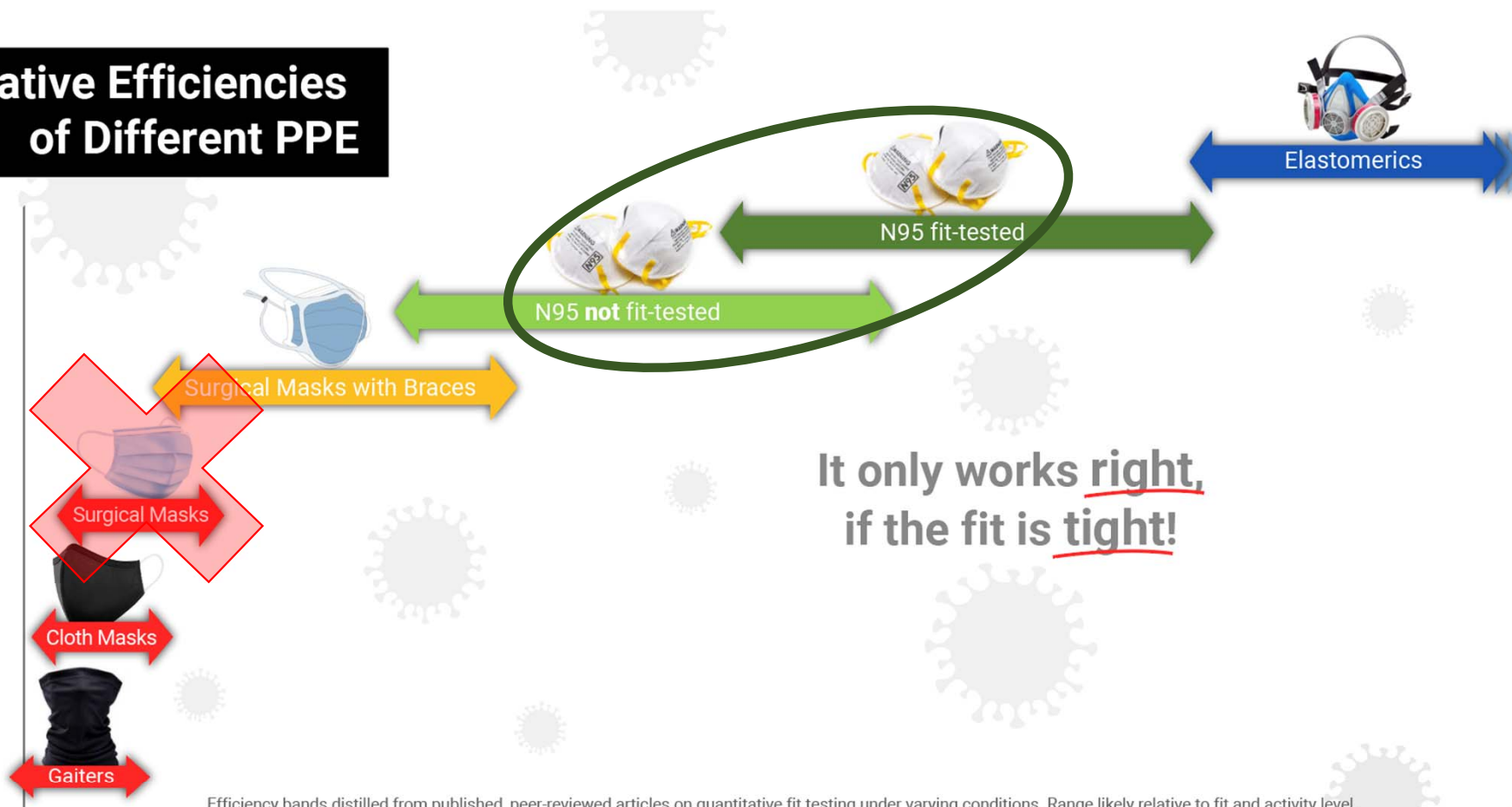
- It is NOT SAFE to wear any mask while sleeping.
- Most respirators and masks cannot protect against the gases in wildfire smoke, which may also cause irritation.
- Wearing a respirator or snugly-fitted mask may make breathing more difficult. Pregnant women and people with respiratory and cardiovascular conditions should talk to their health care

http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/BCCDC_WildFire_FactSheet_FaceMasks.pdf

Relative Efficiencies of Different PPE

Elastomerics

N95 fit-tested

N95 **not** fit-tested

Surgical Masks with Braces

Surgical Masks

Cloth Masks

Gaiters

It only works **right**,
if the fit is **tight**!

Efficiency bands distilled from published, peer-reviewed articles on quantitative fit testing under varying conditions. Range likely relative to fit and activity level.

Capture:	0%	50%	67%	80%		90%		96%
Fit Factor(FF):	1	2	3	5		10		25
Leakage:	100%	50%	33%	20%		10%		4%

not to scale

OHCOW   Learn more at **www.ohcow.on.ca/covid-19/**

Wildfire Smoke
A Definite Concern for All [Ontario] Workers

Infographic

Wildfire Smoke is made up of a complex mixture of:

FINE PARTICLES (PM2.5)

GASES

...produced when wood, plastics and other materials burn.
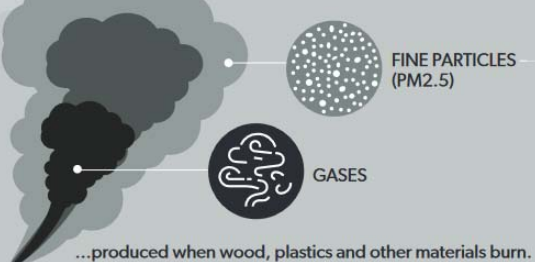
The **biggest health concern** from smoke is from fine particles (PM2.5). These microscopic particles can irritate or harm:

EYES

RESPIRATORY SYSTEM

Smoke from wildfires can affect you when working both **indoors** and **outdoors**.

Signs and Symptoms

BURNING EYES

RUNNY NOSE

PHLEGMY COUGH

SORE THROAT

DIFFICULTY BREATHING

Vulnerable Workers

Some people are more vulnerable than others to harm from the smoke:

RESPIRATORY CONDITIONS (e.g. Asthma, COPD, COVID)

HEART CONDITIONS

OTHER HEALTH CONDITIONS

OTHER HIGH RISK GROUPS

https://www.ohcow.on.ca/wp-content/uploads/2023/06/wildfire-smoke-infographic-06-22-23.pdf

OHCOW

Prevention

Working Outdoors

CONSULT the Air Quality Health Index (AQHI)* for your region for recommendations
*www.airqualityontario.com/aqhi/

8 High Risk

TAKE BREAKS indoors - in buildings or vehicles (vehicle air filters do filter PM2.5)
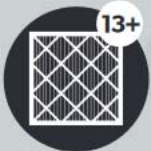
WEAR a tight fitting respirator (N95 or better)

N95

AVOID over exertion

REPORT ALL questions, concerns and symptoms to your supervisor or Health and Safety Committee / Representative

Working Indoors

REDUCE exposure to outdoor air:

13+
MAKE SURE air filters in the HVAC system are MERV 13 or higher

CLEAN or REPLACE air filters that are dirty or in poor condition

CHECK that the furnace fan is running

KEEP all windows and doors closed

IMPROVE on mechanical ventilation systems with portable air cleaners (e.g. DIY Corsi-Rosenthal Box)

AVOID air purifiers with ionizers

REMEMBER
People will react differently or have different tolerances for wildfire smoke.

OHCOW

Unfortunately, there are no specific rules for employers about outdoor or indoor air. However, the law still says they must do everything *'reasonable'* to protect workers.

Employer Responsibilities

Employers should provide:

PROPER AIR FILTERING, VENTILATION / MOVEMENT

PROPER FITTING RESPIRATORS (N95 or better)

N95

ADDITIONAL BREAKS

RE-SCHEDULE STRENUOUS WORK

ENVIRONMENTAL / EMERGENCY RESPONSE PLAN

INFORMATION and TRAINING

AQHI MONITORING and COMMUNICATION

Employers should also have a process to **IDENTIFY, PREVENT and REDUCE** factors that contribute to the effects of wildfire smoke. This process should:

INCLUDE workers, health and safety representatives, and/or joint health and safety committee members.
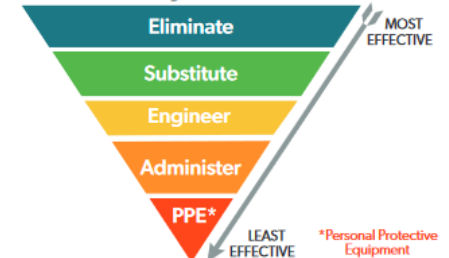
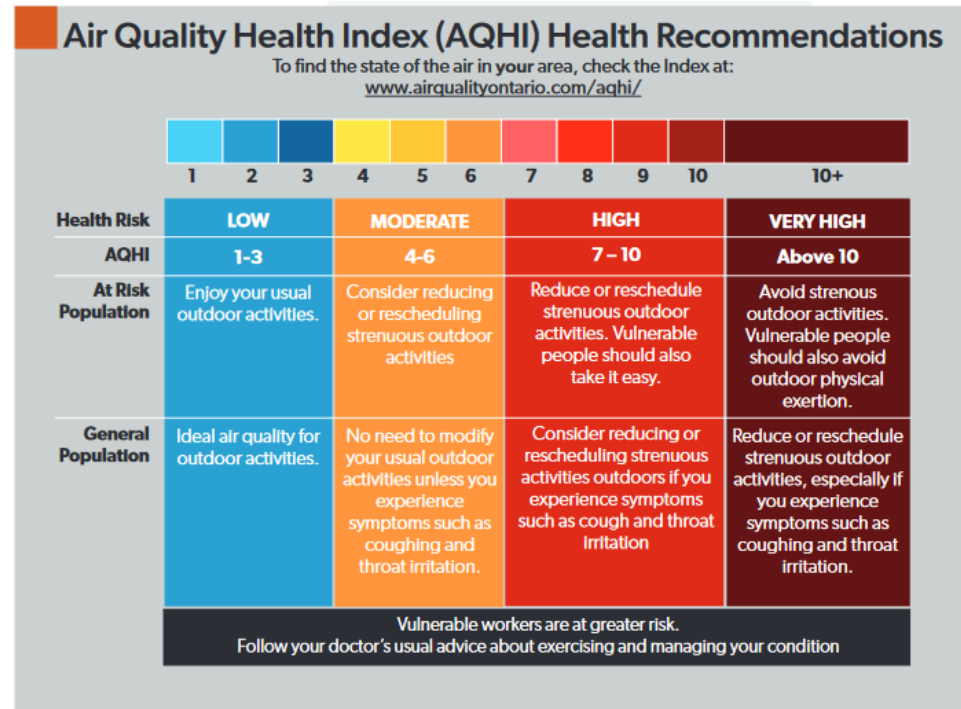**PROVIDE** translation / interpretation as needed to allow everyone to contribute effectively.

BE SUPPORTED by the employer so workers feel comfortable participating.

R **RECOGNIZE** a hazard /possible improvements

A **ASSESS** risk level of hazard

C **CONTROL** the hazard using the Hierarchy of Controls

E **EVALUATE** effectiveness and identify room for improvement

Hierarchy of Controls

Eliminate — MOST EFFECTIVE
Substitute
Engineer
Administer
PPE* — LEAST EFFECTIVE

*Personal Protective Equipment

Special thanks to Lesley Scime for the graphic artwork

https://www.ohcow.on.ca/wp-content/uploads/2023/06/wildfire-smoke-infographic-06-22-23.pdf