

Enabling the Remote Measurement of Air Pollution Emissions in UK Ports

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Project aim:

Assess the potential of **Low Cost Sensors (LCS)** to monitor air pollution in ports and calculate **emission ratios** from individual ships

1. Design, characterise and test a LCS package
 - AlphaSense B-Series (NO , NO_2 , SO_2), smartGAS flowEVO (CO_2)
2. Perform field measurements to monitor emissions of NO_x , SO_2 , CO_2 and PM from a UK port
3. Compare the LCS with a suite of reference, high sensitivity instrumentation
 - Airyx ICAD (NO_x), Thermo 43i-TLE (SO_2), Los Gatos UGGA (CO_2)



Ship emissions from the Port of Tyne

- 26 plumes were sampled from 18 unique vessels
- Average sulfur fuel content (SFC) = $0.04 \pm 0.03\%$ - lower than the 0.1% limit
- Average $\Delta\text{NO}_x/\Delta\text{CO}_2 = 0.008 \pm 0.0002 \text{ ppb ppb}^{-1}$
 - Higher than road vehicles - Euro 6 diesel: 0.0017–0.0026 ppb ppb⁻¹

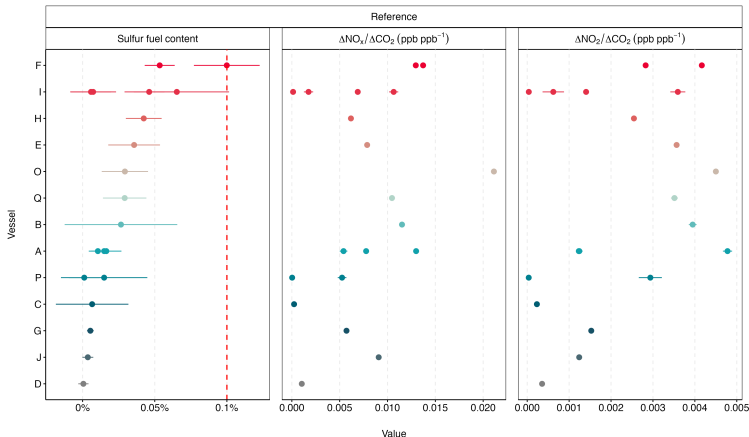


Figure 1: Sulfur fuel content (SFC) and enhancement ratios of $\Delta\text{NO}_2/\Delta\text{CO}_2$ and $\Delta\text{NO}_x/\Delta\text{CO}_2$ for individual ship plumes.

Suitability of low cost sensors

- Good agreement between the reference and LCS data for $\Delta\text{NO}_2/\Delta\text{CO}_2$
- For $\Delta\text{NO}_x/\Delta\text{CO}_2$, the correlation was reasonably strong ($R^2 = 0.68$) but the LCS values were significantly lower (slope = 0.29)
 - Likely due to negative interference in high NO_2 , low O_3 plumes on the NO sensor
- $\Delta\text{SO}_2/\Delta\text{CO}_2$ LCS values were 5 \times higher than the reference measurements
 - SO_2 sensor measurement is not sensitive enough for this calculation

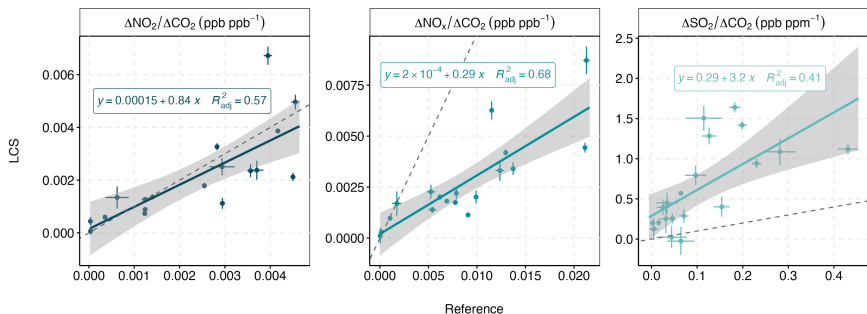


Figure 2: Comparison between enhancement ratios calculated using reference and LCS data.

Dashed line is the 1:1 line

For NO_2 , representative values for emission factors from ships can be obtained from LCS