bulkley valley - lakes district
airshed management society

Purple Air Monitors in our Plan area in 2017

In 2017 we installed Purple Air PA-II monitors in Hazelton, Gitanyow, Telkwa and Witset, in that order. The installations were generally easy and we had reliable operation throughout the balance of 2017 after installation. For reference then we have collected data for these dates by location:

Hazelton	May 10-Dec. 31
Gitanyow	Sept. 10-Dec. 31
Telkwa	Oct. 11-Dec. 31
Witset	Dec. 11-Dec. 31

Information gathered is automatically archived online and can be downloaded as a .csv file for analysis or for safekeeping. In most cases I've downloaded the data monthly and posted it to an archive section of the websites.

And speaking of websites, they are organized by community as subdomains of our main site which is at https://cleanairplan.ca and are like this:

https://hazelton.cleanairplan.ca/
https://gitanyow.cleanairplan.ca/
https://telkwa.cleanairplan.ca/
https://witset.cleanairplan.ca/

I usually access the sites by a link at https://new.cleanairplan.ca on the right hand sidebar with link text, "our air monitor communities." I usually point my mouse to the map label in the bottom left and then toggle terrain on. Helps with visualization.

Each of these sites contains some background information and a link to the purple air map for that community. That map has a marker on it that displays basic information about real time values. The menu box on the top left of the map (a modified Google map) allows toggling and selecting how the summary data is presented, so F vs C temperatures, Imperial vs Metric and mass vs AQI. I personally always want Celsius, metric and mass. Suit yourself, the settings will persist on your device.

If you click on the marker you'll get a pop-up box with scads of information. It's a lot of work to see what all is there, I still see new stuff from time to time. What I mostly look at is the 1-hour readings and 24 -hour readings. There are two rows of coloured boxes – one for each of the sensors in that monitor, and you'll see slightly different readings in each. The purple air site calls these channels sometimes. Generally they don't differ much. At the bottom of the box is a display of readings from both sensors displayed x-y fashion with a coefficient called R^2, a correlation value, values closer to 1 indicate better agreement.

The AQI value displayed is problematic. The Air Quality Index is a national standard in both the US and in Canada but they are not the same. The purple air project is based in the US so it's natural that the US EPA standard would be used. But it isn't. Instead the short-term reading (over a 10 minute period) is used as if it were the arithmetic base measurement in the AQI calculation. But the AQI definition is based on a 24 hour measurement. So if you looked at a sequence of purple air AQI measurements and a sequence of EPA AQI figures, you'd be looking at different numbers. I think this is not accidental, the project sponsors include medical people who want to call attention to short term spikes in pollutants and this is how they've chosen to proceed. So *caveat emptor* – let the viewer beware.

The cleanairplan.ca web site has become a dog's breakfast after many difficulties over the last couple of years and the AMS now has a work plan item to update it. As I write the work in progess has been going into https://new.cleanairplan.ca. In the near future that content will be moved to http://cleanairplan.ca and the current site will become a zombie at http://cleanairplan.ca/old. The purple air sub-sites won't be changed.

References to air pollutants below mention PM. The PM reference is to **p**articulate **m**atter. Some terminology is probably in order. PM is basically little chunks of stuff floating around in the air that have several relevant aspects. If a particle can be suspended in the air it's a suspendable particle, if it can be inhaled it's a respirable particle. A smaller particle has, all else being equal, a couple of salient characteristics – it can travel further from its source and it can be inhaled deeper into the lungs. The relevant mass units for PM are micrograms - millionths of a gram – and the useful size units are microns – millionths of a metre. The Greek letter mu[1] - μ - is used for a millionth so μg for microgram. A common reference would be to a concentration of 25 $\mu g/m^3$ of PM2.5. If you think of particles small enough to fit through a round hole 2.5 microns in diameter that would be the size fraction. A particle smaller than that is PM2.5 too, *everything* that fits through the hole. As a matter of experience in health effect estimation, PM10, PM2.5 and really small stuff at PM0.1 are commonly used, as is total PM, all suspendable particles.

I prepared a report for some of my BC environmental colleagues and talked a bit about our purple air communities as well as other northern communities and I'll happily send a copy if anyone wants a broader overview. For now, though it means I can plagiarize the other report for information specific to these places. To quote then...

We were especially concerned that upcoming changes in the Open Burning Smoke Control Regulation might increase smoke exposure in small villages. If you refer to this table of MoE monitor locations you won't see Witset or Gitanyow on the list.

Station name	2017 Annual PM2.5
Valemount	16.4

1 A learned young curate in Kew
Kept an aged tomcat in a pew
To teach it to speak
Alphabetical Greek
But it never got further than mu!

Prince George – Plaza 400	11.5
Vanderhoof	9.4
Burns Lake	6.9
Houston	8.9
Smithers	7.6
Terrace	6.3
Kitimat - Whitesail	7.5
Kitimat - Riverlodge	4.2
Kitimat – Haisla Village	8.8
Dawson Creek (Pouce Coupe)	5.1
Fort St John – Old Fort	4.8
Fort St John – Key Learning Ctr	6.0
Fort St John - 85th Ave	4.6
Fort St John North Camp	5.2
Peace Valley Attachie	3.6
Taylor Lone Wolf Golf Course	5.9

Highlighted values exceed annual objectives. (non-reviewed data from MoE archive)

The typical small village in our area is a reserve. It's exactly in the backa beyond where the slash burning takes place and some anticipated OBSCR changes will tend to make matters worse. The experience of people in Gitanyow, Hazelton, Witset and Telkwa, where we have monitors, is that things are far from good now. With monitors in use we are starting to put background data collection in place.

It is widely acknowledged in the public health literature that there is no safe level of exposure to PM. If you can measure it you'll be harmed by breathing it. It would make some sense then to perhaps take steps to make people aware of PM levels of less than 25 $\mu g/m^3$ but as far as I know no such mechanism exists apart from looking at the monitor. There are also health effects issues around the whole idea of averaging, conspicuously biological relevance of a non-statistical nature. It does no-one any good to know that the 24 hour average is less than 25 $\mu g/m^3$ if you've choked at the 11 $\mu g/m^3$ level and are now dead. There's a famous bad joke about a statistician who drowned in a creek that was only 20 cm deep – *on average*. So biological relevance must always be borne in mind when looking at levels, especially annual averages as I'm about to do.

A conspicuous example of the need to examine the data closely and not rely on averages[2] arose this year in Valemount where cold weather PM levels showed frequent really phenomenal spikes for a few hours, typically overnight.

There are 8760 hours in a year and in 2017 in Valemount there were:
1374 hours with PM ≥ 25, (≥ is greater than or equal)

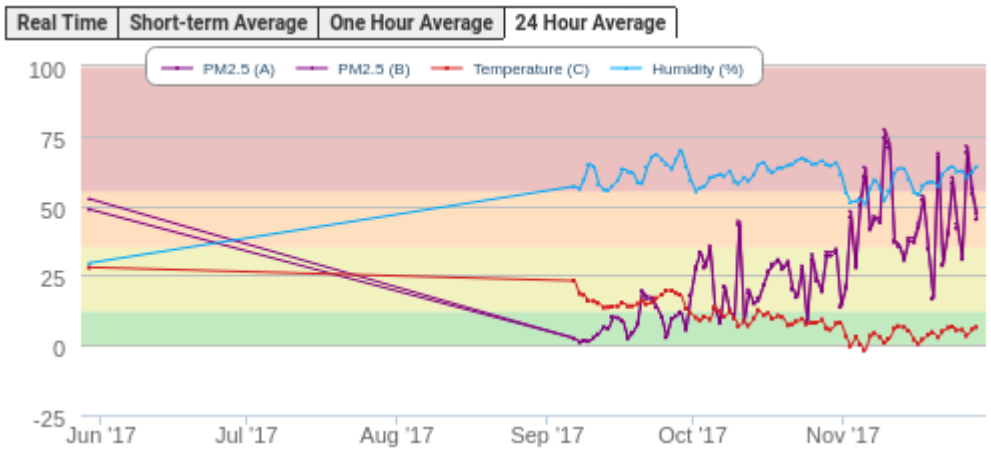
2 http://www.sjsu.edu/faculty/gerstman/StatPrimer/anscombe1973.pdf

709 hours with PM ≥ 50
279 hours with PM ≥ 100 and a phenomenal
84 hours with PM ≥ 200

The highest was 421 µg/m³. This kind of occasional anomalous behaviour of interest to informed health decisions is not so uncommon and ought not to be concealed in summary figures.

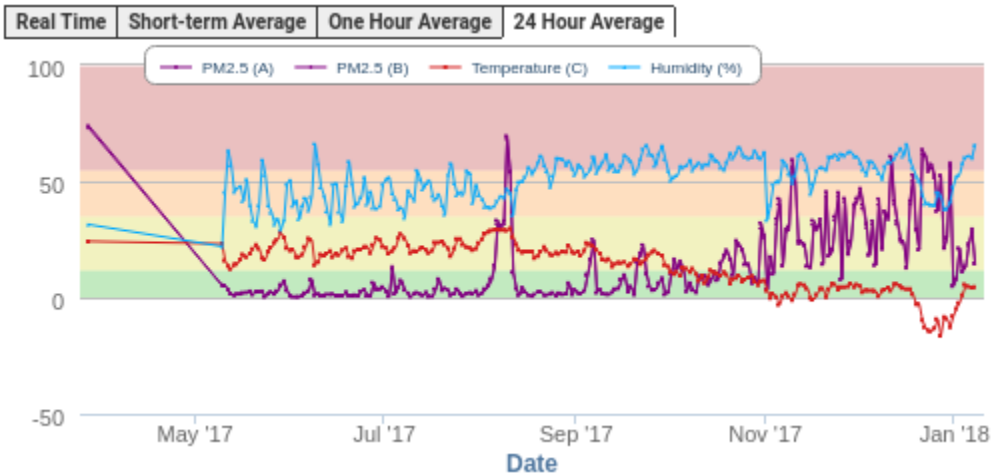
For those who look at the details I want to include some charts here. They consist of recent readings, data points are averaged every 24 hours and the points are those on the chart lines.

Gitanyow first:

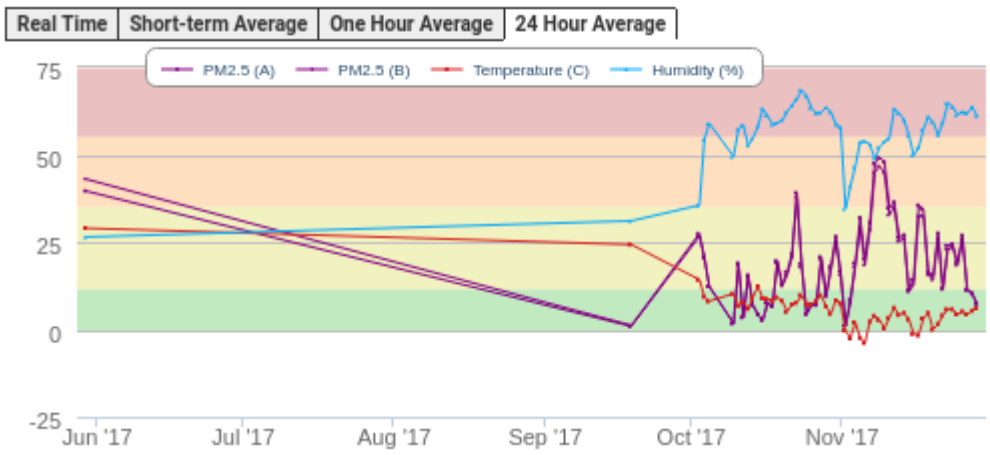


Levels shown here start on September 11 and run to November 29th. Roughly the levels have increased erratically but steadily to about 65.

Hazelton next:

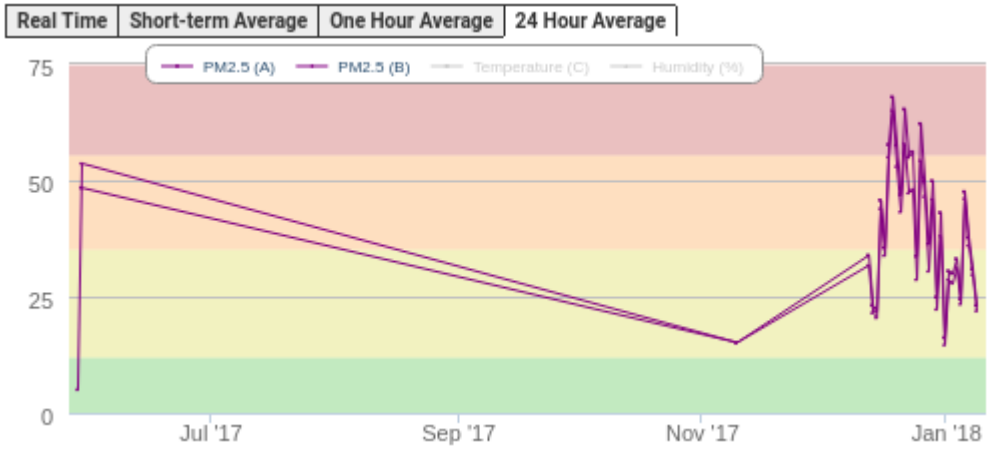


Here we can see low levels from the May 10th installation to the big fat forest fire blip in August, then starting in mid- to late- September the beginning of the climb to about 30 µg/m³. And now Telkwa:



So from October 11th a rise from around 10 to around 23 or 24 with a blip in mid-November.

The Witset monitor started operation Dec. 11Th:



So the 24 hour averages have pretty consistently been above 25 µg/m^3 and sometimes three times that. Not good.

Remember that the BC objective for 24 hour PM2.5 is 25 µg/m^3.

Data gathered by purple air monitors is archived and readily available online for download as .csv files, suitable for spreadsheet use. We don't have a year of data and several caveats apply to data quality but a first cut 2017 average analysis of the four communities we monitor is like this:

Hazelton:	14.8
Gitanyow:	45.4
Telkwa:	33.4
Witset (Moricetown):	55.8

These levels are high but not incredible. The Hazelton readings (from May-Dec) include lotsa nice sunny breezy weather that drive the average down and lots of forest fire smoke and quite a lot of winter chimney smoke. Gitanyow (Sept-Dec) was showing high short term levels early on and rose through the cooler weather. Telkwa (Oct-Dec) was pretty much entirely in cold weather, it's also the

only monitor that is quite close to a busy road, Highway 16. And Witset (formerly Moricetown) started up December 10th and shows winter high levels.

There are several potential sources of error in these figures and I think it's only reasonable to point them out. The purple air monitors contain particle counters made by a firm called Plantower who claim ±10% accuracy and say the counters are not accurate below -10°C. The readings above all include some -10°C weather and may be biased in an unassessed way. Unfortunately the temperature readings that the purple air monitors gather are known to be biased and can't be used. There's a MoE met. station in Telkwa and in principle the readings for colder periods could be removed. This would tend to lower the readings. It's more work than I can take on right now though so I'll have to set that bit aside. In future a colocated weather station would be extremely useful, something to think about.

As time goes by it becomes possible to look at seasonal trends. Hazelton, having the longest data collection, is a good starting point. From May 10th 2017, when the monitor was installed, to June 21st, so the tail end of Spring, readings averaged .999 µg/m^3. From June 22nd to Sept 21st levels averaged 6.61 µg/m^3. From September 22, 2017 to December 31, 2017 the average PM2.5 reading in Old Town was 27.6 µg/m^3.

Gitanyow, Telkwa and Witset have not been installed long enough to take a seasonal overview but the numbers set out above are indicative of their Fall and early Winter conditions.

If any of you don't know, you can subscribe to air quality notifications by text or email at https://aqadvisories.ca. Step through the pages, it's meant to be easy and self explanatory. Air quality advisories are sent when the 24 hour PM2.5 levels exceed 25 µg/m^3. Given that notifications can be sent easily it's possible that informational notices might be sent at other levels that might be of interest to specific people but putting that in place would be more work (probably a lot.) Also, notices might be sent around advisories triggered by other pollutants than PM as well, though not by us. MoE is anticipating doing this in Kitimat for SOx as and when the occasion arises. And on the same topic we offer notifications on slash burning, too, at https://openburning.ca. My email notices this past Fall pointed to 25,432 slash piles being burned in the Bulkley and Nadina districts, so well worth paying attention to.

If for the sake of discussion we accept the reading shown above as indicative of annual levels we are in the position that all communities exceed the CAAQS. Or they would if these were obtained from three years of readings. But the CAAQS is not a health based standard. A more appropriate approach might be to examine the data for potential threats to public health then consider precautionary interventions. It wouldn't be hard to find cause for concern but the actual path forward is not clear.

Sources and references

For Ministry of Environment readings and data archive https://www.bcairquality.ca

For purple air monitors, especially in the northwest: https://www.purpleair.com/map?&zoom=9&lat=55.00696613138566&lng=-127.32795650482177&clustersize=30&orderby=L&latr=0.9797253527364873&lngr=2.77130126953125

CAAQS, Canadian Ambient Air Quality Standards: https://www.ccme.ca/en/current_priorities/air/caaqs.html

BC Air zones: https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality/current-air-quality-data

Purple air downloadable data: https://www.purpleair.com/sensorlist

Field tests of purple air monitors - http://www.aqmd.gov/aq-spec/product/purpleair

Statistics and Comparisons

One of the nice things about spreadsheets is that they are so much smarter than I am about descriptive statistics. Below I've set out 4 sets of stats for each of the purple air community monitors' datasets. In every case they take in all the 2017 readings. Following is a pair of results about the Victoria Topaz colocated MoE and Purple Air monitors.

Gitanyow 2017 *Mean* 45.4235 *Standard Error* 0.15998 *Median* 25.38 *Mode* 1 *Standard Deviation* 55.1409 *Sample Variance* 3040.52 *Kurtosis* 7.97987 *Skewness* 2.20596 *Range* 1063.98 *Minimum* 0 *Maximum* 1063.98 *Sum* 5396544 *Count* 118805	*Telkwa 2017* *Mean* 33.4319 *Standard Error* 0.15416 *Median* 21.05 *Mode* 0.24 *Standard Deviation* 45.2468 *Sample Variance* 2047.27 *Kurtosis* 242.536 *Skewness* 9.42303 *Range* 2286.51 *Minimum* 0 *Maximum* 2286.51 *Sum* 2880095 *Count* 86148
Witset (Moricetown) 2017 *Mean* 55.8478 *Standard Error* 0.35007 *Median* 42.29 *Mode* 8.05 *Standard Deviation* 47.4593 *Sample Variance* 2252.39 *Kurtosis* 5.79582 *Skewness* 1.7035 *Range* 698.37 *Minimum* 0 *Maximum* 698.37 *Sum* 1026483 *Count* 18380	*Hazelton Old Town 2017* *Mean* 14.7595 *Standard Error* 0.05622 *Median* 3.52 *Mode* 1 *Standard Deviation* 28.0829 *Sample Variance* 788.649 *Kurtosis* 48.724 *Skewness* 4.6268 *Range* 923.31 *Minimum* 0 *Maximum* 923.31 *Sum* 3683191 *Count* 249547

Note revised summary figures from previous version of this document to correct a calculation.

Colocated MoE and Purple Air monitors at the Victoria Topaz location, descriptive statistics

Purple Air all of 2017	MoE all of 2017
Mean 10.3081327943844	*Mean* 7.1661
Standard Error 0.019436514454219	*Standard Error* 0.08358
*Mode Err:*538	*Median* 5
Median 5.7	*Mode* 0
First Quartile 2.07	*Standard Deviation* 7.73859
Third Quartile 12.56	*Sample Variance* 59.8858
Variance 185.23857734097	*Kurtosis* 9.96343
Standard Deviation 13.6102379604829	*Skewness* 2.59289
Kurtosis 13.3165182862268	*Range* 74
Skewness 3.0645035507036	*Minimum* 0
Range 222.1	*Maximum* 74
Minimum 0.02	*Sum* 61435
Maximum 222.12	*Count* 8573
Sum 5054458.91	
Count 490337	

These figures derive from very different types of equipment and were computed on different spreadsheets and only rough comparisons are worthwhile. It is my understanding that the Ministry of Environment is undertaking testing and analysis of the Purple Air monitors and will report on their findings. These table should be used for only approximate purposes, for example note that N=490337 in one case and N=8573 in the other. There are other significant differences as well.