

CASAP – X

**Tenth Colombian Congress and International Conference on Air
Quality, Climate Change, and Public Health**

May 14-16, 2025

Medellin - Colombia



Retos emergentes en la evaluación de los efectos de los contaminantes del aire en estudios epidemiológicos observacionales

Emerging challenges in assessing the effects of air pollutants in observational epidemiological studies

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No conflicts of interest to declare



Content



Trends in air
pollution and
health



Climate change &
air pollution: Smoke
from wildfires
- Canada



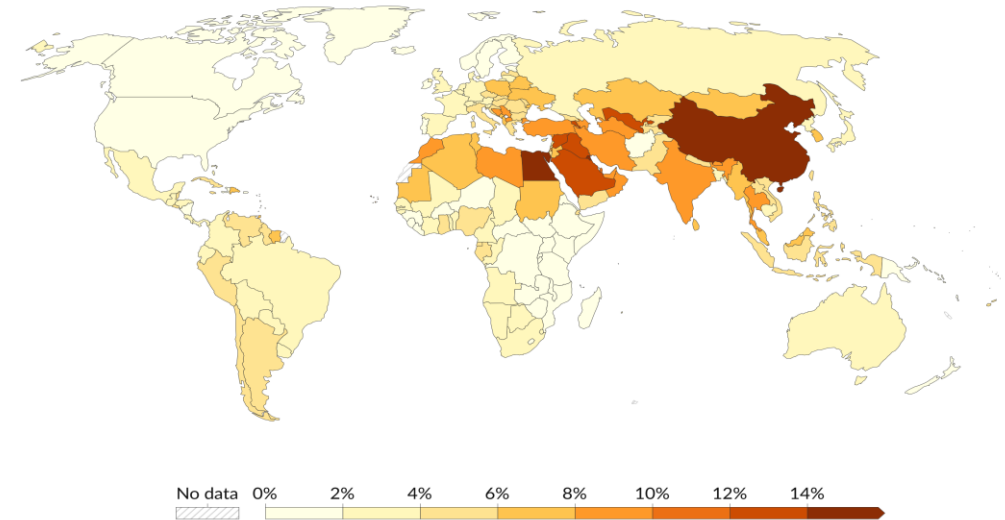
The project:
*Impact of Air Pollution on
Respiratory and Mental
Health in Children in
Ontario in the Context of
Climate Change*

Air pollution and health

~7 million deaths
(household and
ambient) in 2019
(Fuller, et al 2022)

Share of deaths attributed to outdoor air pollution, 2021

Share of deaths, from any cause, where ambient particulate matter air pollution is a risk factor.



Data source: IHME, Global Burden of Disease (2024)

OurWorldinData.org/outdoor-air-pollution | CC BY

<https://ourworldindata.org/grapher/share-deaths-outdoor-pollution>

Air pollution

Air pollution affects millions of people worldwide. Both household and outdoor air pollution pose severe threats related to cardiovascular and respiratory diseases, cancers, and other conditions.

Photo by Sergei Karpukhin, Reuters.

8%

of total disease burden in 2021 was caused by particulate matter air pollution (level 3), making it the leading contributor among risk factors.

48%

of chronic obstructive pulmonary disease (COPD) is attributable to air pollution.

34%

of preterm births in 2021 were attributed to exposure to air pollution.

33%

of deaths due to air pollution occurred in South Asia in 2021.

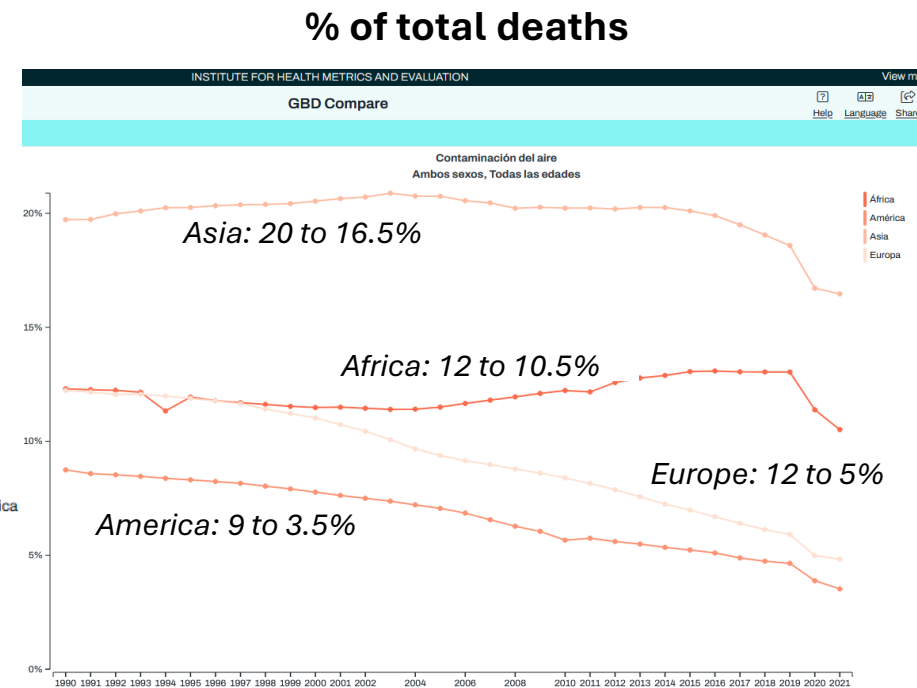
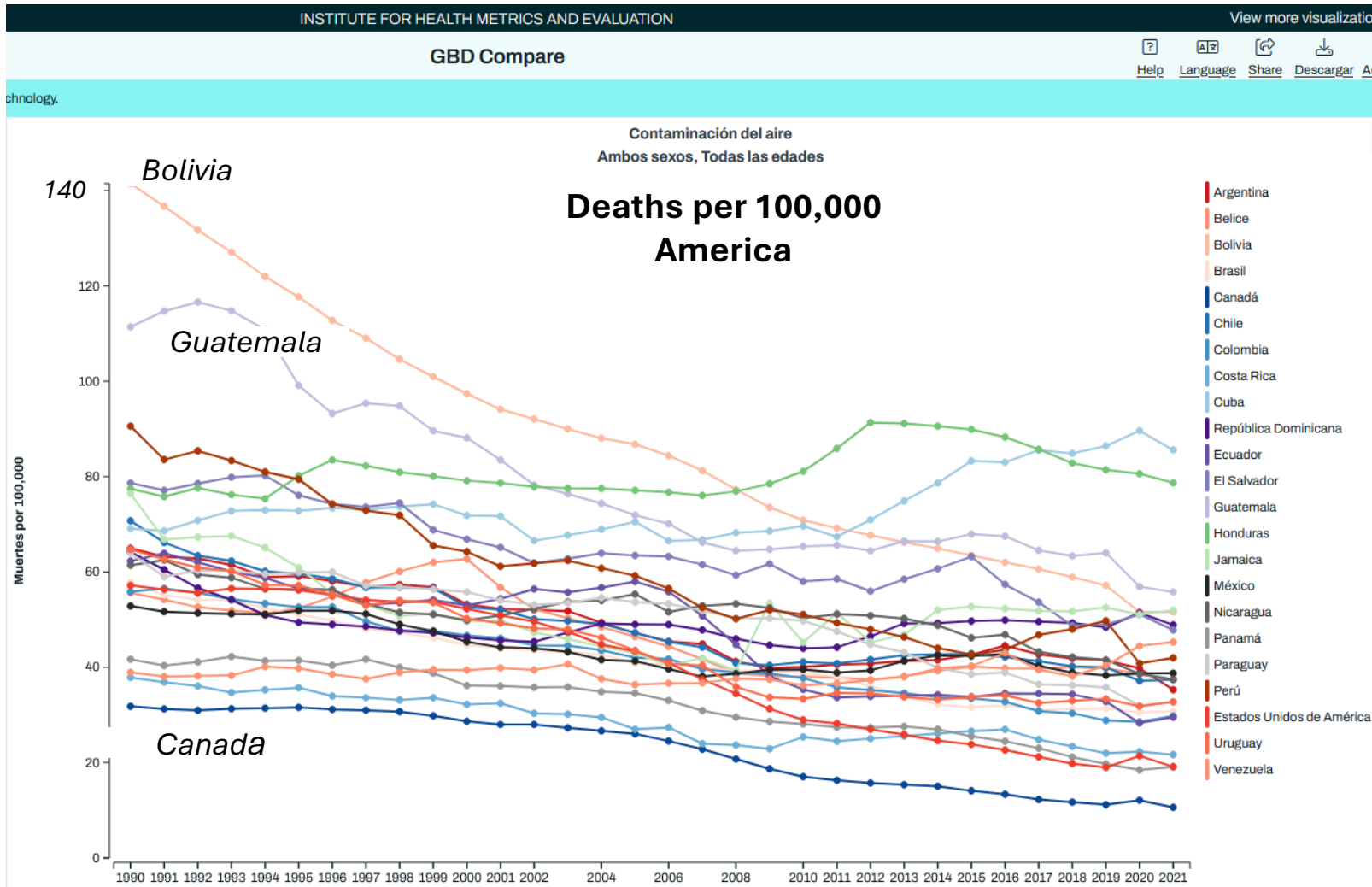
IHME: <https://www.healthdata.org/research-analysis/health-risks-issues/air-pollution>

Fuller R. et al, **Pollution and health: a progress update**. *Lancet Planet Health* 2022

Our World in Data: Share of deaths attributed to outdoor air pollution (2024).

Reduction in deaths rates from air pollution until 2021

Death rates
from air pollution overall have
dropped by 46%
from 1990 to 2021
(IHME, 2024)



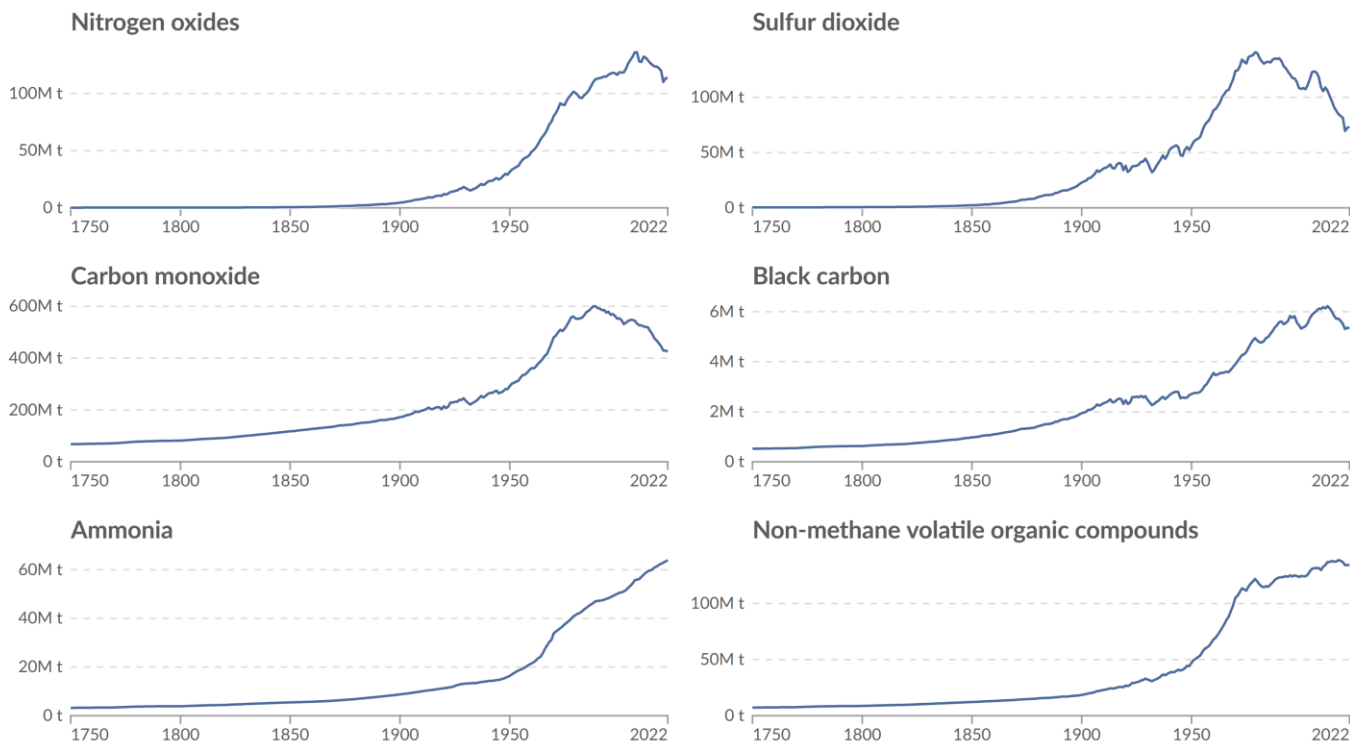
Source: IHME: Global Burden of Disease (GDB); <https://vizhub.healthdata.org/gbd-compare/>

Air pollutant emissions

Emissions of air pollutants, World, 1750 to 2022

Our World
in Data

Air pollutants are gases that can lead to negative impacts on human health and ecosystems. Most are produced from energy, industry, and agriculture.



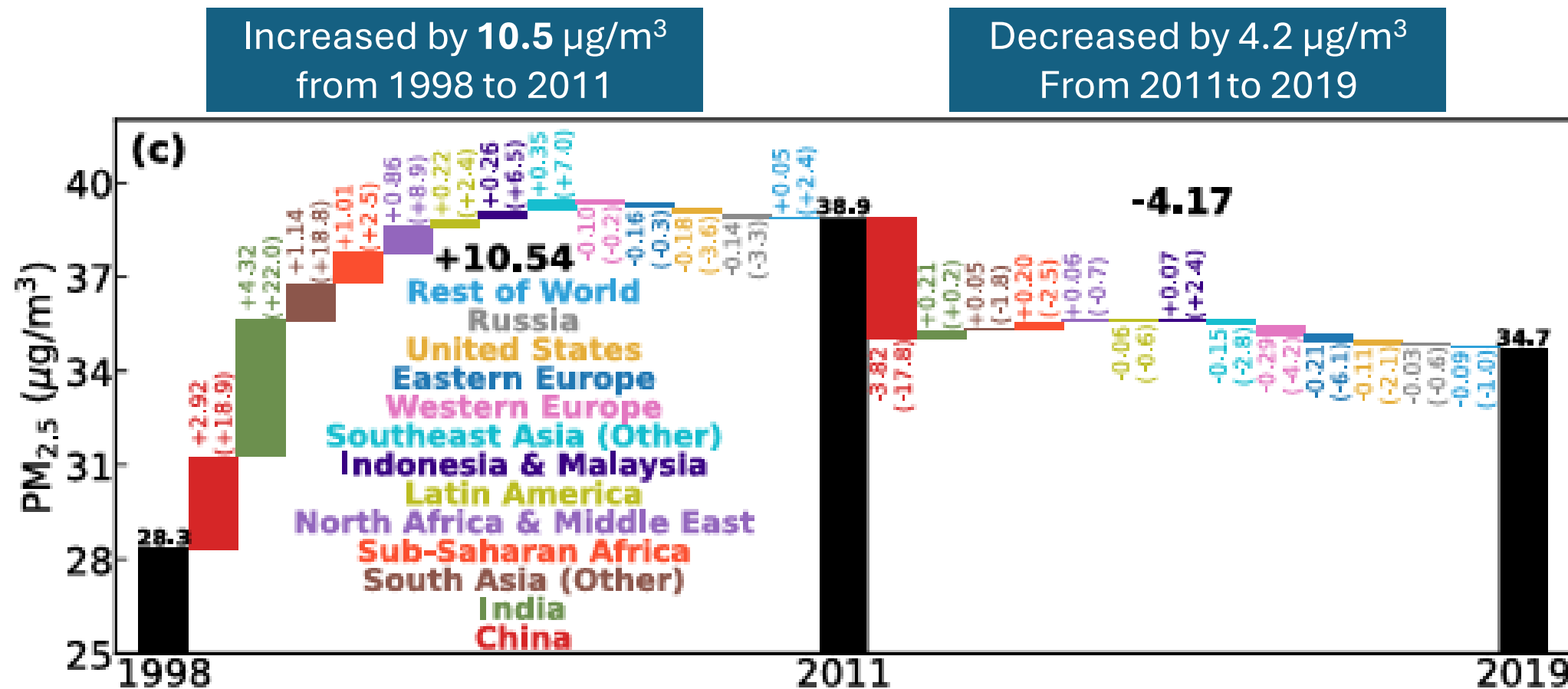
Data source: Hoesly et al. (2024) - Community Emissions Data System (CEDS)

OurWorldinData.org/air-pollution | CC BY

Air pollutant	Trends
NOx	↑2008; ↓until 2022 (comparable to 1990)
SO2	↑1979; ↓until 2022 (comparable to 1956)
CO	↑1988; ↓until 2022 (comparable to 1968)
BC	↑2012; ↓until 2022 (comparable to 2003)
NH3	↑ 2022
NMVOC	↑ 2022

Data source: Hoesly, R. et al: (2024). Community Emissions Data System (CEDS) / Release Emission Data (v_2024_07_08)
The Community Emissions Data System (CEDS) produces consistent estimates of global air emissions species (BC, CO, CO₂, NH₃, NMVOC, NO_x, OC, SO₂) over the industrial era (1750 - present) along with CH₄ and N₂O over recent decades.
Taken from <https://ourworldindata.org/grapher/so-emissions-by-world-region-in-million-tonnes>

Air pollutant emissions: PM_{2.5} by region



While PM_{2.5} exposures decreased marginally on a global scale between 2000 and 2019 (an average annual decline of -0.2 %), 65 % of cities experienced rising levels (Sicard et al., 2023).

Air pollutant emissions: PM_{2.5} and health

PM_{2.5} annual mean 7.4 -12.5 µg/m³

No threshold exists in the association between PM_{2.5} and adverse health.

Air quality standards may need to be reevaluated

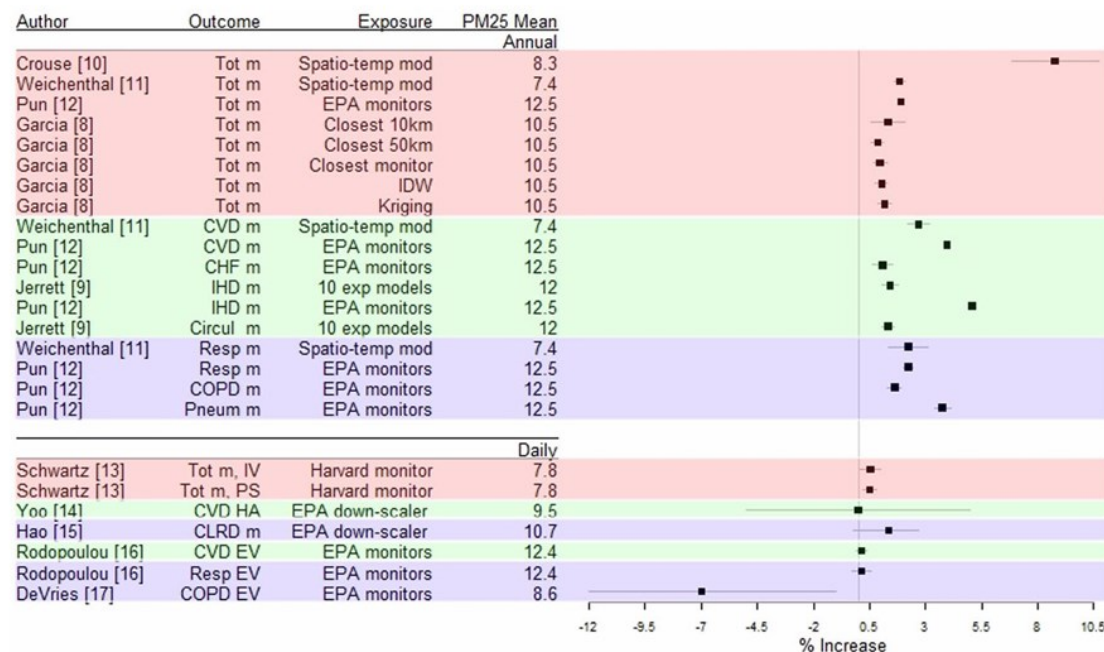
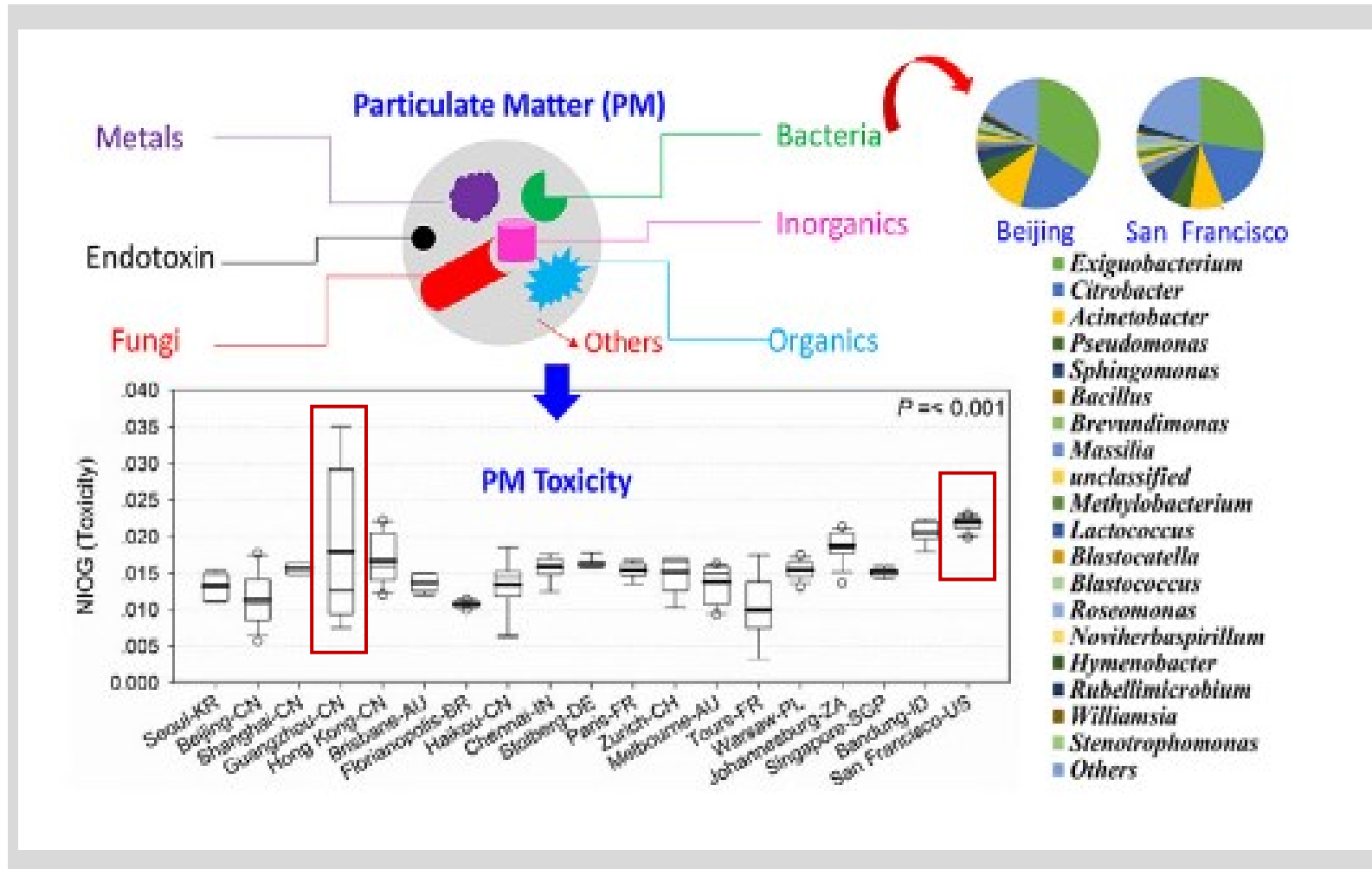


Fig. 1.

List of the studies conducted at low levels. The results are presented as percent increase in the outcome for 1 µg/m³ increase in PM_{2.5}

PM_{2.5} toxicity



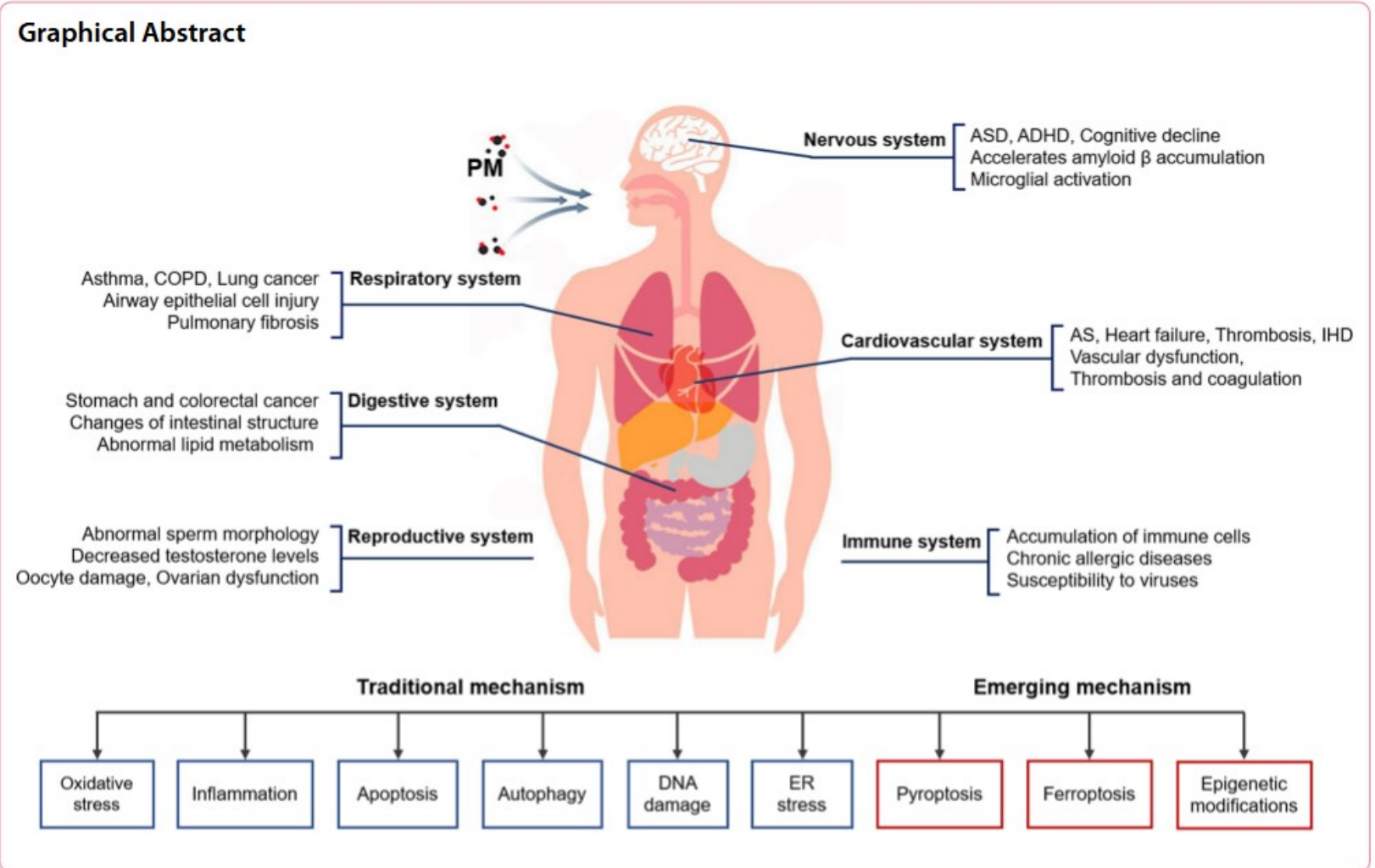
The **normalized index of oxidant generation (NIOG)**

PM samples in **San Francisco**
annual average **PM₁₀ = 16 µg/m³**

was found to be **twice**
that in **Beijing** (PM₁₀ = 135 µg/m³).

PM_{2.5} metabolic pathways

An update on adverse health effects from exposure to PM_{2.5} (Sangkham, et al, 2024).



Li, et al. 2022. A comprehensive understanding of ambient **particulate matter** and its components on the adverse health effects based from epidemiological and laboratory evidence. Particle and Fibre Toxicology

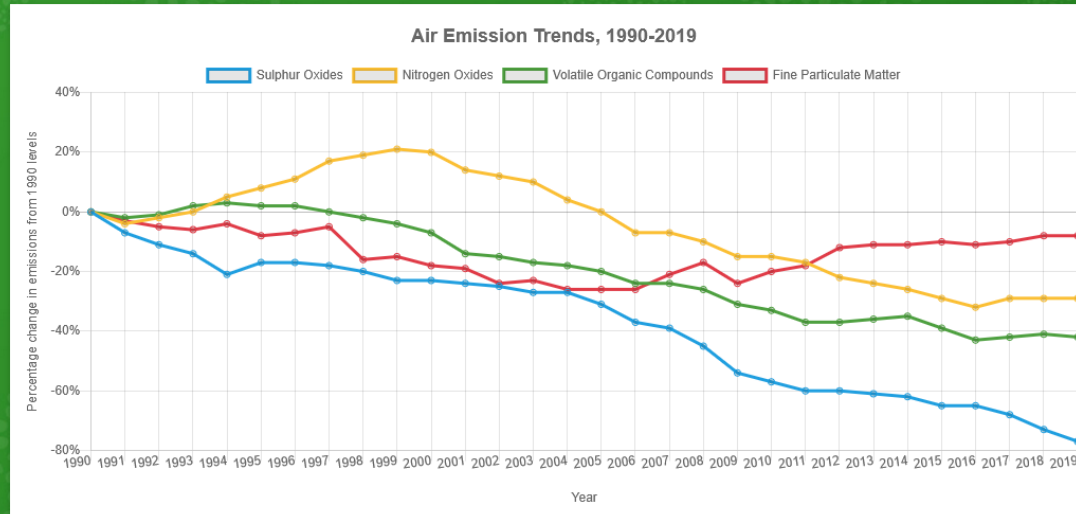
Other air pollutants

Canada-Wide Air Pollutant Emissions Trends Over Time

Overall, air pollutant emissions have decreased since 1990. Governments, businesses and individual Canadians have all contributed to these achievements. This chart shows the percentage change in emissions from 1990 levels of four key air pollutants.

Source: Environment and Climate Change Canada, 2021, Air Pollutant Emissions Indicators

[Download Data](#)



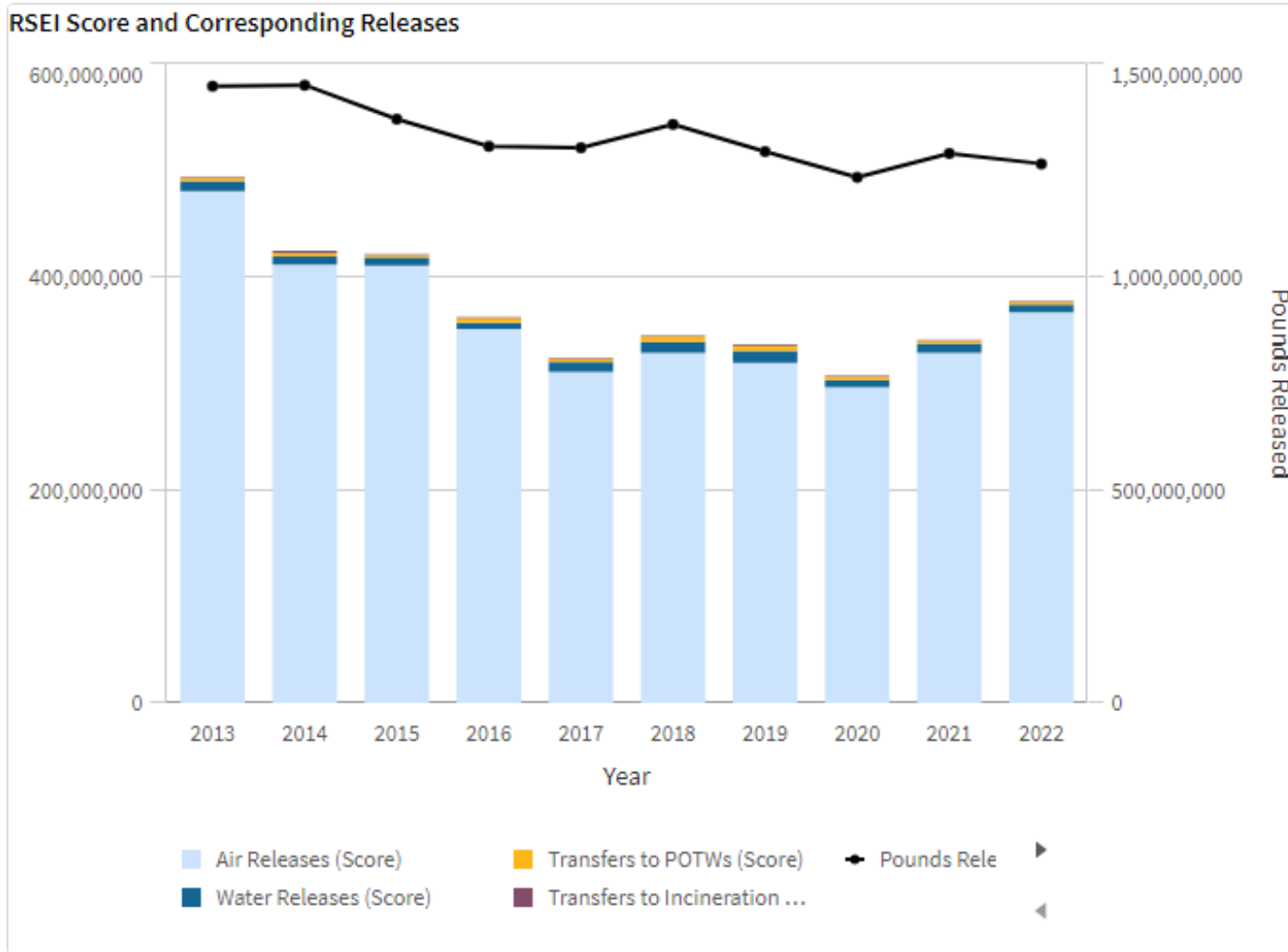
Between 2014 and 2023, pollutant releases to air decreased by **16%**.

Most of the pollutants that were released directly to the environment were released into the atmosphere. Air pollutant emissions totalled over 2.66 million tonnes and included **165 different substances**.

Canada's National Pollutant Release Inventory: 2023 data highlights

<https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/fact-sheet.html>

Other air pollutants



The silent threat of chemical pollution: (Fuller, et al. 2022)

- Global chemical manufacturing is **increasing at a rate** of about **3-5% per year** and is on track to double by 2030.
- Approximately 2/3 of current chemical production is in LMICs.
- A **small fraction of the many thousands of manufactured chemicals in commerce have been adequately tested for safety or toxicity**, and the disease burdens attributable to these chemicals cannot be quantified.

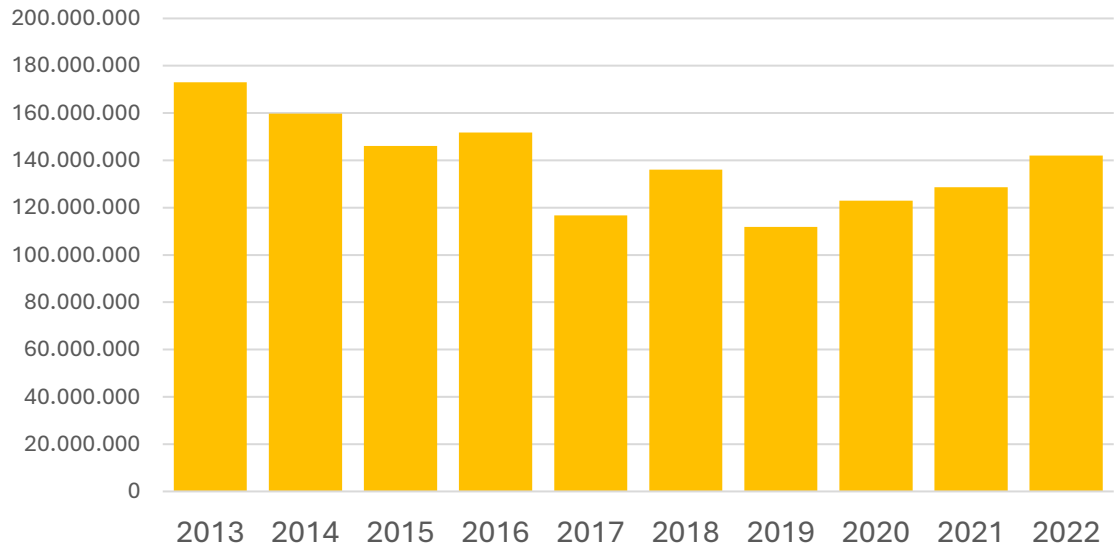
Risk Screening Environmental Indicators

<https://edap.epa.gov/public/extensions/EasyRSEI/EasyRSEI.html#>

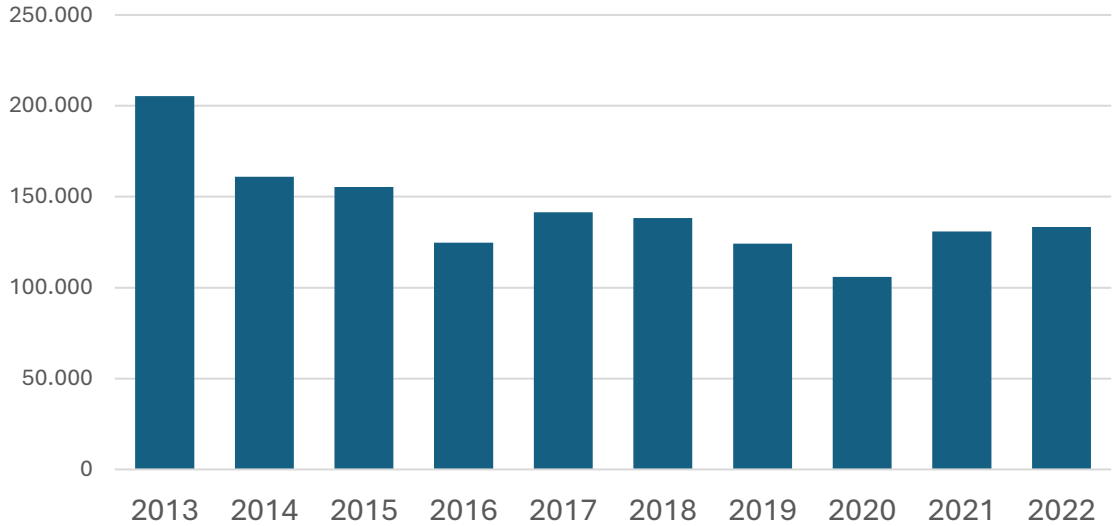


Trends of other pollutants

RSEI Score
325 chemicals



RSEI Modeled Pounds
(7440-47-3 Chromium)



Risk Screening Environmental Indicators:

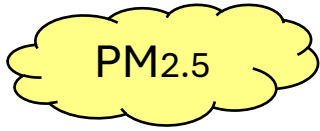
<https://edap.epa.gov/public/extensions/EasyRSEI/EasyRSEI.html#>



Air Pollution and Human Health & **Climate Change**



Emissions: Modifying PM2.5 trends



PM2.5

Health



Preterm birth (Picciotto S. et al: 2024)



Stress-disorders in children and adults (Rizzo, et al. 2025). Anxiety, depression, post-traumatic stress disorder.

Toxicity

Activation of cytochrome P450 genes, a family of enzymes involved in many biological and pathological processes, was more intense in WFS-PM compared to urban-PM (Nakayama LS, et al. 2011)

Public Health

Incorporating the WILDFIRES into epidemiological surveillance
Linking to ALERTS - Risk Assessment
Suggesting thresholds revision of air quality guidelines

Fuller R. et al, Pollution and health: a progress update. *Lancet Planet Health* 2022; 6: e535-47

Picciotto S, et al. Pregnancy exposure to PM2.5 from wildland fire smoke and preterm birth in California. *Environ Int.* 2024.

Nakayama LS, et al. Fine particulate matter from urban ambient and wildfire sources from California's San Joaquin Valley initiate differential inflammatory, oxidative stress, and xenobiotic responses in human bronchial epithelial cells. *Toxicology in Vitro.* 2011.

Rizzo LV, et al. Wildfire smoke and health impacts: a narrative review. *Jornal de Pediatria.* 2025

The contribution of wildfire to PM_{2.5} trends in the USA

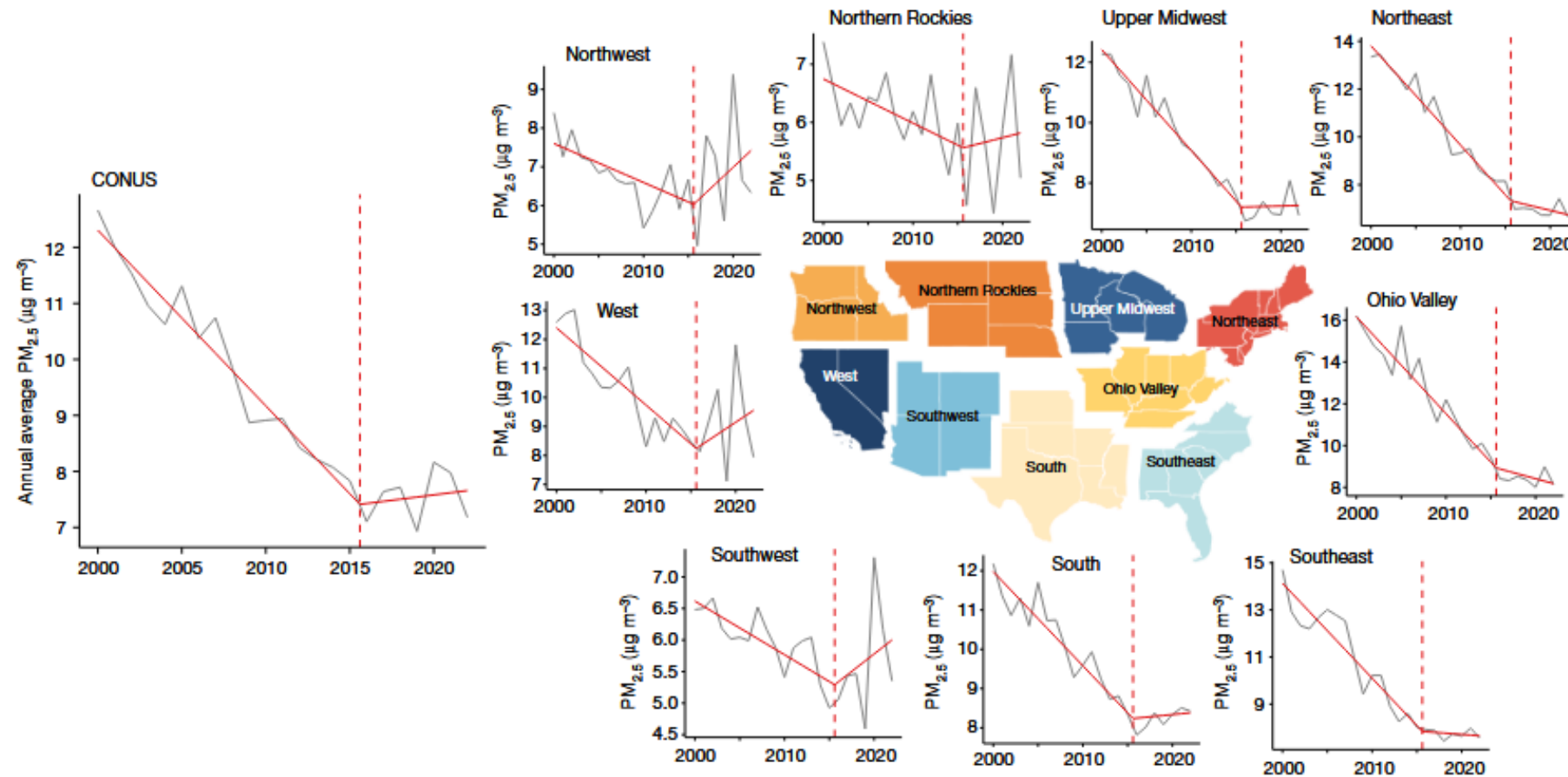
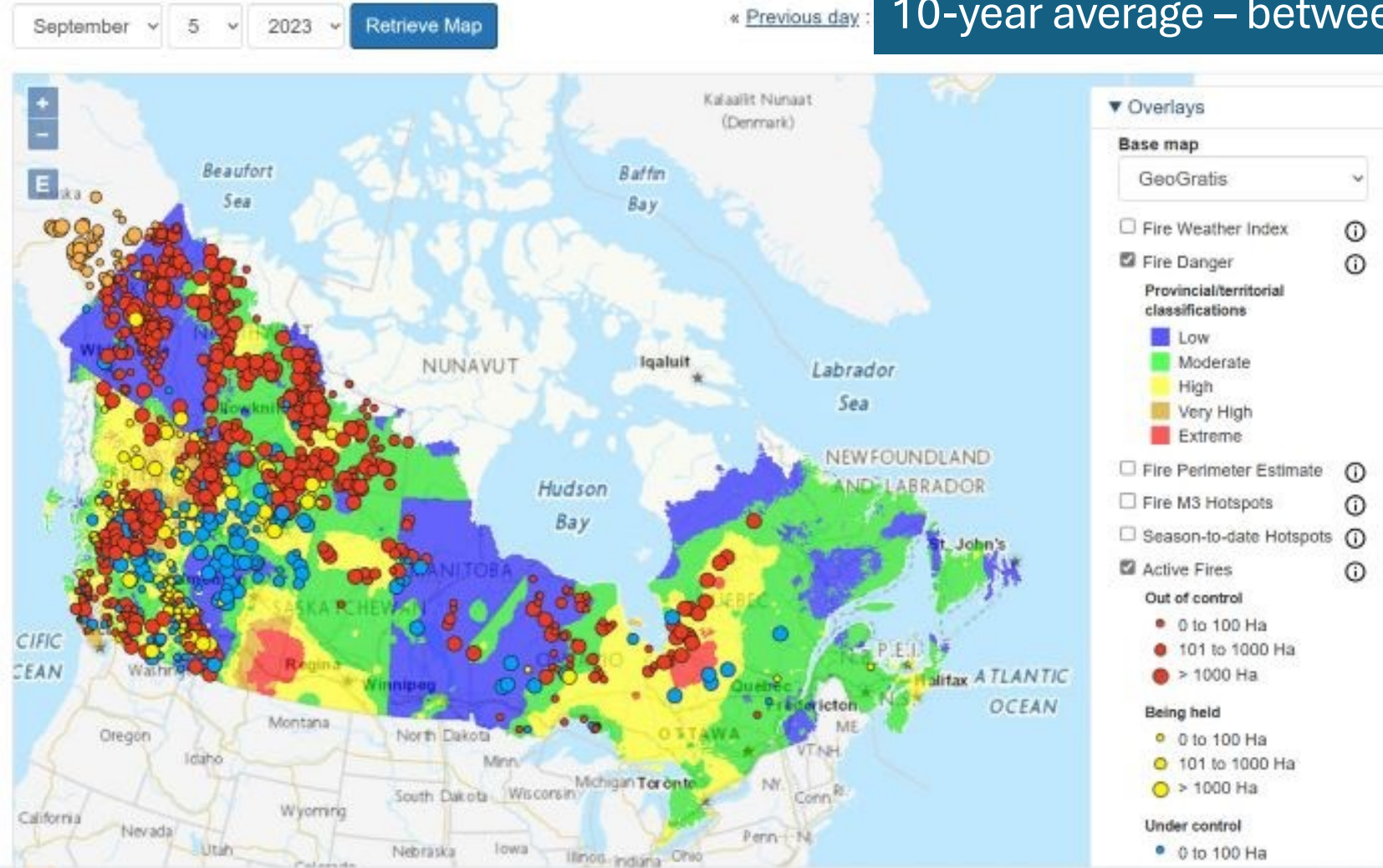


Fig. 1 | National and regional trends in ambient concentrations of PM_{2.5} show steady declines through 2016 and then stagnation or reversal. Grey lines in each subplot are annual average regional or CONUS concentrations of PM_{2.5} averaged over monitoring stations reporting consistently over the period in each US climate region^{32,33}. Regional and national averages are computed

from monitoring stations reporting over 50 days per year for at least 15 years to prevent station intermittency from influencing trends. Red lines are linear fits to each region's annual average time series, with separate slopes fits for before and after the series breakpoint, denoted as the red vertical dotted line.

Wildfires in Canada: 2023

The 2023 wildland fire season in Ontario (April – September) saw **741 fires** – 3 times more than the 10-year average – between April and October.



Active fires as of September 5, 2023

Source: Natural Resources of Canada. Canada's record-breaking wildfires in 2023: A fiery wake-up call. Online resource: <https://natural-resources.canada.ca/stories/simply-science/canada-s-record-breaking-wildfires-2023-fiery-wake-call> (April 5, 2025).

Wildfires in Canada: 2023

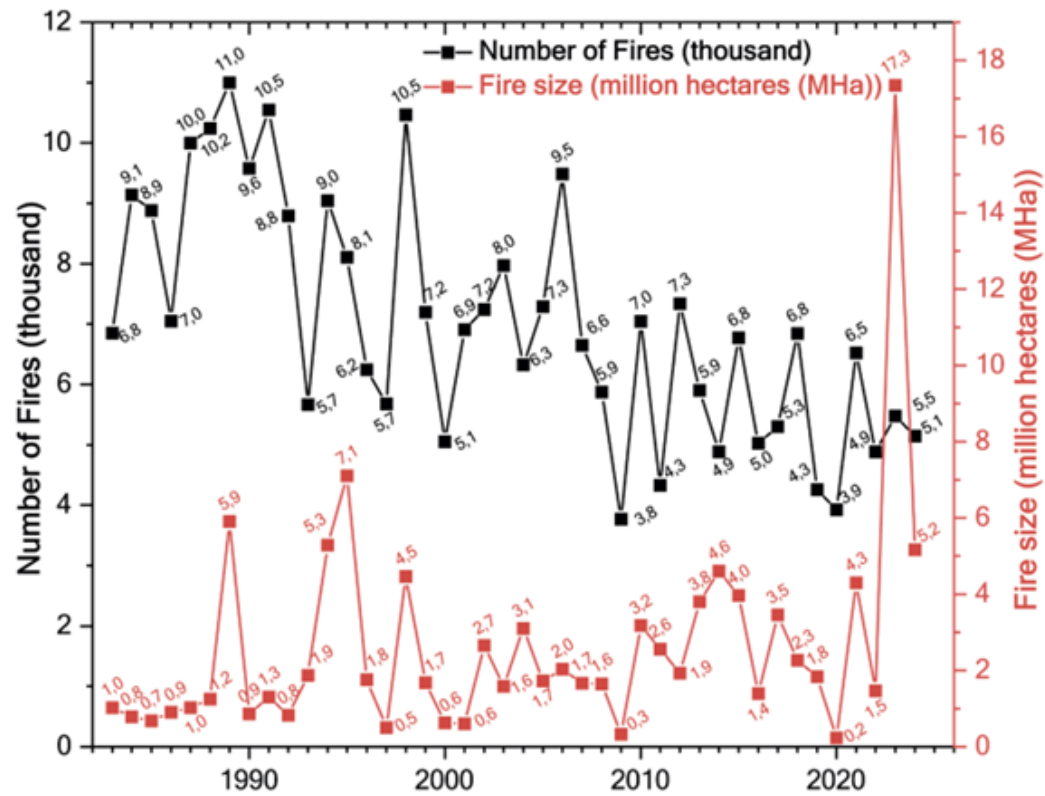
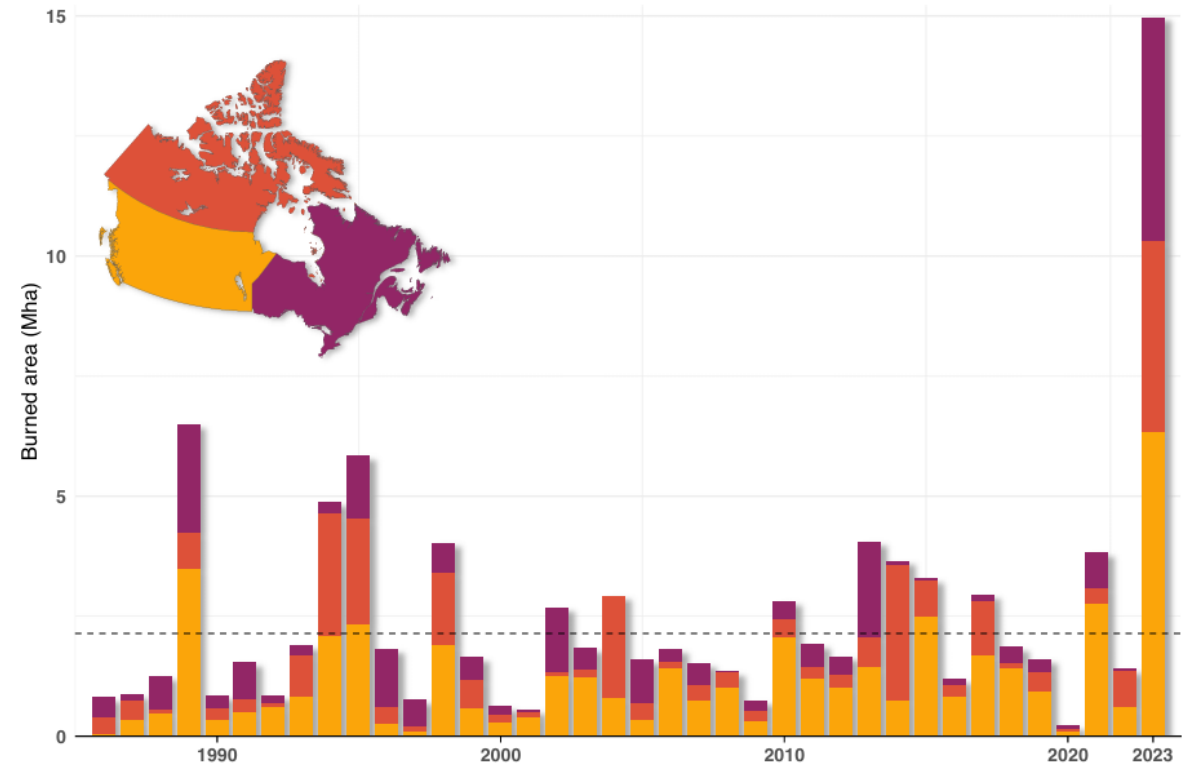


Fig. 1. Number of wildfires and burned areas in Canada from 1983 to 2024.

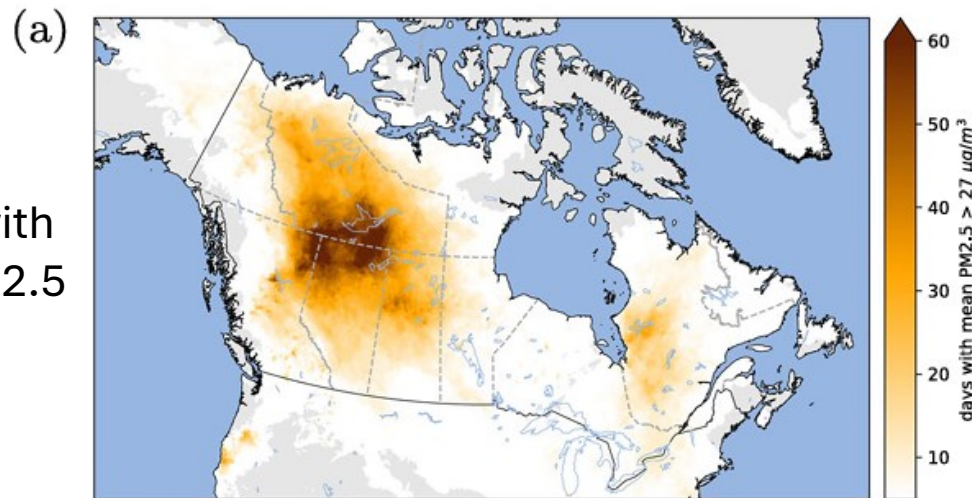


Jain, et al. 2024. *Drivers and impacts of the record-breaking 2023 wildfire season in Canada.*

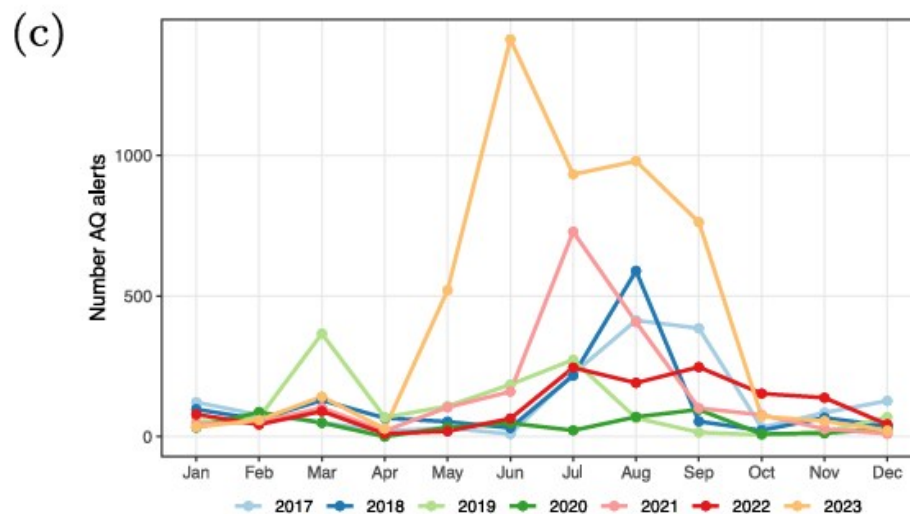
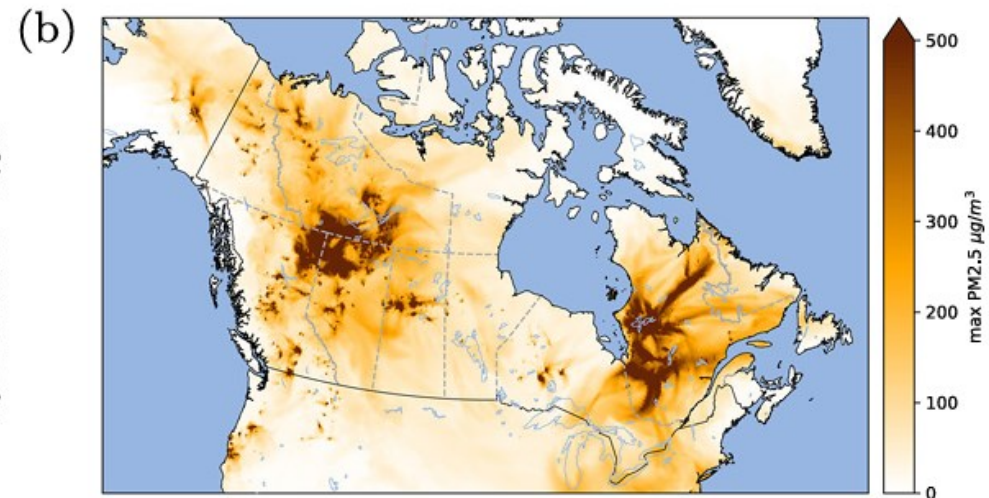
Filonchik, et al. 2025. *Estimating air pollutant emissions from the 2024 wildfires in Canada and the impact on air quality.*

Wildfires in Canada: 2023

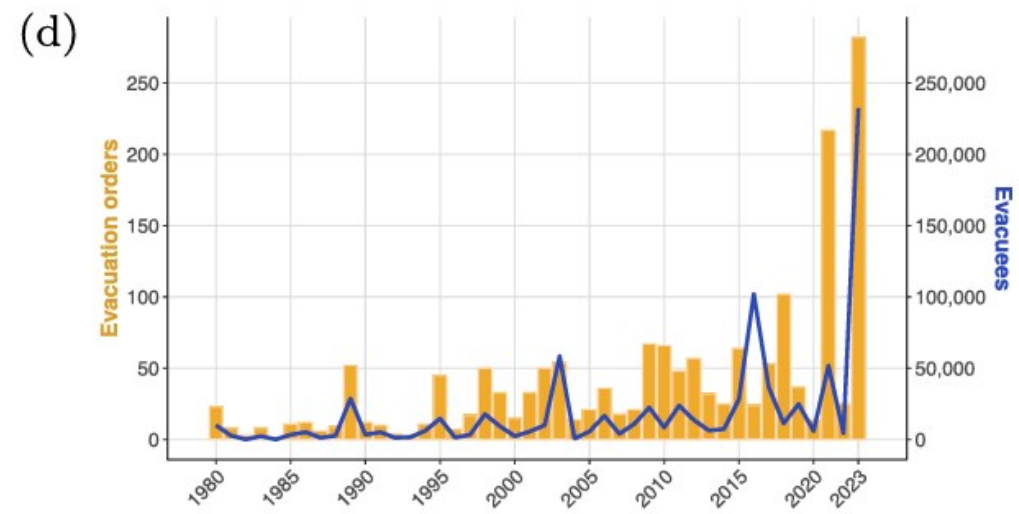
The number of days in 2023 with daily mean PM2.5 > 27 $\mu\text{g}/\text{m}^3$



Maximum daily value of PM2.5 in 2023



Number of air quality bulletins each month issued by Environment and Climate Change Canada between 2017 and 2023



Number of annual evacuation orders and evacuees from 1980–2023



Wildfires in Canada: 2023

Impact of the 2023 wildfire smoke episodes in Ontario, Canada, on asthma and other health outcomes: an interrupted time-series analysis

Hong Chen et al.: **CMAJ 2025 May 5;197**

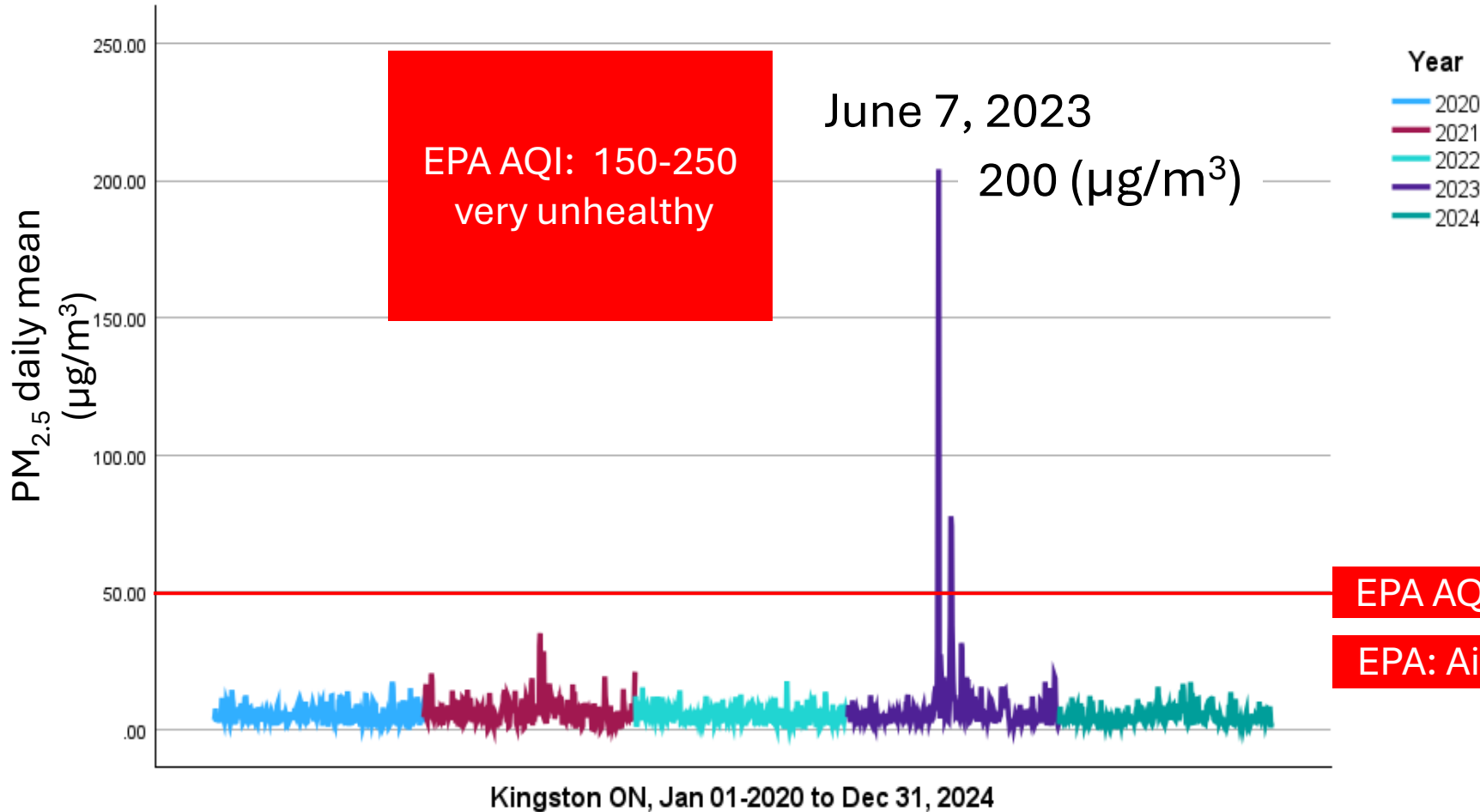
Daily asthma-related visits increased substantially across Ontario, peaking at a 23.6% increase (95% CI 13.2%–34.9%) at a 1-day lag and lasting up to a lag of 5 days after the start of the smoke episode

Asthma-Associated Emergency Department Visits During the Canadian Wildfire Smoke Episodes – United States, April– August 2023

McArdle CE, et al. *MMWR Morb Mortal Wkly Rep.* **2023**

That same wildfire smoke also impacted large parts of the United States, contributing to a 17% increase in asthma-related ED visits during the 19 days with wildfire smoke exposure

Wildfires: PM_{2.5} in Kingston, Ontario



'A wake up call': ER visits for asthma spiked during destructive wildfire season

By Owen Guo

Published: May 05, 2025 at 8:14AM EDT



Smoke from wildfires burning across both Ontario and Quebec blanket the skyline in Kingston, Ont., Tuesday, June 6, 2023. THE CANADIAN PRESS/Lars Hagberg

EPA AQI: > 55.5 unhealthy

EPA: Air Quality Standards < 35

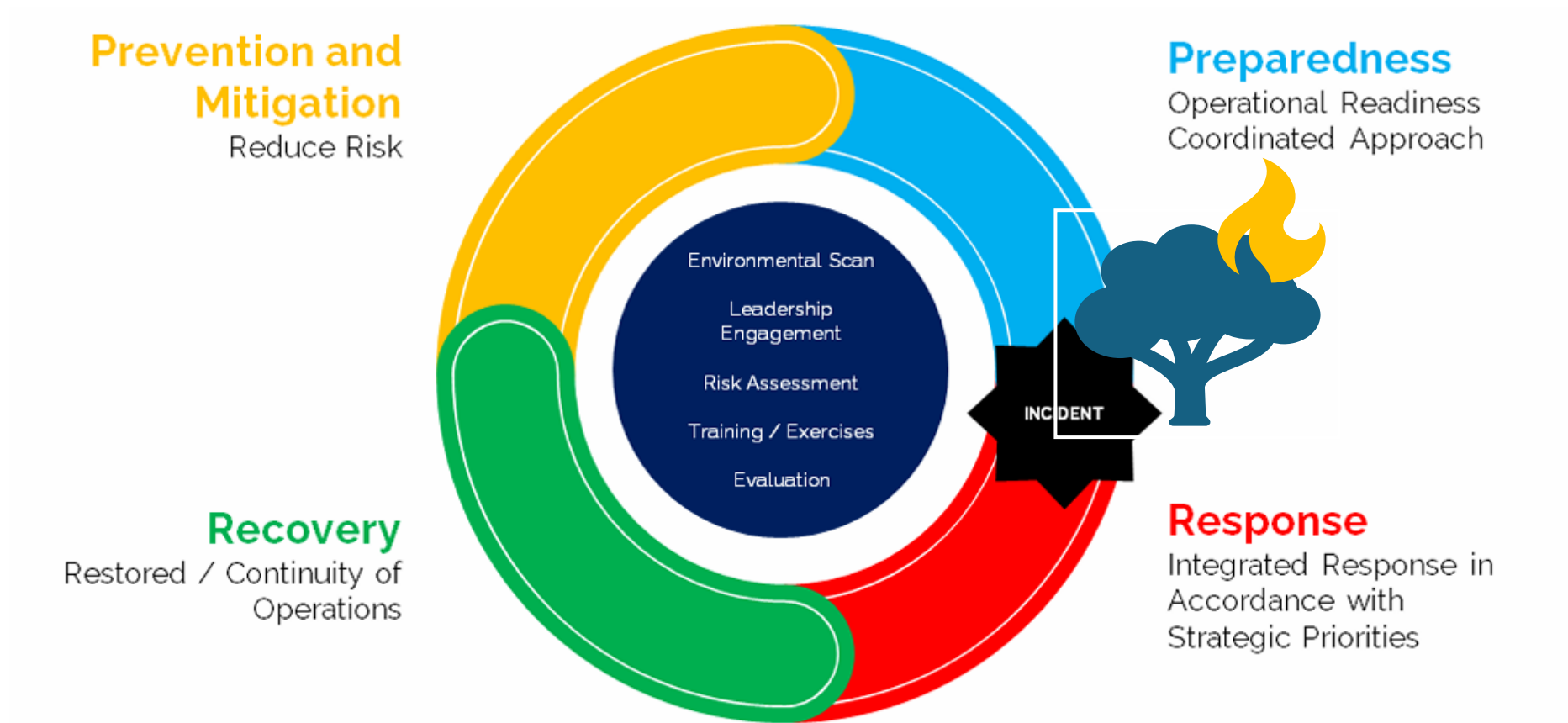
Beginning in 2024: Air quality Index of Canada: 1-hour trigger for PM_{2.5} of 60 Mg/m³ the AQI will be reported as 7 (high risk category).

***Wildfire Smoke and Air Quality Reference Document, 2024.
Ontario. Ministry of Health (05/2024)***

- *To support local boards of health response to wildfire smoke or poor air quality events impacting health and wellbeing of Ontarians*
- *It is not part of Ontario Public Health Standards, Protocols, or Guidelines – nor is it legally binding*
- *It is intended to support local boards of health and local partners their air quality health response planning*

Response from Authorities in Ontario

Fig. 1 - Emergency Management Cycle



Epidemiological Surveillance: Syndromic surveillance

Knowledge Management

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Projects ▾

Contact

[Home](#) > Acute care enhanced surveillance



ACES: Acute Care Enhanced Surveillance



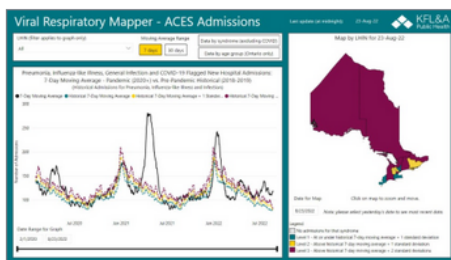
Real-time
epidemiological
surveillance

Records from over
95% of Ontario's
acute care hospitals

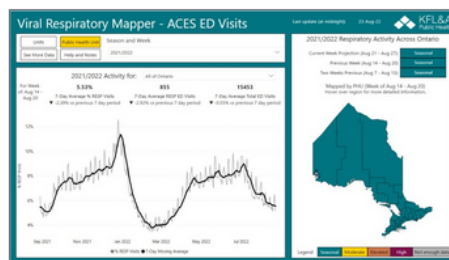
Real-time situational
awareness for
disease outbreak and
other potential health
risks

Acute Care Enhanced Surveillance (ACES) provides real-time epidemiological surveillance for Ontario. ACES monitors triage (emergency department visits) and inpatient (admissions to hospital) records from over 95% of Ontario's acute care hospitals. Records are monitored as the patients are being treated, giving real-time situational awareness for disease outbreak and other potential health risks. Hospital visits are monitored with a sliding scale of specificity, from a province-wide assessment to our smallest level of geography, the FSA (forward sortation area, the first three characters of Canadian postal codes). ACES has built-in temporal and spatial capabilities to enable public health to be better informed on the health of the community to improve public health protection and prevention initiatives.

View ACES Information Products:



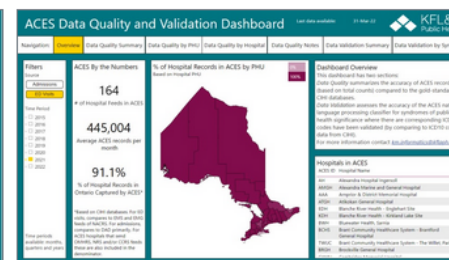
Viral Respiratory Mapper - ACES
Admissions



Viral Respiratory Mapper - ACES ED Visits



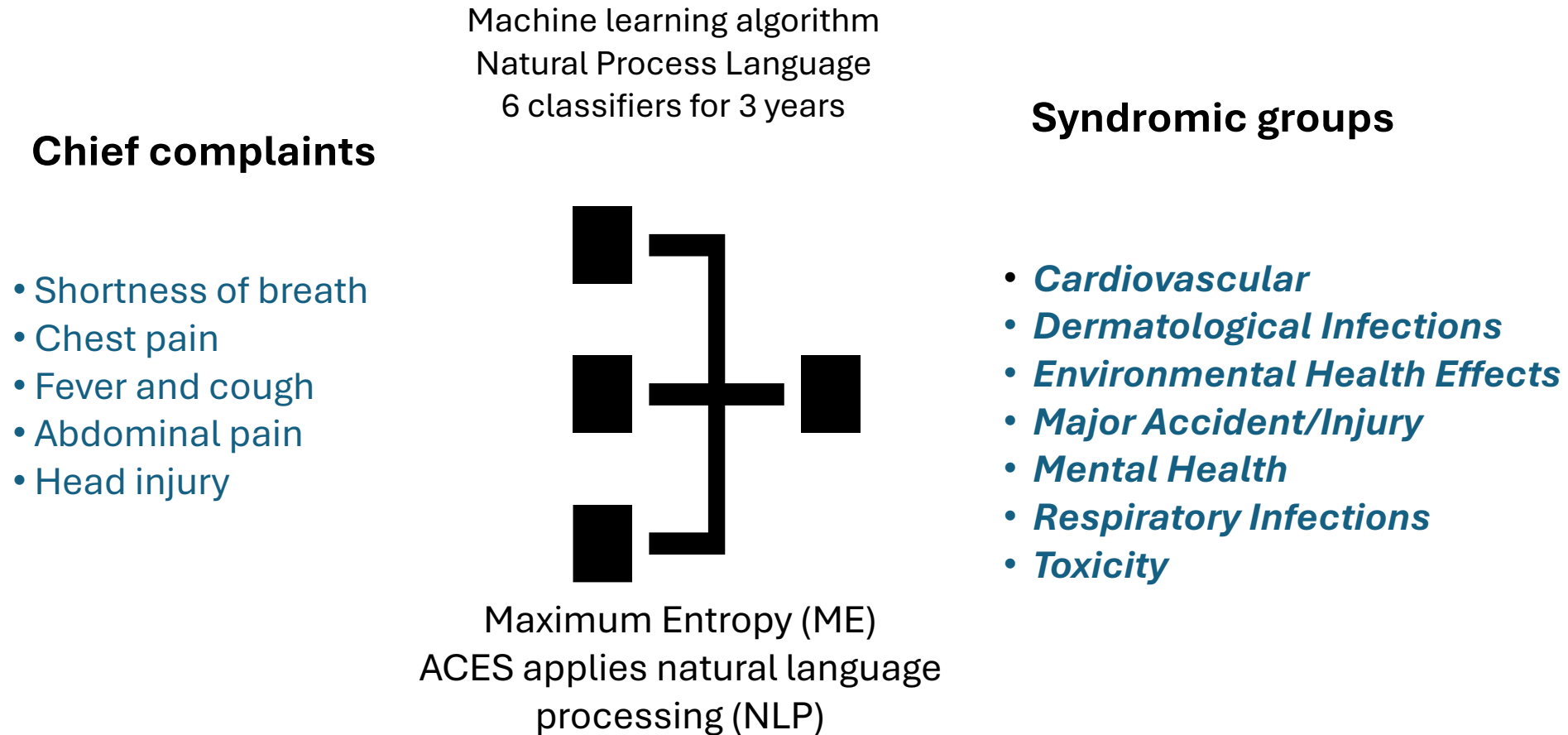
ACES ED Volume Monitor



ACES Data Quality and Validation
Dashboard

Web page: <https://www.kflaphi.ca/acute-care-enhanced-surveillance/>

Acute Care Enhanced System



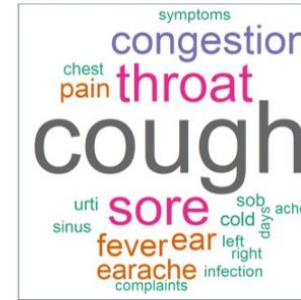
ACES

Table 4. Syndromes Included in Current Buckets

Bucket	Syndromes Included
All	All syndromes
Cardiovascular	CAD (coronary artery disease, chest pain) CHF (congestive heart failure) CV (cardiovascular (excludes MI and strokes; includes peripheral vascular disease)
Dermatological Infections	CELL (cellulitis, non-wound infection, non-abscess) DERM (rash, undifferentiated, lesion, wart) NEC (necrotizing fasciitis, severe cellulitis, gangrene)
Environmental Health Effects	AST (asthma, wheeze, difficulty breathing, SOB) COPD (chronic obstructive pulmonary disease) DEHY (dehydration) ENVIRO (heat stroke, heat syncope, heat exhaustion, cold-frost bite, hypothermia) SI (smoke inhalation, chemical, gases)
Health System CQI	CDIFF (c difficile) PO (post op infection or complication)
Major Accident or Injury	ORTHF (fracture, non-hip) ORTHH (fracture of the femur or hip) TRMVC (trauma from a MVC/ATV) TRO (trauma from another means, fall etc.) TRW (gunshot or stab, violence, assault)
Mental Health	MH (mental health) MHS (suicidal ideation, attempt or overdose) SOC (social admission)
Respiratory Infections	BRONCH (bronchiolitis, RSV) CROUP (croup-PIV) ILI (fever, myalgia, undifferentiated flu) PN (pneumonia) RESP (respiratory infection non-croup, non-bronchiolitis)
Toxicity	EOH (alcohol and complications-intoxication, addiction, withdrawal or end organ damage) OPI (opioid intoxication, addiction overdose, withdrawal) TOX (toxicology-not alcohol or opioids, withdrawal, substance abuse, chemical exposure)

Source: KM 2020

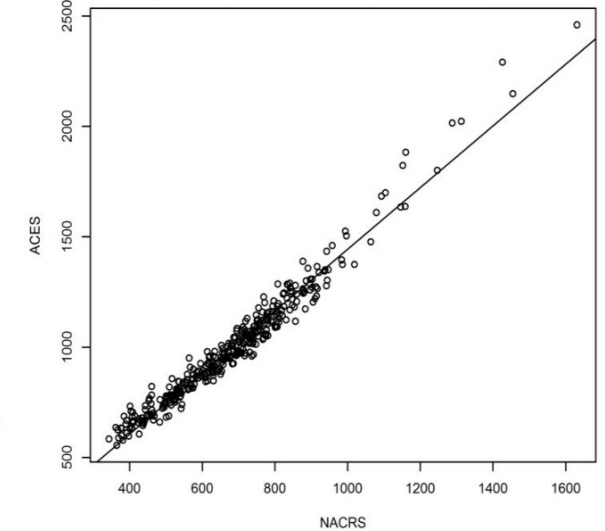
Figure 1. Word cloud for RESP



Source: Syndrome Validation Report, KM 2018

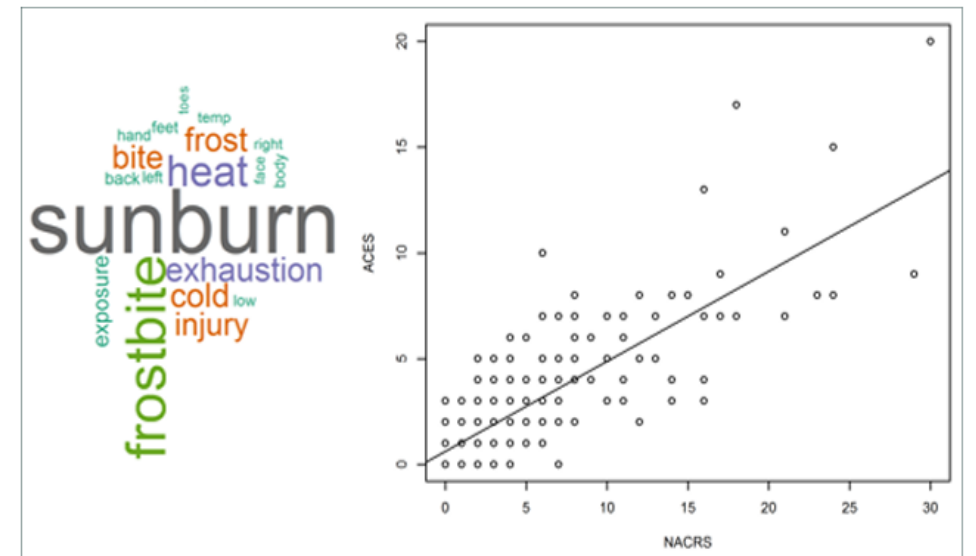
Asthma
Heat stroke
Smoke inhalation, chemical gases

Figure 2. RESP, r=0.98 (2017 Daily Counts).



Source: Syndrome Validation Report, KM 2018

Figure 4. ENVIRO, r=0.81 (2017 Daily Counts).



Source: Syndrome Validation Report, KM 2018

Mental Health

ACES : Risk assessment



ACES ALERTS: RISK ASSESSMENT

Alert and Document Actions Based on Risk Assessment



RISK ASSESSMENT CHECKLIST		SCORE	TOTAL
SYNDROME	1. Is there appropriate classification of the syndrome?	Yes = 1 No = 0	
	2. Is it a syndrome of public health concern? <i>Note: take into consideration, for example, seasonality and event planning.</i>	Yes = 1 No = 0	
	3. Would it require urgent investigation or follow up by public health?	Yes = 2 No = 0	
	4. Does it inform situational awareness?	Yes = 1 No = 0	/5
EXCESS COUNTS	1. Check ACES normalized function of syndrome in question (% of total visits). Is the number of syndrome specific visits accounting for a disproportionate amount of total visits to a given geography?	Yes = 1 No = 0	
	2. Is the excess dispersed across entire public health unit geography (large geography) or confined to a smaller area? (e.g., CSD, event site)	Small geography = 2 Large geography = 1	
	3. Which alerts were set off?	SPC Extreme, CUSUM = 2 All others = 1	/5
SEVERITY	1. Review CTAS codes, age distribution, and admission to hospital pattern for syndrome. <i>NOTE: If CTAS codes equal 1 or 2 and admissions for similar symptoms are apparent and increasing = 1, otherwise = 0.</i>	CTAS 1, 2 = 1 CTAS ≠ 1,2 = 0	
	2. What is the timing in relation to an event (is there a risk or association)?	<24 hours post event = 2 24-48 hours post event = 1 48+ hours post event = 0	
	3. Is there potential for public concern?	Yes = 1 No = 0	
	4. Is there potential for media attention?	Yes = 1 No = 0	/5
GEOGRAPHY	Is there evidence of a point source?	Yes = 1 No = 0	
	Is there evidence of multiple geographic areas being affected?	Yes = 1 No = 0	
	Is there potential for water distribution system involvement? Is there potential for a vector borne or airborne disease?	Yes = 1 No = 0	
	Does it involve visitors (postal code assessment)?	Yes = 1 No = 0	/5



Search





Epidemiological surveillance of wildfire smoke related health outcomes in Kingston Ontario: an ongoing project



Interventions to address exposure and health outcomes linked with **air pollution and climate change** - an **interdisciplinary team approach**



Impact of Air Pollution on Respiratory and Mental Health in Children in Ontario in the Context of Climate Change



KFL&A
Public Health

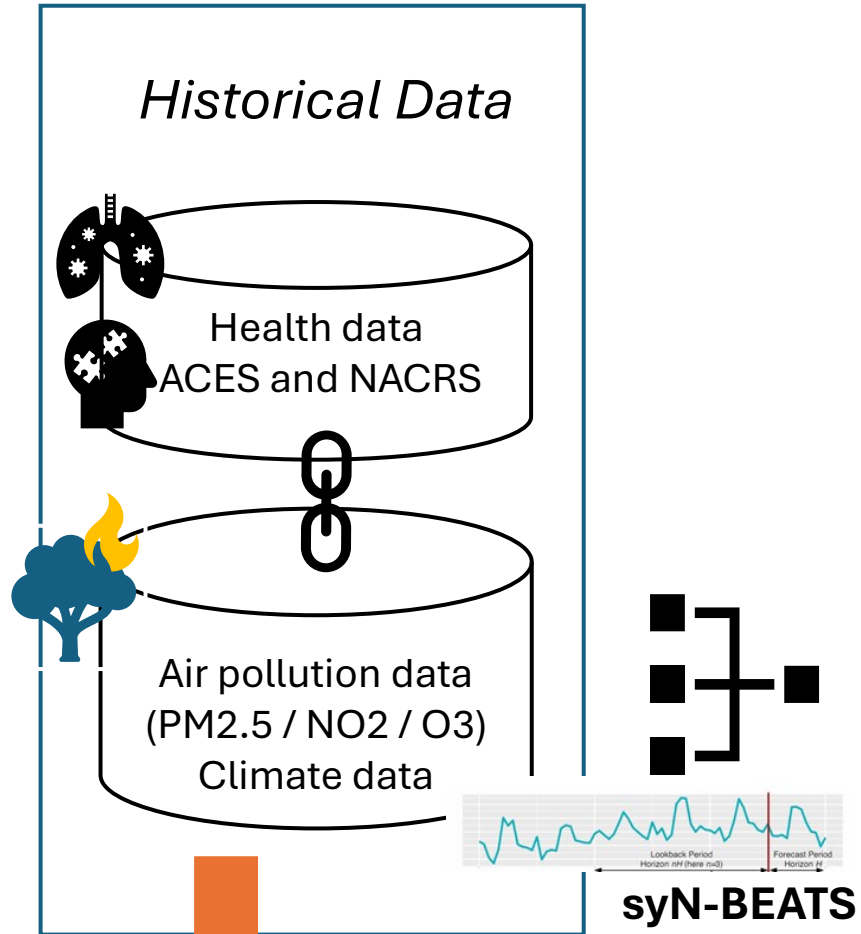
Public Health Agency
Kingston, Frontenac and Lennox &
Addington area in Ontario



Objectives:

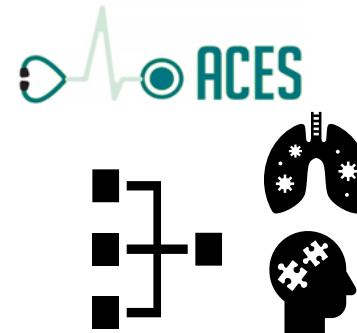
To evaluate: (1) the excess in ED visits during wildfire events, and (2) the association between forecasted air pollution levels and time series data on ED visits for children's respiratory and mental health outcomes in Ontario, distinguishing impacts observed during wildfire and non-wildfire events.

Epidemiological surveillance of wildfire smoke related health outcomes in Kingston Ontario: an ongoing project



Association with
confirmed cases

2025

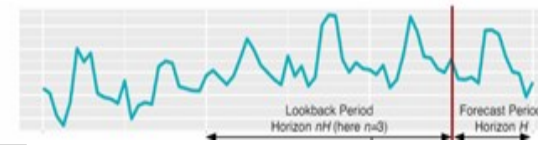
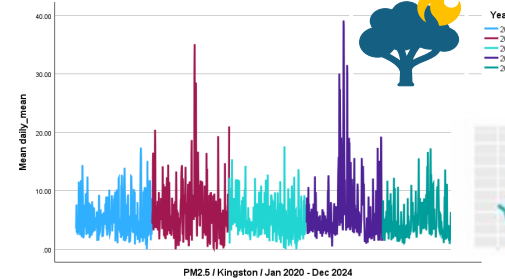


Syndromic



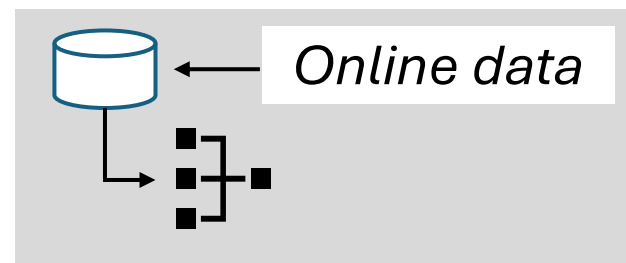
**KFL&A
Public Health**

Air quality forecast



ACES ALERTS: RISK ASSESSMENT
Alert and Document Actions Based on Risk Assessment

RISK ASSESSMENT CHECKLIST		SCORE	TOTAL
1. Is there appropriate classification of the population?	Yes = 5, No = 0		
2. Is there appropriate classification of the population?	Yes = 5, No = 0		
3. Does the population have a high level of vulnerability?	Yes = 5, No = 0		
4. Does the population have a high level of vulnerability?	Yes = 5, No = 0		
5. Check ACES (normalised) location of population (by total area). Is the number of population specifically at risk (e.g. elderly, pregnant women, etc.) high?	Yes = 5, No = 0		
6. Is the population at risk (e.g. elderly, pregnant women, etc.) high?	Yes = 5, No = 0		
7. Which alerts were set off?	Yes = 5, No = 0		
8. Monitor (100% coverage, age distribution, and education) to hospital patterns for symptoms, signs, or (100% coverage) or 2 subpopulations for similar symptoms are reported and increasing? (100% coverage)	Yes = 5, No = 0		
9. What is the timing in relation to an event (e.g. there is a risk or association)?	Yes = 5, No = 0		
10. Is there potential for public concern?	Yes = 5, No = 0		
11. Is there evidence of a public concern?	Yes = 5, No = 0		
12. Is there evidence of a public concern?	Yes = 5, No = 0		
13. Is there potential for public concern?	Yes = 5, No = 0		
14. Is there potential for public concern?	Yes = 5, No = 0		
15. Is there potential for public concern?	Yes = 5, No = 0		
16. Is there potential for public concern?	Yes = 5, No = 0		
17. Is there potential for public concern?	Yes = 5, No = 0		
18. Is there potential for public concern?	Yes = 5, No = 0		
19. Is there potential for public concern?	Yes = 5, No = 0		
20. Is there potential for public concern?	Yes = 5, No = 0		



Suggest air
quality
thresholds

Epidemiological surveillance of wildfire smoke related health outcomes in Kingston Ontario: an ongoing project

Berman J, et al. 2024. syN-BEATS for robust pollutant forecasting in data-limited context. Environ Monit Assess. 196(11):1002.

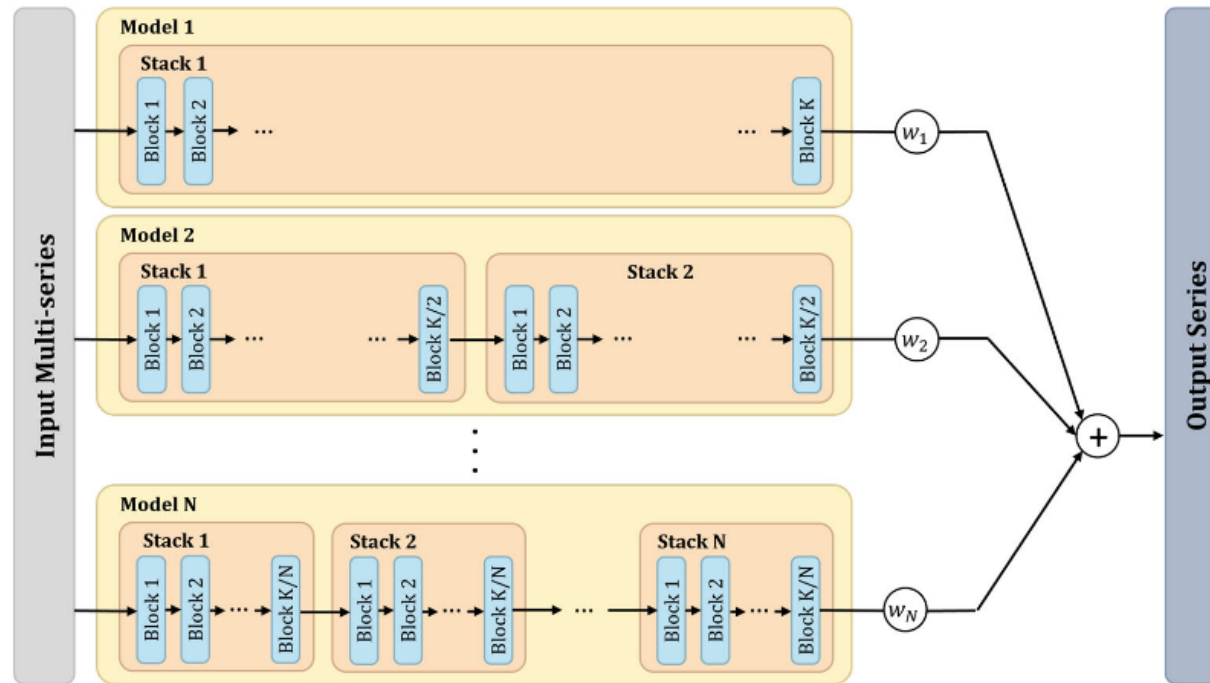
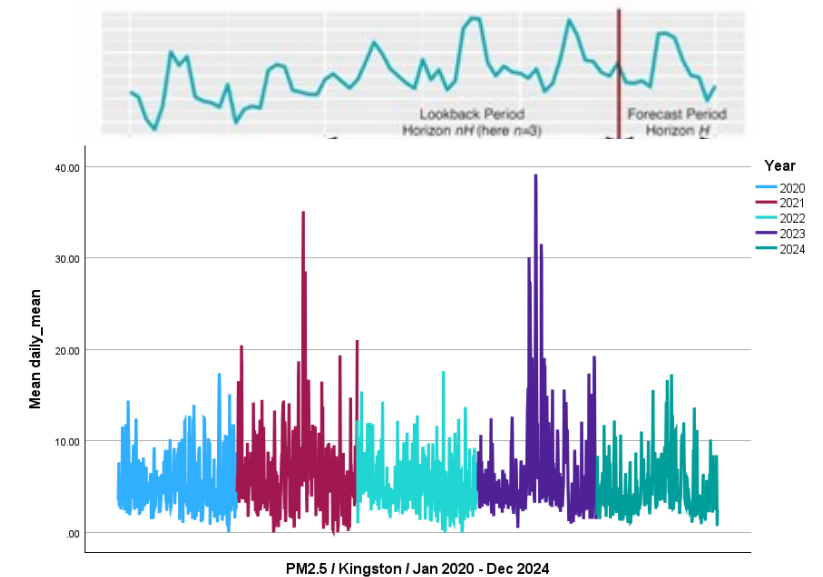
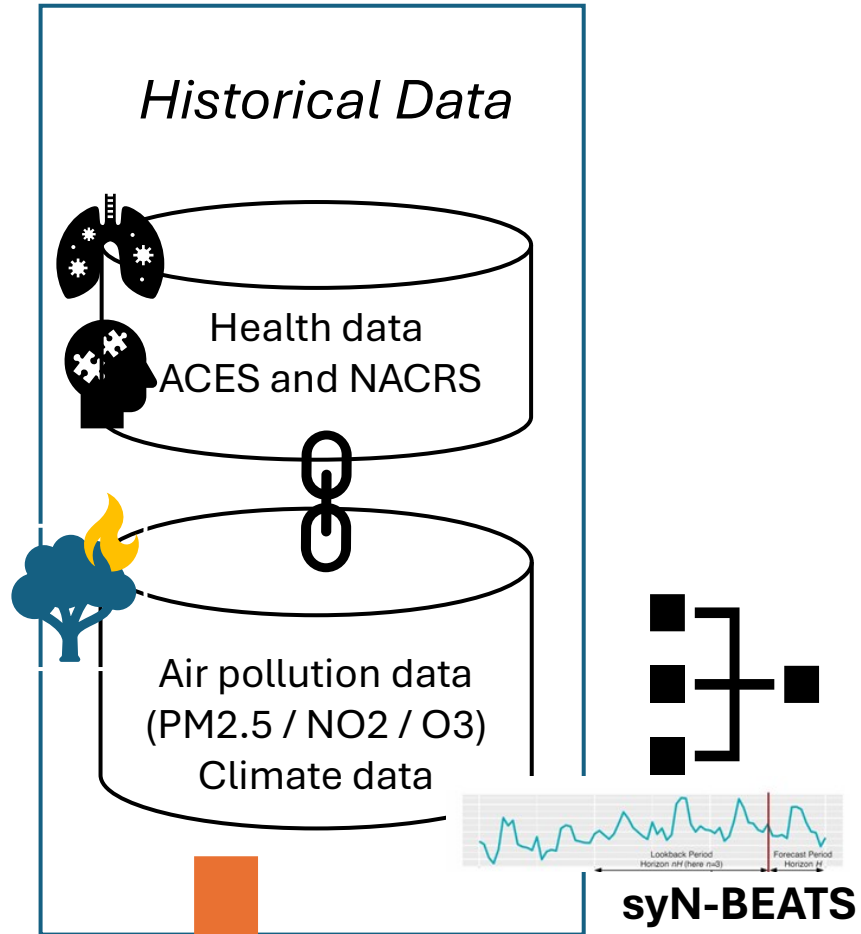


Fig. 2 Architecture of syN-BEATS: ensemble of N-BEATS models with varying configurations of blocks and stacks, keeping a consistent total block count across configurations. The fore-

cast of all configurations then linearly combined using a set of weights, either predefined or optimized

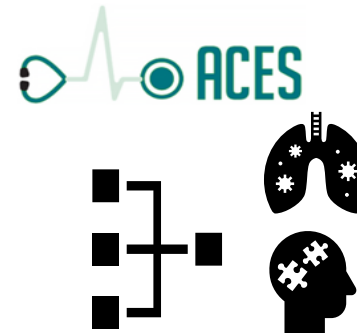


Epidemiological surveillance of wildfire smoke related health outcomes in Kingston Ontario: an ongoing project



Association with
confirmed cases

2025

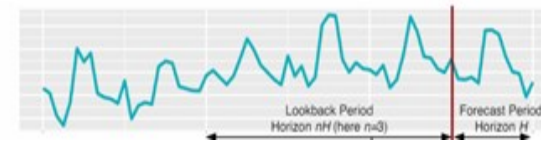
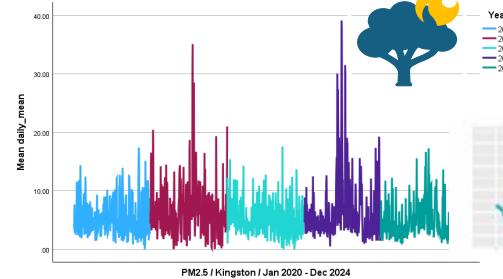


Syndromic



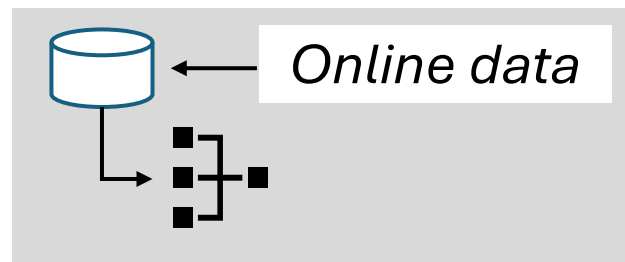
KFL&A
Public Health

Air quality forecast



ACES ALERTS: RISK ASSESSMENT
Alert and Document Actions Based on Risk Assessment

RISK ASSESSMENT CHECKLIST		SCORE	TOTAL
1. Is there appropriate classification of the population?	Yes = 1, No = 0		
	Is a representative of public health contact? Have data been reviewed, for example, intensity and most pressing?	Yes = 1, No = 0	
	Has the incident been investigated or followed up by public health?	Yes = 1, No = 0	
	Does it affect a vulnerable population?	Yes = 1, No = 0	25
2. Check ACES (normalised location of variables in question (10 of total score). Is the number of variables specifically identified for a risk assessment or a total score to a given geography?	Yes = 1, No = 0		
	Is the score reported across public health and geography (large geography) or confined to a smaller area (e.g., CSD, most sites)?	Yes = 1, No = 0	
	Which alerts were set off?	Yes = 1, No = 0	25
	Score: 100 points, age distribution, and distribution to hospital patterns for variables, history of (100) confirmed or 2 predictions for similar symptoms are reported and reviewed. 100 points = 100	Yes = 1, No = 0	
3. What is the link to a risk or association?	Yes = 1, No = 0		
	Is there evidence of a public concern?	Yes = 1, No = 0	
	Is there evidence of a public concern?	Yes = 1, No = 0	25
	Is there evidence of a public concern?	Yes = 1, No = 0	
4. Is there potential for media attention?	Yes = 1, No = 0		
	Is there potential for media attention?	Yes = 1, No = 0	
	Is there potential for media attention?	Yes = 1, No = 0	
	Is there potential for media attention?	Yes = 1, No = 0	25
5. Is there potential for a public concern?	Yes = 1, No = 0		
	Is there potential for a public concern?	Yes = 1, No = 0	
	Is there potential for a public concern?	Yes = 1, No = 0	
	Is there potential for a public concern?	Yes = 1, No = 0	25



Suggest air
quality
thresholds

CASAP – X

Gracias!!

Wildfires in Latin America

World Meteorological Organization. ***The State of the Climate in Latin America and the Caribbean 2024***. March 2025



Wildfires in the Amazon and Pantanal regions, central Chile, Mexico and Belize were fuelled by drought and extreme heatwaves, breaking records in many countries. In Chile, wildfires resulted in over 130 deaths, making these fires the country's worst disaster since the 2010 earthquake.

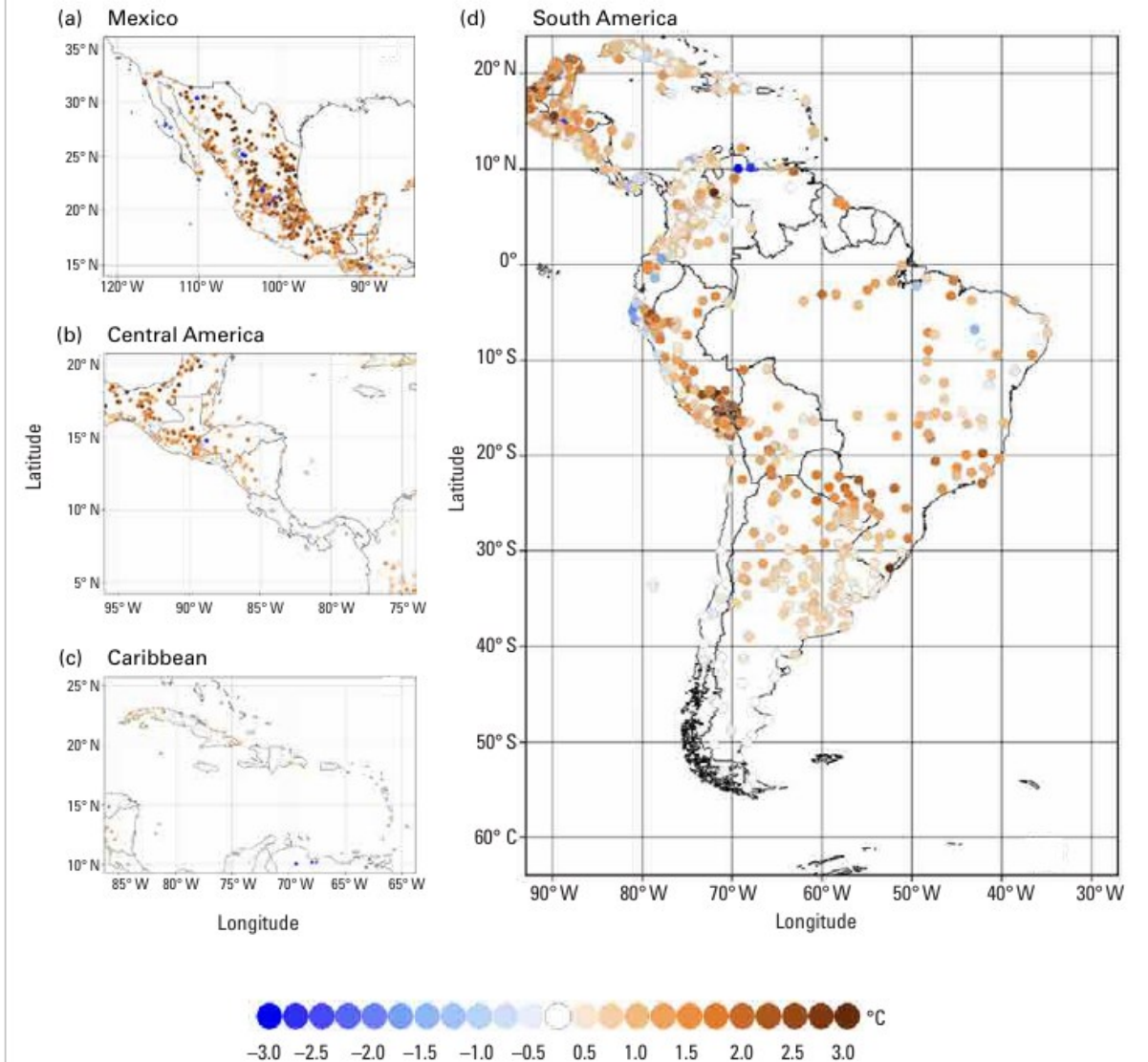


Figure 3. In situ mean air temperature (2 m) anomalies for 2024 (relative to 1991–2020) for (a) Mexico, (b) Central America, (c) the Caribbean and (d) South America, in °C. The colour scale is shown at the bottom of the figure.

Source: International Research Centre on El Niño (CIIFEN), from data from Latin American and Caribbean National Meteorological and Hydrological Services (NMHSs).