bulkley valley - lakes district
airshed management society

January 20th, 2019

The Airshed Management Society's Purple Air monitors in 2018

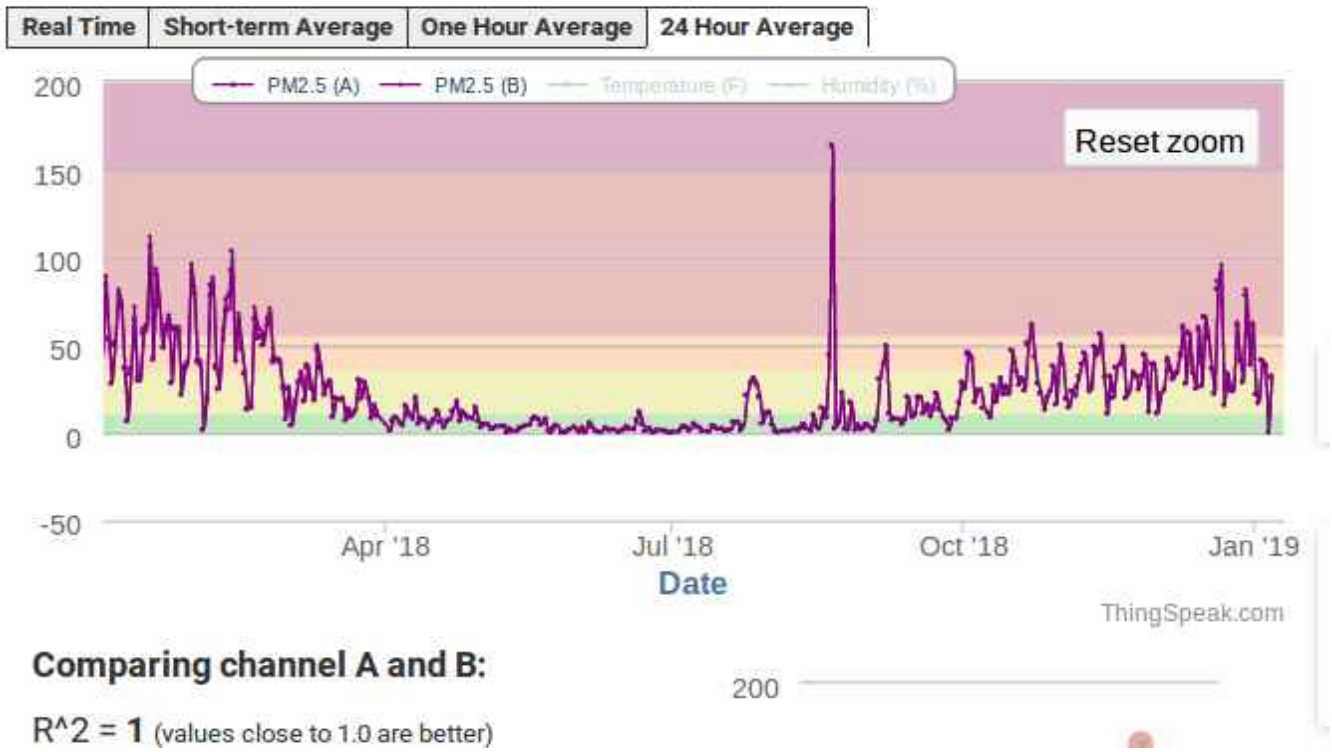
It was a very busy and interesting year with more monitors, a long cold snowy winter and a lot of forest fire smoke.

As of the end of 2018 there are AMS Purple Air monitors (PA-IIs) in Gitanyow, Hazelton Old Town, Witset, Smithers and Telkwa. Three monitors have been donated to public libraries for loan to patrons – in Hazelton, Smithers and Houston. The Granisle fire department bought one that's online, we helped set it up.

Having more monitors in the field means more trouble with equipment; it seems the fans don't like cold weather and in some instances the sensors have had to be replaced. It isn't clear how the accuracy of the instruments declines with use but one of the oldest of ours is now 18 months in the field and no red flags showing, it has not needed service.

Before proceeding, it's assumed in this document that the reader knows what a purple air monitor is, what the purple air project is all about and has some familiarity with air pollution and its ill effects. It might be useful to read up on this at https://www.purpleair.com and perhaps look over the map at https://www.purpleair.com/map. Our web site is at https://cleanairplan.ca and contains background and discussion.

In order then from west to east, here are specific results by community, discussion and charts. Data sources are extracts from the Purple Air archive at http://purpleair.com/sensorlist and associated graphing facilities. More on data issues at the end.



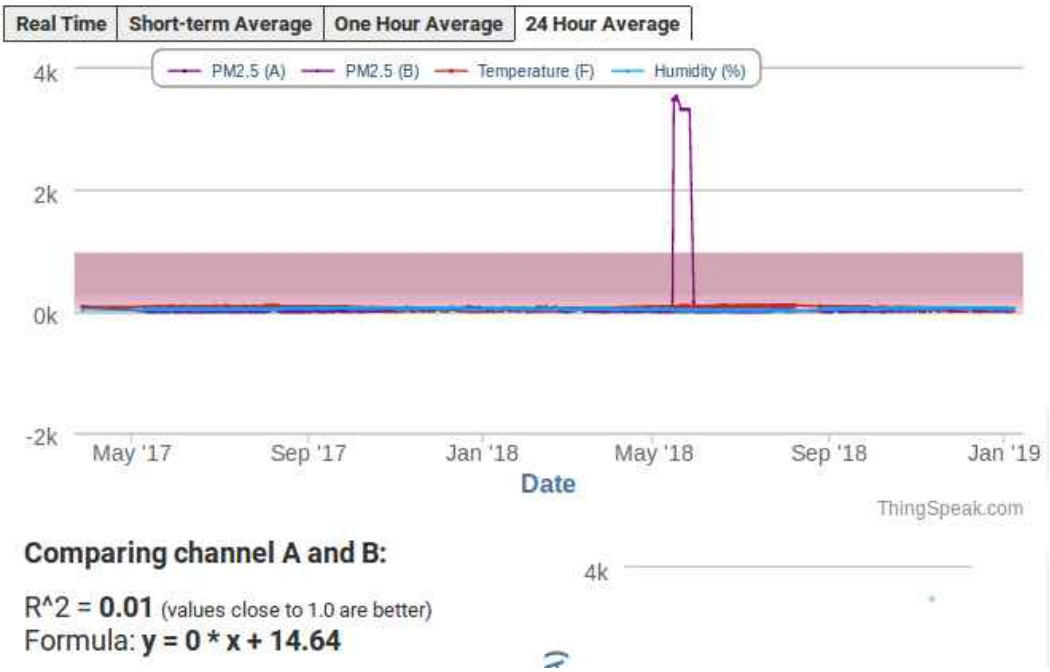
Above is the overview chart of **Gitanyow** for 2018. Below is its spreadsheet descriptive statistical summary of real time[1] values.

Mean	27.8965
Standard Error	0.07454
Median	8.17
Mode	0.24
Standard Deviation	46.1238
Sample Variance	2127.4
Kurtosis	53.5579
Skewness	3.81869
Range	2331.02
Minimum	0
Maximum	2331.02
Sum	1.1E+07
Count	382935

The graph shows clearly the forest fire smoke influence in August with readings as high as about 175 µg/m^3. Details of the fire season and which fire influenced which readings are too complicated to go into here so the influence is noted. Anyone who has better information to provide is invited to do so.

The **Hazelton** monitor mostly behaved well but with an important exception which can be seen here.

1 Real time is every 80 seconds



The vertical blip was apparently caused by a stuck fan on one channel. The unit was removed from service on May 13, 2018 and not returned until August. The presence of readings in the archive for the intervening period does not indicate Hazelton conditions, but those in my office where the unit was being tested. *Caveat emptor.* Spreadsheet values given below are for two ranges, Jan 1-May 10 then Sept 1-Dec 31.

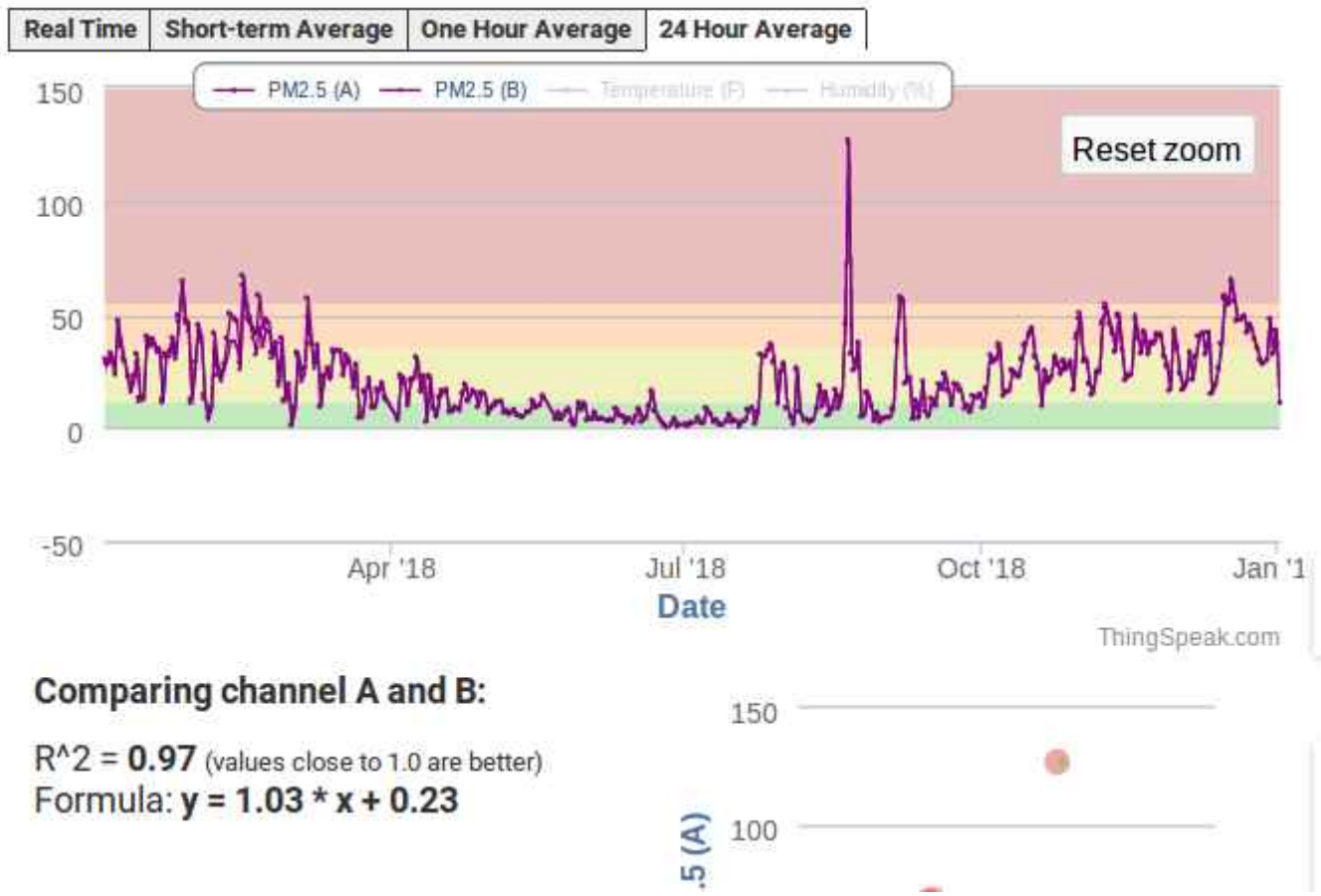
Mean	20.8599
Standard Error	0.08845
Median	7.23
Mode	1
Standard Deviation	32.8093
Sample Variance	1076.45
Kurtosis	15.7848
Skewness	3.08853
Range	723.77
Minimum	0
Maximum	723.77
Sum	2870260
Count	137597

Mean	22.9467
Standard Error	0.0765
Median	13.51
Mode	1

Standard Deviation	26.1818
Sample Variance	685.486
Kurtosis	10.0541
Skewness	2.34194
Range	442.49
Minimum	0
Maximum	442.49
Sum	2687954
Count	11713

Some shortcomings for these data are clear; although maximum readings are given, no date for the maximum values is noted, this would be pretty interesting. The curious reader is referred to https://www.purpleair.com/sensorlist, the data source.

The **Witset** instrument was installed IIRC on December 11, 2017 and has run faultlessly since then. It's mounted on the roof of the health centre. We have complete readings for 2018 like this:



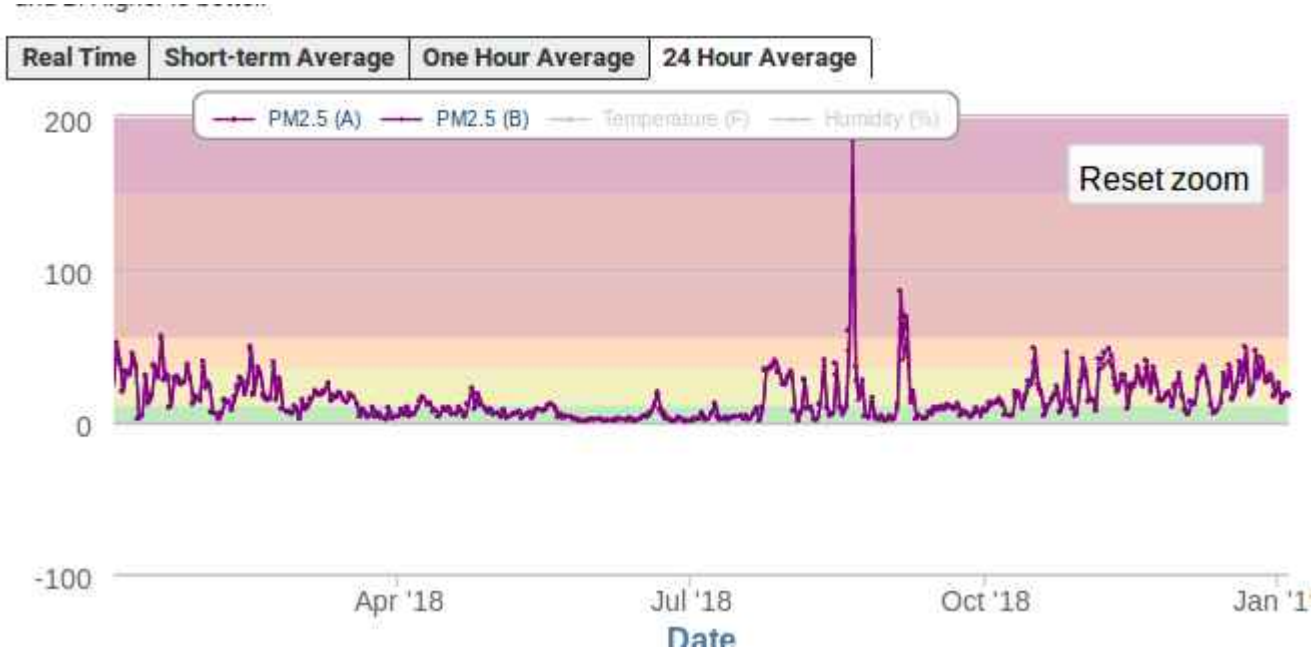
The big forest fire spike in August is clear as are the high winter seasonal values.

Stats next:

Mean	24.9667
Standard Error	0.05314
Median	12.8
Mode	1
Standard Deviation	32.7763
Sample Variance	1074.29
Kurtosis	27.0677
Skewness	3.46938
Range	551.32
Minimum	0
Maximum	551.32
Sum	9498130
Count	380432

In **Telkwa** we have now two monitors. These have been bought jointly by the Village of Telkwa and the Airshed Management Society. The first is installed at the Village office on Hankin, the second on Walnut St.

Here's the 2018 chart for the Hankin Ave. instrument.



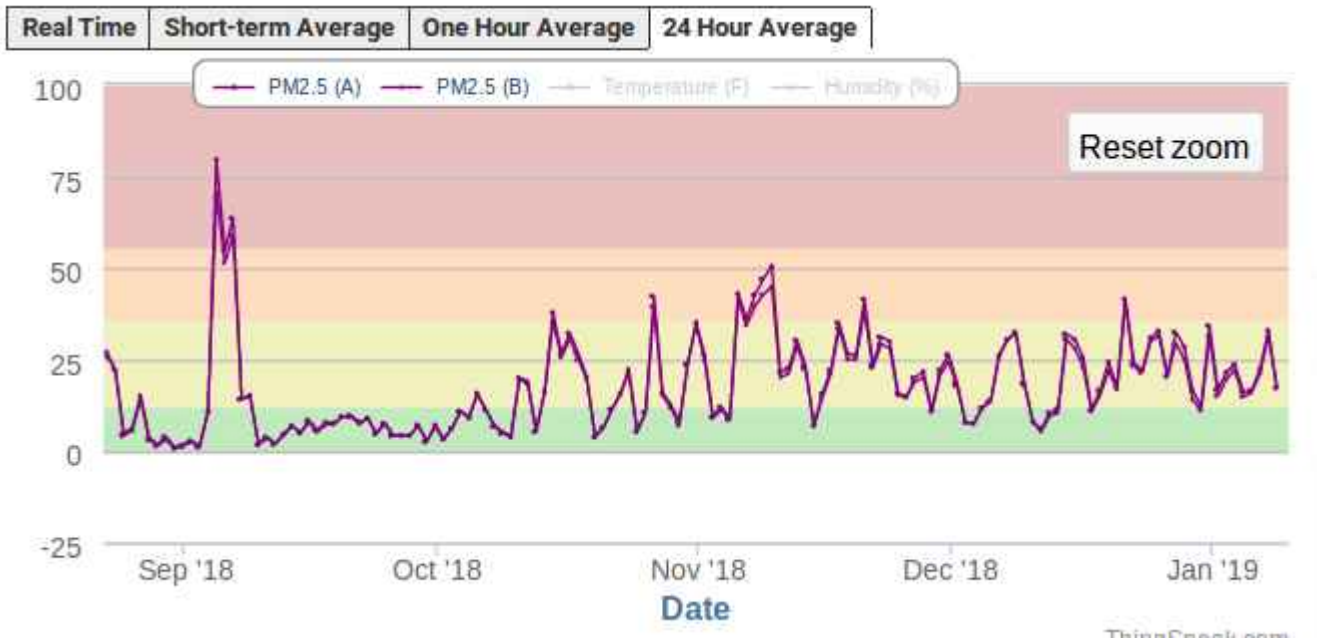
The full year of readings are here barring two short maintenance intervals of about 2 hours each so good data capture. And the stats:

Mean	17.065
Standard Error	0.04897
Median	7.56

Mode	1
Standard Deviation	30.6439
Sample Variance	939.047
Kurtosis	138.595
Skewness	8.52083
Range	1392.7
Minimum	0
Maximum	1392.7
Sum	6681514
Count	391533

Even though the average is lower than more westerly measurements the peak value is higher, reflecting the closer location to August fires.

The Telkwa Walnut St. instrument went live in September 2018 and the chart for the balance of 2018 is here.



Stats:

Mean	19.5942
Standard Error	0.07048
Median	10.09
Mode	1
Standard Deviation	26.1877
Sample Variance	685.794

Kurtosis	54.0778
Skewness	4.2655
Range	795.86
Minimum	0
Maximum	795.86
Sum	2705306
Count	138067

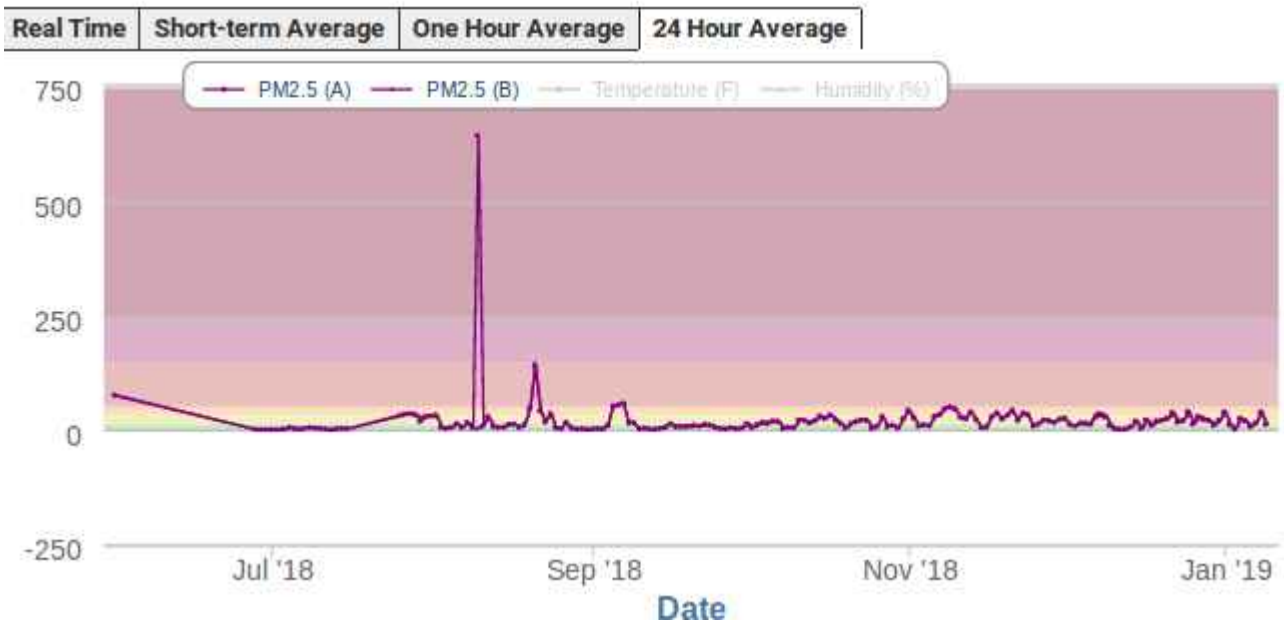
The mean is higher than the Hankin Avenue instrument, not very surprisingly since it includes some tag end forest fire levels and then the wood heating season onset increases.

For comparison below are the Hankin readings over that same period. I used a different spreadsheet but the stats are comparable. Note how not much improvement is evident from living in a quiet leafy suburban environment compared to right beside Highway 16.

Mean	21.652938545
Standard Error	0.0681101884
Mode	Err:538
Median	12.95
First Quartile	4.69
Third Quartile	29.73
Variance	649.10248373
Standard Devi	25.477489745
Kurtosis	20.413127216
Skewness	2.9092659037
Range	735.91
Minimum	0
Maximum	735.91
Sum	3029744.12
Count	139923

Several instruments have been used in **Smithers** in 2018, at least for a part of the year.

Here's a Smithers chart from June 27, 2018 to year end. This instrument is mounted near the intersection of Toronto St. and Railway Avenue.

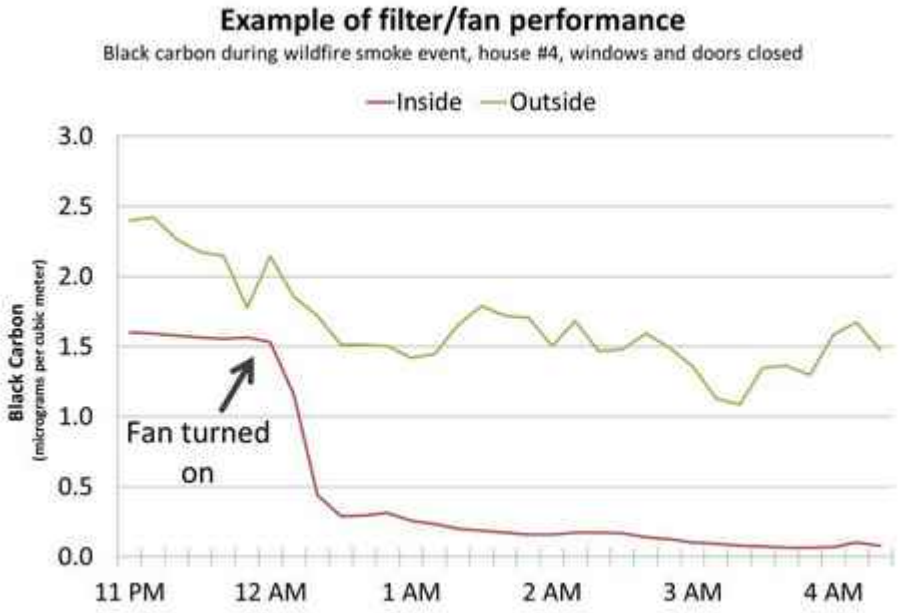


And the stats,

Mean	22.6508
Standard Error	0.36545
Median	8.27
Mode	1
Standard Deviation	158.206
Sample Variance	25029.1
Kurtosis	879.244
Skewness	28.9064
Range	5166.92
Minimum	0
Maximum	5166.92
Sum	4244858
Count	187404

This station is downwind from chimneys in the middle of Smithers, from both PIR and Pinnacle Pellet, is near two busy streets with significant industrial traffic and is within a block of the CN Rail line to Prince Rupert. Not surprising then that the mean is high but perhaps surprising that it is as high as it is. As a matter of curiosity and since we have an undeployed PA-II monitor we colocated an instrument for a little while nearby inside the hosts' home, in an open-plan main floor location where there is a small Bionaire particle filter always running. The mean *inside* PM2.5 for the period December 22, 2018 to January 11, 2019 was 2.2 while for the same period the *outside* instrument measured 20.3. So if you want a quick demo on the value of air filtering that pretty much makes the case.

During last year's fire season there was a lot of smoke south of the border too and the Puget Sound Clean Air Agency prepared a video about how to make a particle filter. The graph included on that page shows it achieving a sharp reduction like this:



One of our members got interested enough to make one of these and its only drawback is that it's noisy, but earplugs may be preferable to an asthma attack or heart disease. So a 20" fan isn't very expensive ($33 at Canadian Tire) and a MERV 13 filter can be had for about $10 (in dozens) and

everybody's got duct tape. Should we make some of these for next year's forest fire season? Lend them out? Hold a workshop?

Data issues, interpretation and caveats

In viewing the statistical tables in this report it needs to be noted that most of the numbers given are pure gibberish. Sources of error are rife, the sensors produce only integer values of PM2.5 levels, all real numbers are averages of some sort, including averages of averages reported without note. Data archived at https://purpleair.com/sensorlist has been used as a good faith best effort data record, spreadsheets were used for the data analysis tables and highcharts for graphs of data values. I have not truncated or rounded spreadsheet generated descriptive values, giving them here as they are produced by the software.

That said however, it needs also to be noted that the South Coast Air Quality Management District of the California Air Resources Board has tested these instruments and found them to compare very well with US EPA FEM colocated equipment. So pretty good results, especially considering costs. It is unfortunate that the white PVC weather shield traps the waste heat of the ~1 watt power consumption of the ESP8266 processor board and so skews the temperature and humidity measurements of the BME280 sensor. We're working on that.

The heat problem is well known and noted on the purple air web site as a source of potential error. An effort is under way at the University of Northern BC, under the direction of Dr. Peter Jackson, to take into account colocation readings of PA-II sensors as used by the AMS and BC Ministry of Environment BAMs to develop a regionally specific correction that will take local weather conditions into account. Early results of this project can be viewed on a map that shows both (some of) our instruments and MoE instruments with corrections applied to ours. No doubt further work will be needed and Dr. Jackson confirms that a further funding round will be needed to move the work forward. Pretty interesting though even if in its early stages.

Discussion, conclusion and path forward

What we're seeing here is the not very surprising outcome that by and large the places with highest incomes have the cleanest air. With the important exception of Smithers, where there are large industrial sources to take into account, the major sources appear to be domestic wood heat combustion and forest industry smoke, both from wildfires and slash burning. This is derived from direct observation, industry reports and preliminary emissions inventory data.

Direct measurement of adverse health outcomes has been impractical other than statistically by health agencies, so the inference of prevalence of ill health from poor air conditions has been proxy-based on ambient measurements. For historical reasons the BC Ministry of Environment has done the most ambient monitoring in population centres. In order to measure impacts on exposed people in a somewhat cost-effective and reliable way, EPA FEM equipment has been used. This gear is expensive both to buy and to maintain and the effect has been to not measure small settlements. In our area this means Old Fort, Tachet, Kispiox, Wet'suwet'en Village and other small First Nations communities don't get ambient measurements. Placement of AMS monitors has offset this to a small degree.

Measurements of conditions in one place are useful but the question of representativeness is sure to arise. In some cases this is of less interest because the place being measured is of great importance. In Smithers the Ministry's long monitoring of conditions at St. Joseph's School is highly relevant to the well-being of the kids who spend their days right beside the MoE trailer. So pretty high value information. The same argument of relevance though can easily be applied to Moricetown Elementary, any seniors' residence, hospitals and so on. And one's own home. It may be that library loans of AMS provided purple air monitors will be a service that helps inform people about conditions in places they care about.

It's clear that if a person or an instrument is exposed to air pollution it is only sensible to look upwind for the source. But in most of the AMS purple air locations weather information is not available. Telkwa has the remnants of a MoE pollution measurement station and the information that's still provided is wind speed and direction, so that's very useful. The Smithers St. Josephs MoE station provides met. data, as does the Smithers airport. It seems as if that's all the colocated weather data in places with AMS instruments. It's interesting to look at windy.com for a high level view of prevailing winds.

We've had a full-on regulatory grade weather station donated this past year. It includes a mast, anemometer, temperature and humidity sensors and data logger. Some repair and service work is needed. It will likely be installed in Witset near the health centre where our PA-II is installed. The need to pour a concrete base will likely delay deployment until Spring.

It may be that we will again receive donations to help with our purple air network as we have done in the past two years. It would make for a better network if we had a spare PA-II to swap out. Likewise the only thing that has gone wrong with the instruments has been sensor failure. After some experimenting with repairs it seems quite feasible to exchange old sensors for new, so a supply of spares would be desirable there too. After about two years of use some purple air monitors which had been colocated at the Smithers St Josephs MoE station were removed from service in November. It might be possible that the Ministry would donate these as-is. After replacing both sensors these could be returned to service in some currently unmonitored communities. For perspective, refurbishing an instrument with two new sensors would cost more or less $40 *vs* $350 to buy a new PA-II, so quite a worthwhile saving.

References

https://www.purpleair.com for general information about the purple air project and ordering

https://www.purpleair.com/map for a global map display of current public monitor readings. This map uses openstreetmap as a base layer.
https://www.purpleair.com/gmap?&zoom=7&lat=54.67286953227461&lng=-126.18353610450878&clustersize=31&orderby=L&latr=3.4530402547109063&lngr=12.12890625 as a google map base layer for display of public monitors, this map offers quite good terrain display from the dropdown tick box.

https://www.purpleair.com/sensorlist is the online public data archive, downloads as .csv files.

https://cleanairplan.ca for information about the Airshed Management Society and https://cleanairplan.ca/blog for the coordinator's blog, mostly wood heat issues.

http://www.aqmd.gov/docs/default-source/aq-spec/summary/purpleair-pa-ii---summary-report.pdf?sfvrsn=4 for tests of these instruments.

http://weather.unbc.ca/aqmap/?zoom=8&lat=54.498&lng=-126.161 for UNBC's combined map of BC MoE station readings and purple air readings, including ours.

Puget Sound Clean Air Agency for homebrew air filter instructions