City of Jacksonville

City Odor Study

Annual Report

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1 Introduction

The City of Jacksonville has commissioned Envirosuite a 12-month study to better comprehend and manage odor complaints within urban areas. To accomplish this, a complete environmental intelligence solution, comprising both hardware and software, has been deployed by Envirosuite. This provided the city with an auxiliary tool to respond to community concerns, even when staff is unavailable for on-site inspections, and to gain a more profound understanding of perceived odor traits and the impact of weather variables throughout the day, over a whole year.

This document concerns the annual study, prepared by the Environmental Intelligence Services (EIS) team of Envirosuite, presenting the results of the study 12 months after the project's commencement.

The structure of the document consists first in the presentation of the objectives of the study, followed by the executive summary, which shows its most relevant results. This is followed by a section that presents the reasons of the study, with a deep analysis of the temporal and geographical distribution of historical complaints received by the city along with an assessment around historical weather information, this historical information was the basis for Envirosuite to build the solution.

Then the city odor study is presented, which is broken down into 3 main subsections that start with a detailed explanation of the designed solution; including the deployment of meteorology and air quality hardware with a discussion around the reasons of why each device was placed at each location, this is followed by the description of the software solution which consists on the description of each of the modules (monitoring, modelling, trajectories, incident intelligence, and reports) of the Envirosuite platform called OMNIS. After that, there is an explanation around the Environmental Intelligence Services support to the city throughout the study.

The second main subsection consists of the results obtained during the study period, a whole year between April 2022 to March 2023. First, an analysis of the complaints received by the city during the study is presented with an evaluation of its temporal and geographical distribution and an assessment on how the incident intelligence module tool was used to manage complaints.

This is followed by the presentation of the analysis of the monitored data during the study, including surface meteorology (wind speed, wind direction, temperature, and relative humidity) and air quality (ammonia, hydrogen sulfide, and volatile organic compounds). To this end, the data is presented in appropriate graphs including time series, hourly, daily weekly, monthly and seasonal cycles, wind roses and pollution roses.

Then the modelling results are presented, this includes the evaluation of the qualitative and quantitative uncertainty of the forecast weather model performance against surface meteorological observations, followed by an analysis on upper air forecast parameters, followed by the presentation of the results of the odor dispersion model and an assessment on how the trajectory module tool was used by the city during the year.

The third main subsection presents the study discussion, which consists in the evaluation of how the complaints received by the city relate to the monitoring and modelling results. This is done to study trends that can help understanding how weather impacts dispersion of pollutants, particularly for the days when the city received a high number of complaints.

Finally, the main conclusions of the study are presented followed by recommendations proposed by Envirosuite to the City of Jacksonville and to the industries present in the city, targeting to minimize the affection to the people that live in the city by harnessing the power of the environmental intelligence.

2 Objectives

The main objective of the yearly report is to provide the City of Jacksonville with a comprehensive summary of the City Odor Study developed by Envirosuite between April 2022 and March 2023. Secondary objectives that are expected because of the study are:

- To provide a summary of the reasons of why the study was needed, including both complaints and meteorological historical data.
- To deliver an extensive explanation of the solution designed by Envirosuite to help the city.
- To present a detailed analysis of the results of the study; including complaints received during the year, monitored, and modeled data, along with a discussion to evaluate how they relate to obtain insights based on data.
- To provide the City of Jacksonville with recommendations based on the study results, so actions can be taken to help minimizing odor events in the city in the future.
- To conclude on how the solution provided by Envirosuite can be improved and enhanced to continue helping the City of Jacksonville in the future.

3 Executive Summary

Between September 2020 and November 2021, the City of Jacksonville received more than 3,300 odor complaints from people living in the city. The odor was mainly addressed by complainants as “chemical”, “noxious”, “sweet turpentine”, “pine scent”, “nauseating”, etc. The temporal analysis of the historical complaints showed that most of the odor problems were documented to occur in the morning between 6am and 11am, more frequently in autumn and winter. The geographical analysis showed that most of them came people living on addresses with zip codes 32205, 32204, 32210, 32254, and 32207.

Weather is a critical element in the dispersion of atmospheric pollutants. To investigate this phenomenon, historical surface weather data was analyzed by Envirosuite. The findings indicate that during early morning hours, the prevailing wind speeds were low, specifically from the N and NNW directions. Based on the location of potential odor sources within the industrial area of the city, coupled with the higher number of complaints coming from the SE direction of the industrial area, it was inferred that a possible correlation existed between the potential odor emissions originating from that area and it was impacting the quality of life for the surrounding communities.

To assist the city in comprehending and responding to this environmental situation, Envirosuite was commissioned to conduct a 12-month odor study, comprising a solution that consisted in the following:

- **Air quality and meteorology monitoring:** Envirosuite installed 2 weather stations and 11 eNoses (air quality indicative devices equipped with H_2S, NH_3 and VOC sensors) around the city. Four existing weather stations belonging to the city supplemented this monitoring network.

- **Modelling:** Observed and forecast models were set for both meteorology and air quality dispersion.

- **Backward and Forward Trajectories:** These tools allow the city personnel to confirm potential complaints and the probable odor source. By running backward or forward trajectories, the system shows the wind path from the last hour or since the selected hour one hour forward respectively.

- **Incident Intelligence:** It is a centralized ticketing system for complaint management that allows to log in complaints when they are received, providing relevant information such as descriptions of the odor or air quality problem perceived, contact details of the reporter, date and time of the complaints and their location. The system runs an automatic backward trajectory each time a complaint is received, then after the ticket is validated by the city personnel, the information gets stored and its available to be visualized on a map that allows understanding the geographical distribution of complaints.

- **Environmental Intelligence Services (EIS) support:** EIS is a team of professionals within Envirosuite that supported the city by developing monthly reports, responding to technical inquiries, assisting to meetings whenever needed, and completing other pertinent periodic tasks.

- **OMNIS Environmental Intelligence Platform:** Envirosuite distinct tools were accessible on the OMNIS platform for the city personnel to manage odor complaints, monitor air quality and meteorological parameters, and model weather and air dispersion in real-time and for forecasts, 24/7.

The 12-month study was conducted between April 2022 to March 2023. The main results of the study are summarized below:

✓ The complaints received by the city during the study (627 in total) show a similar pattern to the historical complaints, most complaints occurred during the early morning (between 6am and 11am), particularly from people living in areas covered by zip code 32205. It was noticeable that there were considerably fewer complaints comparing both periods (historical vs study).

- ✓ Surface meteorological data collected by all 6 weather stations showed that wind speeds are expected to be lower at night and dawn and higher during the day. Wind direction at stations west of the river showed prevailing NNE, NE, S and SSW winds, while stations east of the river showed prevailing NW, WNW, and NNW winds. As for temperature and humidity, all stations showed reasonable trends which are higher temperatures during the day and lower at night and dawn, and the reverse for humidity.

- ✓ The air quality data collected by the eNoses showed that for most of them there is a similar trend in H_2S and VOC concentrations, which consists of higher concentrations of these pollutants during dawn and morning, and lower concentrations during the day. The opposite occurs with NH_3, whose concentrations are highest during the day and lowest at night and dawn.

- ✓ The uncertainty assessment of the weather forecast model (WRF-CALMET) indicates that the model can represent the daily and annual cycles of the main observed surface meteorological parameters, which are wind speed, wind direction and temperature. Although it was shown that the model significantly overpredicts wind speed, while it can better represent wind direction and temperature ranges.

- ✓ The analysis of forecast upper air data showed that the model can represent an expected diurnal cycle of mixing height, which is lower during night and higher during the day and the afternoon. The opposite was shown for the inversion strength which shown to be higher during dawn and very low during the day and afternoon. This allows to explain the worse ventilation conditions during the early morning.

- ✓ The virtual odor dispersion model showed that for given odor emission sources in the industrial area and for given alert points located where most of the complaint come from (zip code area 32205), there is an expected high level of odor concentrations during the early morning.

The study's discussion centered on analyzing complaints, monitored data, and modeled data to assess their interrelationships. For the top four days with the most complaints during the study period (June 21, 2022, October 10 and 25, 2022, and January 10, 2023), the risk report highlighted an extreme risk of complaints, which aligned with the hours with more complaints each day, with the odor dispersion plume and wind trajectories provided by the models. Additionally, these days were characterized by poor dispersion conditions (low mixing heights and high inversions) and elevated levels of H_2S, and VOCs as measured by air quality monitors.

Envirosuite recommendations to the City of Jacksonville moving forward include several steps. These include socializing the study with citizens and industries, upgrading the eNoses to the new Air Quality Monitor to the 5S model to be able to measure more gases and particles, upgrading the modeling solution to Envirosuite new METRIQA modelling system, improving the odor dispersion model to better represent most sources in the city, improving the risk report by adding more parameters and identifying new potential odor sources, and upgrading the incident intelligence module by adding an odor report form to facilitate the ingestion of complaints.

In conclusion, the study's findings suggest that the solution provided by Envirosuite is a useful tool for the city to better understand and manage odor problems. Envirosuite recommendations for improvement can enhance the effectiveness of the solution and improve environmental management going forward.

4 Reason of The Study: Odor Complaints & Meteorology – Historical Data Analysis

This section aims to provide historical context around the main reasons that make the City of Jacksonville develop this odor study.

Between September 2020 and November 2021, the City of Jacksonville received more than 3,300 odor complaints from people living in the city. The odor has been mainly addressed by complainants as "chemical", "noxious", "sweet turpentine", "pine scent", "nauseating", etc.

Envirosuite Environmental Intelligence Services (EIS) team studied the historical complaint data provided by City of Jacksonville, to find some insights around the temporal and spatial distribution of the information, which was a valuable input for the study design.

4.1 Temporal Distribution of Historical Complaints

Table 1 shows the temporal distribution of the historical complaints per month and per hour of the day (00:00-23:00). From the table is possible to conclude that most complaints occurred during the autumn-winter months during the morning (between 6:00-11:00 am).

Table 1. Monthly and hourly distribution of historical complaints.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
2020	**12**	**5**	**2**	**3**	**6**	**11**	**29**	**56**	**107**	**90**	**65**	**30**	**35**	**16**	**27**	**23**	**23**	**16**	**13**	**24**	**29**	**35**	**24**	**11**	**692**
September	4			1					6	2	6	5	3	2	6	4	5	3	1	1	3	5	2		**59**
October	2		1			3	7	16	39	49	17	14	13	5	11	6	9	6	2	6	3	3	2	1	**215**
November	3	2			1	2	10	8	14	9	4	2	6	3	3	9	5	3	7	13	20	23	14	4	**165**
December	3	3	1	2	5	6	12	32	48	30	38	9	13	6	7	4	4	4	3	4	3	4	6	6	**253**
2021	**17**	**31**	**15**	**24**	**19**	**67**	**168**	**390**	**520**	**299**	**211**	**127**	**82**	**72**	**57**	**53**	**64**	**69**	**53**	**63**	**79**	**71**	**62**	**27**	**2640**
January	4	8	6	1	4	3	7	29	66	56	63	32	11	9	5	8	12	12	7	16	19	21	18	5	**422**
February	3	2	1	3	1	2	7	41	51	29	25	13	5	11	6	12	10	7	7	6	16	8	6	4	**276**
March		2			3	7	25	46	27	21	33	15	8	6	2	2	9	8	1	2	5	6	5	2	**235**
April	2	5	1	3		2	15	52	65	42	20	17	11	5	6	5	10	4	9	6	7	10	3	2	**302**
May	1	2	1	6	3	6	17	36	49	13	8	6	1	3	1	2	1	3	7	3	3	3	1		**176**
June				1	1	1	6	2	6	3		2	3	7	6	2	5	1	2	9	1	4	3		**65**
July	2	2	1			4	6	22	27	20	7	7	3	8	6	4	4	10	6	6	7	4	5	4	**165**
August						3	2	5	15	10	5	5	4		4	4	2	3		2	2	1		2	**69**
September	2	1		1		8	19	62	116	49	31	19	19	10	10	6	4	11	4	7	5	10	8	3	**405**
October	1	1	2		3	20	29	54	51	29	7	5	1	8		2	5		5	3	10	1	7		**244**
November	2	8	3	9	4	11	35	41	47	27	12	6	16	5	11	6	2	10	5	3	4	3	6	5	**281**
Total	**29**	**36**	**17**	**27**	**25**	**78**	**197**	**446**	**627**	**389**	**276**	**157**	**117**	**88**	**84**	**76**	**87**	**85**	**66**	**87**	**108**	**106**	**86**	**38**	**3332**

Table 2 shows the spatial and temporal distribution of the historical complaints per zip code and per hour of the day (00:00-23:00). From the table most complaints come from addresses in zip codes 32205, 32204, 32210, 32254, and 32207, during the morning (between 06:00-11:00 AM).

Table 2. Hourly distribution of historical complaints per zip code.[1]

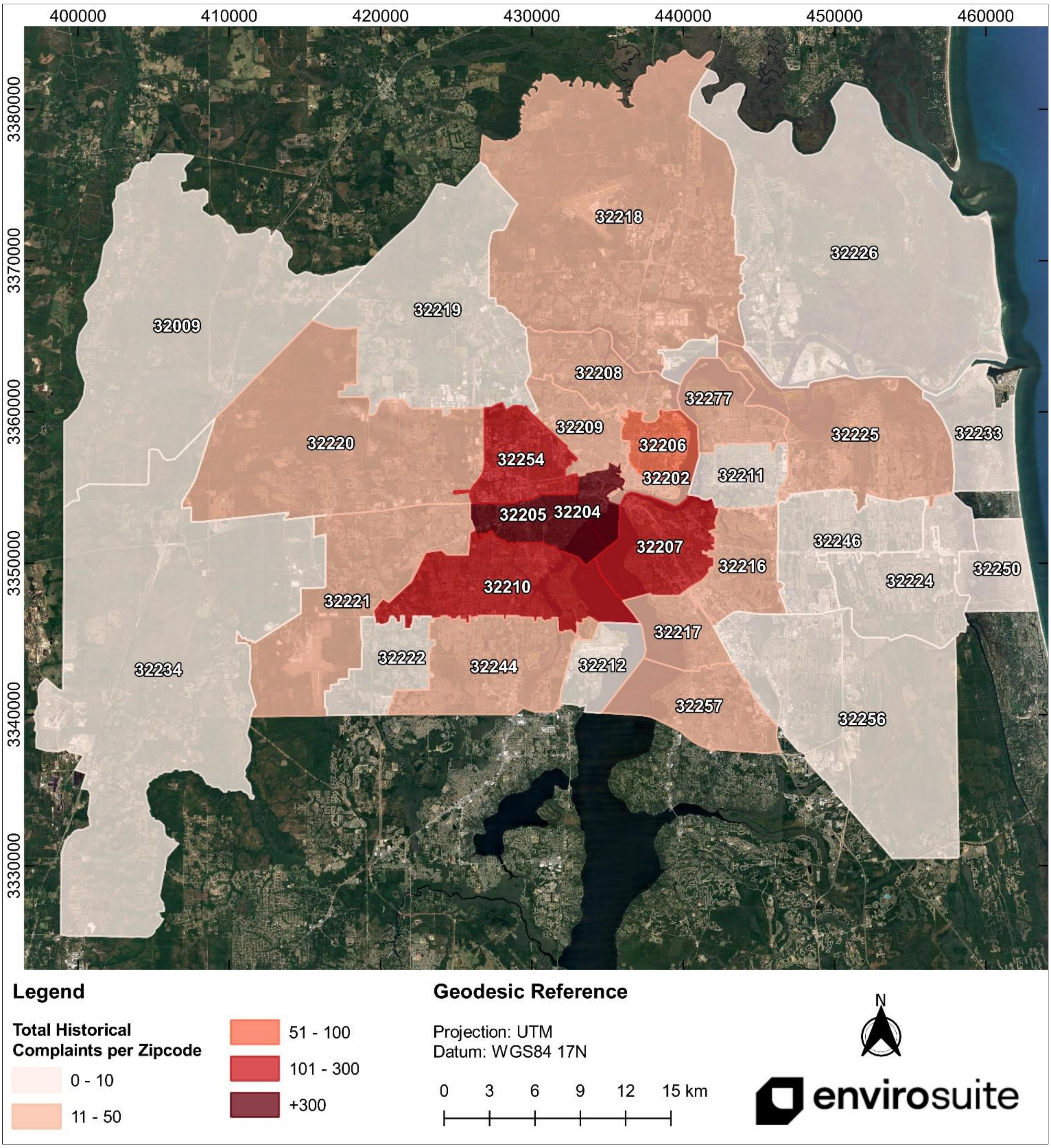
zip code	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
32202								1	4	1			2	1				3		1					**13**
32204	2	4			2	9	21	46	52	35	18	9	16	7	9	3	8	10	10	17	17	14	10	1	**320**
32205	17	22	13	15	14	62	143	328	396	227	174	84	53	37	41	39	36	32	32	46	60	66	56	27	**2020**
32206	3	1		2		3		2	8	8	5	2	5	3	1	1		2		1	4	3	1		**55**
32207				1		1	6	16	29	27	19	13	7	2	3	2	4	1	3	3	2	6	2	1	**148**
32208			1	1	5			1	5	3	3	3	2	1	2	1	3	1		1	1		1		**35**
32209				2				1	1	4	3	2	2	1	1	5	1								**23**
32210	4	7	1	3	1	2	12	30	49	48	18	12	13	7	7	3	7	7	6	3	13	6	9	5	**273**
32211								1	1	1	3	1	1	1		1									**10**
32216								1	4	2		1	1			1		1	1	1	1	1			**15**
32217							1	1	4		1					2	3			1			1		**14**
32218			1	1			4	3	3	3	3	4	2	3	2	1	2								**32**
32219								1	2				1	1			1						1		**7**
32220							3	1	2		1	4	2	4	2	2	4	10	6	5		2			**48**
32221		1					1		3	1			1	1		1		2		1	1				**13**
32222																1									**1**
32223									1	3	2		2	2	2	1	2	1							**16**
32225									1	4	3					3	1		2		1				**15**
32226								1	1																**2**
32233													1		1										**2**
32244	1		1				2	3	4	1	7	2	1	5	3	1	1	3	2	2	2				**41**
32246														1			3	1				1			**6**
32254	1	1		1	2	1	2	6	47	19	10	10	3	8	7	3	8	8		2	3	4	2	4	**152**
32256									1		1					1									**3**
32257	1								1	1	1	4		1	1						1	1	2		**14**
32258																			1	1	1				**3**
32277					1		1	2				2	2		1		1	2	1						**13**
99999				1			1	1	8	1	4	4		2	1	4	2	1	2	2	1	2	1		**38**
Total	**29**	**36**	**17**	**27**	**25**	**78**	**197**	**446**	**627**	**389**	**276**	**157**	**117**	**88**	**84**	**76**	**87**	**85**	**66**	**87**	**108**	**106**	**86**	**38**	**3332**

[1] Zip code 99999 correspond to complaints without zip code data.

4.2 Geographical Distribution of Historical Complaints

Figure 1 presents a map with the historical complaint's locations per zip code at City of Jacksonville:

Figure 1. Historical complaints map (between September 2020 – November 2021).

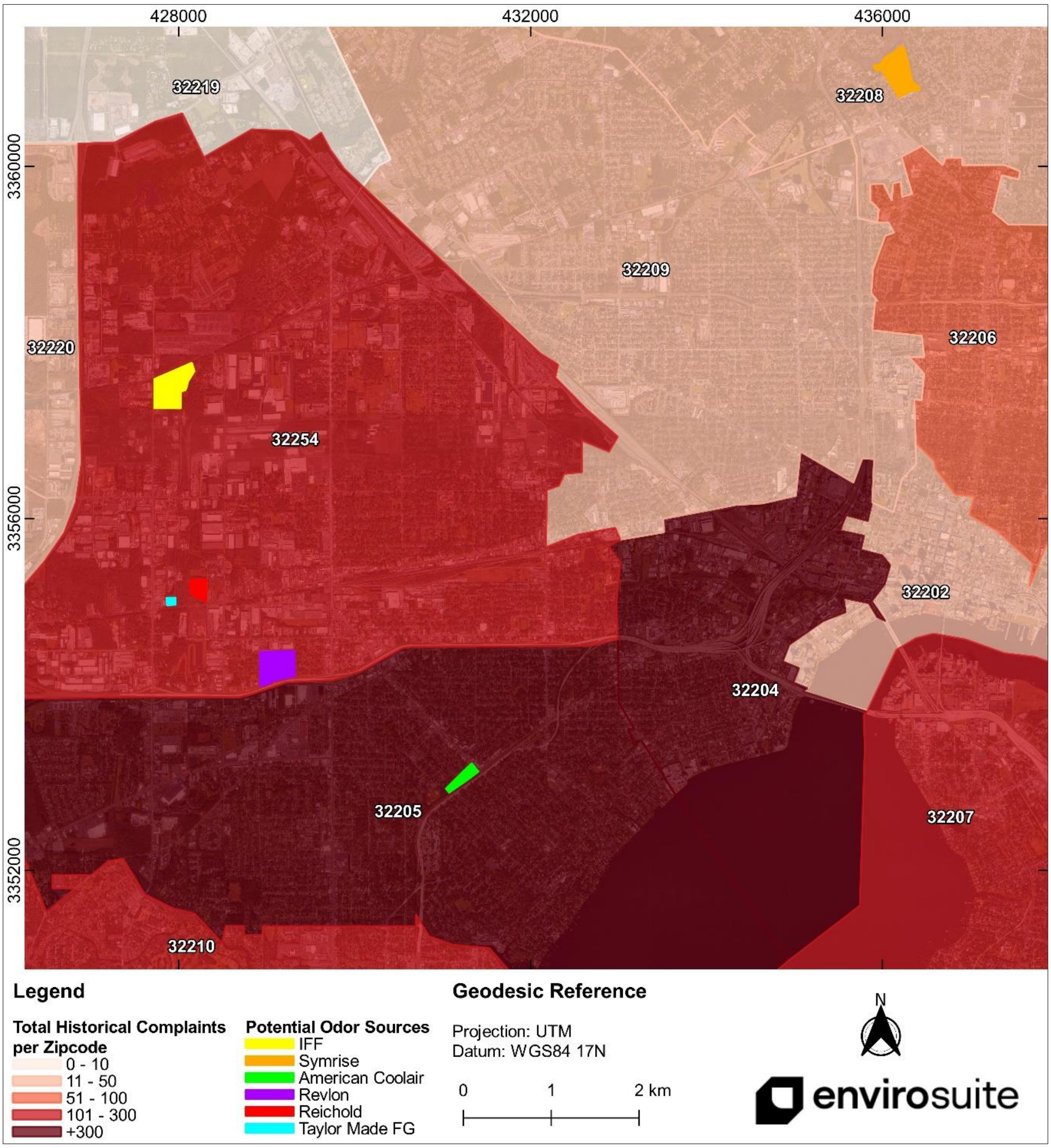


In this context, it is also important to consider the presence of different industries in the city, being the main alleged odor sources by the complainants the following:

1. **IFF (International Flavor Fragrance):** provides products and ingredients for the food and beverage, home and personal care, and health and wellness industries.
2. **Symrise** produces fragrance, flavor, natural nutrition, and cosmetics products.
3. **American Coolair Corporation:** manufacturer of ventilation products.
4. **Revlon:** warehouse of beauty products.
5. **Reichold:** supplier to the composite and coating industry.
6. **Taylor Made FG:** fiberglass manufacturer.

Figure 2 presents a map with a zoom for the zip codes for historical complaints, along with the location of the main industries in the city:

Figure 2. Zoom view to historical complaints map (between September 2020 – November 2021) and potential odor sources.

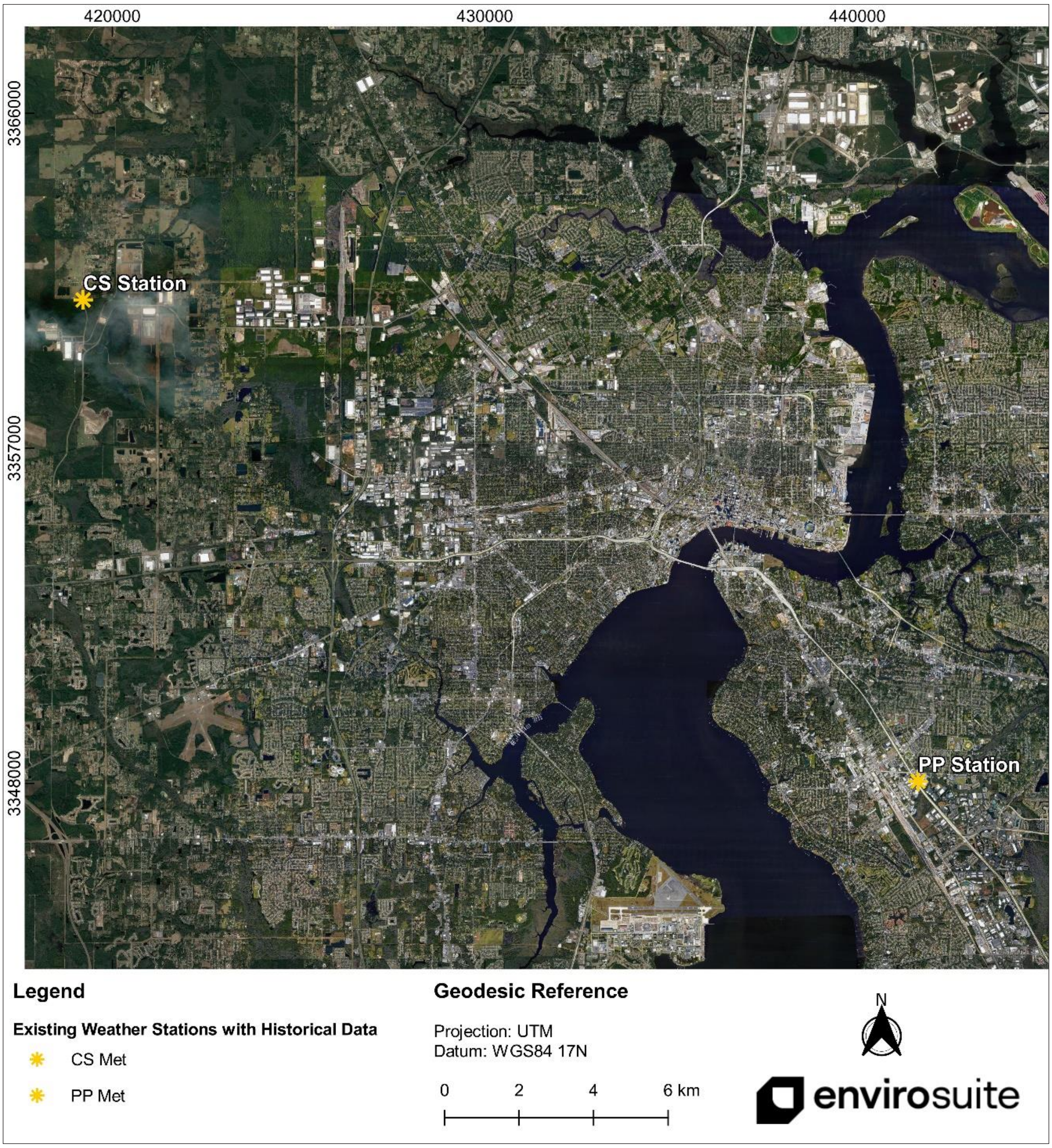


The main problem the city had was the difficulty finding the source of the odor promptly in each of the complaints they received. Given that there are at least 6 alleged sources and that the complaints came from different parts of the city and at different times of the day and the year, it was difficult to allocate human and material resources to establish responsibility for each complaint. There were occasions when municipal personnel arrived at the location of the complaint and the odor had disappeared, given they tend to occur as particular events that can only last for some minutes.

4.3 Meteorology From Historical Weather Stations

The City of Jacksonville also provided the EIS historical meteorological data measured at two existing weather stations owned by the city (one at each side of the river), called CS Met and PP Met. Figure 3 presents a map with the location of each station.

Figure 3. Location of Existing Weather Stations with Historical Data.



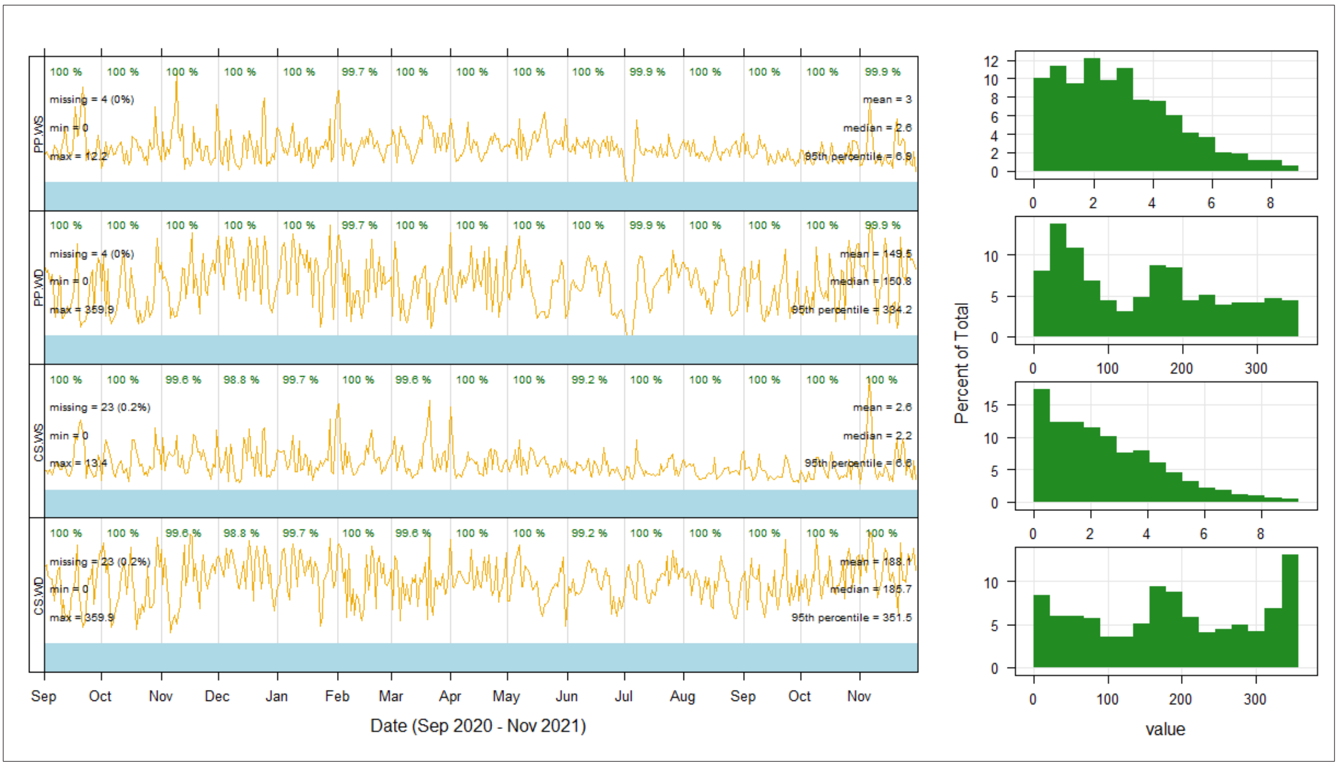
Considering that changes throughout the day and year in surface meteorology have a direct impact on the dispersion of atmospheric pollutants, this section presents for each station (CS Met and PP Met), the time series, wind roses, daily cycles and seasonal cycles for wind speed and direction, for the period September 2020 to November 2021.

This analysis was built by the Envirosuite EIS Team, and it corresponded to an important input for the City Odor Study design.

4.3.1 Time Series

Figure 4 presents the time series of wind speed and direction for the CS and PP stations, these figures allow visualizing the completeness of the available data:

Figure 4. Wind speed and wind direction time series for CS and PP stations. Historical Data.



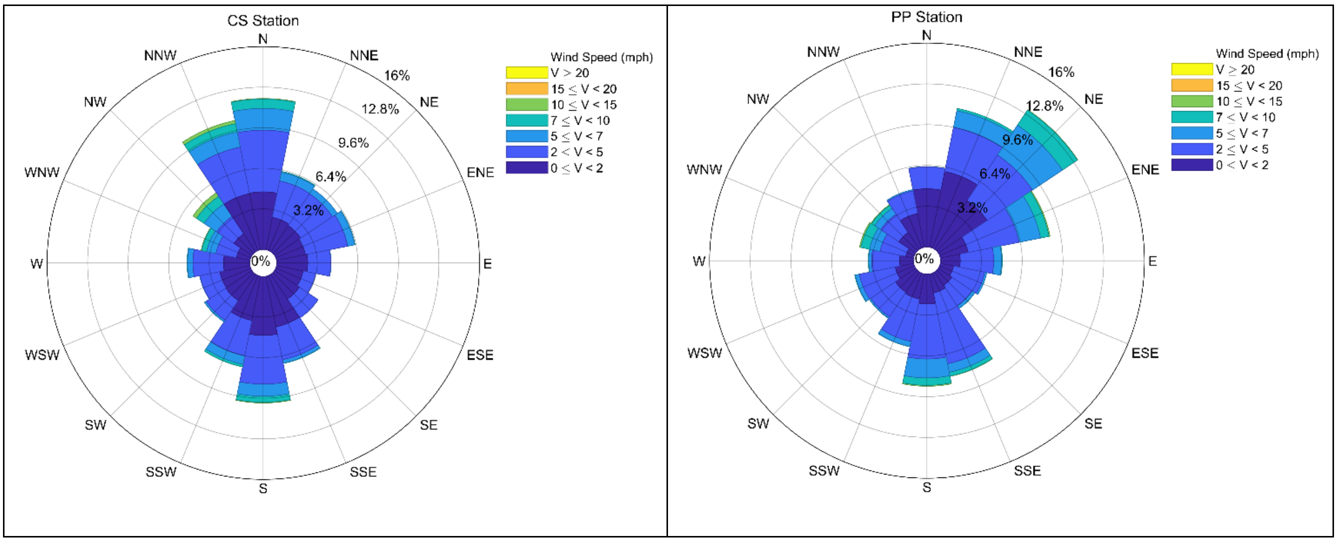
The above graphs show a robust data set available for both wind speed and wind direction at both weather stations.

4.3.2 Wind Roses

Figure 5 presents wind speed and wind direction wind roses for CS and PP stations for the whole historical period, while Figure 6 presents wind roses broken down by time of day.

The wind rose at CS station (west side of the river) shows that N, NNW, and S winds occurred most frequently, with wind speeds ranging from 0 to 10 mph. The wind rose at PP station (east side of the river) shows that NE, NNE, ENE, S, and SSE winds occur most frequently, with wind speeds ranging from 0 to 10 mph too.

Figure 5. Wind speed and wind direction wind roses for CS and PP stations, full period. Historical Data.



The description of the wind roses broken down by hour of the day is presented below:

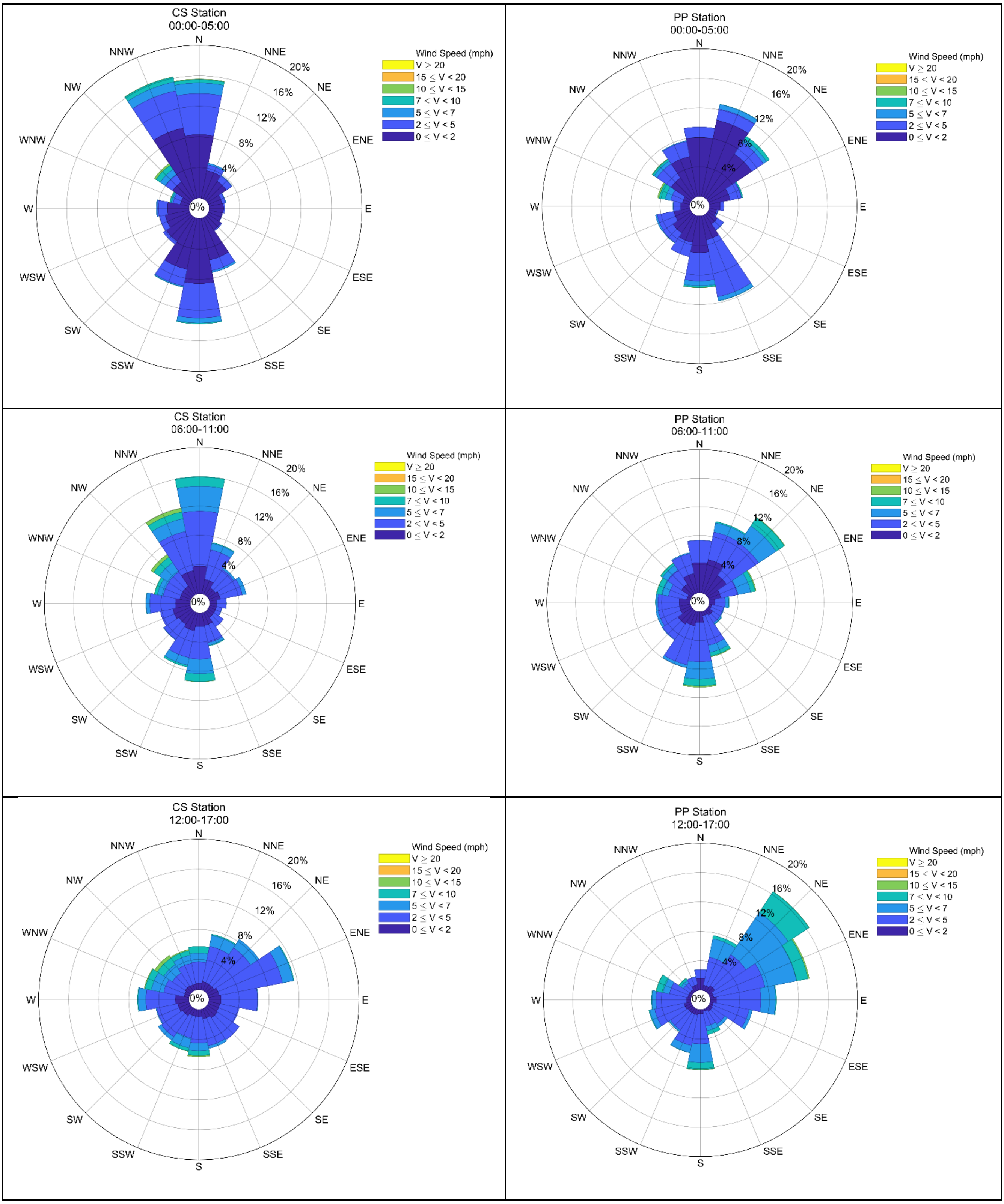
- **<u>00:00-05:00:</u>** for CS station (west side of the river) prevailing winds from the NNW, N, and S. For PP station (east side of the river) prevailing winds from the NNE, N, NE, SSE, and S. Wind speeds between 0-10 mph (predominantly 0-5 mph) for both stations.

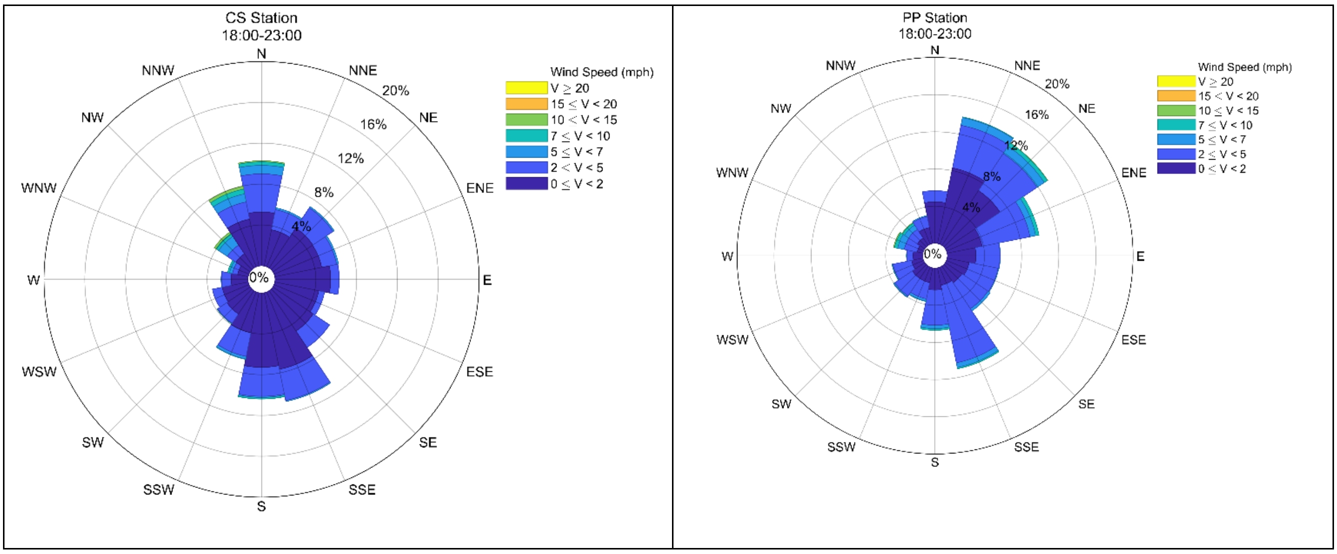
- **<u>06:00-11:00:</u>** for CS station (west side of the river) prevailing winds from the N, NNW, and S. For PP station (east side of the river) prevailing winds from the NE, NNE, and S. Wind speeds between 0-10 mph (predominantly 2-7 mph) for both stations.

- **<u>12:00-17:00:</u>** for CS station (west side of the river) prevailing winds from the ENE, NE, NNE, and W. For PP station (east side of the river) prevailing winds from the NE, ENE, and NNE. Wind speeds between 0-10 mph (predominantly 5-10 mph) for both stations.

- **<u>18:00-23:00:</u>** for CS station (west side of the river) prevailing winds from the SSE, S, N, and NNW. For PP station (east side of the river) prevailing winds from the NNE, NE, ENE, and SSE. Wind speeds between 0-10 mph (predominantly 0-5 mph) for both stations.

Figure 6. Wind speed and wind direction wind roses for CS and PP stations, broken down by time of day. Historical Data.





4.3.3 Hourly, daily, weekly, and monthly cycles

Figure 7 and Figure 8 presents wind speed and wind direction cycles for CS and PP stations respectively, these figures allow to visualize the changes of each variable during the day, the week, and months.

Regarding wind speed the diurnal cycles for both stations show that faster winds occur during the morning and the day (between 10:00-16:00) reaching a maximum on average of around 4-5 mph, while slower wind speed occur during the afternoon, night, and dawn (between 17:00-09:00) reaching a minimum on average of around 2 mph.

The wind direction diurnal cycle histogram for CS station (west side of the river) shows that between the dawn and morning (00:00-11:00) prevailing winds come from the N and the NNW followed by S winds with lower frequency. During the transition to the midday and through part of the afternoon (12:00-17:00) prevailing winds come from the ENE and NE with more frequency. Finally, during the last part of the afternoon and during the night (18:00-23:00) prevailing winds come from the S and the SSE followed by N and NNW with lower frequency.

The wind direction diurnal cycle histogram for PP station (east side of the river) shows that between prevailing winds come from the NNE, NE, and ENE during the whole day, with increased frequency between 10:00-23:00. There is also presence of SSE and S winds, particularly between 00:00 and 12:00.

Figure 7. Wind speed cycles for CS and PP stations. Historical Data.

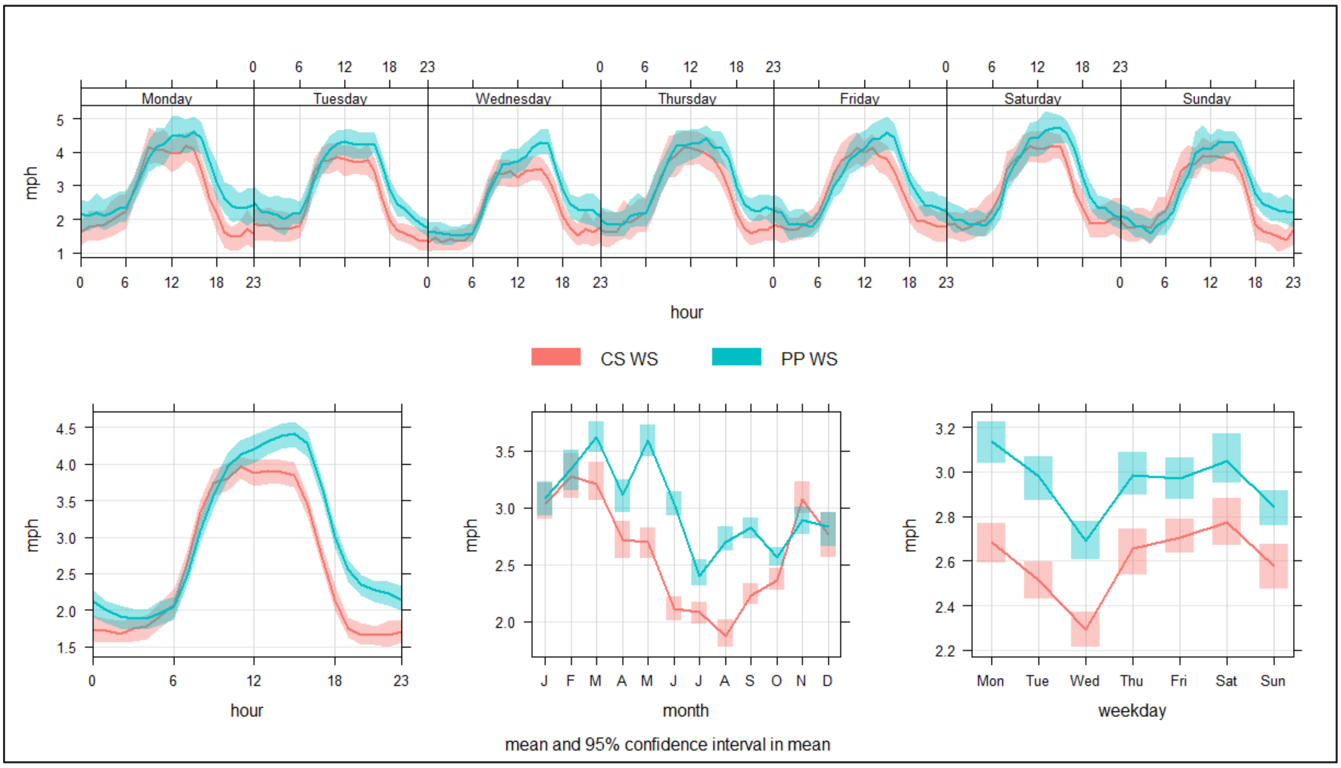
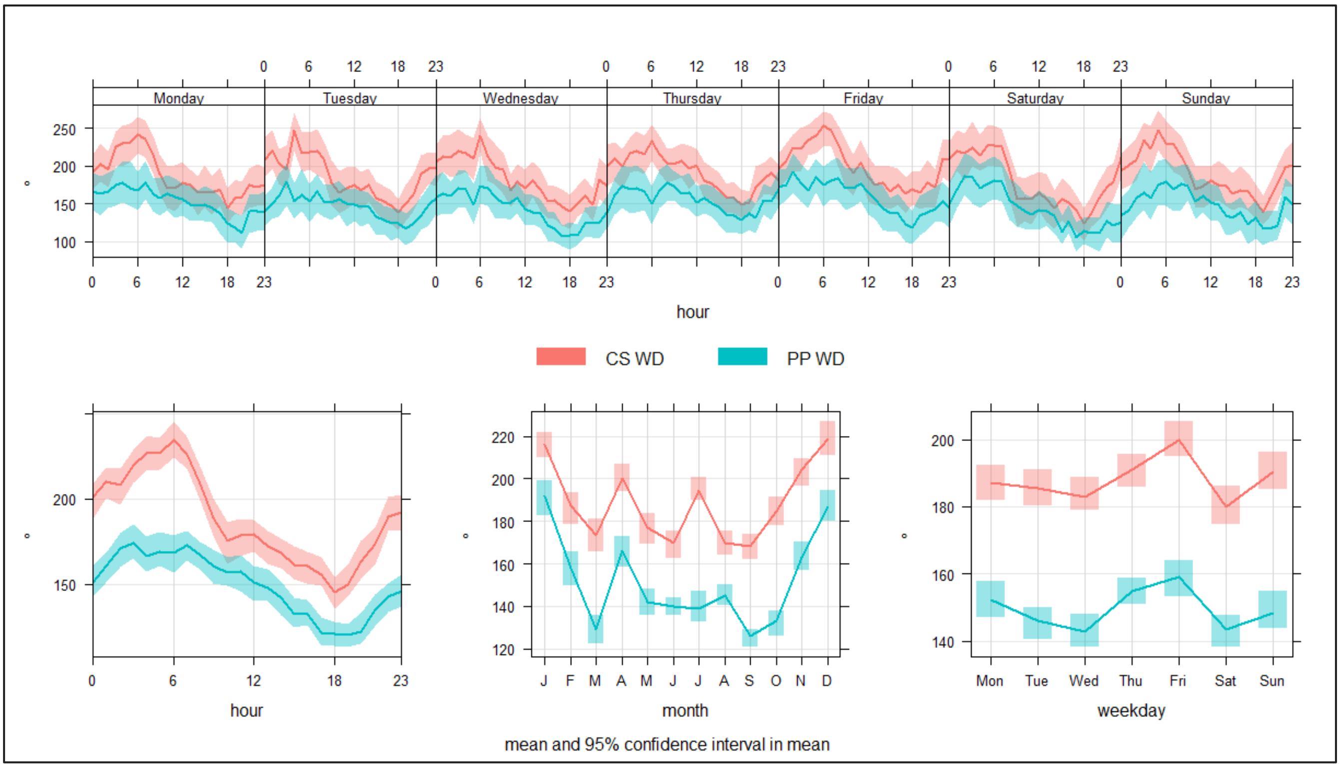


Figure 8. Wind direction cycles for CS and PP stations. Historical Data.



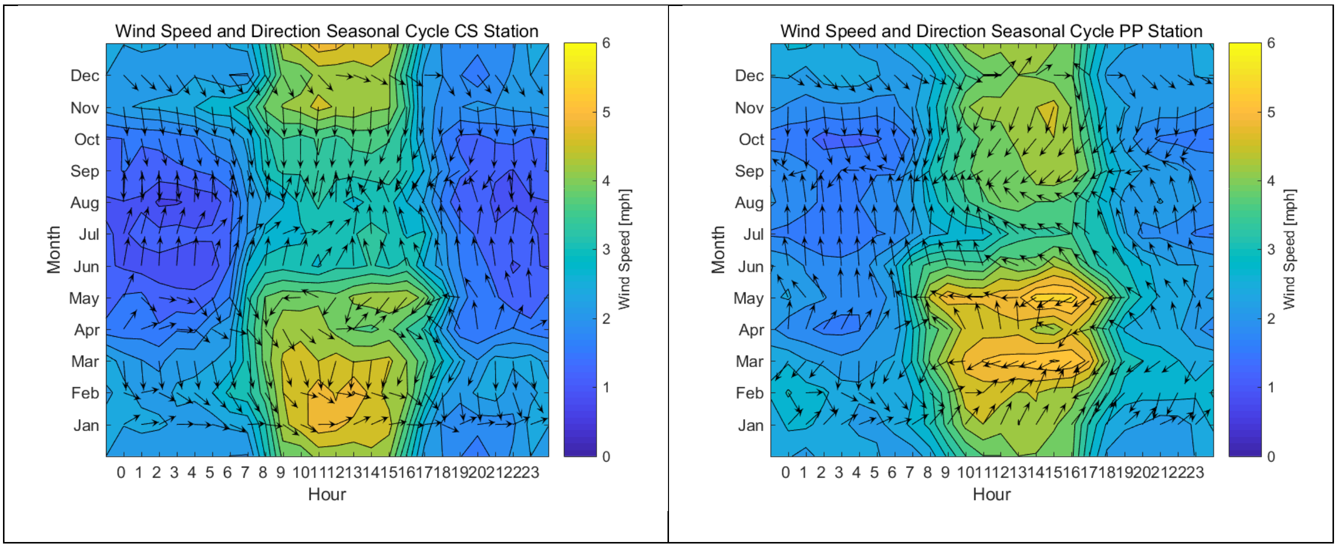
4.3.4 Seasonal Cycles

Figure 9 presents wind speed and wind direction seasonal cycles for CS and PP stations, these figures allow to visualize the changes of each variable during the year, broken down by hour of the day and month of the year. The black arrows represent the wind direction while the color scale represents the wind speed.

The figure on the left shows the seasonal cycle of the CS station (west side of the river). The wind speed data show that the highest wind speeds occur during the daytime throughout the year (between 07:00-17:00), being the highest during the winter months, while the lowest wind speeds occur during night and dawn (18:00-06:00), being the lowest during the summer months. Wind direction data indicate that during winter, autumn and spring the prevailing winds are from the N, NNW, and E throughout the day. During summer, the prevailing winds are from the S, SSW and SSE.

The right-hand side figure shows the seasonal cycle for PP station (east side of the river). The wind speed data show that the highest wind speeds occur during the daytime throughout the year (between 08:00-17:00), being the highest during the winter and spring months, while the lowest wind speeds occur during night and dawn (18:00-06:00), being the lowest during October at dawn. Wind direction data indicate that between April-August and the month of January predominant winds come from the S, SW, and SE throughout the day. Between September-December and February-March prevailing winds come from the N, NW, and NE.

Figure 9. Wind speed and wind direction seasonal cycles for CS and PP stations. Historical Data.



4.4 Discussion of Historical Data

Section 4.3 presented an analysis of the temporal-geographical distribution of historical complaints (September 2020 to November 2021), along with a meteorological analysis of the predominant wind speed and direction data during the same period.

From the temporal and geographical distribution of historical complaints presented in section 4.1 and 4.2, as shown in Table 1 and Table 2 it is noticeable that the majority of the historical complaints occurred in winter and fall months, during dawn and morning (specifically between 06:00-11:00 AM), predominantly in the area covered by zip codes 32205, 32204, 32210, 32254, and 32207. From this information and the geographical distribution of complaints and alleged sources presented in Figure 1 and Figure 2 respectively, it was shown that the area with most complaints (zip code 32205) is located are located SE from various industries considered are potential odor sources within the city (IFF, American Coolair Corporation, Revlon, Reichhold, and Taylor Made FG), and located SW from Symrise.

Focusing the analysis in that area (zip code 32205) and time (winter-fall months between 06:00-11:00 AM), from the meteorological analysis presented in section 4.3, at Figure 6 (wind roses), Figure 7 (diurnal cycles), and Figure 9 (seasonal cycles) it was shown for CS station (west side of the river) that during winter-fall months between 06:00-11:00 AM there are prevailing winds from the NNW and N, with increasing wind speeds during those hours that in average go from 2 mph to 4 mph.

This surface meteorology analysis for wind speed and direction demonstrates that any air pollutants emitted from any of the identified potential industrial odor sources will be dispersed and transported by the prevailing NW and N winds towards the SE and S, which coincides with the area where the highest number of complaints are recorded during the same period (zip code 32205).

4.5 Public Media & News Around the Case

This case has been extensively covered by the media with articles and videos before and during this project, as can be seen in more detail on the following links that show some of the news available online:

- **October 2 2020:** Complaints pour in as city investigates 'chemical-like' odor in Murray Hill (jacksonville.com)

- **June 29 2021:** What is the 'vile' Jacksonville odor and where is it coming from? | firstcoastnews.com

- **October 28 2021:** Action News Jax Investigates: 'Vile, sickening odor' in Jacksonville neighborhood – Action News Jax

- **November 17 2021:** Origin of mysterious Jacksonville odor still unclear, city says (news4jax.com)

- **November 17 2021:** Residents angered by foul smell hanging over Jacksonville | firstcoastnews.com

- **February 18 2022:** The city of Jacksonville installs sensors to figure out the source of terrible smells around town (news4jax.com)

- **April 13 2022:** Murray Hill residents hopeful sensors will identify source of foul odor - The Resident Community News Group, Inc. | The Resident Community News Group, Inc. (residentnews.net)

- **September 5 2022:** City's hunt continues to find source of bad smells - The Resident Community News Group, Inc. | The Resident Community News Group, Inc. (residentnews.net)

- **January 4 2023:** Source of Murray Hill odor issue still unresolved - The Resident Community News Group, Inc. | The Resident Community News Group, Inc. (residentnews.net)

5 City Odor Study

This section presents the City Odor Study conducted by Envirosuite for the City of Jacksonville.

5.1 Solution Design

The solution proposed by Envirosuite to the City of Jacksonville consists in 3 main parts: Hardware (installation of air quality and meteorological devices), Software (deployment of Envirosuite Environmental Intelligence Platform) and constant EIS Support throughout the study. A detailed description of each part is presented in this section, to provide context of everything that was done.

5.1.1 Hardware

This first subsection aims to present the hardware deployed onsite by Envirosuite along with the existing hardware owned by the City of Jacksonville. Envirosuite installed 11 eNose Ambient with a H_2S, NH_3 VOC sensor each and 2 Delta Ohm weather stations- Additionally, the city owns 4 weather stations which were integrated into the same system.

Regarding the hardware installed by Envirosuite, below a description of both air quality and meteorological devices is presented in the following subsections.

5.1.1.1 Meteorology: Delta Ohm Weather Station

To measure surface meteorology parameters, Envirosuite installed 2 Delta Ohm HD52.3D[2], which is an all-in-one compact and light weather station that contains ultrasonic static anemometers that allow to measure wind speed and wind direction, along with other parameters such as temperature, solar radiation, humidity, and atmospheric pressure.

Below are the advantages of using these types of devices to measure meteorological parameters:

- Absence of moving parts minimizes maintenance.
- High sensitivity for detecting very low wind speeds, which are not detectable by traditional methods.
- The low power of the instrument allows installation in remote sites, with power from solar panel and battery.
- Fast and easy installation, alignment facilitated by built-in compass.
- The available measurement options join in one single, compact, and lightweight instrument.

The scope of the study considers the installation of two (2) new Delta Ohm weather stations.

Figure 10 presents a reference image of this weather station:

[2] For more information visit: https://www.deltaohm.com/product/hd52-3d-serie-2-axis-ultrasonic-anemometer/

Figure 10. Delta Ohm Weather Station. Reference Image.

Figure 11 presents a summary of the technical specifications of the Delta Ohm weather station:

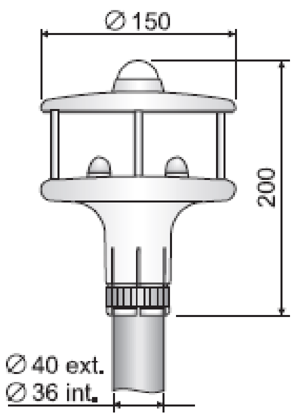
Figure 11. Specification Summary for Delta Ohm Weather Station.

Technical Specification

WIND SPEED	
Sensor	Ultrasounds
Measuring range	0…60 m/s (0…50 m/s with rain gauge option)
Resolution	0.01 m/s
Accuracy	± 0.2 m/s or ± 2%, the greatest (0…35 m/s), ± 3% (> 35 m/s)
WIND DIRECTION	
Sensor	Ultrasounds
Measuring range	0…359.9°
Resolution	0.1°
Accuracy	± 2° RMSE from 1.0 m/s
COMPASS	
Sensor	Magnetic
Measuring range	0…360°
Resolution	0.1°
Accuracy	± 1°
AIR TEMPERATURE *(option 17)*	
Sensor	Pt100
Measuring range	-40…+70 °C
Resolution	0.1 °C
Accuracy	± 0.15 °C ± 0.1% of measurement
RELATIVE HUMIDITY *(option 17)*	
Sensor	Capacitive
Measuring range	0…100% RH
Resolution	0.1%
Accuracy (@ T = 15…35 °C)	± 1.5% RH (0…90% RH), ± 2% RH (remaining range)
Accuracy (@ T = -40…+70 °C)	± (1.5 + 1.5% of measurement) % RH
BAROMETRIC PRESSURE *(option 4)*	
Sensor	Piezoresistive
Measuring range	300…1100 hPa
Resolution	0.1 hPa
Accuracy	±0.5 hPa @ 20 °C
SOLAR RADIATION *(option P)*	
Sensor	Thermopile
Measuring range	0…2000 W/m²
Resolution	1 W/m²
Accuracy	2nd Class Pyranometer

GENEARAL FEATURES	
Power Supply	10…30 Vdc
Power consumption	26 mA @ 24 Vdc without heater 8W @ 24Vdc with heater
Serial outputs	RS232, RS485 (¼ Unit Load), RS422 and SDI-12
Communication protocols	NMEA, MODBUS-RTU, SDI-12, proprietary RS232 and RS485
Analog outputs	2 analog outputs, for wind speed and direction. Output at choice among 4…20 mA (standard), 0…1 V, 0…5 V and 0…10 V (option 0…10 V needs 15…30 Vdc power supply)
Wind speed averaging interval	Configurable from 1 s to 10 min
Electrical connection	19-pole M23 male connector
Operating temperature	-40…+70 °C Minimum temperature for the rainfall sensor 1 °C
Protection degree	IP 66
Survival speed	90 m/s (60 m/s with rain gauge option)
Weight	About 1 kg (version HD52.3DP147) About 1.5 kg (version HD52.3DT147)
Case	Plastic material. Metal parts: AISI 316

Dimensions



5.1.1.2 Air Quality: eNose Ambient

The eNose Ambient is an air quality device, which allows to monitor pollutants in real time 24/7. The scope of the study considered the installation of eleven (11) of them. The features of these devices are presented below.

- Real-time measurement of key indicators for air quality.
- Designed for rapid and easy deployment.
- Automatic integration with Envirosuite unique toolkit for analysis, response, and reporting.
- Easy to use power supply and mounting options.
- Modular design, simple component changes to keep down operating costs.
- Mobile connectivity.

Among the common applications for these devices are:

- Urban air quality networks.
- Industrial emissions monitoring.
- Water, waste, mining, industrial, construction, cities.
- Dense monitoring networks.
- Community monitoring networks.

Each eNose Ambient contains 3 gas sensors inside of it, below is a description of each gas, which are pollutants typically monitored when there are industrial odor problems:

a) Hydrogen sulfide (H_2S)

According to the Agency for Toxic Substances and Disease Registry (ATSDR, 2016), Hydrogen Sulfide (H_2S) is a colorless gas that smells like rotten eggs, people can usually smell H_2S at very low concentrations in air ranging from 0.0005 to 0.3 ppm.

This pollutant occurs naturally in crude petroleum, natural gas, volcanic gases, and hot springs. It can also result from bacterial breakdown of organic matter. Industrial sources of this pollutant include petroleum refineries, natural gas plants, petrochemical plants, coke oven plants, food processing plants, landfills, wastewater treatment plants and tanneries.

The effects on human health include damage in the respiratory tract and nervous system. Exposure to low concentrations may cause irritation to the eyes, nose, or throat. It may also cause difficulties in breathing for some asthmatics. Respiratory distress or arrest has been observed in people exposed to very high concentrations of hydrogen sulfide.

Exposure to low concentrations of hydrogen sulfide may cause headaches, poor memory, tiredness, and balance problems. Brief exposures to high concentrations of hydrogen sulfide can cause loss of consciousness. In most cases, the person appears to regain consciousness without any other effects. However, in some individuals, there may be permanent or long-term effects such as headaches, poor attention span, poor memory, and poor motor function.

According to the California Air Resources Board (CARB, n.d.), the effects of H_2S in the environment are that this pollutant is a key participant in the global sulfur cycle. It is oxidized in the atmosphere to SO_2, which can then be converted to sulfate through three different chemical pathways. H_2S is somewhat soluble in water, resulting in formation of sulfhydric acid, which is corrosive to metals, and contributes to acidic deposition to soil and water. H_2S is not a climate change gas, although because H_2S is converted in the atmosphere to sulfate, it contributes to the cooling influence provided by atmospheric sulfate.

b) Ammonia (NH_3)

Ammonia (NH_3) is as colorless gas with a pungent strong odor. It is the most abundant alkaline gas in the atmosphere. The largest source of this pollutant is agriculture, including animal husbandry and ammonia-based fertilizer applications. Other sources include industrial processes, landfills, vehicular emissions and volatilization from soils and oceans.

The effect on human health includes irritation and burn of the skin, mouth, throat, lungs, and eyes. Very high levels of this pollutant can damage the lungs or even cause death. As for the effect on the environment, ammonia plays a significant role in the formation of atmospheric particulate matter, visibility degradation and atmospheric deposition of nitrogen to sensitive ecosystems (Behera, Sharma, & Aneja, 2013).

c) Volatile Organic Compounds (VOC)

Volatile organic compounds (VOCs) are thousands of organic chemical compounds that in ambient conditions evaporate rapidly due to their high vapor pressure and low boiling point. Once emitted into the atmosphere, they take part on different complex chemical reactions from which other toxic compounds are formed. Some VOCS contain sulfur compounds in its chemical structure, which means the release of bad odor compounds into the atmosphere.

Some of the anthropogenic sources of VOC are the use of fossil fuels, solvents, domestic aerosols, pesticides, paints, among others. There are also natural sources of VOC gases, such as the trees and vegetation.

The health effects of inhaling VOC are related to cancer and other health problems. They contribute to ozone formation with its associated health effects. The effects on the environment also include ozone formation with its corresponding climate effects, it also contributes to the formation of CO_2 and secondary organic aerosols that can warm and cool the atmosphere, respectively.

Figure 12 present reference images of the eNose Ambient.

Figure 12. eNose Ambient reference images.

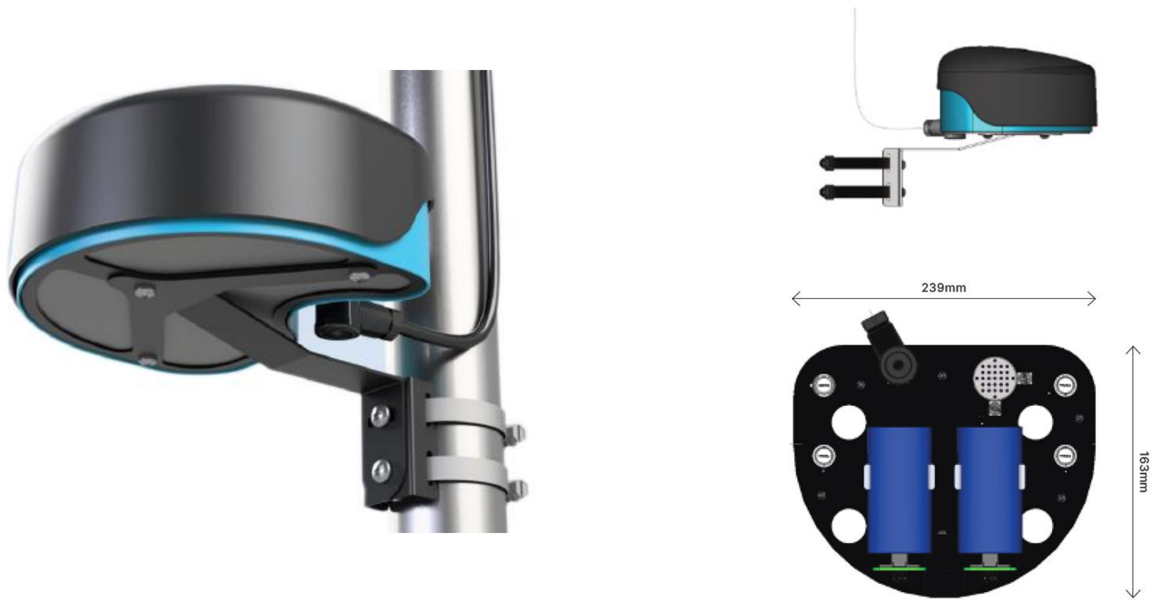


Table 3, Table 4 , and Table 5 present eNose Ambient certifications, technical data, and sensor specification for each gas, respectively:

Table 3. eNose Ambient certifications.

Safety	AS/NZ/EN/IEC 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use
EMC Emission	N 50270:2015/ICES 003 Electromagnetic compatibility - Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen CFR47 FCC Part 15, Subpart B Class B Vertical and Horizontal Planes (residential limits)
Communications	EU RED, FCC, CSA, NEMA6P, KC, Mexico NOM-218

Table 4. eNose Ambient technical data.

eNose Ambient including sensors and Envirosuite Node	
Temperature	-10 to 50°C
Battery	12 V / 96 Wh LiFePO4 Battery
Solar Power	17 W 20 Voc
Direct Power Requirements (if not solar powered)[3]	12 V DC 150mA
Radio Communications	Cellular communications multiband module 3G/4G
Antenna	External Multiband Antenna. N-type connector
Communications Protocol	Low power proprietary control board with cellular communications
Communications Protocol	MODBUS RTU
Battery life	Maximum 64 hours battery-only operation in default configuration
Independendent Operation	Designed for continuous solar operation in a variety of conditions. In extreme conditions where insufficient or no sunlight is available, supplementary battery or permanent power supply is recommended

Table 5. Sensor specification per gas.

Sensor	Minimum Detection Limit	Lower Limit[4]	Upper Limit[4]	Uncertainty	Operating Range
Air Quality Sensors					
Ammonia (NH_3)	500 ppb	1 ppm	25 ppm	± 30%, Linearity < 10%	-20C to + 40 C; 10 to 90 %RH non condensing
Hydrogen sulfide (H_2S)	10 ppb	20 ppb	1 ppm	± 30%, Linearity < 10%	-20C to + 40 C; 10 to 90 %RH non condensing
Volatile organic compounds (VOCs) 10.6 eV	2 ppb	2 ppb	40 ppm	> 15 ppb ± 15%; From -10 C to 50 C	-40C to +55C; 0 to 99 %RH non condensing

5.1.1.3 Hardware Location

To determine the location for each new hardware, EIS conducted the analysis of the historical information provided by the City of Jacksonville for the September 2020-november 2021 period (as was presented in section 4). Hence, the monitoring network was designed considering the geographical distribution of complaints, the evaluation of predominant weather conditions and the location of the main industries within the city.

Based on the above, the EIS team presented proposal for the location of the eNoses (11 devices) and weather stations (2 devices) to the City of Jacksonville, after their validation, the Envirosuite Field Services Team went to the city to check suitability of each one.

The final location of the hardware was decided jointly between Envirosuite and the City of Jacksonville, considering the following criteria to make the decision:

- Technical recommendations from the World Meteorological Organization for weather station installation.
- Historical complaint locations.
- Location of alleged odor sources in the city.
- Historical weather data.
- Availability of public places (City of Jacksonville had only some areas of the city available where it was possible to install the sensors).
- Safety.
- Energy.

The distribution of sensors was done considering the abovementioned criteria, which ended up in the following distribution of each type of sensor installed:

- **11 eNoses**: 2 eNoses located SE of the 5 major suspected source areas (IFF, Reichold, Taylor Made FG, Revlon, and American Coolair Corporation) and 3 eNoses in the Murray Hill area where most of the complaints were filled (zip code 32205). As demonstrated in the historical analysis of complaints and weather, during the morning between 06:00-11:00 AM prevailing winds from the NW and N will transport air pollutants from the industrial area to the SE where most complaints were made.

- **2 weather stations**: one station at each side of the river, Met 1 was placed nearby the main sources/complaints area, considering a distance of more than 3 km from the closest existing weather station (RC Met). Met 2 was placed at the other side of the river more than 3 km away from the closest existing weather station (PP Met).

It is important to mention that the City of Jacksonville had the opportunity to request Envirosuite to move any hardware throughout the study if they considered appropriate. In this context, since the beginning of the project in March 2022 until September 2022 the eNose Ambient configuration was as explained in the first bullet point above. At the end of September 2022, as requested by the City of Jacksonville, Envirosuite Field Services Team relocated the three eNoses Ambient located in the Murray Hill area close to the other alleged source, Symrise. This final configuration remained between October 2022 until March 2023.

Figure 13 and Figure 14 show a map with the location of each hardware between March 2022-September 2022 and between October 2022-March 2023, respectively.

Table 6 and Table 7 shows the name, type, owner, measured parameters with units, and location coordinates of each hardware between March 2022-September 2022 and between October 2022-March 2023, respectively.

Figure 13 Hardware at the City of Jacksonville. From March 2022-September 2022.

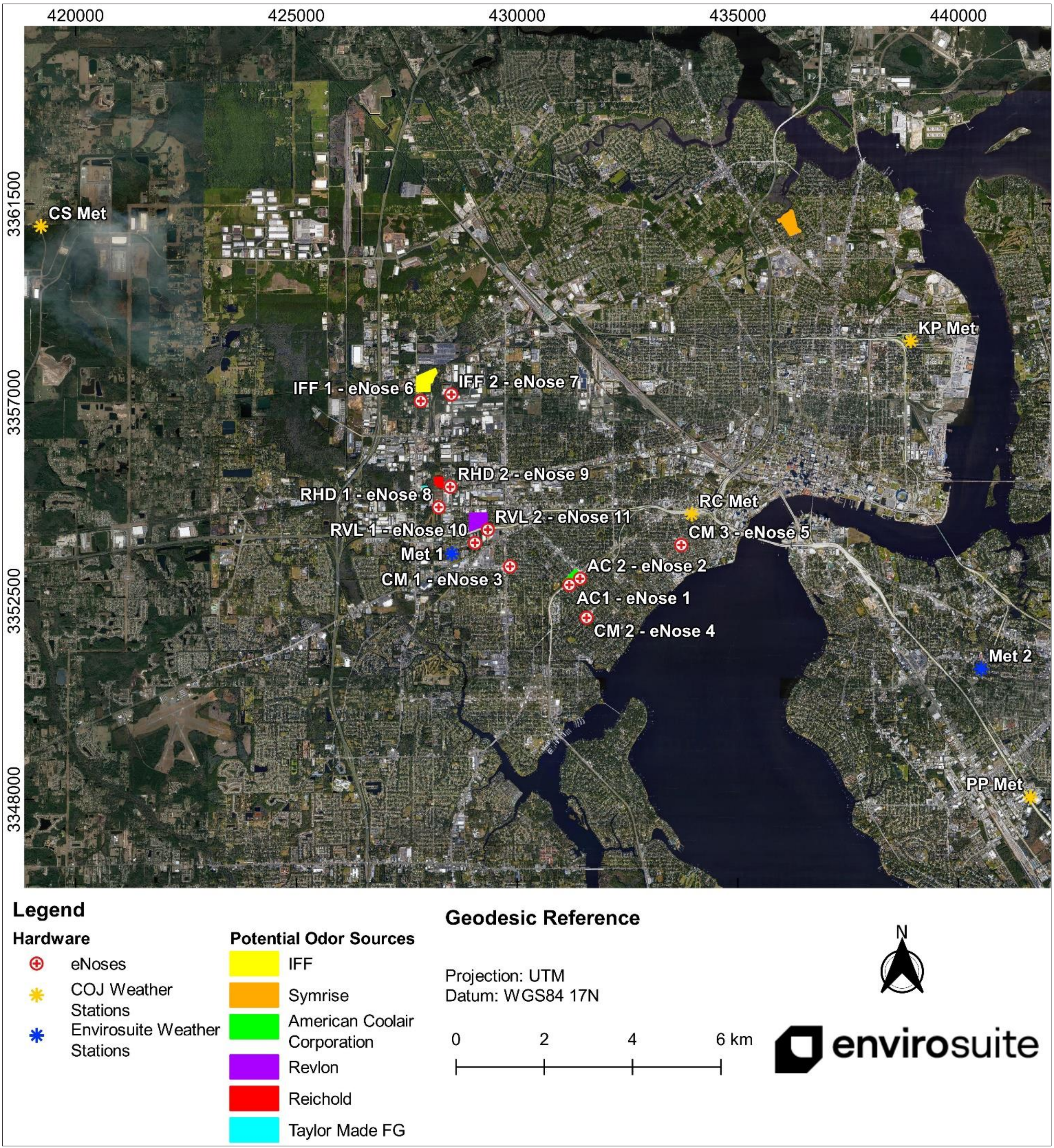


Figure 14 Hardware at the City of Jacksonville. From October 2022-March 2023.

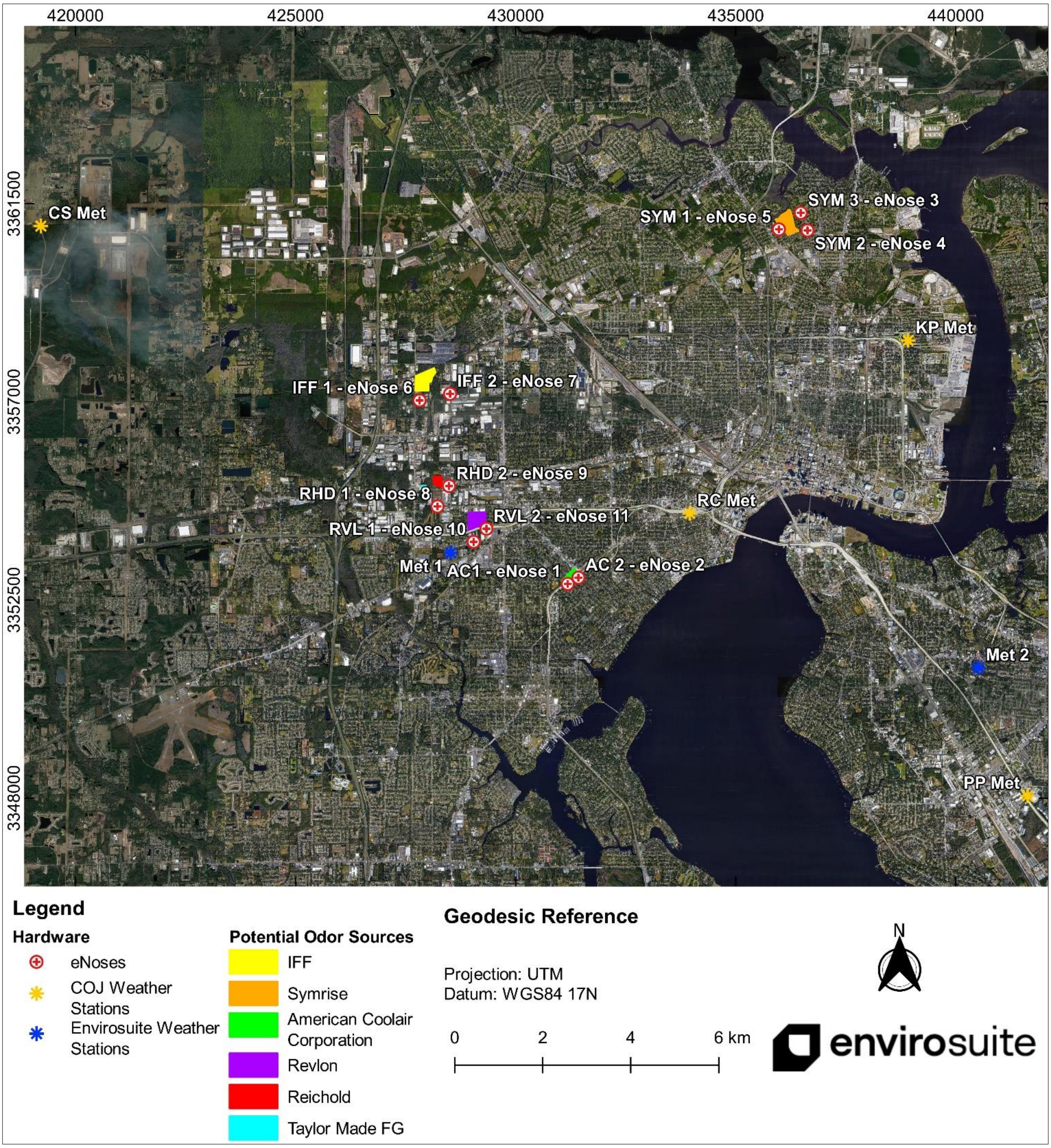


Table 6 Hardware at the City of Jacksonville. From March 2022-September 2022.

Name	Type	Owner	Measured Parameters	Latitude	Longitude
Met 1	Weather Station	Envirosuite	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), solar radiation (W/m^2), Pressure (mb)	30.3118	-81.7434
Met 2	Weather Station	Envirosuite	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), solar radiation (W/m^2), Pressure (mb)	30.2889	-81.6186
CS Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%)	30.3782	-81.8408
KP Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), pressure (mb)	30.3559	-81.6356
PP Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%)	30.2627	-81.6068
RC Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), pressure (mb)	30.3202	-81.6870
AC1 - eNose 1	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3056	-81.7157
AC 2 - eNose 2	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3069	-81.7132
CM 1 - eNose 3	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3093	-81.7297
CM 2 - eNose 4	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.2989	-81.7116
CM 3 - eNose 5	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3139	-81.6894
IFF 1 - eNose 6	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3430	-81.7510
IFF 2 - eNose 7	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3444	-81.7438
RHD 1 - eNose 8	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3213	-81.7466
RHD 2 - eNose 9	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3255	-81.7439
RVL 1 - eNose 10	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3141	-81.7380
RVL 2 - eNose 11	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3168	-81.7350

Table 7 Hardware at the City of Jacksonville. From October 2022-March 2023.

Name	Type	Owner	Measured Parameters	Latitude	Longitude
Met 1	Weather Station	Envirosuite	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), solar radiation (W/m^2), Pressure (mb)	30.3118	-81.7434
Met 2	Weather Station	Envirosuite	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), solar radiation (W/m^2), Pressure (mb)	30.2889	-81.6186
CS Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%)	30.3782	-81.8408
KP Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), pressure (mb)	30.3559	-81.6356
PP Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%)	30.2627	-81.6068
RC Met	Weather Station	City of Jacksonville	Wind speed (mph), wind direction (°), temperature (°F), humidity (%), pressure (mb)	30.3202	-81.6870
AC1 - eNose 1	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3056	-81.7157
AC 2 - eNose 2	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3069	-81.7132
SYM 3 - eNose 3	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3819	-81.6612
SYM 2 - eNose 4	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3783	-81.6595
SYM 1 - eNose 5	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3785	-81.6663
IFF 1 - eNose 6	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3430	-81.7510
IFF 2 - eNose 7	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3444	-81.7438
RHD 1 - eNose 8	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3213	-81.7466
RHD 2 - eNose 9	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3255	-81.7439
RVL 1 - eNose 10	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3141	-81.7380
RVL 2 - eNose 11	eNose	Envirosuite	VOC (ppb), H_2S (ppb), NH_3 (ppb)	30.3168	-81.7350

Finally, Figure 15 presents photos of the hardware deployed by Envirosuite in the City of Jacksonville:

Figure 15. Deployed Hardware Photos.

Met 1 (the same location throughout the study)	Met 2 (the same location throughout the study)
	
AC1 - eNose 1 (the same location throughout the study)	**AC 2 - eNose 2 (the same location throughout the study)**
	

CM 1 - eNose 3 (March to September 2022)	CM 2 - eNose 4 (March to September 2022)
	
CM 3 - eNose 5 (March to September 2022)	**SYM 3 - eNose 3 (October 2022 to March 2023)**
	

SYM 2 - eNose 4 (October 2022 to March 2023)	SYM 1 - eNose 5 (October 2022 to March 2023)
	
IFF 1 - eNose 6 (the same location throughout the study)	**IFF 2 - eNose 7 (the same location throughout the study)**
	

RHD 1 – eNose 8 (the same location throughout the study)	RHD 2 – eNose 9 (the same location throughout the study)
	
RVL 1 – eNose 10 (the same location throughout the study)	**RVL 2 - eNose 11 (the same location throughout the study)**
	

5.1.2 Software

The solution provided by Envirosuite to the City of Jacksonville consists of a SaaS (software as a service), this means that an Environmental Intelligence Platform OMNIS was available 24/7 for the city to operate with it throughout the study. This section aims to provide a detailed explanation of each of the software module and its tools.

The City of Jacksonville personnel that had access to the Envirosuite platform during the study are listed below:

- Michael Williams.
- Melissa Long.
- Charles Farmer.
- Cassandra Gomez.

5.1.2.1 Monitoring Module

Site-generated air quality or odor emissions leaving the boundaries of industrial facilities can trigger community complaints. EVS ES2/OMNIS Monitoring Module provides the City of Jacksonville a bird's-eye-view of real-time and historical data from the environmental monitoring network deployed at the city (explained in detail in section 5.1.1) to obtain situational awareness of all the relevant weather and air quality parameters 24/7.

The main features of this module are:

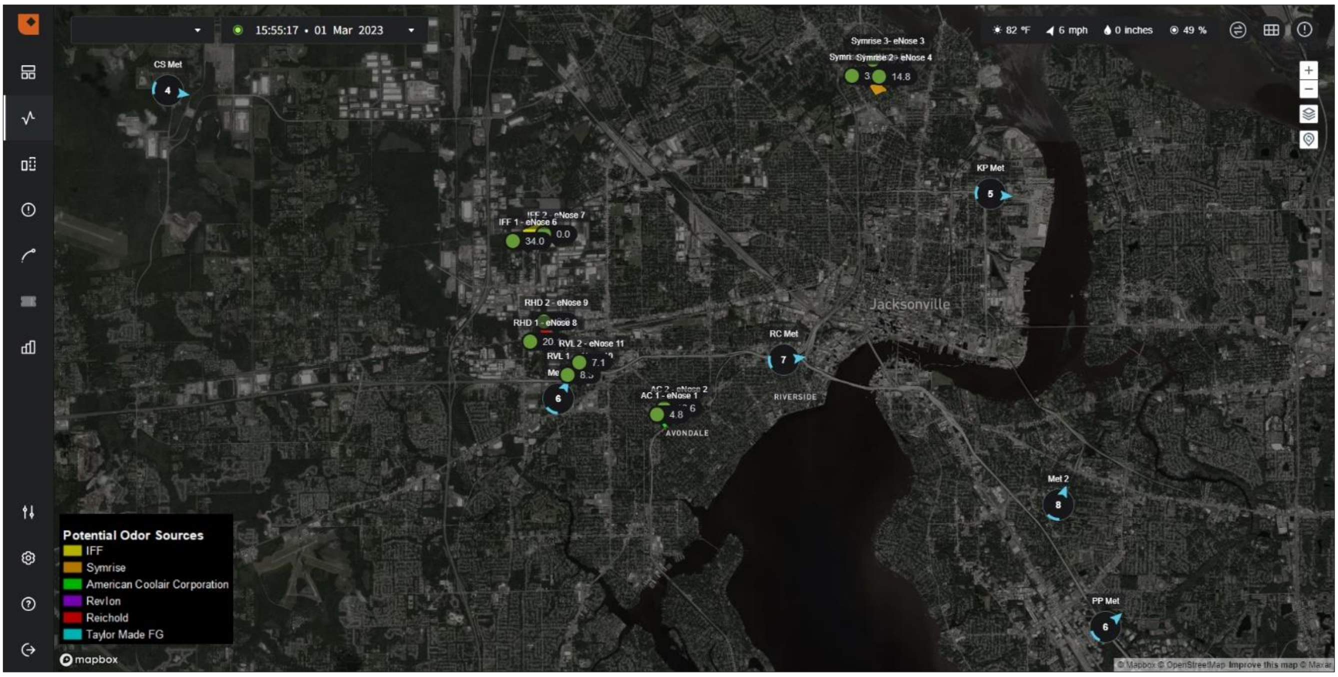
- Sensor visualization.
- Threshold colors.
- Real time and historical data.
- Arcs of influence[3].

Figure 16 shows an example of the appearance of the monitoring module:

[3] Based on the previous 10 minutes measurements, the arc of influence appears in the OMNIS monitoring screen as a colored 2-D cone which radius and angle are worked out internally as follows:

- A radius of the average wind speed x 10 minutes (e.g., 1 m/s -> 600 m).
- A central angle of 2 times the σ_θ (sigma theta) centered on the average wind direction.

Figure 16. Monitoring Module.



5.1.2.2 Modelling Module

EVS Omnis Modelling Module allows the City of Jacksonville to stay ahead of emissions impact from potential odor sources with predictive insights by combining accurate air quality dispersion modelling and hyperlocal weather forecasting. The purpose of this tool is to be able to predict potential impacts in the coming days that industrial facilities in the city might have in surrounding communities, and at the same time use observed models to be able to optimize resources and time to inspect given odor complaints, by using a feature specifically designed considering characteristics and position of the main alleged sources along with modeled meteorological data, so the City can harness the power of environmental intelligence to take decisions that can help to improving the existing odor situation affecting the communities.

The Envirosuite Global Modelling Team (GMT) configured both dispersion and meteorological observed and forecast models in the backend of the system, these models feed the results shown in the modelling module (and to other tools in the platform) so they can be used by the City of Jacksonville on demand.

This section contains the memorandum of the configuration of the models implemented for the study.

Envirosuite has its own automated development processes that allow models to be run in real time and in forecast mode. Below is a brief description of each of the models[4]:

- **WRF (*Weather Research and Forecasting):*** model created and maintained by the National Center for Atmospheric Research (NCAR). It uses the Global Forecast System (GFS) model as initial conditions to kick off meteorological simulations to generate data for atmospheric and land-soil variables using prognostic equations for a wide area considering the location of City of Jacksonville. Envirosuite modelling engineers set up the broad range of physics and dynamics parameters to start a WRF model that runs autonomously every day to produce accurate meteorological forecasts for up to 3 days.

[4] Important: these models are not developed by Envirosuite but are used globally by consultants and similar companies around the world.

- **CALMET:** 3D meteorological model developed by Exponent Inc, that is used to create a meteorological grid considering topography, land use and meteorological information obtained either from the WRF Model (forecast) or from meteorological data taken by onsite weather stations (observed). The resulting grid corresponds to a hyper-local domain that allows our platform to represent and forecast predominant meteorological variables at City of Jacksonville. Envirosuite modelling engineers set up the specific parameters to set up the CALMET model that runs autonomously every day.

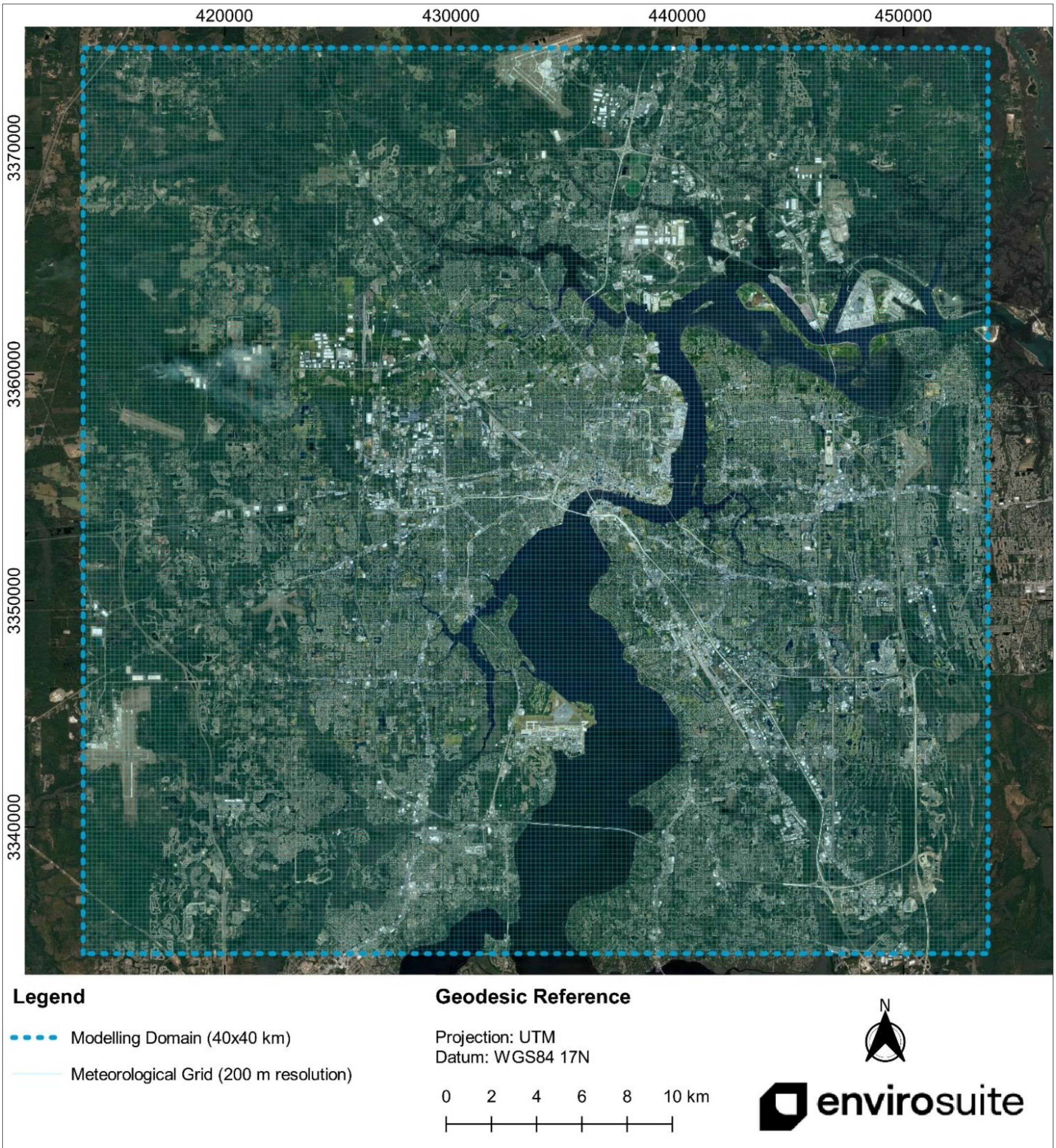
- **CALPUFF:** an advanced non-steady state, Lagrangian- Gaussian, multi-layer, air quality modelling system developed by Exponent Inc that has the capacity to model multiple species, being able to simulate the effects of time and space of the various meteorological conditions on the transport of pollutants. This model combines the hyper-local weather information with source emissions to show how pollutants will disperse within the modelling domain once emitted into the atmosphere. Envirosuite modelling engineers set up the emission sources, emission rates and other key parameters with the input of City of Jacksonville to create the CALPUFF model that runs autonomously every day.

The following subsections provide important details around the configuration of the models that were configured.

a) Modelling Domain

The modelling domain is presented in Figure 17, it covers all the historical odor complaints area, the location of the main alleged odor sources in the city and the location of weather and air quality sensors deployed for the study. It has a size of 40x40 km, with 40.000 cells of 200 meters of resolution each, and its central point coordinates (UTM WGS-84 Zone 17N) are 433,740m E, 3,354,416m N.

Figure 17. Modelling Domain.

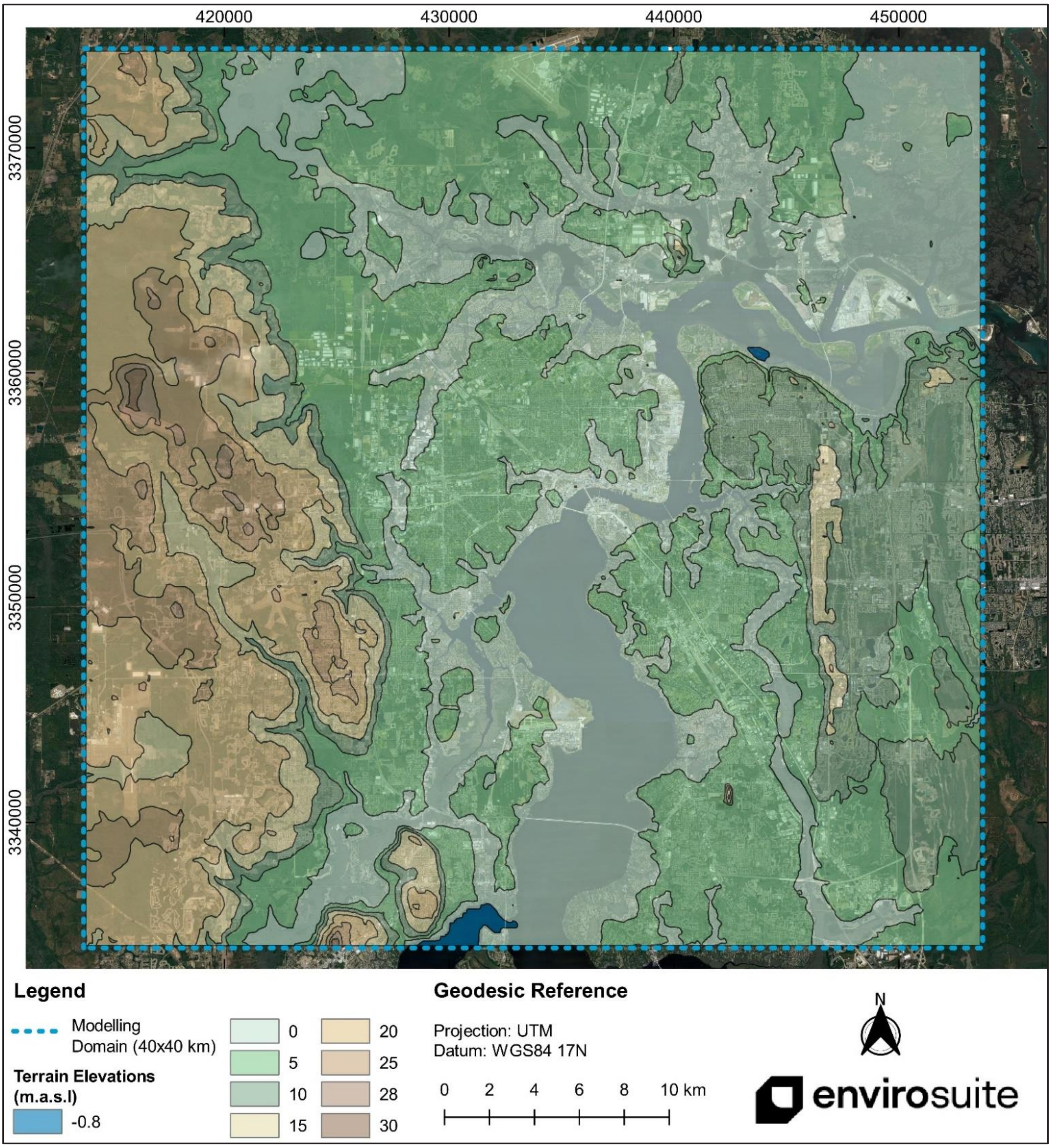


To improve the visualization of the modeling results, in OMNIS only the modeling domain is shown, while the meteorological grid although considered in the model, is hidden.

b) Topography

Topography data was obtained from the United States Geological Survey (USGS), EROS Data Center – National Elevation Dataset (NED1) with 30 m resolution. Figure 18 presents the topography information used within the modelling domain:

Figure 18. Topography for the Modelling Domain.

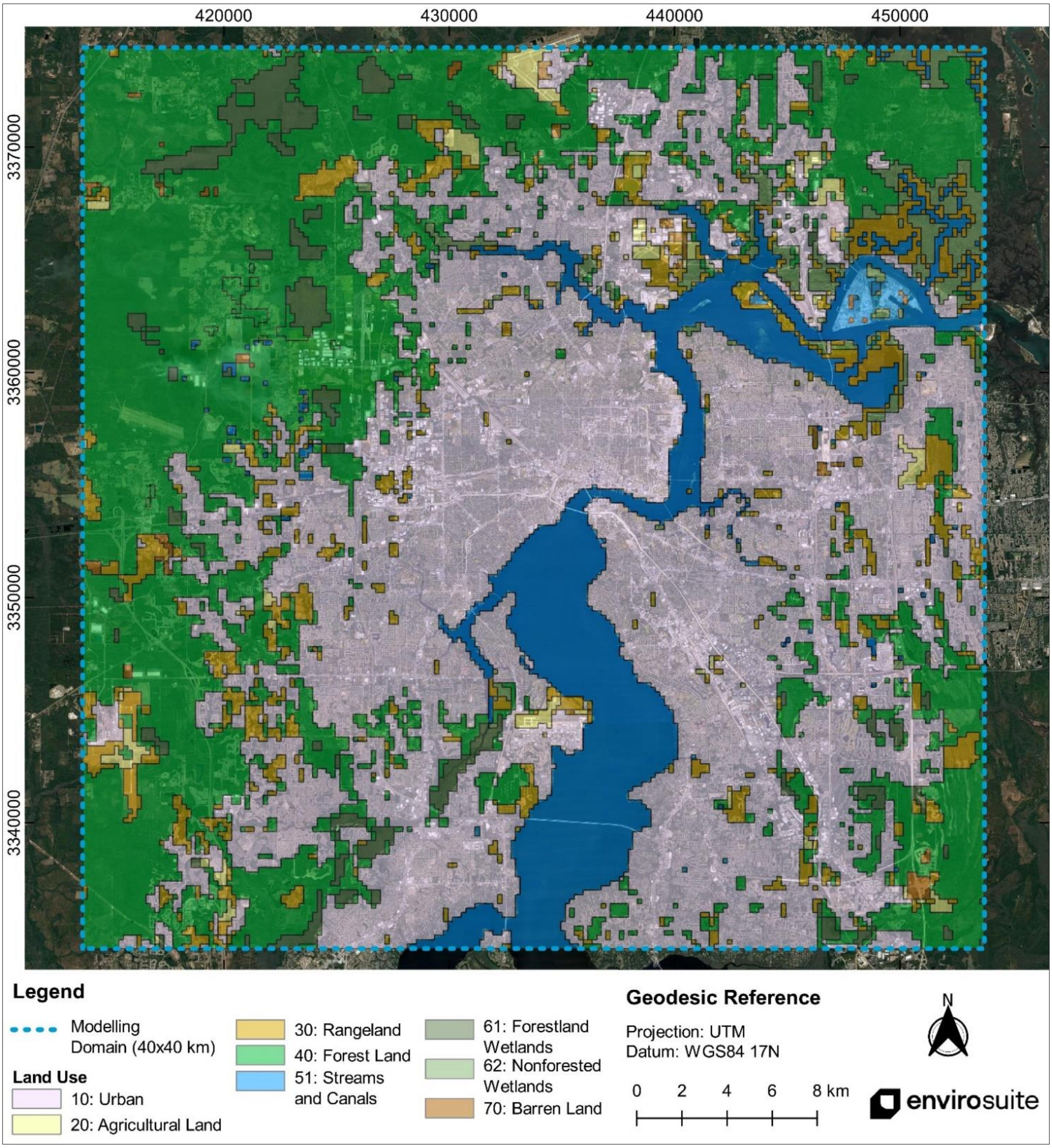


To improve the visualization of the modeling results, in OMNIS only the modeling domain is shown, while the topography information although considered in the model, is hidden.

c) Land Use

Land use information was obtained from global satellite data provided by the European Space Agency Climate Change Initiative, that describes land use in 22 classes which are defined using the Land Cover Classification System (LCCS) of the United Nations Food and Agriculture Organization (FAO). presents the land use information used in the modelling domain (it corresponds to the most recent available data, updated to 2020).

Figure 19. Land Use for the Modelling Domain.



To improve the visualization of the modeling results, in OMNIS only the modeling domain is shown, while the land use information although considered in the model, is hidden.

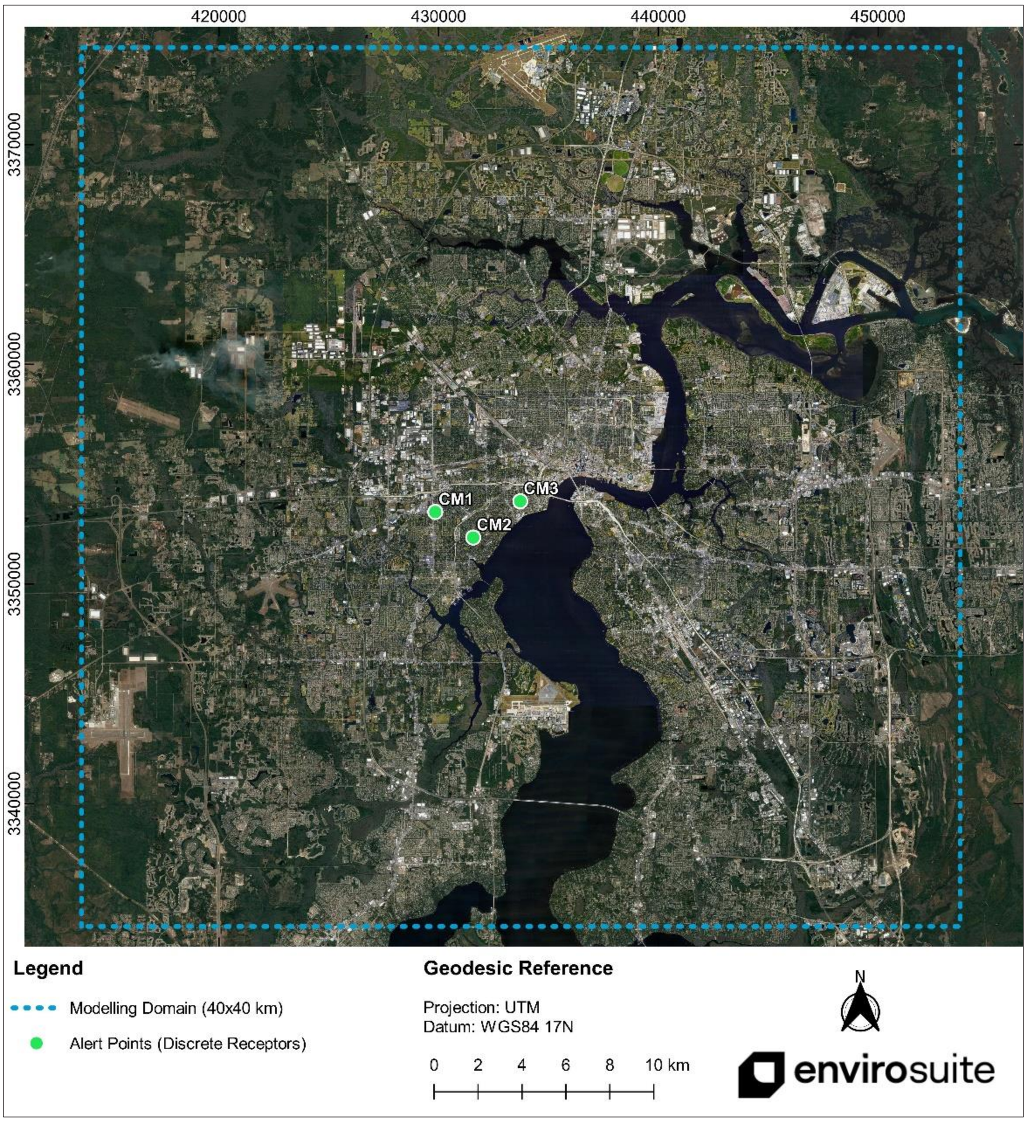
d) Alert Points (Discrete Receptors)

Alert points (also known as discrete receptors), correspond to points of interest for City of Jacksonville which are set up on the CALPUFF model for reference purposes and to store modeled concentration values. Table 8 lists the alert points set up and its characteristics and shows the location of each one within the modelling domain. Figure 20 presents a map with the alert points in the modelling domain.

Table 8. Alert Points.

Alert Point Name	Location Coordinates UTM WGS84 17N		Height (m)	Elevation (m.a.s.l)
	East (m)	North (m)		
CM1 – Community Monitor 1	429,845.13	3,353,280.16	0	24.71
CM2 – Community Monitor 2	431,572.60	3,352,117.71	0	7.36
CM3 – Community Monitor 3	433,715.02	3,353,767.56	0	6.38

Figure 20. Alert Points.



e) Model Types

Observed Models

The observed models should be used to analyze real-time' and past-day events, and it presents modelling results every 10 minutes (delta-t of 600 seconds).

I. Observed Wind Field

This model represents the wind field in "real time"[5], by displaying wind patterns inside the modelling domain. The model is continuously using meteorological data recorded in 6 weather stations representing the area within the modeling domain to set up a CALMET model. Table 9 presents the information of each station and Figure 21 presents a map with their location.

The wind field displayed in OMNIS show arrows indicating wind direction (where the wind is coming from and blowing to) and with changing size the wind speed.

Table 9. Weather stations that feed the observed wind field model.

Weather Station	Location Coordinates UTM WGS84 17N		Height (m)	Elevation (m.a.s.l)
	East (m)	North (m)		
Met 1	428,524.59	3,353,573.62	10	7.60
Met 2	440,513.94	3,350,963.85	10	7.39
CS Met	419,214.96	3,360,989.96	10	27.91
PP Met	441,626.99	3,348,055.00	10	7.14
RC Met	433,951.95	3,354,465.99	10	5.67
KP Met	438,917.99	3,358,389.04	10	0.00

[5] This is more 'near real time' as there might be some minutes of delay with exact real time considering the modelling chain that needs to take place to run the observed model. The Envirosuite system receives meteorological data taken by weather stations, then a modelling sequence takes place to run the model automatically every day.

Figure 21. Weather stations that feed the observed wind field model.

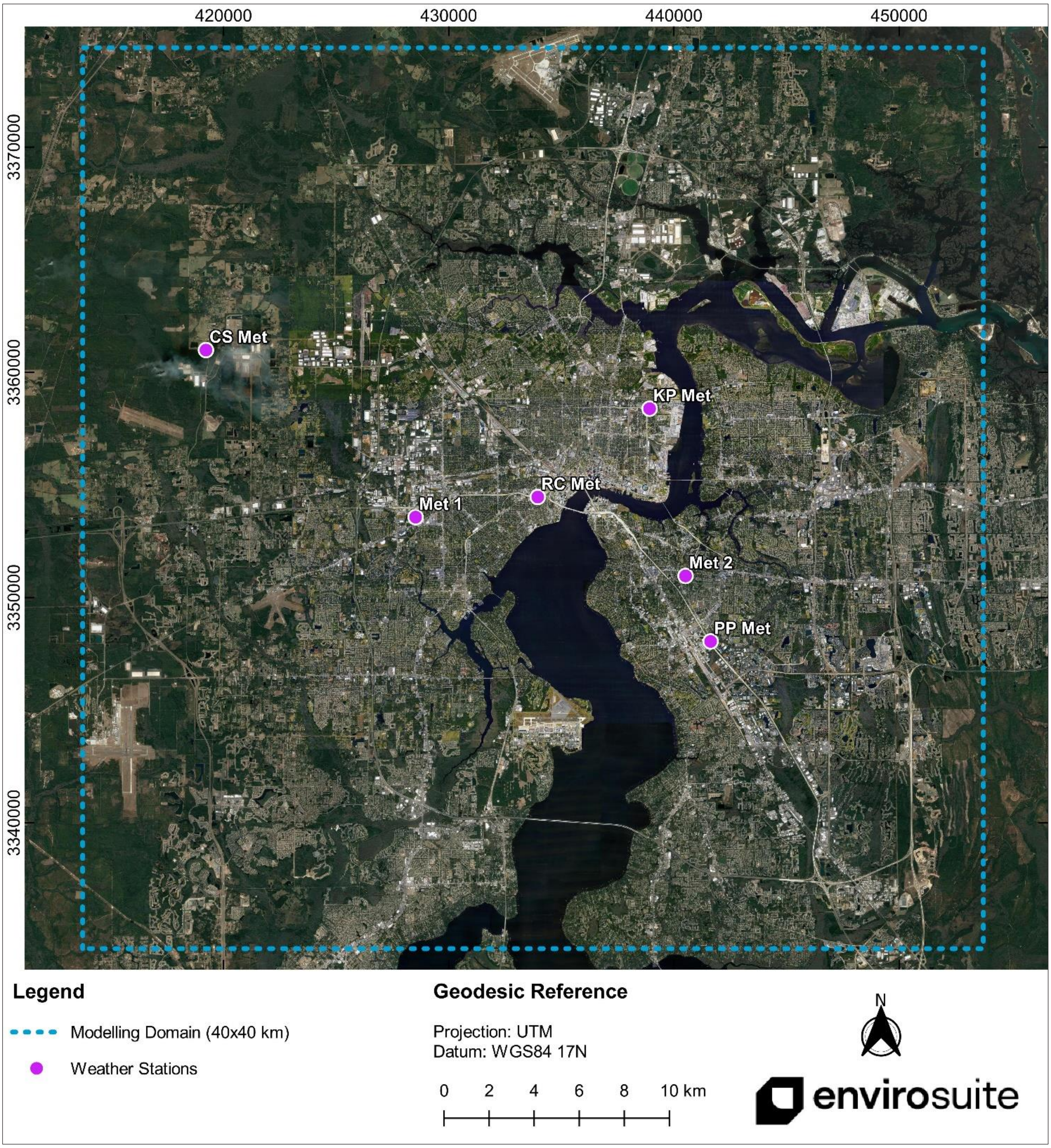
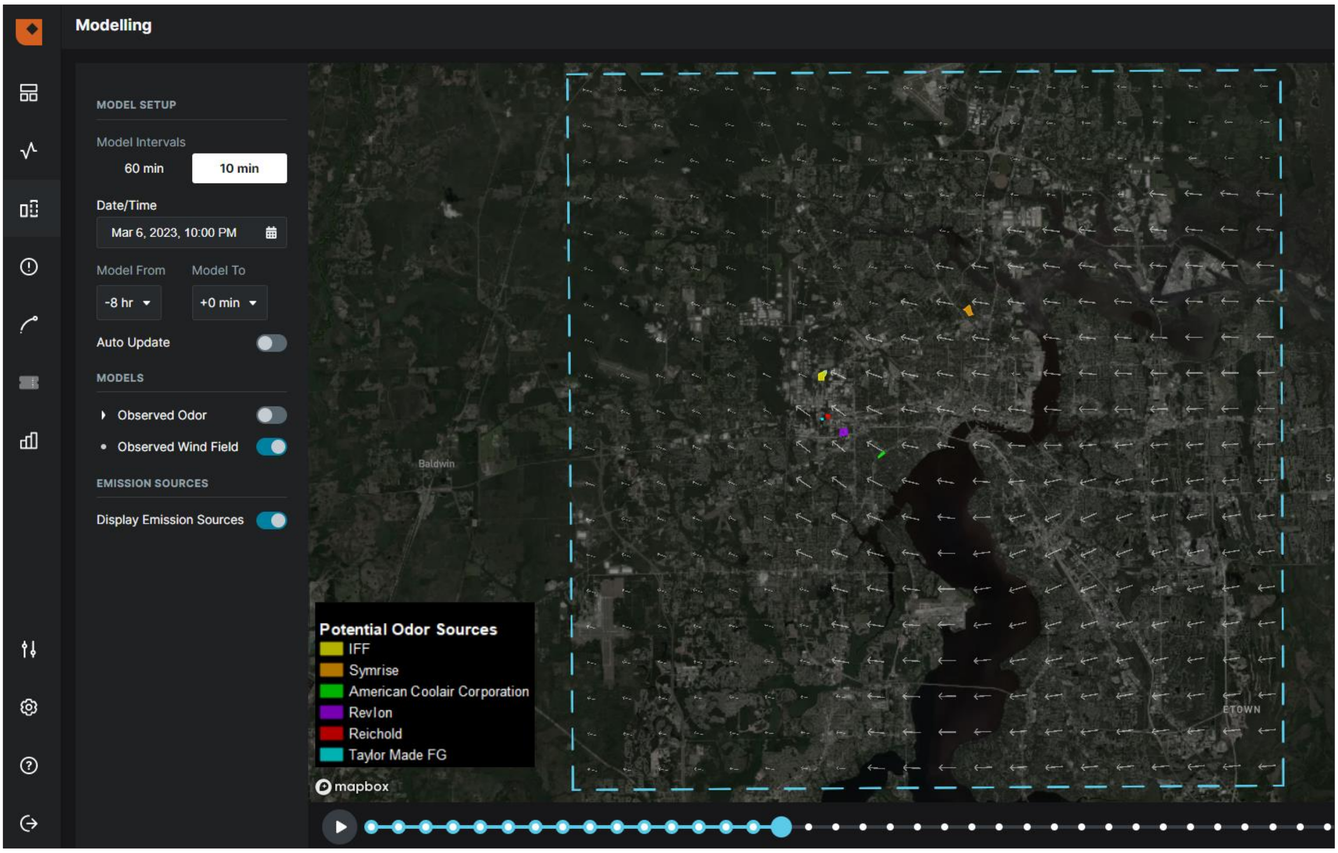


Figure 22 presents an example of the observed wind field model results in OMNIS.

Figure 22. Example of observed wind field model results in OMNIS.



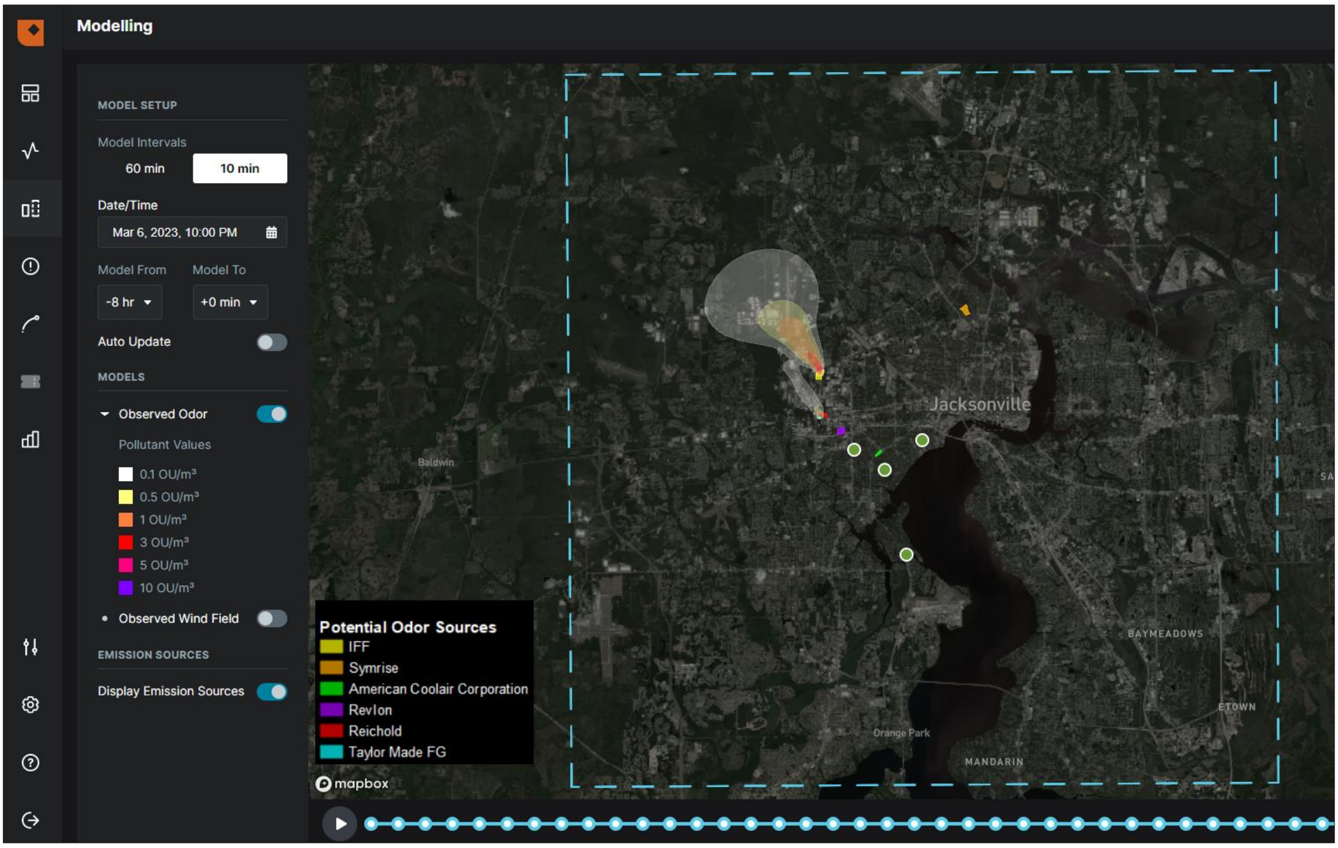
II. Observed Odor

Using the outputs of the observed meteorological model, the observed CALPUFF is configured to display odor isoconcentration curves within the modeling domain. When this model is activated, the modeling module screen will display the isoconcentration curves with colors for the following values: 1 OU/m^3, 3 OU/m^3, 5 OU/m^3 and 10 OU/m^3 and will also display the location of the alert points (discrete receptors) as described on section d).

The detail of the emission sources will be presented in section f).

Figure 23 presents an example of the observed odor model results in OMNIS, the green dots represent the alert points (presented in section d)) and the curve colors legend is presented on the right-hand side of the screen for each odor concentration level.

Figure 23. Example of observed odor model results in OMNIS.



Forecast Models

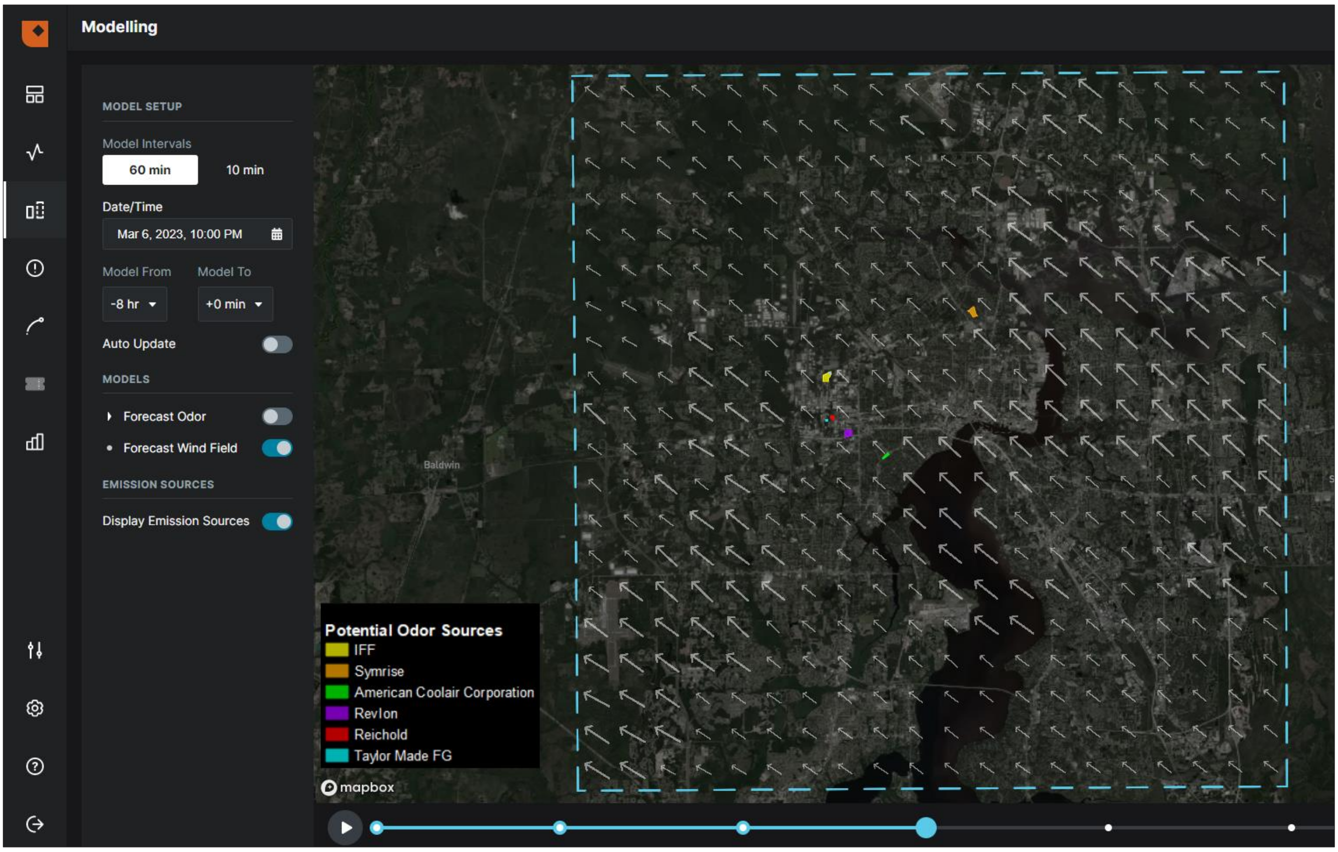
The forecast models should be used to analyze events in the next 3 days, and it presents modelling results every 1 hour (delta-t of 3600 seconds).

I. Forecast Wind Field

The forecast wind field is configured by running the WRF model and using its output to set up a CALMET model in the modelling domain. The wind field displayed in OMNIS will show arrows indicating wind direction (where the wind is coming from and blowing to) and with changing size the wind speed.

Figure 24 presents an example of the forecast wind field model results in OMNIS.

Figure 24. Example of forecast wind field model results in OMNIS.



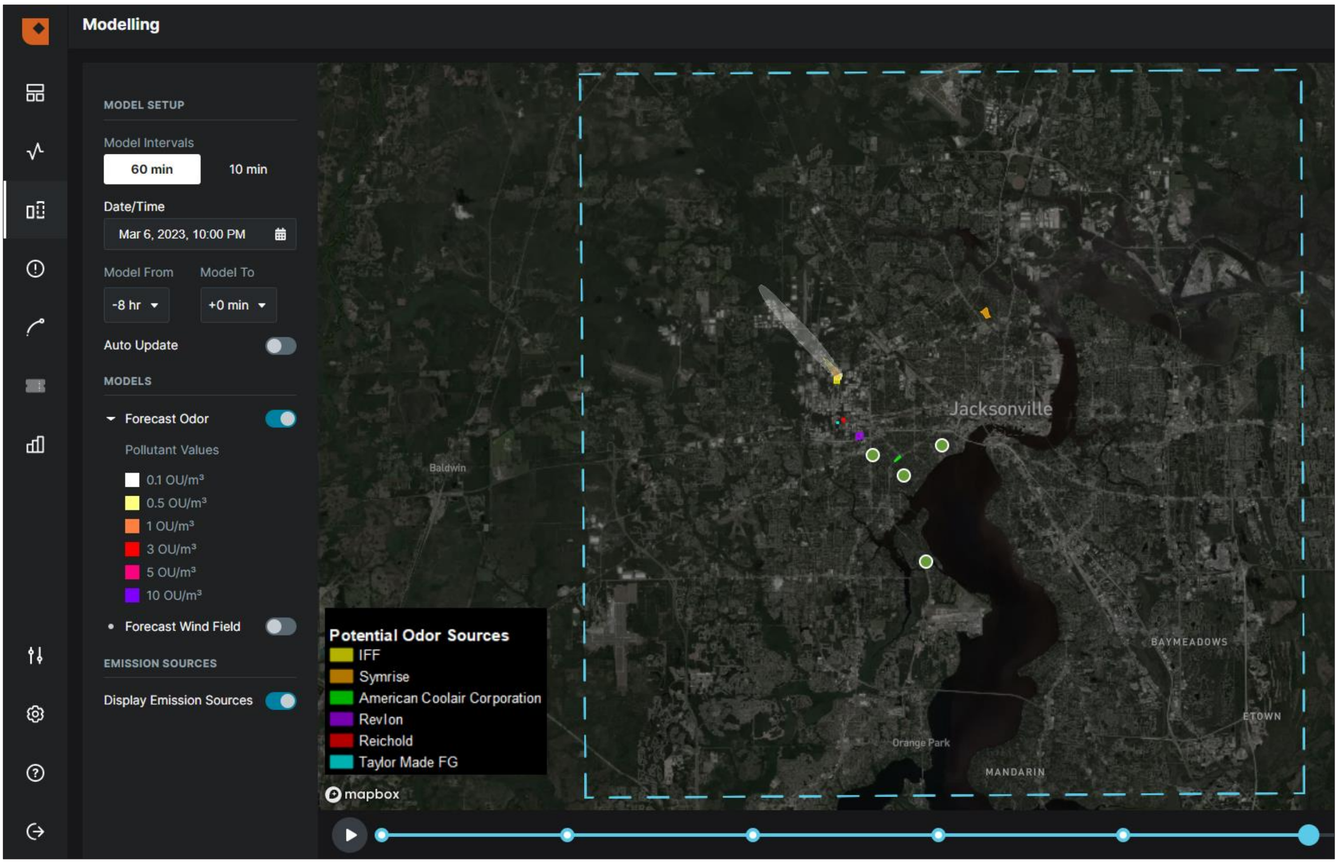
II. Forecast Odor

Using the outputs of the forecast meteorological model, the forecast CALPUFF is configured to display odor isoconcentration curves within the modeling domain. When this model is activated, the modeling module screen will display the isoconcentration curves with colors for the following values: 1 OU/m^3, 3 OU/m^3, 5 OU/m^3 and 10 OU/m^3 and will also display the location of the alert points (discrete receptors) as described on section d).

The detail of the emission sources will be presented in section f).

Figure 25 presents an example of the forecast odor model results in OMNIS, the green dots represent the alert points (presented in section d)) and the curve colors legend is presented on the right-hand side of the screen for each odor concentration level.

Figure 25. Example of forecast odor model results in OMNIS.



f) Emission Sources

The emission sources were set for both the observed and forecast odor models, the configuration of the sources was done by Envirosuite Modelling Engineers, considering their expertise and the information provided by the City of Jacksonville.

It is important to mention that these are virtual models and that the source definition and emission rates are an estimation that allows the City of Jacksonville to visualize where a potential concentration of odor could be based on assuming there are odor emissions from those sources.

The characteristics of each source are presented in Table 10:

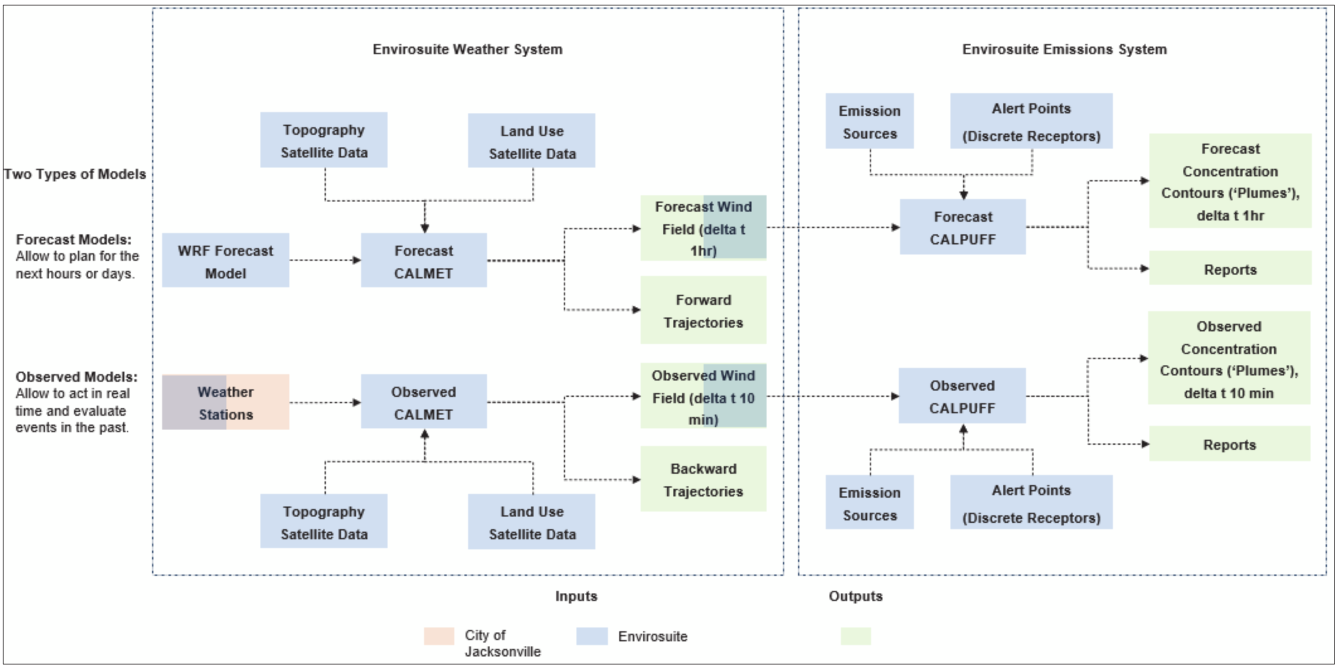
Table 10. Emission sources implemented in both observed and forecast odor dispersion models.

Source Name	Reichold Storage Tank Filling	IFF WW Tank
Source Type	Point	Area
Height (m)	4.27	1
Diameter (m)	0.10	-
Exit Temperature (K)	294.26	-
Exit Velocity (m/s)	1.73	-
Emission Rate	4,762 OU/s	21.02 OU/m^{2}s
Emission Variability	Only emits during weekdays	Constant 24/7
Location	Lat: 30.325955 Long: -81.747573	Lat: 30.349030 Long: -81.747879

g) Modelling Summary

Figure 26 presents a diagram with the summary of the models' inputs and outputs:

Figure 26. Summary diagram of the inputs and outputs of the modelling module.



5.1.2.3 Trajectories Module

The trajectory module provides an easy-to-use analysis system that can help the City of Jacksonville to validate air quality and odor incidents, complaints or observations and identify the most likely source, based on the meteorological model results.

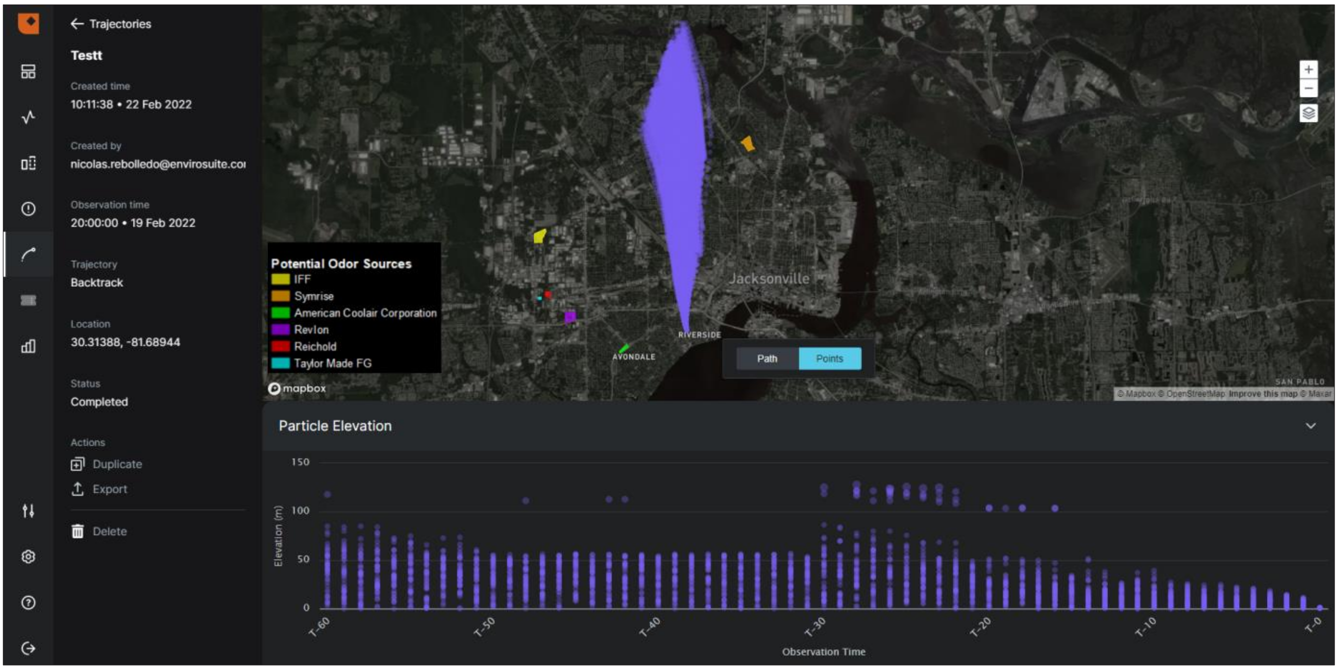
Trajectories rely on the observed meteorological model results (explained in detail in section 5.1.2.2) and they are used to understand the path of any particle or gas during the last hour, which changes depending on the predominant wind fields over time. Whenever a trajectory is run it will use the newest data available, all trajectories are configured to run for an hour (T-0 to T-60 mins) and because of the dynamic nature of dispersion in the atmosphere, the system automatically runs the trajectory 100 times to see all possible paths at that time. The trajectories can only be run for any point inside the modelling domain, if the trajectory reaches the edge of the domain any time before 60 minutes, then it will stop early.

The trajectory results can be visualized in two ways, path mode or point mode. Path mode shows the mean path of the collection of trajectories with a line, it also displays a light purple area surrounding the line which represents the spread in the results. The point mode shows the location of all the air parcels for every minute from the 100 trajectories, hovering over these points will show the time and elevation of each air parcel.

Figure 27 and Figure 28 present an example for a test trajectory in path and point mode, respectively. The results show that for an observation or complaint done in February 2022 at 20:00 (observation time) at Lat: 30.31388, Long: -81.68944, the wind came predominantly from the north and northwest.

Figure 27. Example of a trajectory in path mode.

Figure 28. Example of a trajectory in point mode.



5.1.2.4 Incident Intelligence Module

The Incident Intelligence module corresponds of a centralized ticketing system for complaint management available for the City of Jacksonville. By using the JIRA software, which is coupled to the Envirosuite solution, it is possible to log in complaints when they are received, providing relevant information such as descriptions of the odor or air quality problem perceived, contact details of the reporter, date and time of the complaints and its location.

Whenever a complaint is uploaded to the ticketing system, an automated backward trajectory will be run by Envirosuite and its results will be uploaded as an image of the trajectory results to the ticket, this allows the City of Jacksonville to shorten investigation times by using the tool to help respond and validate complaints based on scientific evidence supported by the meteorological models run by Envirosuite, it also allows the city to focus the investigation efforts of the staff if a site visit or inspection is required.

In addition to that, heat and Cluster Maps in OMNIS allow to visualize hotspots in the city to get a bird's eye view of areas where complaints are lodged the most. Figure 29 and Figure 30 resent examples of how heat and cluster maps look, respectively:

Figure 29. Example of the incident intelligence module for visualization of complaints in cluster mode.

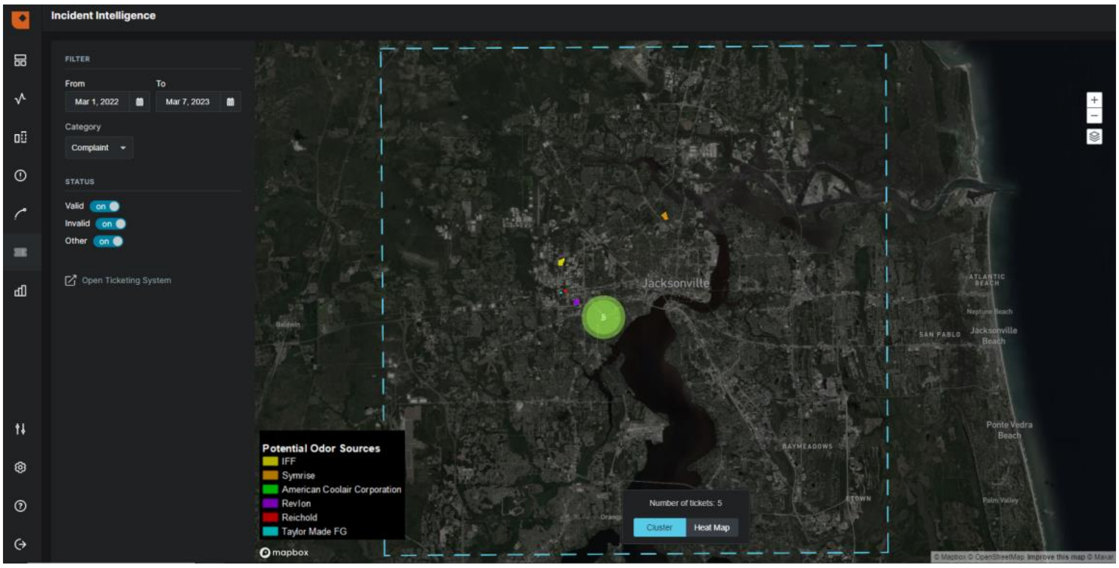
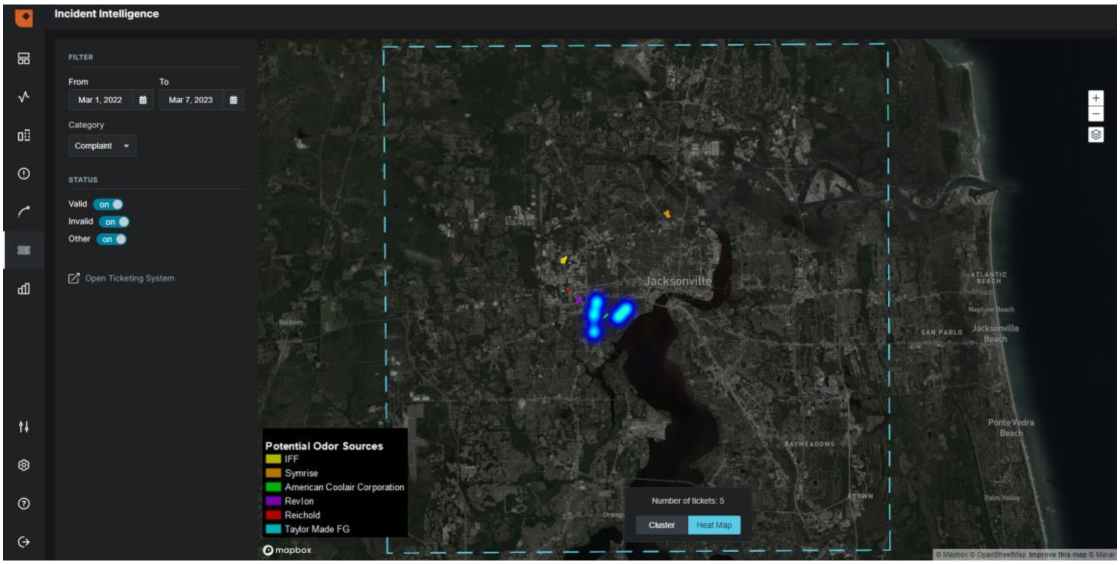


Figure 30. Example of the incident intelligence module for visualization of complaints in heat map mode.



5.1.2.5 Reports Module

The Reports module provides the City of Jacksonville with a variety of tools to enhance the environmental management of the different parts of the solution deployed by Envirosuite, considering both hardware and software. Below is a description of each of the reports implemented, which the city can access 24/7 for all available hardware and software tools and, if needed, any of the reports listed can be automatically sent to specific recipient's email.

a) Tabulated Report

A report that presents selected monitor and/or process variable data as a table with a CSV and PDF export option, for a given timeframe. The first column of the table represents the time, followed by each parameter selected in the format: *Monitor Name – Parameter (Units)*.

Figure 31 presents an example of a tabulated report for 3 parameters in Met 1 weather station:

Figure 31. Tabulated report example.

Tabulated Report

Edit Report Details

Site: City of Jacksonville - City Odor Study
Report Issued: Mar 10, 2023 3:28 PM
Report Period: Jan 1, 2023 12:00 AM - Jan 31, 2023 12:00 AM

Generate PDF | Export CSV

Time	Met 1 - Temperature (ºF)	Met 1 - Wind Direction (°)	Met 1 - Wind Speed (mph)
Jan 1, 2023 12:02 AM	63.68	281.50	0.60
Jan 1, 2023 12:04 AM	63.68	259.50	0.67
Jan 1, 2023 12:06 AM	63.68	214.80	0.36
Jan 1, 2023 12:08 AM	63.50	196.00	0.00
Jan 1, 2023 12:10 AM	63.50	124.80	0.45
Jan 1, 2023 12:12 AM	63.14	169.70	0.78
Jan 1, 2023 12:14 AM	63.14	163.40	1.03
Jan 1, 2023 12:16 AM	63.14	169.80	0.89
Jan 1, 2023 12:18 AM	63.14	169.70	0.78
Jan 1, 2023 12:20 AM	63.14	143.30	1.01
Jan 1, 2023 12:22 AM	62.96	160.30	0.69
Jan 1, 2023 12:24 AM	62.78	151.30	0.72
Jan 1, 2023 12:26 AM	62.78	143.10	0.76
Jan 1, 2023 12:28 AM	62.60	124.70	0.76
Jan 1, 2023 12:30 AM	62.60	131.00	0.69
Jan 1, 2023 12:32 AM	62.60	93.70	0.47

b) **Data Trend Report**

A report that presents selected monitor and/or process variable data as a graph with an option for PDF export, for a given timeframe. The x-axis displays the timeframe, and the y-axis will automatically adapt the range depending on the selected parameter values, a tag will be displayed in the axis with the name of the parameter and its units in parenthesis. The data trend can be visualized as a line or columns. If two parameters are selected, there will be two y-axis (one for each parameter). The system will automatically assign a color for each trend to easily identify each parameter.

Figure 32 and Figure 33 present examples of a data report for 1 parameter and 2 parameters in Met 1 weather station, respectively:

Figure 32. Data trend report example with 1 parameter.

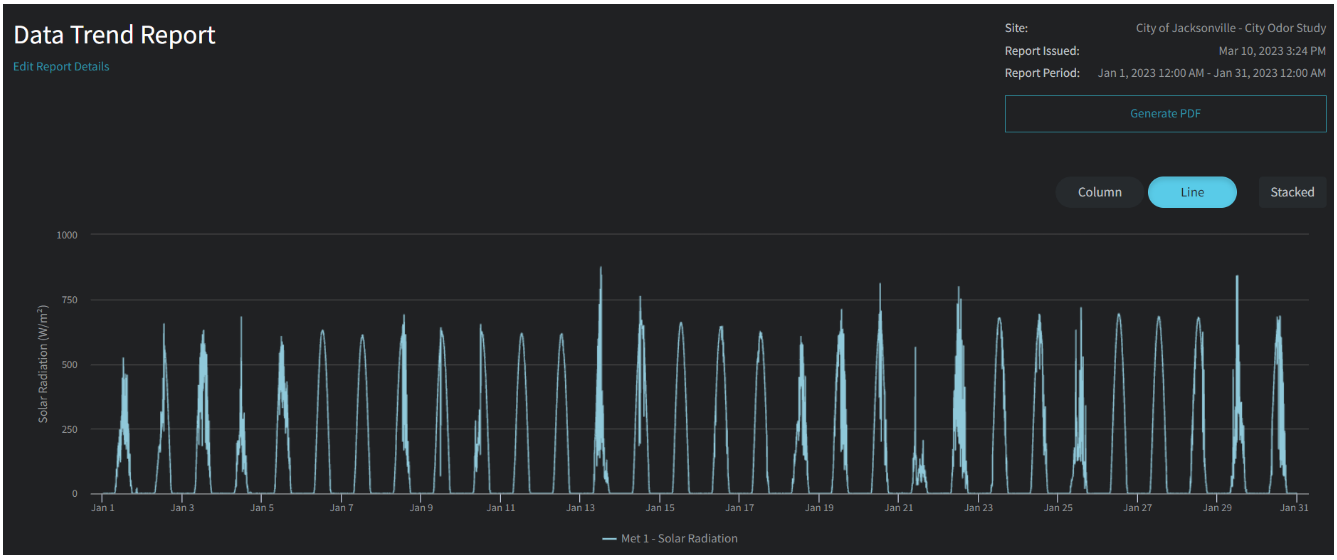


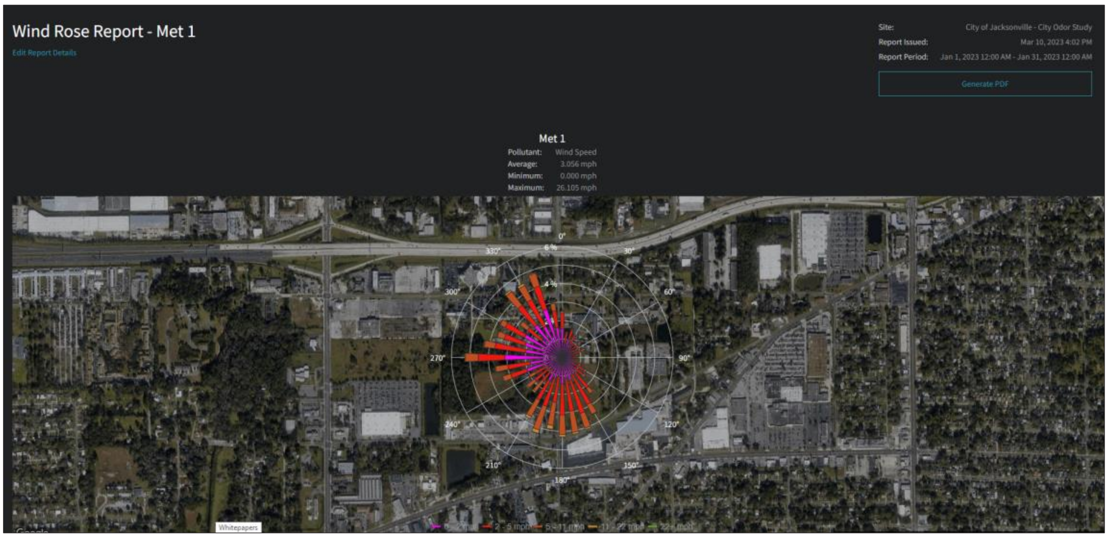
Figure 33. Data trend report example with 2 parameters.

c) Wind Rose Report

A wind rose report configured for just wind displays the distributions of wind speeds and the frequency of the varying wind directions on a compass rose based on the meteorological observations of wind speeds and wind directions from a weather station with an option for PDF export. The bars represent the frequency distribution of wind direction showing where the wind is coming from while the colors represent the ranges of wind speed, the wind rose is presented over an image of the map where each weather station is located.

Figure 34 presents an example of a weather report for Met 1 weather station:

Figure 34. Wind rose report example.

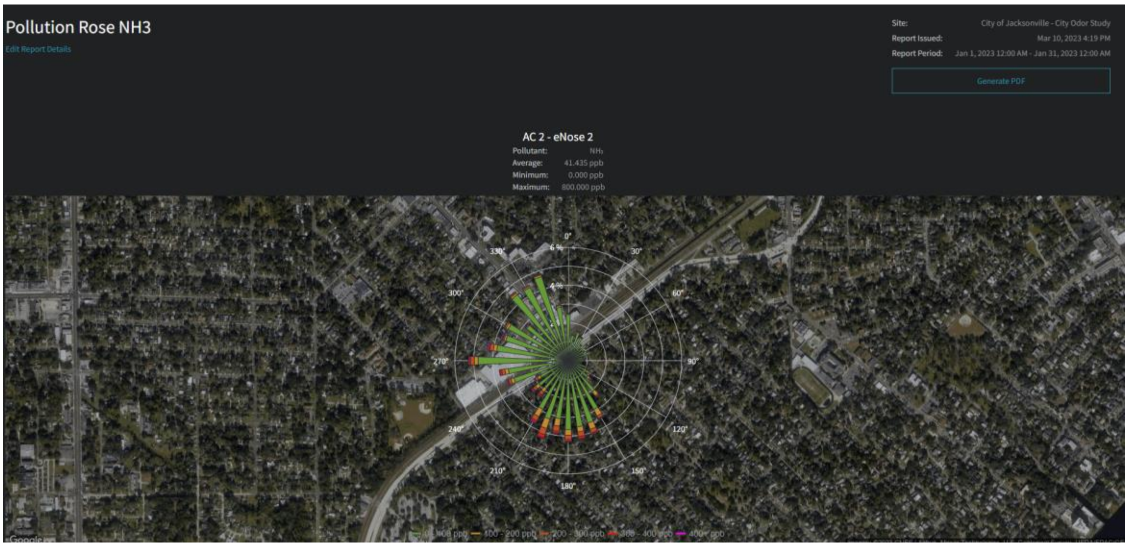


d) Pollution Rose Report

A rose report configured as a pollution rose is basically another means of illustrating the frequency distribution of wind direction temporally correlated with a chosen pollutant concentration from a given air quality monitoring device with an option for PDF export. The bars represent the frequency distribution of wind direction showing where the wind is coming from while the colors represent the ranges of concentration for the pollutant, the pollution rose is presented over an image for the map where each air quality monitoring device is located:

Figure 35 presents an example of a pollution rose report for AC2 – eNose 2:

Figure 35. Pollution rose report example.

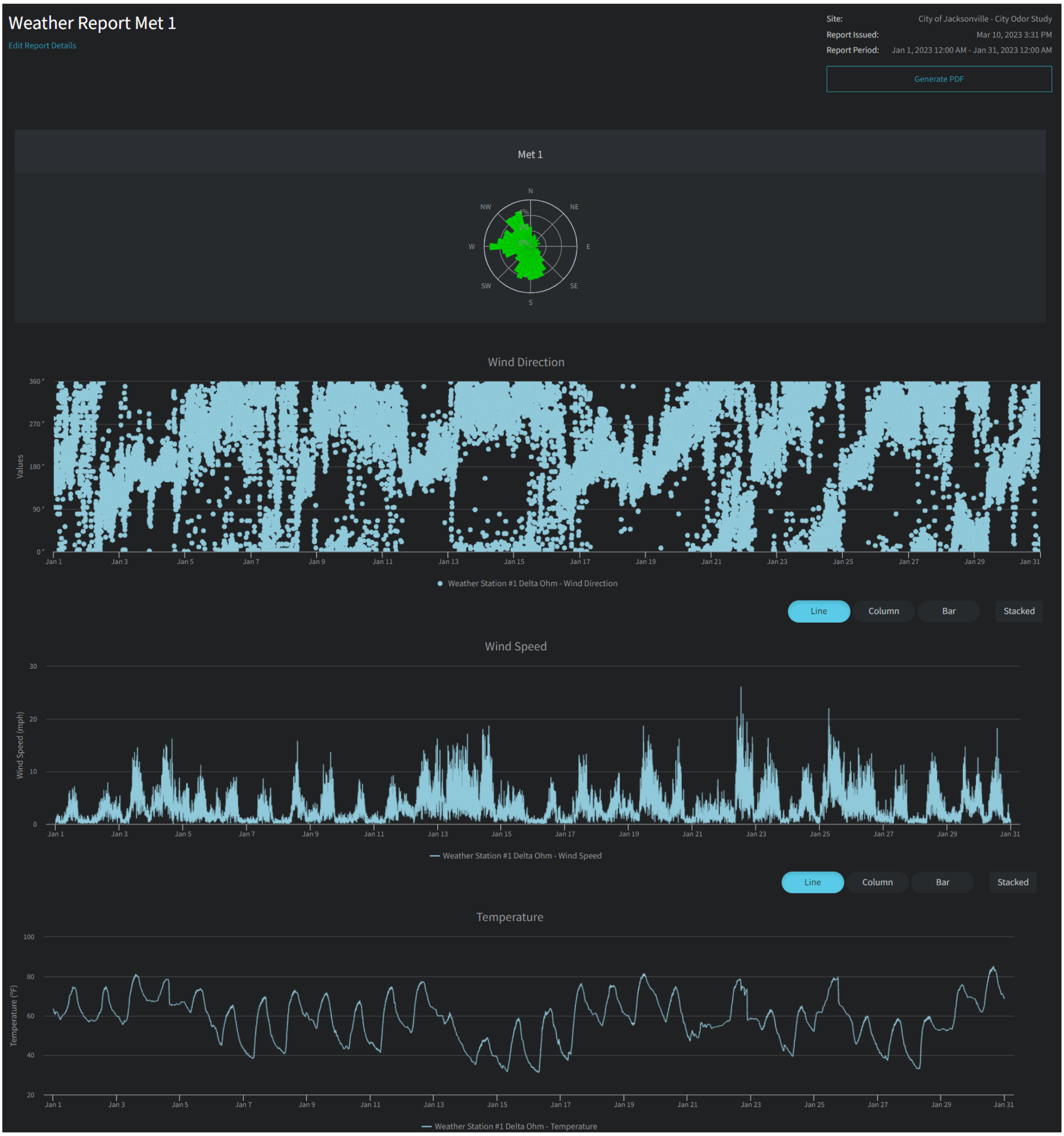


e) **Weather Report**

A report which displays a wind rose from a selected weather station followed by meteorological data trend in chart form with an option for PDF export. This includes wind direction, wind speed, temperature, and rainfall, if one parameter is not measured then it will simply not be displayed in the report. The report allows to configure more than one real or virtual weather station to compare trends.

Figure 36 presents an example of a weather report for Met 1 weather station:

Figure 36. Weather report example.



f) Odor Risk Report

A report based on forecasted meteorological conditions obtained from the WRF Model run and the risk of odor events at different periods of time/work shifts for the next 3 days since a selected day, with an option for PDF export.

The report first displays a graph which in its x-axis the timeline starting from the selected day to 3 days ahead, the y-axis shows the weekly risk trend (none, low, moderate, high, and extreme). The graph is followed by tables for each day and night shifts for the next 3 days, the information displayed in the table is the hourly weather data obtained from the WRF Forecast model results at the same location where Met 1 weather station is for certain parameters (wind speed, wind direction, temperature, rainfall, mixing height, inversion strength and humidity).

The risk color and type change depending on specific conditions that were set by Envirosuite considering the City of Jacksonville inputs according to their experience managing complaints, these conditions only consider the changes in wind speed and direction, so all the other parameters are displayed for reference, but they do not change the risk categories.

Table 11 presents the risk conditions set for the odor risk report:

Table 11. Odor risk report conditions.

Risk	Wind Speed (mph)	Wind Direction (°)
Extreme	WS ≤ 6 mph	290° (WNW) – 10° (N)
High	WS ≤ 6 mph	160° (S) - 190° (S)
Moderate	WS ≤ 6 mph	65° (ENE) - 85° (E)
Low	WS > 6 mph	All others WD

Whenever there are low wind speeds, atmospheric dispersion becomes slow due to the absence of turbulence, also considering the predominant wind direction predominance's, pollutants can be slowly transported to the affected communities. The odor risk reports prevent the City of Jacksonville based on the meteorological forecast model results whenever these conditions are likely to happen so they are aware from potential odor events or days where they might receive complaints.

Figure 37, Figure 38 , and Figure 39 show a map that explains the wind direction conditions set for each risk level; extreme, high, and moderate, respectively:

Figure 37. Extreme odor risk condition map.

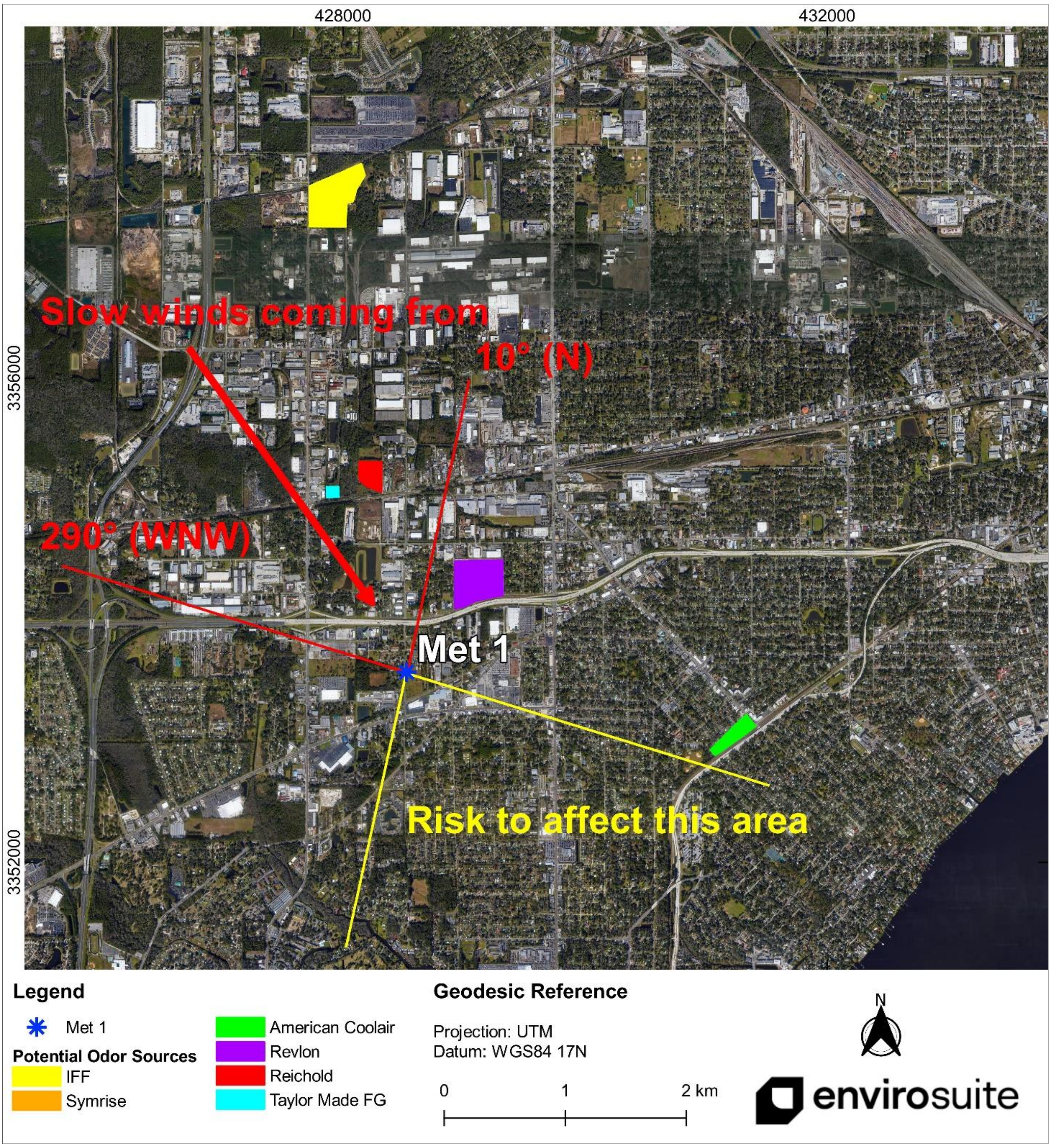


Figure 38. High odor risk condition map.

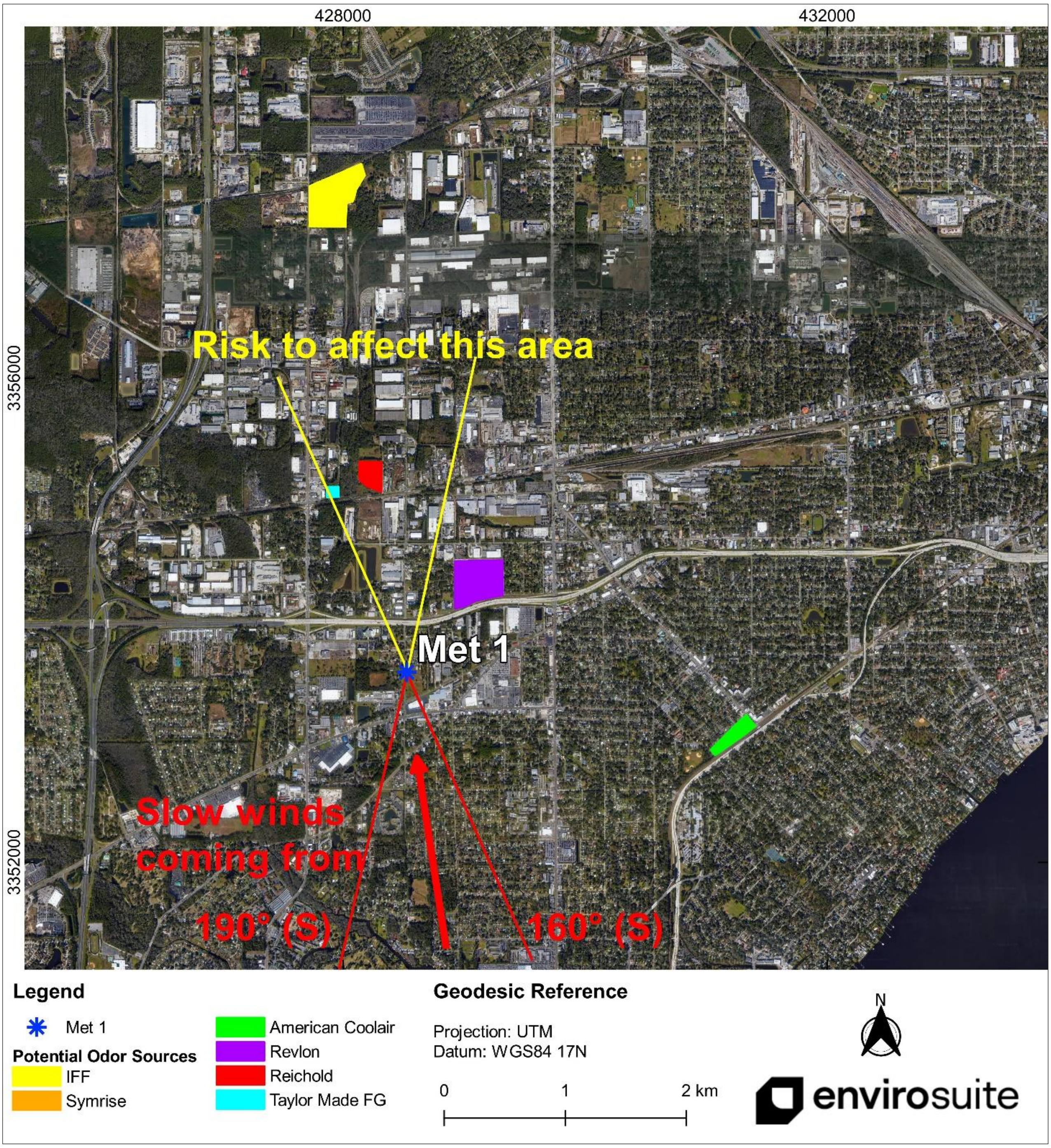


Figure 39. Moderate odor risk condition map.

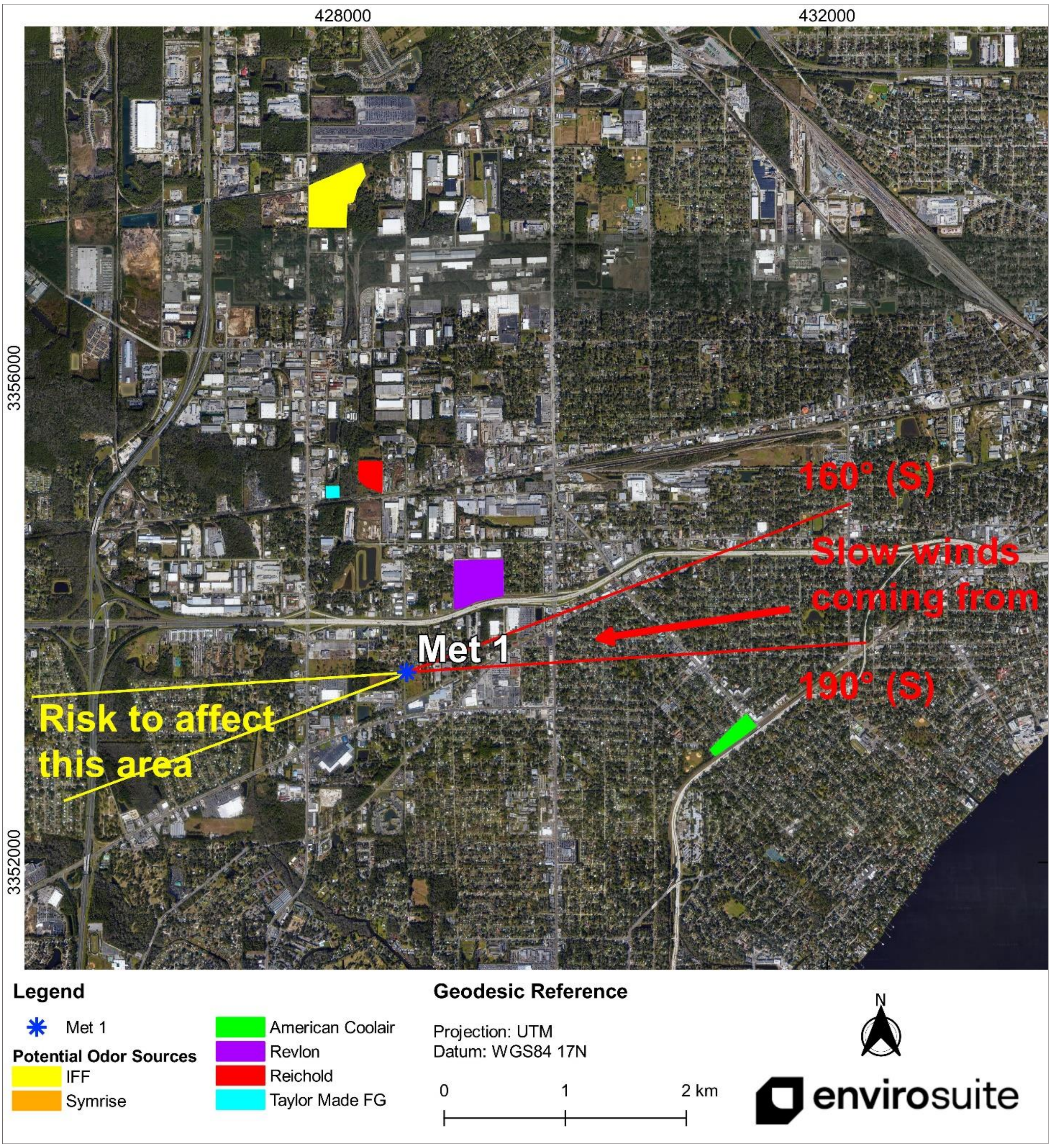


Figure 40 presents an example of the odor risk report for January 10, 2023, the report warns of an extreme odor risk between 06:00-11:00 AM on that first day morning shift due to forecasted hourly wind speeds below 6 mph and wind directions greater than 290° and less than 10°. This means that during those hours there will be a bad dispersion condition that will transport any pollutants emitted in the industrial area located to the northwest (NW) towards the southeast (SE) area where historically most complaints have been recorded.

Figure 40. Risk report example (January 10, 2023).

Risk Report

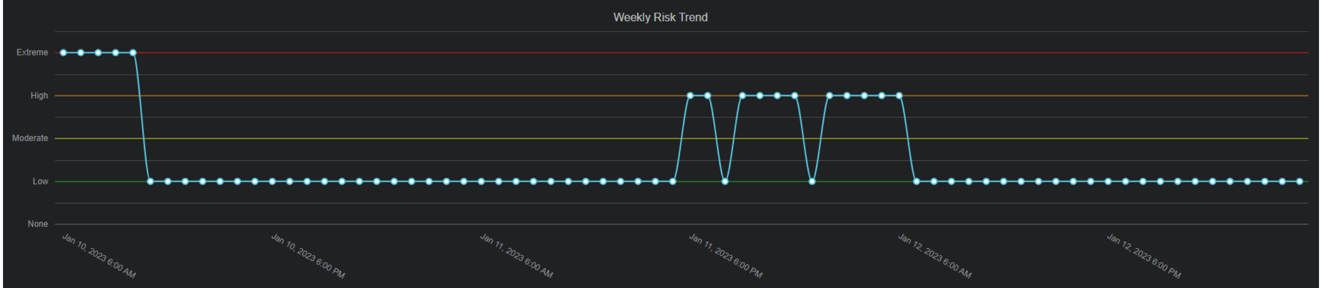
Daily Risk

Edit Report Details

Site: City of Jacksonville - City Odor Study
Report Issued: Mar 10, 2023 4:25 PM
Report Period: Shift starting Jan 10, 2023 6:00 AM

Generate PDF

No Data None Low Moderate High Extreme



Day Shift - Tuesday

Jan 10, 2023 6:00 AM - Jan 10, 2023 6:00 PM

Hours	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11	11 - 12	12 - 13	13 - 14	14 - 15	15 - 16	16 - 17	17 - 18
Risk	Extreme	Extreme	Extreme	Extreme	Extreme	Low	Low	Low	Low	Low	Low	Low
Humidity (%)	64	64	58	52	45	38	36	34	34	36	36	42
Inversion Strength (°C/100 m)	0.52	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixing Height (m)	49.18	49.15	112.30	112.93	426.53	428.08	591.07	1322.09	1034.55	1035.51	793.50	793.00
Rainfall (inches)	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	50.10	50.03	52.23	55.43	59.35	62.56	64.65	66.21	66.85	66.49	65.38	63.64
Wind Direction	NW (318°)	NW (333°)	NW (335°)	NW (304°)	NW (293°)	W (268°)	W (278°)	W (292°)	W (261°)	W (282°)	W (277°)	W (290°)
Wind Speed (mph)	3.84	3.23	4.47	2.44	2.82	6.05	9.53	9.07	7.70	10.06	8.99	7.03

Alerts

Tuesday 06:00 - 11:00: Dry, extremely high winds forecast.
Tuesday 11:00 - 18:00: Strong winds forecast, low risk of odour impacts offsite.

Night Shift - Tuesday

Jan 10, 2023 6:00 PM - Jan 11, 2023 6:00 AM

Hours	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23	23 - 00	00 - 01	01 - 02	02 - 03	03 - 04	04 - 05	05 - 06
Risk	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Humidity (%)	49	53	56	58	58	61	65	65	65	68	60	61
Inversion Strength (°C/100 m)	0.00	1.09	1.72	1.86	2.64	1.90	3.36	3.17	3.17	3.40	1.79	1.75
Mixing Height (m)	50.42	114.57	50.00	49.85	49.75	49.63	49.44	49.39	49.34	49.29	49.22	49.19
Rainfall (inches)	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	61.65	59.42	57.68	56.21	55.25	54.13	52.49	51.97	51.48	50.90	50.73	50.38
Wind Direction	W (289°)	W (275°)	W (279°)	W (281°)	W (283°)	W (255°)	SW (245°)	W (252°)	W (272°)	W (268°)	W (270°)	W (269°)
Wind Speed (mph)	3.41	3.55	3.31	2.76	2.38	5.60	2.78	2.79	2.90	2.98	2.42	1.28

Day Shift - Wednesday

Jan 11, 2023 6:00 AM - Jan 11, 2023 6:00 PM

Hours	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11	11 - 12	12 - 13	13 - 14	14 - 15	15 - 16	16 - 17	17 - 18
Risk	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Humidity (%)	62	63	55	50	47	42	37	32	28	32	33	39
Inversion Strength (°C/100 m)	1.98	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixing Height (m)	49.13	49.12	112.75	194.82	429.82	594.34	797.44	1043.32	1045.26	1047.43	436.47	51.10
Rainfall (inches)	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	49.78	49.88	53.82	58.25	62.64	66.28	69.10	71.01	71.99	72.04	70.76	68.82
Wind Direction	SW (226°)	SW (247°)	W (249°)	W (248°)	SW (228°)	S (201°)	SW (205°)	S (198°)	SW (225°)	SW (234°)	SW (221°)	SW (204°)
Wind Speed (mph)	2.95	2.97	1.70	2.04	2.61	4.16	5.07	6.07	7.29	7.62	8.21	4.13

Alerts

Wednesday 06:00 - 18:00: Strong winds forecast, low risk of odour impacts offsite.

Night Shift - Wednesday

Jan 11, 2023 6:00 PM - Jan 12, 2023 6:00 AM

Hours	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23	23 - 00	00 - 01	01 - 02	02 - 03	03 - 04	04 - 05	05 - 06
Risk	High	High	Low	High	High	High	High	Low	High	High	High	High
Humidity (%)	43	48	65	62	65	66	65	62	57	59	66	68
Inversion Strength (°C/100 m)	0.11	1.21	2.52	2.26	1.74	1.47	2.40	4.04	4.48	3.84	1.93	1.94
Mixing Height (m)	50.90	50.78	50.48	50.35	50.31	50.22	50.13	50.03	49.91	49.83	114.10	113.95
Rainfall (inches)	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	66.56	64.87	61.49	60.44	59.72	58.93	58.15	57.45	56.71	55.91	56.67	55.97
Wind Direction	S (173°)	S (168°)	SE (141°)	S (165°)	S (177°)	S (176°)	S (180°)	S (190°)	S (189°)	S (179°)	S (187°)	S (181°)
Wind Speed (mph)	3.37	3.86	4.86	4.53	4.30	4.34	4.19	4.39	4.51	4.52	5.82	4.67

5.1.3 EIS Support

On top of all the hardware and software solution deployed by Envirosuite, the City of Jacksonville had the opportunity to reach out anytime to the Environmental Intelligence Services team of Envirosuite to answer any type of question. The team is composed of subject matter experts around air quality, odor and meteorology and were able to provide support if needed.

The support provided by the EIS team during the study mainly consisted in:

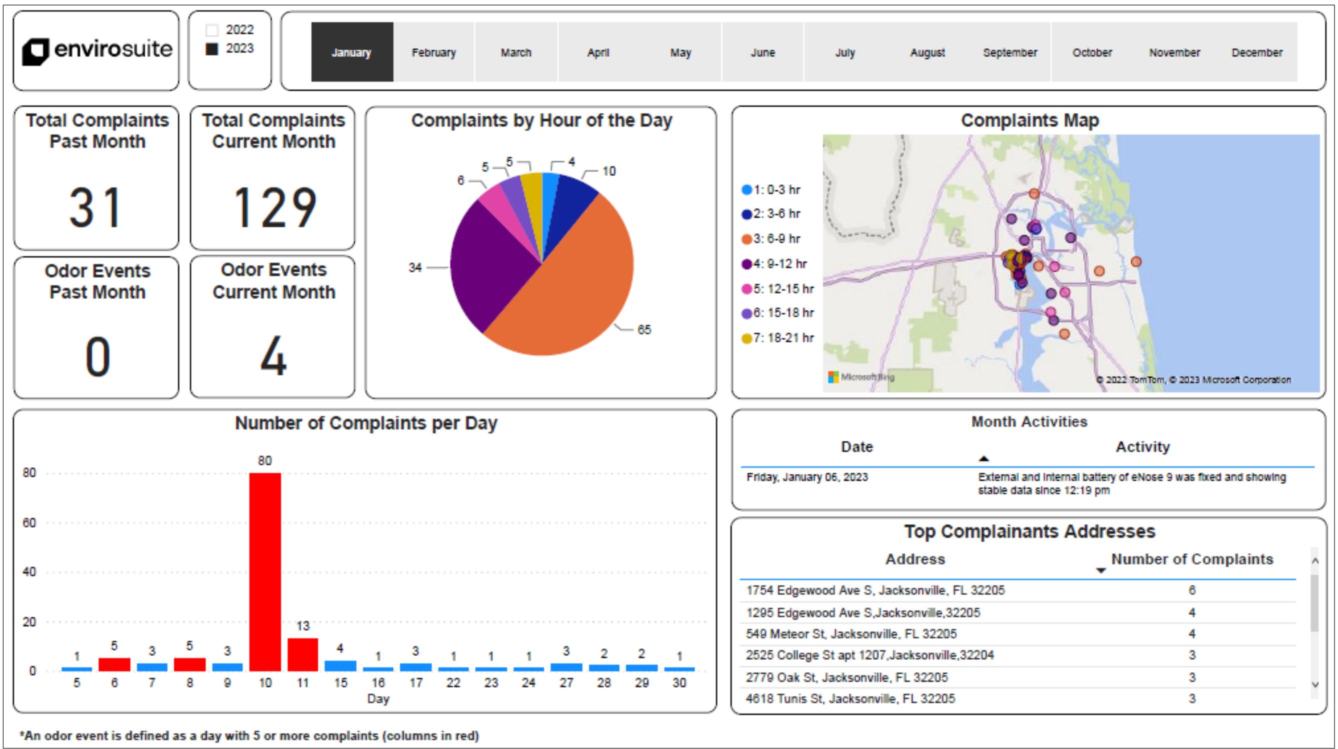
- Updating the model whenever needed by adding or removing weather stations from the CALMET model and adding or updating emission rates for the CALPUFF dispersion models.
- Providing support in changing the configuration parameters for the odor risk reports.
- Daily checking for successful model runs, if a problem around the model was noticed, the corresponding teams were notified to fix them.
- Interpretation of monitored data when the City of Jacksonville members had doubts about it.
- Preparation and delivery of monthly reports (explained in detail the next subsection).

5.1.3.1 Monthly Reports

An important aspect of the EIS Support were the monthly reports provided to City of Jacksonville; these reports are supposed to provide an analysis that goes beyond to what is available in the platform. As requested by the Jacksonville Environmental Protection Board, the report was designed considering the following information:

- **Page 1:** count of total complaints received during the past and current month, count of odor events (a day with 5 or more complaints) during the past and current month, distribution of complaints by hours of the day and map showing the complaints location for the current month. Daily sum of complaints is shown in a graph along with the activities that took place during the month and the top complainants addresses. Figure 41 presents an example of this page of the report:

Figure 41. Example of page 1 of the monthly report showing complaints information.



- **Pages 2, 3, and 4:** daily concentration averages graphs for each pollutant (VOC, H_2S, and NH_3). These graphs allow to quickly identify increasing or decreasing trends in concentration for each day of the month Figure 42, Figure 43, and Figure 44 present examples of these pages of the report:

Figure 42. Example of page 2 of the monthly report showing VOC daily averages.

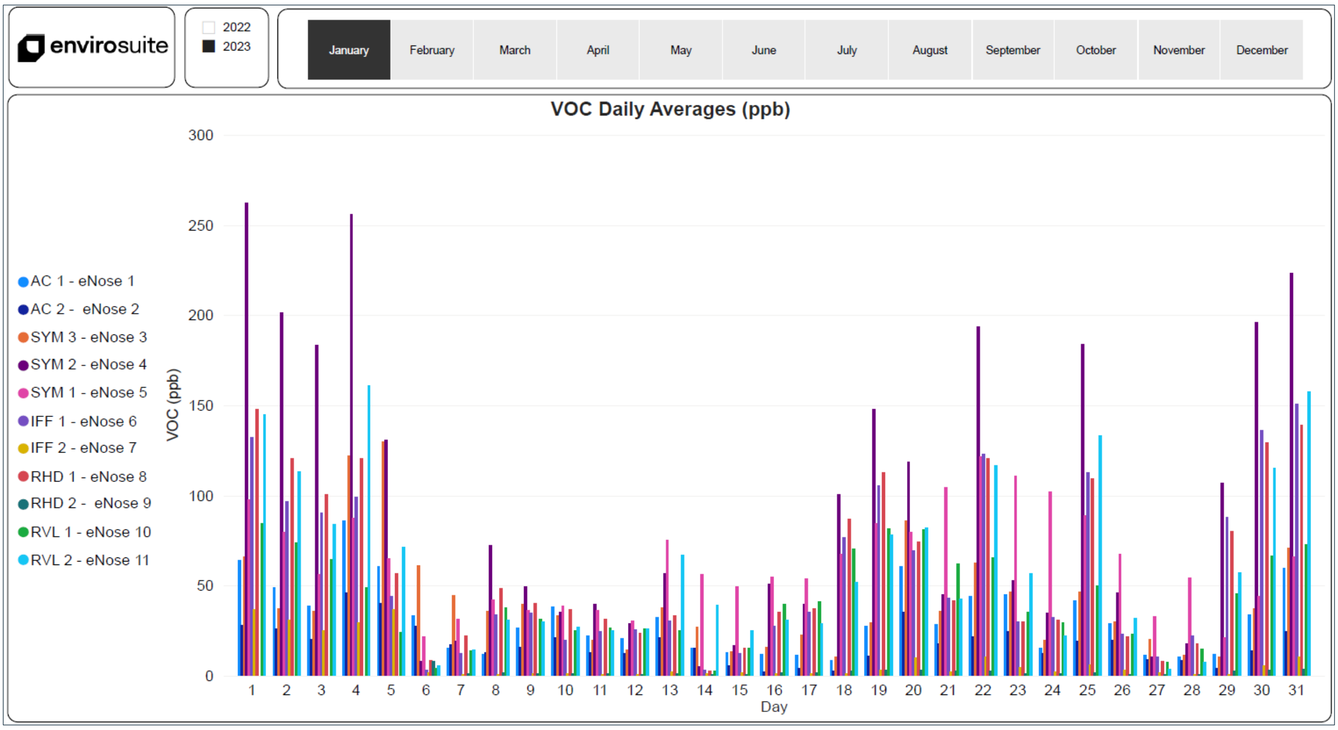


Figure 43. Example of page 3of the monthly report showing H_2S daily averages.

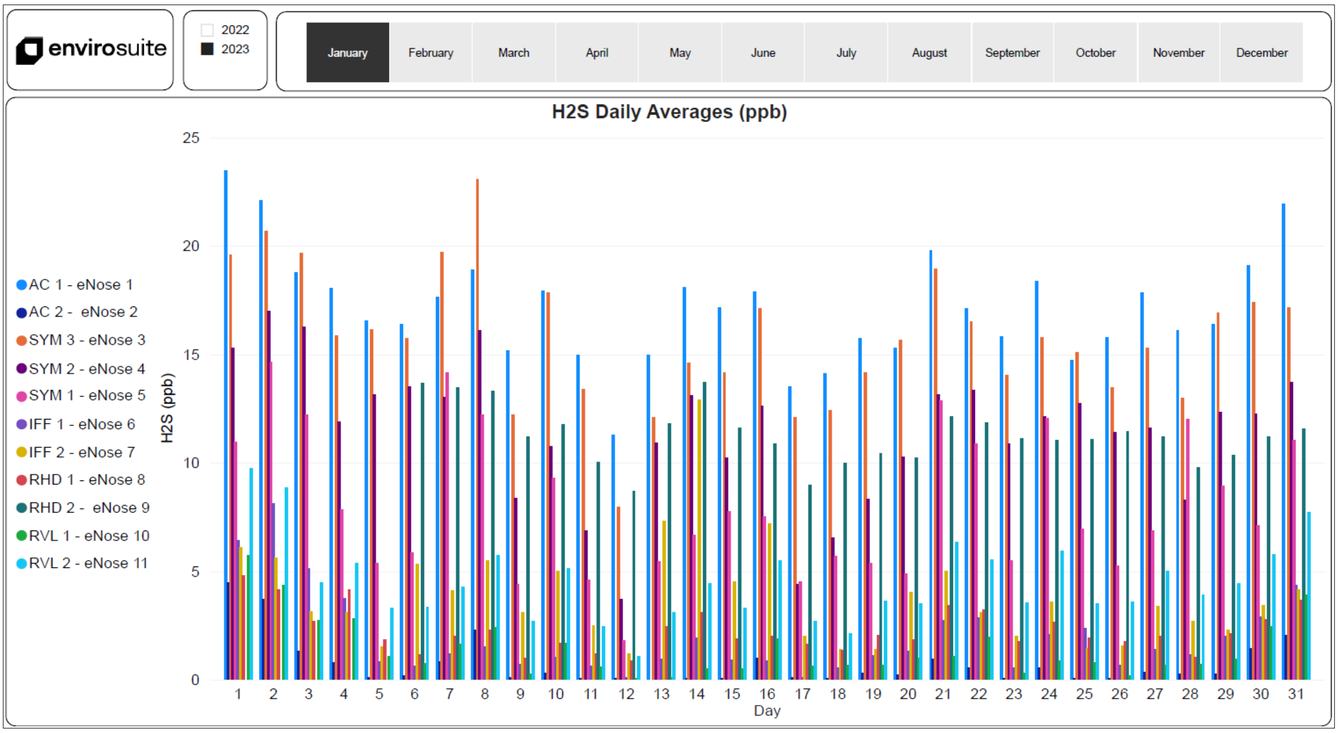
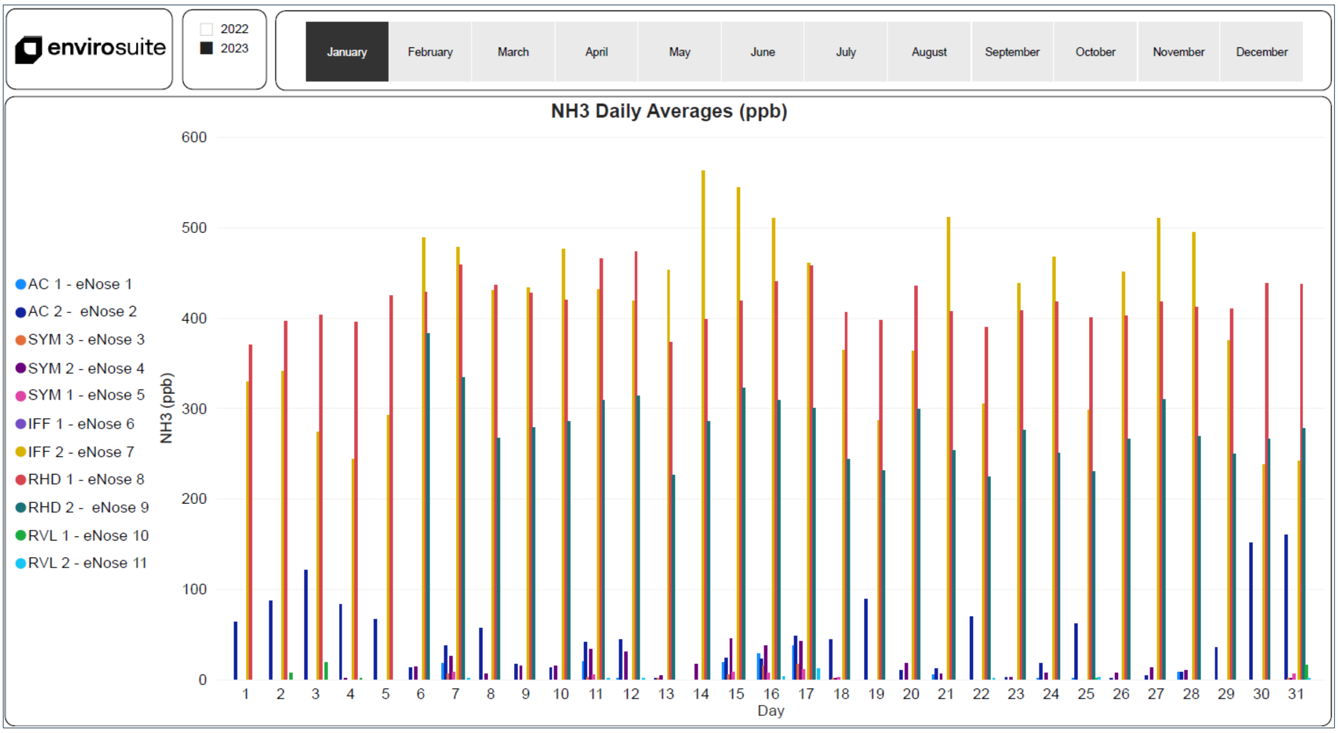


Figure 44. Example of page 4 of the monthly report showing NH_3 daily averages.



- **Pages 5, 6, and 7:** hourly concentration averages graphs for each pollutant (VOC, H_2S, and NH_3) along with hourly averages of temperature data, and wind roses for each period of the day (dawn, morning, afternoon, and night) from Met 1 weather station. A map with the eNoses locations is also presented. These graphs allow to quickly identify increasing or decreasing trends in concentration for each hour of the day.Figure 45, Figure 46, and Figure 47 present examples of these pages of the report:

Figure 45. Example of page 5 of the monthly report showing VOC and temperature hourly averages and wind roses.

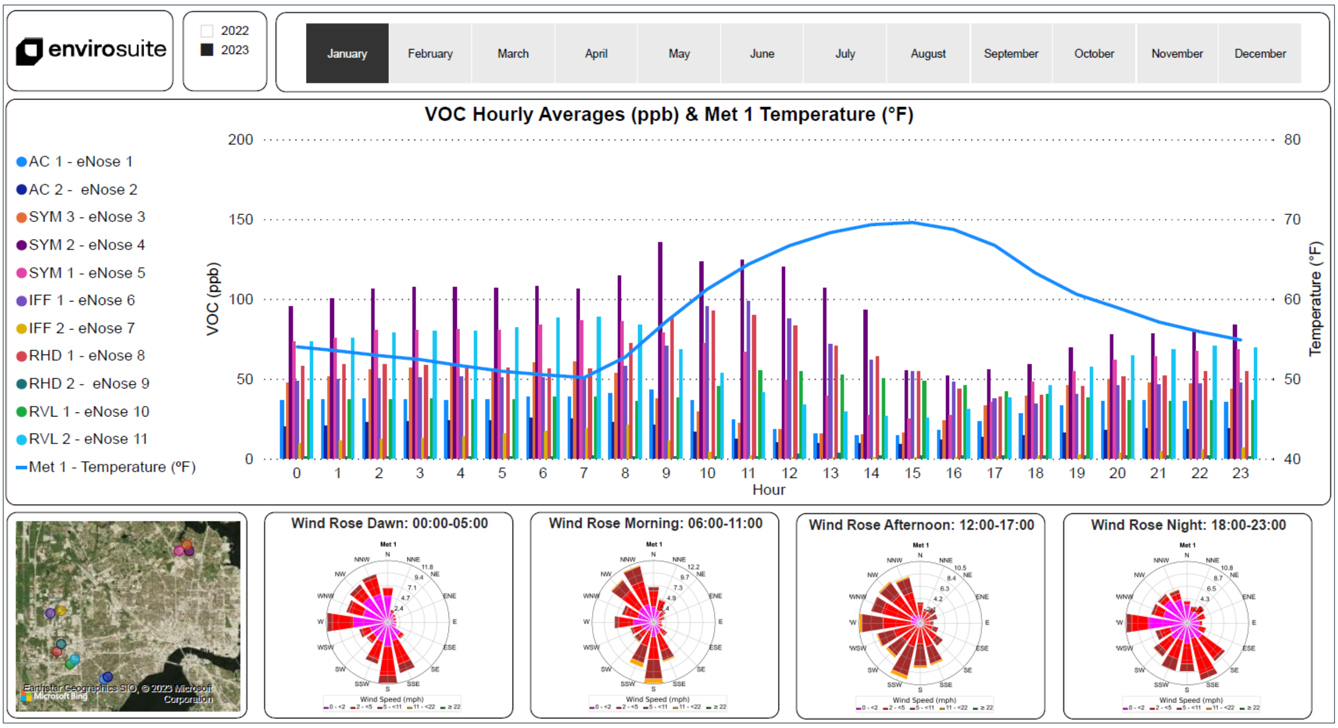


Figure 46. Example of page 6 of the monthly report showing H2S and temperature hourly averages and wind roses.

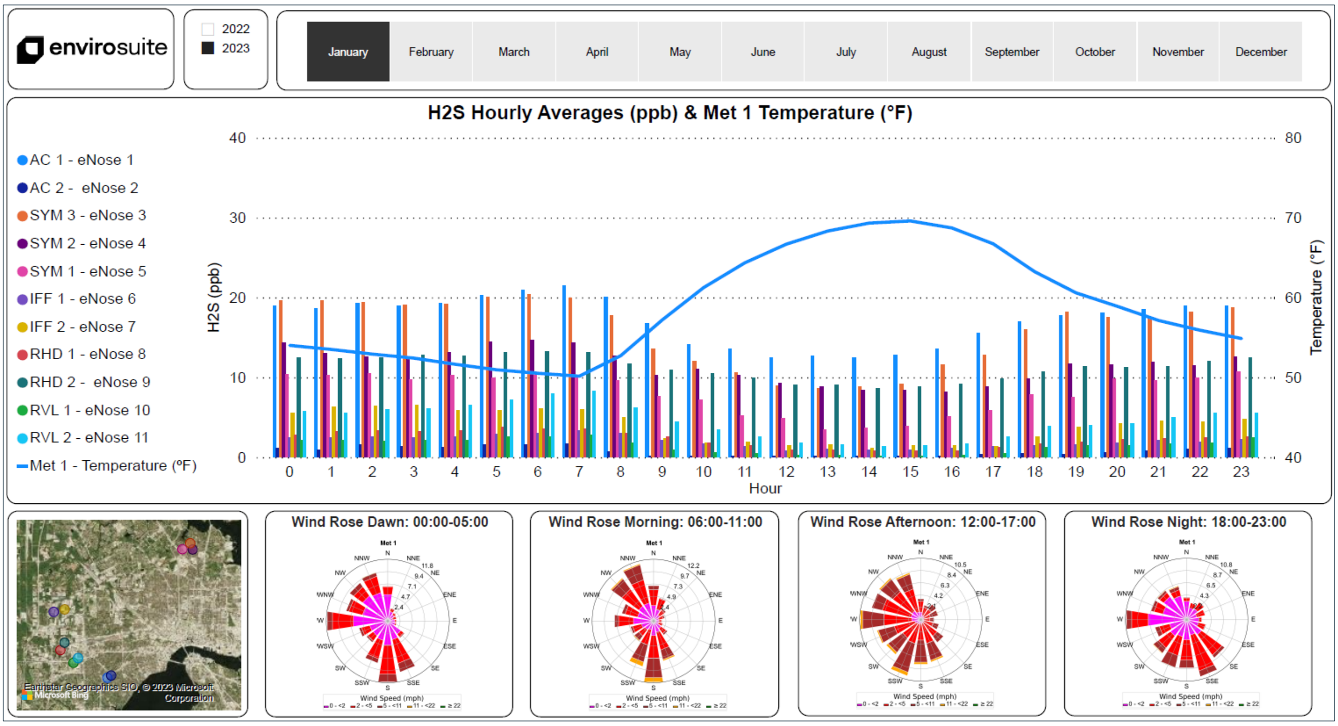
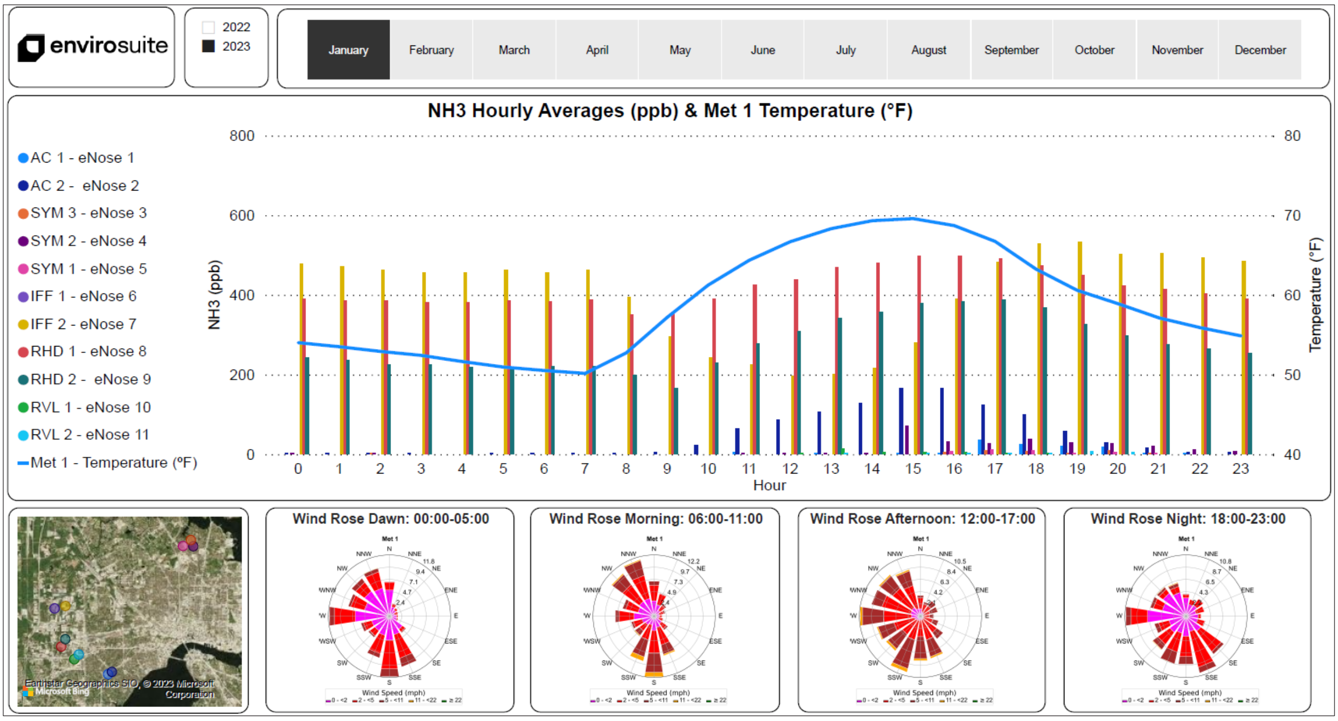
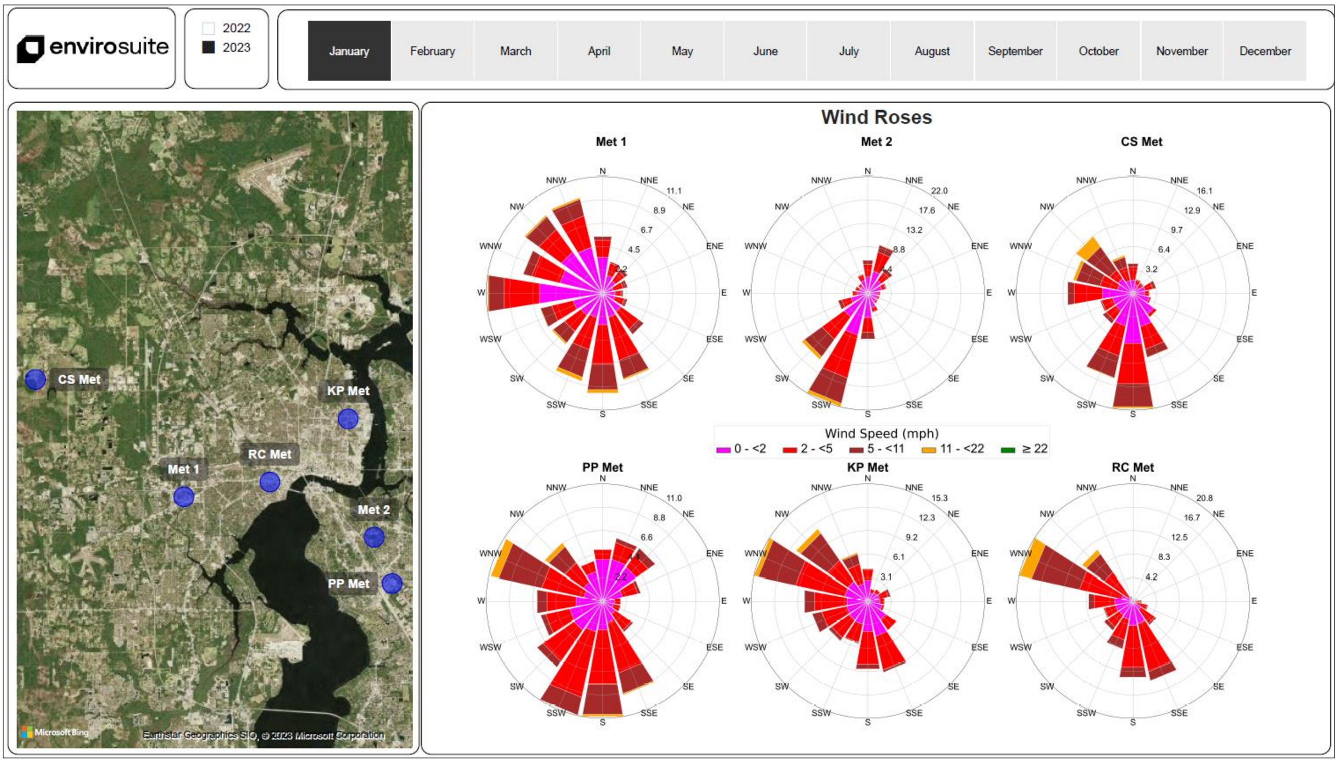


Figure 47. Example of page 7 of the monthly report showing NH3 and temperature hourly averages and wind roses.



- **Page 8:** wind roses for all 6 weather stations along with a map showing the location of each of them. These graphs allow to understand the predominant wind speed and direction conditions at each weather station during the month. Figure 48 presents an example of this page of the report:

Figure 48. Example of page 8 of the monthly report showing wind roses for each weather station.



- **Pages 9, 10, and 11:** pollution roses for each pollutant (VOC, H_2S, and NH_3) at each eNose along with a map showing the location of each of them. These graphs allow to determine under which prevailing wind direction frequencies there are higher concentrations for each pollutant during the month. Figure 49, Figure 50, and Figure 51 present examples of these pages of the report:

Figure 49. Example of page 9 of the monthly report showing VOC pollution roses for each eNose.

Figure 50. Example of page 10 of the monthly report showing H_2S pollution roses for each eNose.

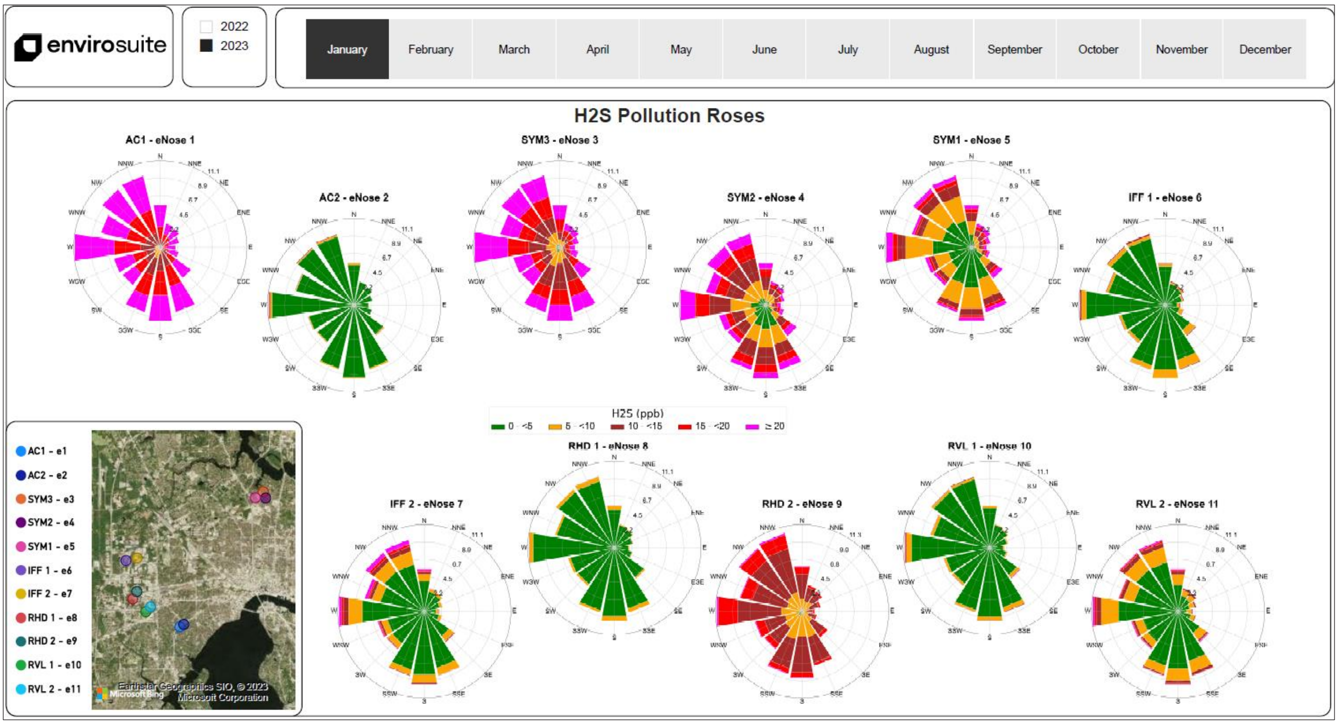
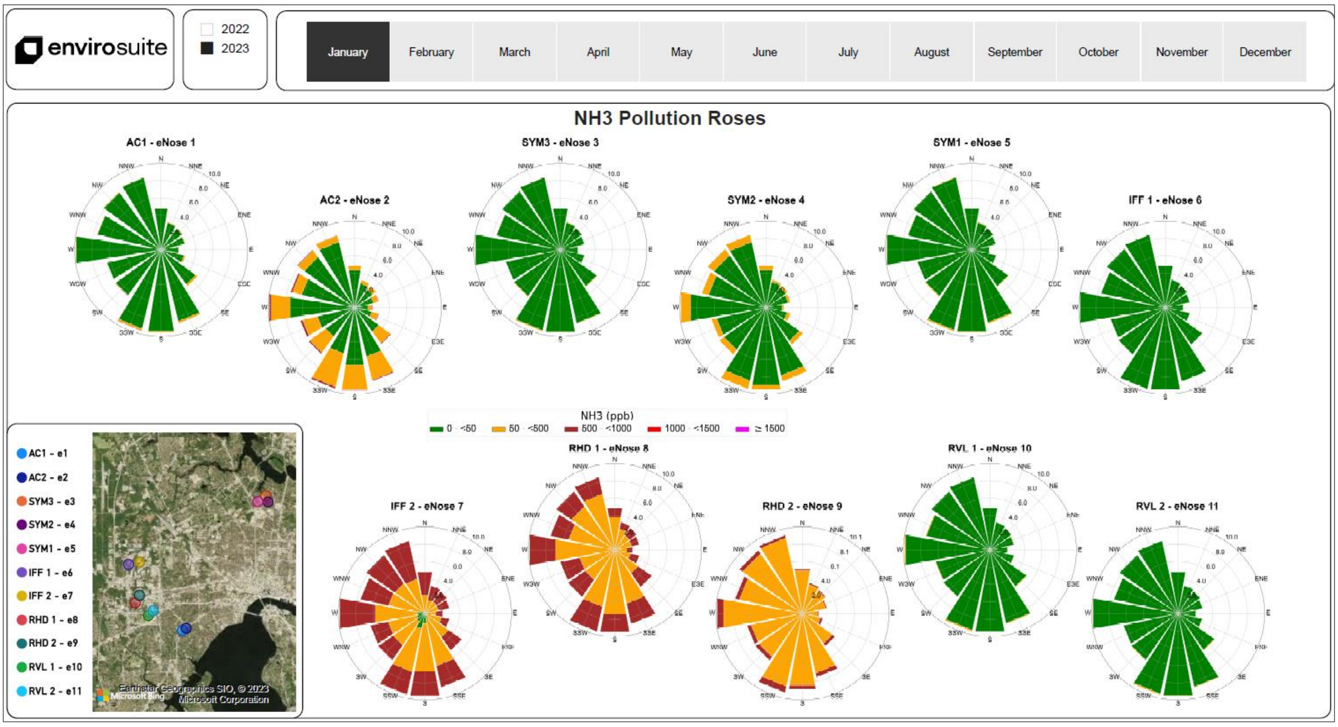


Figure 51. Example of page 11 of the monthly report showing NH_3 pollution roses for each eNose.



5.2 Study Results

This section presents the study results during the whole between April 2022 to March 2023. The first subsection correspond to an analysis of the complaints received by the city with an evaluation of its temporal and geographical distribution and an assessment on how the incident intelligence module tool was used to manage complaints.

This is followed by the presentation of the analysis of the monitored data during the study, including surface meteorology (wind speed, wind direction, temperature, and relative humidity) and air quality (ammonia, hydrogen sulfide, and volatile organic compounds). To this end, the data is presented in appropriate graphs including time series, hourly, daily weekly, monthly and seasonal cycles.

Then the modelling results are presented, this includes the evaluation of the qualitative and quantitative uncertainty evaluation of the forecast weather model performance against surface meteorological observations, followed by an analysis on upper air forecast parameters, followed by the presentation of the results of the odor dispersion model and an assessment on how the trajectory module tool was used by the city.

5.2.1 Complaints Analysis

This section presents the temporal and geographical distribution of the complaints received by the city during the study, from now on they will be named 'study complaints', to differentiate them to the historical complaints (received before the study, and that were presented in sections 4.1 and 4.2).

5.2.1.1 Temporal Distribution of Study Complaints

Table 12 shows the temporal distribution of the study complaints per month and per hour of the day (00:00-23:00). From the table is possible to conclude that most complaints occurred during the autumn-winter months during the morning (between 6:00-11:00 am).

Table 12. Monthly and hourly distribution of study complaints.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
2022	**5**	**3**	**4**	**2**	**1**	**6**	**25**	**62**	**111**	**57**	**20**	**29**	**16**	**11**	**13**	**22**	**12**	**7**	**17**	**11**	**11**	**10**	**6**	**8**	**469**
April	1	1			1		8	5	13	6		3	3	3	2	7	2		2			2	1	1	61
May	1			1		1	2	4	13	3		1	1	2	2	3	2						1		37
June						1	3	14	9	3	4	6	2	2	1	1	1					1			48
July								3	5	2	1				1	4	3	1	2	2	1	1	1	2	29
August				1		2	2	12	16	8	2	3				4		1	2	1					54
September						1	1	4	9	2	1	3	2	1	1		2	3	2	2					34
October		2	4			1	7	14	35	22	4	6	2	2	1	1	2	2	2	3	4	2	2	2	120
November	2						1	4	7	5	5	5	3	1	3	1			5	2	6	3	1	1	55
December	1						1	2	4	6	3	2	3		2	1			2	1		1		2	31
2023	**2**	**2**		**2**	**3**	**4**	**6**	**11**	**36**	**21**	**13**	**18**	**10**	**7**	**2**	**4**	**5**	**3**	**1**	**3**	**4**		**1**		**158**
January	2	1		1	3	2	5	10	34	21	13	13	8	4		2	2	3		3	2				129
February				1		1			2			2	2	1		2	2						1		14
March		1				1	1	1				3		2	2		1		1		2				15
Total	**7**	**5**	**4**	**4**	**4**	**10**	**31**	**73**	**147**	**78**	**33**	**47**	**26**	**18**	**15**	**26**	**17**	**10**	**18**	**14**	**15**	**10**	**7**	**8**	**627**

By comparing this result with what was presented in Table 1, it is noticeable that despite there are considerably less complaints than the historical data, the trend is the similar, being most of the complaints during the early morning in similar months of the year.

Table 13 shows the spatial and temporal distribution of the study complaints per zip code and per hour of the day (00:00-23:00). From the table most complaints come from addresses in zip codes 32205, 32208, 32210, 32254, and 32204, during the morning (between 06:00-11:00 AM).

Table 13. Hourly distribution of study complaints per zip code.

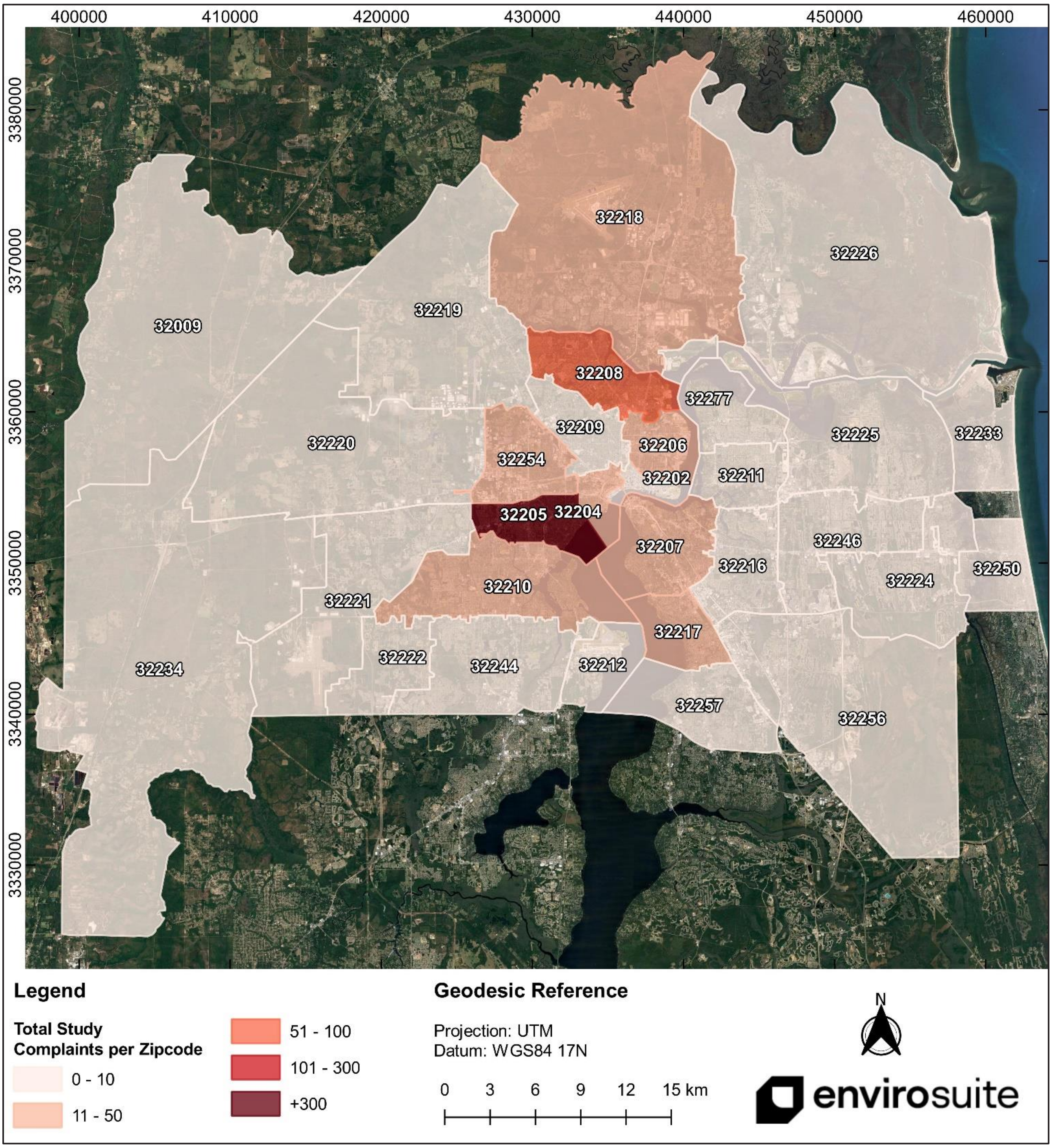
zip code	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
32202								2			1														3
32204							2	4	4	2	1	1	4						1	1	1	1	2	2	26
32205	2	1	1	2	3	9	25	53	90	49	22	22	10	5	2	8	6	8	10	10	13	4	2	1	358
32206		1							5			1	1		1	1	2								12
32207								1	7			2	1			3	1								15
32208	3	3	3	1	1		3	2	5	6	2	5	2	4	1	2	4		2	1	1	2	1	3	57
32209												1		2	1										4
32210				1			1	7	12	4	4	2	2	2	3	2			1			1			42
32211												1													1
32216											1	2				1									4
32217									10	4		2													16
32218								1	2	4		1	1				2	1							12
32219									1	2						2							1		6
32220														1	1				2	1		1			6
32221								1		1							1								3
32223											1														1
32224									1					1											2
32225										1			1				1					1			4
32233										1															1
32244	1												2		4										7
32250										1															1
32254						1		2	6	2	1	4			2	3		1	2	1				2	27
32256														3		2									5
32257													1			1									2
32258									3			2													5
32277	1								1	1		1	1			1							1		7
Total	7	5	4	4	4	10	31	73	147	78	33	47	26	18	15	26	17	10	18	14	15	10	7	8	627

By comparing this result with what was presented in Table 2, it is noticeable that despite there are considerably less complaints than the historical data, the trend is similar, being most of the complaints during the early morning in similar zip code areas.

5.2.1.1 Geographical Distribution of Study Complaints

Figure 52 presents a map with the study complaints locations along with the area covered by each zip code at City of Jacksonville:

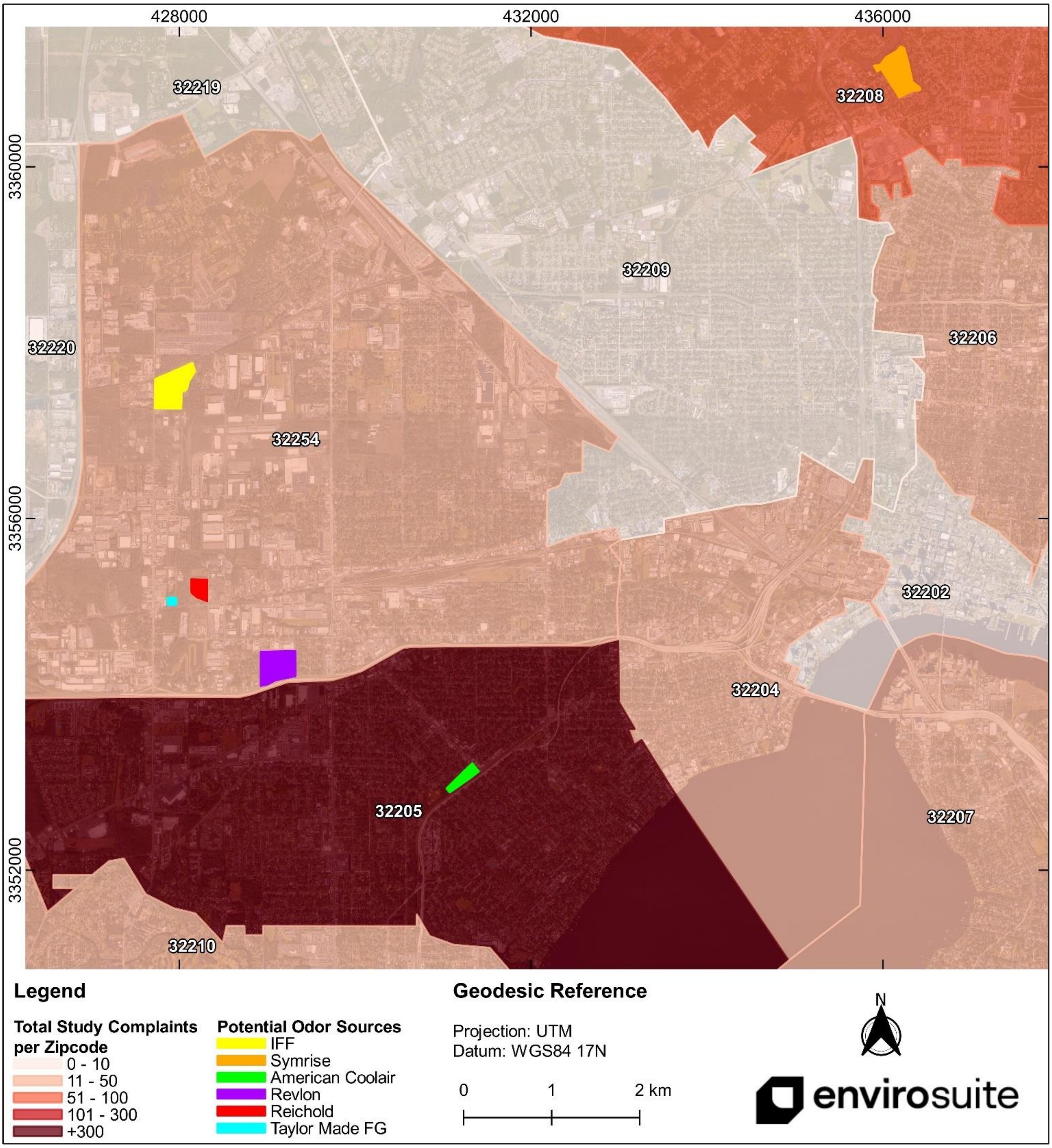
Figure 52. Study complaints map (between April 2022 - March 2023).



It is important to mention that the scale presented in this map is the same that was presented in Figure 1, this allows to compare both figures and it is noticeable that the majority of complaints come from similar zip code areas, but there is a considerable reduction in the total complaints compared to the historical data period.

Figure 53 presents a map with a zoom for the zip codes for the study complaints, along with the location of the main industries in the city:

Figure 53. Zoom view to study complaints map (between April 2022 - March 2023) and potential odor sources.



It is important to mention that the scale presented in this map is the same that was presented in Figure 2, this allows to compare both figures and it is noticeable that the majority of complaints come from similar zip code areas, but there is a considerable reduction in the total complaints compared to the historical data period.

5.2.1.2 Usage of Incident Intelligence Module

During the study only 10 JIRA tickets were ingested in the system, this means that despite having this tool available, the City of Jacksonville personnel preferred to manage the complaints information outside the OMNIS platform.

5.2.2 Monitoring Analysis

The monitoring analysis consists of the presentation of the surface meteorology and air quality data collected during the study. Depending on each parameter relevance, appropriate graphs are shown to present the monitoring results, which are explained below:

- ✓ **Time series:** a graph that shows the available time series data for each parameter on a yellow line, along with basic statistics for the data set (percentage of available data, percentage of missing data, minimum, maximum, mean, median, and 95th percentile) along with a green histogram with the data distribution. At the bottom of each graph the light blue area represents available data, and the red area represents the missing data.

- ✓ **Hourly, daily, weekly, and monthly cycles:** a variety of graphs that average the data presented for the eNoses on an hourly-weekly basis (top), hourly (bottom left), monthly (bottom center), and weekly (bottom right). These graphs allow to visualize and analyze concentration of trends over time to understand the periods where they are higher and lower.

- ✓ **Wind roses:** a graph showing the prevailing wind directions frequencies along with the wind speed values in a color scale.

- ✓ **Pollution roses:** a graph showing the concentration of each pollutant on a color scale, which varies depending on the wind speed (in mph), its levels are shown on the circumferences of the rose, and the wind direction (in degrees) is also shown on the graph. The meteorological data presented for all the pollution roses come from the Met 1 meteorological station, as it is the most representative and closest to the main area from which the complaints originate.

- ✓ **Seasonal cycles:** a graph that shows the concentration of each pollutant on a color scale, the hour is shown in the x-axis, and the months of the year are shown in the y-axis. There are also arrows that change in size depending on the wind speed level and their position depending on the wind direction (the arrow shows where the wind is blowing to). The meteorological data presented for all the pollution roses come from the Met 1 meteorological station, as it is the most representative and closest to the main area from which the complaints originate. These graphs allow to visualize in one place the changes in concentration during the hour of the day and the month of the year, considering the changes in wind speed and direction.

It is important to mention that to present the information in appropriate figures, the data was filtered to consider only information within each sensor range, to remove outliers and any wrong data registered when the hardware was malfunctioning during the study.

5.2.2.1 Meteorology

This section presents the monitoring analysis for surface meteorological parameters: wind speed and wind direction, temperature, and relative humidity data collected in all weather stations (CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met) during the study.

a) Wind Speed and Wind Direction

Below are the time series, hourly, daily, weekly, and monthly cycles, wind roses and seasonal cycles for wind speed and wind direction.

Time Series

Figure 54 presents the wind speed time series:

Figure 54. Wind speed time series at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.

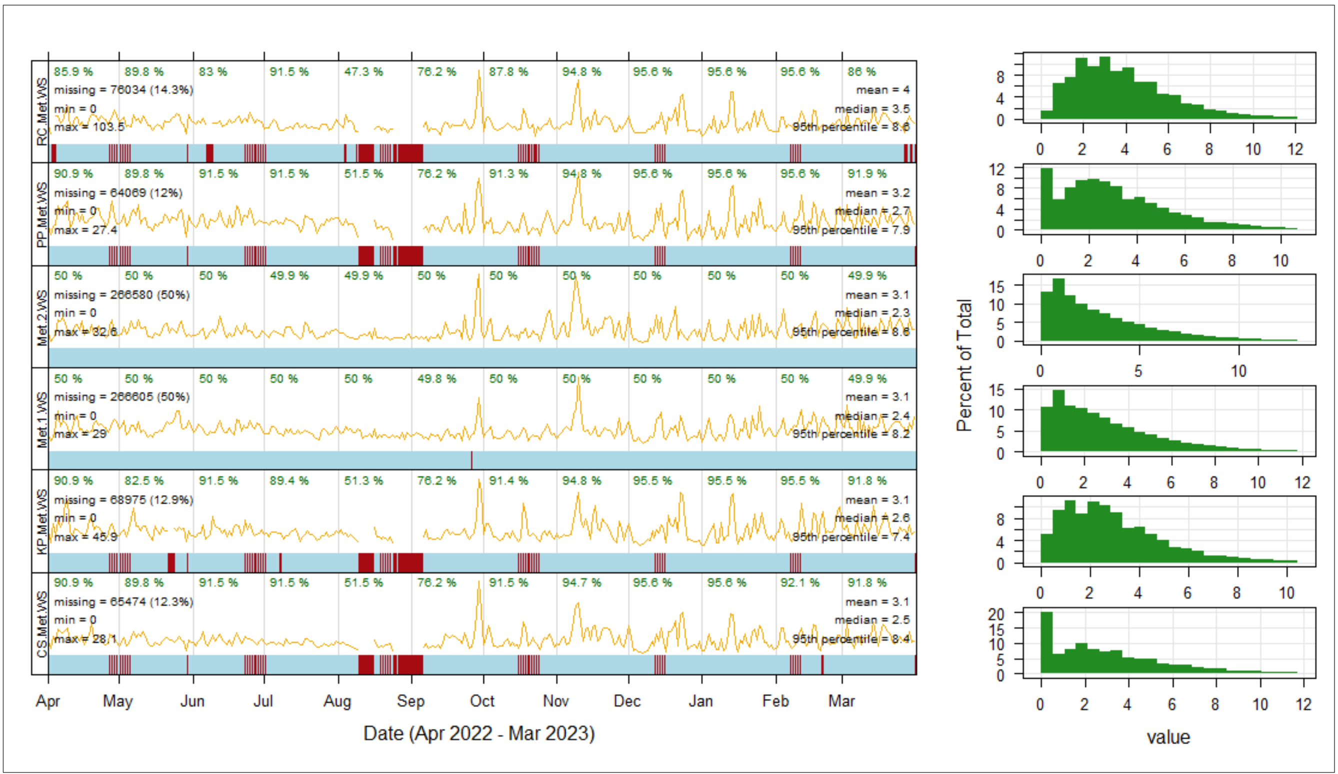
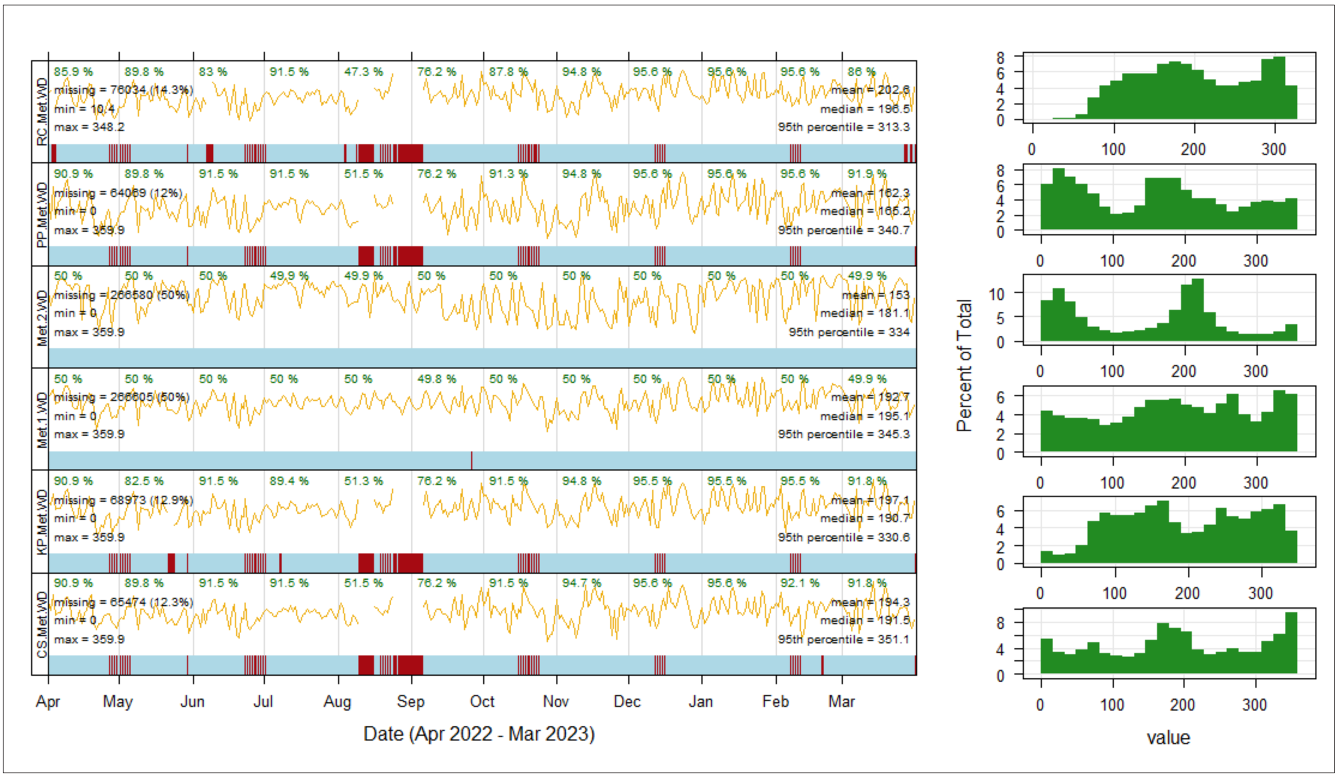


Figure 55 presents the wind direction time series:

Figure 55. Wind direction time series at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.



The time series show a high availability of information for Met 1 and Met 2. For CS Met, KP Met, PP Met, and RC Met, there are similar patterns of missing data, which normally was due to transfer issues from the City of Jacksonville server into the Envirosuite system, however there is still a high level of data availability at all stations for both wind speed and wind direction.

Note: The ‘missing’ and low percentage values shown for Met 1 and Met 2, are simply because the data collected at these stations had a temporal resolution of 2 minutes, while the data collected at the other weather stations from the city had a resolution of 1 minute, since the graph was built with all stations together, this is reason of why this is shown that way, but as can be seen from the light blue lines below the lines, there is a high availability of information in both Met 1 and Met 2 stations.

Hourly, daily, weekly, and monthly cycles

Figure 56 presents the wind speed hourly, daily, weekly, and monthly cycles:

Figure 56. Wind speed hourly, daily, weekly, and monthly cycles at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.

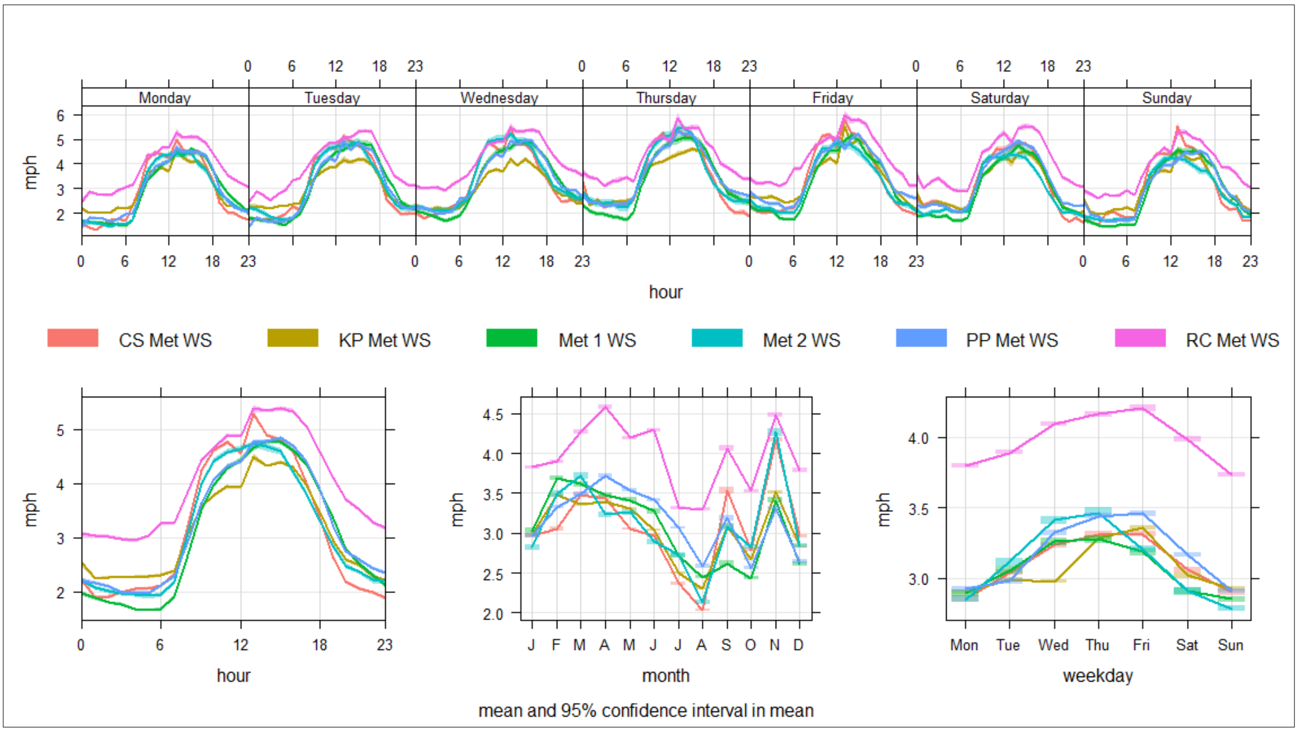
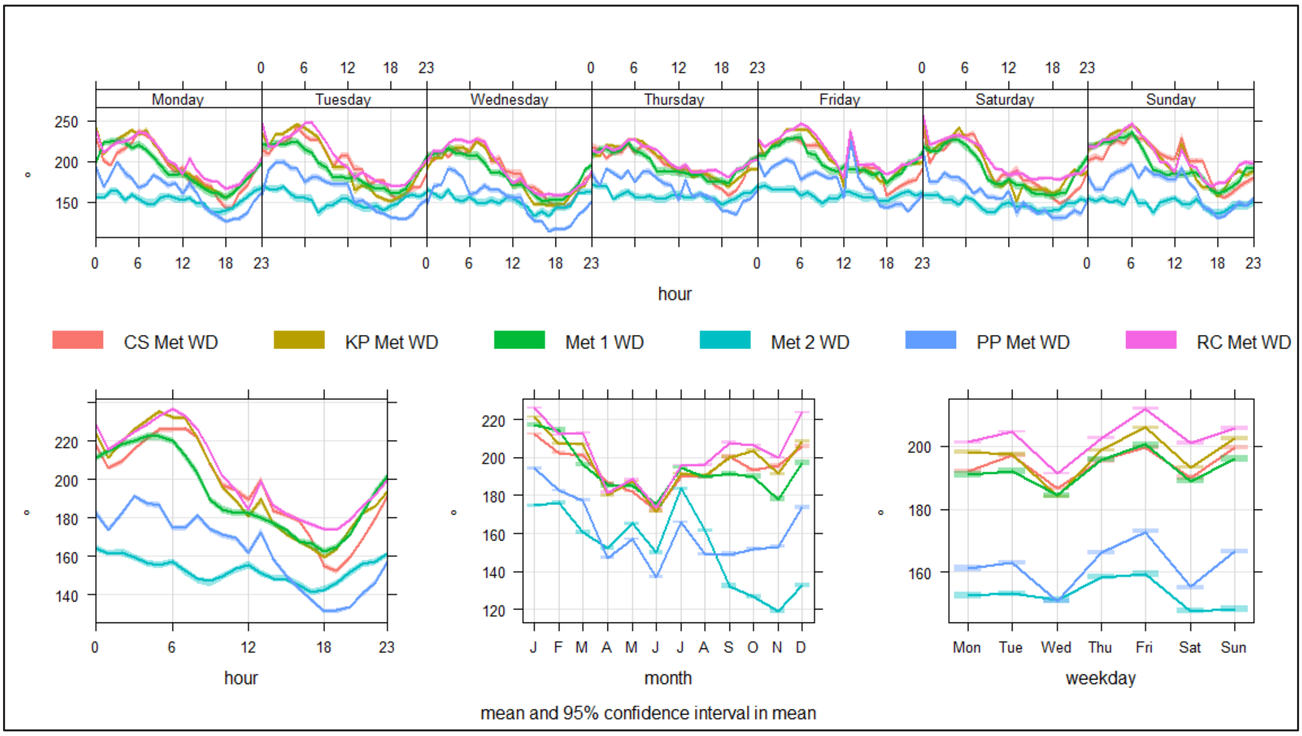


Figure 57 presents the wind direction hourly, daily, weekly, and monthly cycles:

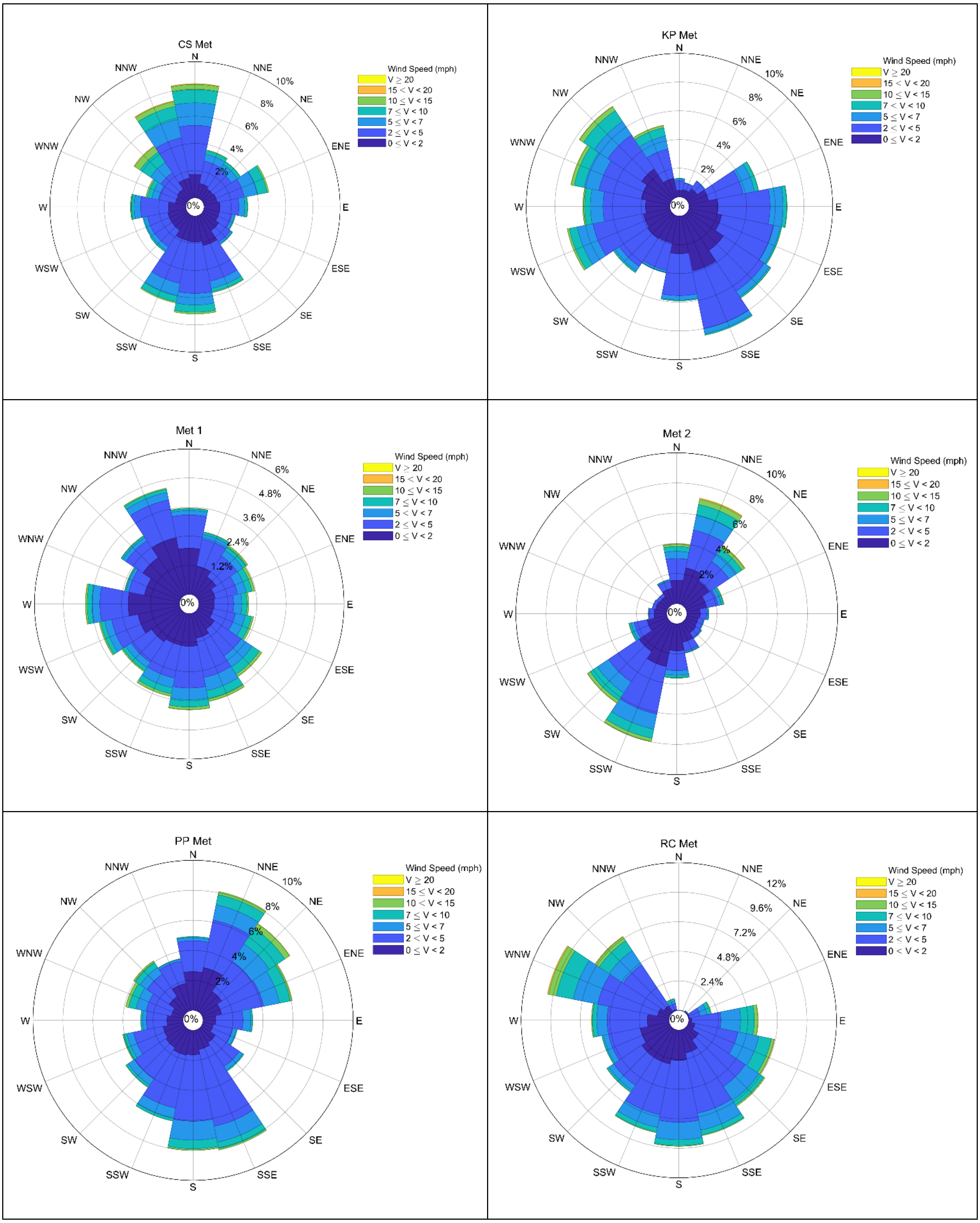
Figure 57. Wind direction hourly, daily, weekly, and monthly cycles at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.



Wind roses

Figure 58 presents the wind roses:

Figure 58. Wind roses at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.

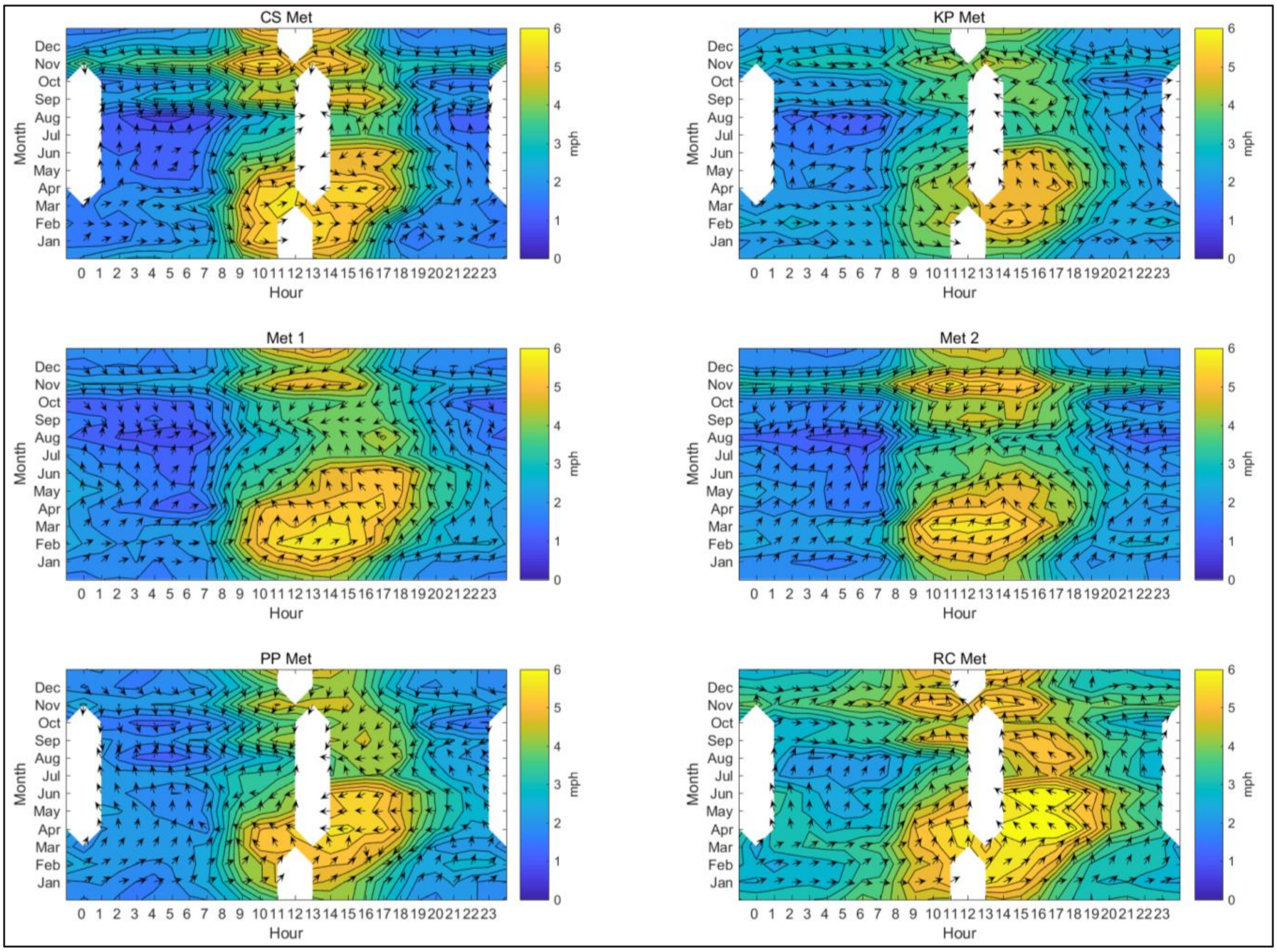


The wind speed and wind direction cycles show similar trends across all weather stations in the city, the wind speed cycles show peaks during the morning, midday and early afternoon and lower values during the night and dawn. As for the wind direction, both stations located east of the river (PP Met and Met 2) show a likely trend of predominant NNE and NE winds, along with S and SSW. The other 4 stations located west of the river (CS Met, KP Met, Met 1, and RC Met) show predominant NW, WNW, NNW winds, along with other wind directions but with fewer frequency.

Seasonal cycles

Figure 59 presents the wind speed and direction seasonal cycles:

Figure 59. Wind speed and direction seasonal cycles at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.



Seasonal cycles show similar wind speed patterns for all weather stations; higher wind speeds during the day (between 9am and 5pm) and lower wind speeds during the night and dawn (6pm and 8am). The arrows show the variability of wind directions.

Note: the white areas presented in the weather stations owned by the city (CS Met, KP Met, PP Met, and RC Met) represent missing data that was not available for analysis.

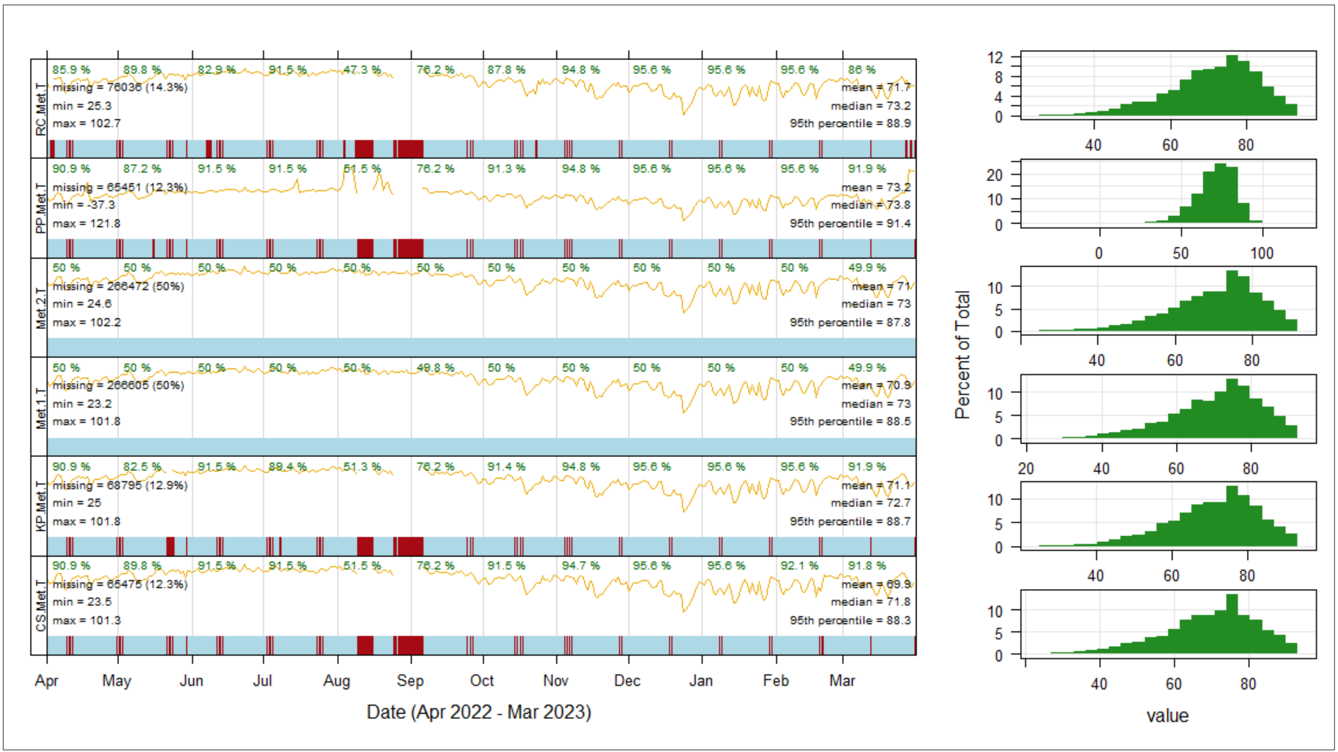
b) Temperature

Below are the time series, hourly, daily, weekly, and monthly cycles, and seasonal cycles for temperature.

<u>Time Series</u>

Figure 60 presents the temperature time series:

Figure 60. Temperature time series at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.



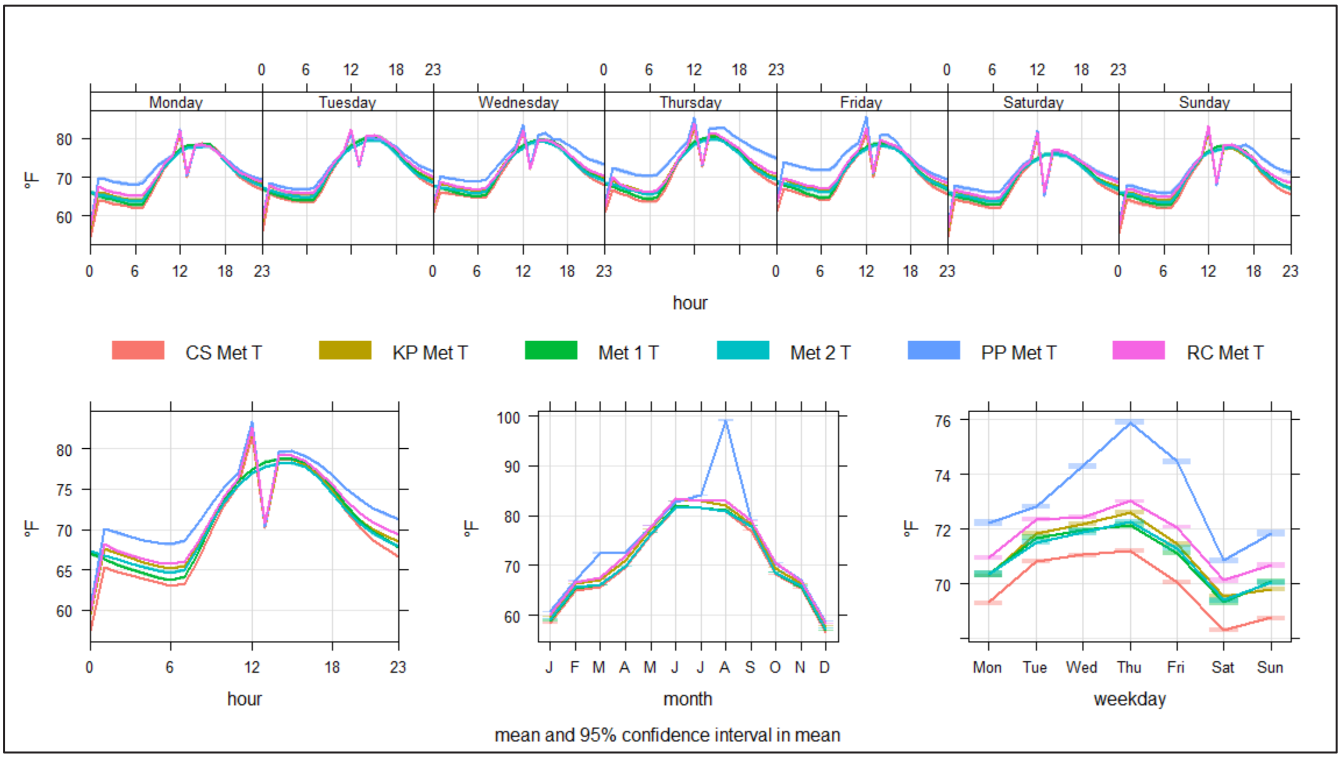
The time series show a high availability of information for Met 1 and Met 2. For CS Met, KP Met, PP Met, and RC Met, there are similar patterns of missing data, which normally was due to transfer issues from the City of Jacksonville server into the Envirosuite system, however there is still a high level of data availability at all stations for temperature.

<u>Note:</u> The 'missing' and low percentage values shown for Met 1 and Met 2, are simply because the data collected at these stations had a temporal resolution of 2 minutes, while the data collected at the other weather stations from the city had a resolution of 1 minute, since the graph was built with all stations together, this is reason of why this is shown that way, but as can be seen from the light blue lines below the lines, there is a high availability of information in both Met 1 and Met 2 stations.

Hourly, daily, weekly, and monthly cycles

Figure 61 presents the temperature hourly, daily, weekly, and monthly cycles:

Figure 61. Temperature hourly, daily, weekly, and monthly cycles at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.

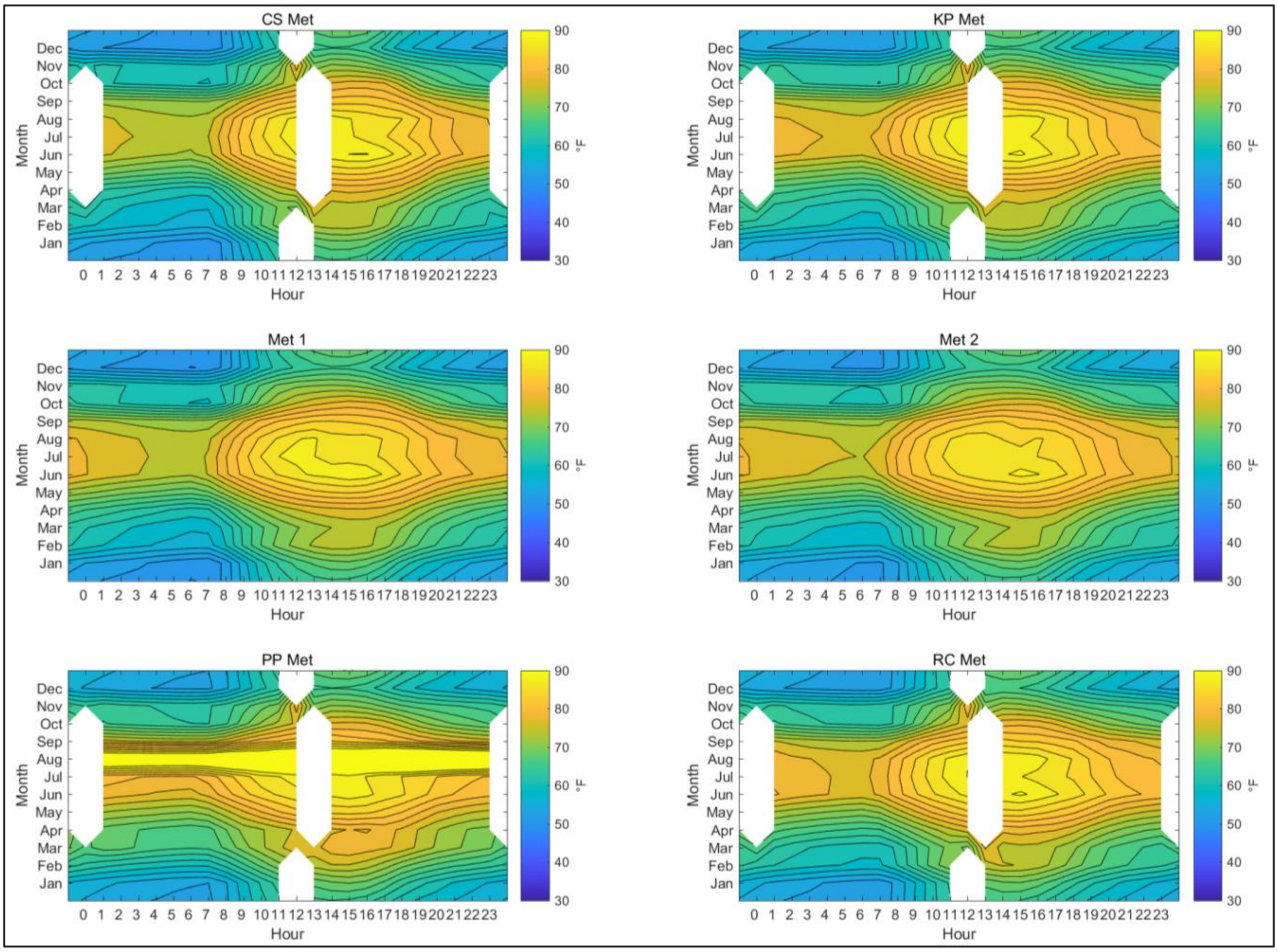


The cycles present an expected behavior of temperature across all stations, showing higher temperatures during the day and lower temperatures during the night and dawn.

Seasonal cycles

Figure 62 presents the temperature seasonal cycles:

Figure 62. Temperature seasonal cycles at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.



The seasonal cycles present an expected behavior of temperature across all stations, showing higher temperatures during the day and summer months and lower temperatures during the night and dawn in winter months.

Note: the white areas presented in the weather stations owned by the city (CS Met, KP Met, PP Met, and RC Met) represent missing data that was not available for analysis.

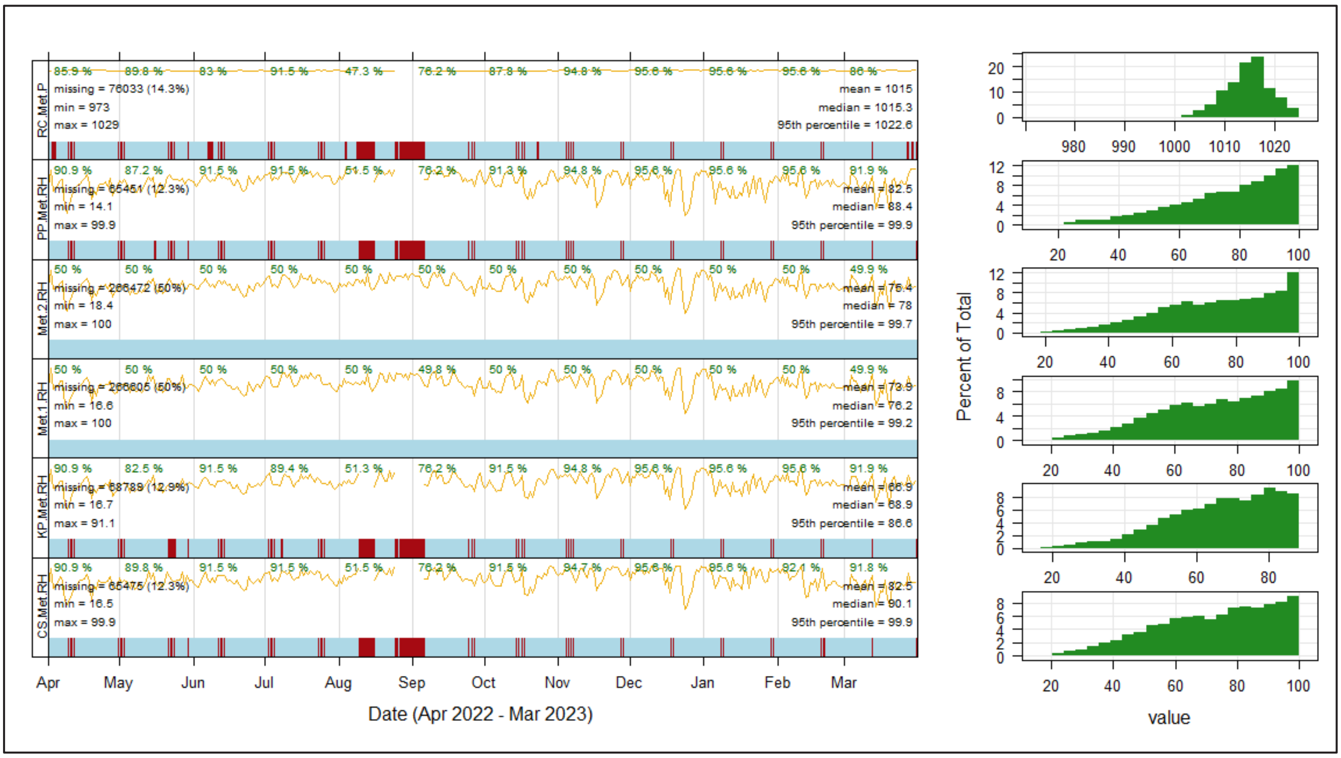
c) Relative Humidity

Below are the time series, hourly, daily, weekly, and monthly cycles, and seasonal cycles for relative humidity.

Time Series

Figure 63 presents the relative humidity time series:

Figure 63. Relative humidity time series at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.



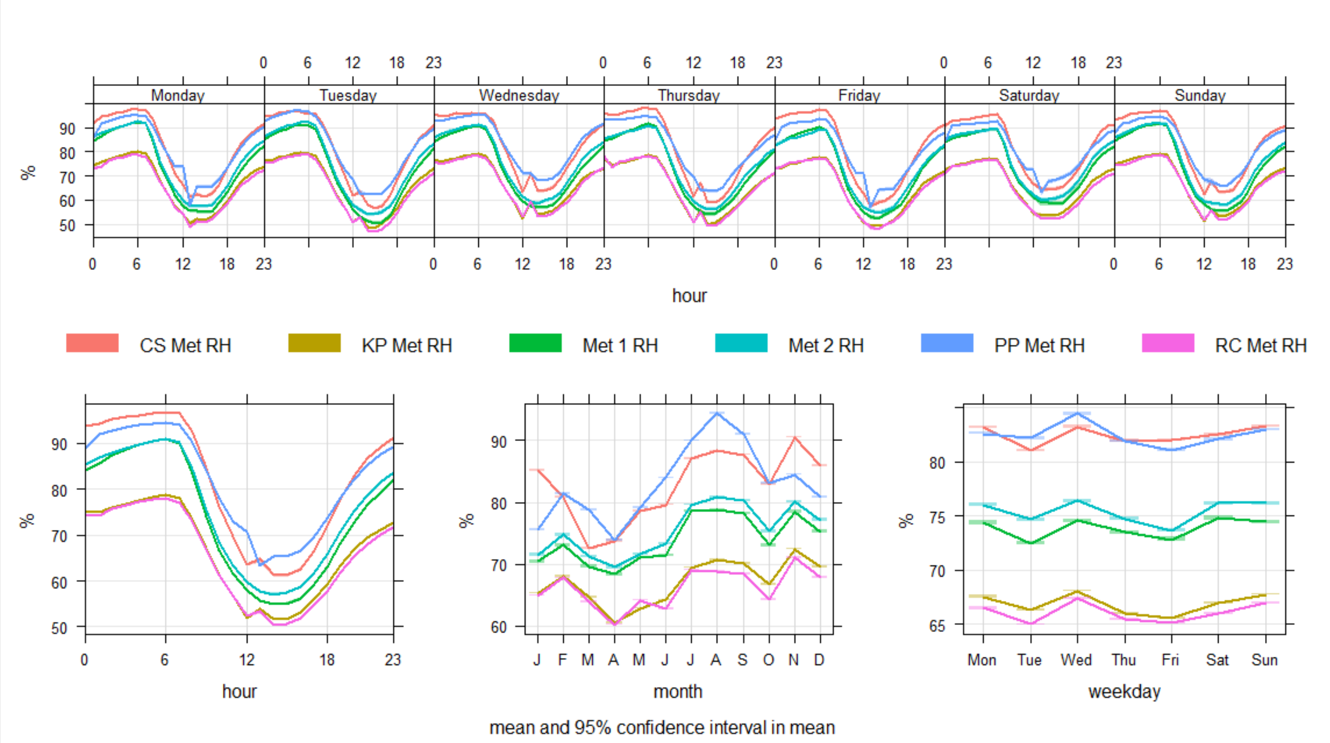
The time series show a high availability of information for Met 1 and Met 2. For CS Met, KP Met, PP Met, and RC Met, there are similar patterns of missing data, which normally was due to transfer issues from the City of Jacksonville server into the Envirosuite system, however there is still a high level of data availability at all stations for relative humidity.

<u>Note:</u> The 'missing' and low percentage values shown for Met 1 and Met 2, are simply because the data collected at these stations had a temporal resolution of 2 minutes, while the data collected at the other weather stations from the city had a resolution of 1 minute, since the graph was built with all stations together, this is reason of why this is shown that way, but as can be seen from the light blue lines below the lines, there is a high availability of information in both Met 1 and Met 2 stations.

Hourly, daily, weekly, and monthly cycles

Figure 64 presents the relative humidity hourly, daily, weekly, and monthly cycles:

Figure 64. Relative humidity hourly, daily, weekly, and monthly cycles at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.

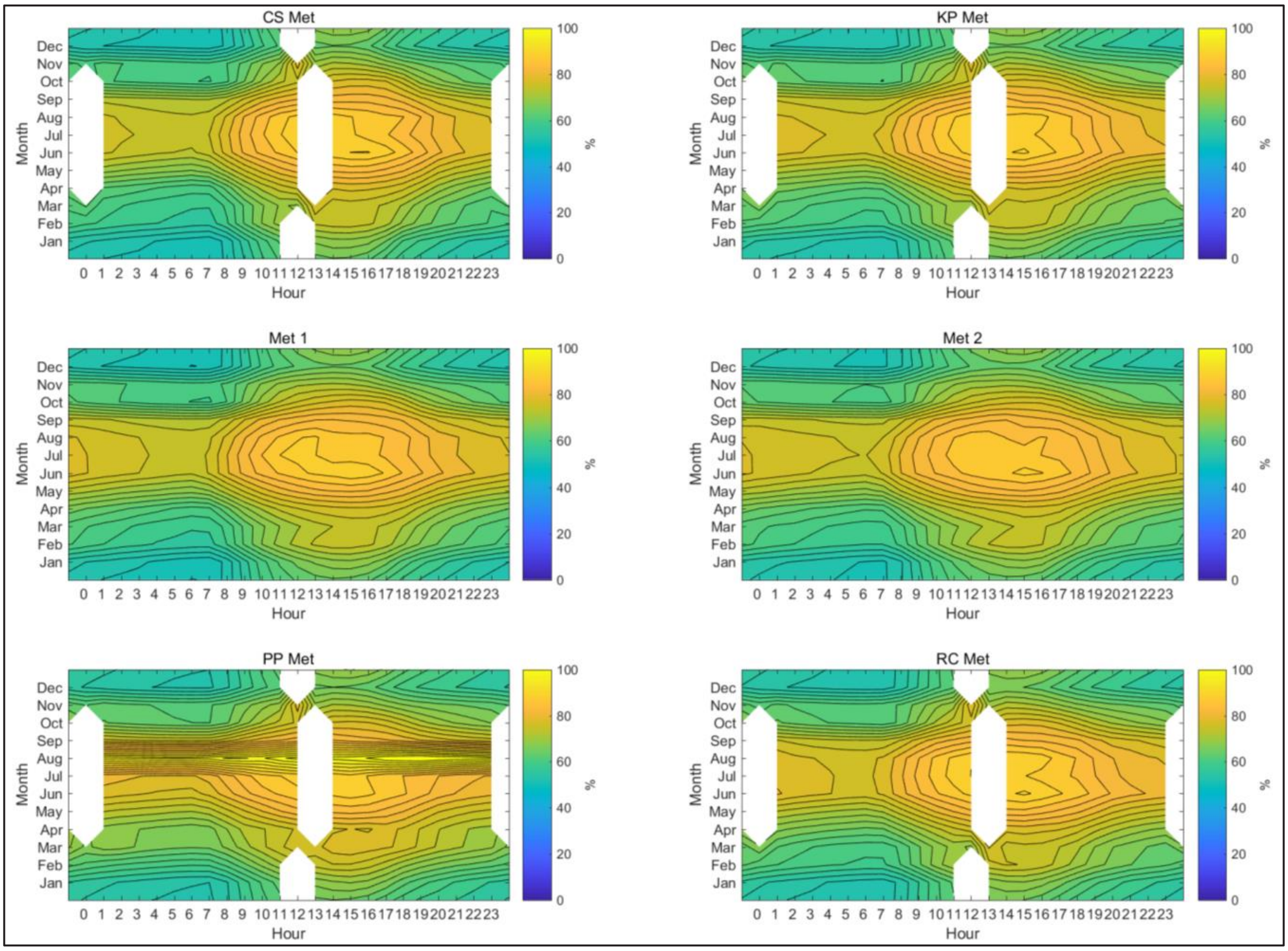


The cycles present an expected behavior of relative humidity across all stations, showing higher humidity during the night and dawn and lower humidity during the day.

Seasonal cycles

Figure 65 presents the relative humidity seasonal cycles:

Figure 65. Relative humidity seasonal cycles at CS Met, KP Met, Met 1, Met 2, PP Met, and RC Met.



The seasonal cycles present higher humidity during the day and summer months and lower humidity during the night and dawn in winter months.

Note: the white areas presented in the weather stations owned by the city (CS Met, KP Met, PP Met, and RC Met) represent missing data that was not available for analysis.

5.2.2.2 Air Quality – eNoses

This section presents the results of the air quality monitored data during the study. The eNoses data is separated in groups, considering their location nearby potential odor emission sources (see section 5.1.1.3):

a) AC1 – eNose 1 and AC2 – eNose 2.
b) CM1 - eNose 3, CM2 – eNose 4, and CM3 – eNose 5.
c) SYM3 - eNose 3, SYM2 – eNose 4, and SYM1 – eNose 5.
d) IFF1 - eNose 6 and IFF2 – eNose 7.
e) RHD1 - eNose 8 and RHD2 – eNose 9.
f) RVL1 - eNose 10 and RVL2 – eNose 11.

a) AC1 – eNose 1 and AC2 – eNose 2.

This section contains the monitored air quality data for AC1 – eNose 1 and AC2 – eNose 2 between April 2022 and March 2023.

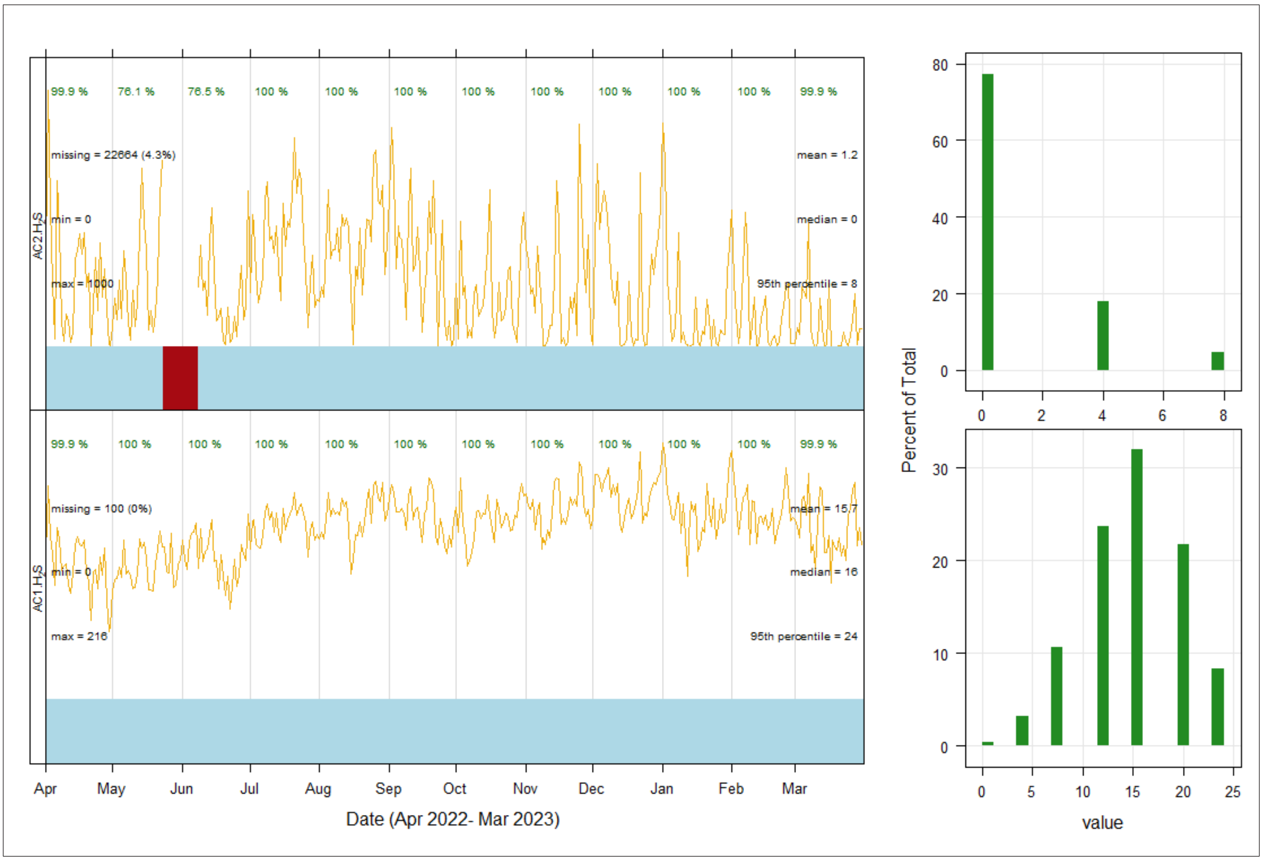
H_2S

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for hydrogen sulfide (H_2S).

I. Time series

Figure 66 presents the H_2S time series:

Figure 66. H_2S Time series at AC1 – eNose 1 and AC2 – eNose 2.

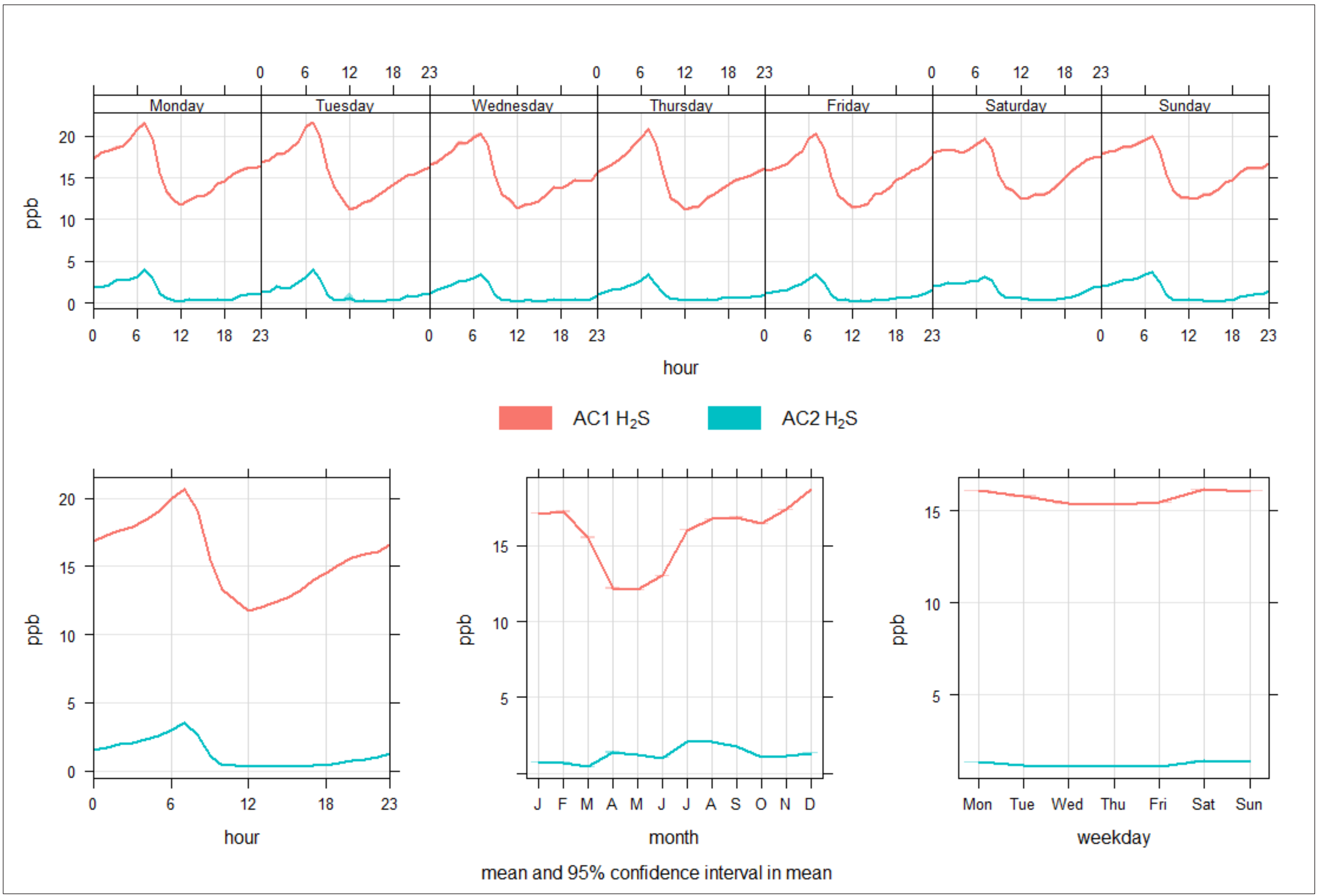


The time series show a high level of data completeness, with some data missing around the end of May and June 2022 in the AC2 monitor.

II. Hourly, daily, weekly, and monthly cycles

Figure 67 presents the H_2S hourly, daily, weekly, and monthly cycles:

Figure 67. H_2S hourly, daily, weekly, and monthly cycles at AC1 – eNose 1 and AC2 – eNose 2.

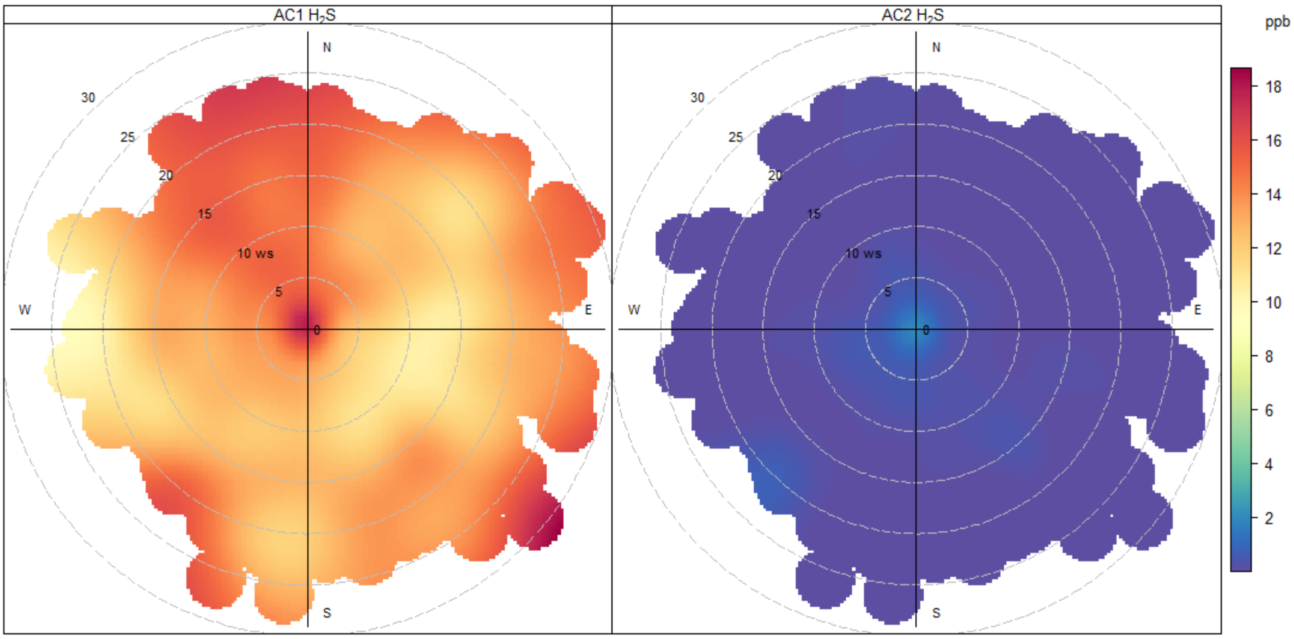


Both monitor cycles show a trend of peaks in H_2S concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 68 presents the H_2S pollution roses:

Figure 68. H_2S pollution roses at AC1 – eNose 1 and AC2 – eNose 2.

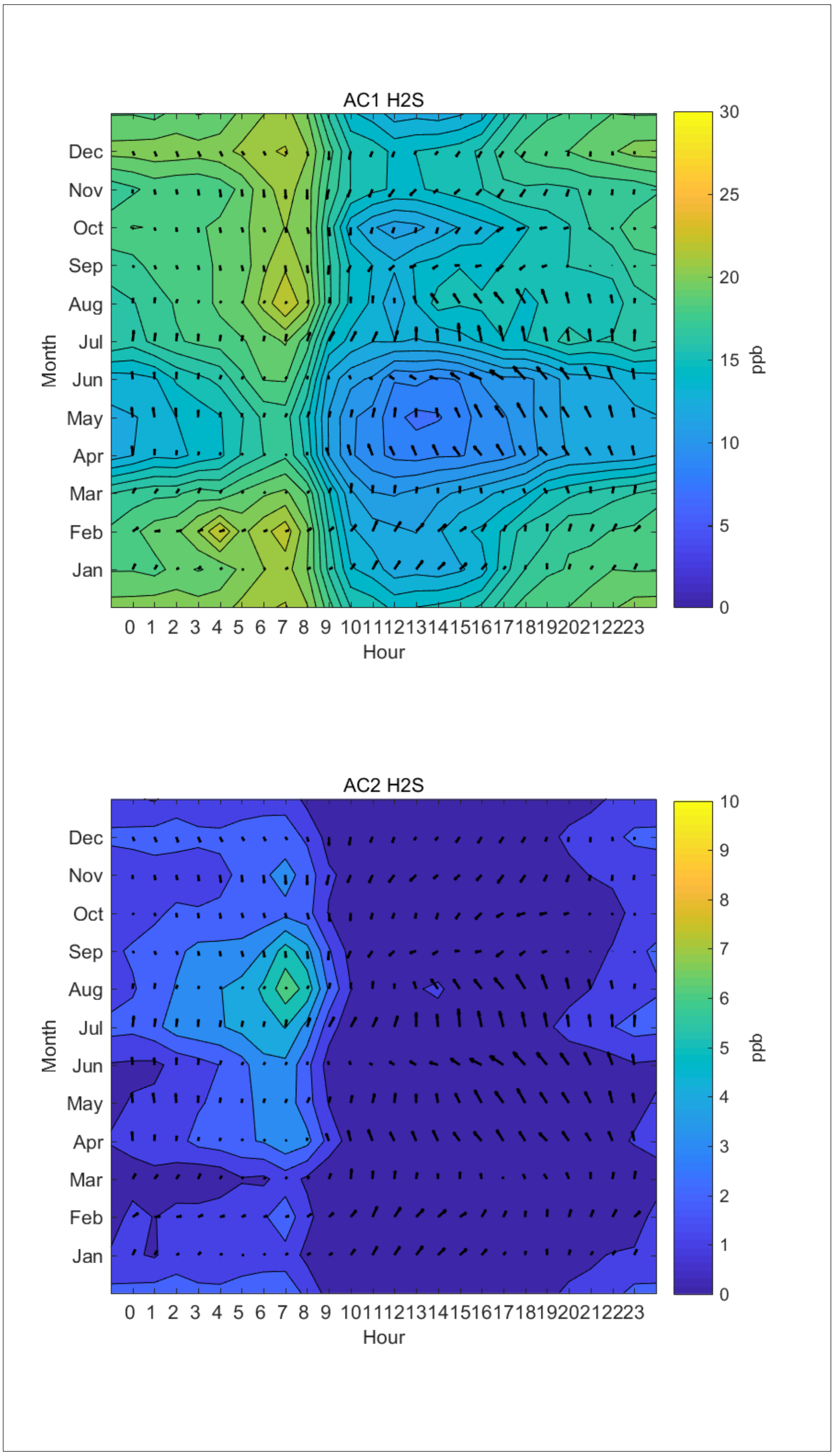


The pollution roses show higher concentrations of H_2S were registered at AC1 compared to AC2, being higher when there are winds below 5 mph and with SE winds at high wind speeds.

IV. Seasonal cycles

Figure 69 presents the H_2S seasonal cycles:

Figure 69. H_2S seasonal cycles at AC1 – eNose 1 and AC2 – eNose 2.



The seasonal cycles show a similar trend on both eNoses; higher concentrations of H_2S were collected during the early morning, particularly between 6am and 9 am in autumn and winter.

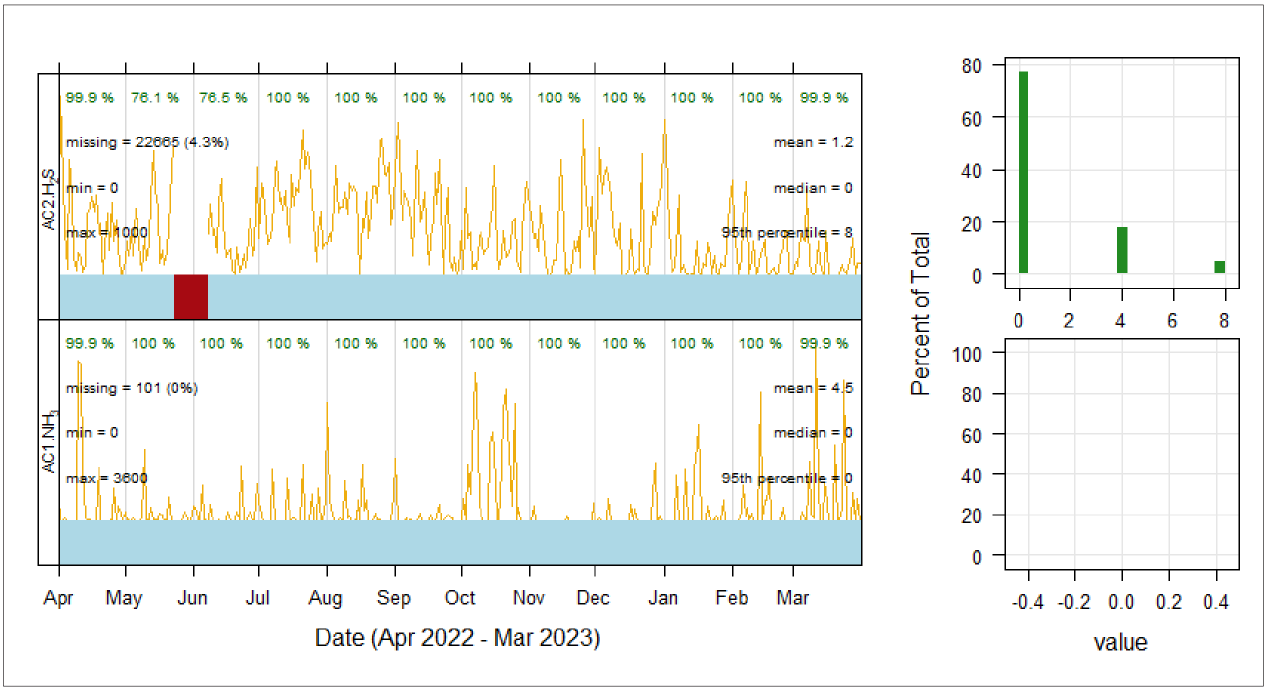
NH₃

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (NH_3).

I. Time series

Figure 70 presents the NH_3 Time series:

Figure 70. NH_3 Time series at AC1 – eNose 1 and AC2 – eNose 2.

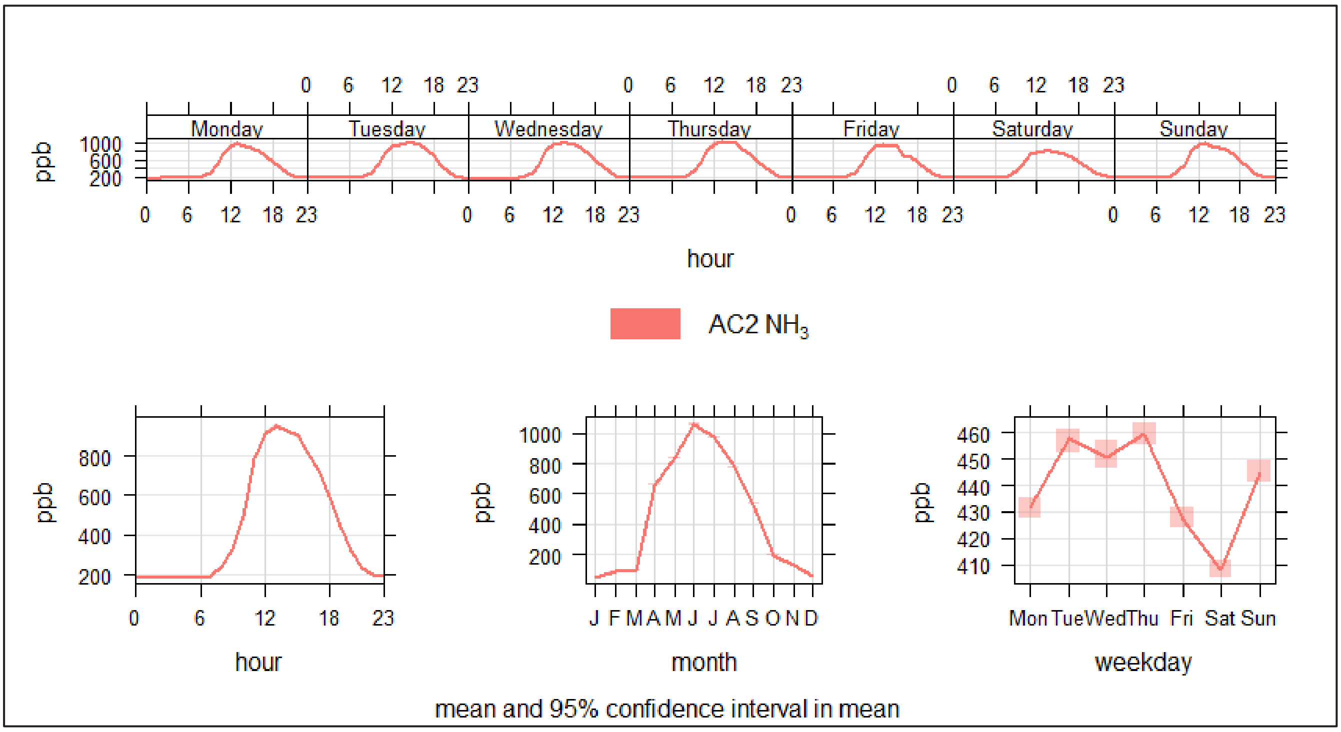


The time series show a high level of data completeness for AC2 except for missing data during May and June 2022. AC1 shows high level of data completeness but as can be seen from the histogram, most of the data recorded by the monitor is 0, for this reason the following graphs will only consider the readings taken at AC2 for NH_3.

II. Hourly, daily, weekly, and monthly cycles

Figure 71 presents the NH_3 hourly, daily, weekly, and monthly cycles:

Figure 71. NH_3 hourly, daily, weekly, and monthly cycles at AC2 – eNose 2.

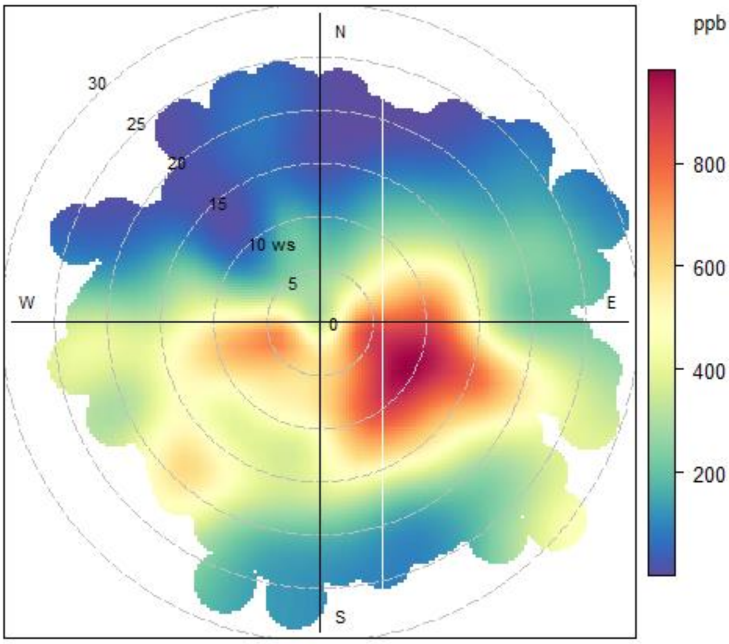


NH_3 cycles at AC2 show peaks during the day and afternoon, and lower concentrations during the night and dawn.

III. Pollution roses

Figure 72 presents the NH_3 pollution roses:

Figure 72. NH_3 pollution roses at AC2 – eNose 2.

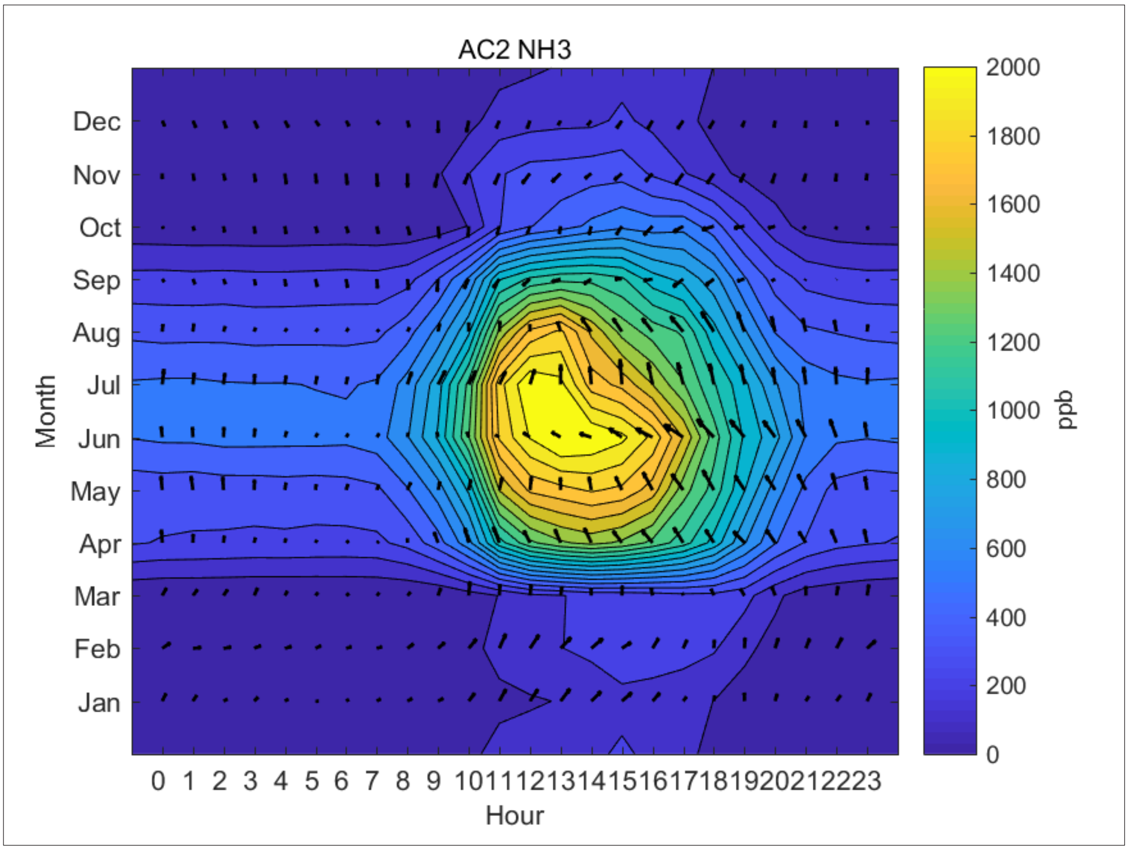


The pollution rose shows at AC2 higher NH_3 concentrations when there are prevailing winds from the E, SE, and SSE ranging from 5-15 mph.

IV. Seasonal cycles

Figure 73 presents the NH_3 seasonal cycles:

Figure 73. NH_3 seasonal cycles at AC2 – eNose 2.



The seasonal cycle at AC2 shows higher concentrations of ammonia occur during the day and afternoon, particularly between 10am and 6pm in summer months.

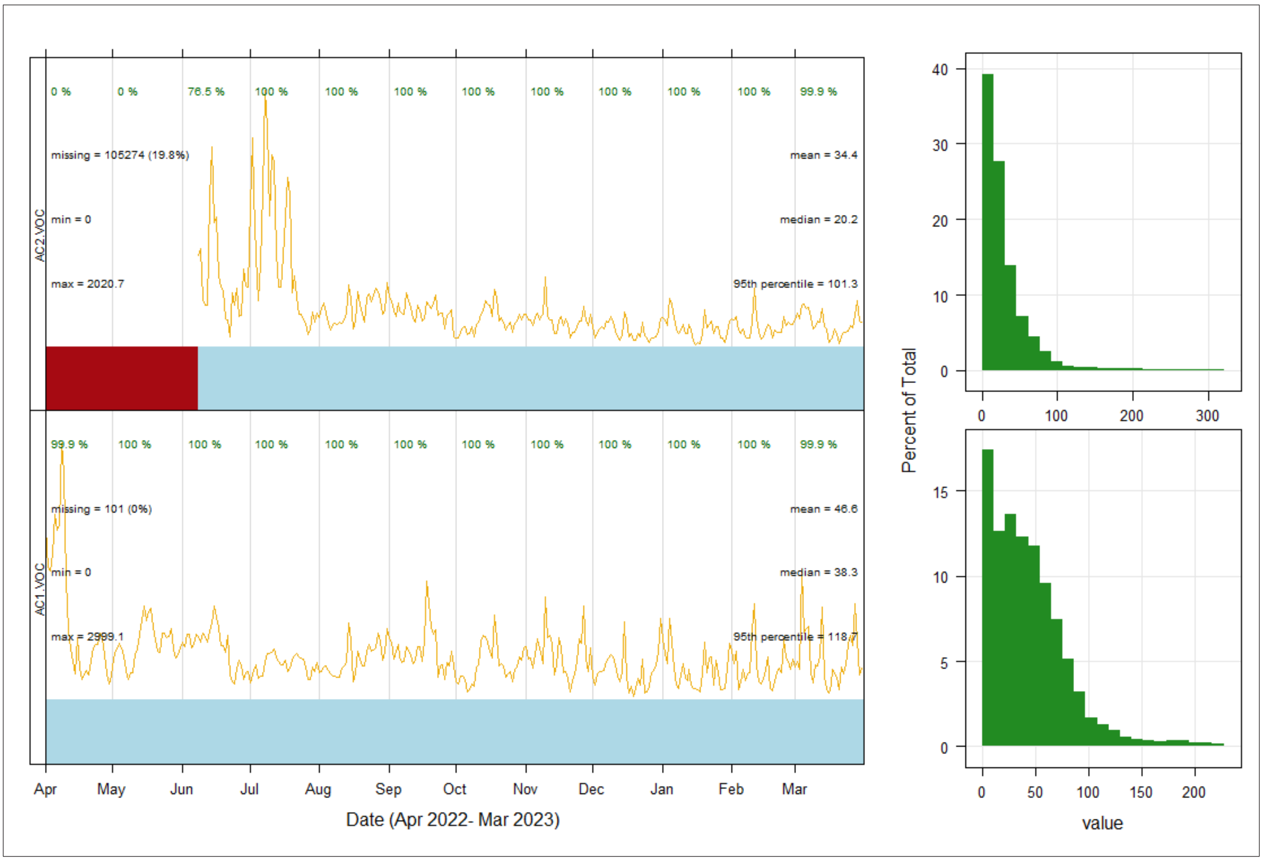
VOC

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for volatile organic compounds (VOC).

I. Time series

Figure 74 presents the VOC time series:

Figure 74. VOC Time series at AC1 – eNose 1 and AC2 – eNose 2.

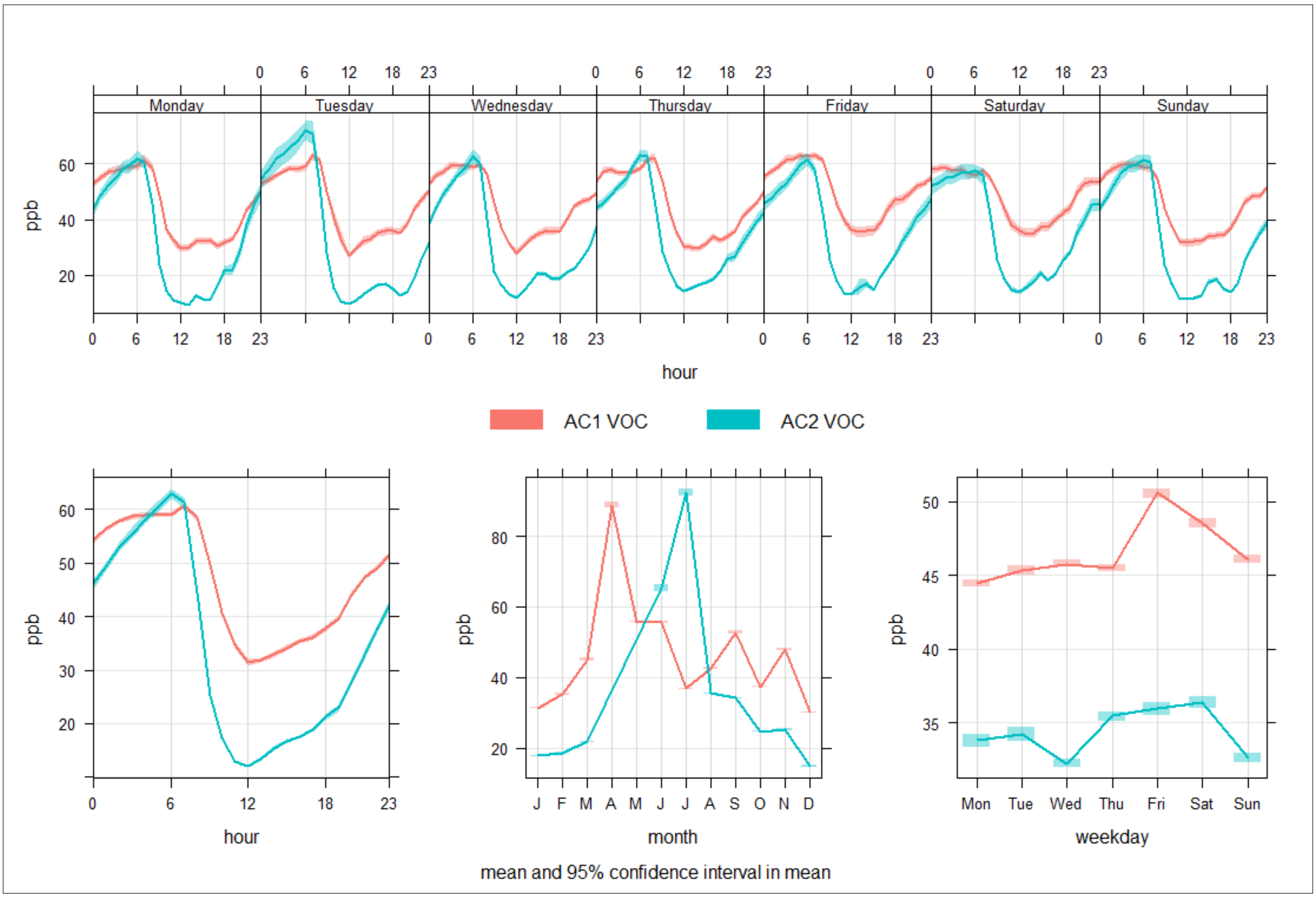


The time series show a high level of data completeness, except for the period from April and early June 2022, where the AC2 VOC sensor malfunctioned.

II. Hourly, daily, weekly, and monthly cycles

Figure 75 presents the VOC hourly, daily, weekly, and monthly cycles:

Figure 75. VOC hourly, daily, weekly, and monthly cycles at AC1 – eNose 1 and AC2 – eNose 2.

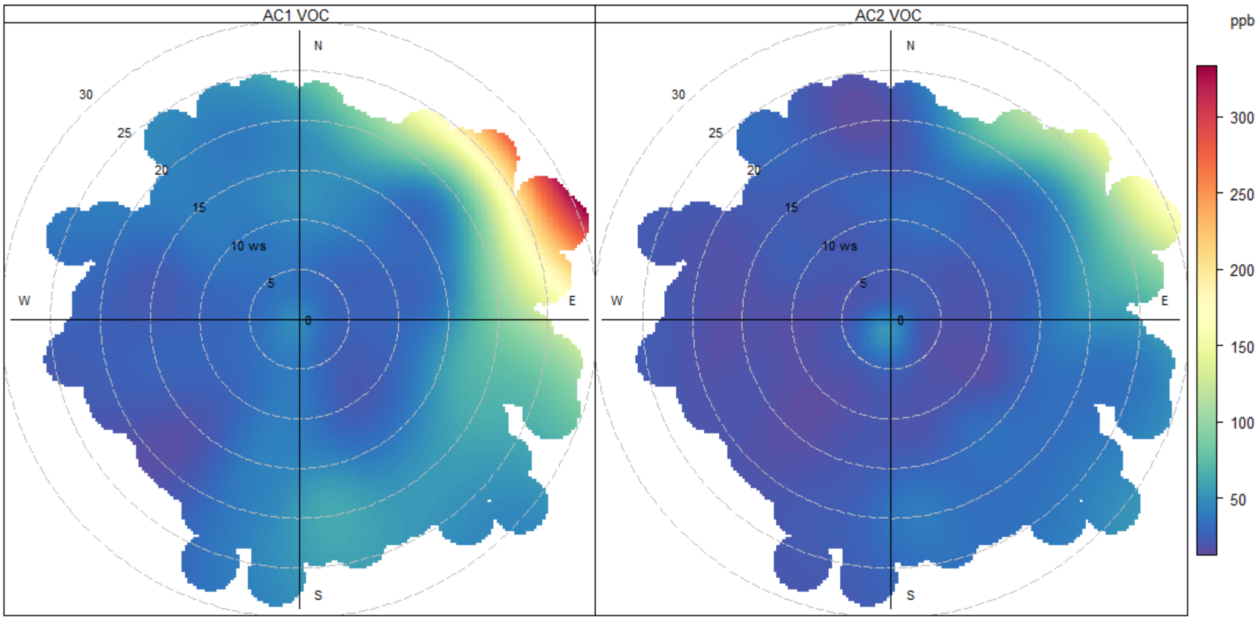


Both monitor cycles show a trend of peaks in VOC concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 76 presents the VOC pollution roses:

Figure 76. VOC pollution roses at AC1 – eNose 1 and AC2 – eNose 2.

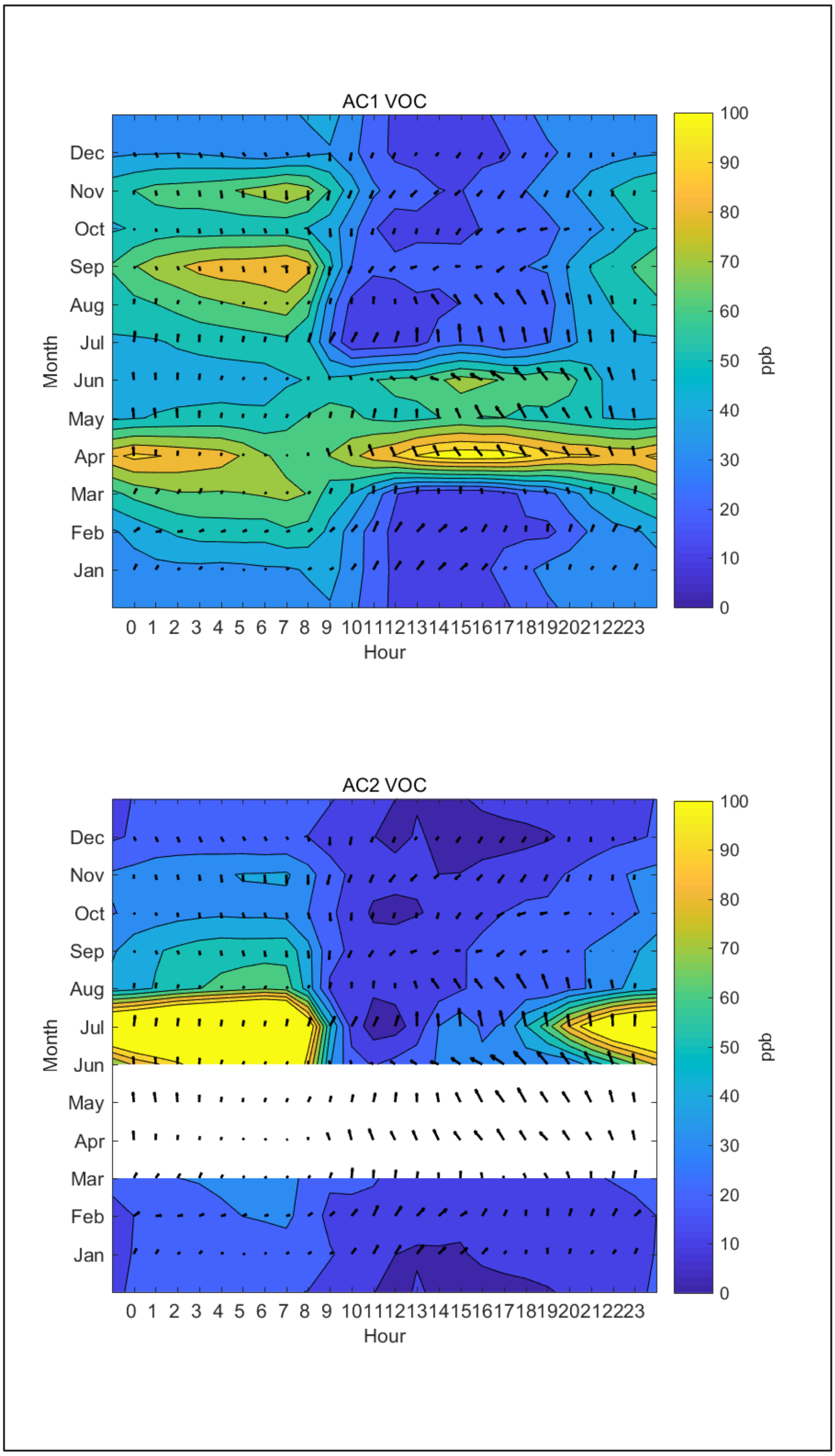


The pollution roses show higher VOC concentrations when there are prevailing winds from the NE at high wind speeds.

IV. Seasonal cycles

Figure 77 presents the VOC seasonal cycles:

Figure 77. VOC seasonal cycles at AC1 – eNose 1 and AC2 – eNose 2.



The seasonal cycles show a similar trend on both eNoses; higher concentrations of VOC were collected during the early morning, particularly between midnight and 9 am April and September in AC1 and in July in AC2.

The white area presented in the AC2 graph corresponds to the missing data.

b) CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

This section contains the monitored air quality data for CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5 between April and September 2022. As was explained in section 5.1.1.3, the City of Jacksonville decided to move these eNoses near Symrise at the end of September 2022, for that reason this section only presents the data collected on each of the eNoses before they were moved.

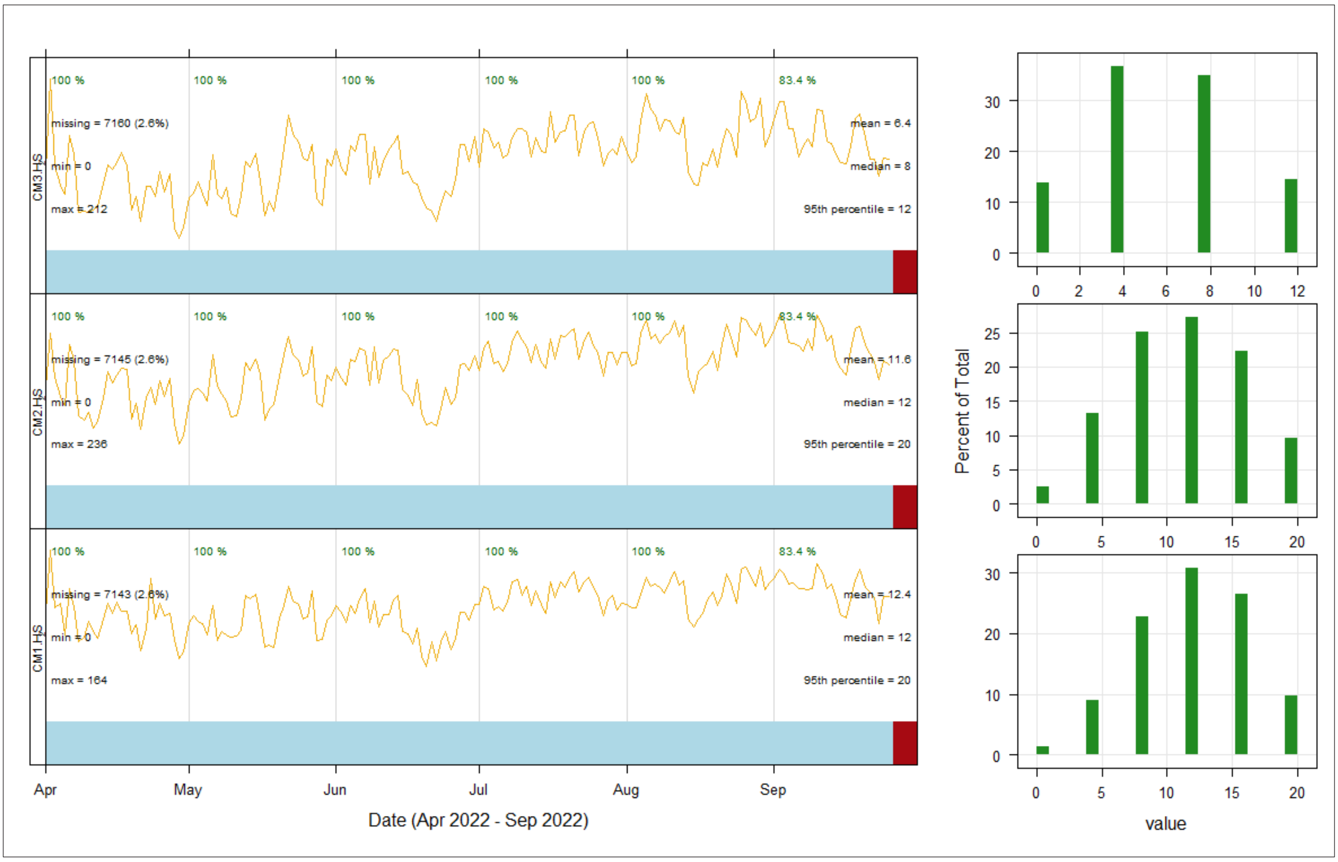
H_2S

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for hydrogen sulfide (H_2S).

I. Time series

Figure 78 presents the H_2S time series:

Figure 78. H_2S time series at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

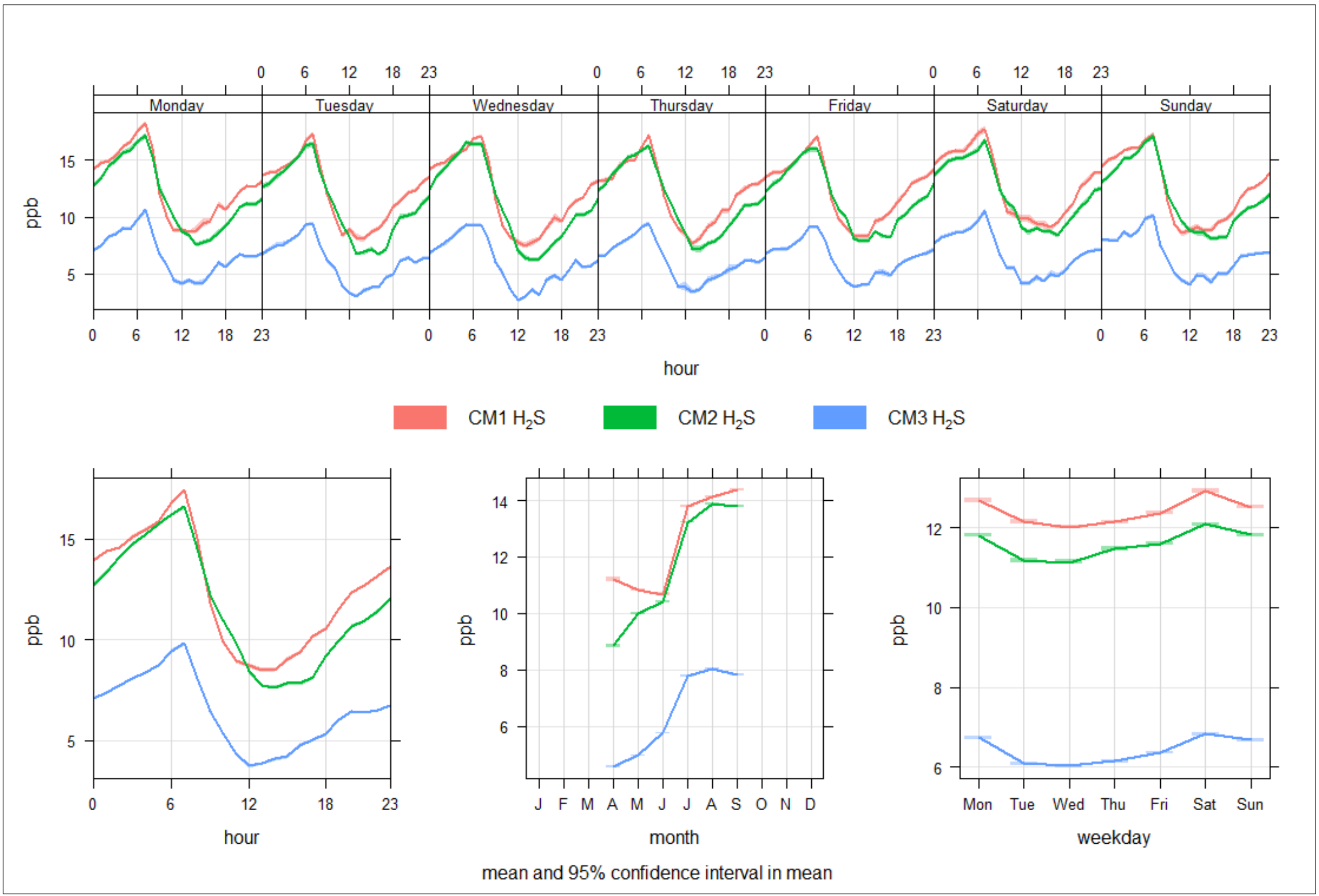


The time series show a high level of data completeness, with some data missing at the end of September in all monitors that corresponds to when they were being moved.

II. Hourly, daily, weekly, and monthly cycles

Figure 79 presents the H_2S hourly, daily, weekly, and monthly cycles:

Figure 79. H_2S hourly, daily, weekly, and monthly cycles at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

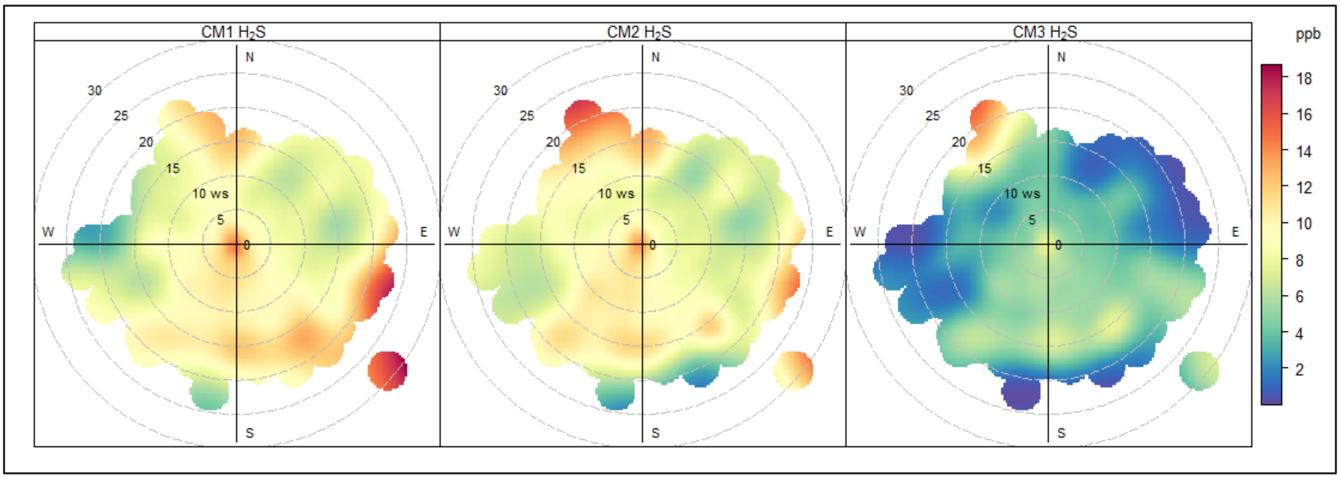


All three monitor cycles show a trend of peaks in H_2S concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 80 presents the H_2S pollution roses:

Figure 80. H_2S pollution roses at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

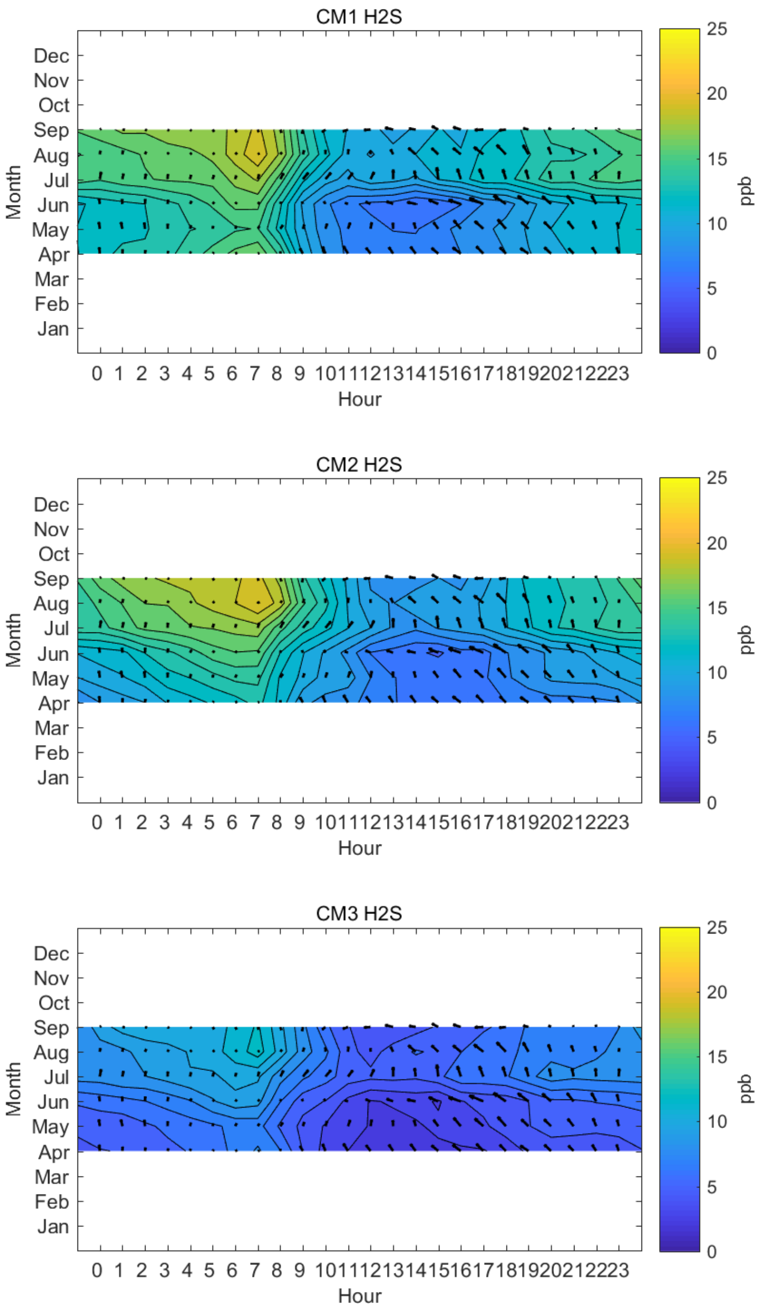


The pollution rose for CM1 show higher concentrations of H_2S when there are low wind speeds (below 5 mph) and when there are high winds coming from the SE. CM2 and CM3 pollution roses show higher concentrations of H2S when there are faster winds coming from the NW.

IV. Seasonal cycles

Figure 81 presents the H_2S seasonal cycles:

Figure 81. H_2S seasonal cycles at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.



All 3 seasonal cycles show higher H_2S concentrations during dawn and early morning, particularly between 5am and 9am. The white area represents the missing data since these 3 monitors only were in those locations between April and September 2022.

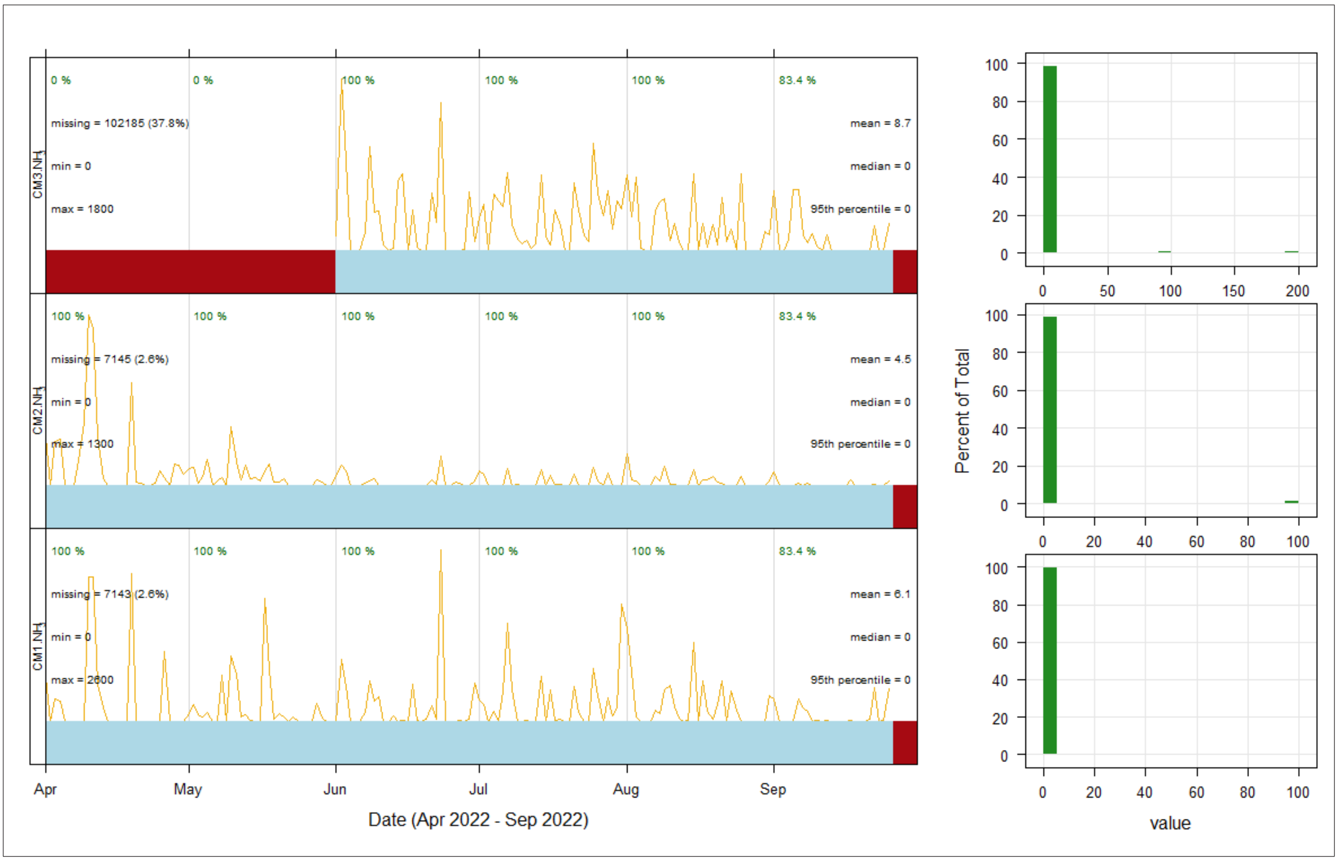
NH_3

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (NH_3).

I. Time series

Figure 82 presents the NH_3 time series:

Figure 82. NH_3 time series at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

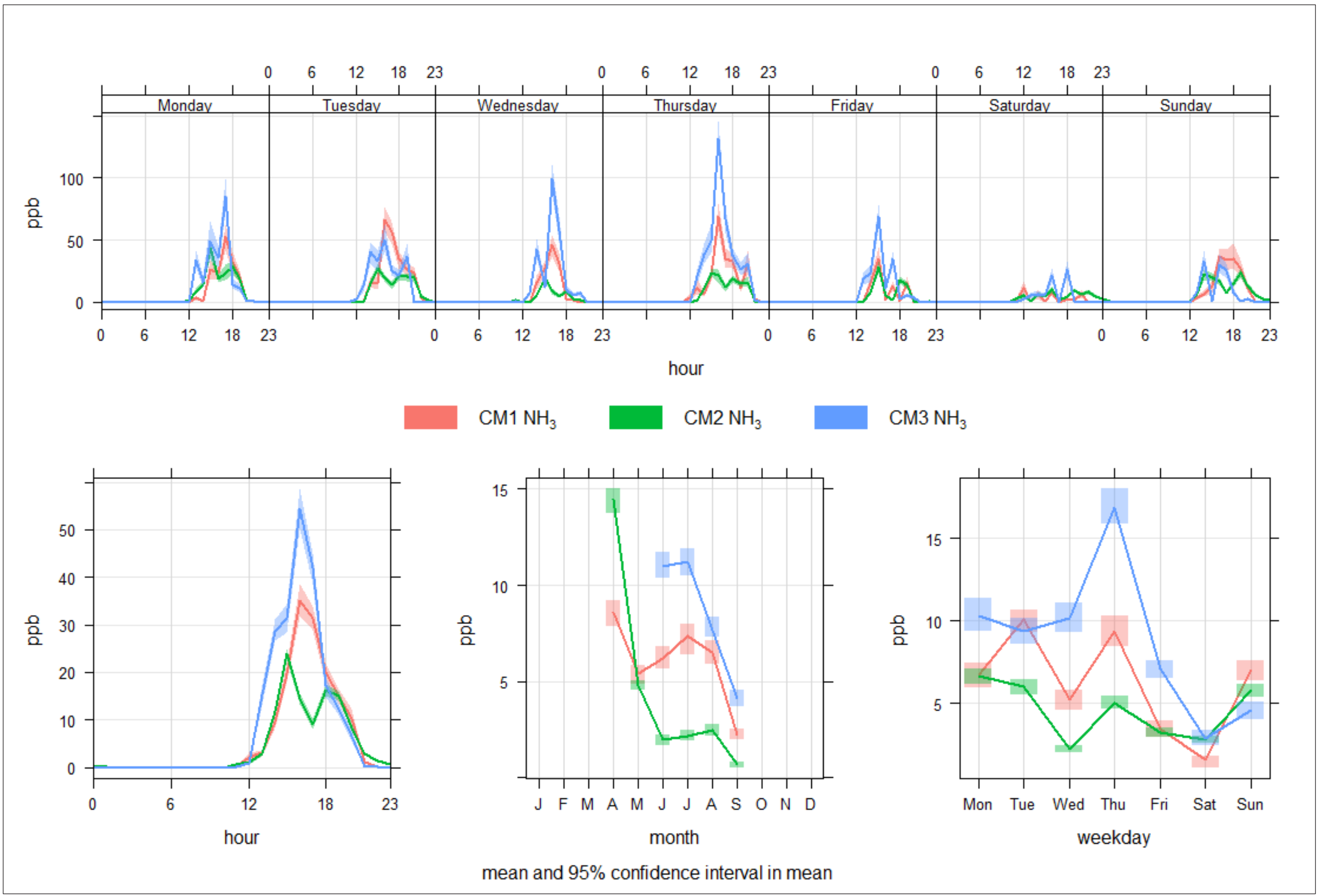


The time series show a high level of data completeness for CM1 and CM2, with some data missing at the end of September in all monitors that corresponds to when they were being moved. For CM3 the NH_3 sensor malfunctioned between April and June 2022 and that is the reason of the missing information during those months.

II. Hourly, daily, weekly, and monthly cycles

Figure 83 presents the NH_3 hourly, daily, weekly, and monthly cycles:

Figure 83. NH_3 hourly, daily, weekly, and monthly cycles at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

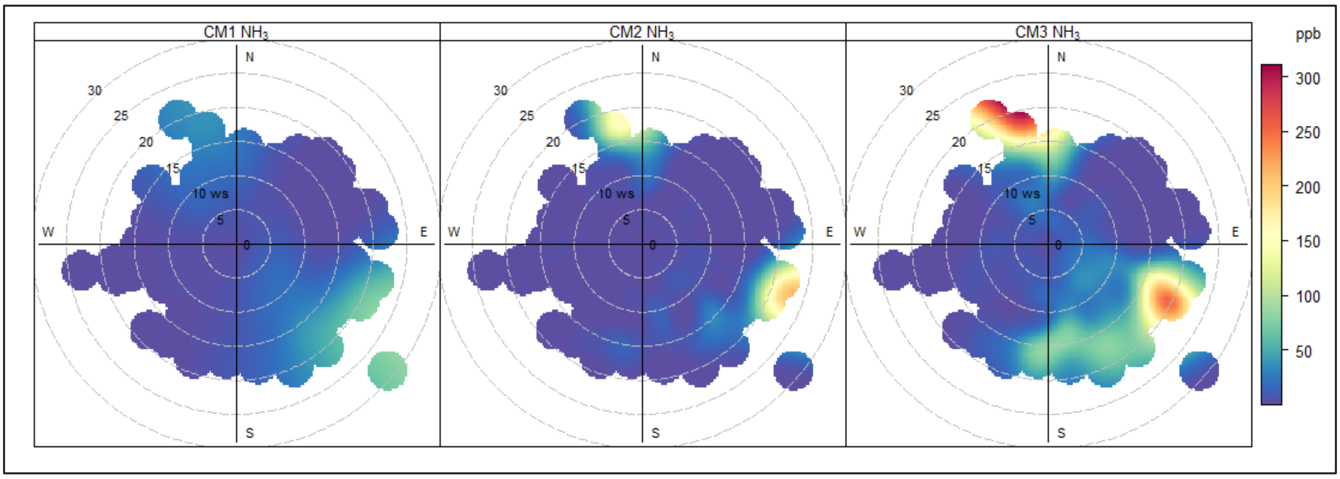


All 3 NH_3 cycles show a similar trend, with peaks during the day and afternoon, and lower concentrations during the night and dawn.

III. Pollution roses

Figure 84 presents the NH_3 pollution roses:

Figure 84. NH_3 pollution roses at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

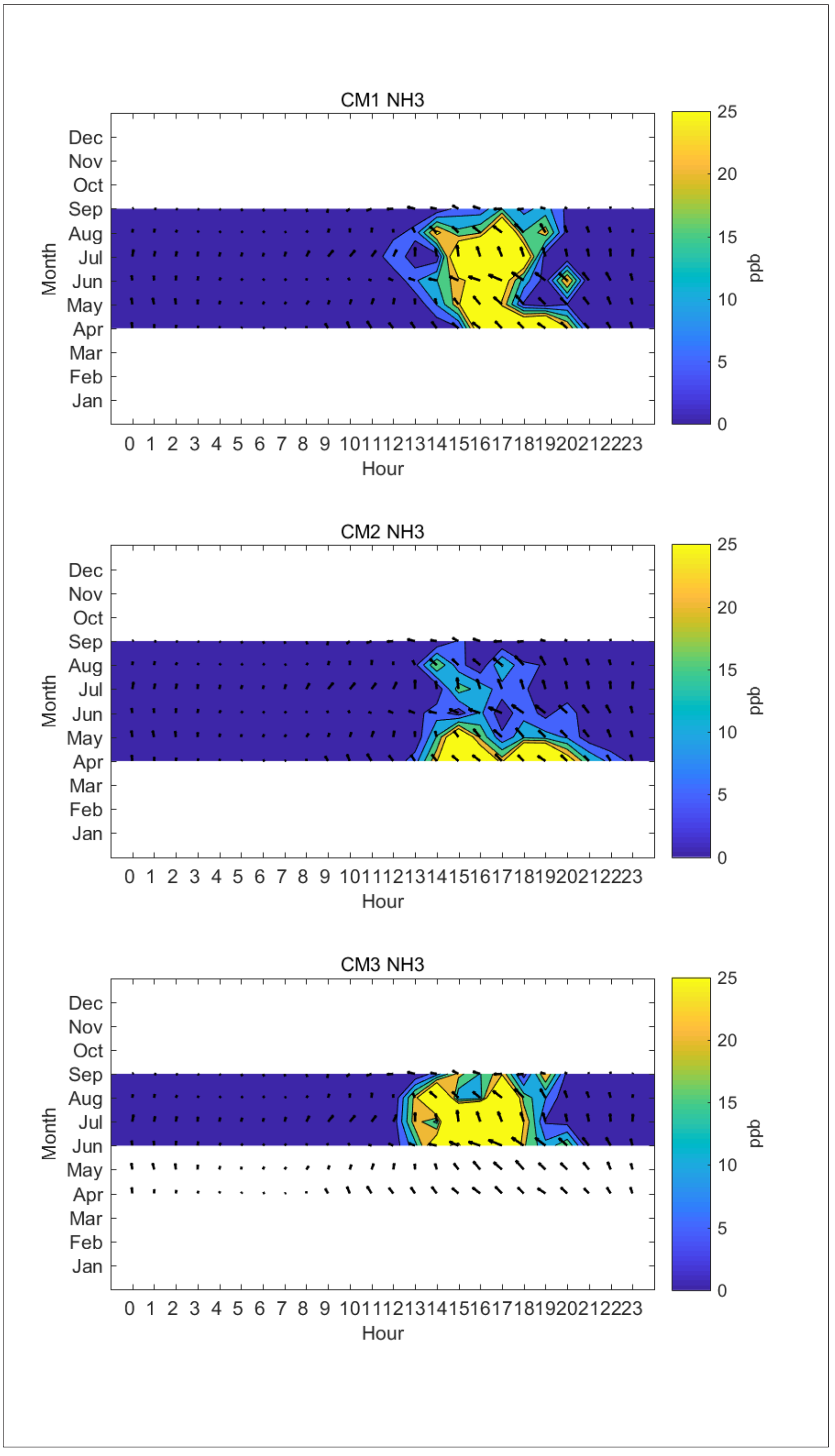


The pollution roses show a similar pattern in all 3 eNoses for NH_3, which is higher concentrations of this pollutant when there are prevailing winds coming from the NNW and ESE.

IV. Seasonal cycles

Figure 85 presents the NH_3 seasonal cycles:

Figure 85. NH_3 seasonal cycles at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.



The seasonal cycles show a similar trend across all eNoses; higher concentrations of ammonia occur during the day and afternoon, particularly between midday and 6pm in summer months. The white area represents the missing data since these 3 monitors only were in those locations between April and September 2022.

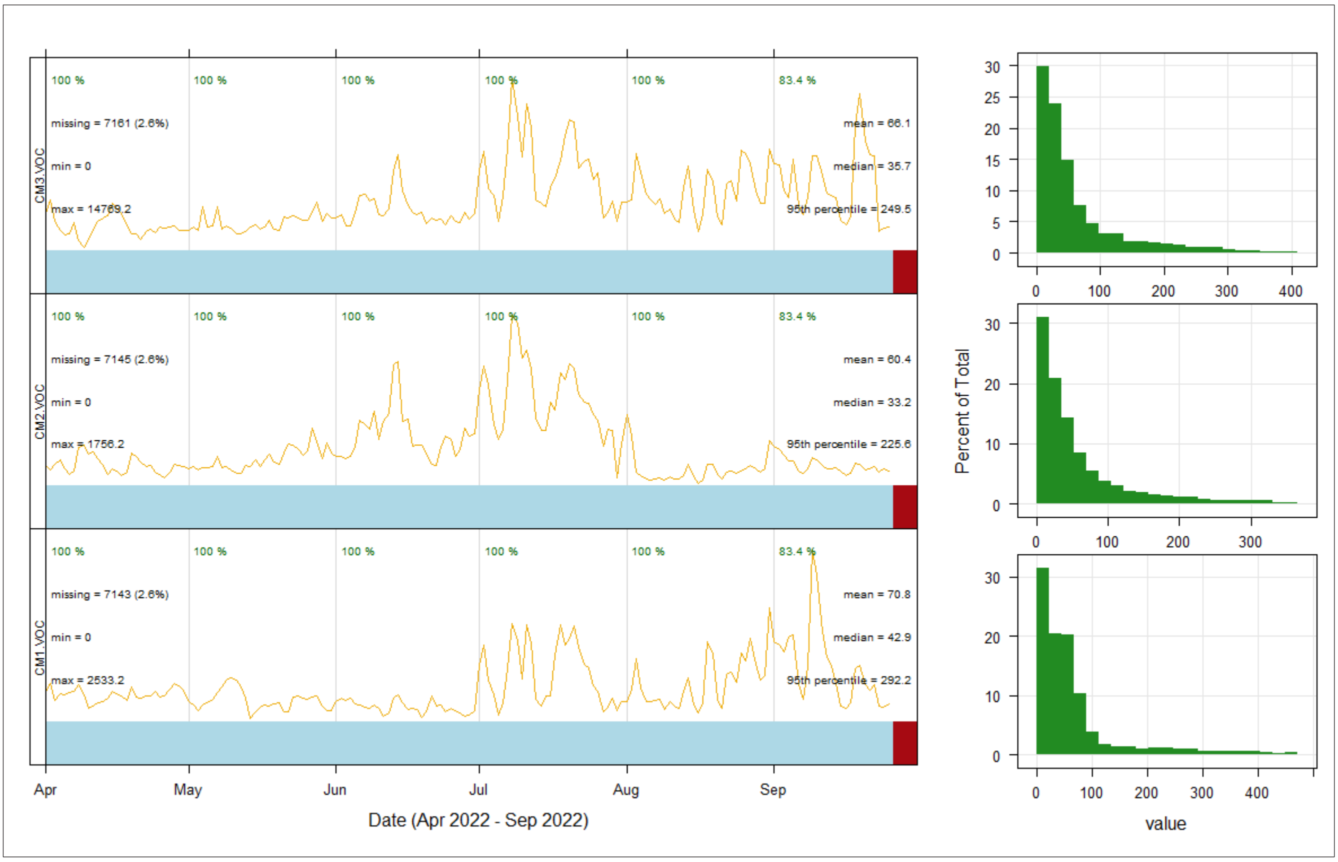
VOC

Below are the Time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for volatile organic compounds (VOC).

I. Time series

Figure 86 presents the VOC time series:

Figure 86. VOC time series at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

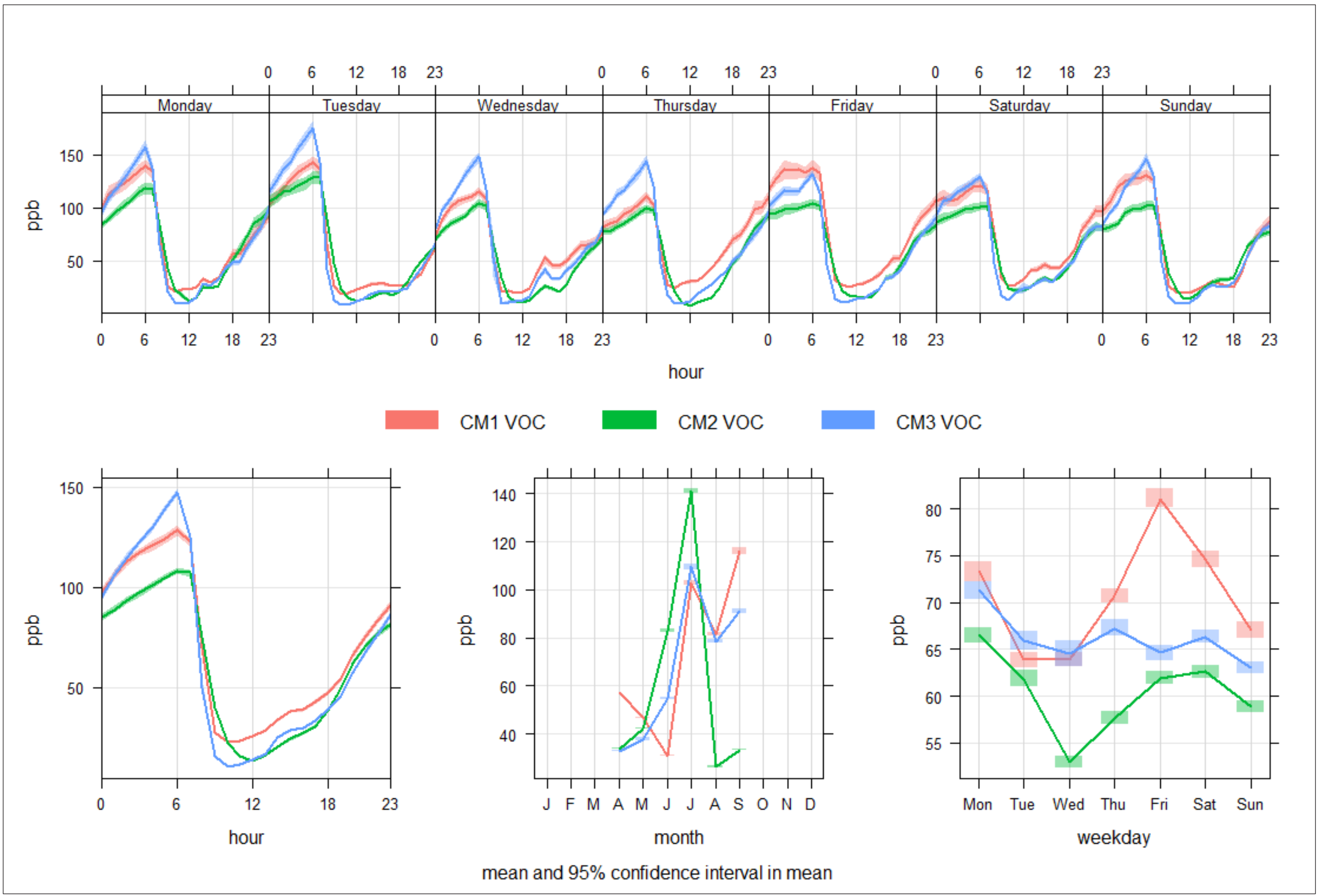


The time series show a high level of data completeness, with some data missing at the end of September in all monitors that corresponds to when they were being moved.

II. Hourly, daily, weekly, and monthly cycles

Figure 87 presents the VOC hourly, daily, weekly, and monthly cycles:

Figure 87. VOC hourly, daily, weekly, and monthly cycles at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

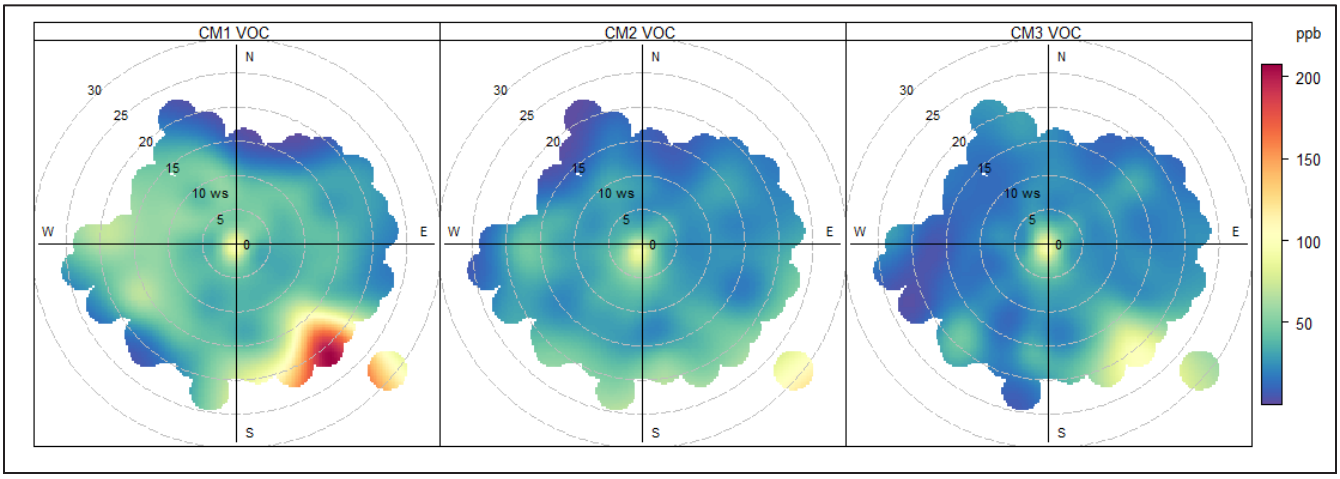


All three monitor cycles show a trend of peaks in VOC concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 88 presents the VOC pollution roses:

Figure 88. VOC pollution roses at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.

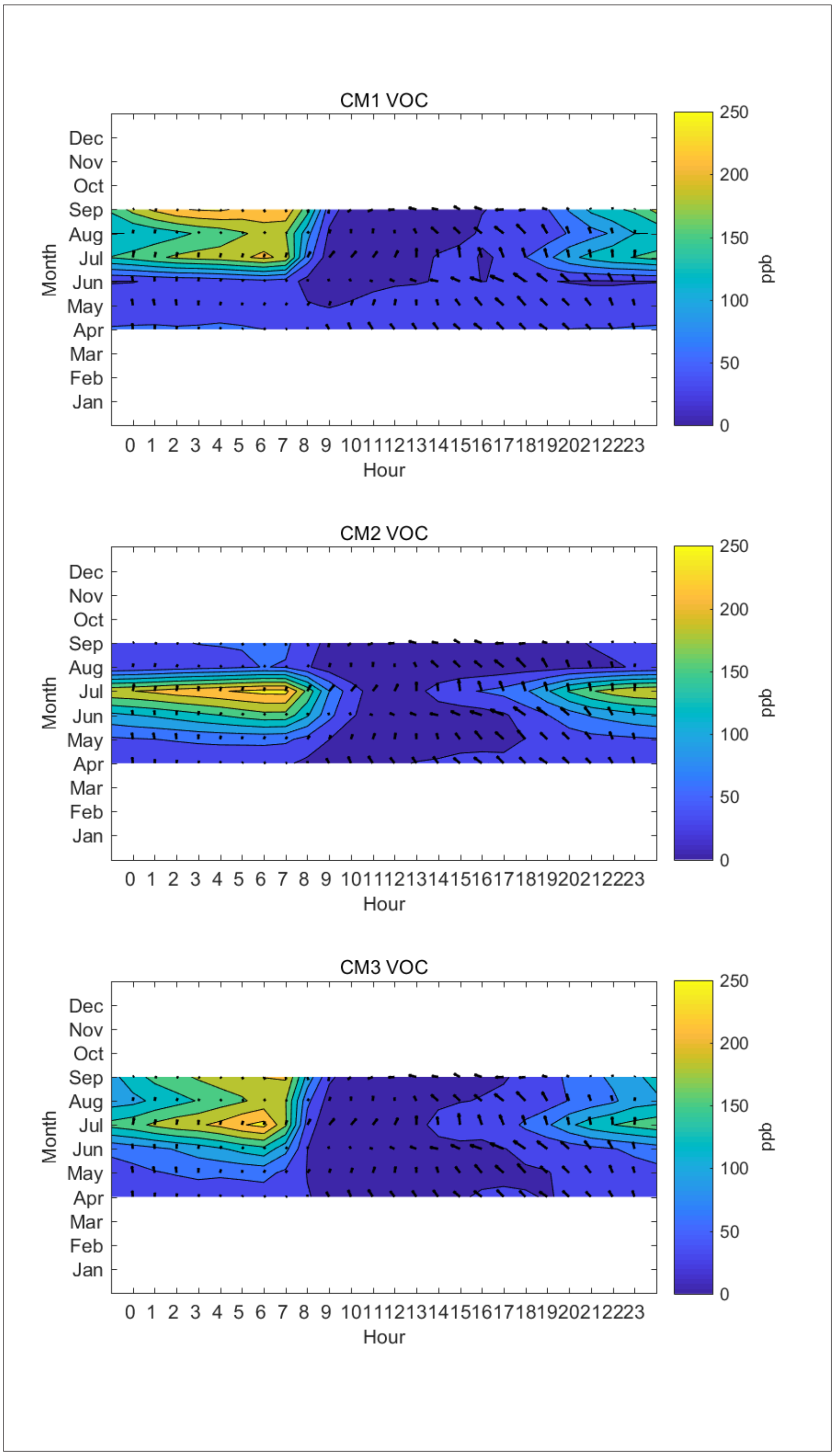


The pollution roses show a similar pattern in all 3 eNoses for VOC, which is higher concentrations of this pollutant when there are winds below 5mph, and prevailing winds coming from the SE at higher wind speeds.

IV. Seasonal cycles

Figure 89 presents the VOC seasonal cycles:

Figure 89. VOC seasonal cycles at CM1 – eNose 3, CM2 – eNose 4, CM3 – eNose 5.



The seasonal cycles show a similar trend across all eNoses; higher concentrations of VOC occur during the night, dawn, and early morning, particularly between 8pm and 9am in summer months. The white area represents the missing data since these 3 monitors only were in those locations between April and September 2022.

c) SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

This section contains the monitored air quality data for SYM3 – eNose 3, SYM2 – eNose 4, and SYM1 – eNose 5 between October 2022 and March 2023. As was explained in section 5.1.1.3, the City of Jacksonville decided to move these eNoses from the community area to new locations near Symrise at the end of September 2022, for that reason this section only presents the data collected on each of the eNoses after they were moved.

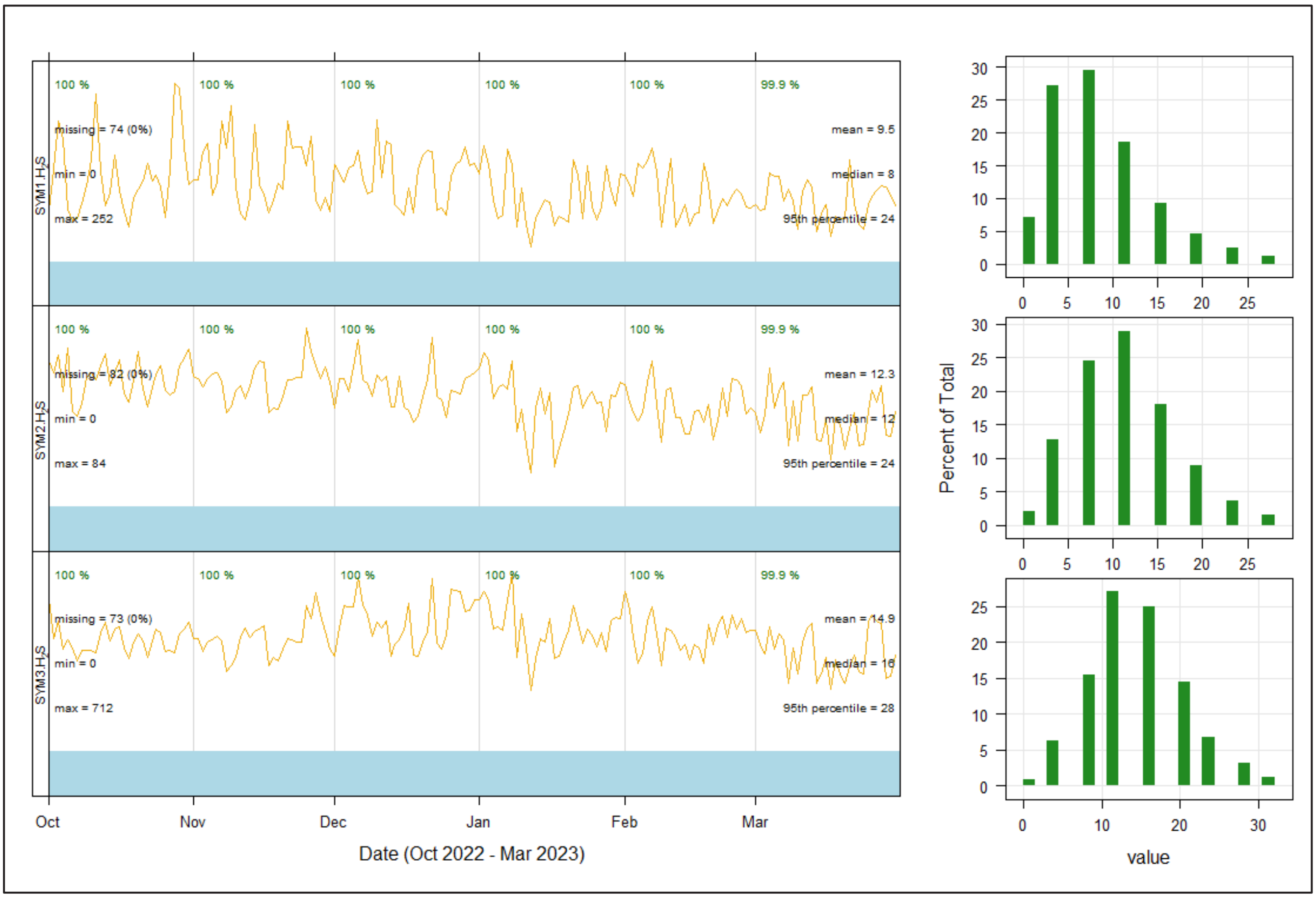
<u>H_2S</u>

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for hydrogen sulfide (H_2S).

I. Time series

Figure 90 presents the H_2S time series:

Figure 90. H_2S time series at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

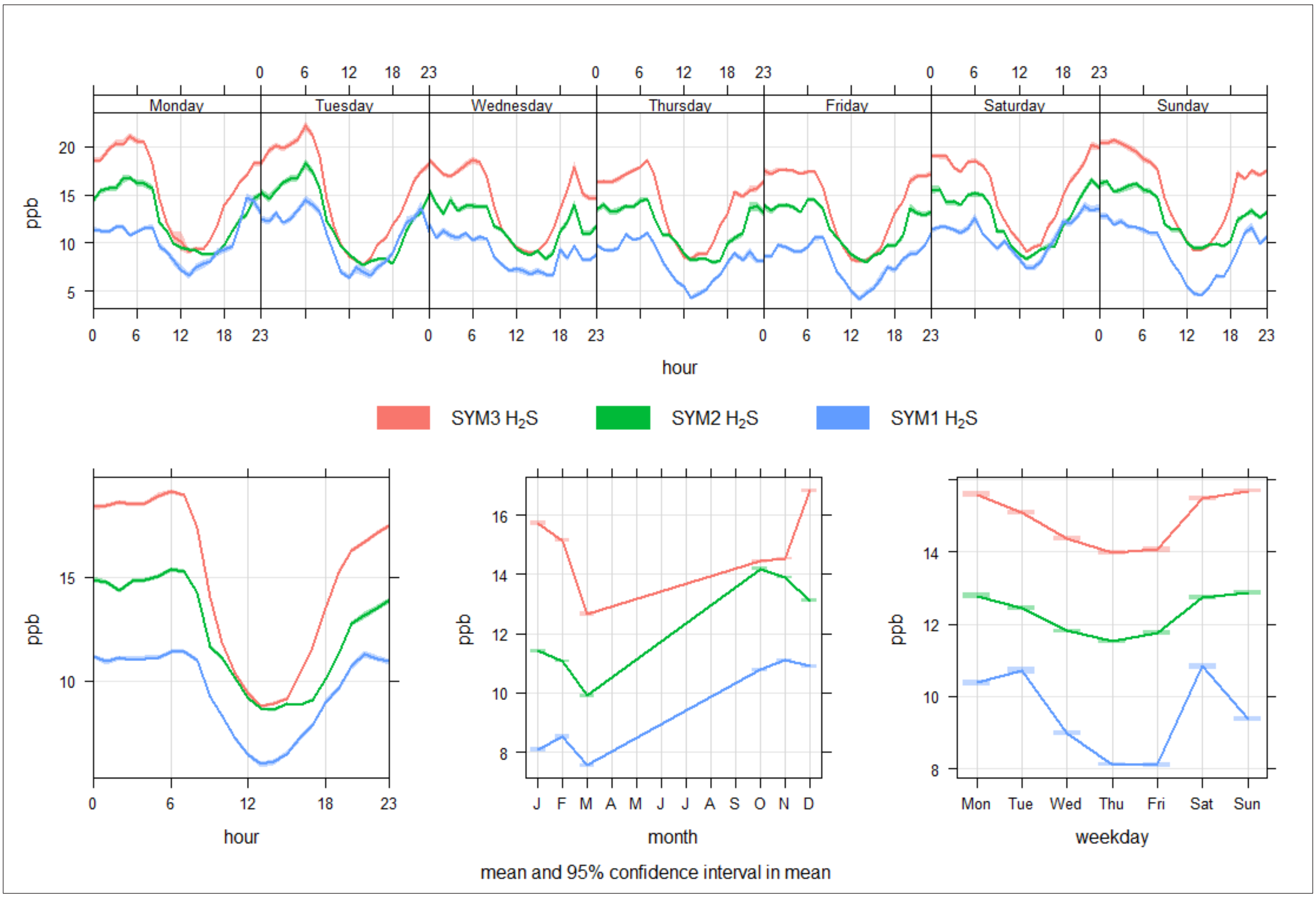


The time series show a high level of data completeness on all 3 eNoses for H_2S.

II. Hourly, daily, weekly, and monthly cycles

Figure 91 presents the H_2S hourly, daily, weekly, and monthly cycles:

Figure 91. H_2S hourly, daily, weekly, and monthly cycles at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

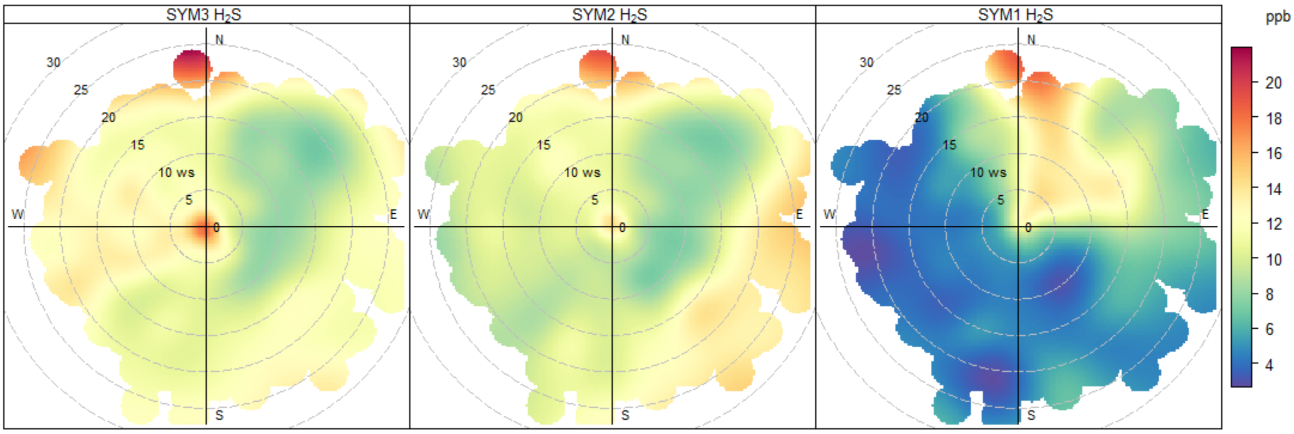


All 3 monitor cycles show a trend of peaks in H_2S concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 92 presents the H_2S pollution roses:

Figure 92. H_2S pollution roses at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

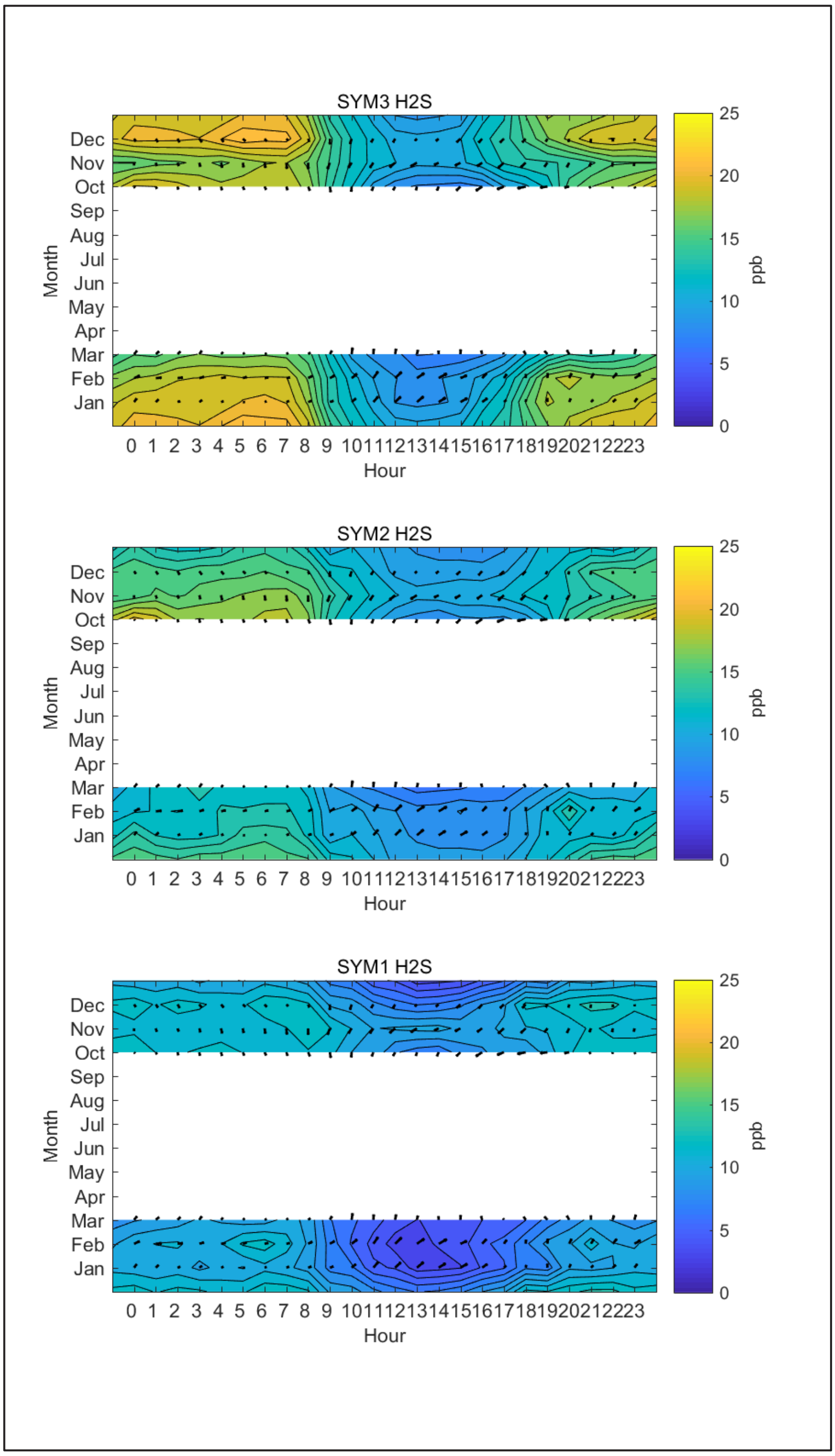


The pollution roses show a similar pattern in all 3 eNoses for H_2S, which is higher concentrations of this pollutant when there are low wind speeds (below 5mph) and prevailing winds coming from the NNW and N.

IV. Seasonal cycles

Figure 93 presents the H_2S seasonal cycles:

Figure 93. H_2S seasonal cycles at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.



All 3 seasonal cycles show higher H_2S concentrations during the night, dawn, and early morning, particularly between 8pm and 9am. The white area represents the missing data since these 3 monitors only were in those locations between October 2022 and March 2023.

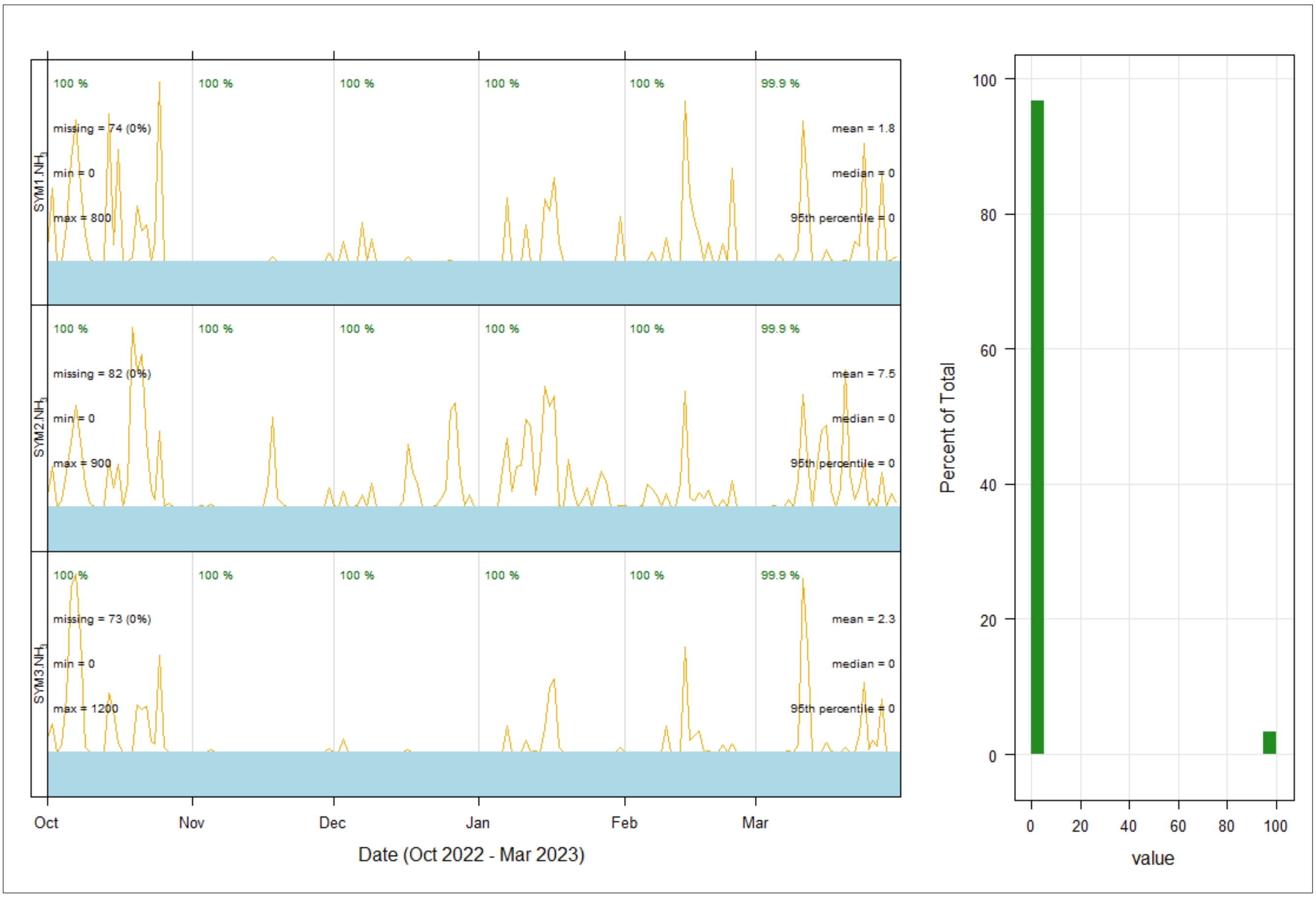
NH_3

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (NH_3).

I. Time series

Figure 94 presents the NH_3 time series:

Figure 94. NH_3 time series at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

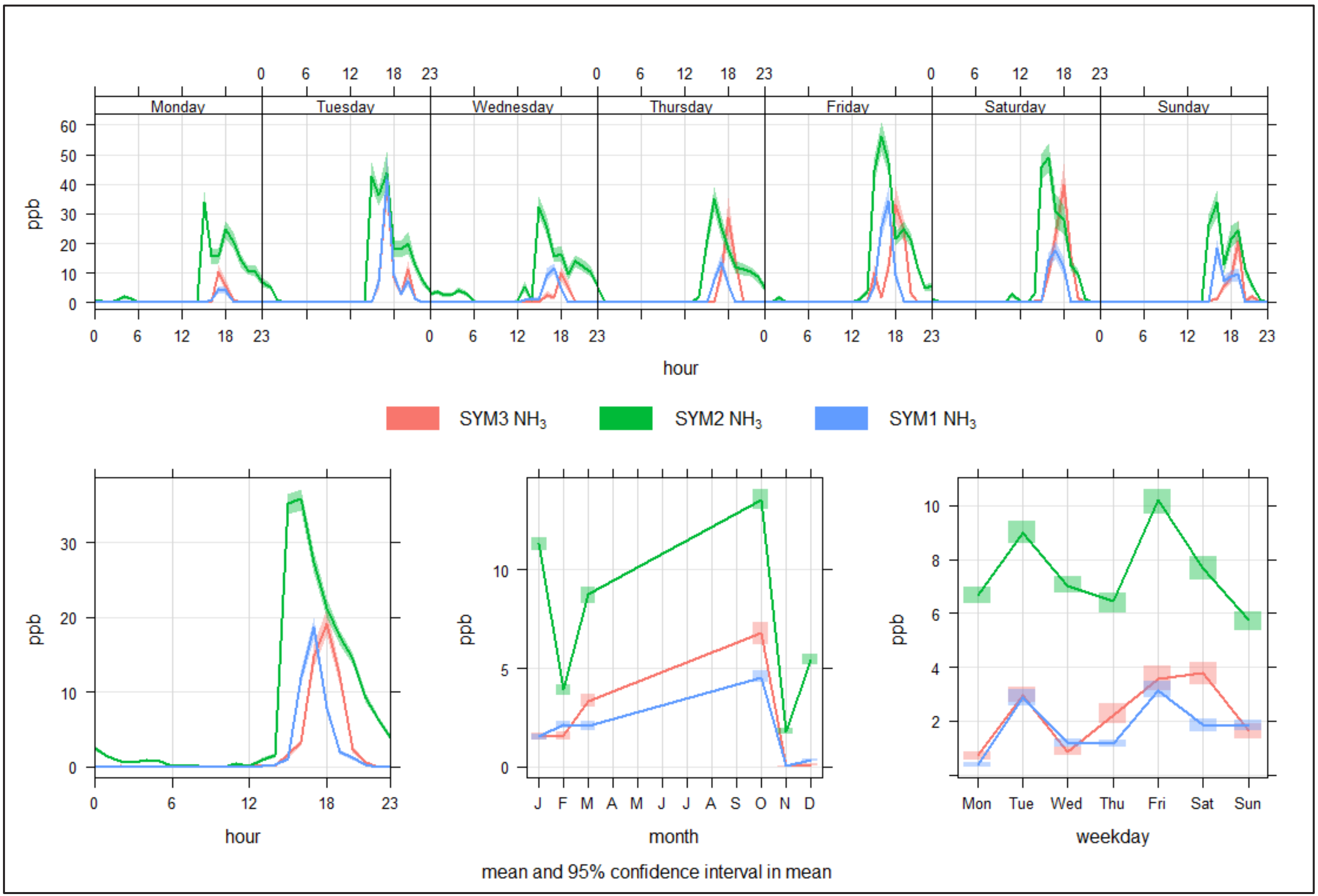


The time series show a high level of data completeness on all 3 eNoses for NH_3.

II. Hourly, daily, weekly, and monthly cycles

Figure 95 presents the NH_3 hourly, daily, weekly, and monthly cycles:

Figure 95. NH_3 hourly, daily, weekly, and monthly cycles at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

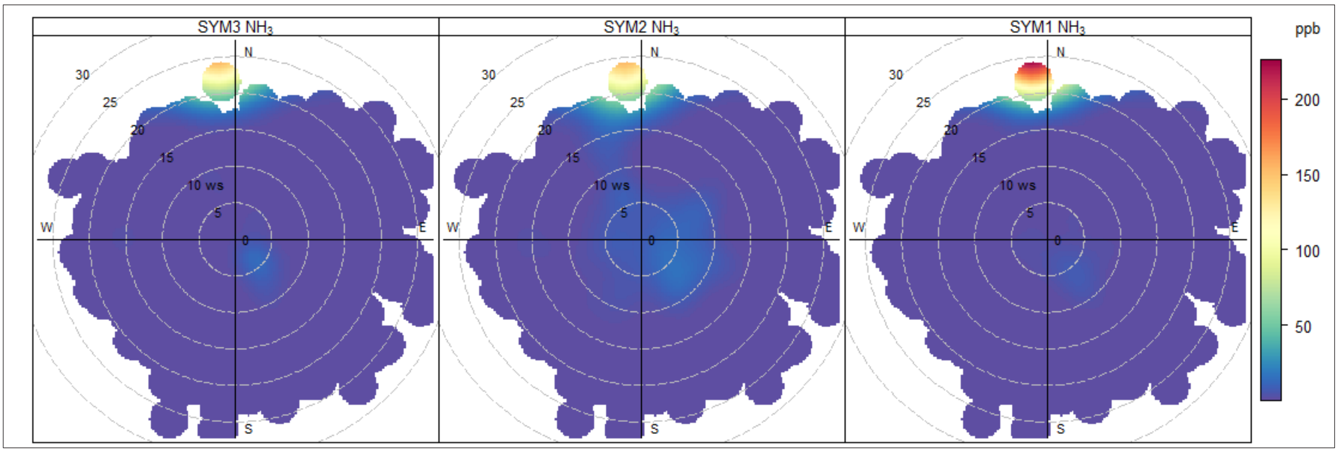


All 3 NH_3 cycles show a similar trend, with peaks during the day and afternoon, and lower concentrations during the night and dawn.

III. Pollution roses

Figure 96 presents the NH_3 pollution roses:

Figure 96. NH_3 pollution roses at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

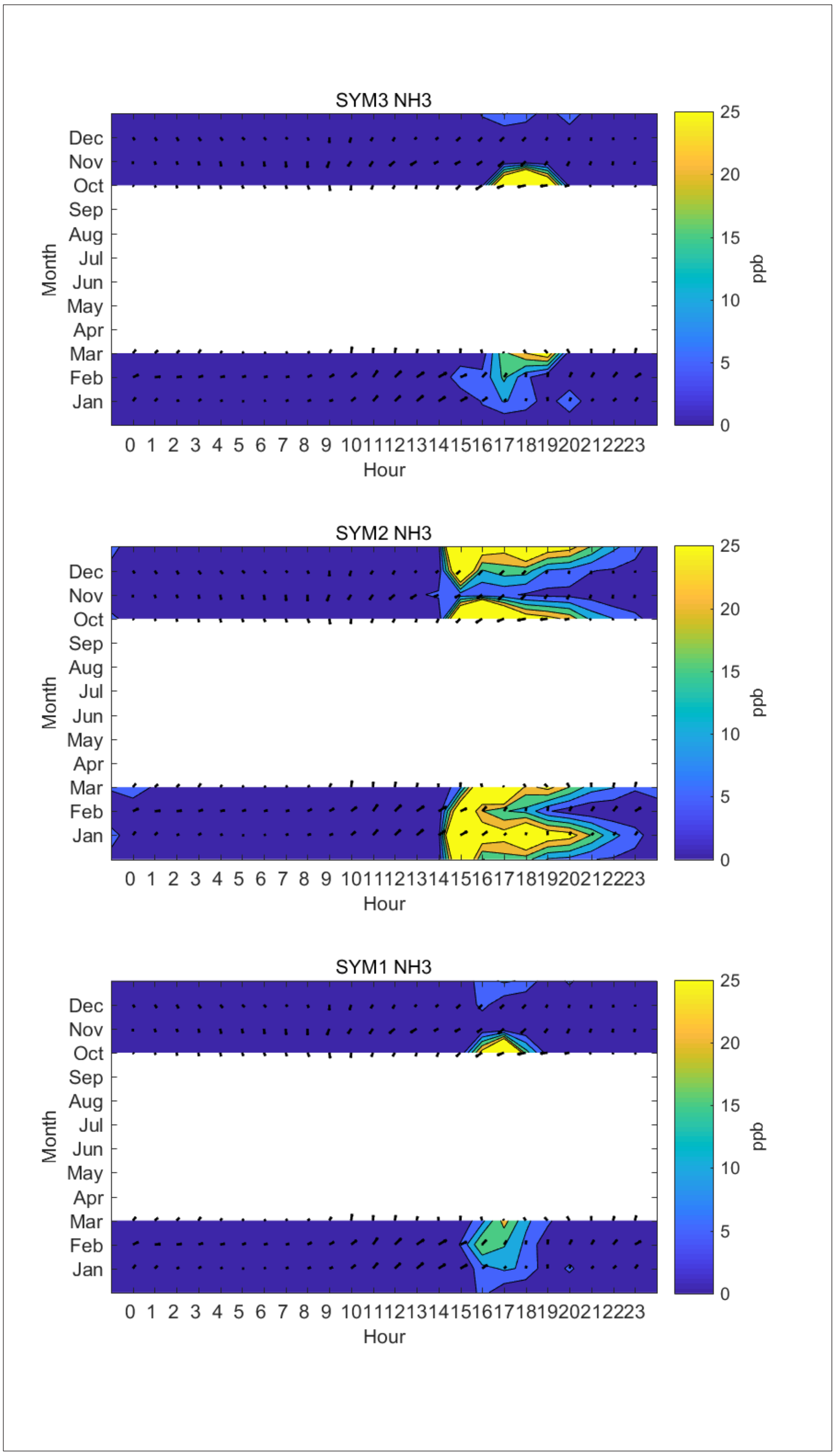


The pollution roses show a similar pattern in all 3 eNoses for NH_3, which is higher concentrations of this pollutant when there are low wind speeds (below 5mph) and prevailing winds coming from the NNW and N.

IV. Seasonal cycles

Figure 97 presents the NH_3 seasonal cycles:

Figure 97. NH_3 seasonal cycles at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.



The seasonal cycles show a similar trend across all eNoses; higher concentrations of ammonia occur during the day and afternoon, particularly between midday and 8pm. The white area represents the missing data since these 3 monitors only were in those locations between October 2022 and March 2023.

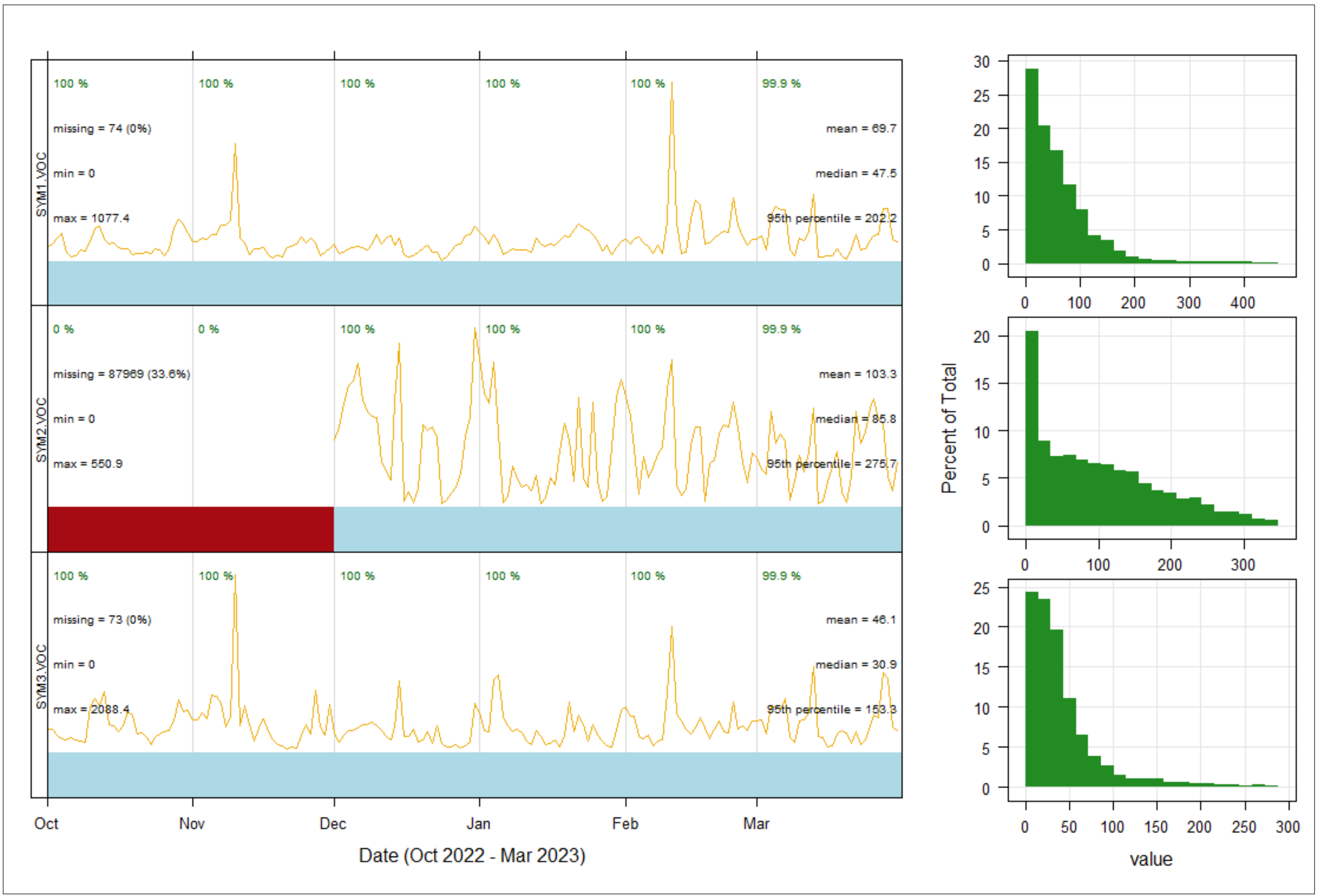
VOC

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for volatile organic compounds (VOC).

I. Time series

Figure 98 presents the VOC time series:

Figure 98. VOC time series at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

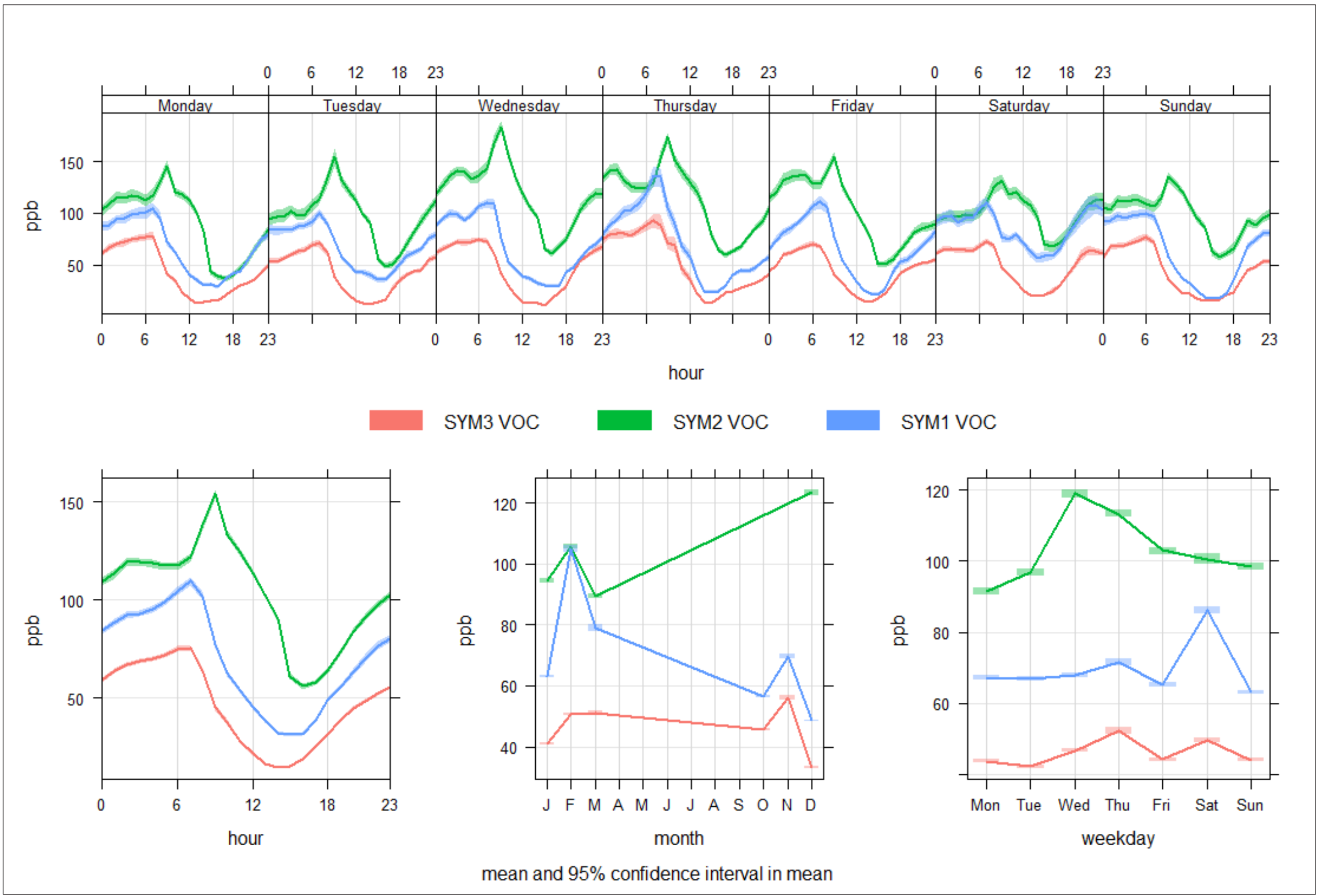


The time series show a high level of data completeness on SYM3 and SYM1 for VOC, the sensor at SYM2 malfunctioned between October and December 2022 and this explains the missing data on that period.

II. Hourly, daily, weekly, and monthly cycles

Figure 99 presents the VOC hourly, daily, weekly, and monthly cycles:

Figure 99. VOC hourly, daily, weekly, and monthly cycles at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

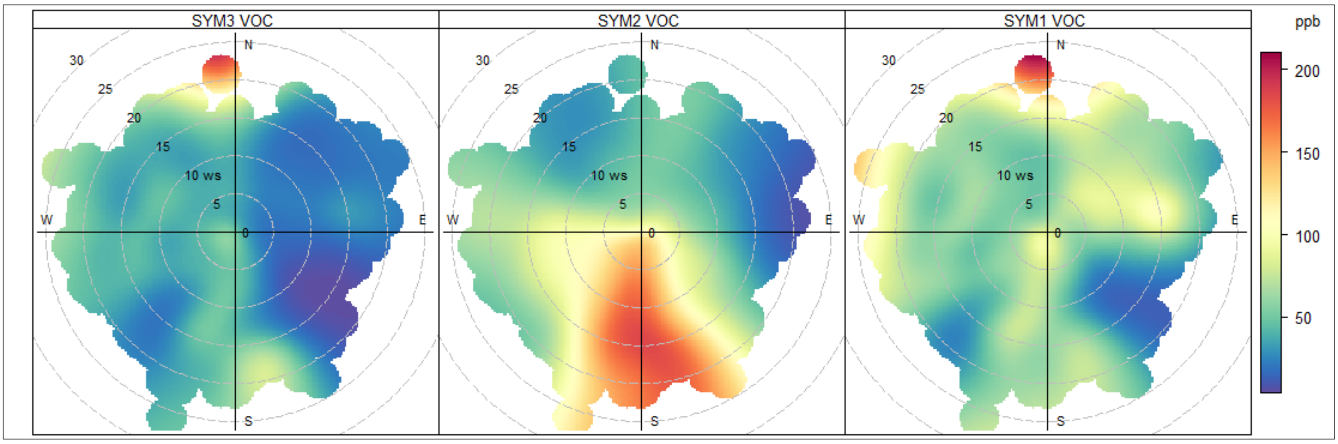


All 3 monitor cycles show a trend of peaks in VOC concentrations during the early morning, and lower values during the day, particularly right after midday.

III. Pollution roses

Figure 100 presents the VOC pollution roses:

Figure 100. VOC pollution roses at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.

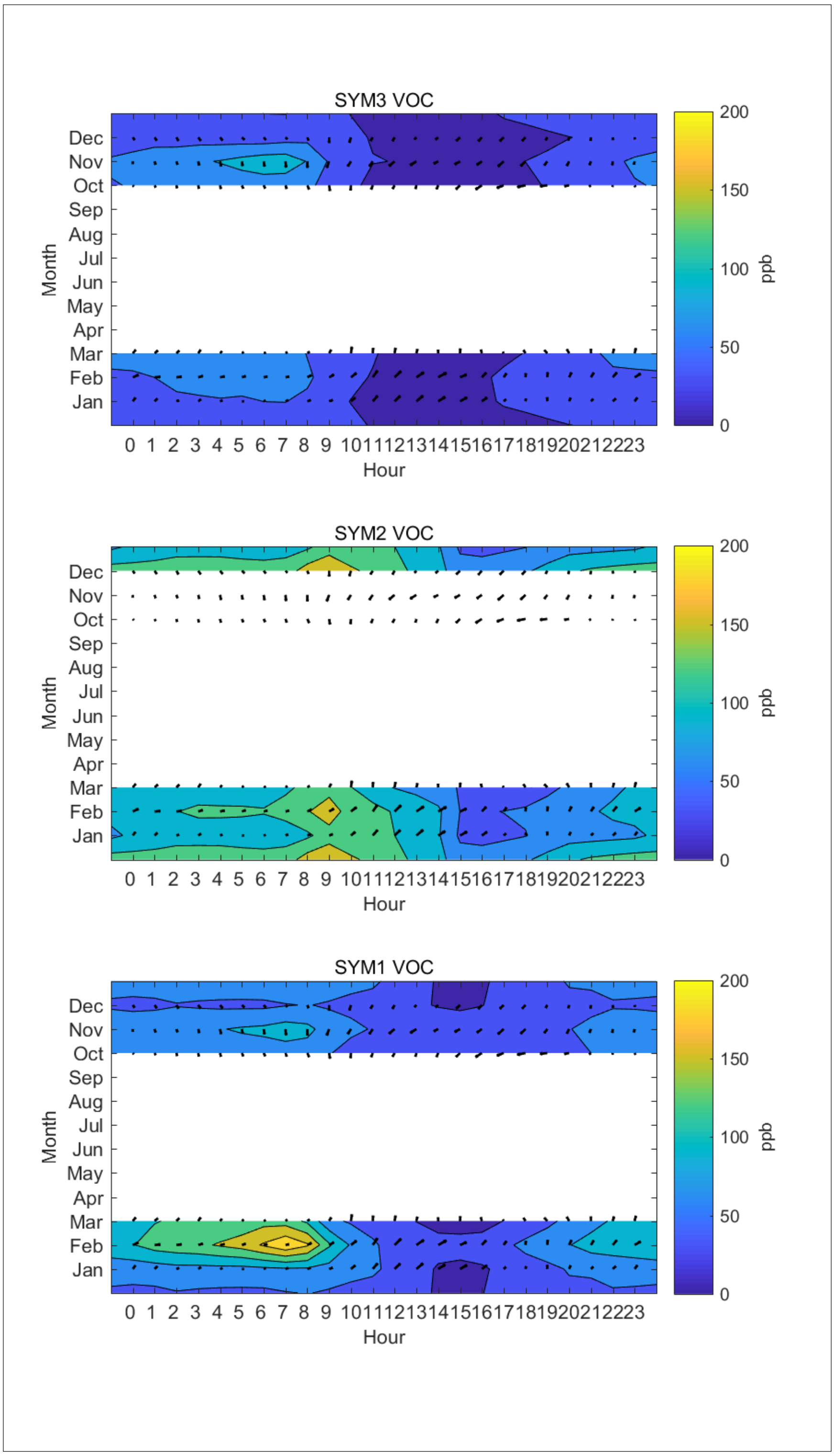


The pollution roses show a similar pattern for SYM3 and SYM1 for VOC, which is higher concentrations of this pollutant when there are prevailing winds coming from the NNW and N. SYM2 shows higher concentrations of VOC when there are prevailing winds coming from the S.

IV. Seasonal cycles

Figure 101 presents the VOC seasonal cycles:

Figure 101. VOC seasonal cycles at SYM3 – eNose 3, SYM2 – eNose 4, SYM1 – eNose 5.



The seasonal cycles show a similar trend across all eNoses; higher concentrations of VOC occur during the night, dawn, and early morning, particularly between 10pm and 9am. The white area represents the missing data since these 3 monitors only were in those locations between October 2022 and March 2023.

d) **IFF1 – eNose 6 and IFF2 – eNose 7.**

This section contains the monitored air quality data for IFF – eNose 6 and IFF – eNose 7 between April 2022 and March 2023.

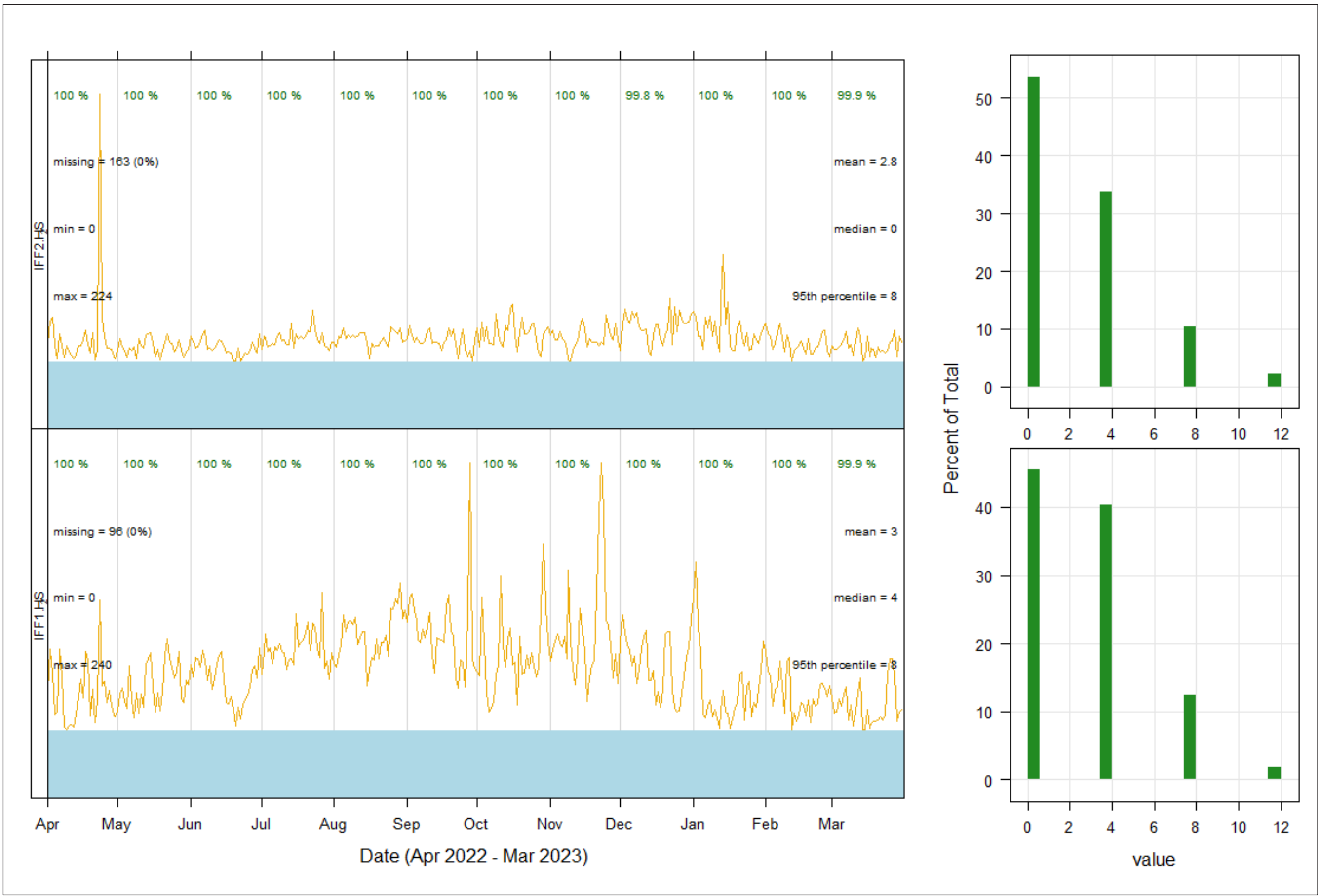
H_2S

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for hydrogen sulfide (H_2S).

I. Time series

Figure 102 presents the H_2S Time series:

Figure 102. H_2S Time series at IFF – eNose 6 and IFF – eNose 7.

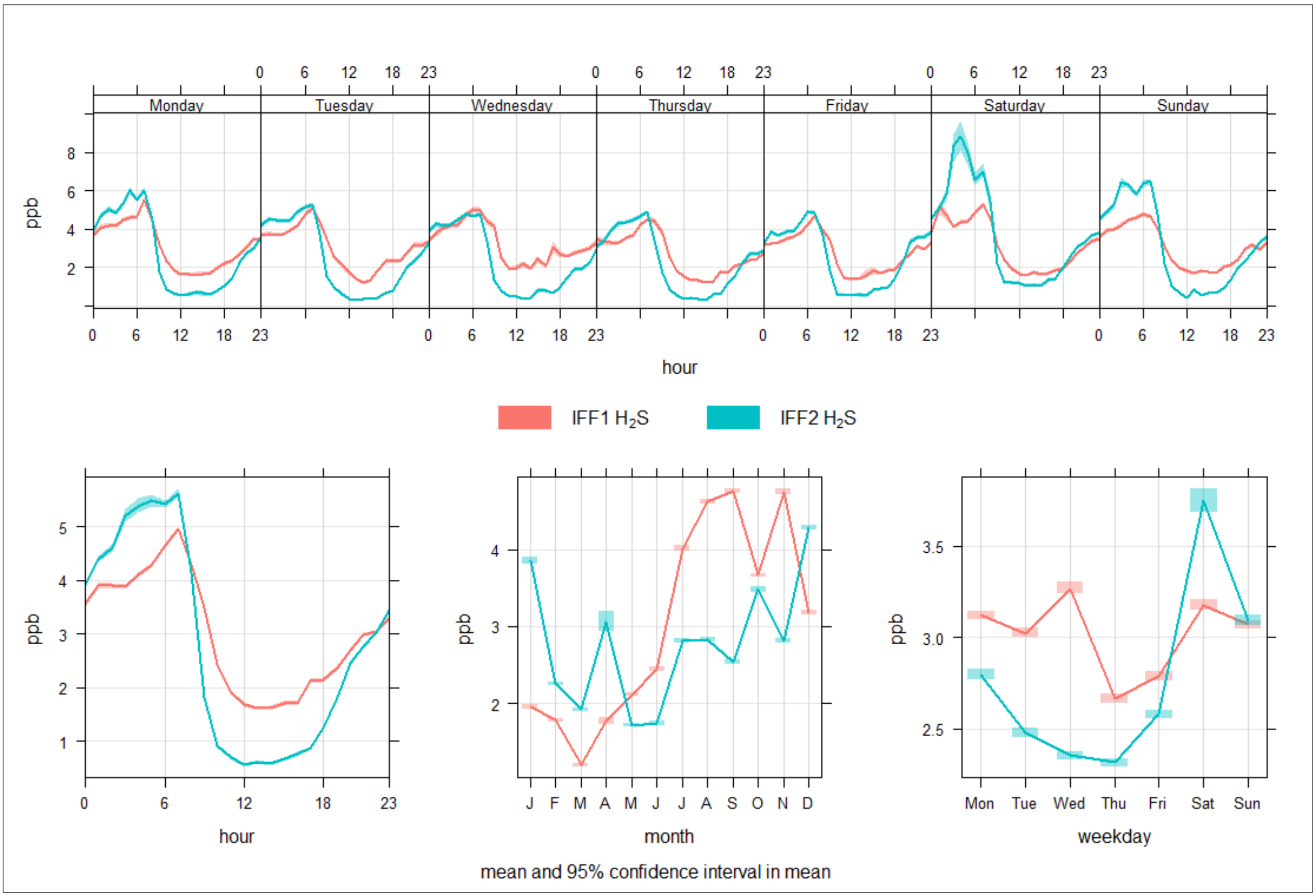


The time series show a high level of data completeness on both eNoses for H_2S.

II. Hourly, daily, weekly, and monthly cycles

Figure 103 presents the H_2S hourly, daily, weekly, and monthly cycles:

Figure 103. H_2S hourly, daily, weekly, and monthly cycles at IFF – eNose 6 and IFF – eNose 7.

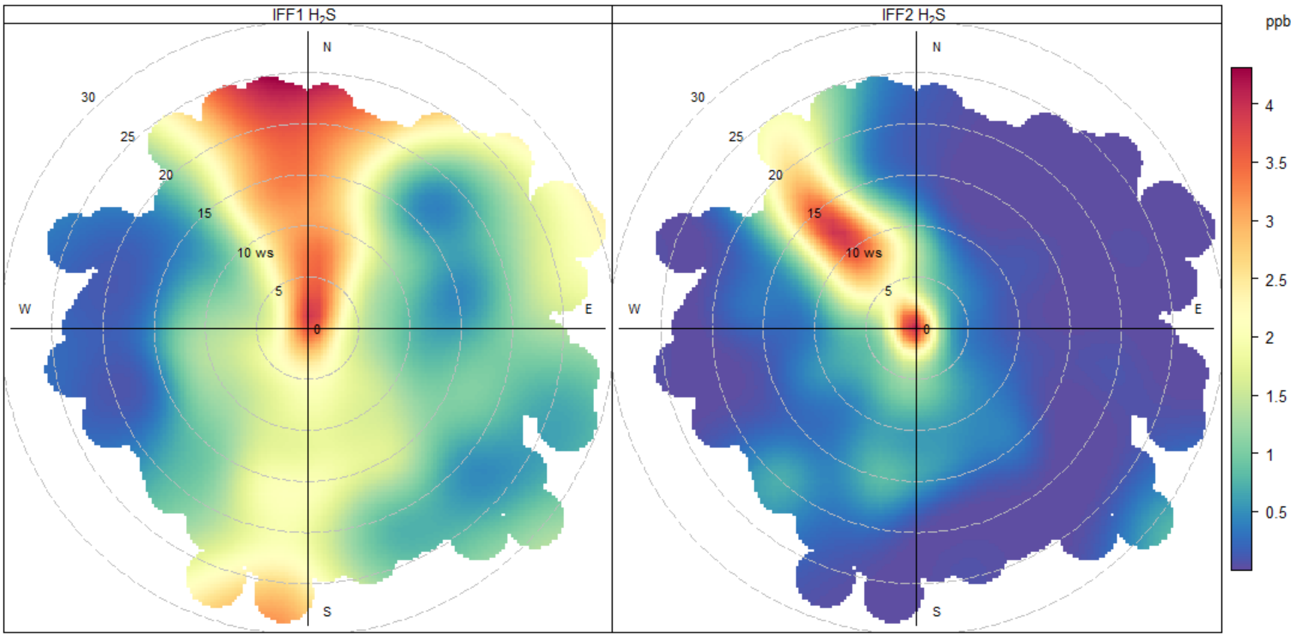


Both monitor cycles show a trend of peaks in H_2S concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 104 presents the H_2S pollution roses:

Figure 104. H_2S pollution roses at IFF – eNose 6 and IFF – eNose 7.

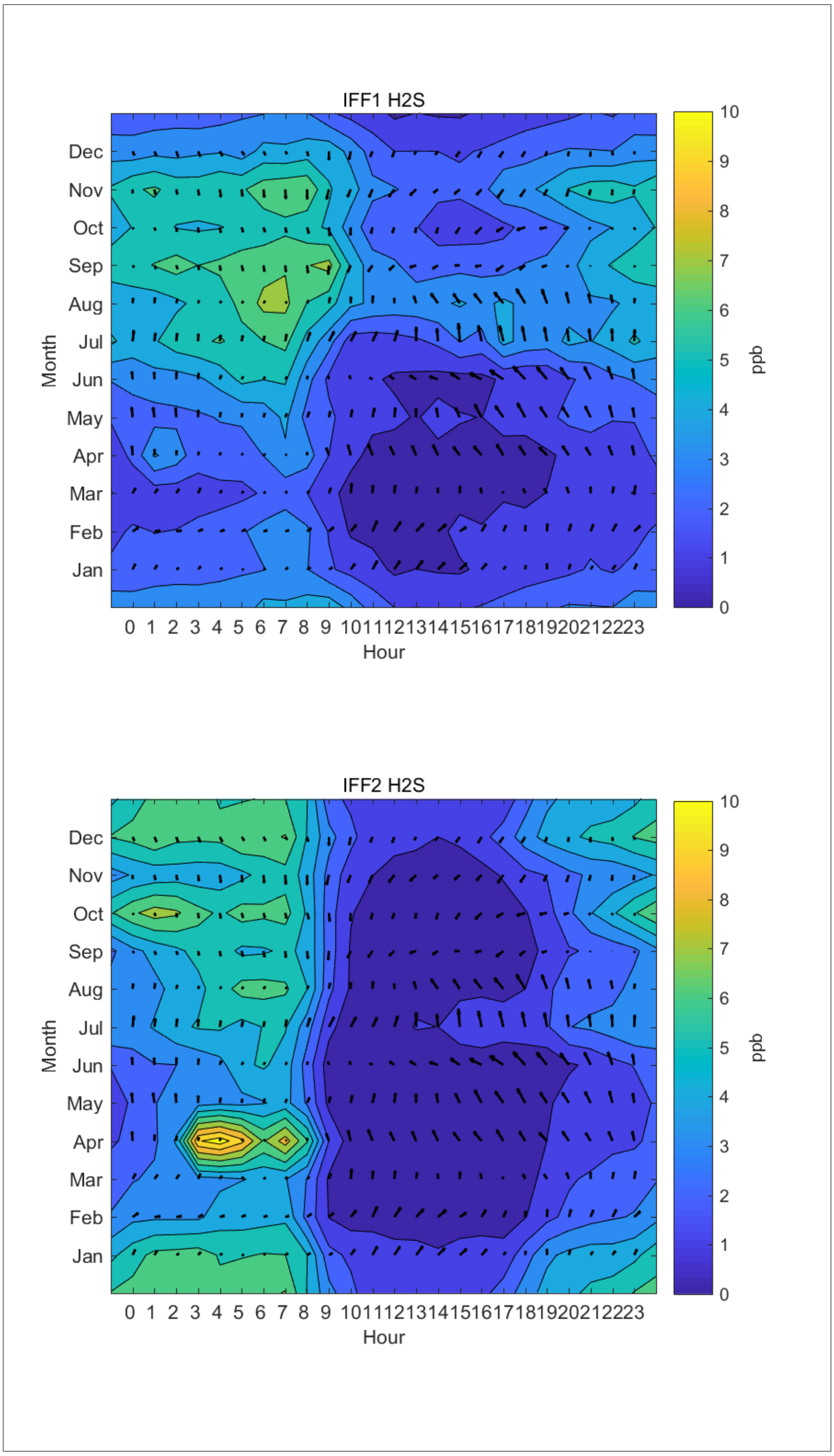


The pollution rose at IFF 1 shows that higher concentrations of H_2S occur when there are prevailing NNW and N winds at a wide range of wind speeds, IFF2 shows a similar pattern that intensifies when there are NW winds.

IV. Seasonal cycles

Figure 105 presents the H_2S seasonal cycles:

Figure 105. H_2S seasonal cycles at IFF – eNose 6 and IFF – eNose 7.



Both seasonal cycles show higher H_2S concentrations during dawn and early morning, particularly between 3am and 9am.

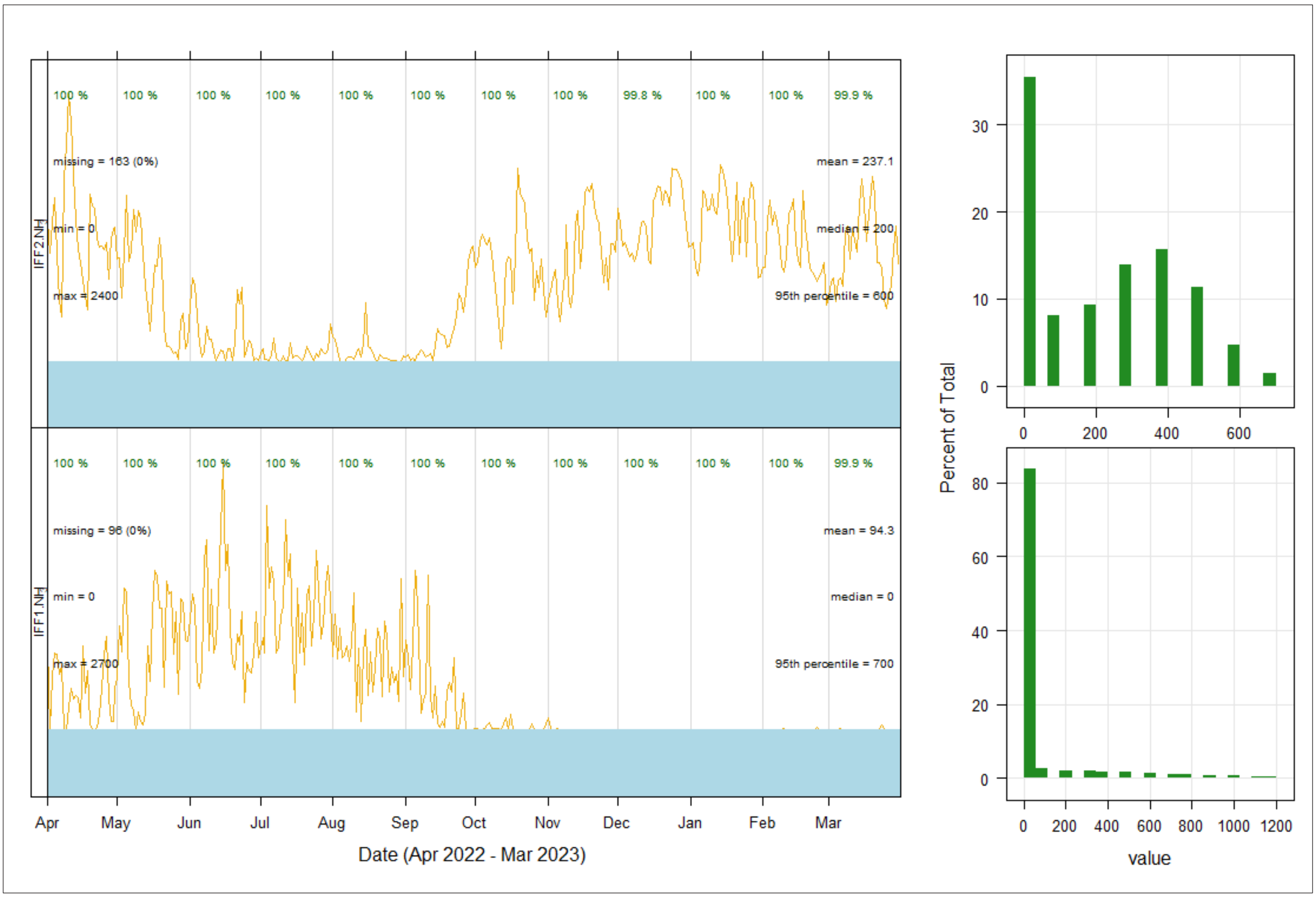
NH$_3$

Below are the Time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (NH$_3$).

I. Time series

Figure 106 presents the NH$_3$ Time series:

Figure 106. NH$_3$ Time series at IFF – eNose 6 and IFF – eNose 7.

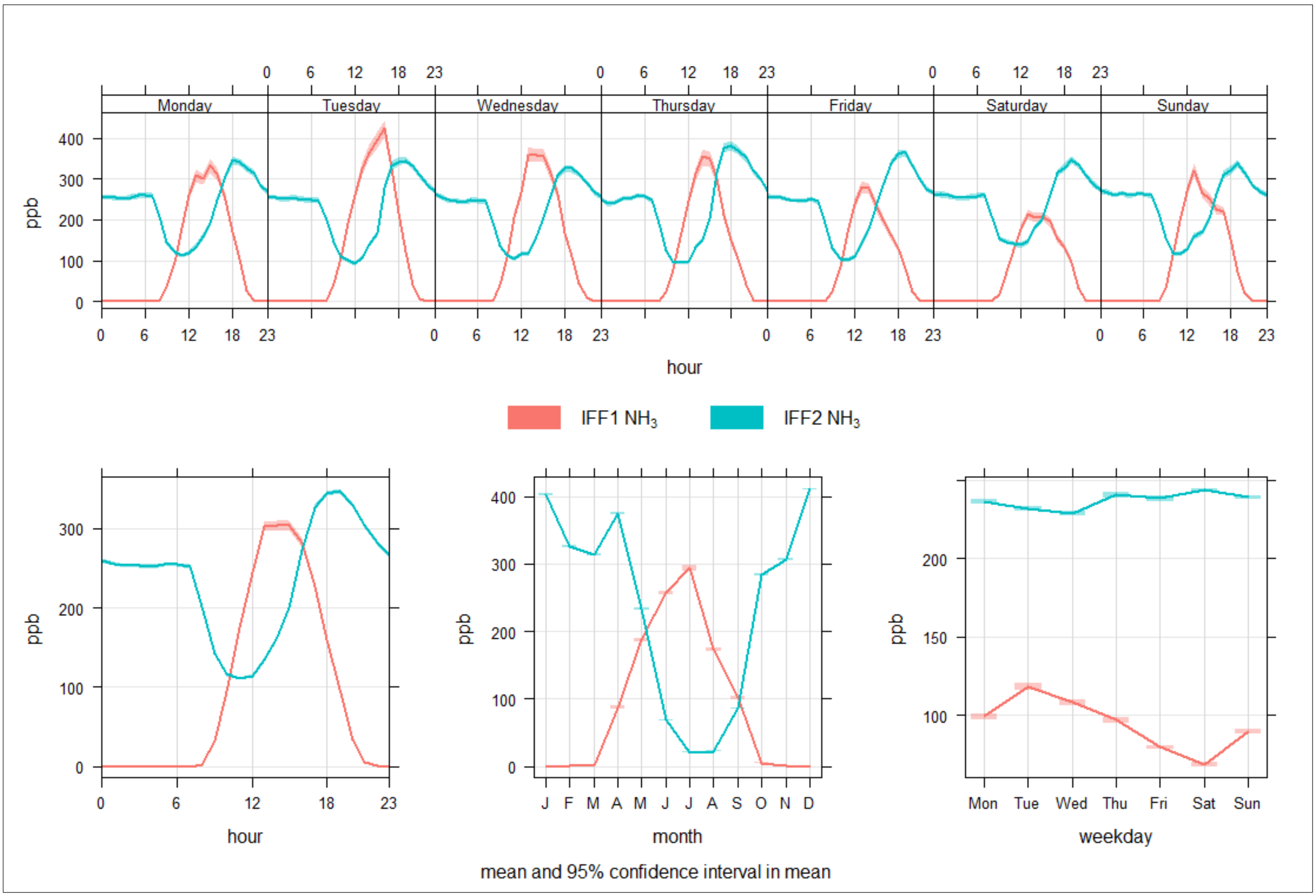


The time series show a high level of data completeness.

II. Hourly, daily, weekly, and monthly cycles

Figure 107 presents the NH_3 hourly, daily, weekly, and monthly cycles:

Figure 107. NH_3 hourly, daily, weekly, and monthly cycles at IFF – eNose 6 and IFF – eNose 7.

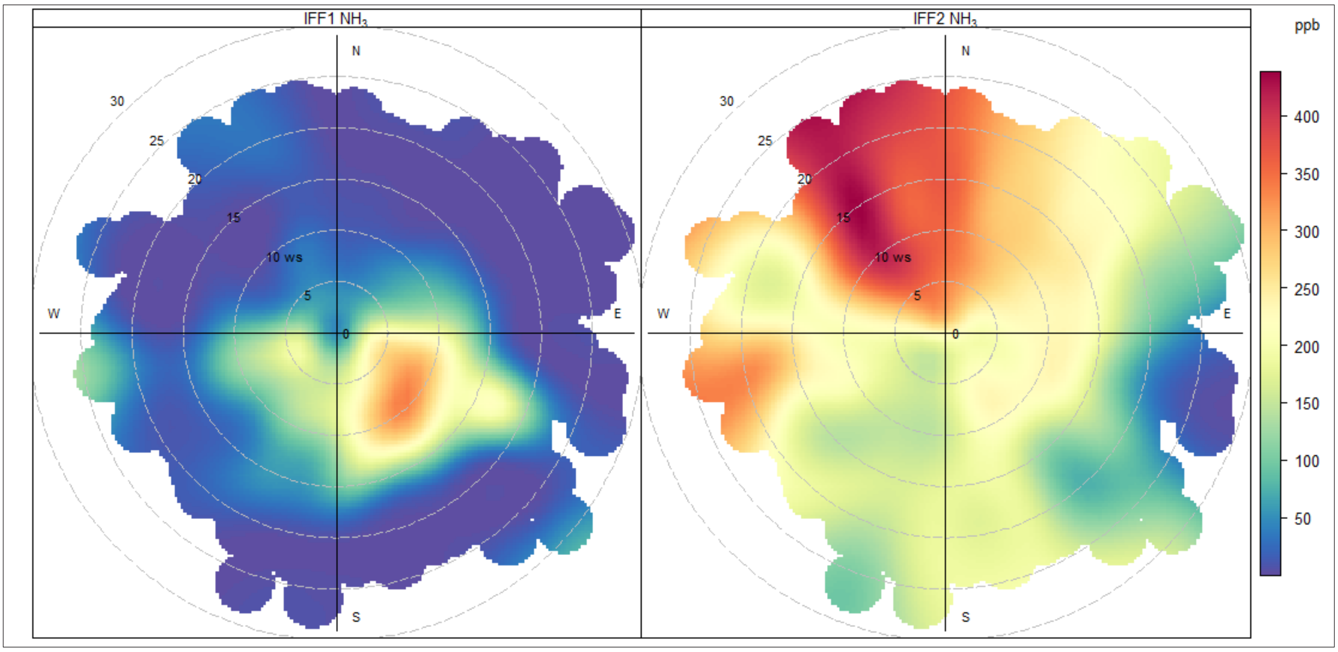


IFF1 monitor shows an increase in NH_3 concentrations during the day and afternoon, particularly in the summer. IFF2 shows an opposite trend, this could be either the sensor malfunctioning or that is influenced by a local source of this pollutant.

III. Pollution roses

Figure 108 presents the NH_3 pollution roses:

Figure 108. NH_3 pollution roses at IFF – eNose 6 and IFF – eNose 7.

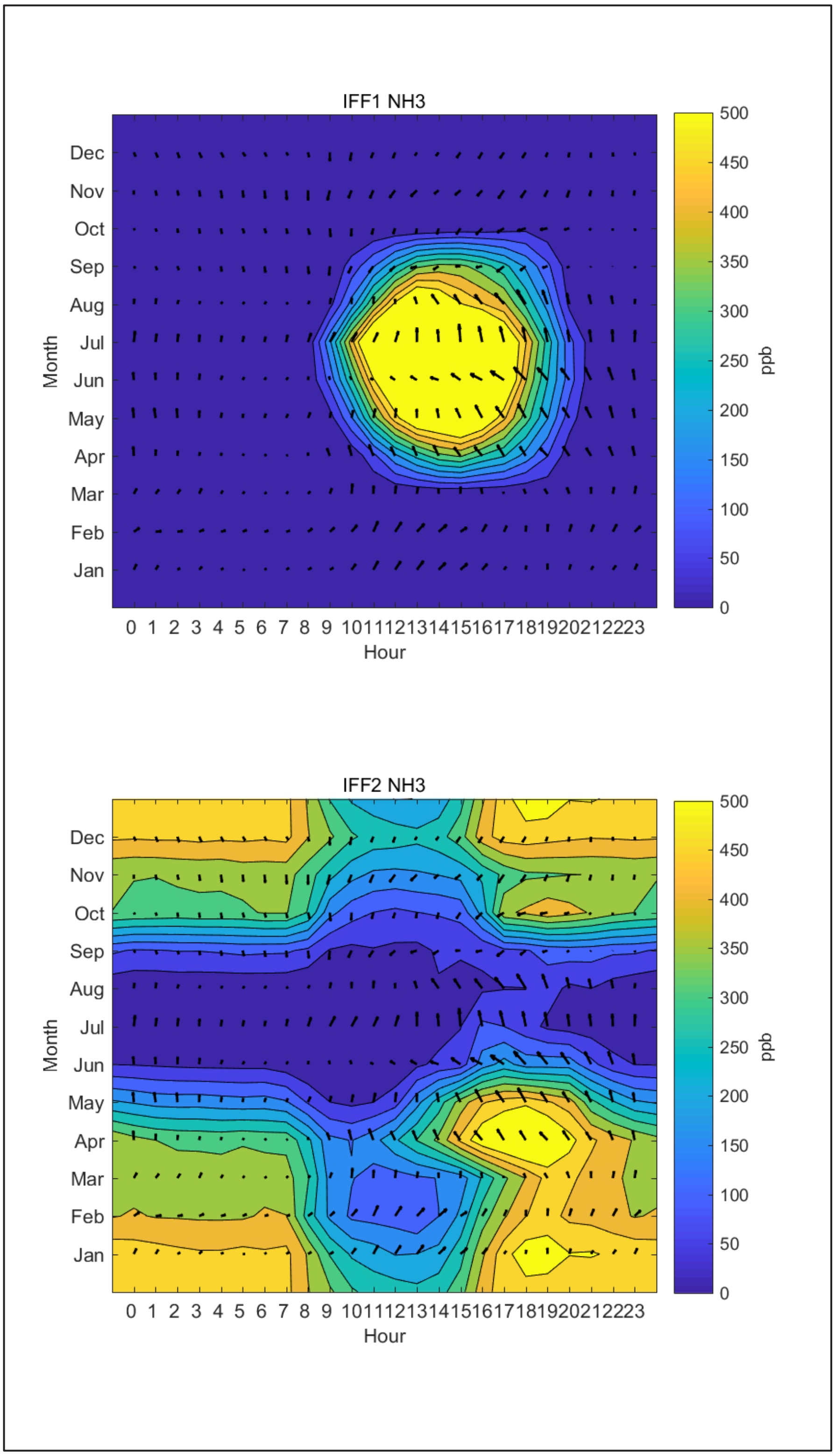


IFF1 shows higher concentrations of NH_3 when there are winds coming from the SW at wind speeds around 10mph. IFF2 shows higher concentrations of NH_3 when there are N and NNW winds between 5-25 mph.

IV. Seasonal cycles

Figure 109 presents the NH_3 seasonal cycles:

Figure 109. NH_3 seasonal cycles at IFF – eNose 6 and IFF – eNose 7.



IFF1 seasonal cycle shows higher concentrations of ammonia occurring during the day and afternoon, particularly between 10am and 6pm in summer months. IFF2 seasonal cycle shows higher ammonia concentrations during the afternoon, night, and dawn, particularly between 4pm and 8am in winter months.

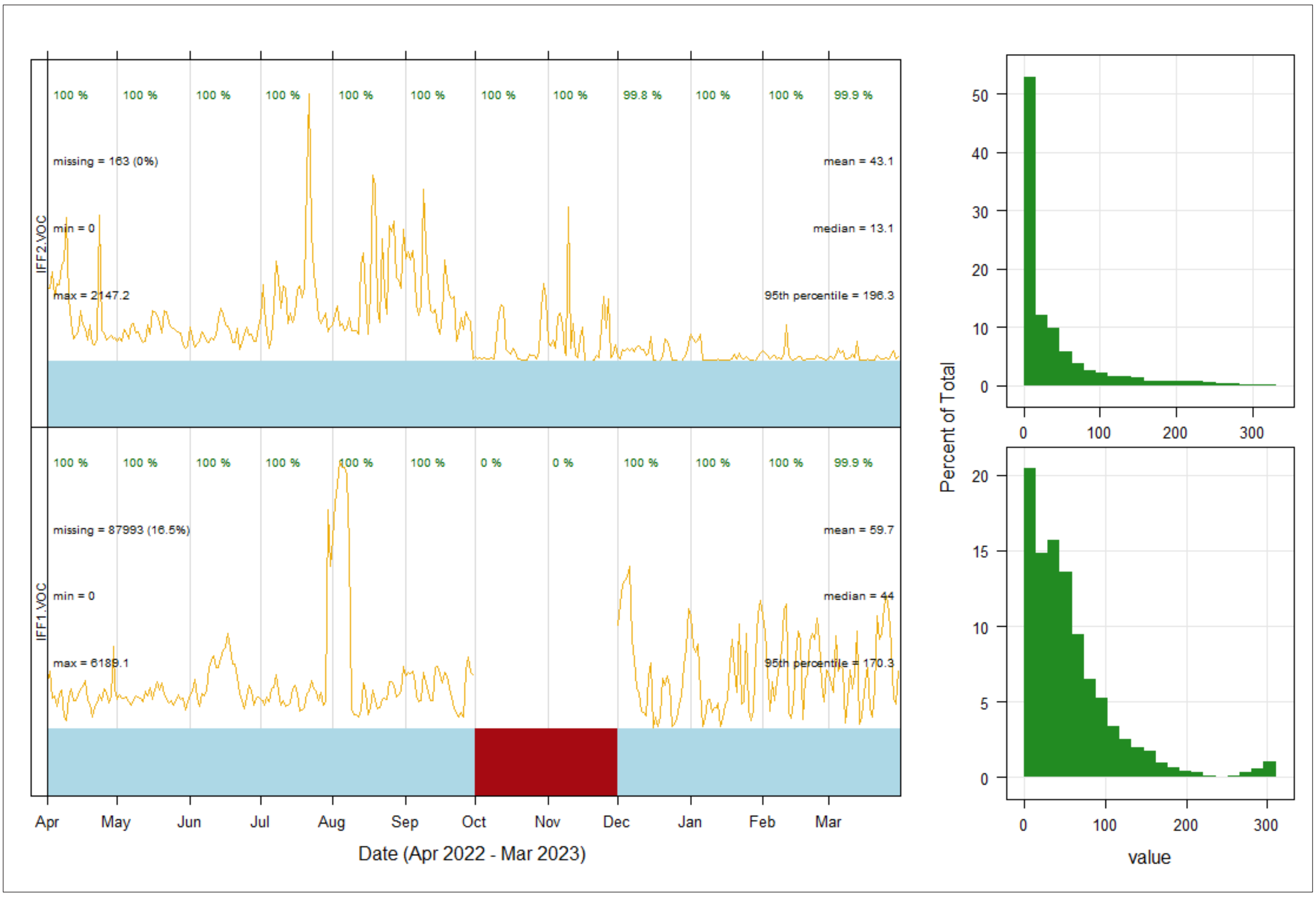
VOC

Below are the Time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (VOC).

I. Time series

Figure 110 presents the VOC time series:

Figure 110. VOC time series at IFF – eNose 6 and IFF – eNose 7.

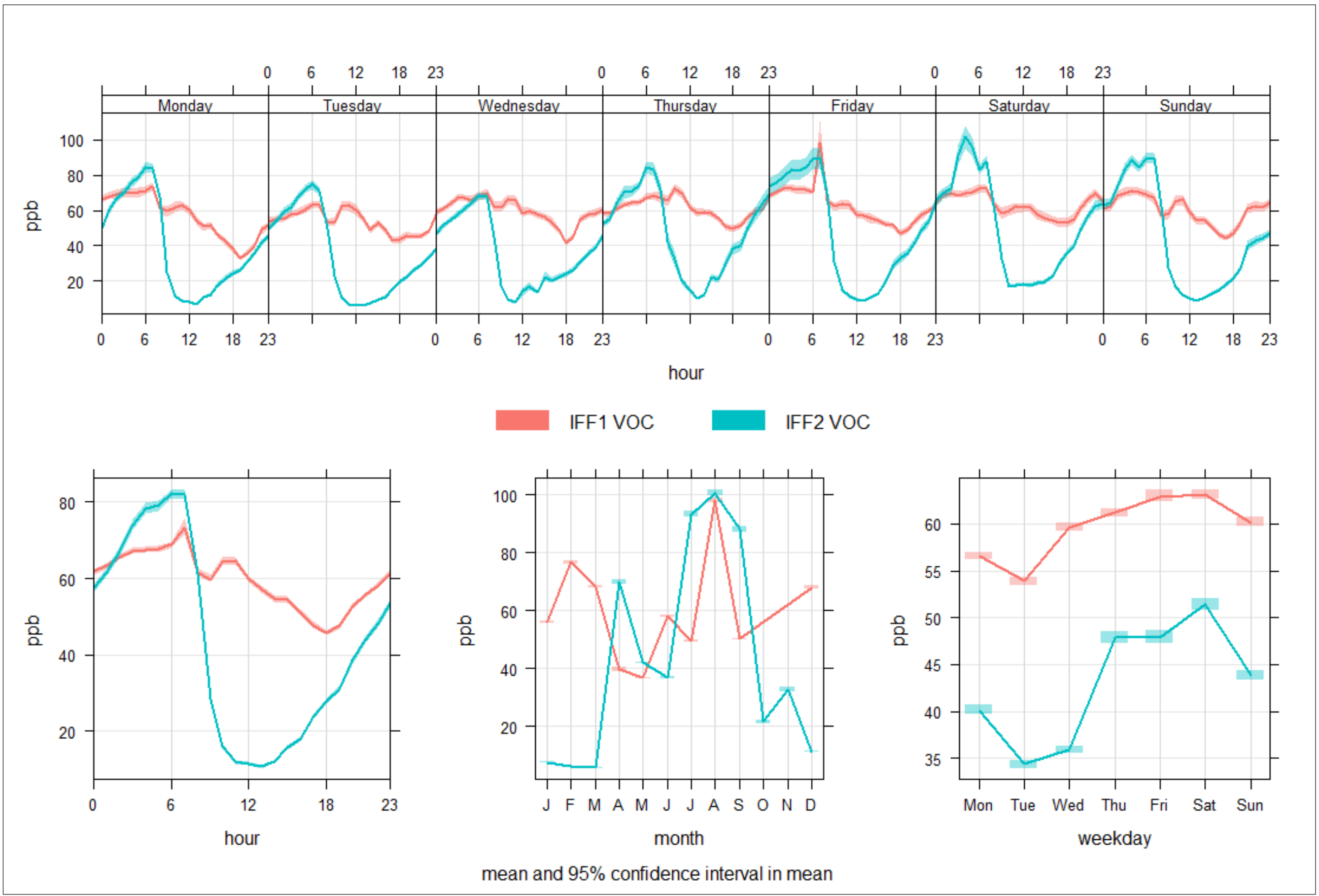


The time series show a high level of data completeness, with some data missing in the IFF1 VOC monitor between October and December due sensor malfunctioning.

II. Hourly, daily, weekly, and monthly cycles

Figure 111 presents the VOC hourly, daily, weekly, and monthly cycles:

Figure 111. VOC hourly, daily, weekly, and monthly cycles at IFF – eNose 6 and IFF – eNose 7.

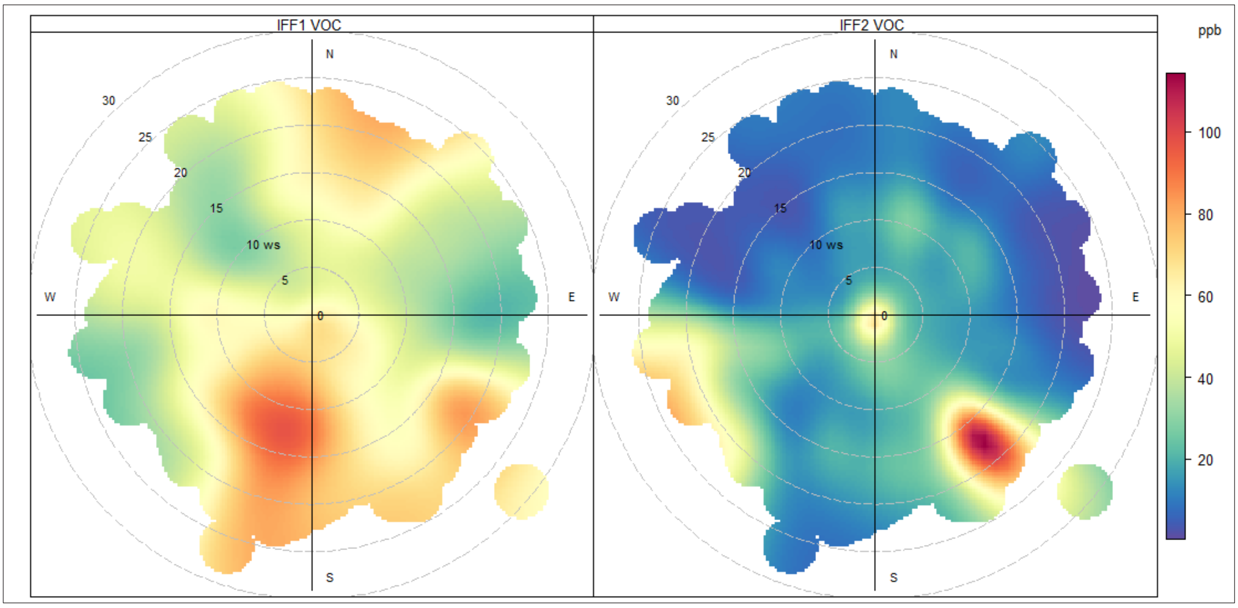


The VOC cycles have a similar trend on both monitors, which is higher VOC concentrations during the dawn and in summer months, however IFF1 shows more variability during the day compared to IFF2.

III. Pollution roses

Figure 112 presents the VOC pollution roses:

Figure 112. VOC pollution roses at IFF – eNose 6 and IFF – eNose 7.

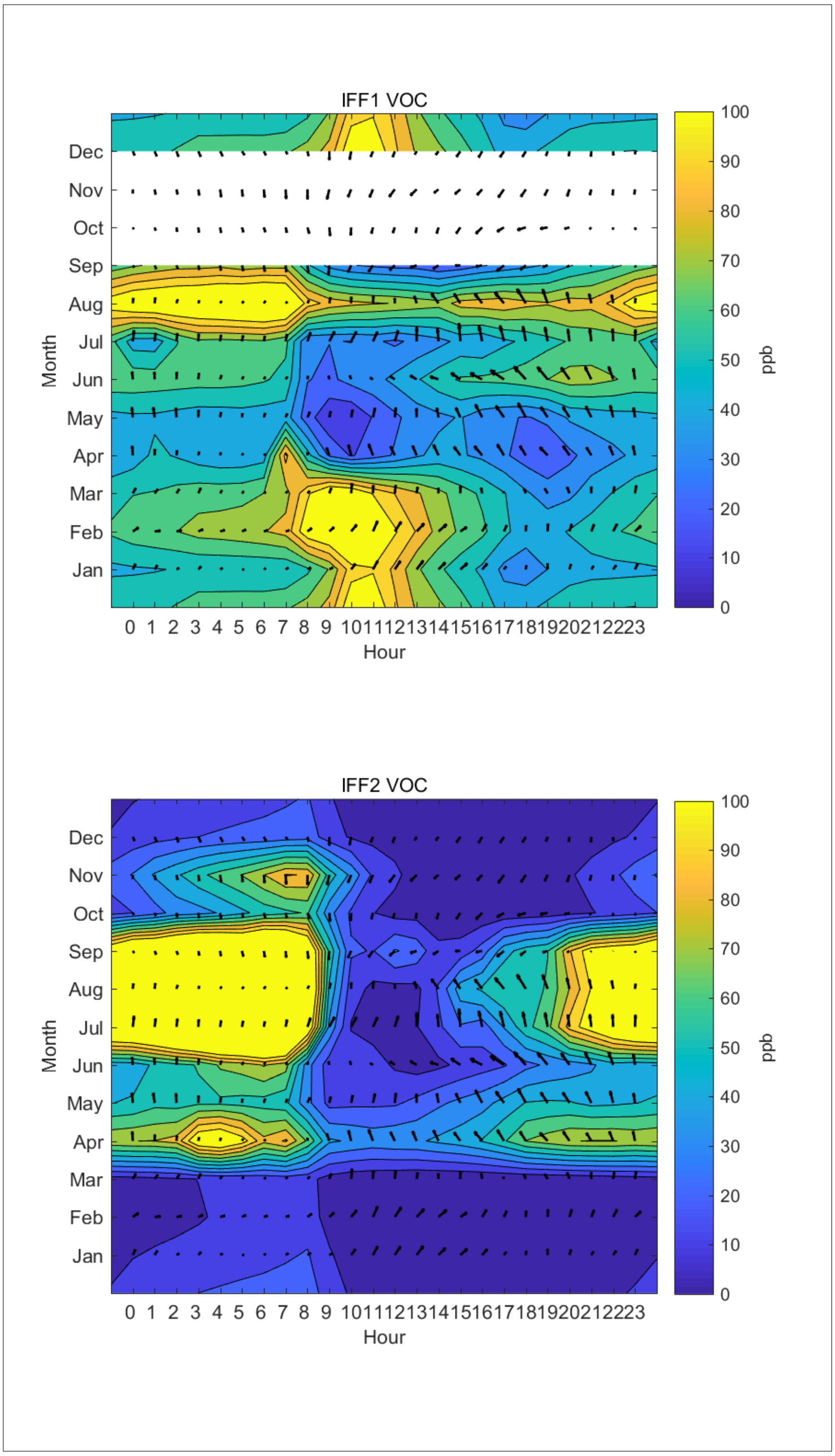


The pollution rose for IFF1 indicates that there are higher concentrations of VOC when there are SSE, SE, and NE winds, particularly at wind speeds between 10-15mph. On the other side, the pollution rose for IFF2 shows higher concentrations of VOC when there are low winds below 5mph, WSW winds higher than 20mph and SE winds between 15-20 mph.

IV. Seasonal cycles

Figure 113 presents the VOC seasonal cycles:

Figure 113. VOC seasonal cycles at IFF – eNose 6 and IFF – eNose 7.



IFF1 seasonal cycle shows higher concentrations of VOC during the month of August at night and dawn between 10pm and 8am and between December and march between 7am and midday. IFF2 seasonal cycle shows higher VOC concentrations in April and between June and September from 8pm to 9 am.

e) RHD1 - eNose 8 and RHD2 – eNose 9.

This section contains the monitored air quality data for RHD1 – eNose 8 and RHD2 – eNose 9 between April 2022 and March 2023.

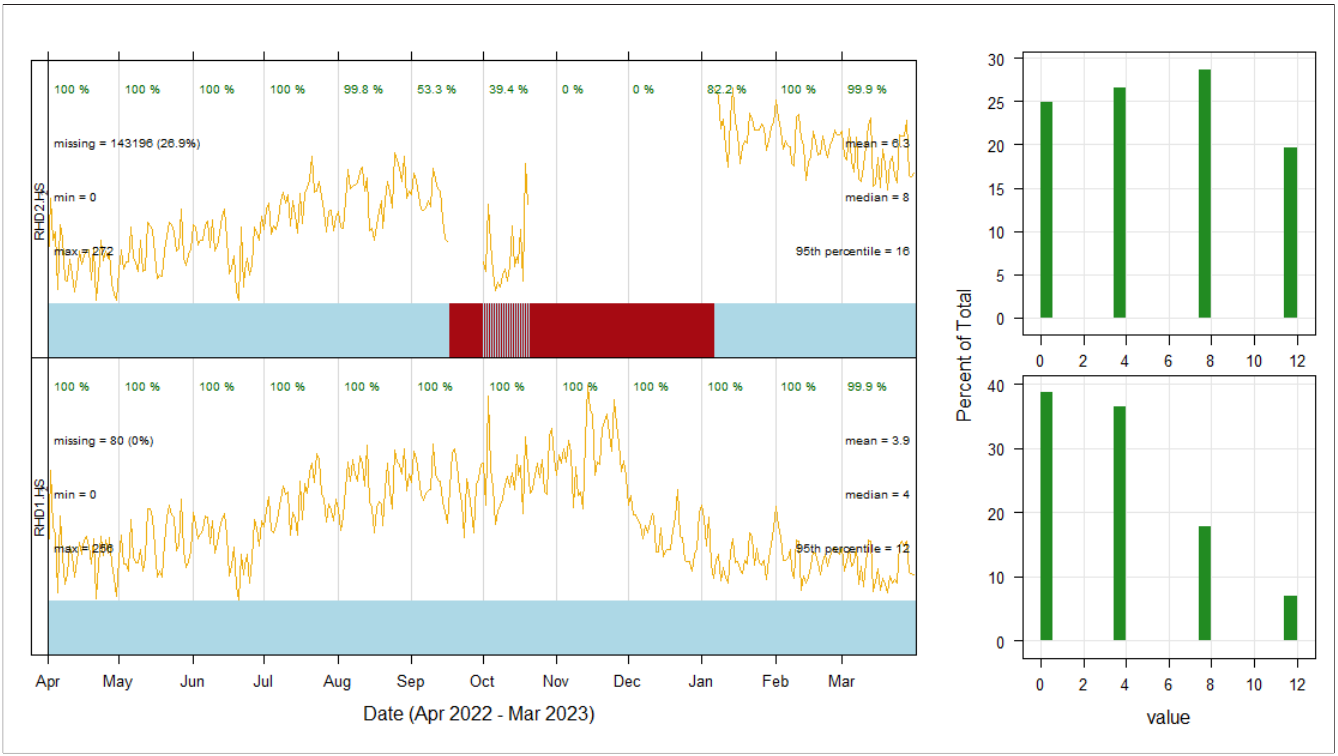
H_2S

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for hydrogen sulfide (H_2S).

I. Time series

Figure 114 presents the H_2S time series:

Figure 114. H_2S Time series at RHD – eNose 8 and RHD2 – eNose 9.

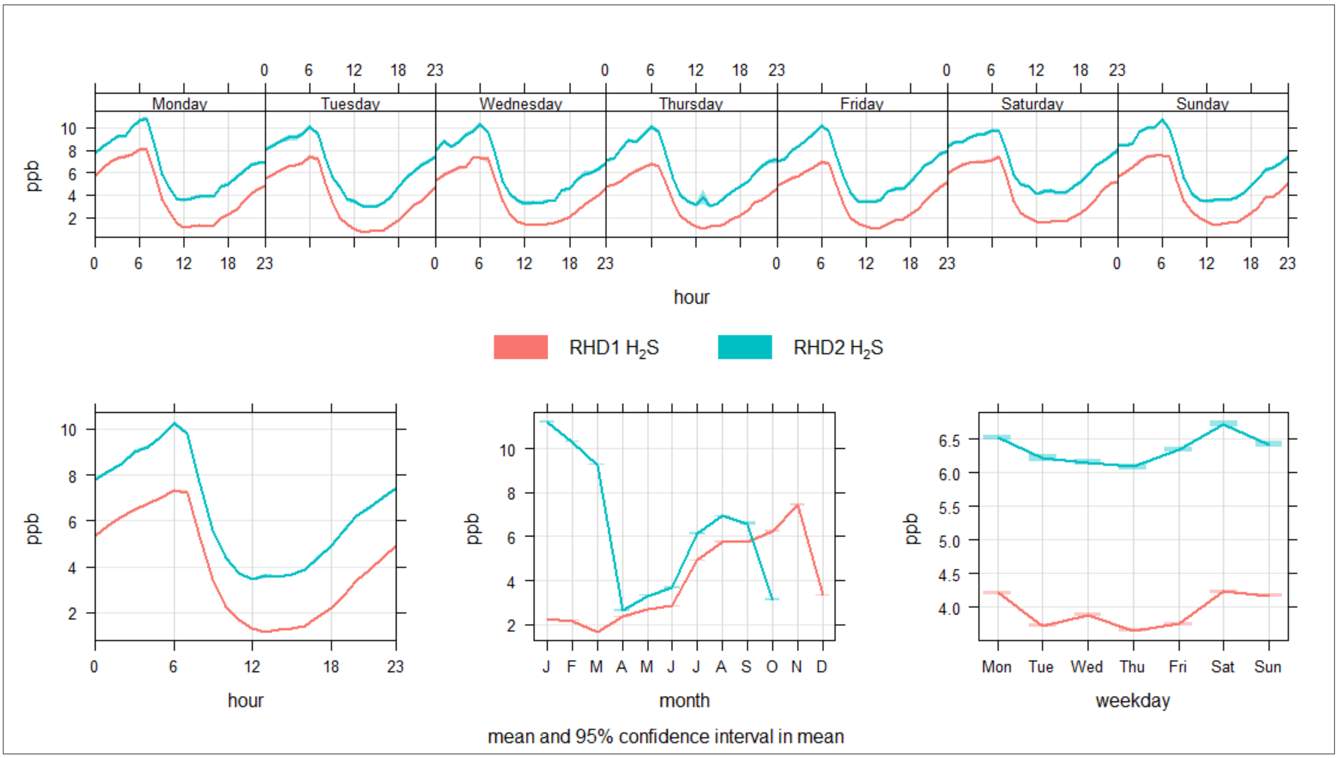


RHD1 time series show a high level of data completeness, RHD2 time series show that the sensor malfunctioned between September 2022 and the beginning of January 2023.

II. Hourly, daily, weekly, and monthly cycles

Figure 115 presents the H_2S hourly, daily, weekly, and monthly cycles:

Figure 115. H_2S hourly, daily, weekly, and monthly cycles at RHD – eNose 8 and RHD2 – eNose 9.

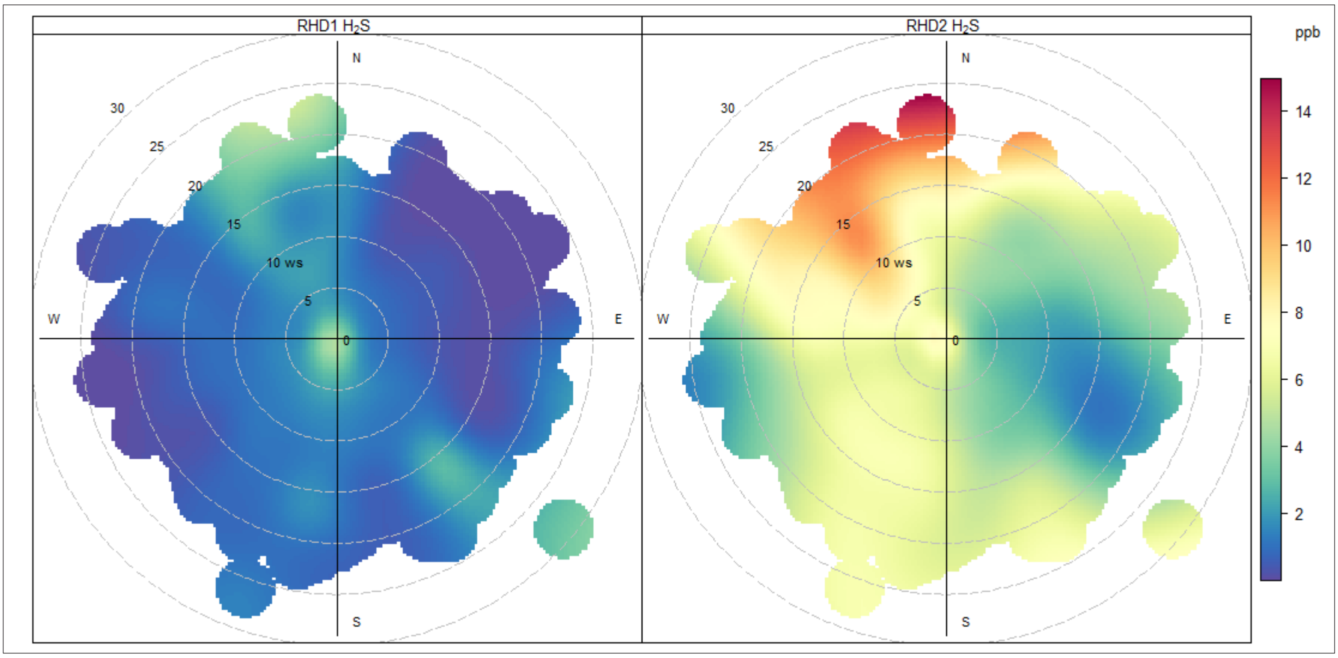


Both cycles show a trend of peaks in H_2S concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 116 presents the H_2S pollution roses:

Figure 116. H_2S pollution roses at RHD – eNose 8 and RHD2 – eNose 9.

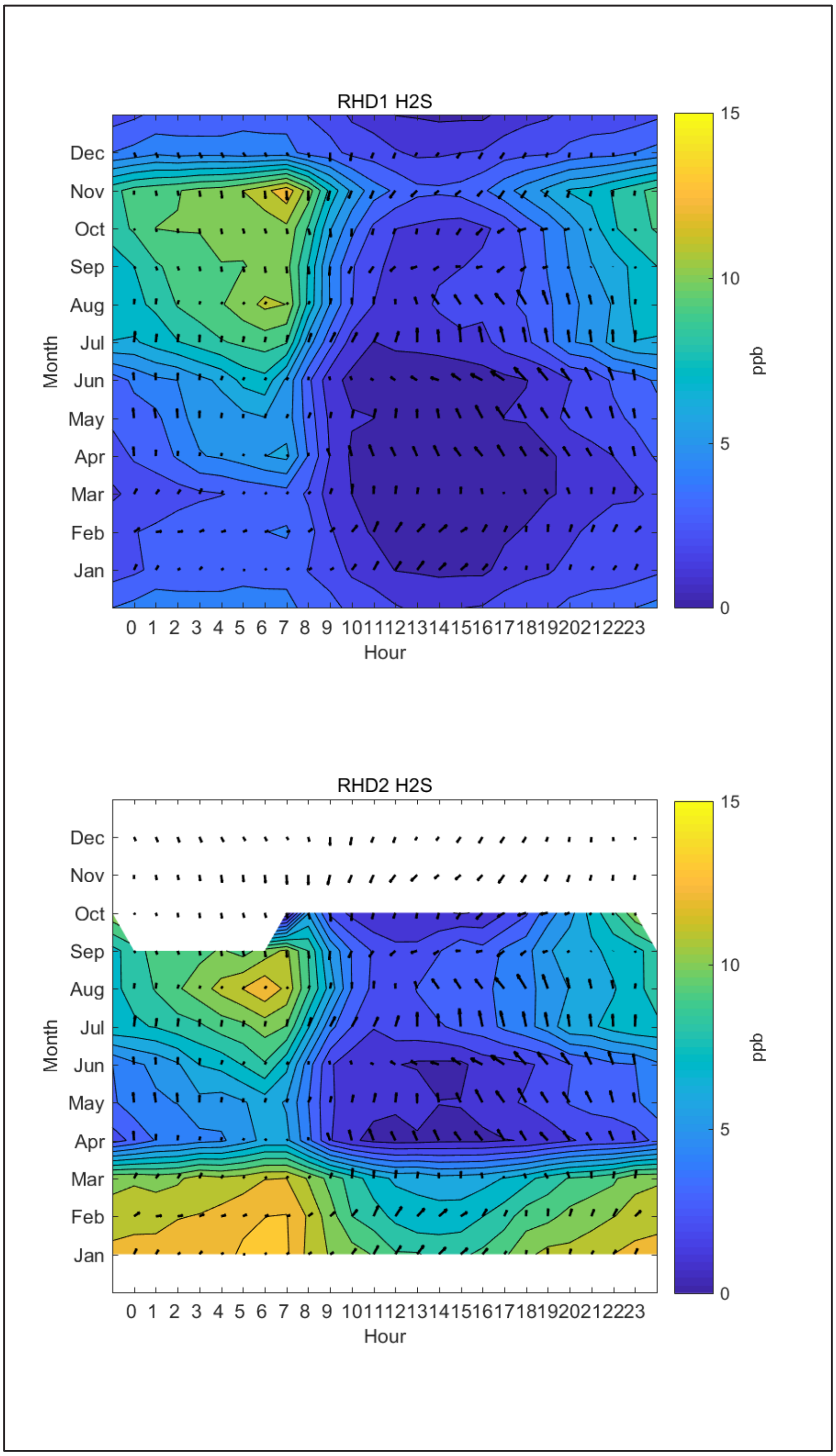


Both pollution roses show higher concentrations of H_2S when there are NW and NNW winds between 10-25 mph.

IV. Seasonal cycles

Figure 117 presents the H_2S seasonal cycles:

Figure 117. H_2S seasonal cycles at RHD – eNose 8 and RHD2 – eNose 9.



Both seasonal cycles show higher H_2S concentrations during night, dawn, and early morning, particularly between 1am and 8am. The white area in RHD2 represents the missing data for the period when the sensor malfunctioned.

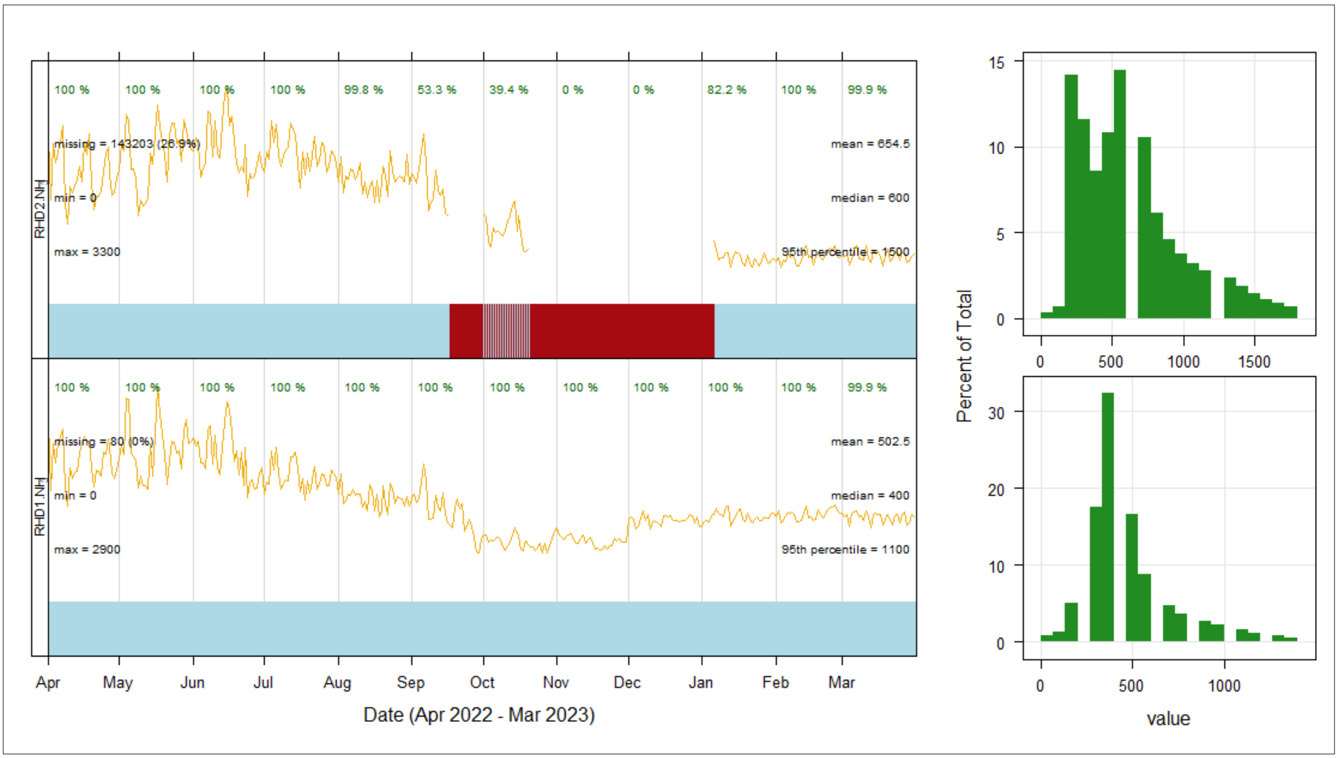
NH₃

Below are the Time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (NH_3).

I. Time series

Figure 118 presents the NH_3 Time series:

Figure 118. NH_3 Time series at RHD1 – eNose 8 and RHD2 – eNose 9.

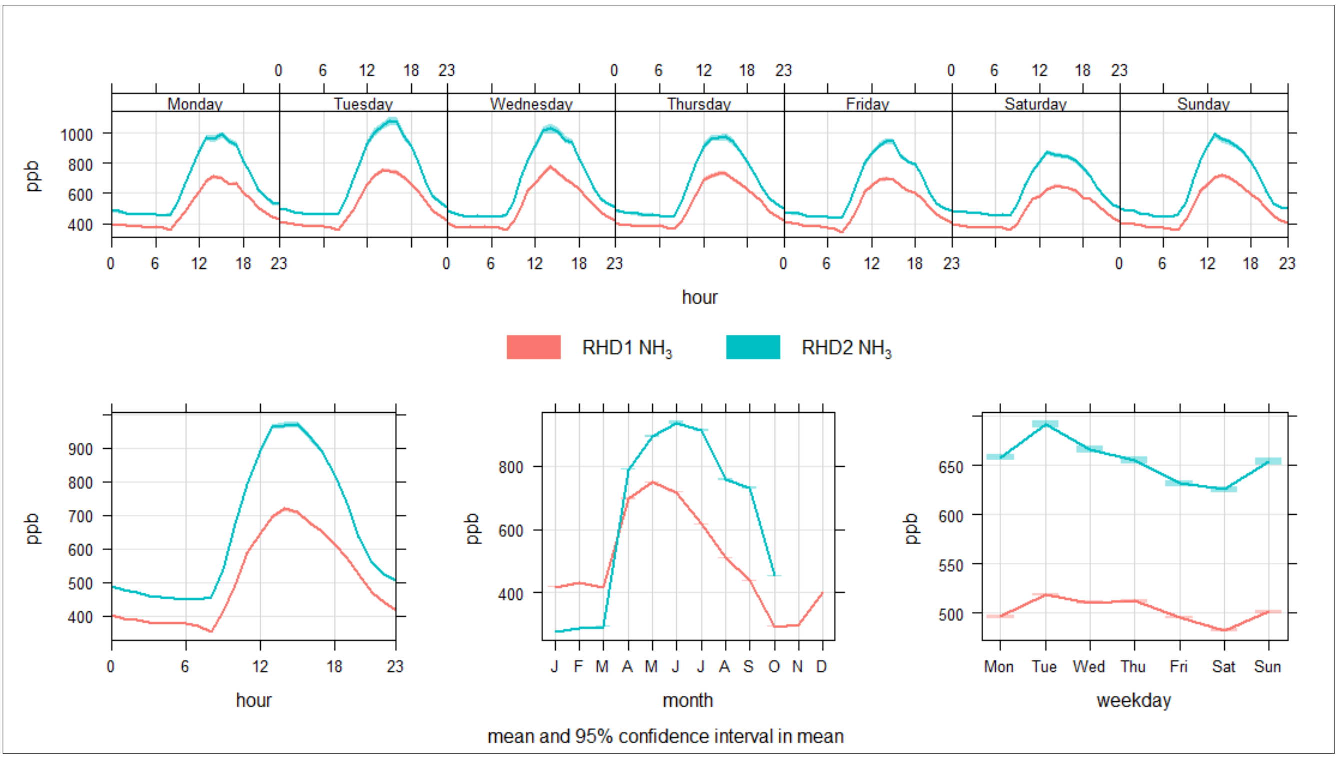


RHD1 time series show a high level of data completeness, RHD2 time series show that the sensor malfunctioned between September 2022 and the beginning of January 2023.

II. Hourly, daily, weekly, and monthly cycles

Figure 119 presents the NH_3 hourly, daily, weekly, and monthly cycles:

Figure 119. NH_3 hourly, daily, weekly, and monthly cycles at RHD1 – eNose 8 and RHD2 – eNose 9.

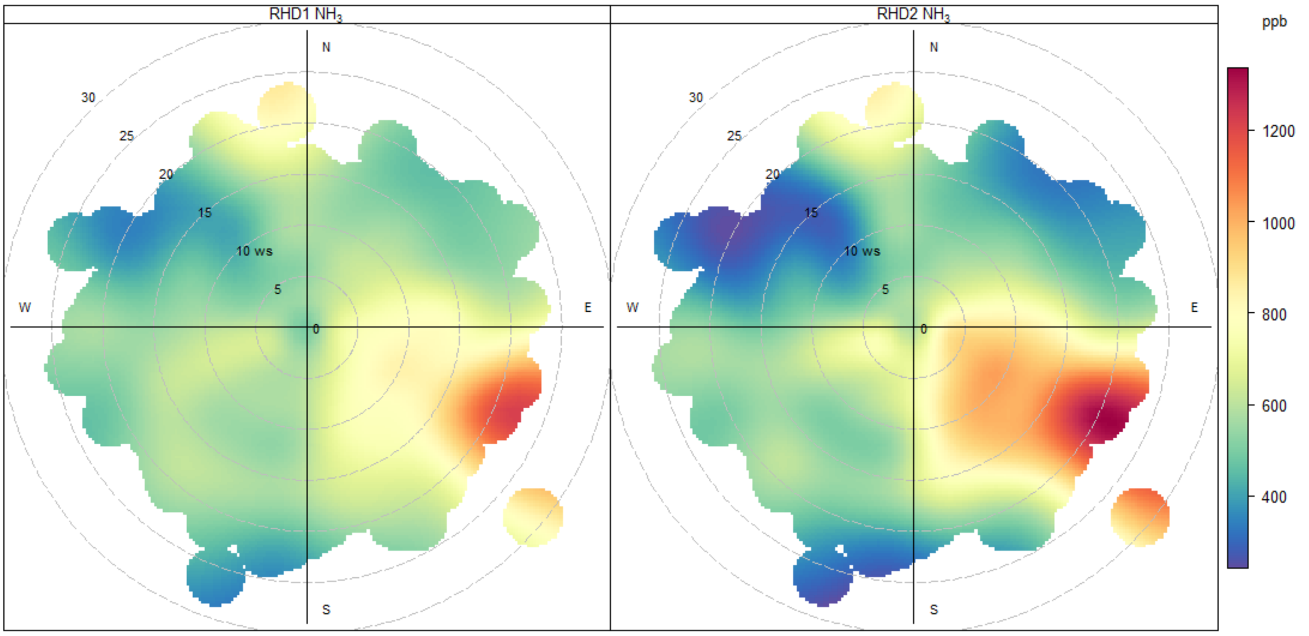


Both NH_3 cycles show a similar trend, with peaks during the day and afternoon, and lower concentrations during the night and dawn.

III. Pollution roses

Figure 120 presents the NH_3 pollution roses:

Figure 120. NH_3 pollution roses at RHD1 – eNose 8 and RHD2 – eNose 9.

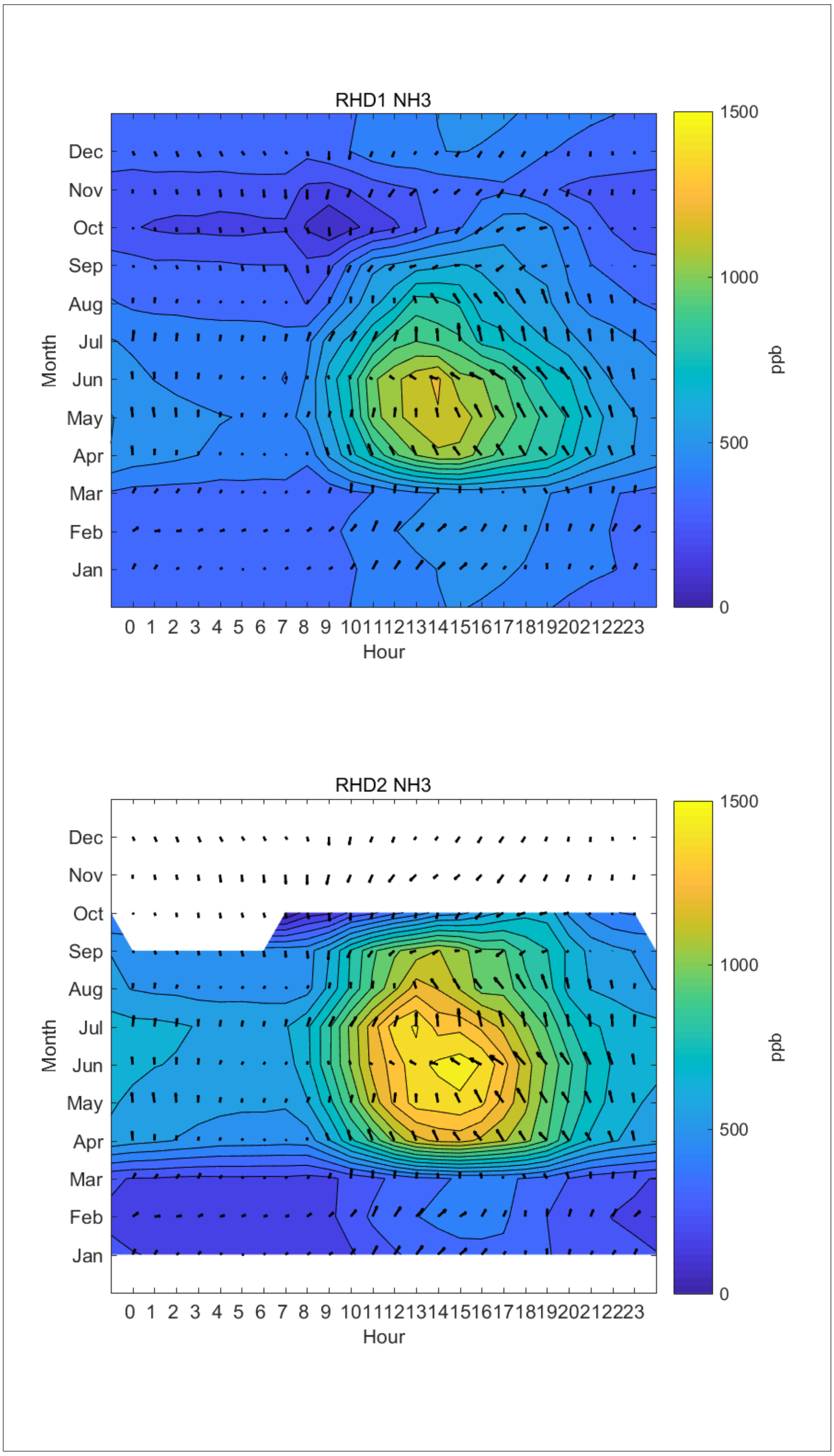


Both pollution roses show higher concentrations of NH_3 when there are SE winds between 10-20 mph, followed by NNW winds between 15-20mph.

IV. Seasonal cycles

Figure 121 presents the NH_3 seasonal cycles:

Figure 121. NH_3 seasonal cycles at RHD1 – eNose 8 and RHD2 – eNose 9.



The seasonal cycles show a similar trend on both eNoses; higher concentrations of ammonia occur during the day and afternoon, particularly between 10am and 6pm in summer months. The white area in RHD2 represents the missing data for the period when the sensor malfunctioned.

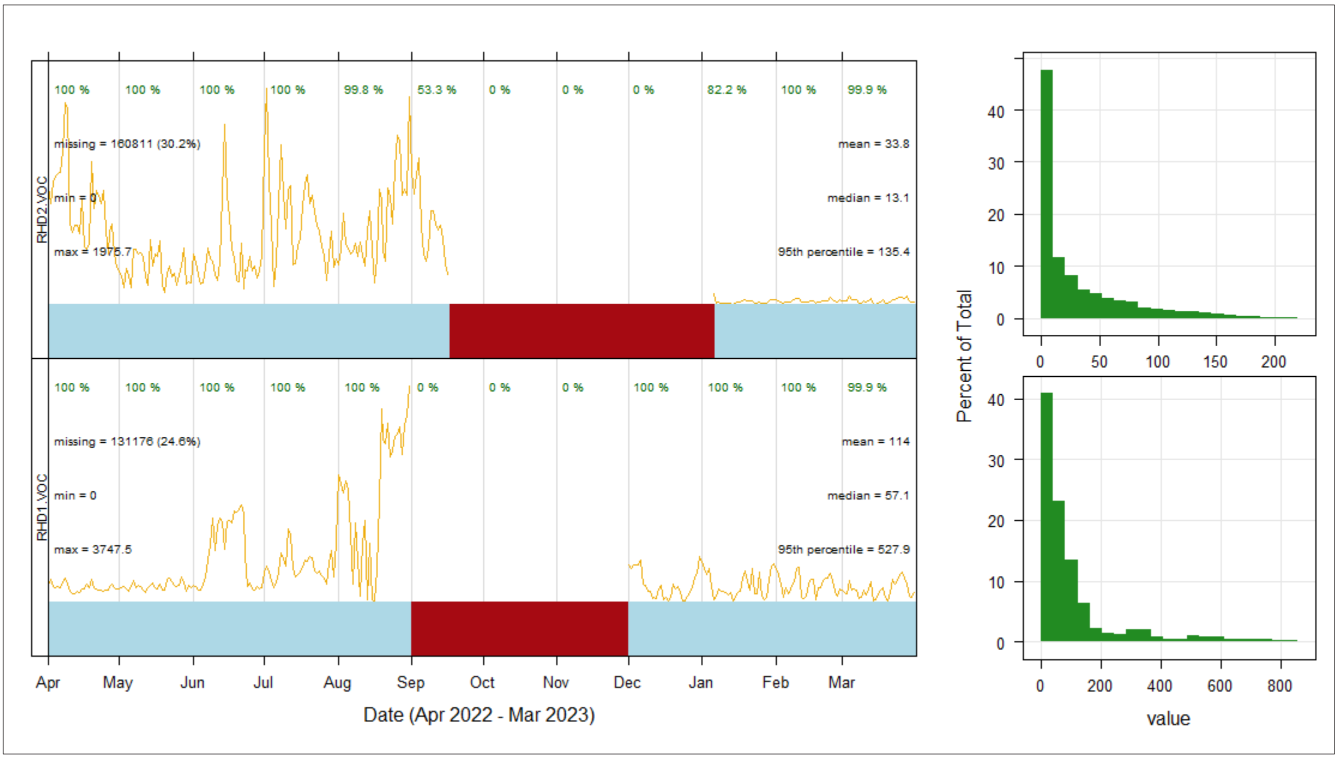
VOC

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (VOC).

I. Time series

Figure 122 presents the VOC Time series:

Figure 122. VOC Time series at RHD1 – eNose 8 and RHD2 – eNose 9.

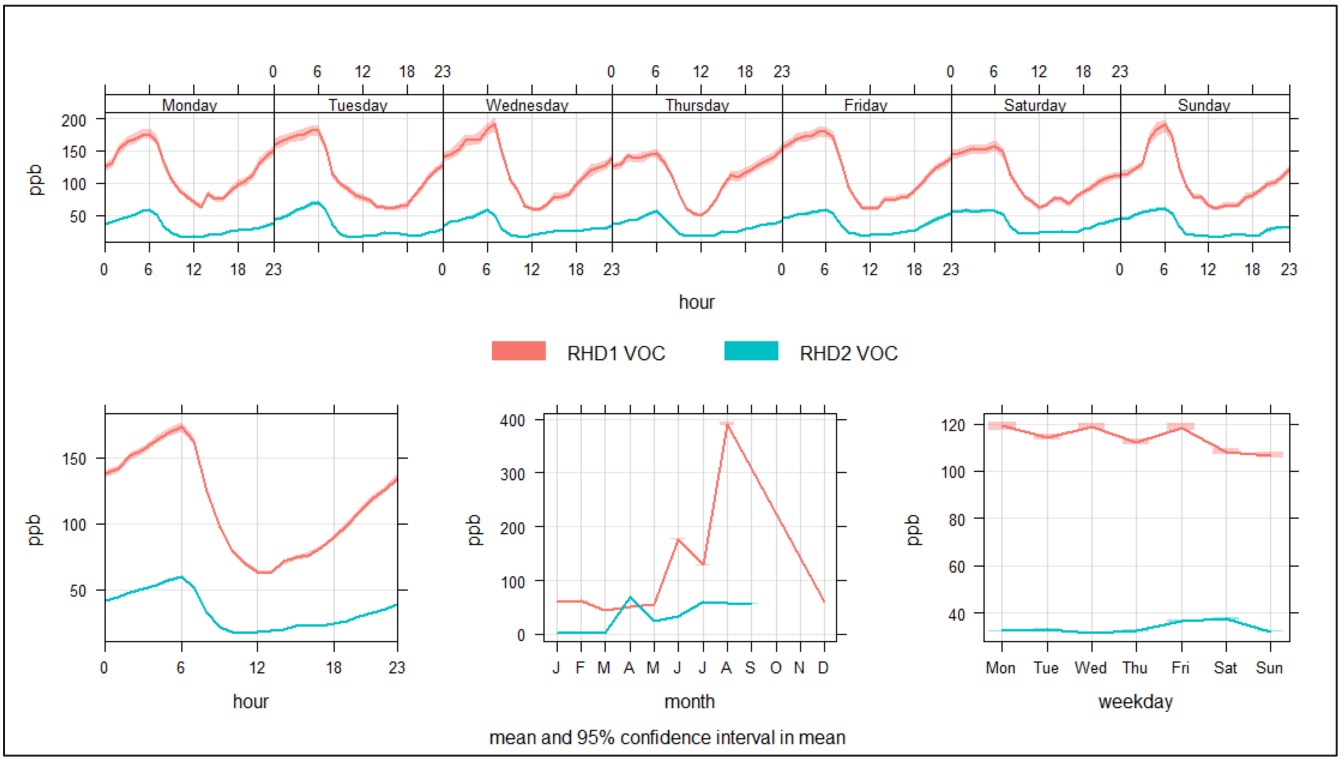


The time series shows that there is missing data due to VOC sensors malfunctioning, RHD1 between September and December 2022 and RHD1 between September 2022 and the beginning of January 2023.

II. Hourly, daily, weekly, and monthly cycles

Figure 123 presents the VOC hourly, daily, weekly, and monthly cycles:

Figure 123. VOC hourly, daily, weekly, and monthly cycles at RHD1 – eNose 8 and RHD2 – eNose 9.

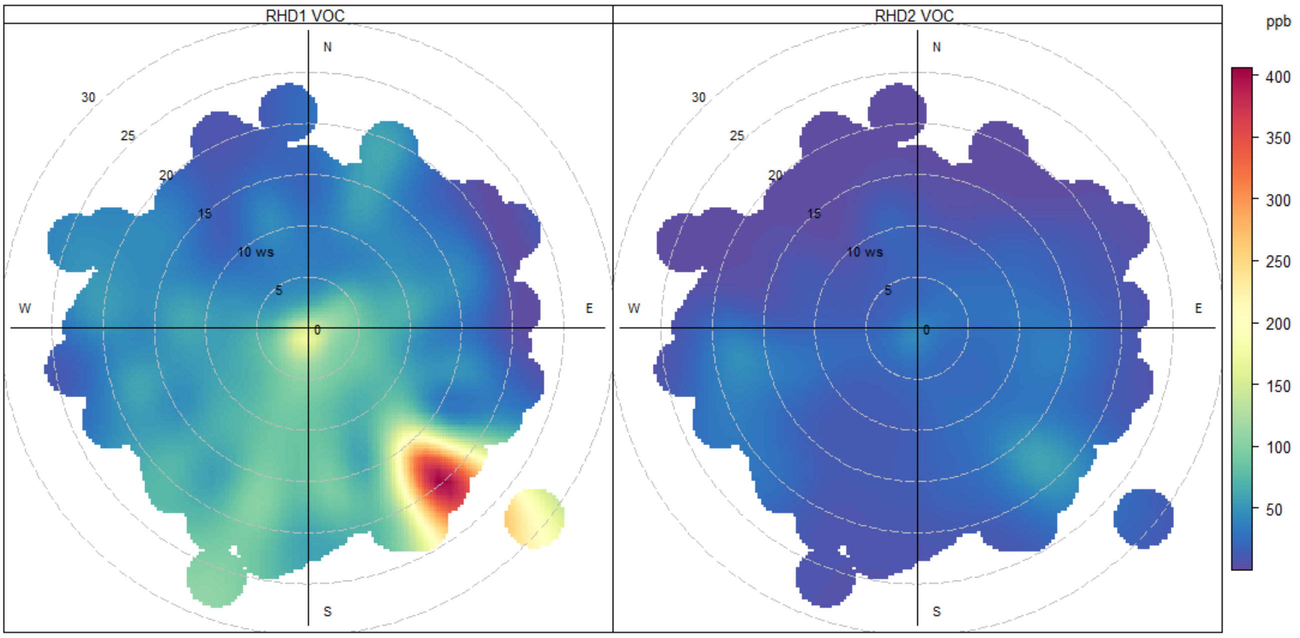


Both monitor cycles show a trend of peaks in VOC concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 124 presents the VOC pollution roses:

Figure 124. VOC pollution roses at RHD1 – eNose 8 and RHD2 – eNose 9.

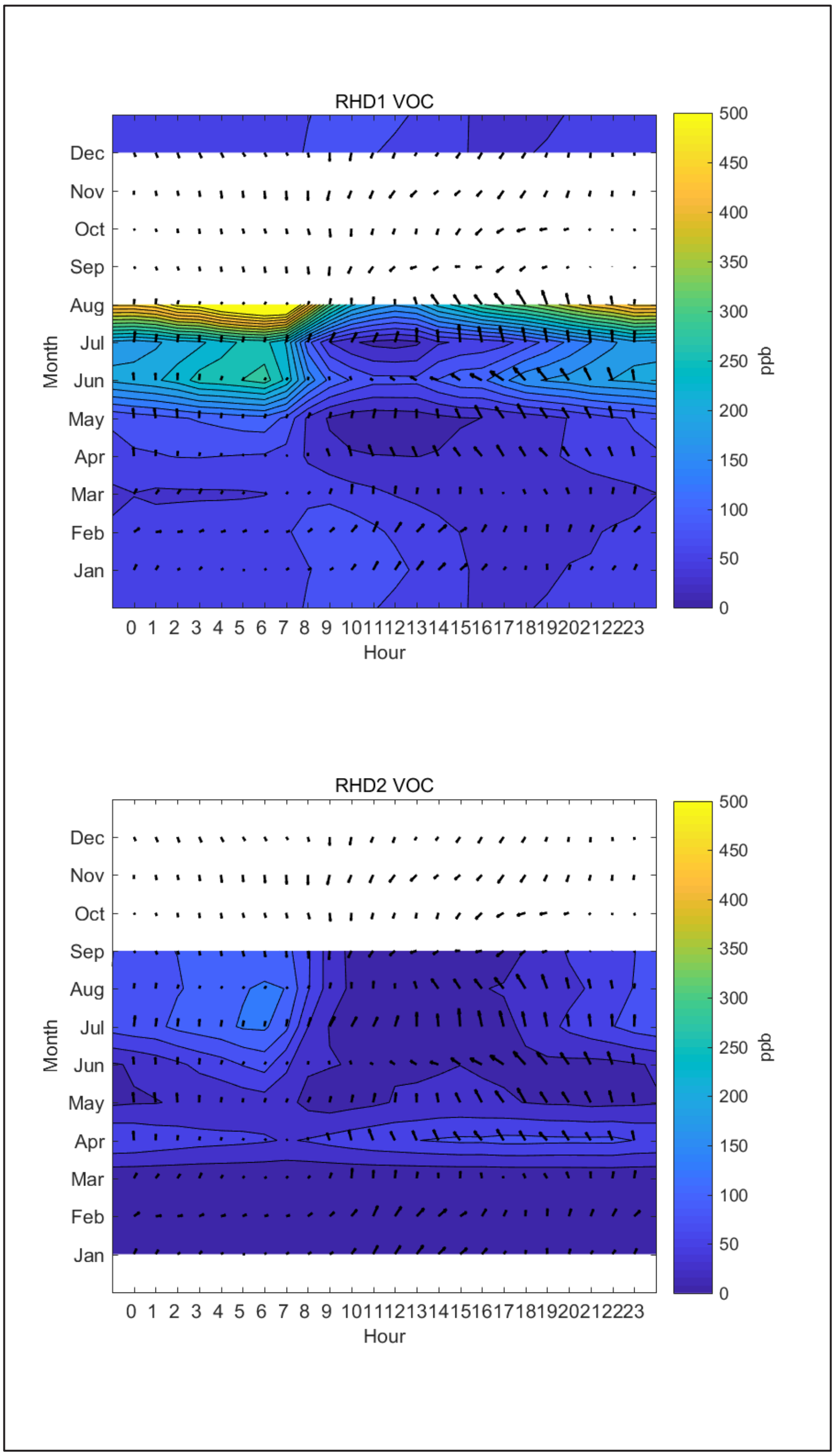


Both pollution roses show higher VOC concentrations when there are low winds below 5mph and when there are SE winds.

IV. Seasonal cycles

Figure 125 presents the VOC seasonal cycles:

Figure 125. VOC seasonal cycles at RHD1 – eNose 8 and RHD2 – eNose 9.



The seasonal cycle shows higher VOC concentrations during dawn, particularly between 12am to 7am. The white areas in both eNoses represent the missing data for the period when the sensors malfunctioned.

f) RVL1 - eNose 10 and RVL2 – eNose 11.

This section contains the monitored air quality data for RVL1 – eNose 10 and RVL2 – eNose 11 between April 2022 and March 2023.

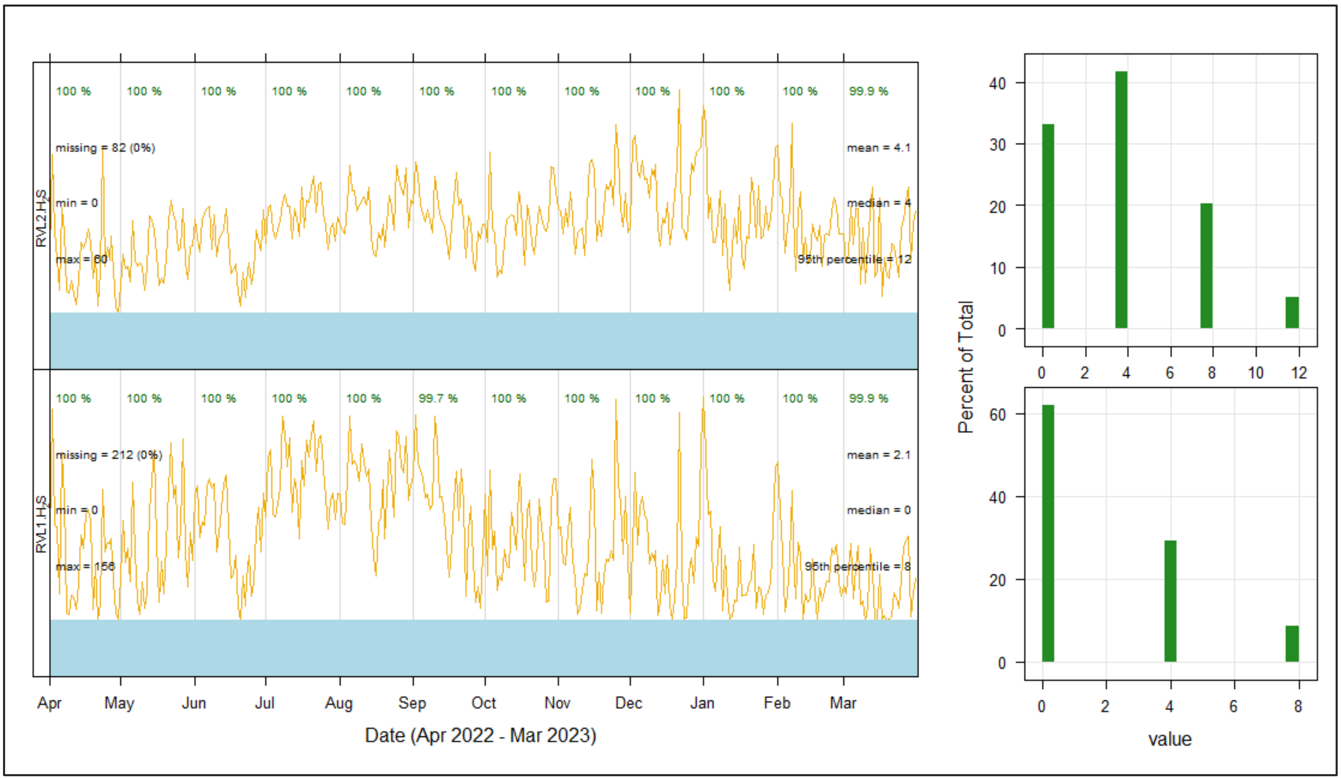
<u>**H_2S**</u>

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for hydrogen sulfide (H_2S).

I. Time series

Figure 126 presents the H_2S time series:

Figure 126. H_2S Time series at RVL1 – eNose 10 and RVL2 – eNose 11.

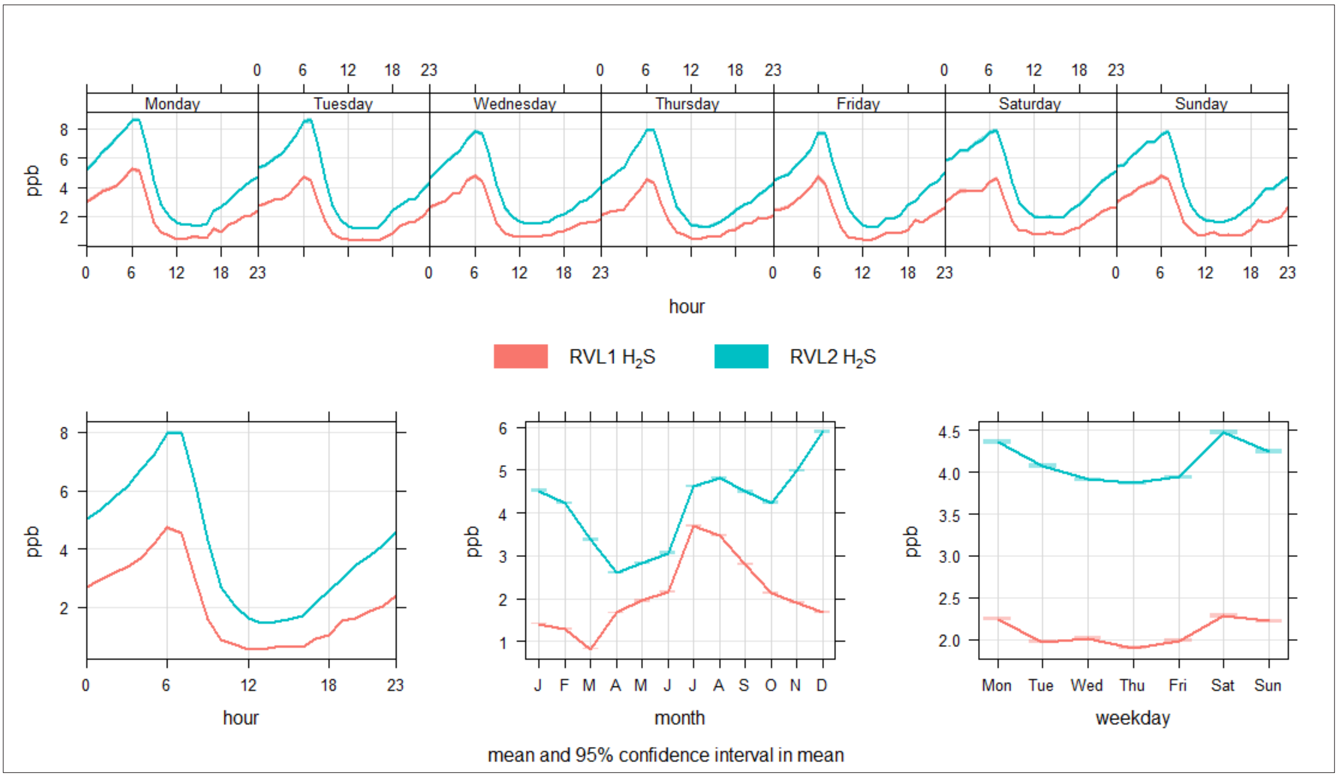


The time series show a high level of data completeness for both eNoses.

II. Hourly, daily, weekly, and monthly cycles

Figure 127 presents the H_2S hourly, daily, weekly, and monthly cycles:

Figure 127. H_2S hourly, daily, weekly, and monthly cycles at RVL1 – eNose 10 and RVL2 – eNose 11.

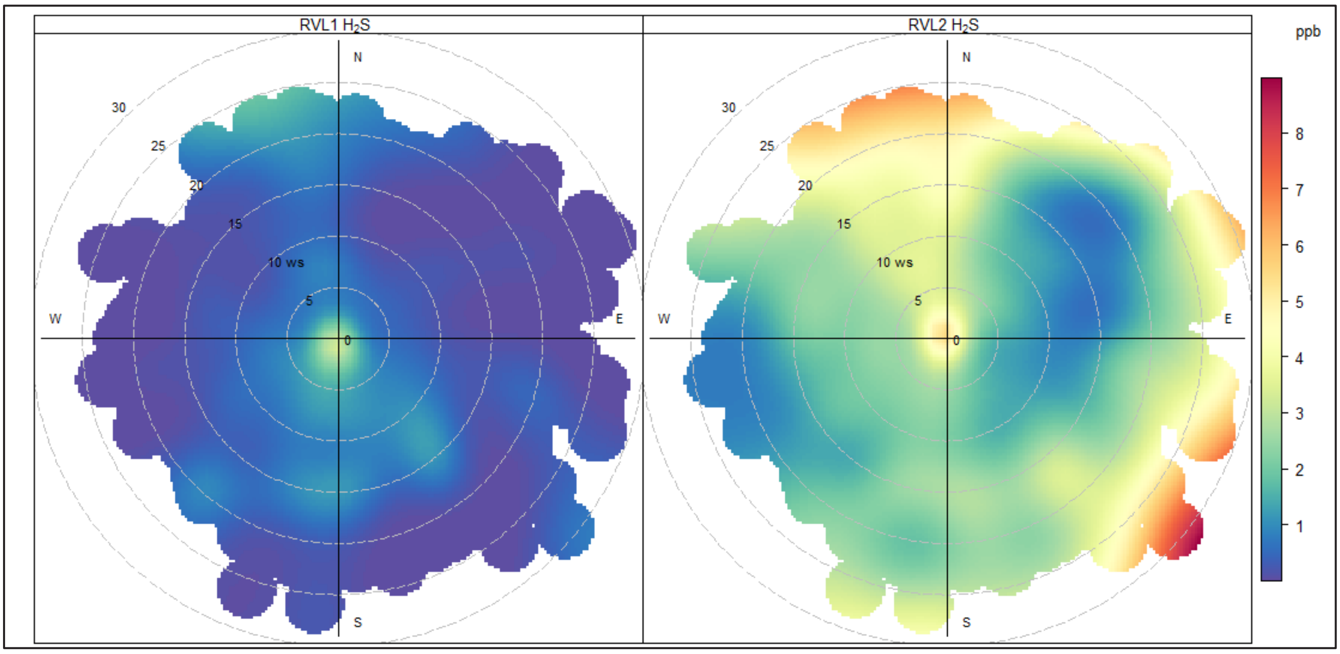


Both cycles show a trend of peaks in H_2S concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 128 presents the H_2S pollution roses:

Figure 128. H_2S pollution roses at RVL1 – eNose 10 and RVL2 – eNose 11.

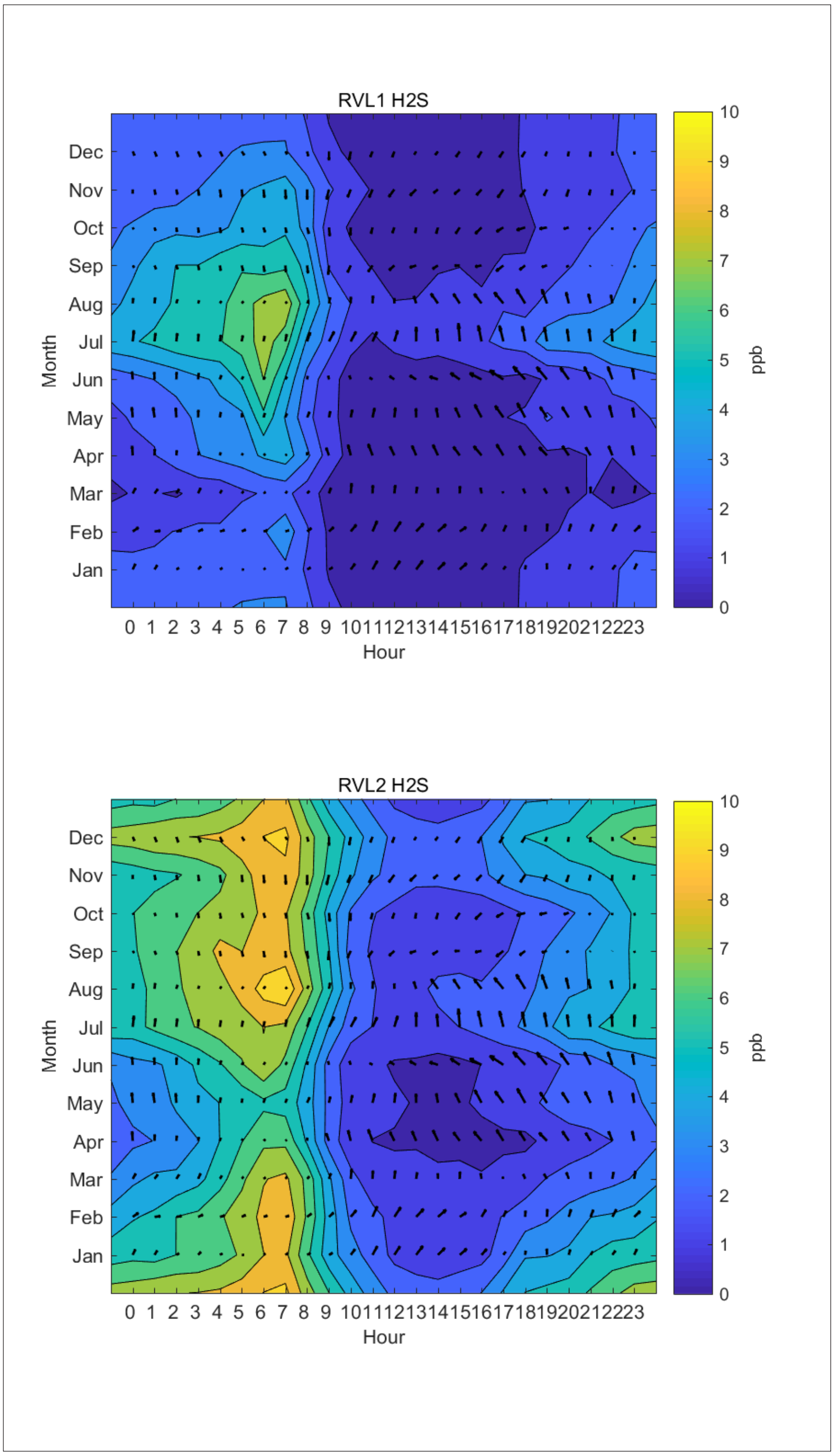


RVL1 shows higher H_2S when there are low winds below 5mph, and RVL2 shows higher concentrations when there are NNW and SE winds higher than 20mph.

IV. Seasonal cycles

Figure 129 presents the H_2S seasonal cycles:

Figure 129. H_2S seasonal cycles at RVL1 – eNose 10 and RVL2 – eNose 11.



Both seasonal cycles show higher H_2S concentrations during dawn and early morning, particularly between 4am and 8am.

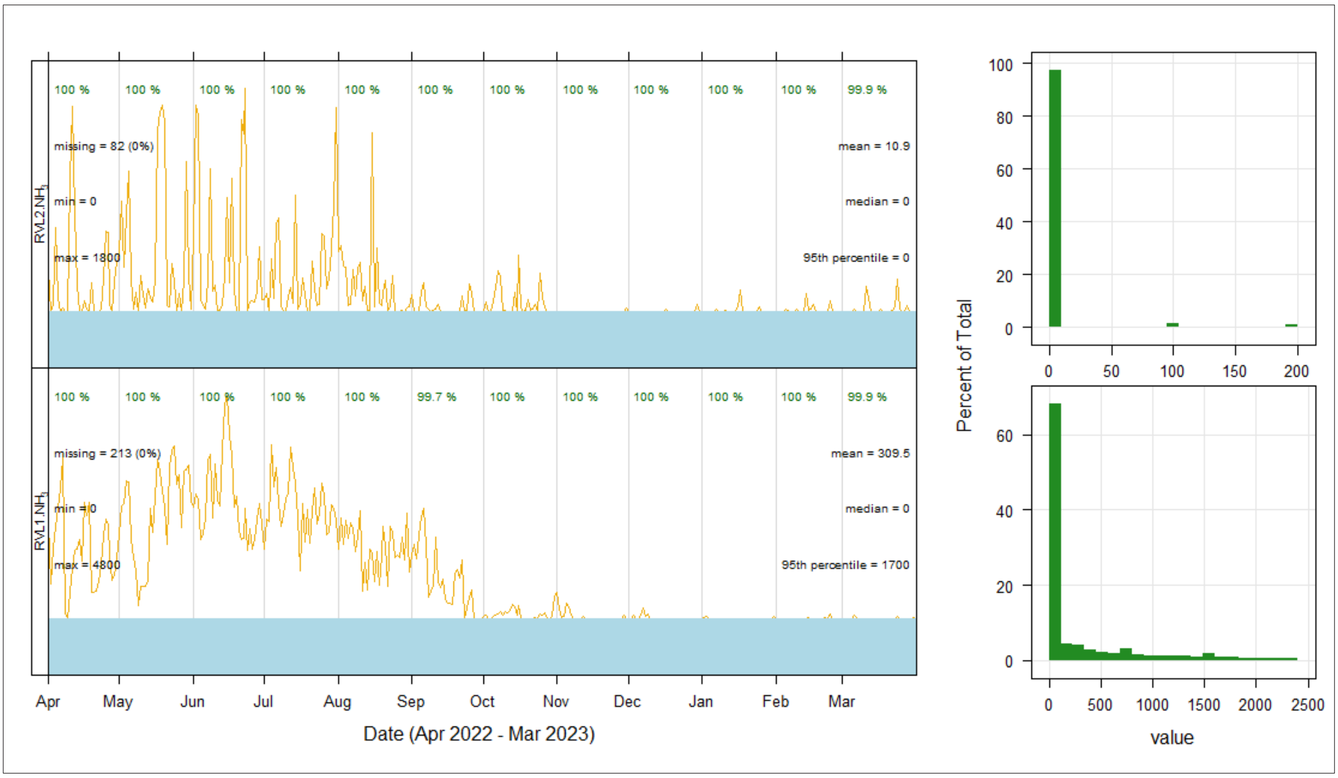
NH_3

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (NH_3).

I. Time series

Figure 130 presents the NH_3 time series:

Figure 130. NH_3 time series at RVL1 – eNose 10 and RVL2 – eNose 11.

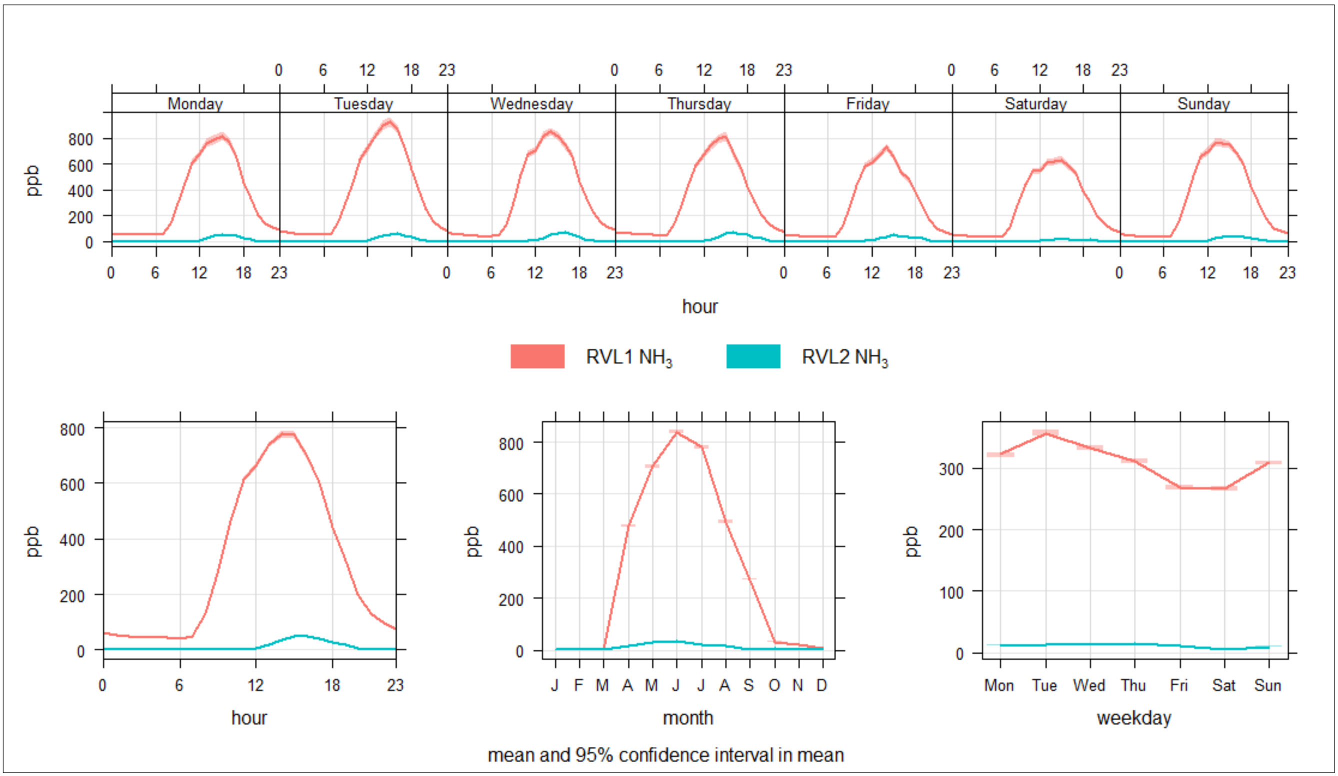


The time series show a high level of data completeness for both eNoses.

II. Hourly, daily, weekly, and monthly cycles

Figure 131 presents the NH_3 hourly, daily, weekly, and monthly cycles:

Figure 131. NH_3 hourly, daily, weekly, and monthly cycles at RVL1 – eNose 10 and RVL2 – eNose 11.

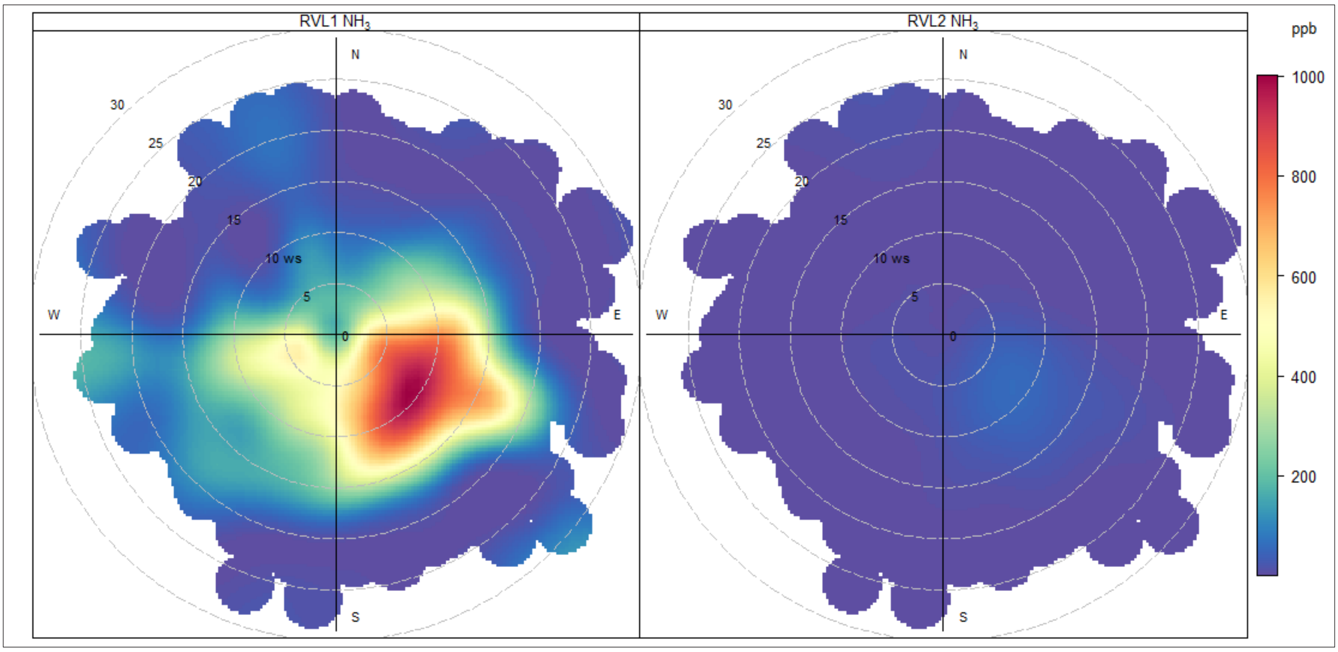


Both NH_3 cycles show a similar trend, with peaks during the day and afternoon, and lower concentrations during the night and dawn. RVL1 shows higher concentrations compared to RVL2.

III. Pollution roses

Figure 132 presents the NH_3 pollution roses:

Figure 132. NH_3 pollution roses at RVL1 – eNose 10 and RVL2 – eNose 11.

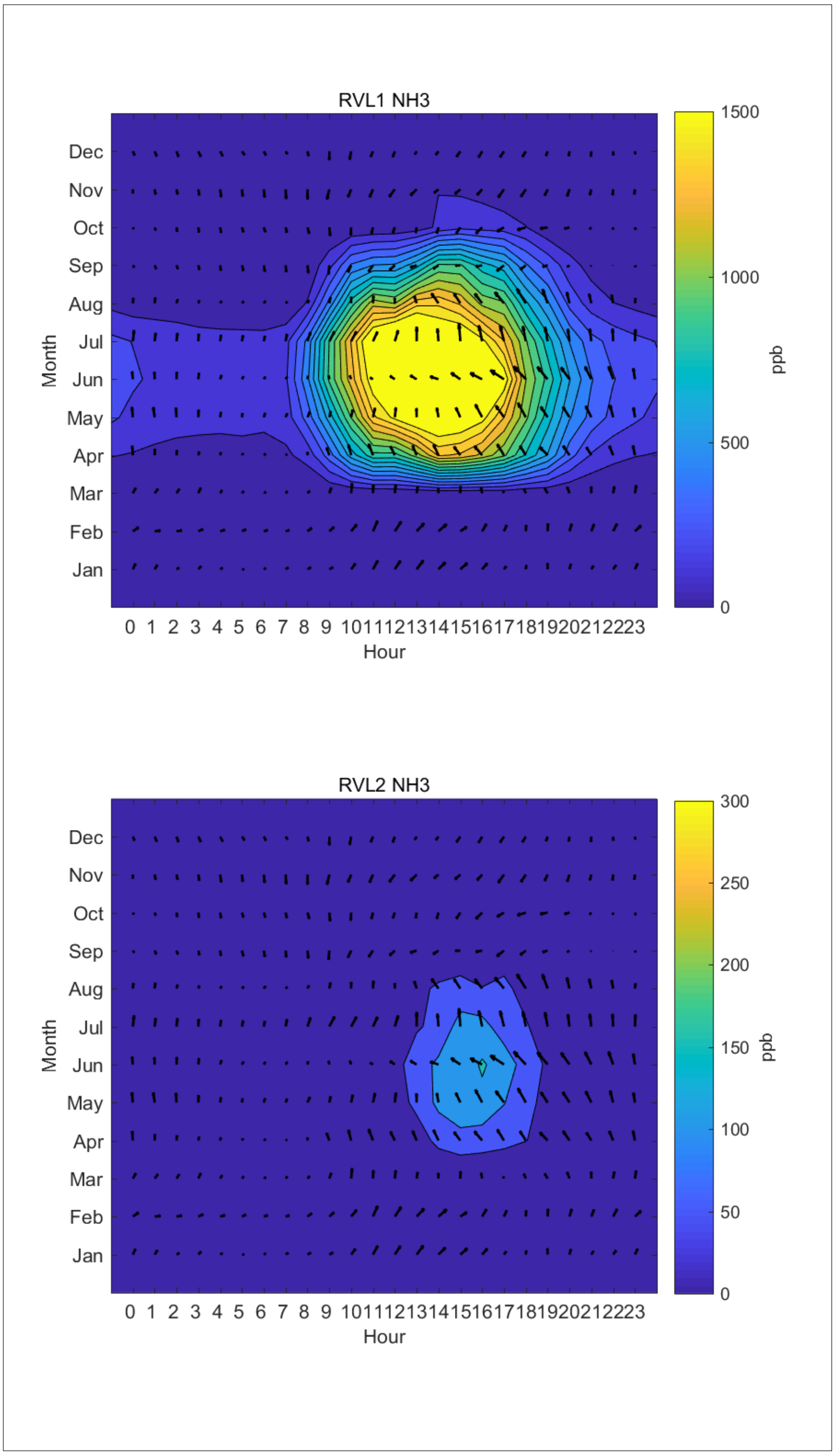


Both pollution roses show that higher NH_3 concentrations occur when there are SE winds between 5-15mph.

IV. Seasonal cycles

Figure 133 presents the NH_3 seasonal cycles:

Figure 133. NH_3 seasonal cycles at RVL1 – eNose 10 and RVL2 – eNose 11.



The seasonal cycles show a similar trend on both eNoses, higher concentrations of ammonia occur during the day and afternoon, particularly between 10am and 6pm in summer months.

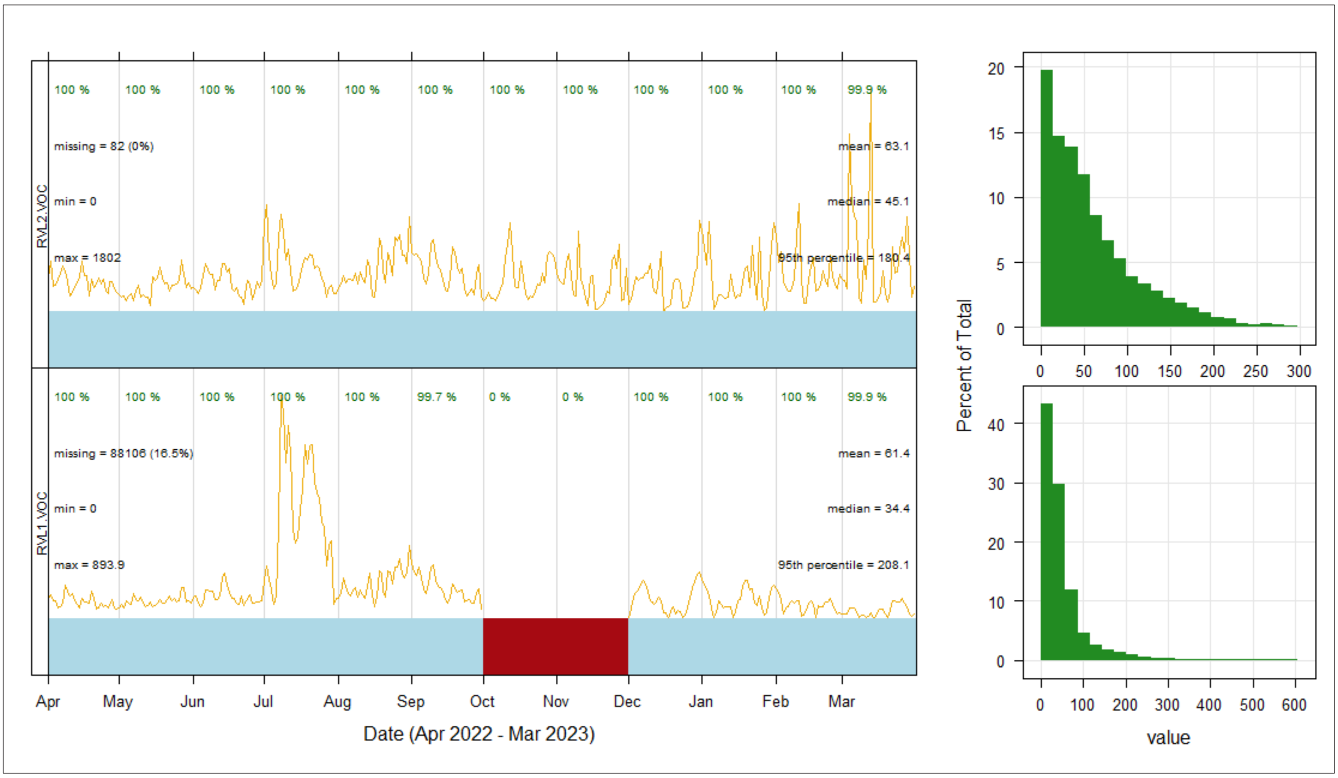
VOC

Below are the time series, hourly, daily, weekly, and monthly cycles, pollution roses and seasonal cycles for ammonia (VOC).

I. Time series

Figure 134 presents the VOC time series:

Figure 134. VOC Time series at RVL1 – eNose 10 and RVL2 – eNose 11.

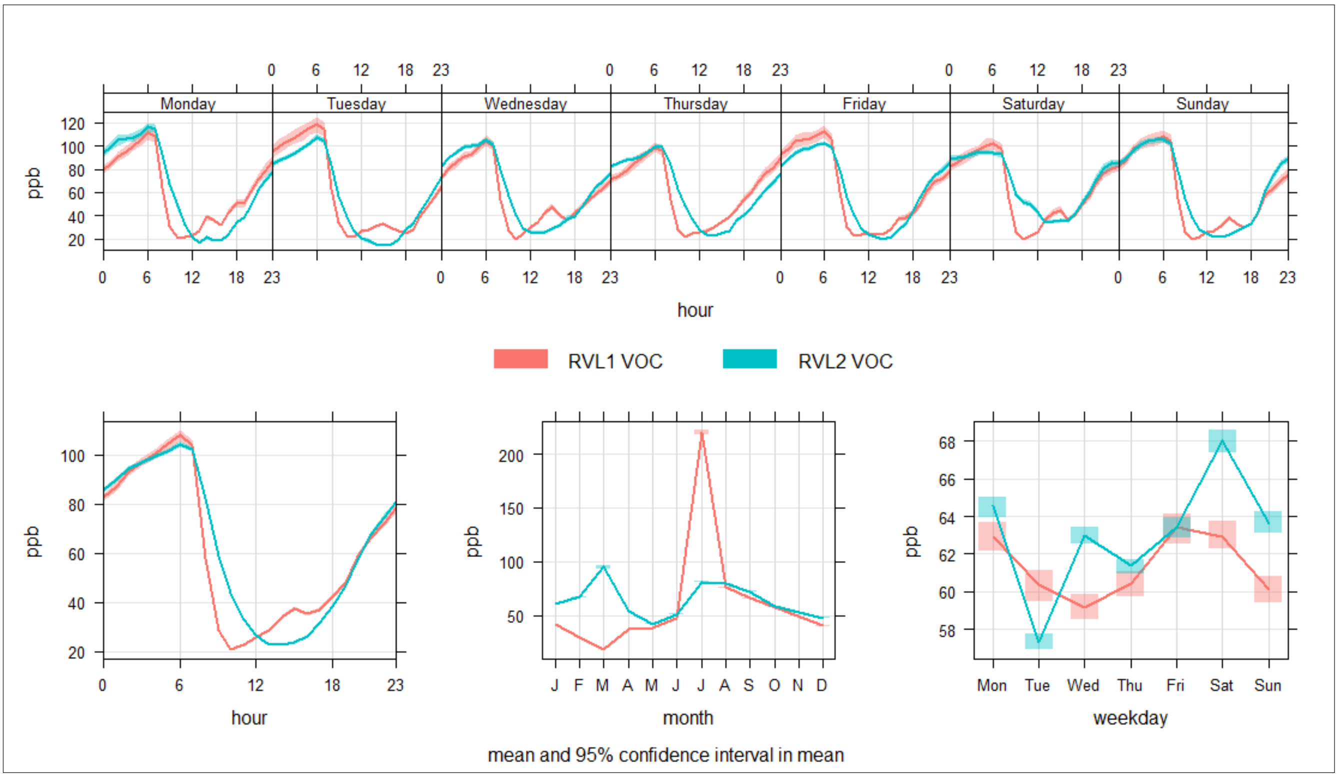


The time series show a high level of data completeness for RVL2, there is missing data on RVL1 between October and December 2022 due to sensor malfunctioning.

II. Hourly, daily, weekly, and monthly cycles

Figure 135 presents the VOC hourly, daily, weekly, and monthly cycles:

Figure 135. VOC hourly, daily, weekly, and monthly cycles at RVL1 – eNose 10 and RVL2 – eNose 11.

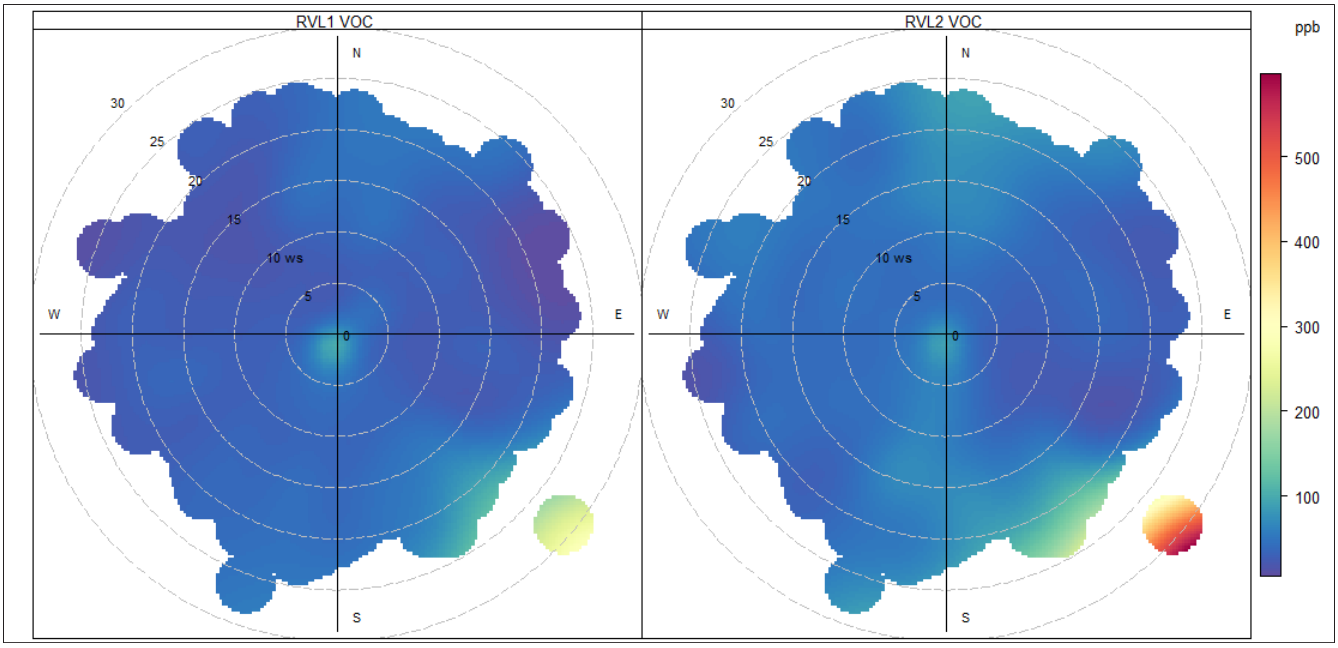


Both cycles show a trend of peaks in VOC concentrations during the early morning, and lower values during the day, particularly at midday.

III. Pollution roses

Figure 136 presents the VOC pollution roses:

Figure 136. VOC pollution roses at RVL1 – eNose 10 and RVL2 – eNose 11.

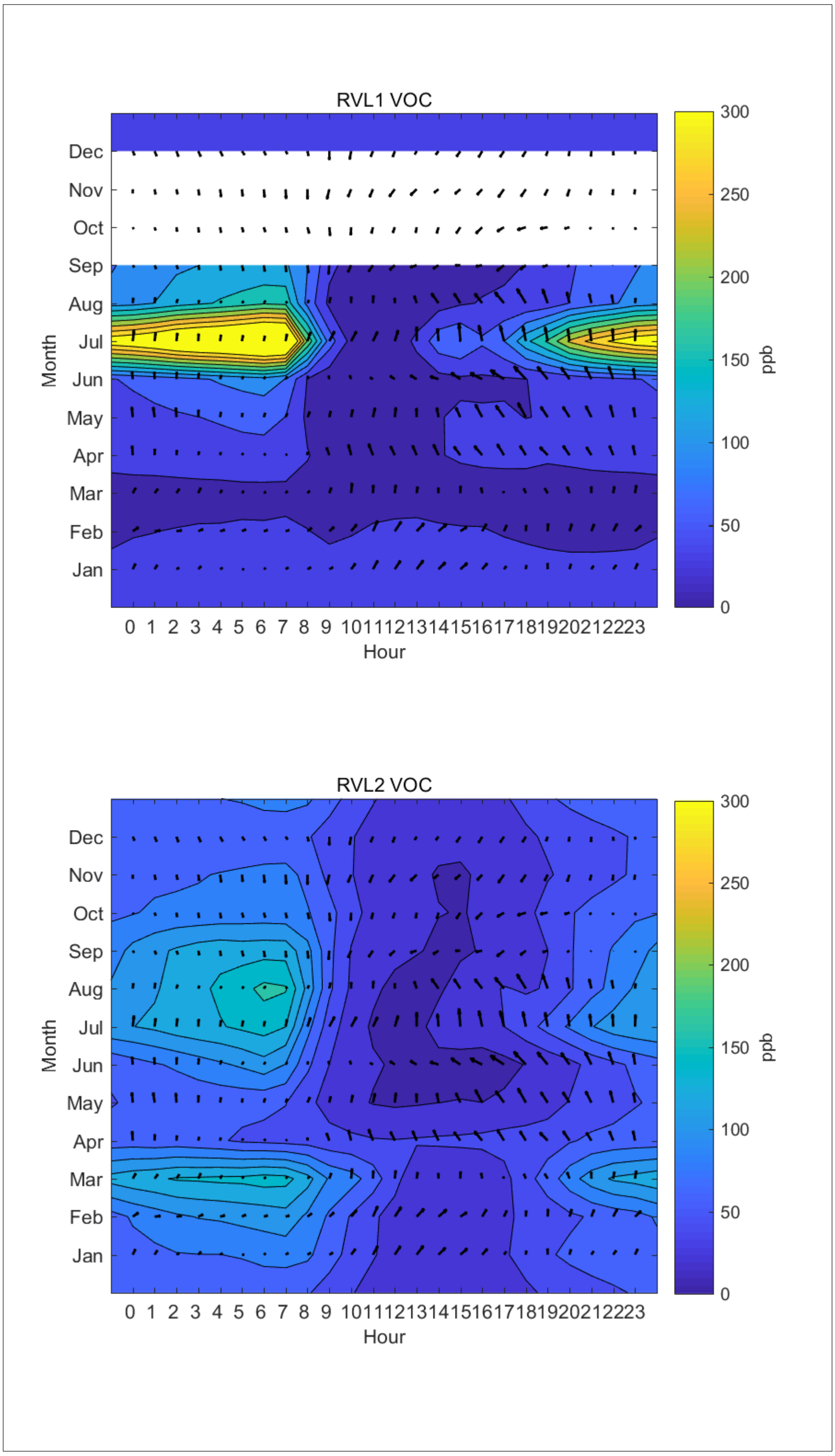


Both pollution roses show an increase in VOC concentrations when there are SE winds at wind speeds higher than 25mph.

IV. Seasonal cycles

Figure 137 presents the VOC seasonal cycles:

Figure 137. VOC seasonal cycles at RVL1 – eNose 10 and RVL2 – eNose 11.



The seasonal cycle shows higher VOC concentrations during dawn, particularly between 12am to 7am. The white areas in RVL1 represent the missing data for the period when the sensor malfunctioned.

g) Discussion on Air Quality Data

From the data presented in this section, it was found that during the study period most of the eNoses results show a similar trend in the cycles of H_2S and VOCs. There are higher concentrations of these pollutants during dawn. This could be associated with the local release of pollutants from sources within the city during this time of day that take time to dilute due to poor atmospheric dispersion conditions during these hours, then most of the cycles show a decrease in concentrations for these pollutants as the day progresses, when there are better ventilation conditions.

As for NH_3, most of the results presented a trend with higher concentrations of ammonia during the day, from de morning to the afternoon, this correlates well with documented research around this pollutant (Ellis, et al., 2010), where it has been demonstrated that increases in ammonia occur naturally between the morning and the afternoon due to one or more of the following reasons:

- Evaporation of dew.
- Volatilization of particulate ammonium.
- Emission from plant stomata.
- Mixing down of ammonia from the residual layer.

Important things to consider in the information presented in the air quality analysis are:

- As mentioned in section 5.1.1.2, the H_2S, VOC, and NH_3 sensors in the eNoses are indicative devices that can help show trend changes in concentrations, as demonstrated in this section. This is useful for understanding when there are higher and lower concentrations of each pollutant.

- As shown in section 5.1.1.3, although an effort was made to place the eNoses as close as possible to the suspected industrial sources, they were not right next to the main source of odor emissions at each facility and were installed in nearby public places. Considering that these are ambient monitors, this means that they are likely to pick up any concentration of gas from the suspected sources or not, which may explain some of the differences between the eNoses presented in this section.

5.2.3 Modelling Analysis

5.2.3.1 Uncertainty Evaluation of Meteorological Model vs Observations

To assess the forecast model performance at City of Jacksonville, point-based hourly model predictions that align with an onsite weather station hourly averages were compared. Model verification is conducted for meteorological parameters that are important to dispersion, such as wind speed and direction, and temperature.

Considering the representative location of the main complaint area and data availability, the evaluation is presented for Met 1 weather station. The evaluation consists in two types of analysis, as presented below:

- **Qualitative analysis:** graphs are presented to compare observed and modeled daily cycles (to visualize variations throughout the day), seasonal cycles (to visualize variations throughout the day and year), and wind roses.

- **Quantitative analysis:** As there is no single best-performance indicator for spatially and temporally varying of forecast data, a set of statistical parameters are calculated to assess the ability and accuracy of the model to represent observed weather conditions. The World Meteorological Organization (WMO) published the document "Manual on the Global Data-processing and Forecasting System: Annex IV to the WMO Technical Regulations" (WMO, 2019) to standardise the verification systems used in the assessment of model performance. The statistical parameters used for assessing performance, are explained in detail below:

  - ✓ **Model Bias (MB):** The model bias is the mean error and is given by:

$$MB = \frac{1}{n}\sum_{i=1}^{n}(O_i - M_i)$$

    where:
    n = the number of pairs of observed data
    O_i= the observed value for the i-th hour
    M_i = the predicted value for the i-th hour

    The ideal value for the bias is zero.

  - ✓ **Gross Error (GE):** The gross error is the mean of absolute error and is given by:

$$GE = \frac{1}{n}\sum_{i=1}^{n}|O_i - M_i|$$

    where:
    n = the number of pairs of observed data
    O_i= the observed value for the i-th hour
    M_i = the predicted value for the i-th hour

    The ideal value for gross error is zero. GE is greater than MB, representing the expected error for each hourly observation.

✓ **Root Mean Square Error (RMSE):** The Root Mean Square Error is given by:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(O_i - M_i)^2}$$

where:
n = the number of pairs of data
O_i= the observed (measured) value for the i-th hour
M_i = the predicted (modelled) value for the i-th hour

While the ideal RMSE value is 0, large errors in a small section of the data may produce a large RMSE even though errors may be small elsewhere.

✓ **Index of Agreement (IOA):** The index of agreement is the measure of how well the model estimates departure from the observed mean.

$$IOA = 1 - \frac{\sum_{i=1}^{n}(O_i - M_i)^2}{\sum_{i=1}^{n}(|M_i - \overline{O}| + |O_i - \overline{O}|)^2}$$

where:
n = the number of pairs of observed data
O_i= the observed value for the i-th hour
M_i = the predicted value for the i-th hour
$\overline{O}$ = the mean observed value

The index of agreement has a theoretical range of 0 to 1. The ideal value for IOA is 1.

A set of benchmarks were set for mesoscale model evaluation (Emery, Tai, & Yarwood, 2001) and will be considered for this evaluation, these benchmarks and were adopted by the US EPA in 2002 (Tesche, McNally, Emery, & Tai, 2001), they are listed in Table 14:

Table 14. Mesoscale model benchmarks.

Variable	RMSE	BIAS	GE	IOA
Wind speed	≤ 2 m/s	≤ ±0.5 m/s	--	> 0,6
Wind direction	--	≤± 10°	≤ 30°	--
Temperature	--	≤ ±0.5 K	≤ 2 K	> 0,8

Other measures of model accuracy are the UK Met Office operational weather forecast performance metrics (http://www.metoffice.gov.uk/about-us/who/accuracy/forecasts). UK public weather forecasts are routinely verified and assessed against defined metrics and targets covering temperature and wind. The specific metrics are:

- The percentage of times when the temperature forecast is accurate to within ± 2 °C.
- The percentage of times when the wind speed forecast is accurate to within 2.5 m/s.
- The percentage of times when the wind direction forecast is accurate to within 45°.

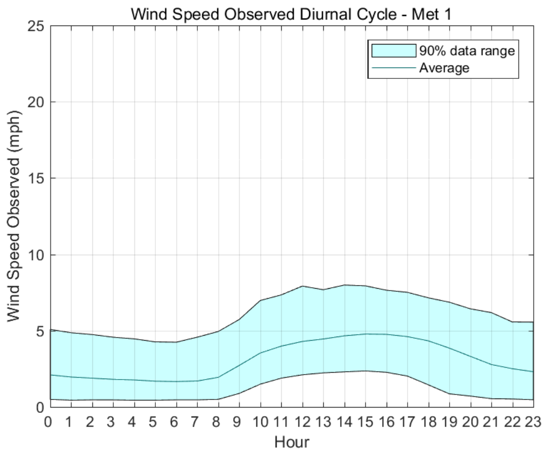
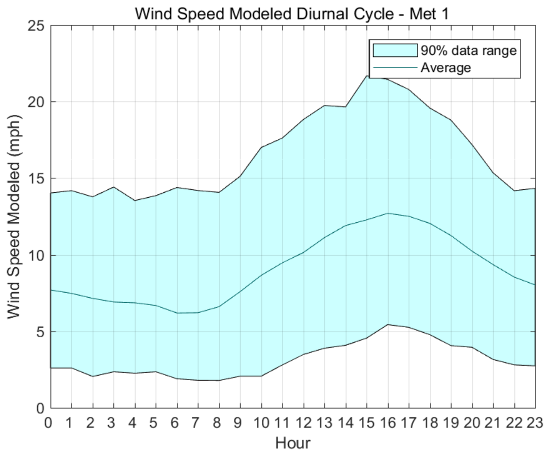
a) **Qualitative analysis**

<u>Wind speed and wind direction</u>

I. Diurnal cycles

Figure 138 presents the comparison of the observed and modeled wind speed diurnal cycles at Met 1:

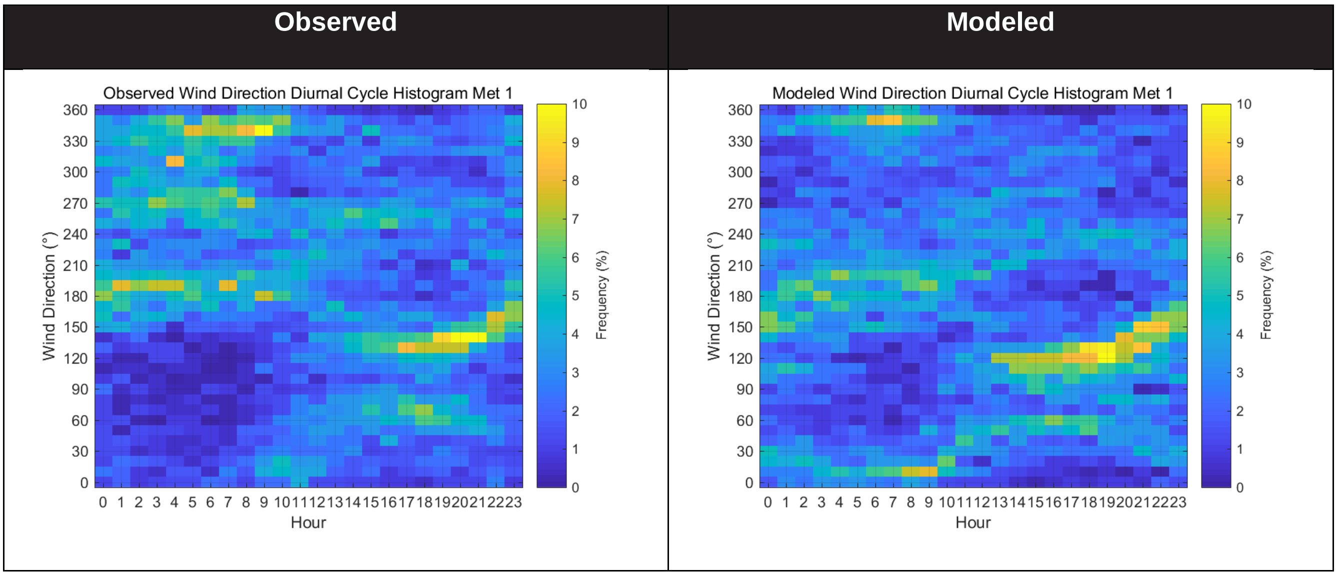
Figure 138. Observed and modeled wind speed diurnal cycles at Met 1.

Observed	Modeled
	

The figures show that the forecast model is capable of represent the times of the day when the wind speed is lower and higher (night-dawn and day-afternoon respectively). However, the model overestimates the wind speed values throughout the day.

Figure 139 presents the comparison of the observed and modeled wind direction diurnal cycles histograms at Met 1:

Figure 139. Observed and modeled wind direction diurnal cycles histograms at Met 1.

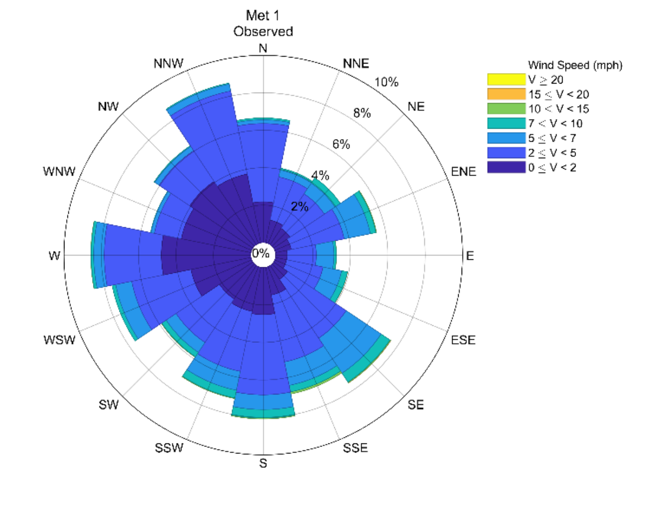
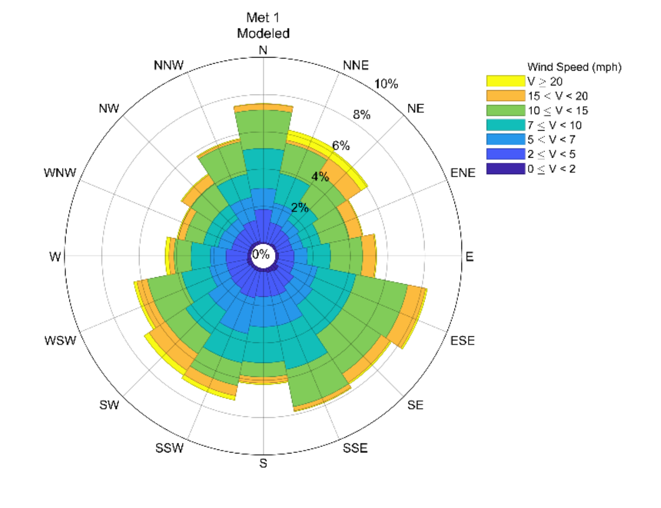


The figures show that the forecast model can represent the wind direction frequencies adequately during the day, both figures show predominance of S, SW, and NNW winds from midnight to 9am, and a shift to SE winds during the afternoon and night which in both figures increase its frequency particularly between 4pm and 10pm.

II. Wind roses

Figure 140 presents the comparison of the observed and modeled wind roses at Met 1:

Figure 140. Observed and modeled wind roses at Met 1.

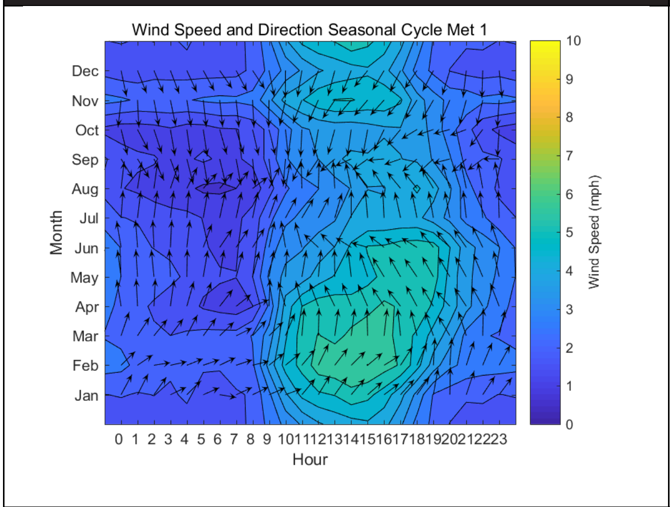
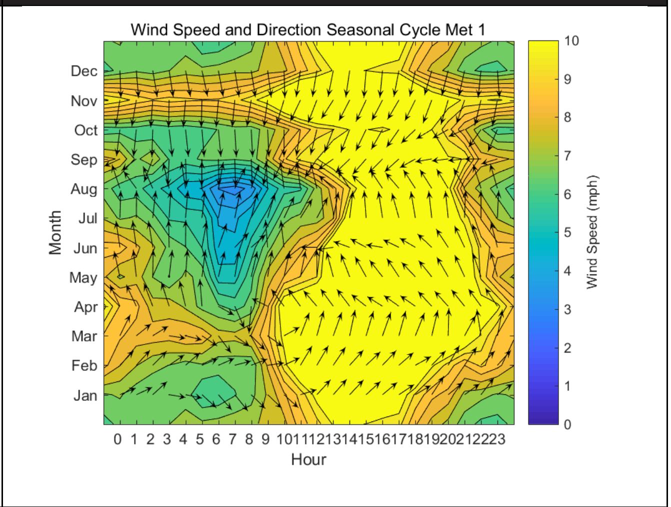
Observed	Modeled
	

The wind roses comparison shows that despite the model can represent the wind direction variability, the wind speed is overestimated.

III. Seasonal cycles

Figure 141 presents the comparison of the observed and modeled wind speed and wind direction seasonal cycles at Met 1:

Figure 141. Observed and modeled wind speed and wind direction seasonal cycles at Met 1.

Observed	Modeled
	

The seasonal cycles comparison shows that despite the model can represent the wind direction variability, the wind speed is overestimated.

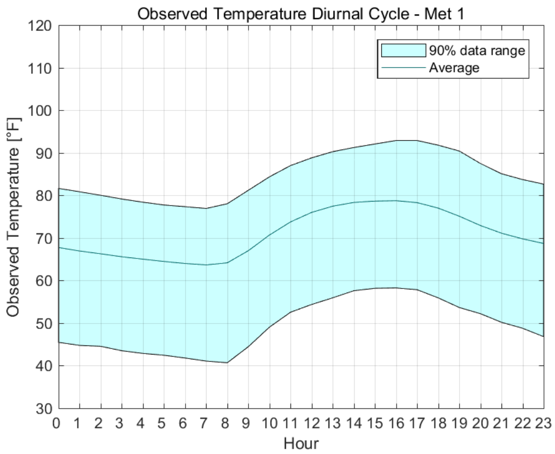
<u>**Temperature**</u>

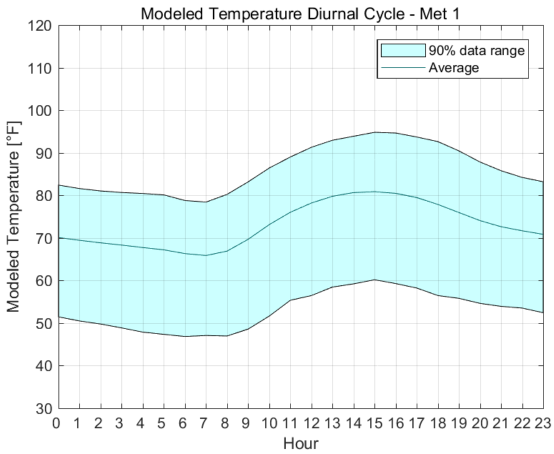
I. Diurnal cycles

Figure 142 presents the comparison of the observed and modeled temperature diurnal cycles at Met 1:

Figure 142. Observed and modeled wind speed diurnal cycles at Met 1.

Observed	Modeled
Observed chart (see below)	Modeled chart (see below)



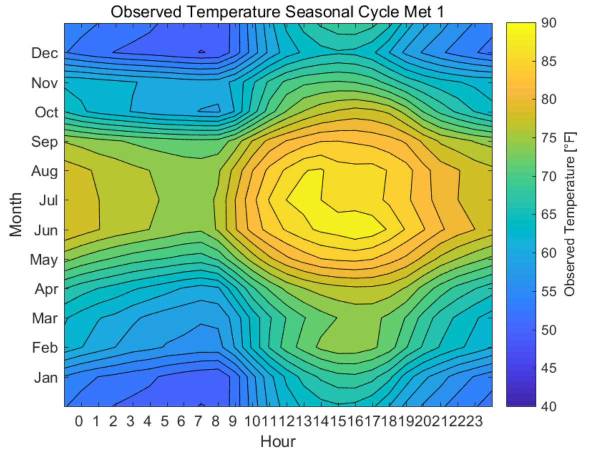
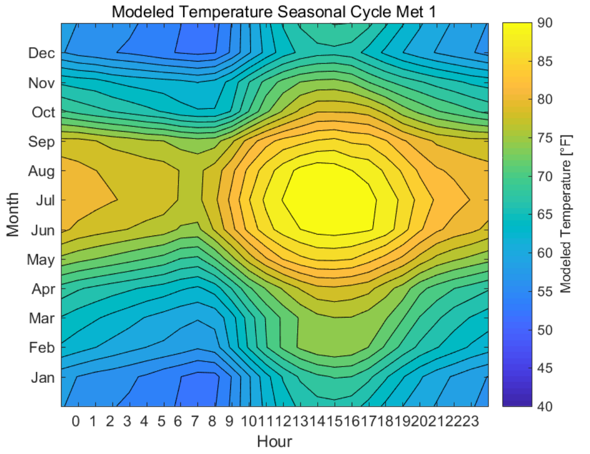


The temperature diurnal cycle comparison shows that the model can represent this parameter adequately, showing higher temperatures during the day and afternoon and lower values during night and dawn.

II. Seasonal cycles

Figure 143 presents the comparison of the observed and modeled temperature seasonal cycles at Met 1:

Figure 143. Observed and modeled temperature seasonal cycles at Met 1.

Observed	Modeled
	

The seasonal cycles comparison shows that the model can represent the observed temperatures during the day and throughout the year.

b) Quantitative analysis

Table 15 presents the calculation of the statistical parameter calculated from both observed and modeled data in Met 1, to assess model performance quantitatively:

Table 15. Statistics for model performance at Met 1.

Parameter	Test	Benchmark	Result	Assessment
Wind Speed	RMSE	<2 m/s	3.14	Out of range
	BIAS	<0.5 m/s	-2.69	Pass
	IOA	>0.6	0.43	Out of range
Temperature	GE	< 2 K	1.63	Pass
	BIAS	<0.5 K	-1.16	Pass
	IOA	>0.8	0.97	Pass
Wind Direction	GE	< 30°	36.60	Out of range
	BIAS	<10°	5.22	Pass

The accuracy of the model, assessed against the UK Met Office operational weather forecast performance metrics show that, for the period assessed, these correspond to:

- Temperature is forecast accurately for 70% of the time.
- Wind speed is forecast accurately 50% of the time.
- Wind direction is accurately forecast 73% of the time.

The model statistics show that the while de model has an acceptable capability for representing wind direction and temperature (having only one statistical benchmark slightly out of range for wind direction), it overestimates the wind speed and 2 out of 3 benchmarks are out of range.

5.2.3.2 Upper Air Evaluation of Meteorological Model

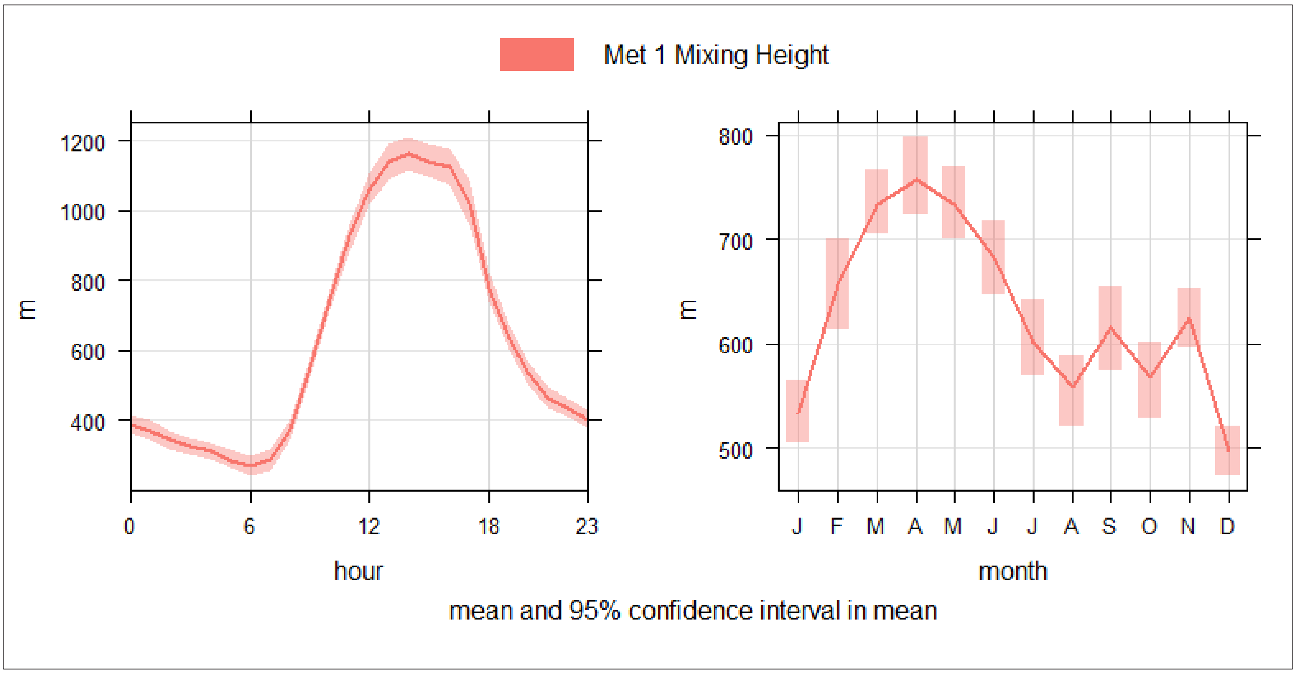
Upper air meteorology was not measured during the study, as there was no hardware available to measure these parameters. However, the WRF-CALMET model can provide this information because of the forecast run.

This section aims to present the forecast upper air data modeled from a virtual location corresponding to Met 1 weather station, to better understand the changes of mixing height and temperature inversions during the day and the months of the year.

A series of internal algorithms within the WRF-CALMET forecast model are used to calculate mixing heights for the site where it is assumed that mixing height is formed through mechanical means (wind speed) at night and through a mixture of mechanical and convective means (wind speed and solar radiation) during the day (Scire, Robe, Fernau, & Yamartino, 2000). During the night and early morning when the convective mixed layer is absent or small, the full depth of the planetary boundary layer (PBL) may be controlled by mechanical turbulence. During the day, the height of the PBL during convective conditions is then taken as the maximum of the estimated (or measured if available) convective boundary layer height and the estimated (or measured if available) mechanical mixing height. It is calculated from the early morning potential temperature sounding (prior to sunrise), and the time varying surface heat flux to calculate the time evolution of the convective boundary layer.

The hourly and monthly variation of mixing height is summarised in Figure 144 with the diurnal cycle clear. At night, mixing height is normally low and after sunrise it typically increases to between 1,000 m and 1,200 m in response to convective mixing generated by solar heating of the Earth's surface.

Figure 144. Mixing height diurnal and monthly cycles.

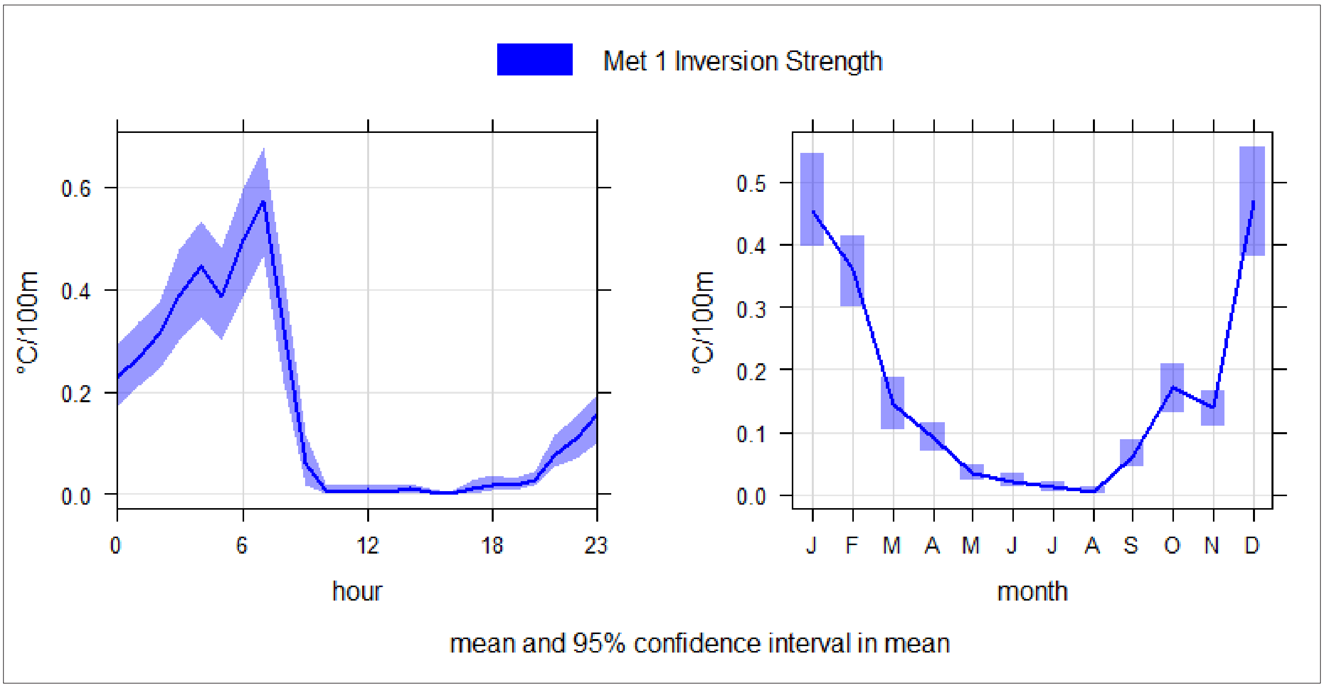


In the troposphere (the lowest layer in the atmosphere), temperature typically decreases with height up to the tropopause (9-12 km high). However, sometimes a small layer can form where the temperature increases with height. This is inverted compared to what you would normally expect, hence the term 'inversion'.

Inversions often occur in areas of high pressure, where air aloft subsides towards the ground. As it descends, it warms up adiabatically. This warm layer of air then acts as a lid and traps cooler air near the surface due to the warmer air being more buoyant than the cooler air below. Inversions can also form when the surface cools rapidly during clear nights through radiation, thereby creating a colder layer of air close to the surface, overlain by a warmer layer. This is known as a radiation inversion.

Inversions are important inhibitors of dispersion of pollutants due to vertical transport of releases being restricted, Figure 145 presents the hourly and monthly cycles for forecast inversions, the data shows that worst ventilation conditions occur at dawn, particularly between 4am-8am and in winter months.

Figure 145. Inversion strength diurnal and monthly cycles.



5.2.3.3 Odor Dispersion Model

As was explained in section 5.1.2.2, a virtual odor dispersion model was established for the industrial area, with fixed emission rates for some of the identified sources. This model was utilized to investigate the dispersion of potential odorous emissions from these sources, as well as to evaluate the impacts of weather changes.

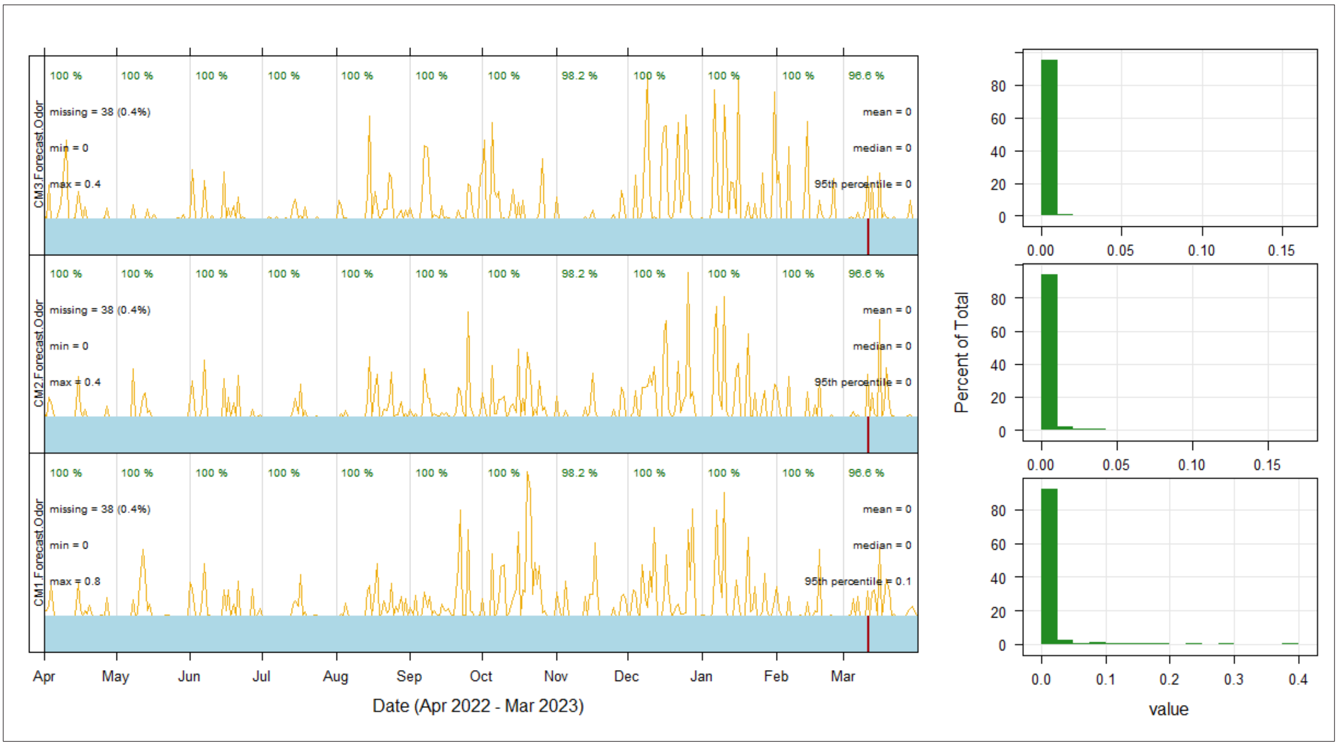
Throughout the year-long study, both observed and forecast dispersion models were implemented. These models recorded odor concentrations at virtual alert points, positioned at the same locations as CM1 - eNose 3, CM2 - eNose 4, and CM3 - eNose 5, which correspond to the area with the highest number of historical complaints (refer to Table 8 and Figure 20).

This section aims to present the results of the forecast odor dispersion model; to this end, the time series are presented, along with the hourly, daily, weekly, and monthly cycles and the seasonal cycles.

a) Time Series

Figure 146 presents the forecast odor time series:

Figure 146. Forecast odor time series.

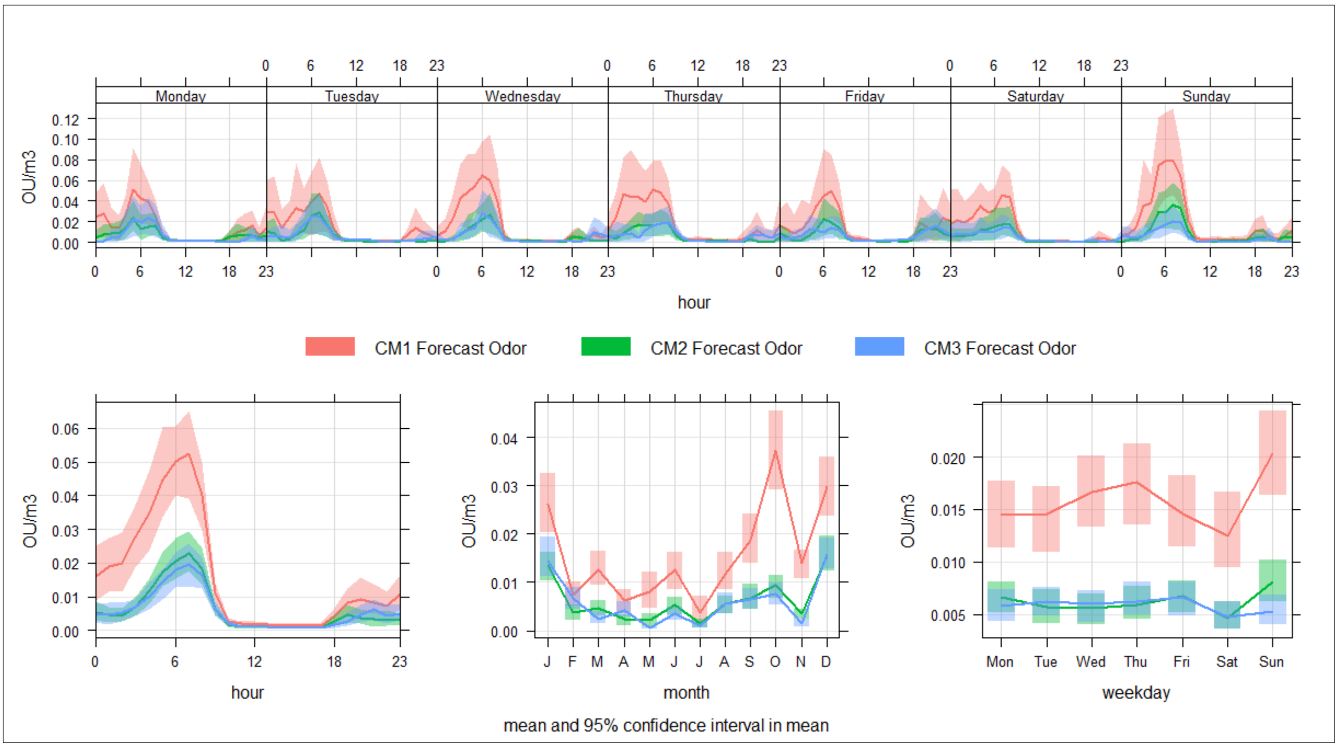


As expected, there is a high level of data completeness for the forecast odor concentrations at all alert points.

b) Hourly, daily, weekly, and monthly cycles

Figure 147 presents the forecast odor hourly, daily, weekly, and monthly cycles.

Figure 147. Forecast odor hourly, daily, weekly, and monthly cycles.

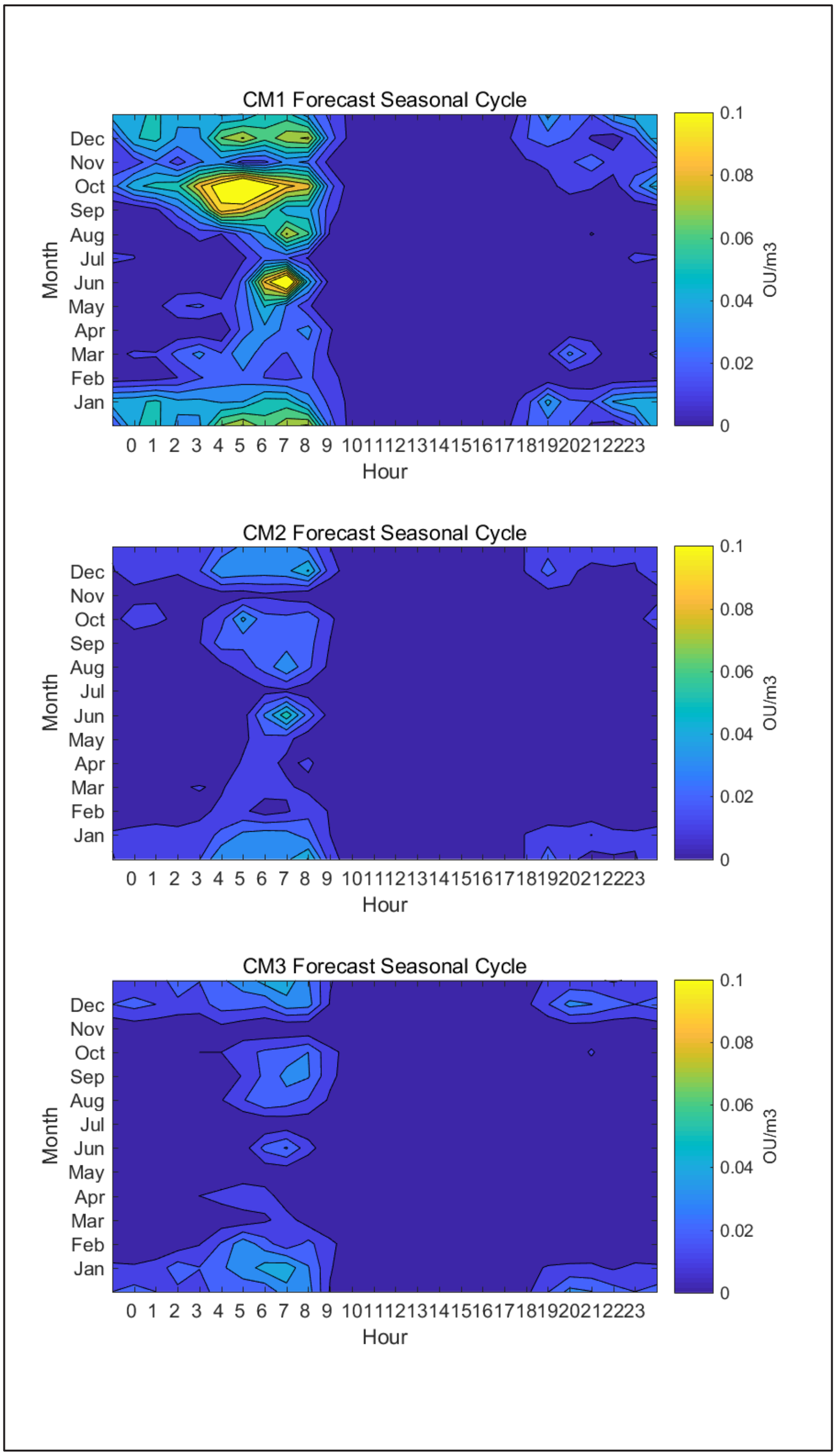


Hourly and daily odor concentration cycles exhibit a consistent trend across all alert points, with elevated forecasted odor concentrations during the dawn and morning periods. Concentrations then decrease to a minimum in the afternoon before increasing again at night. These findings align with the results presented in section 5.2.3.2, which demonstrated that the poorest atmospheric dispersion conditions generally occur during the dawn and morning periods due to low mixing heights and heightened inversion strength. Additionally, monthly cycles indicate that odor concentrations are elevated during autumn and winter, particularly from October to January.

c) Seasonal cycles

Figure 148 presents the forecast odor seasonal cycle.

Figure 148. Forecast odor seasonal cycle.



The figure indicates that all three alert points exhibit a comparable trend, with elevated odor concentrations occurring between midnight and 9am, especially from October to January. CM1 displays higher maximum concentration values relative to the other two alert points, which is anticipated since it is in closer proximity to the configured sources in the model.

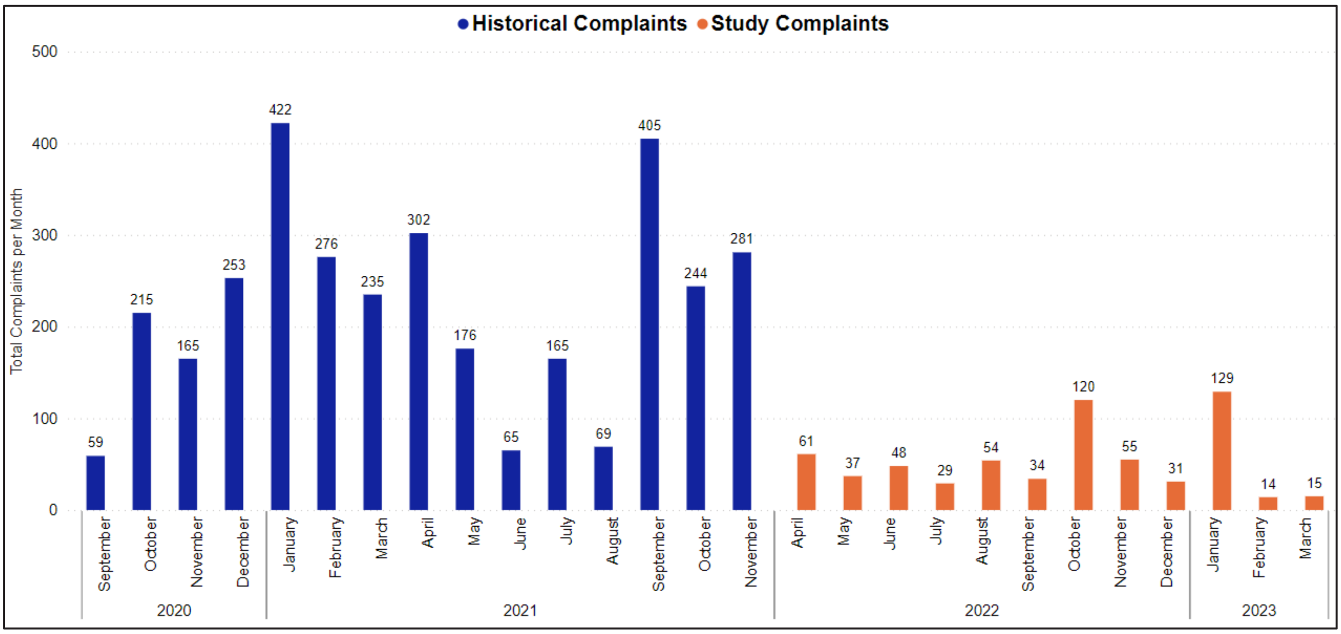
5.2.3.4 Trajectories Module Usage

A total of 135 trajectories (see section 5.1.2.3) were created by the City of Jacksonville personnel throughout the study period to help evaluating complaint cases raised by people living in the city, 126 of them backward trajectories and 9 of them forward trajectories.

5.3 Study Discussion

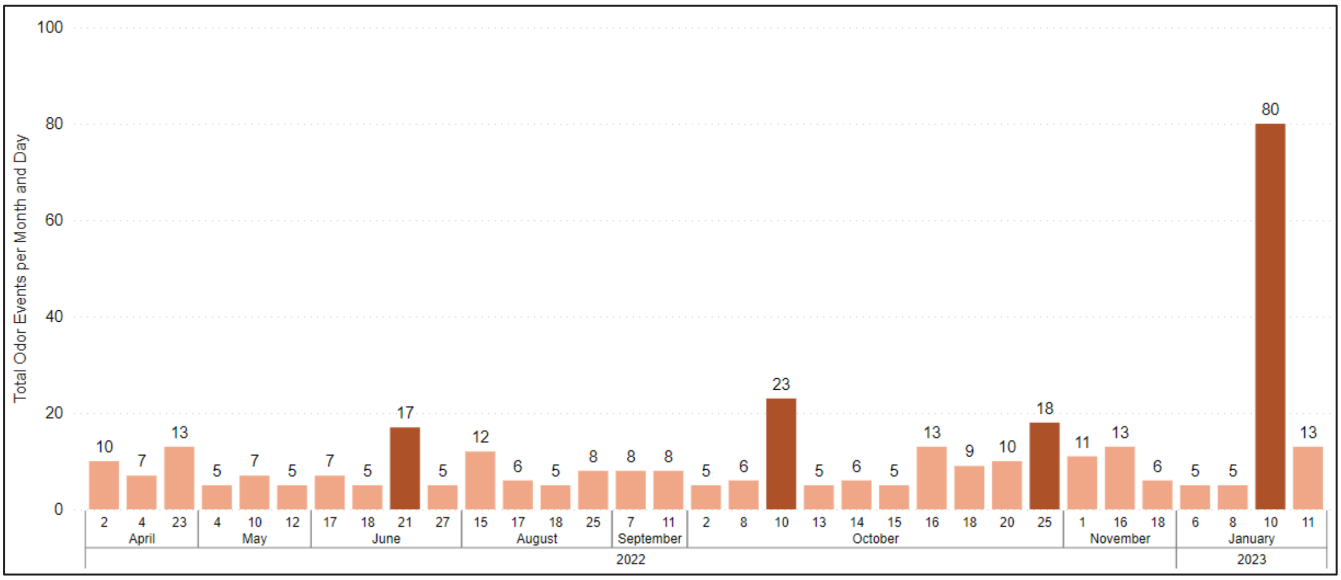
Figure 149 presents the total complaints per month for the historical period (September 2020 to November 2021, in blue) and the study period (April 2022 to March 2023, in orange). It is noticeable that during the study period there were considerable fewer complaints compared to the historical record (627 vs +3300):

Figure 149. Historical and study complaints per month.



Considering that during the study there were days with more complaints than others, and considering the definition of 'odor event' by the City of Jacksonville as a day with more than or equal to 5 complaints (see section 5.1.3.1), Figure 150 presents the study complaints filtered by only the odor event days, to help determine what were the days with more complaints:

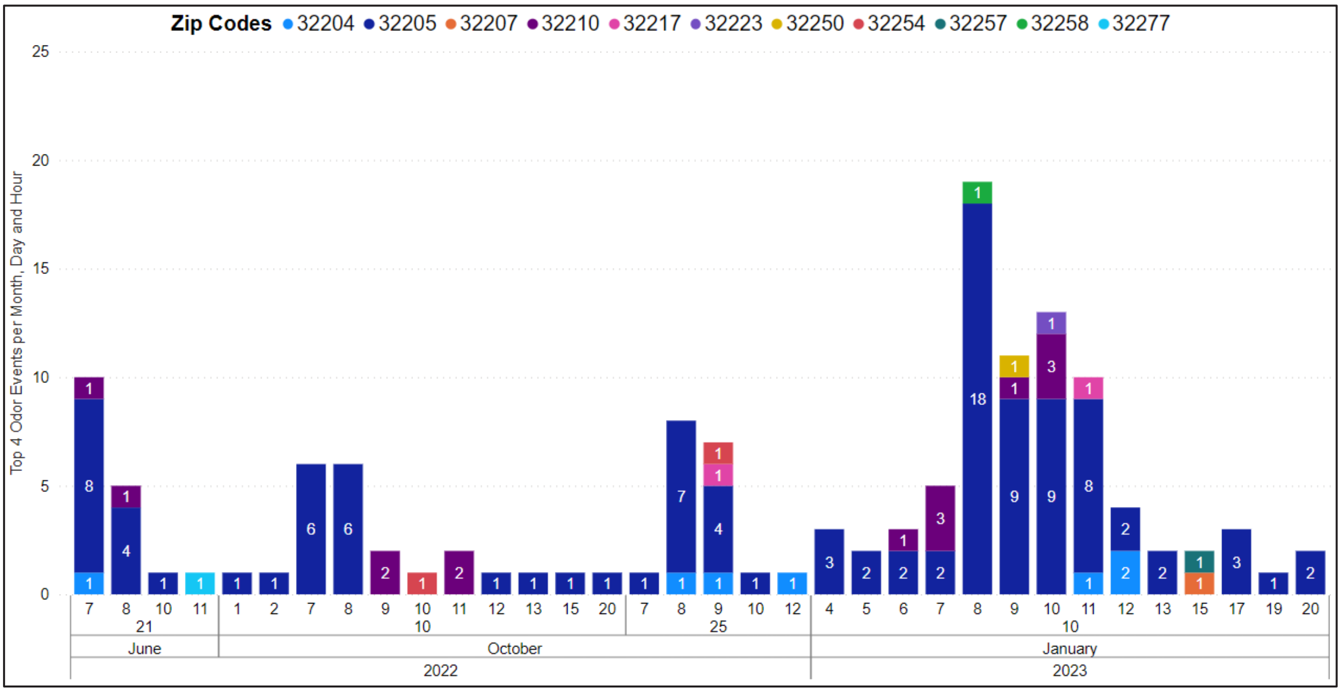
Figure 150. Odor events during the study period.



From the figure above, among all the odor event days during the study period, four of them are highlighted as they were days with more than 15 complaints: June 21, 2022 (17 complaints), October 10 and 25 2022 (23 and 18 complaints respectively), and January 10, 2023 (80 complaints). These days will be used for the discussion to evaluate how some of the tools provided by the Envirosuite solution respond to these types of situations and to determine what common aspects have the days with more complaints.

Figure 151 presents the hourly distribution of complaints for the top 4 odor events during the study (June 21, October 10, 25, 2022 and January 10, 2023), stacked by their corresponding zip code:

Figure 151. Hourly distribution of complaints for top 4 odor events during the study, stacked by zip codes.



The figure indicates that on June 21 and October 10, 2022, most of the complaints were reported between 7am to 8am, whereas on October 25, 2022, they were reported between 8am to 9am, and on January 10, 2023, most complaints were recorded between 7am to 11am. Furthermore, most of these complaints were linked to the zip code 32205.

Figure 152 displays a segment extracted from the risk report dated June 21, 2022. The report highlights an extreme risk of receiving complaints during the hours of 6am to 9am, which aligns with the timeframe in which most complaints were recorded on that day.

Figure 152. Risk report on June 21, 2022.

Day Shift - Tuesday

Jun 21, 2022 6:00 AM - Jun 21, 2022 6:00 PM

Hours	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11
Risk	Extreme	Extreme	Extreme	Low	Low
Humidity (%)	72	63	55	48	41
Inversion Strength (°C/100 m)	0.78	0.00	0.00	0.00	0.00
Mixing Height (m)	51.81	203.42	311.71	823.16	1076.63
Rainfall (inches)	0	0	0	0	0
Temperature (°F)	72.69	75.68	79.40	82.61	85.57
Wind Direction	NW (333°)	N (353°)	N (9°)	NE (24°)	NE (66°)
Wind Speed (mph)	4.38	5.78	5.21	4.13	6.63

Figure 153 presents an excerpt from the wind and odor forecast models for June 21, 2022, at 7 am. From the figure at this hour, the prevailing slow winds blowing from the NW that go over some of the potential odor sources will disperse pollutants to the SE, where the area represented by the 32205-zip code is located.

Figure 153. Wind and odor forecast models on June 21, 2022, at 7am.

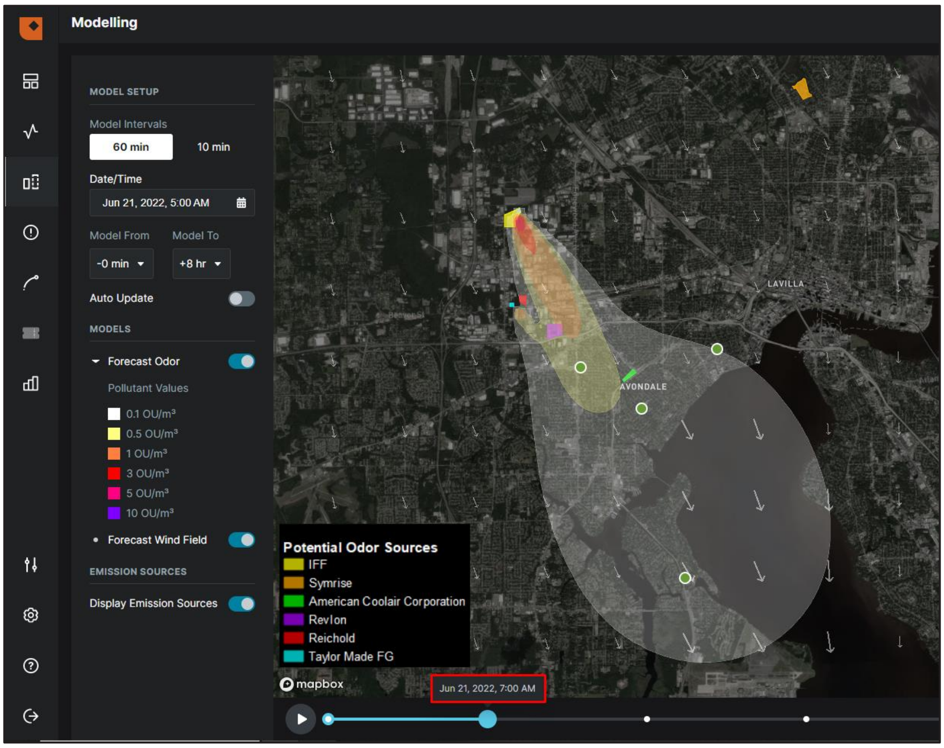


Figure 154 and Figure 155 display backward trajectories constructed using the observed weather model, which is fed by weather stations. The trajectories were generated by the City of Jacksonville personnel with an observation time of 7:00am and 7:30am on June 21, 2022, respectively. The trajectories reveal that one hour prior to the observation time, there were low winds originating from the northwest, suggesting that an odor emission may have originated from the industrial zone.

Figure 154. Backward trajectory on June 21, 2022, at 7:00 am.

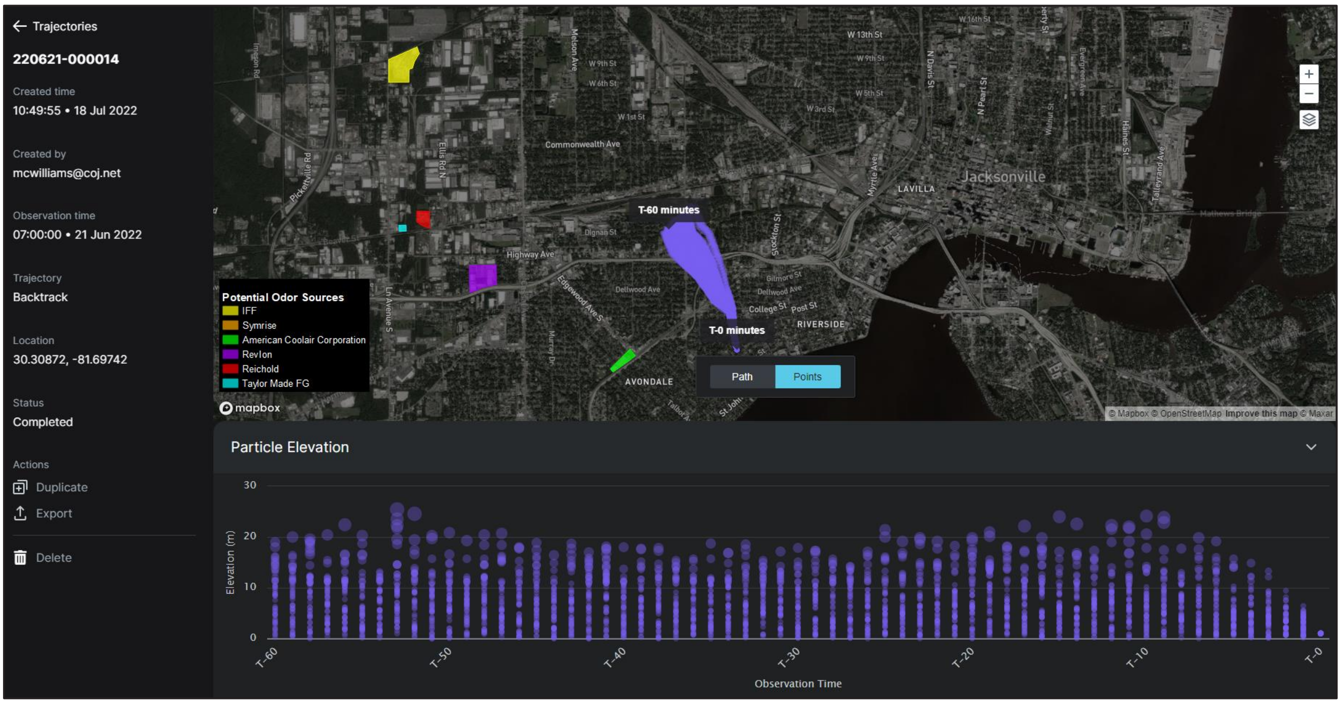


Figure 155. Backward trajectory on June 21, 2022, at 7:30 am.

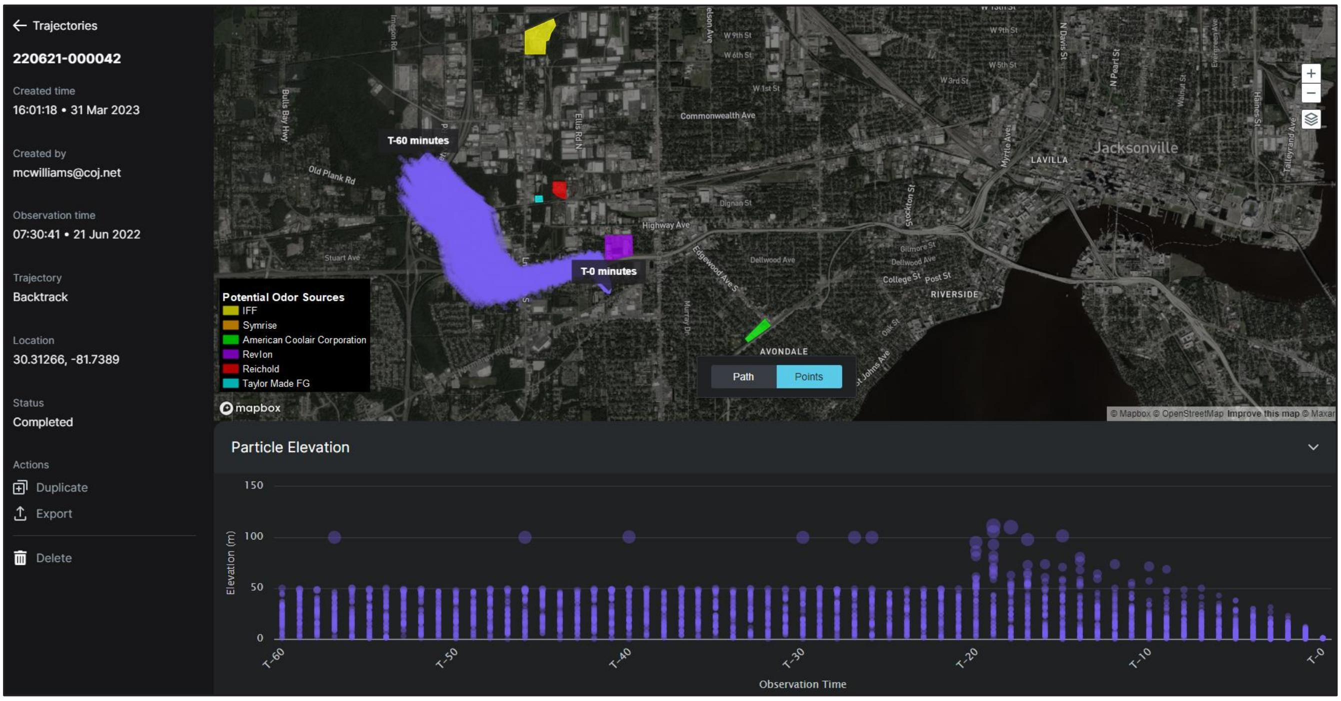


Figure 156 displays a segment extracted from the risk report dated October 10, 2022. The report highlights an extreme risk of receiving complaints during the hours of 8am to 10am, which gets close to the timeframe in which most complaints were recorded on that day.

Figure 156. Risk report on October 10, 2022.

Day Shift - Monday

Oct 10, 2022 6:00 AM - Oct 10, 2022 6:00 PM

Hours	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11
Risk	Low	Low	Extreme	Extreme	Low
Humidity (%)	93	94	93	78	64
Inversion Strength (°C/100 m)	0.00	0.00	0.00	0.00	0.00
Mixing Height (m)	201.60	201.13	200.92	308.96	445.17
Rainfall (inches)	0	0	0	0	0
Temperature (°F)	68.12	67.33	67.03	72.10	77.42
Wind Direction	N (350°)	N (348°)	N (344°)	N (354°)	N (5°)
Wind Speed (mph)	7.29	7.37	5.63	5.52	6.29

Figure 157 presents an excerpt from the wind and odor forecast models for October 10, 2022, at 8am. From the figure at this hour, the prevailing slow winds blowing from the NW and the N that go over some of the potential odor sources will disperse pollutants to the SE and S, where the area represented by the 32205-zip code is located.

Figure 157. Wind and odor forecast models on October 10, 2022, at 8am.

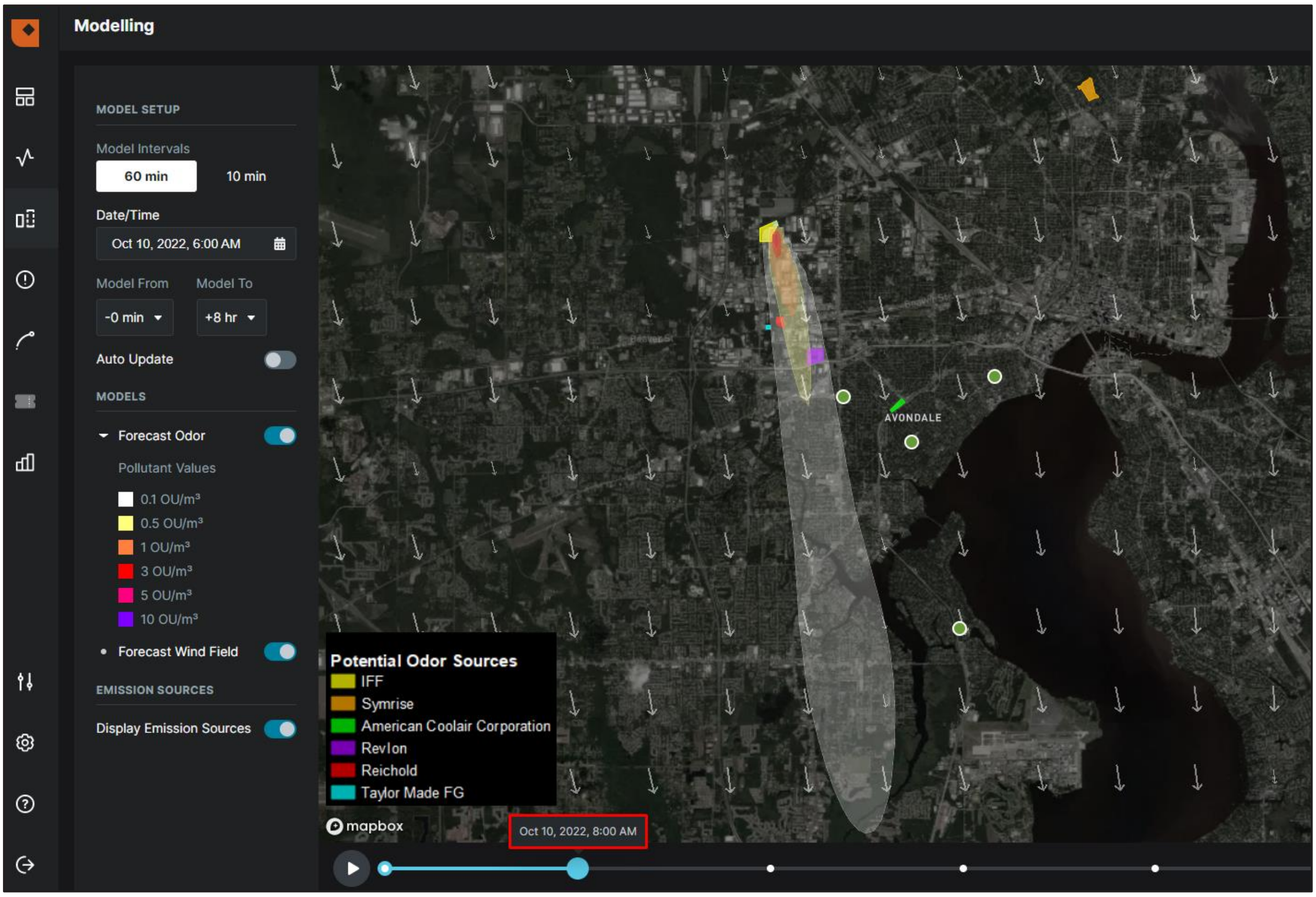


Figure 158 and Figure 159 display backward trajectories constructed using the observed weather model, which is fed by weather stations. The trajectories were generated by the City of Jacksonville personnel with an observation time of 7:30am and 10:00am on October 10, 2022, respectively. The trajectories reveal that one hour prior to the observation time, there were low winds originating from the northwest, suggesting that an odor emission may have originated from the industrial zone, particularly the trajectory at 7:30am goes over the yellow polygon that represents the IFF area at around T-26, this could mean that there might have been an emission coming from this or another nearby facility at around 7:04am that day.

Figure 158. Backward trajectory on October 10, 2022, at 7:30 am.

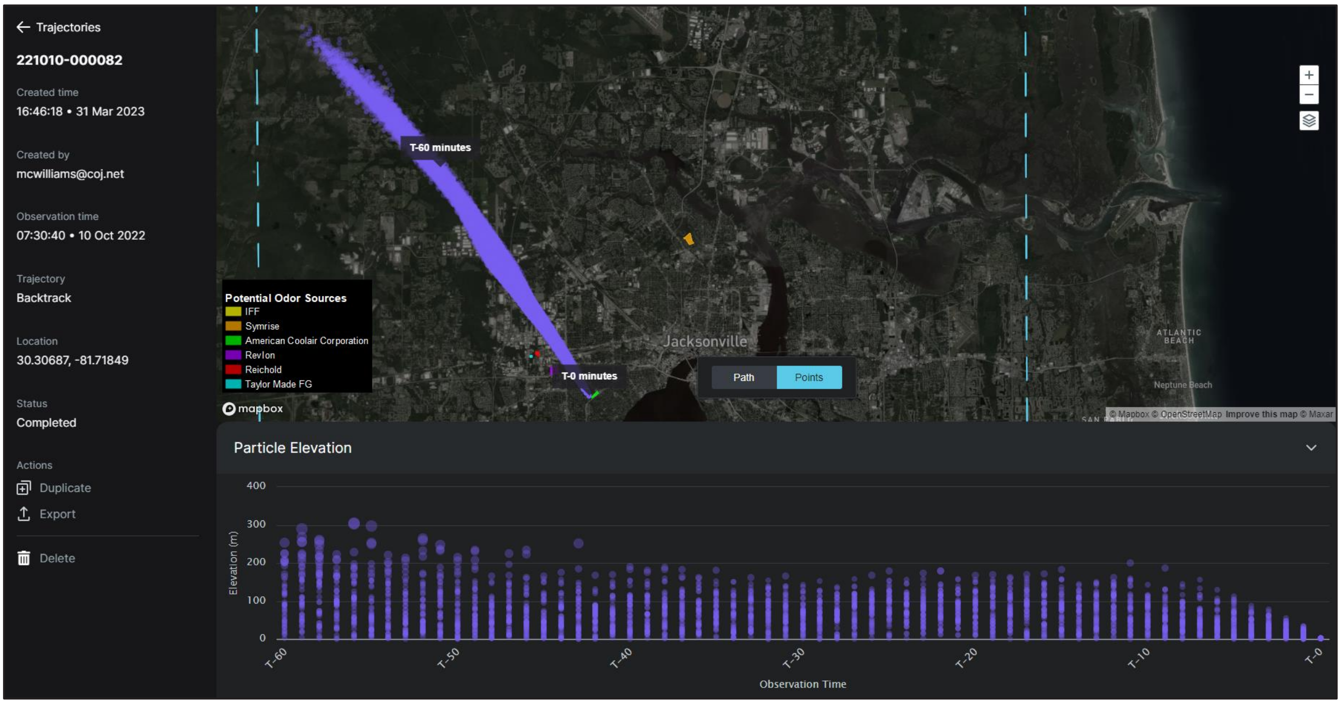


Figure 159. Backward trajectory on October 10, 2022, at 10:00 am.

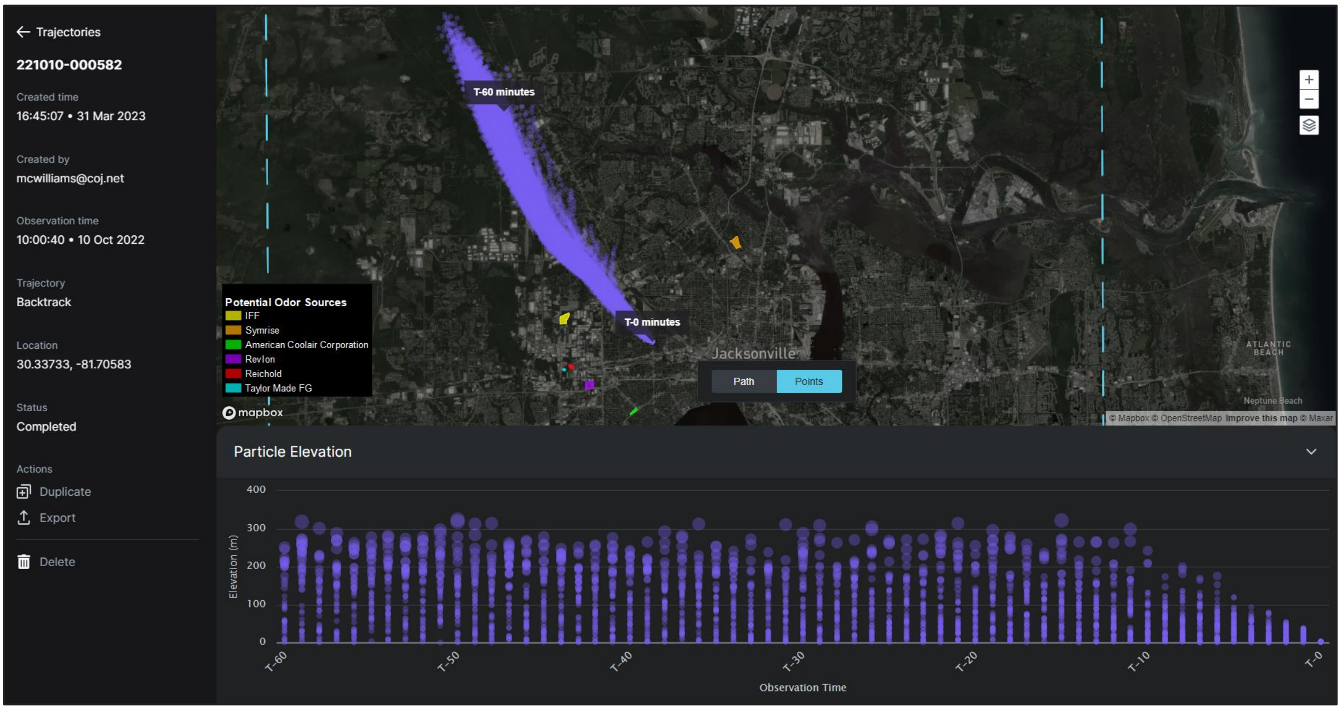


Figure 160 displays a segment extracted from the risk report dated October 25, 2022. The report highlights an extreme risk of receiving complaints during the hours of 6am to 9am, which aligns with the timeframe in which most complaints were recorded on that day.

Figure 160. Risk report on October 25, 2022.

Day Shift - Tuesday

Oct 25, 2022 6:00 AM - Oct 25, 2022 6:00 PM

Hours	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11
Risk	Extreme	Extreme	Extreme	Low	Low
Humidity (%)	69	69	62	55	55
Inversion Strength (°C/100 m)	2.84	2.97	0.63	0.00	0.00
Mixing Height (m)	50.53	50.49	50.71	199.74	604.33
Rainfall (inches)	0	0	0	0	0
Temperature (°F)	61.72	61.77	64.53	69.27	72.84
Wind Direction	N (6°)	N (341°)	NW (337°)	N (10°)	E (104°)
Wind Speed (mph)	2.35	3.13	2.06	2.43	5.53

Figure 161 presents an excerpt from the wind and odor forecast model for October 25, 2022, at 8am. From the figure at this hour, the prevailing slow winds blowing from the NW and the N that go over some of the potential odor sources will disperse pollutants to the SE and S, where the area represented by the 32205-zip code is located.

Figure 161. Wind and odor forecast models on October 25, 2022, at 8am.

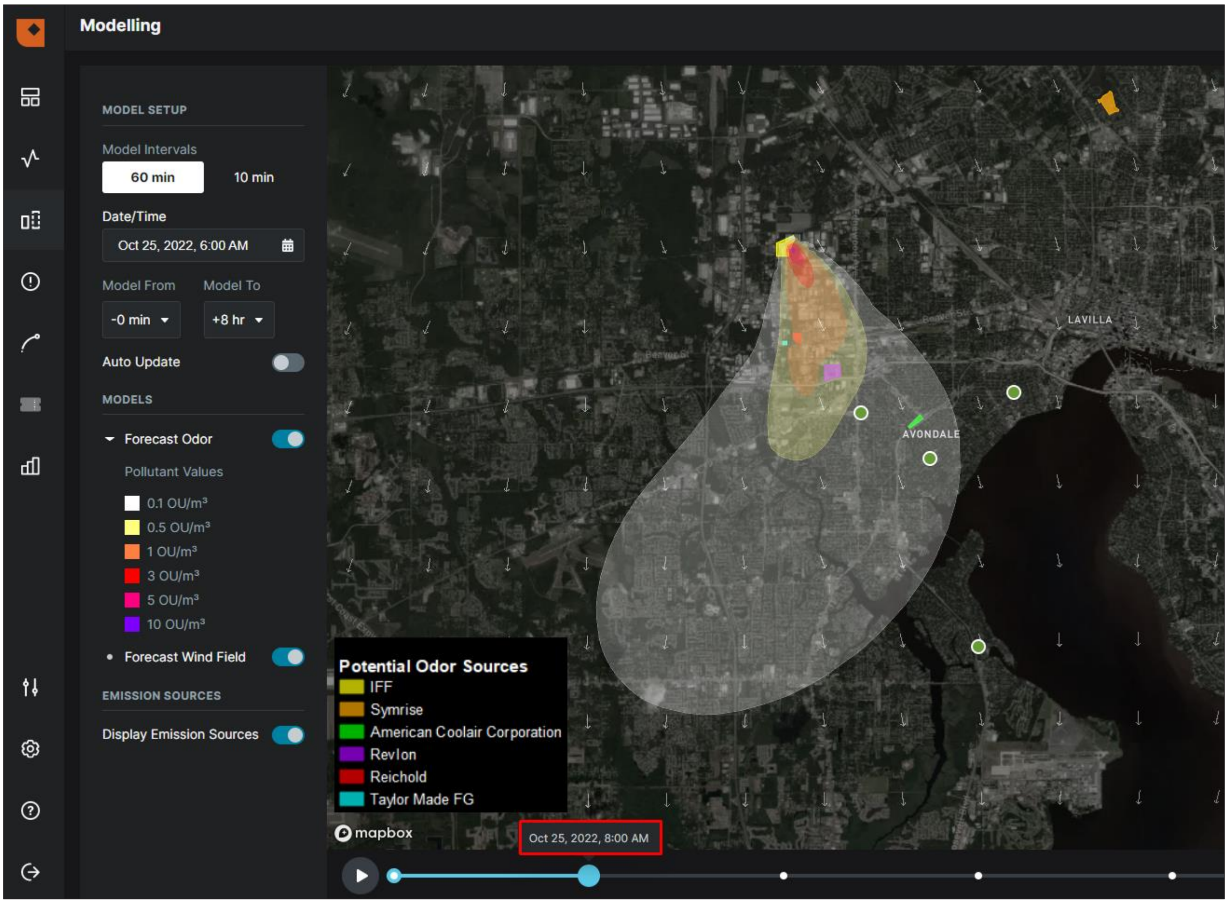


Figure 162 presents a backward trajectory constructed using the observed weather model, which are fed by weather stations. The trajectory was generated by the City of Jacksonville personnel with an observation time of 8:30am on October 25, 2022. The trajectory reveals that one hour prior to the observation time, there were low winds originating from the E and NE, suggesting that an odor emission may have originated from the industrial zone.

Figure 162. Backward trajectory on October 25, 2022, at 08:30 am.

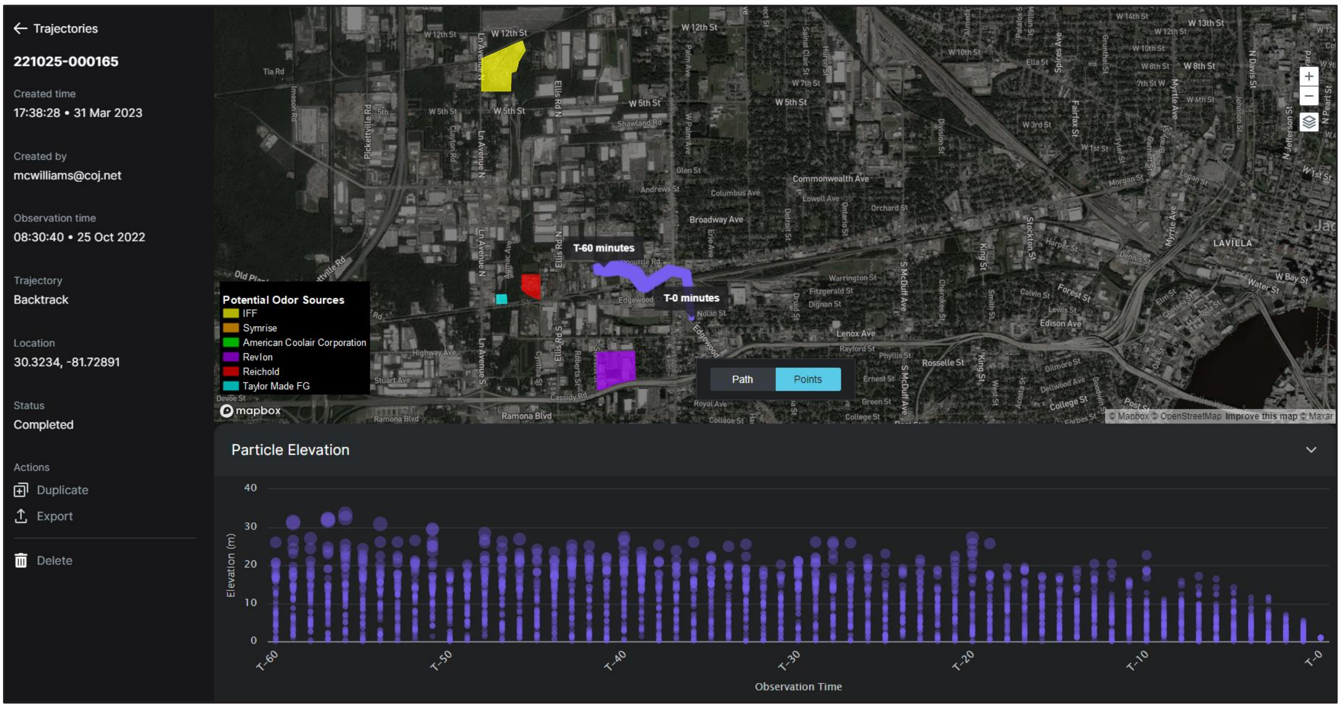


Figure 163 displays a segment extracted from the risk report dated January 10, 2023. The report highlights an extreme risk of receiving complaints during the hours of 6am to 11am, which aligns with the timeframe in which most complaints were recorded on that day.

Figure 163. Risk report on January 10, 2023.

Day Shift - Tuesday

Jan 10, 2023 6:00 AM - Jan 10, 2023 6:00 PM

Hours	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11	11 - 12
Risk	Extreme	Extreme	Extreme	Extreme	Extreme	Low
Humidity (%)	64	64	58	52	45	38
Inversion Strength (°C/100 m)	0.52	0.11	0.00	0.00	0.00	0.00
Mixing Height (m)	49.18	49.15	112.30	112.93	426.53	428.08
Rainfall (inches)	0	0	0	0	0	0
Temperature (°F)	50.10	50.03	52.23	55.43	59.35	62.56
Wind Direction	NW (318°)	NW (333°)	NW (335°)	NW (304°)	NW (293°)	W (268°)
Wind Speed (mph)	3.84	3.23	4.47	2.44	2.82	6.05

Figure 164 presents an excerpt from the wind and odor forecast model for January 10, 2023, at 8am. From the figure at this hour, the prevailing slow winds blowing from the NW that go over some of the potential odor sources will disperse pollutants to the SE, where the area represented by the 32205-zip code is located.

Figure 164. Wind and odor forecast models on January 10, 2023, at 8am.

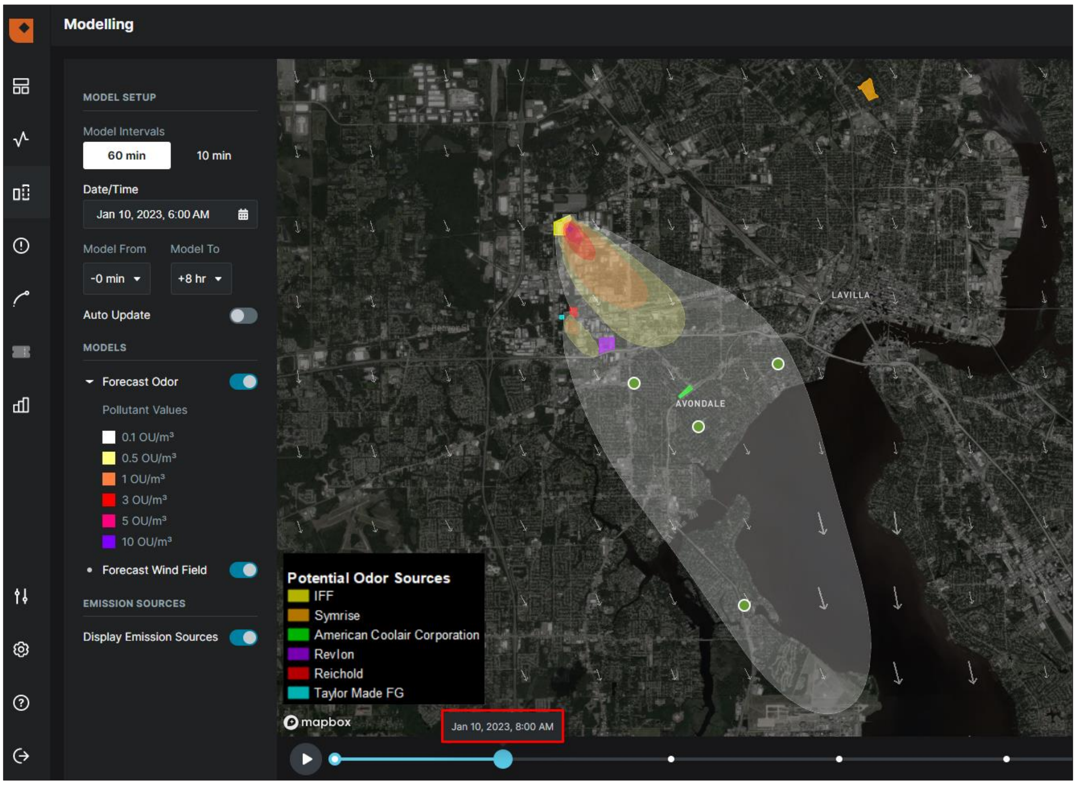
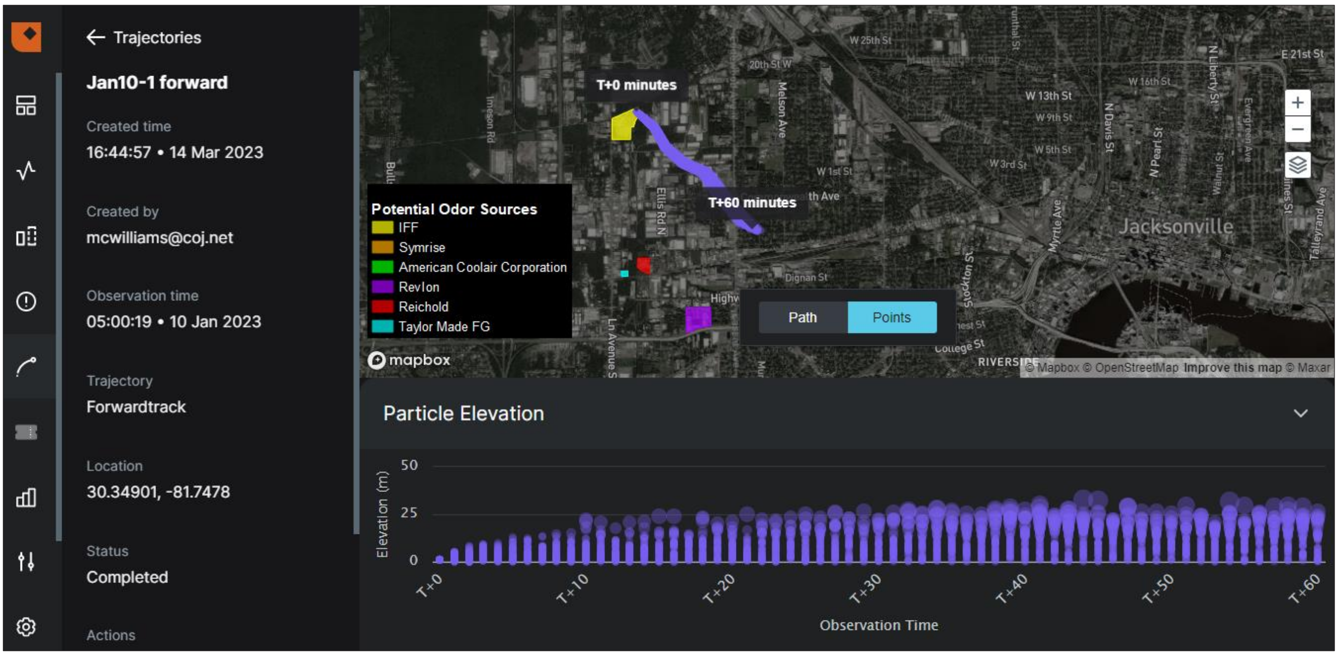


Figure 165 presents a forward trajectory constructed using the forecast weather model, which is fed by the WRF-CALMET system. The trajectory was generated by the City of Jacksonville personnel with an observation time of 05:00am on January 10, 2023. The trajectory reveals that one hour after to the observation time, there were low winds originating from the NW, so any odorous emission that might have been released from IFF would have gone towards the SW.

Figure 165. Forward trajectory on January 10, 2023, at 05:00 am.



Below is a summary of what has been identified in the discussion section, along with the complaint analysis, monitoring analysis and modelling analysis (section 5.2.1 to section 5.2.3):

- Most complaints received during the study were during autumn and winter months, particularly in January 2023 (129 complaints) seconded by October 2022 (120 complaints). They occurred more often between 6am and 11am, particularly from the area covered by zip code 32205.

- From the monitoring analysis it was shown that most of the eNoses show higher concentrations of H_2S and VOCs during the early morning, at the same time most complaints were made. For NH_3 it was shown that the peaks occur during the day, particularly around midday.

- The odor dispersion model showed that higher odor concentrations are expected to occur during the early morning, when dispersion conditions are worst (low mixing heights and higher temperature inversions).

- The risk report was proved to be a good tool for predicting the days and hour within those days that there was an extreme risk of receiving complaints, given that it warned extreme risks for the early morning at the top 4 days with more complaints during the study.

- Both backward and forward trajectories were proven to be a good tool for investigating the potential source of an odor emission source or area.

6 Recommendations

This section aims to provide the City of Jacksonville with recommendations from the EIS team, based in the results of the study, in case the city would like to continue working with Envirosuite:

1. Communicate the results of the study with the citizens and the industries within the city, lessons learned from the data analyzed in this report can help them understand when the times of the day and months of the year are when it is more likely to cause odor problems due to atmospheric emissions.

2. Upgrade the air quality hardware to the new Envirosuite Air Quality Monitor 5S, which will allow to measure more pollutant types, such as particulate matter (PM2.5 and PM10), and up to 5 gases in the same place (CO, CO_2, NOx, NO, NO_2, O_3, H_2S, SO_2, NH_3, and VOCs). This can help broadening the number of parameters collected to do analysis and to improve the understanding of how air pollutants vary their concentration.

3. If it is decided to deploy new hardware, it is recommended to place them as close as possible to the current potential odor sources (or to any new odor source found by the city during the study) and leave them in the same position throughout the year, so there is available information for every month of the year.

4. Upgrade the modelling solution to Envirosuite new METRIQA system, which consists of an improved forecast weather solution that will allow to more accurate weather forecast to feed the variety of tools offered by Envirosuite, this can help reducing the uncertainty of wind speed overestimation from the current WRF-CALMET model as was found in this study.

5. Improve the odor dispersion model by characterizing as many emission sources as possible within the city. For this, odor sources information (location and emission rates) is needed. Also, it is recommended to add more virtual alert points in areas of concern, with this an alert point analysis report can be built to have an estimation of which sources are contributing the most to the odor concentrations modeled at each alert point.

6. Upgrade the incident intelligence module by adding the odor report form, this is an additional tool that can help the City of Jacksonville to better manage complaints. By having the online form that can be filled directly by the people, providing information such as date and time, description of the odors perceived and location. The data will be ingested into the system and automatic reverse trajectories will be run, then the city personnel only must validate the complaints and they will appear in the incident intelligence map. This is valuable information for the city to visualize spatial and temporal distribution of complaints, and to compare similar periods to evaluate if there were increases or reductions of complaints.

7. Improve the risk report by feeding it using the new METRIQA forecast system and by adding more relevant parameters into its conditions (apart from wind speed and wind direction), such as mixing heights. It is also recommended to build a multi-series risk report that considers all potential odor emission sources within the city to prevent winds coming from its corresponding direction. Once this is done, send the report in an automated way daily to all the industrial facilities so they can plan work shifts considering the times when extreme and high risks of causing odor events can happen.

7 Conclusions

Envirosuite supported the City of Jacksonville over a 12-month period (April 2022 to March 2023) with a solution to understand how weather influences the dispersion of odorous pollutants from the city's industrial zone to residential areas. This report presents the results of the study, and the key conclusions are as follows:

- Although the total number of complaints received during the study was lower than the historical data (September 2020 to November 2021), the datasets showed a similar trend. It is concluded that most complaints occur during the autumn and winter months, between 6am and 11am, and within the area covered by zip code 32205.

- The spatial and temporal distribution of complaints aligns with the air quality data obtained from the eNoses, surface weather parameters from the weather stations, observed and forecast weather models, and odor dispersion models. Therefore, the solution provided by Envirosuite to the city is a proven useful tool for better understanding odor problems and improving environmental management going forward.

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