

## Fall 2013

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## Case Study: St. Louis Ozone Gardens

In the southeast corner of a garden in St. Louis, an ozone monitor and a weather station can be found. Of course this is not just any garden - this is the St. Louis Ozone Garden, a collaboration between the Saint. Louis Science Center (SLSC), Saint. Louis University's Center for Environmental Science (CES), and NASA's Air Quality Applications Science Team (AQAST). Led by Jack Fishman and Kelley Belina, the garden was created with the intention of observing foliar damage to a variety of plants by exposure to ground-level ozone. The instrument to monitor ozone at this garden is none other than a GO3 Ozone Monitor designed by 2B Technologies to measure absorption of UV light at 254 nm.

Ozone reacts with molecules in the cell walls of plants to produce highly reactive oxygen species such as hydrogen peroxide and hydroxyl radical (OH), causing a toxic chemical build up in the leaf interior where cells are responsible for photosynthesis. In many plant species, this produces pigmentation on the surface of the leaves, or "stippling". This visual damage of the foliage makes it possible for the layperson to assess damage, creating a whole new network of citizen scientists.



A student assesses ozone damage in the garden

The garden is host to a myriad of plants that serve as bio-indicators to air pollution: common milkweed, cutleaf coneflower, yellow crownbeard, an ozone sensitive potato variety, an ozone sensitive soybean variety, and two types of snap beans - one sensitive, the other tolerant, to ozone. In its second year, the garden is thriving, but perhaps not in the same way other garden enthusiasts would expect. While the plants have grown tall and flowered, Jack and Kelley are encouraged to see visual damage to the leafage they've doted upon, especially obvious this year on the common milkweed and cutleaf coneflower plants. Though ozone levels in 2013 have not been especially high (relatively few code "orange" alerts which suggest air quality is unhealthy to sensitive groups), concentrations have consistently been above 40 ppb, which has provided significant detriment to the plants. High-school students from the SLSC's Youth Exploring Science (YES) program have helped to collect this ozone damage data, and the project has been so successful in its public outreach that they've installed two more ozone gardens in the area! With a number of students and the general public visiting the grounds, the ozone gardens of St. Louis has proven to be an invaluable educational tool.



Foliar injury by ozone on  
*Prunus avium*

To read about this project in more detail, visit [this link](#) or contact Jack Fishman at [jfishma2@slu.edu](mailto:jfishma2@slu.edu)

### Monitoring Tip: Is your ozone monitor lamp noisy?

The specification for precision of 2B Tech Ozone Monitors depends on the model. Before shipping, they are extensively tested and calibrated to make sure they meet all specifications. For all of our products, precision is calculated as the standard deviation of 10 consecutive measurements. The required precisions with no ozone present are 0.5 ppb for the Model 211, 1.0 ppb for the Model 205, 1.5 ppb for the Model 202, 2.0

ppb for the Model 106-L and POM, 0.01 ppm for the Model 106-M and 0.01 wt% for the Model 106-H. On average, instruments will perform about 20% better than these specifications.

You can test the precision of your ozone monitor by placing an external ozone scrubber on the instrument and making a large number (e.g., for 10 minutes) of 10-s measurements. These can be saved to a file on your computer using the 2B Tech Data Display software and opened in Excel. Now calculate the running standard deviation of 10 points and take an average of that result. This precision should be less than the specification for your model of ozone monitor. If the precision is out of spec, it could be caused by a number of factors; the most common causes are a dirty internal ozone scrubber and/or flow path or a noisy lamp. The instruments are easily cleaned and scrubbers and lamps replaced using procedures described in our Tech Notes on the [downloads](#) page of the 2B Tech website.

Note that if you normally average your data, much of the instrument noise will average out. If you are averaging for one hour, for example, the noise (precision) will be improved by the  $(N-1)^{1/2}$  where N is the number of points you average. So, the precision is improved by factors of 2.2, 5.4 and 18.9 for 1-min, 5-min and 1-hr averaging of 10-s measurements, respectively. Thus, if you average your data, a lamp out of spec may have no significant effect on the precision of your ozone measurement. Also, a noisy lamp does not affect the accuracy of ozone measurements since UV absorbance is based on a ratio of light intensities (with and without ozone present).

2B Tech offers an affordable calibration and cleaning service for all of our instruments. If you return the instrument to us, we will clean the flow path, replace the internal scrubber and calibrate to a NIST-traceable standard for a fixed fee (usually \$150).

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## Air Pollution News: Ozone Linked to Heart Disease

Heart disease is the number one cause of death in the U.S., and now researchers at UC, Berkeley are linking ozone as another potential cause. Modeling mortality and ozone levels from 1982 to 2000, this research team has found that in sunny areas of California such as Los Angeles where high levels of ozone occur, many more deaths occur from cardiovascular issues. Though it's well established that a high concentration of ozone leads to respiratory disease, this study is the first to suggest that ozone exposure can cause cardiovascular disease as well.



Air pollution in Los Angeles

Ozone, acting as a harmful pollutant in the lower atmosphere, also penetrates deep into the lungs and causes "oxidative stress." Mounting a defense, surrounding tissues become inflamed and this inflammatory process can spread to the cardiovascular system, causing both a "shrinking and thickening of the coronary artery" Michael Jerret explains, who is not only a participant in the study but also the chair of the School of Public Health's environmental health sciences department. When the coronary artery is irritated it can reduce or entirely block blood flow to the heart - the perfect storm for a heart attack.

Perhaps the staggering numbers their statistical model has found, that anywhere from 100,000 to 500,000 deaths can be attributed to air pollution each year, will trigger interest in re-evaluating the EPA's Ambient Air Quality Standard for this Criteria Pollutant.

To read the full article [click here](#).

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### New Product: Model 405 nm NO<sub>2</sub>/NO/NO<sub>x</sub> Monitor for Direct Measurement of NO<sub>2</sub> by Absorbance



2B Tech is proud to announce the introduction of its new, Model 405 nm NO<sub>2</sub>/NO/NO<sub>x</sub> Monitor for measuring NO<sub>2</sub> directly by visible absorbance at 405 nm. We are now taking orders for shipment in January!

The Model 405 nm NO<sub>x</sub> Monitor ("nm" for "nanometer" and for "NO<sub>x</sub> Monitor") is designed for the direct measurement of atmospheric nitrogen dioxide (NO<sub>2</sub>), nitric oxide (NO) and total reactive oxides of nitrogen (NO<sub>x</sub> = NO + NO<sub>2</sub>) in the concentration range 0-200 ppm for NO<sub>2</sub> and 0-2,000 ppb (0-2 ppm) for NO and NO<sub>x</sub> with high precision and accuracy. In this instrument NO<sub>2</sub> is measured directly by absorbance at 405 nm. NO is measured by selective conversion with ~100% efficiency using the highly selective reaction of NO with ozone (O<sub>3</sub>). Total NO<sub>x</sub> is obtained by addition of NO and NO<sub>2</sub>.

Unlike chemiluminescence instruments where NO<sub>2</sub> must be converted to NO using either a molybdenum or photolytic converter with highly variable efficiencies, in the Model 405 NO<sub>x</sub> Monitor nitrogen dioxide is measured directly by absorbance, analogous to an ozone monitor. Because NO<sub>2</sub> has a much lower absorption cross section than ozone, a miniature White cell is used to produce a long absorbance path of 2.2 m to achieve approximately the same sensitivity (< 2 ppb). The wavelength of 405 nm was chosen because no other species found in ambient air has significant absorbance at that wavelength, making the Model 405 nm extremely selective for NO<sub>2</sub>. Although our Model 410 Nitric Oxide Monitor can measure NO and NO<sub>x</sub> when used in combination with our Model 401 NO<sub>2</sub> Converter, because it is a direct method and requires less power the Model 405 nm is the preferred method for NO<sub>2</sub> while providing an accurate measurement of NO as well.

For more detailed information on the instrument, including theory of operation and specifications, see [Model 405 nm](#).

## The GO3 Project Newsletter



The GO3 Project, with over 85 participating schools, has recently created a *GO3 Newsletter* to reach its participants and interested parties across the world.

The newsletter highlights different schools and their engagement in the GO3 Project, shares student-made videos, artwork, and environmental blogs, and elaborates on different educational opportunities the GO3 Foundation offers. It's also the best way to stay updated with all of our ozone endeavors and beyond -

including the Black Carbon Experiment, sister school networking, new activities, and new GO3 activities to implement in the classroom.

If you'd like to receive the next edition of the GO3 Newsletter, you can join the mailing list by clicking [here](#) and checking the box for 'GO3 Email List'.

If you'd like to view past editions, contact Kali at

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