NCore Multipollutant Data Quality Dashboard

Contents

Summary

This application provides a Quality Assurance (QA) and data analysis dashboard for the National Core multipollutant monitoring stations (NCore). Monitors at these sites are required to measure particles ($PM_{2.5}$, speciated $PM_{2.5}$, $PM_{10-2.5}$), O_3, SO_2, CO, nitrogen oxides (NO/NO_y), and meteorology (wind speed, wind direction, temperature, relative humidity). Assessments may be generated for each year when corresponding data are available from the AQS database; sample data from years 2017 through the present year are available for review in most tabs. The visual assessments are intended to assist agencies by providing quick summary access to information at the site or network level for the required pollutants measured at NCore stations. The assessments are expected to have three major advantages over existing assessments:

- Data are visualized to illustrate large amounts of information in a concise way.
- The site of interest is compared to all other sites, allowing agencies to understand whether their program's data quality is similar to other agencies or perhaps an outlier.

- The dashboard applications are expected to remain openly available so that users do not have to worry about user authentication IDs and passwords. In this way, we hope that users can efficiently use the data dashboard for their program's monitors.

The NCore Multipollutant Data Quality Dashboard provides multiple indicators and analysis tools for the key subset of parameters required to be measured at NCore monitoring stations.

- Site location and selection through a United States site map
- Site and method summary that provides a tabular summary of key monitors, counts, and method types
- Yearly summary statistics for required parameters
- Pollution roses for ozone and $PM_{2.5}$ with options for year and meteorological season subsets
- Time series of NO_z ($NO_z = NO_y \breve{} NO_x$), ozone, and $PM_{2.5}$

- Generic time series investigation tool – combines a time series, scatter plot, and pollution rose visualization of any parameter or combination of two parameters

Additionally, the NCore Multipollutant Data Quality Dashboard provides a few network wide indicators.

- Trends for key required parameters at a network and site level
- Detection limits for required parameters at a network level

- Network completeness for required NCore parameters compared across all stations

Tabs Overview

You can view two types of assessments within the data quality dashboard as shown in **Figure 1**. Tabs colored green indicate *network level assessments* that focus on network wide quality indicators. Tabs colored purple indicate *specific site-level assessments* focused on site-specific quality indicators and analysis tools. Green tabs will always be shown. Purple tabs require that a site is selected on the Map Tab (see **Map Tab** section). NO_z Time Series and Pollution Roses tabs are only displayed when a program station is (1) selected and (2) has the required data for display.

Figure 1: Dashboard tabs, shown for the NCore dashboard, categorized by color. Green are Network-level Assessments. Purple are Specific Site-level Assessments, and require that a site is selected on the Map Tab.

Network-wide Quality Indicator Tabs

Four network wide tabs are available: Map, Trends, Detection limits, and Network Completeness.

Map

The map tab is the default landing page for a data quality dashboard. **Figure 2** shows the default map display for the NCore dashboard. Each circle on the map represents an individual monitoring site. By toggling between radio buttons above the map on the right, a user can update which sites are displayed. The categories of this filter may change based on monitoring program, but as seen in Figure 2, the NCore Dashboard allows a user to display either active (default selected) or inactive sites. Sites may be colored to display a characteristic across the network. For example, the NCore sites in Figure 2 are color-coded by urban/suburban (blue) or rural designation (green).

To **select a site**, a user should click a circle on the map. A user must select a site on the map to view metrics on purple *Site Specific Quality Indicator* tabs. To **deselect a site**, a user may click the background of the map (i.e. any non-circle location on the map).

The table below the map provides site details, including location, site code, and site name. The table will update once a site is selected on the map to show information only for the selected site. Deselecting a site will re-populate the table with information for all sites.

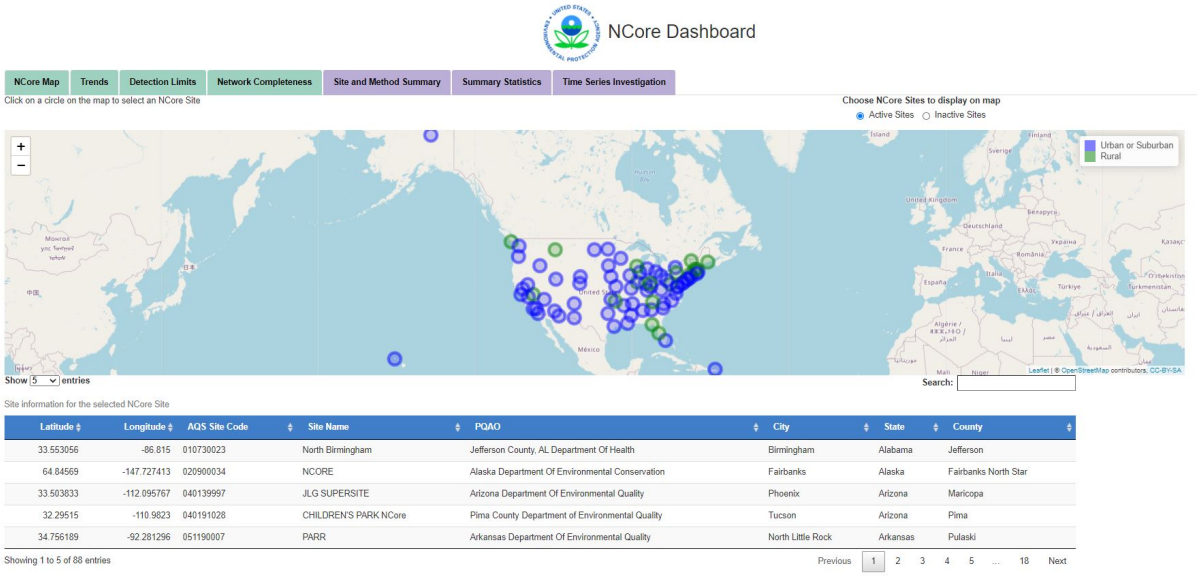


Figure 2: Map tab (default landing page) for the NCore Dashboard. NCore sites shown in the map are also listed in the table below.

Trends

The trends tab provides annual trends figures for required monitoring program pollutants. **Figure 3** shows the top half of the standard trends analysis tab. The boxplot shown in Figure 3 shows the distribution of slopes across the network over the past 10 years for each required pollutant. The annual percent change in concentration is plotted on the x-axis, and each required pollutant is plotted on the y-axis. A reference line at a slope change of 0% is plotted as a dotted gray line. Pollutants are shown only if they have at least 10 stations with at least 7 out of a possible 10 years available (>=70% completeness).

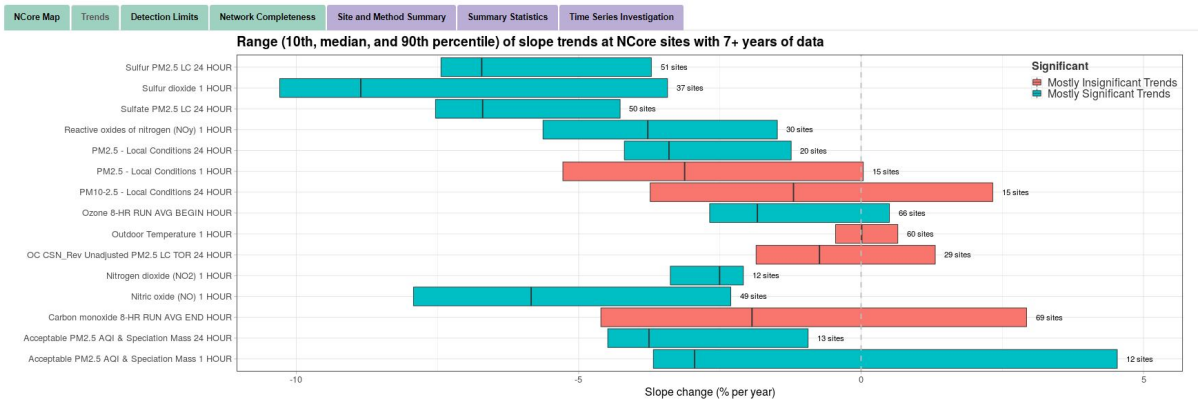


Figure 3: Trends tab with Slope Trends figure displayed.

Each box plot represents the collection of slopes across all sites that measure the pollutant. The number of sites represented by each box is noted to the right of the box. The left end of the box is drawn at the 10th percentile slope (% change per year), the right end of the box is drawn at the 90th percentile slope, and the median slope is drawn as a black line within the box. Boxes are color coded to indicate whether f-test values of individual trends are statistically significant at the 95% confidence level at more than 50% of the available trend stations; boxes that are blue indicate most site trends are statistically significant and

red boxes indicate that trends are mostly insignificant (i.e., not significantly different from a flat trend). See **Figure 4 for reference**. Slope trends are normalized by site, so the network distributions show the three distributional points (10th, 50th, 90th percentile) percentage change per year per pollutant.

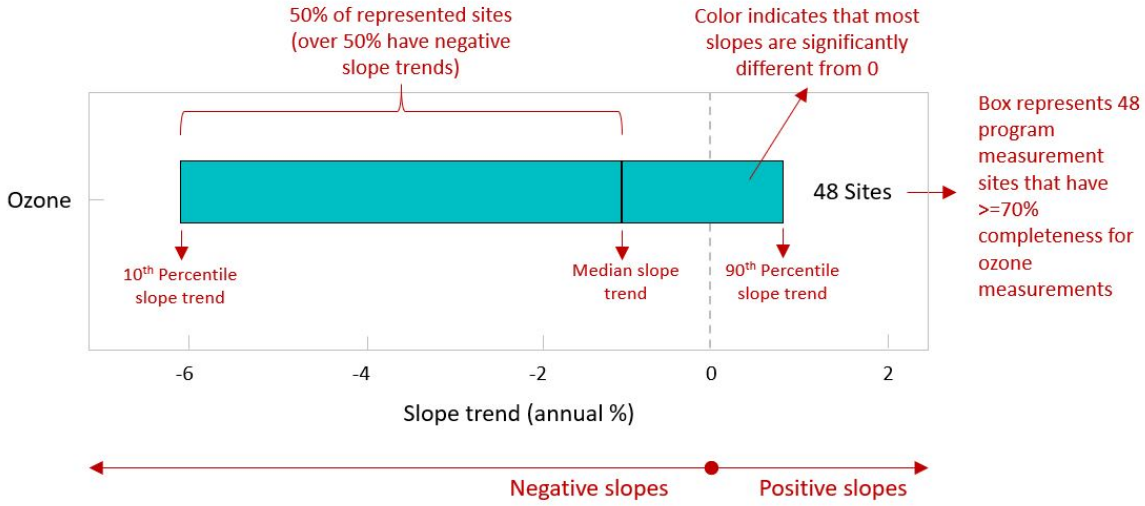


Figure 4: Reference for Slope Trends figure box.

The bottom image on the trends tab (**Figure 5 and 6**) shows Individual Station Trends for a selected pollutant and sample duration. When a site is selected on the map that has a valid and complete trend, it is highlighted as a colored line on this figure. This figure allows the user to identify how a 7+ year trend at any measurement site compares to nationwide trends at other stations for the same time period. If the site selected does not have a valid or complete trend, the colored line will not appear in this figure.

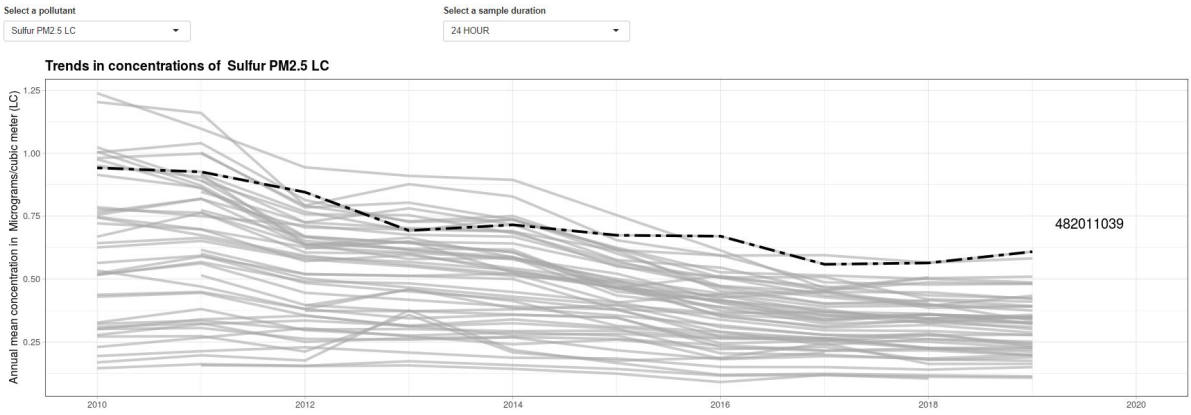


Figure 5: Individual Station Trends figure with site selected.

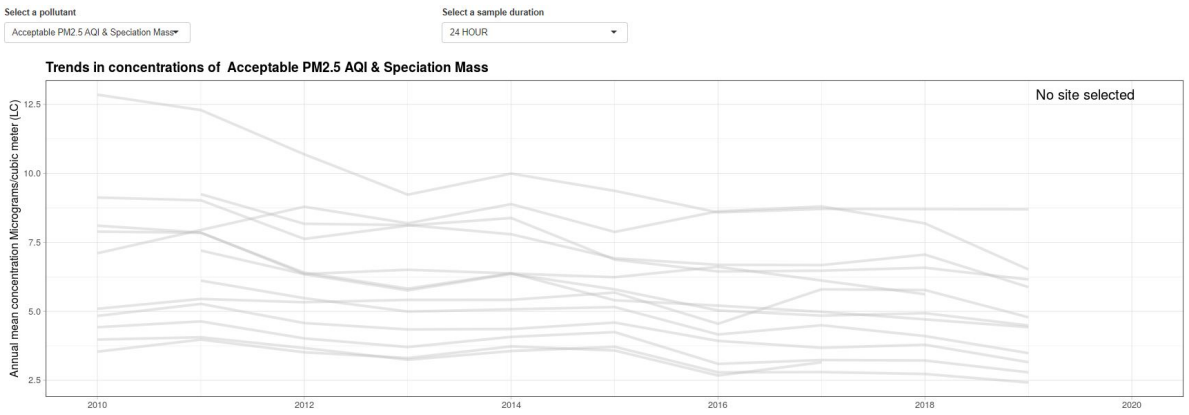


Figure 6: Individual Station Trends figure with no site selected.

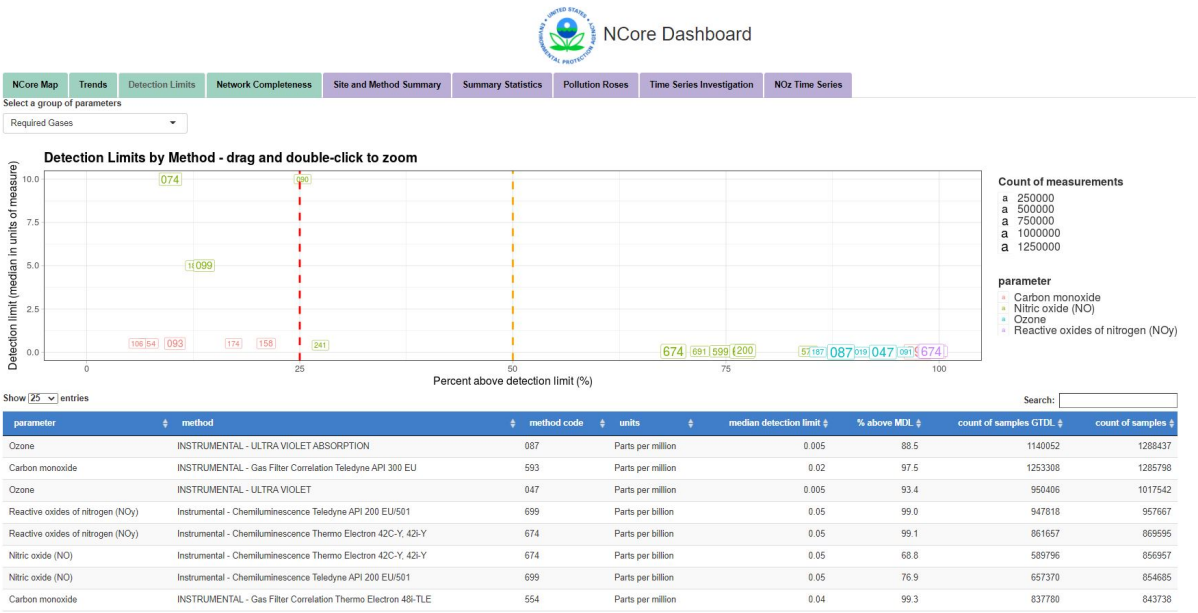
Detection Limits

Figure 7 shows the Detection Limits tab display for required gases at program monitoring stations. In this tab, the network wide detection limits are summarized by methods in use across the network. A user may select to display methods for required gases (default) or other parameter groups by selecting from the drop-down menu in the upper left-hand corner.

The detection limits figure plots the percentage of samples observed above the method detection limit on the x-axis, and median method detection limit on the y-axis. Individually colored numbers indicate the method codes of the parameters. The size of the text indicates the number of samples, and the color indicates the associated parameter. The red and orange vertical lines indicate 25% and 50% of the data reported above method detection limits. Methods to the left of the orange horizontal line are reporting data below method detection limits most of the time and are therefore insufficiently sensitive to quantify the typical concentrations.

The table displays details on parameter, method code, units, median detection limit reported across all samples, percentage of records above the method detection limit, and count of samples.

A user may **zoom in** on the detection limit figure by dragging a box across the figure to select a range and double-clicking. This will update the table to show only methods enclosed in the selected area. To **reset the zoom**, double-click the plot area.



parameter	method	method code	units	median detection limit	% above MDL	count of samples GTDL	count of samples
Ozone	INSTRUMENTAL - ULTRA VIOLET ABSORPTION	087	Parts per million	0.005	88.5	1140052	1288437
Carbon monoxide	INSTRUMENTAL - Gas Filter Correlation Teledyne API 300 EU	593	Parts per million	0.02	97.5	1253308	1285798
Ozone	INSTRUMENTAL - ULTRA VIOLET	047	Parts per million	0.005	93.4	950406	1017542
Reactive oxides of nitrogen (NOy)	Instrumental - Chemiluminescence Teledyne API 200 EU/501	699	Parts per billion	0.05	99.0	947818	957667
Reactive oxides of nitrogen (NOy)	Instrumental - Chemiluminescence Thermo Electron 42C-Y, 42i-Y	674	Parts per billion	0.05	99.1	861657	869595
Nitric oxide (NO)	Instrumental - Chemiluminescence Thermo Electron 42C-Y, 42i-Y	674	Parts per billion	0.05	68.8	589796	856957
Nitric oxide (NO)	Instrumental - Chemiluminescence Teledyne API 200 EU/501	699	Parts per billion	0.05	76.9	657370	854685
Carbon monoxide	INSTRUMENTAL - Gas Filter Correlation Thermo Electron 48i-TLE	554	Parts per million	0.04	99.3	837780	843738

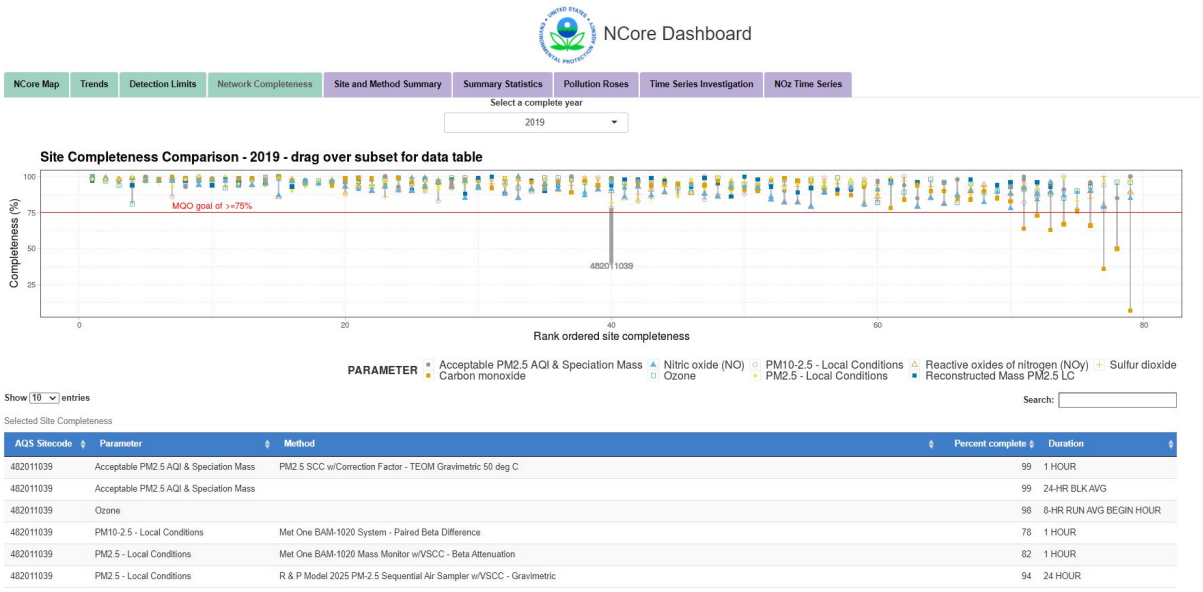
Figure 7: Detection Limits Tab display for Required Gases, shown for the NCore Dashboard.

Network Completeness

Figure 8 shows the Network Completeness tab display for required parameters at program monitoring stations. The figure shows the percent completeness of required pollutant parameters for the program network by site and year. The main table shows parameter and duration percent completeness for the site selected on the Map Tab (if one has been selected).

Year may be changed using the drop-down menu above the plot. The menu only shows complete years of monitoring data. The dropdown menu does not allow a user to select partial years (before reporting deadlines to AQS). This means that the most recent complete year is updated in April of the following year (e.g. 2020 will become available in April, 2021).

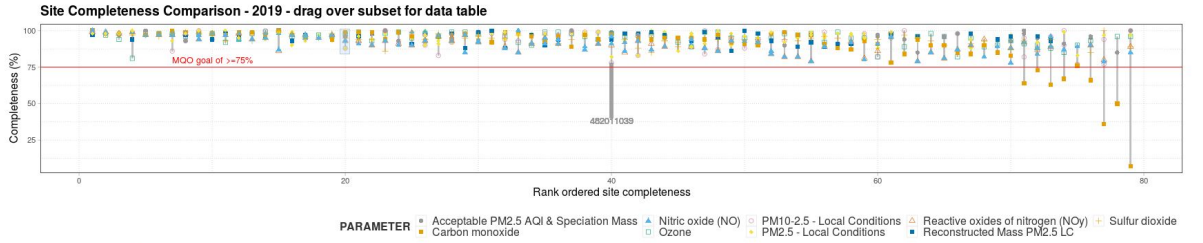
Each monitoring site is represented by a gray line segment according to rank-ordered completeness, plotted on the x-axis. Completeness (%) per parameter is plotted on the y-axis. Each parameter measured at a site is represented by a colored shape and plotted on the gray line segment representing the site.



AQS Sitecode	Parameter	Method	Percent complete	Duration
482011039	Acceptable PM2.5 AQI & Speciation Mass	PM2.5 SCC w/Correction Factor - TEOM Gravimetric 50 deg C	99	1 HOUR
482011039	Acceptable PM2.5 AQI & Speciation Mass		99	24-HR BLK AVG
482011039	Ozone		98	8-HR RUN AVG BEGIN HOUR
482011039	PM10-2.5 - Local Conditions	Met One BAM-1020 System - Paired Beta Difference	78	1 HOUR
482011039	PM2.5 - Local Conditions	Met One BAM-1020 Mass Monitor w/VSCC - Beta Attenuation	82	1 HOUR
482011039	PM2.5 - Local Conditions	R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric	94	24 HOUR

Figure 8: Pollution roses for primary (hourly) and secondary parameters (hourly).

If a site is selected on the Map Tab, the segment representing that site is highlighted on the plot. A user can drag and double-click across a subset of the plot to view detailed information about the data point enclosed within the drag-box, which will appear in a temporary table between the plot and the main table (see **Figure 9**).



AQS_SITECODE	PARAMETER	YEAR	Duration	percent_complete
090050005	Ozone	2019	8-HR RUN AVG BEGIN HOUR	98
090050005	PM10-2.5 - Local Conditions	2019	24 HOUR	96
090050005	PM10-2.5 - Local Conditions	2019	1 HOUR	88
090050005	PM2.5 - Local Conditions	2019	24 HOUR	99
090050005	PM2.5 - Local Conditions	2019	1 HOUR	88
090050005	Reactive oxides of nitrogen (NOy)	2019	1 HOUR	93
090050005	Acceptable PM2.5 AQI & Speciation Mass	2019	24 HOUR	96
090050005	Carbon monoxide	2019	8-HR RUN AVG END HOUR	99
090050005	Nitric oxide (NO)	2019	1 HOUR	93
090050005	Sulfur dioxide	2019	1 HOUR	95

Figure 9: Network completeness tab with dragbox over the representing site 090050005 (rank order site completeness = 20). The temporary table is shown below the plot.

Site Specific Quality Indicator Tabs

Pollution Roses

The pollution roses tab shows pollution roses for ozone and $PM_{2.5}$ at the monitoring site selected on the Map Tab. **Figure 12** shows the layout of the tab. There are drop-down menus for year (or year range) and meteorological season (or seasons). The seasons are defined as:

- Spring: March, April, and May
- Summer: June, July, and August
- Fall: September, October, and November
- Winter: December, January, and February

These plots are followed by a table with the number of hourly observations used to generate the pollution roses based on the selected year(s) and season(s). Two pollution roses are displayed side-by-side for ozone and $PM_{2.5}$, with a drop-down menu allowing for color-codes that represent either concentrations or AQI value bins. Below the two pollution roses is an urban-scale (~25 km) map showing the site location within its local area (**Figures 12 and 13**).

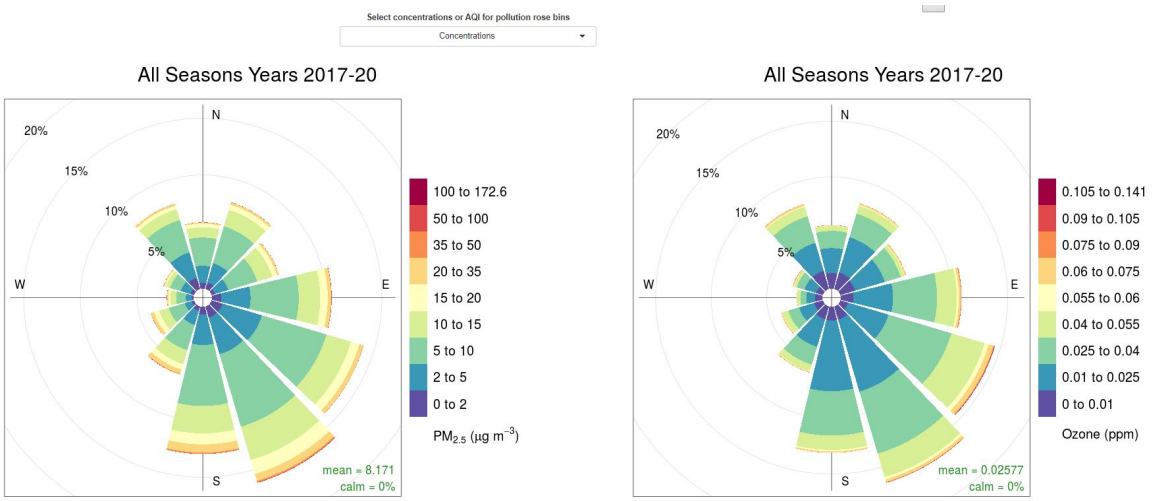


Figure 10: Pollution Roses Tab showing concentrations of $PM_{2.5}$ ($\mu g/m^3$) and ozone (ppm) by wind arc. A table of observational completeness and a local map are also displayed.

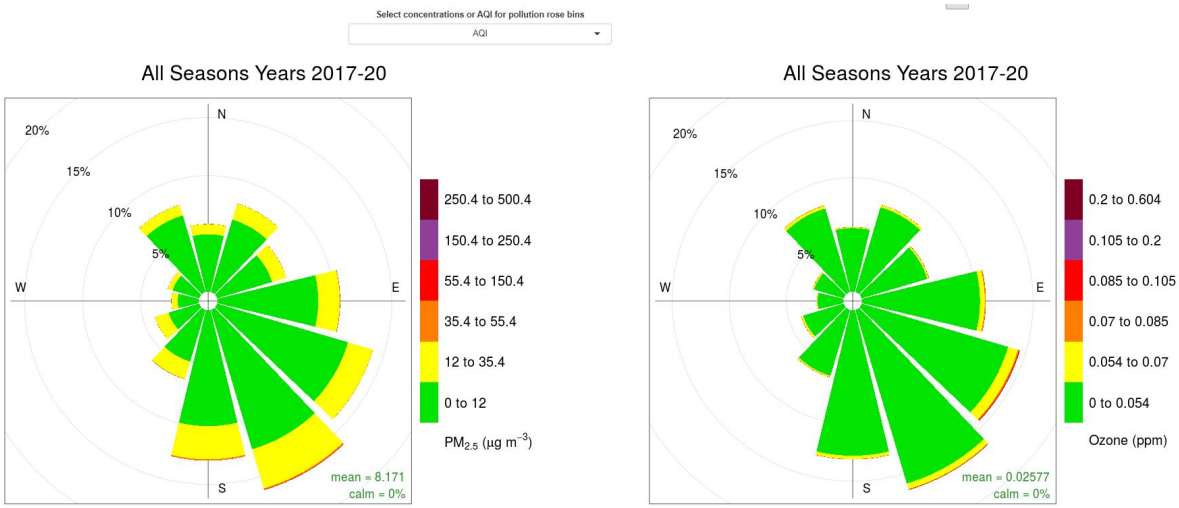


Figure 11: Pollution Roses Tab showing AQI of $PM_{2.5}$ ($\mu g/m^3$) and ozone (ppm) by wind arc. A table of observational completeness and a local map are also displayed.

Site and Method Summary

The Site and Method Summary tab provides an annually selectable set of Quality indicators for the required parameters and a subset of optional parameters. **Figure 10** shows an example for the Idaho St. Luke's Meridian NCore station data in 2019. Directly below the tabs is a description of the selected site and its metadata. A selectable drop-down menu allows the user to select a year of interest – data is currently available for 2017-2020. Finally, the main table shows individual required parameters and monitor specific information including method, POC, sample duration, and units. The color-coding of the table indicates the type of parameter being measured. Types include:

- **Required Gases** – required program parameters that are gas-phase measurements
- **Required PM** – required program parameters that are particle-phase measurements
- **Required Meteorology** – required program parameters that are meteorology measurements
- **Additional Supporting** – optional program parameters
- **Ion** – only shows sulfate PM2.5 measurements as a proxy for key components of PM mass
- **Speciation** – only shows Sulfur PM2.5 measurements as a proxy for speciated atomic measurements of PM
- **Collocated Measurements** – shows any required parameters with secondary POC measurements at the program station

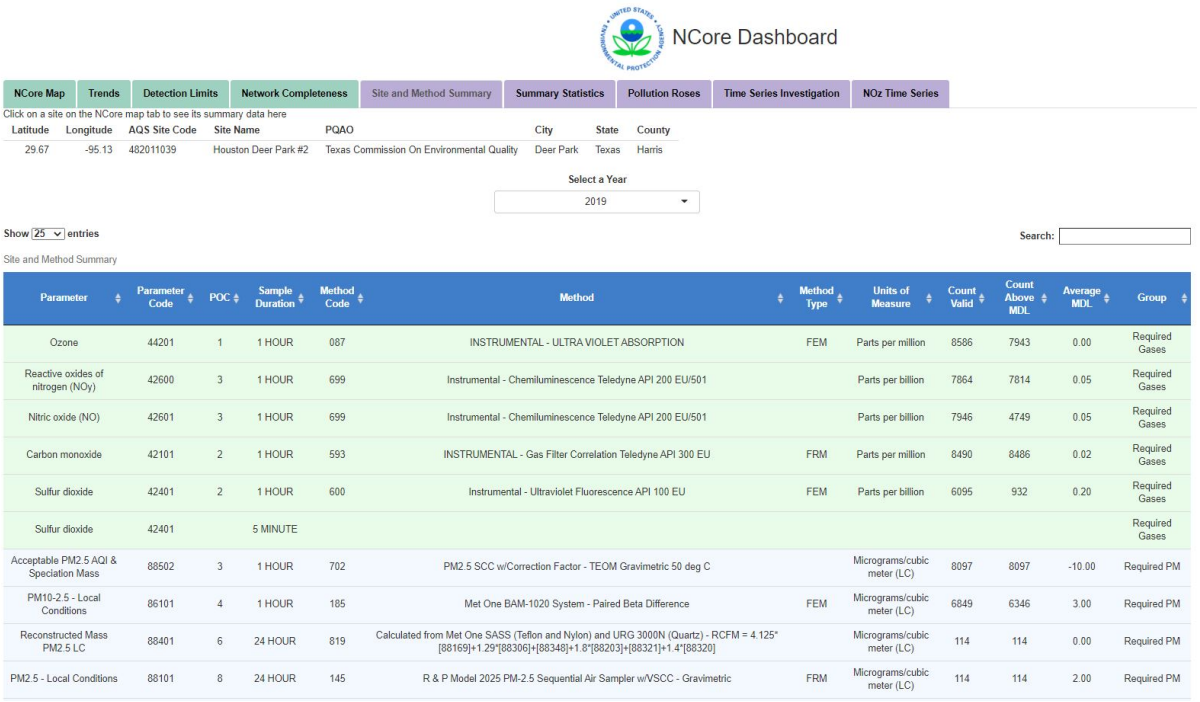


Figure 12: Example of the Site and Method Summary tab for the Idaho St. Luke's Meridian NCore station.

Summary Statistics

The Summary Statistics Tab (**Figure 11**) is intended to provide a quick glance at summary statistics for each of the key program parameters. The format is very similar to the Site and Method Summary tab, with an identical site metadata table, followed by the Year drop-down menu, and then the table with summary statistics by monitor.

The color-coding of the primary data table is the same as the Site and Method Summary tab. Parameters are sorted first by required groups, and then the optional groups. The primary difference between this tab and the Site and Method Summary tab is the Yearly data table provides the summary values (maximum, average,

median, minimum) for each parameter. Additional quality indicators columns indicate the number of valid reported samples, the number of samples above the method detection limit (MDL), and the percentage of samples above the MDL.

One final feature is a mouse-over for the method code that displays the method collection and analysis information. Placing your mouse cursor over the method code for a given parameter will show the detailed method information.

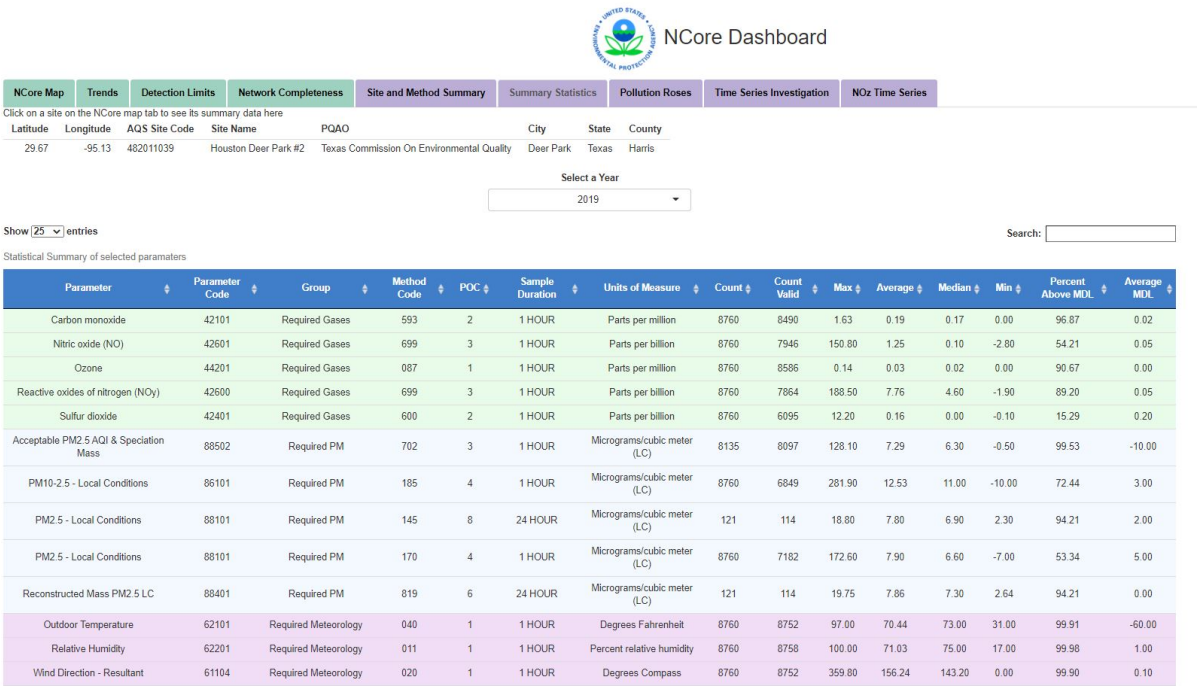


Figure 13: Example of the Summary Statistics tab, shown for the NCore Dashboard.

Time Series Investigation

The Time Series investigation tab allows a user to compare two parameters, one hourly, and the other either hourly or daily, in a time series, pollution rose, and a scatter plot. **Pollution rose and scatter plot comparisons are only available if both parameters are hourly**.

Options at the top of the tab allow a user to select a primary hourly parameter to display, and optionally, a secondary hourly or daily parameter to compare. Once the user selects a radio button other than "None" to display a secondary parameter, a drop-down menu will appear with the available options based on chosen duration (either 1-hour parameters or 24-hour parameters).

If one hourly parameter is chosen:

- The timeseries plot will display the primary parameter concentration as a solid line.
- A single pollution rose will display the primary parameter concentration.
- Scatter plot comparison is unavailable.

If two hourly parameters are chosen:

- The timeseries plot will display the primary parameter concentration as a solid line and the secondary parameter as a dashed line. A secondary y-axis (right-hand side) will be included to reference the secondary parameter values. (**Figure 14**)
- Two pollution roses will display the primary and secondary parameter concentrations, respectively. (**Figure 15**)

- A scatter plot comparison will display, with the option to overlay a one-to-one line and/or a linear regression line using check-box selections. (**Figure 16**)

If one hourly parameter and one daily parameter is chosen:

- The timeseries plot will display the primary parameter concentration as a solid line and the secondary parameter as points. A secondary y-axis (right-hand side) will be included to reference the secondary parameter values.
- A single pollution rose will display the primary parameter concentration (daily pollution rose unavailable).
- Scatter plot comparison is unavailable.

Plot Reactivity

A user may zoom in on a particular time range in the timeseries plot by clicking-and-dragging a box across the desired subset of data on the plot, and double-clicking within the drawn box to zoom in. If displayed, pollution roses and the scatterplot will update to reflect this zoomed time period. To reset the zoom, double-click the timeseries plot.

Two reference lines are available to overlay on a scatter plot comparison: a one-to-one line, and a linear regression line. These may be drawn by selecting one or both checkboxes to the right of the scatter plot. A one-to-one line may not appear within the plot boundaries if the scales of the primary and secondary parameters do not overlap (e.g. ozone and barometric pressure).

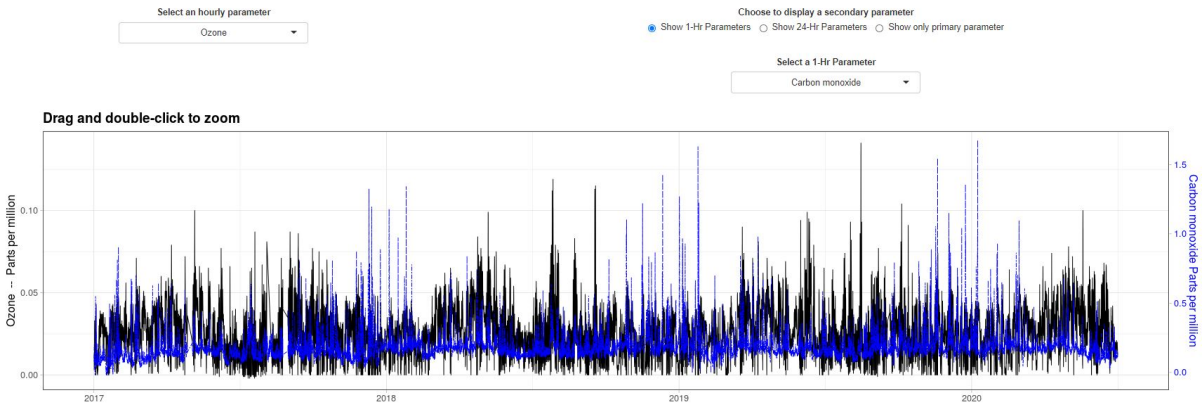


Figure 14: Time series plot a primary (hourly) and secondary parameter (hourly). The right-hand y-axis represents the secondary parameter.

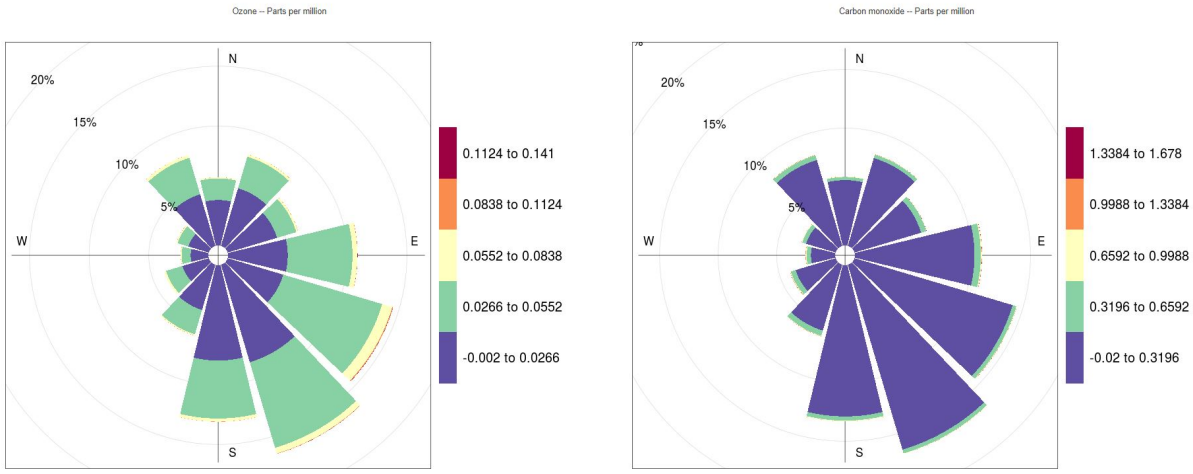


Figure 15: Pollution roses for primary (hourly) and secondary parameters (hourly).

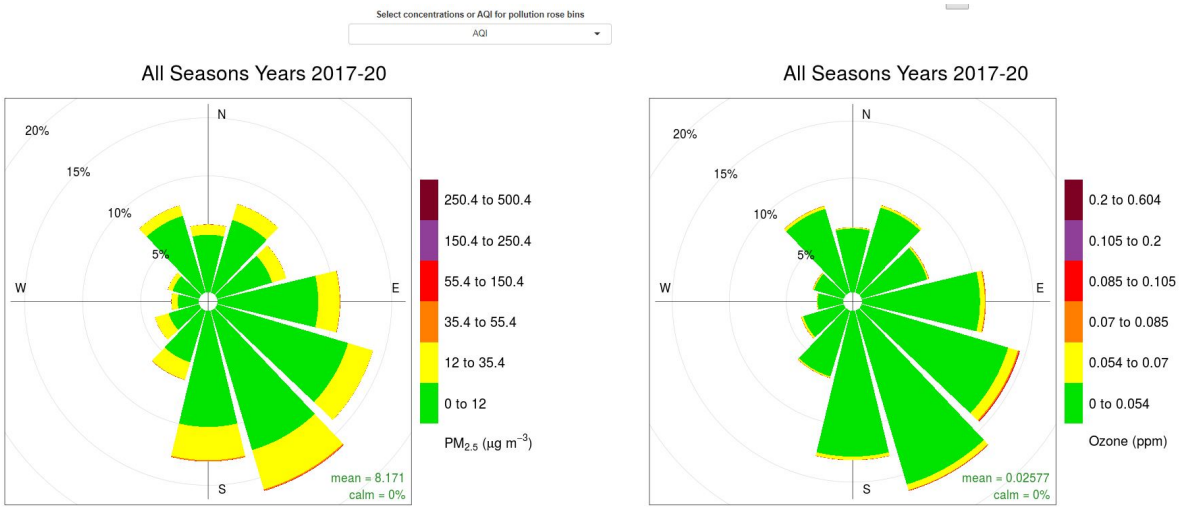


Figure 16: Scatter plot comparing primary (hourly) and secondary parameter (hourly), and one-to-one and linear regression lines shown. A scatter plot comparison is only available when two hourly parameters are chosen.