Guardian2 Particulate Data Equivalency

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Introduction

The Guardian 2 measures particulate for assessing air quality around construction sites. Particulate matter measurements on instruments within the market vary in their measurement technique and therefore accuracy. Some local authorities are requiring accreditation of particulate matter monitors to be able to demonstrate equivalency to reference monitors that have a high accuracy.

'Reference' level monitors are the highest level of accuracy for use of field measurements of air quality, with the next level of accuracy being 'indicative'. There is an MCERTS accreditation scheme to demonstrate published accuracy with field trials, ultimately providing a certificate of compliance to either reference or indicative level. Local authorities will either accept this certification or data demonstrating equivalency to data produced by other particulate monitors. This document uses published data of the particulate sensor within the Guardian2 to demonstrate a level of equivalency, therefore satisfying local authority needs without MCERTS certification.

Particulate Measurement Overview

Particulate measurement within the Guardian2 is primarily defined within three size fractions. Firstly, PM10 which is particles with a size of less than 10µm. Then PM2.5 which is finer particles, known to be a higher risk to health where these particles are less than 2.5µm in size. These are the two most common required for air quality measurements. Historic measurements on construction sites have primarily been PM10, but the latest guidance has started to introduce PM2.5 on some sites, mainly because of its known health risks. The other particle size measurement available from the Guardian2 is PM1, but this is not normally required for construction site measurements.

Measurements are also averaged over various time periods. Construction sites limits are typically based on 15 minute averages of PM10, but the Guardian2 also does 5 minute and one hour measurements, which are rolling averages.

Technical details of the particle sensor are as follows:

- Particle range: 0.35 to 40µm
- Number of software data bins: 24
- Sampling interval histogram period: 1 to 30s
- Total flow rate (typical): 5.5L/min
- Sample flow rate (typical): 280mL/min
- Max particle count rate: 10,000Particles/second

The measurement technique uses a particle counter, using a laser light source. As with any particle counter the measurements can be affected by environmental conditions, primarily humidity. Humidity can condensate around PM10 particles, effectively enlarging the particles and overestimating the mass concentration. As humidity reaches 100%, then moisture droplets themselves are measured as water causing highly exaggerated PM10 measurements. For these reasons, sensors are used in conjunction with a heated inlet to reduce the effects of moisture on the mass concentration.

Particle Size Equivalency

The response of a sensor used in the Guardian2 was tested with particulate over a wide size range up to PM10. Comparison measurements were taken against a TSI 3330 (non MCERTS) and a Grimm sensor (MCERTS certified). The Guardian2 particulate sensor showed excellent correlation between both units as illustrated in Figure 1. This demonstrates the validity of a measurement using a Guardian2 particulate sensor across the range of particulates with the derivation of PM2.5 and PM10.

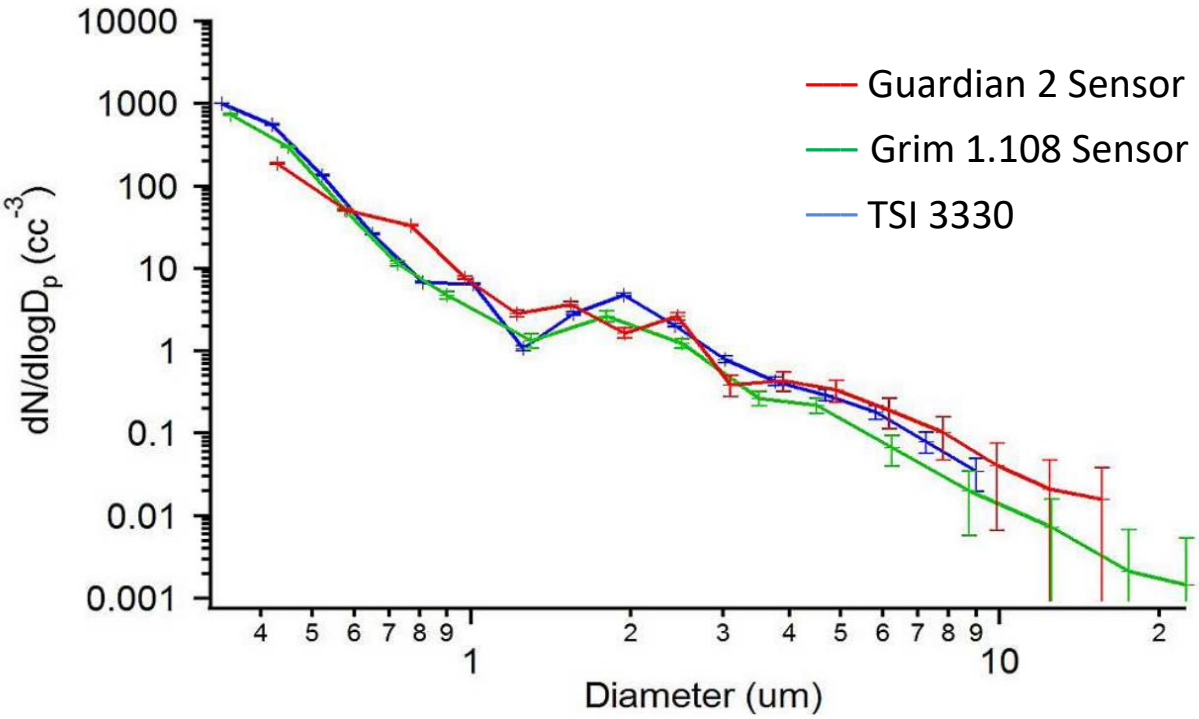

Figure 1 Particle size equivalency

Data Equivalency In Environmental Conditions

To test the ability of a sensor to accurately measure against other units in real world conditions, co-location sites are used. Sensors are mounted in an adjacent position in an outdoor environment over a long enough time to be subjected to variety of environmental conditions such as varying humidity levels and temperatures. Data is displayed from two of these measurements below, the first for PM2.5 in Figure 2 and for PM10 in Figure 3.

For PM2.5, Figure 2 shows a comparison of PM2.5 monitoring by two Guardian2 sensors and TSI OPS 3330 and DustTrak instruments. All are set at 5s averaging and are sampling the ambient air. Particle concentrations vary from <10µg/m^3 to more than 200µg/m^3. Both Guardian2 sensors demonstrate good correlation with the TSI units right across the range off particle concentrations throughout the measurement period and in a consistent manner. When high dust levels occur, such as those that could occur on construction sites (e.g. >150µg/m^3) the Guardian2 sensor recognised those levels in a consistent way.

Similarly, for PM10, Figure 3 shows a comparison of PM10 monitoring by two Guardian2 sensors and TSI OPS 3330 and DustTrak instruments, again set at 5s averaging and sampling the ambient air. Particle concentrations vary from low to high levels as before, over 'real world' levels. Both Guardian2 sensors demonstrate good correlation of PM10 measurements with the TSI units right across the range off particle concentrations and the measurement period. When PM10 levels occur the Guardian2 sensor recognised those levels in a consistent way to the other instruments.

For both PM10 and PM2.5 measurements, data is very consistent between the two Guardian2 sensors demonstrating excellent repeatability and giving confidence in results.

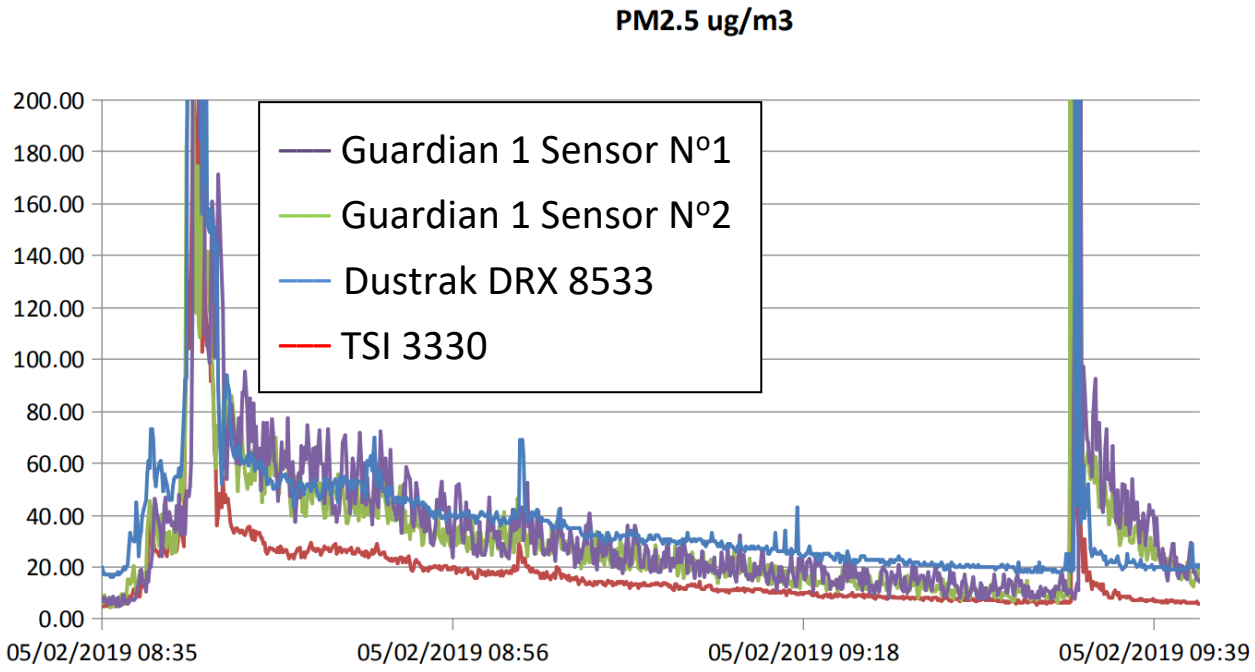

Figure 2 PM2.5 Comparison over time

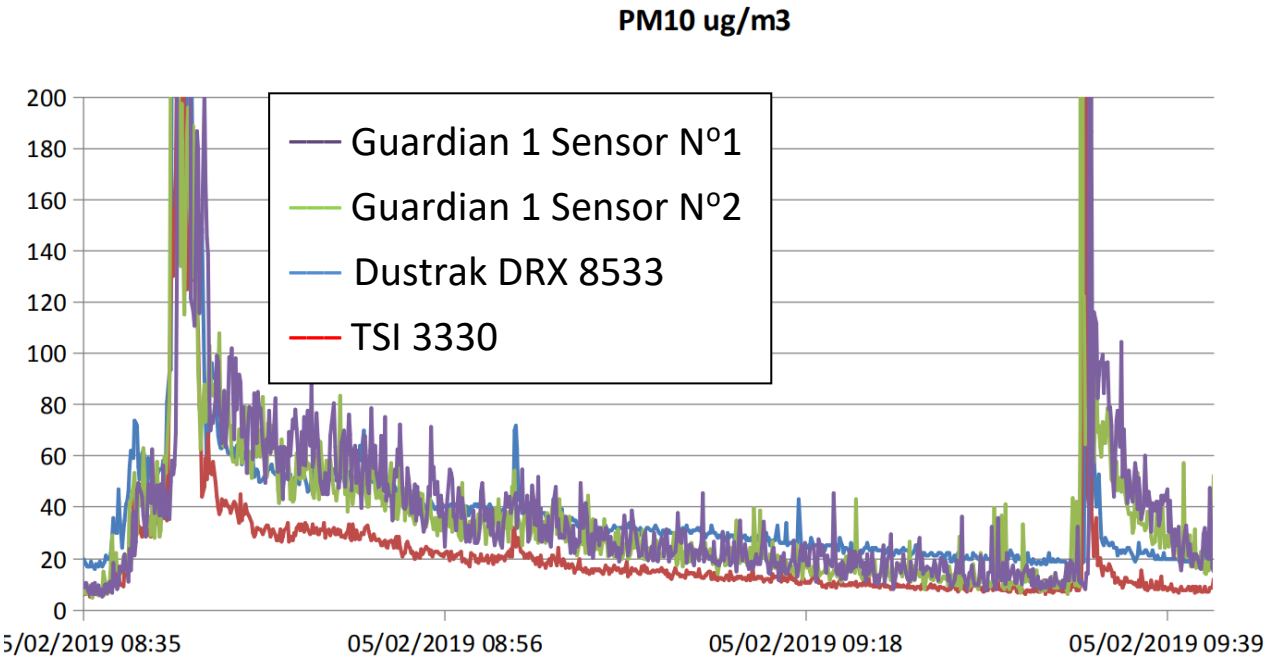

Figure 3 PM10 Comparison over time

Summary

The Guardian2 sensors have been tested against other particulate sensors across particle size ranges and over a period of time. The Guadian2 sensors show consistency in measurement from low particle size up to PM10, covering the range of sizes they would be exposed to in normal environments such as construction. Over time and in ambient conditions, the sensors likewise demonstrated good consistency across a wide range of concentrations, responding to the same high levels of PM10 and PM2.5 the sensors were exposed to.