

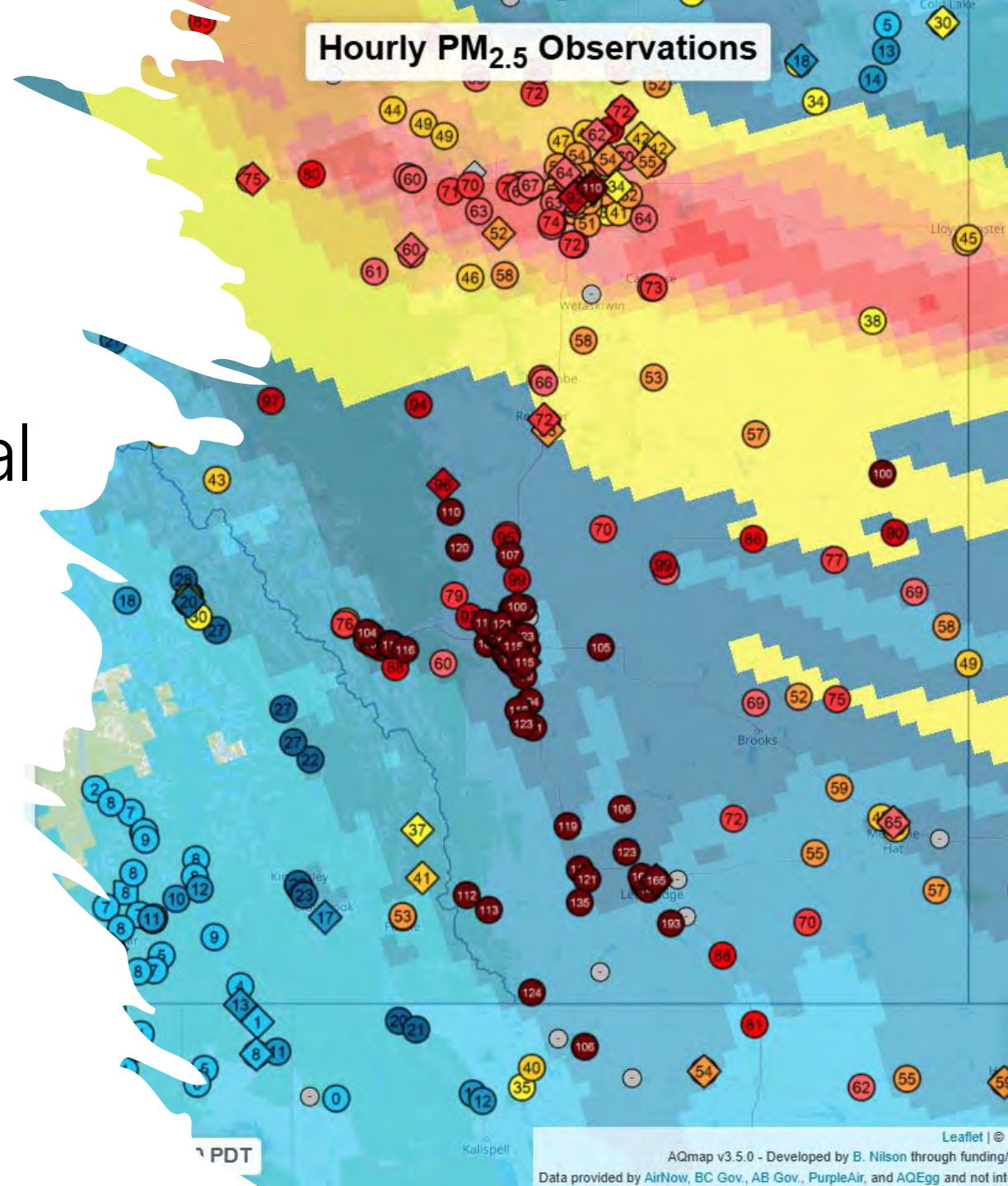
AQmap in Action: Tracking wildfire smoke in real time for cleaner air decisions

Presented on July 16th, 2025 @ 12–1 PT
NCCEH Environmental Health Seminar Series



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Environment and Climate Change Canada

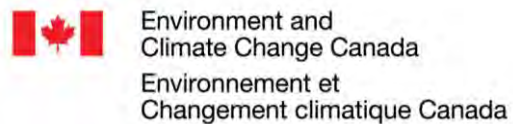
✉ brayden.nilson@ec.gc.ca



Many have been involved in this work, special thanks to:

Environment and Climate Change Canada

- Keith Jones
- Corinne Schiller
- Julie Narayan
- Chris Nayet
- Matt Parsons
- Andrew Teakles
- Lucy Chisholm
- Robert Keenan
- Morgan Mitchell
- Céline Audette
- Lawrence Sham
- Karole-Ann Roy-Chretien
- Sherry Williams
- Sean Perry



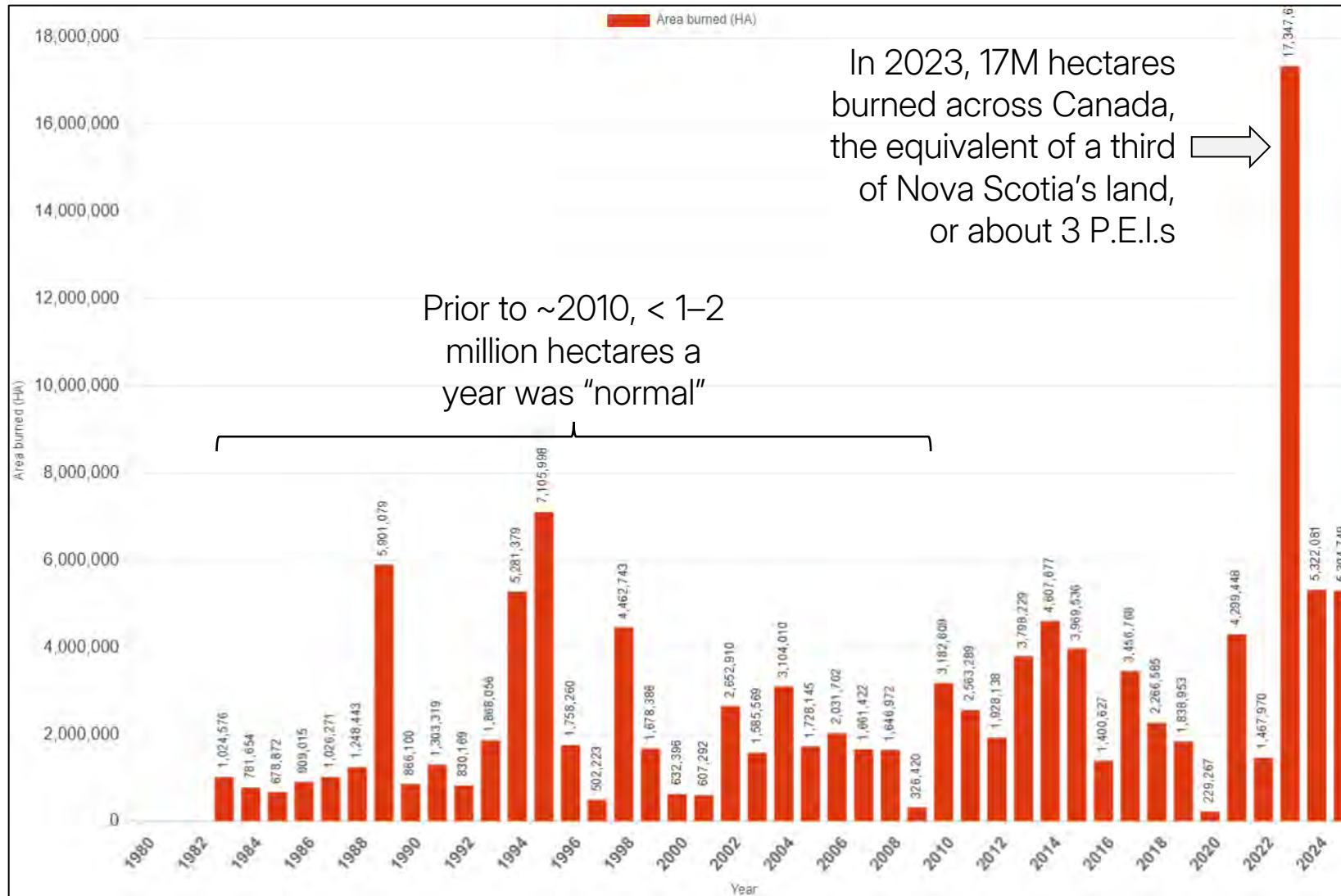
University of Northern BC

- Dr. Peter Jackson
- IT Services

And too many partners to list here, including:



The annual area burned by wildfires in Canada is increasing, raising the risk of harmful smoke exposure



<https://ciffc.net/>

As of July 15 (2025), nearly all the area burned in 2024 has already burned

Exposure to wildfire smoke is associated with an increased risk of premature death and a range of health conditions



3.0 CONCLUSIONS AND CONSIDERATIONS

As wildfires are projected to increase in frequency and severity, the health effects of wildfire smoke will continue to be an active area of research. Based on published systematic reviews of the

“increased risk of premature mortality and adverse respiratory effects”

“increased risk of cardiovascular mortality and morbidity”

studies are needed to differentiate the effects attributable to wildfire smoke versus the effects resulting from other sources. More research is needed to differentiate the effects between wildfire smoke and other sources of PM_{2.5} and limited evidence on the mental health impacts of wildfire smoke specifically. With respect to other health outcomes, there is emerging evidence of potential associations between exposure

“reproductive and developmental effects”

“neurological effects [...], cancer, and skin and eye conditions”

the long-term effects of wildfire smoke exposure, which is attributable to the episodic nature of wildfires, seasonal and spatial variability in wildfire smoke exposure, and the difficulties in differentiating wildfire-PM_{2.5} from PM_{2.5} from all sources (Gao et al., 2023; Gould et al., 2023).

PM_{2.5} is the primary health concern of wildfire smoke, and has the highest health burden of Canada's key air pollutants

Chronic exposure to **PM_{2.5}** air pollution contributed to 8.0% of all-cause nonaccidental mortality among Canadians over 25 years of age,

The economic cost of the 15,300 premature deaths associated with air pollution is estimated at \$114 billion per year (2016 CAD).

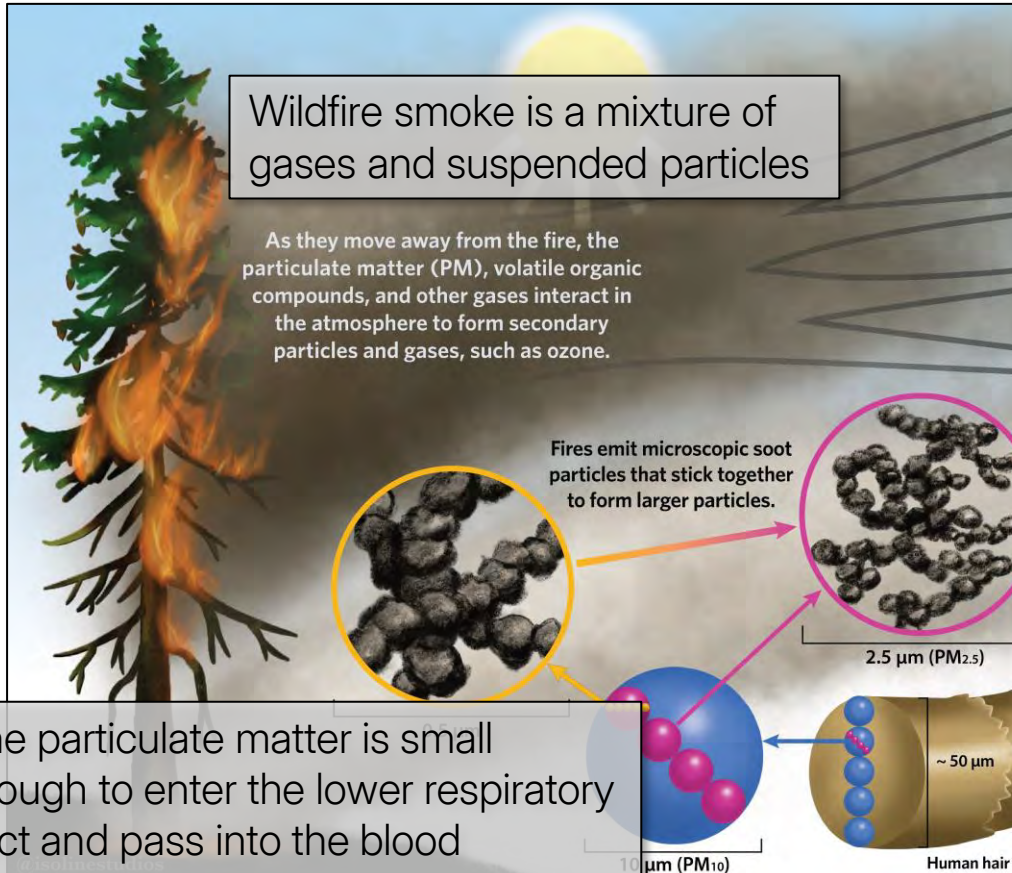
Health Impacts of Air Pollution in Canada

Table 7. Comparison of Health Canada analyses - population-weighted exposure to air pollution (above-background) and premature mortality estimates

Exposure Period ^a	Population (Year)	NO ₂		Annual ozone		Summer ozone		PM _{2.5}		Total Deaths	
		pwe (ppb)	count	pwe (ppb)	count	pwe (ppb)	count	pwe (µg/m ³)	count	count	per 100,000
2007-2012 ^b	34,342,780 (2011)	8.3	1,300	12.8	2,400	15.6	1,200	4.7	9,500	14,400	42
2014-2016 ^c	35,851,774 (2015)	5.4	940	13.0	2,700	14.8	1,300	4.3	9,700	14,600	41
2014-2017 ^d	36,229,449 (2016)	7.2	1,300	13.2	2,800	14.4	1,300	4.3	10,000	15,300	42

pwe: population-weighted exposure

PM_{2.5} accounted for ~2/3 of premature mortality estimates

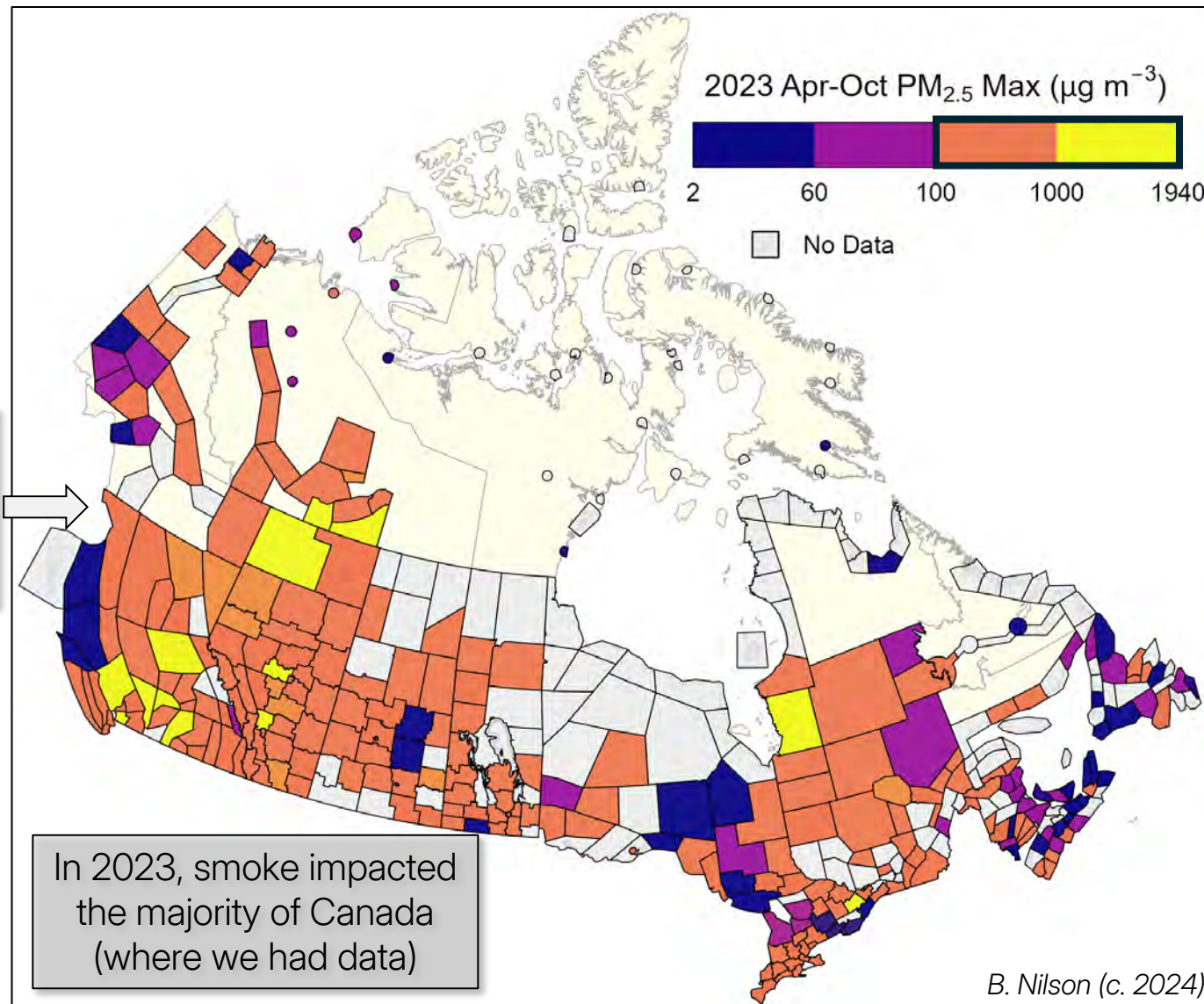


Created by Jen Burgess/IsolineStudios for BC CDC



<https://www.canada.ca/en/health-canada/services/publications/healthy-living/health-impacts-air-pollution-2021.html>
(or search for "Health impacts air pollution Canada")

Unlike typical air pollution which is concentrated in urban areas, wildfire smoke can impact communities across the country



Highest observed PM_{2.5} concentration from any monitor in the zone April-October (2023)

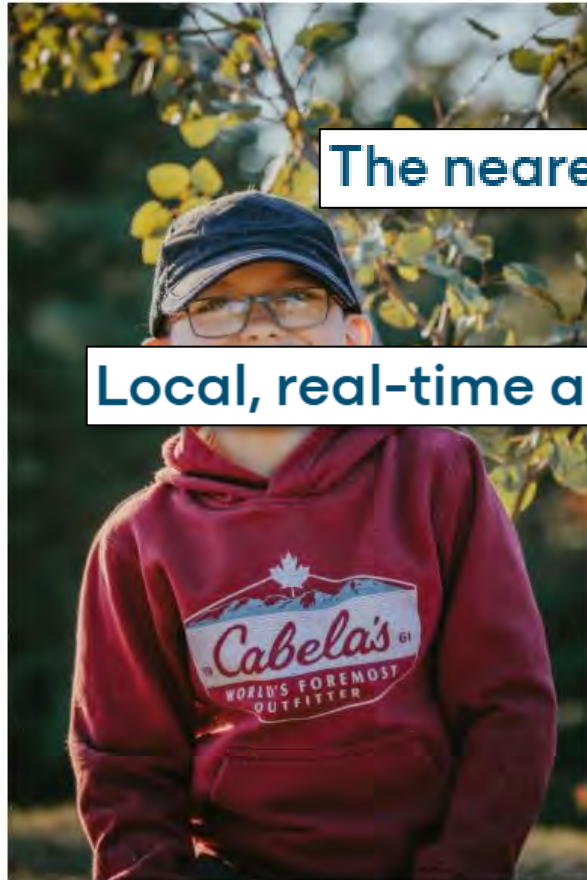
In 2023, smoke impacted the majority of Canada (where we had data)

$>100 \mu\text{g m}^{-3}$ is uncommon in Canada unless impacted by wildfire smoke

$<100 \mu\text{g m}^{-3}$ could still be mild/moderate smoke impacts, or a lack of observations at the time/place of smoke impacts

B. Nilson (c. 2024)

It is important to be able to quickly understand where and when smoke is present at the surface in real time



The nearest air quality monitoring station was 100km;

In July 2023 in 100 Mile House, 9-year old Carter Vigh sadly passed away due to an asthma attack triggered by poor air quality. The nearest air quality monitoring station was 100km; the skies were clear, but the air over 100 Mile was, invisibly, very poor. Local, real-time air quality monitoring would likely have saved his life.

Local, real-time air quality monitoring would likely have saved his life.

awareness of air quality monitoring and educate communities about air quality and its effects.

On May 14, 2024, the BC Lung Foundation put Carter's project into action as they visited 100 Mile House to distribute air quality monitors to local families who want access to real time data on air quality. BC Lung

throughout the community which provide real-time air quality information that all residents can access online.

BC Lung also provided demonstrations for the monitors and how to use them, as well as a workshop on how to make DIY air cleaners.

Let's keep our community and families safe this wildfire season!

To donate to provide a potentially life-saving air quality monitor, click below.

DONATE



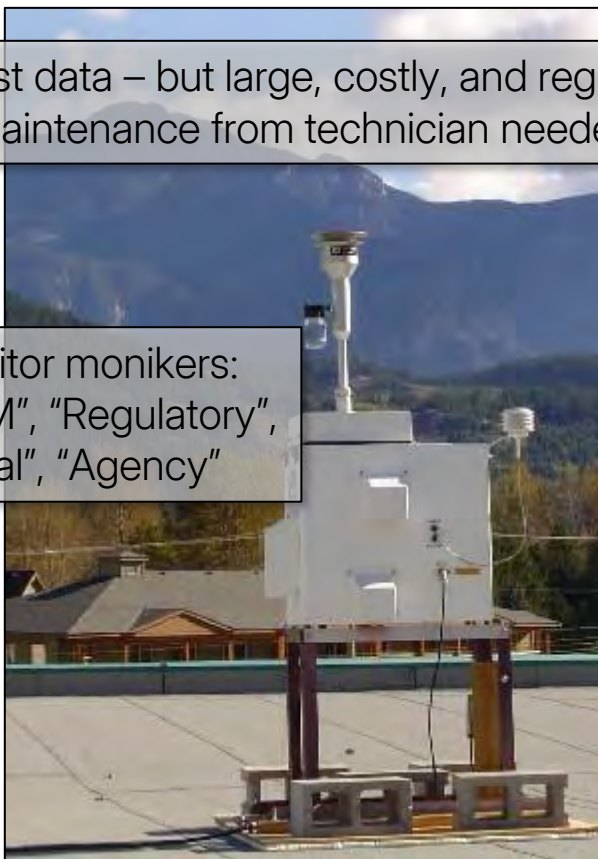
<https://bclung.ca/lung-health/air-quality/carters-project/>
(or search for "Carter's Project")

Traditional air quality monitoring in Canada is managed by each province/territory as part of the *NAPS* program

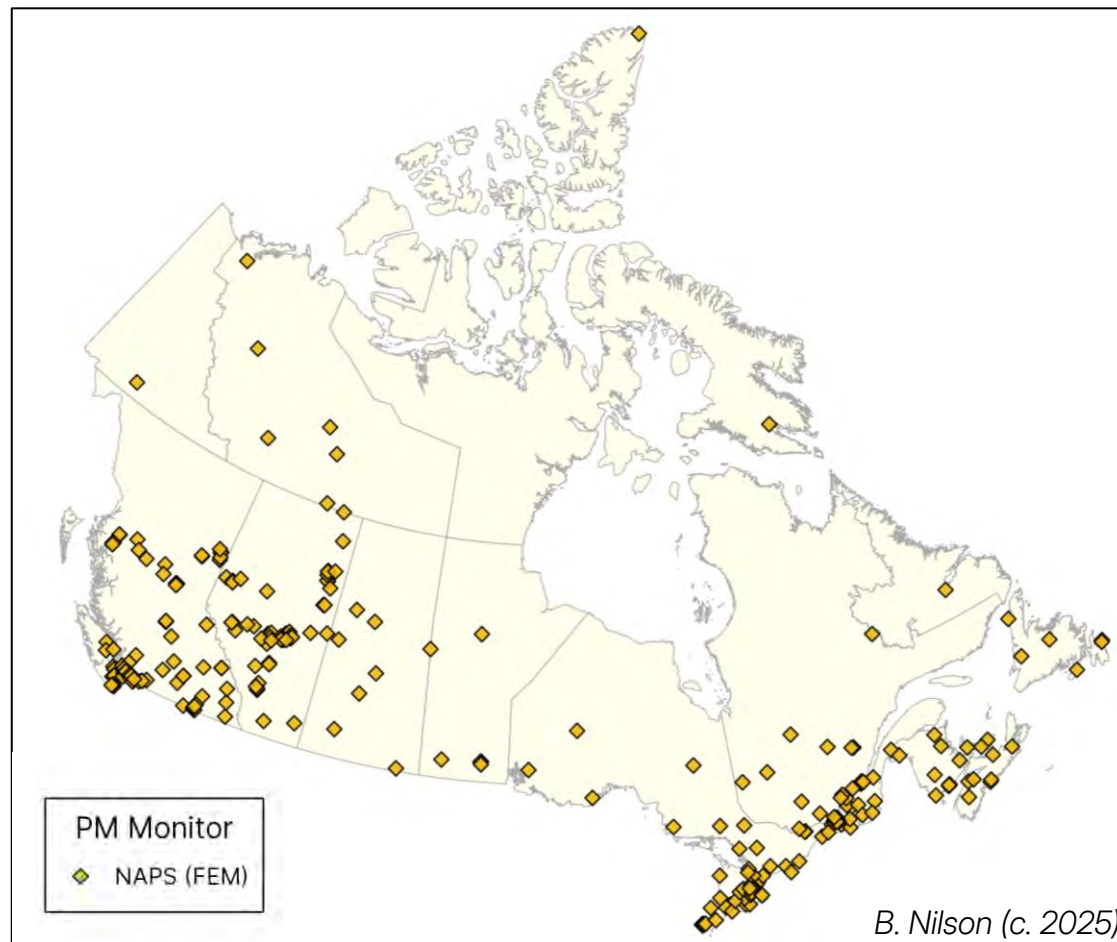
"National Air Pollution Surveillance"

Best data – but large, costly, and regular maintenance from technician needed

Many monitor monikers:
"NAPS", "FEM", "Regulatory",
"Traditional", "Agency"



www.pemberton.ca/municipal-services/air-quality



These monitoring stations are expensive to install and maintain, largely limiting them to urban cities

Low-cost monitors (LCMs), such as PurpleAir, are a cost-effective way to improve access to PM_{2.5} observations

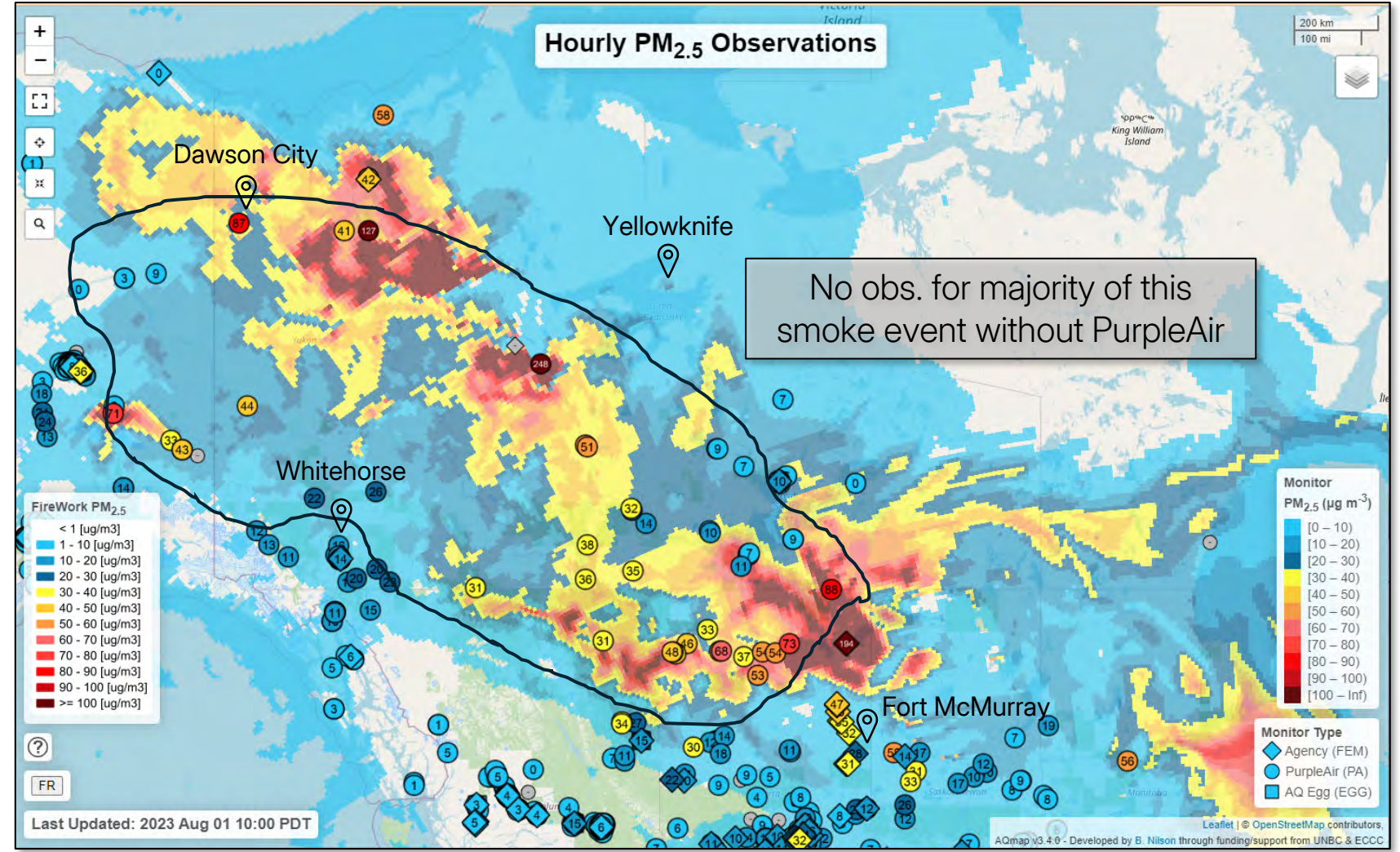


Dual internal sensors allow for error checking



Easy to install, just need a host + power + WiFi

www2.purpleair.com



<https://aqmap.ca> - modelled PM_{2.5} with obs. from NAPS (diamonds) and PurpleAir (circles)

However, inequities still exist in access to nearby PM_{2.5} observations

Estimated percentage within 25 km of a PM_{2.5} monitor (either a NAPS or PurpleAir) in September of 2024

Province / Territory	Canadian Population			Canadian Communities		
	Total	Urban	Rural	Total	Non-Indigenous	Indigenous
Canada	92%	97%	70%	58%	58%	57%
British Columbia	99%	99.5%	93%	79%	78%	77%
Alberta	96%	99%	80%	77%	78%	73%
Saskatchewan	74%	91%	39%	33%	32%	34%
Manitoba	86%	97%	54%	32%	43%	14%
Ontario	92%	96%	65%	57%	64%	41%
Québec	92%	96%	73%	76%	75%	84%
Nova Scotia	86%	96%	73%	61%	59%	69%
New Brunswick	83%	96%	70%	65%	64%	73%
Newfoundland & Labrador	76%	92%	53%	43%	44%	22%
Prince Edward Island	93%	100%	87%	69%	64%	100%
Yukon	95%	99.8%	88%	81%	81%	81%
Northwest Territories	95%	100%	86%	90%	88%	90%
Nunavut	16%	20%	12%	8%	13%	7%

As well as Indigenous communities, many of which are in the boreal forest which is prone to wildfires

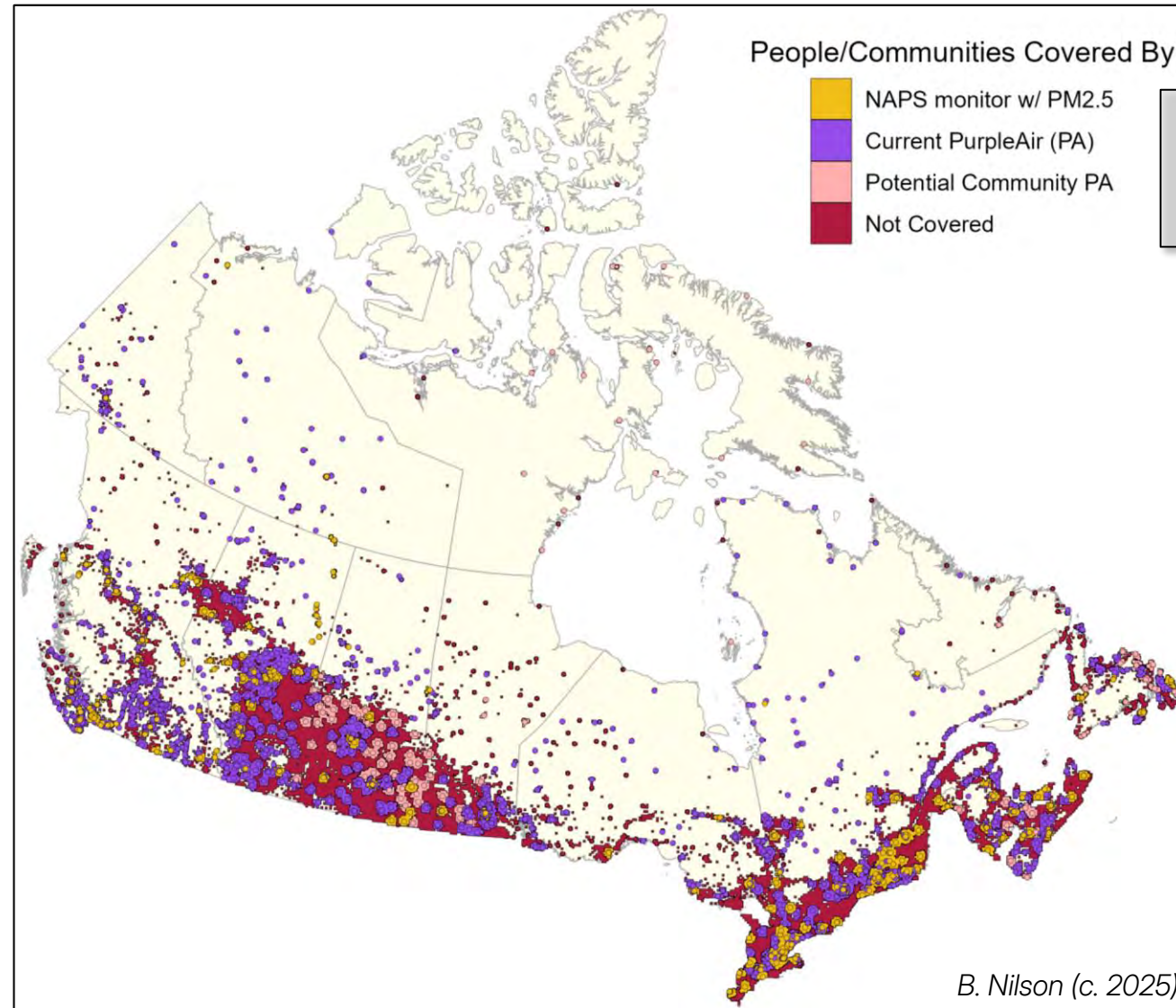
Some prov./terr. have poorer access

Particularly for rural Canadians

B. Nilson (c. 2025)

Near the end of last year, ~30% of rural Canadians and ~43% of Indigenous communities were more than 25 km from a monitor

We are working with partners to *equitably* improve access to these critical data for wildfire smoke events

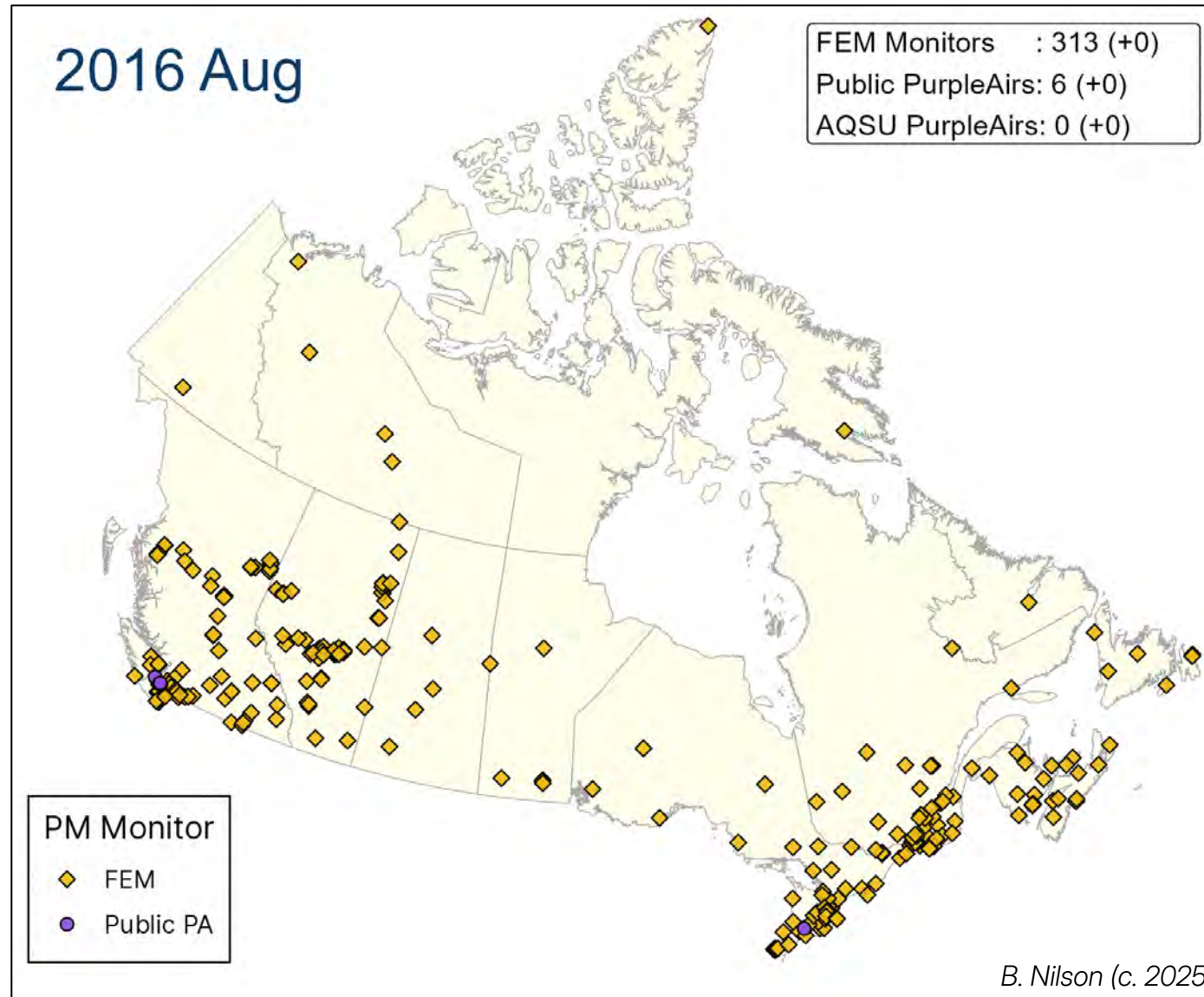


Red area is where people/communities 25+ km from a PM_{2.5} monitor

Gold/purple areas are people/communities with a monitor in a reasonable distance

90+% population across each prov./terr. being within 25 km of a monitor would require installing additional monitors in 91 communities

We have provided many of the PAs active in Canada, and the growth of the “public” network points to their usefulness



Public PAs are any PurpleAir monitors not purchased by ECCC

AQSU PAs are purchased by ECCC and (mostly) installed by partners
(AQSU = Air Quality Science Unit)

However, real-time air quality data is often scattered across multiple platforms, complicating access and interpretation

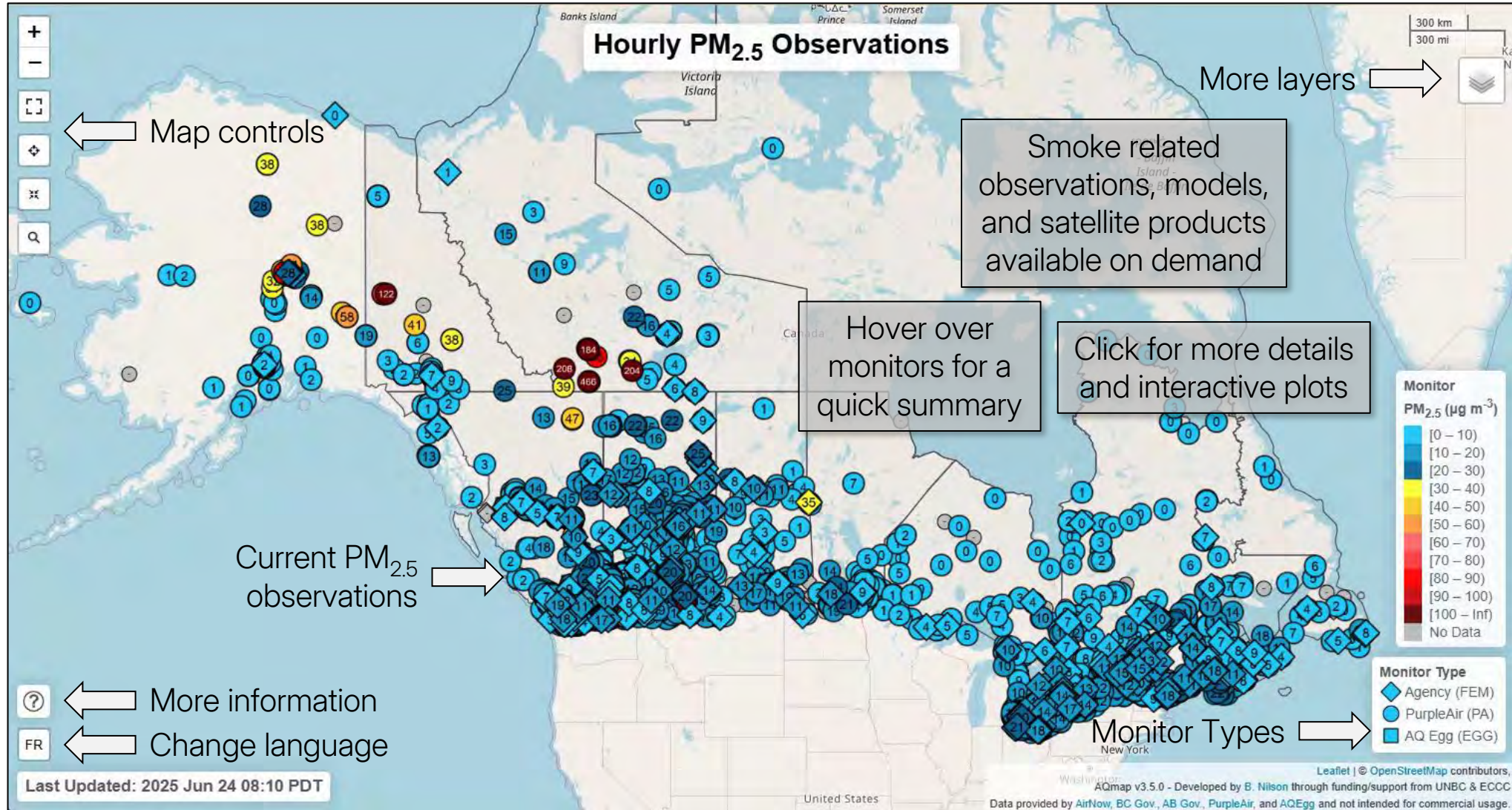
The image displays a collage of various air quality monitoring websites and maps, illustrating the fragmentation of data. A central meme overlay reads "NOT SURE WHICH TOOL I SHOULD USE" and "SO MANY CHOICES".

Visible websites and data include:

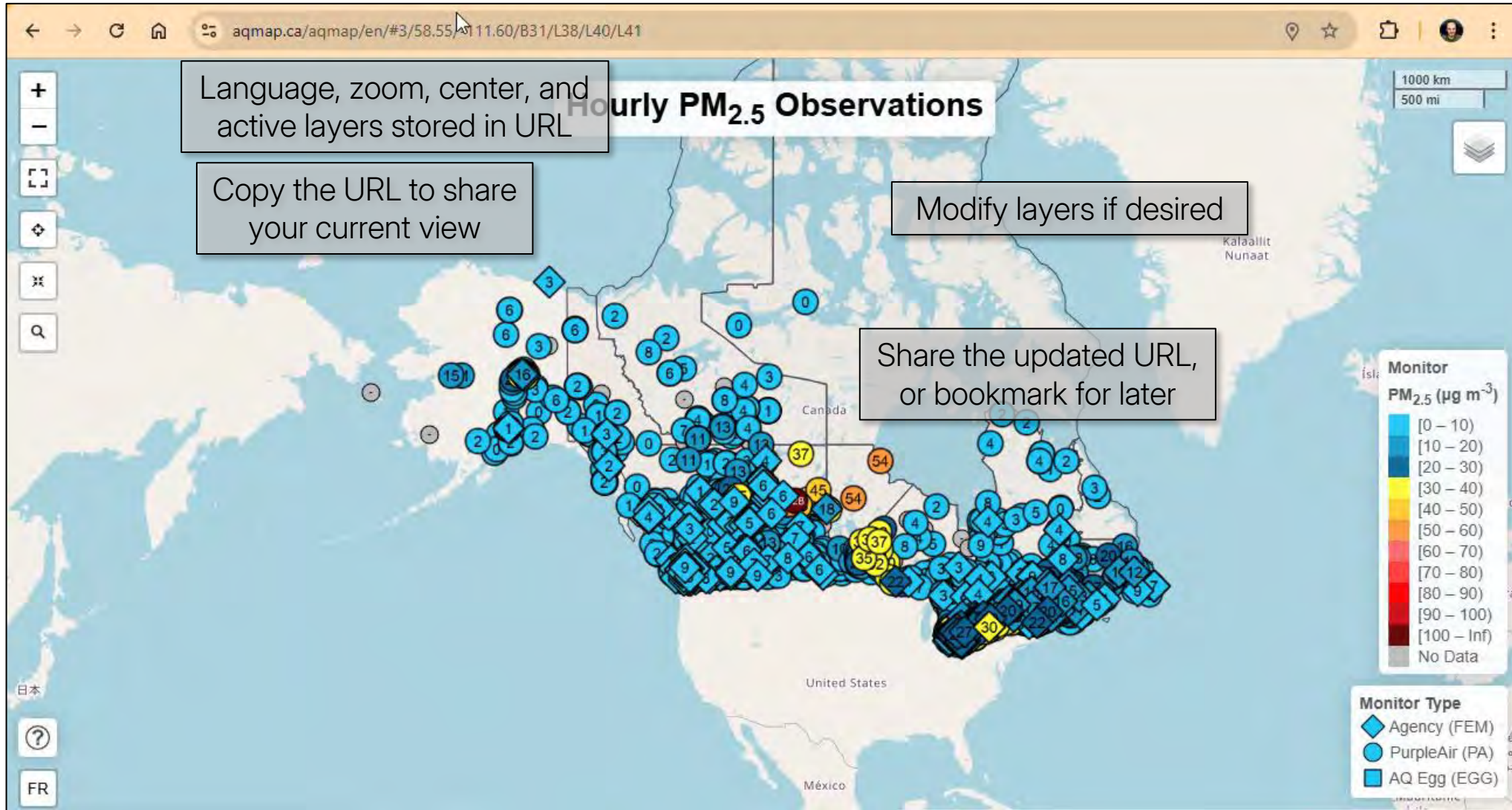
- BC Air Quality** (British Columbia)
- Manitoba** (Manitoba)
- IQAir** (Nanaimo Air Quality, Nanaimo Air Quality Index, weather data)
- Government of British Columbia** (Air Quality Health Index, AQHI)
- Environment Canada** (British Columbia - Air Quality Health Index (AQHI))
- Canadian PM2.5**
- Search Canada.ca**
- Local A**
- Home > Env**
- Late**
- Commun**
- Saskatch**
- Pur**
- 1. Sele**
- Inuvik**
- lqaluit**

The maps show various air quality indices and AQHI values across different regions, including Nanaimo, British Columbia, and other areas.

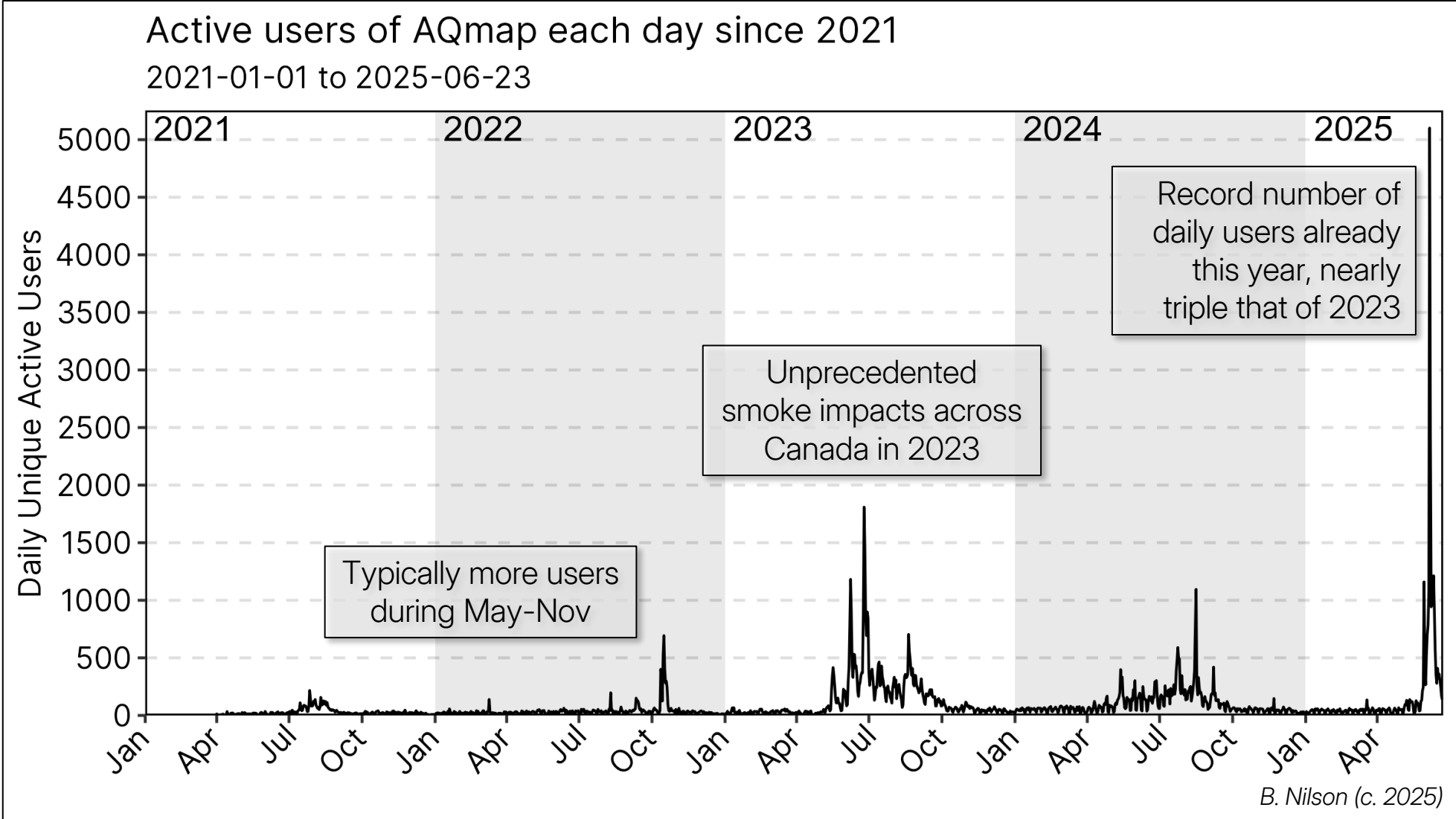
AQmap aggregates PM_{2.5} observations, models, and satellite data in a standardised format in both English and French



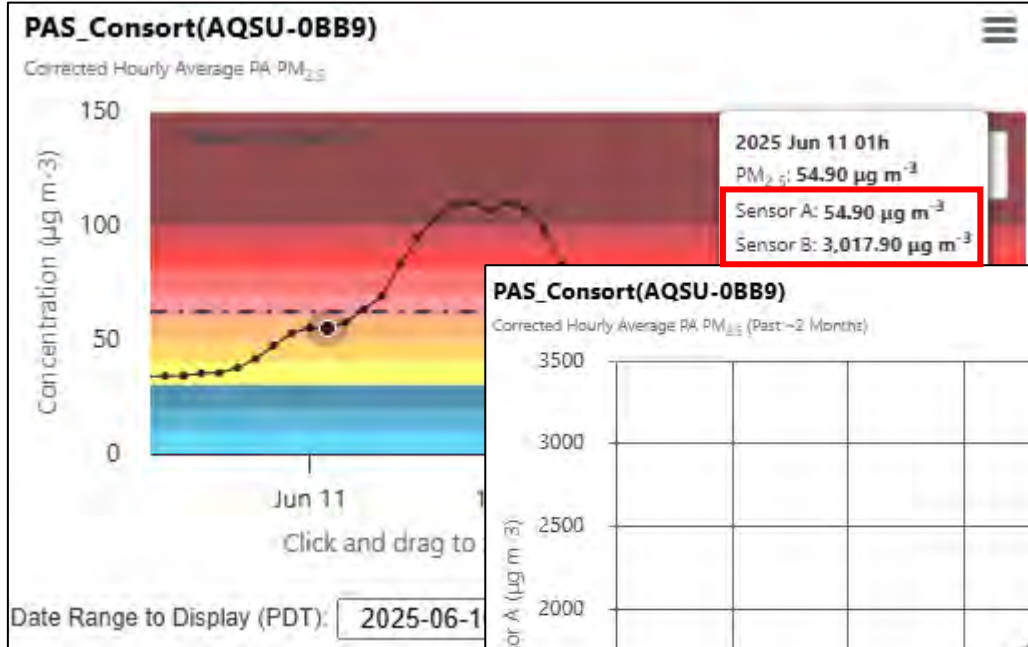
You can easily bookmark or share your preferred view thanks to the dynamic URL



AQmap has proven to be a key resource during past wildfire seasons

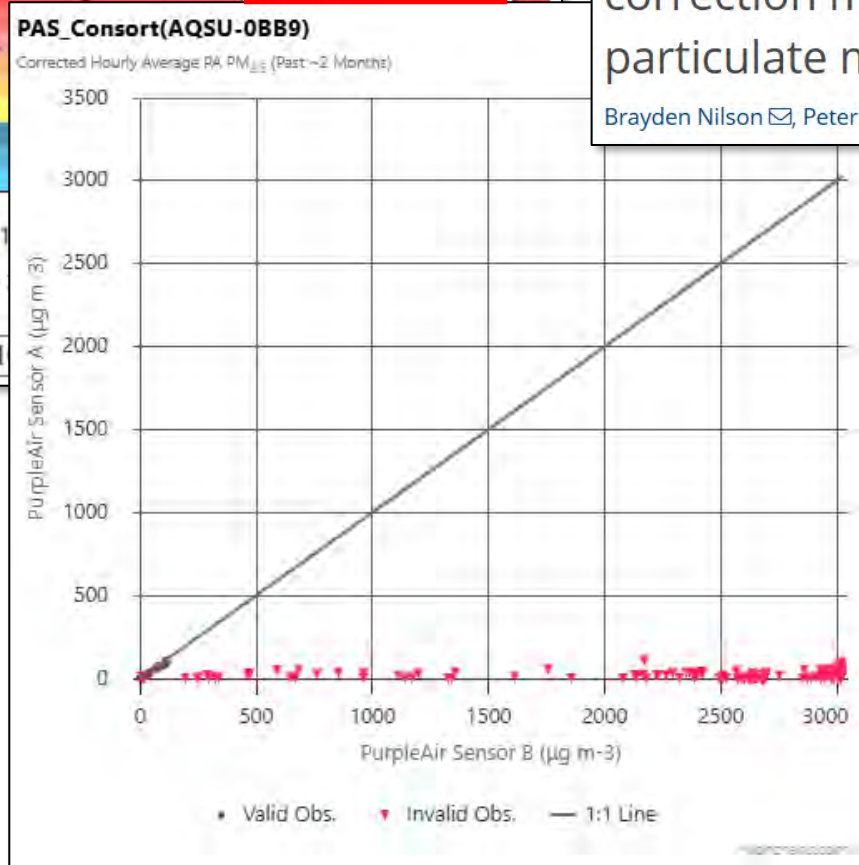


We try to display the best quality data on AQmap using an automated QA/QC and bias correction for LCM observations



<https://aqmap.ca>

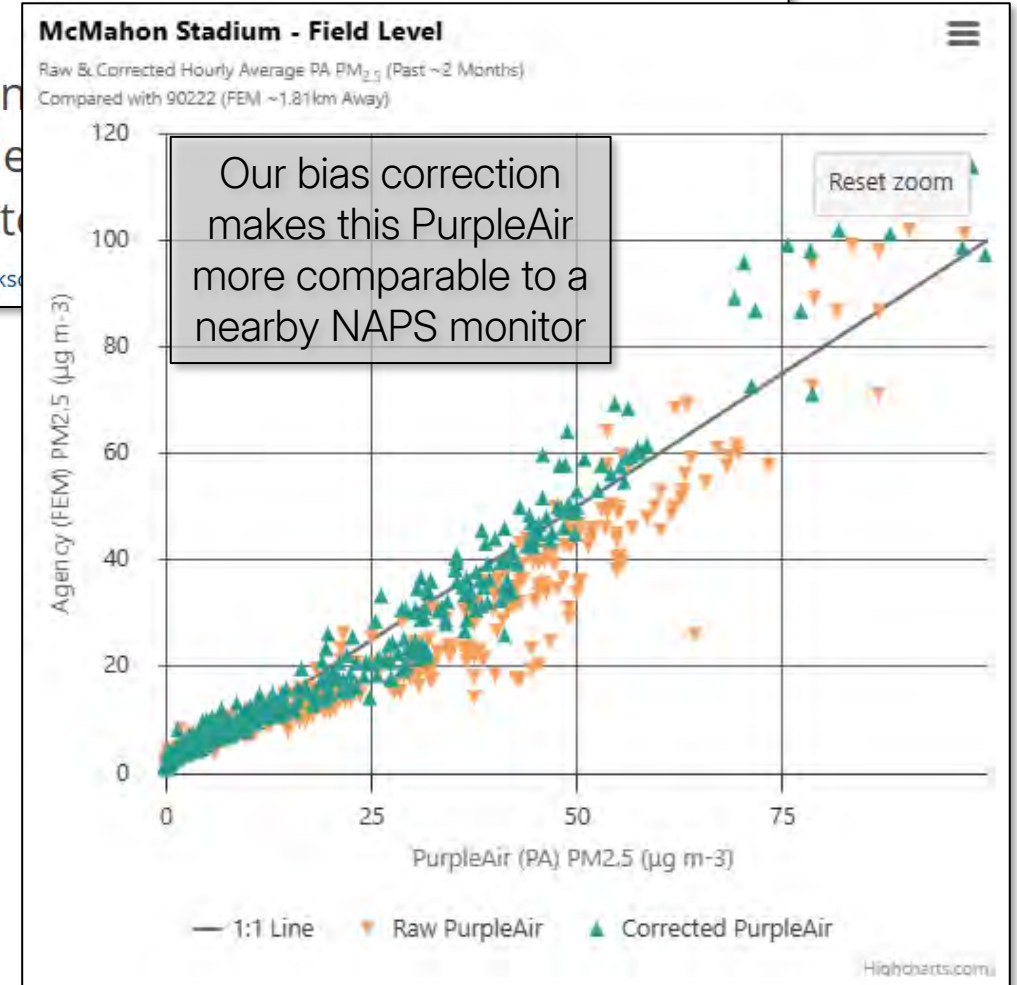
Sensor "B" has failed high for this PurpleAir and has been filtered out by our QA/QC



<https://doi.org/10.5194/amt-15-3315-2022>
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Research article |
Development and
correction mode
particulate matt
Brayden Nilson , Peter L. Jackso

<https://aqmap.ca>

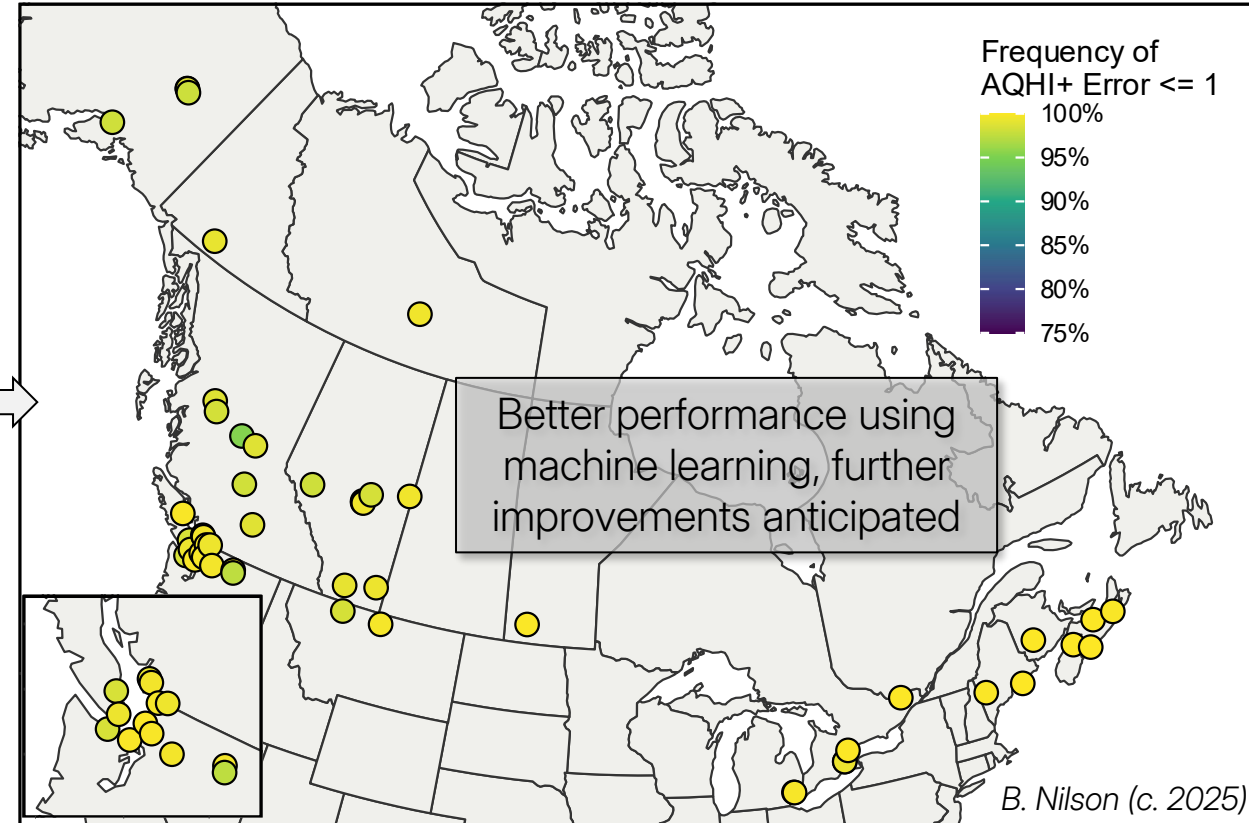
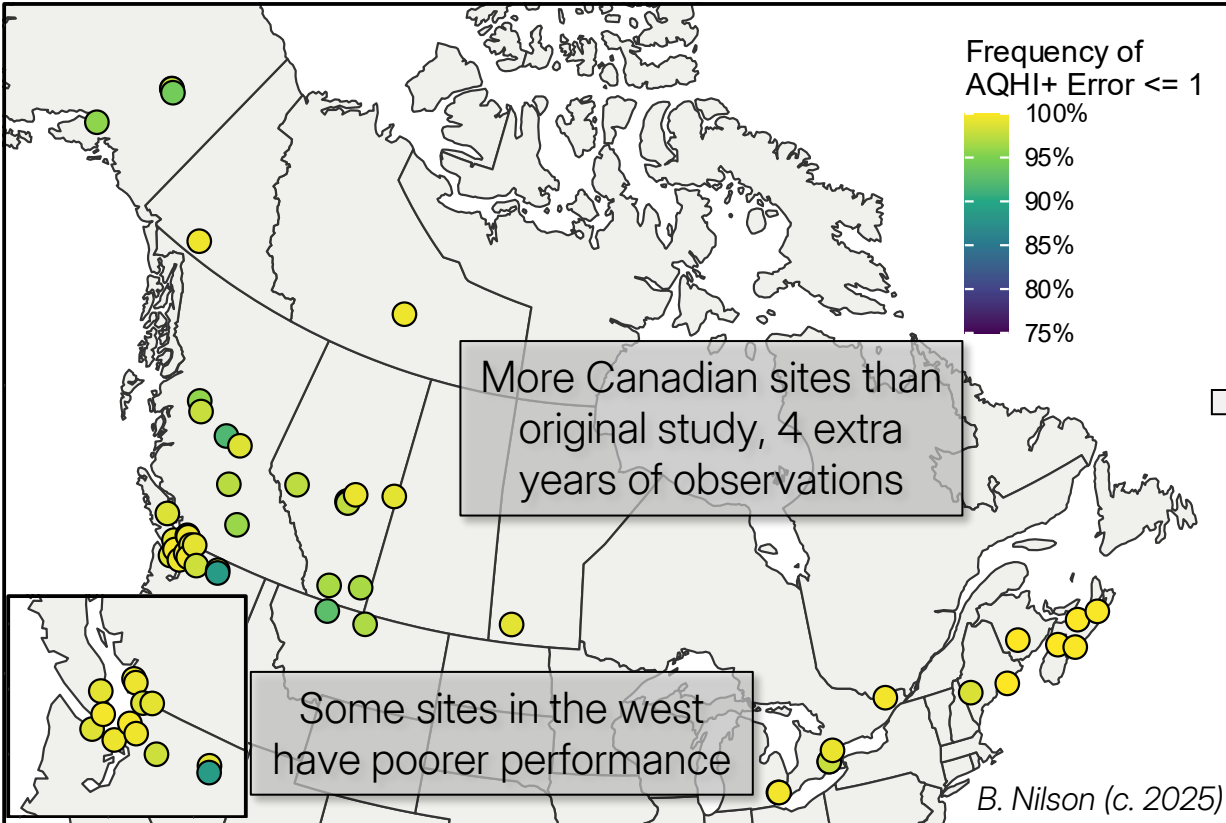


<https://aqmap.ca> 17

I am working on a machine-learning QA/QC and bias correction, hoping to implement by 2026

Current QA/QC and bias correction on AQmap

New (preliminary) QA/QC and bias correction



More yellow = Better PurpleAir data quality from that site

Based on PurpleAir/NAPS colocation data ranging from Sep. 2016 to Dec. 2024

Aiming to implement an update to AQmap by this Fall

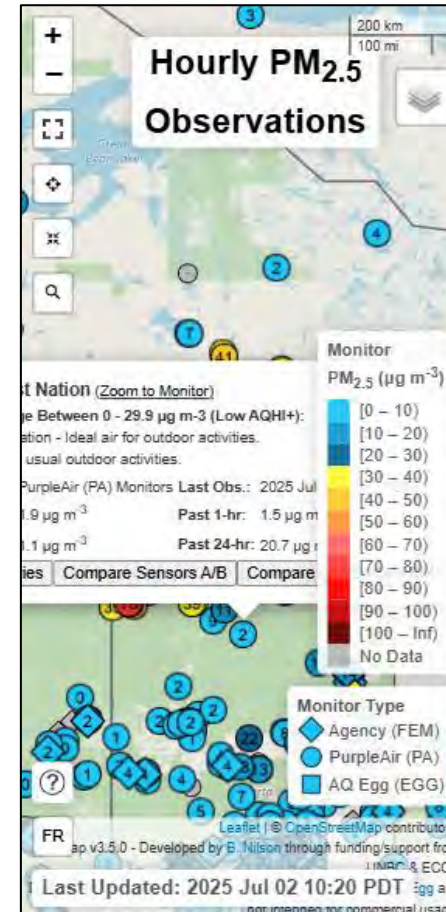
Page-load times: (will differ by computer and network)

- Current version: **~11 seconds**
- Updated version (so far): **~5.5 seconds**

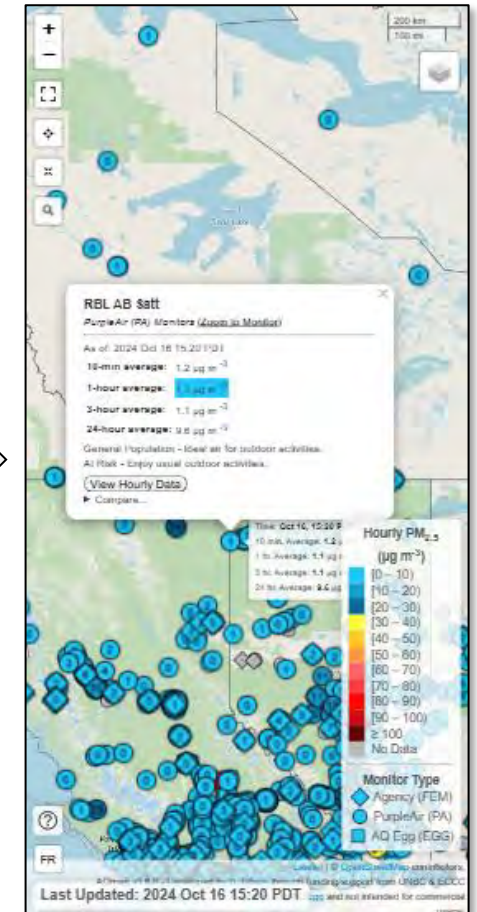
New features (so far):

- Improved sensor popups
- More mobile-friendly interface
- Less cluttered layers menu
- Improved data collection speed
- Cleaned up text, updated links, etc.
- New QA/QC & bias correction implementation (once completed)

Current mobile experience



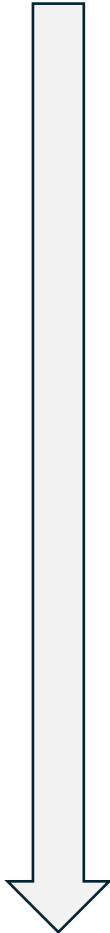
Improved, preliminary, version



Focus on improving user experience, especially on smaller screens, as well as data frequency/quality

AQmap services a range of audiences due to it being interactive, bilingual, and cross-boundary

National



Local

National/regional air quality agencies

- What regions are being impacted?
- Where do we not have observations?

Air quality forecasters

- Where/when is smoke reaching the surface?
And where/when will it go?
- How well are models agreeing with observations?

Public health professionals

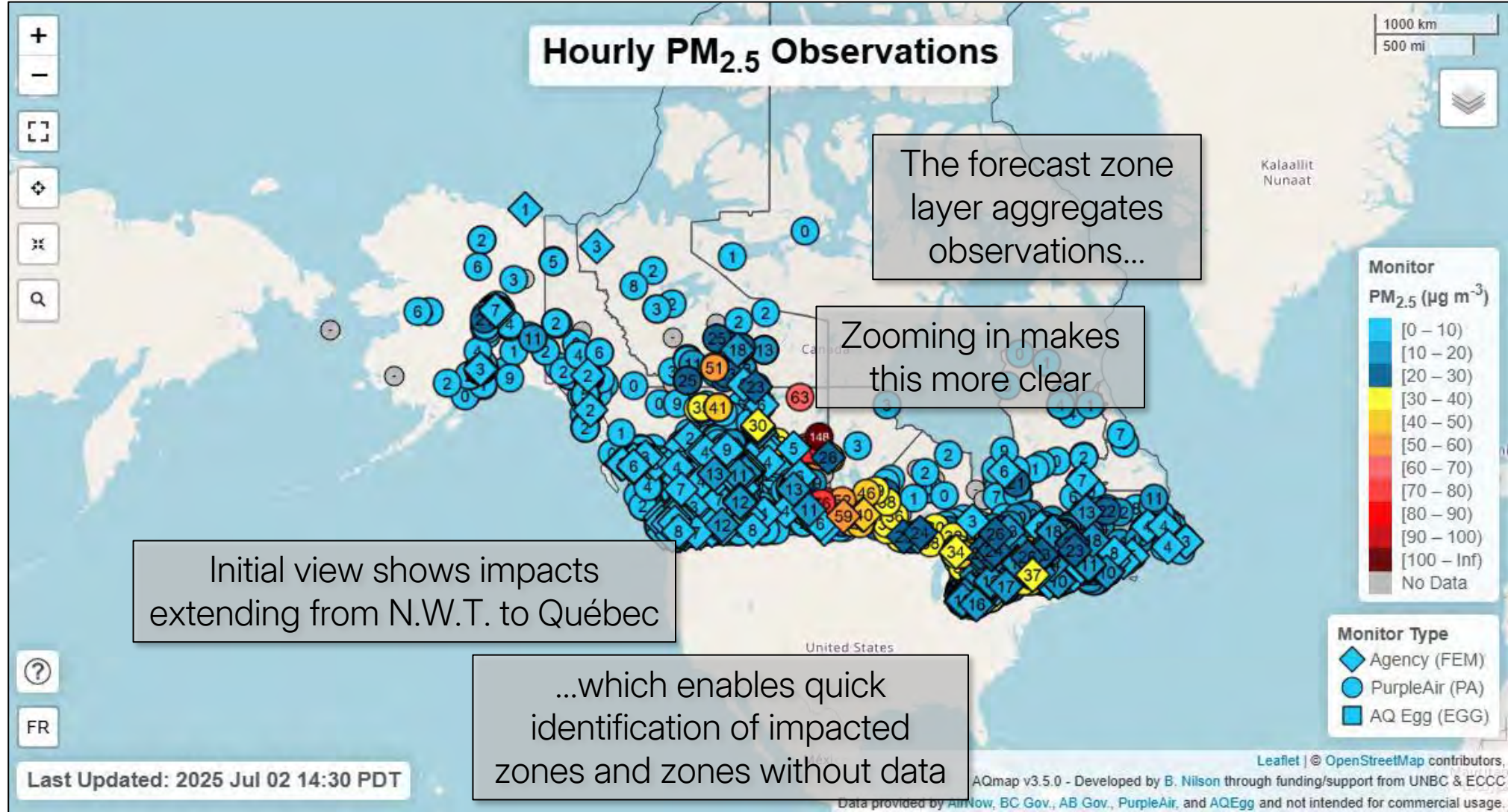
- How bad is the smoke exposure?
- Are certain areas more/less impacted?

Concerned citizen

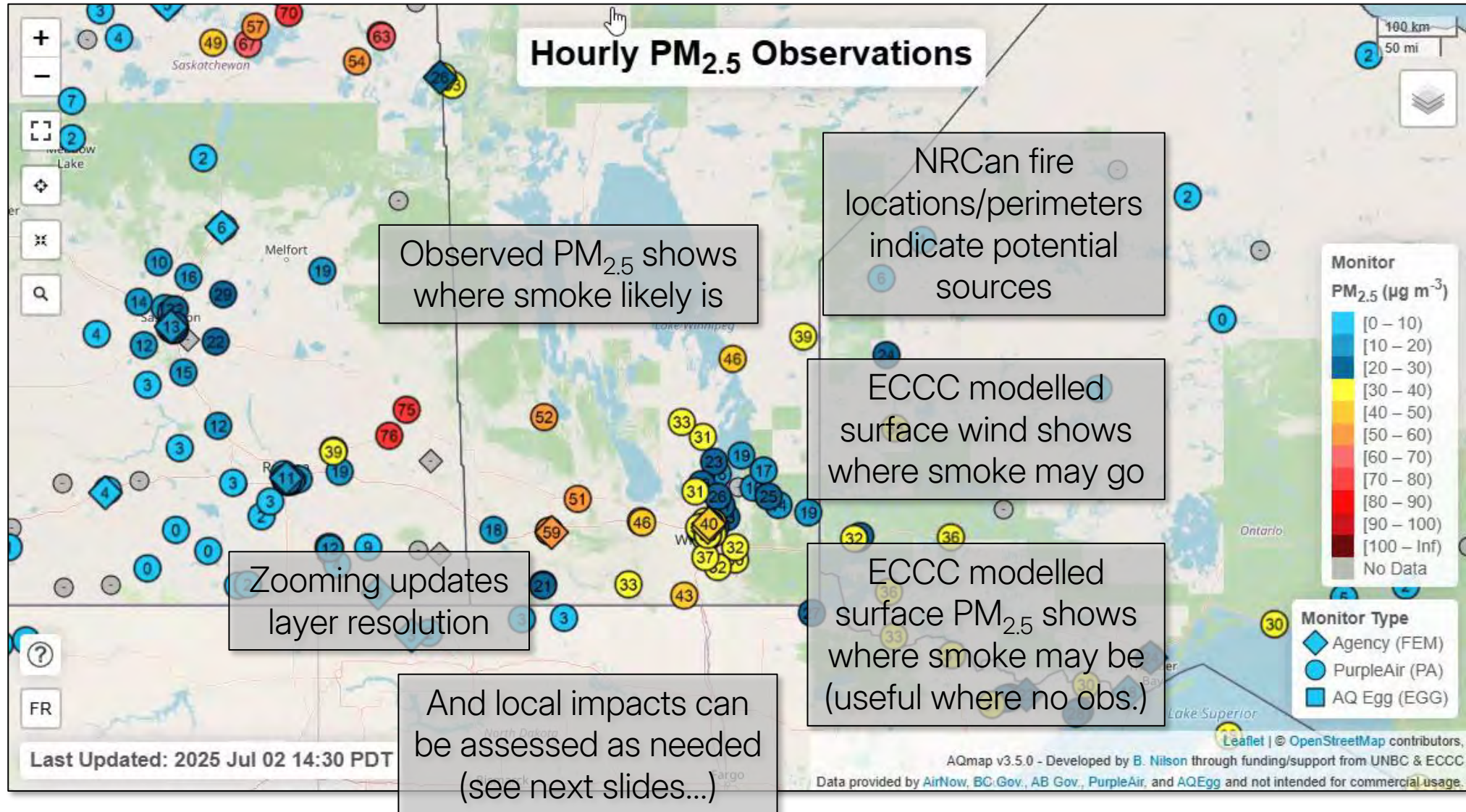
- Why is it smoky?
- Should I not go play [insert sport] today?

AQmap enables access to PM_{2.5} data regardless of language and location

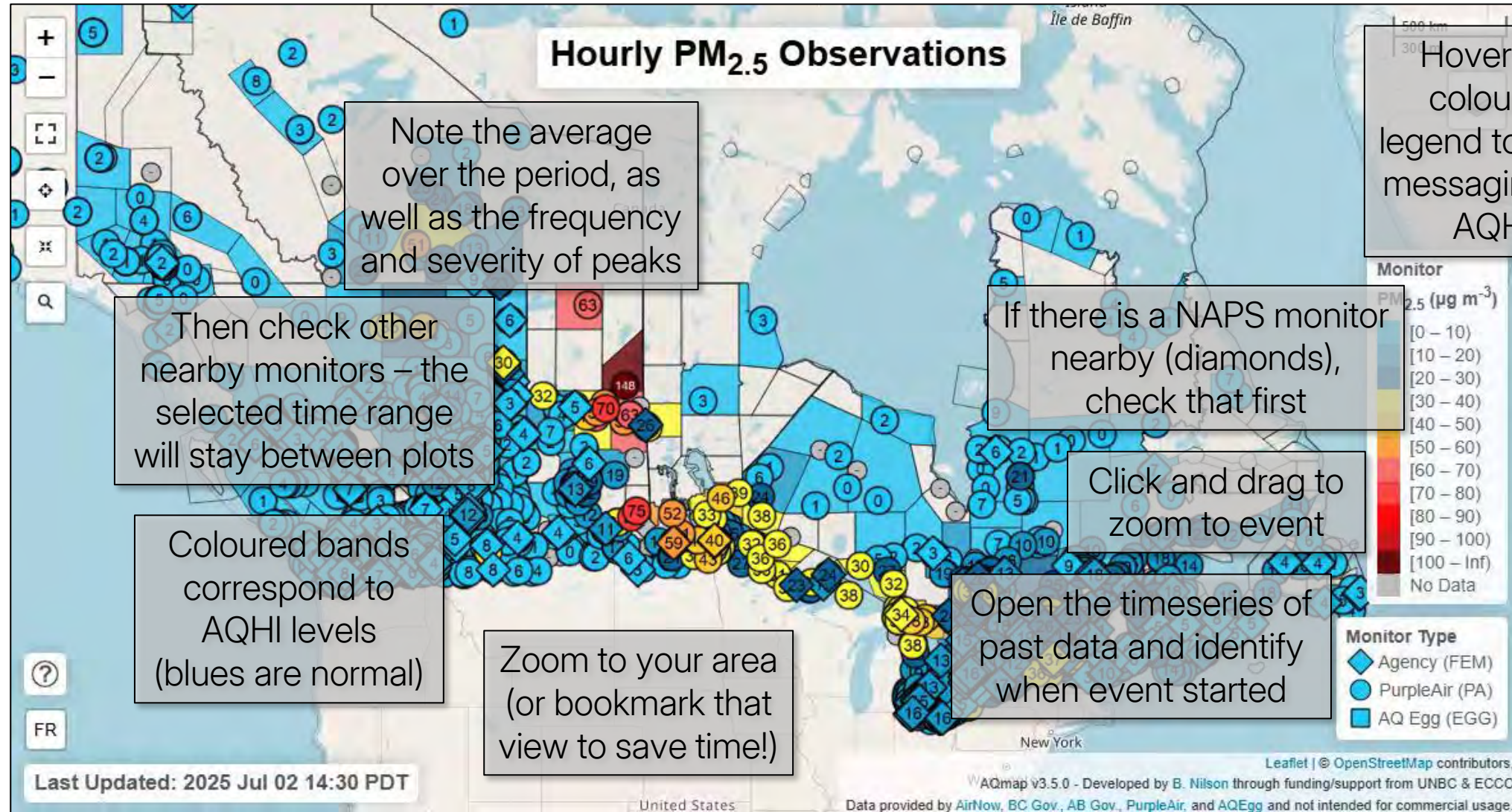
Imagine you are a manager of a national/regional air quality agency...



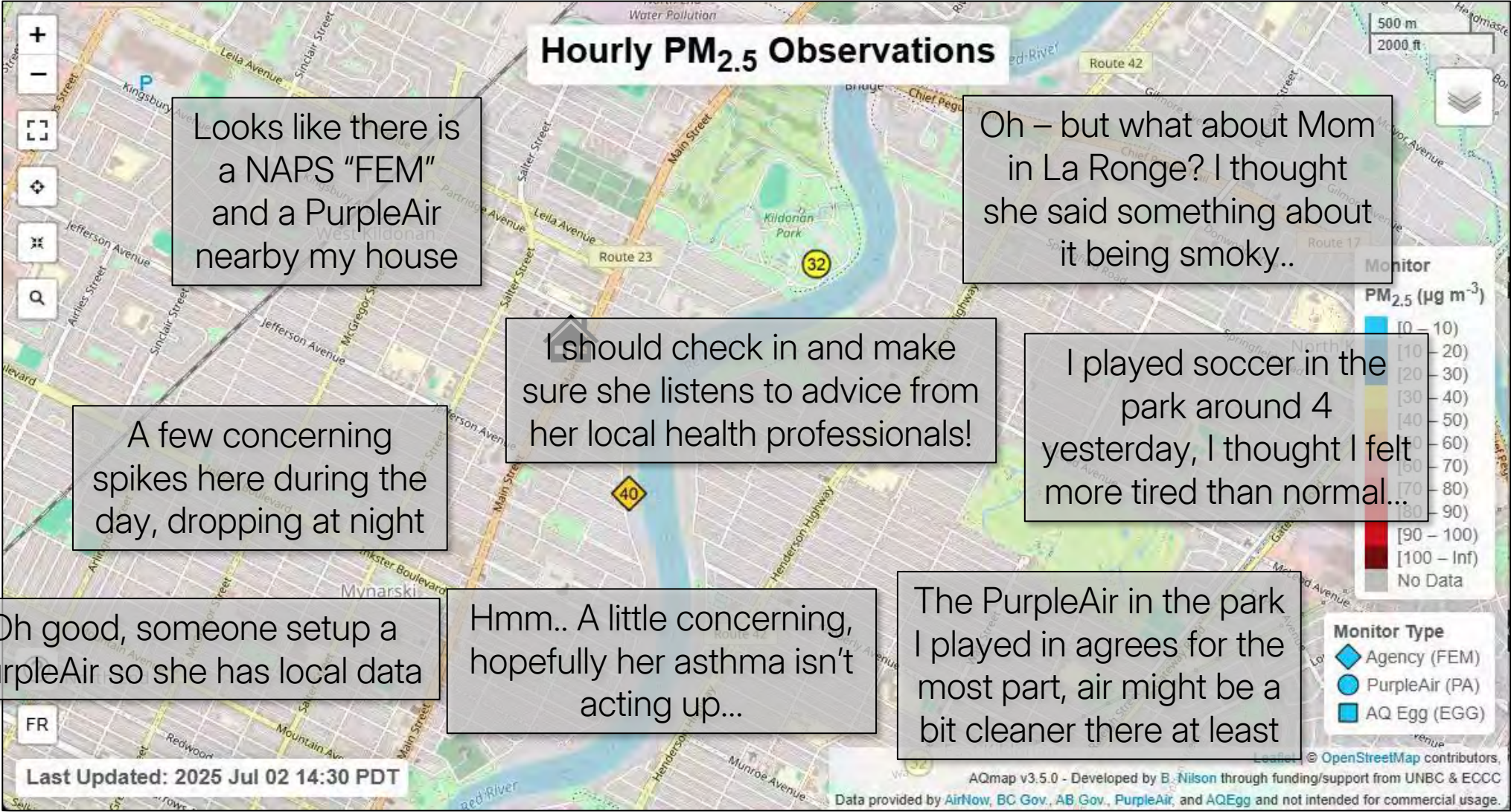
Imagine you are an air quality forecaster...



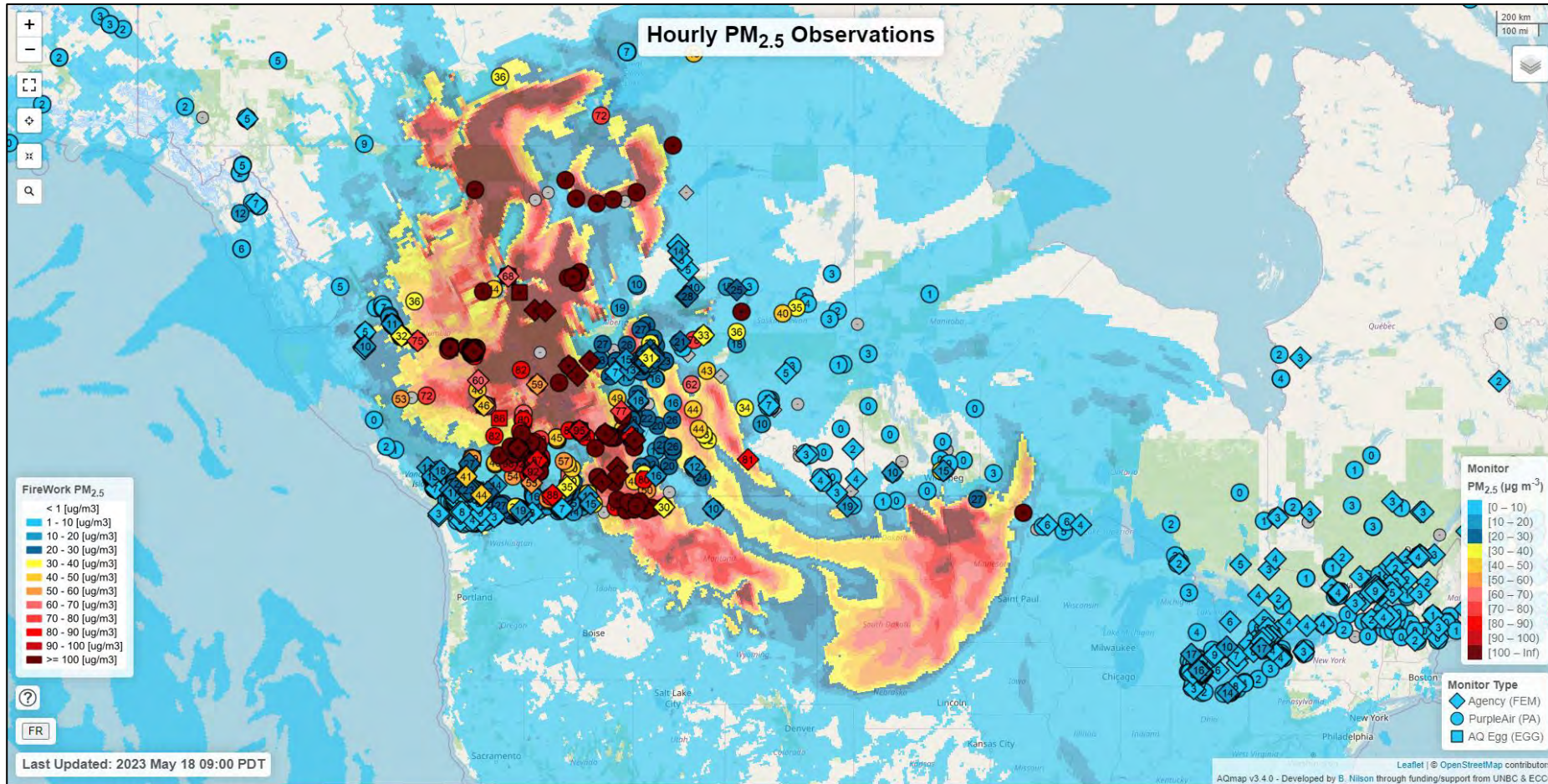
Imagine you are a public health professional...



Imagine you are a concerned citizen...



We want to improve access to critical information on wildfire smoke for all people in Canada

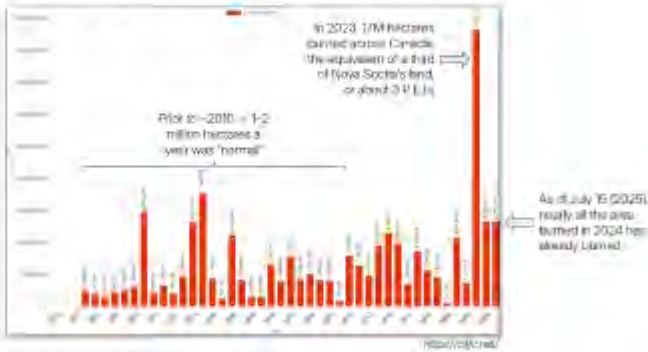


Mechanisms:

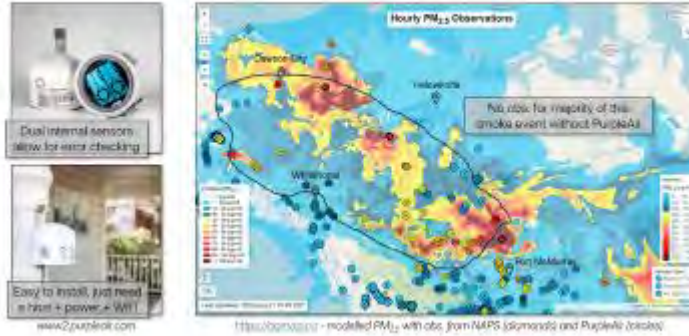
- Data access tools
 - AQmap
 - Tools/training for partners and air quality forecasters
- Low-cost monitors
 - Purchasing and repairing/replacing where possible
 - Assessing emerging technologies
- Outreach and collaboration
 - Presentations
 - Data sharing for research

<https://aqmap.ca> - modelled PM_{2.5} with obs. from NAPS (diamonds) and PurpleAir (circles)

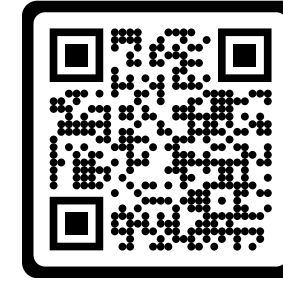
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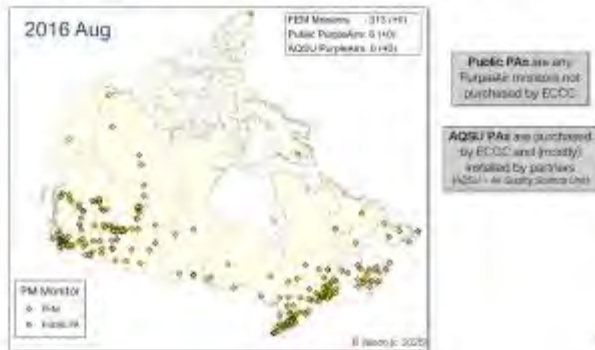
AQmap - EN



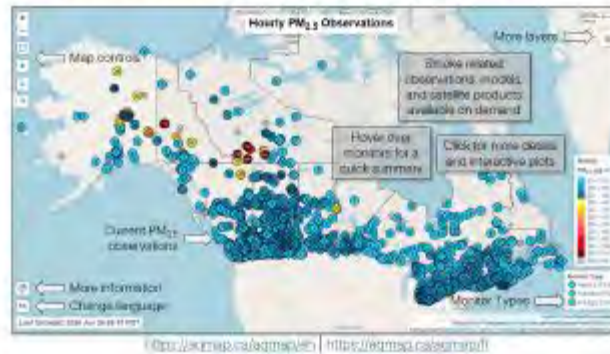
AQmap - FR



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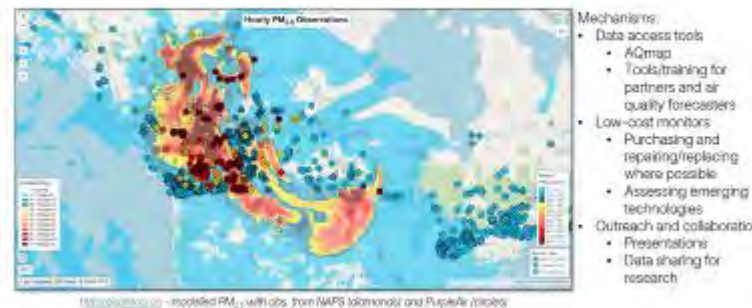
Visit <https://aqmap.ca> and try it for yourself

Reach out to me at brayden.nilson@ec.gc.ca if you have any questions

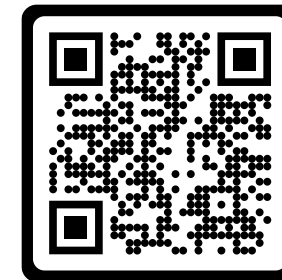
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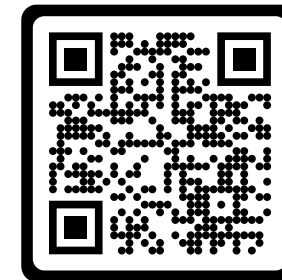
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Bias Correction



Smoke Health Effects



AQ impacts Canada

