Summer 2020 Newsletter

2B Technologies — 2B Buzz

We Are Open, and Accepting/Shipping New Orders

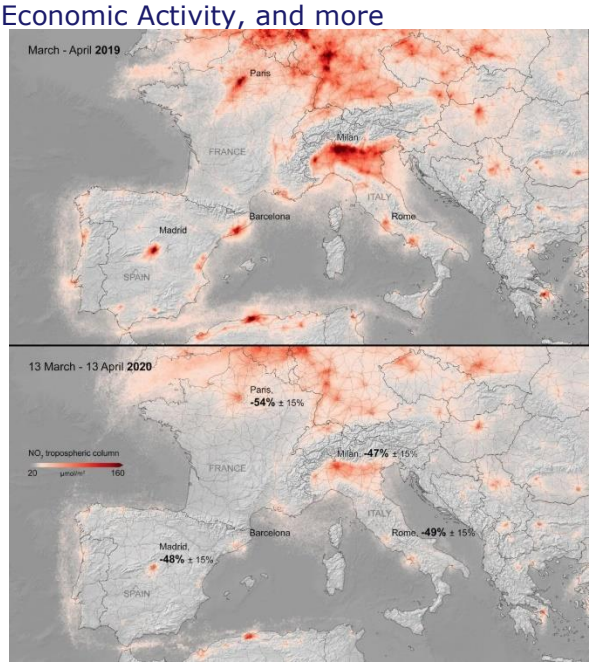
2B Technologies is playing a role in the fight against COVID-19. We manufacture the ozone monitors used in "ozone disinfection robots" that destroy viruses and bacteria by use of gas-phase ozone. Our instruments are also used in other areas important to public health, such as food safety and water treatment. As a result, we are designated as an essential business. We remain open and are able to fulfill orders for any of the monitors and calibrators in our product lineup. We have adjusted our procedures to protect the health and safety of our employees and the community at large, which remains our top priority. We wish everyone the best in these challenging times.

Air Pollution News

COVID-19 Impacts as Viewed from Space

New Websites Display Lockdown Effects on Air Pollution, Economic Activity, and more

Human activity has taken a major detour during the global pandemic, and it's showing up in air quality and other data in many ways. The major space agencies of the U.S. (NASA), Europe (ESA), and Japan (JAXA) have partnered together to develop the joint COVID-19 Earth Observation Dashboard. At the touch of a finger, visitors to the website can explore changes in air and water quality, climate change, economic activity, and agriculture. A tutorial describes what's available and how to navigate the dashboard.



Satellite measurements of NO2 above Europe from March-April in 2019 (top) and 2020 (bottom) show the effects of COVID-19. From the CoOVID-19 Earth Observation Dashboard. [Credit: ESA]

Also, through a rolling solicitation program of NASA, a new website is tracking the nitrogen dioxide (NO_2) columns measured from the OMI and TROPOMI satellite instruments before, during, and after virus peaks in cities worldwide. NO_2 is produced during fossil fuel burning, and its transportation sources have plummeted during the COVID-19 lockdowns. The website enables you to explore individual cities, regions, and continents across the globe. Video visualizations are especially fascinating, such as the one for Europe linked here. The website was developed through the Rapid Response and Novel Research in Earth Science (RRNES) solicitation of the NASA Headquarters Earth Science Division, which was initiated in 2020 to support COVID-19 impact studies.

COVID-19 Earth Observation Dashboard

NASA NO2 Website

Case Study

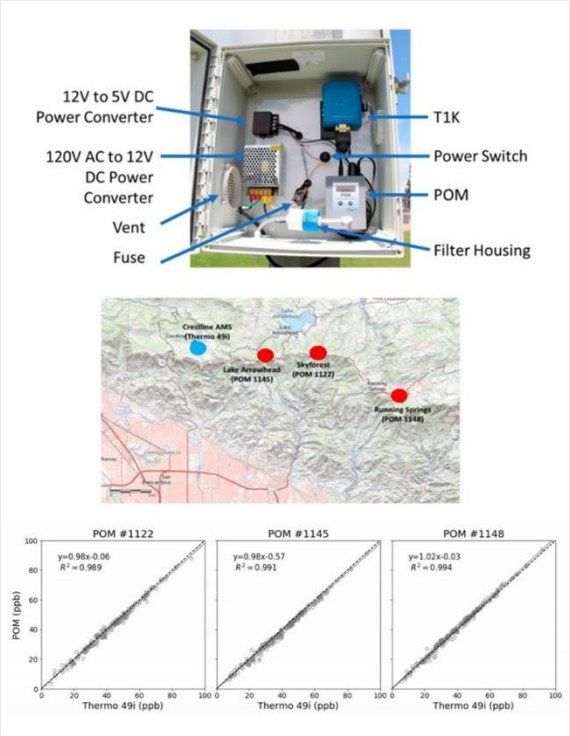
What to Do When Your Long-Term Ozone Monitoring Site Might Have to Move

Three 2B Tech POMS Provide Rigorous Data in CA Site Comparison Study

Scientists in California's South Coast Air Quality Monitoring District were facing a dilemma. It was possible that they might not be able to continue the lease on their long-term "Crestline" air monitoring site in the San Bernardino Mountains. The site is especially important because it registers some of the highest ozone values in the South Coast Air Basin, thus providing a key metric for the protection of public health in a highly populated region that experiences some of the worst air pollution in the U.S. If continuity at the site became impossible, the comparability of the replacement site would be crucial.

The researchers came up with a cost-effective way to study multiple potential relocation sites within a few miles of the Crestline station. At the heart of their approach was 2B Tech's Personal Ozone Monitor (POM), a robust UV absorption-based, miniaturized instrument capable of remote operation that also happens to be designated as a Federal Equivalent Method (FEM) by the U.S. Environmental Protection Agency. Three POMs were used to construct three separate weatherproof "ozone sensor nodes" that also included an "Internet of Things" communications device for data acquisition, edge data processing, and data telemetry to a cloud-based platform for data storage and visualization. Each node (shown in the top panel of the figure) was constructed at a cost of about $6500.

The study, published by Brandon Feenstra et al. in the journal *Sensors*, describes the protocols for pre- and post-calibrations of the POMs versus the Crestline reference monitor, and the results of the 2-month deployment during the high-ozone summer months of 2017. The post-calibrations showed that for hourly averaged ozone data, the POMs all maintained excellent agreement with the reference monitor throughout the study (correlation coefficients of >0.98, and average intercept offsets of about 0.6 ppb). The POMs performed reliably during the 2-month deployment, with only one interruption caused when one of the three enclosures developed a leak. As noted by the authors, "...*the individual POMs maintained their calibration throughout the deployment period and collected accurate measurements... Additionally, the performance was not adversely affected by changing weather conditions, interfering pollutants, or length of deployment.*"



Top: One of the three "ozone sensor nodes," with the POM in the lower right. Middle: The Crestline site (blue circle) and the three relocation sites (red circles) studied in the intercomparison. Bottom: The POMs' agreement with the Crestline reference instrument after the 2-month deployment. (Figures from Feenstra et al., 2020)

The network of sensor nodes proved valuable in showing that the three relocation sites, though all near Crestline, would have varying levels of comparability that were important to consider. The detailed measurements from the POMs would have enabled the scientists to choose the best site for optimized data continuity. It appears, though, that a move has not yet been necessary. The Crestline station is still operating.

Development of a Network of Accurate Ozone Sensing Nodes for Parallel Monitoring in a Site Relocation Study, B. Feenstra, V. Papapostolou, B.D. Boghossian, D. Cocker, and A. Polidori, *Sensors* (2020) 20(1), 16.

2B Tech Personal Ozone Monitor

Link to Feenstra et al.

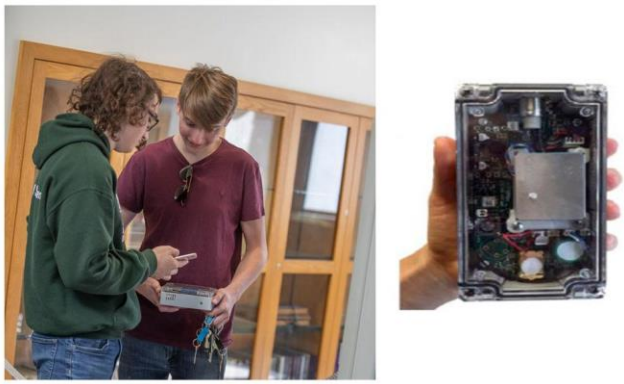
Case Study

High School Students Motivate School's Air Quality Improvements

2B Tech's Personal Air Monitor (PAM) Sparks CO_2, CO Discoveries

Question: What do you get when you combine students (and their smart phones) with a 2B Tech Personal Air Monitor and an innovative curriculum?

Answer: *Action!*



Petaluma High School students use a 2B Tech Personal Air Monitor (right) to measure CO2, CO, and particulates.

Students at Petaluma High School in California discovered that their occasional classroom grogginess could be caused by more than late-night homework or social media activities. Armed with a 2B Tech hand-held Personal Air Monitor (PAM) and some background research, they found another explanation: Science. Specifically, elevated carbon dioxide (CO_2) levels in the classroom that are known to induce droopy eyelids.

The PAM has sensors for measuring CO_2, carbon monoxide (CO), and particulate matter. As part of a project in Kris Camacho's AP Environmental Science class, the high school juniors and seniors hypothesized where they might find elevated pollutant levels at the school and then made measurements around their campus. Their research led them to expect high CO_2 in classrooms, but they were still surprised at the levels they found. The measurements ranged from 3,000 to 4,700 parts per million -- with the maximum being nearly 5 times higher than the amount known to impair cognitive functioning. As a student noted, "No wonder I'm always so sleepy in class!" The CO_2 levels they found are about 10 times higher than ambient concentrations.

The work was part of a curriculum called AirActions, developed by Tim Dye of TD Environmental Services LLC (www.TDEnviro.com). As implied by the program's name, the idea is for students to take the next step to formulate actions based on their science findings. The Petaluma HS students followed through by working with teachers to increase the air flow in classrooms. A simple no-cost solution, opening windows and doors, did the trick.

The students were also able to track down a faulty furnace as the cause of high CO levels in a locker room, and then motivate the school maintenance department to conduct testing and to monitor the situation more closely.

The students were enthusiastic that their project resulted in actions to improve the indoor air quality at their own school. The small size of 2B Tech's PAM, and its easy communication of data in real time via the students' smart phones, made for a scientifically meaningful but fun example of "doing

science." Perhaps the experience planted the seeds for some future careers in environmental science.

Check out the full story written by Tim and Kris about the project, linked here.

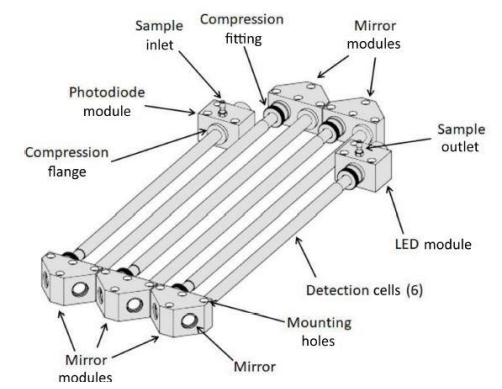
2B Tech Personal Air Monitor | **AirAction Story**

Company Spotlight

Another Patent for 2B Tech: Folded Tubular Photometer

Innovative Absorption Cell Enables Sensitive, Rapid Measurements in a Compact Design

In June, the U.S. Patent and Trade Office issued a patent for "Method for Measuring Air Pollutants Using a Folded Tubular Photometer."



The folded tubular photometer (FTP) provides a new way to measure the air pollutants nitrogen dioxide (NO_2), nitric oxide (NO) and black carbon ("soot") and protects the Model 405 nm NO_2/NO/NOx Monitor and the Black Carbon Photometer. Additional future products based on the absorption of specific wavelengths of light, such as a sulfur dioxide (SO_2) monitor, would be protected as well.

In order to measure levels of air pollutants as low as one part per billion (ppb), a long absorbance path length (2 meters or about 6 feet) is required. The FTP achieves this by using a cylindrical detection cell (a metal tube) that is "folded" by the use of mirrors in a compact design that enables the instrument to fit in a rack-mount-sized enclosure. The design minimizes the cell volume while providing the long path length, both key to increasing measurement sensitivity and reducing the measurement times. In the case of the Black Carbon Photometer, the FTP is literally an example of "smoke and mirrors" as the soot particles absorb light from an LED on its tortuous path to a photodiode detector.

One might ask the definition of a part-per-billion. Imagine circling the globe at the equator with golf balls. Now remove one golf ball. That golf ball is one part per billion of all the golf balls around the equator. Even these very low levels of air pollutants are damaging to human health, causing asthma attacks for example, and contribute to climate change.

2B Tech published a peer-reviewed paper on the Folded Tubular Photometer in the journal *Atmospheric Measurement Techniques* in 2018.

Patent: Folded Tubular Photometer | **Published Paper: Folded Tubular Photometer**
