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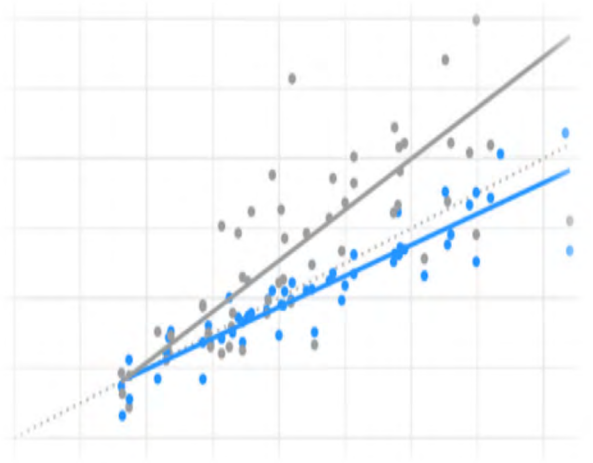
Accurate air quality data starts with calibration



Calibration is crucial for obtaining accurate air quality sensor measurements.

Calibration improves the accuracy and reliability of your data. Clarity's rigorous, patent-pending **Remote Calibration**[SM] process ensures your air quality measurements are scientifically validated and defensible.

Clarity Nodes come equipped with preset standard calibrations: the ***Global Calibration*** for $PM_{2.5}$ and NO_2. The standard ***Global Calibrations*** significantly boost accuracy compared to raw sensor data, even when collocation is not possible.

Custom Collocation-Based Calibration further improves accuracy and allows for performance quantification of your air quality measurements. We always recommend performing collocation, which is the gold standard for optimizing air sensor performance.

Sensing-as-a-Service[SM] gives you access to both raw sensor data and measurements enhanced with either ***Global*** or ***Custom Collocation-Based*** calibration — giving you the power to choose what works best for your organization. We guide you through calibration planning, helping you to make optimal decisions for your project.

You always have access to all raw and calibrated data through the ***Clarity Cloud***, and retroactive calibration can be performed if you decide to carry out ***Custom Collocation-Based Calibration*** at a later time.

Included with Sensing-as-a-Service[SM]

Raw Air Quality Sensor Measurements

- ✓ Raw sensor measurements are always available via API and the Clarity Dashboard
- ✓ Provides transparency and traceability of calibrated results to raw measurements
- ✓ Raw data are not recommended for public consumption and are not available on OpenMap

Pre-Calibrated with Standard Global Calibration

- ✓ Enables calibration for improved accuracy even without access to a reference monitor
- ✓ Linear model for $PM_{2.5}$ provides traceability and minimizes errors related to sensor estimates of aerosol composition
- ✓ Machine-learning based model for NO_2 uses advanced statistical methods to counteract temperature and relative humidity fluctuations that affect electrochemical cell sensors

Custom Collocation-Based Calibration (Optional)

- ✓ Custom-built calibration for your project means improved accuracy under your specific climatic and air pollution conditions
- ✓ Collocation-based calibrations are transparent and traceable
- ✓ Allows measurement performance quantification for all Nodes, for both $PM_{2.5}$ and NO_2

The Clarity Remote Calibration Process

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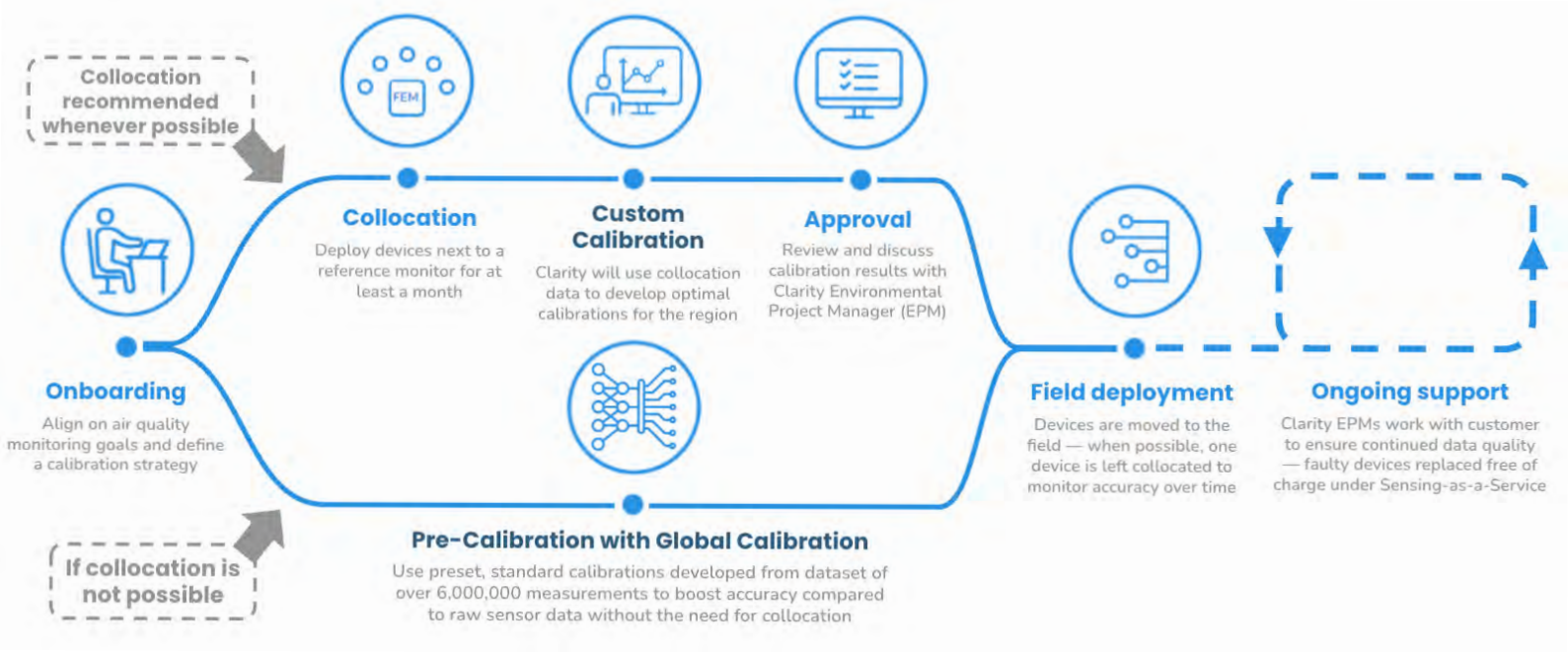
Clarity serves as a partner to drive success for your air quality monitoring project. With ***Sensing-as-a-Service***, you receive more than just hardware and software — we guide you through the entire project, including the essential calibration process.

Calibration is included free of charge with Sensing-as-a-Service℠

We calibrate all air quality sensor data on behalf of our customers. After Onboarding, Clarity customers have the option to choose between pre-calibration using standard *Global Calibrations*, or *Custom Collocation-Based Calibration*, as illustrated by the graphic below.

Choosing your calibration approach



Pre-Calibration with Standard Global Calibration

All Clarity Nodes come equipped with pre-set standard calibrations for $PM_{2.5}$ and NO_2 measurements — the ***Global Calibrations***.

This ensures that calibrated data are available even for organizations without access to a reference monitor or that choose not to perform collocation-based calibration.

The Global Calibrations significantly boost accuracy compared to raw sensor data. They have been developed by the Clarity Lab using advanced statistical methods from a library of hundreds of collocations spanning diverse locations, climate types, and pollutant concentrations.

Custom Collocation-Based Calibration

Whenever possible, we highly recommend ***Custom Collocation-Based Calibration*** for any air sensor network.

Collocation provides calibrations tailored to your environmental conditions and enables robust, project-specific performance evaluation. With collocation, you can calculate accuracy metrics for each of your devices, perform useful data analysis, and corroborate your findings in the field.

If you choose this route, you will need to obtain access to a reference monitor and collocate your devices (i.e. install them in close proximity for at least 4 weeks).

Characterizing Clarity Node performance

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At Clarity, we are committed to transparency and scientific integrity. We recognize that air quality sensor performance specifications should reflect real-world conditions — not just idealized scenarios. That is why we provide performance results that offer the full picture, rather than specifications that selectively showcase only the best outcomes, as is unfortunately often the case in our industry.

By offering performance results for a broad range of conditions across the globe, we hope to empower users to make decisions based on real-world, representative data. We hope that our dedication to transparency ensures that our customers can make well-informed choices when it comes to the best approach to monitoring and improving air quality in their region.

Clarity Performance Quantification Dataset

Clarity has deployed thousands of Node-S devices in more than 80 countries around the world, providing us with a rich and diverse dataset to evaluate their performance. Here are a few quick facts on the dataset we use to quantify summary statistics for Clarity Node-S performance:

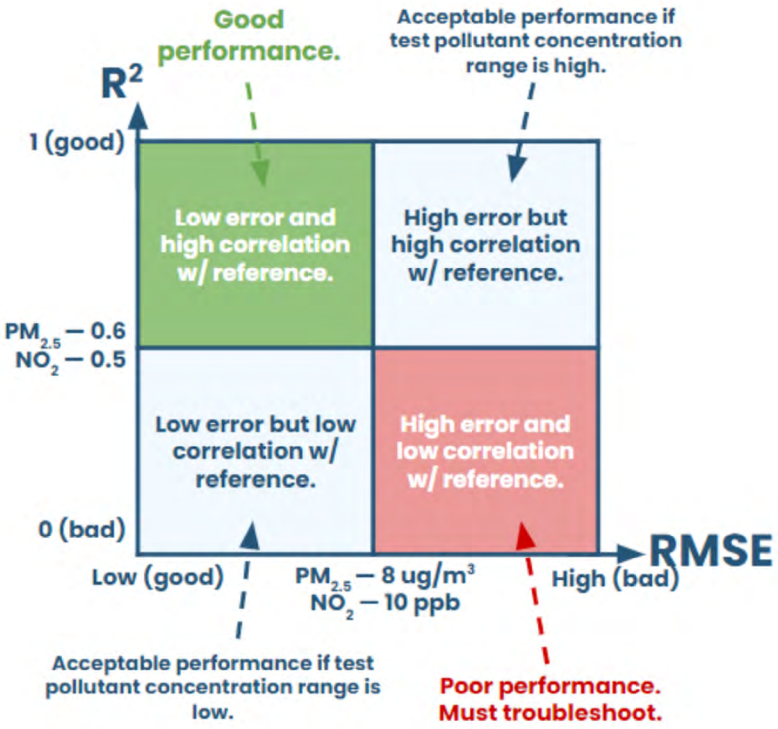
450+	2,000+	45+	6,000,000+
Collocated Clarity Nodes	Collocation Months	Collocation Cities	Collocated Measurements

Evaluating sensor performance: R^2 and RMSE metrics

Clarity's approach to evaluating air quality sensor performance is comprehensive, employing both R^2 and RMSE to ensure a complete picture. By using these metrics together, we can be certain that our sensors are both sensitive and precise, regardless of pollutant concentration ranges.

R^2	RMSE
measures ability to capture fluctuations in pollution levels	evaluates the accuracy of those measurements

This approach led us to define a calibration decision-making framework (see image to the right) to guarantee reliable air quality readings in diverse conditions. If you want to learn more about R^2 and RMSE, visit our Knowledge Base.



Typical R^2 and RMSE from real-world projects

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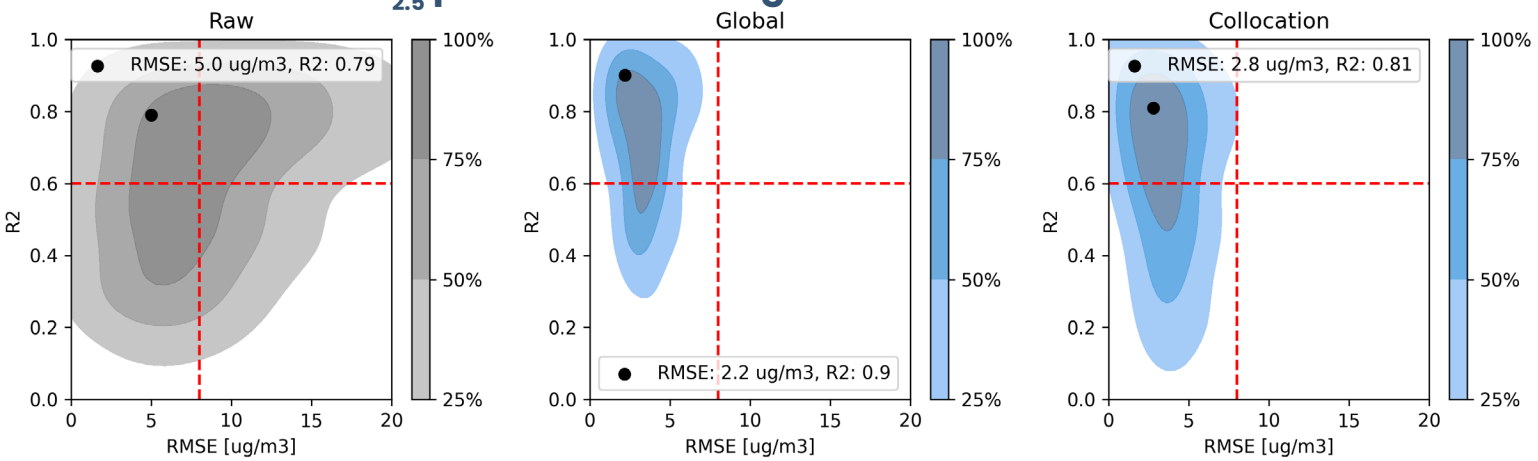
The charts below visualize the typical performance you can expect from the Clarity Node-S in real-world applications, using the Clarity Performance Quantification Dataset.

For each pollutant we show three charts — typical performance using the raw data, applying standard ***Global Calibration***, and applying ***Custom Collocation-Based Calibration***.

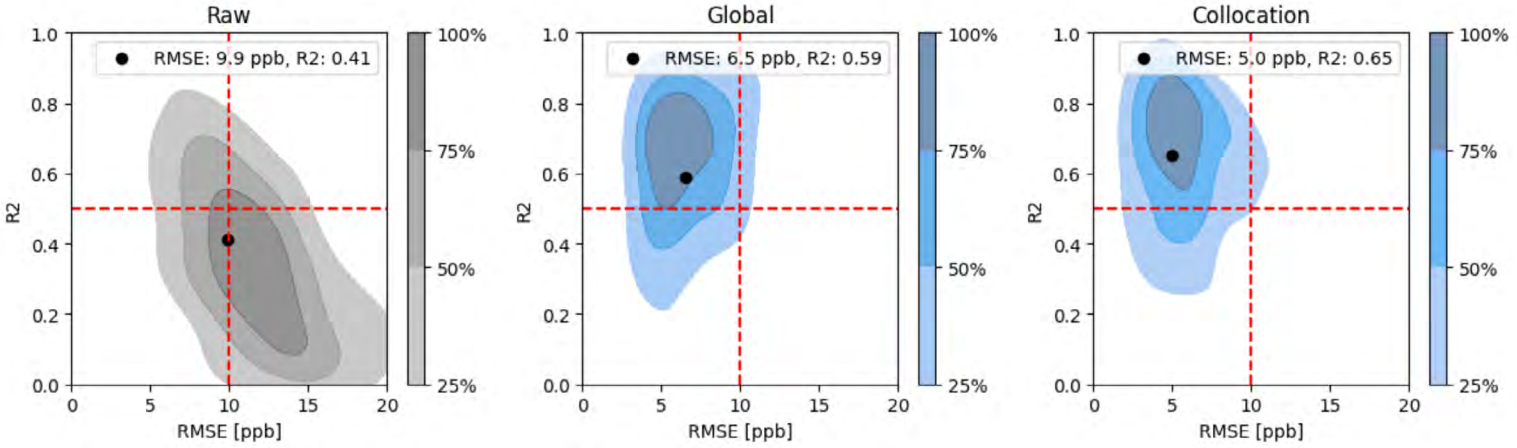
Interpreting the data

- ✓ Charts visualize the range of observed sensor performance in real-world applications against acceptable performance thresholds (horizontal and vertical red lines).
- ✓ Clarity sensors have an observed R^2 (y-axis) and RMSE (x-axis) within the blue contours.
- ✓ The darkest contours represent the more frequently observed sensor performance across various conditions — density decreases as the contour color gets lighter.
- ✓ Black dot indicates the most typical R^2 and RMSE performance across the dataset.

$PM_{2.5}$ performance range across all conditions



NO_2 performance range across all conditions



What this means for you

Set Expectations

Understand the range of Clarity Node-S performance and understand the likeli-hood of different outcomes.

Evaluate Suitability

Assess whether the Clarity Node-S is suitable for your needs based on its typical performance in the field.

Ask for Realistic Data

Ask vendors to share accuracy metrics that are substantiated by enough real-world data — not just idealized scenarios.

$PM_{2.5}$ and NO_2 performance in detail

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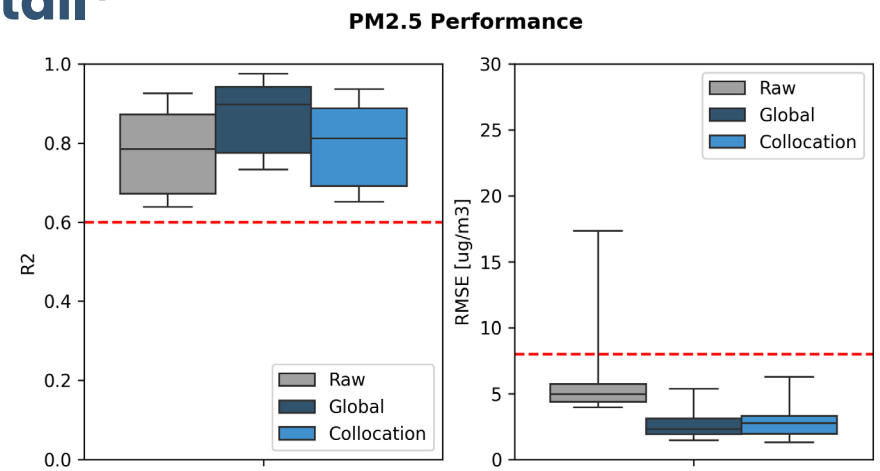
The boxplots below display the distribution of two performance metrics, R^2 and RMSE, for each device in the Clarity Performance Quantification Dataset. These metrics are calculated using the raw data, standard ***Global Calibration***, and ***Custom Collocation-Based Calibration***.

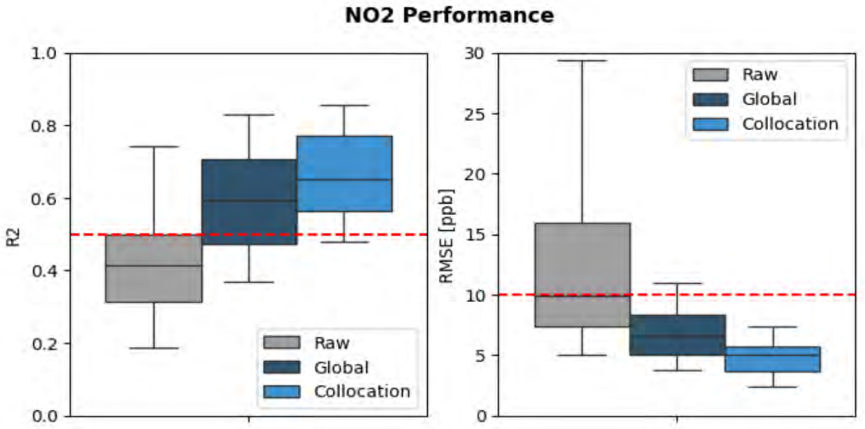
$PM_{2.5}$ performance in detail*

	R^2	RMSE
Raw Sensor Data	Typical: > 0.6 Optimal: 0.93	Typical: < 6 µg/m³ Optimal: 4.0 µg/m³
Global Calibration	Typical: > 0.8 Optimal: 0.98	Typical: < 3 µg/m³ Optimal: 1.4 µg/m³
Collocation-Based Calibration	Typical: > 0.7 Optimal: 0.94	Typical: < 3 µg/m³ Optimal: 1.3 µg/m³



NO_2 performance in detail*

	R^2	RMSE
Raw Sensor Data	Typical: > 0.3 Optimal: 0.75	Typical: < 16 ppb Optimal: 4.9 ppb
Global Calibration	Typical: > 0.5 Optimal: 0.83	Typical: < 8 ppb Optimal: 3.8 ppb
Collocation-Based Calibration	Typical: > 0.6 Optimal: 0.86	Typical: < 6 ppb Optimal: 2.4 ppb



Looking for example results for your geographical region?

Head to Clarity's library of collocation results on our website, where you will find collocation results from different regions and environmental conditions.

VIEW COLLOCATION RESULTS LIBRARY

* In each boxplot, the colored box represents the interquartile range (stretching from the 25th to the 75th percentile) with a median line inside, and whiskers extend from the 5th to the 95th percentile. **Horizontal red lines** indicate acceptable performance thresholds.

Typical performance in the table refers to the range of oberved performance results above the 25th percentile.

Optimal performance in the table refers to the 95th percentile of observed performance results.