

Field Evaluation Liveable Cities – SLX-NO₂



Background

- From 11/19/2021 to 01/19/2022, three **Liveable Cities – SLX-NO₂** multi-sensor pods were deployed at the South Coast AQMD stationary ambient monitoring site in Rubidoux and were run side-by-side with the Federal Reference Method (FRM) instrument measuring the same pollutants
- Liveable Cities - SLX-NO₂ (3 units tested):
 - Sensors: NO₂ – Electrochemical (**Alphasense B43F, non-FEM**)
 - Each unit measures: **NO₂ (ppb)**
 - **Unit cost: \$569 + \$309/year for software, reporting and cellular data**
 - Time resolution: 1-min
 - Units IDs: 0124, 0130 (*three sensors were deployed and one of the sensors reported invalid values and was excluded from the data analysis*)
- South Coast AQMD Reference instruments:
 - NO_x instrument (**Teledyne T200U; FRM NO₂**)
 - **cost: ~\$13,000**
 - Time resolution: 1-min

**Liveable Cities
- SLX-NO₂**

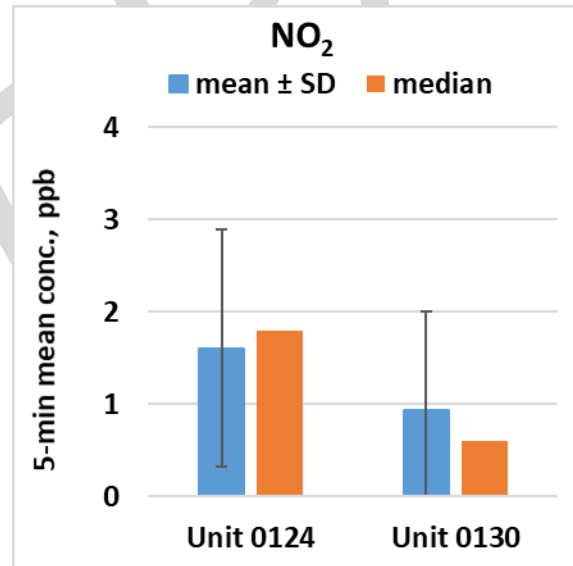


Data validation & recovery

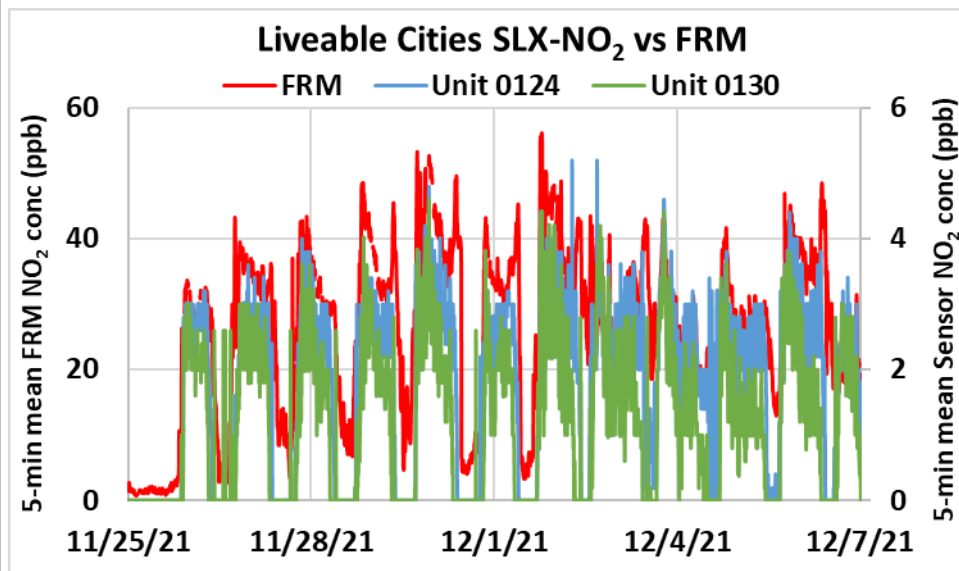
- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for NO₂ from Unit 0124 and Unit 0130 was ~ 90% and 97%, respectively

Liveable Cities - SLX-NO₂; Intra-model variability

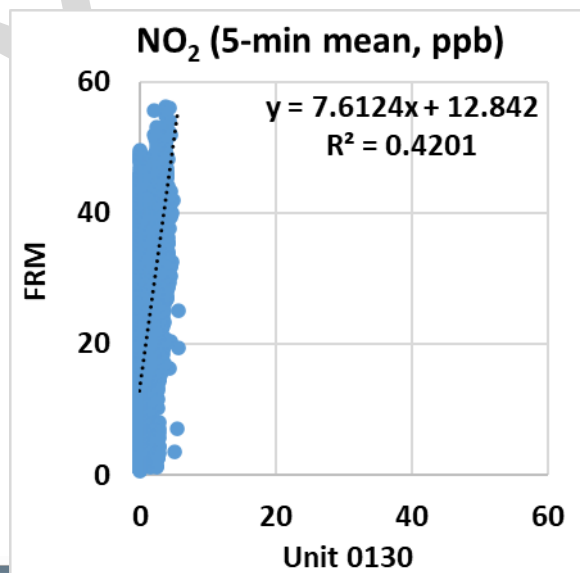
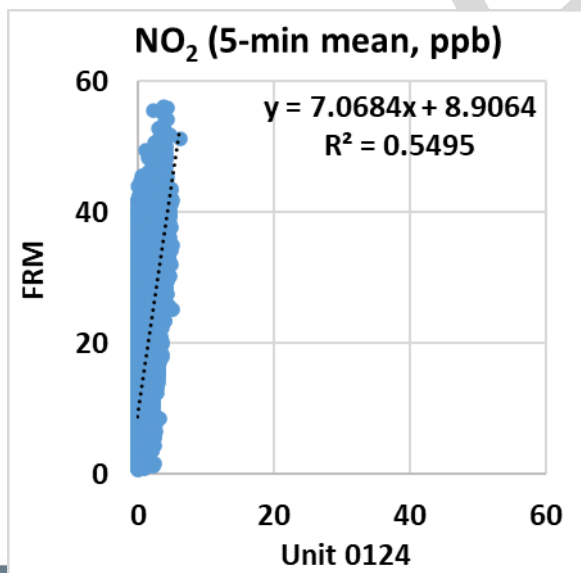
- Absolute intra-model variability was ~ 0.33 ppb for the NO₂ measurements (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 36.2% for the NO₂ measurements (calculated as the absolute intra-model variability relative to the mean of the three sensor means)



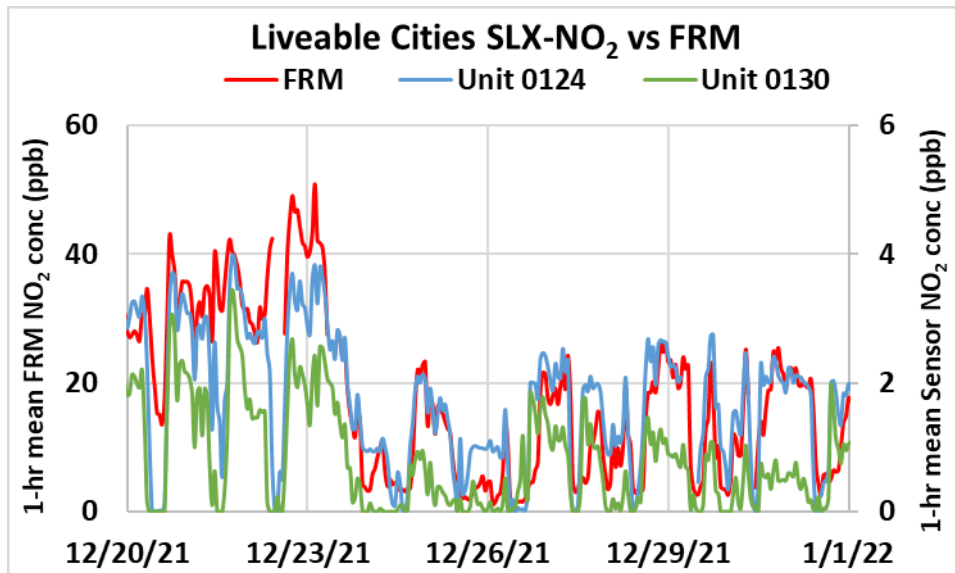
Liveable Cities - SLX-NO₂ vs FRM (NO₂; 5-min mean)



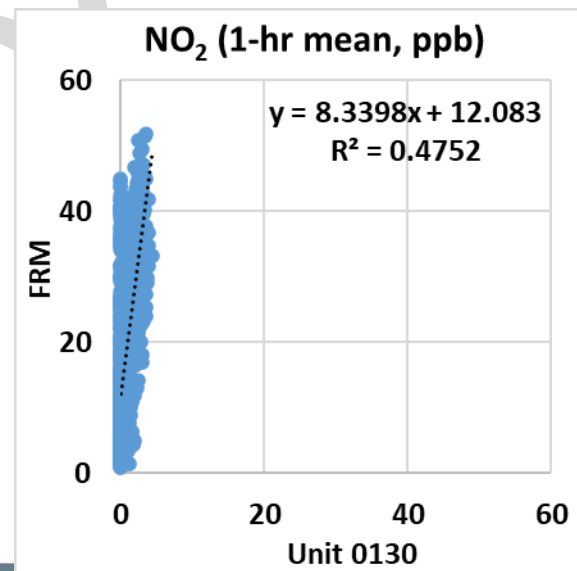
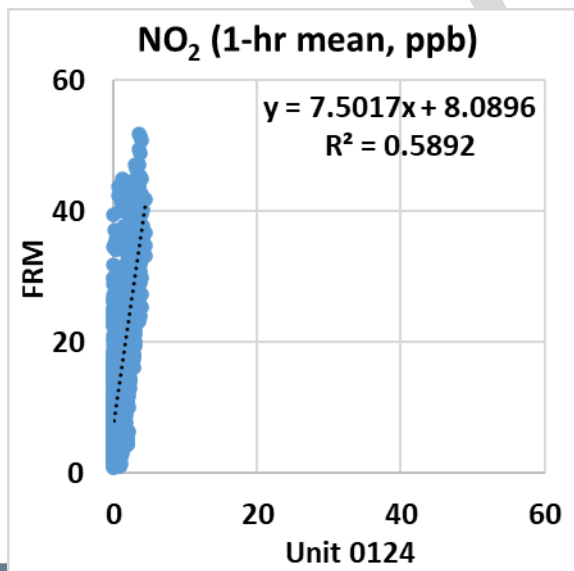
- The Liveable Cities - SLX-NO₂ sensors showed weak to moderate correlations with the corresponding FRM NO₂ data ($0.42 < R^2 < 0.55$)
- Overall, the Liveable Cities - SLX-NO₂ sensors underestimated the NO₂ concentrations as measured by the FRM instrument
- The Liveable Cities - SLX-NO₂ sensors seemed to track the diurnal NO₂ variations as recorded by the FRM instrument



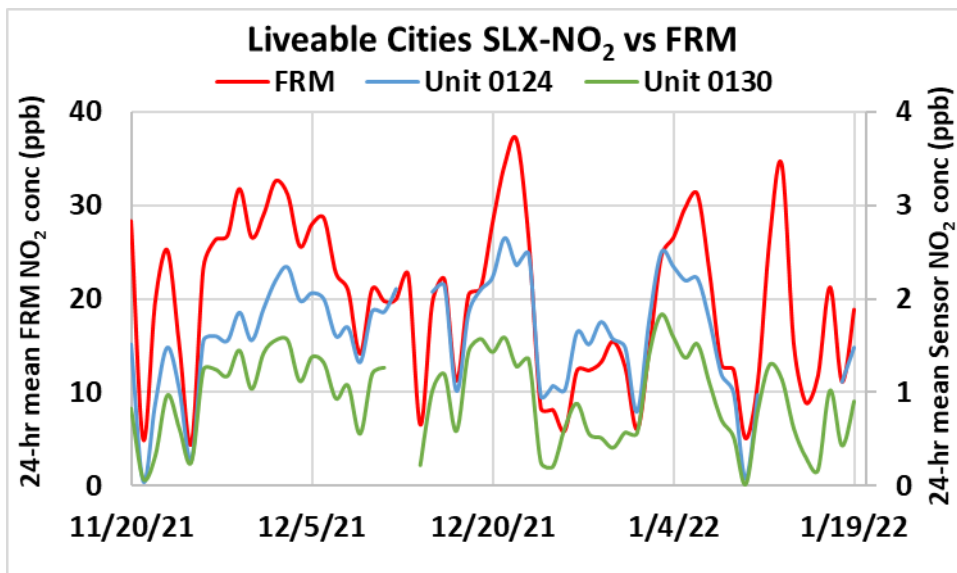
Liveable Cities - SLX-NO₂ vs FRM (NO₂; 1-hr mean)



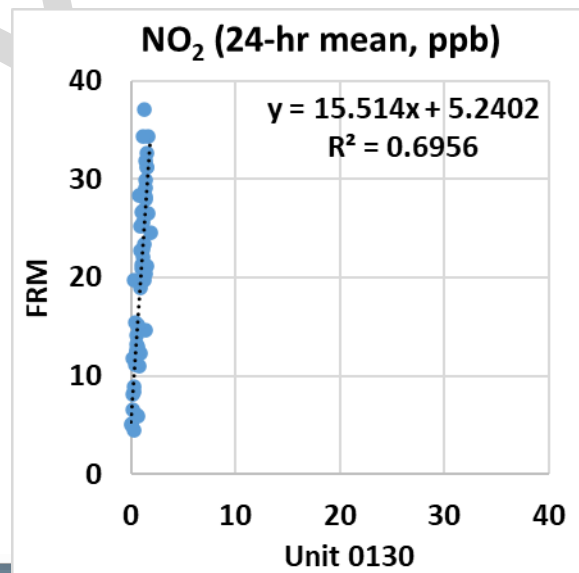
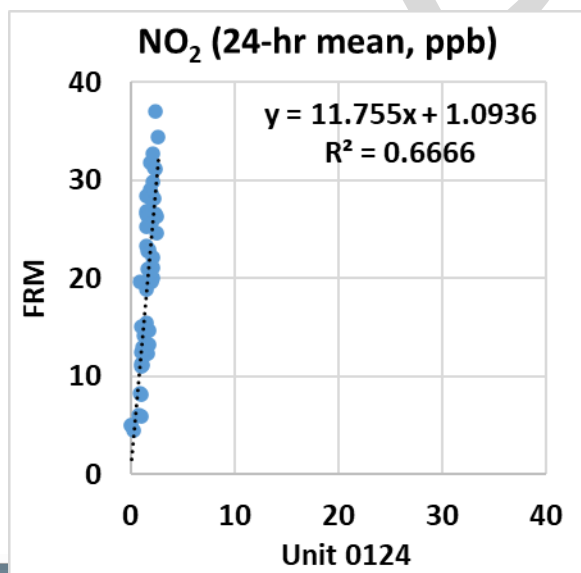
- The Liveable Cities - SLX-NO₂ sensors showed weak to moderate correlations with the corresponding FRM NO₂ data ($0.47 < R^2 < 0.59$)
- Overall, the Liveable Cities - SLX-NO₂ sensors underestimated the NO₂ concentrations as measured by the FRM instrument
- The Liveable Cities - SLX-NO₂ sensors seemed to track the diurnal NO₂ variations as recorded by the FRM instrument



Liveable Cities - SLX-NO₂ vs FRM (NO₂; 24-hr mean)



- The Liveable Cities - SLX-NO₂ sensors showed moderate correlations with the corresponding FRM NO₂ data ($0.66 < R^2 < 0.70$)
- Overall, the Liveable Cities - SLX-NO₂ sensors underestimated the NO₂ concentrations as measured by the FRM instrument
- The Liveable Cities - SLX-NO₂ sensors seemed to track the diurnal NO₂ variations as recorded by the FRM instrument



Summary: NO₂

	Average of 3 Sensors, NO ₂		Liveable Cities - SLX-NO ₂ vs FRM NO ₂						FRM NO ₂ (ppb)		
	Average (ppb)	SD (ppb)	R ²	Slope	Intercept	MBE ¹ (ppb)	MAE ² (ppb)	RMSE ³ (ppb)	FRM Average	FRM SD	Range during the field evaluation
5-min	1.3	1.2	0.42 to 0.55	7.07 to 7.61	8.9 to 12.8	-18.8 to -18.4	18.4 to 18.8	21.6 to 22.2	19.8	12.3	0.7 to 56.2
1-hr	1.3	1.2	0.48 to 0.59	7.50 to 8.34	8.1 to 12.1	-19.0 to -18.5	18.6 to 19.0	21.6 to 22.2	20.0	12.1	0.9 to 51.9
24-hr	1.3	0.5	0.67 to 0.70	11.76 to 15.51	1.1 to 5.2	-18.9 to -18.5	18.5 to 18.9	20.1 to 20.6	11.4	4.4	3.0 to 20.9

¹ Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).

² Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.

³ Root Mean Square Error (RMSE): another metric to calculate measurement errors.

Discussion

- Data recovery for NO₂ from Unit 0124 and Unit 0130 was ~ 90% and 97%, respectively
- The absolute intra-model variability for NO₂ was ~ 0.33 ppb.
- During the entire field deployment testing period:
 - NO₂ sensors showed weak to moderate relations with the FRM instrument ($0.42 < R^2 < 0.55$, 5-min mean) and underestimated the corresponding FRM data
- No sensor calibration was performed by AQ-SPEC staff for this evaluation.
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under controlled T and RH conditions and known target and interferent pollutants concentrations.
- These results are still preliminary