

PurpleAir PA-II Air Quality Sensor

Real-time measurements of particulate matter

What is the PurpleAir Sensor?

The PurpleAir PA-II is a small, low-cost air quality sensor that:

- measures particulate matter (PM₁₀, PM_{2.5}, and PM₁), ambient temperature, pressure, and relative humidity using sensor technology;
- is very easy to transport, deploy and maintain;
- reports data in real-time on a user-friendly map website; and
- can be used to provide information on air quality, for example when a community experiences wildfire smoke.



Current PurpleAir PM_{2.5} data are available in real-time on the [AQMap](#), which is hosted by University of Northern British Columbia (UNBC)¹.

Why monitor PM_{2.5}?

PM_{2.5} is an air pollutant that can be harmful to human health.

PM_{2.5} is generally the largest contributor to poor air quality during episodes of wildfire smoke. PM_{2.5} is made up of very small particles, with a size of 2.5 micrometers or smaller. PM_{2.5} can be inhaled into the lungs and may cause symptoms such as coughing or may worsen existing heart and lung conditions. PM₁ and PM₁₀ refer to particles smaller than 1 and 10 micrometers in size, respectively.

How can I interpret PM_{2.5} data?

The [AQMap](#) presents PM_{2.5} concentrations from PurpleAir sensors and associated health messaging. One-hour averaged PM_{2.5} concentrations can be compared to the [Alberta Ambient Air Quality Guideline](#) (AAAQG) of 80 µg/m³. 24-hour averaged PM_{2.5} concentrations can be compared to the [Alberta Ambient Air Quality Objective](#) (AAAQO) of 29 µg/m³. The PM_{2.5} AAAQO and AAAQG are based on health effects as well as other factors.

The AQMap health messaging can serve as broad guidance since individuals can react differently to air pollution. It is recommended that you monitor your symptoms and adjust your activities to reduce your exposure levels as needed. The AQMap health messaging was developed to generally reflect Air Quality Health Index (AQHI) health messaging².

¹ AQMap applies a correction to account for known overestimation of PurpleAir PM_{2.5} concentrations. Real-time PurpleAir data broadly indicate air quality and may include data quality issues. Data are also available on the [PurpleAir website](#), but are not corrected and therefore may over-report PM_{2.5} concentrations.

² The AQMap considers only PM_{2.5}, whereas the national AQHI includes PM_{2.5}, ozone, and nitrogen dioxide. For information on how Alberta reports the AQHI visit the [Alberta Air Quality Health Index \(AQHI\)](#).

How does Alberta Environment and Protected Areas use PurpleAir sensors?

Community wildfire smoke monitoring

[Wildfire smoke](#) is the most prevalent form of air pollution in the summertime in Alberta, has known health effects, and is expected to become more severe in the future. Therefore, [wildfire smoke monitoring](#) is a priority for Alberta Environment and Protected Areas. Alberta Environment and Protected Areas has deployed PurpleAir sensors to dozens of communities for wildfire smoke monitoring (Figure 1). Suitable communities were selected based on geospatial analysis and monitoring gaps identified in previous fire seasons. PurpleAir sensors are delivered by mail and deployed by the communities.

The public can access the PurpleAir data in real-time through the [AQMap](#). The PurpleAir data will also contribute to the understanding of Alberta's air quality during wildfire season. Alberta Environment and Protected Areas can use PurpleAir data to understand the magnitude and scale of wildfire smoke across the province, and to inform decision-making when wildfire smoke is severe. In addition, Environment and Climate Change Canada is starting to use PurpleAir data to improve smoke forecasting capabilities.



Figure 1: Ten PurpleAir sensors undergoing testing in Edmonton in March 2021, in preparation for the wildfire season.

Focused studies

Focused studies are shorter-term monitoring projects (less than five years) designed to answer specific questions that cannot be addressed by existing monitoring. This includes investigations of specific or highly localized air quality issues, such as complaints from the public. Alberta Environment and Protected Areas may use the PurpleAir sensor for selected focused monitoring applications. For example, Alberta Environment and Protected Areas has deployed PurpleAir sensors where wind-blown dust may affect nearby residents.

What are the limitations of the PurpleAir sensor?

- **The PurpleAir is not suitable for regulatory compliance monitoring.**
For regulatory compliance monitoring, Alberta accepts Federal Equivalent Methods (FEM) for PM_{2.5}, as designated by the United States Environmental Protection Agency. The PurpleAir sensor is not an FEM.
- **The PurpleAir monitors particulate matter (PM₁₀, PM_{2.5}, and PM₁) and some meteorological parameters only.**
The PurpleAir may not be ideal for all air quality monitoring applications or identifying specific sources of air pollution.

How are PurpleAir sensors deployed and maintained?

Alberta Environment and Protected Areas, airshed organizations, Environment and Climate Change Canada, and community members deploy PurpleAir sensors in Alberta. The PurpleAir is very easy to deploy compared to traditional air monitoring equipment. The PurpleAir is a standalone sensor, requiring only a power connection, a WiFi connection, and a secure area for deployment. The PurpleAir sensor can be delivered by mail and installed by members of the public. Once running, the PurpleAir sensor automatically collects and transfers data to publicly available map websites. No routine maintenance is required unless data quality issues are observed.

Prior to deployment, Alberta Environment and Protected Areas tests each PurpleAir sensor in order to verify that it is working correctly. Alberta Environment and Protected Areas provides a set of installation instructions, including guidance on selecting a monitoring site, when supplying PurpleAir sensors to communities for wildfire smoke monitoring. Airsheds, Environment and Climate Change Canada, and community members also deploy PurpleAir sensors in Alberta.

How does the PurpleAir compare to other monitoring methods?

The performance of the PurpleAir was evaluated for use in Alberta by comparing against other PM_{2.5} monitoring methods. Prior to comparisons, the PurpleAir data were adjusted using the correction factor developed for the UNBC [AQMap](#) website³. This correction factor accounts for a [known high bias in PurpleAir data](#). Figure 2 and Figure 3 show that the corrected PurpleAir PM_{2.5} data agree well with other monitoring methods in Alberta.

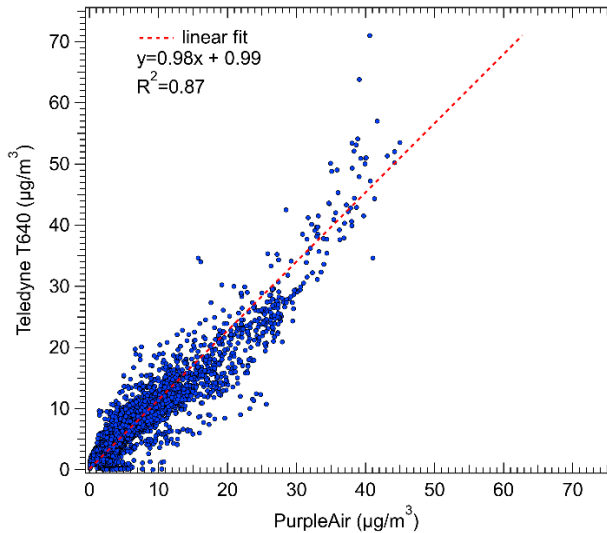


Figure 2: Good agreement observed between the corrected PurpleAir and the Teledyne T640 for typical urban PM_{2.5} concentrations⁴, with slope = 0.98 and $R^2 = 0.87$. The Teledyne T640 is FEM designated.

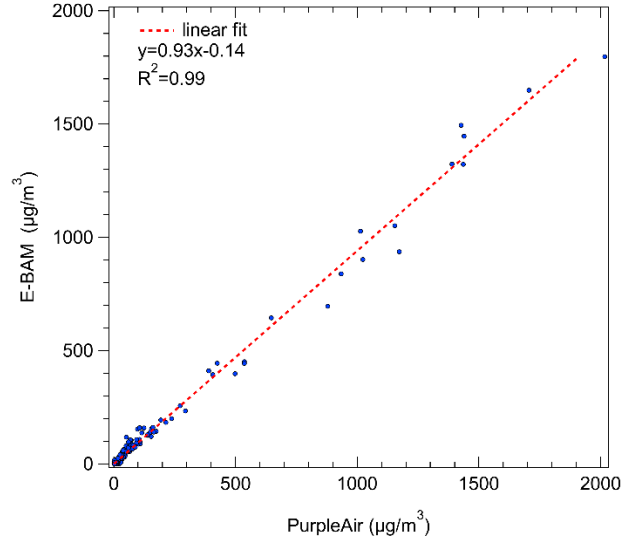


Figure 3: Good agreement observed between the corrected PurpleAir and the E-BAM under wildfire smoke conditions⁵, with slope = 0.93 and $R^2 = 0.99$. The E-BAM is not FEM designated, but is used routinely by Alberta Environment and Protected Areas for wildfire emergency response support.

Related Resources

- Real-time PurpleAir data on the UNBC AQMap <https://cyclone.unbc.ca/aqmap>
- PurpleAir sensor technical specifications: <https://www2.purpleair.com/collections/air-quality-sensors>
- Wildfire smoke monitoring in Alberta: <https://aep-aws-air.shinyapps.io/wildfiresmokemonitoring/>
- AQ-Spec Field evaluation of Purple Air (PA-II) PM Sensor: <http://www.aqmd.gov/docs/default-source/aq-spec/field-evaluations/purple-air-pa-ii--field-evaluation.pdf?sfvrsn=2>

³ The correction used for the [AQMap](#) as of May 13, 2021 was applied. The correction formula is shown below, where $PM_{Corrected}$ and PM_{RAW} are the corrected and raw PurpleAir PM_{2.5} data, respectively, and RH is the relative humidity measured by the PurpleAir. If RH is lower than 30, then RH is set to 30. If RH is greater than 70, then RH is set to 70. The most up-to-date correction formula can be found on the [AQMap](#) website.

$$PM_{Corrected} = PM_{RAW} * 0.54 + PM_{RAW}^2 * 0.0011 - RH * 0.09 + 6.4$$

⁴ Hourly average PM_{2.5} measurements for the corrected PurpleAir were compared against the Teledyne T640 monitor at McCauley station in Edmonton for September 2019 to July 2020. If axes are reversed (PurpleAir on y-axis, T640 on x-axis): $y = 0.88x - 0.10$; $R^2 = 0.87$.

⁵ Hourly average PM_{2.5} measurements for the corrected PurpleAir were compared against the Environmental Beta Attenuation Mass Monitor (E-BAM) in High Level during wildfire season in 2019. If axes are reversed (PurpleAir on y-axis, E-BAM on x-axis): $y = 1.06x - 0.80$; $R^2 = 0.99$.