

# **Air Quality Update for the Cowichan Valley**

## **Cowichan Airshed Roundtable Meeting**

**June 28, 2022**

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**Environmental Protection Division**

# Air Zone Management

Management Level	O <sub>3</sub> (ppb)		PM <sub>2.5</sub> – Annual (µg/m <sup>3</sup> )		PM <sub>2.5</sub> - 24h (µg/m <sup>3</sup> )	
	2015	2020	2015	2020	2015	2020
<b>Red</b>	<b>Actions for Achieving Air Zone CAAQS</b>					
Threshold (CAAQS)	63	62	10	8.8	28	27
<b>Orange</b>	<b>Actions for Preventing CAAQS Exceedance</b>					
Threshold	56		6.4		19	
<b>Yellow</b>	<b>Actions for Preventing Air Quality Deterioration</b>					
Threshold	50		4		10	
<b>Green</b>	<b>Actions for Keeping Clean Areas Clean</b>					



## 2017-2019 PM<sub>2.5</sub> metrics and air zone management levels for the Georgia Strait Air Zone

Location	No. Valid Years	PM <sub>2.5</sub> 24-Hour Metric (98 <sup>th</sup> Percentile, µg/m <sup>3</sup> )		PM <sub>2.5</sub> Annual Metric (Annual Average, µg/m <sup>3</sup> )		Air Zone Management Level
		As Measured	TF/EE Adjustment	As Measured	TF/EE Adjustment	
Campbell River	3	20	18	7.2	7.0	Goal: Prevent CAAQS Exceedance
Colwood	2	28	18	7.1	6.2	
Courtenay	2	30	28	9.0	8.6	
Crofton	3	23	23	5.1	4.3	
Duncan	2	27	25	8.3	8.0	
Duncan-Deykin Ave.	3	27	20	8.0	7.2	
Langdale	3	35	16	7.3	6.3	
Nanaimo	3	22	13	5.1	4.3	
Port Alberni	3	28	27	9.7	9.3	
Powell River-James Thomson School	3	20	8	3.1	2.5	
Squamish	3	42	14	6.3	5.1	
Victoria	3	22	19	7.7	7.3	
Whistler	3	55	17	7.9	6.0	

# Provincial Air Quality Management

Contaminant	Avg. Period	BC AQO	2020 CAAQS
PM <sub>2.5</sub>	24 hours	25 µg/m <sup>3</sup>	27 µg/m <sup>3</sup>
	1 year	8 µg/m <sup>3</sup>	8.8 µg/m <sup>3</sup>
O <sub>3</sub>	1 hour	82 ppb	–
	8 hours	–	62 ppb
NO <sub>2</sub>	1 hour	100 ppb	60 ppb
	1 year	32 ppb	17 ppb
SO <sub>2</sub>	1 hour	–	70 ppb
	1 year	–	5 ppb

Contaminant	Avg. Period	BC PCO
TRS	1 hour	5 ppb
	24 hours	2 ppb

# Air Quality Monitoring in Cowichan Valley

- Main monitoring station in Duncan since July 2009
  - Moved in Jan 2018 from Cairnsmore to College Street
  - Continuous monitoring of:
    - Fine Particulate matter (PM<sub>2.5</sub>)
    - Ozone (O<sub>3</sub>)
    - Nitrogen Oxides (NO & NO<sub>2</sub>)
    - Meteorology
- } AQHI
- Other permittee sites for: PM<sub>2.5</sub>, SO<sub>2</sub> & TRS
  - Crofton Georgia Park Heights moved to Elementary School in 2019:  
Better representation with less elevation, re-evaluation after 3 yrs
  - PurpleAir network: grown to around 20 monitors

<https://www2.gov.bc.ca/gov/content/environment/air-land-water/air>

AQHI

PM<sub>2.5</sub>

PM<sub>2.5</sub>(24hr)

PM<sub>10</sub>

PM<sub>10</sub>(24hr)

O<sub>3</sub>

O<sub>3</sub>(8hr)

NO<sub>2</sub>

SO<sub>2</sub>

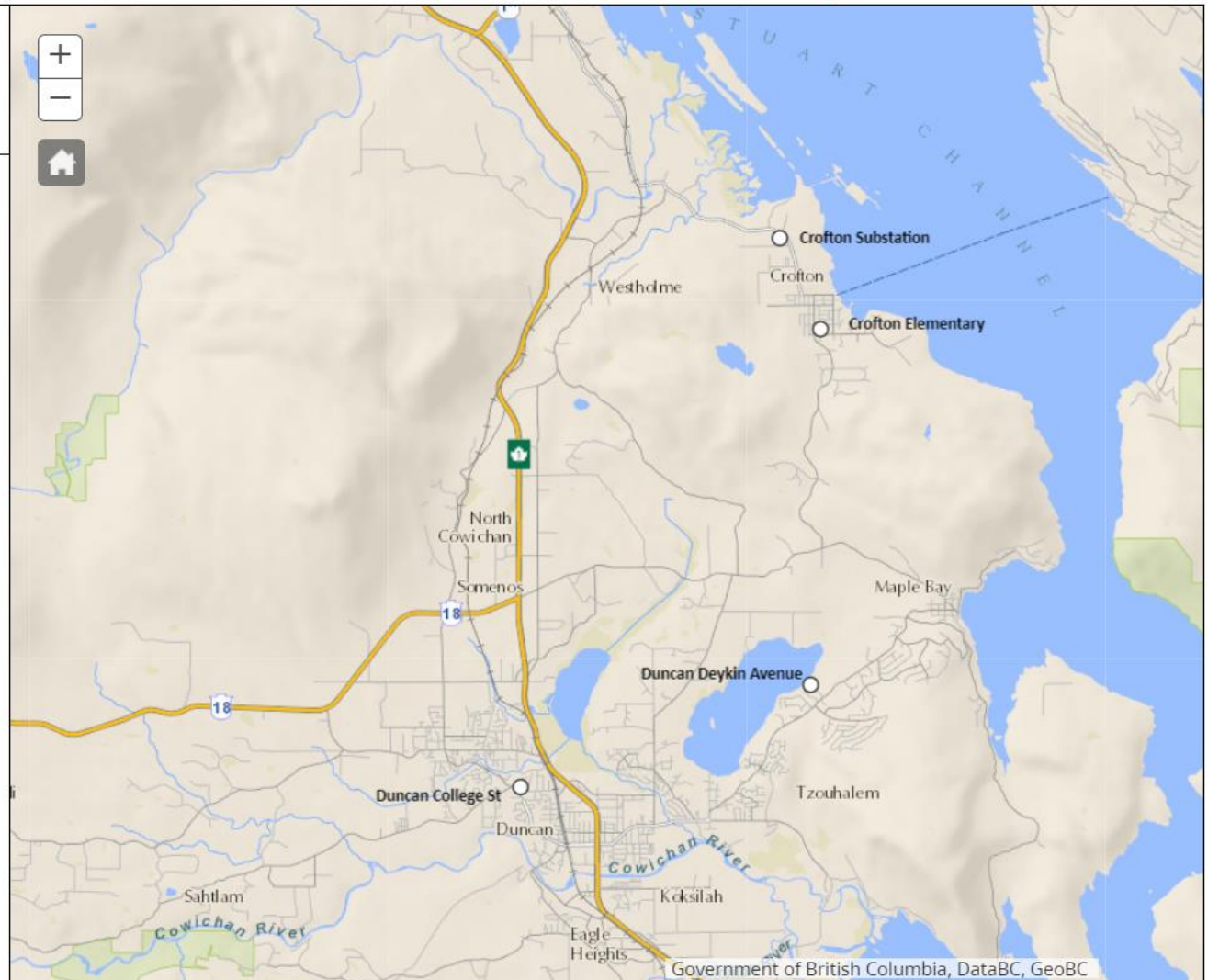
TRS

All Station Data

Select a station on the map



# Provincial Air Quality Network

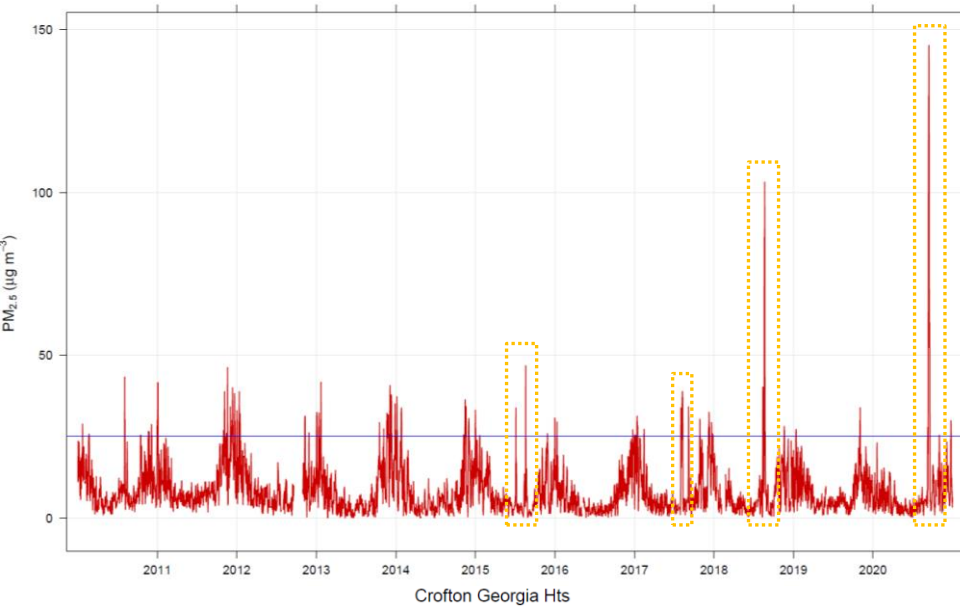




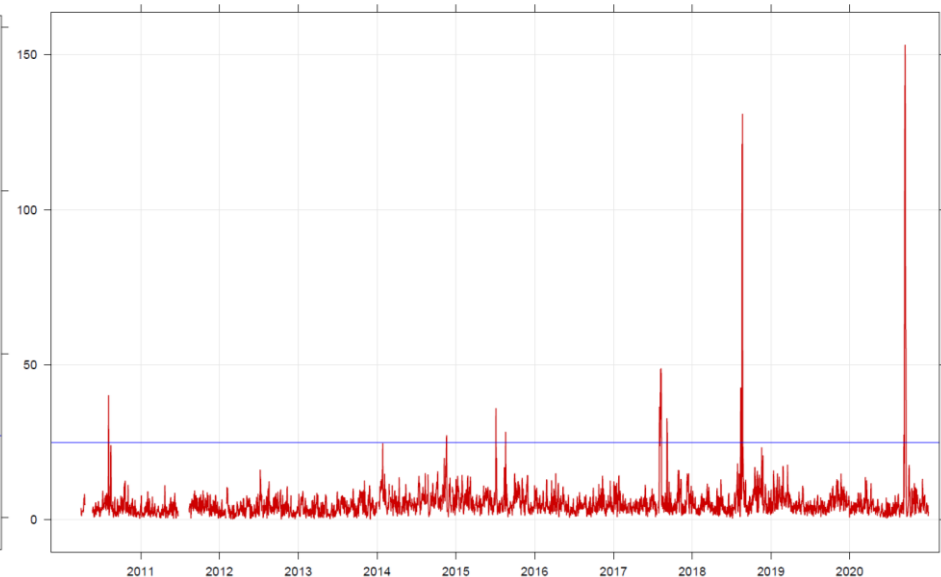
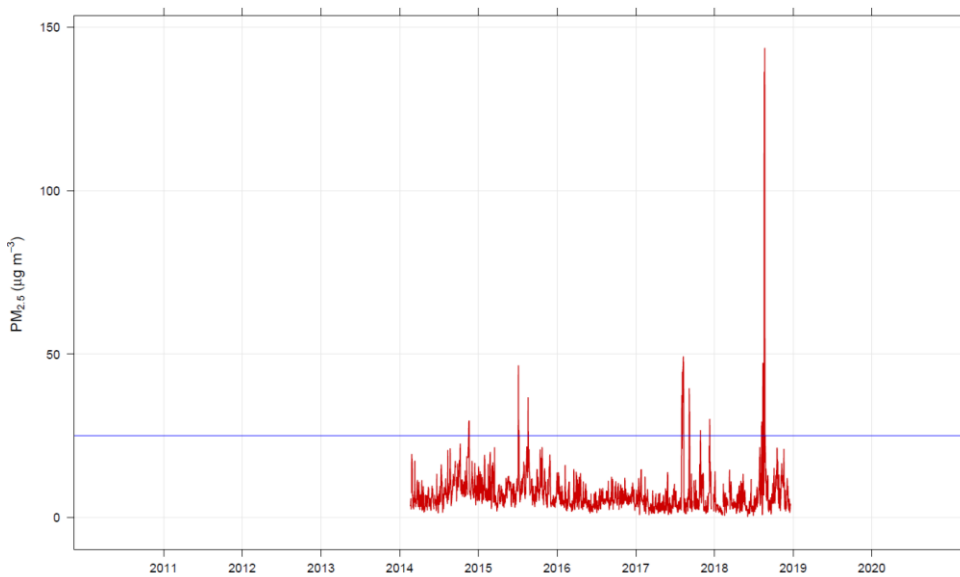
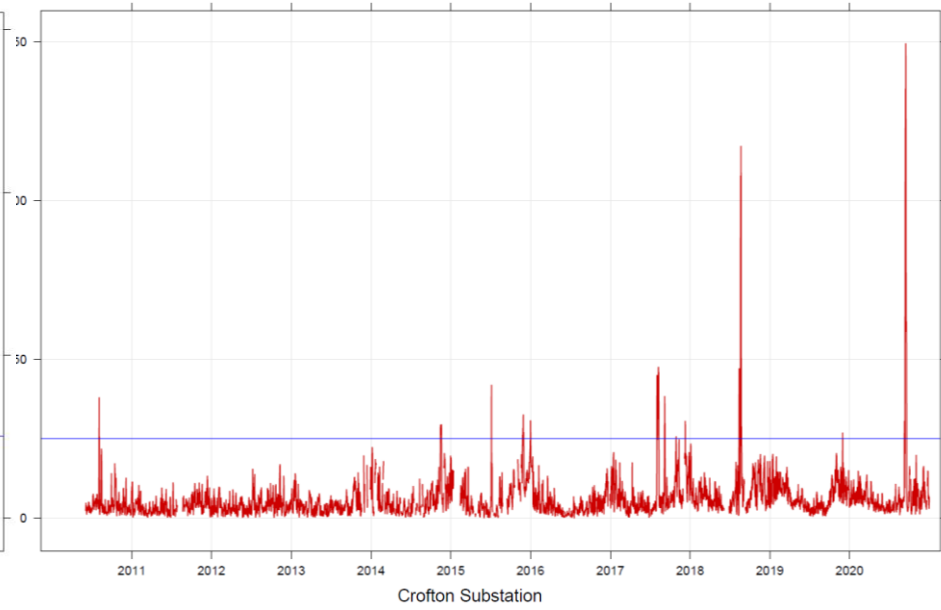
# Provincial Air Quality Monitors

# Fine Particulate Matter

Daily-Average Data  
Duncan Cairnsmore College Street

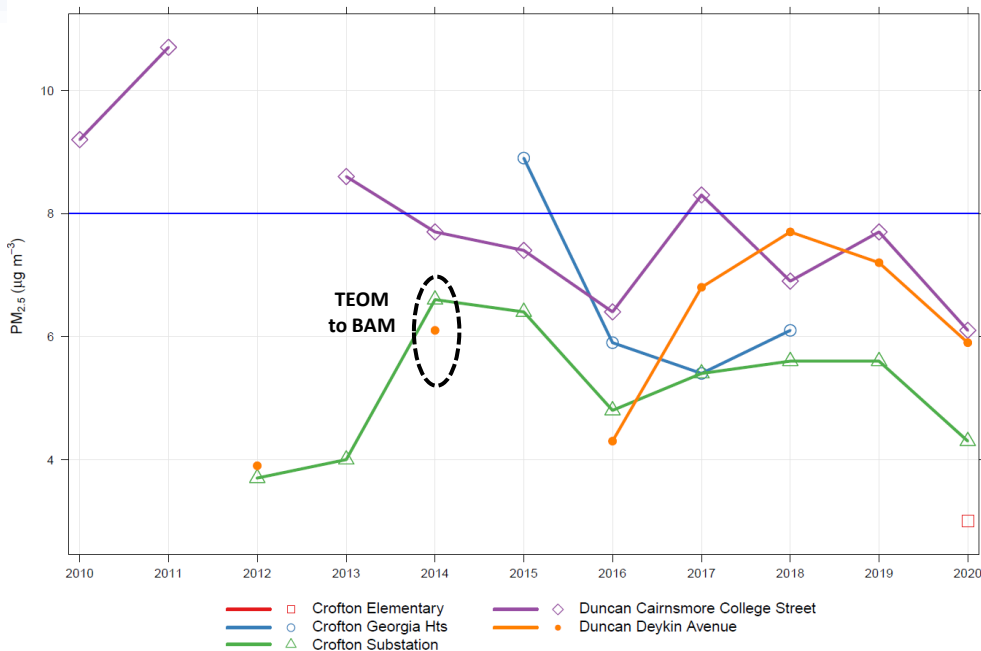


Daily-Average Data  
Duncan Deykin Avenue



# PM<sub>2.5</sub> Annual Trends (Wildfires Removed)

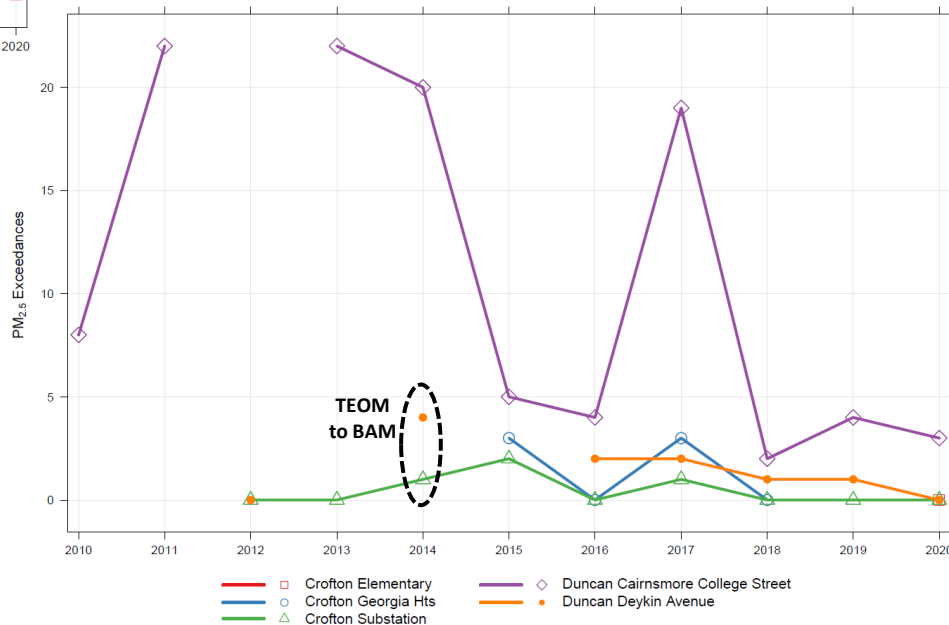
Annual Mean – Wildfires Removed



Annual 98th Percentile of Daily Average – Wildfires Removed



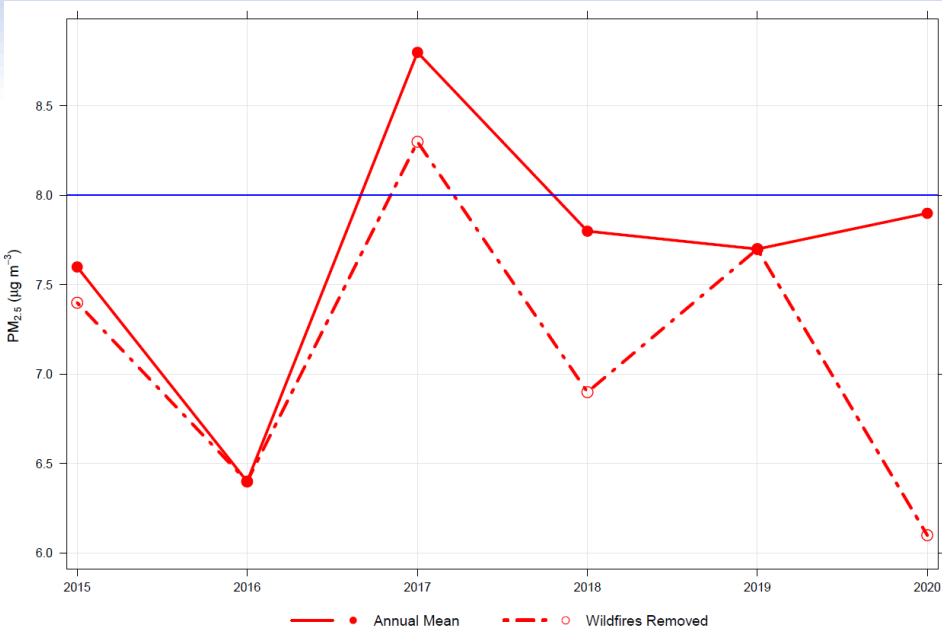
Annual Daily Exceedances – Wildfires Removed



With WF effects removed:

- Overall decreasing trends in annual mean & 98<sup>th</sup> percentile, especially last few years
- Trends increased at Deykin Ave 2016 – 2018, then declined in 2020
- Since 2018, PM<sub>2.5</sub> annual metrics meeting BC AQOs
- Significant decrease in PM<sub>2.5</sub> daily exceedances (except for 2017)

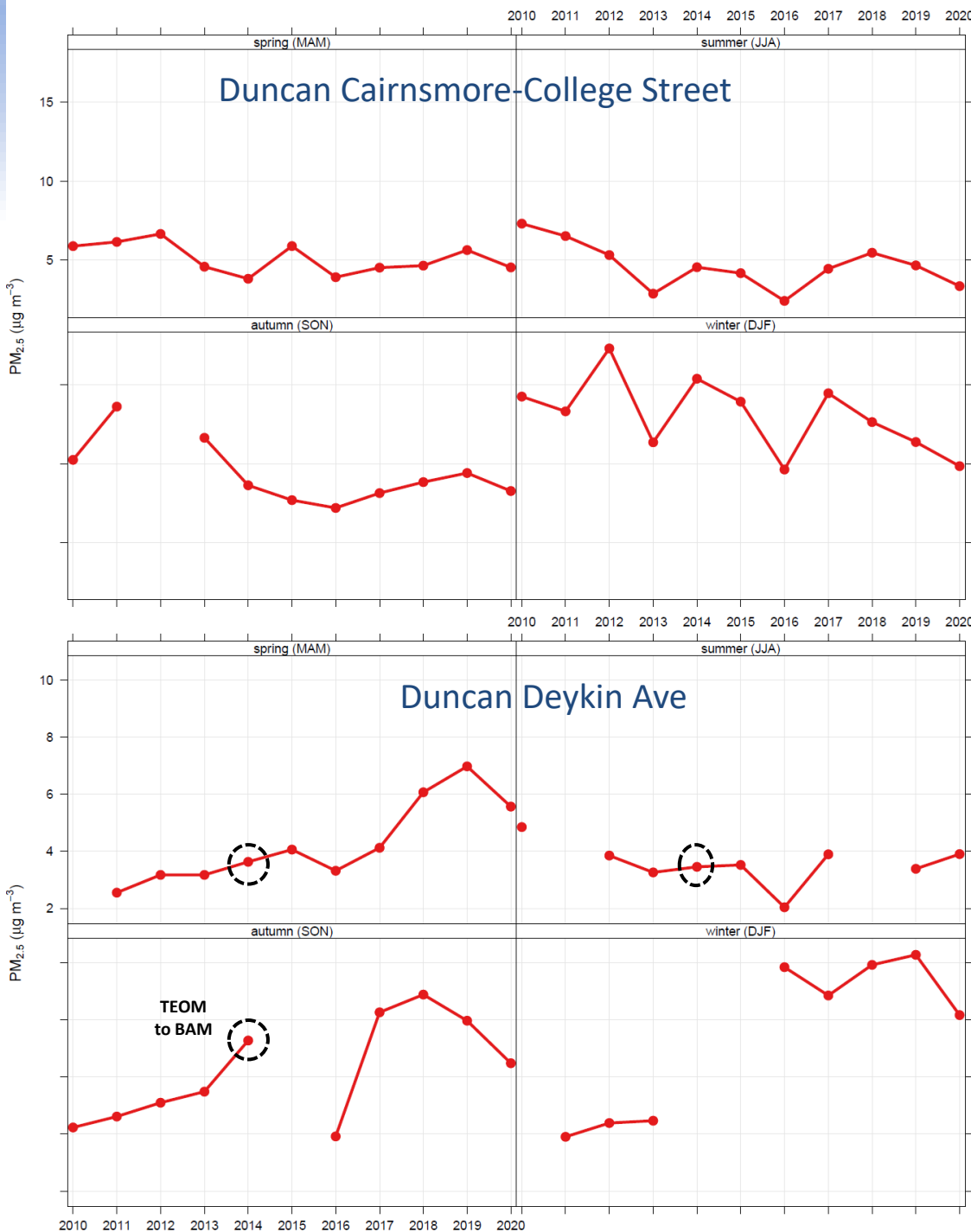
# Wildfire Effects on PM<sub>2.5</sub> levels



- Annual metrics from Duncan Cairnsmore – College Street
- Significant impacts of wildfires between 2015 and 2020
- In 2018 and 2020, PM<sub>2.5</sub> annual mean nearly exceeded AQO & 98P daily av exceeded AQO due to WF



# PM<sub>2.5</sub> Seasonal Trends (Wildfires Removed)



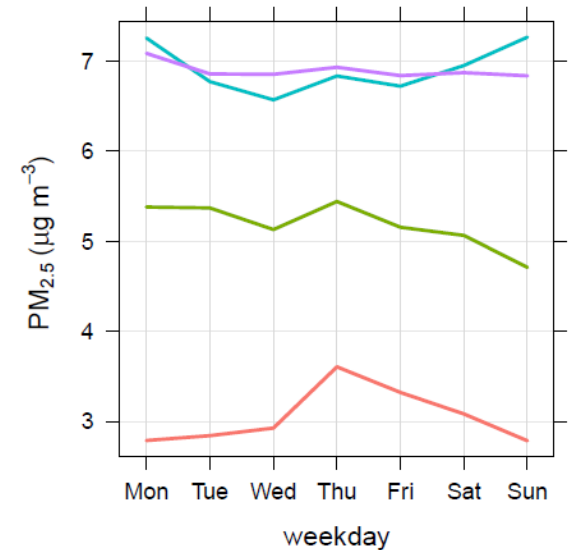
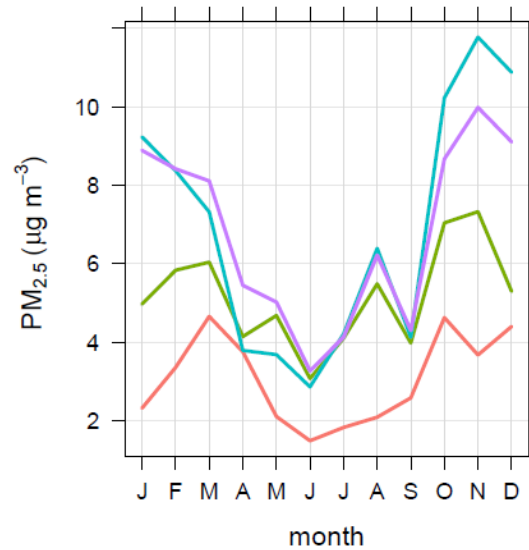
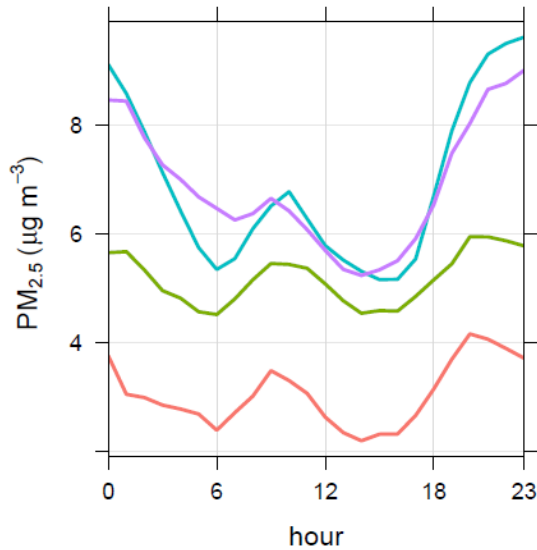
PM<sub>2.5</sub> seasonal means (WF removed) at Cairnsmore-College Street (CCS) & Duncan Deykin Ave (DDA) stations

- Winter trends
  - CCS: steady decline since 2012
  - DDA: relatively constant, 2020 drop
- Autumn trends
  - CCS: decline until 2016, relatively steady increase 2016-2019, decline in 2020
  - DDA: significant increase 2017-2018, decline in 2019-2020
- Spring trends
  - CCS: relatively small changes
  - DDA: significant increase until 2019, decline in 2020

Possible influence of open burning on trends increase in spring & autumn

Encouraging recent decreases in autumn and winter

# PM<sub>2.5</sub> Time Variations 2018–2020 (Wildfires Removed)



- Average concentrations consistently higher at Duncan stations relative to Crofton stations
- Highest in evening-nighttime, higher in morning hours: more emissions (wood heating & traffic) + typically poor venting
- Evening-nighttime peaks more pronounced at Duncan stations compared to Crofton

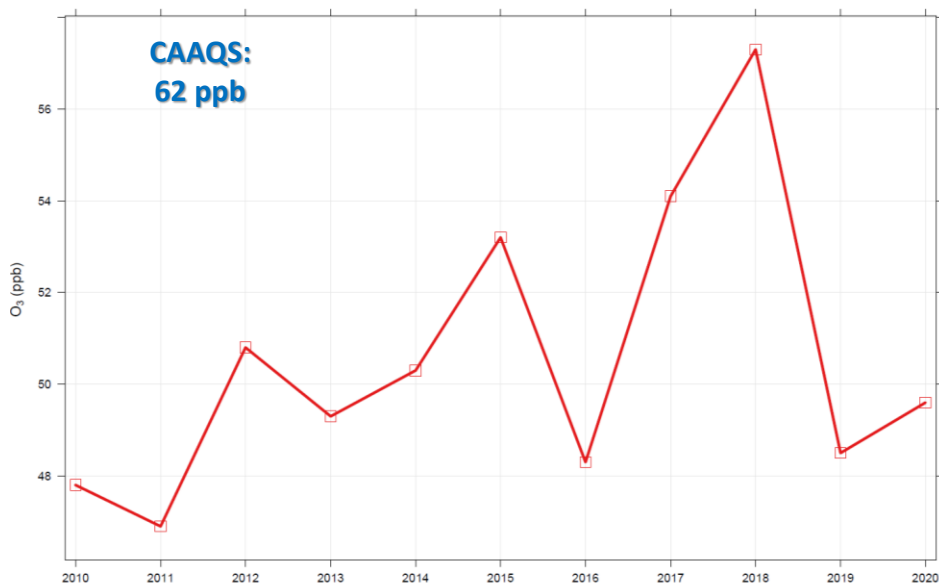
- Typical pattern of higher concentrations during cold season (more emissions + poorer venting)
- Early-spring and late-fall peaks at Crofton stations notably different from Duncan (industrial or open burning emissions)

- Relatively higher concentrations on weekends and Mondays at Cairnsmore-College Street
- Higher midweek at Crofton stations

# O<sub>3</sub> & NO<sub>2</sub> Annual Trends

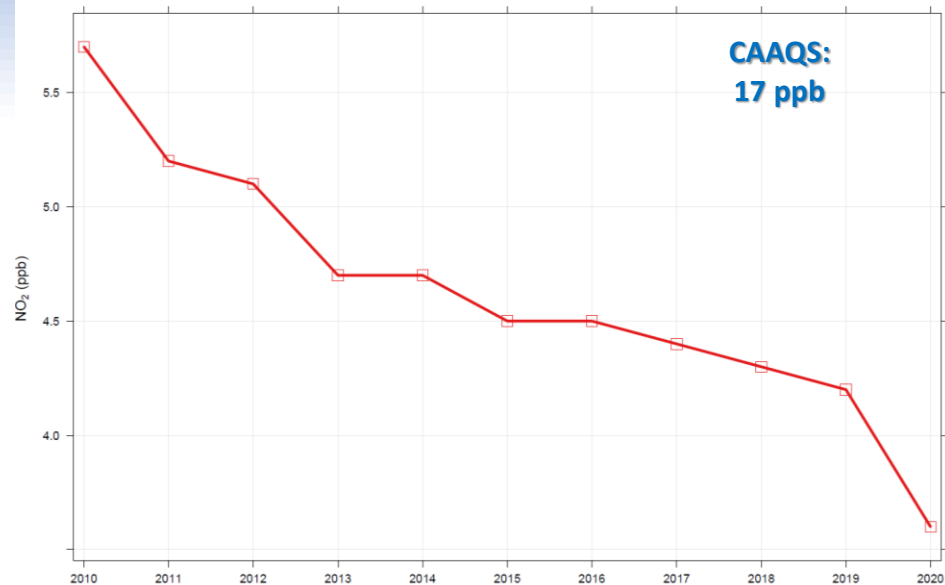
## Duncan Cairnsmore-College Street

Annual 4th Highest Daily 8-Hr Max

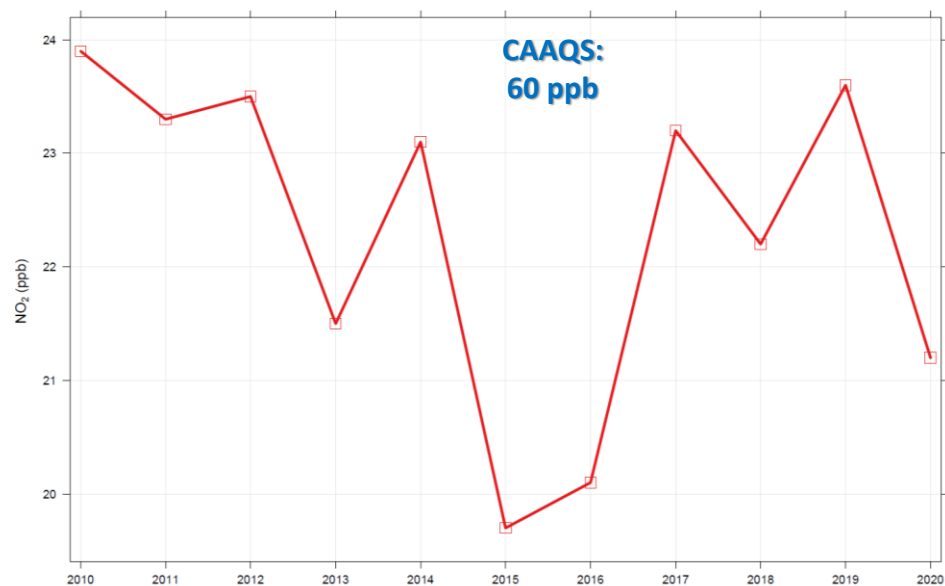


- O<sub>3</sub> main metric has remained below the applicable CAAQS since 2010.
- Wildfire impacts during 2015, 2017 & 2018.
- NO<sub>2</sub> main metrics have also remained well below the applicable CAAQS.
- Annual mean shows steady decline since 2010, 98<sup>th</sup> percentile of D1HM shows a narrowly-fluctuating trend - overall decline.

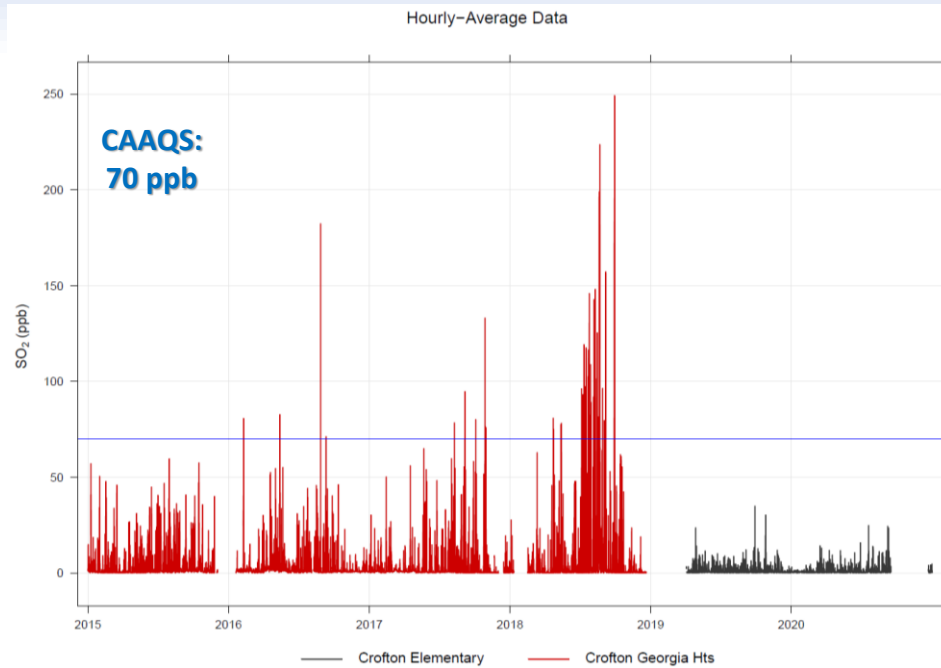
Annual Mean



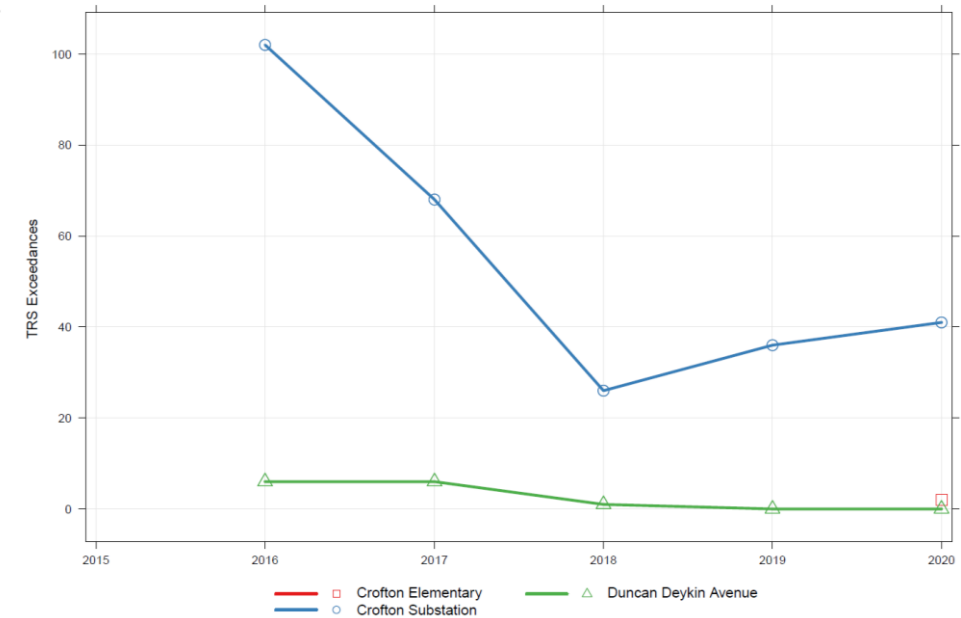
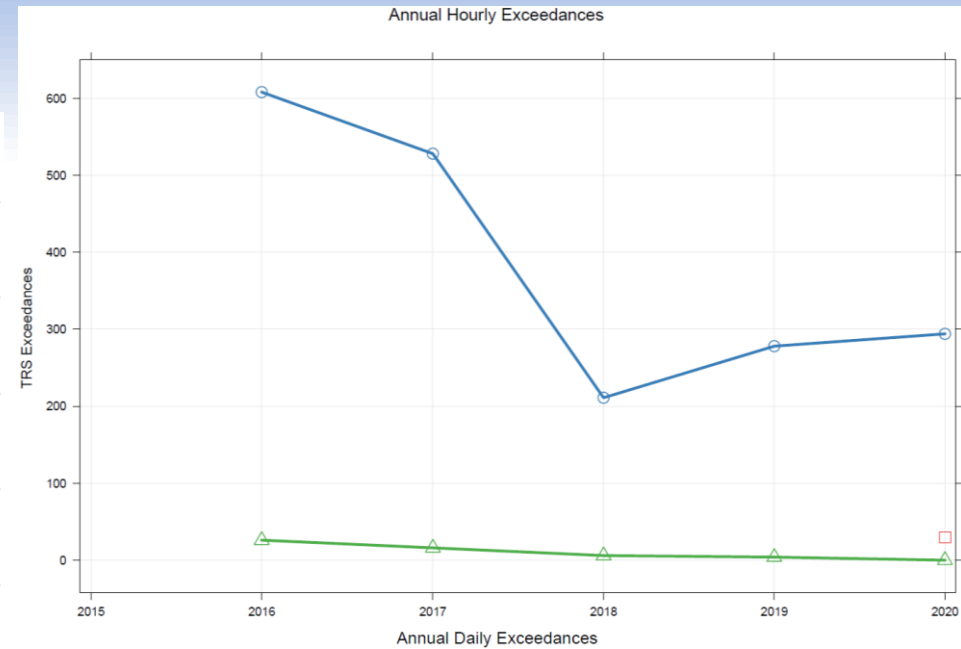
Annual 98th Percentile of Daily 1-Hr Max



# SO<sub>2</sub> & TRS Annual Trends



- SO<sub>2</sub> levels exhibit sharp decline since the Crofton station relocation in 2019
- Unlike previous exceedances at Georgia Heights, SO<sub>2</sub> hourly concentrations at Crofton Elementary are well below the CAAQS
- TRS levels show significant decline in hourly & daily exceedances of BC PCOs at Crofton Substation and Duncan Deykin since 2016
- Higher at Crofton Substation (source proximity)



# Cowichan PurpleAir Monitors

# PA data processing and analysis tools

- **Codes for acquisition and processing of hourly-average data:**
  - UNBC or PA 10-min database
  - Corrected, filtered hourly averages
- **Guided by:**
  - UNBC's PA mapping
  - ECCC's PA data validation
- **New mapping tool to summarize distributions**
- **Different nature of data, new analysis and presentation challenges**
- **75% data completeness criteria: only complete years included**

# PA data validation

## Data Quality Control Flags (Automated)

Sensors are flagged as suspicious, and not used in ECCC smoke forecasting tools when:

- 1) Intrasensor comparisons (between A and B channels) show inconsistencies such as when one channel gets plugged or otherwise compromised.
- 2) Intersensor comparisons (between the sensor and its two nearest-neighbour sensors) show significant differences, with the threshold for significance based on distance to neighbour such that one would expect closer  $PM_{2.5}$  agreement as sensors approach each other in distance.
- 3) Temperature data is too stable or is significantly higher than ambient temperature, suggesting that the sensor may actually be located indoors (or occasionally exposed to direct sunlight). Newly installed sensors will also show a temperature flag until sufficient data are collected to demonstrate temperature variability.
- 4) Sensors are offline (as a result of loss of power or WiFi connection).

\*\*\* Sensor data have been corrected according to UNBC correction algorithm \*\*\*

## 1. Intrasensor: Channels A & B

- Based on UNBC's 10-min flagging criteria

$$\{ (A + B)/2 \text{ is greater than } 5 \text{ AND } |A - B| > 0.5*(A + B)/2 \}$$

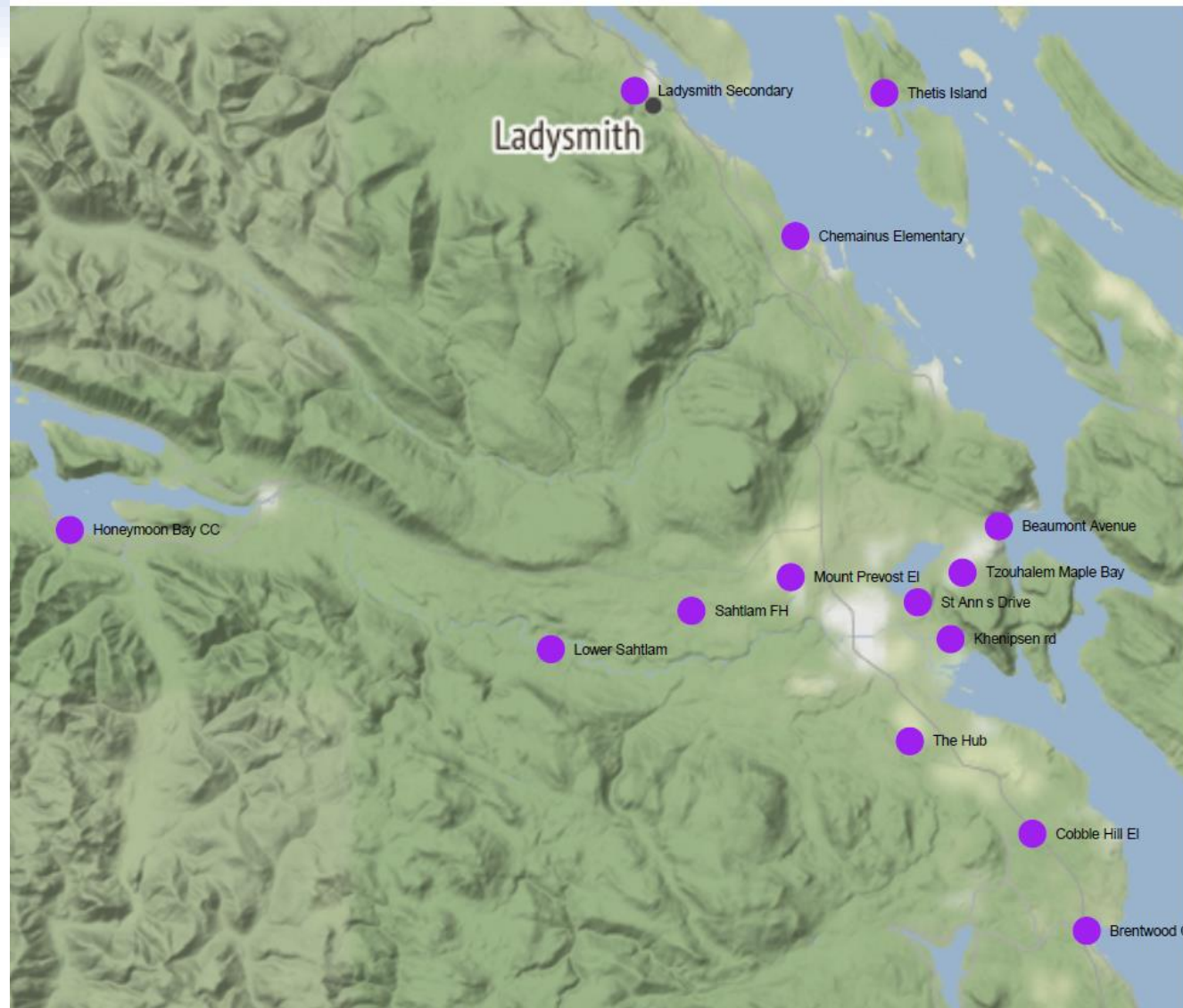
- Substitutes PurpleAir channel downgrading criteria

## 2. Intersensor: anomalous 'spikes'

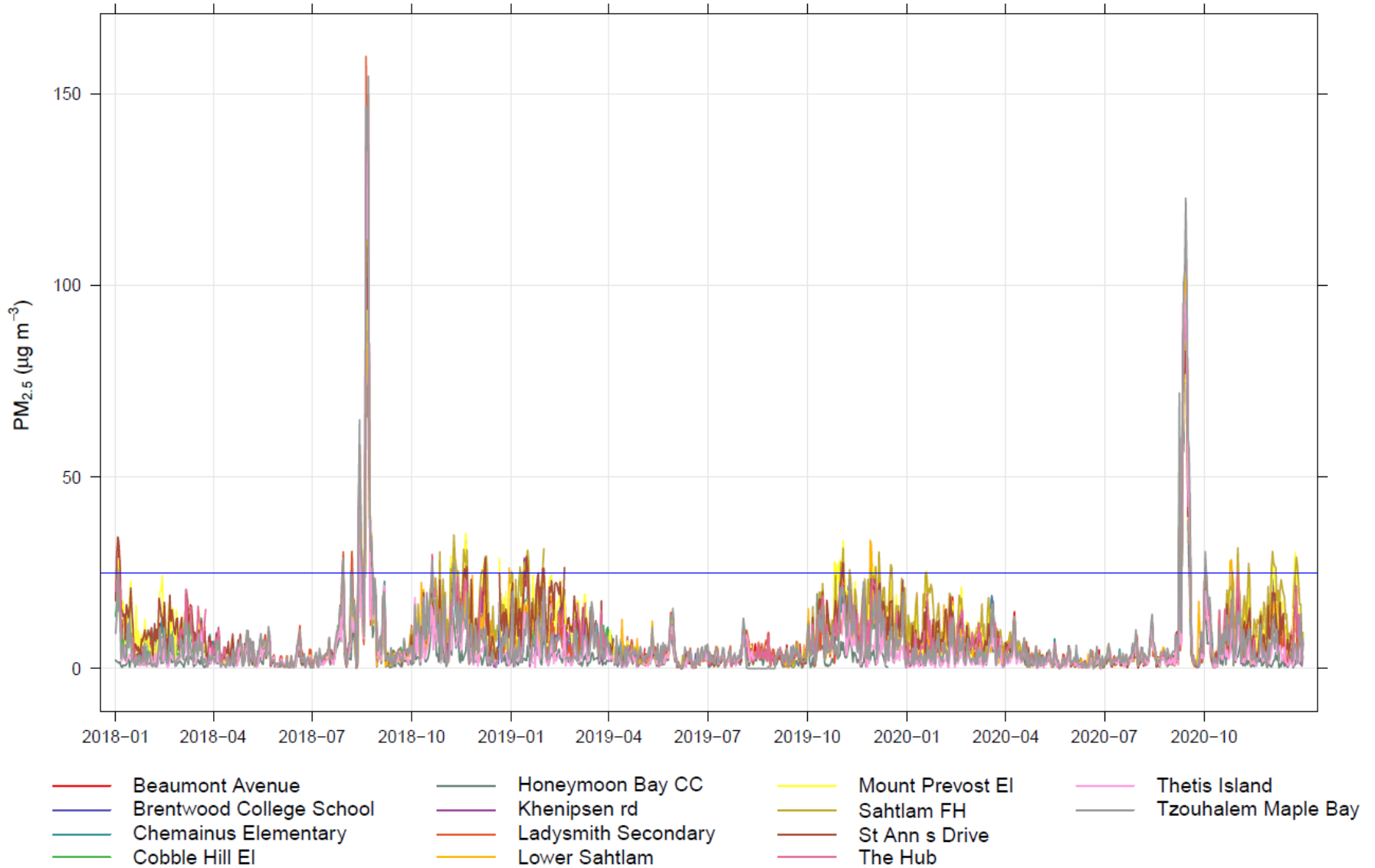
- ECCC developing automated criteria for anomalously high concentrations
- Visual inspection and manual hourly comparisons for now, flagging and 'invalidating' a few data

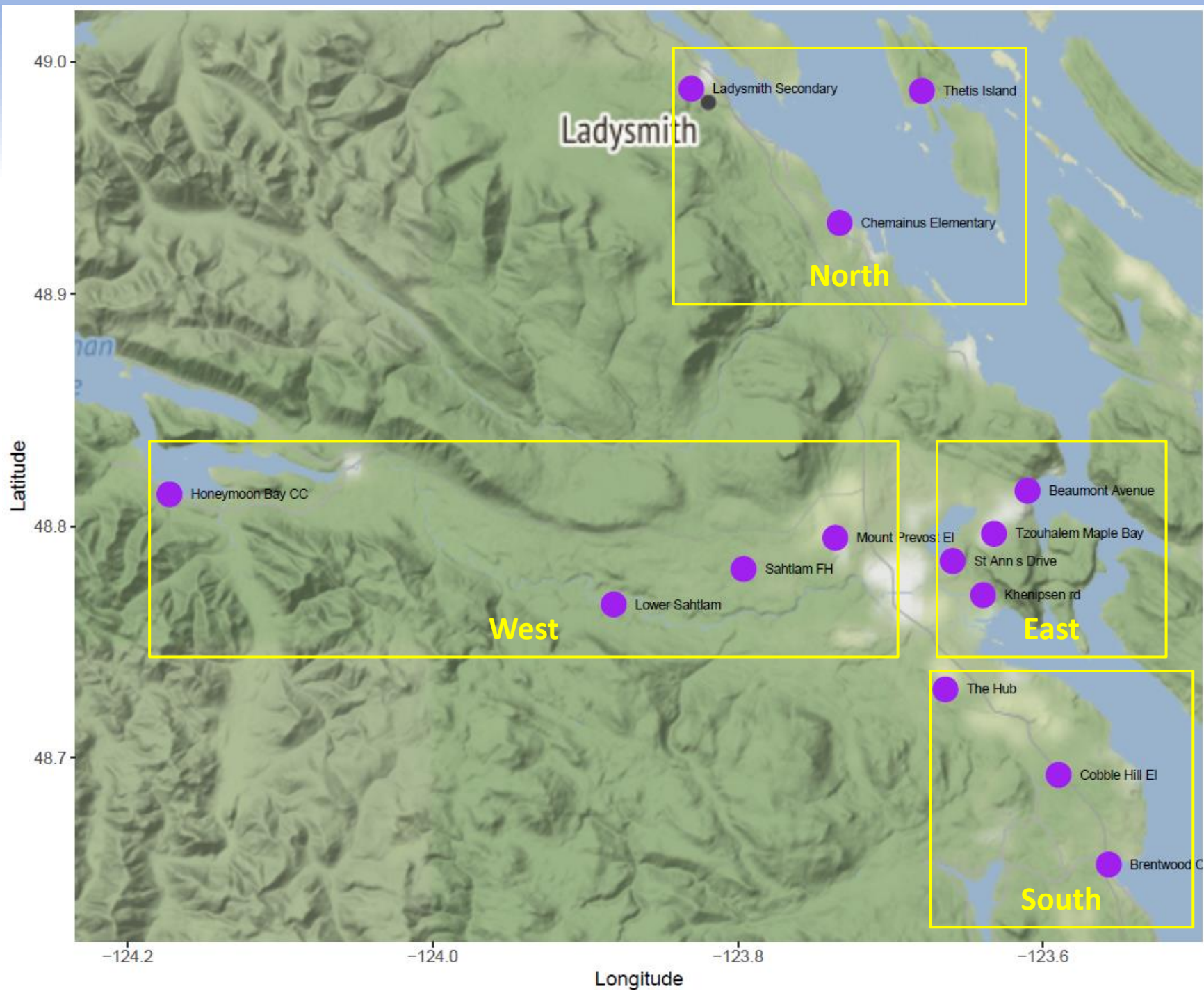
## 3. Visual inspection of baselines for any drifts

- Data included from 2018 to 2020
- 14 sites had adequate data
- 2 did not meet data completeness criteria



# Daily-Average Data

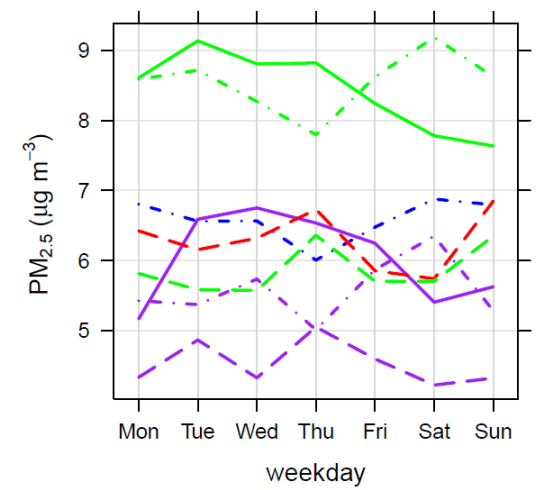
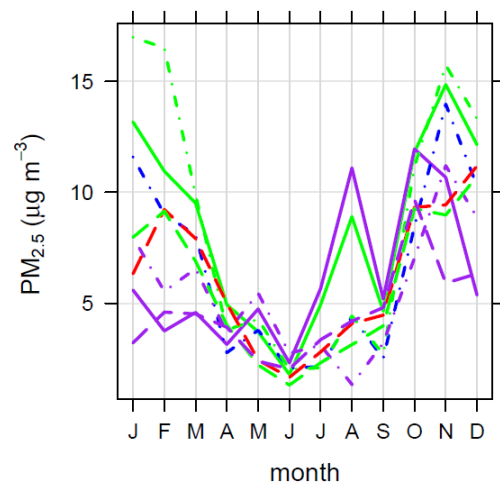
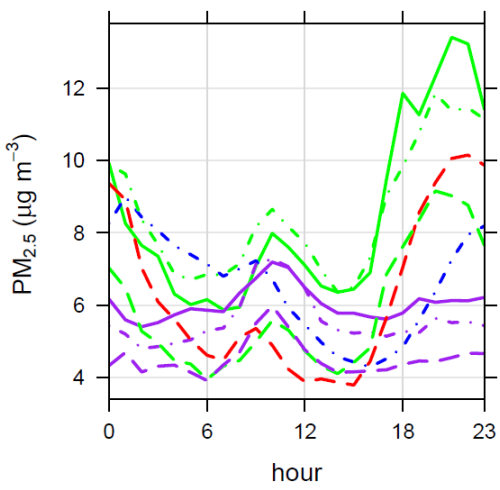




**East**

- Beaumont Avenue
- Khenipsen rd
- St Ann s Drive
- Tzouhalem Maple Bay

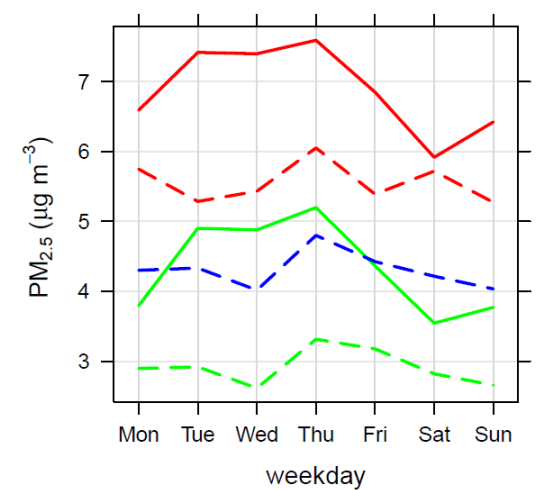
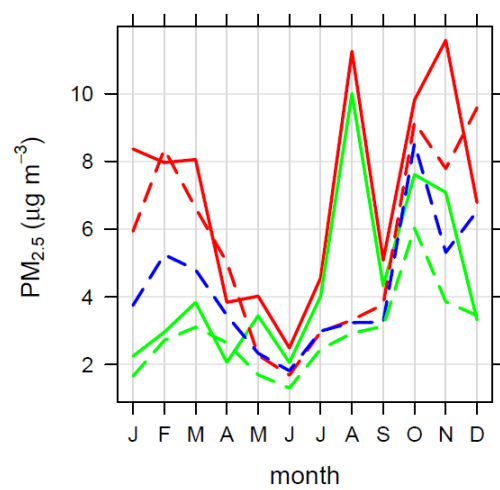
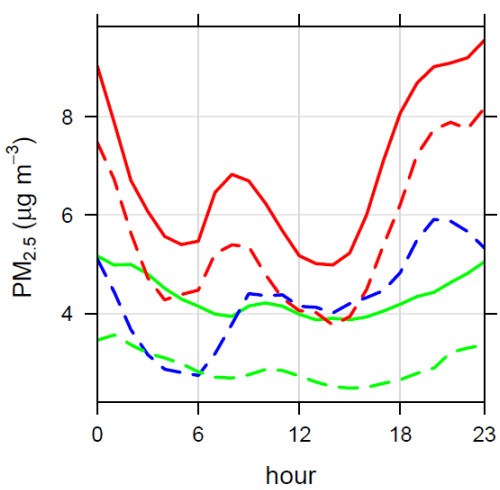
- 2018
- . - . 2019
- - - 2020



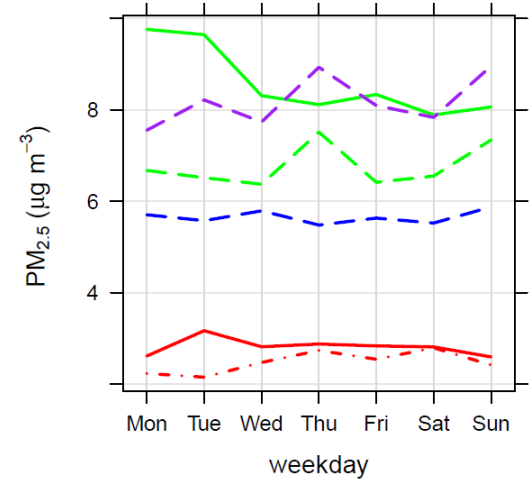
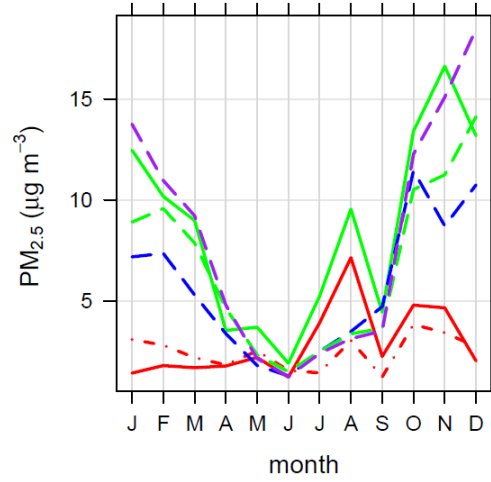
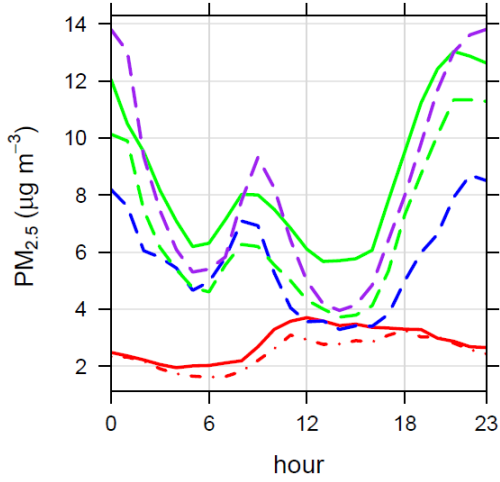
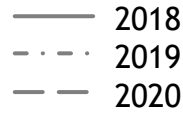
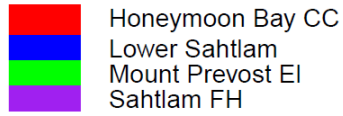
**North**

- Chemainus Elementary
- Ladysmith Secondary
- Thetis Island

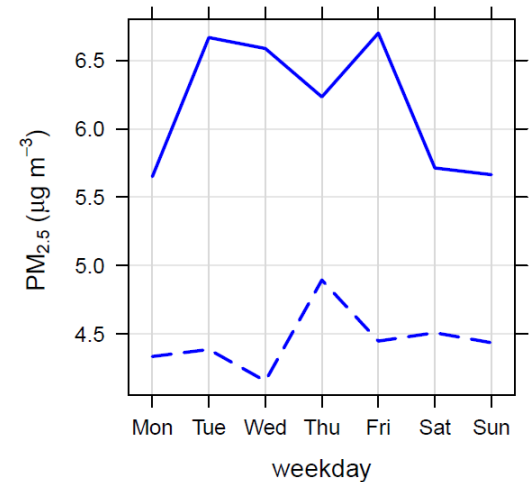
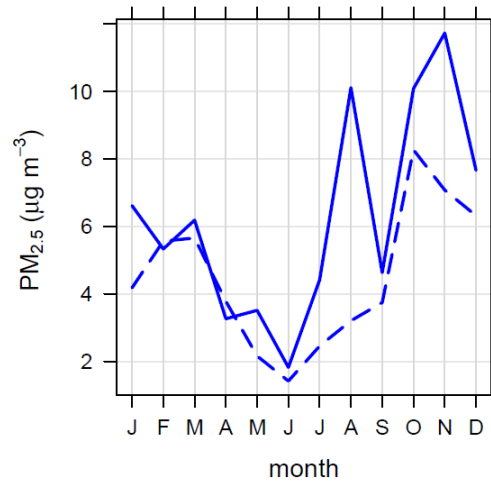
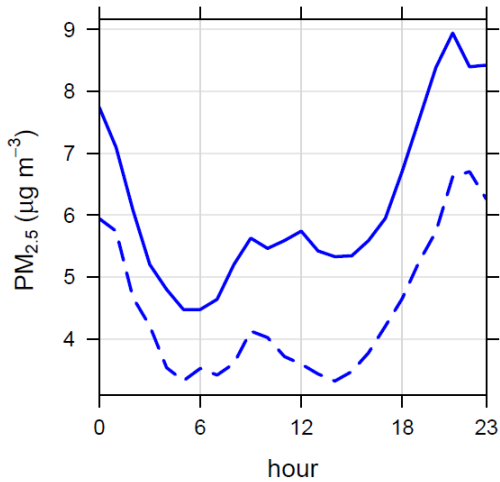
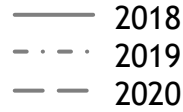
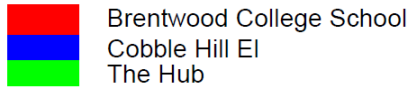
- 2018
- . - . 2019
- - - 2020



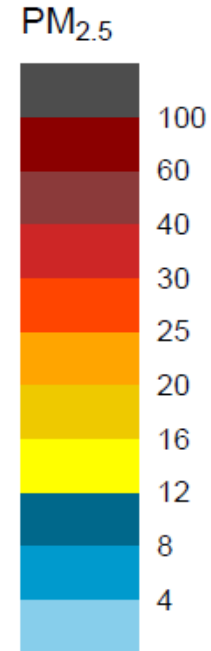
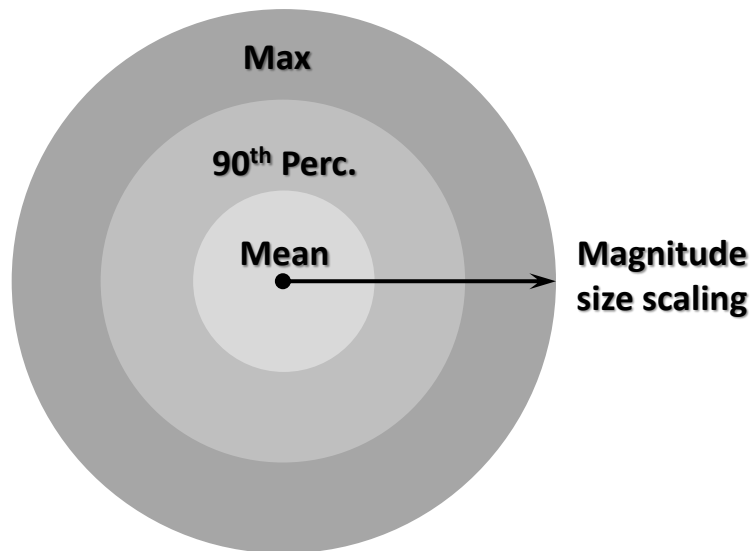
# West



# South



# Mapping Tool for PM<sub>2.5</sub> daily-average concentrations



- Mean: shows average PM<sub>2.5</sub> conc., indicates overall exposure
- Max: shows worst daily PM<sub>2.5</sub> conc., indicates highest exposure - important for most vulnerable
- 90<sup>th</sup> percentile: important to understand distribution of PM<sub>2.5</sub> concentrations, indicates range of highest values
- Smaller increments at lower end of scale: capture spatial and time variations, esp. for mean values
- Larger increments at upper end of scale: capture exceptional smoke events

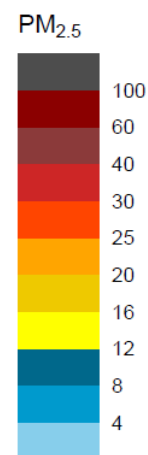
Spring 2018 (Wildfires Removed)



Spring 2019

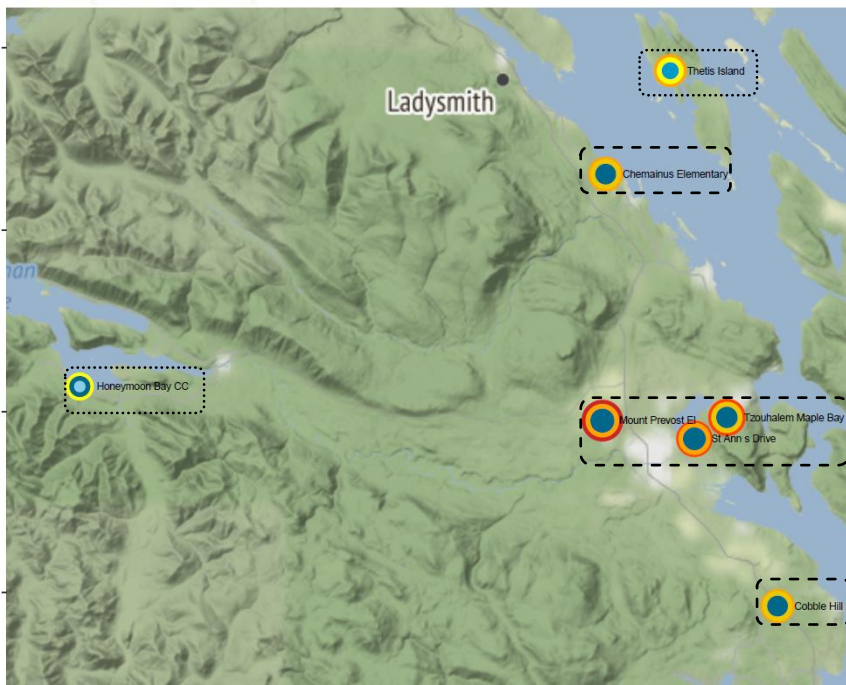


Spring 2020 (Wildfires Removed)

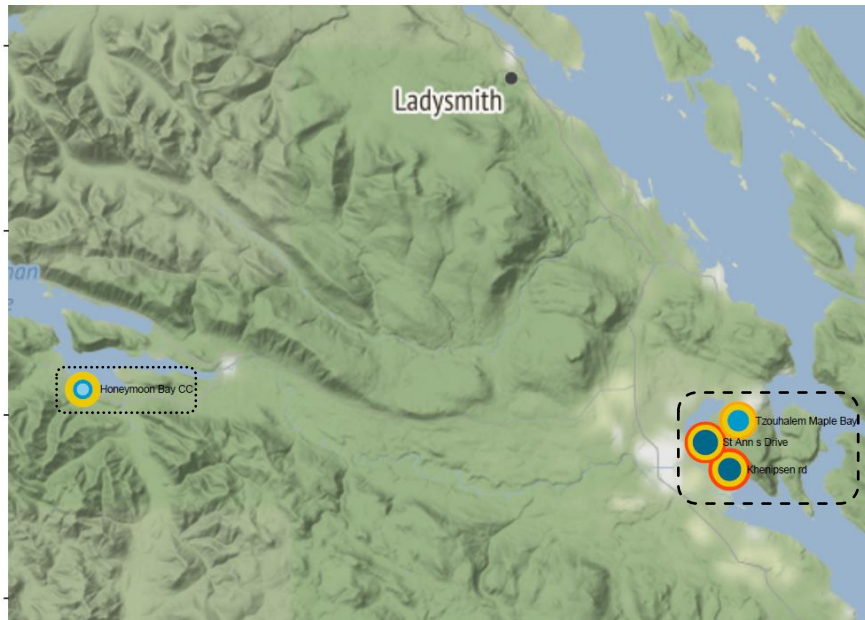


- Relatively low mean concentrations at all sites
- Daily concentrations largely on the lower end at most sites
- Except for Honeymoon Bay & Thetis Is & Lower Sahtlam, elevated daily max. suggest open-burning impacts on certain days

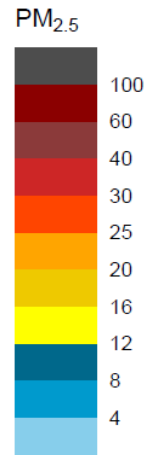
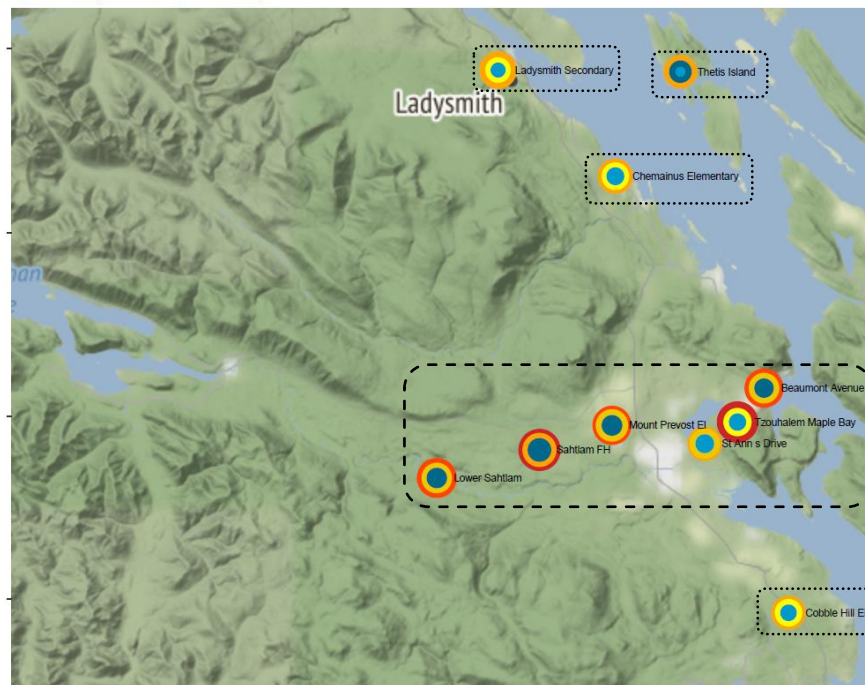
Fall 2018 (Wildfires Removed)



Fall 2019



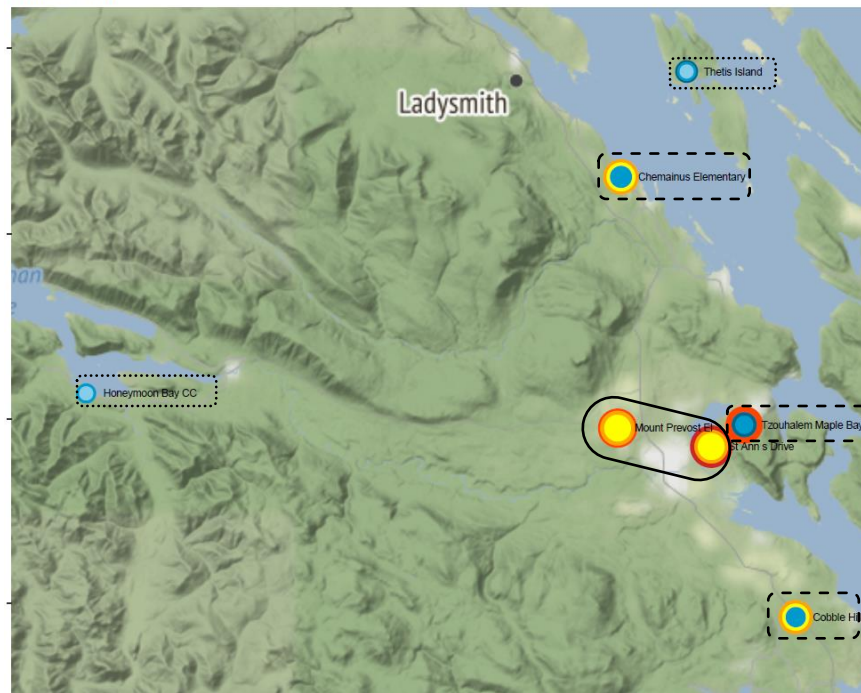
Fall 2020 (Wildfires Removed)



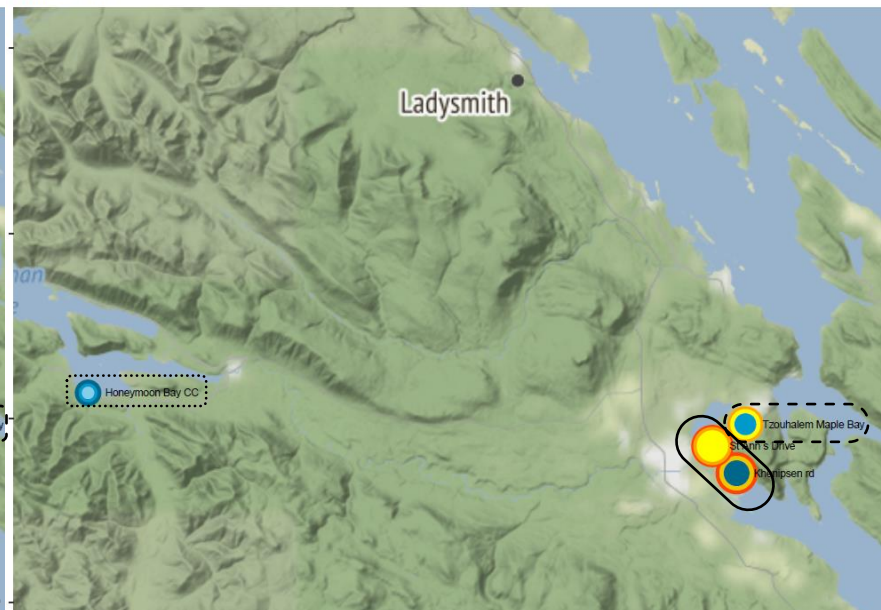
- Lower mean conc.
- Daily conc. mostly on lower-end
- Elevated max. conc.

- Elevated mean conc.
- Higher occurrences of elevated conc.
- Elevated/high max. conc.

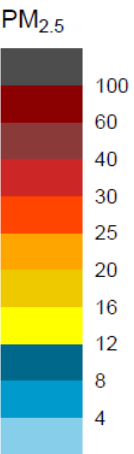
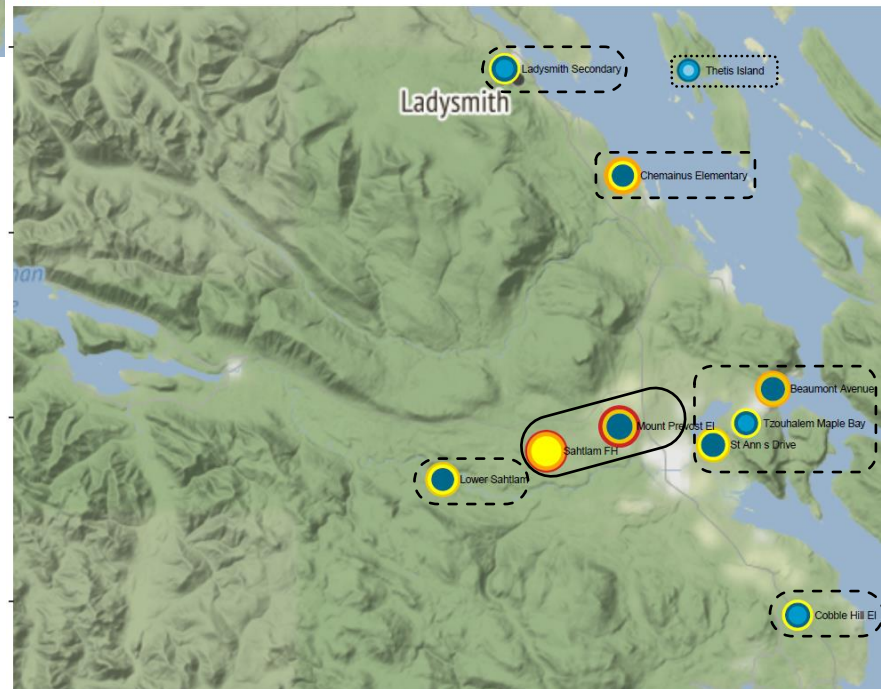
Winter 2018



Winter 2019



Winter 2020



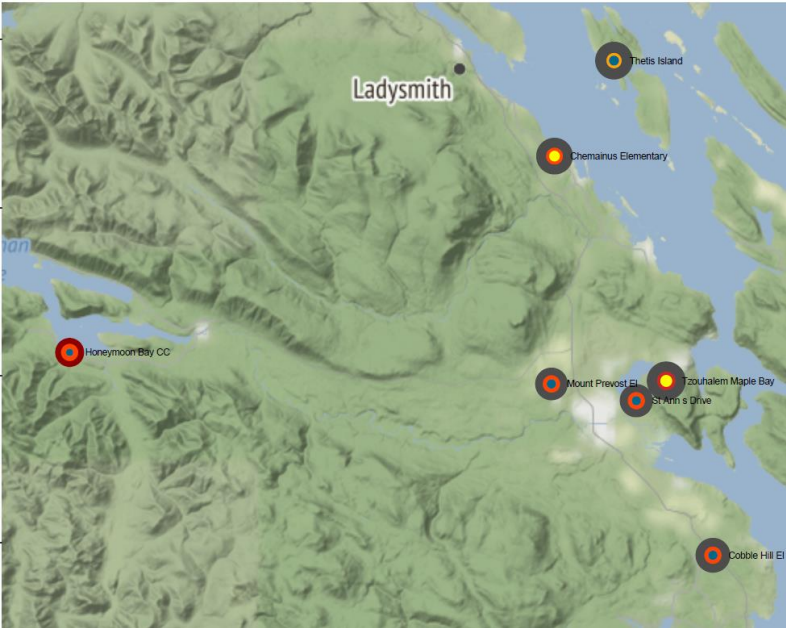
- Lower mean conc.
- Overall lower-end conc.

- Elevated mean conc.
- Higher occurrences of elevated conc.
- Elevated/high max. conc.

- Higher mean conc.
- Higher occurrences of elevated conc.
- High max. conc.

# Wildfire smoke captured by PA network

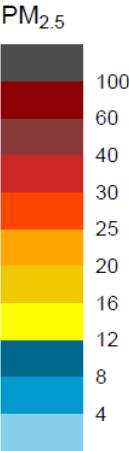
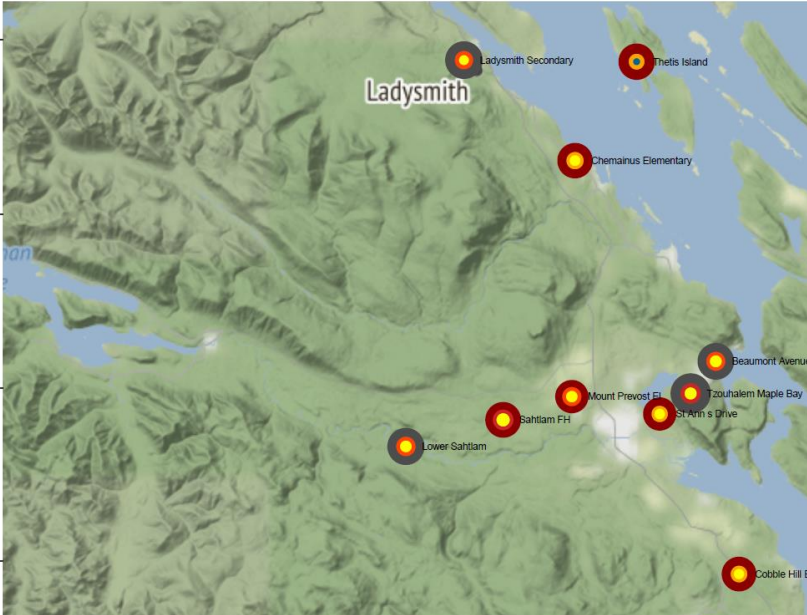
Summer 2018



Summer 2020



Fall 2020



# Summary

- **PM<sub>2.5</sub>**
  - Encouraging trends with recent annual levels meeting federal and provincial limits.
  - Highest concentrations in fall-winter months: wood burning and poor venting.
  - Continued actions still needed: metrics not far below acceptable limits, significant impacts of wildfire smoke.
  - PA data indicating hotspots impacted by wood burning in the fall and winter, with some significant inter-annual variations
- **NO<sub>2</sub> well-below standards, O<sub>3</sub> meeting standards - wildfire influence.**
- **Significant reduction in SO<sub>2</sub> with monitoring station relocation**
- **Noticeable improvements in TRS at Duncan Deykin and Crofton Substation.**

**Thank You!**

**Questions?**