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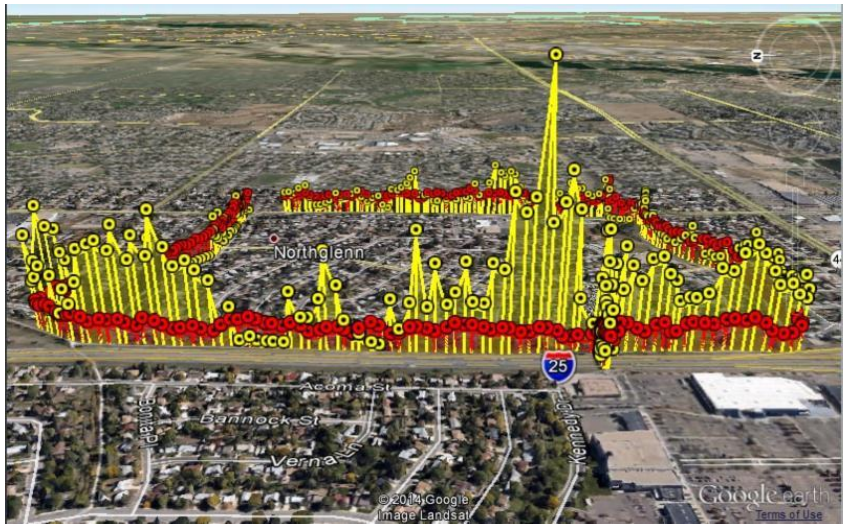
GO3 TREKS

Case Study: GO3 Treks

This fall 2B Technologies kicked off the first round of GO3 Treks, a project hosted by the GO3 Project and funded by a grant from NIH/NIEHS, that allows students around the country to measure ozone and black carbon (two of the most significant air pollutants for human health) using hand-held, portable instruments to measure personal exposure to these pollutants. Each chosen school is provided with a 2B Tech Personal Ozone Monitor (POM™) and a personal black carbon monitor (AethLabs MicroAeth™) for a period of two weeks.

The POM includes GPS capabilities so students can track their treks and become citizen scientists by uploading their data as a Google Earth file embedded in a blog where the data can be discussed with other students, teachers and scientists. The mapping of these data allow students and educators to visualize how air pollutant concentrations vary in their communities.

So far, 17 schools in Boulder Valley, St. Vrain Valley, and Adams 12 School Districts of Colorado have participated, uploading their data to the GO3 social network to analyze and compare air quality. This week a school is venturing to Moab, Utah to explore air quality along the Slot Canyons. You can view more than 100 uploaded treks on Google Earth here!



One-hour trek by Northglenn Middle School of Northglenn, CO on 10/6/14. Black carbon measurements (yellow) show large spikes (up to 11.1 ug/m3) along heavily traveled I-25 highway while ozone concentrations (red) remained fairly constant at about 35 ppb.

As the semester progresses we will be distributing the instrumentation to dozens of additional schools across the country; stay tuned!

Featured Product: Personal Ozone Monitor™ (POM™)

2B Tech has taken the next step in miniaturization of UV-based ozone monitors by developing the Personal Ozone Monitor™ or "POM™". The POM has dimensions of 4 x 3 x 1.5 inches and weighs only 0.75 lb (340 g). It has a built in GPS so that ozone measurements may be logged continuously along with geographic location. By folding the optical path in the shape of a "U", it was possible to achieve the same path length in the POM as in the Models 202, 205 and 106-L and thus have similar precision and accuracy (~2 ppb for 10-s measurements).

Applications:

- Personal exposure monitoring for studies of health effects of air pollutants
- Health and safety monitoring at industrial sites using ozone
- Vertical profiling using balloons, kites, RPVs and light aircraft where space and weight are highly limited
- Long-term monitoring at remote locations where power is highly limited
- Urban arrays of ground-based detectors
- Educational projects such as GO3 Treks

For more detailed information on the POM, see Model POM.

Monitoring Tip: Noise, Precision and Negative Values

A frequent question we receive is, "Why does my instrument output small negative values even when properly zeroed?" The answer is that all measurements are subject to noise. Noise is a random fluctuation of the measured value in both positive and negative directions and may have contributions from many sources. For example, there is electronic noise due to random fluctuations in voltages and currents within the electronic circuit. There are several contributions to electronic noise such as thermal (Johnson-Nyquist), shot and flicker (*1/f*) noise. However, 2B Tech measurement circuits are designed to reduce electronic noise contributions to negligible levels.

In instruments based on absorbance, such as 2B Tech ozone and NO_x monitors, the largest source of noise is usually lamp flicker. Since the measurements of ozone and NO_2 are based on a difference in light intensity passing through the detection cell when the analyte is present (unscrubbed, light intensity I) and absent (scrubbed, light intensity I_o), the slightest change in lamp output between these two measurements results in a false contribution to the measurement. For example a change in light intensity between measurements of I and I_o of only 0.0004% corresponds to a deviation of ±1 ppb in the ozone measurement for our Model 202 Ozone Monitor. The sign of the deviation depends on which direction the light intensity varied between those two measurements. Lamp flicker occurs in both directions (brighter and dimmer), so if you are measuring air with no ozone present, you should expect to have as many negative as positive values with the result that the average ozone concentration is zero. Low frequency noise due to long term drift in lamp intensity is eliminated by frequently switching between measurements of the light intensity for scrubbed and unscrubbed air. For our ozone monitors, the solenoid valve that diverts air through or around an ozone scrubber is switched every 2 seconds. Any remaining drift is removed in real time within the firmware by correcting for the observed drift in lamp intensity.

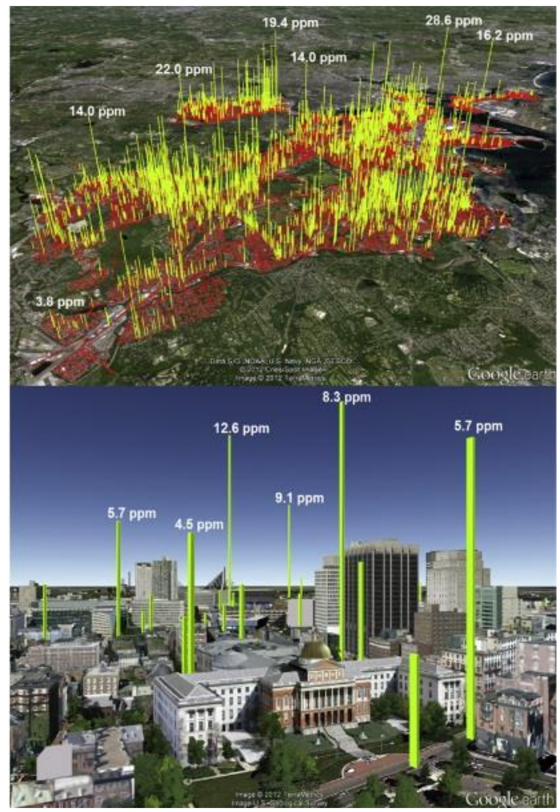
You can measure the noise, also known as the precision, of your instrument by attaching an external scrubber, allowing the instrument to warm up, and then logging or outputting the data to a computer. If the instrument has been zeroed, the average of the measurements should be very close to zero. For our instruments, we define the precision to be the standard deviation (σ) of 10 sequential measurements. 2B Tech provides a specification for the acceptable level of precision (noise) for each product. For example, the specs are 2.0 ppb for the POM and Model 106-L, 1.5 ppb for the Model 202, 1.0 ppb for the Model 205 and 0.5 ppb for the Model 211 Ozone Monitor. Every instrument must consistently meet this specification before being shipped to a customer, and the calibration data includes the measured precision for that instrument. Typically, precisions are 10-40% better (lower) than the specification.

If your instrument does not meet the precision spec (i.e., it's a "noisy" instrument), then you should run the Lamp Test, according to instructions in the instrument manual, to determine whether the lamp needs to be replaced. The Lamp Test measures the noise that is due to fluctuations in the lamp only. If the lamp passes the test, there must be other factors responsible for the noise. For example, noise can also be caused by fluctuations in pressure, flow rate and current draw due to a failing air pump, in which case the pump needs to be replaced. And, there can be chemical noise due to fluctuations of contaminants desorbing from surfaces of the scrubber, connecting tubing, valve(s), detection cell, etc. In that case it is recommended that the instrument be cleaned according to the Cleaning Procedure and the scrubber replaced. If you need help diagnosing your noise problems please feel invited to contact us at sales@twobtech.com or through online ticketing system at twobtech.com/techsupport.htm.

Air Pollution News: Mapping Urban Pipeline Leaks

A recent study published in *Environmental Pollution* mapped out methane levels in Boston to explore methane leaks along the 785 miles of road throughout the city. Methane (CH_4), a potent greenhouse gas, has a large potential to create explosions when leaking, resulting in injuries, deaths and property damage. Furthermore, the slow photooxidation of methane in the presence of NO_x forms ozone on a global basis, thereby contributing to background air pollution levels and global warming. At present, methane leakages from natural gas extraction and pipeline transmission are the largest anthropogenic sources of emissions in the US.

The study was conducted over a course of six weeks using a Picarro G2301 Cavity Ring-Down Spectrometer to detect leaks. Measurements of $\delta^{13}CH_4$ showed that the excess CH_4 was heavily thermogenic rather than biogenic, meaning the leaks were derived predominately from sources of natural gas rather than bacterial sources. In total, 3,356 CH_4 leaks with concentrations exceeding 2.5 ppm were identified. The study also found that most leaks in the Boston area were correlated with old cast iron mains.



Methane leaks (3356 yellow spikes > 2.5ppm) mapped in Boston (top). Leaks around Beacon Hill and Massachusetts State House (bottom).

Identifying and reducing methane leaks from pipelines are crucial steps to reducing greenhouse gas emissions, improving air quality, and reducing risks from methane explosions. For additional information see the journal article:

[Mapping urban pipeline leaks: Methane Leaks Across Boston]