

# Zephyr PM2.5

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## Device Information

Four devices were deployed:

- Two were kept in Manchester for the whole study.
- One device was in Manchester (10/12/19) -> London (11/03/20)-> Manchester (2022-04-29).
- One device was in Manchester (10/12/19) -> York (roadside side) (23/03/20) -> Manchester (2022-04-29).

This report aims to show how well the devices have performed throughout the study and how they were effected by different locations (urban background and roadside).

The calibration(s) performed by the manufacturers were completed on:

- no calibration was performed (out-of-box)
- no second calibration performed (out-of-box)

## Equations Used

$$cRMSE(R, L) = \sqrt{\text{mean}(L_i - R_i - \bar{L} + \bar{R})^2}$$

- $R_i$  = reference measurement at time i for measurements 1 to n
- $L_i$  = LCS (low cost sensor) measurement at time i for measurements 1 to n
- $\bar{L}$  = mean LCS measurement
- $\bar{R}$  = mean reference measurement

$$RMSE(R, L) = \sqrt{\text{mean}(R_i - L_i)^2}$$

- $R_i$  = reference measurement at time i for measurements 1 to n
- $L_i$  = LCS (low cost sensor) measurement at time i for measurements 1 to n
- n = number of measurements

$$\text{Bias}(R, L) = |\bar{L} - \bar{R}|$$

- $\bar{L}$  = mean LCS measurement
- $\bar{R}$  = mean reference measurement

# Urban Background

## Manchester

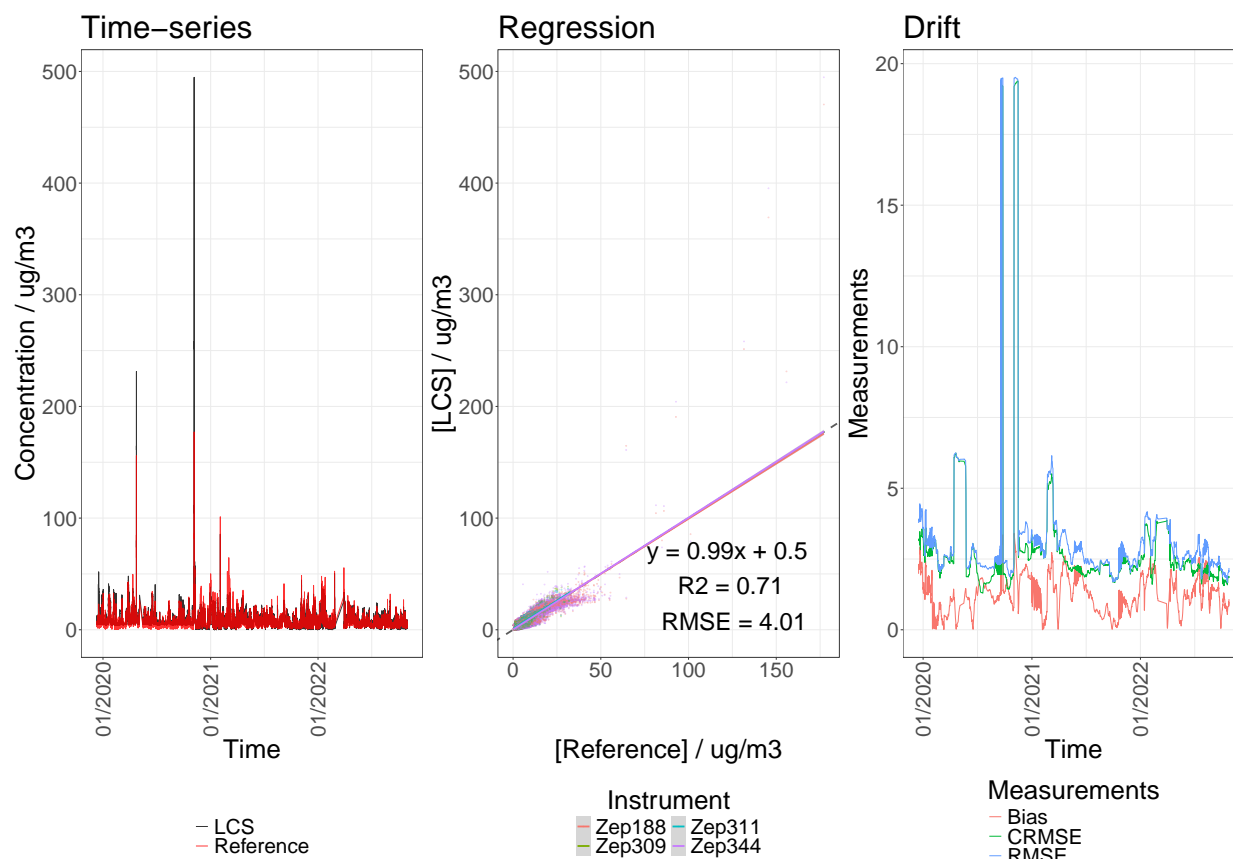


Figure 1: Manchester quantitative evaluation. Column 1: Time-series plot of the LCS measurements (black line) vs the reference measurements (red line). Column 2: Regression plot against reference data. The grey dashed line represents  $y=x$ . Column 3: Measure of drift plot (blue line indicates root mean squared error, the red line represents the mean bias and the green line shows the centered root mean squared error).

## London

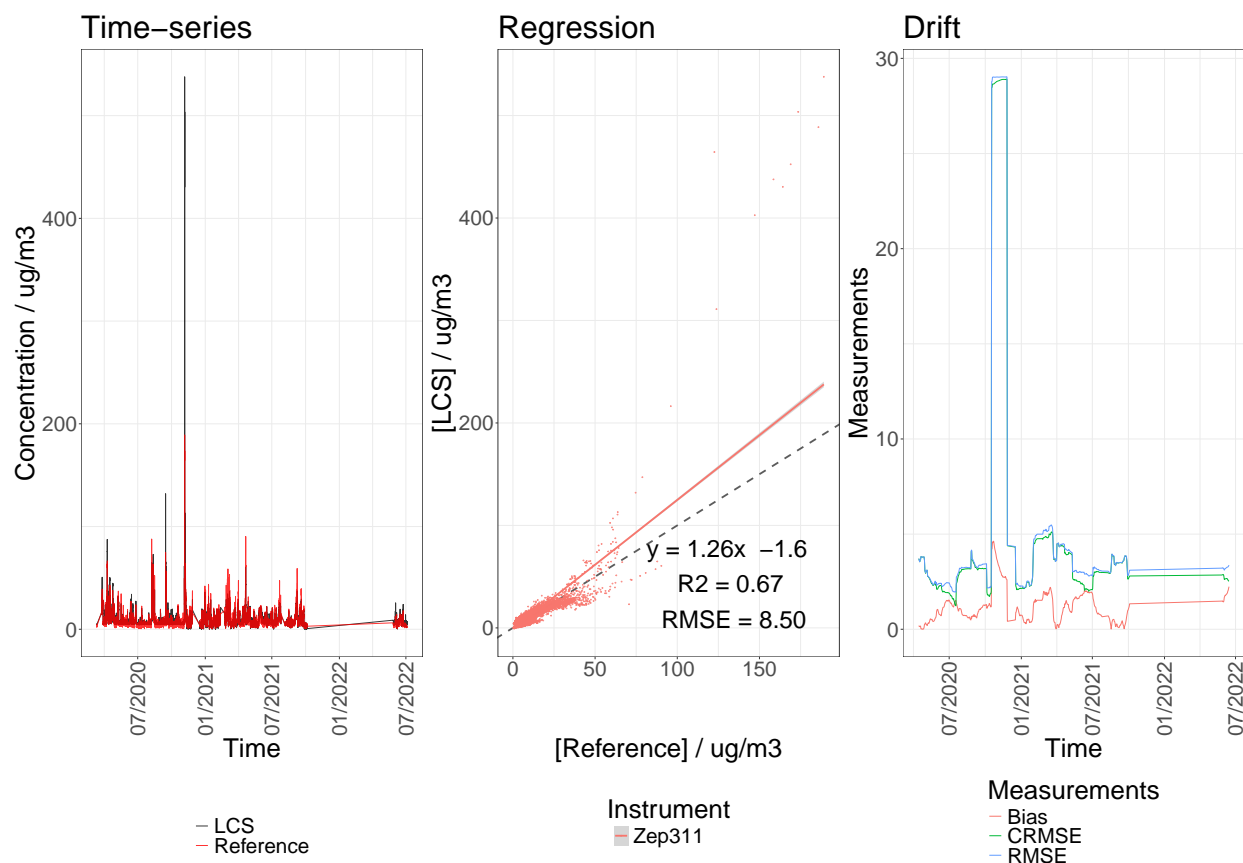


Figure 2: London quantitative evaluation. Column 1: Time-series plot of the LCS measurements (black line) vs the reference measurements (red line). Column 2: Regression plot against reference data. The grey dashed line represents  $y=x$ . Column 3: Measure of drift plot (blue line indicates root mean squared error, the red line represents the mean bias and the green line shows the centered root mean squared error).

## Interpreting the data

- Time-series - the darker red colour shows the overlap between the lcs measurements and the reference measurements taken.
- RMSE - the closer the value is to 0, means that the reference values closely matched the tested sensors values.
- Bias - the difference between average sensor measurements and the average reference measurements
- CRMSE - similar to the RMSE but with the bias subtracted. This measures error around an average.
- R-squared ( $r^2$ ) - a value closer to 1 indicates the regression predictions fit more accurately.
- Drift - a gradual increase shows a larger effect of RMSE, CRMSE or bias that the device possesses.

## Roadside (York Fishergate)

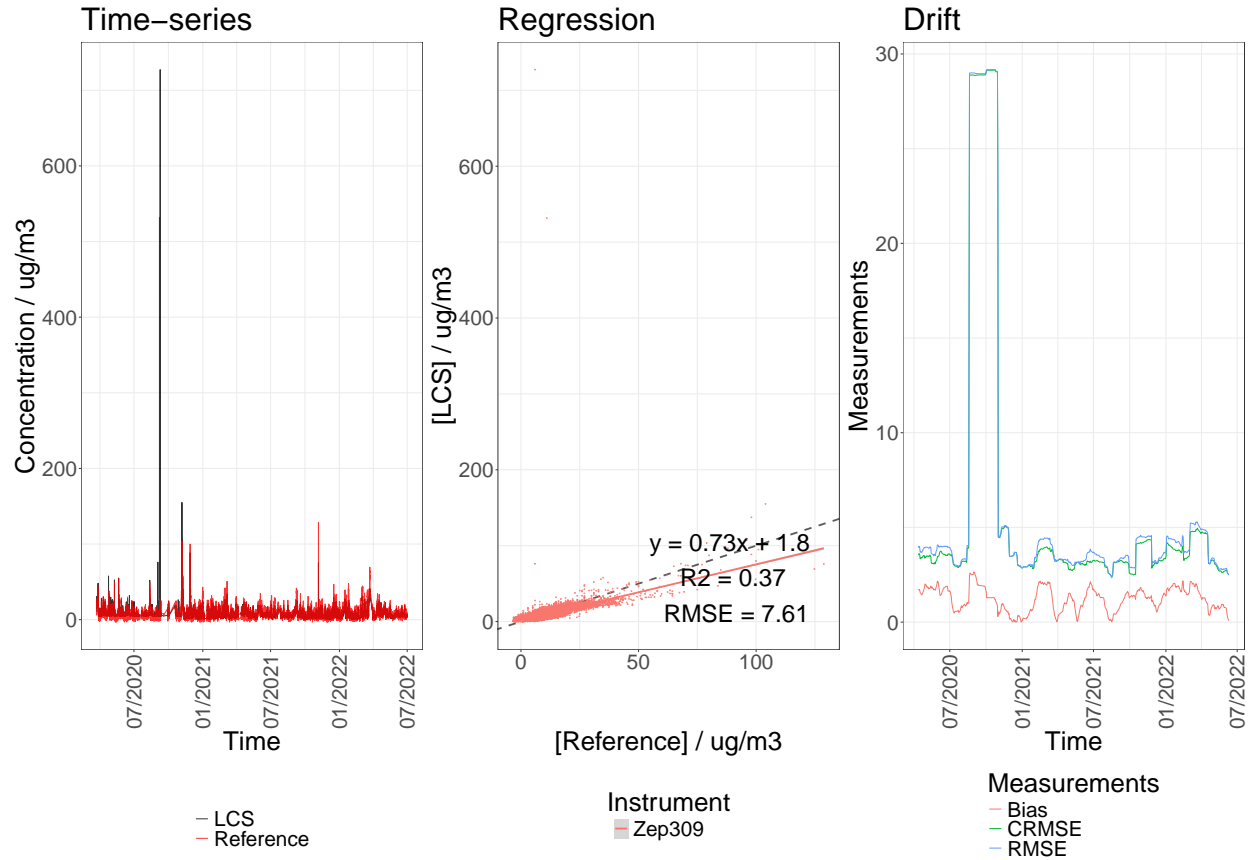


Figure 3: York quantitative evaluation. Column 1: Time-series plot of the LCS measurements (black line) vs the reference measurements (red line). Column 2: Regression plot against reference data. The grey dashed line represents  $y=x$ . Column 3: Measure of drift plot (blue line indicates root mean squared error, the red line represents the mean bias and the green line shows the centered root mean squared error).