

**BEFORE THE AIR QUALITY CONTROL COMMISSION  
STATE OF COLORADO**

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**REBUTTAL STATEMENT OF COALITION OF ENERGY PRODUCING ATTAINMENT  
COUNTIES (INCLUDING THE COUNTIES OF GARFIELD, MESA, MOFFAT,  
MONTEZUMA AND RIO BLANCO)**

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**IN THE MATTER OF PROPOSED REVISIONS TO REGULATION NUMBERS 3, 6  
AND 7 AS IT RELATES TO THE SCHEDULED OIL AND GAS RULEMAKING  
HEARING FEBRUARY 19-21, 2014**

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The Energy Producing attainment counties, through its undersigned counsel, hereby submits its Rebuttal Statement in this matter pursuant to Sections V.E.6.c. of the Procedural Rules of the Colorado Air Quality Control Commission ("AQCC" or the "Commission"), and pursuant to the Commission's December 10, 2013 Notice of Public Rulemaking Hearing ("Notice").

**I. EXECUTIVE SUMMARY**

The Energy Producing Attainment Counties (EPAC) coalition consisting of Garfield, Mesa, Moffat, Montezuma and Rio Blanco Counties support regional regulation of oil and gas operations and we support many of the Division's draft proposed rule changes. As EPAC reviewed the Division's draft rules and the prehearing statements and exhibits from the Division and other parties, we note one compelling fact and unity of opinion consistent with longstanding Division air quality designations—there are no locations in Colorado outside of the Northern Front Range and Denver Metropolitan Area non-attainment area (NAA) that fail to meet EPA National Ambient Air Quality Standards (NAAQS) for any criteria pollutant including ozone (McNally et al., 2009). This is based on ambient measurements from a substantial network of air quality monitoring stations throughout the region including western Colorado and the Commission should consider rules with flexibility to address the differential needs of attainment versus nonattainment areas.

The EPAC coalition is concerned that the Division's proposed rules and assertions made in their prehearing statement regarding development and application of a statewide emission control rule is counter to well established case law and Federal and state statutes. By rule, the air quality standards adopted by the Colorado Air Quality Control Commission (Commission) may vary for different parts of the state "as may be necessitated by variations in altitude, topography, climate, or meteorology." [CRS 25-7-108(1)(a)]. Expanding on the foregoing statutory language in light of apparent legislative intent, the Colorado Supreme Court found that the Commission regulations addressing those variables must be

formulated with regard to the various factors that constitute, produce or dispel air pollution, describe maximum concentrations of contaminants that can be tolerated, consider the degree to which particular types of emissions are subject to treatment, and consider the continuous, intermittent, or seasonal nature of the emission to be controlled. According to the Court, Commission's action must also be both reasonable and necessary. [see for example, Fry Roofing Co. v. State Department of Health Air Pollution Variance Board, 179 Colo. 223,499 P.2d 1176 (1972)]. In simplest terms, the Commission and the Division have ample legal precedent and applicable statutes to guide them toward a set of rules with flexibility to account for what are sure to be different tiers of cost and benefit for disparate areas such as attainment areas of western Colorado and the nonattainment areas of Eastern Colorado.

The Division's prehearing statement and draft proposed rules do not clearly show alignment between the new regulatory requirements and a demonstrated and feasible implementation plan that is enforceable by the Division without additional and unidentified dedicated resources. Other parties including the Local Government Coalition and the Conservation Groups have proposed draft rule revisions and alternate proposals that will compound the workload impact for the Division as relates to regulatory oversight and enforcement. We understand the Division proposes reducing APEN permitting requirements as one way to reduce staff workload but there still seems to be inadequate accounting for the resources needed to enforce the proposed regulations. EPAC's concern is that promulgation of even the best new regulations, absent a sound plan to enforce them and demonstrate to the public and the regulated community that the regulations are being enforced and are in fact providing the expected benefit could erode public confidence. We request the Commission and Division communicate an effective enforcement and evaluation strategy before approving new regulations.

Garfield County likely has implemented and self-funded the most comprehensive long-term baseline air quality monitoring program of any rural county in the United States. This is indicative of the concern the county has to ensure the best industry practices reasonably available are in place at all times and that we can directly measure pollutant concentrations rather than rely on easily generated and grossly inaccurate estimates of emissions as an indicator of what is in our air. This monitoring program requires annual investment of over \$250,000 each year plus 1.5 staff positions dedicated to the monitoring program and related air quality management and improvement programs. Additionally, Garfield County recently committed \$1,000,000 to a first-in-kind world-class study to directly measure air emissions from oil and gas drilling. Led by one of the world's premier scientists in the field, Dr. Jeffrey Collett, Colorado State University's Atmospheric Science Department is currently conducting experiments over three years in the Piceance Basin to help county commissioners make scientifically informed decisions. Following county leadership, the State of Colorado found merit in our study and has engaged the same scientists to similarly study drilling emissions in eastern Colorado, using our design. The point of this information is to advise the Commission that our western Colorado Counties are the first to step up to ensure the best science is developed to define and mitigate oil and gas impacts and we expect the Commission to

carefully consider this information to develop science-based regulations where practical as indicated in Federal and state statutes.

Calculated air quality trends associated with criteria and non-criteria air pollutant levels indicate baseline concentrations dropping over the past several years in EPAC counties, including Garfield County, where longstanding and uniquely comprehensive air monitoring for concentrations of 80+ criteria and noncriteria pollutants in western Colorado is apparently not being taken into consideration by the Division. EPAC believes the Division, in its prehearing statement and in the draft proposed rules, erred by omission in failing to discuss and account for substantial locally-funded (and Division supported and encouraged) long-term air monitoring networks that produce hundreds of samples each year for a broad suite of VOCs including many hazardous air pollutants (HAPs) and continuous monitor data for ozone and other criteria pollutants at many locations in the EPAC attainment area. This omission seems counter to applicable statutes. These monitoring data are readily accessible and should have been utilized by the Division and other Parties to the rulemaking for the purpose of developing science-based proposed rules and alternate proposals for attainment areas that may or may not mesh exactly with proposed rules for nonattainment areas. Our point is that the analysis and consideration of the voluminous ambient air quality data should be evaluated as new regulations are drafted. In rebuttal, EPAC provides Exhibits in the form of monitoring reports, statistical summaries and trends calculations for consideration by the Commission.

The Local Community Organizations, in their prehearing statement has requested greater transparency through public access to site inspection and other compliance data. EPAC agrees with this concept within reasonable constraints and emphasizes the value of this transparency will come from an inspection program that also requires the Division to consistently review Leak Detection and Repair (LDAR) inspection reports and to publicly post periodic LDAR program information that informs the public and the regulated community how and if the program is achieving stated goals.

WPX Energy, in their prehearing statement at Exhibit A, Figure 4, has provided compelling information regarding the diminishing return on investment for repeated LDAR cycles. WPX requests reduced instrument based monitoring inspection frequencies within narrow circumstances including those where an operator demonstrates a high degree of success finding, repairing and ultimately preventing leaks going forward. Perhaps this is an area where some flexibility and difference between rules in attainment and nonattainment areas could be accommodated and where a statewide rule is not strictly required or supported by existing data. The EPAC coalition provides rebuttal data regarding ambient air quality conditions that supports the notion that air quality impacts (and emissions that cause them) within the EPAC area are declining rather than increasing as some prehearing statements seem to indicate. The EPAC coalition plans to provide testimony regarding the Division's proposed LDAR frequency and the more intensive LDAR proposals from other parties. Proposed regulations placing the burden of inspection

and reporting on the regulated community should apply common sense, non-punitive, approaches that will most optimally and cost effectively help the Division reach its stated emission-control goals.

The EPAC coalition requests the Commission consider flexible time frames for implementation of specific control measures and LDAR requirements in a manner that reasonably accounts for nonattainment versus attainment areas relative to immediate need to reduce ozone precursor emissions. Western Colorado, and the EPAC area in particular, is well within attainment and there should be some opportunity to allow our regulated community an opportunity to make the investments necessary to comply with new requirements that may be approved by the Commission.

The EPAC coalition restates from our prehearing statement our concern that the Division's cost benefit and regulatory analysis documents remain unavailable for review. Based on the information gaps evident in the Division's initial economic analysis and prehearing statement, EPAC requests the Commission ensure an adequate cost benefit analysis includes fiscal impacts to local, County, State and Federal governments. The Division cannot know if statewide rules are in fact the most reasonable and beneficial approach unless it also evaluates non-statewide approaches. The EPAC coalition expects and looks forward to reviewing a comprehensive cost benefit analysis document that recognizes and evaluates the differential costs that will be required of: 1) different operators large and small and 2) different oil and gas basins as well as the differential benefits to be derived between liquids-rich and dry gas basins.

The EPAC coalition supports stronger regulation of oil and gas emissions. However, there needs to be a demonstrated balance within these stronger regulations to scale differing emissions reduction potential and the implementation costs that certainly exist between liquids rich (and higher emission potential) basins in eastern Colorado and the dry gas basins of western Colorado. The Division's prehearing statement and the referenced Initial Economic Analysis seem to make the case for against a one-size-fits-all statewide rule: "...there are 6,422 tanks or tank batteries in the nonattainment area, and 8,080 tanks or tank batteries state-wide." The division then describes lofty growth projects for the liquids-rich DJ basin as justification for the proposed statewide rule—EPAC disagrees with these broad assumptions and mischaracterizations that so plainly ignore the differential benefits to be achieved between the nonattainment and attainment areas. The lack of provided information about costs and benefits significantly hinders our ability to effectively evaluate and provide definitive perspectives regarding the Division's proposed rule changes as currently drafted. We reserve the right to provide additional analysis, comment and alternative proposals as warranted, including discussion of fiscal impacts to local governments, once these crucial documents become available for review.

The Division's prehearing statement and other documentation for the draft proposed rules provides overly simplistic and exaggerated projections for growth in oil and gas activity in western Colorado oil and gas basins. EPAC requests the Commission and Division provide more substantial analysis of industry growth patterns and in a manner that reasonably addresses differences between western Colorado dry gas

basins and the liquids-rich basins in eastern Colorado. We note other parties, including the DGS group have provided growth projection data and studies that may help the Commission ensure new regulations are based on a sound understanding of the growth scenarios the regulations should account for. EPAC reserves the right to provide testimony at the hearing related to western Colorado oil and gas activity growth and retraction patterns characteristic of our area.

The EPAC coalition agrees with the prehearing statements made by several parties that note the stakeholder process and discussions leading up to this rulemaking emphasized the need to fully implement new EPA OOOO rules and to look for opportunity to reasonably reduce nonmethane VOCs. The original premise was that improved control of greenhouse gases such as methane would be a beneficial, albeit coincidental, outcome as reasonable control strategies were developed for the priority hydrocarbon emissions targeted during the stakeholder meeting process. Ultimately the Division partnered with only a fraction of the original stakeholder group and that smaller partnership developed draft rules with a scope and primary goal (greenhouse gas emission control) not contemplated by the full stakeholder group discussions over 8 months. EPAC remains challenged to fully endorse draft proposed rules that clearly lack the expected and required full stakeholder discussion process. We continue to review the draft rules and prehearing statements and look forward to reviewing rebuttal statements and especially the Division's regulatory and cost benefit analysis.

## **II. RESPONSE TO ISSUES RAISED BY PARTIES**

The Air Pollution Control Division prehearing statement and statements from other parties including the Local Government Coalition and the Local Community Organizations advocate for a statewide one-size-fits-all set of rules as logical and appropriate. They hold to this position even as they fail to fairly and reasonably consider readily available air quality monitoring data and studies that may indicate a flexible science-based set of rules could equally, or perhaps more optimally and effectively, achieve stated emission control goals while encouraging control investments where they are most needed. Some of these same parties, including the Division, are the first to impress upon EPAC members such as Garfield County that they should continue to invest heavily in air monitoring and assessments, so it seems contradictory to then ignore this science at the critical moment when they can best be used to inform this critical rulemaking process.

Air quality resources throughout the west slope and within the EPAC boundaries are generally considered good to pristine and similar to background levels found throughout the rural western US. Based on available data, only in nearfield, source-dominated environments (e.g., along roadways, within city and town areas, and downwind of industrial or resource development facilities) are there measured concentrations above those background levels. In most cases these impacted receptors are nearfield to

the emission sources and not necessarily indicative of regionally persistent impacts. Only ozone data demonstrates an area and regional impact.

## EMISSIONS

The EPAC coalition area, like many western Colorado regions, is in a relatively complex terrain and mostly rural setting. Air pollutant emissions at most western Colorado locations can be dominated by mobile sources (e.g., diesel trucks, automobiles industry and farm equipment), biogenic sources (e.g., forest turpine and forest fires), residential heating (e.g., natural gas and wood), oil and gas exploration and production, and electric power generation (CDPHE, 2013). Although it is understandable that the VOC emissions are dominated by E&P and naturally occurring biogenics, total annual VOC emissions are still considered relatively low, relative to urban airsheds.

The EPAC coalition review of the Division's and other parties prehearing statements indicate they are flawed to the extent they propose statewide control measures but fail to consider that over the past 6 years, the oil and gas industry in western Colorado has implemented enhanced emissions control technology and made operational changes to reduce volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). For instance, industry began implementing green completions as early as 2002 and this practice became a requirement in the 2008 COGCC rule making. Enclosed vapor combustors were added to control emissions from condensate tanks with the potential to emit more than 20 tons of VOCs per year and in Garfield, Mesa, and Rio Blanco Counties (2008 COGCC rule making). These vapor combustors typically reduce VOC emissions by over 98%. Enclosed vapor combustors were also added to condensate, crude oil, and produced water tanks with the potential to emit more than 5 tons of VOCs per year located within a quarter mile of a building. Glycol dehydration units located in Garfield, Mesa, or Rio Blanco Counties which have the potential to emit more than 5 tons of VOCs per year located within a quarter mile of a building are also required to be controlled and reduce VOC emissions by at least 90 percent.

Industry has also reduced VOC and HAP emissions by constructing centralized water management facilities that significantly reduce truck traffic and associated emissions. These facilities also include rigorous control technologies that satisfy the State's Regulation 7 RACT requirements. These centralized water management strategies have replaced trucks that were needed for well servicing and reduced truck traffic (36,100 fewer water truck trips in Garfield County for WPX Energy in 2013) (Tyler Bittner, Engineering team lead, WPX Energy written commun. Jan. 29, 2014). Finally, Industry has also removed and replaced high bleed pneumatic devices with low or no bleed units in response to 2008 COGCC rule making and in preparation of NSPS Subpart OOOO and proposed state Regulation 7 requirements.

All of these technology and operational changes have resulted in reduced impacts to air quality resources in the region. This is reflected in the Garfield County ambient air quality data and data for the surrounding

west slope. With current state and federal E&P regulatory programs already in place combined with the economic incentives to minimize emissions and capture product for sale, the proposed statewide rulemaking requirements seem unlikely to have the intended and proportional beneficial impact on air resources for the disproportionate costs to industry.

Ozone on the other hand is not a directly emitted pollutant but requires a complex combination of oxides of nitrogen (NO<sub>x</sub>) and volatile organic compounds (VOCs) in significant quantity, plenty of solar energy, and extended residence time (days) to form at elevated concentrations. These characteristics make localized formation in remote locations difficult to achieve. Measured ambient ozone concentrations in isolated rural areas like Garfield and surrounding counties are believed to be primarily the result of regional and long range transport into the area as evidenced by ozone data compiled by the Division (CDPHE, 2014). Modeling studies indicate that on average, 95% of the peak predicted ozone (i.e., 82 ppb) and 92% of the fourth highest predicted ozone (i.e., 74 ppb) in 2008 at monitors in Garfield county are primarily due to precursor emissions and ozone coming from outside the state of Colorado (Environ, 2013). This reflects long range contribution from natural sources (e.g., stratospheric injection, western US forest fires, etc.), from western U.S. urban centers (e.g. Los Angeles, San Francisco, Las Vegas, etc.), and from international transport into North America (e.g., Lin et al., 2014). This is additionally exacerbated by naturally occurring biogenic contributions upwind from the surrounding region.

Emissions of HAPs such as benzene, formaldehyde, polycyclic aromatic hydrocarbon (PAHs), etc. are highly localized and generally associated with short-term events with limited exposure. An important example of these emissions, relevant to air quality resources on the west slope, include formaldehyde and benzene from internal combustion engines, exploration and production, diesel particulate matter and associated polycyclic aromatic hydrocarbons (PAHs), and benzo(a)pyrene and benzene from wood smoke, all of which are proven human carcinogens. These sources are prevalent on the west slope.

## **AMBIENT AIR IMPACTS**

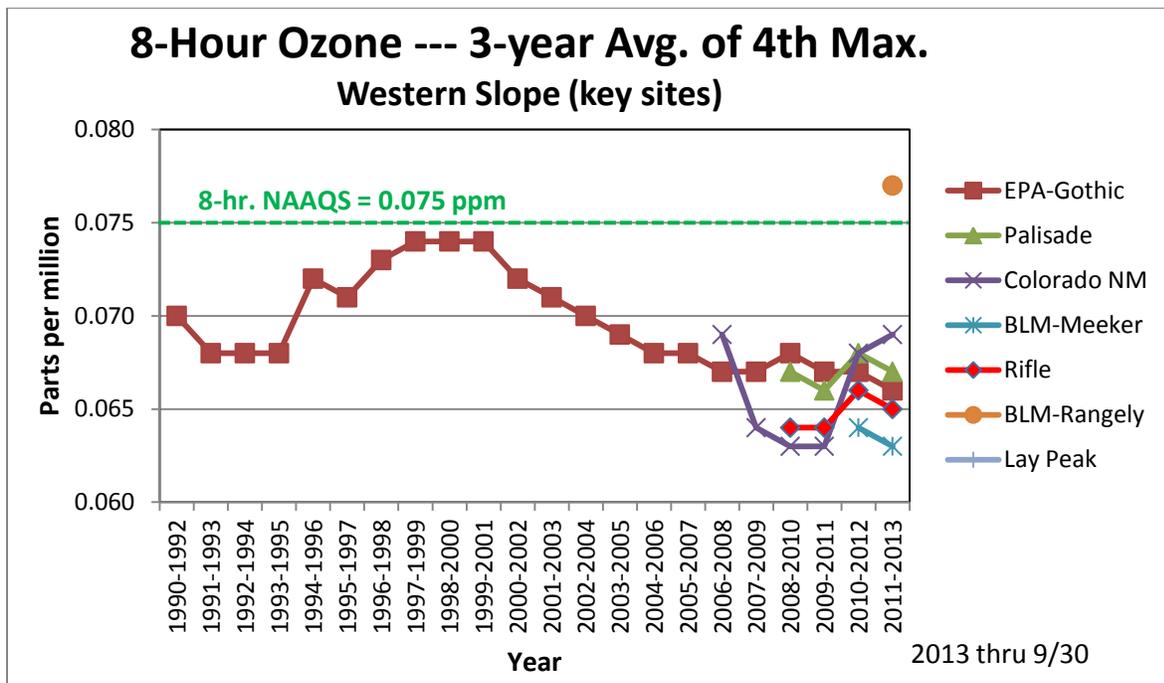
### **Criteria Pollutants**

Ambient air quality monitoring is a direct measurement of air quality impacts at any given receptor. Based on the Garfield County 2012 Air Quality Monitoring Summary (Exhibit 1), concentrations of all criteria pollutants measured are well-below applicable NAAQS thresholds. This includes continuous monitoring of ozone, nitrogen dioxide and particulate matter. Concentrations of carbon monoxide, sulfur dioxide, and lead in western Colorado are extremely low, at or near instrument detection levels (Air Pollution Control Division, 2013) and are not routinely monitored because of a lack of significant emissions.

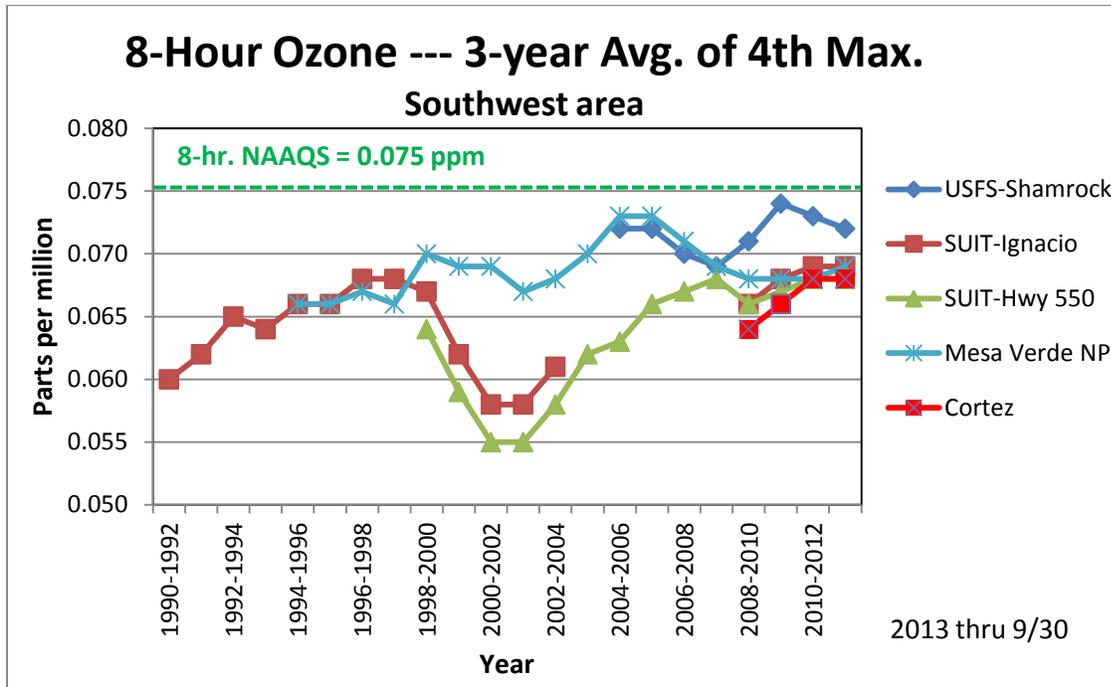
### **Summer Ozone**

As rebuttal to Division and other prehearing statements that statewide control measures will improve ozone levels statewide, including within the EPAC area, a review of a Division-provided compilation of

ambient data, summary statistics and data graphs of collected ozone data are provided (CDPHE, 2014). Central and western Colorado over the past 23 years show background contribution to Garfield County ozone levels unchanged or slightly lower since 1990. The Gothic station, located between Gunnison and Crested Butte, is isolated from E&P development and other localized and near-region air emissions and would be considered representative of background ozone levels into Garfield County. Ozone data collected for Gothic shows 3-year averages of the 4<sup>th</sup> highest 8-hour concentrations at 70 ppb for the period 1990-1998 and lower at 70 ppb for 2004-2013 (EPA, 2014a). These data also indicates ozone concentrations in Garfield County and Mesa County are well below the applicable ambient air standard.



Ozone data collected at southwest Colorado stations upwind of Garfield County in the summertime include Mesa Verde and Ignacio (CDPHE, 2014). This ozone data at Mesa Verde and Ignacio show identical characteristics with 3-year averages of 4<sup>th</sup> highest 8-hour concentrations for 1994 through 2001 averaging 67 ppb and 66 ppb respectively (EPA, 2014b). This pattern repeats for the period, 2008 through 2013, with Mesa Verde 69 ppb, Ignacio 67 ppb, and Cortez 67 ppb and Rifle the lowest at 65 ppb (EPA 2014b). This clearly demonstrates measured ozone impacts in Garfield County are the result of transport into the region from outside the state and not the result of localized emissions impacts. This pattern repeats itself throughout western Colorado and re-enforces the belief that the proposed rulemaking would have no effect on ozone impacts in western Colorado.



### Winter Ozone

Where ozone is considered a summertime pollutant, over the past few years there have been several elevated ozone events in winter-type conditions in the intermountain region (i.e., Utah, Wyoming and Colorado) that have exceeded the NAAQS threshold. Importantly, where ozone is considered a summertime pollutant, this has occurred in wintertime conditions and in select E&P source-dominated locations with unique and easily identifiable topographical settings. Referred to as cold pool ozone, to form it requires sustained snow cover; shallow and persistent (i.e., days) stable atmospheric layer at ground level and; accumulation of trapped pollutants in a restricted dispersion topography (e.g., basin-type) with little air exchange (Lyman et al., 2013). As can be seen by the regional 8-hour average data previously discussed, this pollution cannot be transported to other locations, including Garfield County. Any winds capable of advecting this cold, dense air would mix and dilute the plume thereby reducing the concentrations to background levels. Rangely and Dinosaur, both unique in their topographical setting, have documented these events which are under intense study by industry and research community. However, both locations cannot be generalized as typical statewide exposures. This suggests statewide rulemaking for a unique exposure is not economically responsible nor an efficient strategy. More needs to be learned about this unique condition before an emissions control strategy is developed for the Rangely area.

### Non-Criteria Air Pollutants

In rebuttal to prehearing statement assertions by the Division and others that statewide emissions controls are advisable without first reviewing relevant and available data, the EPAC coalition provides

rebuttal exhibits and data summaries. Garfield County likely has implemented the most comprehensive long-term baseline air quality monitoring program of any rural county in the United States. This is indicative of the concern the county has to ensure the best industry practices are in place and that we can directly measure ambient pollutant concentrations rather than rely on easily generated and grossly inaccurate estimates of emissions as an indicator of what is in our air. This program requires annual investment of over \$250,000 each year plus 1.5 staff dedicated to the monitoring program and related air quality management and improvement programs. This does not include the \$1,000,000 Garfield County recently committed to first-in-kind world-class study to directly measure air emissions from oil and gas drilling. Led by one of the world's premier scientists in the field, Dr. Jeffrey Collett, Colorado State University's Atmospheric Science Department is currently gathering data over three years in the Piceance Basin to help commissioners make scientifically informed decisions. Following county leadership, the State of Colorado found merit in our study and has engaged the same scientists to similarly study drilling emissions in eastern Colorado, using our design. The point of this information is to advise the Commission that our western Colorado Counties are the first to step up to ensure the best science is utilized to define and mitigate oil and gas impacts and we expect the Commission to carefully consider this information to develop science-based regulations where practical as indicated in Federal and state statutes.

We operate five long-term air quality monitoring stations located in Parachute, Battlement Mesa, Rifle, Carbondale, and mobile collection equipment that collects air quality samples every six days (Exhibit 1 and Exhibit 2). Unlike many monitoring programs, ours continually invests in data review and interpretation including annually published summary reports (ARS 2009, 2010, 2011 and 2012) and invited public health risk assessments (CDPHE, 2010) which enables us to keep the pulse of air quality in our area. Annual reports and other County air monitoring efforts have produced an unparalleled data set—one that shows we have very good air quality and it is improving every year. These monitoring data are well known to the Division, readily accessible and should have been utilized by the Division and other Parties to the rulemaking for the purpose of developing science-based proposed rules and alternate proposals for attainment areas that may or may not mesh exactly with proposed rules for nonattainment areas.

These data include speciated VOCs and other hazardous air pollutants such as formaldehyde, benzene, polycyclic aromatic hydrocarbons (PAHs). Although not widely monitored throughout western Colorado, non-criteria pollutant data are densely collected in Garfield County and show decreasing annual trends in measured ambient concentrations throughout the county from 2008 to 2012 (Air Resource Specialists, 2013).. These concentrations are generally well below significance level or potential adverse human health thresholds.

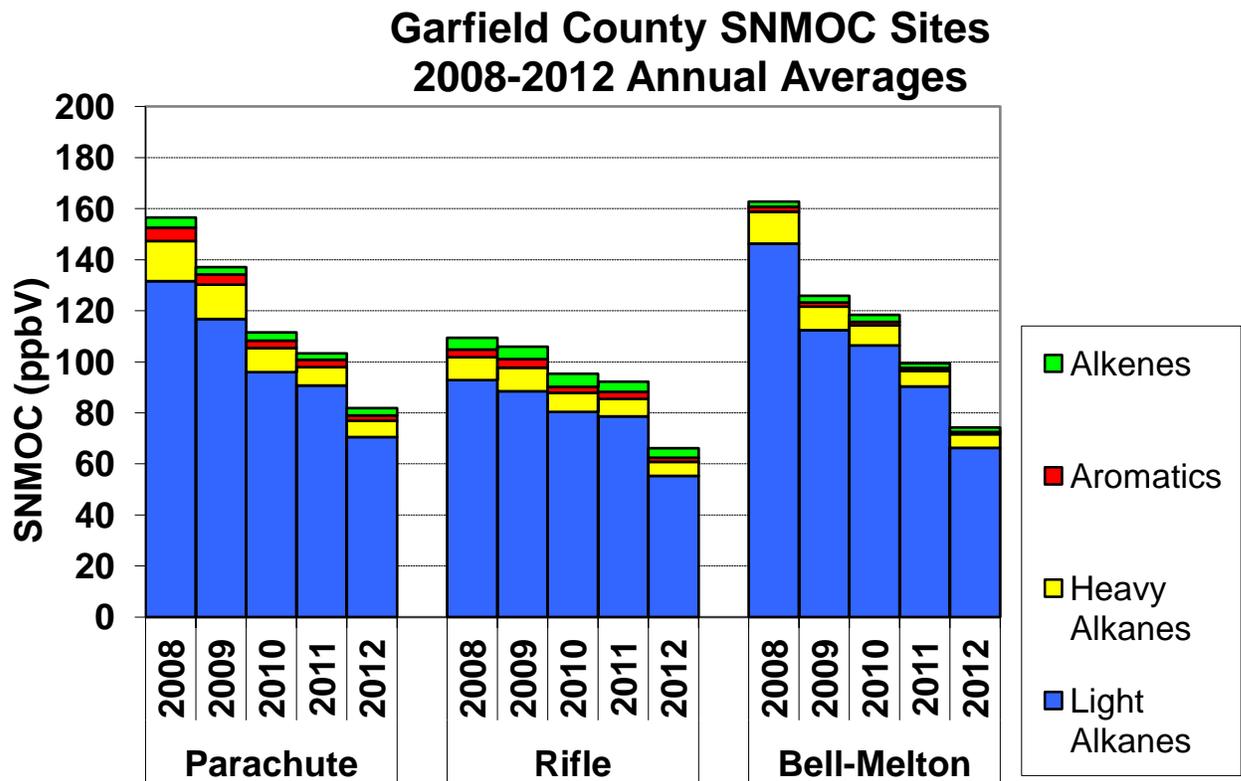
Table 4-1 from Rebuttal Exhibit 1 Garfield County 2012 Air Quality Monitoring Summary.

Parachute Site  
Annual Average Mass Trends (HAPs Parameters)  
2008-2012

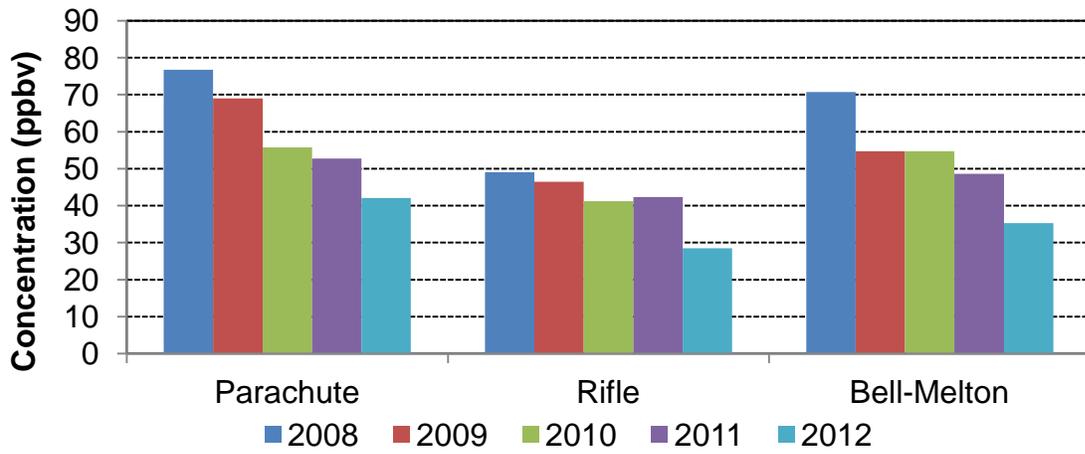
**p-value in bold blue indicates significantly decreasing 2008-2012 concentration trend**

HAP	Average Mass ( $\mu\text{g}/\text{m}^3$ )					Slope ( $\mu\text{g}/\text{m}^3$ per year)	p-Value
	2008	2009	2010	2011	2012		
1,2,4-Trimethylbenzene	0.91	0.62	0.42	0.43	0.39	<b>-0.11</b>	<b>0.04</b>
1,3,5-Trimethylbenzene	0.61	0.51	0.40	0.22	0.18	<b>-0.11</b>	<b>0.01</b>
1,3-Butadiene	0.08	0.12	0.10	0.10	0.09	0.00	0.59
Acetaldehyde	1.11	0.99	0.92	0.90	0.75	<b>-0.08</b>	<b>0.01</b>
Acetone	3.42	3.28	2.67	2.79	2.34	<b>-0.26</b>	<b>0.04</b>
Benzene	2.31	2.69	1.74	1.44	1.31	<b>-0.28</b>	<b>0.04</b>
Crotonaldehyde	0.10	0.10	0.12	0.09	0.08	-0.01	0.24
Cyclohexane	3.92	3.77	2.90	2.22	1.99	<b>-0.54</b>	<b>0.01</b>
Ethylbenzene	0.59	0.44	1.04	0.32	0.17	-0.10	0.12
Formaldehyde	1.74	1.73	1.53	1.64	1.27	<b>-0.11</b>	<b>0.04</b>
Isopropylbenzene	0.09	0.08	0.07	0.08	0.06	<b>-0.01</b>	<b>0.04</b>
Methylcyclohexane	9.24	9.43	6.41	4.65	4.19	<b>-1.47</b>	<b>0.04</b>
m-Xylene/p-Xylene	3.91	3.63	2.20	1.11	1.15	<b>-0.84</b>	<b>0.04</b>
n-Hexane	5.78	5.64	3.93	3.34	3.01	<b>-0.75</b>	<b>0.01</b>
n-Nonane	2.20	2.01	1.13	0.97	0.61	<b>-0.40</b>	<b>0.01</b>
n-Propylbenzene	0.18	0.15	0.13	0.10	0.10	<b>-0.02</b>	<b>0.01</b>
o-Xylene	0.77	0.65	0.43	0.40	0.27	<b>-0.13</b>	<b>0.01</b>
Propionaldehyde	0.12	0.09	0.09	0.09	0.07	<b>-0.01</b>	<b>0.04</b>
Propylene	0.57	0.57	0.62	0.55	0.69	0.03	0.41
Styrene	0.12	0.08	0.12	0.13	1.56	<b>0.04</b>	<b>0.04</b>
Toluene	9.86	5.83	3.96	5.79	4.27	-1.38	0.12

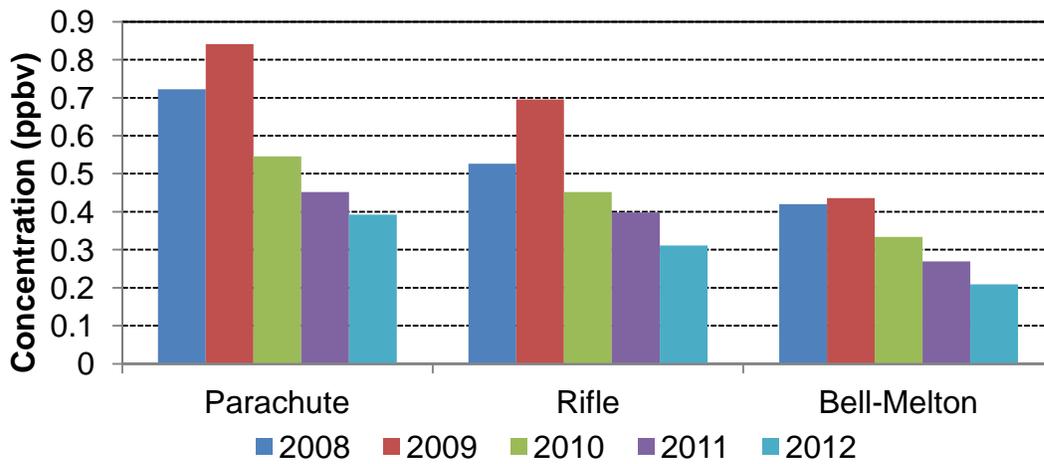
Benzene is one of the non-criteria pollutants measured that has its origin from E&P gas production, gasoline burning engines, and wood combustion. Over the past 5 years (2008-2012), average benzene concentrations have dropped throughout Garfield County with current annual average concentrations less than 0.3 ppb and maximum levels for the most recent 2 years, generally less than 1.5 ppb. For comparison the Alberta, Canada Ambient Air Quality Objective (Standard) for benzene (Alberta Government, 2013.) is 9 ppb for a 1-hour average and 0.9 ppb for an annual average. That is 3 times higher than the Garfield County annual average at a Canadian location that has seen significant E&P development. National Institute of Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have set chronic exposures at or well above 100 ppb, nearly one thousand times higher than Garfield County averages.



### Garfield County Annual Average Trends Ethane



### Garfield County Annual Average Trends Benzene



## Legal Analysis

The EPAC coalition is concerned that the Division's proposed rules and assertions made in their prehearing statement regarding development and application of a statewide emission control rule is counter to well established case law and Federal and state statutes. By rule, the air quality standards adopted by the Colorado Air Quality Control Commission (Commission) may vary for different parts of the state "as may be necessitated by variations in altitude, topography, climate, or meteorology." [CRS 25-7-108(1)(a)]. Expanding on the foregoing statutory language in light of apparent legislative intent, the Colorado Supreme Court found that the Commission regulations addressing those variables must be formulated with regard to the various factors that constitute, produce or dispel air pollution, describe maximum concentrations of contaminants that can be tolerated, consider the degree to which particular types of emissions are subject to treatment, and consider the continuous, intermittent, or seasonal nature of the emission to be controlled. According to the Court, the Commission's action must also be both reasonable and necessary. [see for example, Fry Roofing Co. v. State Department of Health Air Pollution Variance Board, 179 Colo. 223,499 P.2d 1176 (1972)].

Western Colorado is remotely populated with a complex terrain setting characterized by good to pristine air quality resources. This is much different than exists within the Denver and Northern Front Range urban corridor that is also within the State's only nonattainment area. The source-receptor geometry and atmospheric dispersion conditions are also substantially different between the two. Western Colorado ambient air quality data is compelling and shows trends that reflect successful implementation of advanced emissions control technologies. Therefore, there does not appear to be sufficient reason to simply assume the proposed rulemaking, in current form, will have any reasonably predictable effect on impacts to air quality resources on a statewide basis and for western Colorado in particular. For this reason, the EPAC coalition again requests the Commission closely scrutinize the available air quality data available within this rebuttal statement and elsewhere and ensure the best science is applied in the place of loosely estimated calculations of air quality benefits and a less than rigorous attempt to adhere to the prevailing statutes and case law that urge caution before ignoring ready opportunities to understand the air quality dynamics of an area before attempting to impose new regulations.

### **III. LIST OF WITNESSES**

At this time the EPAC Coalition is unable to determine all rebuttal witnesses who may be called upon until we are afforded opportunity to review the unreleased regulatory analysis and cost benefit analysis and have opportunity to review the rebuttal statements from other parties. As a result, EPAC not only reserves the right but expects to list further witnesses either jointly or as individual counties in response to other parties' rebuttal statements.

Witnesses may include EPAC coalition county staff and elected officials. Selected consultants and topical experts as may be needed to provide rebuttal testimony, including, without limitation:

Dr. Robert A. Arnott, Principal/Owner, Strategic Environmental Analysis. Dr. Arnott may testify regarding the Division's proposed regulatory changes as well as any issues raised in connection with these issues. Dr. Arnott may testify regarding timelines for regulation implementation and relationships to cost benefit claims made by any party. Dr. Arnott testify regarding any alternative proposals submitted by other parties. Dr. Arnott may testify regarding the relationship of methane emissions to ozone NAA impacts. Dr. Arnott may testify regarding issues other parties raise regarding EPAC prehearing statements, rebuttal statements, alternative proposals and testimony.

Mr. Kirby Wynn, Oil and Gas Liaison for Garfield County. Mr. Wynn may testify regarding the Division's proposed regulatory changes as well as any issues raised in connection with these issues including other parties' alternative proposals and rebuttal statement and the cost benefit and regulatory analysis. Mr. Wynn may testify regarding issues other parties raise regarding EPAC prehearing statements, rebuttal statements, alternative proposals and testimony.

Dr. Jim Wilkinson, senior consultant with Golder Associates. Dr. Wilkinson may testify regarding the Division's proposed regulatory changes as well as any issues raised in connection with these issues including other parties' alternative proposals and rebuttal statements. Dr. Wilkinson may testify regarding the relationship of methane and nonmethane hydrocarbon emissions to ozone NAA impacts and other impacts. Dr. Wilkinson may testify regarding issues other parties raise regarding EPAC prehearing statements, rebuttal statements, alternative proposals and testimony.

#### **IV. EXHIBITS AND REFERENCES**

Exhibit 1, Air Resource Specialists (ARS). 2013. *Garfield County 2012 Air Quality Monitoring Summary*. Produced for Garfield County Public Health Department. Available online at <http://www.garfield-county.com/air-quality/documents.aspx>.

Exhibit 2, 2013, Garfield County air quality monitoring program design.

Exhibit 3, Two Regional Ozone plots inserted to rebuttal statement text: Colorado Department of Public Health and Environment, Air Pollution Control Division. "Western Colorado Ozone Graph". 17 January 2014. Gordon Pierce written communication.

Exhibit 4, Air Resource Specialists (ARS). 2014. Letter transmittal of data and results

#### References cited

Air Resource Specialists (ARS). 2009. *Garfield County 2008 Air Quality Monitoring Summary*. Produced for Garfield County Public Health Department. Available online at <http://www.garfield-county.com/air-quality/documents.aspx>.

Air Resource Specialists (ARS). 2010. *Garfield County 2009 Air Quality Monitoring Summary*. Produced for Garfield County Public Health Department. Available online at <http://www.garfield-county.com/air-quality/documents.aspx>.

Air Resource Specialists (ARS). 2011. *Garfield County 2010 Air Quality Monitoring Summary*. Produced for Garfield County Public Health Department. Available online at <http://www.garfield-county.com/air-quality/documents.aspx>.

Air Resource Specialists (ARS). 2012. *Garfield County 2011 Air Quality Monitoring Summary*. Produced for Garfield County Public Health Department. Available online at <http://www.garfield-county.com/air-quality/documents.aspx>.

Air Resource Specialists (ARS). 2013. *Garfield County 2012 Air Quality Monitoring Summary*. Produced for Garfield County Public Health Department. Available online at <http://www.garfield-county.com/air-quality/documents.aspx>.

Alberta Government. "Alberta Ambient Air Quality Objectives and Guidelines Summary." August 2013. Available online at <http://environment.gov.ab.ca/info/library/5726.pdf>

Garfield County Public Health Department. December 2007. *Garfield County Ambient Air Quality Monitoring Summary: June 2005-May 2007*. Available online at <http://www.garfield-county.com/air-quality/documents.aspx>.

Colorado Department of Public Health and Environment, Air Pollution Control Division. "2013 Stakeholder Meeting #2". 28 February 2013. PowerPoint Presentation.

Colorado Department of Public Health and Environment, Air Pollution Control Division. "Colorado Air Quality Data Report." November 2013. Available online at [http://www.colorado.gov/airquality/tech\\_doc\\_repository.aspx](http://www.colorado.gov/airquality/tech_doc_repository.aspx)

Colorado Department of Public Health and Environment, Air Pollution Control Division. "Western Colorado Ozone Graph". 17 January 2014. Gordon Pierce written communication.

Colorado Department of Public Health and Environment, Disease Control and Epidemiology Division. "Garfield County Air Toxics Inhalation: Screening Level Human Health Risk Assessment: Inhalation of Volatile Organic Compounds Measured in 2008 Air Quality Monitoring Study." June 2010. Available online at <http://www.garfield-county.com/environmental-health/human-health-risk-of-oil-gas.aspx>

Environ. "Western Regional Air Partnership (WRAP) West-wide Jump-start Air Quality Modeling Study (WestJumpAQMS): Final Report." September 2013. Prepared for Tom Moore, Western Regional Air Partnership. Prepared by Environ International Corporation, Alpine Geophysics, LLC, and University of North Carolina.  
[www.wrapair2.org/pdf/WestJumpAQMS\\_FinRpt\\_Finalv2.pdf](http://www.wrapair2.org/pdf/WestJumpAQMS_FinRpt_Finalv2.pdf),  
[www.wrapair2.org/pdf/Appendix\\_B\\_O3\\_10hi\\_Model\\_Days.xlsx](http://www.wrapair2.org/pdf/Appendix_B_O3_10hi_Model_Days.xlsx)

EPA (2014a). CASTNET, Download Data, Ozone 8HR DMAX.

[http://java.epa.gov/castnet/epa\\_jsp/prepackageddata.jsp](http://java.epa.gov/castnet/epa_jsp/prepackageddata.jsp)

EPA (2014b). AirData. [http://www.epa.gov/airdata/ad\\_data\\_daily.html](http://www.epa.gov/airdata/ad_data_daily.html)

EPA (2013a). Currently Designated Nonattainment Areas for All Criteria Pollutants.

[www.epa.gov/oaqps001/greenbk/ancl.html](http://www.epa.gov/oaqps001/greenbk/ancl.html)

Lin, Jintai; Pan Da; Davis, Steven J.; Zhang, Qiang; He, Kebin; Wang, Can; Streets, David G.; Wuebbles, Donald J.; and Guan, Dabo. "China's international trade and air pollution in the United States." PNAS 2014 ; published ahead of print January 21, 2014.

[www.pnas.org/content/early/2014/01/16/1312860111.full.pdf+html?with-ds=yes](http://www.pnas.org/content/early/2014/01/16/1312860111.full.pdf+html?with-ds=yes)

Lyman et al. 2013. *2013 Uintah Basin Winter Ozone & Air Quality Study*. Utah State University.

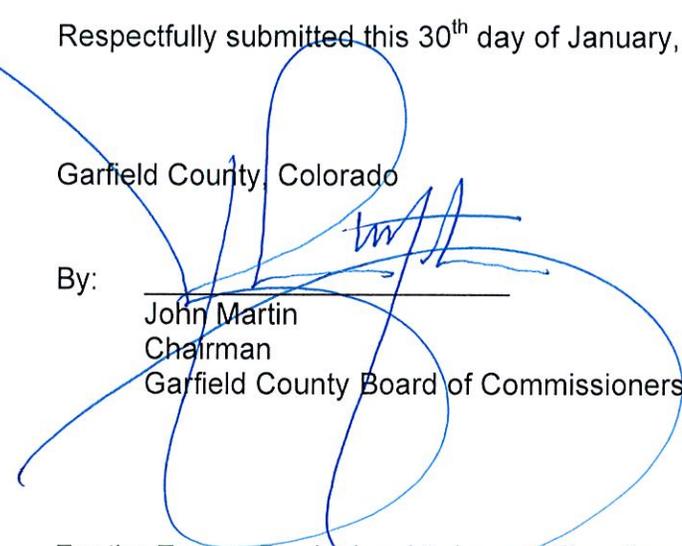
McNally, D. E., C. Loomis, R. Morris, and T. Saskulyanontvittaya "Draft Final Report: 2020 Ozone Source Apportionment Modeling for the Denver Area." 2009.

[http://www.ozoneaware.org/postfiles/documentsandpresentations/modeling/Draft%20Final%202020\\_OSAT\\_Report.pdf](http://www.ozoneaware.org/postfiles/documentsandpresentations/modeling/Draft%20Final%202020_OSAT_Report.pdf)

Respectfully submitted this 30<sup>th</sup> day of January, 2014:

Garfield County, Colorado

By:



\_\_\_\_\_  
John Martin  
Chairman  
Garfield County Board of Commissioners

For the Energy Producing Attainment Counties: Garfield County, Mesa County, Moffat  
County, Montezuma County, Rio Blanco County



**GARFIELD COUNTY  
2012 AIR QUALITY MONITORING SUMMARY**

Prepared for:

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July 31, 2013

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## LIST OF ACRONYMS AND ABBREVIATIONS

ARS	Air Resource Specialists, Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
BMCO	Battlement Mesa, Colorado Air Quality Monitoring Site
BRCO	Bell-Melton, Colorado Air Quality Monitoring Site
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CARB	California Air Resources Board
CDPHE	Colorado Department of Public Health and Environment
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
FRM	Federal Reference Method
GCPHD	Garfield County Public Health Department
HAPs	Hazardous Air Pollutants
NAAQS	National Ambient Air Quality Standards
NATTS	National Air Toxics Trends Stations
NIOSH	National Institute for Occupational Safety and Health
NO <sub>x</sub>	Oxides of nitrogen
O <sub>3</sub>	Ozone
PACO	Parachute Creek, Colorado Air Quality Monitoring Site
PM <sub>2.5</sub>	Particulate matter ≤ 2.5 microns in diameter
PM <sub>10</sub>	Particulate matter ≤ 10 microns in diameter
RICO	Rifle, Colorado Air Quality Monitoring Site
SNMOC	Speciated non-methane organic compounds
TEI	Thermo Environmental Instruments
TEOM	Tapered Element Oscillating Microbalance
TNMOC	Total non-methane organic compounds
UATMP	Urban Air Toxics Monitoring Program
VOC	Volatile organic compounds

## EXECUTIVE SUMMARY

This report summarizes air quality monitoring data collected during 2012 in Garfield County, Colorado. Air quality is currently monitored at five locations in the county, which are all in close proximity to urban areas in the county, and to oil and gas development areas. Parameters monitoring include:

- Meteorology (e.g., wind speed, wind direction, temperature, relative humidity and precipitation).
  - Meteorological data are collected along with air quality parameters to better understand the local conditions and transport of air pollutants.
- Criteria pollutants (e.g. particulate matter  $\leq 10$  micrometers in diameter (PM<sub>10</sub>), particulate matter  $\leq 2.5$  micrometers in diameter (PM<sub>2.5</sub>), ozone (O<sub>3</sub>) and (NO<sub>2</sub>).
  - Criteria pollutants are pollutants subject to National Ambient Air Quality Standards (NAAQS).
- Volatile organic compounds (VOCs), including subsets of speciated non-methane organic carbon (SNMOCs), carbonyls and hazardous air pollutants (HAPs).

Results through 2012 indicate that:

- Air quality measurements in Garfield County did not violate NAAQS for PM<sub>10</sub>, PM<sub>2.5</sub>, O<sub>3</sub>, or NO<sub>2</sub>.
- Total SNMOC measurements have decreased on an annual average basis since measurements began in 2008.
- Light alkanes (e.g., ethane, propane, iso/n-butane, and iso/n-pentane), which are commonly associated with natural gas, made up 83-89% of the total SNMOC compounds measured. These light alkanes may contribute to ozone formation and odor issues but are not considered HAPs.

Of the 78 SNMOC and 12 carbonyl compounds measured in Garfield County, 21 compounds are considered as HAPs. The health effects of HAPs measured in Garfield County were reported for data collected in 2008 in the *Garfield County Air Toxics Inhalation Screening Level Human Risk Assessment* (CDPHE 2010), which is available from the Garfield County Air Quality Management website (<http://www.garfield-county.com/air-quality/>). Findings of this risk assessment report indicated that, individually, the HAP components were below risk assessment criteria, but cumulative effects approached chronic (70-year exposure period) non-hazard levels. The largest contributors to the cumulative levels were benzene and formaldehyde. For HAPs measurements, results through 2012 indicate that:

- Most parameters, including benzene, showed statistically significant decreasing annual average trends at all sites.
- Formaldehyde showed slightly decreasing trends at the more rural sites and no significant trend at the more urban Rifle site. Comparisons to regional measurements

indicated that formaldehyde was measured at much lower levels than larger nearby urban sites (e.g., Grand Junction).

- Of the 21 HAPS measured in Garfield County, the only parameter that showed an increasing annual average trend was styrene, which is primarily associated with the production of polystyrene plastics and resins.

Detailed air quality monitoring information through 2012 is provided in this report. Additional information, including real-time air quality data, previous air quality data reports, educational materials, air quality management plans, emissions assessments, and health assessments are available from the Garfield County Air Quality Management website (<http://www.garfield-county.com/air-quality/>). Any questions regarding air quality in Garfield County should be addressed to:

**Garfield County Public Health Department**

195 West 14th Street  
Rifle, CO 81650

Phone: 970-625-5200

Fax: 970-625-4804

## 1.0 INTRODUCTION

Air quality monitoring in Garfield County has expanded in recent years in response to increases in citizens' concerns regarding air quality in the area, especially related to increased population and the expansion of oil and gas development in the county. The Garfield County Public Health Department (GCPHD) has implemented and maintains a network of air quality monitors designed to serve a wide range of purposes, including monitoring of criteria pollutant levels, ozone formation potential, toxics assessments, and source attribution for specific pollutants. This annual air quality data report presents data collected in Garfield County through 2012. The 2012 monitoring network in Garfield County consisted of five monitoring locations, which are described below.

- Parachute (PACO): Parachute is a small urban center of approximately 1,300 people within very close proximity to oil and development and production activities. The town is located along Interstate 70 and is the transportation hub for heavily traveled roads which service the surrounding canyons.
- Rifle (RICO): Rifle is a rapidly growing urban center on the Interstate 70 corridor with estimated population of about 9,200 people. Rifle is in close proximity to oil and gas development activities, and is also central to industrial support for the oil and gas industry.
- Bell-Melton (BRCO): The Bell-Melton site is a rural homestead approximately four miles south of the town of Silt, in close proximity to moderate oil and gas development and heavy natural gas production.
- Battlement Mesa (BMCO): Battlement Mesa is a rural community located about 1.5 miles southeast of Parachute. This site began operation in September 2010 in response to a proposed large natural gas development within to community, and to begin developing baseline data in advance of the project.
- Carbondale (RFCO): Carbondale is a rural community located about 12.5 miles southeast of Glenwood Spring at the confluence of the Roaring Fork and Crystal River valleys. The Carbondale, or Roaring Fork, monitor began monitoring in March 2012 to characterize air quality in the area and also to gather data downwind of the Colorado valley sites.

Figure 1-1 is a map of the monitoring sites and Table 1-1 lists the parameters monitored. The GCPHD monitors pollutants and meteorology at these stations with technical support from several agencies, as noted in Table 1-1 near real-time. Real-time data, including camera images, are displayed on the Garfield County Air Quality Monitoring website (<http://www.garfieldcountyaq.net>).

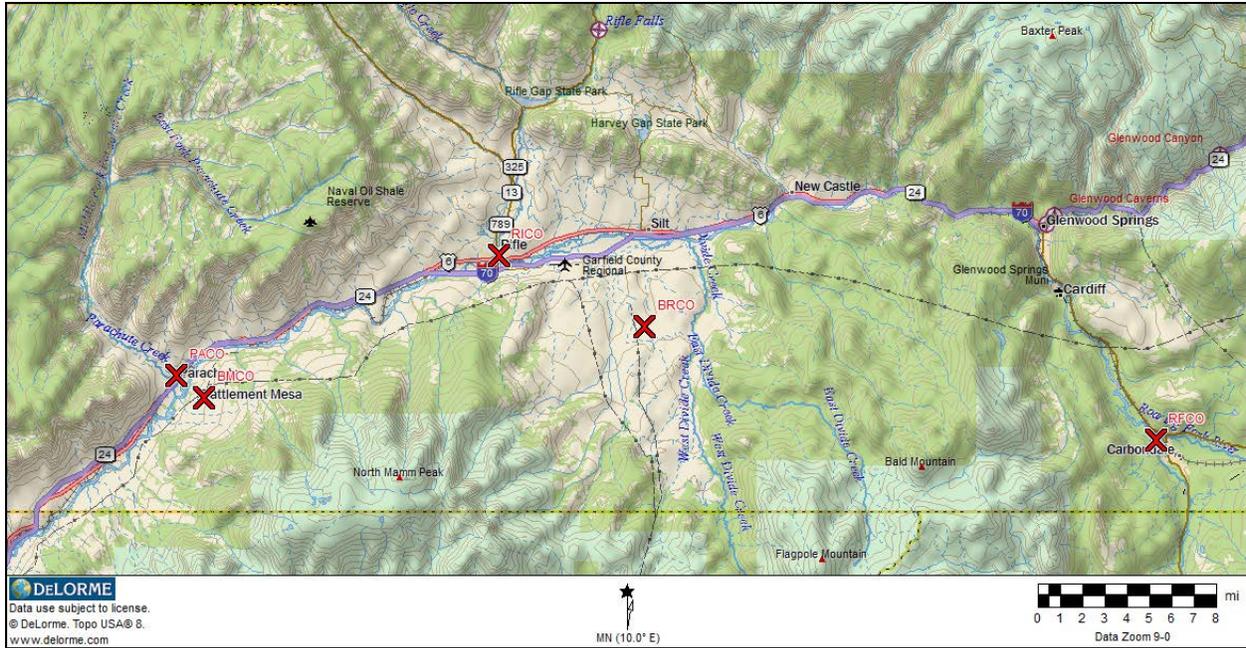


Figure 1-1. Map of Garfield County Monitoring Sites.

Table 1-1

Garfield County  
Parameters Monitored by Site

<b>Component</b>	<b>Method</b>	<b>Sampling Frequency</b>	<b>Reporting Agency</b>
<b>Rifle, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
PM <sub>10</sub>	FRM	24-hour (1/3 day)	CDPHE
PM <sub>10</sub>	TEOM	Hourly	ARS
PM <sub>2.5</sub>	TEOM	Hourly	ARS
Ozone	42C	Hourly	ARS
Meteorology	Various	Hourly	ARS
Visibility Web Camera	Digital	15-min	ARS
<b>Parachute, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
PM <sub>10</sub>	FRM	24-hour (1/3 day)	CDPHE
Meteorology	Various	Hourly	ARS
<b>Bell-Melton, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
Meteorology	Various	Hourly	GCPHD
<b>Battlement Mesa, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
PM <sub>10</sub>	BAM	Hourly	ARS
PM <sub>2.5</sub>	BAM	Hourly	ARS
Ozone	API	Hourly	ARS
NO/NO <sub>2</sub> /NO <sub>x</sub>	API	Hourly	ARS
CH <sub>4</sub> /NMHC/THC	Baseline MOCON	Hourly	ARS
Meteorology	Various	Hourly	ARS
<b>Carbondale, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
PM <sub>10</sub>	FRM	24-hour (1/3 day)	CDPHE
PM <sub>2.5</sub>	E-BAM	Hourly	ARS
Ozone	2B	Hourly	ARS
Meteorology	Various	Hourly	ARS

## 2.0 METEOROLOGICAL SUMMARIES

Meteorological data are collected along with air quality parameters to better understand the local conditions and transport of air pollutants. Meteorological data includes wind speed, wind direction, temperature, relative humidity, and precipitation.

Figure 2-1 presents a map overlaid with wind roses from each of the Garfield County monitoring sites depicting wind direction and wind speed measured in 2012. The direction of the bar signifies the direction the wind is coming from, the length of the bars indicate the cumulative frequency for each direction, and the colors indicate wind speed. Note that, due to power supply issues, there was not sufficient wind data collected at the Bell-Melton site to construct an annual wind rose. Also, annual winds for Carbondale are not indicated on the chart, as monitoring at this site began in late 2012.

The map shows that winds at the Garfield County sites are influenced by flow along the Colorado River Basin, where Interstate 70 crosses through the county. Also, airflow is influenced by various drainage flows through valleys along various Colorado River tributaries.

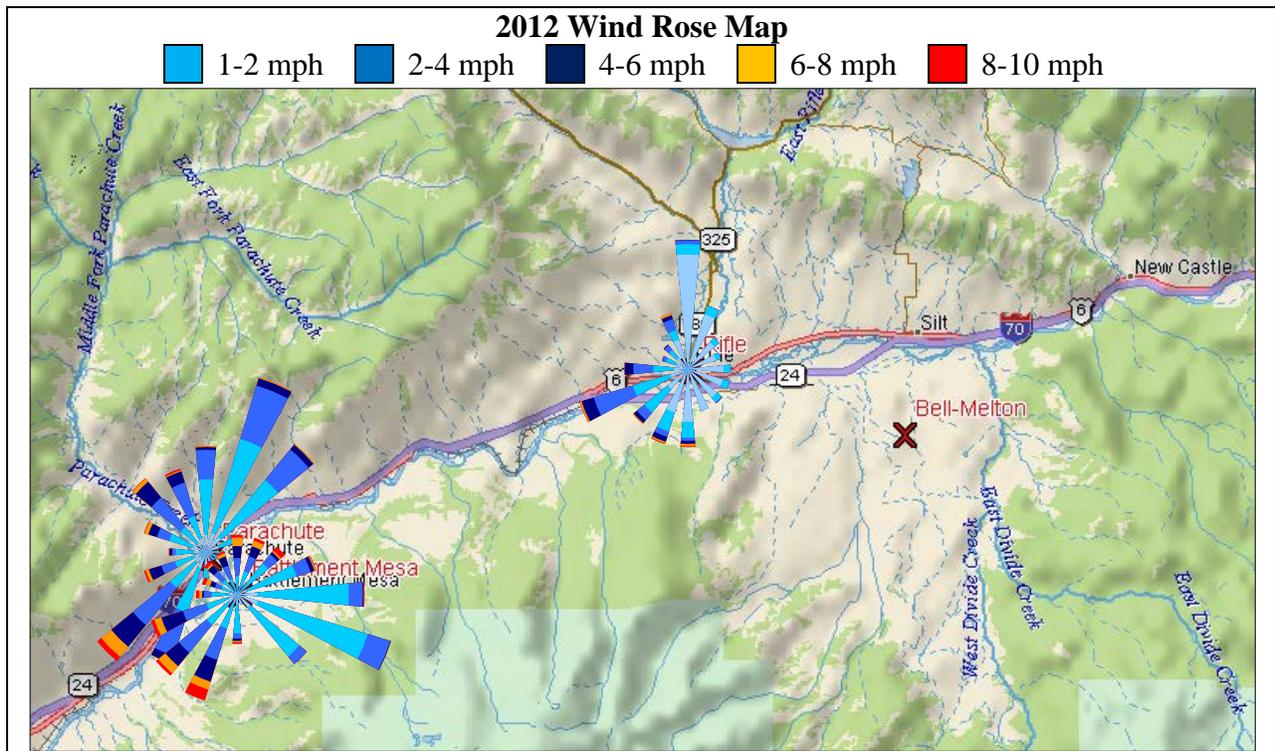


Figure 2-1. Map with Wind Roses Depicting 2012 Wind Speed and Direction Measured at the Garfield County Monitoring Sites.

### 3.0 CRITERIA POLLUTANT SUMMARIES

The Clean Air Act requires the Environmental Protection Agency (EPA) to set two types of National Ambient Air Quality Standards (NAAQS) for ground-level ozone (O<sub>3</sub>), particle pollution (PM<sub>2.5</sub> and PM<sub>10</sub>), lead, nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), and sulfur dioxide (SO<sub>2</sub>). The types of standards are as follows:

- Primary Standards: These standards are designed to protect public health with an adequate margin of safety, including the health of sensitive populations such as asthmatics, children, and the elderly.
- Secondary Standards: These standards are designed to protect public welfare from adverse effects, including visibility impairment and effects on the environment (e.g., vegetation, soils, water, and wildlife).

PM<sub>10</sub> is monitored using filter-based Federal Reference Method (FRM) samplers at the Parachute, Rifle and Carbondale sites. Continuous PM<sub>2.5</sub> and PM<sub>10</sub> are also monitored at the Rifle and Battlement Mesa sites and continuous PM<sub>2.5</sub> at the Carbondale site. The level of the national primary and secondary ambient air quality standards for PM<sub>10</sub> is a 24-hour average concentration of 150 micrograms per cubic meter (µg/m<sup>3</sup>). A violation of the standard occurs when the number of days with a 24-hour average concentration above 150 µg/m<sup>3</sup> over a 3-year period is equal to or less than one. The standards for PM<sub>2.5</sub> are an annual arithmetic mean of 15 µg/m<sup>3</sup>, and a 24-hour average of 35 µg/m<sup>3</sup>. A violation of the PM<sub>2.5</sub> standard occurs when the 3-year average of the weighted annual mean exceeds that annual standard, or the 3-year average of the 98th percentile 24-hour average value exceeds the 24-hour standard.

Continuous O<sub>3</sub> is monitored at the Rifle, Battlement Mesa, and Carbondale sites. The NAAQS for O<sub>3</sub> is currently 0.075 ppm (75 ppb) over an 8-hour period. An exceedance of the standard occurs when an 8-hour average O<sub>3</sub> concentration is greater than or equal to 76 ppb. A violation of the standard occurs when the three-year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 76 ppb.

Continuous NO<sub>2</sub> is monitored at the Battlement Mesa site. The NAAQS for NO<sub>2</sub> include an annual arithmetic mean of 0.053 ppm (53 ppb) and a 1-hour daily maximum of 0.100 ppm (100 ppb). A violation of the 1-hour standard occurs when the 3-year average of the 98th percentile of the daily maximum 1-hour averages is greater than the standard.

Values measured as comparable to standards are presented with the corresponding NAAQS in Tables 3-1 through 3-4. At present, air quality measurements in Garfield County do not violate air quality standards for these criteria pollutants.

Table 3-1

## 2012 Standards Summary for the Rifle Site

Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Ozone (O <sub>3</sub> )	Rolling 8-hour	0.075 ppm/ 75 ppb	Highest Daily Max.: 78 ppb	4/28
			4 <sup>th</sup> Highest Daily Max.: 68 ppb	4/14, 5/26
Particulate Matter ≤2.5µm* (PM <sub>2.5</sub> )	Annual	15 µg/m <sup>3</sup>	Arithmetic Mean: 10.4 µg/m <sup>3</sup>	1/1-12/31
	24-hour	35 µg/m <sup>3</sup>	Highest Daily Max.: 47.4 µg/m <sup>3</sup>	8/16
2 <sup>nd</sup> Highest Daily Max.: 41.7 µg/m <sup>3</sup>			8/17	
Particulate Matter ≤10µm** (PM <sub>10</sub> )	24-hour	150 µg/m <sup>3</sup>	Highest Daily Max.: 50 µg/m <sup>3</sup>	4/6
			2 <sup>nd</sup> Highest Daily Max.: 46 µg/m <sup>3</sup>	8/16

\*Calculated using continuous TEOM measurements

\*\*Calculated using 1/3 day filter-based measurements

Table 3-2

## 2012 Standards Summary for the Parachute Site

Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Particulate Matter ≤10µm* (PM <sub>10</sub> )	24-hour	150 µg/m <sup>3</sup>	Highest Daily Max.: 65 µg/m <sup>3</sup>	3/7
			2 <sup>nd</sup> Highest Daily Max.: 44 µg/m <sup>3</sup>	8/16

\*Calculated using 1/3 day filter-based measurements

Table 3-3

Battlement Mesa Site  
Standards Summary  
October 24, 2012 – December 31, 2012

Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Ozone (O <sub>3</sub> )	Rolling 8-hour	0.075 ppm/ 75 ppb	Highest Daily Max.: 45 ppb	11/3
			4 <sup>th</sup> Highest Daily Max.: 43 ppb	11/4, 11/8
	Annual	0.053 ppm/ 53 ppb	Arithmetic Mean: 16.6 ppb	10/24- 12/31
Nitrogen Dioxide (NO <sub>2</sub> )	1-hour	0.100 ppm/ 100 ppb	Highest Daily Max.: 31.8 ppb	12/30
			2 <sup>nd</sup> Highest Daily Max.: 30.2 ppb	12/23
Particulate Matter ≤2.5µm* (PM <sub>2.5</sub> )	Annual	15 µg/m <sup>3</sup>	Arithmetic Mean: 2.6 µg/m <sup>3</sup>	10/24-12/31
	24-hour	35 µg/m <sup>3</sup>	Highest Daily Max.: 5.9 µg/m <sup>3</sup>	12/24
			2 <sup>nd</sup> Highest Daily Max.: 5.6 µg/m <sup>3</sup>	11/9
Particulate Matter ≤10µm* (PM <sub>10</sub> )	Annual	50 µg/m <sup>3</sup>	Arithmetic Mean: 4.8 µg/m <sup>3</sup>	10/24-12/31
	24-hour	150 µg/m <sup>3</sup>	Highest Daily Max.: 17.7 µg/m <sup>3</sup>	11/9
			2 <sup>nd</sup> Highest Daily Max.: 10.1 µg/m <sup>3</sup>	12/30

\*Calculated using continuous BAM measurements

Table 3-4

Carbondale Site  
Standards Summary  
March 29, 2012 – December 31, 2012

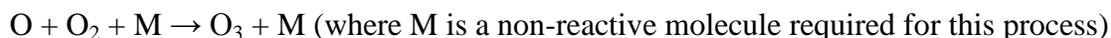
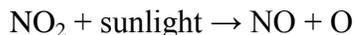
Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Ozone (O <sub>3</sub> )	Rolling 8-hour	0.075 ppm/ 75 ppb	Highest Daily Max.: 69 ppb	5/26
			4 <sup>th</sup> Highest Daily Max.: 66 ppb	4/14
Particulate Matter ≤2.5µm* (PM <sub>2.5</sub> )	Annual	15 µg/m <sup>3</sup>	Arithmetic Mean: 5.9 µg/m <sup>3</sup>	3/29-12/31
	24-hour	35 µg/m <sup>3</sup>	Highest Daily Max.: 24.2 µg/m <sup>3</sup>	8/16
			2 <sup>nd</sup> Highest Daily Max.: 21.3 µg/m <sup>3</sup>	5/26
Particulate Matter ≤10µm** (PM <sub>10</sub> )	24-hour	150 µg/m <sup>3</sup>	Highest Daily Max.: 40 µg/m <sup>3</sup>	11/2
			2 <sup>nd</sup> Highest Daily Max.: 38 µg/m <sup>3</sup>	8/16

\*Calculated using continuous E-BAM measurements

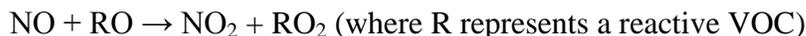
\*\*Calculated using 1/3 day filter-based measurements

### 3.1 OZONE

Ozone is a secondary pollutant, meaning it is not emitted directly from sources, but is formed from photochemical interactions of volatile organic compounds (VOCs) and oxides of nitrogen ( $\text{NO}_x$ ) in the presence of sunlight. The basic formation and depletion equations for  $\text{O}_3$  are presented below:



Without the presence of VOCs, the diurnal cycle is a balanced reaction, with equal production and depletion of  $\text{O}_3$ . When VOCs are present, they can react with nitric oxide (NO) to produce  $\text{NO}_2$  as follows:



This effectively creates competition for NO, allowing  $\text{O}_3$  to build up instead of being depleted by NO. Also, when NO reacts with hydrocarbons, additional  $\text{NO}_2$  is produced without consuming  $\text{O}_3$ . The produced  $\text{NO}_2$  can further react to produce more  $\text{O}_3$ .

Ozone measurements began in June 2008 at the Rifle site, in March 2013 at the Carbondale site, and in October 2012 at the Battlement Mesa site.  $\text{NO}_2$  is monitored along with the  $\text{O}_3$  at the Battlement Mesa site, and Figure 3-1 illustrates the average diurnal cycle of measured hourly  $\text{O}_3$  and  $\text{NO}_2$  for the partial year available in 2012. The cycle shows lowest  $\text{O}_3$  concentrations in the early morning hours and maximum concentrations in the late afternoon. This pattern results from daytime photochemical production from  $\text{NO}_x$  ( $\text{NO} + \text{NO}_2$ ) and VOC precursors, and ozone loss by dry deposition and reaction with NO at night.

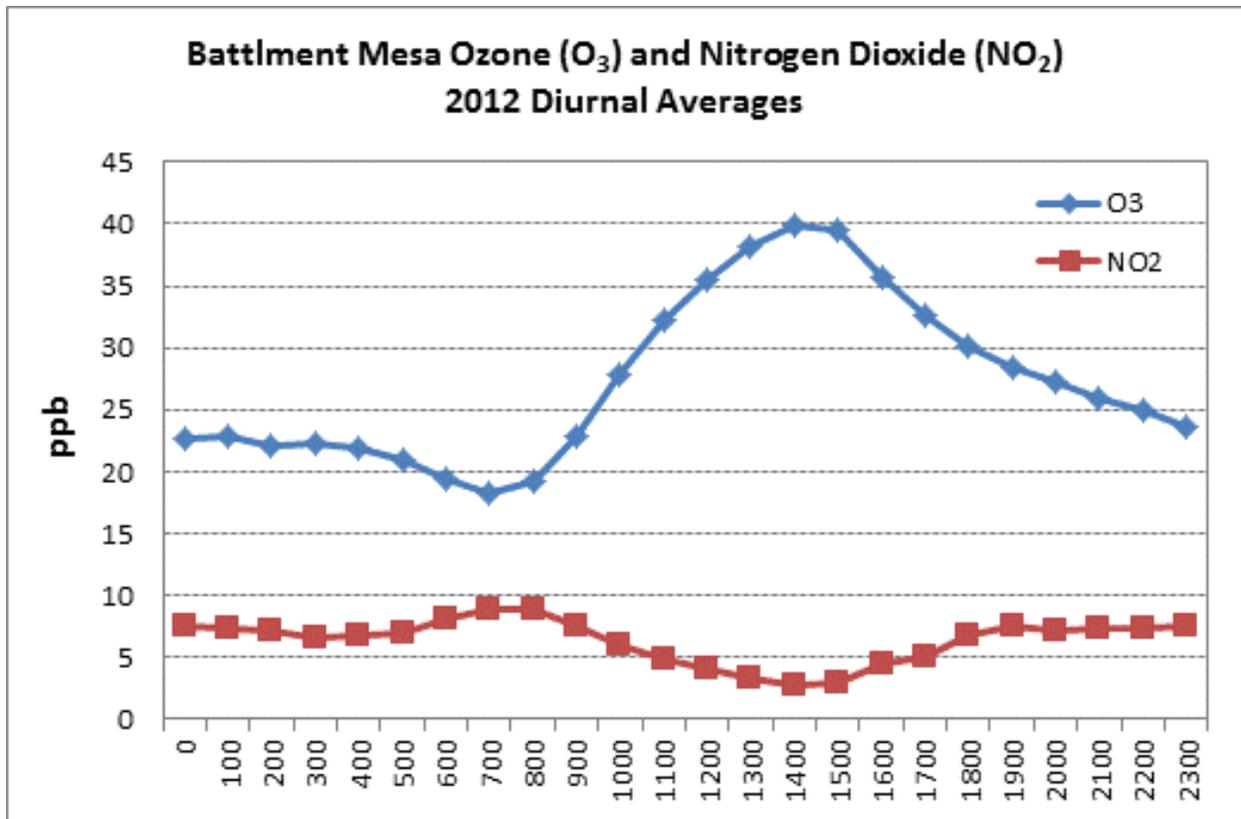


Figure 3-1. 2012 Diurnal Average Concentrations of Ozone and Nitrogen Dioxide Measured at the Battlement Mesa Site.

Figures 3-2 through 3-4 present daily maximum 8-hour averages of O<sub>3</sub> monitored at the Rifle, Battlement Mesa, and Carbondale sites in 2012 respectively, along with the NAAQS. In Garfield County, O<sub>3</sub> measurements at the Rifle site are highest in the summer, which is consistent with the expected photo activity associated with hot summer months. It was previously thought that, due to the nature of ozone formation, elevated levels of O<sub>3</sub> were only possible during the summer. Recently, high O<sub>3</sub> readings have been recorded during the wintertime in the Green River Basin in Wyoming, and the Uintah Basin in Utah. Wintertime O<sub>3</sub> formation requires, along with VOC and NO<sub>2</sub> emissions, distinct meteorological conditions. The meteorological conditions associated with wintertime O<sub>3</sub> include strong temperature inversions, low winds, snow cover, and bright sunlight. O<sub>3</sub> measurements in Garfield County do not currently appear to be affected by the same conditions that have contributed to wintertime O<sub>3</sub> highs in Wyoming and Utah.

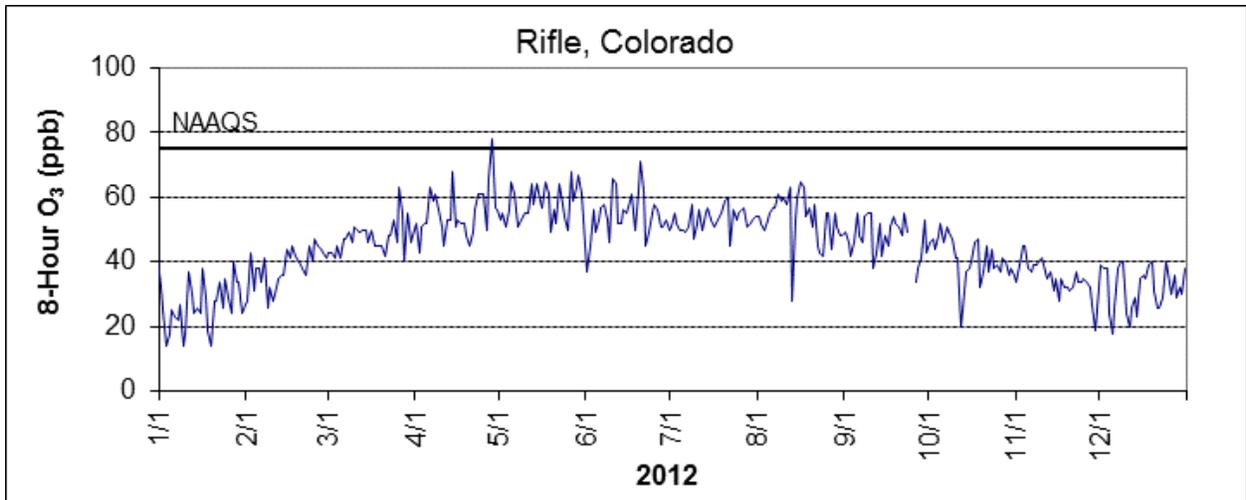


Figure 3-2. Daily Maximum 8-Hour Averages of Ozone Monitored at the Rifle Site.

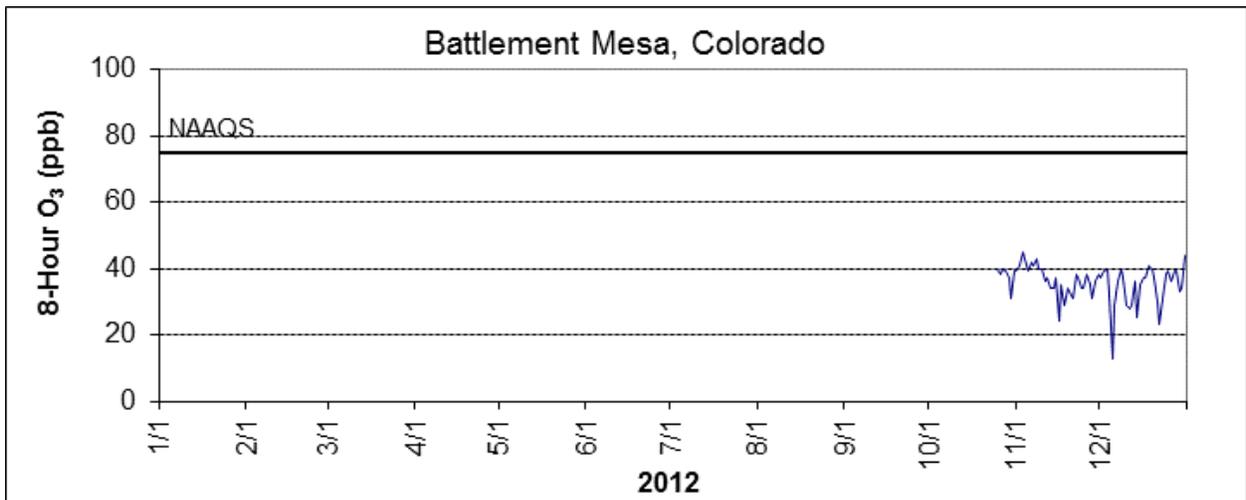


Figure 3-3. Daily Maximum 8-Hour Averages of Ozone Monitored at the Battlement Mesa Site.

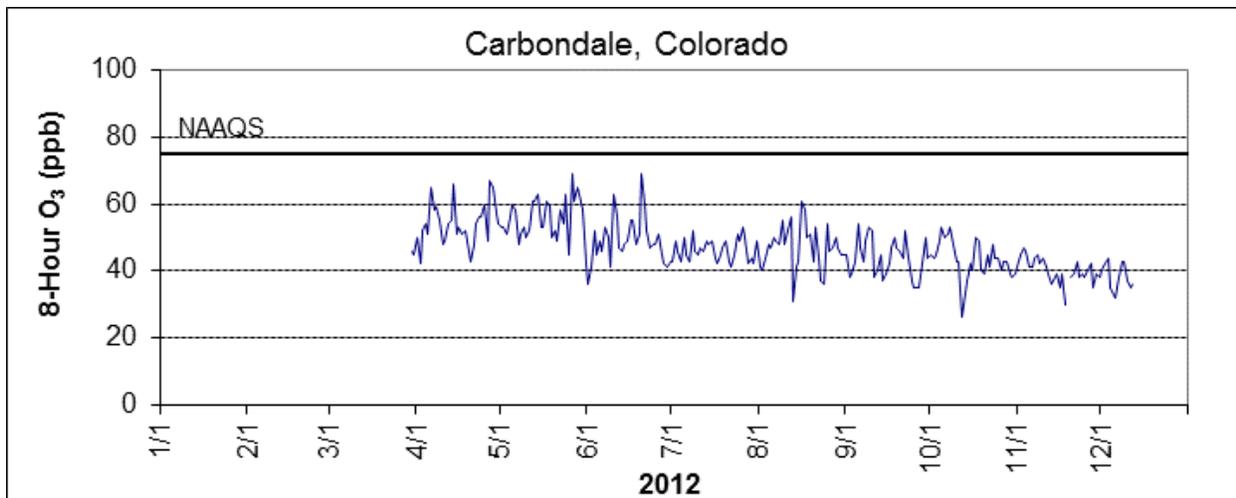


Figure 3-4. Daily Maximum 8-Hour Averages of Ozone Monitored at the Carbondale Site.

### 3.2 NITROGEN DIOXIDE

Oxides of nitrogen (NO<sub>x</sub>) released from emission sources primarily consist of nitric oxide (NO), with lesser amounts of nitrogen dioxide (NO<sub>2</sub>). NO is a colorless and odorless gas which, in the presence of O<sub>3</sub>, will react to form NO<sub>2</sub>. NO<sub>2</sub> is a reddish-brown gas which is partially responsible for the "brown haze" observed near large cities. Only NO<sub>2</sub> is considered a regulated pollutant, but it is generally measured alongside NO, where NO and NO<sub>2</sub> are collectively reported as NO<sub>x</sub> (NO<sub>x</sub> = NO + NO<sub>2</sub>). The components of NO<sub>x</sub> have been identified as precursors for both O<sub>3</sub> and particulate matter.

NO<sub>2</sub> measurements began at the Battlement Mesa site in late 2012. Figure 3-5 presents daily maximum 1-hour averages of NO<sub>2</sub> along with the NAAQS, indicating that measured values were well below the standard. Hourly average values for the Battlement Mesa site are presented in time series plots along with other parameters in Appendix A.

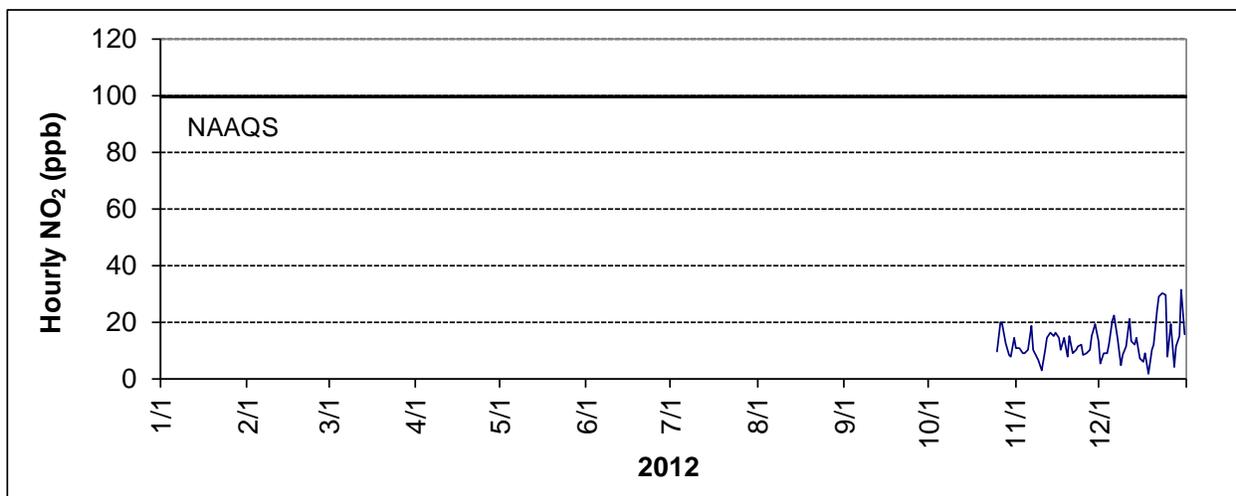


Figure 3-5. Daily Maximum 1-Hour Averages of Nitrogen Dioxide Monitored at the Battlement Mesa Site.

### 3.3 PARTICULATE MATTER

Particulate matter (PM) consists of solid particles and liquid droplets that are small enough to be inhaled. The size of particles is directly linked to their potential for causing health problems. Particulate matter with diameter larger than 2.5 microns (PM<sub>2.5</sub>) and smaller than 10 microns (PM<sub>10</sub>) pose the greatest concern, because they can get deep into the lungs and cause serious health problems. Particulate matter can be emitted directly into the air or can be formed in the atmosphere through complex chemical reactions from emissions of sulfur dioxides, nitrogen oxides, and other compounds. Coarse particulate matter can come from sources like road dust, construction, and wood-burning. Particulate sources associated with natural gas development may include grading and leveling of well pads, construction of facilities, construction of access roads to well pads, and subsequent vehicle traffic. Natural emissions like forest fires can also contribute to particulate matter.

Filter based 24-hour PM<sub>10</sub> is measured every third day at the Parachute, Rifle, and Carbondale sites. Continuous PM<sub>10</sub> and PM<sub>2.5</sub> monitoring began at the Rifle site in September 2008 and at the Battlement Mesa site in November 2012, and continuous PM<sub>2.5</sub> monitoring began at the Carbondale site in March 2012. Annual summaries are provided here, and hourly and 24-hour average values for these sites are presented in time series plots along with other parameters in Appendix A.

#### 3.3.1 Filter Based PM<sub>10</sub> Measurements

Figure 3-6 presents the annual average PM<sub>10</sub> measured at the Parachute site since 2000, and Figure 3-7 presents annual average PM<sub>10</sub> measured at the Rifle site since 2005. At both the Rifle and Parachute sites, the highest average recorded PM<sub>10</sub> was recorded in 2008, but measurements at this site have dropped since 2009. Note that annual averages for the Carbondale site are not presented, as only a partial year was available in 2012.

Figures 3-8 and 3-9 present the highest and second highest 24-hour average values measured at the Parachute and Rifle sites, respectively. The NAAQS for PM<sub>10</sub> is a 24-hour average of 150 ppb, which was exceeded at the Parachute site in 2008. No exceedances have been recorded at the Rifle site. Note that an exceedance of the standard is not a violation unless the average number of annual exceedances over a 3-year period is greater than or equal to 1.

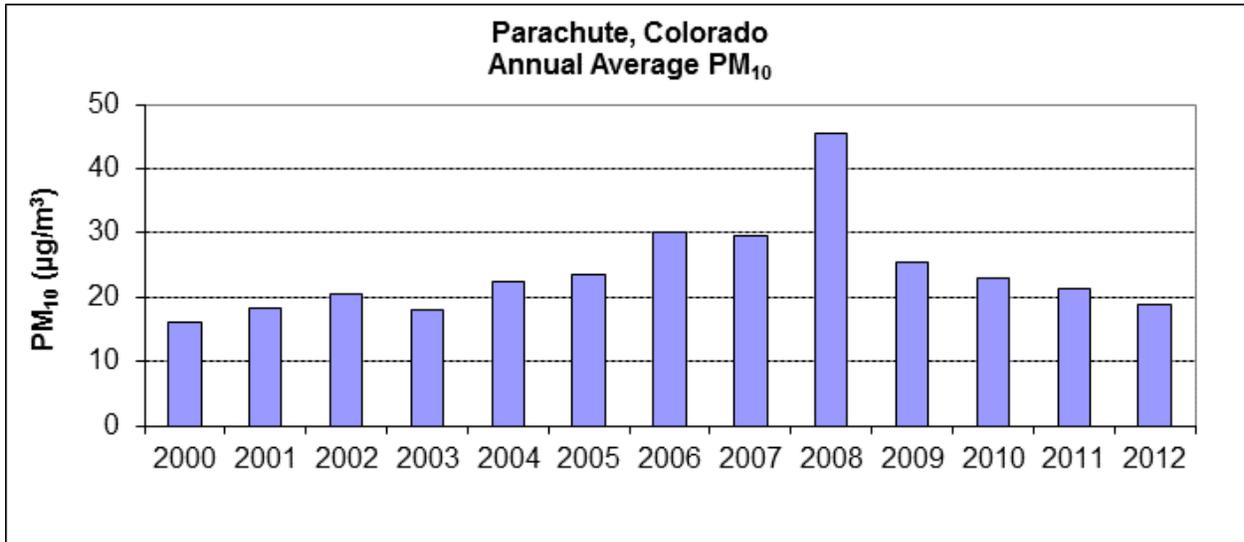


Figure 3-6. Annual Average PM<sub>10</sub> Measured at the Parachute Site.

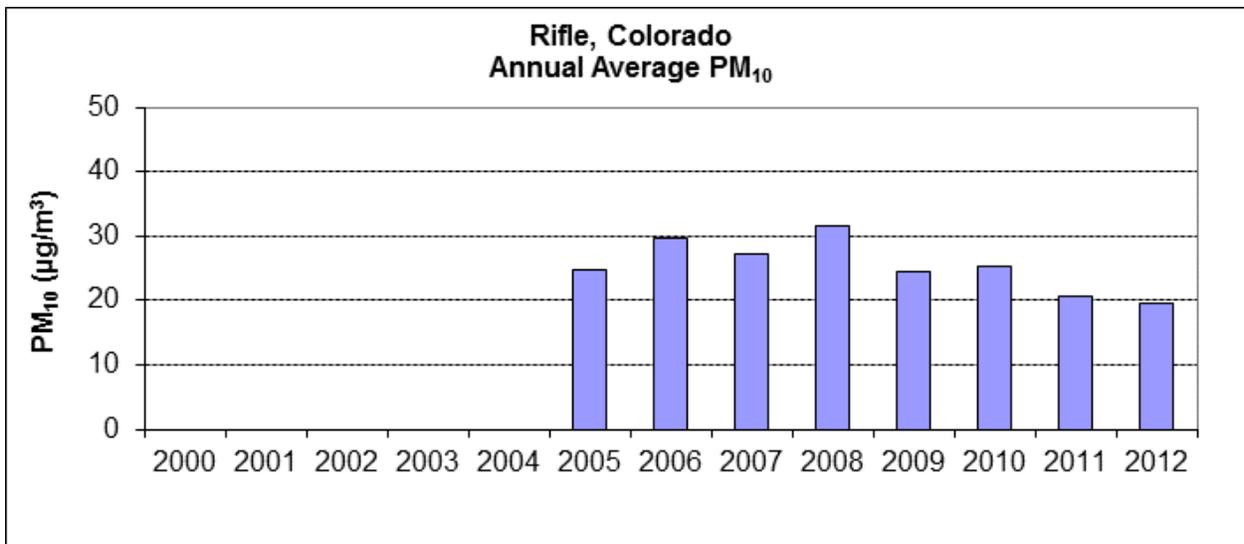


Figure 3-7. Annual Average PM<sub>10</sub> Measured at the Rifle Site.

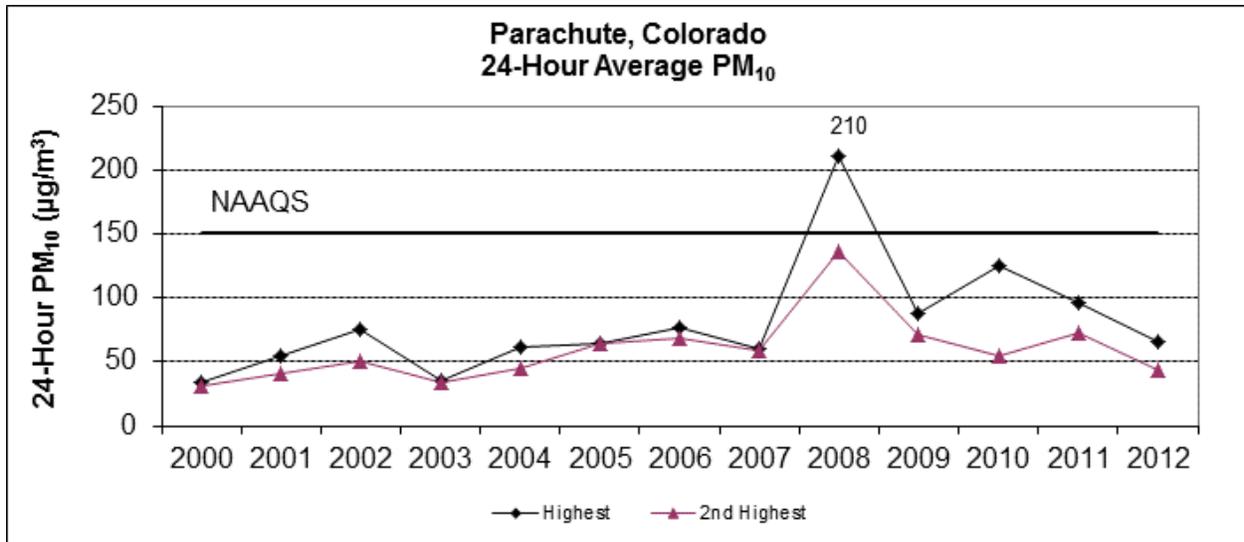


Figure 3-8. Highest and Second Highest 24-Hour Average PM<sub>10</sub> Measured at the Parachute Site.

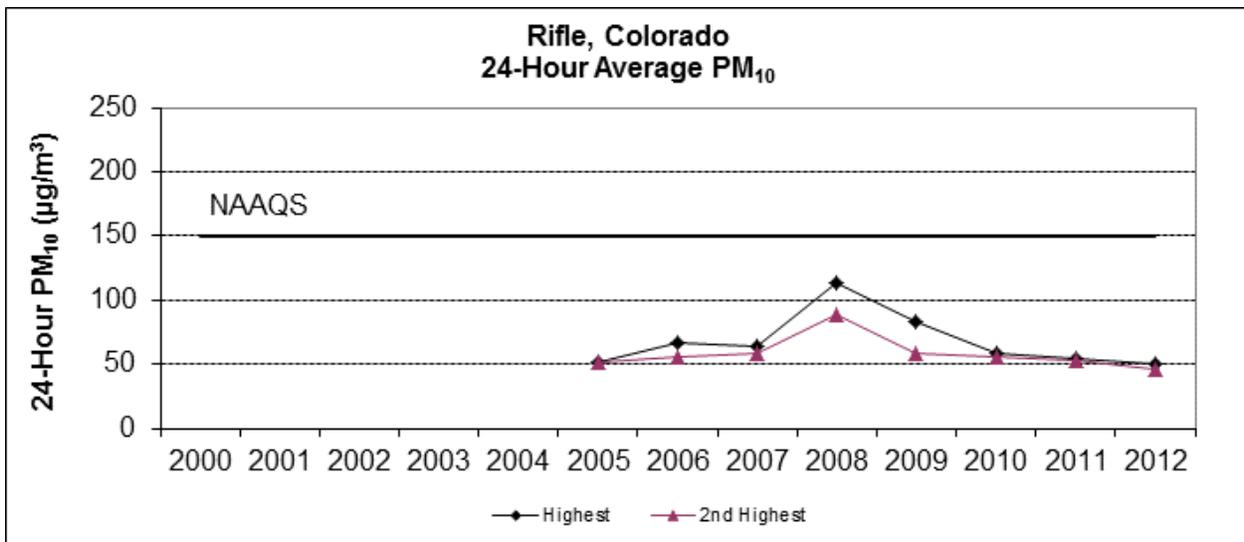


Figure 3-9. Highest and Second Highest 24-Hour Average PM<sub>10</sub> Measured at the Rifle Site.

### 3.3.2 Continuous PM Measurements

Continuous PM<sub>10</sub> and PM<sub>2.5</sub> have been monitored at the Rifle site since mid-2008, at the Battlement Mesa site since November 2012 and continuous PM<sub>2.5</sub> has been monitoring at the Carbondale site since March 2012. Continuous PM<sub>10</sub> data are useful to monitor alongside filter-based PM in part to make continuous data available in real-time on the Garfield County Air Quality Management website (<http://www.garfield-county.com/air-quality/>).

Continuous data are also comparable to regulatory standards, as presented for PM<sub>2.5</sub> here. Figure 3-10 presents the annual average of continuous PM<sub>2.5</sub> measured at the Rifle site since 2009, and Figure 3-11 presents the highest and 98th percentile 24-hour average values measured

at the Rifle site. The NAAQS for PM<sub>2.5</sub> is an arithmetic mean of 15 µg/m<sup>3</sup> and a 24-hour average of 35 µg/m<sup>3</sup>. A violation of the PM<sub>2.5</sub> standard occurs when the 3-year average of the weighted annual mean exceeds that annual standard, or the 3-year average of the 98th percentile 24-hour average value exceeds the 24-hour standard. The highest 24-hour PM<sub>2.5</sub> value in 2009 measured above the standard, but this is not considered an exceedance because the 98th percentile value was below the standard.

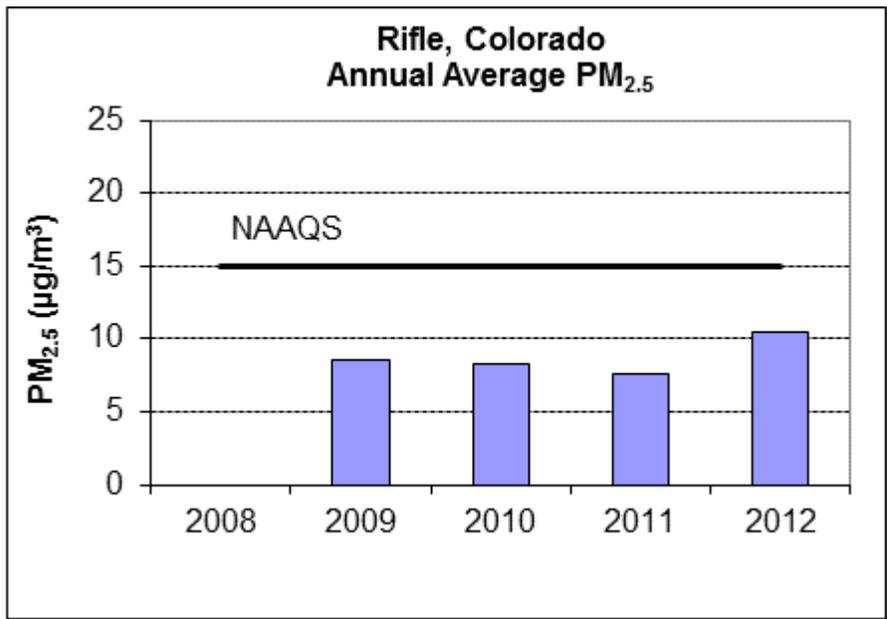


Figure 3-10. Annual Average PM<sub>2.5</sub> Measured at the Rifle Site.

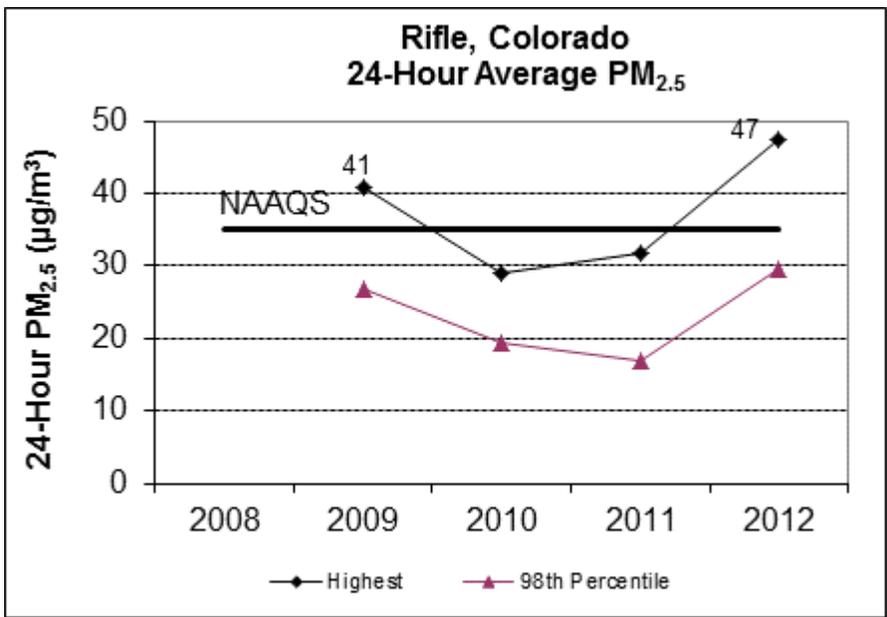


Figure 3-11. Highest and 98th Percentile 24-Hour Average PM<sub>2.5</sub> Measured at the Rifle Site.

## 4.0 VOLATILE ORGANIC COMPOUNDS

In 2012, speciated non-methane hydrocarbons (SNMOCs) and carbonyl compounds were monitored at all Garfield County sites. SNMOCs and carbonyl compounds are subsets of volatile organic compounds (VOCs), which are carbon- and hydrogen-based chemicals that exist in the gas phase or can evaporate from liquids. VOCs can react in the atmosphere to form ozone (O<sub>3</sub>) and particulate matter. Hazardous air pollutants (HAPs) are a subset of VOC compounds, and include compounds that are known or believed to cause human health effects. Summaries of SNMOCs, carbonyls, and HAP levels measured in 2012 are presented in this section. Plots of the sum of all SNMOCs measured, or total non-methane organic carbon (TNMOC), are presented alongside other particulate, gaseous and meteorological measurements at each site in Appendix A.

### 4.1 SPECIATED NON-METHANE HYDROCARBONS

SNMOC compounds were collected and analyzed according to EPA Compendium Method TO-12, with 24-hour samples collected on a 1-in-6 day schedule. This method includes analyses for 78 different compounds. Annual averages are presented here, and Appendix B lists minimum, maximum, and average concentrations of all detected SNMOC compounds by site.

SNMOC compounds can be grouped into classifications with similar characteristics. For annual average summaries, measured SNMOC compounds were grouped into the following categories:

- **Light Alkanes:** Alkanes are the simplest hydrocarbons, consisting of only carbon and hydrogen with single bonds. Light alkanes, which include alkanes with up to five carbon atoms (ethane, propane, iso/n-butane and iso/n-pentane), along with methane, are primary components of natural gas and gasoline vapors.
- **Heavy Alkanes:** The hydrocarbons in crude oil are mostly heavy alkanes, which here include alkanes with more than five carbon atoms (C<sub>5</sub>). Crude oil products include gasoline, a refined mix of predominantly C<sub>6</sub> to C<sub>10</sub> hydrocarbons, and diesel, which is a refined mix ranging from approximately C<sub>10</sub> to C<sub>15</sub>.
- **Alkenes:** Alkenes are more complex than alkanes, with at least one carbon to carbon double bond. These compounds are not generally found in crude oil. Alkenes are much more reactive than alkanes, and will deplete quickly in the atmosphere. Alkenes are produced in refineries when larger alkane molecules are dissociated (or cracked) into smaller compounds. Some alkene compounds, including terpenes such as isoprene and a- and b-pinene, are naturally emitted from vegetation.
- **Aromatics:** Aromatic compounds are the most abundant compounds emitted from gas-fired engines. These compounds include the BTEX parameters (benzene, toluene, ethylbenzene, and m/p-xylenes), which are commonly associated with motor vehicles, but can also have sources associated with oil and gas production.

Figure 4-1 presents categories of measured SNMOCs in units of ppbV (parts per billion by volume) measured in 2012 at each site. In general, measured compounds consisted mostly of light alkanes, which represented between 83% and 89% of total SNMOCs measured. Seasonal variation showed higher concentrations in winter and lower concentrations in summer. These trends can be influenced by the variations in temperature, as VOCs deplete faster during the summer due to higher reactivity at higher temperatures. Also, some emissions, including cold-start engine emissions and residential wood burning, are higher in the winter.

Figure 4-2 presents measurements by category in units of ppbC, where ppbC represents the number of carbon molecules measured (ppbV multiplied by the number of carbons in each compound). Heavier alkanes and aromatics are more significant sources of carbon than the lighter alkanes. The unknown category indicates the part of the total carbon measurements where individual species were not identified. Note that for the Carbondale site, the majority of carbon compounds detected were not among the species identified. The specific compounds targeted for analysis in Garfield County are intended to focus on natural gas influences and hazardous compounds, which appear to comprise relatively small proportions of the compounds measured in Carbondale.

Carbon content in a molecule is important because it is related to compound reactivity, which contributes to O<sub>3</sub> formation potential. O<sub>3</sub> is formed from photochemical interactions of VOCs and NO<sub>x</sub> in the presence of sunlight, as described in Section 3.1. The light alkanes that dominate measurements by volume are the least reactive compounds but could theoretically contribute significantly to O<sub>3</sub> formation potential. Highly reactive compounds including aromatics such as toluene and m/p-xylenes, which are less abundant, but have greater potential to contribute to the O<sub>3</sub> formation due to their higher reactivity. Currently, Garfield County does not violate O<sub>3</sub> standards, but if O<sub>3</sub> levels become more of a concern in Garfield County, it would be useful to target further controls for emissions of VOCs that have the greatest potential to contribute to O<sub>3</sub> formation.

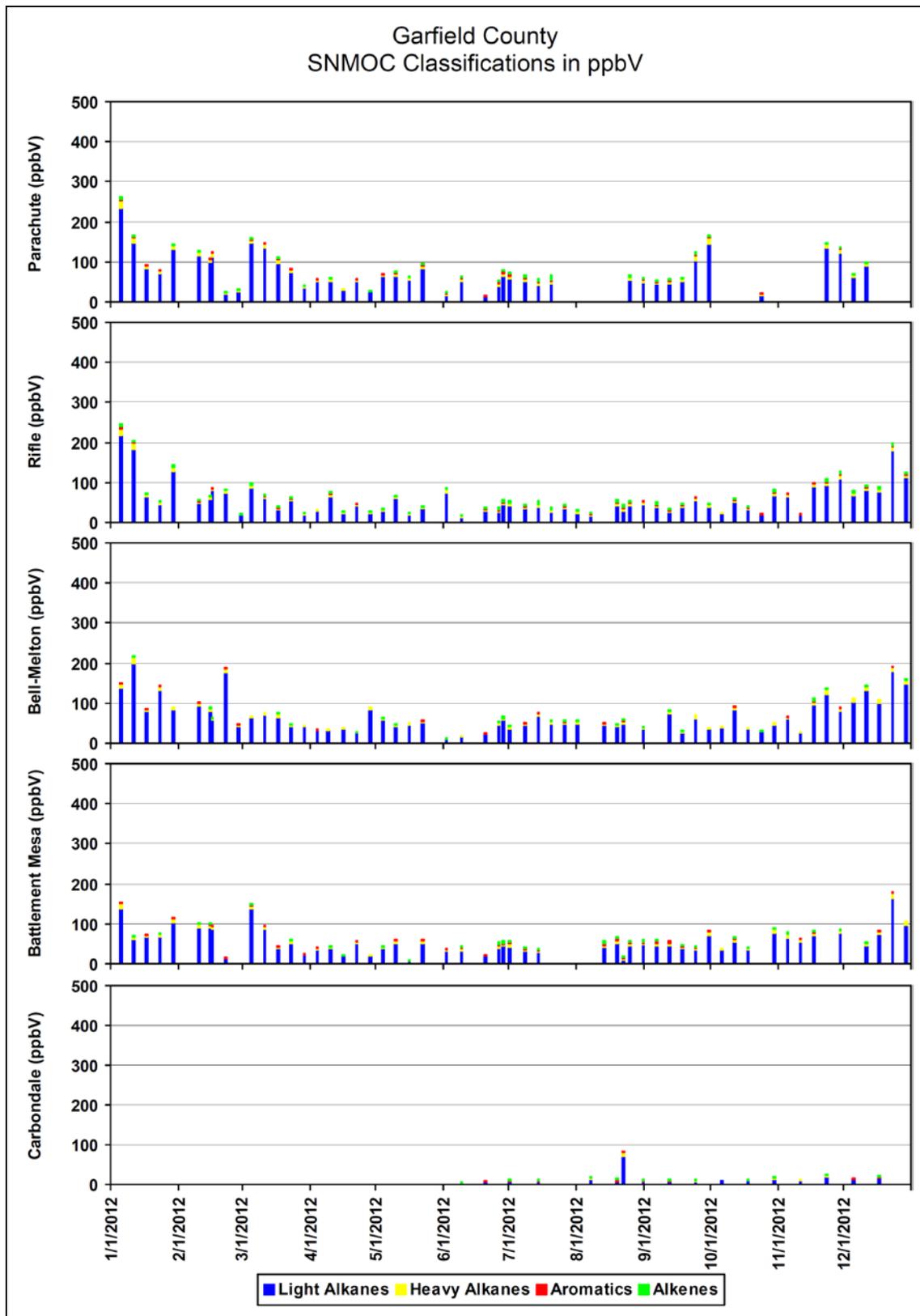


Figure 4-1. 2012 24-Hour SNMOC Measurements by Category in Units of ppbV.

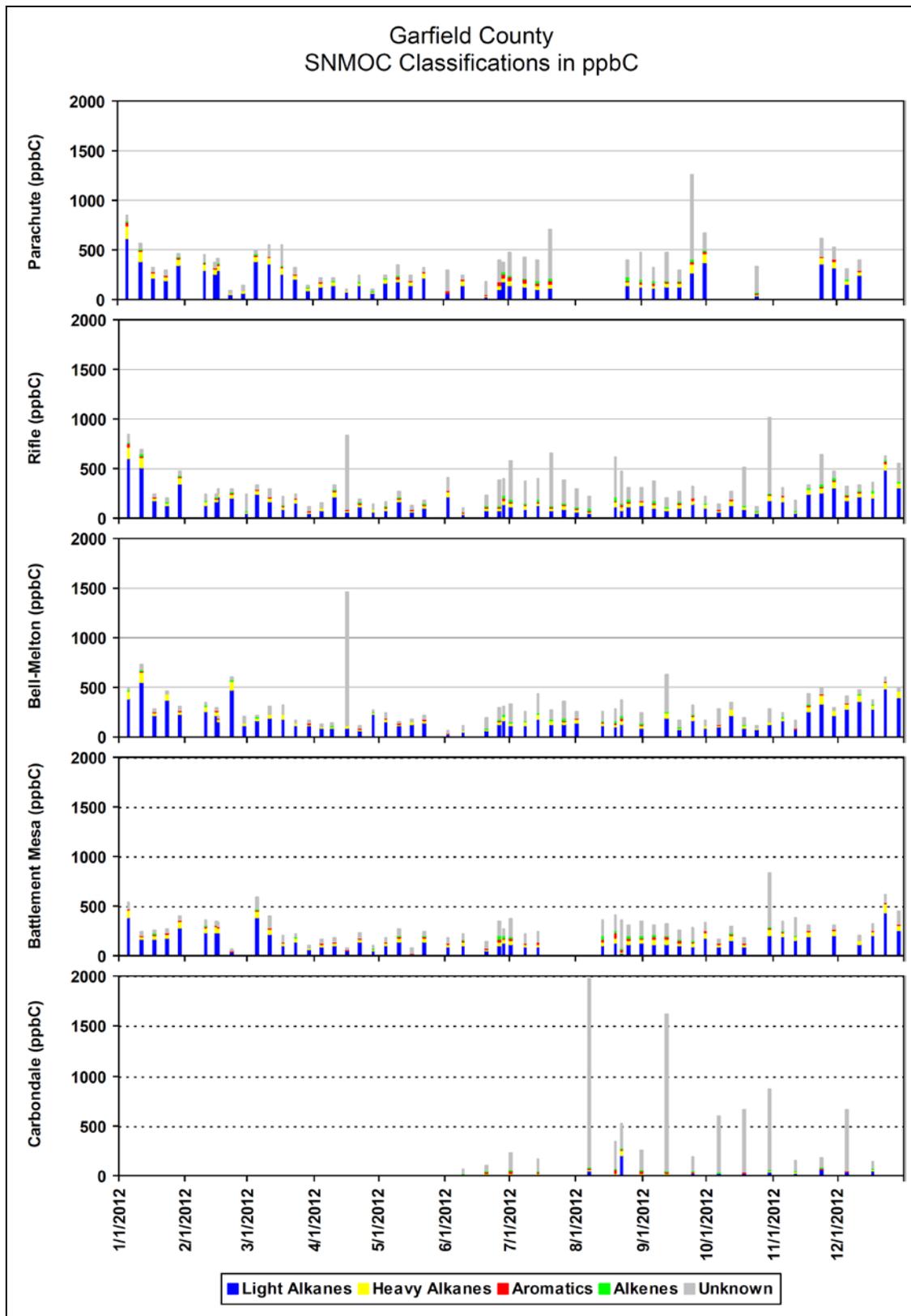


Figure 4-2. 2012 24-Hour SNMOC Measurements by Category in Units of ppbC.

### 4.1.1 Annual Average SNMOCs

Garfield County began collecting SNMOC data at the Parachute (PACO), Rifle (RICO), and Bell-Melton (BMCO) sites in 2008, at the Battlement Mesa (BMCO) in September 2010, and at the Carbondale (RFCO) in 2012. Figure 4-3 presents comparisons of annual average SNMOC data collected between 2008 and 2012. For sites that monitored all five years (PACO, RICO and BRCO), SNMOC concentrations have been decreasing since 2008, with the largest relative decreases between 2011 and 2012. Decreases in total SNMOC concentrations are mainly attributable to decreases in light alkane concentrations (depicted in blue), which are the primary components of natural gas. Note that insufficient data were available for the RFCO site to calculate a representative annual average.

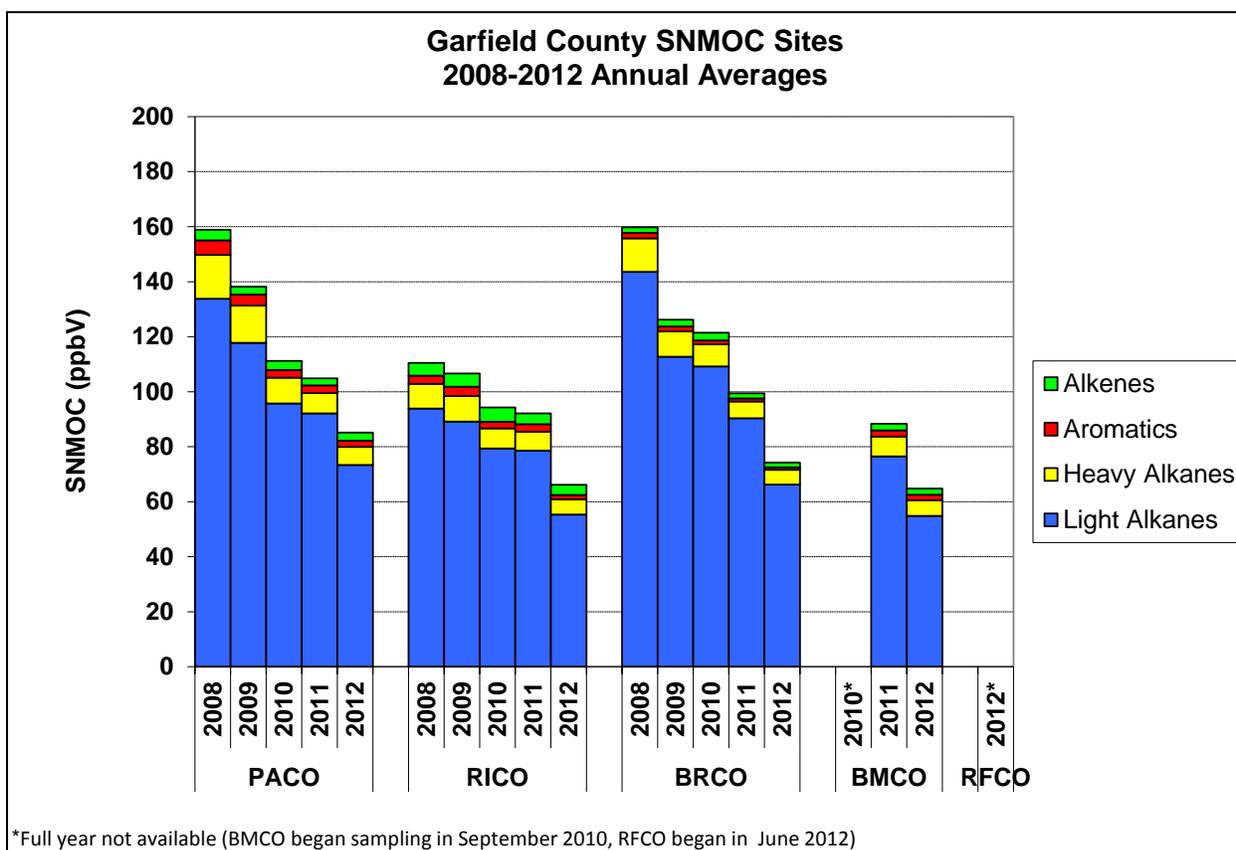


Figure 4-3 Average SNMOC Concentrations Measured by the Garfield County Air Monitoring Program between 2008 and 2012.

## 4.2 CARBONYLS

Carbonyl compounds were collected and analyzed according to EPA Compendium Method TO-11A, with 24-hour samples collected at all five sites on a 1-in-12 day schedule. This method includes analysis for 12 different carbonyl compounds.

Carbonyls are highly reactive and play a critical role in the formation of O<sub>3</sub>. Some carbonyls, including formaldehyde and acetaldehyde, also have adverse chronic and acute health effects. The major sources of directly emitted carbonyls are fuel combustion, mobile sources, and process emissions from oil refineries.

Figure 4-4 presents time series plots of the major compounds, and Appendix C lists minimum, maximum, and average concentrations of all detected carbonyl compounds. Major compounds measured included formaldehyde, acetaldehyde, and acetone. In general, carbonyl compounds were highest during summer months as warm temperatures affected the photochemical production that contributes to the formation of these compounds.

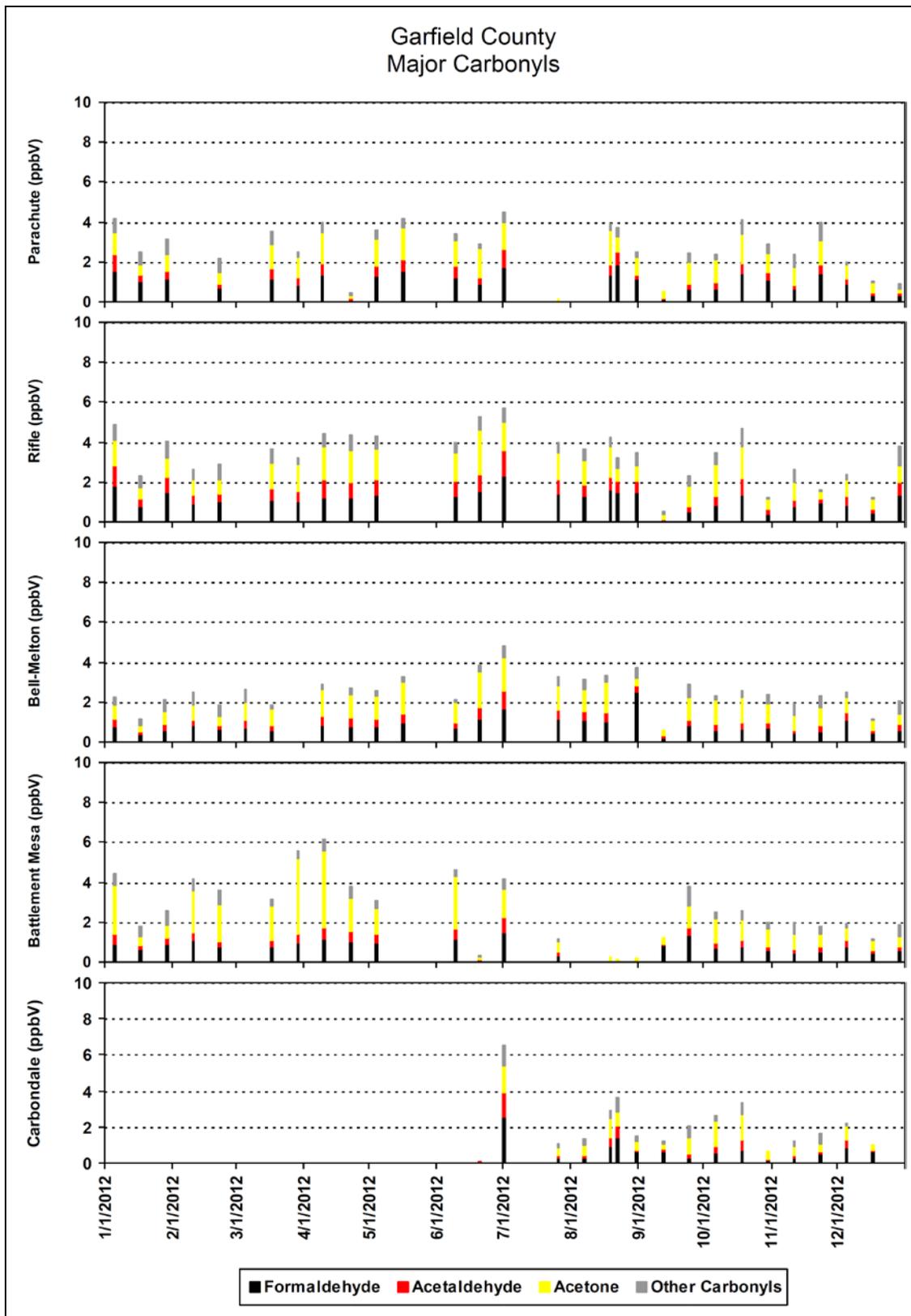


Figure 4-4. 2012 24-Hour Major Carbonyl Compound Concentrations in Units of ppbV.

#### 4.2.1 Annual Average Carbonyl Concentrations

Garfield County began collecting SNMOC data at the Parachute, Rifle, and Bell-Melton sites in 2008, at the Battlement Mesa (BMCO) in September 2010, and at the Carbondale (RFCO) in June 2012. Figure 4-5 presents comparisons of annual average carbonyl data collected between 2008 and 2012. In 2012, average measured total carbonyl levels were the lowest since measurements began 2008.

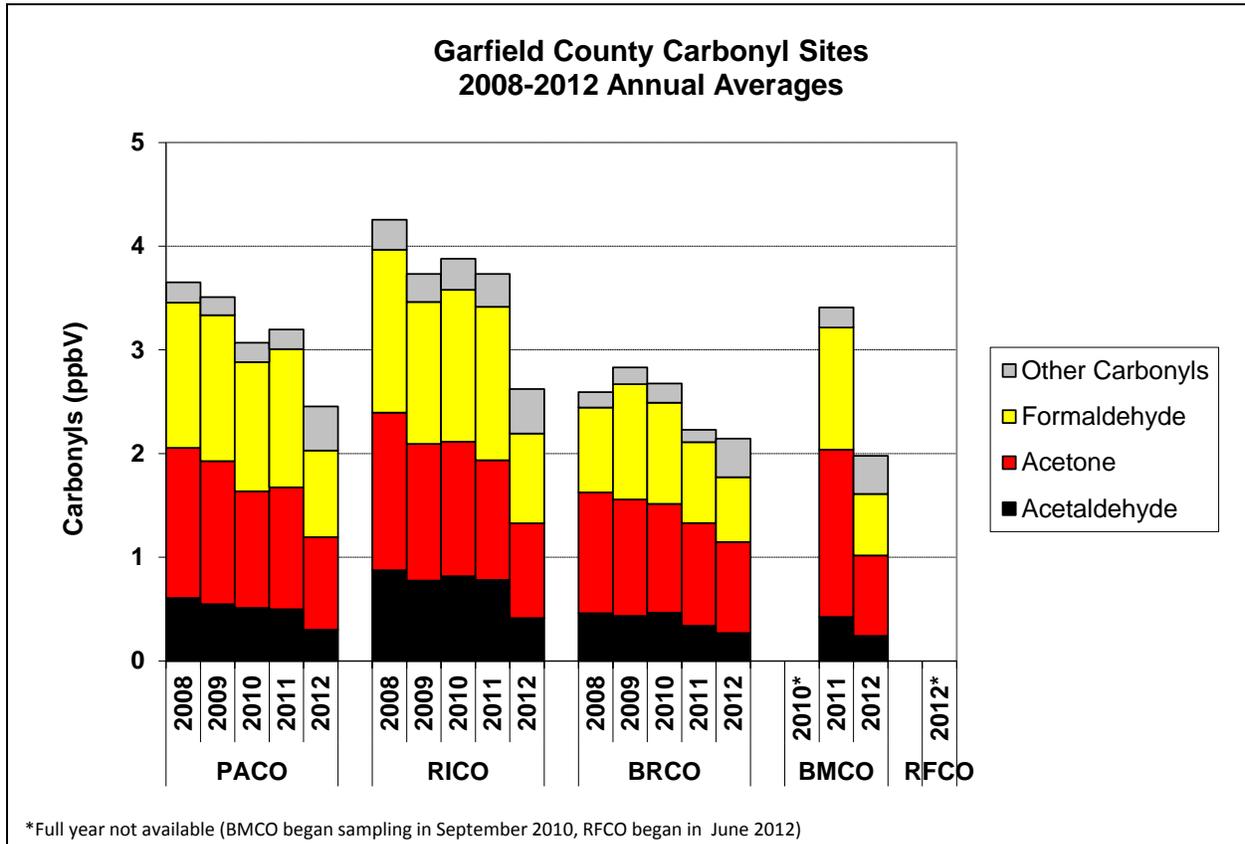


Figure 4-5. Average Carbonyl Concentrations Measured by the Garfield County Air Monitoring Program between 2008 and 2012.

### 4.3 HAZARDOUS AIR POLLUTANTS SUMMARIES

VOCs include a class of compounds called hazardous air pollutants (HAPs). The EPA has designated approximately 190 VOC compounds as HAPs, including benzene, toluene, ethylbenzene and xylenes (also known as the BTEX compounds). No NAAQS or any other ambient air standards exist for VOCs. Instead, emissions limits on industrial sources have been set, and the EPA has developed a set of risk factors for both acute and chronic exposures for HAPs. In addition, risk factors from the Agency for Toxic Substances and Disease Registry (ATSDR), the California Air Resources Board (CARB), the National Institute for Occupational Safety and Health (NIOSH), and others can be used to determine potential risks from exposure to VOCs.

Of the 78 SNMOC and 12 carbonyl compounds measured in Garfield County, 21 compounds have been identified as HAPs. *The Garfield County Air Toxics Inhalation Screening Level Human Risk Assessment* (CDPHE 2010) assessed data collected in 2008, and risk assessments based on 2009 through 2012 HAP levels will be prepared in separate risk assessment reports prepared by the CDPHE Disease Control and Environmental Epidemiology Division. Findings of the 2008 report indicated that, individually, the HAP components were below risk assessment criteria, but cumulative effects approached chronic (70 year exposure period) non-hazard levels. The largest contributors to the cumulative levels were benzene and formaldehyde. Summaries below look at annual averages for the HAPs measured in Garfield County and regionally, but do not address health effects of these compounds.

#### 4.3.1 Annual Average HAP Concentrations

Tables 4-1 through 4-4 present annual averages and trends for of HAP concentrations measured between 2008 and 2012. Annual trends were calculated for each HAP, with a trend defined as the slope derived using Theil statistics, which is a nonparametric regression technique that is commonly applied to environmental data to determine statistically significant trends. The significance of the trend is represented with p-values calculated using Mann-Kendall trend statistics. Determining a significance level helps to distinguish random variability in data from a real tendency to increase or decrease over time, where lower p-values indicate higher confidence levels in the computed slopes. Regional trends are presented here for aerosol species trends with p-value statistics less than 0.05 (95% confidence level). Statistically significant decreasing trends are indicated in blue, and statistically significant increasing trends are depicted in red. Note that annual averages are presented for 2011 and 2012 measurements at the Battlement Mesa site, but trends are not calculated as the EPA recommends using at least five years of data to determine reliable trend statistics.

Annual averages for these components are also depicted graphically in in Figures 4-6 through 4-9. For perspective on concentrations measured in Garfield County, the average, maximum, and minimum of annual average data reported for 45 urban sites across the United States in 2009, excluding the Garfield County sites, is also presented in the figures. The 2009 average was obtained from an annual report published by the EPA for sites across the country as part of the Urban Air Toxics Monitoring Program (UATMP) and National Air Toxics Trends Stations (NATTS) (EPA 2011). Specific observations are listed below.

- A number of HAPs compounds, including benzene, have measured statistically significant decreasing annual average trends at all sites.
- A number of additional compounds, including formaldehyde, showed statistically significant decreasing trends at the Parachute and Bell-Melton sites, but insignificant trends at the more urban Rifle site.
- Of the 21 HAPS measured in Garfield County, the only statistically significant increasing trend was measured for styrene at all sites, where annual average increases were small, between 0.01 to 0.04  $\mu\text{g}/\text{m}^3$  per year. Styrene in the atmosphere is primarily associated with the production of polystyrene plastics and resins. Styrene measurements were much higher in 2012 than previous years, and may require further investigation to determine possible sources for these measurements.

It is important to note that annual average values summarized here do not necessarily indicate a health risk. Actual magnitudes of these HAP compounds related to possible health risk are evaluated separately in the CDPHE risk assessment reports.

Table 4-1

Parachute Site  
Annual Average Mass Trends (HAPs Parameters)  
2008-2012

HAP	Average Mass ( $\mu\text{g}/\text{m}^3$ )					Slope ( $\mu\text{g}/\text{m}^3$ per year)	p-Value
	2008	2009	2010	2011	2012		
1,2,4-Trimethylbenzene	0.91	0.62	0.42	0.43	0.39	-0.11	0.04
1,3,5-Trimethylbenzene	0.61	0.51	0.40	0.22	0.18	-0.11	0.01
1,3-Butadiene	0.08	0.12	0.10	0.10	0.09	0.00	0.59
Acetaldehyde	1.11	0.99	0.92	0.90	0.75	-0.08	0.01
Acetone	3.42	3.28	2.67	2.79	2.34	-0.26	0.04
Benzene	2.31	2.69	1.74	1.44	1.31	-0.28	0.04
Crotonaldehyde	0.10	0.10	0.12	0.09	0.08	-0.01	0.24
Cyclohexane	3.92	3.77	2.90	2.22	1.99	-0.54	0.01
Ethylbenzene	0.59	0.44	1.04	0.32	0.17	-0.10	0.12
Formaldehyde	1.74	1.73	1.53	1.64	1.27	-0.11	0.04
Isopropylbenzene	0.09	0.08	0.07	0.08	0.06	-0.01	0.04
Methylcyclohexane	9.24	9.43	6.41	4.65	4.19	-1.47	0.04
m-Xylene/p-Xylene	3.91	3.63	2.20	1.11	1.15	-0.84	0.04
n-Hexane	5.78	5.64	3.93	3.34	3.01	-0.75	0.01
n-Nonane	2.20	2.01	1.13	0.97	0.61	-0.40	0.01
n-Propylbenzene	0.18	0.15	0.13	0.10	0.10	-0.02	0.01
o-Xylene	0.77	0.65	0.43	0.40	0.27	-0.13	0.01
Propionaldehyde	0.12	0.09	0.09	0.09	0.07	-0.01	0.04
Propylene	0.57	0.57	0.62	0.55	0.69	0.03	0.41
Styrene	0.12	0.08	0.12	0.13	1.56	0.04	0.04
Toluene	9.86	5.83	3.96	5.79	4.27	-1.38	0.12

Table 4-2

Rifle Site  
Annual Average Mass Trends (HAPs Parameters)  
2008-2012

HAP	Average Mass ( $\mu\text{g}/\text{m}^3$ )					Slope ( $\mu\text{g}/\text{m}^3$ per year)	p-Value
	2008	2009	2010	2011	2012		
1,2,4-Trimethylbenzene	0.62	0.71	0.52	0.42	0.54	-0.05	0.24
1,3,5-Trimethylbenzene	0.33	0.33	0.30	0.18	0.17	<b>-0.04</b>	<b>0.04</b>
1,3-Butadiene	0.13	0.12	0.17	0.19	0.16	0.02	0.24
Acetaldehyde	1.55	1.39	1.47	1.41	1.16	-0.07	0.12
Acetone	3.58	3.11	3.08	2.74	2.80	<b>-0.19</b>	<b>0.04</b>
Benzene	1.68	2.22	1.44	1.27	0.97	<b>-0.21</b>	<b>0.04</b>
Crotonaldehyde	0.15	0.17	0.18	0.14	0.13	-0.01	0.24
Cyclohexane	2.46	2.48	1.95	1.86	1.55	<b>-0.24</b>	<b>0.04</b>
Ethylbenzene	0.48	0.56	0.84	0.35	0.27	-0.07	0.24
Formaldehyde	1.89	1.67	1.80	1.82	1.52	-0.05	0.24
Isopropylbenzene	0.08	0.08	0.08	0.08	0.06	0.00	0.41
Methylcyclohexane	4.78	5.08	3.74	3.36	2.58	<b>-0.57</b>	<b>0.04</b>
m-Xylene/p-Xylene	2.35	2.58	1.70	0.90	1.08	-0.40	0.12
n-Hexane	4.50	4.61	3.48	4.40	2.88	-0.35	0.12
n-Nonane	0.81	0.86	0.59	0.44	0.32	<b>-0.13</b>	<b>0.04</b>
n-Propylbenzene	0.15	0.16	0.16	0.12	0.13	-0.01	0.24
o-Xylene	0.64	0.75	0.51	0.43	0.38	<b>-0.07</b>	<b>0.04</b>
Propionaldehyde	0.16	0.15	0.16	0.13	0.11	<b>-0.01</b>	<b>0.04</b>
Propylene	0.86	1.05	1.04	0.93	0.96	0.00	0.59
Styrene	0.08	0.08	0.08	0.10	0.75	<b>0.01</b>	<b>0.04</b>
Toluene	4.34	4.62	3.07	5.90	2.14	-0.51	0.41

Table 4-3

Bell-Melton Site  
Annual Average Mass Trends (HAPs Parameters)  
2008-2012

HAP	Average Mass ( $\mu\text{g}/\text{m}^3$ )					Slope ( $\mu\text{g}/\text{m}^3$ per year)	p-Value
	2008	2009	2010	2011	2012		
1,2,4-Trimethylbenzene	0.91	0.62	0.42	0.43	0.39	-0.11	0.04
1,3,5-Trimethylbenzene	0.61	0.51	0.40	0.22	0.18	-0.11	0.01
1,3-Butadiene	0.08	0.12	0.10	0.10	0.09	0.00	0.59
Acetaldehyde	1.11	0.99	0.92	0.90	0.75	-0.08	0.01
Acetone	3.42	3.28	2.67	2.79	2.34	-0.26	0.04
Benzene	2.31	2.69	1.74	1.44	1.31	-0.28	0.04
Crotonaldehyde	0.10	0.10	0.12	0.09	0.08	-0.01	0.24
Cyclohexane	3.92	3.77	2.90	2.22	1.99	-0.54	0.01
Ethylbenzene	0.59	0.44	1.04	0.32	0.17	-0.10	0.12
Formaldehyde	1.74	1.73	1.53	1.64	1.27	-0.11	0.04
Isopropylbenzene	0.09	0.08	0.07	0.08	0.06	-0.01	0.04
Methylcyclohexane	9.24	9.43	6.41	4.65	4.19	-1.47	0.04
m-Xylene/p-Xylene	3.91	3.63	2.20	1.11	1.15	-0.84	0.04
n-Hexane	5.78	5.64	3.93	3.34	3.01	-0.75	0.01
n-Nonane	2.20	2.01	1.13	0.97	0.61	-0.40	0.01
n-Propylbenzene	0.18	0.15	0.13	0.10	0.10	-0.02	0.01
o-Xylene	0.77	0.65	0.43	0.40	0.27	-0.13	0.01
Propionaldehyde	0.12	0.09	0.09	0.09	0.07	-0.01	0.04
Propylene	0.57	0.57	0.62	0.55	0.69	0.03	0.41
Styrene	0.12	0.08	0.12	0.13	1.56	0.04	0.04
Toluene	9.86	5.83	3.96	5.79	4.27	-1.38	0.12

Table 4-4

Battlement Mesa Site  
Annual Average Mass Trends (HAPs Parameters)  
2011-2012

HAP	Average Mass ( $\mu\text{g}/\text{m}^3$ )					Slope* ( $\mu\text{g}/\text{m}^3$ per year)	p-Value*
	2008	2009	2010	2011	2012		
1,2,4-Trimethylbenzene	--	--	--	0.44	0.37	N/A	N/A
1,3,5-Trimethylbenzene	--	--	--	0.22	0.15	N/A	N/A
1,3-Butadiene	--	--	--	0.06	0.09	N/A	N/A
Acetaldehyde	--	--	--	0.76	0.57	N/A	N/A
Acetone	--	--	--	3.83	3.28	N/A	N/A
Benzene	--	--	--	1.56	1.10	N/A	N/A
Crotonaldehyde	--	--	--	0.07	0.07	N/A	N/A
Cyclohexane	--	--	--	2.09	1.64	N/A	N/A
Ethylbenzene	--	--	--	0.37	0.19	N/A	N/A
Formaldehyde	--	--	--	1.45	0.93	N/A	N/A
Isopropylbenzene	--	--	--	0.08	0.05	N/A	N/A
Methylcyclohexane	--	--	--	4.23	3.35	N/A	N/A
m-Xylene/p-Xylene	--	--	--	1.12	1.03	N/A	N/A
n-Hexane	--	--	--	3.34	2.68	N/A	N/A
n-Nonane	--	--	--	0.68	0.42	N/A	N/A
n-Propylbenzene	--	--	--	0.14	0.10	N/A	N/A
o-Xylene	--	--	--	0.46	0.27	N/A	N/A
Propionaldehyde	--	--	--	0.08	0.06	N/A	N/A
Propylene	--	--	--	0.42	0.42	N/A	N/A
Styrene	--	--	--	0.08	1.94	N/A	N/A
Toluene	--	--	--	2.99	4.40	N/A	N/A

\*Note that annual averages are indicated, but trend statistics could not be calculated with only 2 years of complete data.

(--) No data available.

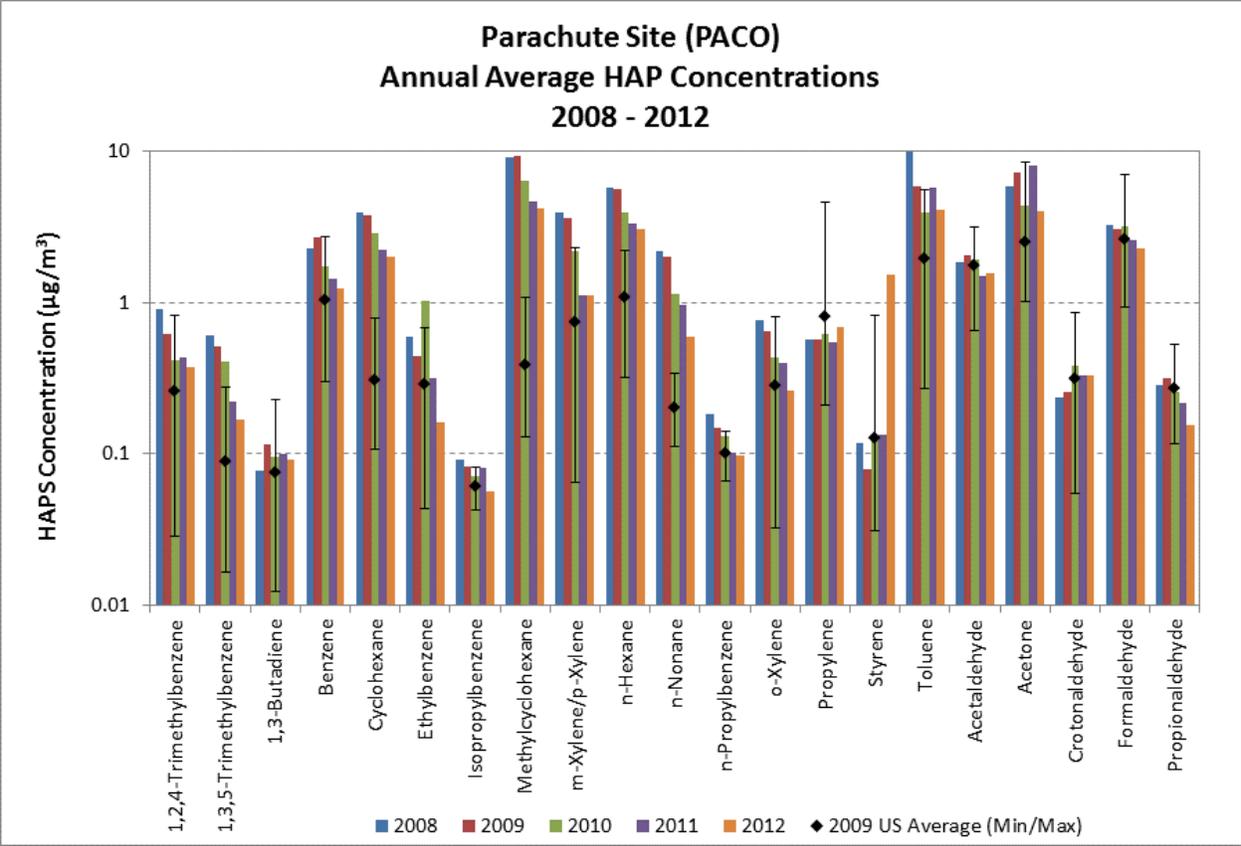


Figure 4-6. Annual Average HAP Concentrations Measured at the Parachute Site between 2008 and 2012, along with 2009 US Average, Minimum, and Maximum Annual Average Values as Reported by the EPA.

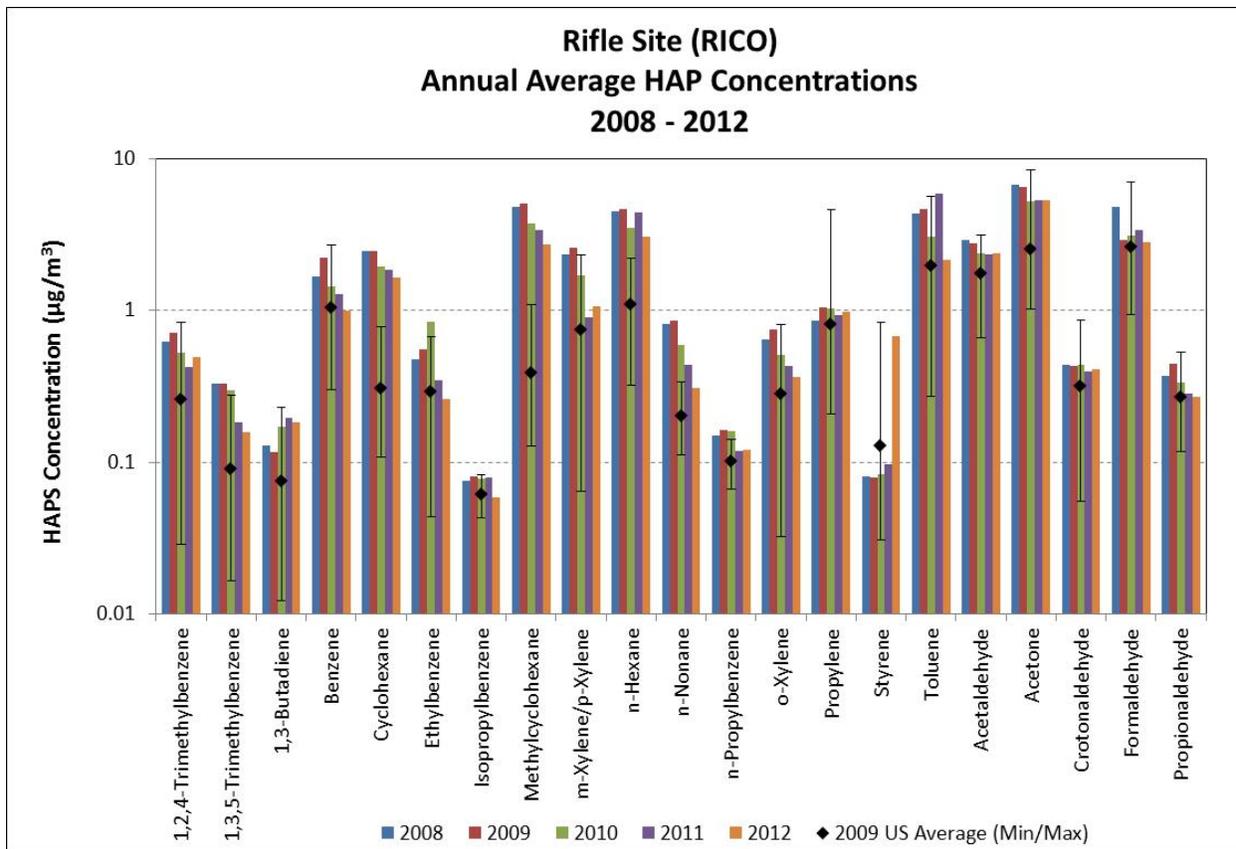


Figure 4-7. Annual Average HAP Concentrations Measured at the Rifle Site between 2008 and 2012, along with 2009 US Average, Minimum, and Maximum Annual Average Values as Reported by the EPA.

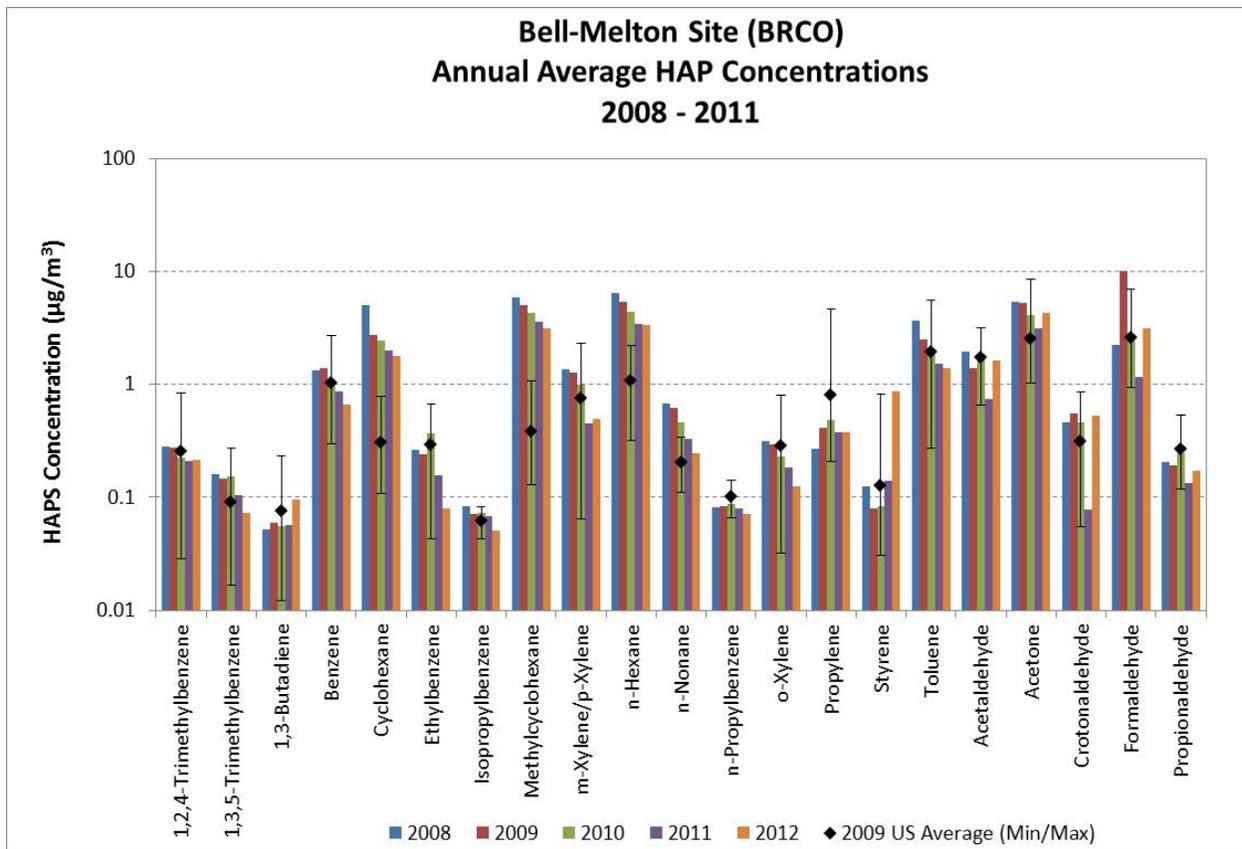


Figure 4-8. Annual Average HAP Concentrations Measured at the Bell-Melton Site between 2008 and 2012, along with 2009 US Average, Minimum, and Maximum Annual Average Values as Reported by the EPA.

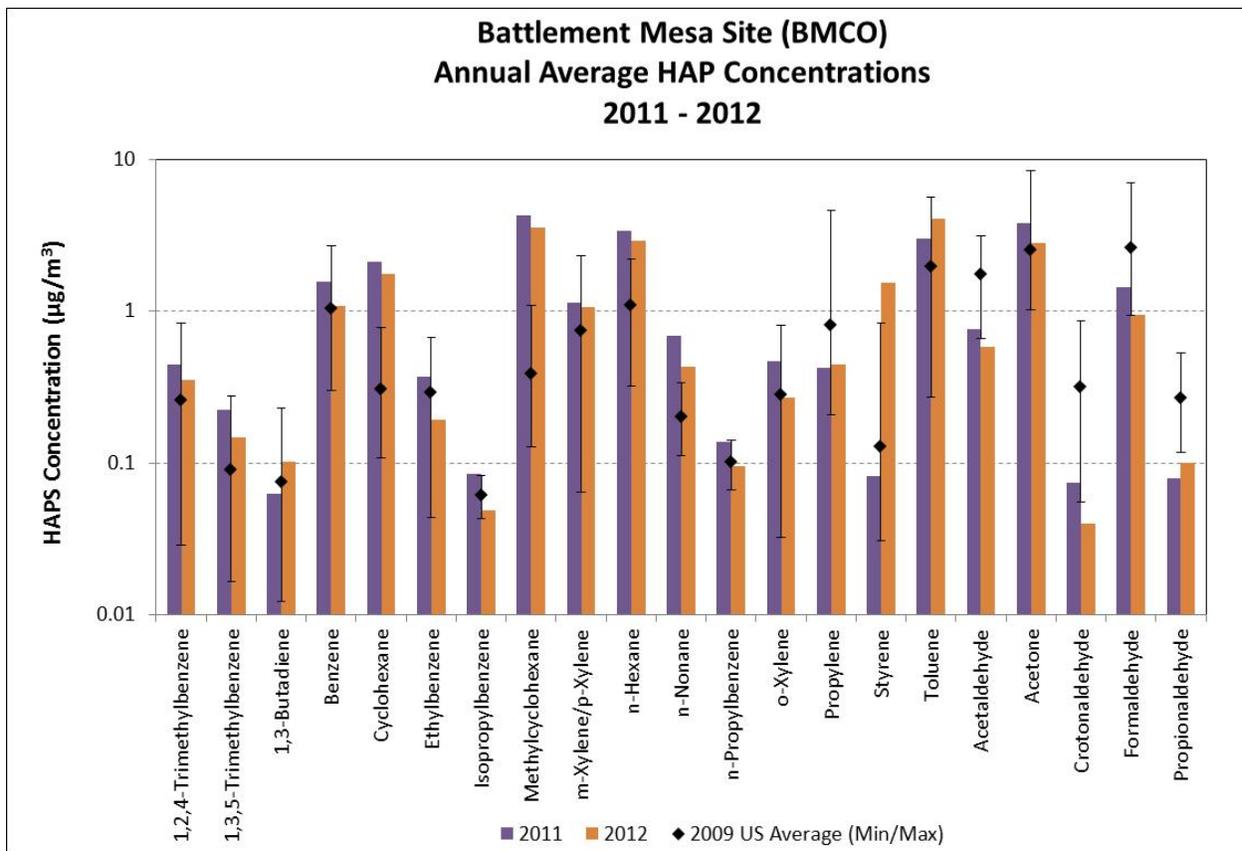


Figure 4-9. Annual Average HAP Concentrations Measured at the Battlement Mesa Site in 2011 and 2012, along with 2009 US Average, Minimum and Maximum Annual Average Values as Reported by the EPA.

## 5.0 REFERENCES

Colorado Department of Public Health and Environment (CDPHE). 2010. *Garfield County Air Toxics Inhalation: Screening Level Human Health Risk Assessment*. Available online at <http://www.garfield-county.com/public-health/documents/>.

Environmental Protection Agency (EPA). 2011. *2008-2009 National Monitoring Programs Annual Report (UATMP, NATTS, and CSATAM)*. Available online at <http://www.epa.gov/ttnamti1/uatm.html>.

## **APPENDIX A**

### **Garfield County**

#### **2012 Monthly Time Series Plots**

##### **Acronyms Used on Plots:**

TNMOC = Total Non-Methane Organic Carbon

PM<sub>10</sub> = Particulate Matter ≤ 10 μm

PM<sub>2.5</sub> = Particulate Matter ≤ 2.5 μm

O<sub>3</sub> = Ozone

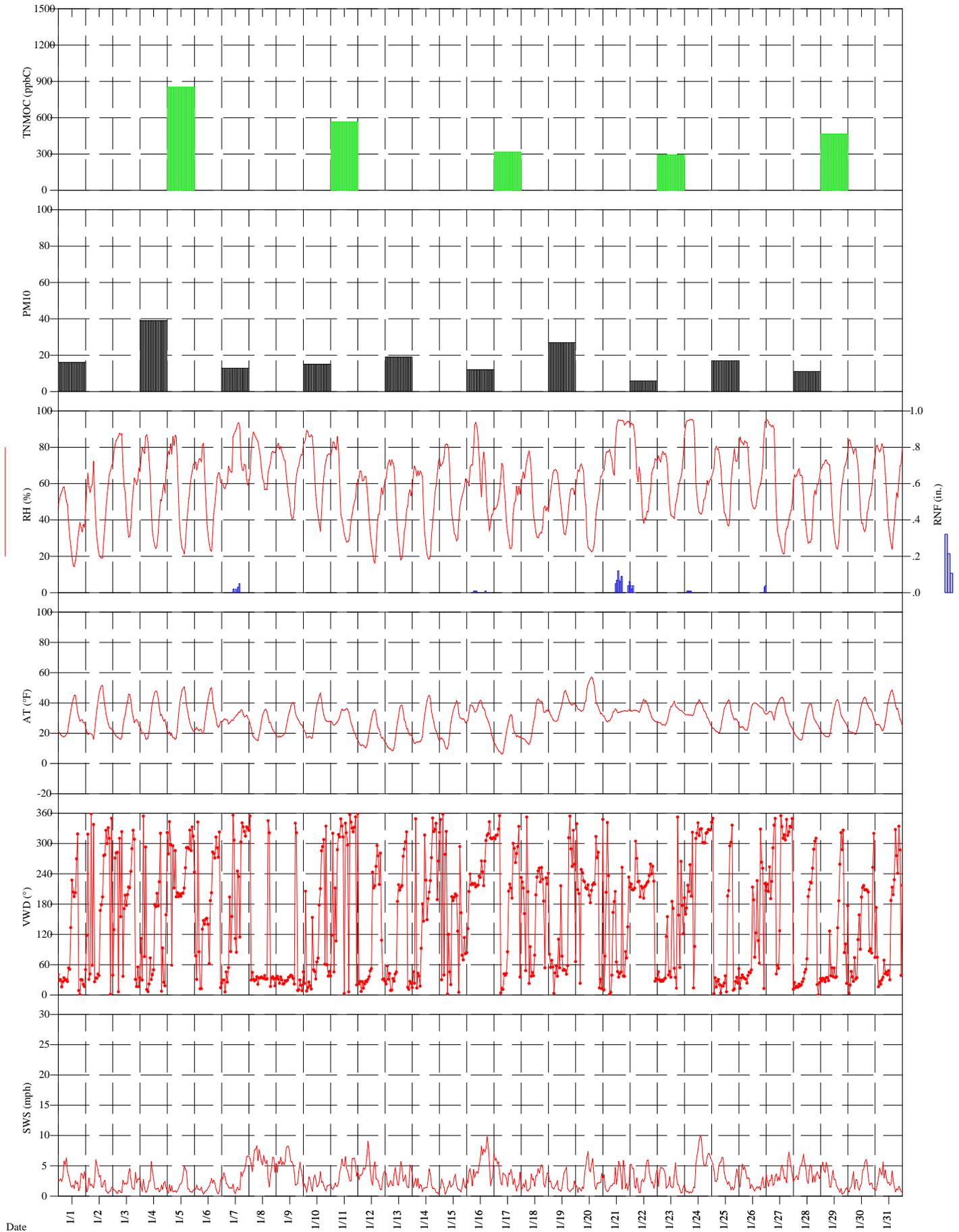
RH = Relative Humidity

AT = Atmospheric Temperature

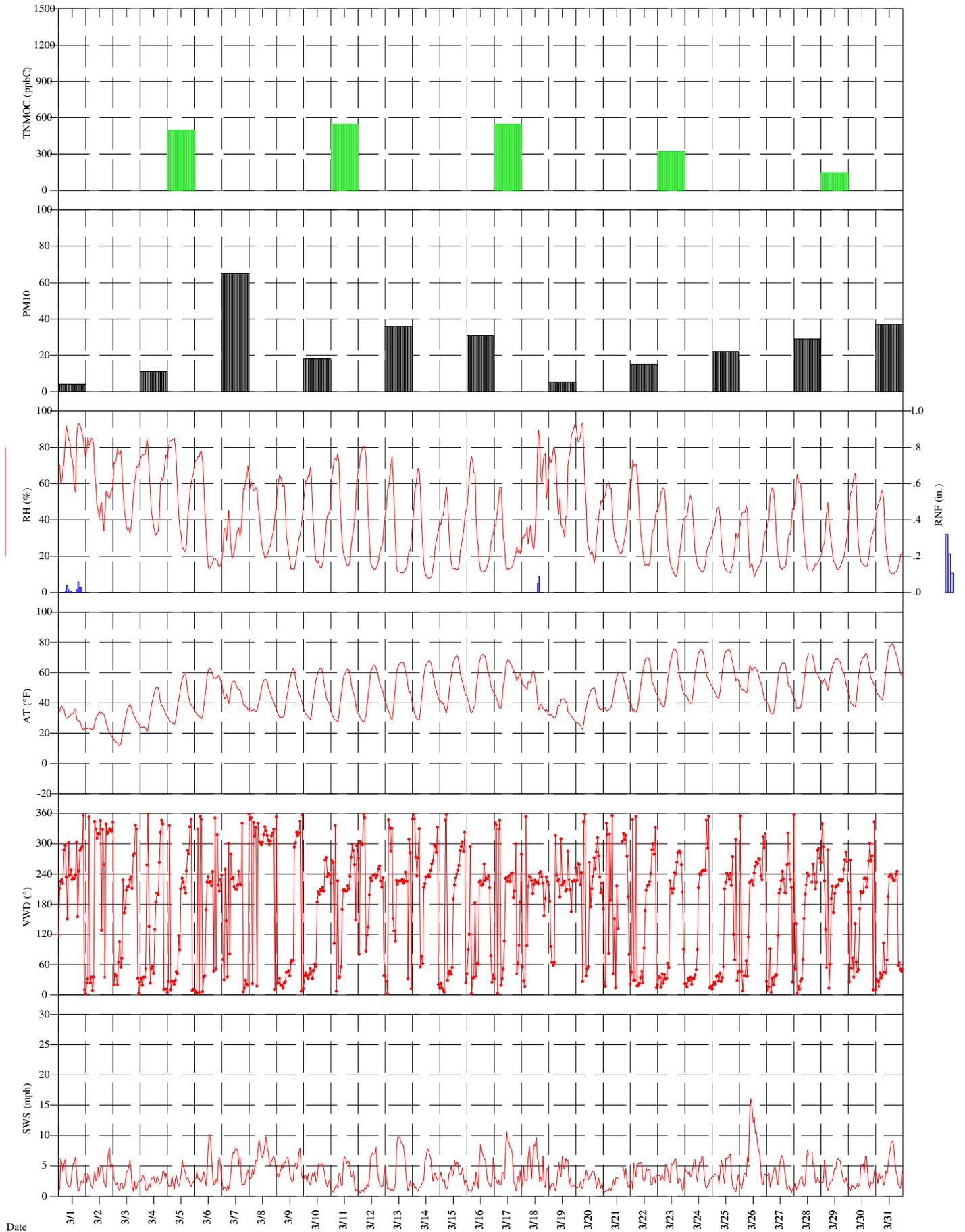
VWD = Vector Wind Direction

SWS = Scalar Wind Speed

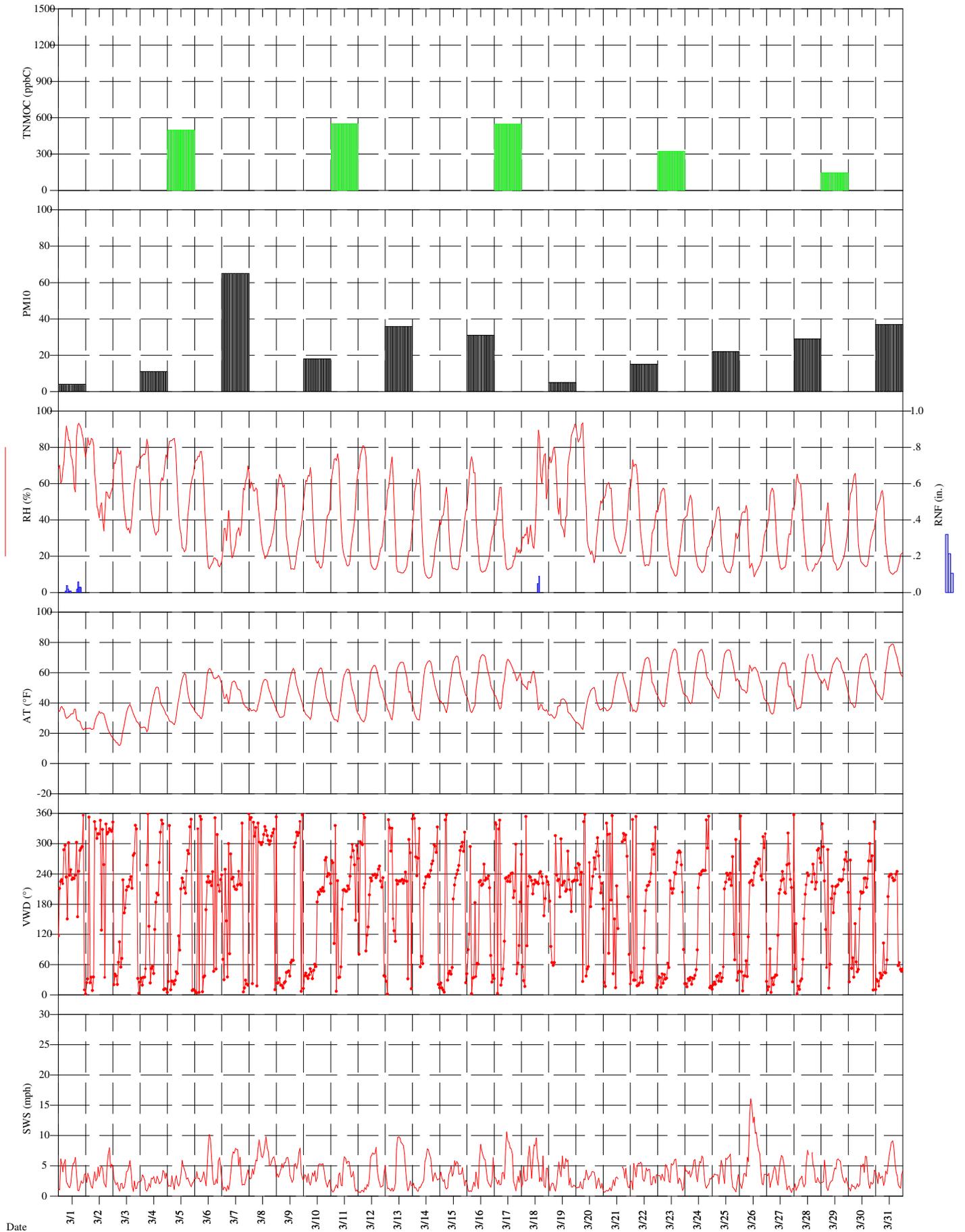
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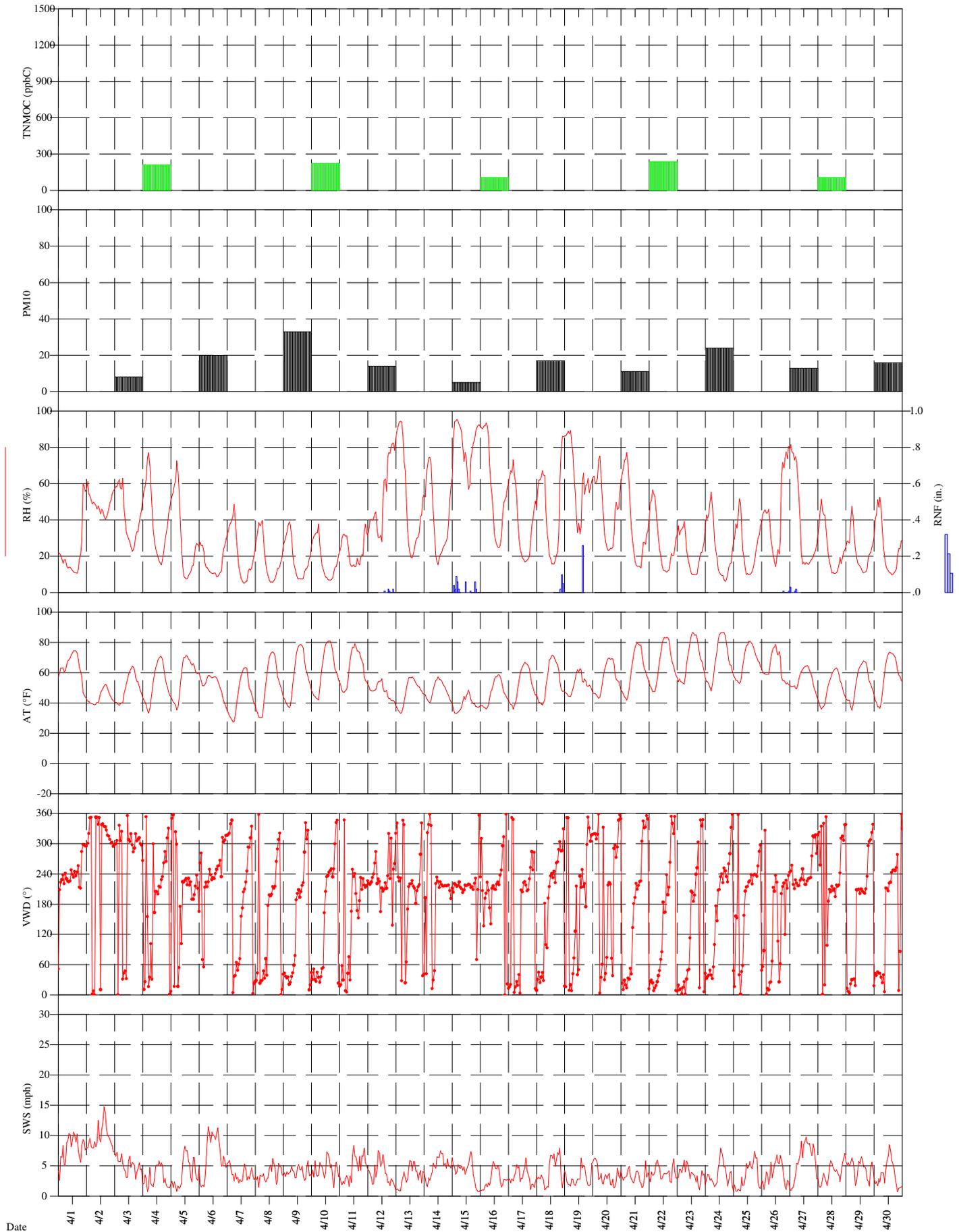
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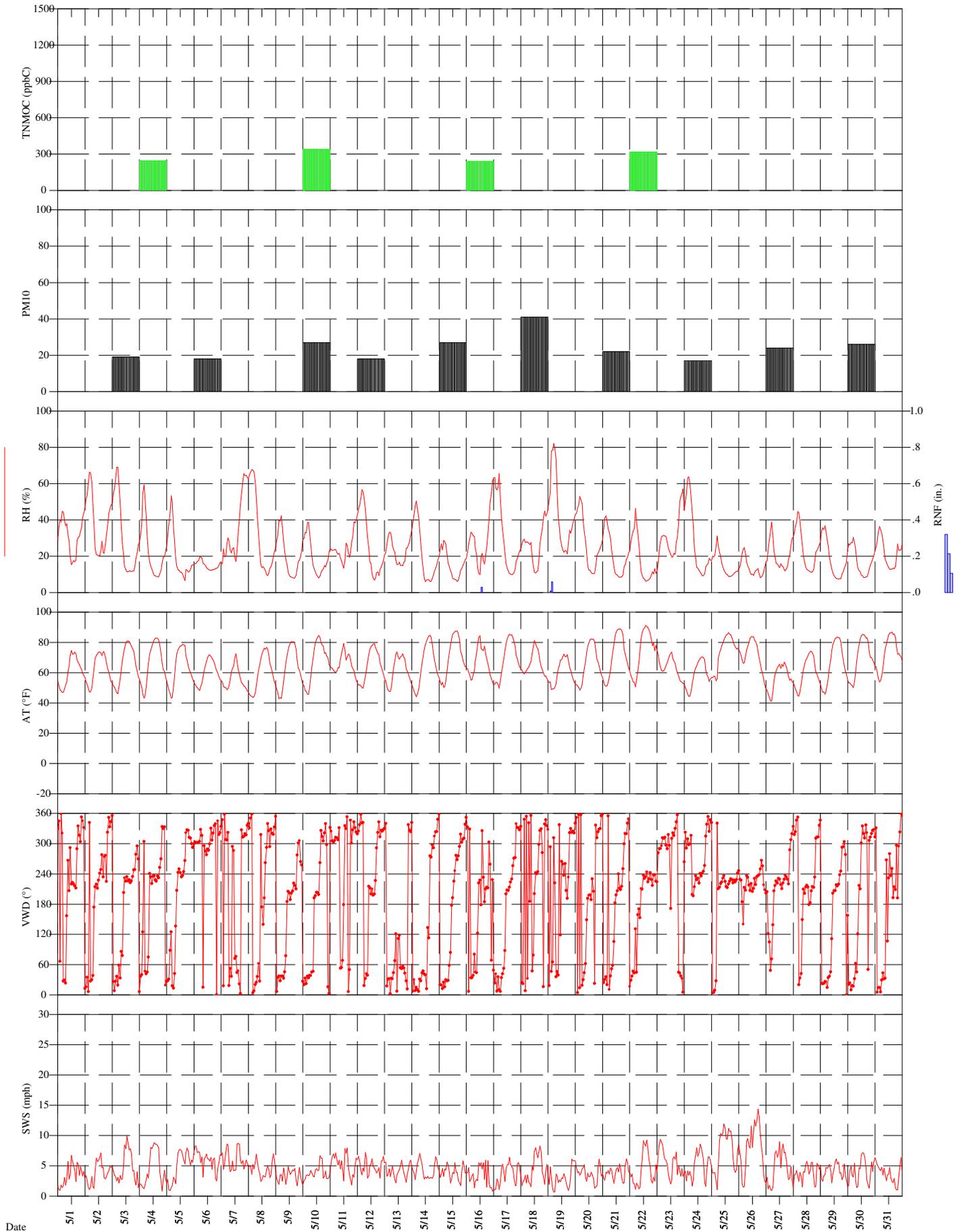
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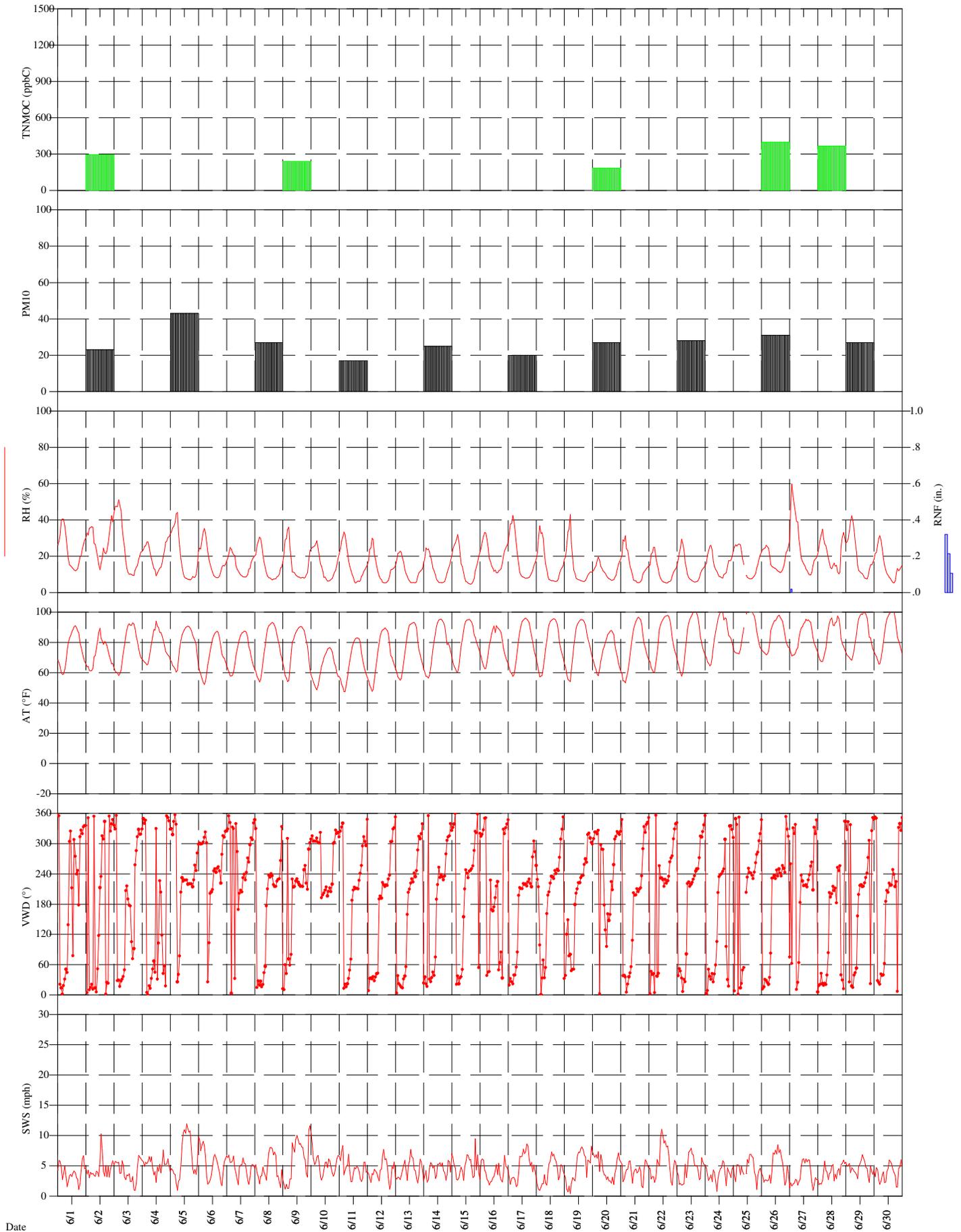
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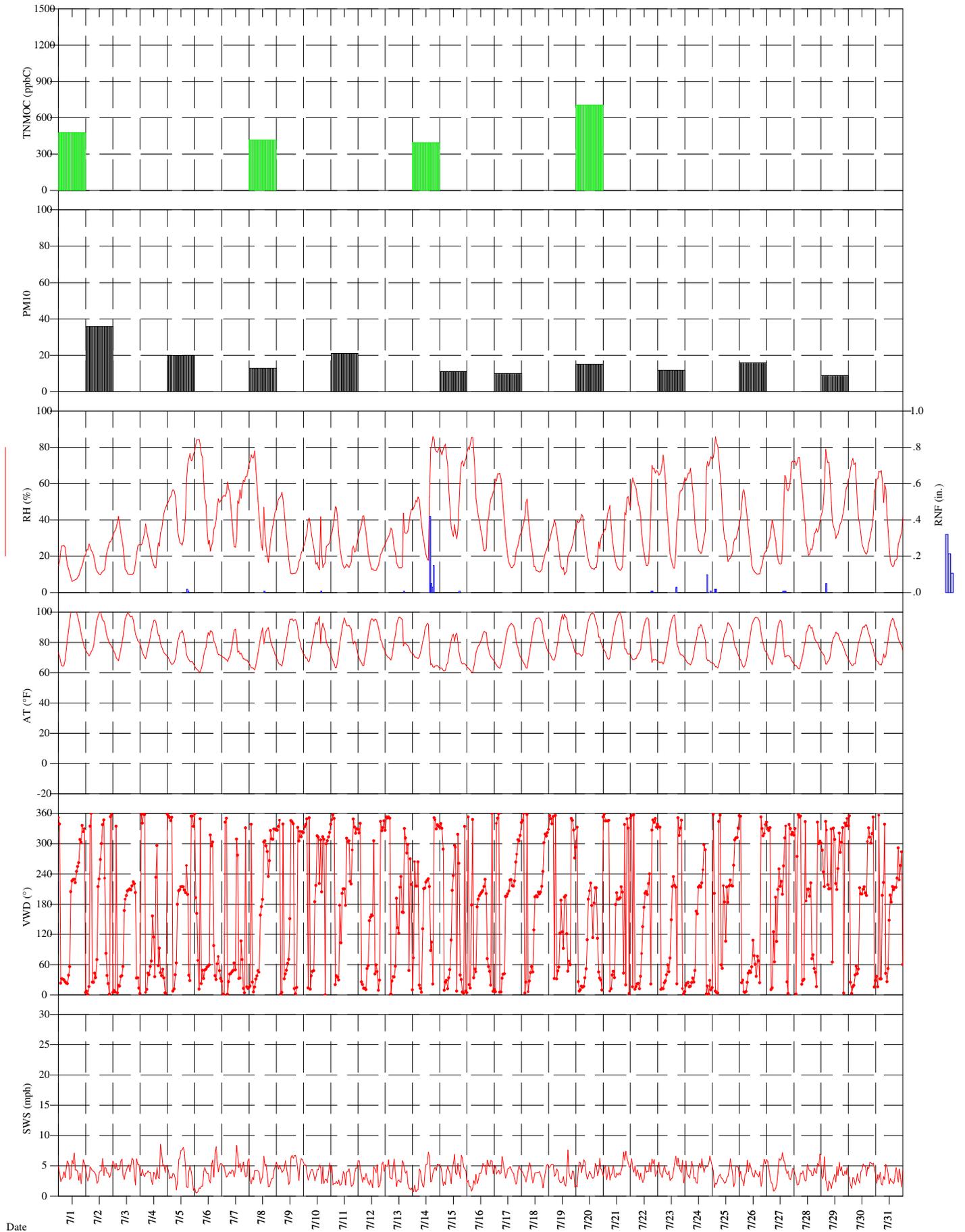
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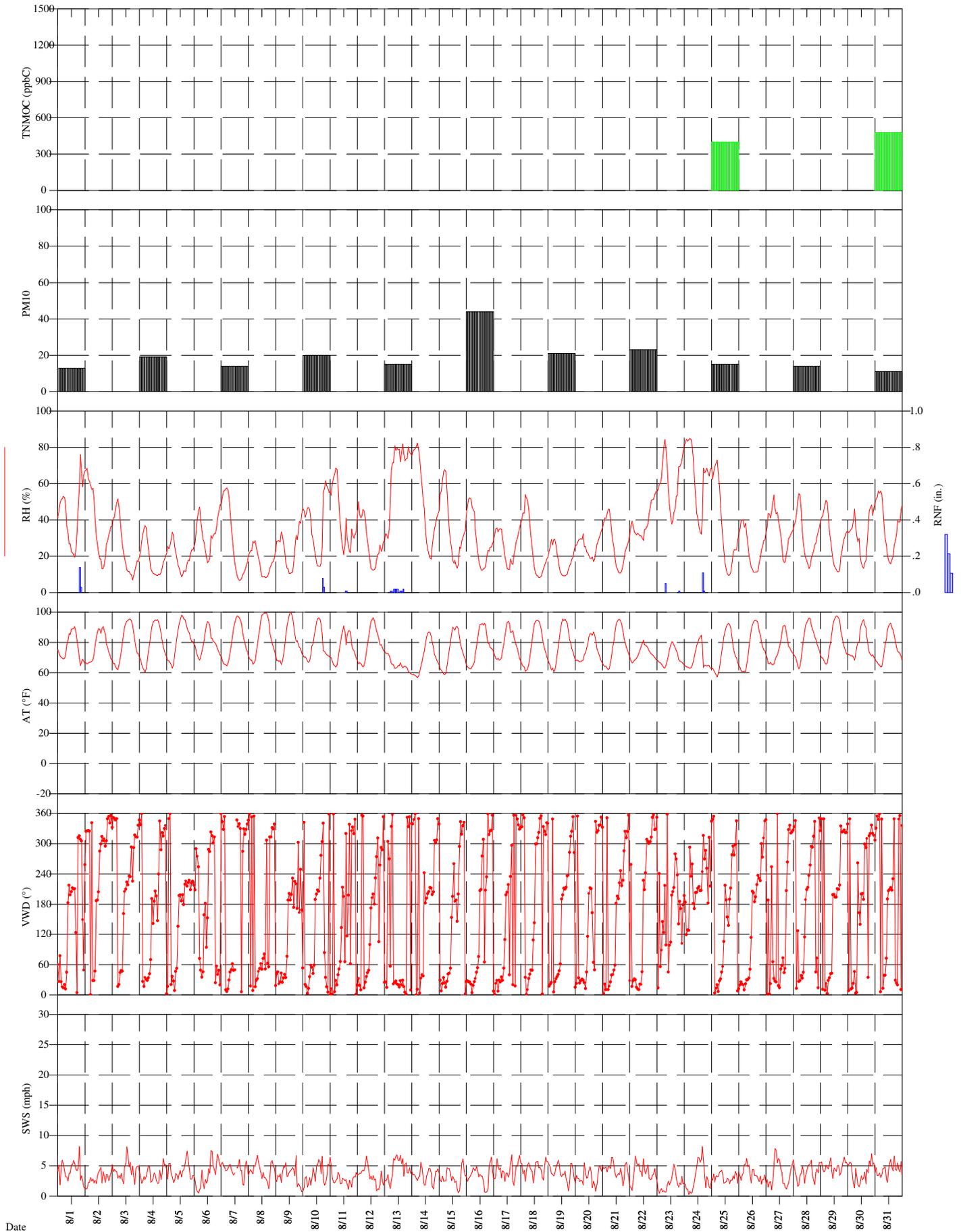
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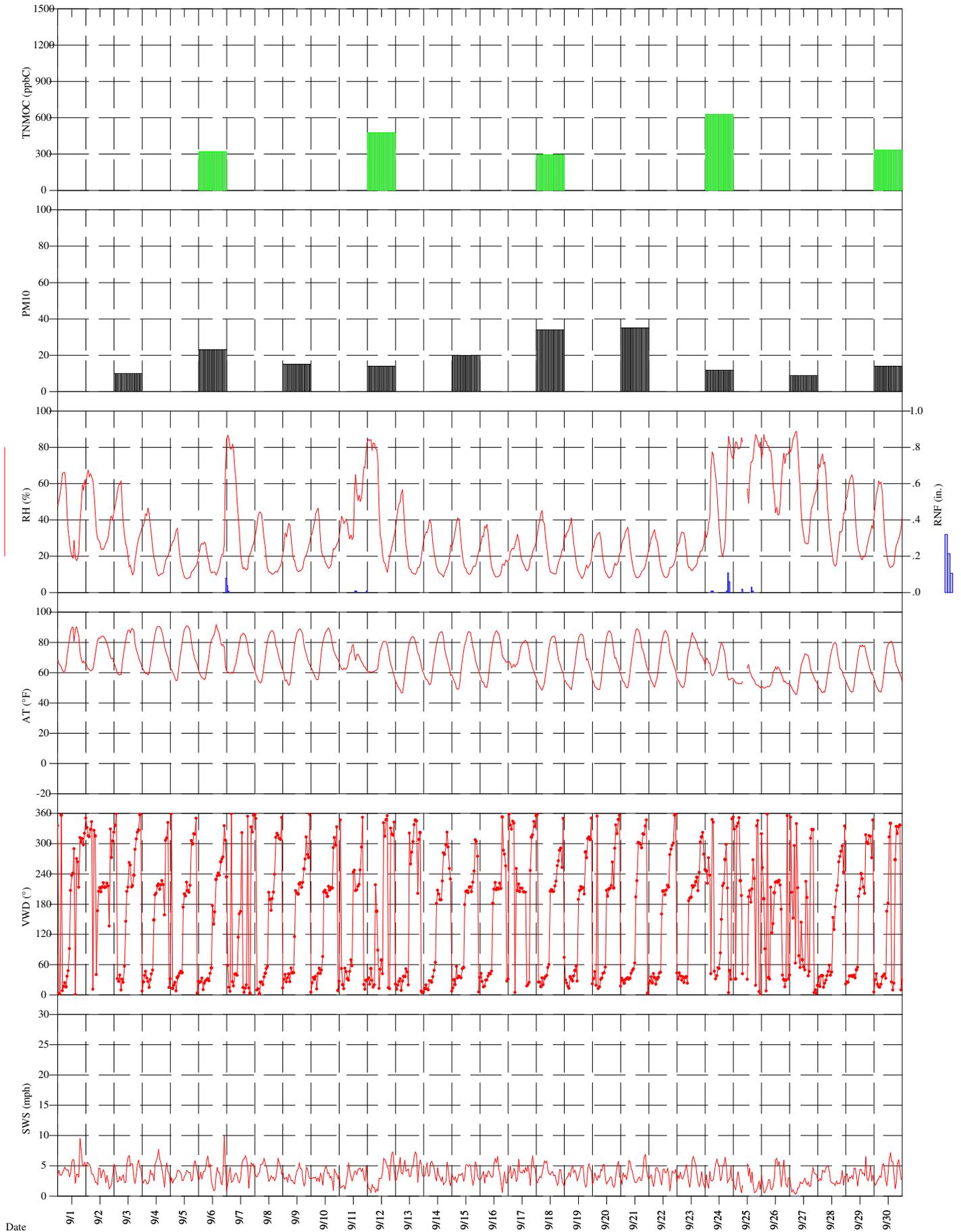
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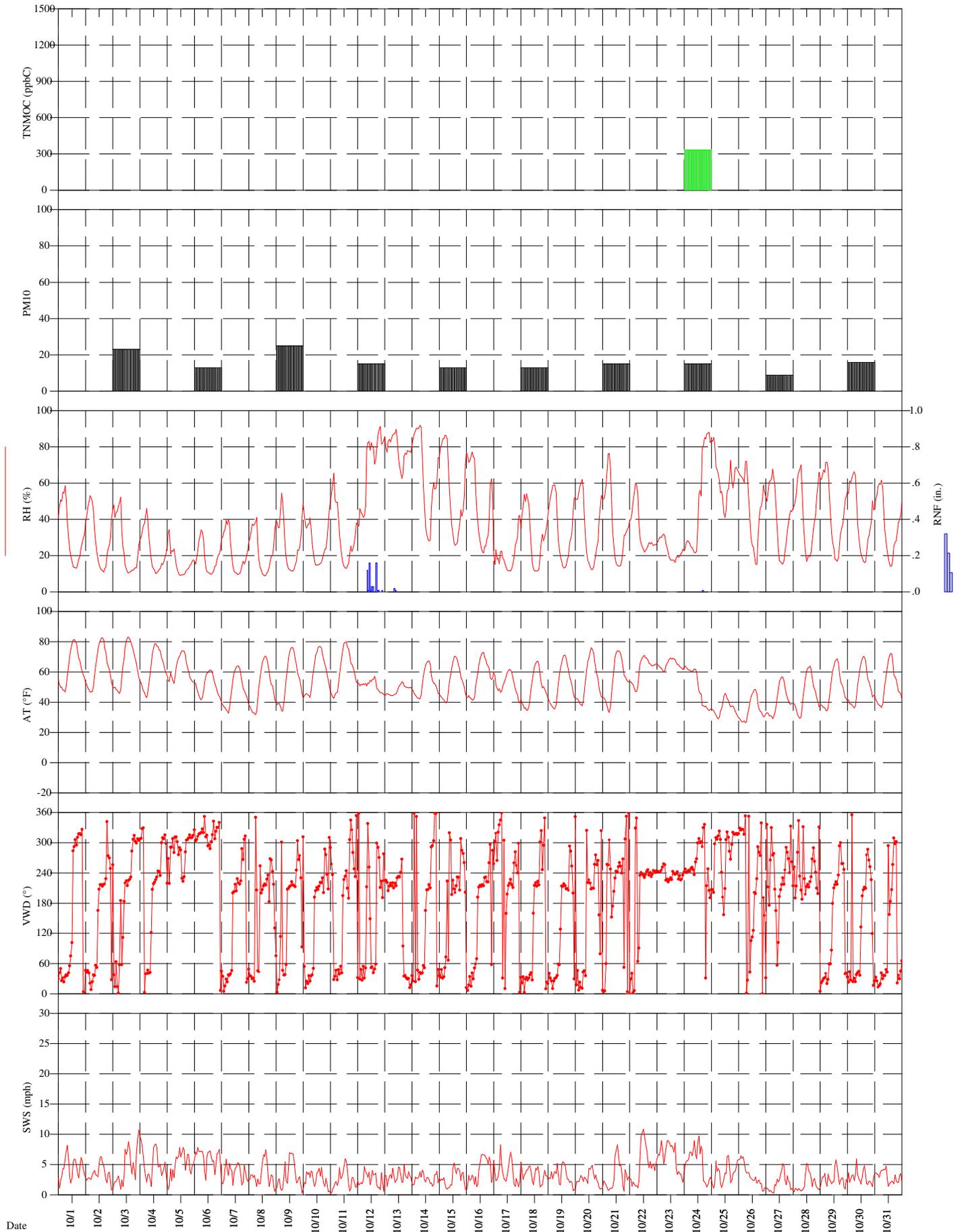
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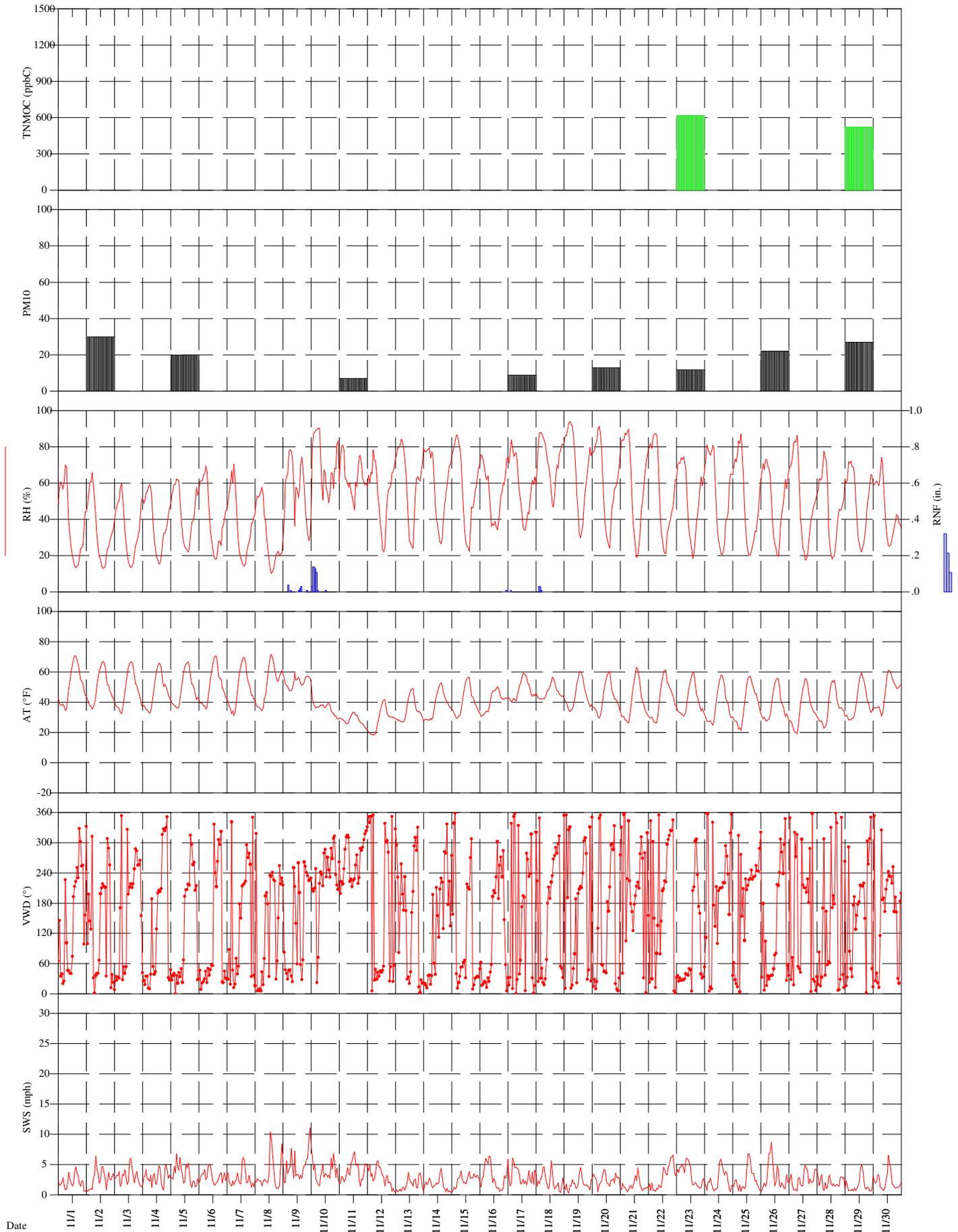
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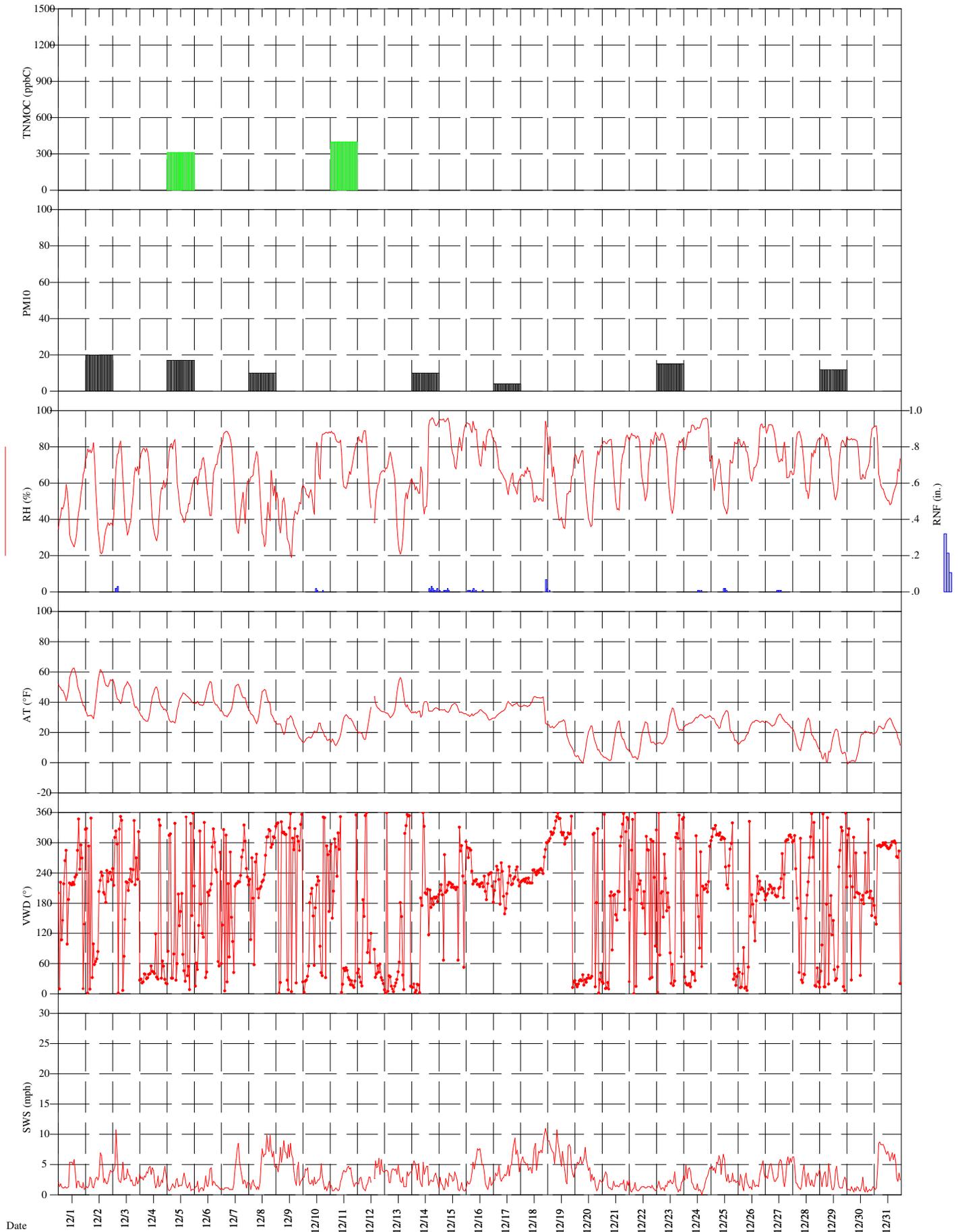
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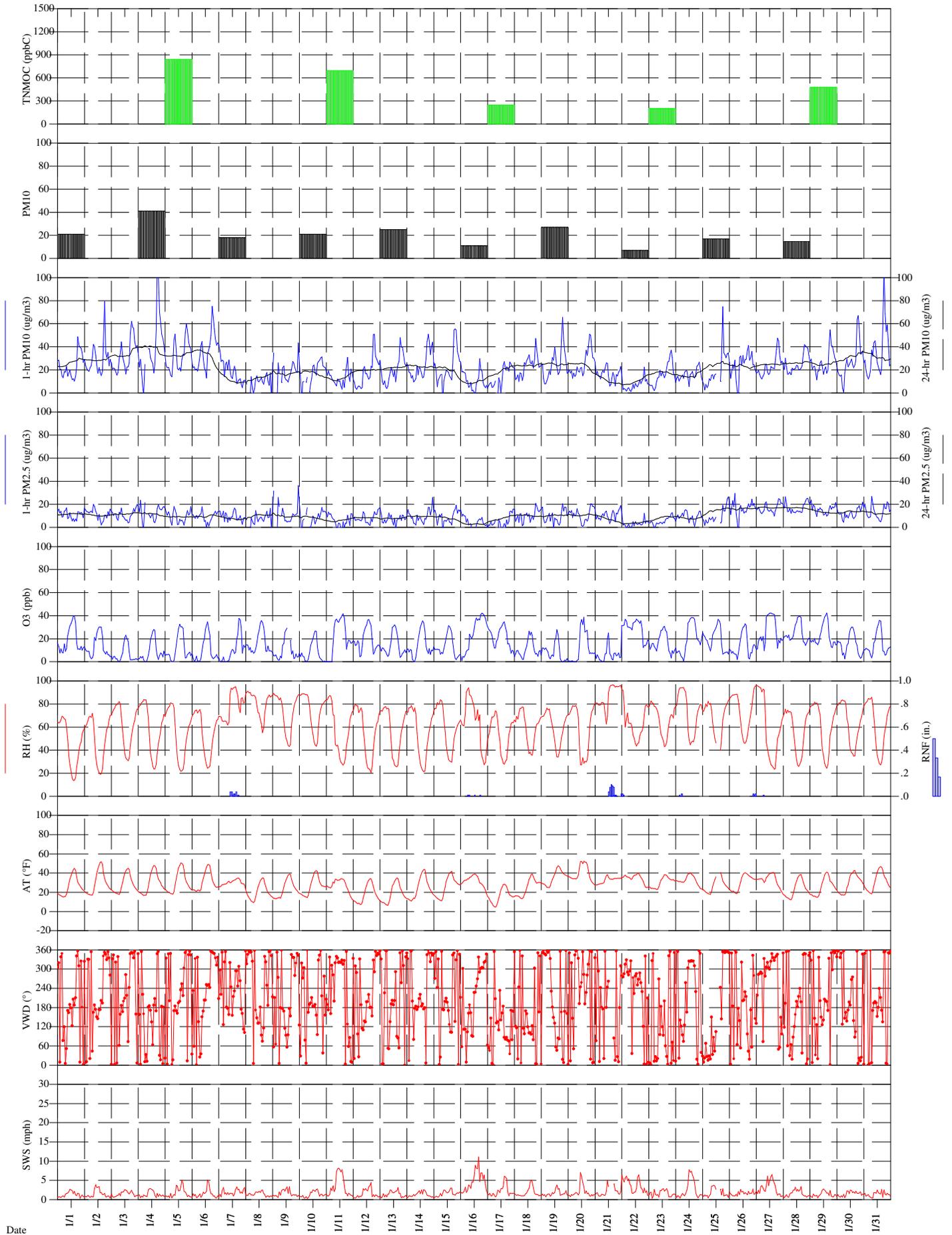
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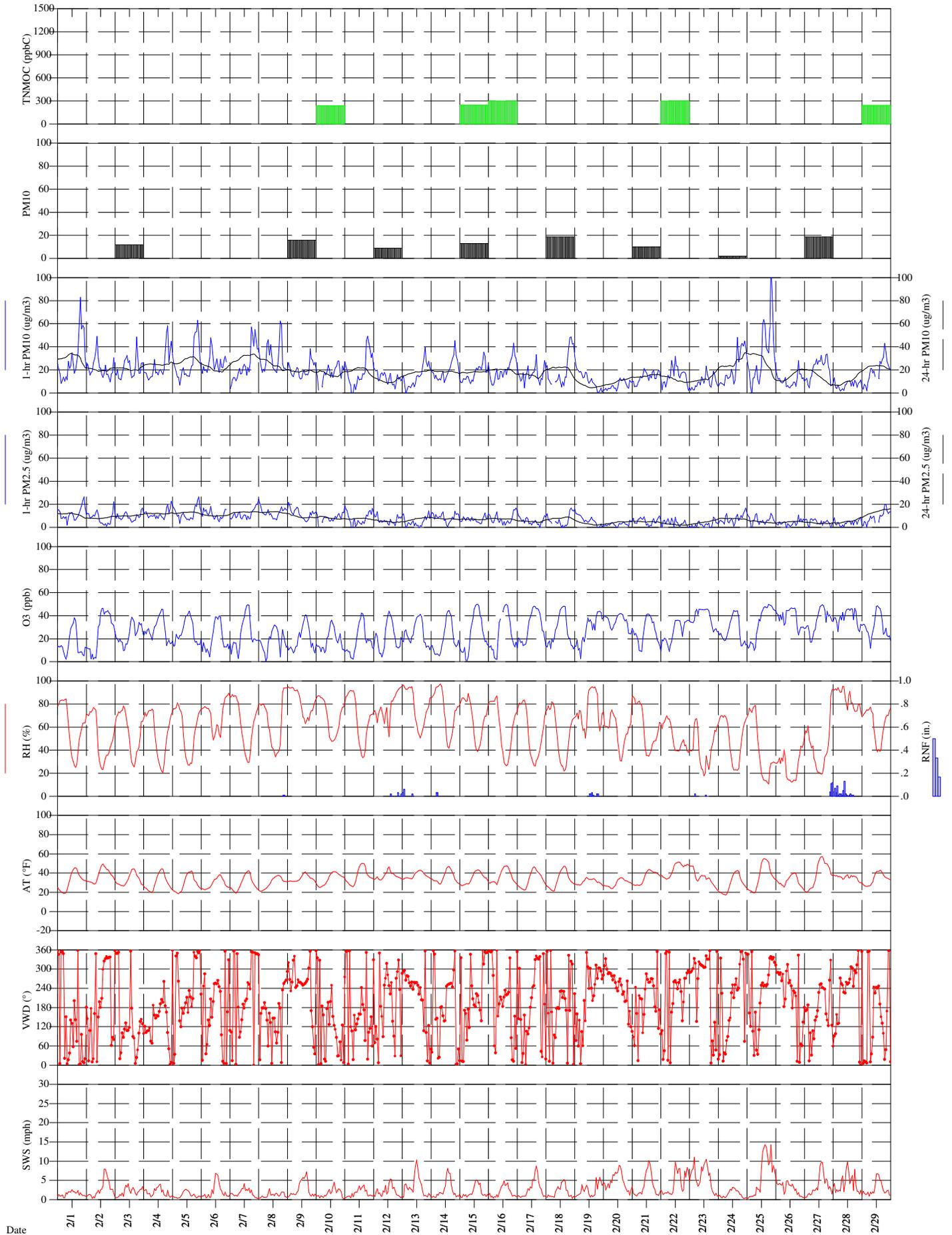
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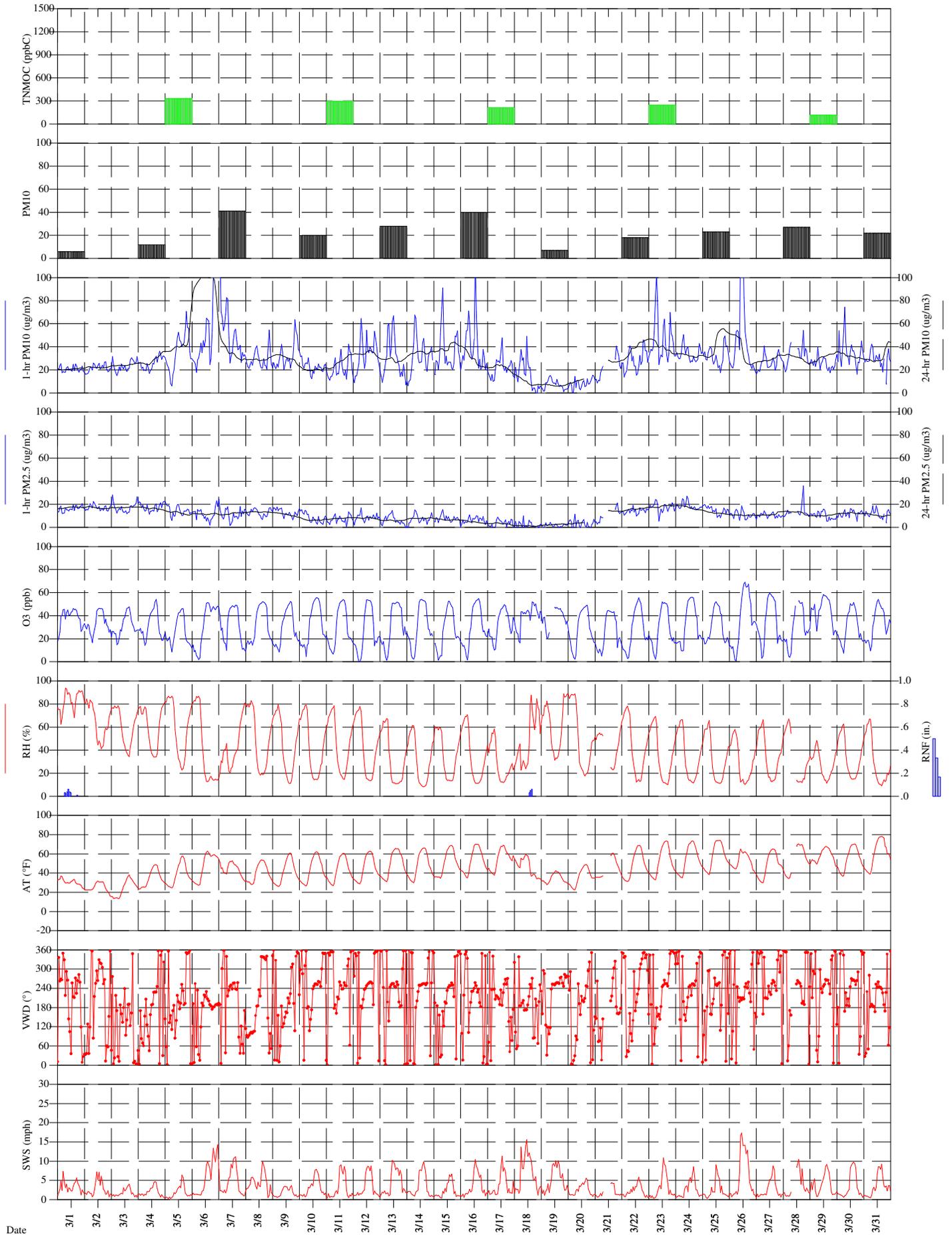
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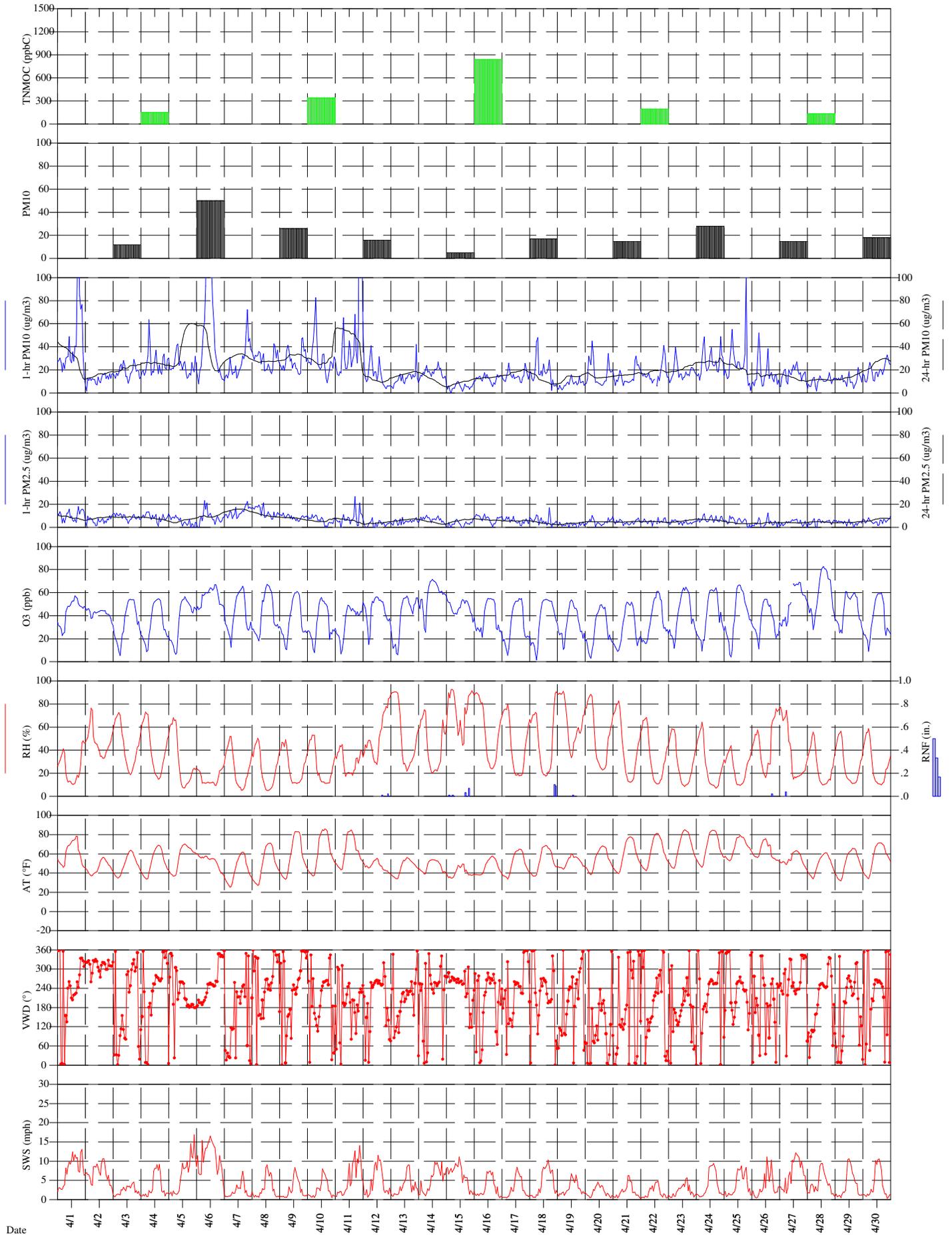
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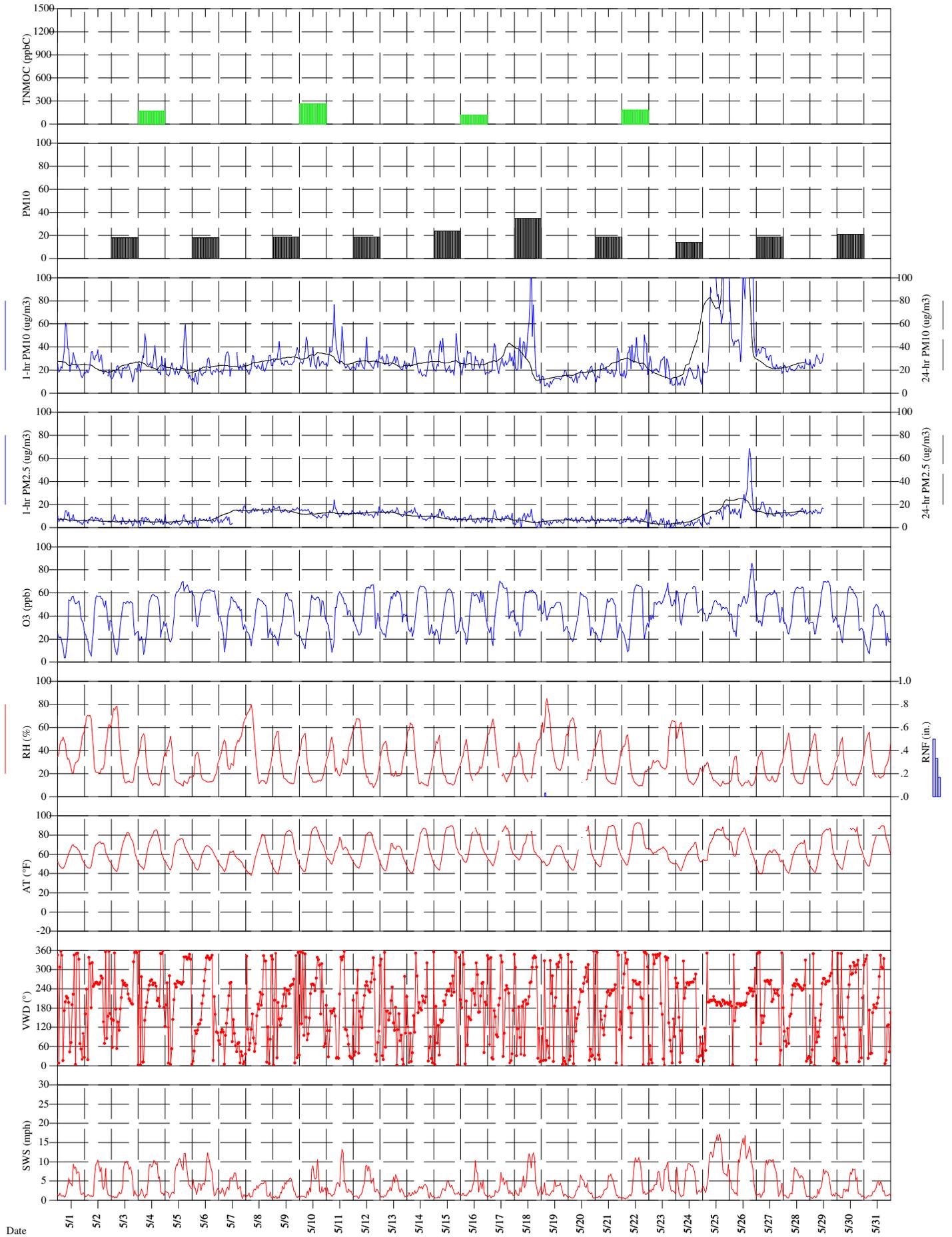
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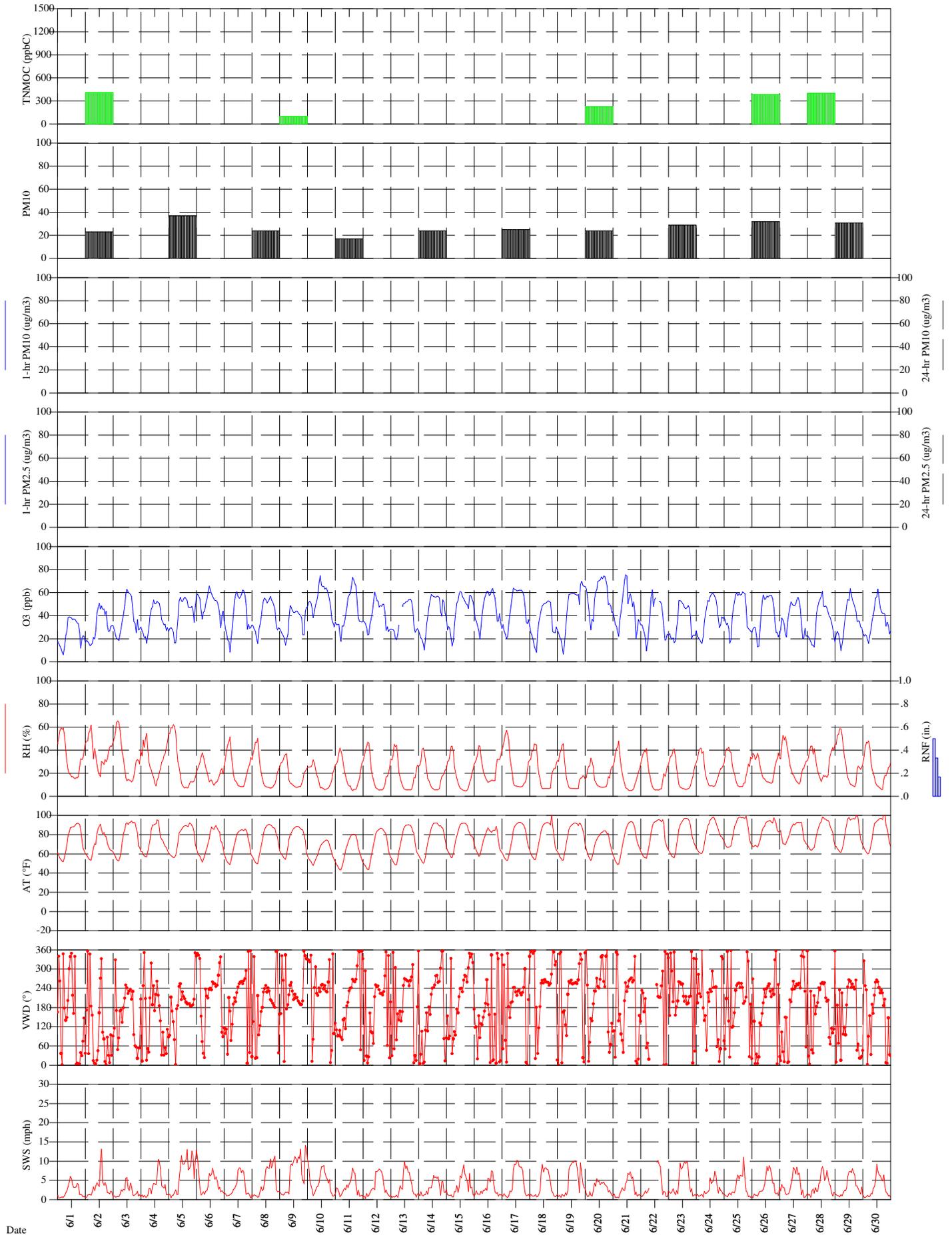
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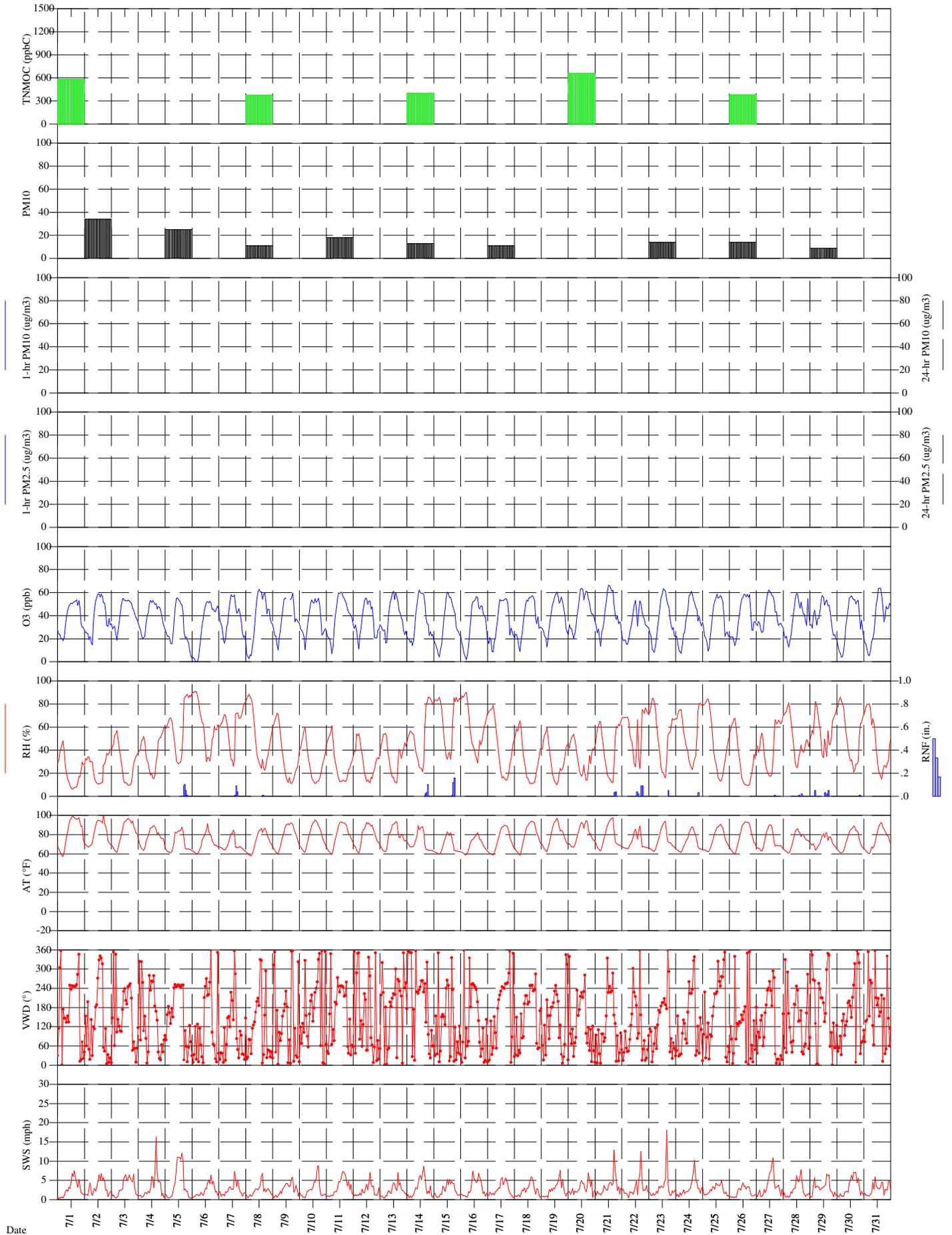
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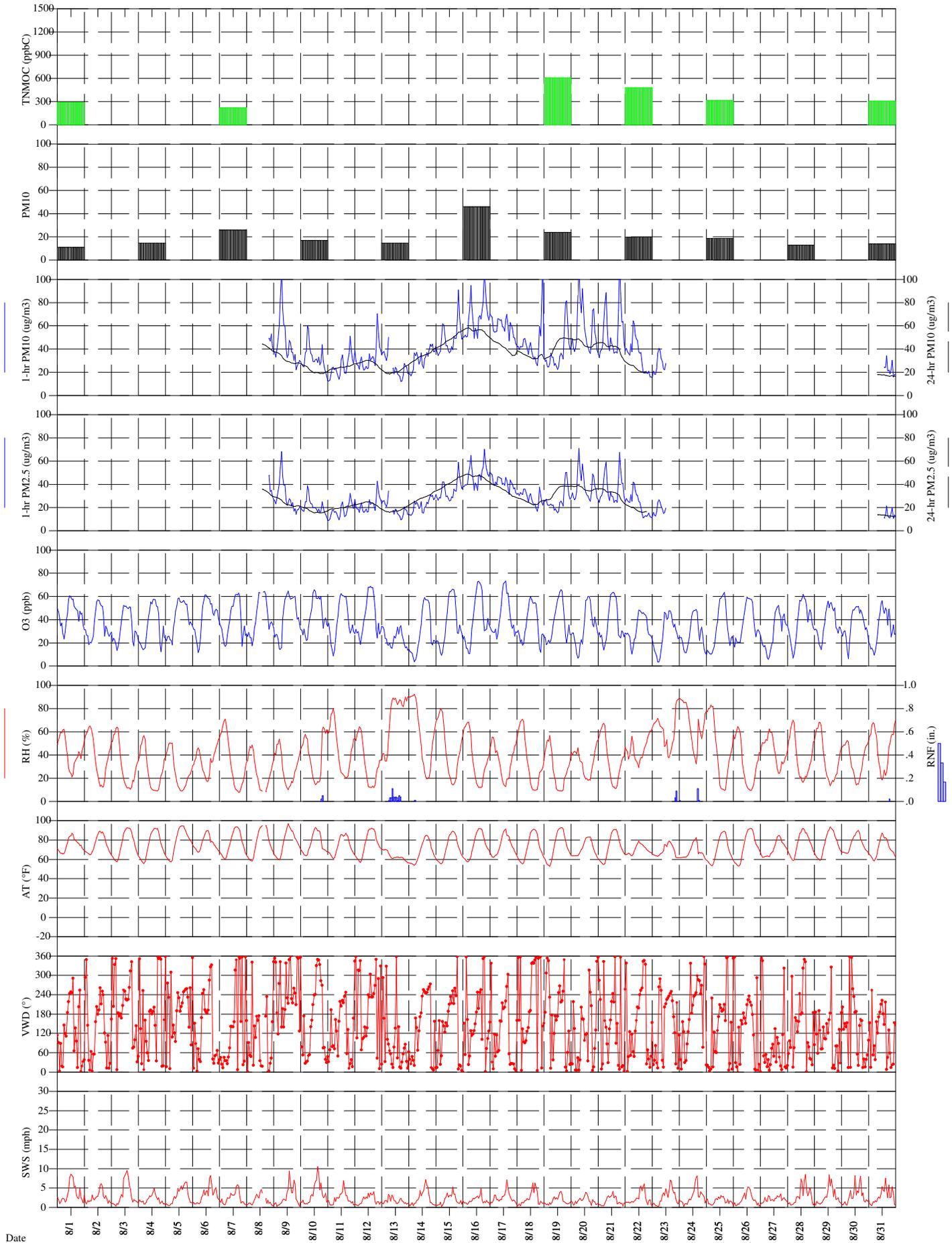
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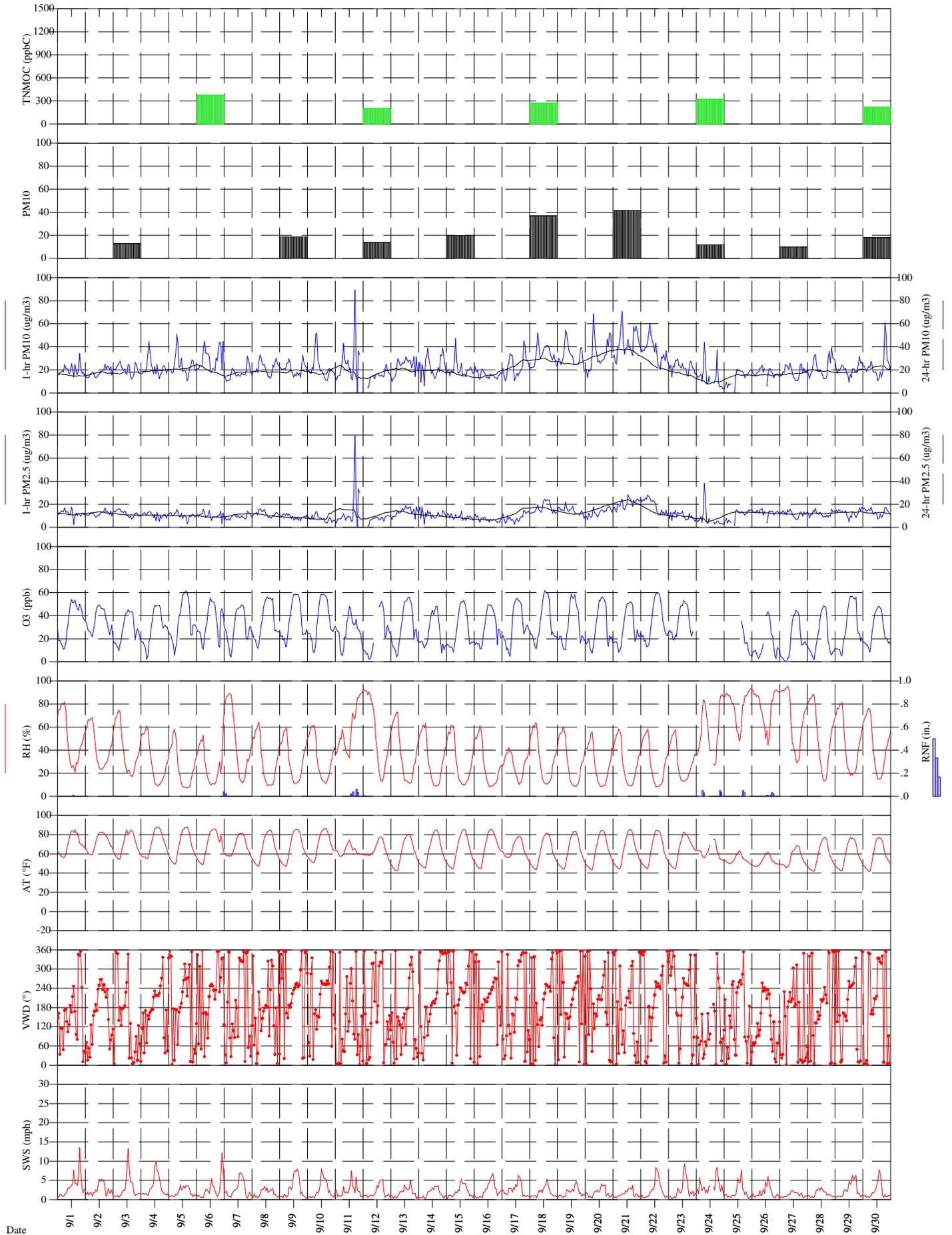
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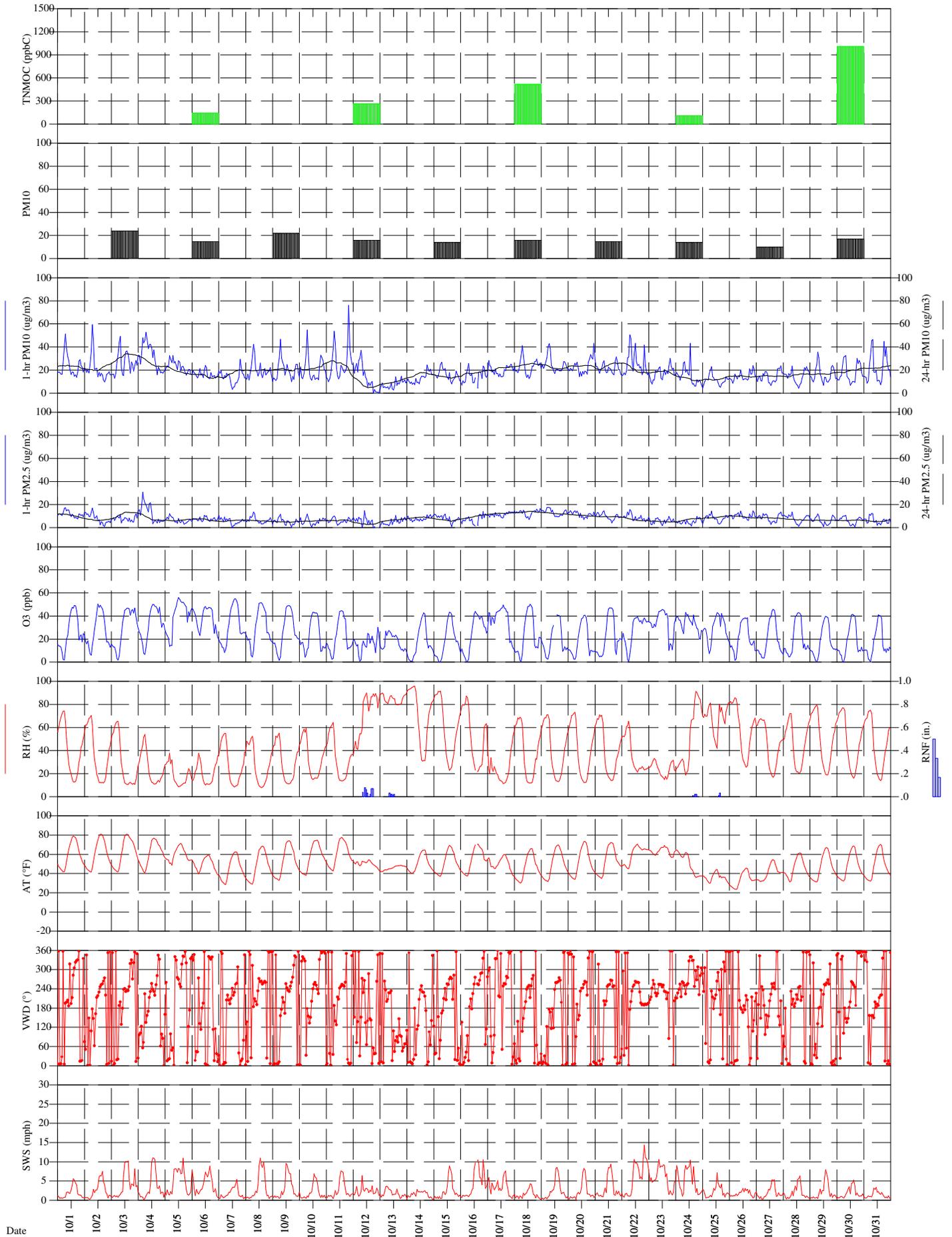
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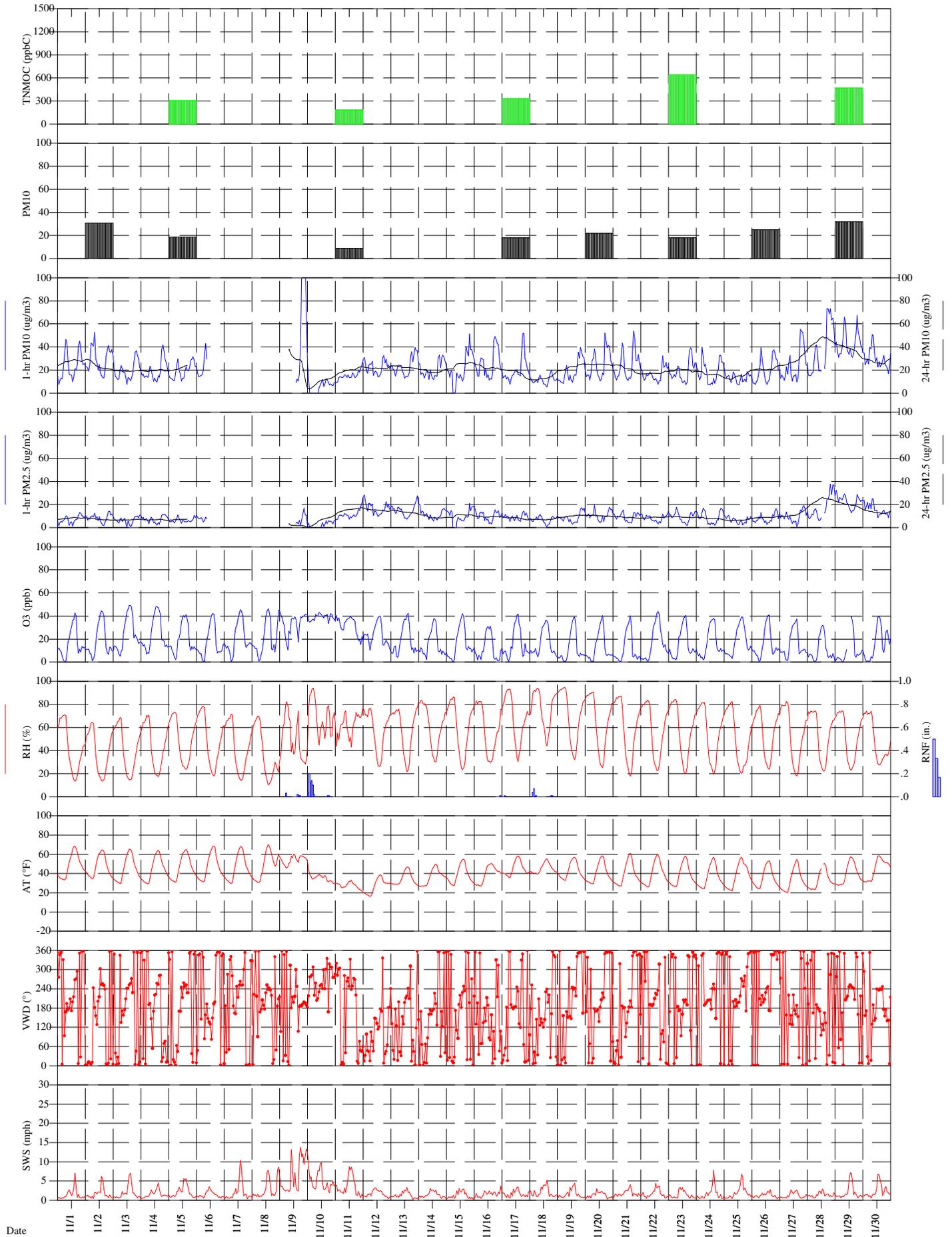
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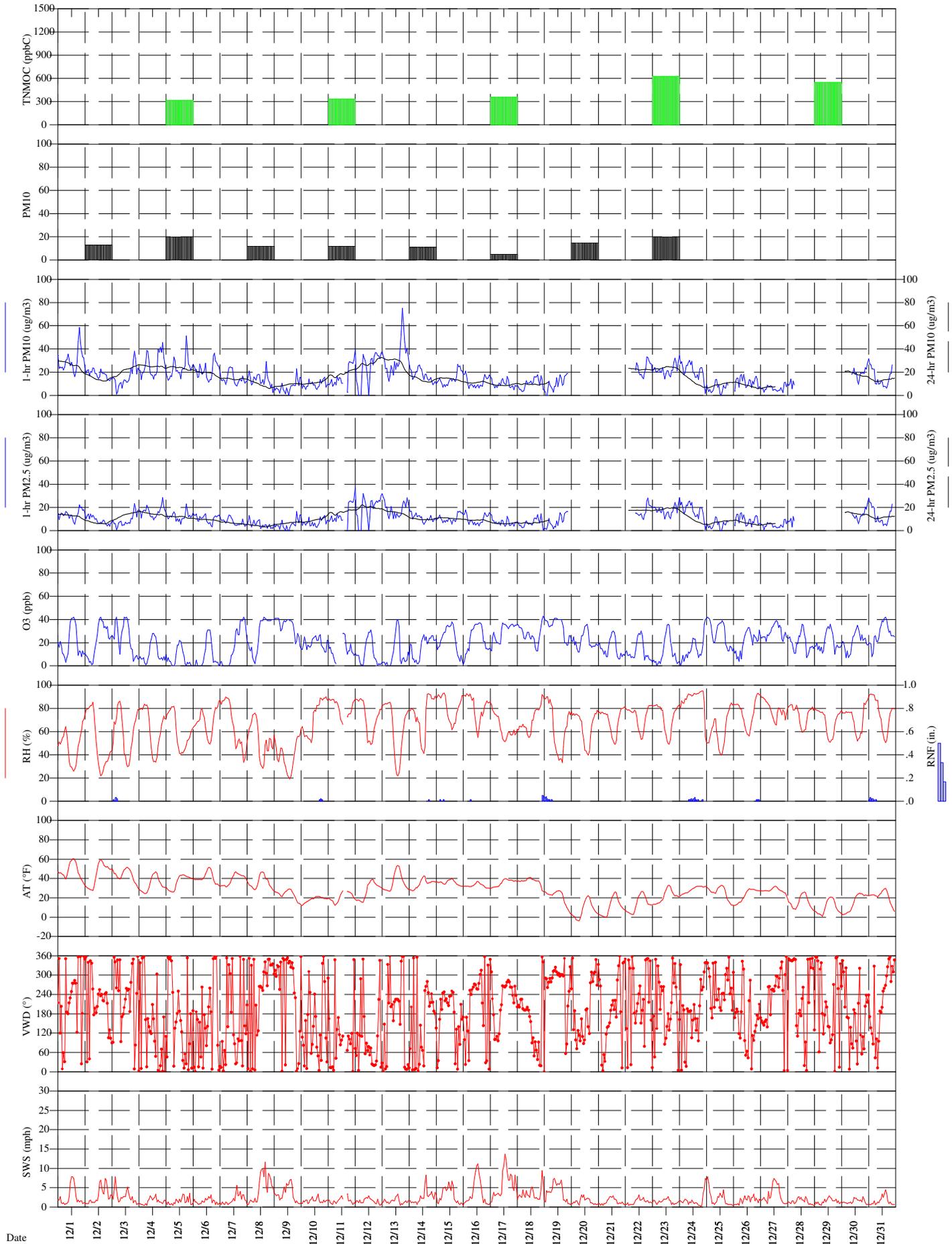
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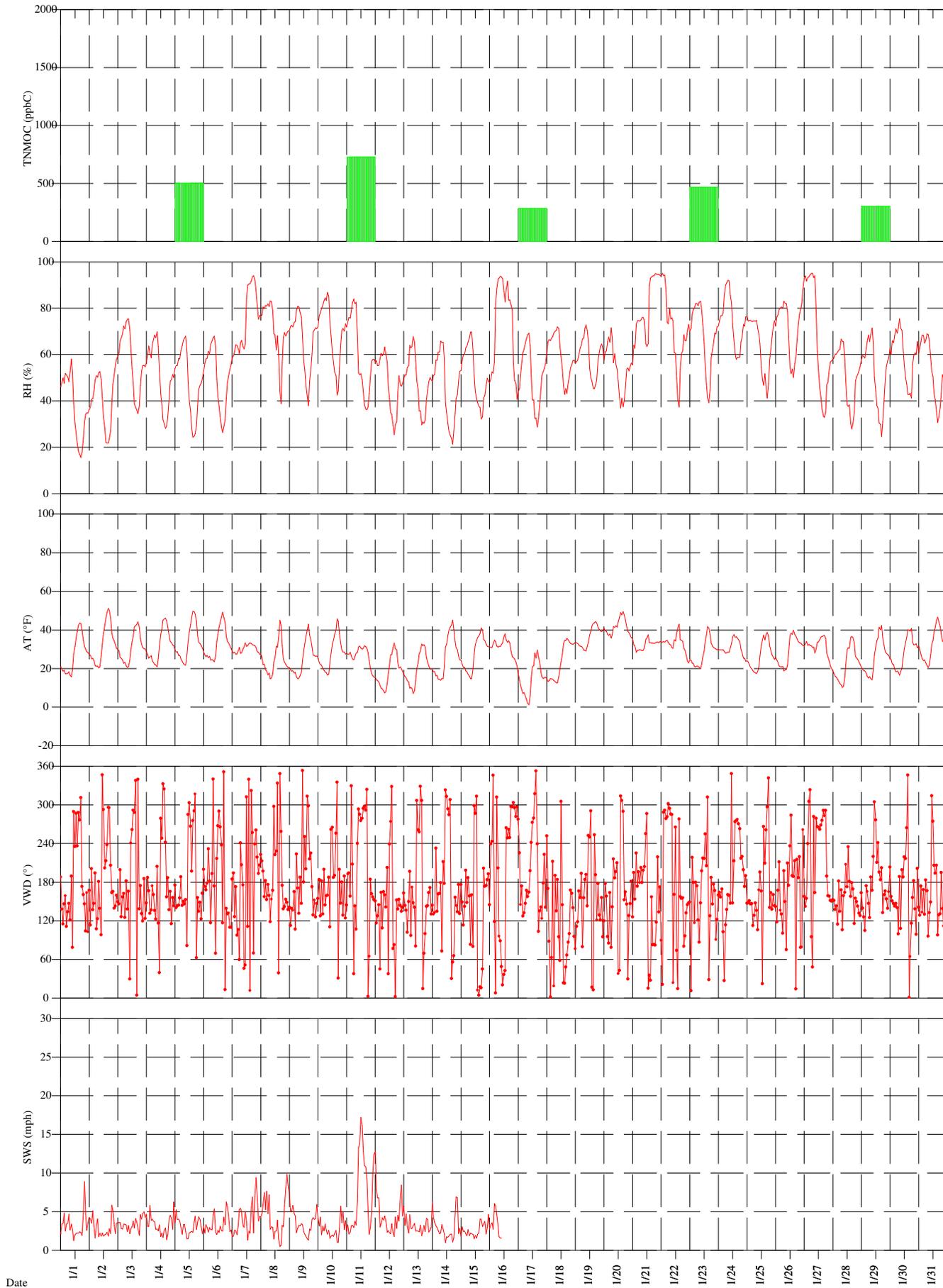


Garfield County, CO  
Rifle Site



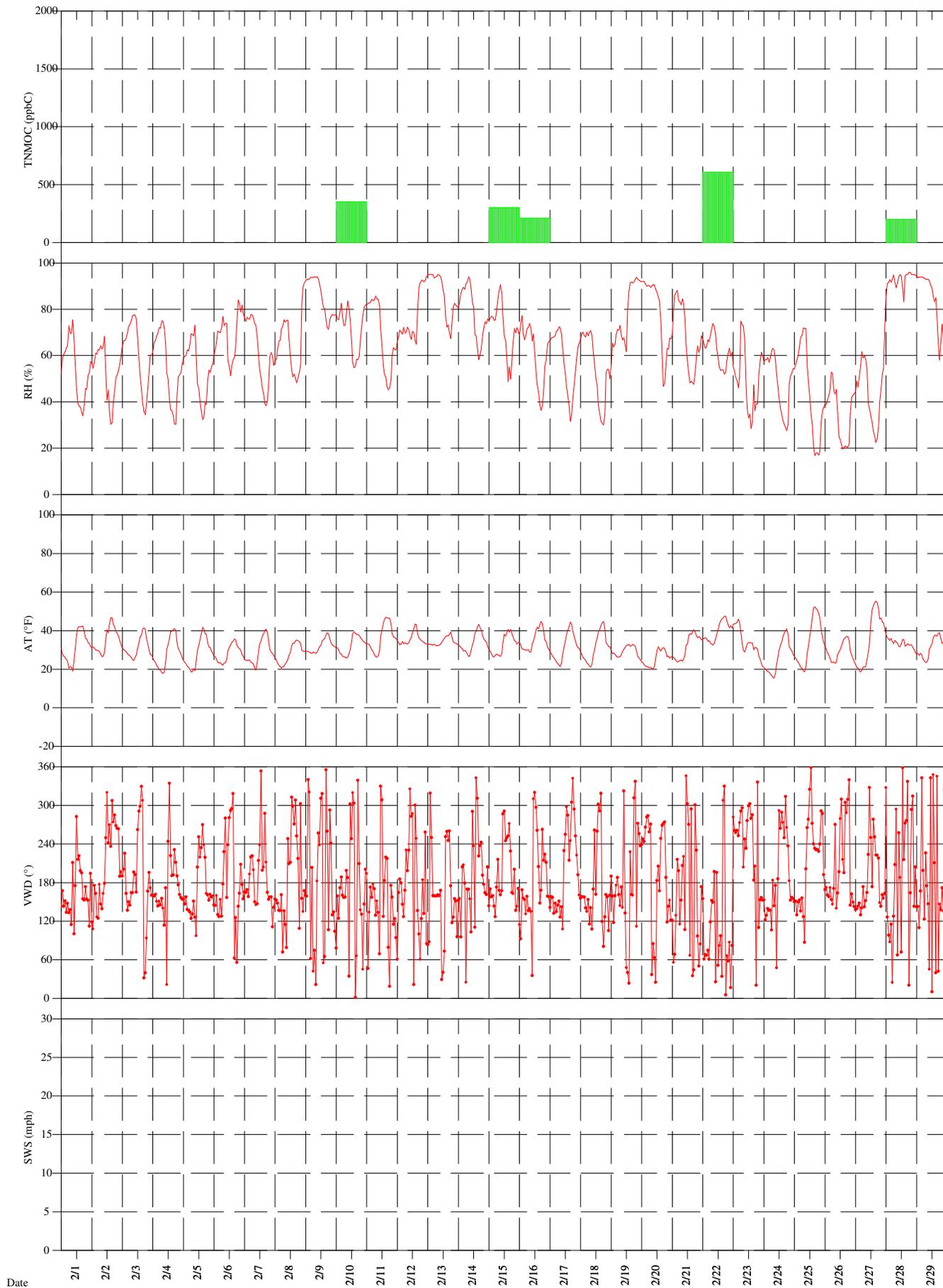
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## Bell Melton Site



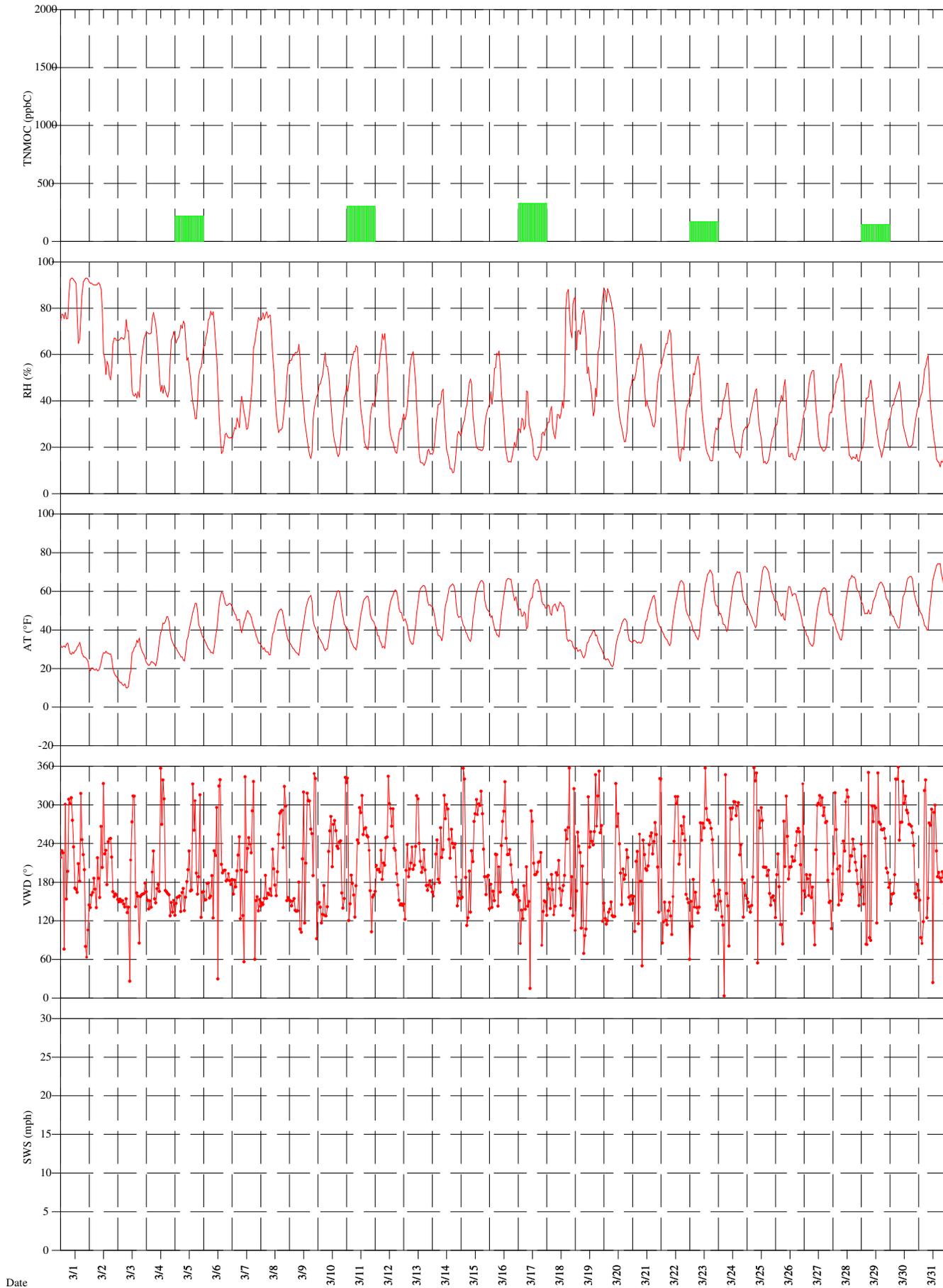
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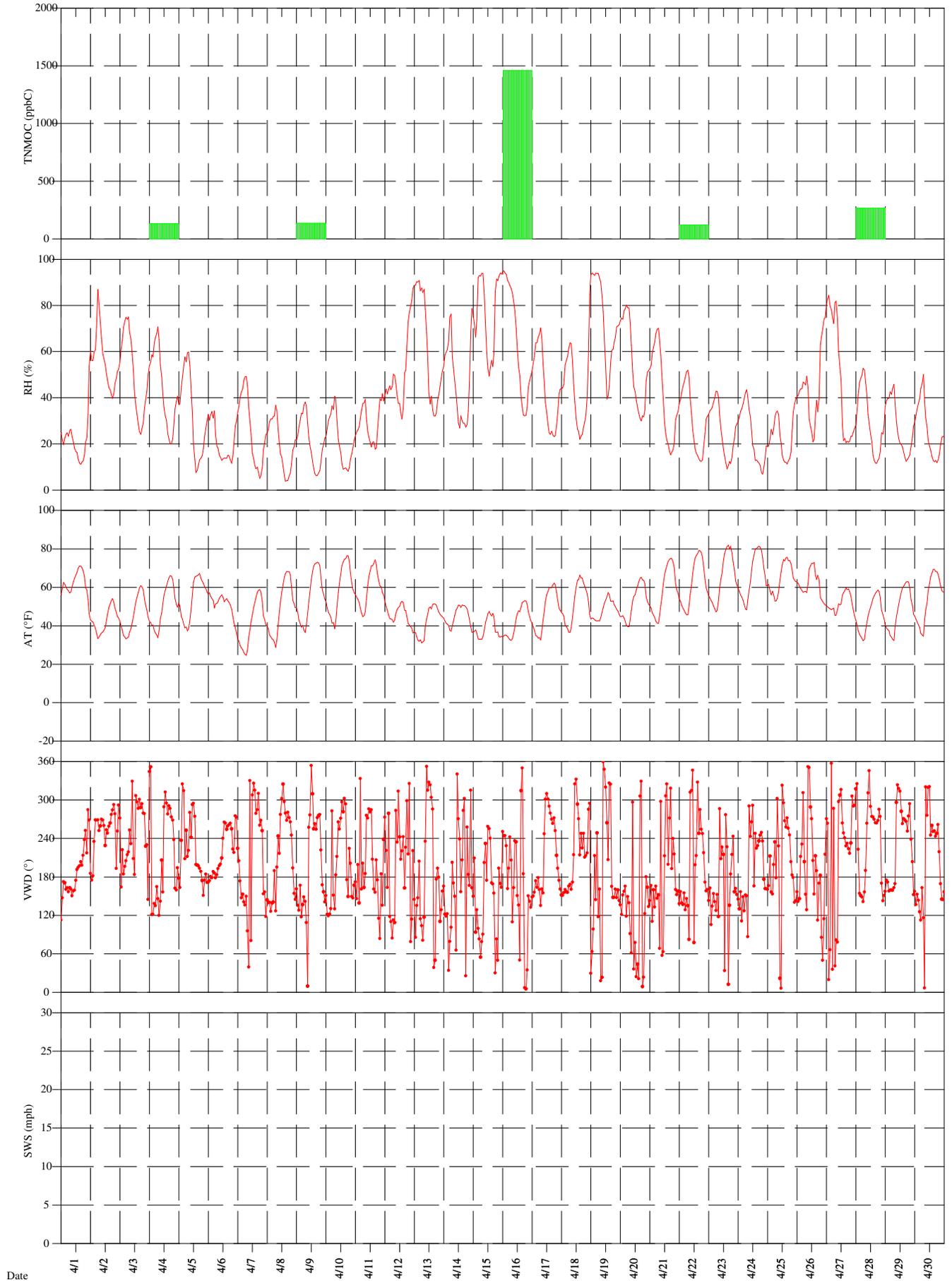


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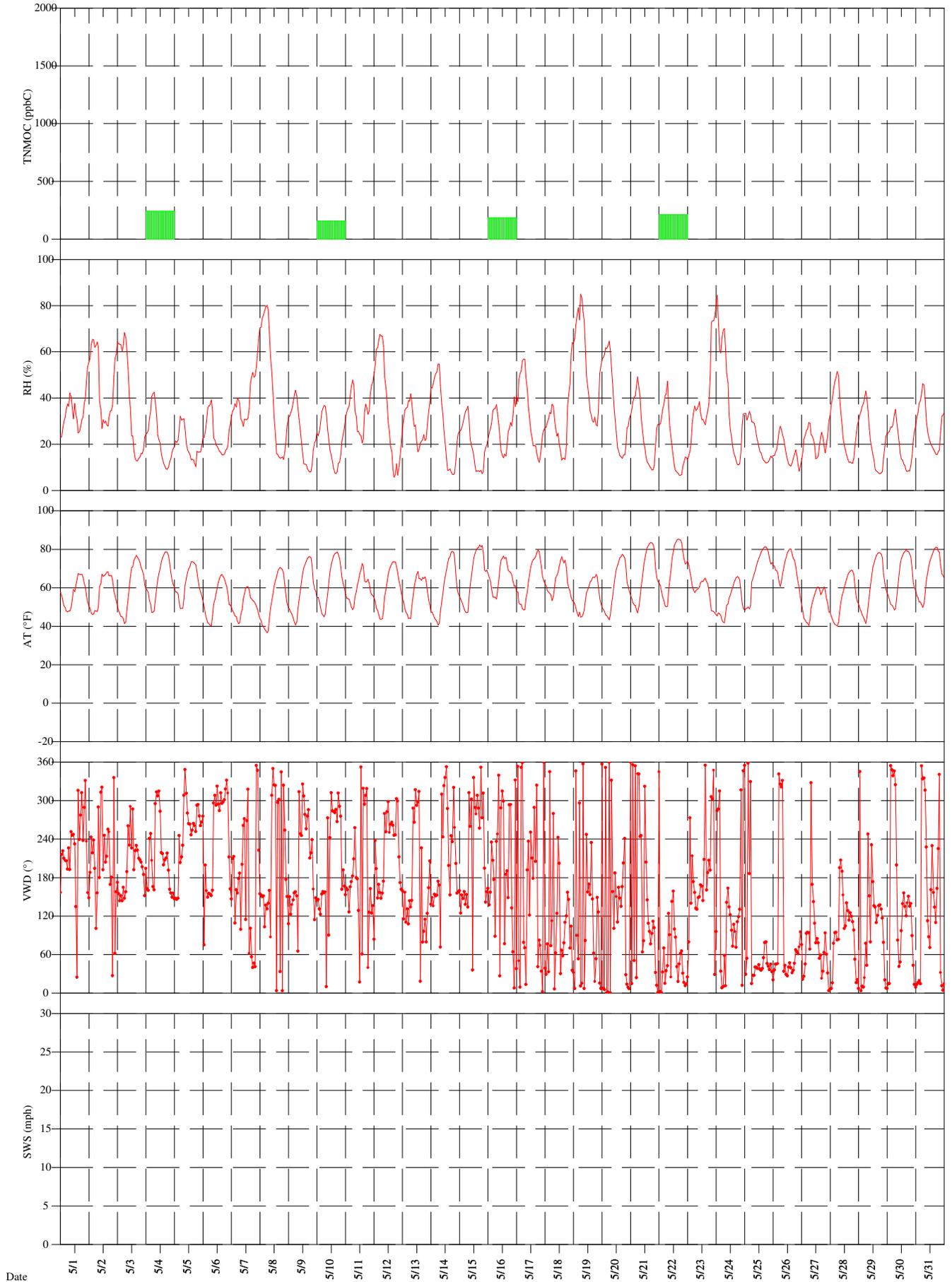
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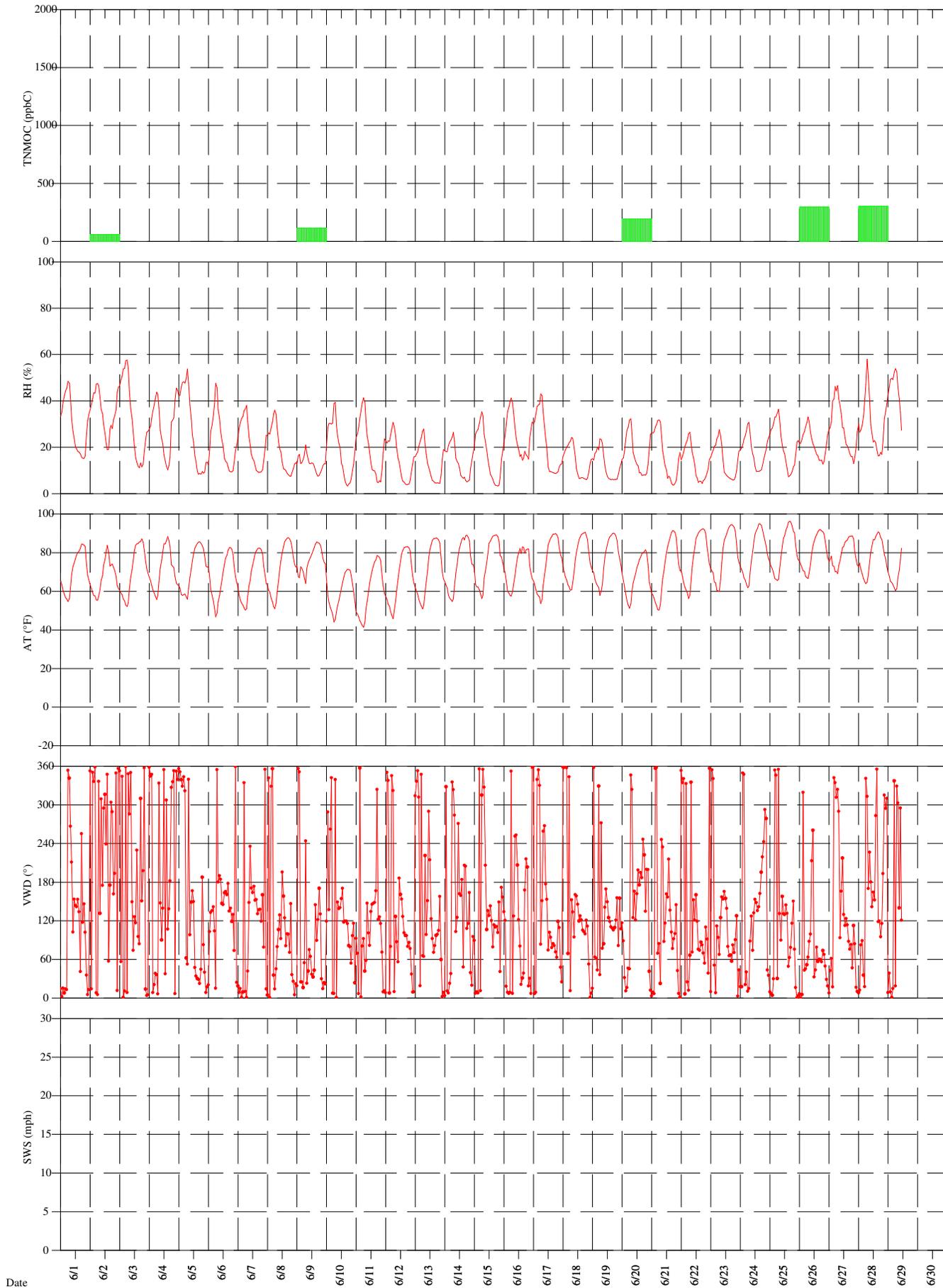


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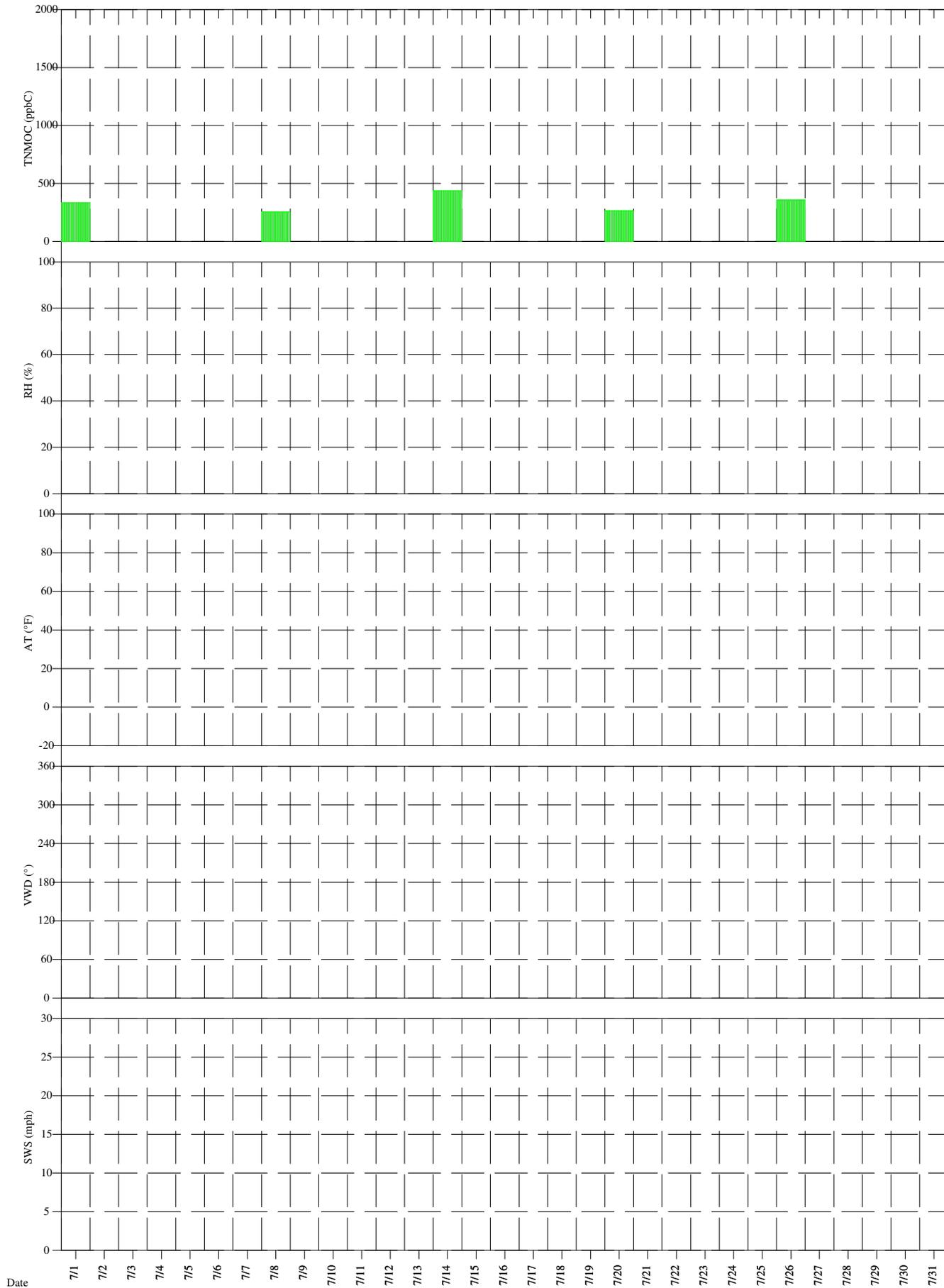
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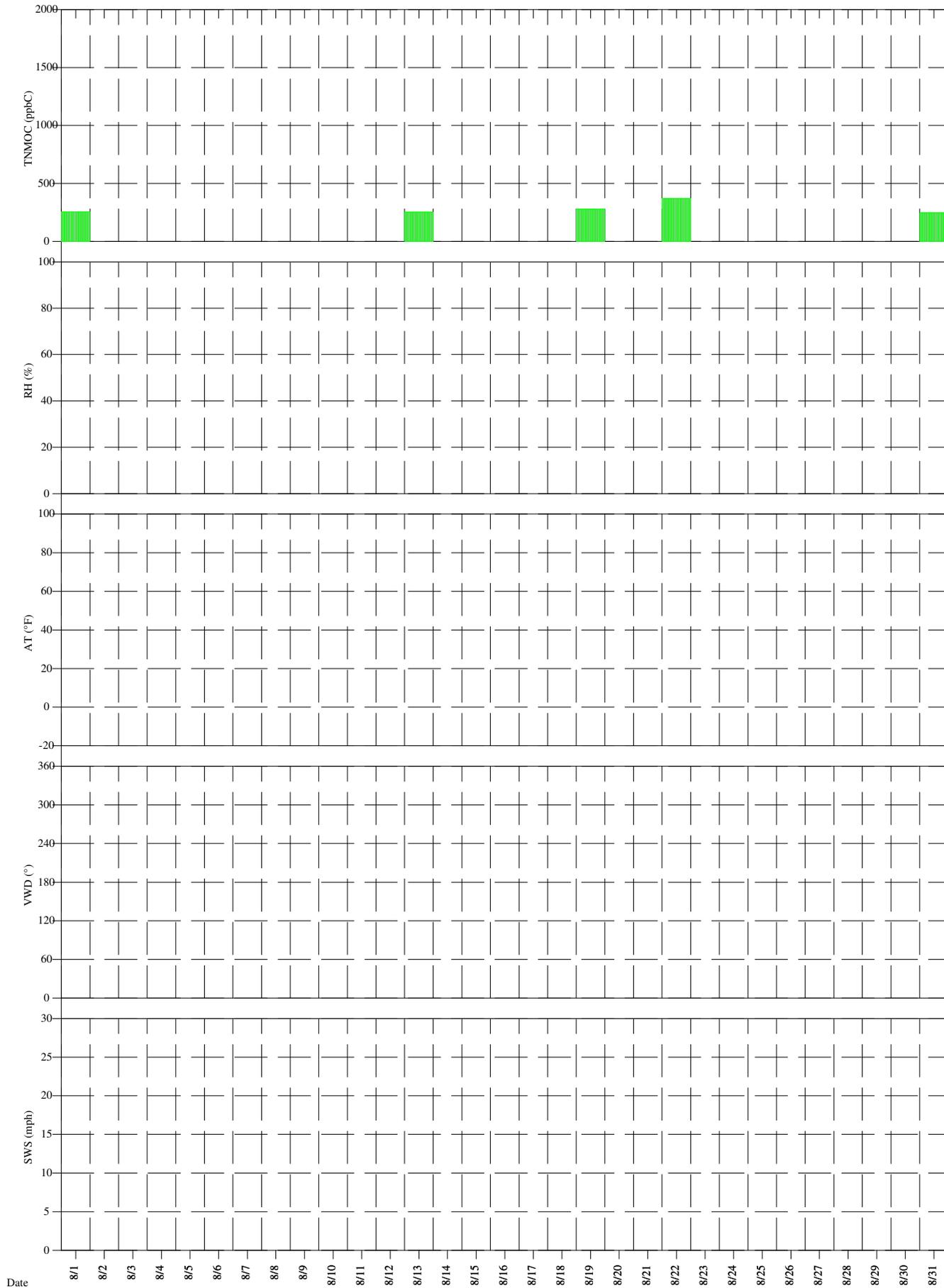
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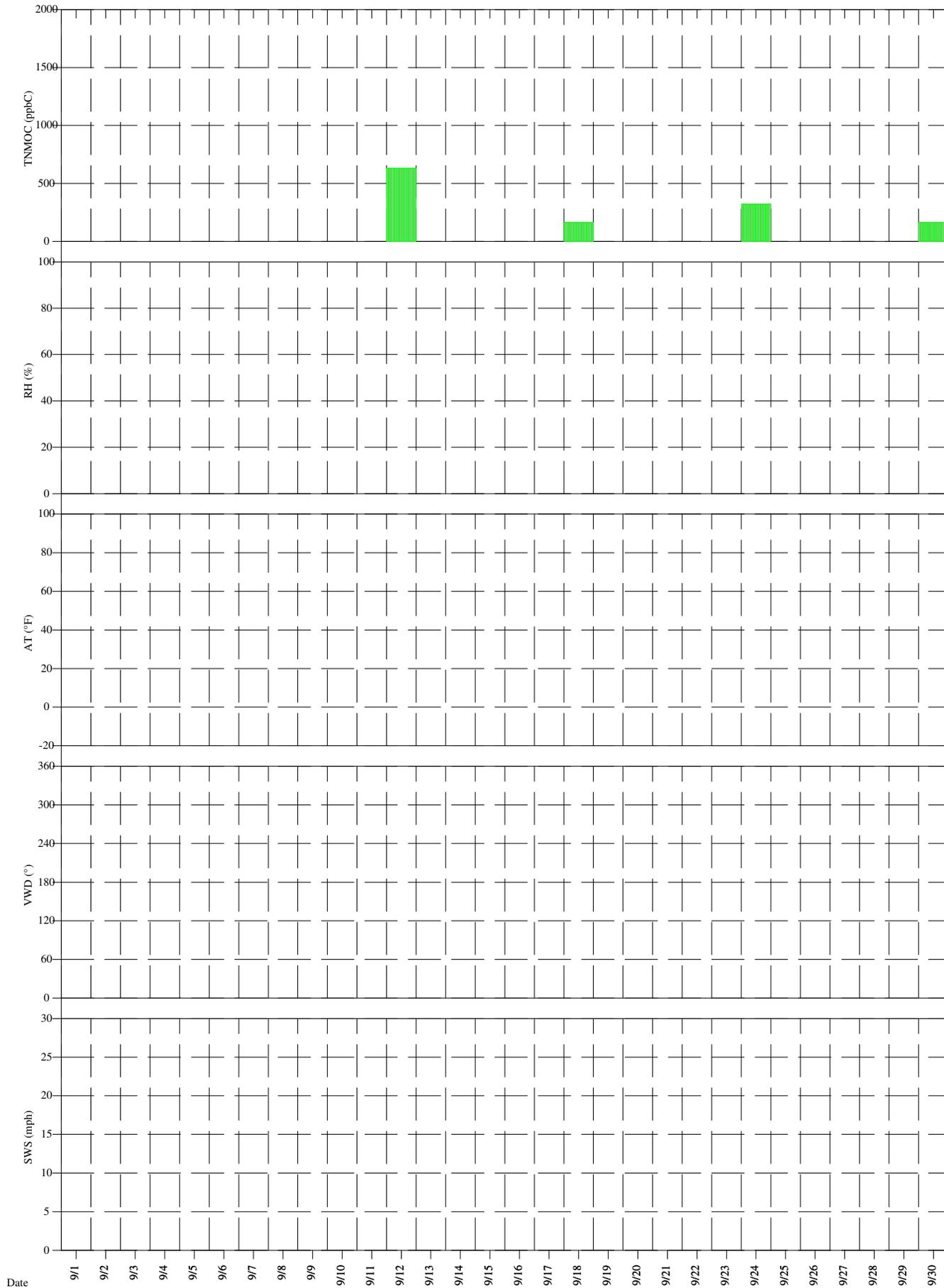
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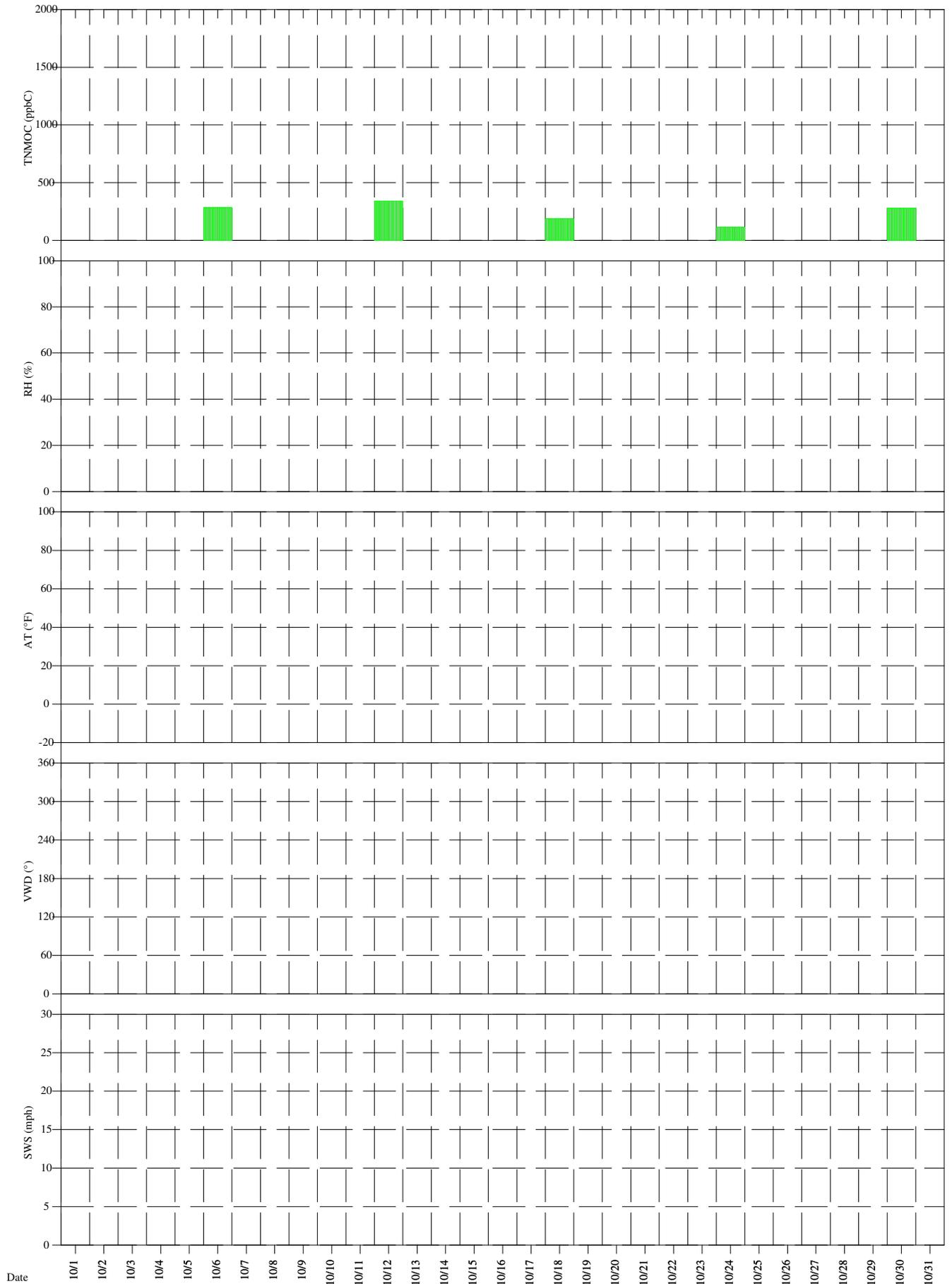
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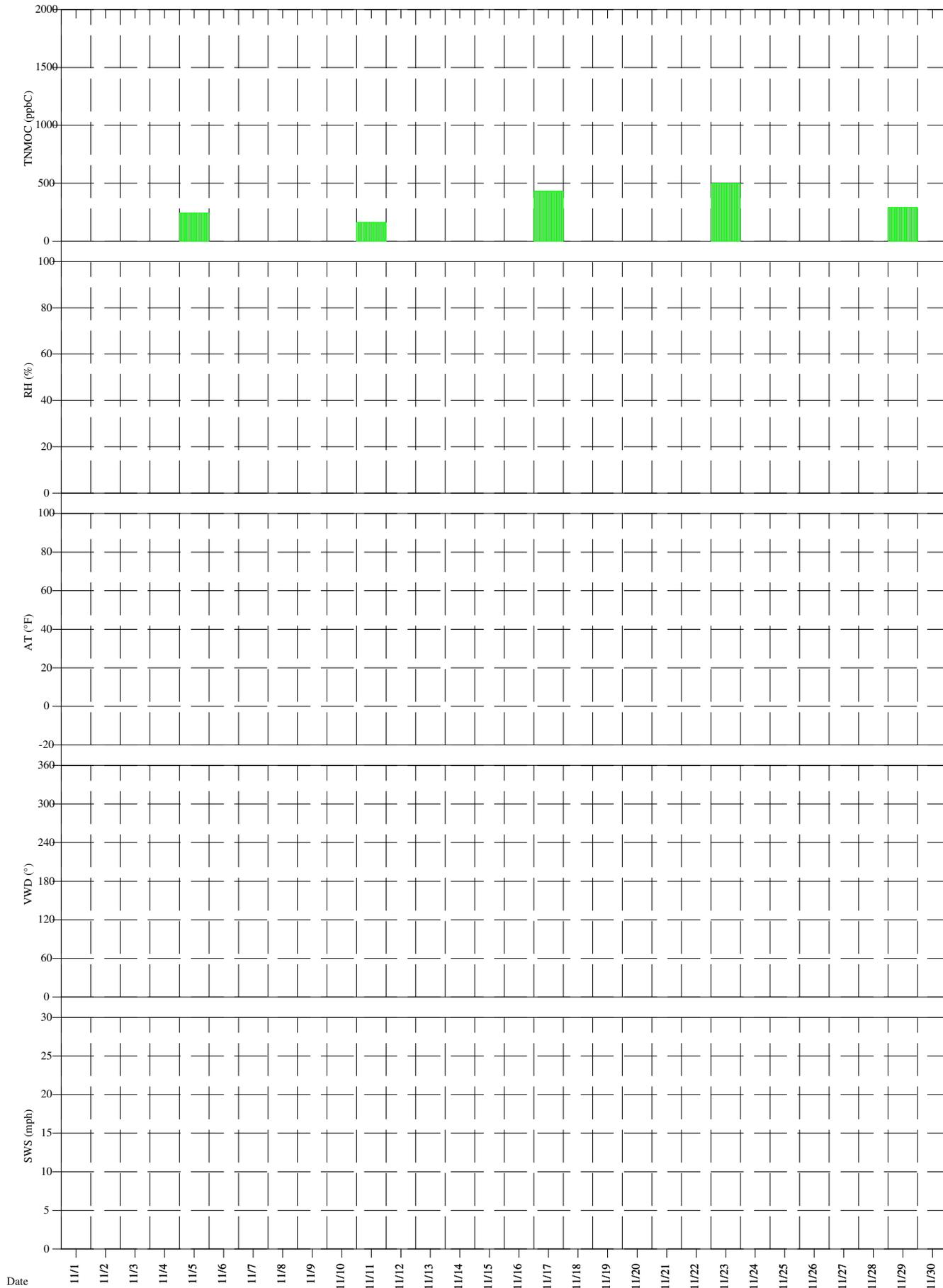
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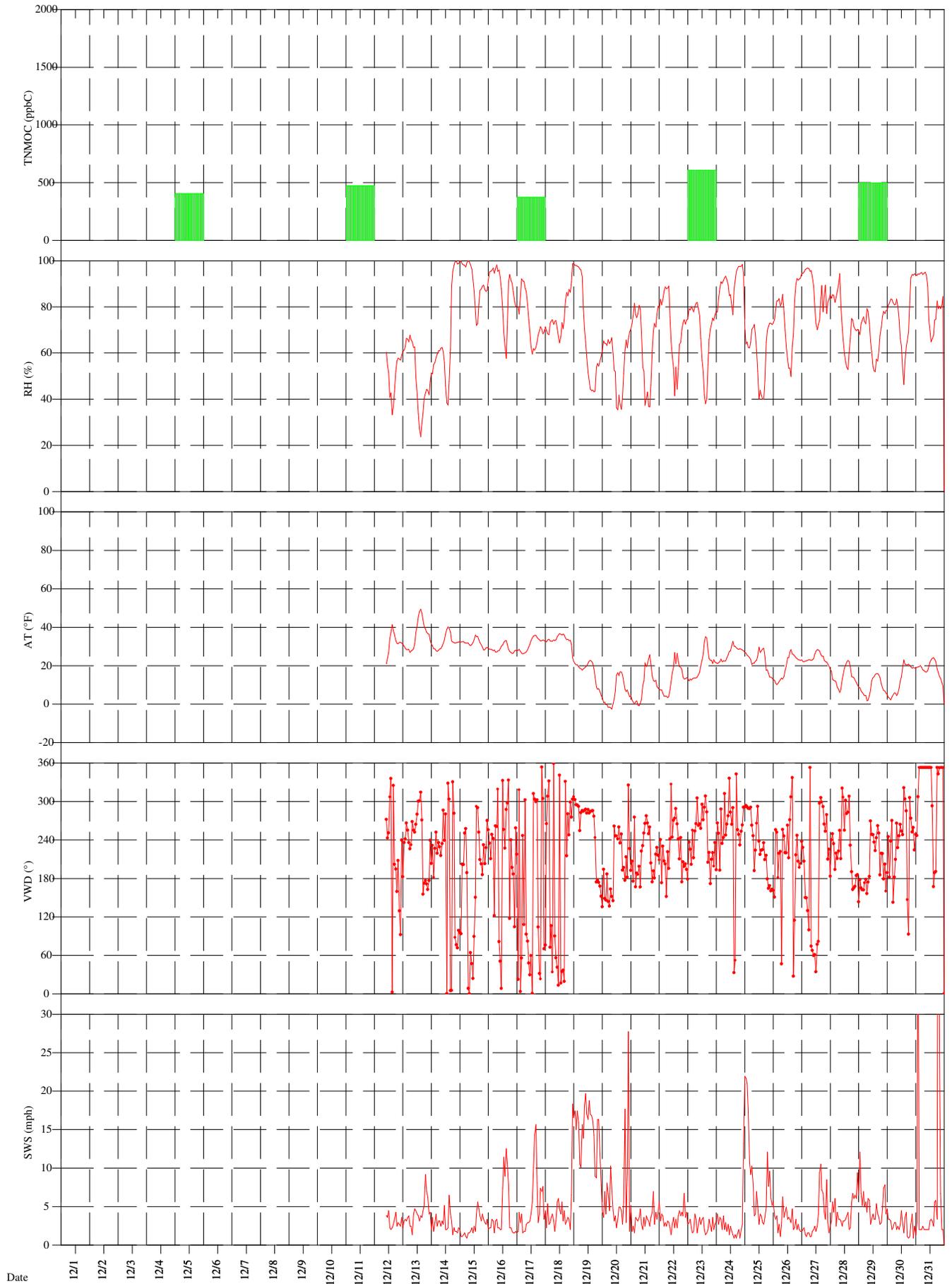
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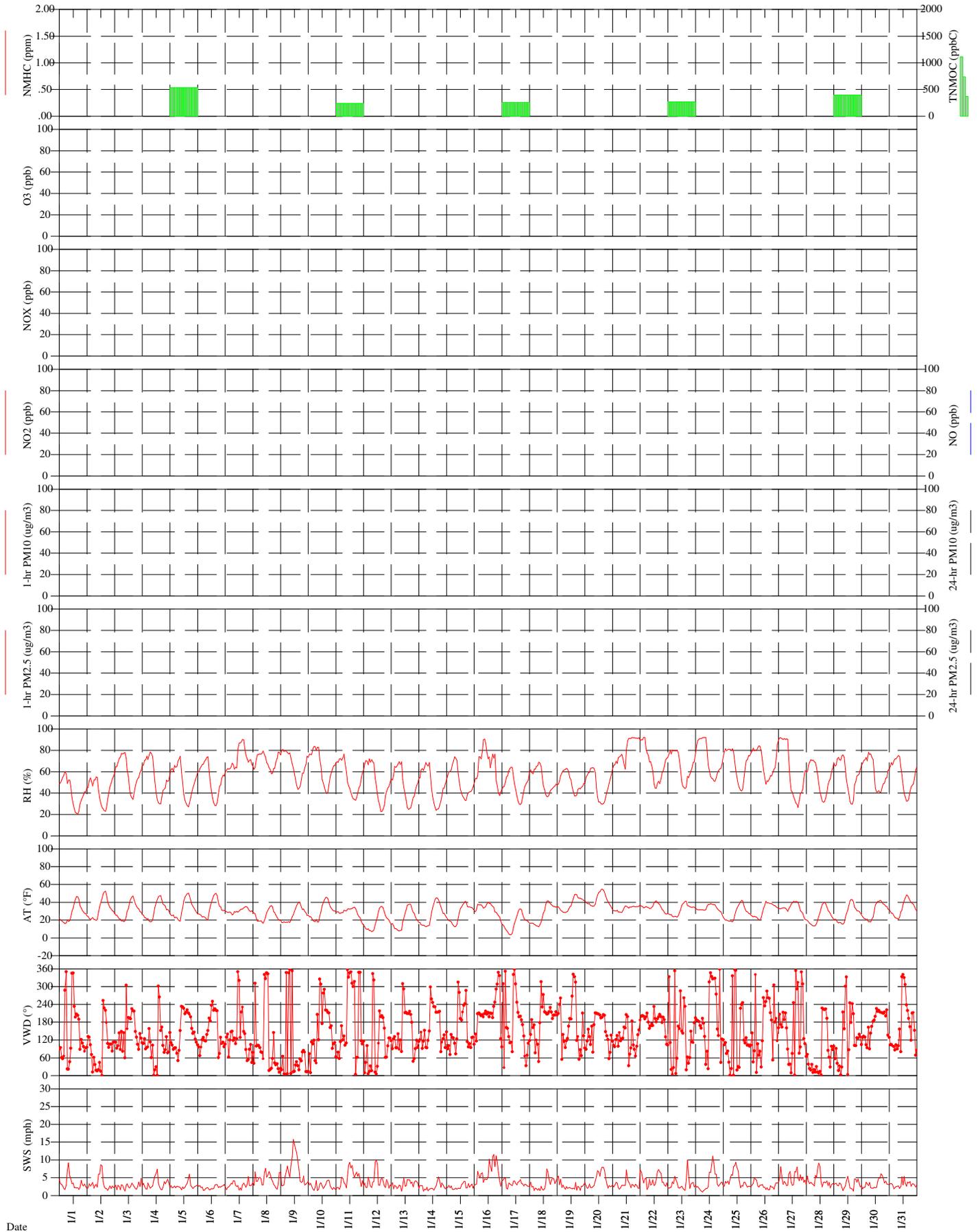


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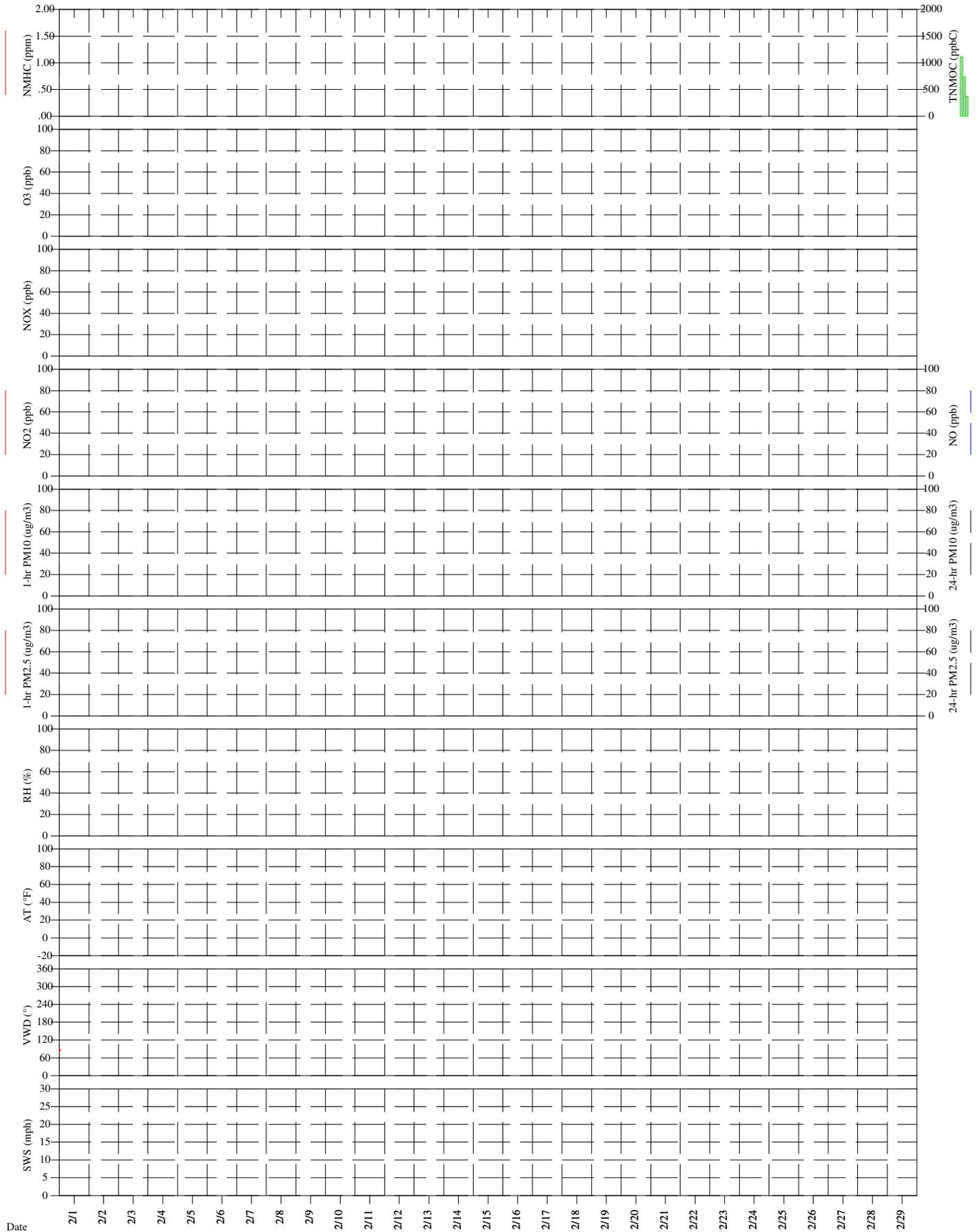
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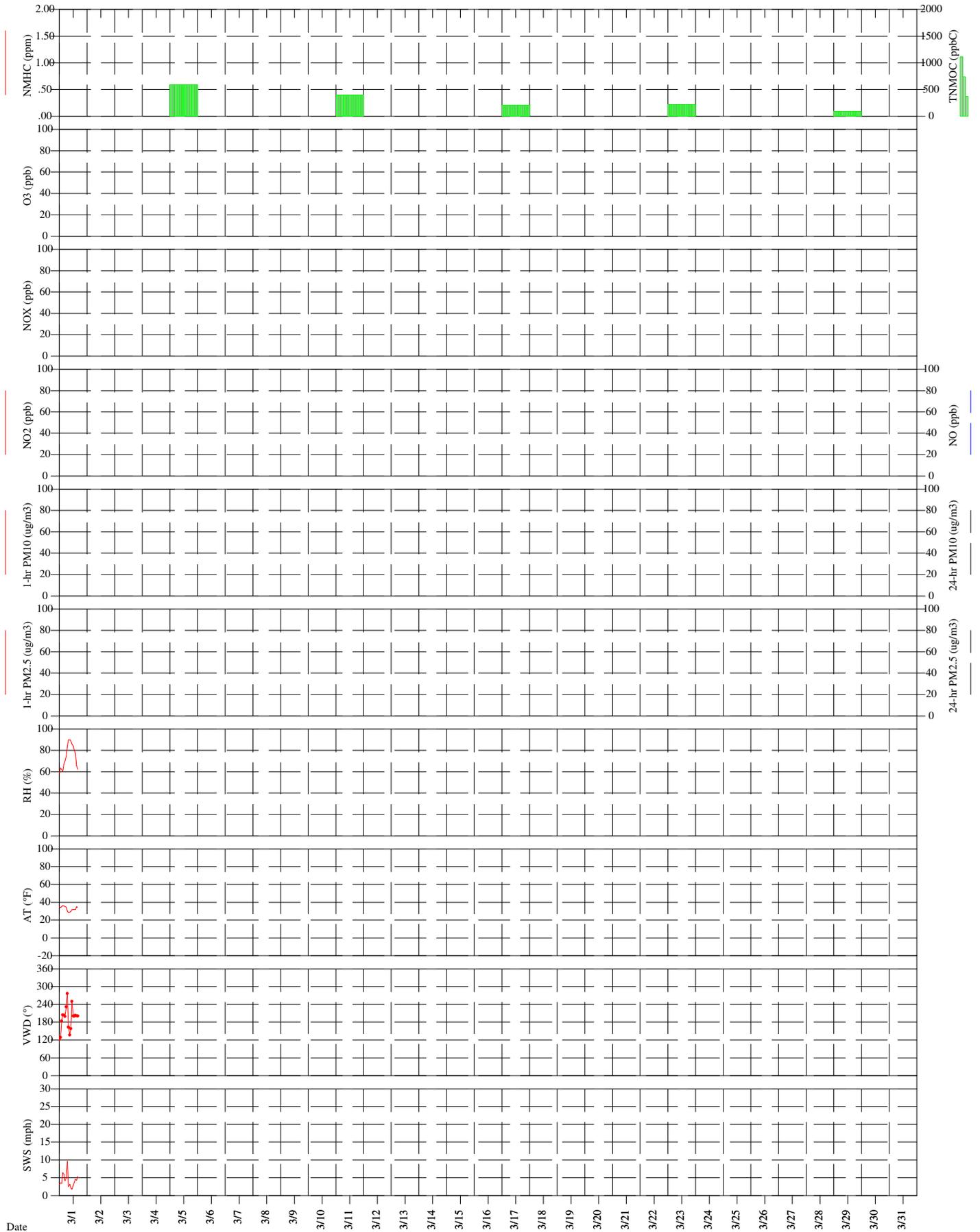
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Battlement Mesa Site



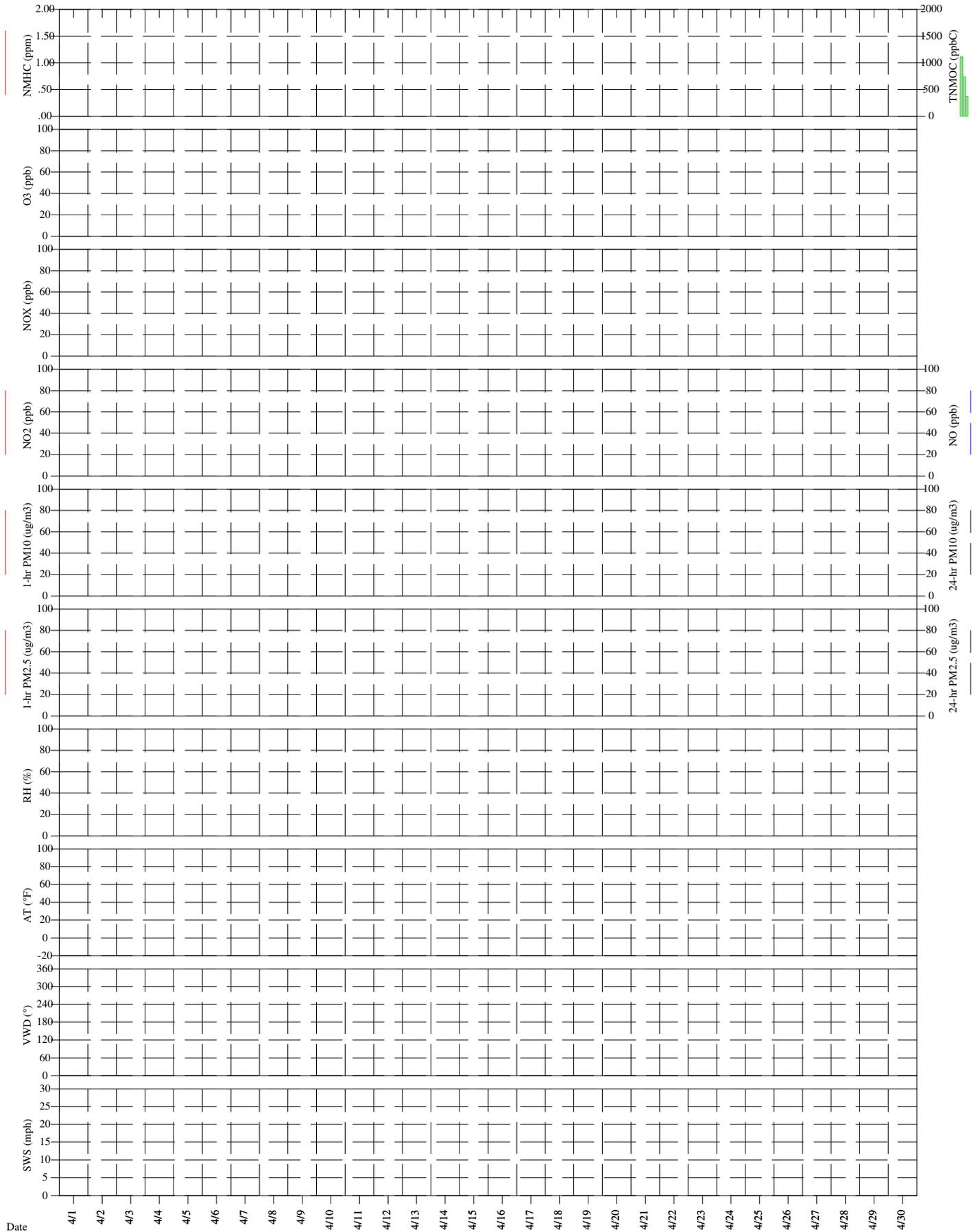
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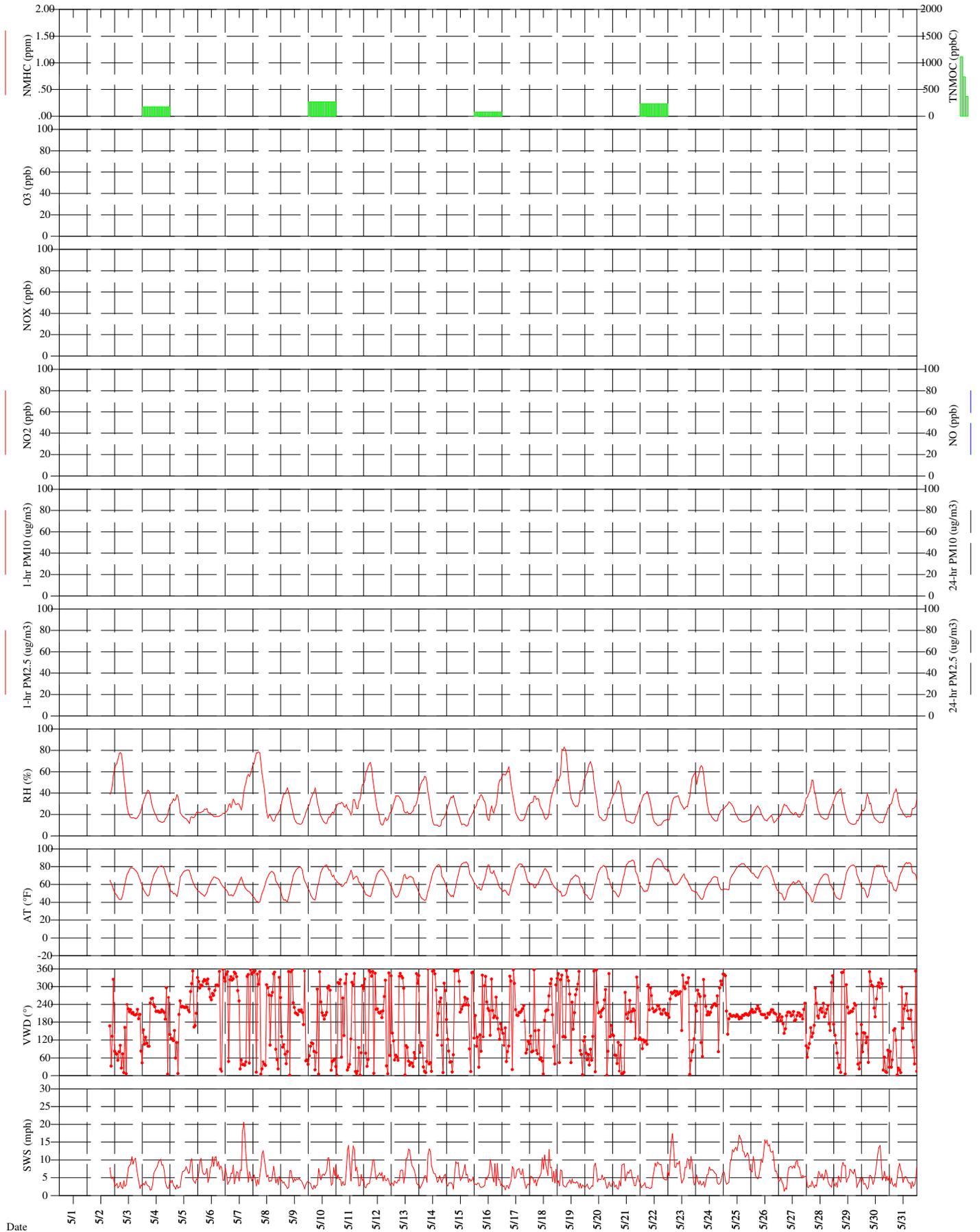
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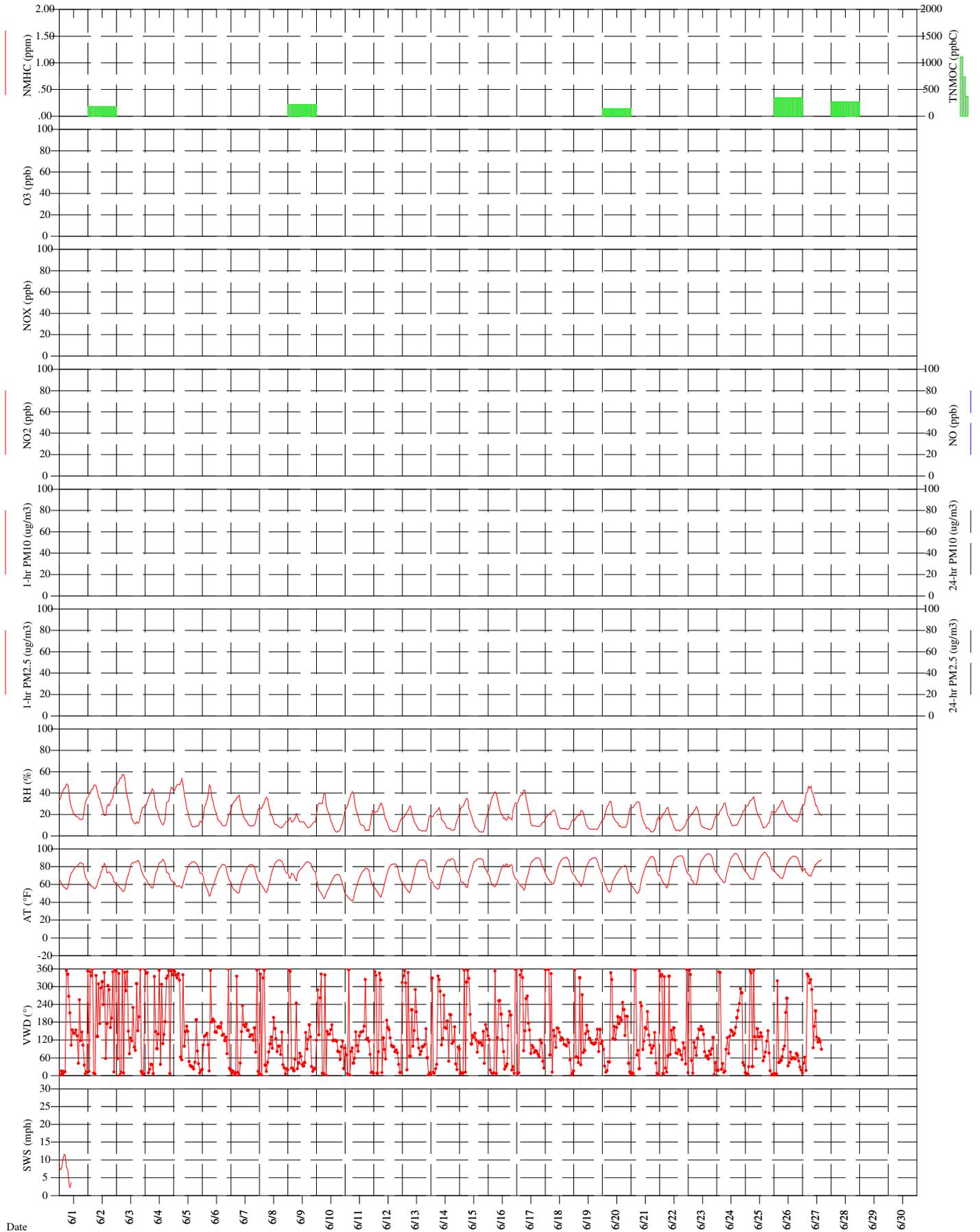
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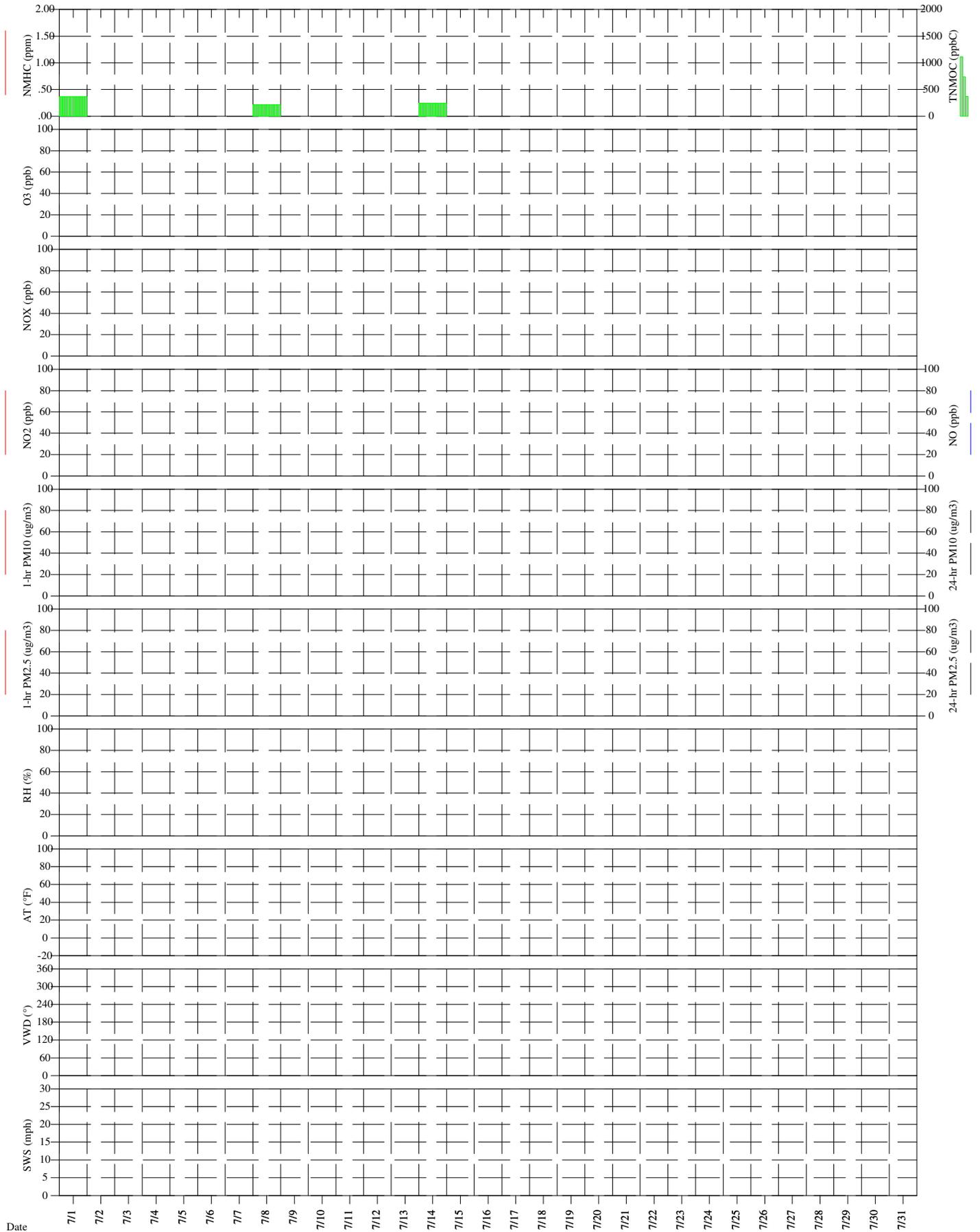
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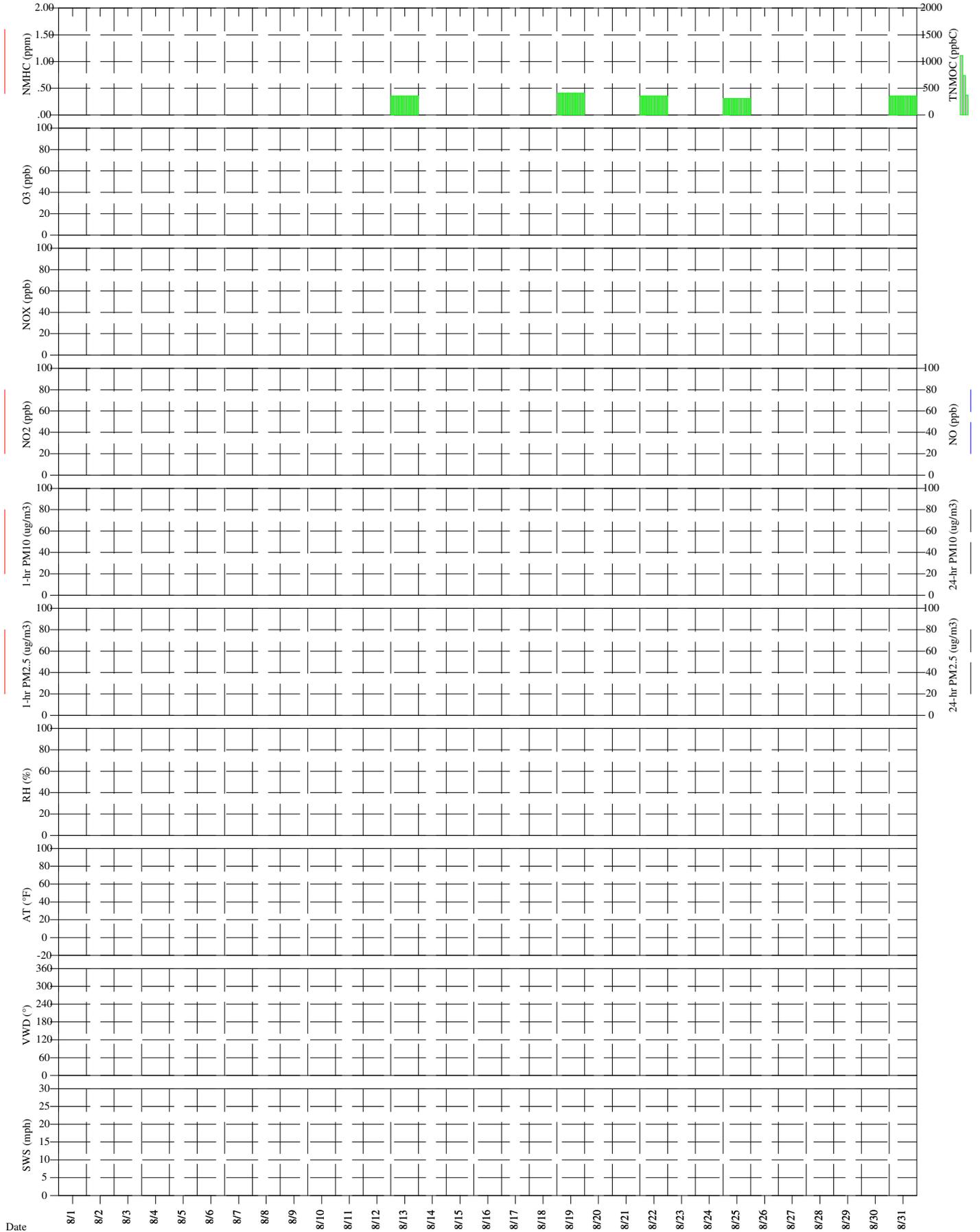
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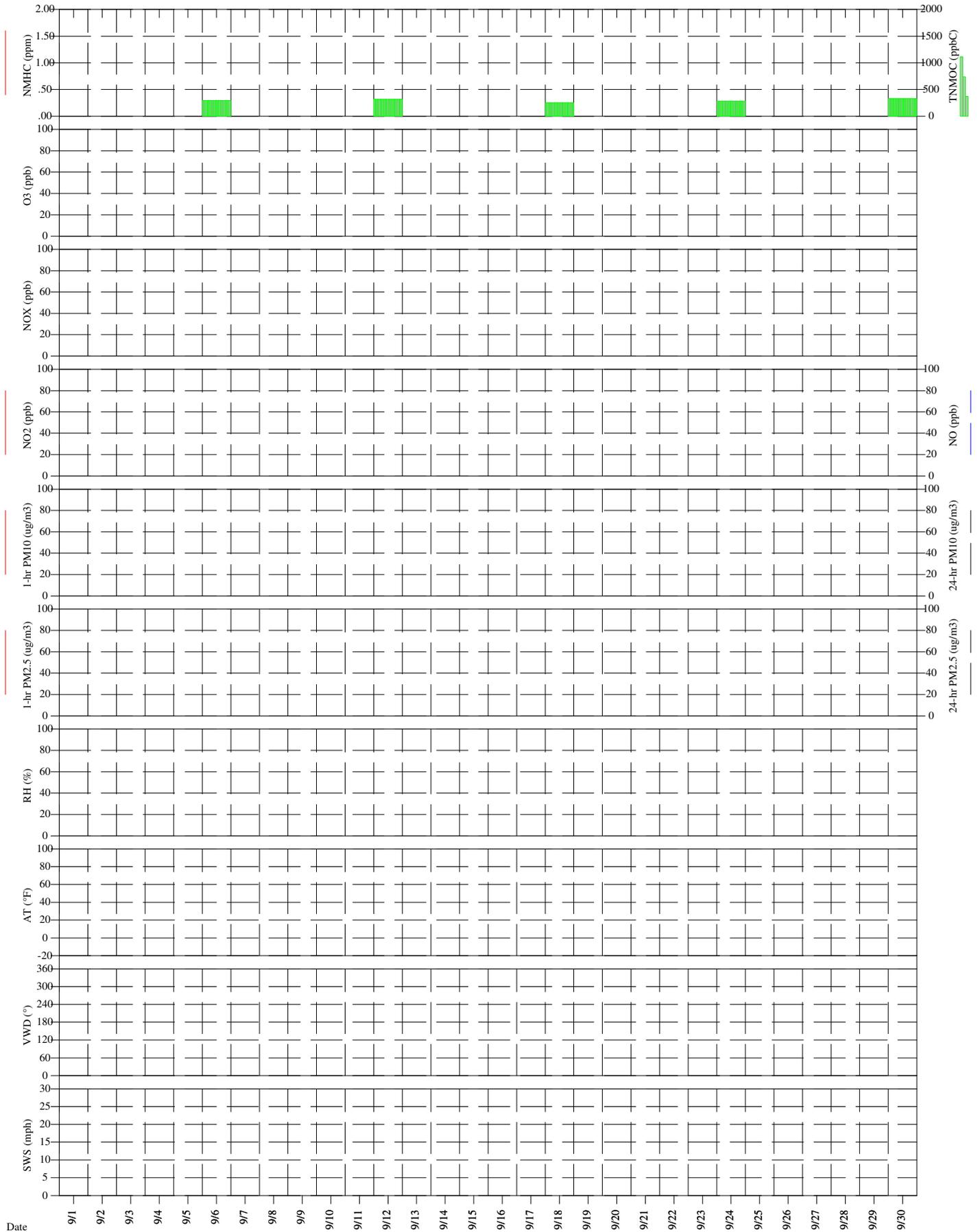
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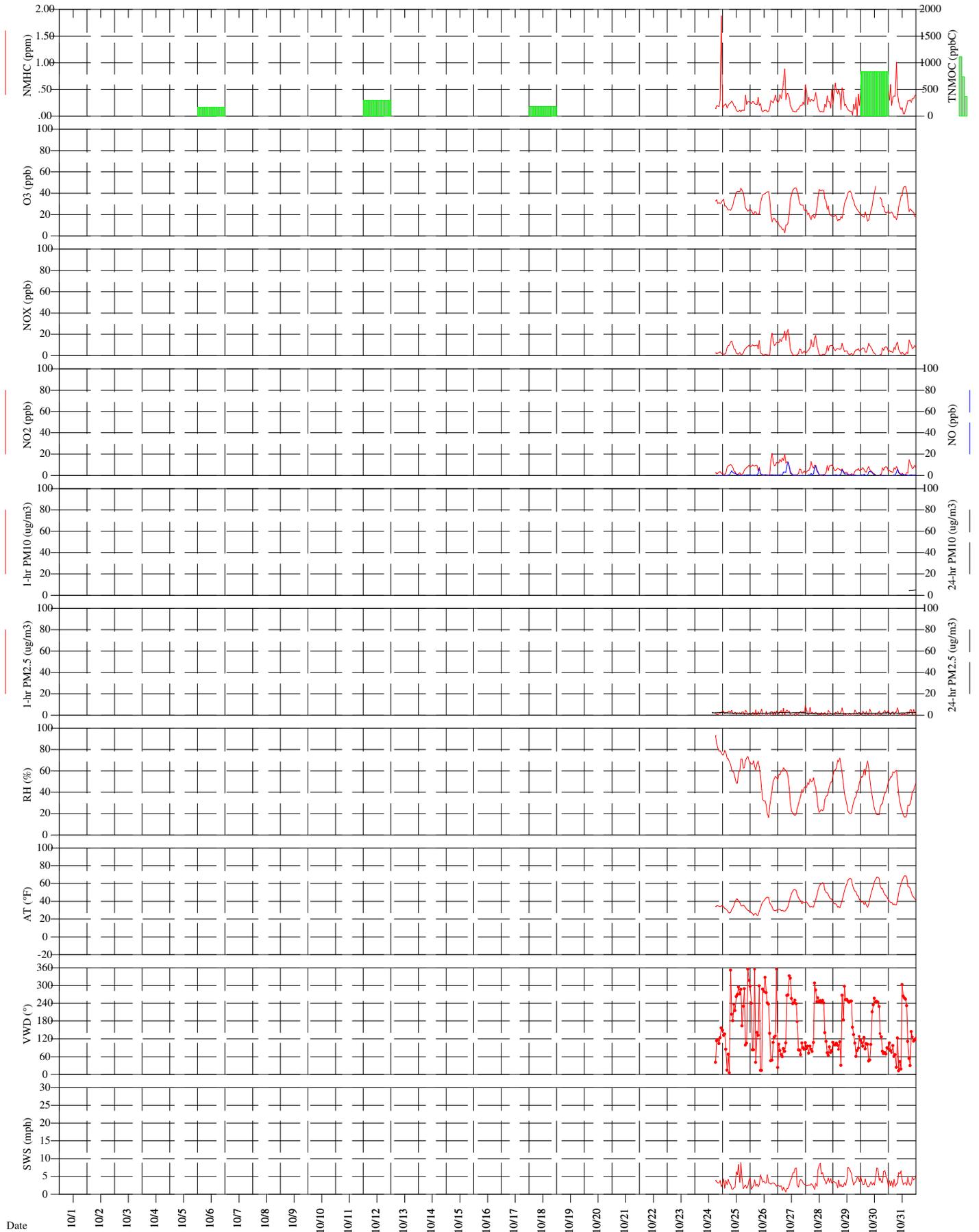
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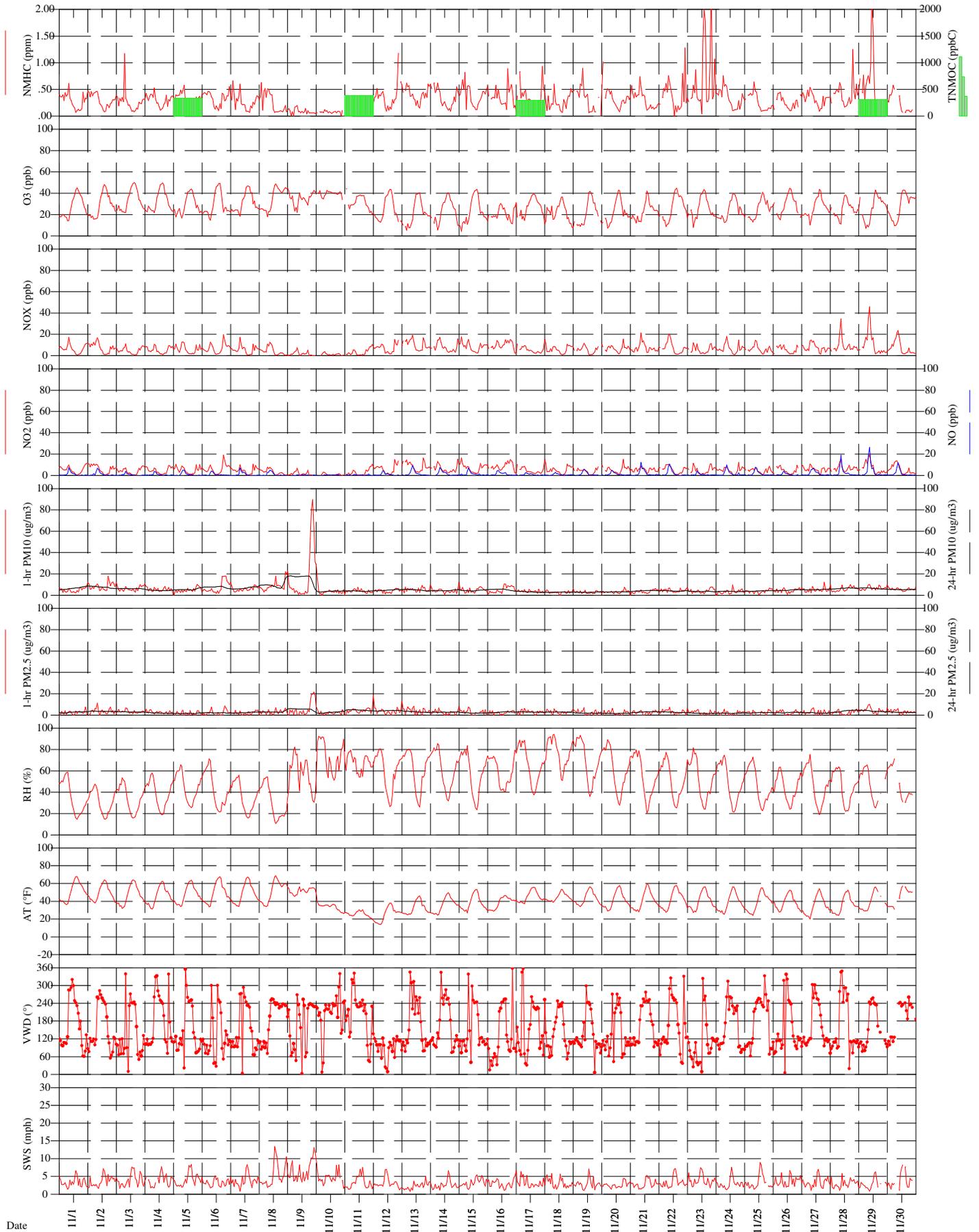
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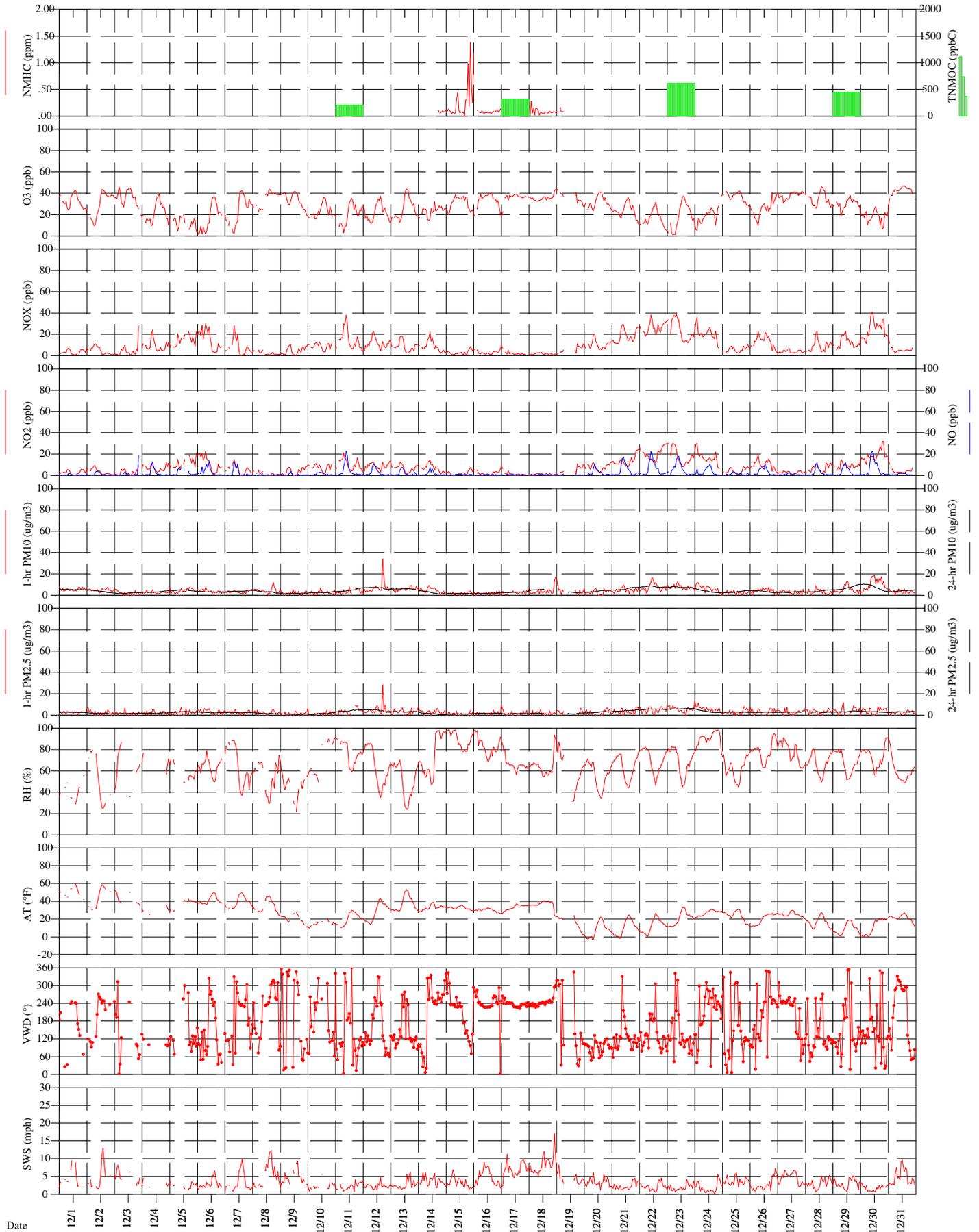
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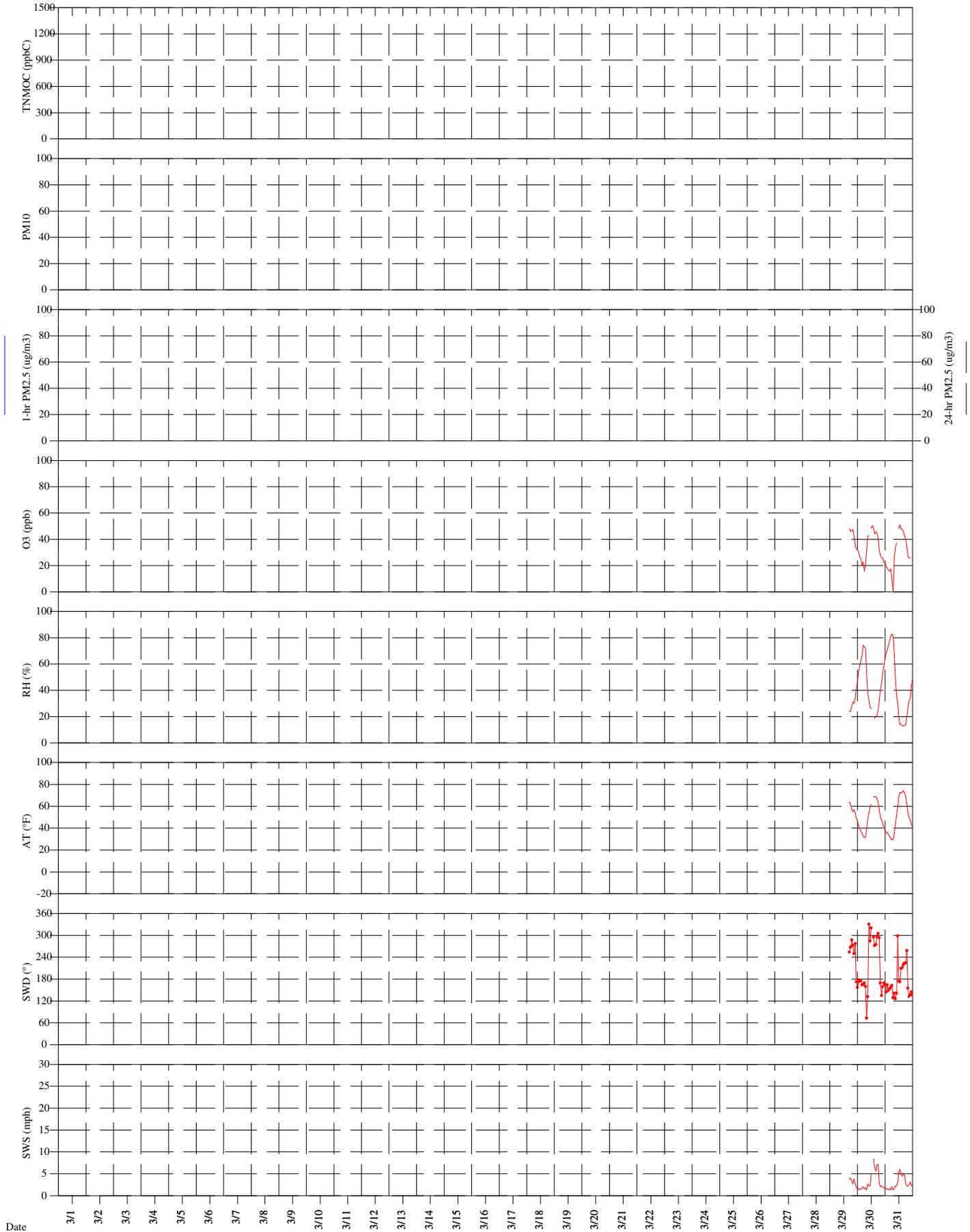
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Battlement Mesa Site



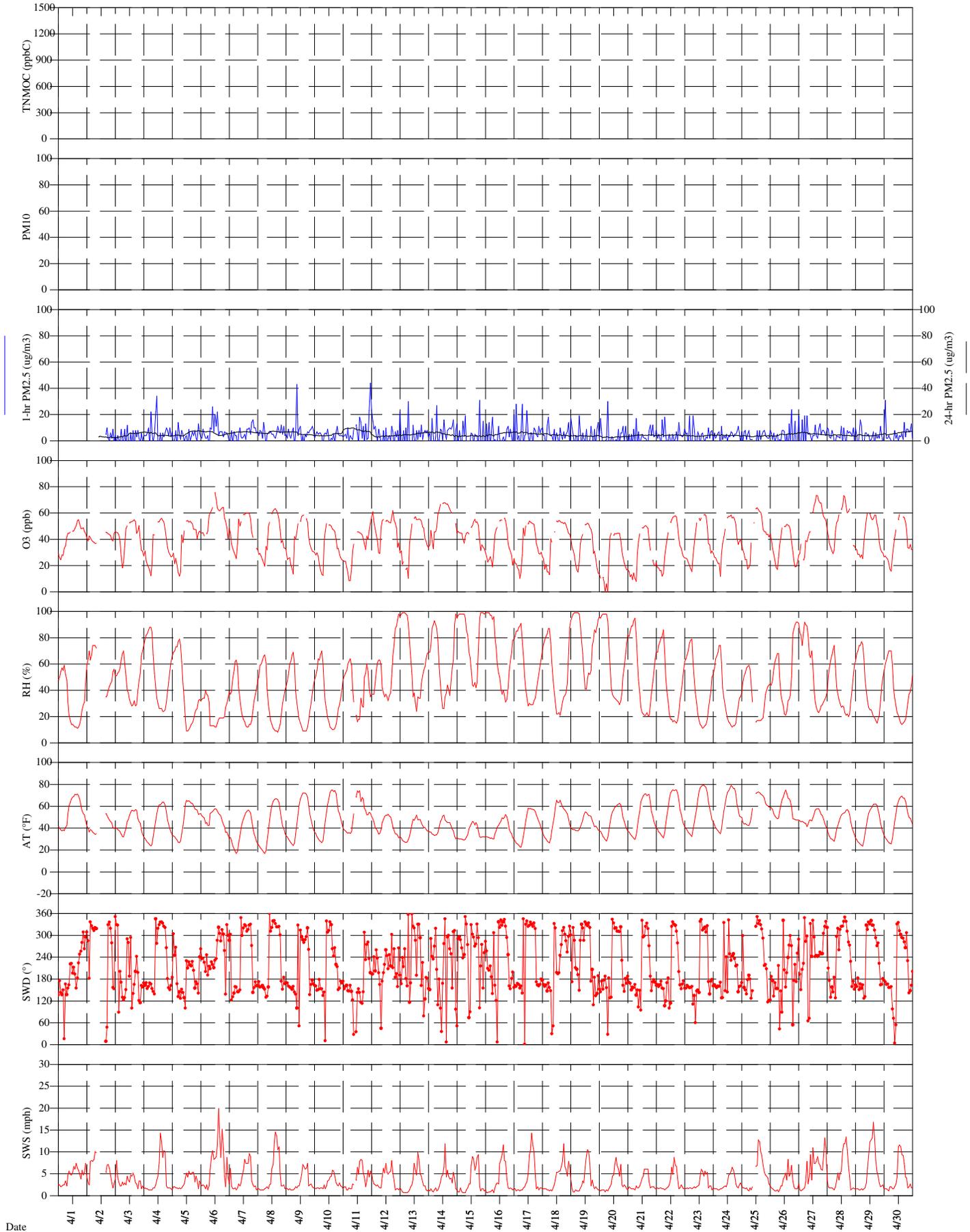
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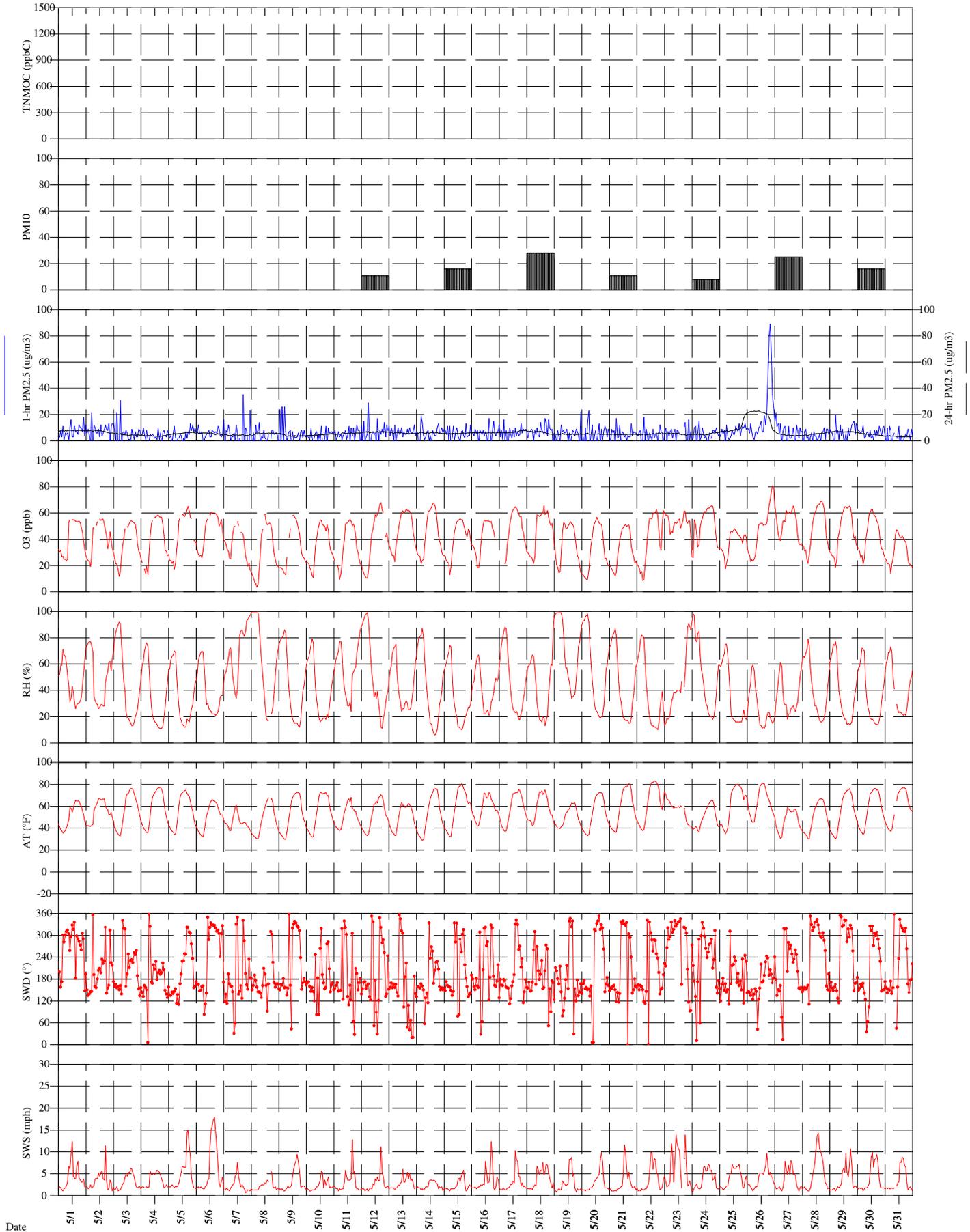
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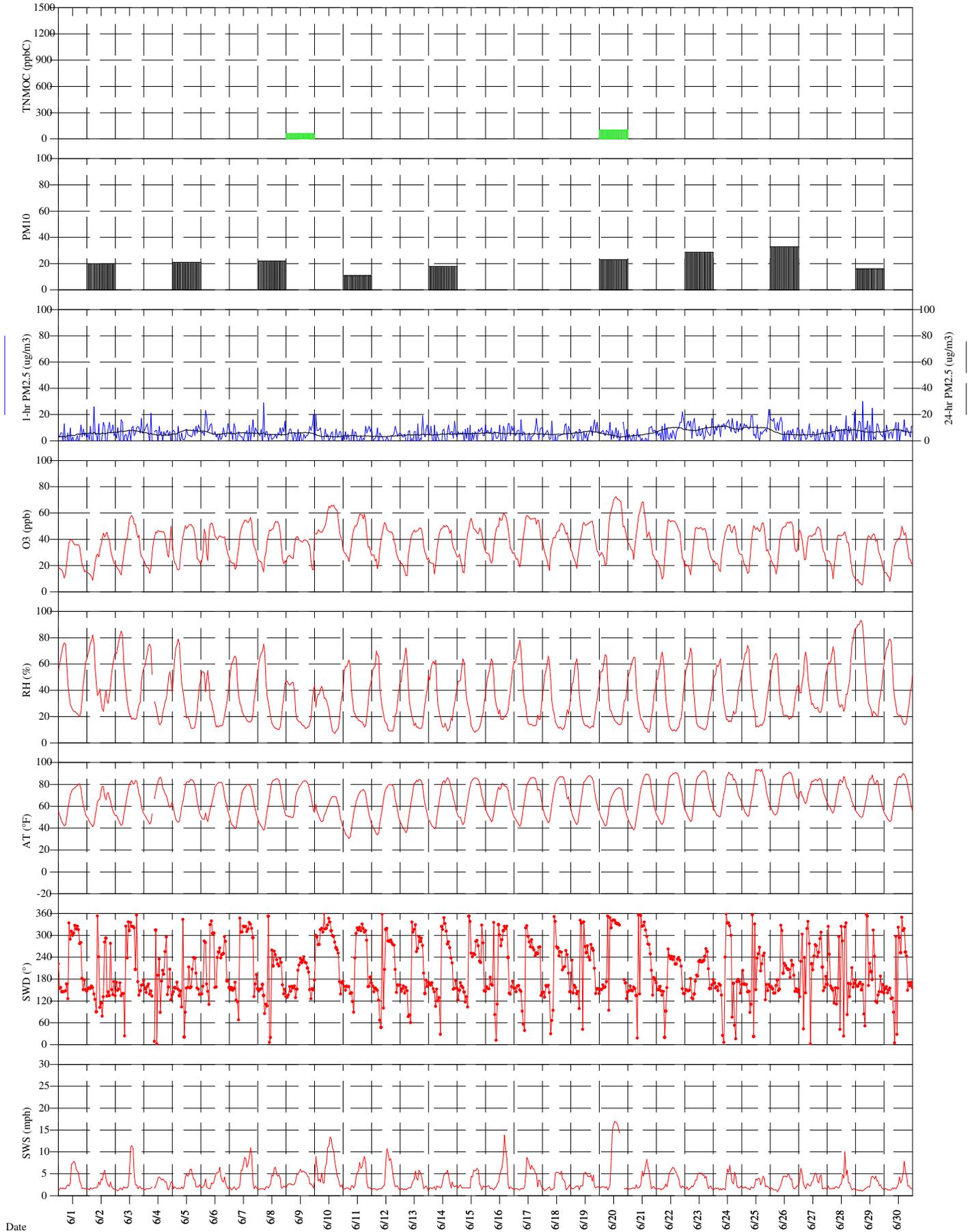
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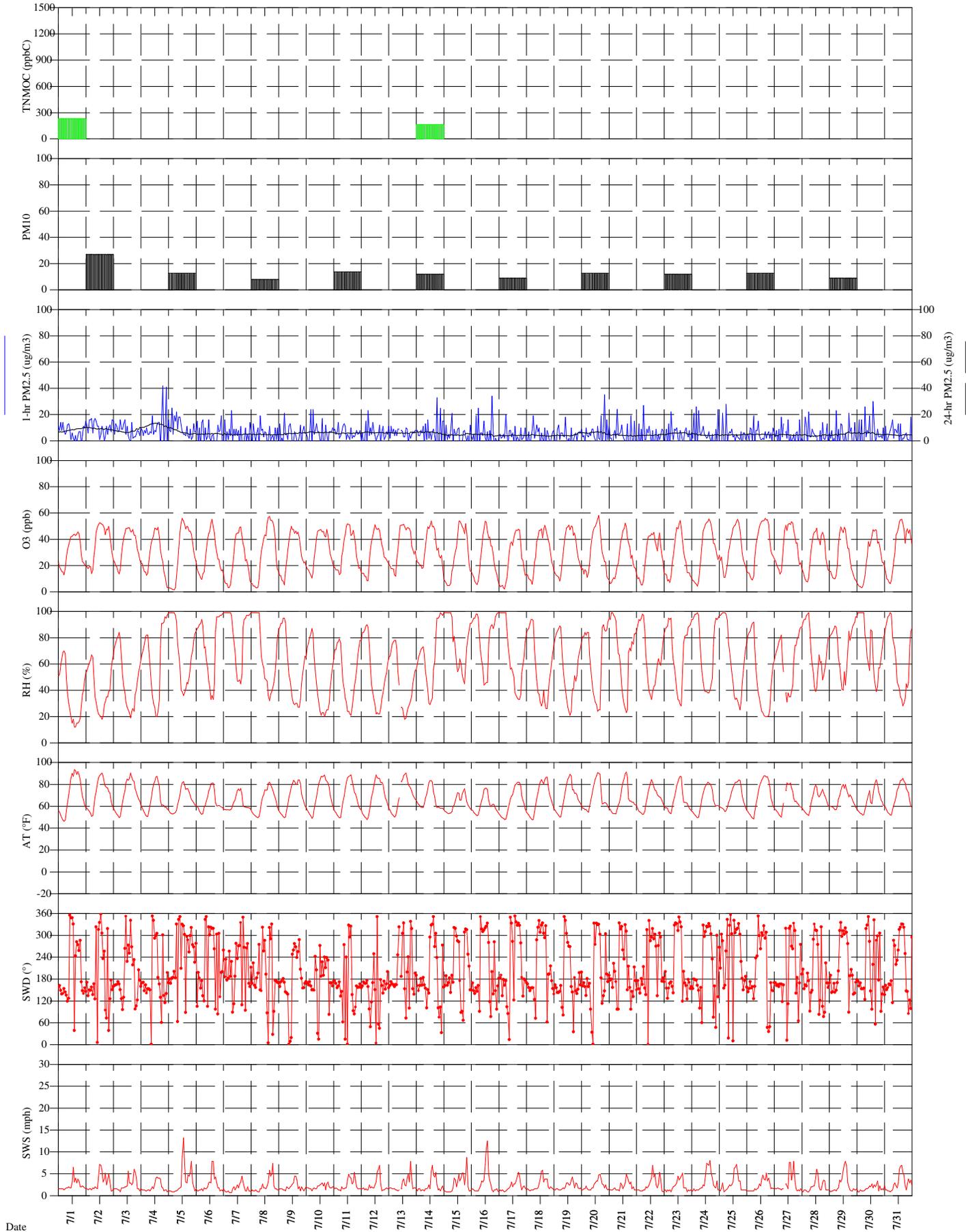
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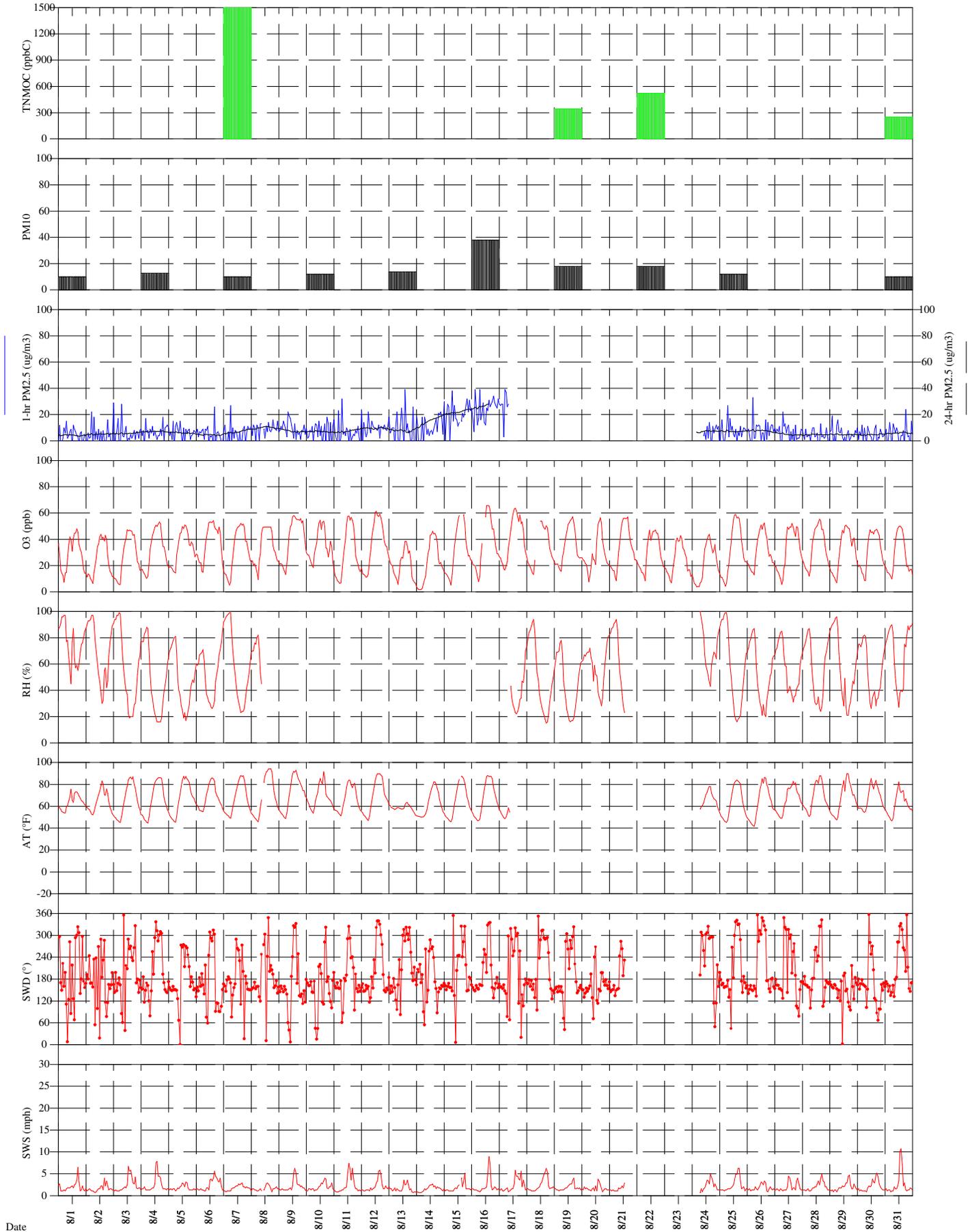
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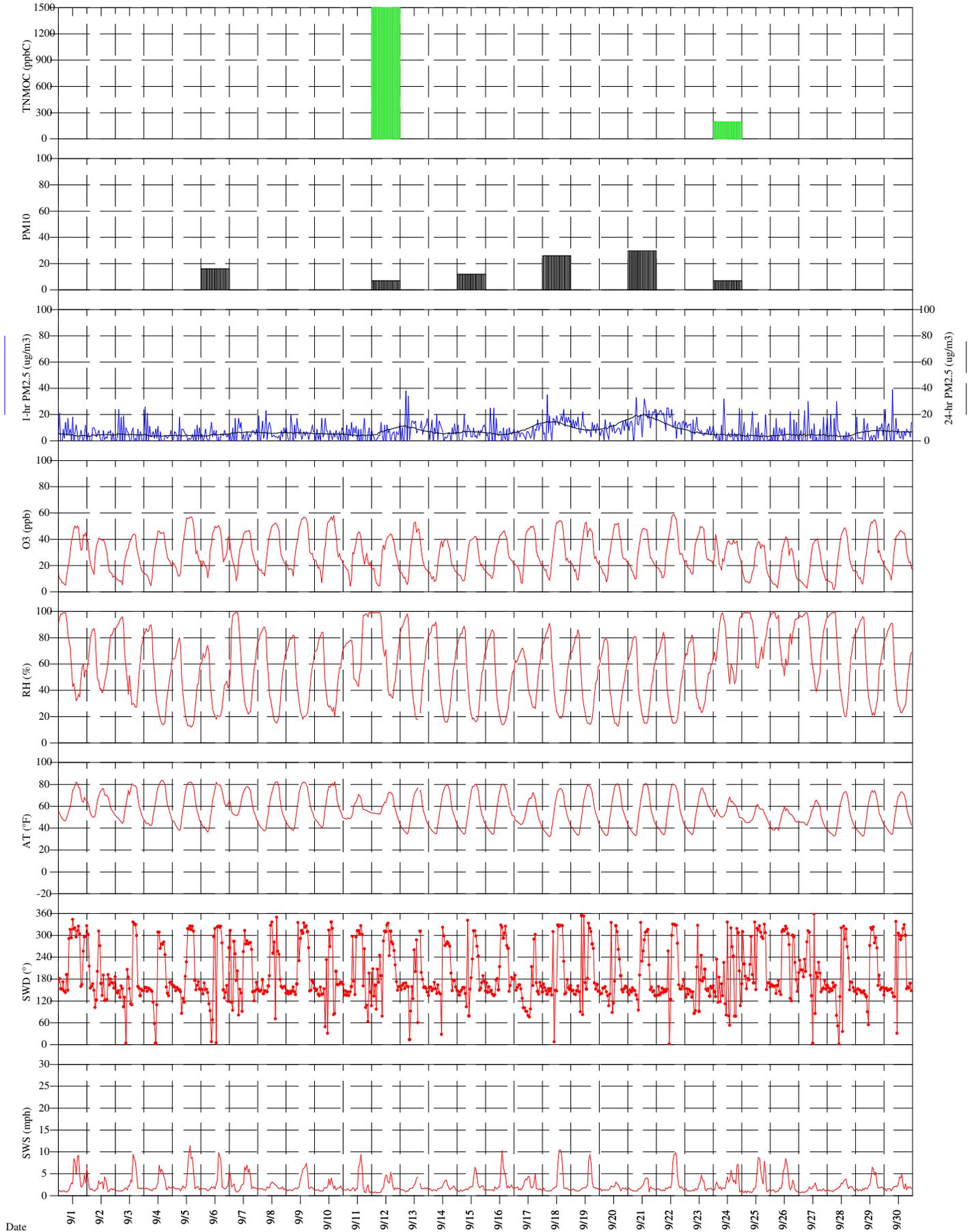
Garfield County, CO  
Carbondale Site



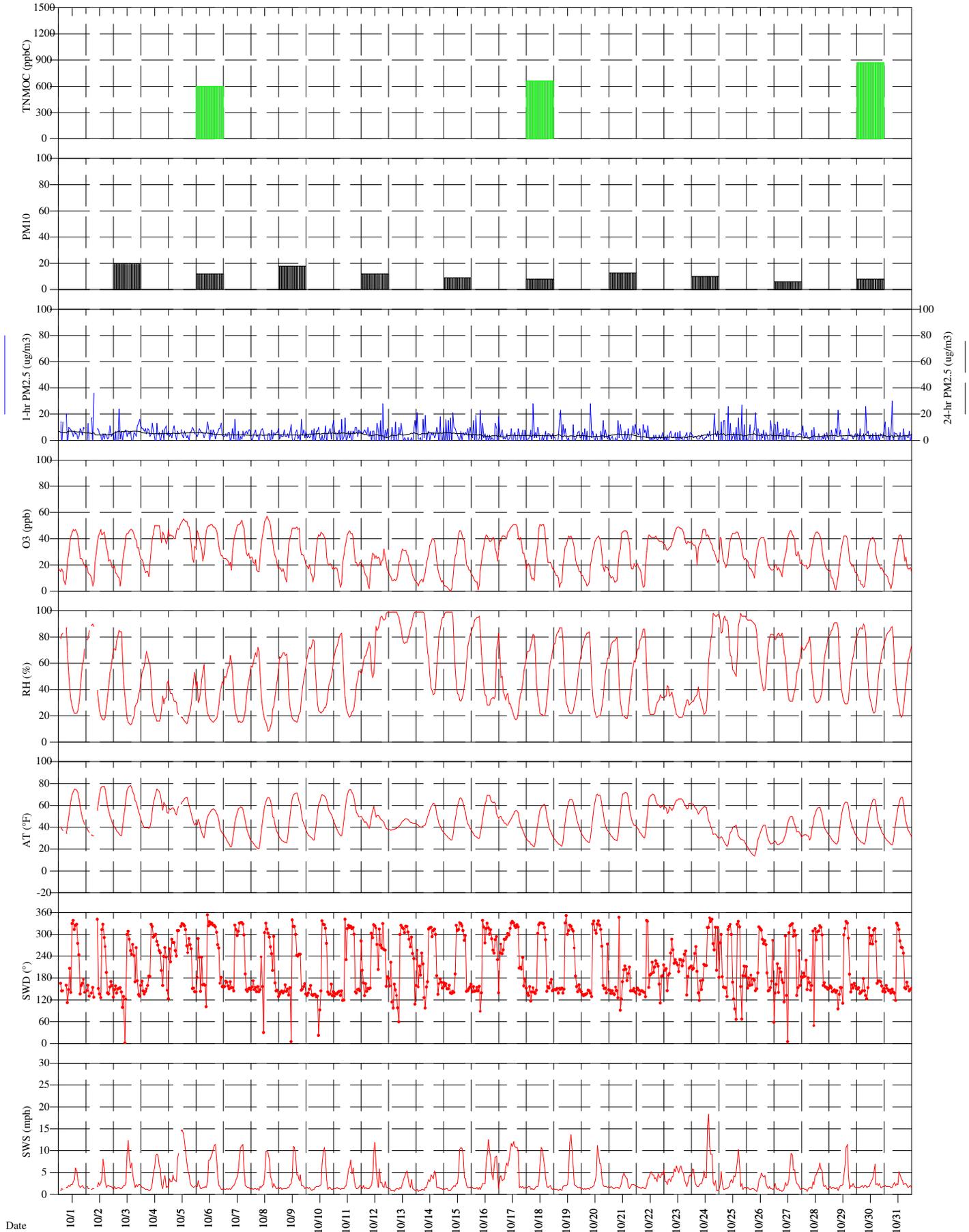
Garfield County, CO  
Carbondale Site



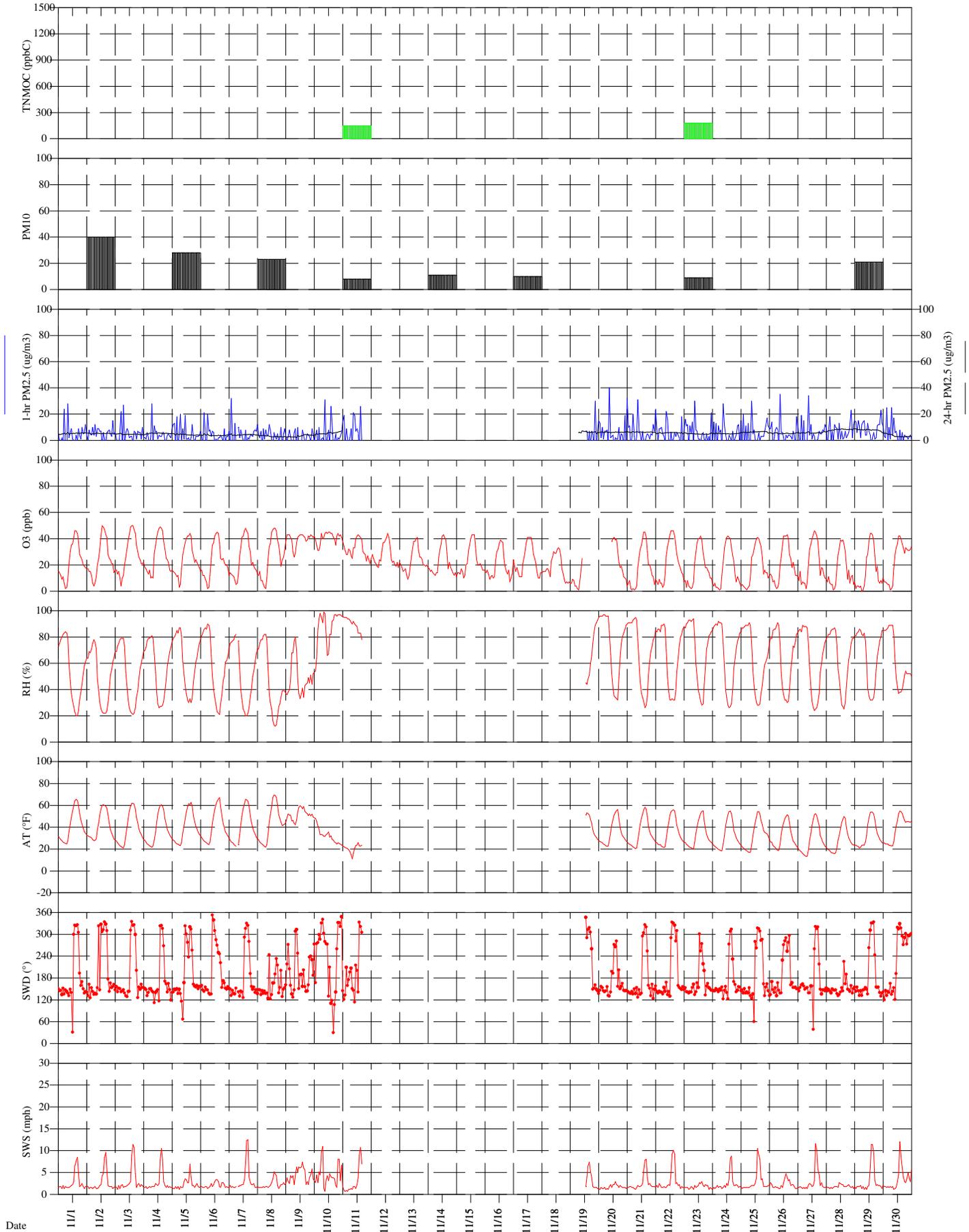
Garfield County, CO  
Carbondale Site



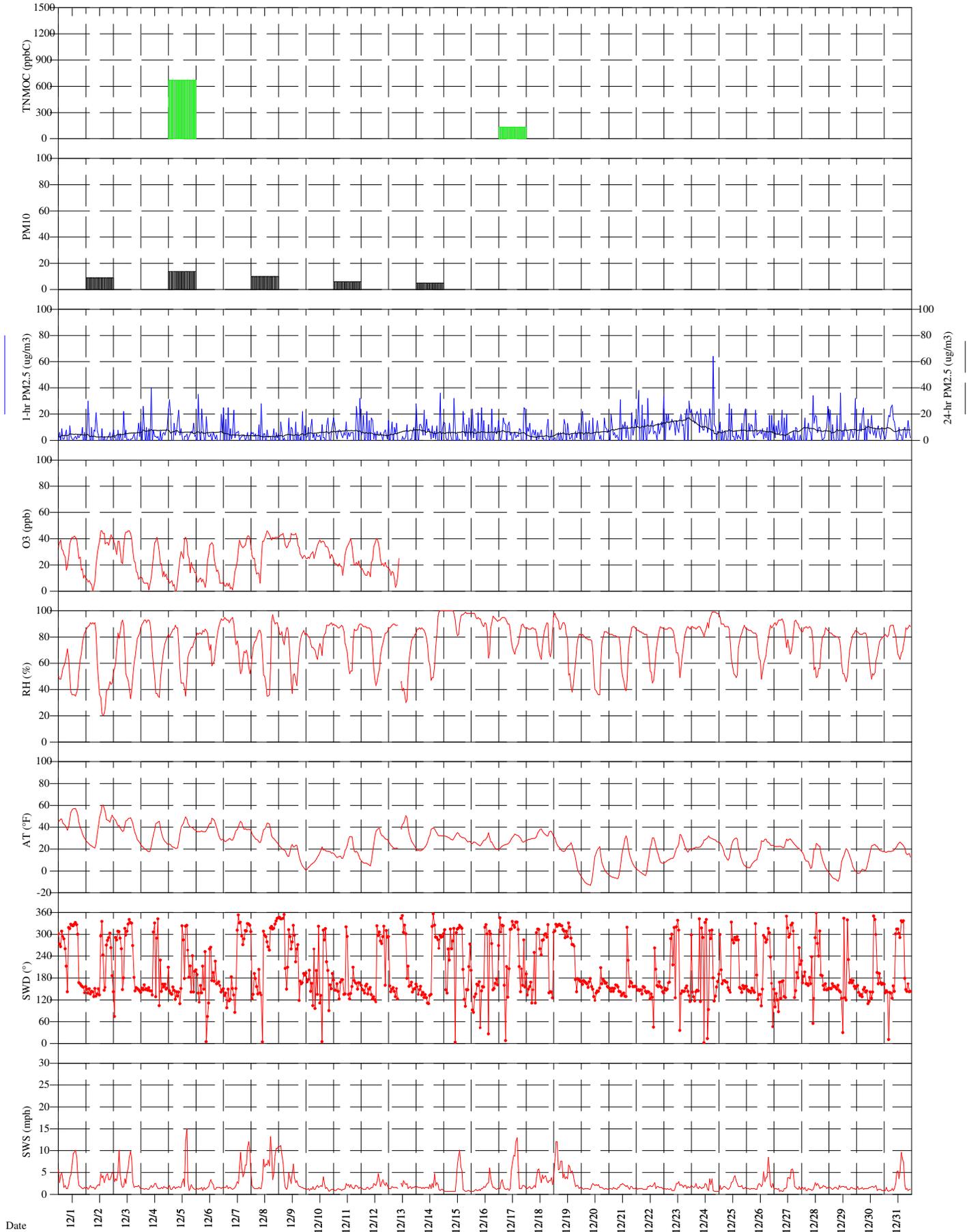
Garfield County, CO  
Carbondale Site



Garfield County, CO  
Carbondale Site



Garfield County, CO  
Carbondale Site



**APPENDIX B**

**Garfield County**

**2012 SNMOC Concentrations**

Table B-1  
Garfield County SNMOC Monitoring  
Parachute (PACO)  
1/5/2012-12/11/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	47	25	0.01	0.06	0.01
1,2,4-Trimethylbenzene (95-63-6)	47	47	0.02	0.28	0.08
1,3,5-Trimethylbenzene (108-67-8)	47	37	0.01	0.10	0.03
1,3-Butadiene (106-99-0)	47	33	0.02	0.13	0.04
1-Dodecene (112-41-4)	47	7	0.01	0.10	0.02
1-Heptene (592-76-7)	47	30	0.04	0.34	0.09
1-Hexene (592-41-6)	47	13	0.01	0.07	0.03
1-Nonene (124-11-8)	47	20	0.01	0.05	0.02
1-Octene (111-66-0)	47	26	0.02	0.08	0.03
1-Pentene (109-67-1)	47	40	0.02	0.15	0.04
1-Tridecene (2437-56-1)	47	1	0.01	0.01	0.01
1-Undecene (821-95-4)	47	2	0.01	0.02	0.01
2,2,3-Trimethylpentane (564-02-3)	47	12	0.02	0.04	0.02
2,2,4-Trimethylpentane (540-84-1)	47	7	0.01	0.12	0.01
2,2-Dimethylbutane (75-83-2)	47	45	0.02	0.33	0.11
2,3,4-Trimethylpentane (565-75-3)	47	27	0.01	0.04	0.02
2,3-Dimethylbutane (79-29-8)	47	35	0.04	0.36	0.13
2,3-Dimethylpentane (565-59-3)	47	46	0.02	0.22	0.08
2,4-Dimethylpentane (108-08-7)	47	45	0.01	0.17	0.06
2-Ethyl-1-butene (760-21-4)	47	1	0.77	0.77	0.04
2-Methyl-1-butene (563-46-2)	47	22	0.02	0.14	0.04
2-Methyl-2-butene (513-35-9)	47	24	0.02	0.18	0.04
2-Methylheptane (592-27-8)	47	47	0.01	0.33	0.10
2-Methylhexane (591-76-4)	47	47	0.08	0.67	0.27
2-Methylpentane (107-83-5)	47	47	0.18	2.58	0.85
3-Methyl-1-butene (563-45-1)	47	3	0.03	0.09	0.03
3-Methylheptane (589-81-1)	47	47	0.02	0.25	0.08
3-Methylhexane (589-34-4)	47	45	0.05	0.66	0.24
3-Methylpentane (96-14-0)	47	47	0.09	1.46	0.46
Acetylene (74-86-2)	47	47	0.09	1.48	0.49
a-Pinene (80-56-8)	47	2	0.02	0.03	0.01
Benzene (71-43-2)	47	45	0.14	0.93	0.39
b-Pinene (127-91-3)	47	20	0.02	0.26	0.04
cis-2-Butene (590-18-1)	47	32	0.02	0.54	0.06
cis-2-Hexene (7688-21-3)	47	1	0.01	0.01	0.03
cis-2-Pentene (627-20-3)	47	14	0.02	0.06	0.02
Cyclohexane (110-82-7)	47	47	0.13	1.92	0.58
Cyclopentane (287-92-3)	47	47	0.04	0.38	0.13
Cyclopentene (142-29-0)	47	5	0.02	0.25	0.03
Ethane (74-84-0)	47	47	6.10	138.00	41.95
Ethylbenzene (100-41-4)	47	45	0.01	0.10	0.04
Ethylene (74-85-1)	47	47	0.51	6.70	1.52

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-1 (continued)  
Garfield County SNMOC Monitoring  
Parachute (PACO)  
1/5/2012-12/11/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
Isobutane (75-28-5)	47	47	0.55	14.15	4.05
Isobutene/1-Butene (115-11-7 / 106-98-9)	47	2	1.12	1.30	0.07
Isopentane (78-78-4)	47	28	0.53	7.98	2.10
Isoprene (78-79-5)	47	31	0.02	0.41	0.11
Isopropylbenzene (98-82-8)	47	12	0.01	0.03	0.01
m-Diethylbenzene (141-93-5)	47	16	0.01	0.58	0.03
Methylcyclohexane (108-87-2)	47	47	0.23	3.30	1.04
Methylcyclopentane (96-37-7)	47	47	0.10	1.61	0.50
m-Ethyltoluene (620-14-4)	47	44	0.01	0.25	0.06
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	47	47	0.07	0.82	0.26
n-Butane (106-97-8)	47	47	0.86	14.52	4.23
n-Decane (124-18-5)	47	47	0.02	0.24	0.07
n-Dodecane (112-40-3)	47	43	0.01	0.06	0.03
n-Heptane (142-82-5)	47	47	0.09	1.22	0.41
n-Hexane (110-54-3)	47	47	0.18	2.85	0.87
n-Nonane (111-84-2)	47	47	0.03	0.38	0.11
n-Octane (111-65-9)	47	46	0.07	0.84	0.26
n-Pentane (109-66-0)	47	47	0.37	5.90	1.84
n-Propylbenzene (103-65-1)	47	26	0.01	0.08	0.02
n-Tridecane (629-50-5)	47	20	0.00	0.02	0.01
n-Undecane (1120-21-4)	47	46	0.01	0.13	0.04
o-Ethyltoluene (611-14-3)	47	27	0.01	0.06	0.02
o-Xylene (95-47-6)	47	47	0.02	0.14	0.06
p-Diethylbenzene (105-05-5)	47	6	0.01	0.04	0.01
p-Ethyltoluene (622-96-8)	47	39	0.01	0.15	0.04
Propane (74-98-6)	47	47	2.71	51.33	15.43
Propylene (115-07-1)	47	47	0.14	2.19	0.40
Styrene (100-42-5)	47	15	0.16	2.76	0.36
Toluene (108-88-3)	47	47	0.20	4.24	1.09
trans-2-Butene (624-64-6)	47	33	0.02	0.60	0.07
trans-2-Pentene (646-04-8)	47	29	0.01	0.12	0.03

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-2  
Garfield County SNMOC Monitoring  
Rifle (RICO)  
1/5/2012-12/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	60	36	0.01	0.11	0.02
1,2,4-Trimethylbenzene (95-63-6)	60	60	0.03	0.43	0.10
1,3,5-Trimethylbenzene (108-67-8)	60	53	0.01	0.10	0.03
1,3-Butadiene (106-99-0)	60	56	0.02	0.26	0.08
1-Dodecene (112-41-4)	60	11	0.01	0.25	0.02
1-Heptene (592-76-7)	60	36	0.03	0.34	0.06
1-Hexene (592-41-6)	60	21	0.02	0.07	0.03
1-Nonene (124-11-8)	60	18	0.01	0.42	0.02
1-Octene (111-66-0)	60	34	0.01	0.07	0.02
1-Pentene (109-67-1)	60	59	0.02	0.18	0.07
1-Tridecene (2437-56-1)	60	1	0.01	0.01	0.01
1-Undecene (821-95-4)	60	3	0.01	0.03	0.01
2,2,3-Trimethylpentane (564-02-3)	60	27	0.01	0.05	0.02
2,2,4-Trimethylpentane (540-84-1)	60	42	0.01	0.69	0.04
2,2-Dimethylbutane (75-83-2)	60	60	0.03	0.30	0.10
2,3,4-Trimethylpentane (565-75-3)	60	52	0.01	0.09	0.03
2,3-Dimethylbutane (79-29-8)	60	48	0.05	0.40	0.14
2,3-Dimethylpentane (565-59-3)	60	60	0.03	0.26	0.09
2,4-Dimethylpentane (108-08-7)	60	60	0.02	0.18	0.06
2-Methyl-1-butene (563-46-2)	60	51	0.03	0.28	0.07
2-Methyl-1-pentene (763-29-1)	60	1	0.01	0.01	0.03
2-Methyl-2-butene (513-35-9)	60	54	0.03	0.35	0.08
2-Methylheptane (592-27-8)	60	60	0.02	0.26	0.07
2-Methylhexane (591-76-4)	60	59	0.08	0.70	0.25
2-Methylpentane (107-83-5)	60	60	0.26	2.92	0.89
3-Methyl-1-butene (563-45-1)	60	5	0.03	0.16	0.03
3-Methylheptane (589-81-1)	60	60	0.02	0.19	0.06
3-Methylhexane (589-34-4)	60	59	0.06	0.71	0.22
3-Methylpentane (96-14-0)	60	60	0.14	1.58	0.47
4-Methyl-1-pentene (691-37-2)	60	5	0.02	0.02	0.03
Acetylene (74-86-2)	60	60	0.31	3.30	1.02
a-Pinene (80-56-8)	60	14	0.01	0.05	0.01
Benzene (71-43-2)	60	60	0.12	0.96	0.31
b-Pinene (127-91-3)	60	23	0.02	0.44	0.03
cis-2-Butene (590-18-1)	60	57	0.03	0.63	0.10
cis-2-Hexene (7688-21-3)	60	1	0.01	0.01	0.03
cis-2-Pentene (627-20-3)	60	48	0.02	0.15	0.03
Cyclohexane (110-82-7)	60	60	0.13	1.72	0.48
Cyclopentane (287-92-3)	60	60	0.05	0.43	0.14
Cyclopentene (142-29-0)	60	5	0.02	0.09	0.03
Ethane (74-84-0)	60	60	5.75	113.00	28.47
Ethylbenzene (100-41-4)	60	60	0.02	0.16	0.06

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-2 (continued)  
Garfield County SNMOC Monitoring  
Rifle (RICO)  
1/5/2012-12/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
Ethylene (74-85-1)	60	60	0.73	6.30	2.04
Isobutane (75-28-5)	60	60	0.92	15.30	3.89
Isobutene/1-Butene (115-11-7 / 106-98-9)	60	2	0.82	1.38	0.06
Isopentane (78-78-4)	60	37	0.73	10.74	2.35
Isoprene (78-79-5)	60	53	0.02	0.58	0.11
Isopropylbenzene (98-82-8)	60	22	0.01	0.02	0.01
m-Diethylbenzene (141-93-5)	60	20	0.01	0.69	0.04
Methylcyclohexane (108-87-2)	60	60	0.18	2.57	0.67
Methylcyclopentane (96-37-7)	60	60	0.14	1.53	0.44
m-Ethyltoluene (620-14-4)	60	60	0.01	0.22	0.07
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	60	60	0.08	0.77	0.25
n-Butane (106-97-8)	60	60	1.30	17.40	4.62
n-Decane (124-18-5)	60	60	0.01	0.13	0.05
n-Dodecane (112-40-3)	60	55	0.00	0.08	0.02
n-Heptane (142-82-5)	60	60	0.10	1.17	0.32
n-Hexane (110-54-3)	60	60	0.23	3.17	0.87
n-Nonane (111-84-2)	60	60	0.02	0.19	0.06
n-Octane (111-65-9)	60	60	0.05	0.56	0.16
n-Pentane (109-66-0)	60	60	0.59	6.98	2.05
n-Propylbenzene (103-65-1)	60	45	0.01	0.11	0.02
n-Tridecane (629-50-5)	60	11	0.00	0.03	0.01
n-Undecane (1120-21-4)	60	58	0.01	0.06	0.02
o-Ethyltoluene (611-14-3)	60	41	0.01	0.06	0.02
o-Xylene (95-47-6)	60	60	0.03	0.20	0.08
p-Diethylbenzene (105-05-5)	60	9	0.01	0.02	0.01
p-Ethyltoluene (622-96-8)	60	57	0.01	0.13	0.04
Propane (74-98-6)	60	60	2.56	51.00	12.79
Propylene (115-07-1)	60	60	0.15	1.48	0.57
Styrene (100-42-5)	60	20	0.02	1.66	0.16
Toluene (108-88-3)	60	60	0.18	1.63	0.57
trans-2-Butene (624-64-6)	60	57	0.03	0.67	0.12
trans-2-Hexene (4050-45-7)	60	5	0.01	0.03	0.03
trans-2-Pentene (646-04-8)	60	56	0.02	0.28	0.07

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-3  
Garfield County SNMOC Monitoring  
Bell-Melton (BRCO)  
1/5/2012-12/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	58	13	0.01	0.03	0.01
1,2,4-Trimethylbenzene (95-63-6)	58	54	0.01	0.19	0.04
1,3,5-Trimethylbenzene (108-67-8)	58	27	0.01	0.07	0.01
1,3-Butadiene (106-99-0)	58	23	0.01	0.12	0.04
1-Dodecene (112-41-4)	58	5	0.02	0.04	0.02
1-Heptene (592-76-7)	58	35	0.02	0.26	0.06
1-Hexene (592-41-6)	58	13	0.02	0.06	0.03
1-Nonene (124-11-8)	58	18	0.01	0.05	0.02
1-Octene (111-66-0)	58	32	0.01	0.12	0.03
1-Pentene (109-67-1)	58	39	0.02	0.12	0.04
1-Undecene (821-95-4)	58	4	0.01	0.03	0.01
2,2,3-Trimethylpentane (564-02-3)	58	7	0.01	0.03	0.01
2,2,4-Trimethylpentane (540-84-1)	58	6	0.01	0.06	0.01
2,2-Dimethylbutane (75-83-2)	58	57	0.02	0.26	0.09
2,3,4-Trimethylpentane (565-75-3)	58	21	0.01	0.05	0.01
2,3-Dimethylbutane (79-29-8)	58	46	0.02	0.48	0.13
2,3-Dimethylpentane (565-59-3)	58	57	0.02	0.19	0.07
2,4-Dimethylpentane (108-08-7)	58	55	0.02	0.14	0.05
2-Methyl-1-butene (563-46-2)	58	9	0.02	0.08	0.03
2-Methyl-2-butene (513-35-9)	58	13	0.01	0.13	0.03
2-Methylheptane (592-27-8)	58	55	0.01	0.16	0.07
2-Methylhexane (591-76-4)	58	58	0.04	0.54	0.21
2-Methylpentane (107-83-5)	58	58	0.12	2.80	0.84
3-Methyl-1-butene (563-45-1)	58	2	0.02	0.23	0.03
3-Methylheptane (589-81-1)	58	55	0.01	0.11	0.04
3-Methylhexane (589-34-4)	58	54	0.05	0.54	0.18
3-Methylpentane (96-14-0)	58	58	0.05	1.48	0.43
4-Methyl-1-pentene (691-37-2)	58	4	0.02	0.02	0.03
Acetylene (74-86-2)	58	58	0.08	2.58	0.49
a-Pinene (80-56-8)	58	13	0.01	0.06	0.02
Benzene (71-43-2)	58	57	0.05	0.47	0.21
b-Pinene (127-91-3)	58	21	0.01	0.40	0.03
cis-2-Butene (590-18-1)	58	19	0.02	0.30	0.03
cis-2-Pentene (627-20-3)	58	9	0.02	0.07	0.02
Cyclohexane (110-82-7)	58	58	0.06	1.64	0.52
Cyclopentane (287-92-3)	58	57	0.05	0.41	0.13
Cyclopentene (142-29-0)	58	2	0.02	0.05	0.03
Ethane (74-84-0)	58	58	4.42	101.00	35.28
Ethylbenzene (100-41-4)	58	45	0.01	0.09	0.02
Ethylene (74-85-1)	58	58	0.35	3.48	1.01
Isobutane (75-28-5)	58	58	0.50	14.02	4.49
Isobutene/1-Butene (115-11-7 / 106-98-9)	58	1	1.27	1.27	0.04

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-3 (continued)  
Garfield County SNMOC Monitoring  
Bell-Melton (BRCO)  
1/5/2012-12/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
Isopentane (78-78-4)	58	39	0.80	8.34	2.17
Isoprene (78-79-5)	58	28	0.03	0.45	0.07
Isopropylbenzene (98-82-8)	58	11	0.01	0.02	0.01
m-Diethylbenzene (141-93-5)	58	19	0.01	0.12	0.02
Methylcyclohexane (108-87-2)	58	58	0.11	2.30	0.79
Methylcyclopentane (96-37-7)	58	58	0.06	1.40	0.43
m-Ethyltoluene (620-14-4)	58	44	0.01	0.15	0.03
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	58	58	0.03	0.36	0.11
n-Butane (106-97-8)	58	57	0.57	15.90	5.05
n-Decane (124-18-5)	58	55	0.01	0.11	0.03
n-Dodecane (112-40-3)	58	38	0.01	0.04	0.02
n-Heptane (142-82-5)	58	58	0.05	1.06	0.34
n-Hexane (110-54-3)	58	58	0.13	3.28	0.94
n-Nonane (111-84-2)	58	58	0.01	0.13	0.05
n-Octane (111-65-9)	58	58	0.03	0.43	0.16
n-Pentane (109-66-0)	58	58	0.26	6.94	2.12
n-Propylbenzene (103-65-1)	58	25	0.01	0.07	0.01
n-Tridecane (629-50-5)	58	5	0.00	0.02	0.01
n-Undecane (1120-21-4)	58	43	0.01	0.04	0.02
o-Ethyltoluene (611-14-3)	58	22	0.01	0.06	0.01
o-Xylene (95-47-6)	58	53	0.01	0.11	0.03
p-Diethylbenzene (105-05-5)	58	10	0.01	0.02	0.01
p-Ethyltoluene (622-96-8)	58	40	0.01	0.10	0.02
Propane (74-98-6)	58	58	1.92	49.67	16.51
Propylene (115-07-1)	58	58	0.10	0.94	0.22
Styrene (100-42-5)	58	22	0.02	2.56	0.21
Toluene (108-88-3)	58	58	0.09	1.04	0.37
trans-2-Butene (624-64-6)	58	13	0.02	0.33	0.03
trans-2-Pentene (646-04-8)	58	24	0.02	0.11	0.02

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-4  
Garfield County SNMOC Monitoring  
Battlement Mesa (BMCO)  
1/5/2012-12/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	53	26	0.01	0.06	0.02
1,2,4-Trimethylbenzene (95-63-6)	53	53	0.01	0.20	0.07
1,3,5-Trimethylbenzene (108-67-8)	53	46	0.02	0.06	0.03
1,3-Butadiene (106-99-0)	53	28	0.02	0.20	0.05
1-Dodecene (112-41-4)	53	10	0.01	0.12	0.02
1-Heptene (592-76-7)	53	36	0.01	0.22	0.07
1-Hexene (592-41-6)	53	11	0.01	0.07	0.03
1-Nonene (124-11-8)	53	10	0.01	0.02	0.01
1-Octene (111-66-0)	53	31	0.01	0.06	0.03
1-Pentene (109-67-1)	53	47	0.02	0.23	0.06
1-Undecene (821-95-4)	53	1	0.01	0.01	0.01
2,2,3-Trimethylpentane (564-02-3)	53	23	0.01	0.05	0.02
2,2,4-Trimethylpentane (540-84-1)	53	15	0.01	0.08	0.02
2,2-Dimethylbutane (75-83-2)	53	51	0.03	0.22	0.10
2,3,4-Trimethylpentane (565-75-3)	53	39	0.01	0.04	0.02
2,3-Dimethylbutane (79-29-8)	53	42	0.02	0.40	0.14
2,3-Dimethylpentane (565-59-3)	53	53	0.02	0.15	0.08
2,4-Dimethylpentane (108-08-7)	53	51	0.02	0.11	0.06
2-Methyl-1-butene (563-46-2)	53	34	0.02	0.21	0.05
2-Methyl-2-butene (513-35-9)	53	39	0.03	0.28	0.06
2-Methylheptane (592-27-8)	53	52	0.01	0.18	0.09
2-Methylhexane (591-76-4)	53	53	0.07	0.57	0.25
2-Methylpentane (107-83-5)	53	53	0.13	1.77	0.79
3-Methyl-1-butene (563-45-1)	53	3	0.03	0.10	0.03
3-Methylheptane (589-81-1)	53	52	0.01	0.15	0.07
3-Methylhexane (589-34-4)	53	52	0.03	0.47	0.22
3-Methylpentane (96-14-0)	53	53	0.06	0.96	0.43
4-Methyl-1-pentene (691-37-2)	53	5	0.02	0.02	0.03
Acetylene (74-86-2)	53	53	0.10	6.50	0.60
a-Pinene (80-56-8)	53	7	0.01	0.03	0.01
Benzene (71-43-2)	53	53	0.08	0.74	0.34
b-Pinene (127-91-3)	53	20	0.01	0.23	0.04
cis-2-Butene (590-18-1)	53	46	0.02	0.61	0.06
cis-2-Pentene (627-20-3)	53	26	0.01	0.12	0.03
Cyclohexane (110-82-7)	53	53	0.04	1.28	0.52
Cyclopentane (287-92-3)	53	51	0.05	0.28	0.13
Cyclopentene (142-29-0)	53	5	0.03	0.08	0.03
Ethane (74-84-0)	53	53	1.98	94.50	31.54
Ethylbenzene (100-41-4)	53	53	0.01	0.09	0.04
Ethylene (74-85-1)	53	53	0.46	2.67	1.04
Isobutane (75-28-5)	53	53	0.13	9.70	3.15
Isobutene/1-Butene (115-11-7 / 106-98-9)	53	2	0.66	1.12	0.05

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-4 (continued)  
Garfield County SNMOC Monitoring  
Battlement Mesa (BMCO)  
1/5/2012-12/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
Isopentane (78-78-4)	53	35	0.53	8.12	2.07
Isoprene (78-79-5)	53	30	0.02	0.64	0.08
Isopropylbenzene (98-82-8)	53	10	0.01	0.02	0.01
m-Diethylbenzene (141-93-5)	53	22	0.01	0.10	0.02
Methylcyclohexane (108-87-2)	53	51	0.15	2.14	0.89
Methylcyclopentane (96-37-7)	53	53	0.05	1.06	0.46
m-Ethyltoluene (620-14-4)	53	51	0.01	0.17	0.05
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	53	53	0.07	0.43	0.24
n-Butane (106-97-8)	53	53	0.31	10.42	3.78
n-Decane (124-18-5)	53	53	0.01	0.12	0.06
n-Dodecane (112-40-3)	53	49	0.01	0.05	0.02
n-Heptane (142-82-5)	53	53	0.03	0.84	0.36
n-Hexane (110-54-3)	53	53	0.07	1.95	0.82
n-Nonane (111-84-2)	53	53	0.01	0.19	0.08
n-Octane (111-65-9)	53	53	0.02	0.50	0.22
n-Pentane (109-66-0)	53	53	0.18	10.36	1.89
n-Propylbenzene (103-65-1)	53	32	0.01	0.06	0.02
n-Tridecane (629-50-5)	53	13	0.01	0.01	0.01
n-Undecane (1120-21-4)	53	51	0.01	0.07	0.03
o-Ethyltoluene (611-14-3)	53	39	0.01	0.06	0.02
o-Xylene (95-47-6)	53	53	0.02	0.11	0.06
p-Diethylbenzene (105-05-5)	53	7	0.01	0.02	0.01
p-Ethyltoluene (622-96-8)	53	46	0.01	0.11	0.03
Propane (74-98-6)	53	53	1.40	36.33	11.65
Propylene (115-07-1)	53	53	0.12	0.84	0.26
Styrene (100-42-5)	53	18	0.05	3.09	0.36
Toluene (108-88-3)	53	53	0.16	5.20	1.08
trans-2-Butene (624-64-6)	53	46	0.02	0.68	0.07
trans-2-Hexene (4050-45-7)	53	3	0.01	0.02	0.03
trans-2-Pentene (646-04-8)	53	42	0.02	0.23	0.04

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-5  
Garfield County SNMOC Monitoring  
Carbondale (RFCO)  
6/9/2012-12/17/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	17	12	0.01	0.05	0.02
1,2,4-Trimethylbenzene (95-63-6)	17	17	0.02	0.16	0.07
1,3,5-Trimethylbenzene (108-67-8)	17	10	0.01	0.04	0.02
1,3-Butadiene (106-99-0)	17	12	0.03	0.14	0.06
1-Dodecene (112-41-4)	17	1	0.13	0.13	0.02
1-Heptene (592-76-7)	17	5	0.01	0.18	0.02
1-Hexene (592-41-6)	17	3	0.03	0.05	0.03
1-Nonene (124-11-8)	17	10	0.01	0.04	0.02
1-Octene (111-66-0)	17	14	0.01	0.06	0.02
1-Pentene (109-67-1)	17	15	0.02	0.14	0.07
2,2,3-Trimethylpentane (564-02-3)	17	2	0.01	0.03	0.01
2,2,4-Trimethylpentane (540-84-1)	17	12	0.01	0.04	0.02
2,2-Dimethylbutane (75-83-2)	17	6	0.02	0.11	0.03
2,3,4-Trimethylpentane (565-75-3)	17	9	0.01	0.03	0.01
2,3-Dimethylbutane (79-29-8)	17	16	0.02	0.26	0.05
2,3-Dimethylpentane (565-59-3)	17	16	0.02	0.11	0.04
2,4-Dimethylpentane (108-08-7)	17	7	0.01	0.08	0.02
2-Methyl-1-butene (563-46-2)	17	8	0.02	0.07	0.04
2-Methyl-2-butene (513-35-9)	17	15	0.04	0.08	0.05
2-Methylheptane (592-27-8)	17	4	0.01	0.14	0.02
2-Methylhexane (591-76-4)	17	17	0.05	0.57	0.11
2-Methylpentane (107-83-5)	17	17	0.10	1.36	0.24
3-Methylheptane (589-81-1)	17	10	0.01	0.07	0.02
3-Methylhexane (589-34-4)	17	7	0.04	0.28	0.05
3-Methylpentane (96-14-0)	17	17	0.04	0.69	0.12
4-Methyl-1-pentene (691-37-2)	17	2	0.01	0.02	0.03
Acetylene (74-86-2)	17	17	0.13	1.01	0.44
a-Pinene (80-56-8)	17	14	0.02	0.19	0.06
Benzene (71-43-2)	17	16	0.06	0.34	0.14
b-Pinene (127-91-3)	17	2	0.06	0.07	0.02
cis-2-Butene (590-18-1)	17	13	0.02	0.19	0.06
cis-2-Pentene (627-20-3)	17	6	0.02	0.04	0.02
Cyclohexane (110-82-7)	17	17	0.03	0.82	0.10
Cyclopentane (287-92-3)	17	7	0.04	0.18	0.04
Ethane (74-84-0)	17	17	1.37	37.05	6.32
Ethylbenzene (100-41-4)	17	15	0.01	0.04	0.02
Ethylene (74-85-1)	17	17	0.56	2.12	1.07
Isobutane (75-28-5)	17	17	0.15	5.70	0.85
Isobutene/1-Butene (115-11-7 / 106-98-9)	17	1	1.12	1.12	0.08
Isopentane (78-78-4)	17	6	0.34	6.90	0.65
Isoprene (78-79-5)	17	17	0.02	0.98	0.27
Isopropylbenzene (98-82-8)	17	3	0.01	0.02	0.01

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-5 (continued)  
Garfield County SNMOC Monitoring  
Carbondale (RFCO)  
6/9/2012-12/17/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
m-Diethylbenzene (141-93-5)	17	9	0.01	0.07	0.02
Methylcyclohexane (108-87-2)	17	15	0.03	1.26	0.12
Methylcyclopentane (96-37-7)	17	16	0.04	0.71	0.11
m-Ethyltoluene (620-14-4)	17	17	0.02	0.16	0.07
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	17	17	0.03	0.14	0.07
n-Butane (106-97-8)	17	17	0.28	6.85	1.19
n-Decane (124-18-5)	17	17	0.02	0.15	0.05
n-Dodecane (112-40-3)	17	15	0.01	0.09	0.03
n-Heptane (142-82-5)	17	17	0.03	0.58	0.08
n-Hexane (110-54-3)	17	17	0.09	1.62	0.24
n-Nonane (111-84-2)	17	16	0.01	0.06	0.02
n-Octane (111-65-9)	17	17	0.02	0.30	0.06
n-Pentane (109-66-0)	17	17	0.19	2.86	0.56
n-Propylbenzene (103-65-1)	17	13	0.01	0.05	0.02
n-Tridecane (629-50-5)	17	4	0.00	0.08	0.02
n-Undecane (1120-21-4)	17	13	0.01	0.04	0.01
o-Ethyltoluene (611-14-3)	17	12	0.01	0.06	0.02
o-Xylene (95-47-6)	17	17	0.01	0.05	0.03
p-Diethylbenzene (105-05-5)	17	2	0.01	0.02	0.01
p-Ethyltoluene (622-96-8)	17	15	0.01	0.10	0.04
Propane (74-98-6)	17	17	0.93	19.47	3.49
Propylene (115-07-1)	17	17	0.14	0.49	0.28
Styrene (100-42-5)	17	8	0.08	1.20	0.30
Toluene (108-88-3)	17	17	0.13	4.21	1.02
trans-2-Butene (624-64-6)	17	11	0.03	0.24	0.06
trans-2-Pentene (646-04-8)	17	15	0.02	0.07	0.04

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

**APPENDIX C**

**Garfield County**

**2012 Carbonyl Concentrations**

Table C-1  
 Garfield County Carbonyl Monitoring  
 Parachute (PACO)  
 1/5/2012-12/29/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	27	0	ND	ND	0.00
2-Butanone (78-93-3)	27	24	0.01	0.69	0.29
Acetaldehyde (75-07-0)	27	27	0.02	0.86	0.38
Acetone (67-64-1)	27	27	0.08	1.71	0.96
Benzaldehyde (100-52-7)	27	26	0.00	0.04	0.02
Butyraldehyde (123-72-8)	27	25	0.01	0.06	0.02
Crotonaldehyde (123-73-9)	27	23	0.01	0.12	0.02
Formaldehyde (50-00-0)	27	27	0.03	1.88	0.98
Hexaldehyde (66-25-1)	27	25	0.00	0.03	0.01
Isovaleraldehyde (590-86-3)	27	0	ND	ND	0.00
Propionaldehyde (123-38-6)	27	26	0.00	0.06	0.03
Tolualdehydes (NA)	27	20	0.01	0.05	0.02
Valeraldehyde (110-62-3)	27	21	0.00	0.03	0.01

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

Table C-2  
 Garfield County Carbonyl Monitoring  
 Rifle (RICO)  
 1/5/2012-12/29/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	28	0	ND	ND	0.00
2-Butanone (78-93-3)	28	25	0.06	0.68	0.33
Acetaldehyde (75-07-0)	28	28	0.06	1.31	0.58
Acetone (67-64-1)	28	28	0.25	2.25	1.10
Benzaldehyde (100-52-7)	28	28	0.01	0.06	0.03
Butyraldehyde (123-72-8)	28	25	0.01	0.11	0.03
Crotonaldehyde (123-73-9)	28	25	0.01	0.14	0.04
Formaldehyde (50-00-0)	28	28	0.08	2.28	1.13
Hexaldehyde (66-25-1)	28	28	0.00	0.04	0.02
Isovaleraldehyde (590-86-3)	28	1	0.01	0.01	0.00
Propionaldehyde (123-38-6)	28	27	0.01	0.11	0.04
Tolualdehydes (NA)	28	24	0.01	0.08	0.03
Valeraldehyde (110-62-3)	28	26	0.00	0.06	0.02

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

Table C-3  
 Garfield County Carbonyl Monitoring  
 Bell-Melton (BRCO)  
 1/5/2012-12/29/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	28	0	ND	ND	0.00
2-Butanone (78-93-3)	28	26	0.04	0.57	0.26
Acetaldehyde (75-07-0)	28	28	0.09	0.90	0.34
Acetone (67-64-1)	28	28	0.26	1.80	0.96
Benzaldehyde (100-52-7)	28	27	0.00	0.05	0.02
Butyraldehyde (123-72-8)	28	27	0.01	0.04	0.02
Crotonaldehyde (123-73-9)	28	25	0.00	0.18	0.03
Formaldehyde (50-00-0)	28	28	0.22	2.53	0.83
Hexaldehyde (66-25-1)	28	27	0.00	0.03	0.01
Isovaleraldehyde (590-86-3)	28	0	ND	ND	0.00
Propionaldehyde (123-38-6)	28	27	0.01	0.07	0.03
Tolualdehydes (NA)	28	21	0.01	0.04	0.01
Valeraldehyde (110-62-3)	28	24	0.00	0.02	0.01

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

Table C-4  
 Garfield County Carbonyl Monitoring  
 Battlement Mesa (BMCO)  
 1/5/2012-12/29/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	27	0	ND	ND	0.00
2-Butanone (78-93-3)	27	24	0.01	0.74	0.25
Acetaldehyde (75-07-0)	27	27	0.02	0.78	0.30
Acetone (67-64-1)	27	27	0.08	3.85	1.20
Benzaldehyde (100-52-7)	27	23	0.00	0.12	0.03
Butyraldehyde (123-72-8)	27	23	0.01	0.04	0.02
Crotonaldehyde (123-73-9)	27	21	0.00	0.13	0.02
Formaldehyde (50-00-0)	27	27	0.02	1.47	0.71
Hexaldehyde (66-25-1)	27	23	0.00	0.06	0.02
Isovaleraldehyde (590-86-3)	27	0	ND	ND	0.00
Propionaldehyde (123-38-6)	27	24	0.00	0.06	0.03
Tolualdehydes (NA)	27	19	0.01	0.05	0.02
Valeraldehyde (110-62-3)	27	21	0.00	0.03	0.01

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

Table C-5  
 Garfield County Carbonyl Monitoring  
 Carbondale (RFCO)  
 6/20/2012-12/17/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	16	0	ND	ND	0.00
2-Butanone (78-93-3)	16	12	0.06	0.58	0.21
Acetaldehyde (75-07-0)	16	16	0.02	1.35	0.31
Acetone (67-64-1)	16	16	0.04	1.49	0.70
Benzaldehyde (100-52-7)	16	13	0.01	0.06	0.02
Butyraldehyde (123-72-8)	16	10	0.00	0.06	0.02
Crotonaldehyde (123-73-9)	16	10	0.01	0.39	0.05
Formaldehyde (50-00-0)	16	16	0.02	2.57	0.67
Hexaldehyde (66-25-1)	16	15	0.00	0.05	0.02
Isovaleraldehyde (590-86-3)	16	0	ND	ND	0.00
Propionaldehyde (123-38-6)	16	15	0.01	0.10	0.03
Tolualdehydes (NA)	16	10	0.01	0.09	0.02
Valeraldehyde (110-62-3)	16	11	0.00	0.03	0.01

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

## EPAC Rebuttal Exhibit 2: Garfield County Air Monitoring Program Design Details

Continuing into 2013, the monitoring network in Garfield County consisted of five monitoring locations. Since 2008 the County has invested > \$1,000,000 plus 1.5 fulltime staff (FTE) for air quality monitoring and air quality management and improvement programs. Annual program O&M exceeds \$250,000 per year plus 1.5 FTE. The scientific data produced by this program was omitted from the Division's analysis as they developed a proposal for statewide rules.

- Parachute (PACO): Parachute is a small urban center of approximately 1,300 people within very close proximity to oil and development and production activities. The town is located along Interstate 70 and is the transportation hub for heavily traveled roads which service the surrounding canyons. This site is bounded by extensive oil and gas development to the North, South, East and West.
- Rifle (RICO): Rifle is a rapidly growing urban center on the Interstate 70 corridor with estimated population of about 9,200 people. Rifle is in close proximity to oil and gas development activities, and is also central to industrial support for the oil and gas industry. The site is downwind of extensive oil and gas development and infrastructure to the South, East and West.
- Bell-Melton (BRCO): The Bell-Melton site is a rural homestead approximately four miles south of the town of Silt, in close proximity to moderate oil and gas development and heavy natural gas production to the North, South, East and West.
- Battlement Mesa (BMCO): Battlement Mesa is a residential community located about 1.5 miles southeast of Parachute. This site began operation in September 2010 in response to a proposed large natural gas development within to community, and to begin developing baseline data in advance of the project. The site originally monitored VOC and meteorological parameters, and in November 2012, the site was augmented with a mobile air quality monitoring station, which added the collection of continuous gaseous (NO<sub>x</sub> and ozone) and particulate measurements to existing VOC measurements. The site is bounded by significant oil and gas activity to the South, East and West.
- Carbondale (RFCO): Carbondale is a rural and urban community located about 12.5 miles southeast of Glenwood Spring at the confluence of the Roaring Fork and Crystal River valleys. The Carbondale, or Roaring Fork, monitor began monitoring in March 2012 to characterize air quality in the area and also to gather data downwind of the Colorado valley sites.

Figure 1 is a map of the monitoring sites and Table 1 lists the parameters monitored. Real-time data, including camera images, are displayed on the Garfield County Air Quality Monitoring website (<http://www.garfieldcountyaq.net>).

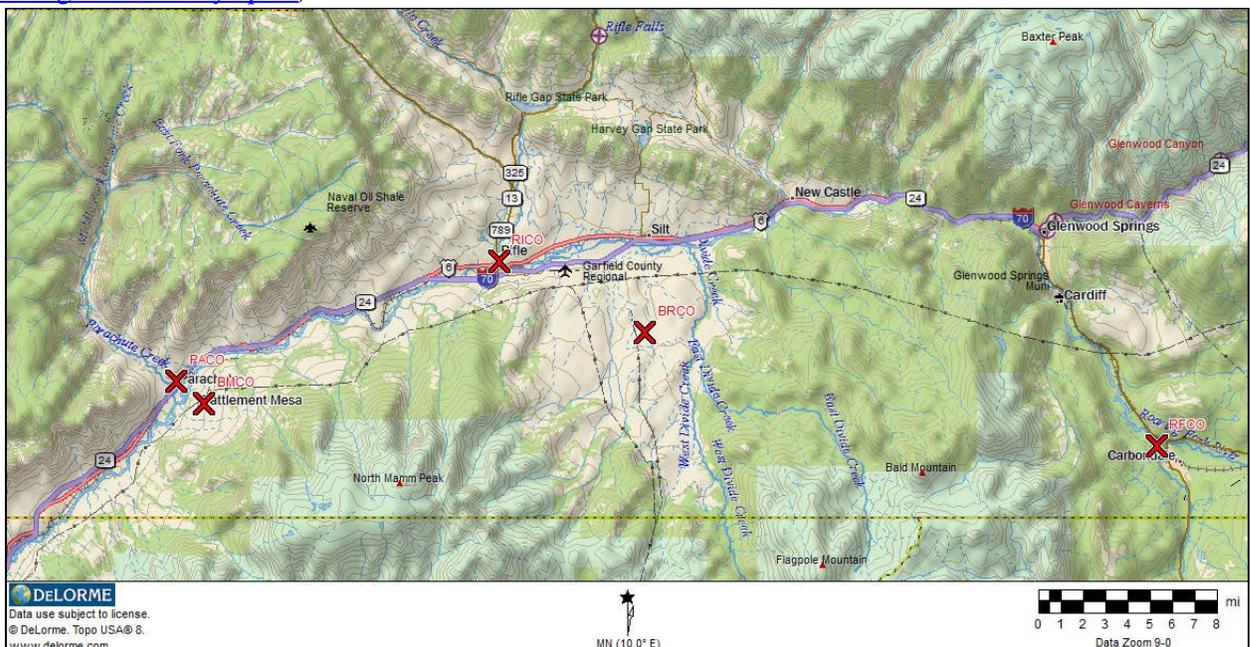


Figure 1. Map of Garfield County Monitoring Sites.

Table 1: Garfield County Parameters Monitored by Site

Component	Period	EPA Method	Sampling Frequency
<b>Rifle, Colorado (RICO)</b>			
SNMOCs <sup>1</sup>	2008-current	TO-12	24-hour (~60 samples/year, one every 6 <sup>th</sup> day)
Carbonyls <sup>2</sup>	2008-current	TO-11A	24-hour (~30 samples/year, one every 12 <sup>th</sup> day)
PM <sub>10</sub>	2008-current	FRM	24-hour (~120 samples/year, one every 3 <sup>rd</sup> day)
PM <sub>10</sub>	2008-current	TEOM	Hourly
PM <sub>2.5</sub>	2008-current	TEOM	Hourly
Ozone	2008-current	42C	Hourly
Meteorology	2008-current	Various	Hourly
Visibility Web Camera	2008-current	Digital	15-min
<b>Parachute, Colorado (PACO)</b>			
SNMOCs <sup>1</sup>	2008-current	TO-12	24-hour (~60 samples/year, one every 6 <sup>th</sup> day)
Carbonyls <sup>2</sup>	2008-current	TO-11A	24-hour (~30 samples/year, one every 12 <sup>th</sup> day)
PM <sub>10</sub>	2008-current	FRM	24-hour (~120 samples/year, one every 3 <sup>rd</sup> day)
Meteorology	2008-current	Various	Hourly
<b>Bell-Melton, Colorado (BRCO)</b>			
SNMOCs <sup>1</sup>	2008-current	TO-12	24-hour (~60 samples/year, one every 6 <sup>th</sup> day)
Carbonyls <sup>2</sup>	2008-current	TO-11A	24-hour (~30 samples/year, one every 12 <sup>th</sup> day)
Meteorology	2008-current	Various	Hourly
<b>Battlement Mesa, Colorado (BMCO)</b>			
SNMOCs <sup>1</sup>	9/2011-current	TO-12	24-hour (~60 samples/year, one every 6 <sup>th</sup> day)
Carbonyls <sup>2</sup>	9/2011-current	TO-11A	24-hour (~30 samples/year, one every 12 <sup>th</sup> day)
PM <sub>10</sub>	11/2012-current	BAM	Hourly
PM <sub>2.5</sub>	11/2012-current	BAM	Hourly
Ozone	11/2012-current	API	Hourly
NO/NO <sub>2</sub> /NO <sub>x</sub>	11/2012-current	API	Hourly
Methane/Non-Methane VOCs	11/2012-current	Baseline MOCON	Hourly
Meteorology	11/2012-current	Various	Hourly
<b>Carbondale, Colorado (RFCO)</b>			
SNMOCs <sup>1</sup>	6/2012-current	TO-12	24-hour (~60 samples/year, one every 6 <sup>th</sup> day)
Carbonyls <sup>2</sup>	6/2012-current	TO-11A	24-hour (~30 samples/year, one every 12 <sup>th</sup> day)
PM <sub>10</sub>	6/2012-current	FRM	24-hour (~120 samples/year, one every 3 <sup>rd</sup> day)
PM <sub>2.5</sub>	6/2012-current	E-BAM	Hourly
Ozone	6/2012-current	2B	Hourly
Meteorology	6/2012-current	Various	Hourly

<sup>1</sup> **80 SNMOC compounds monitored using method TO-12:** 1,2,3-Trimethylbenzene, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene, 1,3-Butadiene, 1-Butene, 1-Decene, 1-Dodecene, 1-Heptene, 1-Hexene, 1-Nonene, 1-Octene, 1-Pentene, 1-Tridecene, 1-Undecene, 2,2,3-Trimethylpentane, 2,2,4-Trimethylpentane, 2,2-Dimethylbutane, 2,3,4-Trimethylpentane, 2,3-Dimethylbutane, 2,3-Dimethylpentane, 2,4-Dimethylpentane, 2-Ethyl-1-butene, 2-Methyl-1-butene, 2-Methyl-1-pentene, 2-Methyl-2-butene, 2-Methylheptane, 2-Methylhexane, 2-Methylpentane, 3-Methyl-1-butene, 3-Methylheptane, 3-Methylhexane, 3-Methylpentane, 4-Methyl-1-pentene, Acetylene,  $\alpha$ -Pinene, Benzene,  $\beta$ -Pinene, cis-2-Butene, cis-2-Hexene, cis-2-Pentene, Cyclohexane, Cyclopentane, Cyclopentene, Ethane, Ethylbenzene, Ethylene, Isobutane, Isobutene/1-Butene, Isobutylene, Isopentane, Isoprene, Isopropylbenzene, m-Diethylbenzene, Methylcyclohexane, Methylcyclopentane, m-Ethyltoluene, m-Xylene/p-Xylene, n-Butane, n-Decane, n-Dodecane, n-Heptane, n-Hexane, n-Nonane, n-Octane, n-Pentane, n-Propylbenzene, n-Tridecane, n-Undecane, o-Ethyltoluene, o-Xylene, p-Diethylbenzene, p-Ethyltoluene, Propane, Propylene, Propyne, Styrene, Toluene, trans-2-Butene, trans-2-Hexene, trans-2-Pentene

<sup>2</sup> **13 Carbonyl compounds monitored using method TO-11A:** 2,5-Dimethylbenzaldehyde, 2-Butanone, Acetaldehyde, Acetone, Benzaldehyde, Butyraldehyde, Crotonaldehyde, Formaldehyde, Hexaldehyde, Isovaleraldehyde, Propionaldehyde, Tolualdehydes, Valeraldehyde

## EPAC Rebuttal Exhibit 4



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FAX: 970-484-3423

TO: Kirby Wynn; GCPHD  
FROM: Cassie Archuleta  
SUBJECT: Garfield County Monitoring Data Summary Reports  
DATE: January 29, 2014

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Mr. Wynn,

This letter is in response to a request to provide a written statement documenting the source of air quality data summaries provided by Air Resource Specialists (ARS) under contract with the Garfield County Public Health Department (GCPHD).

Specific to this request, since 2008, ARS has provided GCPHD with annual summaries of Volatile Organic Compounds (VOCs) measured in the area. To acquire VOC data, GCPHD contracts separately with the Eastern Research Group (ERG) to facilitate the deployment and analysis of canisters that collect 24-hour samples once every 6 days for several monitoring sites in the County. For sample collection and analysis, ERG uses EPA approved methods consistent with EPA's larger Urban Air Toxics Monitoring Network (UATMN).

Validated VOC data are provided to ARS on a monthly basis, and aggregated annually into an annual report. These summaries are publically available in annual reports online at <http://www.garfield-county.com/air-quality/documents.aspx>. Some specific data summary products recently provided by ARS to GCPHD are described briefly below.

Figure 1 presents an example of a VOC summary from an annual report where all speciated compounds (80 specific compounds as per EPA's TO-12 method) are aggregated into larger groups to show the magnitude of total speciated VOCs measured between 2008 and 2012. Descriptions of these parameter groupings are provided in the annual reports. Figures 2 and 3 present species specific plots for individual parameters measured.

Table 1 presents trends statistics that were calculated based on annual averages of measured Hazardous Air Pollutants (HAPs), which are a subset of the VOCs collected. Annual trends were calculated by ARS for the years 2008-2012, with a trend defined as the slope derived using Theil statistics, which is a nonparametric regression technique that is commonly applied to environmental data to determine statistically significant trends, consistent with Theil statistics

used in EPA's National Air Quality Trends Reports (<http://www.epa.gov/airtrends/>).

Please feel free to address any additional questions about this information to myself at 970/484-7941 or [carchuleta@air-resource.com](mailto:carchuleta@air-resource.com).

Sincerely,



Cassie Archuleta  
Project Scientist  
Air Resource Specialists, Inc.

Figure 1

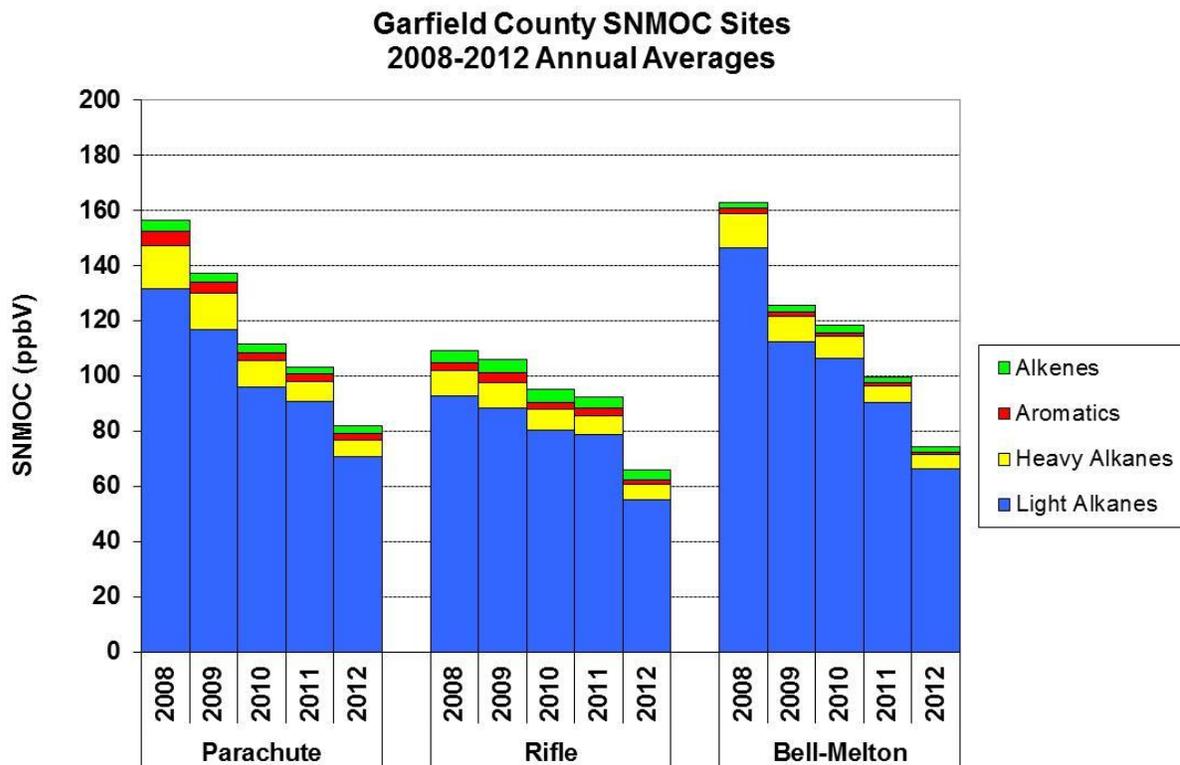


Figure 2

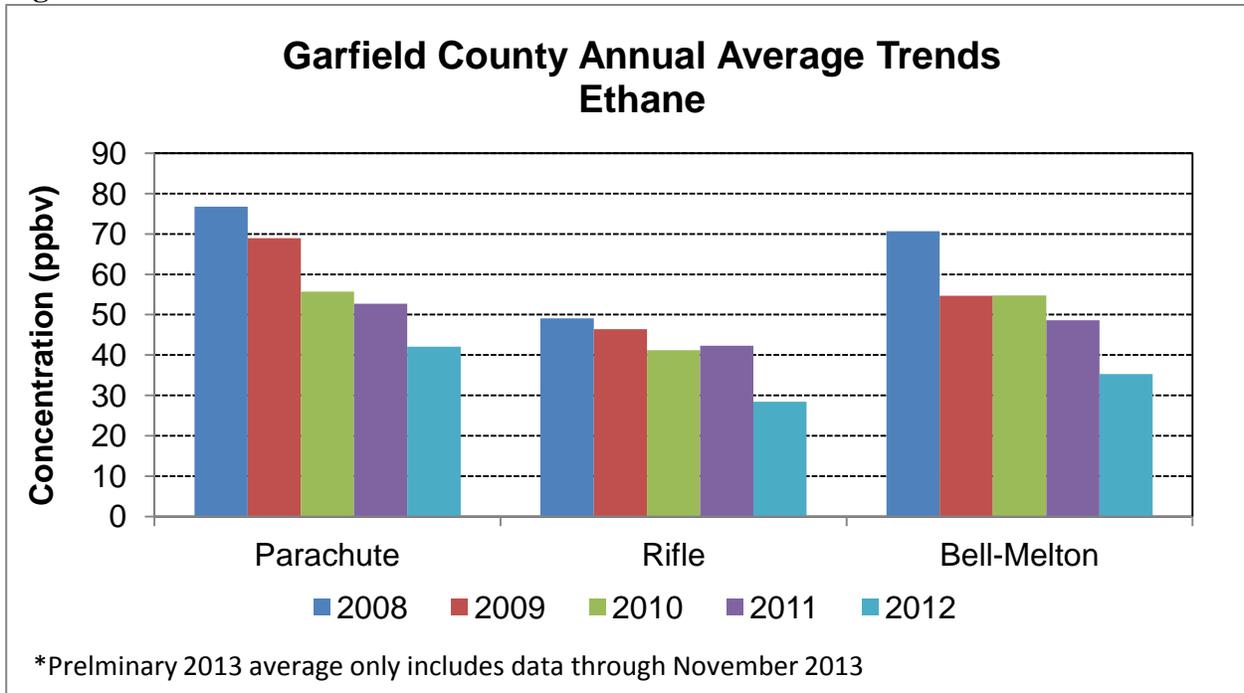
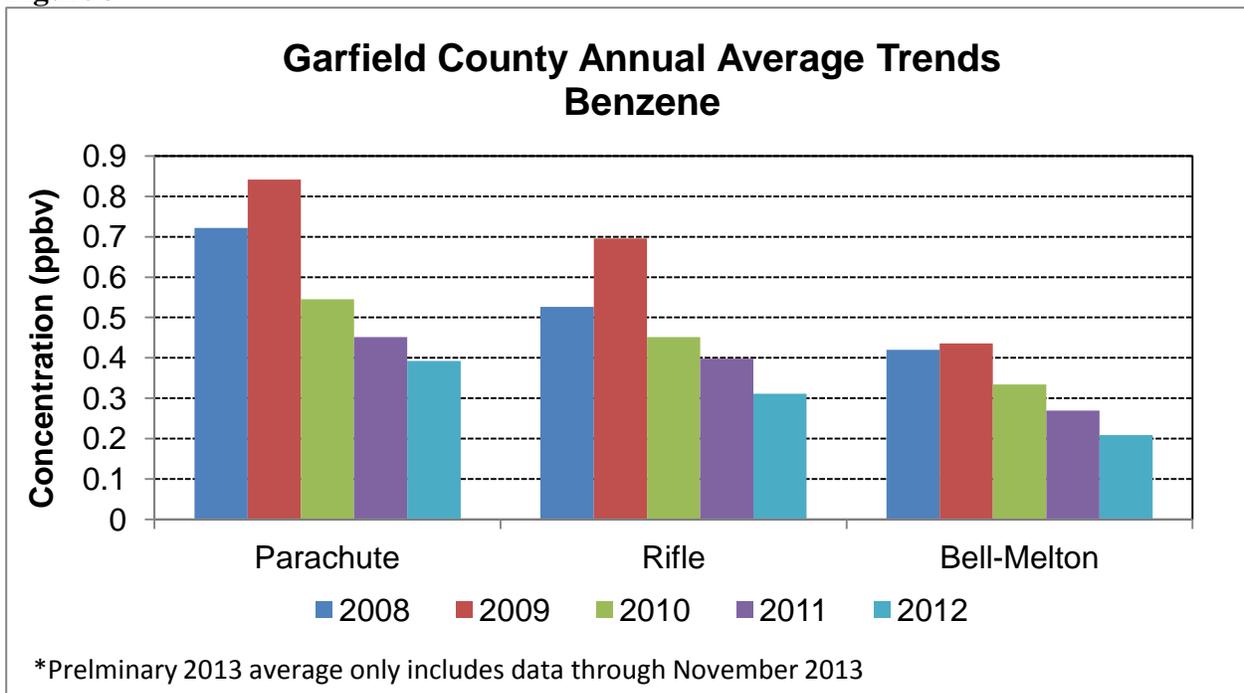


Figure 3



**Table 1**  
Parachute Site  
Annual Average Mass Trends (HAPs Parameters)  
2008-2012

HAP	Average Mass ( $\mu\text{g}/\text{m}^3$ )					Slope ( $\mu\text{g}/\text{m}^3$ per year)	p-Value
	2008	2009	2010	2011	2012		
1,2,4-Trimethylbenzene	0.91	0.62	0.42	0.43	0.39	-0.11	0.04
1,3,5-Trimethylbenzene	0.61	0.51	0.40	0.22	0.18	-0.11	0.01
1,3-Butadiene	0.08	0.12	0.10	0.10	0.09	0.00	0.59
Acetaldehyde	1.11	0.99	0.92	0.90	0.75	-0.08	0.01
Acetone	3.42	3.28	2.67	2.79	2.34	-0.26	0.04
Benzene	2.31	2.69	1.74	1.44	1.31	-0.28	0.04
Crotonaldehyde	0.10	0.10	0.12	0.09	0.08	-0.01	0.24
Cyclohexane	3.92	3.77	2.90	2.22	1.99	-0.54	0.01
Ethylbenzene	0.59	0.44	1.04	0.32	0.17	-0.10	0.12
Formaldehyde	1.74	1.73	1.53	1.64	1.27	-0.11	0.04
Isopropylbenzene	0.09	0.08	0.07	0.08	0.06	-0.01	0.04
Methylcyclohexane	9.24	9.43	6.41	4.65	4.19	-1.47	0.04
m-Xylene/p-Xylene	3.91	3.63	2.20	1.11	1.15	-0.84	0.04
n-Hexane	5.78	5.64	3.93	3.34	3.01	-0.75	0.01
n-Nonane	2.20	2.01	1.13	0.97	0.61	-0.40	0.01
n-Propylbenzene	0.18	0.15	0.13	0.10	0.10	-0.02	0.01
o-Xylene	0.77	0.65	0.43	0.40	0.27	-0.13	0.01
Propionaldehyde	0.12	0.09	0.09	0.09	0.07	-0.01	0.04
Propylene	0.57	0.57	0.62	0.55	0.69	0.03	0.41
Styrene	0.12	0.08	0.12	0.13	1.56	0.04	0.04
Toluene	9.86	5.83	3.96	5.79	4.27	-1.38	0.12