

CSAM Carbon Particulate Sampler



Introducing Met One's New Carbon Monitor Sample

- Un-Paralleled Response Time
 - 2 Samples per second!
- Unequalled Dynamic Range
 - Natural Parks Visibility to Diesel Exhaust
- No Consumables
- AutoSpan and AutoZero
- Mobile Operation for Vehicle Emissions
- Simultaneous Extinction and Absorption
- PM₁₀, PM_{2.5}, PM₁
- Low Power Consumption
- Windows™ based PC controlled

Thermal Optical Reflectance

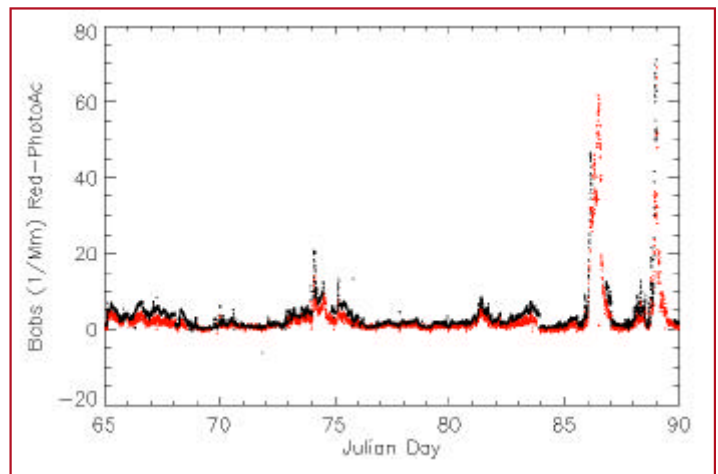
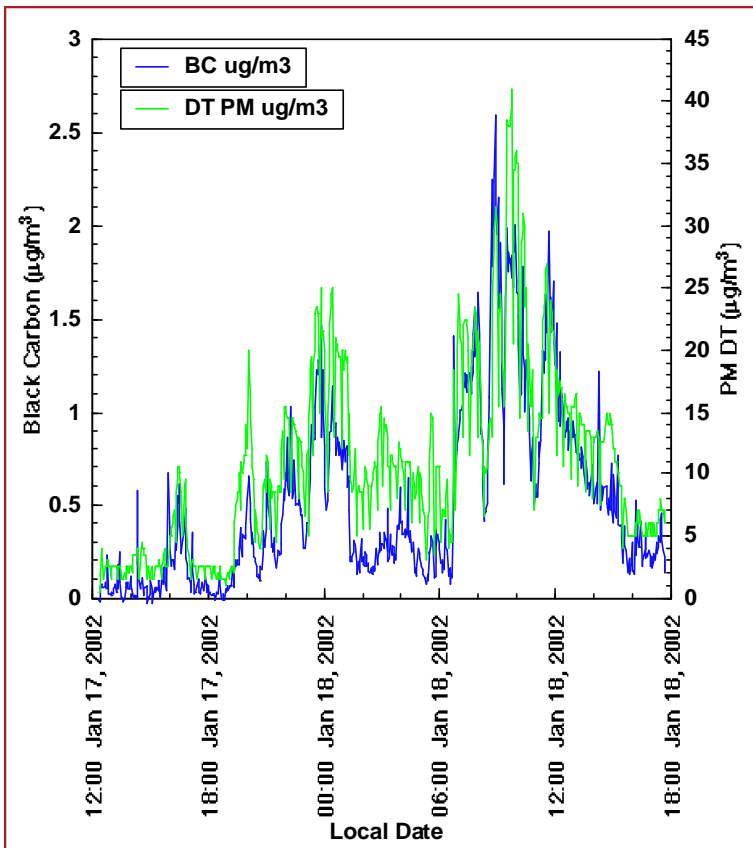
Research has shown that increased particulate levels have an adverse effect on human health. Questions remain as to the importance of particulate size and chemical composition. The area drawing the most interest is small carbon particles.

Thermal Optical Reflectance (TOR) filter method has been the standard to attain the carbon fraction of particulate. While this method is accurate it is time consuming, labor intensive, expensive and it can take weeks to obtain data. Alternative methods have been proposed to automate this analysis but each method has accuracy and/or dependability issues.

Met One Instruments in cooperation with DRI has developed a solution that solves the carbon dilemma. Using the known physical properties of carbon along with a precise optical laser system the Photo Acoustic Carbon Monitor (CSAM) is the fastest, most accurate automatic carbon particulate instrument manufactured.

The CSAM has a dynamic range unmatched in ambient monitoring. The CSAM will easily measure carbon particulate levels in the most pristine National Parks and without modification or dilution measure carbon in diesel exhaust. Along with unsurpassed dynamic range the CSAM has the fastest response of current carbon monitors. The CSAM easily makes 2 measurements per second. The response allows the CSAM to aid in quantifying the emissions of vehicles in real time.

This patent pending technology is based on the unchanging optical properties of carbon. Each real time sample simultaneously measures extinction and absorption of carbon. Results are recorded as both mass (ng/m^3) and the standard visibility term of B_{abs} (m^{-1})



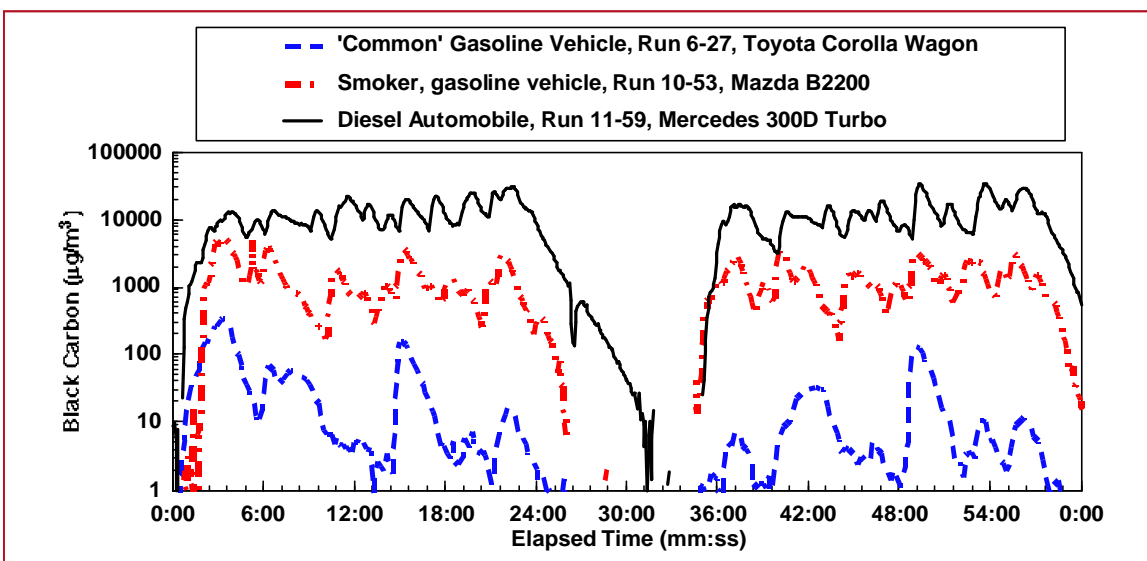
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A major advantage of the CSAM is its versatility. Besides the huge dynamic range and true real time measurement (2 times per second) the CSAM is mobile. A mobile monitoring vehicle in California was outfitted with a CSAM to monitor emission patterns from different vehicles on varying roadways.

The Met One Instrument's CSAM is the only technology that allows for real time mobile monitoring

Ruggedness and dependability are always an issue with a new technology. The CSAM has not only been used in the harsh environment of mobile monitoring, but also in the harsher conditions of a US Navy Jet Engine Exhaust.

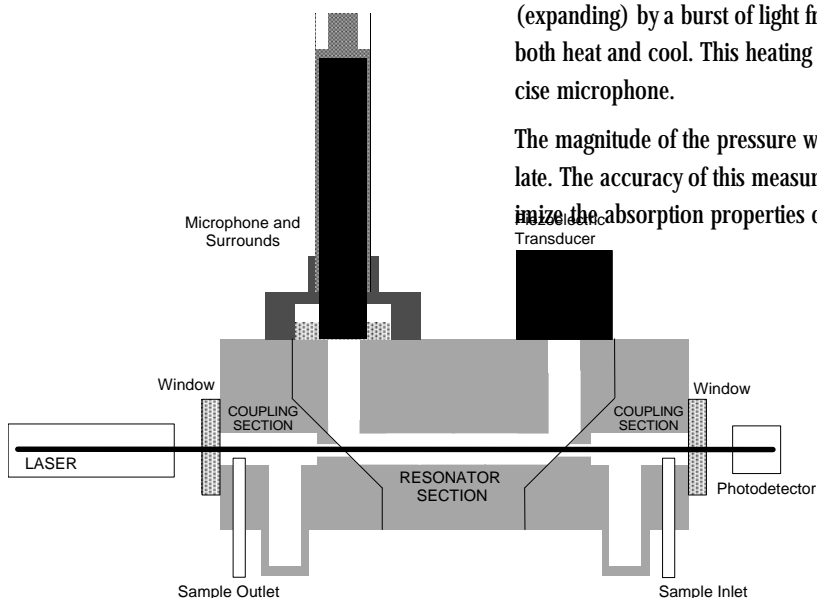
The Navy desired to quantify the changing emission patterns of a **FA-18** fighter jet on North Island, California. The only equipment able to meet their requirements of sample rate, dynamic range and ruggedness was the Met One CSAM.



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The technology of the CSAM is well documented (Amos Env #33 pg2845-2852). The heart of the design is the resonating chamber. This chamber "hears" carbon molecules that are heated (expanding) by a burst of light from a laser. The laser is modulated (on/off) so that the molecules both heat and cool. This heating and cooling sends out a pressure wave that is picked up by a precise microphone.

The magnitude of the pressure wave is proportional to the carbon content of the suspended particulate. The accuracy of this measurement is due to the wavelength of the laser that was chosen to maximize the absorption properties of the carbon and eliminate absorption by other particulate.



A secondary measurement of visibility is also made. With each pulse of the laser the intensity of the laser beam is measured. As the laser travels through the sample a portion of the light is absorbed.

Light Absorption in Dimensions of Inverse Distance = B_{abs}

$$B_{abs} = \frac{P_m}{P_L} \frac{A_{res}}{\gamma - 1} \frac{\pi^2 f_0}{Q}$$

f_0 = Resonance Frequency.

Q = Resonator Quality Factor.

P_m = Peak Acoustic Pressure at f_0 .

γ = Ratio of Isobaric and Isochoric Specific Heats For Air.

P_L = Peak Laser Beam Power at f_0 .

Q = resonator quality factor.

A_{res} = Resonator Cross Sectional Area.

A photo detector measures this change and calculates the visibility of the sample by the equations above.



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