Alaska Community Air Sensor Network
2nd Interim Report

State of Alaska
Department of Environmental Conservation
Division of Air Quality

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1. Executive Summary

The Alaska Department of Environmental Conservation's Air Monitoring and Quality Assurance Program is in the process of establishing a community-based ambient air quality sensor network using QuantAQ Modulair™ sensor pods. This ensemble of sensors is intended to provide a network of publicly available air quality data across Alaska, to help understand impacts and sources of air pollution on historically underserved communities, and to make the data easily available to the communities themselves. This project aims to install sensors in communities throughout Alaska, and provide outreach, education, and assistance to the communities with sensors. This interim document records the progress of the low-cost air sensor program during the six-month period between April and September 2024.

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Abbreviations, Terms, and Definitions

Abbreviation/Term	Definition
AMQA	Air Monitoring and Quality Assurance Program of DEC. Responsible for coordinating all aspects (quality assurance, data collection, and data processing) with respect to ambient air quality and meteorological monitoring of the DEC Division of Air Quality.
AQI	Air Quality Index. The AQI is an index for reporting daily air quality and what associated health concerns the public should be aware of. The AQI focuses on health effects that might happen within a few hours or days of breathing polluted air. The AQI rates the air quality in 6 steps from good to hazardous.
AQMesh	AQMesh™ is a brand of ambient air quality sensor that monitors particulate matter and gaseous pollutants, meteorology is optional. Distributed by Ambilabs in the United States.
ARP	American Rescue Plan
BLM	Bureau of Land Management
°C	Degrees Celsius
CAA	Clean Air Act
CCSC	Campbell Creek Science Center
Criteria Pollutant	Any air pollutant for which the EPA has established a National Ambient Air Quality Standard for regulation under the Clean Air Act.
CO	Carbon monoxide
DEC	Alaska Department of Environmental Conservation. The department of state government with primary responsibility for management and oversight of provisions of the Clean Air Act, including EPA's National Ambient Air Quality Standards.
EPA	U.S. Environmental Protection Agency
FEM	Federal Equivalent Method
FNSB	Fairbanks North Star Borough
FRM	Federal Reference Method
LCS	Low-cost sensor
$\mu g/m^3$	Microgram per cubic meter
MOA	Memorandum of Agreement
Mat-Su	Matanuska-Susitna
MODULAIR™	Ambient air quality sensor by QuantAQ that monitors particulate matter and gaseous pollutants, meteorology is optional.
NAAQS	National Ambient Air Quality Standards
NO	Nitric oxide

NO_2	Nitrogen dioxide
NP / NPP / NPS	National Park / National Park and Preserve / National Park Service
OPC	Optical particle counter
O_3	Ozone
%	Percentage
+/-	Plus or minus
PM_{10}	Particulate matter with an aerodynamic diameter of less than or equal to 10 microns[1].
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than or equal to 2.5 microns.
ppb	Part per billion
QA	Quality Assurance
QAPP	Quality Assurance Project Plan. A plan which identifies data quality goals and identifies pollutant-specific data quality assessment criteria.
QC	Quality Control
QuantAQ	Manufacturer of MODULAIR™ ambient air quality sensor
R^2	Coefficient of determination (R-squared)
RH	Relative Humidity
SIP	State Implementation Plan
SLAMS	State and Local Monitoring Station. The SLAMS network consists of roughly 4000 monitoring stations nationwide. Distribution depends largely on the needs of the State and local air pollution control agencies to meet their respective SIP requirements. The SIPs provide for the implementation, maintenance and enforcement of the NAAQS in each air quality control region within a state. The State of Alaska monitoring network currently has eight SLAMS sites for CO and PM.

[1] https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

2. Introduction

Air pollution is broadly defined by the World Health Organization as any kind of "chemical, physical, or biological agent" that contaminates and alters the natural composition of the atmosphere[2]. Air pollution poses a serious risk to the health of humans and the environment. Regulatory efforts typically focus on fuel quality and emissions standards for vehicle engines and industrial facilities, as these are the primary sources of anthropogenic air pollution. The goal of these regulatory efforts is to develop practical standards, limits, and enforcement mechanisms that maintain public health and welfare.

In time, the federal response to air pollution expanded in scope and function, with the passage of the Clean Air Act (CAA) in 1963 and the formation of the U.S. Environmental Protection Agency (EPA) in 1970. That same year, the CAA was expanded to include the National Ambient Air Quality Standards (NAAQS), which sought to aggressively reduce air pollution with strict regulations and efficiency standards on industrial processes and combustion engines. The NAAQS are applied geographically, with areas either attaining the specified air quality standards or not, referred to as attainment and non-attainment areas, respectively. As states and the EPA developed a technical understanding of their regional air quality and emissions sources, state-level regulations and implementation plans (SIPs) were developed. In Alaska, this manifests as updates to regulations under Title 18, Chapter 50 of the Alaska Administrative Code dealing with Air Quality Control, which came into effect in 2011, with amendments and expansions added over the following decade.

The Air Monitoring and Quality Assurance Program (AMQA) in the Alaska Department of Environmental Conservation (DEC) Air Quality Division operates and maintains the State's air monitoring network; regulatory monitoring sites are established in the Municipality of Anchorage and Matanuska Susitna (Mat-Su) Borough, the Fairbanks North Star Borough (FNSB), and the City and Borough of Juneau. The regulatory network uses Federal Reference Method (FRM) and Federal Equivalent Method (FEM) instrumentation to monitor air pollutants at State and Local Monitoring Stations (SLAMS); FRM and FEM instruments can be very expensive, follow strict performance requirements, are used to make regulatory decisions, and are considered the gold standard for air quality monitoring. Low-cost sensors (LCS) are non-regulatory instruments, often much cheaper than FRM/FEM instruments, and are generally easier to operate than regulatory-grade instruments. LCS technology is a rapidly evolving field, with new sensors introduced on a regular basis. Because of this, capabilities of the sensors and quality of the data is variable.

Alaska's ambient air quality issues focus on particulate matter. Summertime wildland fires, road dust, and wood stove emissions are critical issues for Alaskan air quality; these sources may produce high levels of particulate pollution, which, in combination with lower access to medical resources, have been linked to higher levels of respiratory illnesses in rural communities and Alaska Native populations[3]. Thus, there is strong demand and critical need for improved air quality monitoring in rural Alaskan communities. To address this, DEC has established a network of low-cost air monitoring sensors in communities across Alaska.

[2] https://www.who.int/health-topics/air-pollution
[3] Nelson et al., Environmental Health Consults in Children Hospitalized with Respiratory Infections (April 2021)

3. Goals of the Study

The goal of DEC's community-based air quality sensor network as explained in the Quality Assurance Project Plan[4] (QAPP), is to provide a baseline of non-regulatory air quality data to communities not covered by the State's regulatory monitoring network, to help understand the impacts and sources of air pollution on historically underserved communities, and to make that information easily available to the communities themselves. This network is composed of multiple low-cost air monitor pods, each equipped with multiple sensors to measure a variety of air pollutants. The sensors are distributed across the state to cover as many people and be as representative as possible. In total, DEC has 55 QuantAQ Modulair™ pods; 40 are intended for community deployments, six are for quality assurance (QA) purposes, and nine are reserved for back-ups and replacements[5].

The project is partially funded through a three-year American Rescue Plan (ARP) grant that start in spring 2023. The anticipated data users include community leaders, and community members including adults with health conditions, those who are elderly or pregnant, and students performing air quality research, as well as DEC AMQA staff. By engaging with tribes and rural communities, DEC intends to continue developing a network of ambient air monitoring sensors to provide air quality data that serves Alaska residents. In addition to public awareness, DEC's ambient air monitoring contributes to our knowledge of local and regional differences in air quality and helps Alaska residents understand changes in their local air quality.

3.1 Locations and Partners

To build the community-based air monitoring network across Alaska, DEC partners with rural and tribal communities, as well as borough officials, government staff, and private citizens. DEC aims to create a network that covers as many people as possible, throughout communities that do not have access to local air quality information. Much of the state is not covered by cellular networks or the cellular networks available are not compatible with the QuantAQ Modulair™ pods. Because of this, DEC has had to find alternative communities where the correct cellular service is available. Further discussion on cellular connectivity issues can be found in Section 4.1.

This process begins with DEC reaching out to public officials or residents in a community and briefly describing the ambient air monitoring project. If the community contact consents to hosting an air monitoring pod at some appropriate location on their facilities or properties, they are sent a package of documents including a one-page summary of the project, siting criteria for mounting the sensor, and a memorandum of agreement (MOA) document to formalize approval for hosting a sensor. Once an appropriate site has been identified (typically on a wall or support column of a public building such as a

[4] DEC, Quality Assurance Project Plan, Community-Based Air Sensor Network (December 2023) https://dec.alaska.gov/air/air-monitoring/guidance/quality-assurance-plans/

[5] Low-cost sensors are not as reliable as regulatory sensors. To have fewer data gaps in the low-cost sensor network, it is vital to have replacement sensors on hand for when a deployed sensor needs to be swapped out of the field.

library, administrative office, or community gathering location) and the formal agreement document has been signed, DEC staff will travel to the community to meet the contact in person and install the sensor. On occasion, a sensor may be shipped out to a community and installed by the contact, using the siting criteria document and technical guidance from DEC employees.

For a more detailed discussion on the project's methods, sensor technology, and quality assurance strategies, please refer to the 1st Interim Report[6].

3.2 Deployment History

Previously, DEC initiated the LCS project by installing AQMesh pods in Bethel, Fairbanks, Juneau, Homer, Ketchikan, Kodiak, Kotzebue, Nome, Seward, and Sitka. Although their data performance was acceptable, the AQMesh sensors were difficult to maintain and repair and were phased out in preference for the QuantAQ Modulair™ pods. During the reporting period described in this report (April 1, 2024, to September 31, 2024), DEC staff exclusively installed QuantAQ Modulair™ pods. The QuantAQ Modulair™ devices were placed in new communities, including Soldotna, Ninilchik, Talkeetna, Big Lake, Glennallen, Willow, Palmer, Wasilla, Chickaloon/Sutton-Alpine, Nenana, Cordova, as well as Denali National Park (NP) at the visitor area, and used as replacements for communities that had an AQMesh sensor, including Homer, Nome, Seward, Kodiak, Kotzebue, and Bethel.

Table 1. **Previous Deployment History (since October 1, 2023)**

Sensor ID	Community	Install Date	Notes
QuantAQ 471	Anchorage	10/3/2023	Permanent monitor at Garden regulatory site.
QuantAQ 444	Tok	10/26/2023	
QuantAQ 447	Delta Junction	11/2/2023	
QuantAQ 443	Fairbanks	11/20/2023	Permanent monitor at NCore regulatory site.
QuantAQ 455	Juneau	1/29/2024	Swap out AQMesh with QuantAQ Modulair™
QuantAQ 456	Juneau	1/29/2024	Swap out AQMesh with QuantAQ Modulair™
QuantAQ 450	Haines	1/30/2024	
QuantAQ 452	Hoonah	1/30/2024	
QuantAQ 449	Ketchikan	1/31/2024	Swap out AQMesh with QuantAQ Modulair™
QuantAQ 453	Skagway	1/31/2024	
QuantAQ 451	Wrangell	2/1/2024	
QuantAQ 448	Goldstream	2/20/2024	Swap out AQMesh with QuantAQ Modulair™
QuantAQ 445	Badger	3/21/2024	
QuantAQ 454	Sitka	3/21/2024	Swap out AQMesh with QuantAQ Modulair™

[6] DEC, Alaska Community Air Sensor Network 1st Interim Report (December 2024) https://dec.alaska.gov/air/air-monitoring/instruments-sites/community-based-monitoring/

Table 2. **Deployment History from April 1, 2024, to September 31, 2024**

Sensor ID	Community	Install Date	Notes
QuantAQ 651	Fairbanks	4/11/2024	Permanent pod at NCore regulatory site.
QuantAQ 652	Fairbanks	4/11/2024	Audit pod at NCore regulatory site.
QuantAQ 463	Anchorage	4/16/2024	Audit pod at Garden regulatory site.
QuantAQ 665	Juneau	4/29/2024	Permanent pod at Floyd Dryden site.
QuantAQ 459	Anchorage	5/3/2024	Initial install at Campbell Creek Science Center. Removed 6/18/24 due to sensor malfunction. Replaced same day with QuantAQ 462.
QuantAQ 460	Soldotna	5/13/2024	
QuantAQ 461	Ninilchik	5/13/2024	
QuantAQ 464	Homer	5/14/2024	Swap out AQMesh with QuantAQ Modulair™.
QuantAQ 654	Nome	5/23/2024	Swap out AQMesh with QuantAQ Modulair™.
QuantAQ 465	Seward	6/5/2024	Swap out AQMesh with QuantAQ Modulair™.
QuantAQ 457	Denali Park	6/12/2024	Operating in cooperation with NPS at Denali NP.
QuantAQ 462	Anchorage	6/18/2024	Operating in cooperation with Bureau of Land Management (BLM) at Campbell Creek Science Center.
QuantAQ 467	Talkeetna	7/1/2024	Operating in cooperation with NPS.
QuantAQ 468	Big Lake	7/1/2024	
QuantAQ 660	Kodiak	7/2/2024	Swap out AQMesh with QuantAQ Modulair™.
QuantAQ 662	Kotzebue	7/9/2024	Swap out AQMesh with QuantAQ Modulair™.
QuantAQ 466	Glennallen	7/18/2024	Operating in cooperation with BLM.
QuantAQ 659	Bethel	7/30/2024	Swap out AQMesh with QuantAQ Modulair™.
QuantAQ 470	Willow	8/6/2024	
QuantAQ 657	Palmer	8/6/2024	
QuantAQ 663	Wasilla	8/6/2024	
QuantAQ 649	Chickaloon*/ Sutton-Alpine	8/7/2024	*Sensor is installed at the Chickaloon Village Administration building, which is physically closer to the community of Sutton-Alpine.
QuantAQ 655	Nenana	9/6/2024	
QuantAQ 664	Cordova	9/17/2024	

3.3 Community Outreach

Part of the process of establishing a state-wide low-cost air sensor network involves making contact with rural communities and engaging local residents in constructive and mutually beneficial ways. Community members may be involved to some degree in negotiations over community participation, site selection, sensor installation, and on-going sensor maintenance. During community visits and sensor installation, DEC staff can provide educational materials (such as fliers, pamphlets, and brochures) on air pollution, safe wood burning and stove use, dust control measures, and other air quality topics. Our community contacts often become an informal point person for questions from their community members about the air monitoring program or local air quality conditions.

DEC hosts quarterly community engagement calls, where contacts in participating communities are invited to a presentation with updates on the strategies and goals of the project, the LCS technology being used or considered, an updated history of pod deployments with maps and photos of locally installed pods, and a summary of important or interesting data trends seen over the past season or year. This information is particularly important for communities that regularly or seasonally experience poor air quality due wildland fires, road dust, or combustion emissions such as wood-fired stoves used in winter or idling cruise ships in summer. Previous quarterly community engagement call presentations can be found on AMQA's website (https://dec.alaska.gov/air/air-monitoring/instruments-sites/community-based-monitoring/).

In addition to these outreach efforts, DEC maintains a publicly accessible map that displays real-time air quality data throughout Alaska (https://dec.alaska.gov/air/air-monitoring/responsibilities/database-management/alaska-air-quality-real-time-data/). The website displays the current Air Quality Index (AQI) values and the past 12 hours of data points for all sensors in the community-based sensor network as well as DEC's regulatory network.

In December, DEC sent out data reports to each community covering the summer 2024 season; the reports included calendar plots of daily AQI values, diurnal plots, various statistics, and a data file. DEC plans to send the winter 2024/2025 season reports out in the spring of 2025. The summer 2024 community data reports can be found on AMQA's website (https://dec.alaska.gov/air/air-monitoring/instruments-sites/community-based-monitoring/). Community members can request data from DEC at any time.

DEC has found fostering community engagement and feedback to be challenging. The quarterly community engagement calls often have low attendance and feedback is sparse, but generally positive. Attendees are encouraged to use available services such as the web-based Local Air Quality Observations form[7] to provide local observations that help DEC gain context to air quality events in communities. DEC will continue to provide participating communities with winter and summer season Community Data Reports; the first round of reports for summer 2024 were well received. DEC will also continue to publish semiannual data reports and data analysis/visualization tools on its website, as well as prepare and present data findings at air quality conferences.

4. Interim Results

4.1 Challenges and Successes

DEC has successfully transitioned to a fleet of QuantAQ Modulair™ pods and developed constructive working relationships with the QuantAQ tech support team. Hiring several new Community Air Monitoring Specialists has allowed DEC to rapidly expand the LCS network over the reporting period. Consequently, the volume of data produced by the sensor network increased substantially, leading DEC to develop efficient quality control (QC) techniques to process, verify, and visualize the greater data throughput. DEC is still in the process of analyzing collocation data to develop correction factors for the QuantAQ

[7] https://dec.alaska.gov/air/air-monitoring/instruments-sites/community-based-monitoring/

Modulair™ data, though this is very time consuming and there is limited guidance available from the manufacturer or other sources.

The DEC team has encountered several technical issues with the sensors onboard the QuantAQ Modulair™, with potential impacts on data quality. Typical bias and precision issues have occasionally been observed, as well as idiosyncratic sensor complications, including:

- The limited accuracy of the PM_{10} sensor compared to the $PM_{2.5}$ sensor, including the PM_{10} sensor's susceptibility to false positives due to hygroscopic effects. Heavy fog, ice fog, or high humidity can affect how the nephelometer and optical particle counter (OPC) instruments perceive the size and concentration of particles, resulting in reported PM_{10} concentrations that are far higher than true levels. These false positive signals can be identified by comparison with the $PM_{2.5}$ sensor to confirm the presence or absence of a simultaneous rise in $PM_{2.5}$ particles, in conjunction with weather reports and feedback from community contacts on local weather and air quality conditions. DEC also employs automatic data flagging within the database to keep erroneously elevated particulate matter readings from displaying on the public AQI webpage.
- The tendency for the ozone (O_3) sensor to display a negative bias; the sensor produces a normal waveform with values that show accurate changes and trends, but the values are consistently lower than the true O_3 concentration, and the troughs in the waveform dip below zero. This particular bias issue can be resolved by the manufacturer re-zeroing the sensor to its lowest readings, raising reported values and eliminating the negative bias. Additionally, the O_3 sensor may report sudden brief dips in ozone concentration, usually no more than a few minute averages at a time, with anomalously low or negative values. According to QuantAQ, this is a known operational flaw in the O_3 sensor technology. The issue can be addressed by nullifying the affected data points.
- The nitric oxide (NO) and nitrogen dioxide (NO_2) sensors occasionally show intermittent aberrant function, where continuous sequences or 'chunks' of sensor readings cluster linearly around a limited set of values with little to no variation. When visualizing the data in time series, the affected data points appear as a cluster of one or more parallel horizontal lines interrupting the normal waveform. Troubleshooting discussions between DEC staff and the QuantAQ tech support team have not yet identified a cause for this error; proposed causes include sensor inaccuracies at low pollutant concentrations and cold weather impacts on sensor function. The aberrant data issue can be addressed by nullifying the affected data points.
- Software or computational issues, including a recently observed issue wherein the O_3 and NO_2 sensors report mirrored data trends. Rather than reporting the true values of their respective pollutants, the sensors generate waveforms with mirrored or inverted features. It is unclear if one sensor is reading accurately while the other sensor is creating inaccurate mirrored reads (and if so, which sensor is performing accurately and which is not), or if both sensors are presenting inaccurate data. The issue is currently being investigated.

DEC staff have dealt with a number of mechanical and logistical challenges facing pods in the field, such as unexpected complications during installation, repairing wiring and outlets destroyed by water damage, replacing wiring and power block components that have been stolen or intentionally damaged, repositioning pods when necessary to avoid undue contamination, or finding a site more representative of community air quality.

The QuantAQ Modulair™ pods transmit data over the AT&T and T-Mobile cellular networks. Many rural communities, and much of the interior of the state, do not have compatible cellular cover or no cellular coverage at all; DEC has had to find alternative communities where QuantAQ Modulair™ pods can connect to the cellular network. DEC is currently researching pods that use different methods of data transmission, such as Wi-Fi or satellite communications. Efforts to identify and purchase alternative air monitoring pods are ongoing, but face limited market options for pods that meet the following criteria: (1) being Wi-Fi or satellite compatible; (2) ability to detect at least a majority of the EPA's designated criteria pollutants including $PM_{2.5}$ to a sufficient degree of accuracy equivalent or superior to the QuantAQ Modulair™; (3) a market price that can reasonably be considered 'low cost'; and (4) a physical design enabling easy installation, cold weather tolerance, and simple maintenance.

Another challenge DEC has faced is troubleshooting sensors in remote communities. Due to the vast size of Alaska and road-system limitations, troubleshooting sensors in rural communities can take much longer than troubleshooting sensors on the road-system. The community contacts often wear many hats and are busy with their day-to-day duties and may not be able to assist with troubleshooting activities.

Sensor technology is rapidly evolving with new methods, new devices, and new analytical approaches emerging regularly. DEC conducted a sensor pod comparison study in the winter of '22/23 and found that the QuantAQ Modulair™ performed the best and met many of DEC's needs, including ease of set-up, responsive communication with the manufacturer, and robust suite of pollutants monitored. The climate in Alaska produces another set of challenges for all sensor types with most instrumentation performing poorly in sub-zero temperatures. While the issues discussed above have appeared in one or more pods during the course of network expansion, the majority of the pods in the network have not experienced any issues. DEC still believes that the QuantAQ Modulair™ is currently the best suited pod for DEC's network and provides valuable air quality trend information.

4.2 Data Findings

For data analysis, communities in the sensor network are organized according to general ecoregion. These include the Interior, Western, Southwestern, Southeastern or Panhandle, and Southcentral ecoregions. By grouping sensors into ecoregions, DEC can identify weather and pollution trends affecting one or several ecoregions. Due to the vast size of Alaska, ecoregions may be subdivided into distinct geographic areas; for example, the Southcentral ecoregion can be divided geographically into the Mat-Su Valley area (which includes Anchorage), the Copper River and Chugach Mountain area, and the Kenai Peninsula.

Sensor data can be presented chronologically, to illustrate changes in pollutant concentration over the course of a day, week, month, and year. Time-wise data can be cross-referenced with geographic data to estimate the geospatial movement of air pollution over time and potentially aid in identifying emissions sources. DEC currently uses diurnal and calendar plots to display data in a time-wise manner.

Diurnal plots are useful for comparing changes in pollutant concentration over time in multiple ecoregion (or area within an ecoregion) communities. This facilitates the identification of area- or ecoregion-wide trends in air quality, as well as daily, weekly, or seasonal variation in air quality trends between proximal communities. For example, if pods in an ecoregion show similar $PM_{2.5}$ patterns over a given time period, that may indicate a single major emission source, such as a large wildland fire. In contrast, differences in $PM_{2.5}$ patterns among ecoregion communities may indicate multiple distinct, localized emission sources.

Calendar plots are useful diagrams for tracking air quality patterns over long periods of time. Each day is represented by a calendar square; daily average $PM_{2.5}$ concentrations are calculated and assigned a color code based on the AQI category, where the colors green, yellow, orange, red, purple, and scarlet respectively represent “Good”, “Moderate”, “Poor” or “Unhealthy for Sensitive Groups”, “Unhealthy”, “Very Unhealthy”, and “Hazardous” air quality. Uncolored calendar squares represent days without sufficient data. For example, a pod installed in May will not have any data for April, so the April squares would be uncolored. Other incidents may disrupt the sensor’s operation or invalidate its data for one or more days, such as a power outage or a technical issue. By tracking AQI color coding on the calendar plots, DEC can visualize patterns or changes in air quality in specific communities over days, weeks, or months.

Bethel and Napaskiak are two Southwestern ecoregion communities each previously outfitted with a QuantAQ Modulair™ pod. Unfortunately, cellular network compatibility issues emerged early in the year and disrupted normal pod operation. As a result, there is no data to display for the Bethel and Napaskiak communities during the reporting period covered in this document. If a community received a pod at some point during the reporting period, the historical data will not be fully representative of the entire period. While the hour-to-hour sensor readings may be accurate, it is important to understand the representative limitations of “incomplete” historical data sets. In other words, a community that receives a pod in the summer (the middle of this interim reporting period) and reports good air quality, cannot be assumed to have had good air quality in the spring before the pod was installed.

The following graphs and figures are all generated with QuantAQ Modulair™ data.

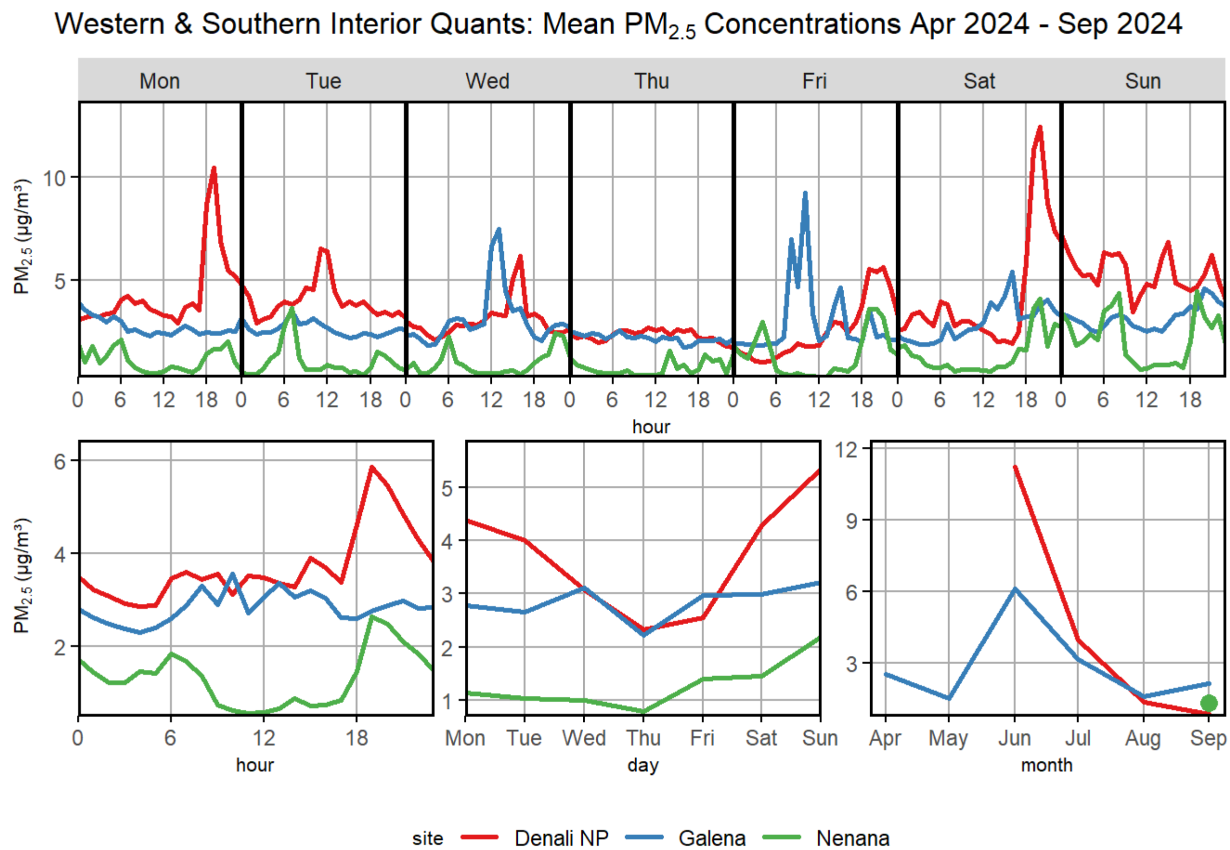

Figure 1. $PM_{2.5}$ Concentrations in Denali NP, Galena, and Nenana (4/1/2024 – 9/30/2024).

Fig. 1 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations in the Denali NP area and two communities west of Fairbanks, Galena and Nenana, during the reporting period. The Denali NP pod is installed at the park headquarters. $PM_{2.5}$ levels in the Denali NP area were generally very low during the observation period, with small daily increases seen in the evening and during the weekend. The difference in weekday versus weekend $PM_{2.5}$ levels in Denali NP could be attributed to changes in visitor frequency. Similarly, Denali NP sees significant visitor activity in the warmer summer months and fewer visitors in the cooler autumnal months, which could also explain the observed downward monthly $PM_{2.5}$ trend. In late June, the Riley Fire broke out near the park headquarters, resulting in elevated $PM_{2.5}$ readings; the fire was contained and extinguished in mid- to early July. Figure 2 shows diurnal plots for the same communities, but exclude all days affected by wildland fire smoke.

Galena and Nenana are residential communities. Galena shows less daily and weekly $PM_{2.5}$ variation, with occasional midday increases. The diurnal plot for Nenana shows more consistent $PM_{2.5}$ patterns over the week with regular increases in the morning and afternoon due potentially to traffic and increased home heating activities. The Nenana pod was installed in September and thus is not representative of community air quality during the reporting period.

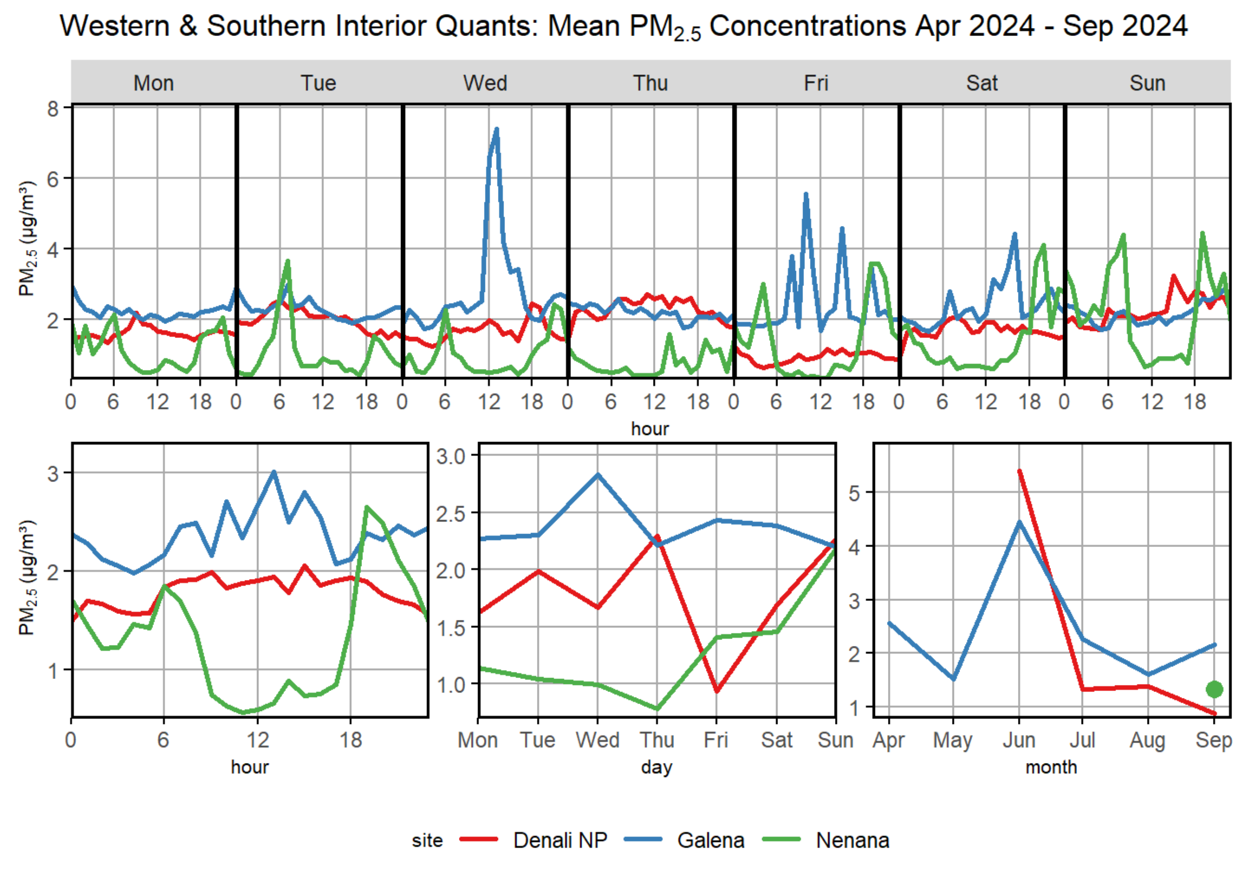

Figure 2. $PM_{2.5}$ Concentrations in Denali NP, Galena, and Nenana (4/1/2024 – 9/30/2024) after removal of days affected by wildland fire smoke.

Fig. 2 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations in the Denali NP area and two communities west of Fairbanks, Galena and Nenana, during the reporting period, excluding all days affected by wildland fire smoke. This calculation produces baseline levels of $PM_{2.5}$ for each community, which can be compared to Fig. 1 to observe the relative impact of wildland fire smoke. For all communities, removal of days with wildfire smoke produced lower overall averages on the hourly, daily, and monthly scales. The impact was minimal on overall daily hour averages but was more noticeable over daily and monthly averages, particularly in Denali NP. Nenana and Galena showed relatively little change in hourly average $PM_{2.5}$ concentrations over the day and week. Galena showed an approximate drop of 2 $\mu g/m^3$ in the monthly average in June, and 1 $\mu g/m^3$ in July, demonstrating the equivalent impact of fire smoke during these months. Nenana was affected by these fires as well, but June and July data is not available as the sensor was installed near the very end of the reporting period. The most significant fire smoke impacts were seen in Denali NP, which experienced a dramatically different pattern in hourly averages over the day and week. When fire smoke days were excluded, all $PM_{2.5}$ spikes in the hourly averages over the day and week disappeared, and baseline concentration levels were lowered by as much as 50%.

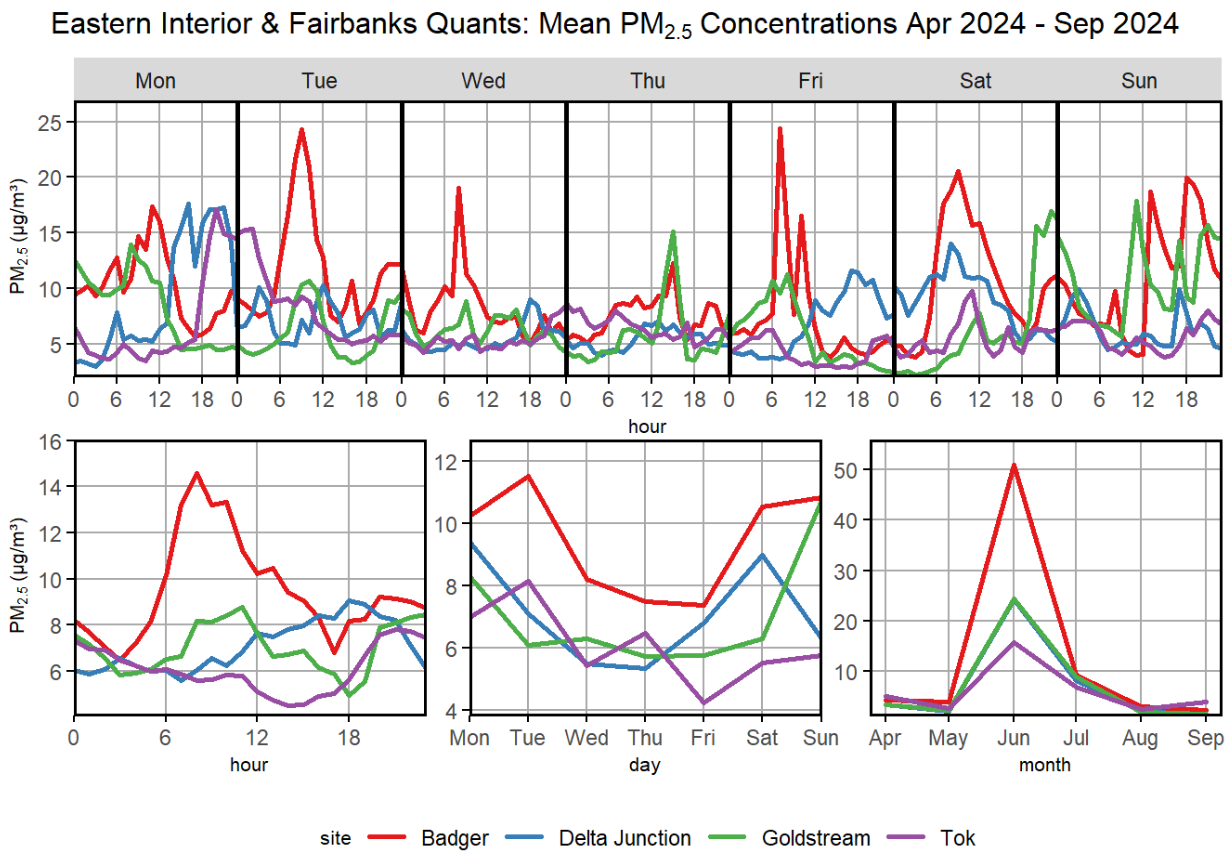

Figure 3. $PM_{2.5}$ Concentrations in Badger Road Area, Delta Junction, Goldstream, and Tok (4/1/2024 – 9/30/2024).

Fig. 3 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations in four Interior region communities proximal to Fairbanks; Badger Road to the east, Goldstream to the northwest, and Delta Junction and Tok to the southeast. For the most part, these communities enjoy 'Good' (AQI) air quality, although wildland fire smoke in the middle of the reporting period elevated $PM_{2.5}$ levels beyond 'Moderate' into the 'Unhealthy' and 'Very Unhealthy' AQI range on multiple days in June and July. These high $PM_{2.5}$ levels were partly due to the McDonald fire that burned south of Fairbanks, and smaller fires in Canada. The Badger Road pod is proximal to a highway, a stoplight intersection, and a small quarry that produces sand and gravel, which may partly explain the elevated $PM_{2.5}$ levels observed in the morning and midday hours. Figure 4 shows diurnal plots for the same communities, but exclude all days affected by wildland fire smoke.

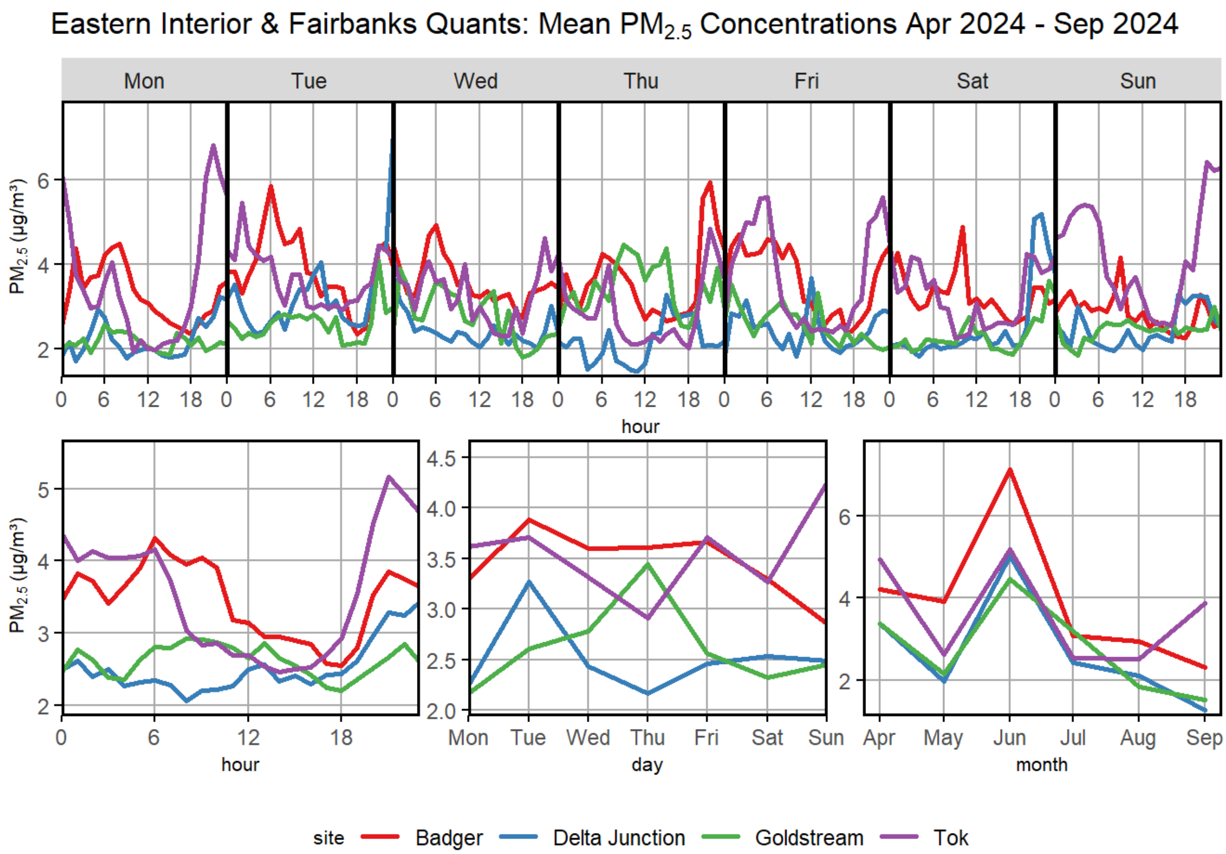

Figure 4. $PM_{2.5}$ Concentrations in Badger Road Area, Delta Junction, Goldstream, and Tok (4/1/2024 – 9/30/2024) after removal of days affected by wildland fire smoke.

Fig. 4 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations in four Interior region communities proximal to Fairbanks; Badger Road to the east, Goldstream to the northwest, and Delta Junction and Tok to the southeast, excluding all days affected by wildland fire smoke. This calculation produces baseline levels of $PM_{2.5}$ for each community, which can be compared to Fig. 3 to observe the relative impact of wildland fire smoke. Relatively little difference was seen in Tok, Goldstream, or Delta Junction, which produced the same overall pattern in hourly averages over the day and week, at about half to one-third the $PM_{2.5}$ concentration. A relatively larger difference was seen in Badger, where the hourly average dropped to about one-third to one-quarter of the levels seen with wildfire smoke days. The biggest overall changes were seen in the monthly averages in June and July, when wildland fires were most intense. In Tok, these monthly averages were halved when wildfire smoke days were excluded. In Delta Junction and Goldstream, the monthly averages for June and July were reduced by a factor of six. In Badger, the July monthly average was reduced by a factor of three, and the June monthly average was reduced by a factor of seven. This suggests that wildland fire smoke had significant effects on Eastern Interior and Fairbanks pods, with Badger experiencing the most severe effects compared to Delta Junction, Goldstream, and Tok. This is likely partly due to the Badger pod's extremely close proximity to the large McDonald and Clear fires that burned in late June.

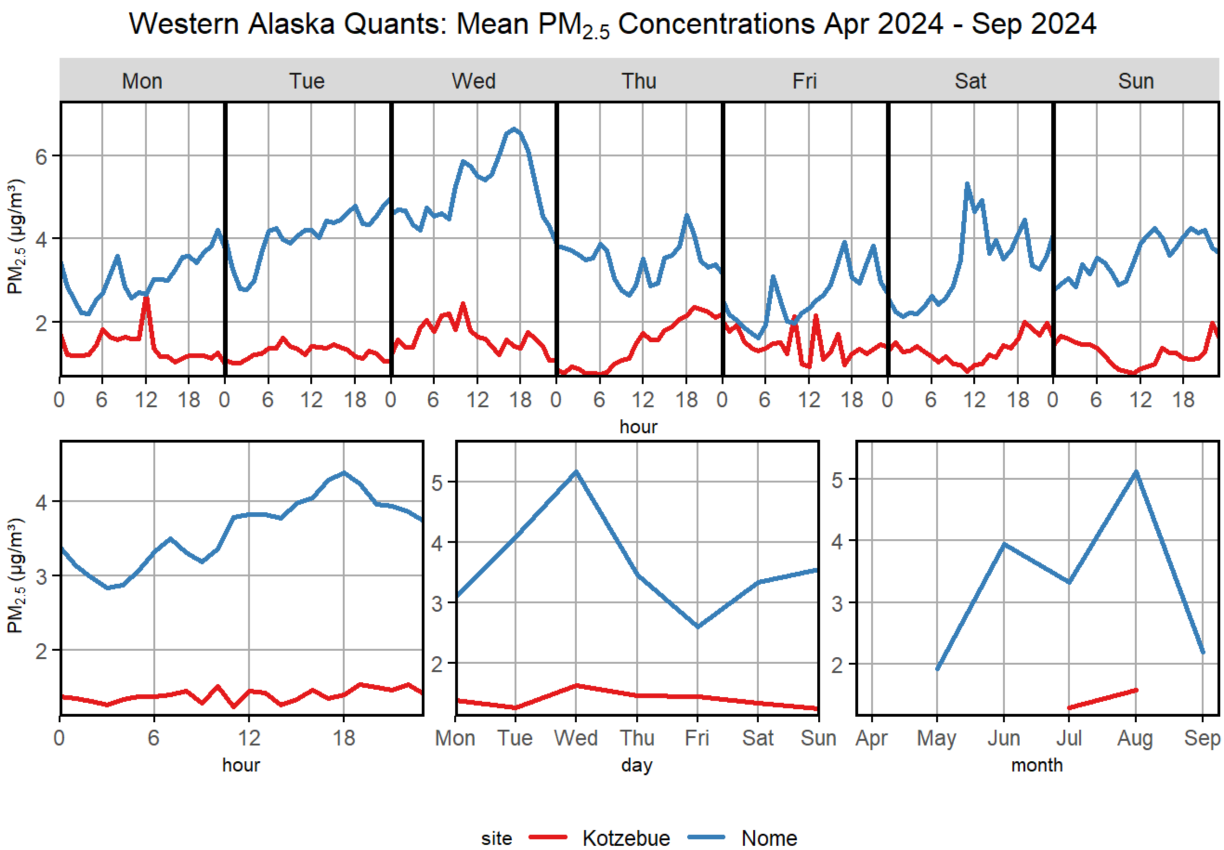

Figure 5. $PM_{2.5}$ Concentrations in Kotzebue and Nome (4/1/2024 – 9/31/2024).

Fig. 5 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations for Kotzebue and Nome, two communities in the Western ecoregion. Both communities show relatively little diurnal variation in $PM_{2.5}$ concentrations. Nome has generally 'Good' (AQI) air quality, despite showing a typical pattern of greater $PM_{2.5}$ concentrations in the middle of the week as opposed to the weekends. Nome saw increasing $PM_{2.5}$ concentrations that peaked on Wednesday afternoons but remained generally steady for much of the rest of the week. Secondary analysis with removal of wildland fire smoke days found no significant difference, suggesting minimal fire smoke impacts in these Western Alaska communities during the 2024 wildfire season.

The Kotzebue pod was installed in July, in the middle of this reporting period. Additionally, the pod underwent a planned outage on August 14th through October 11th due to a site relocation.

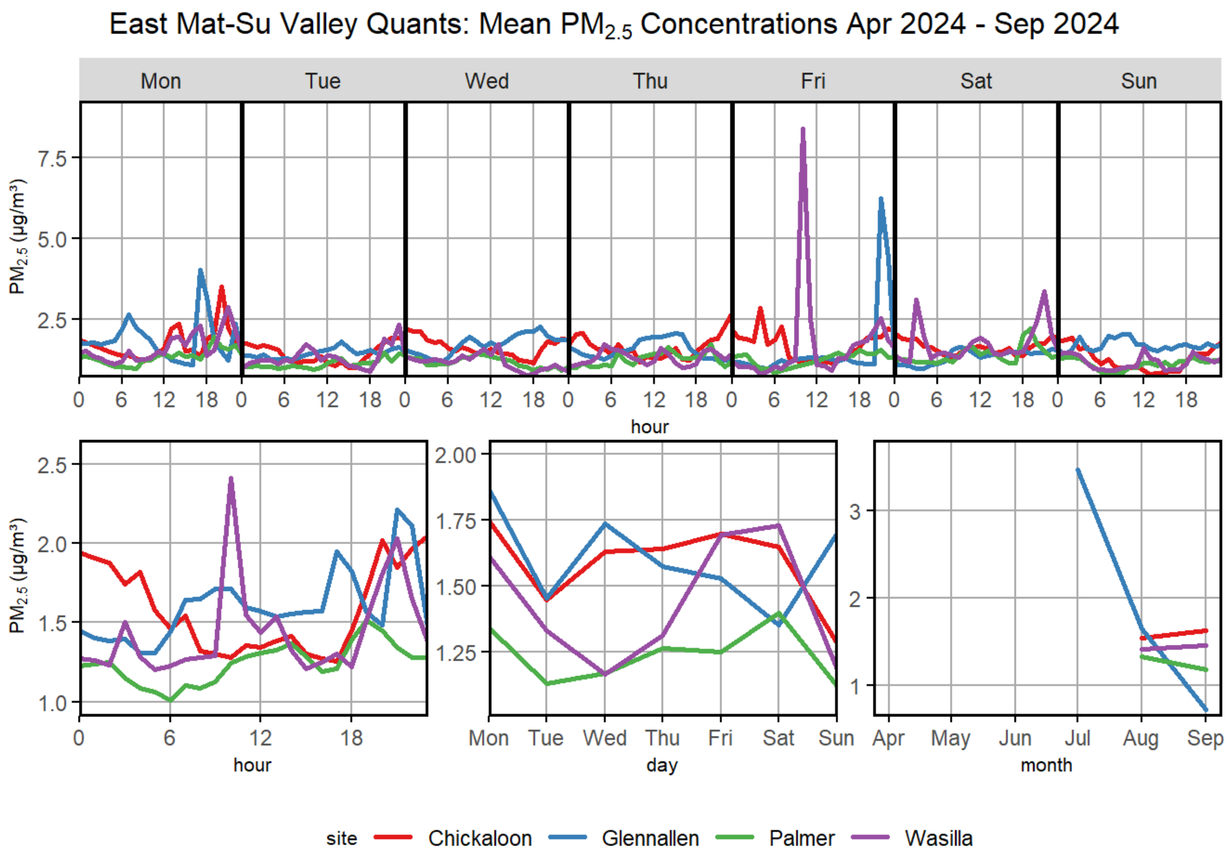

Figure 6. $PM_{2.5}$ Concentrations in Chickaloon, Glennallen, Palmer, Wasilla (4/1/2024 – 9/30/2024).

Fig. 6 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations for several Southcentral ecoregion communities in the eastern Mat-Su Valley area and Glennallen in the Copper River Valley area. Generally, these communities have 'Good' (AQI) air quality and relatively little diurnal variation.

The Glennallen sensor was installed in early July, approximately halfway through the reporting period. Consequently, Glennallen's sensor data is not representative of community air quality during the entire reporting period.

A Southcentral deployment trip was performed in early August, which serviced the communities of Willow, Wasilla, Palmer, and Chickaloon/Sutton-Alpine. While these pods have been performing reliably, they were only operational for less than two months at the end of the reporting period.

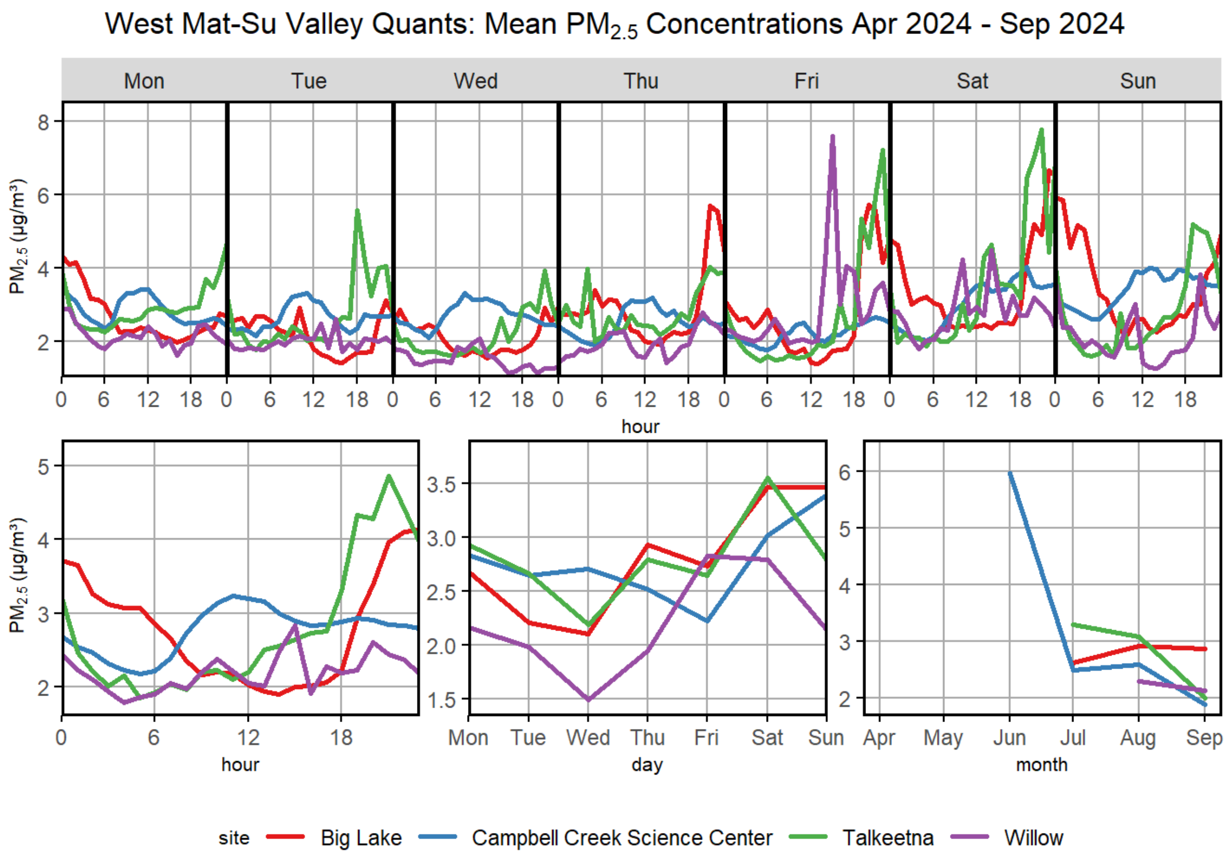

Figure 7. $PM_{2.5}$ Concentrations in Big Lake, Campbell Creek Science Center (CCSC), Talkeetna, and Willow (4/1/2024 – 9/30/2024).

Fig. 7 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations for several Southcentral communities in the western Mat-Su Valley area. Generally, these communities have 'Good' (AQI) air quality and little diurnal variation. Big Lake and Talkeetna show the most hourly $PM_{2.5}$ variation, with higher levels in the mornings and evenings and lower levels at midday. Big Lake, Talkeetna, and Willow show significant variation in hourly and daily average $PM_{2.5}$ concentrations over the week, with lowest levels seen on Wednesdays and highest levels seen on Friday and/or Saturday; mean weekly $PM_{2.5}$ concentrations remain below 4 µg/m^3. This may be due in part to increased weekend traffic in Big Lake and Talkeetna from people using the many camping sites, fishing spots, and hiking trails in the area. CCSC showed less overall variation across the week, with lowest $PM_{2.5}$ concentrations seen on Friday before spiking over the weekend.

A Southcentral deployment trip was performed in early August, which serviced the communities of Willow, Wasilla, Palmer, and Chickaloon/Sutton-Alpine. While these pods have been performing reliably, they were operational for less than two months at the end of the reporting period and did not capture information on fire smoke impacts from earlier in the summer. The pod at CCSC was installed earlier in the summer and reported a relatively high average $PM_{2.5}$ concentration for June compared to levels seen in July, both at CCSC and in other West Mat-Su Valley communities. Secondary analysis with removal of wildland fire smoke days found only minor reductions in CCSC $PM_{2.5}$ levels, suggesting limited fire smoke impact. No change was seen in the other communities, as these pods were installed after the fire season had ended.

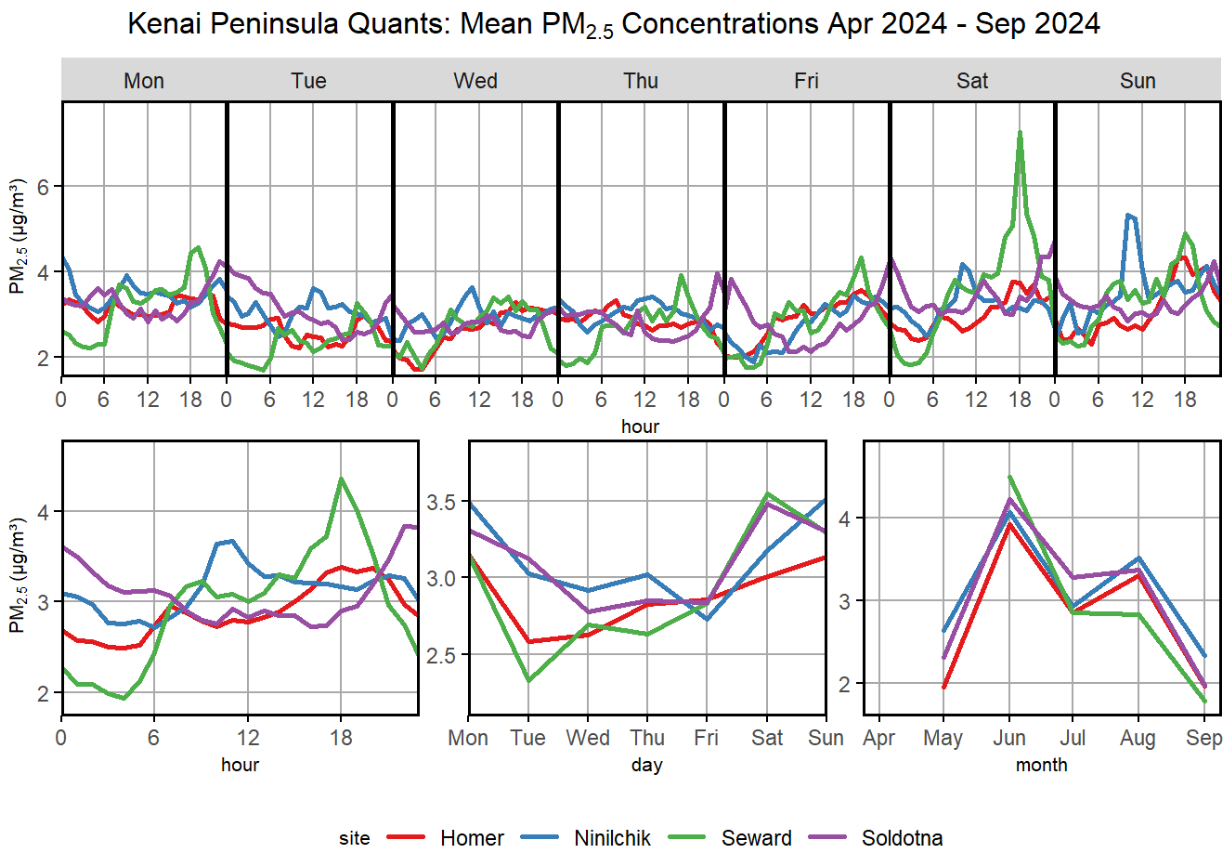

Figure 8. $PM_{2.5}$ Concentrations in Homer, Ninilchik, Seward, and Soldotna (4/1/2024 – 9/30/2024).

Fig. 8 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations for communities on the Kenai Peninsula. These communities show similar weekly trends in $PM_{2.5}$ concentration, with the highest levels seen on the weekend and the lowest levels seen mid-week. Daily $PM_{2.5}$ concentration shows more variation, with Seward and Homer experiencing a typical pattern of higher levels in the mornings and evenings when people are commuting to and from work or are heating their homes more, and lower levels during midday. Ninilchik experienced an inverted daily pattern, with the lowest $PM_{2.5}$ levels in the morning and the highest levels measured during midday. Soldotna shows an interesting pattern, with the highest $PM_{2.5}$ levels seen during the middle of the night, and lower levels during the day.

Soldotna, Ninilchik, and Homer were serviced with QuantAQ Modulair™ pods during a deployment trip in mid-May, so no data was collected in these communities in April. Seward was not incorporated into the network until June.

Secondary analysis with removal of wildland fire smoke days found minimal reductions in Kenai Peninsula community $PM_{2.5}$ levels. Hourly averages were largely unaffected, but several changes became more noticeable at larger average intervals. Ninilchik saw slightly lower daily $PM_{2.5}$ averages on Monday and the weekends, and all communities except Soldotna saw slightly lower monthly $PM_{2.5}$ averages in June, at peak wildland fire activity. These results indicate that wildfire smoke had minor effects on the Kenai Peninsula during the reporting period.

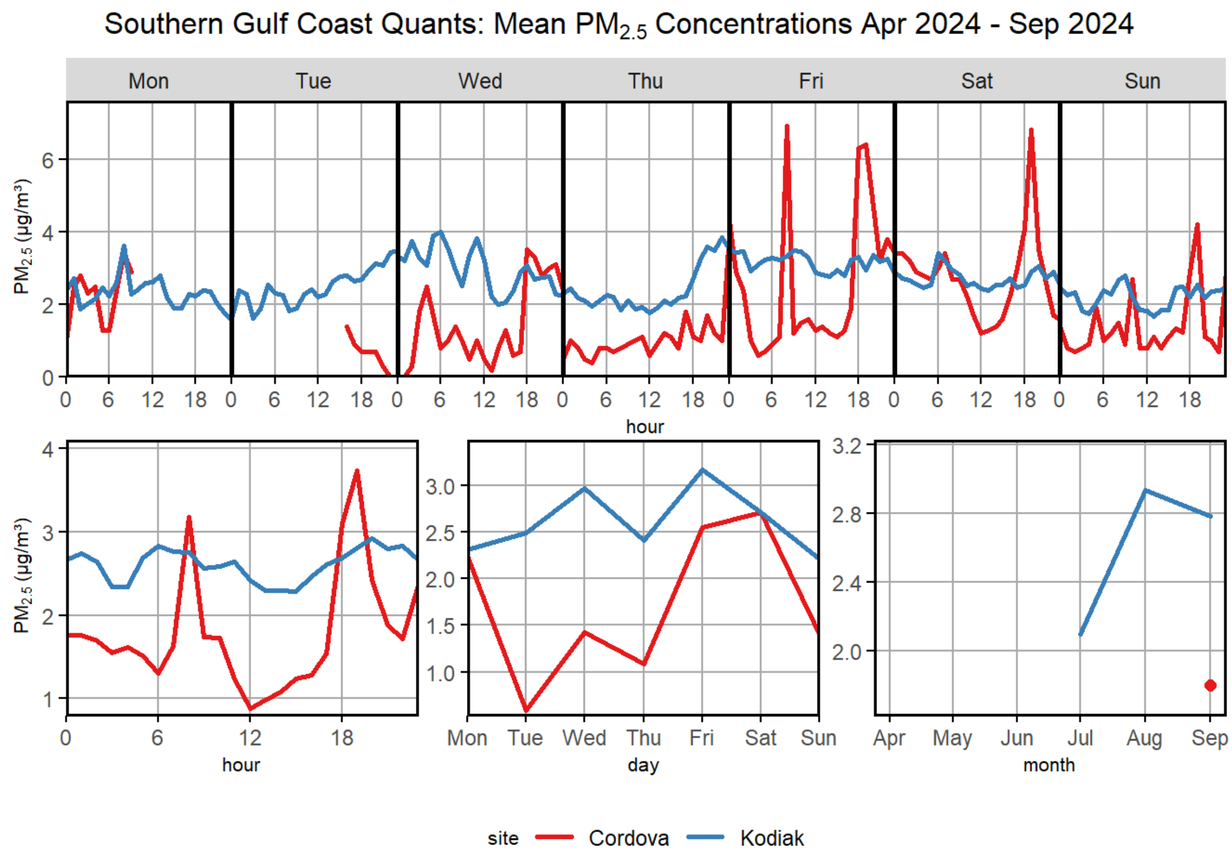

Figure 9. $PM_{2.5}$ Concentrations in Cordova and Kodiak (4/1/2024 – 9/30/2024).

Fig. 9 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations for the southern gulf coast communities of Cordova and Kodiak. Both communities generally have 'Good' (AQI) air quality, with the highest $PM_{2.5}$ levels seen on the weekend. Kodiak exhibits typical daily $PM_{2.5}$ concentration patterns, with highs in the mornings and evenings which could be attributed to commuter traffic or increased home heating activities; $PM_{2.5}$ levels remain safe, even when the community sees relative increases. Kodiak's weekly variation is slightly less typical of residential communities, with higher concentrations and variation seen during the week and lower concentrations seen during the weekend. Kodiak $PM_{2.5}$ activity resembles the trends and concentrations seen in several nearby Kenai Peninsula communities, including Homer, Ninilchik, Seward, and Soldotna.

The Kodiak QuantAQ Modulair™ was installed in early July and replaced the aging AQMesh sensor.

The Cordova pod was installed in September, late in the reporting period. The pod was operational for only the last week of the reporting period; this relatively brief observational time explains the high variation and irregularity observed in the Cordova data.

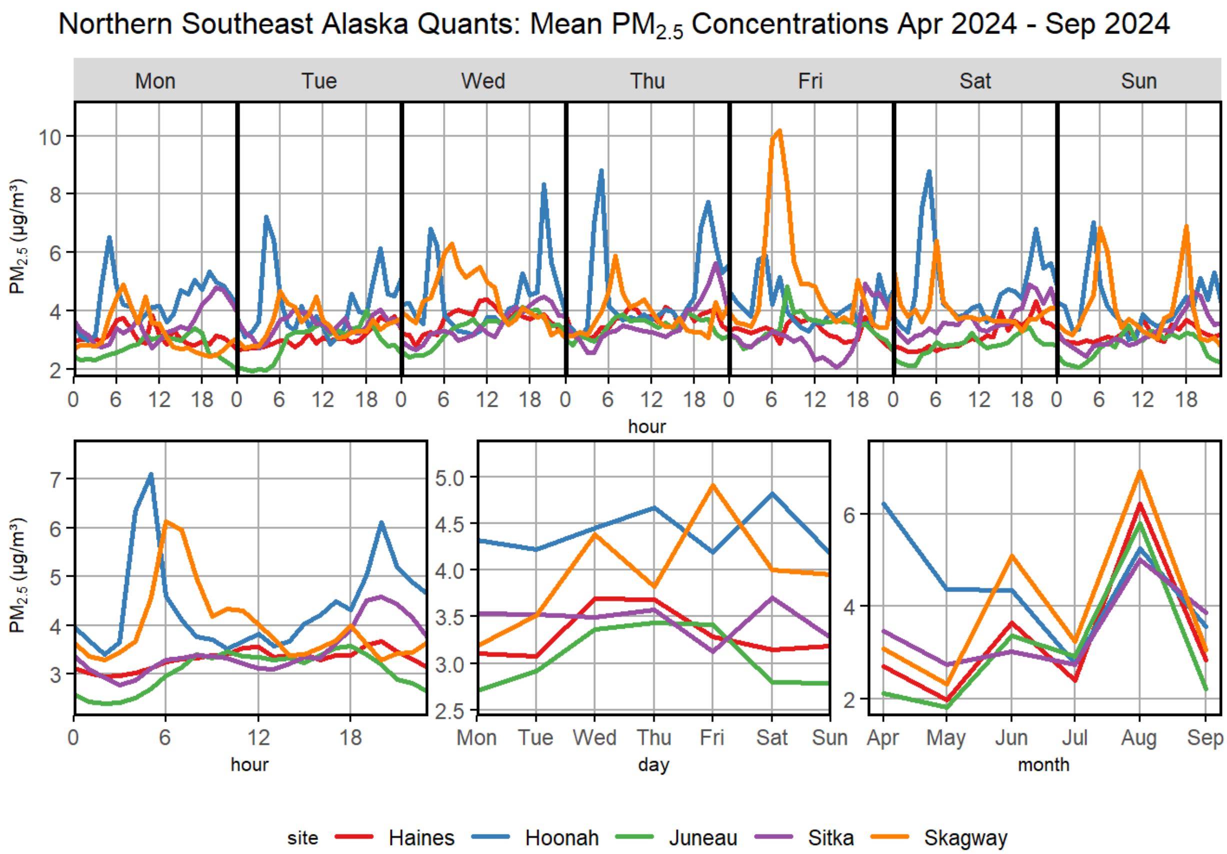

Figure 10. $PM_{2.5}$ Concentrations in Haines, Hoonah, Juneau, Sitka, and Skagway (4/1/2024 – 9/30/2024).

Fig. 10 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations for multiple communities in the northern part of Southeast Alaska, or the 'pan handle'. Sitka and Juneau exhibit similar daily, weekly, and monthly trends in $PM_{2.5}$ concentration. Daily, $PM_{2.5}$ levels are low in the mornings, experience a late morning surge likely due to commuter vehicle traffic, and another surge in the evening as home heating activities increase. Weekly, there is generally little variation, except on weekends when $PM_{2.5}$ levels appear to dip slightly below the weekday averages. In Sitka, the weekend dip in $PM_{2.5}$ levels appears limited to Fridays, whereas Juneau sees the dip sustained over Saturdays and Sundays.

Across the latter half of the reporting period, Hoonah, Sitka, and Juneau showed remarkably consistent $PM_{2.5}$ trends; these communities were affected by late-season wildland fires in Canada whose smoke was carried through passes in the Coastal Boundary Mountains. Hoonah shows elevated levels of $PM_{2.5}$ in the cooler spring and fall months. Upon investigation, it was found that the Hoonah sensor's elevated readings may be due to being in close proximity to woodstove-heated buildings.

Haines and Skagway are proximal communities with similar geography and climate, and similar patterns of $PM_{2.5}$ concentration change over time. Both communities see a moderate rise in $PM_{2.5}$ concentration mid-week, with slightly lower levels on the weekends, and both experienced similar changes in $PM_{2.5}$ concentration over the reporting period. Despite these similar patterns, Skagway consistently demonstrates slightly higher $PM_{2.5}$ concentrations than Haines when measured over a day, week, or month. This could be due to different emissions sources near the sensor, such as combustion engines and home heating exhaust ports. Skagway is a popular tourist destination, and a tour train has a mustering station near the pod's location. Exhaust from the train has been identified as the potential source of time-specific increases in $PM_{2.5}$, NO, and NO_2 in Skagway. Where Haines has relatively little variation in $PM_{2.5}$ concentrations over the day, Skagway experiences relatively large $PM_{2.5}$ spikes during the morning and evening, likely from higher levels of commuter traffic and increase home heating activities in the area.

In August, both communities saw elevated $PM_{2.5}$ concentrations, potentially due to wildland fire smoke from numerous small fires near the Canadian side of the border. Figure 11 shows diurnal plots for the same communities, but excludes all days affected by wildland fire smoke.

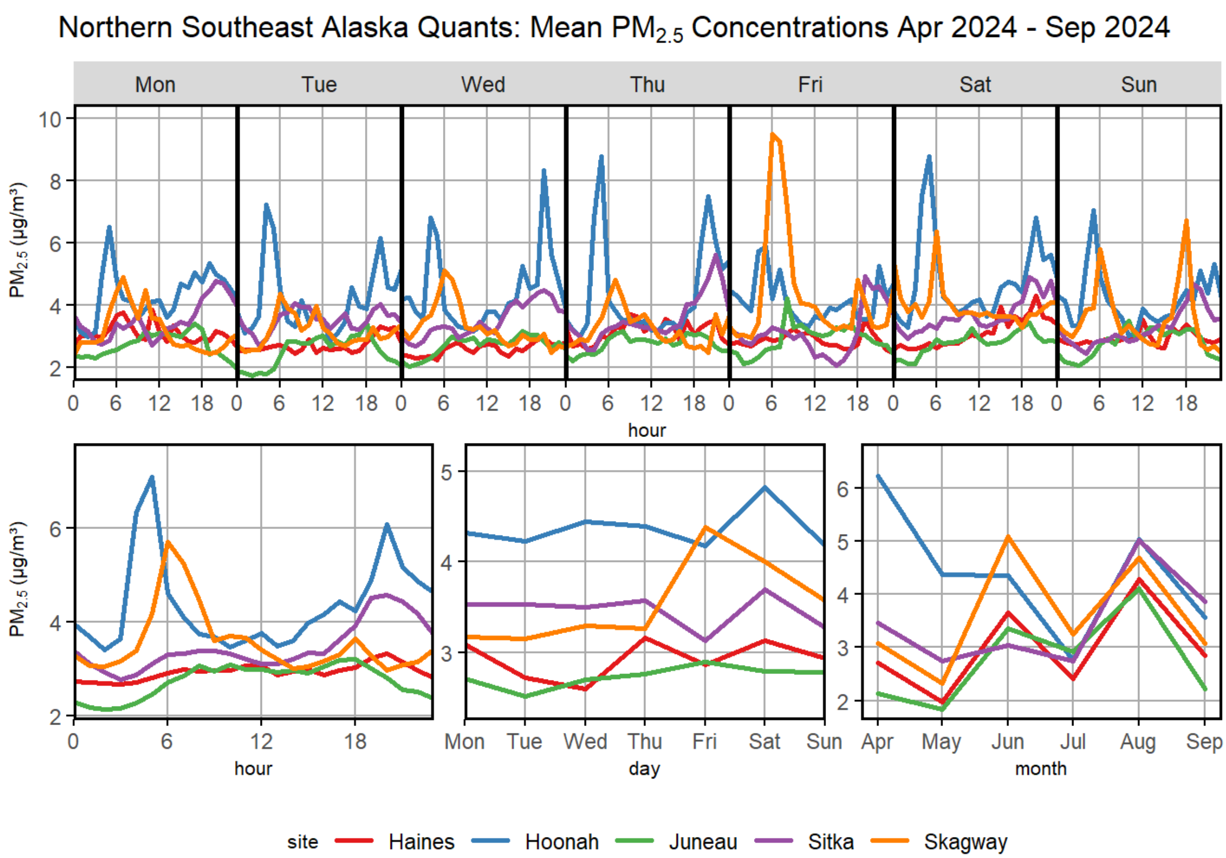

Figure 11. $PM_{2.5}$ Concentrations in Haines, Hoonah, Juneau, Sitka, and Skagway (4/1/2024 – 9/30/2024) after removal of days affected by wildland fire smoke.

Fig. 11 depicts the time series and diurnal graphs of $PM_{2.5}$ concentrations for multiple communities in the northern part of Southeast Alaska, or the 'pan handle', excluding all days affected by wildland fire smoke. This calculation produces baseline levels of $PM_{2.5}$ for each community, which can be compared to Fig. 10 to observe the relative impact of wildland fire smoke. The secondary analysis found minimal reductions in northern Panhandle community $PM_{2.5}$ levels. Hourly and daily averages were largely unaffected, with only Skagway showing a noticeable decrease in mid-week daily averages. Several changes became more noticeable at larger average intervals, notably in August, where Haines, Juneau, and Skagway saw the monthly average decrease by about two µg/m^3. These results indicate that Panhandle communities situated on the mainland are more affected by wildfire smoke than communities on islands, perhaps due in part to their proximity to passes in the Coastal Barrier Mountains. Wildland fires in Canada produce smoke that is can be concentrated and moved west through these passes, with subsequent smoke impacts on northern Panhandle communities.

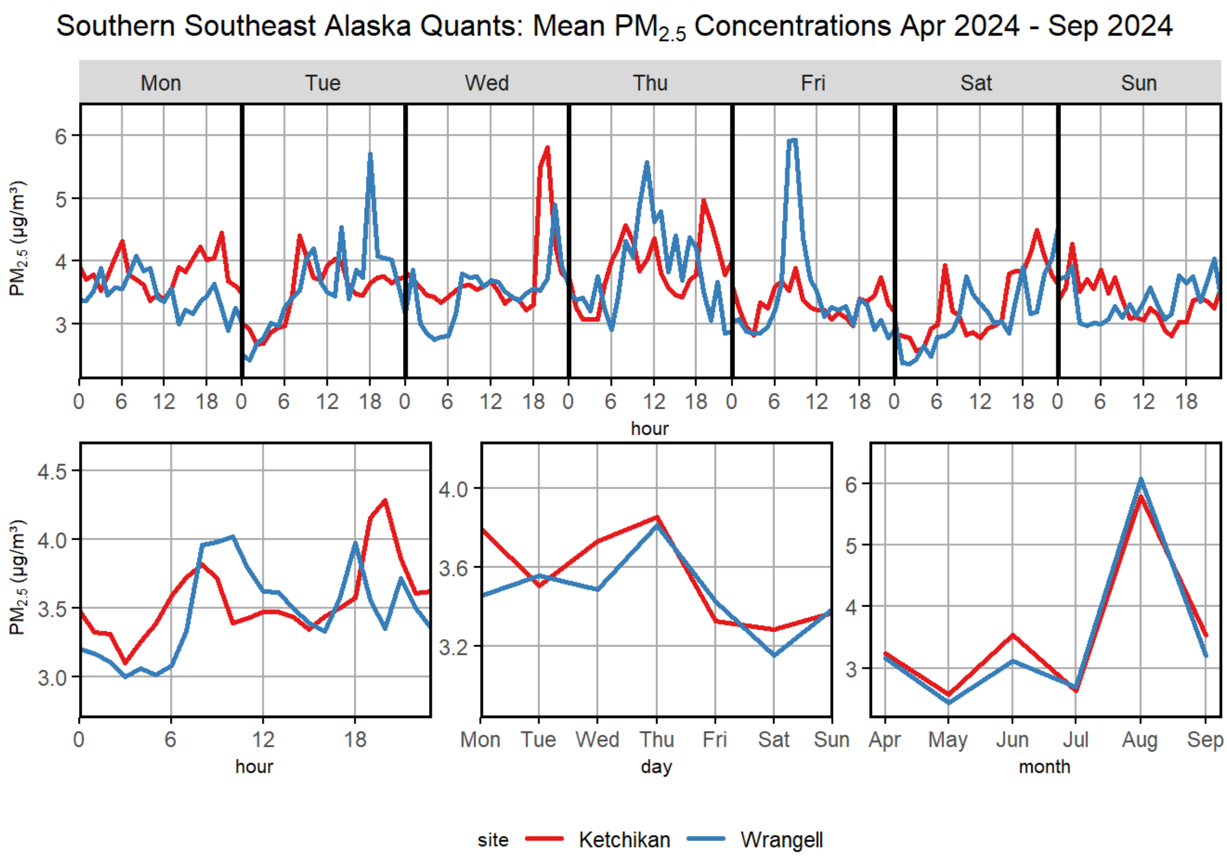

Figure 12. PM$_{2.5}$ Concentrations in Ketchikan and Wrangell (4/1/2024 – 9/30/2024).

Fig. 12 depicts the time series and diurnal graphs of PM$_{2.5}$ concentrations for Ketchikan and Wrangell, two communities near the southern tip of the Southeast ecoregion. Both communities demonstrate similar patterns in PM$_{2.5}$ concentration trends, with spikes seen in the morning and evening corresponding to peak commuting times and increased home heating activities, general decreases over the week with low PM$_{2.5}$ levels on the weekends, and similar seasonal trends including a rise in PM$_{2.5}$ in August, when the region was affected by wildland fire smoke from numerous small fires near the Canadian side of the border.

Secondary analysis with removal of wildland fire smoke days found minimal reductions in southern Panhandle community PM$_{2.5}$ levels. Hourly averages followed similar patterns over the day and week, but at slightly reduced PM$_{2.5}$ levels. Daily PM$_{2.5}$ levels remained similar, with the biggest decrease of about 0.5 µg/m^3 seen during weekdays. Monthly PM$_{2.5}$levels remained similar, with both communities seeing a 1-1.5 µg/m^3 decrease in the August monthly average. These results indicate relatively low wildfire smoke impact on Ketchikan and Wrangell, except in August when the communities were affected by smoke from Canadian wildland fires that moved around the southern tip of the Coastal Barrier Mountains, met with Pacific winds, and was pushed northward into the Panhandle.

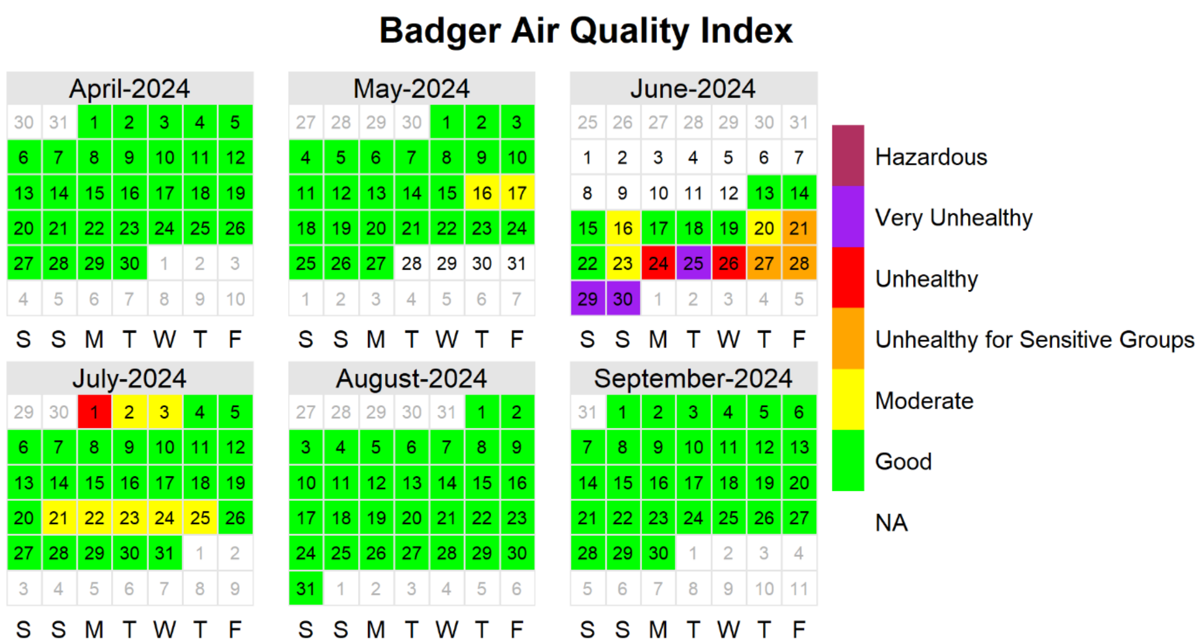

Figure 13. $PM_{2.5}$ Calendar Plots for Badger Road Area (4/1/2024 – 9/30/2024).

Fig. 13 depicts a calendar plot for the Badger Road area during the reporting period. For much of the period, air quality in the Badger Road area remained in the 'Good' AQI range. However, the Badger Road area experienced severely degraded air quality during the wildland fire smoke incidents in June and July, with multiple days exceeding the 'Moderate' AQI range to reach 'Unhealthy' and 'Very Unhealthy' levels of $PM_{2.5}$. Similar daily averages were reported by the regulatory equipment at the NCore SLAMS site in Fairbanks from June 26 through early July, but Goldstream reported higher spikes of $PM_{2.5}$ than NCore on June 20-21 and June 24-25. In June, smoke affecting the Badger Road area was initially generated by the McDonald and Clear fires south and southeast of Fairbanks. Smoke from the Iver, Slate, and Globe fires northwest of Fairbanks had swept over the Badger Road area over the last days of June and into July. The smoke incident in late July was caused by the overlapping smoke of several separate fires, including the Noodor and National fires north of Fairbanks, the East Toklak fire southwest of Fairbanks, and the American fire northeast of Fairbanks.

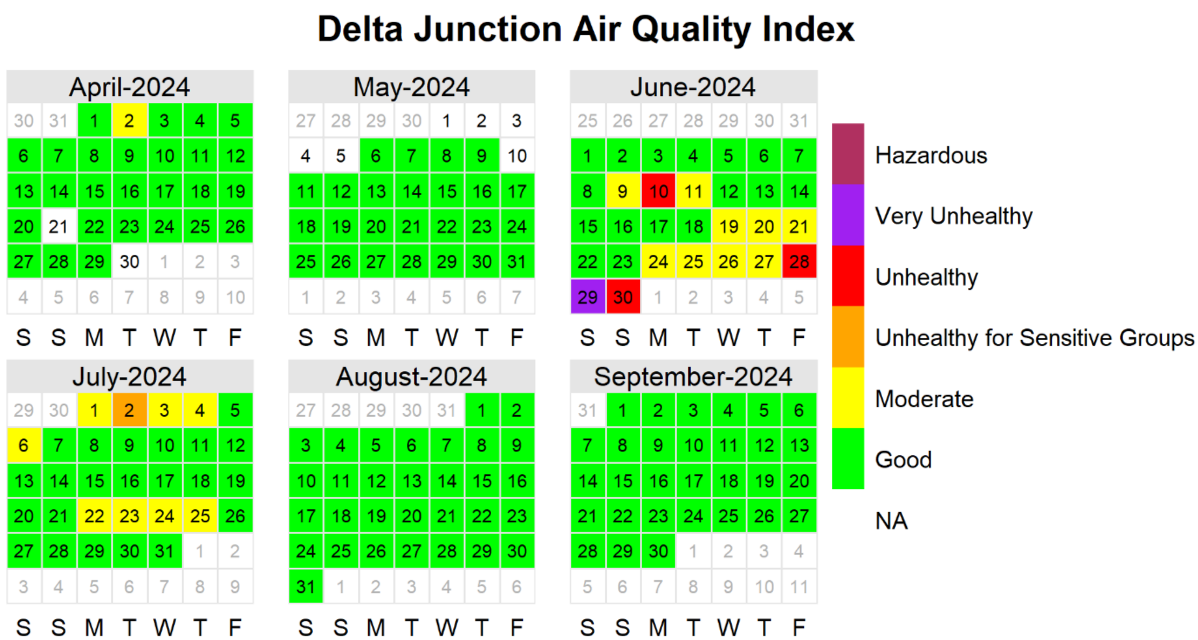

Figure 14. $PM_{2.5}$ Calendar Plots for Delta Junction (4/1/2024 – 9/30/2024).

Fig. 14 depicts a calendar plot for the community of Delta Junction during the reporting period. For much of the period, air quality in Delta Junction remained in the 'Good' AQI range. However, Delta Junction experienced severely degraded air quality during the wildland fire smoke incidents in June and July, with multiple days reaching the 'Moderate' and 'Unhealthy' levels of $PM_{2.5}$, and one day (June 29th) that reached 'Very Unhealthy' levels of $PM_{2.5}$. The smoke incident in early June was produced by Canadian wildfires south of Dawson City, which moved west across Alaska. Similar daily averages were reported by the regulatory equipment at the NCore SLAMS site in Fairbanks, with a delay of 1-2 days due to smoke travel time. In late June, smoke affecting Delta Junction was initially generated by the McDonald and Clear fires south and southeast of Fairbanks. Smoke from the Iver, Slate, and Globe fires northwest of Fairbanks had swept over Delta Junction over the last days of June and then into July. The smoke incident in late July was caused by the overlapping smoke of two separate fires, the East Toklak fire southwest of Fairbanks, and the American fire northeast of Fairbanks

Early in the reporting period, the Delta Junction pod was subject to repeated acts of vandalism, resulting in several data-outages.

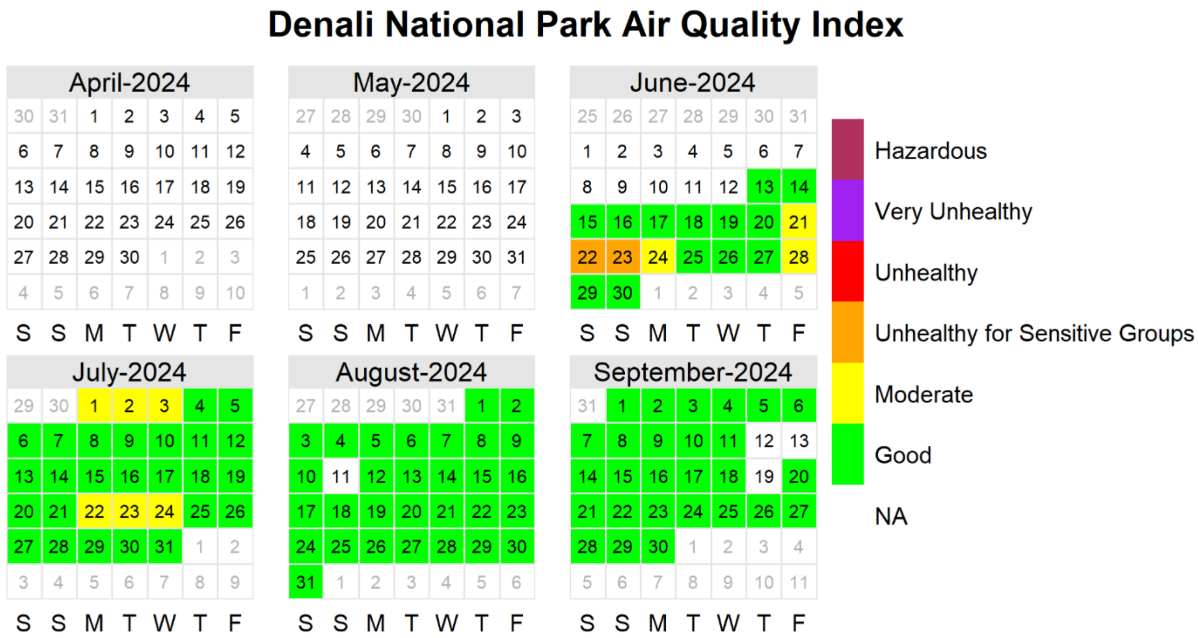

Figure 15. $PM_{2.5}$ Calendar Plots for Denali National Park (6/13/2024 – 9/30/2024).

Fig. 15 depicts a calendar plot for the Denali NP pod during the reporting period. Denali NP generally has very good air quality. However, Denali NP experienced poorer air quality during the wildland fire smoke incidents in June and July, with multiple days reaching the 'Moderate' AQI range, and two days in late June reaching $PM_{2.5}$ levels considered 'Unhealthy for Sensitive Groups'. In late June, the Riley fire near the park entrance produced smoke that affected many interior communities, including Denali NP. In late July, Denali NP was affected by smoke from the Sushana River and East Toklat fires which were active for about a week in an area approximately 30 miles west of Healy.

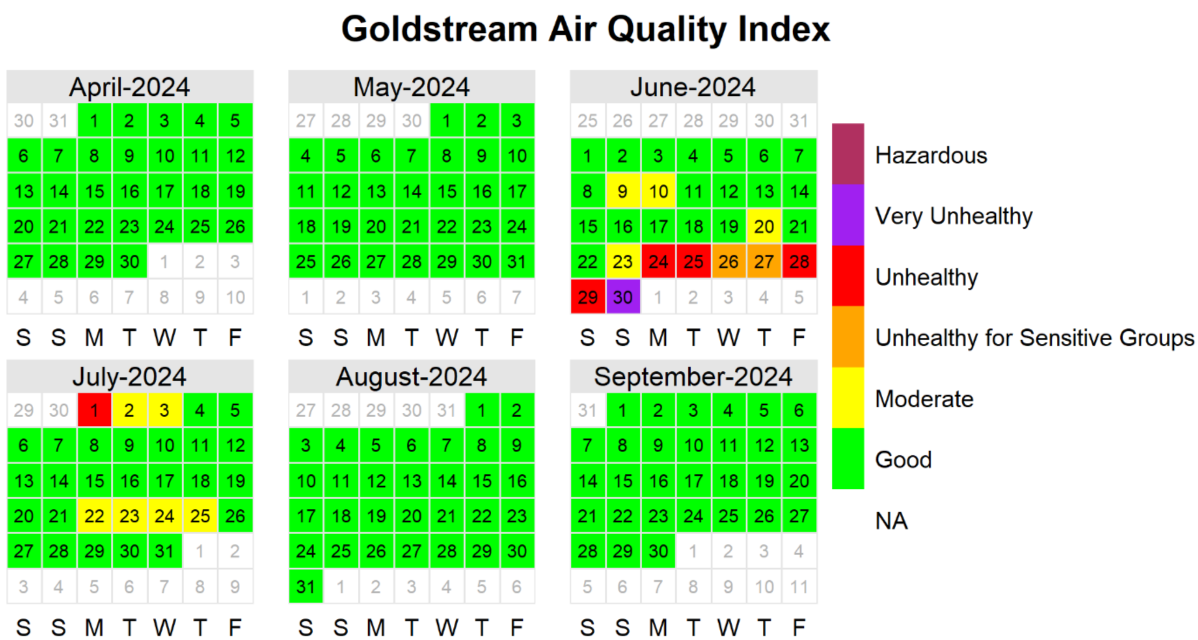

Figure 16. $PM_{2.5}$ Calendar Plots for Goldstream (4/1/2024 – 9/30/2024).

Fig. 16 depicts a calendar plot for the Goldstream area during the reporting period. For much of the period, air quality in Goldstream remained in the 'Good' AQI range. However, Goldstream experienced severely degraded air quality during the wildland fire smoke incidents in June and July, with multiple days exceeding the 'Moderate' AQI range to reach 'Unhealthy for Sensitive Groups' and 'Unhealthy' levels of $PM_{2.5}$, with one day (June 30th) reaching the 'Very Unhealthy' AQI level. In June, the Goldstream area was exposed to smoke from several wildland fires in the area, including the large McDonald and Clear fires south and southeast of Fairbanks. Air quality conditions deteriorated drastically at the end of June due to an influx of smoke from the Iver, Slate, and Globe fires northwest of Fairbanks. The smoke incident in late July was caused by the overlapping smoke of several separate fires, including the Noodor and National fires north of Fairbanks, the American fire northeast of Fairbanks, and the East Toklak fire southwest of Fairbanks.

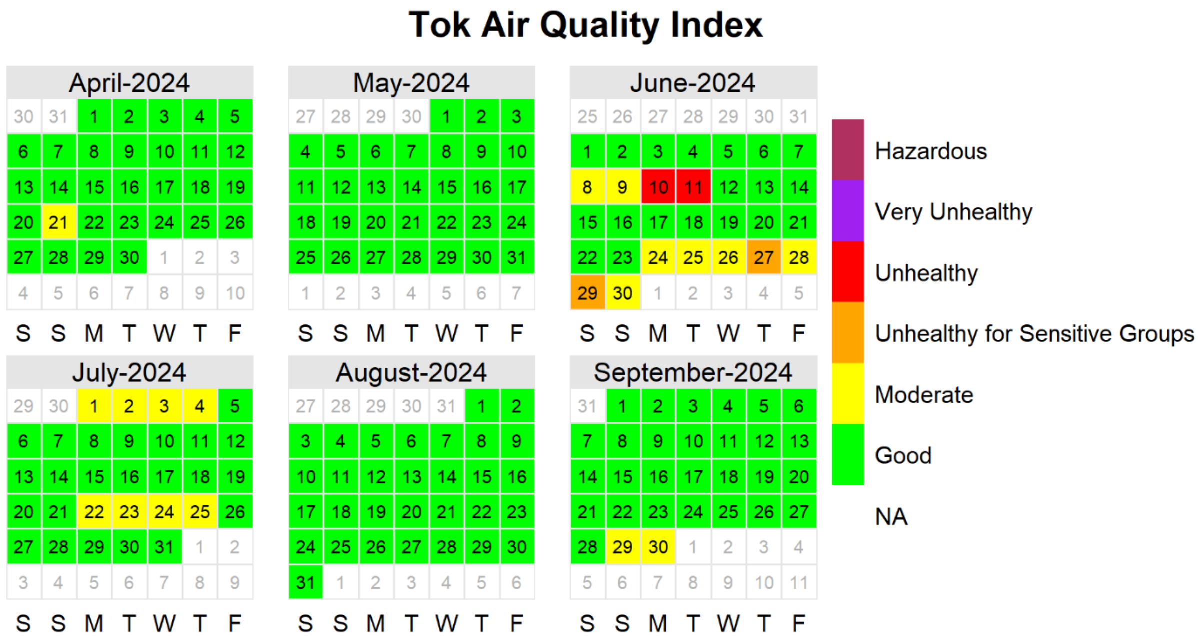

Figure 17. $PM_{2.5}$ Calendar Plots for Tok (4/1/2024 – 9/30/2024).

Fig. 17 depicts a calendar plot for the community of Tok during the reporting period. For much of the period, air quality in Tok remained in the 'Good' AQI range. Tok experienced moderately degraded air quality during the wildland fire smoke incidents in June and July, with multiple days reaching the 'Moderate', 'Unhealthy for Sensitive Groups' and 'Unhealthy' AQI levels of $PM_{2.5}$. Air quality degradation was not as bad as other interior communities like Delta Junction or Goldstream, as the wildland fires contributing to the late June smoke incident were located closer to the interior, and wind patterns kept much of the smoke from moving east towards Tok. In contrast, Tok was more impacted by the early June smoke incidents, as the responsible fires were located near the border in Canada and wind carried the smoke west, over Tok and towards the interior of Alaska.

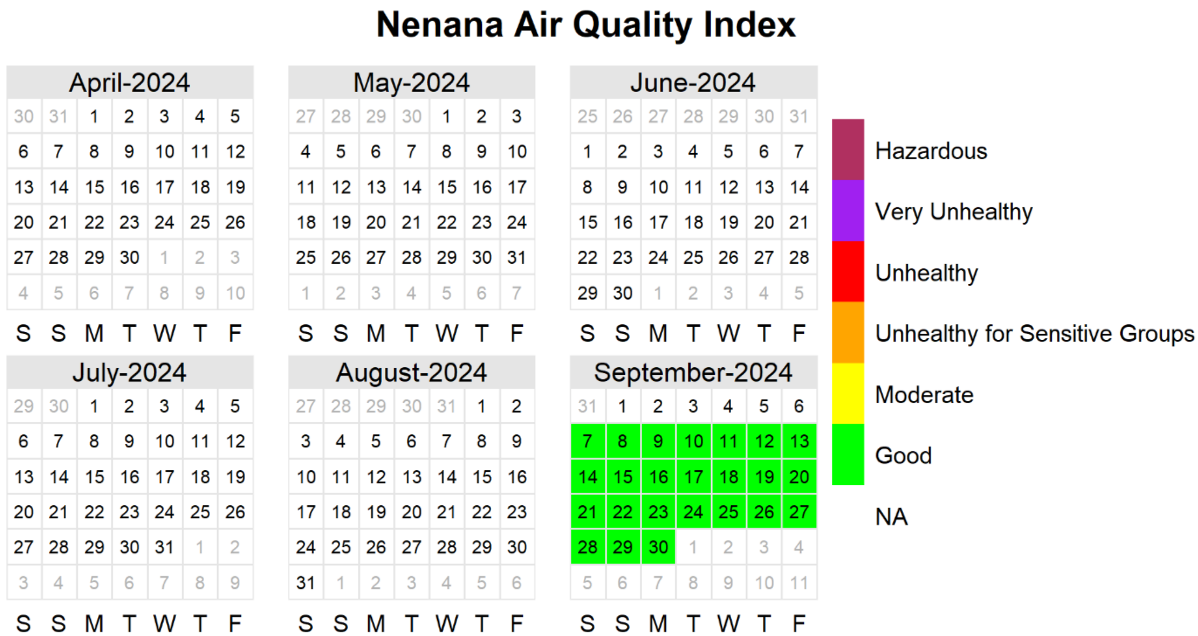

Figure 18. $PM_{2.5}$ Calendar Plots for Nenana (9/7/2024 – 9/30/2024).

Fig. 18 depicts a calendar plot for the community of Nenana during the reporting period. The community of Nenana received a QuantAQ Modulair™ on September 7th, near the end of the reporting period. The pod measured in the 'Good' AQI range for the rest of the month.

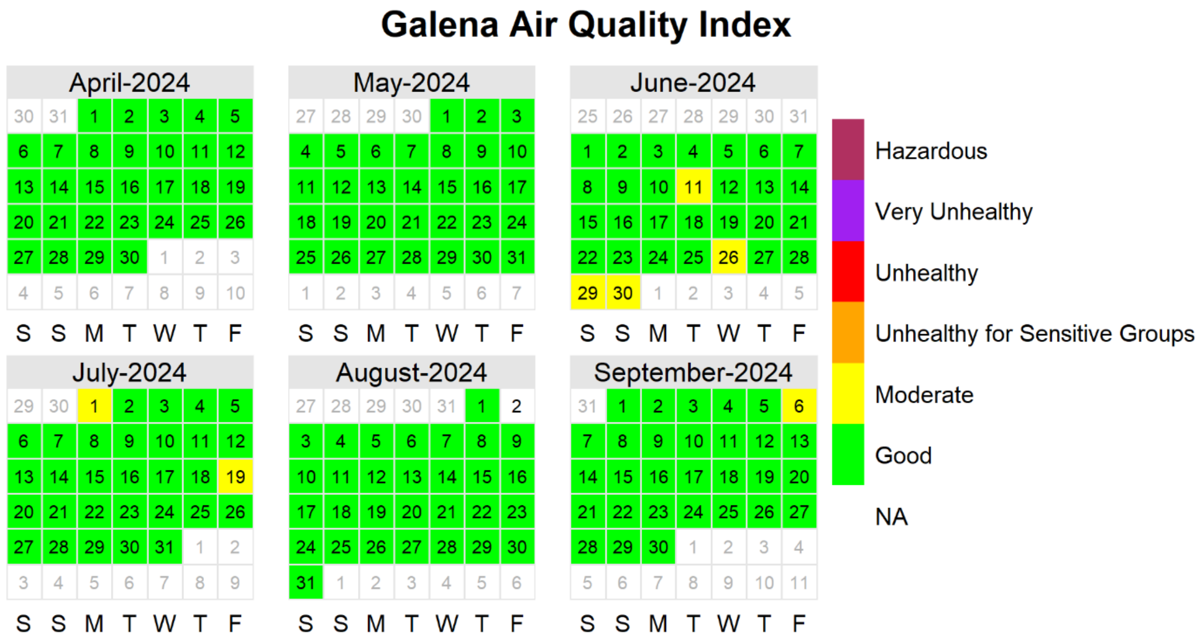

Figure 19. $PM_{2.5}$ Calendar Plots for Galena (4/1/2024 – 9/30/2024).

Fig. 19 depicts a calendar plot for the community of Galena during the reporting period. Generally, Galena experiences good air quality with daily averages in the 'Good' AQI range. During June and July, Galena was impacted by smoke from the Main, Yuki, and Cecil Dome fires between the Yukon River and the northern reach of the Kaiyuh Mountains. $PM_{2.5}$ pollution from wildland fire smoke never exceeded the 'Moderate' AQI level during the reporting period in Galena.

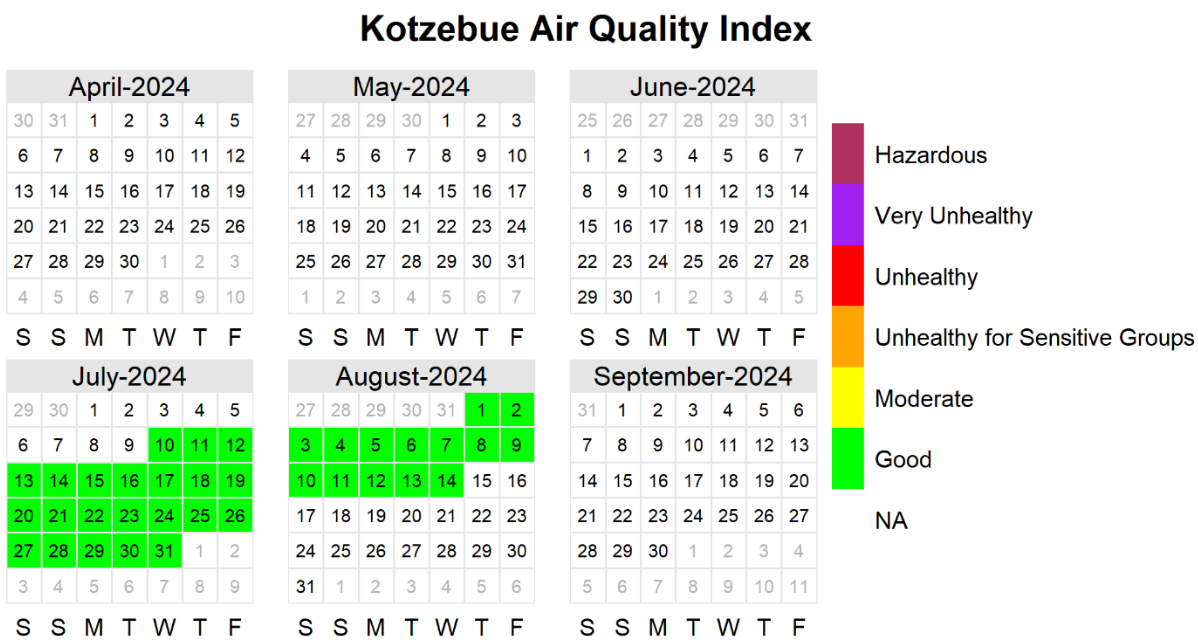

Figure 20. $PM_{2.5}$ Calendar Plots for Kotzebue (7/10/2024 – 9/30/2024).

Fig. 20 depicts a calendar plot for the community of Kotzebue during the reporting period. During this reporting period, the existing AQMesh sensor was removed and replaced by a QuantAQ Modulair™ pod. On August 14th, the QuantAQ Modulair™ pod was taken down and reinstalled in a new location due to construction activities. The pod was re-activated on October 11th, after the reporting period detailed in this report had come to an end. During July and August, air quality in Kotzebue measured in the 'Good' AQI category.

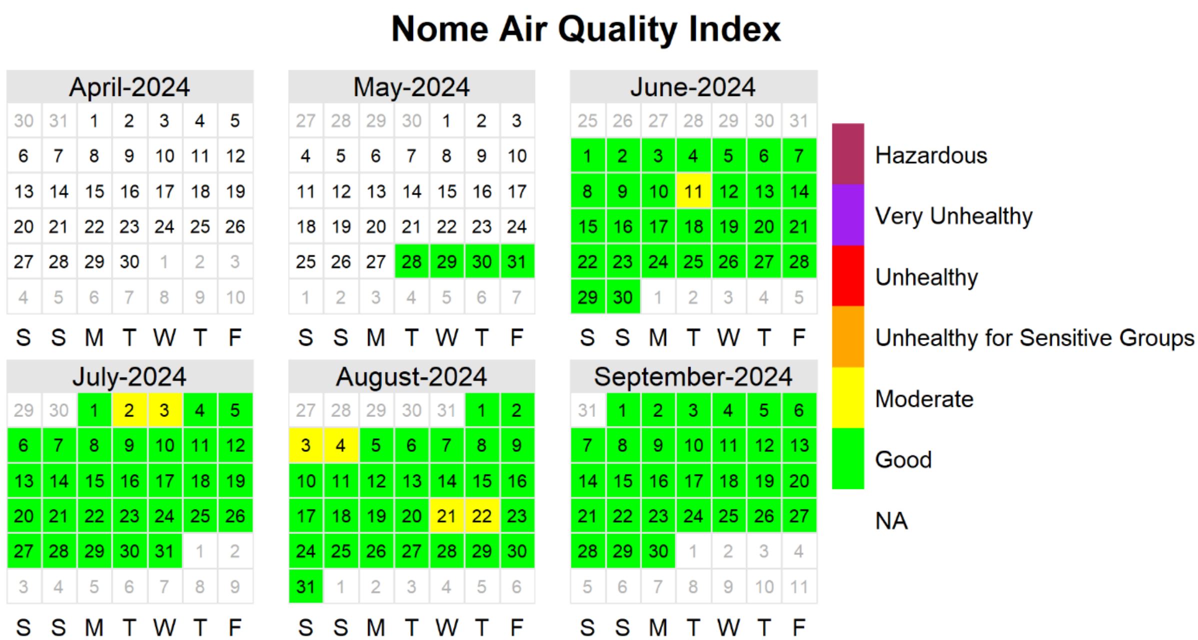

Figure 21. $PM_{2.5}$ Calendar Plots for Nome (5/28/2024 – 9/30/2024).

Fig. 21 depicts a calendar plot for the community of Nome during the reporting period. The QuantAQ Modulair™ sensor was installed on May 23rd and replaced an aging AQMesh sensor installed in the same location. August 21st and 22nd were humid and chilly; the reported 'Moderate' AQI level could be due to thick fog impacting the PM sensors, not wildland fire smoke.

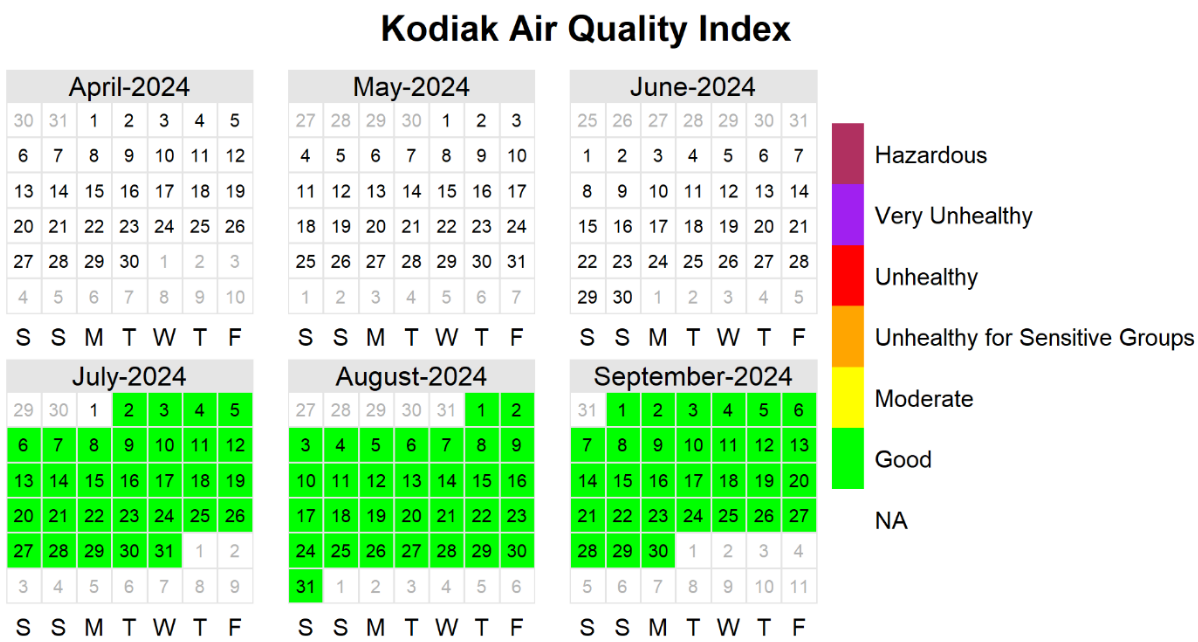

Figure 22. $PM_{2.5}$ Calendar Plots for Kodiak (7/2/2024 – 9/30/2024).

Fig. 22 depicts a calendar plot for the island-based community of Kodiak during the reporting period. The community received a QuantAQ Modulair™ sensor halfway through the reporting period at the beginning of July and replaced the defunct AQMesh sensor. For the rest of the reporting period, Kodiak reported consistently 'Good' AQI levels for $PM_{2.5}$.

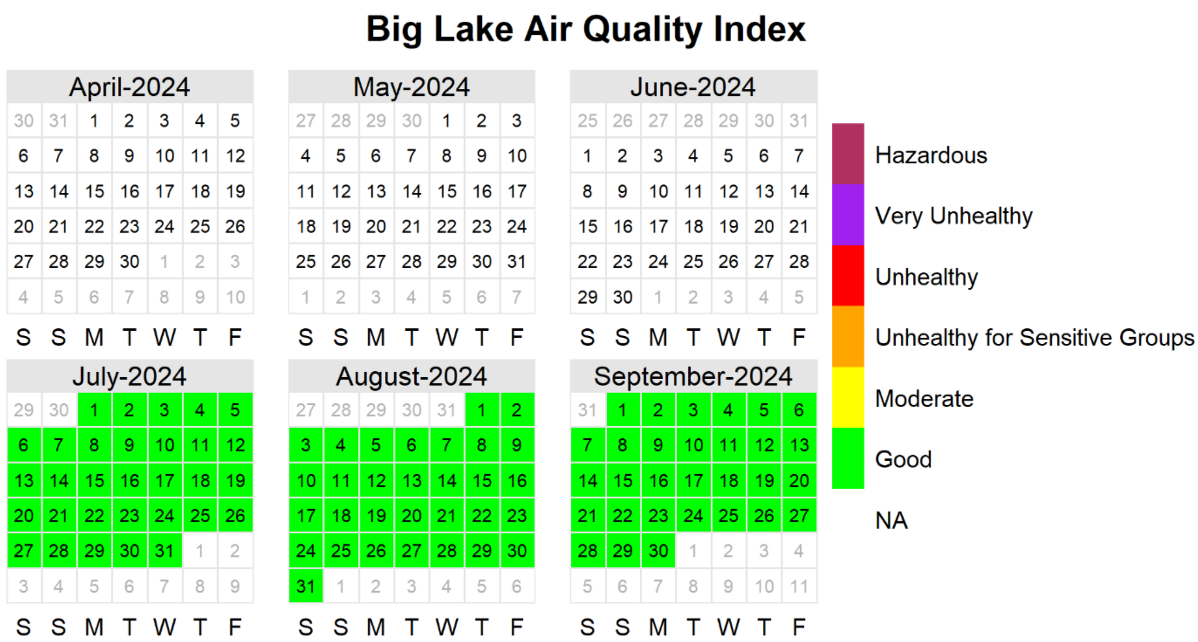

Figure 23. $PM_{2.5}$ Calendar Plots for Big Lake (7/1/2024 – 9/30/2024).

Fig. 23 depicts a calendar plot for the community of Big Lake during the reporting period. Big Lake was equipped with a QuantAQ Modulair™ pod at the start of July and enjoyed 'Good' (AQI) air quality for the second half of the reporting period.

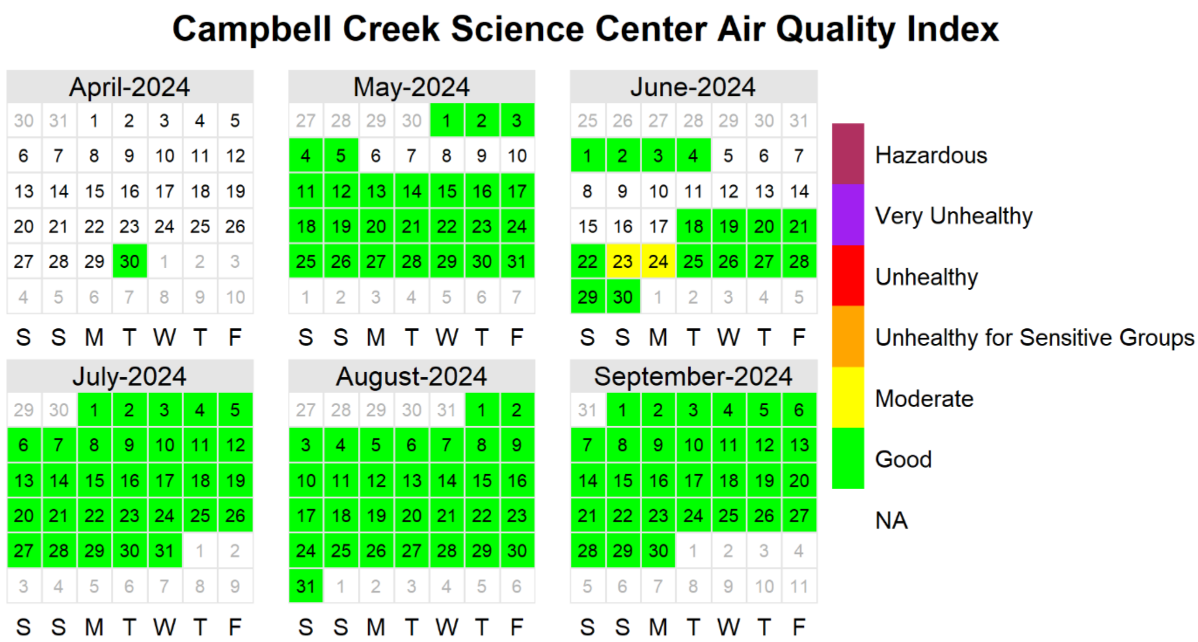

Figure 24. $PM_{2.5}$ Calendar Plots for Campbell Creek Science Center (4/30/2024 – 9/30/2024).

Fig. 24 depicts a calendar plot for the Campbell Creek Science Center located in east Anchorage during the reporting period. The Campbell Creek Science Center was originally outfitted with a pod in early May, but due to mechanical issues the sensor was removed in early June and replaced by another QuantAQ Modulair™ pod about two weeks later.

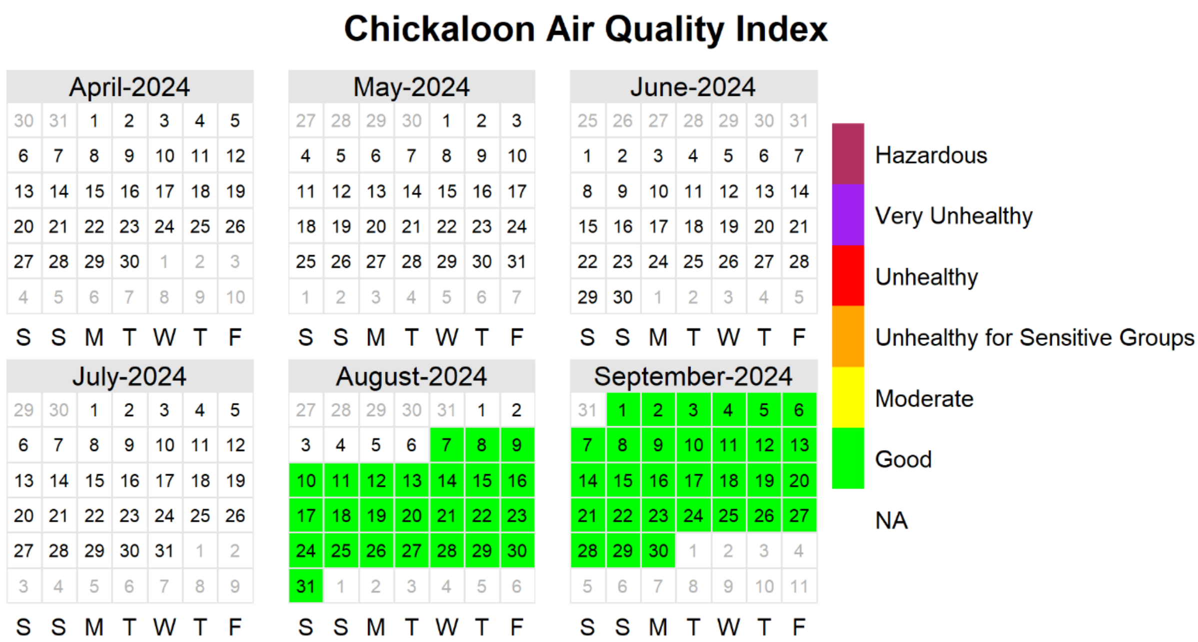

Figure 25. $PM_{2.5}$ Calendar Plots for Chickaloon/Sutton-Alpine (8/7/2024 – 9/30/2024).

Fig. 25 depicts a calendar plot for the community of Chickaloon/Sutton-Alpine during the reporting period. Chickaloon/Sutton-Alpine was one of four communities serviced with a QuantAQ Modulair™ pod during an early August deployment trip. The Chickaloon/Sutton-Alpine pod performed reliably and measured 'Good' (AQI) air quality for the rest of August and September.

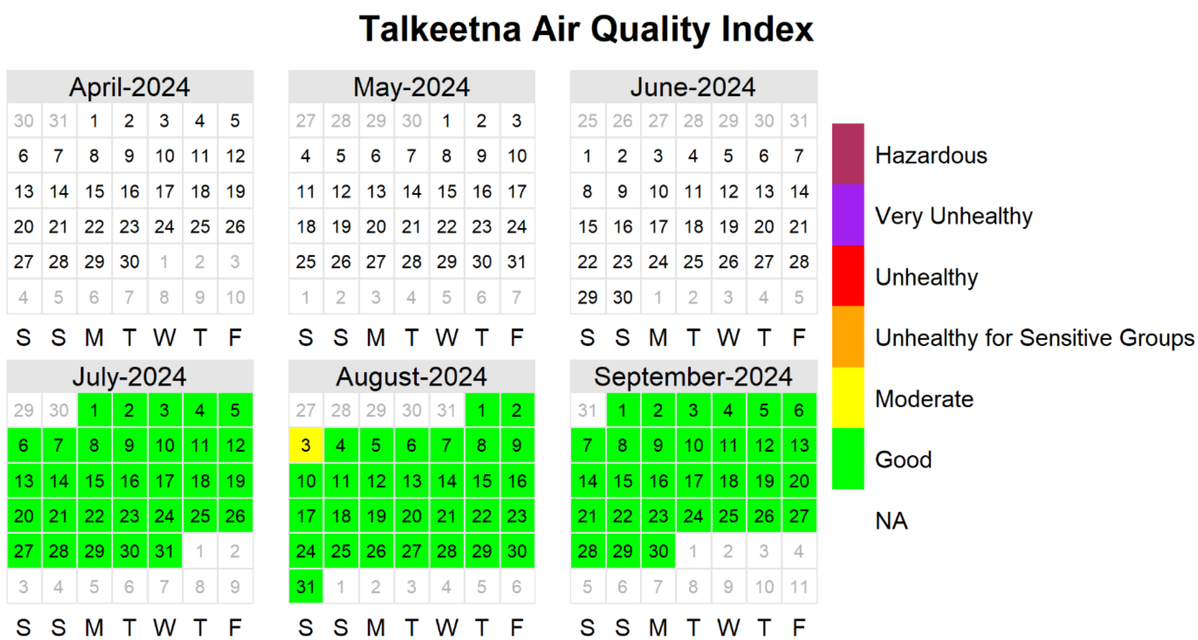

Figure 26. PM$_{2.5}$ Calendar Plots for Talkeetna (7/1/2024 – 9/30/2024).

Fig. 26 depicts a calendar plot for the community of Talkeetna during the reporting period. Talkeetna was serviced with a QuantAQ Modulair™ pod at the start of July. Air quality in Talkeetna is generally 'Good', with only a single day in August reaching the 'Moderate' AQI level, reasons unknown.

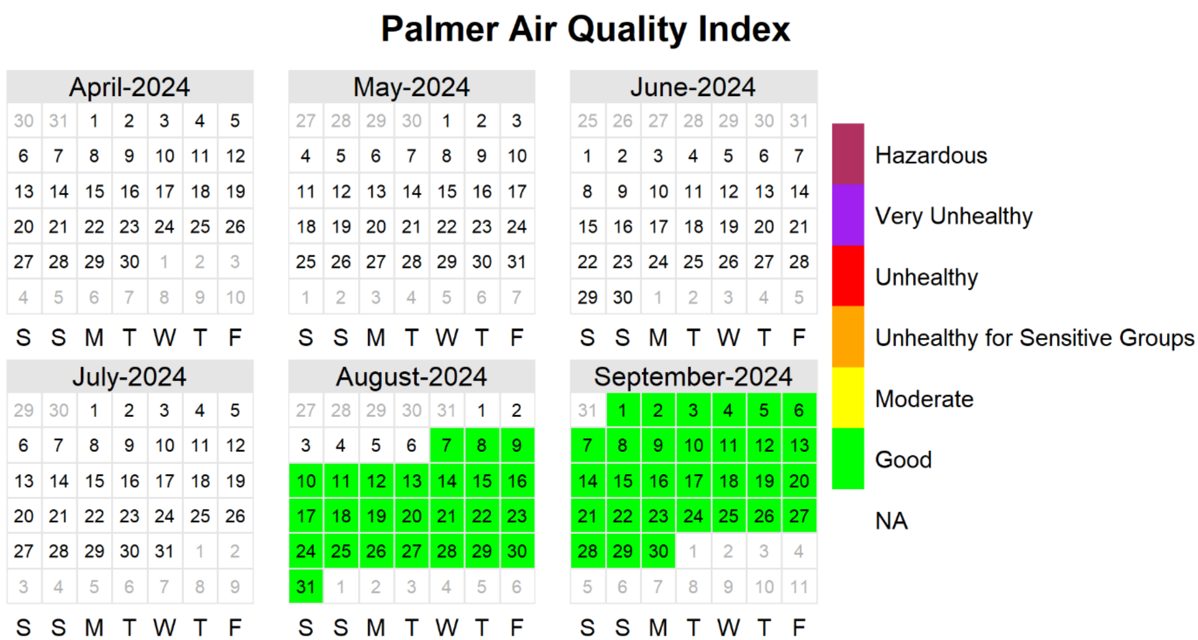

Figure 27. $PM_{2.5}$ Calendar Plots for Palmer (8/7/2024 – 9/30/2024).

Fig. 27 depicts a calendar plot for the community of Palmer during the reporting period. Palmer was one of four communities serviced with a QuantAQ Modulair™ pod during an early August deployment trip. The Palmer pod has performed reliably and measured 'Good' (AQI) air quality for the rest of August and September.

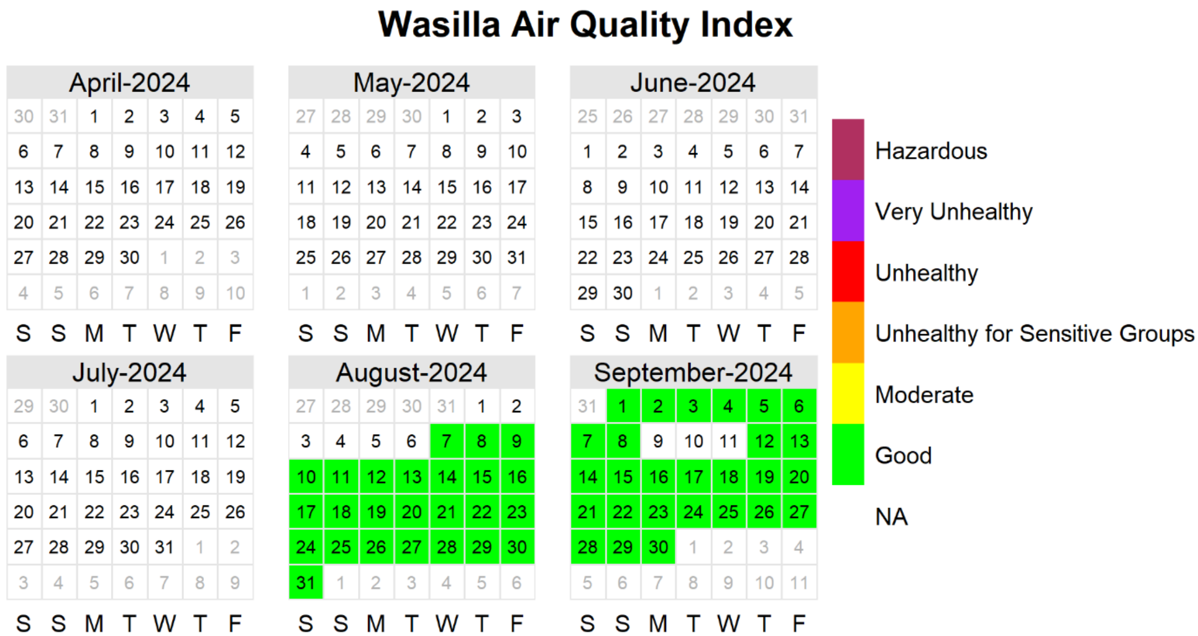

Figure 28. $PM_{2.5}$ Calendar Plots for Wasilla (8/7/2024 – 9/30/2024).

Fig. 28 depicts a calendar plot for the community of Wasilla during the reporting period. Wasilla was one of four communities serviced with a QuantAQ Modulair™ pod during an early August deployment trip. The Wasilla pod has performed reliably and measured 'Good' (AQI) air quality for the rest of August and September.

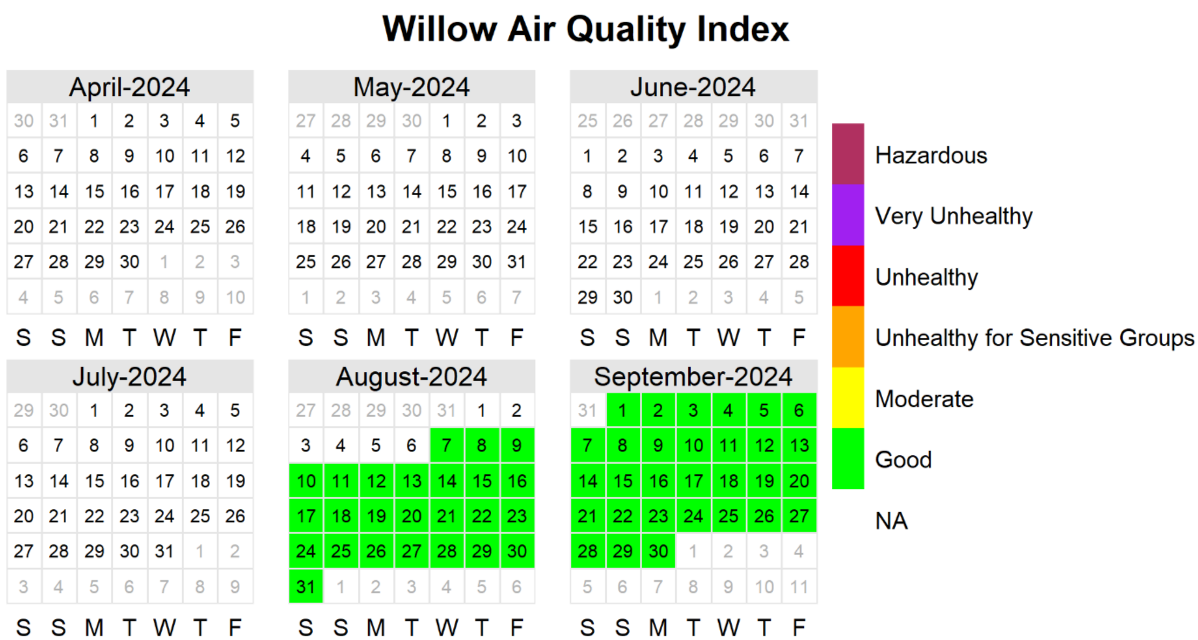

Figure 29. $PM_{2.5}$ Calendar Plots for Willow (8/7/2024 – 9/30/2024).

Fig. 29 depicts a calendar plot for the community of Willow during the reporting period. Willow was one of four communities serviced with a QuantAQ Modulair™ pod during an early August deployment trip. The Willow pod has performed reliably and measured 'Good' (AQI) air quality for the rest of August and September.

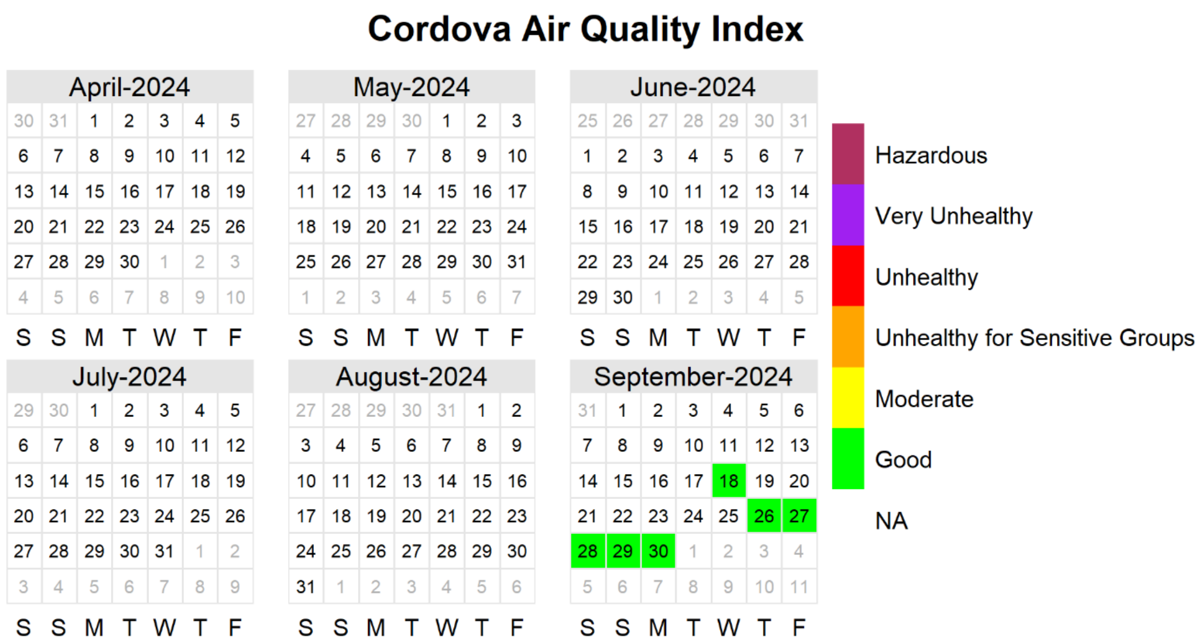

Figure 30. $PM_{2.5}$ Calendar Plots for Cordova (9/18/2024 – 9/30/2024).

Fig. 30 depicts a calendar plot for the community of Cordova during the reporting period. While the pod performed reliable, the initial installation location did not have reliable power supply; it was connected to an outlet regulated by a power switch that was frequently turned off, leading to frequent disruptions to pod operation. DEC worked with the community contact to find a more reliable power supply option.

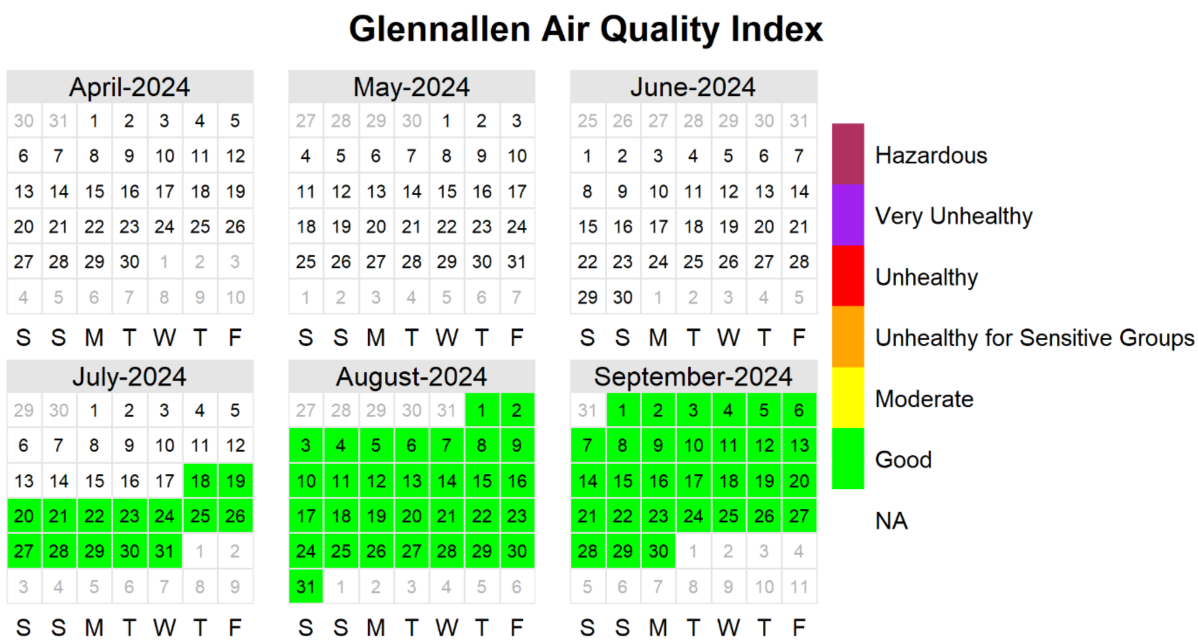

Figure 31. $PM_{2.5}$ Calendar Plots for Glennallen (7/18/2024 – 9/30/2024).

Fig. 31 depicts a calendar plot for the community of Glennallen during the reporting period. The sensor was installed in mid-July and recorded 'Good' AQI levels for the remaining half of the reporting period.

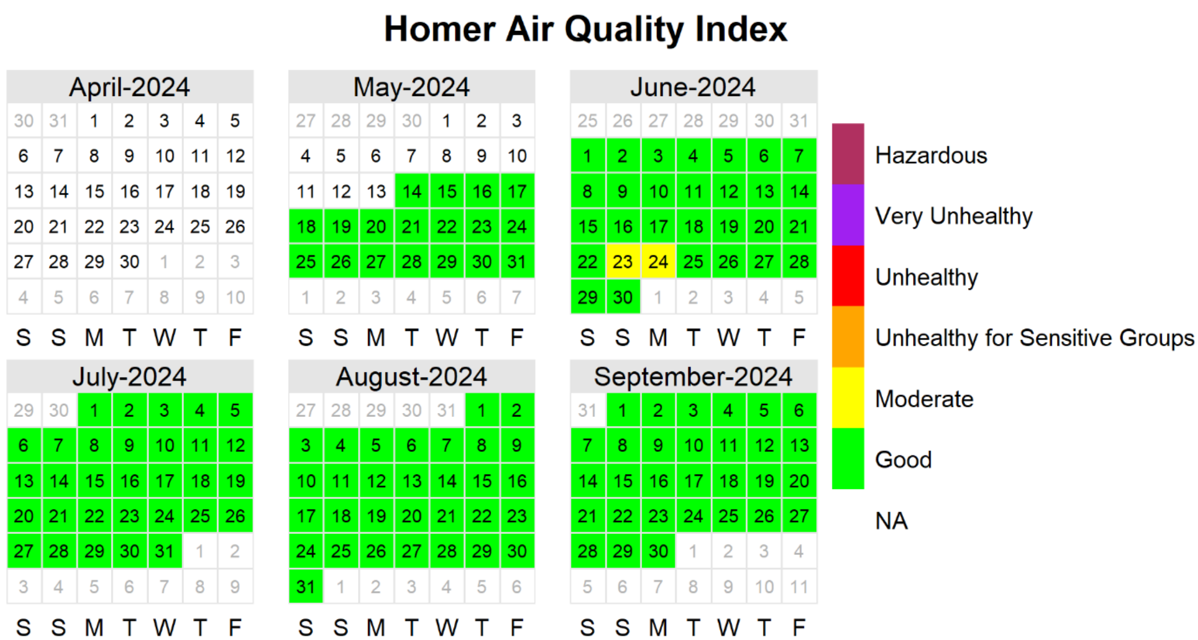

Figure 32. $PM_{2.5}$ Calendar Plots for Homer (5/14/2024 – 9/30/2024).

Fig. 32 depicts a calendar plot for the community of Homer during the reporting period. Homer was one of three communities serviced with a QuantAQ Modulair™ pod during a mid-May deployment trip; The QuantAQ Modulair™ replaced the aging AQMesh sensor. In late June, communities in the Kenai Peninsula were moderately affected by the descent of fine particulate smoke out of the upper atmosphere, originating from wildland fires in the Alaskan Interior and the Yukon Territory in Canada. For the rest of the reporting period, Homer reported in the 'Good' AQI range.

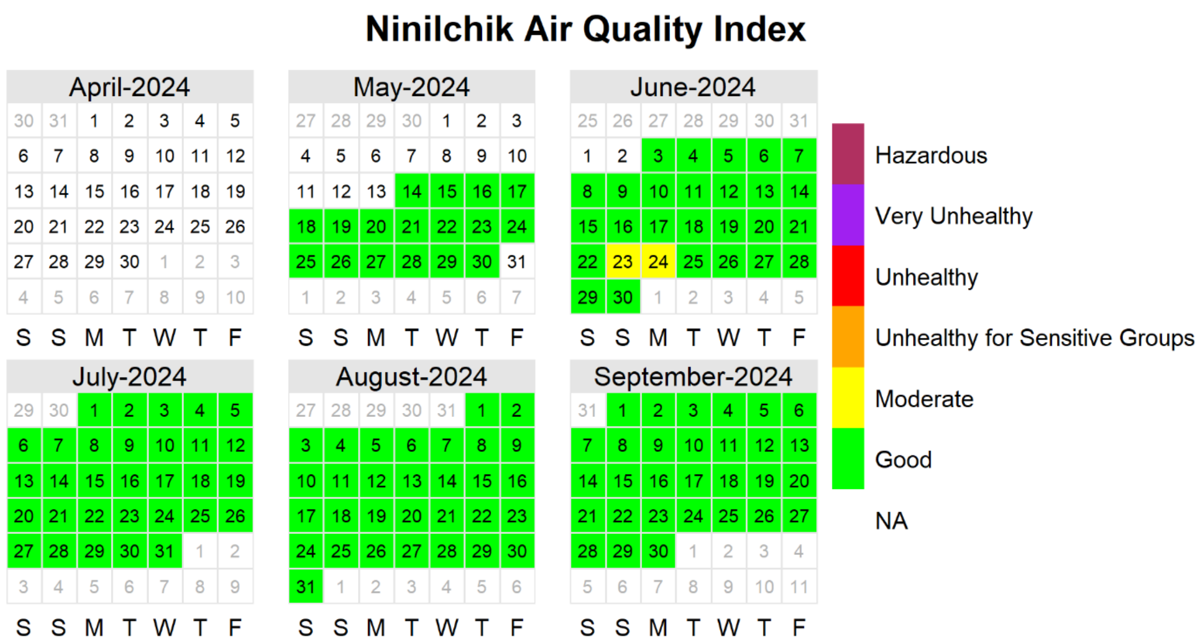

Figure 33. $PM_{2.5}$ Calendar Plots for Ninilchik (5/14/2024 – 9/30/2024).

Fig. 33 depicts a calendar plot for the community of Ninilchik during the reporting period. Ninilchik was one of three communities serviced with a QuantAQ Modulair™ pod during a mid-May deployment trip. In late June, communities in the Kenai Peninsula were moderately affected by the descent of fine particulate smoke out of the upper atmosphere, originating from wildland fires in the Alaskan Interior and the Yukon Territory in Canada. For the rest of the reporting period, Ninilchik reported 'Good' (AQI) air quality.

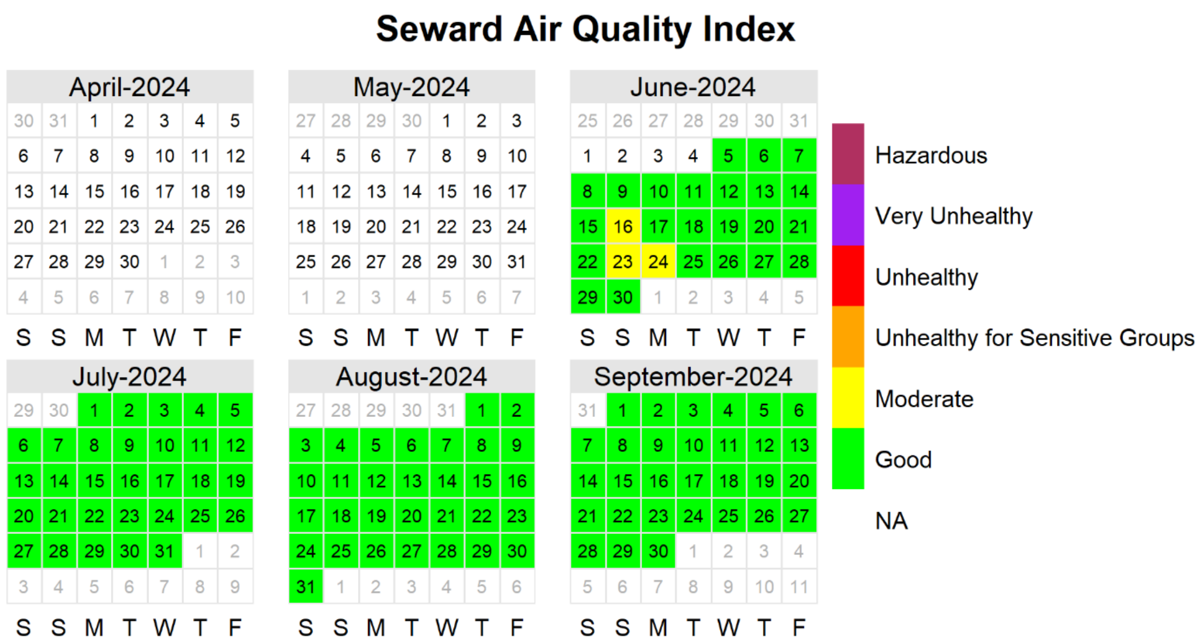

Figure 34. $PM_{2.5}$ Calendar Plots for Seward (6/5/2024 – 9/30/2024).

Fig. 34 depicts a calendar plot for the community of Seward during the reporting period. The aging AQMesh sensor was replaced with a QuantAQ Modulair™ sensor on June 5th. In late June, communities in the Kenai Peninsula were moderately affected by the descent of fine particulate smoke out of the upper atmosphere, originating from wildland fires in the Alaskan Interior and the Yukon Territory in Canada. For the rest of the reporting period, Seward reported 'Good' (AQI) air quality.

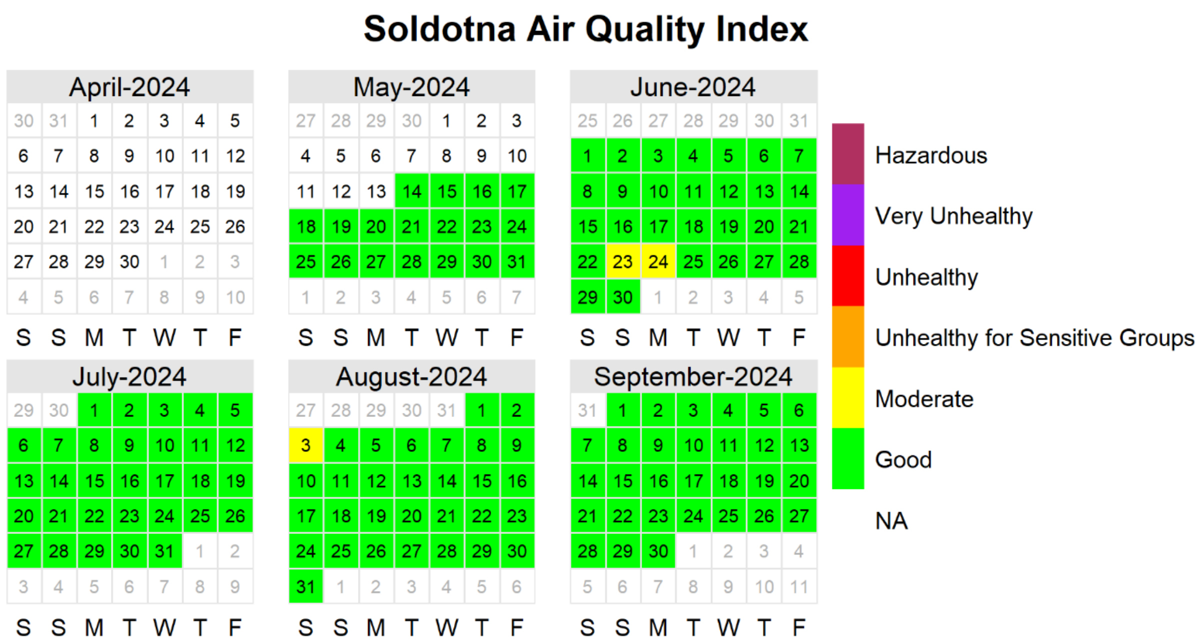

Figure 35. $PM_{2.5}$ Calendar Plots for Soldotna (5/14/2024 – 9/30/2024).

Fig. 35 depicts a calendar plot for the community of Soldotna during the reporting period. Soldotna was one of three communities serviced with a QuantAQ Modulair™ pod during a mid-May deployment trip. In late June, communities in the Kenai Peninsula were moderately affected by the descent of fine particulate smoke out of the upper atmosphere, originating from wildland fires in the Alaskan Interior and the Yukon Territory in Canada. For the rest of the reporting period, Soldotna reported 'Good' (AQI) air quality.

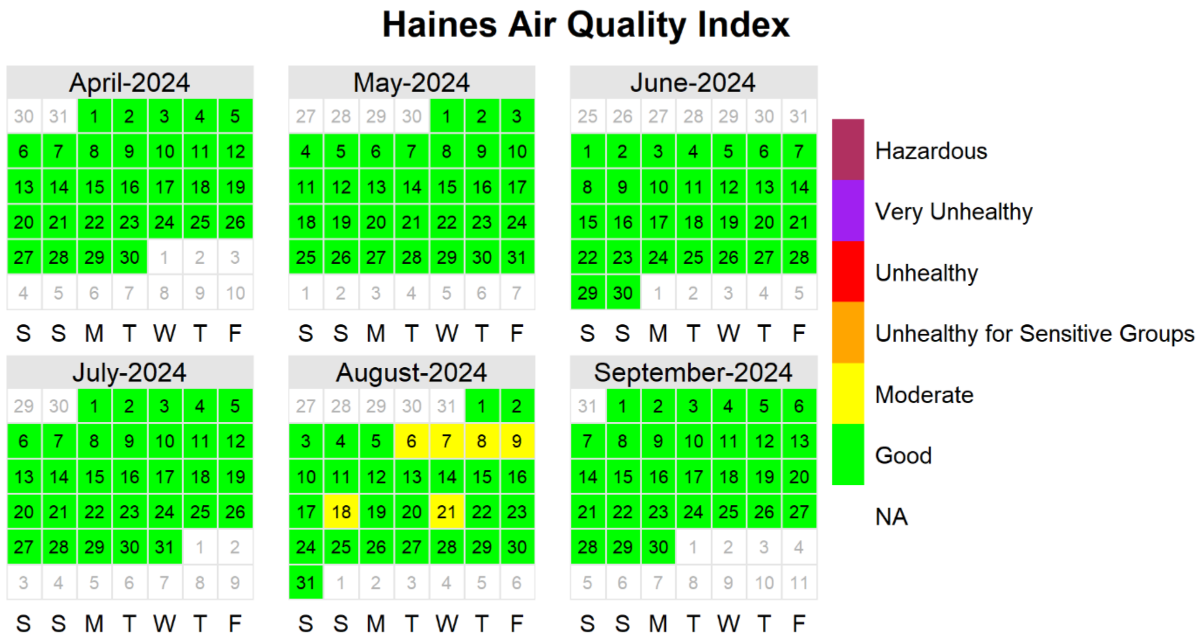

Figure 36. $PM_{2.5}$ Calendar Plots for Haines (4/1/2024 – 9/30/2024).

Fig. 36 depicts a calendar plot for the community of Haines during the reporting period. For most of the reporting period, Haines had 'Good' (AQI) air quality. Several days in August reached the 'Moderate' AQI threshold, likely from wildland fires burning near Tweedsmuir and Entiako Provincial Parks in British Columbia, Canada. These fires produced smoke that was carried westward, impacted with Pacific winds around Prince Rupert, and was pushed northward into the Panhandle region.

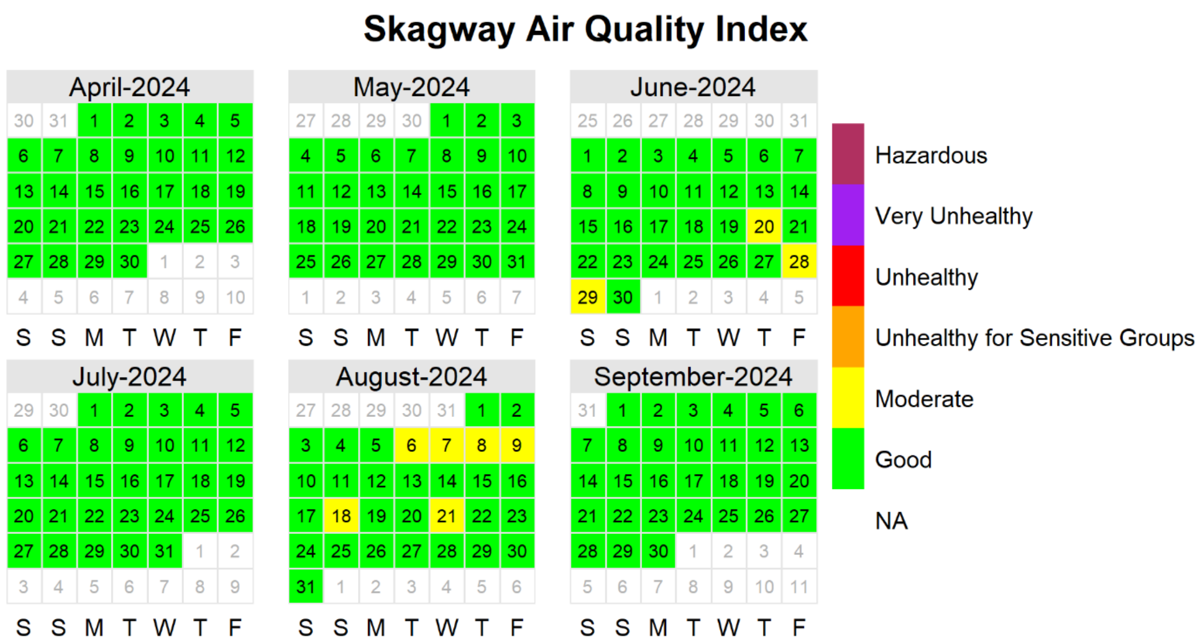

Figure 37. $PM_{2.5}$ Calendar Plots for Skagway (4/1/2024 – 9/30/2024).

Fig. 37 depicts a calendar plot for the community of Skagway during the reporting period. For most of the reporting period, Skagway had 'Good' (AQI) air quality. Skagway is a tourist destination, and the pod is installed near a train station mustering area where tourists are picked up and dropped off. On particularly busy days, $PM_{2.5}$ levels may be elevated from vehicle traffic, such as exhaust from the idling tour train. Several days in August reached the 'Moderate' AQI threshold, likely from wildland fires burning near Tweedsmuir and Entiako Provincial Parks in British Columbia, Canada. These fires produced smoke that was carried westward, impacted with Pacific winds around Prince Rupert, and was pushed northward into the Panhandle region.

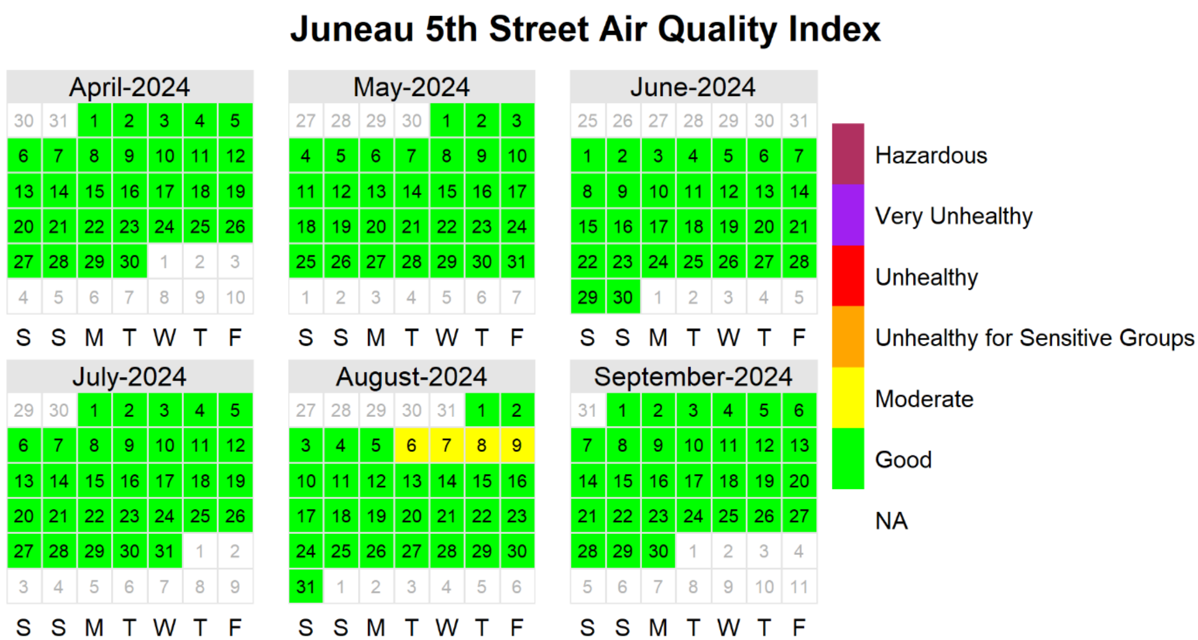

Figure 38. PM$_{2.5}$ Calendar Plots for Juneau at 5th Street (4/1/2024 – 9/30/2024).

Fig. 38 depicts a calendar plot for the 5th Street site pod in Juneau during the reporting period. For most of the reporting period, the 5th Street pod had 'Good' (AQI) air quality. Several days in August reached the 'Moderate' AQI threshold, likely from wildland fires burning near Tweedsmuir and Entiako Provincial Parks in British Columbia, Canada. These fires produced smoke that was carried westward, impacted with Pacific winds around Prince Rupert, and was pushed northward into the Panhandle region. For the rest of the reporting period, the pod in Juneau at 5th Street reported 'Good' (AQI) air quality.

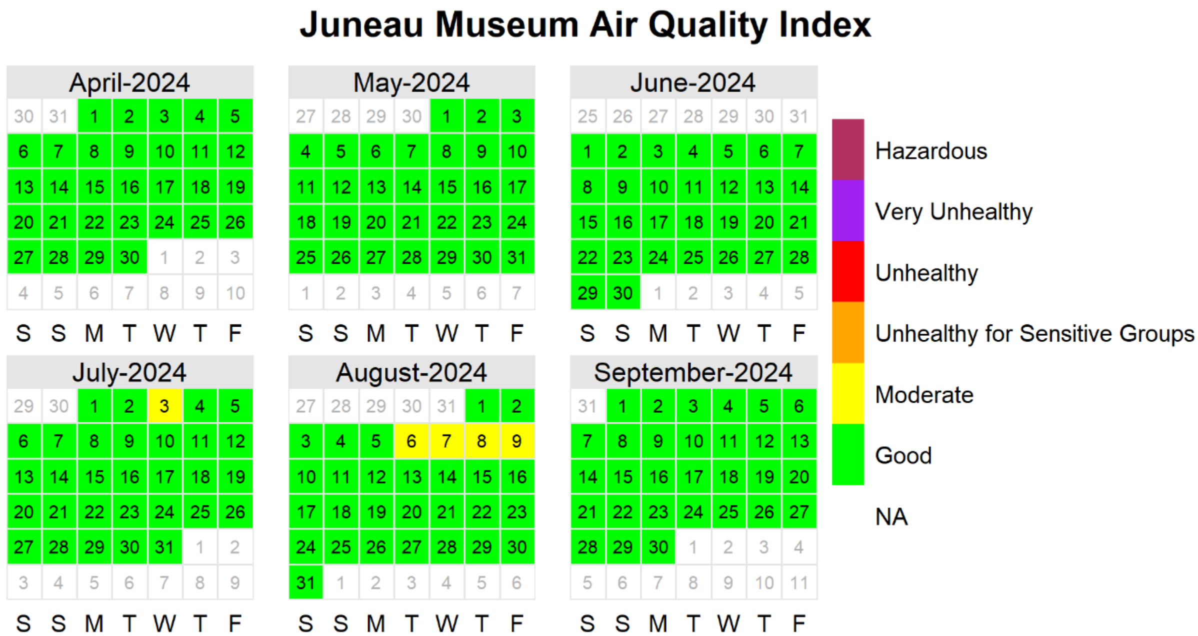

Figure 39. $PM_{2.5}$ Calendar Plots for Juneau at the State Museum (4/1/2024 – 9/30/2024).

Fig. 39 depicts a calendar plot for the State Museum site pod in Juneau during the reporting period. For most of the reporting period, the State Museum sensor had 'Good' (AQI) air quality. Several days in August reached the 'Moderate' AQI threshold, likely from wildland fires burning near Tweedsmuir and Entiako Provincial Parks in British Columbia, Canada. These fires produced smoke that was carried westward, impacted with Pacific winds around Prince Rupert, and was pushed northward into the Panhandle region. For the rest of the reporting period, the pod in Juneau at the State Museum reported 'Good' (AQI) air quality.

In Juneau, Independence Day is celebrated with a fireworks show over the harbor on the evening of July 3rd; the fireworks detonated during this celebration created a very localized increase in $PM_{2.5}$ that raised the daily average AQI into the 'Moderate' range. The $PM_{2.5}$ signal produced by the fireworks was very localized: it was detected by the State Museum pod, which sits at a lower altitude close to the harbor, but not by the 5th Street pod, which sits at a higher altitude in downtown Juneau about twice as far from the harbor.

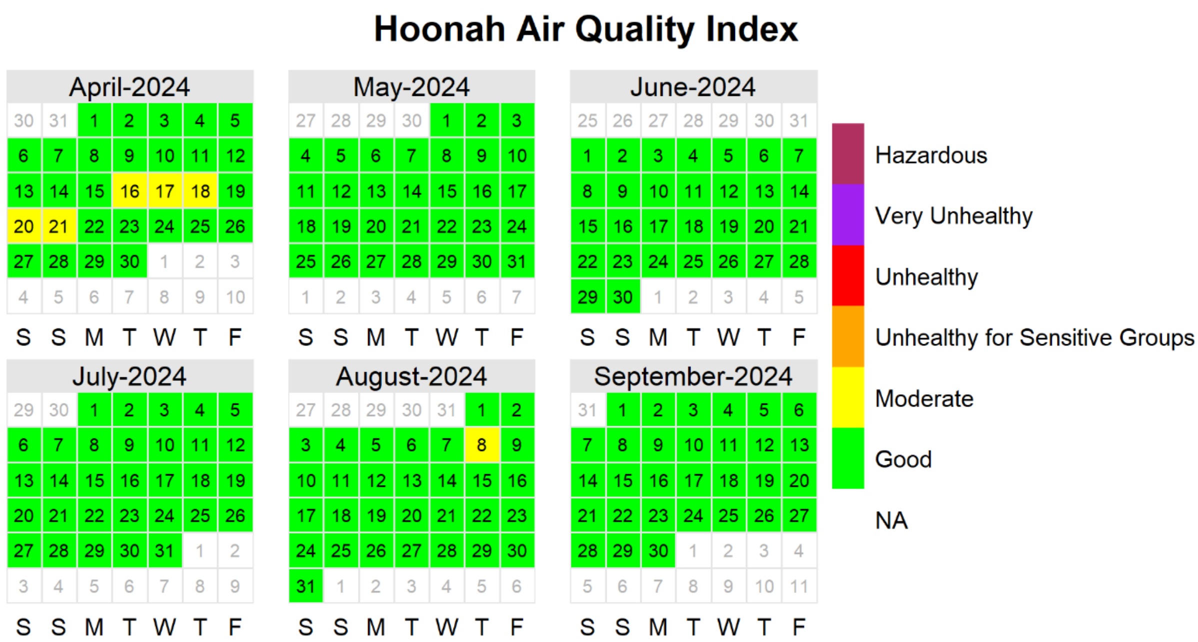

Figure 40. $PM_{2.5}$ Calendar Plots for Hoonah (4/1/2024 – 9/30/2024).

Fig. 40 depicts a calendar plot for the community of Hoonah during the reporting period. For most of the reporting period, Hoonah had 'Good' (AQI) air quality. The 'Moderate' $PM_{2.5}$ levels observed in April are due to smoke from nearby home heating activities, such as wood-burning stoves. The community contact stated that there are multiple buildings with woodstoves near the sensor and on days with little or no wind, the woodstove smoke lingers in the area longer. Several days in August reached the 'Moderate' AQI threshold, likely from wildland fires burning near Tweedsmuir and Entiako Provincial Parks in British Columbia, Canada. These fires produced smoke that was carried westward, impacted with Pacific winds around Prince Rupert, and was pushed northward into the Panhandle region. Hoonah was less affected than other Panhandle communities, in part due to its location on an island, farther away from the Coastal Barrier Mountains where the smoke was being trapped.

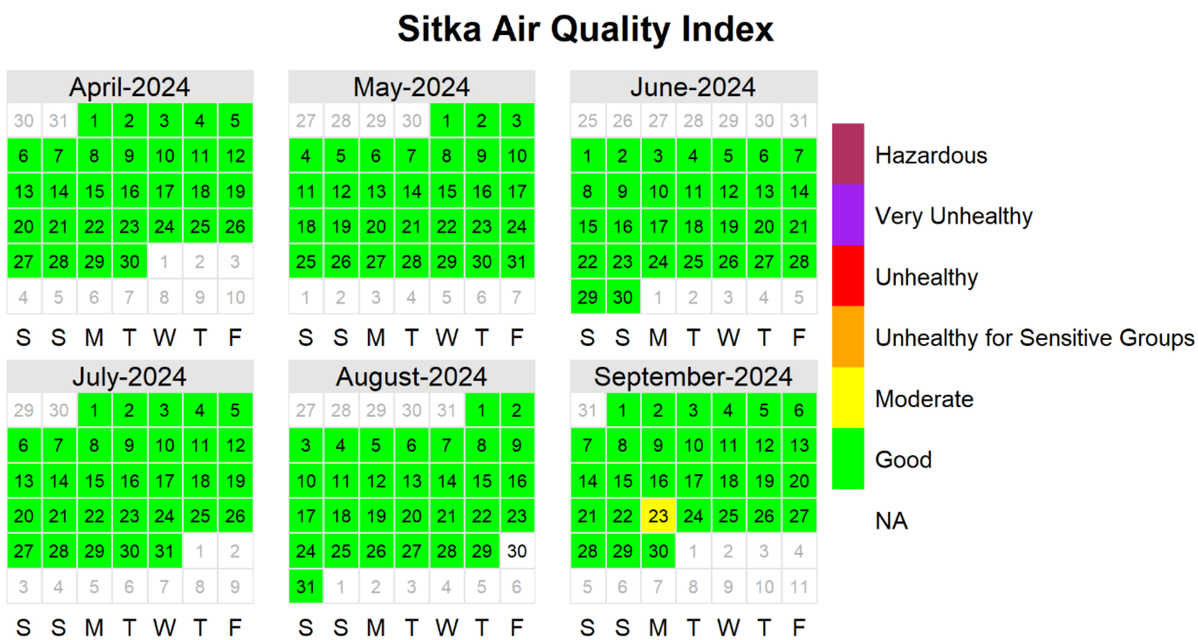

Figure 41. $PM_{2.5}$ Calendar Plots for Sitka (4/1/2024 – 9/30/2024).

Fig. 41 depicts a calendar plot for the community of Sitka during the reporting period. For most of the reporting period, Sitka had 'Good' (AQI) air quality. On August 29th and 30th damage to an offshore fiber optic cable resulted in a loss of data. The daily average on September 23rd was reported as 'Moderate' on the AQI, but this could be attributed to fog causing erroneous PM readings. Sitka was not affected by the early August wildland fire smoke that affected other Panhandle communities, due to Sitka's distal-facing geographic position on the southwestern slope of Baranof Island.

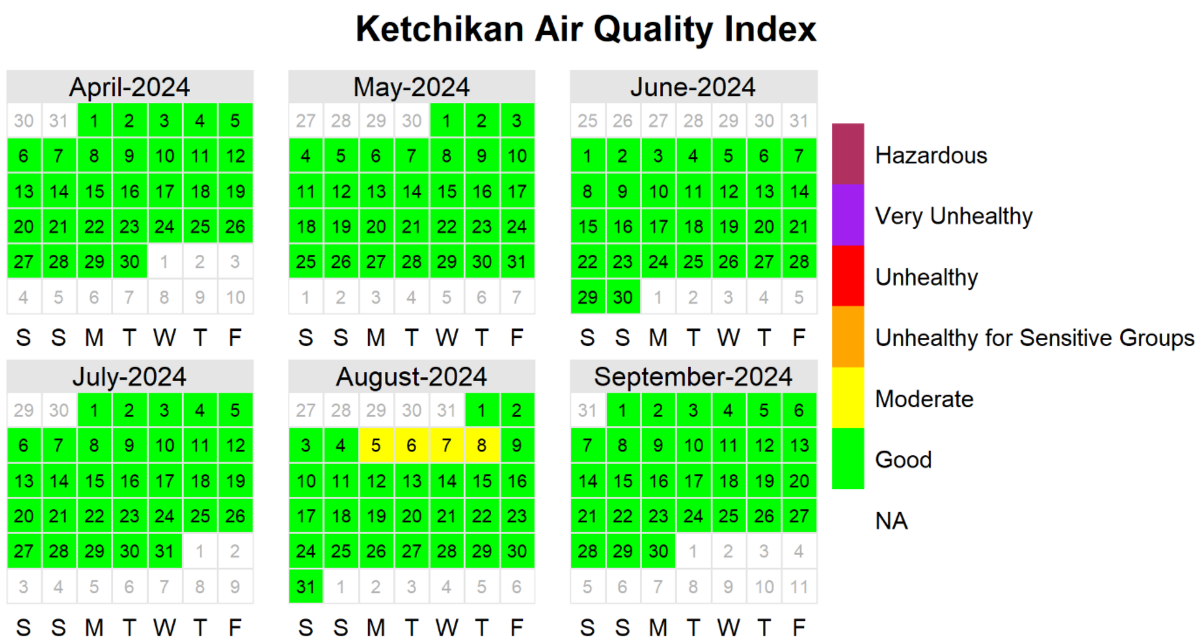

Figure 42. $PM_{2.5}$ Calendar Plots for Ketchikan (4/1/2024 – 9/30/2024).

Fig. 42 depicts a calendar plot for the community of Ketchikan during the reporting period. For most of the reporting period, Ketchikan had 'Good' (AQI) air quality. Several days in August reached the 'Moderate' AQI threshold, likely from wildland fires burning near Tweedsmuir and Entiako Provincial Parks in British Columbia, Canada. These fires produced smoke that was carried westward, impacted with Pacific winds around Prince Rupert, and was pushed northward into the Panhandle region. For the rest of the reporting period, Ketchikan reported 'Good' (AQI) air quality.

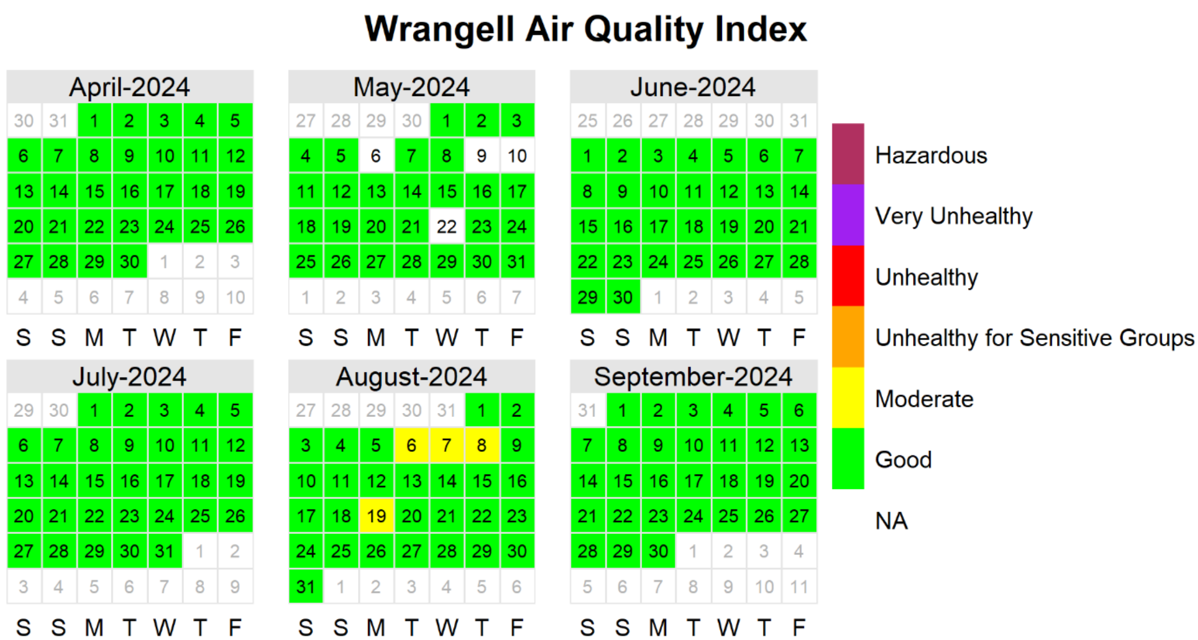

Figure 43. $PM_{2.5}$ Calendar Plots for Wrangell (4/1/2024 – 9/30/2024).

Fig. 43 depicts a calendar plot for the community of Wrangell during the reporting period. For most of the reporting period, Wrangell had 'Good' (AQI) air quality. Several days in August reached the 'Moderate' AQI threshold, likely from wildland fires burning near Tweedsmuir and Entiako Provincial Parks in British Columbia, Canada. These fires produced smoke that was carried westward, impacted with Pacific winds around Prince Rupert, and was pushed northward into the Panhandle region. The Wrangell pod experienced several outages for unknown reasons. These outages were mostly limited to an hour or two a few days a week, but the outages on May 6th, 9th, 10th, and 22nd were extensive enough to prevent the pod from gathering sufficient data to calculate a daily $PM_{2.5}$ average.

5. Future Plans

By the end of the reporting period, DEC has deployed a majority of its QuantAQ Modulair™ sensors in communities throughout Alaska. DEC will continue to monitor the pod data feeds to identify erroneous data and hardware issues and will continue working on data analysis and providing meaningful insights and outreach material to communities and the public. DEC has continued to track pod performance with the goal of developing a robust, multi-year data set that will enable the observation of seasonal trends and season-associated degradation in performance and data quality. To address network limitations that prevent servicing communities with the QuantAQ Modulair™, DEC is working on researching alternative sensor technology to expand the sensor network.

Community outreach remains an integral pillar of the low-cost air sensor network. DEC has continued to update its publicly accessible AQI website, host quarterly community engagement calls, and provide winter/summer data reports to interested communities. DEC hopes to gain feedback from participating communities and tribal entities in order to provide meaningful data products and analysis and improve community outreach. The next interim report will include data from communities participating in the network between October 1st, 2024, and March 31st, 2025.