Scope of Work For

Project # 22-006
Hydrogen Cyanide for Improved Identification of Fire Plumes in the $(BC)^2$ Network

Prepared for

Air Quality Research Program (AQRP)
The University of Texas at Austin

By

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QA Requirements: Audits of Data Quality: 10% Required
Report of QA Findings: Required in Final Report

Approvals

This Scope of Work was approved electronically 8/30/2022 by Vincent M. Torres, The University of Texas at Austin

Vincent M. Torres
Project Manager, Texas Air Quality Research Program

This Scope of Work was approved electronically 9/20/2022 by Erik Gribbin, Texas Commission on Environmental Quality

Erik Gribbin
Project Liaison, Texas Commission on Environmental Quality

Table of Contents

1.0 Abstract

Wildfire incidents in the US have and will continue to increase with a changing climate. Smoke can impact the local air quality in Texas from both local/in-state fires, and transported emissions from other parts of the US and from Mexico. The 2020 Black and Brown Carbon $(BC)^2$ study demonstrated how wavelength-dependent aerosol optical properties could be used to track the influence of biomass burning. The $(BC)^2$ network operated in El Paso, Houston, and Galveston in 2020 -21 and is being expanded to include Dallas-Fort Worth in 2022. Hydrogen cyanide (HCN) is a small nitrogen-containing molecule produced in significant quantities from biomass burning, and in limited quantities from vehicle combustion. The goal of this project is to improve smoke plume characterization with the addition of HCN to the $(BC)^2$ smoke monitoring network. This goal explicitly addresses the AQRP's 2022-2023 research priorities, notably "Domestic Fire Emissions" including transported emissions from wildfires (domestic, international) and their impacts on exceptional events in Texas. Performing this monitoring at a Dallas-Fort Worth site ties in with the AQRP's 2022-2023 research priority "Changing Emission Patterns in Texas", which includes additional research along the Interstate-35. This project will deploy a laser-based instrument measure HCN at a new $(BC)^2$ network site in Dallas-Fort Worth. The work is laid out as 3 tasks: 1) Design measurement campaign; 2) Execute field campaigns; and 3) Data Analysis.

2.0 Background

Wildfire activity has and will continue to increase with changing climate [1,2]. US wildfires in the Western US produce more particulate matter (PM) pollution than all other US aerosol sources combined [3] and they promote widespread, substantial regional increases in ozone (O_3) [4,5]. The risks of wildfires in Texas are also increasing due to dry conditions and fuel load [6], and as of this writing, there are several active wildfires in the state, including the Mesquite Heat Fire, which is only 52% contained [7]. Emissions from wildfires and agricultural burning have the potential to impact Texas' air quality. Sources of smoke observed in Texas originate both from within the state and from sources in Mexico or other parts of the US.

Recent efforts by TCEQ to monitor and study air quality in Texas cities have resulted in an improved understanding of the processes and sources which control urban air quality in Texas. Reductions in anthropogenic emissions through the implementation of cleaner technologies for sectors such as mobile sources and coal-fired power plants, have refocused efforts to understand the contribution of biomass burning to urban air pollution. The Black and Brown Carbon $(BC)^2$ 2019-21 study was designed to identify the influence of wildfires and dust events on urban air quality in Texas, specifically focused first on El Paso and then on the Houston and El Paso metropolitan areas. This project carries forward methodologies that were developed by the PIs in AQRP project 19-031 for El Paso in the 2019 ozone season (Apr – Oct). Specifically, implementation of an aerosol optical monitoring protocol including continuous measurement of aerosol absorption and scattering at three wavelengths, event-based particulate matter (PM) filter-based collection and analysis for enhanced biomass and dust event characterization, colocation with a TCEQ site for meteorology, trace gas and PM measurements and supporting analysis of relevant satellite and trajectory models. The central indicator of biomass burning

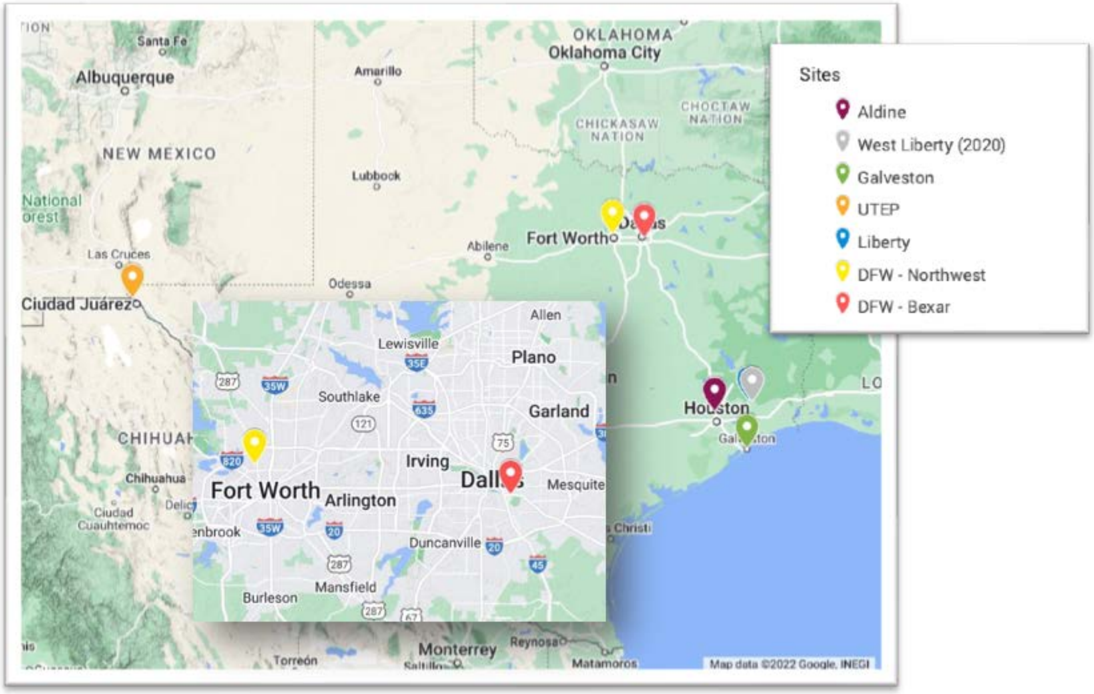

Figure 1. Map of 2020-21 (BC)[2] network. The HCN measurement and associated (BC)[2] measurements will be at the DFW – Northwest site.

and dust impact at the (BC)[2] sites is the Ångström exponent. The Absorption Ångström Exponent (AAE) is used to track the influence of biomass burning through the quantification of the wavelength dependence of the aerosol absorption. Biomass burning aerosol has a strong wavelength dependence which results in an AAE >>1, while fossil combustion from motor vehicles has little wavelength dependence and an AAE ~1. The Scattering Ångström Exponent (SAE) is used to track the influence of dust through the quantification of the wavelength dependence of aerosol scattering. Larger particles have an SAE approaching zero while smaller particles have an enhanced SAE. The AAE and the SAE are monitored in real time to characterize the influence of wildfires and dust on urban air quality in Texas. This scientific data can be directly used to help characterize and address air quality exceedance days.

The (BC)[2] monitoring network in 2020-21 included four monitoring trailers which were deployed adjacent to existing TCEQ sites in the Houston metropolitan area and in El Paso (Figure 1). The Houston sites were Galveston, West Liberty/Liberty, and Aldine. The El Paso site was at the University of Texas at El Paso (UTEP). Each trailer contained two tricolor absorption photometers (TAP, Brechtel) and one three-wavelength nephelometer (Aurora, Ecotech). For 2022, the El Paso site will be moved to accommodate growth on the UTEP campus, while two additional trailers will be deployed in Dallas-Fort Worth. The network nominally operates annually during the ozone season (Apr – Oct).

Identification of biomass burning (BB) smoke influence using aerosol optical measurements has been demonstrated to be effective for a variety of locations and conditions, however, measurement of gas and particle tracers will improve characterization of the chemistry of the smoke plume, thereby improving understanding of BB contribution to gas and particle phase air quality within urban areas.

Here, we propose a pilot project to measure hydrogen cyanide (HCN) within the $(BC)^2$ network. The main scientific objective of this work is to demonstrate improved smoke plume characterization with the addition of hydrogen cyanide measurements at a $(BC)^2$ network site. This pilot project will set the stage for future potential expansions of the $(BC)^2$ network monitoring capabilities across the state.

HCN is a small nitrogen-containing molecule produced in significant quantities from biomass burning [8], and in limited quantities from vehicle combustion [9]. We propose to deploy a tunable infrared direct absorption spectrometry (TILDAS) instrument equipped to measure HCN at 3287 cm^{-1}. This instrument has been demonstrated on a mobile platform during the AQRP-funded 2017 San Antonio Field Study (SAFS), and throughout the 2018 and 2019 Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) studies in the western US. Figure 2 shows SAFS measurements of BB emissions from air passing over the Gulf of Mexico. Background HCN is seen to increase, correlated with acetonitrile and CO, over the course of several hours. The molar emission ratio of HCN to CO (0.0086 ppb/ppb) is similar to those measured previously in Yucatan fire studies (avg = 0.010, stdDev = 0.0044) [10]. HYSPLIT back trajectory footprints show significant overlap of the measured airmass with the Yucatan peninsula in Mexico. Smoke impacts like this, including imported emissions from Mexico, have been the subject of several AQRP studies (Projects 18-031, 20-005).

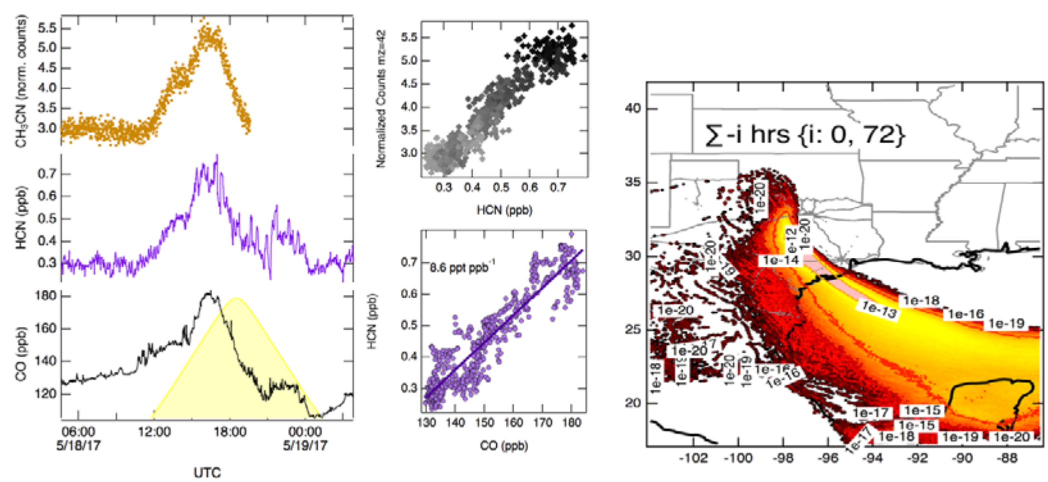

Figure 2. Imported fire emissions measured during the 2017 San Antonio Field Study. Time traces (left) of acetonitrile (CH_3CN, gold), hydrogen cyanide (HCN, purple) and CO are shown, overlaid with the solar elevation angle showing daylight hours (yellow triangle). The slope of HCN to CO (bottom middle) is shown. Acetonitrile (counts at m/z=42) is also well-correlated (top middle). Back-trajectory calculations show the predominant airmass originates from the Gulf of Mexico, with contributions from the Yucatan.

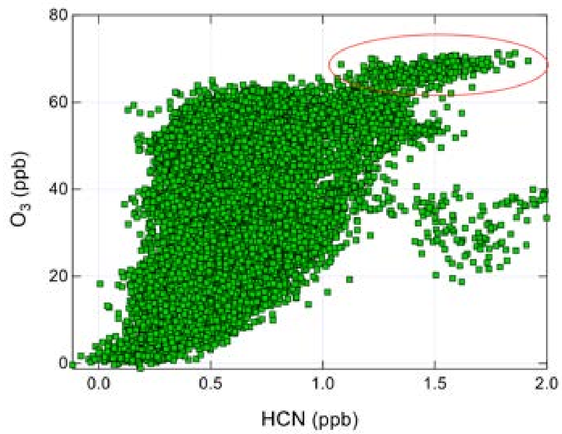

Figure 3. 2018 McCall, Idaho measurements of ozone and HCN in 2018. The circled data shows that the highest measured ozone at this remote site coincided with enhanced HCN concentrations.

Measurement of HCN, in combination with measurements of AAE and tracers such as ozone (O_3) and carbon monoxide (CO), provides expanded ability to measure fire impact, including impacts on ozone. As HCN is more specific to BB emissions than CO, it is expected to be a better indicator of BB plumes within an urban area which has many CO sources. During the 2018 FIREX-AQ campaign, extended stationary measurements were done in McCall, Idaho, a remote rural town. Figure 3 shows a plot of O_3 versus HCN for this data. Most of the time, ozone maxima are around 60 ppb, in line with typical patterns in this rural area. However, the circled data show that times with the highest ozone show corresponding enhancements of HCN, which support a hypothesis that fire emissions are exerting an influence on local ground-level ozone. Previous studies have shown rapid production of O_3 in aged forest fire plumes [10]. Both O_3 and CO will be measured at the planned Dallas-Fort Worth site in the $(BC)^2$ network.

Other gas-phase species have been used as fire tracers, but each has drawbacks. For example, ethane, also measurable by TILDAS, is a good fire tracer, but its presence in areas with significant oil and gas activity is not ideal. Larger, nitrogen-containing BB species are measurable by proton-transfer-reaction mass-spectrometry (PTR-MS), including acetonitrile (CH_3CN), acrylonitrile and furan. However, the instrument cost, power needs, trained operator requirement, and need for lengthy offline analysis make this grade of instrument less useful for long-term monitoring network use.

3.0 Objectives

The goal of this project is to **Improve smoke plume characterization with the addition of hydrogen cyanide, a gas-phase fire tracer, to the $(BC)^2$ network**. This goal explicitly addresses the AQRP's 2022-2023 research priorities, notably "Domestic Fire Emissions" including transported emissions from wildfires (domestic, international) and their impacts on exceptional events in Texas. Performing this monitoring at a Dallas-Fort Worth site ties in with the AQRP's 2022-2023 research priority "Changing Emission Patterns in Texas", which includes additional research along the Interstate-35. We will integrate an HCN spectrometer at an existing monitoring site. The work is laid out as 3 tasks: 1) Design measurement campaign; 2) Execute field campaigns; and 3) Data Analysis.

4.0 Task Descriptions

Task 1. Design measurement campaign

We plan 2 field intensives during this year-long project. The first will be a 45 day-long campaign in the fall of 2022. The second will be a 3-week-long campaign in the spring of 2023, to coincide with AQRP Project 22-010 (PI: Fortner), an Aerodyne Mobile Laboratory study based out of Dallas-Fort Worth. These campaigns will occur in the fall and spring for best chance of capturing the domestic fire season (fall) as well as agricultural burning in the Yucatan (spring). We note that Texas wildfires were active in spring 2022 as well [7]. The fall and spring also coincide with the active measurement season of the current $(BC)^2$ network. The deployments will happen at the DFW-Northwest site of the $(BC)^2$ network (Figure 1), which has been funded for the 2023 fiscal year.

Previous years $(BC)^2$ measurements focused on the Houston and El Paso areas (Figure 1), with 2022 expansion to Dallas-Fort Worth planned as part of Baylor's ongoing work. The choice of the Dallas-Fort Worth Northwest site ties in with the AQRP's 2022-2023 research priority "Changing Emission Patterns in Texas", which includes additional research along the Interstate-35. Measurements in this central part of Texas provide much-needed spatial coverage, particularly given the myriad of measurements occurring as part of the TRACER project, based out of Houston and Galveston Bay.

Integration of the HCN Mini TILDAS instrument (Figure 4) will include external equipment and conditioning of the surroundings. A thermoelectric chiller (500 W) and Peltier controller regulate laser temperature. A scroll pump (1500 W) is typically used to maintain a low cell pressure and provide sample flow (0 – 20 lpm). An uninterruptible power supply protects the instrument electronics from glitches and failures which can damage critical components. Software developed by Aerodyne ("Watchdog") checks on the status of the instrument and sends email alerts in case of an emergency. To minimize drift and characterize the spectroscopic baseline, the inlet is flooded with ultra-zero air on a regular basis for a minute (every 15 – 60 min). Software that runs the instrument ("TDLWintel") can control valves and switches (e.g., 24V solenoid valves) to manage this intermittent event and process the subsequent spectroscopic conditions. Calibrations will be performed by flooding the inlet with known concentrations of an HCN gas standard. The standard is diluted with ultra-zero air to various levels, spanning a relevant range of concentrations. To precisely manage the gas flows, mass flow controllers (Alicat Scientific) are used in conjunction with solenoid valves controlled by instrument software.

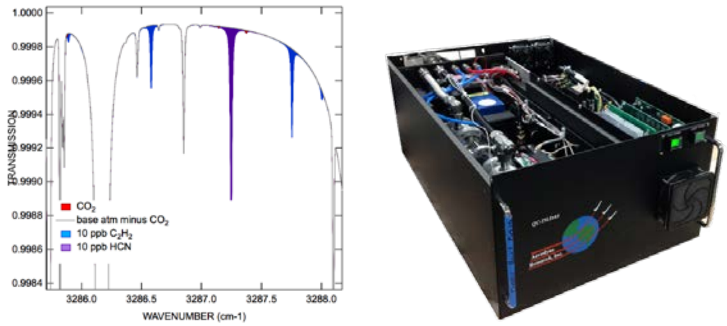

Figure 4. Left: Spectral window for the TILDAS measurement of HCN (purple). Acetylene (C_2H_2, blue) and water are also present in this spectral region. Right: mini-TILDAS chassis.

- **Deliverable:** Campaign planning document including chosen site(s) and integration plan. Due date: 1 week prior to shipment of instrument to Texas (dates to be finalized: Sept/Oct 2022)

Task 2. Execute field measurements

At the beginning of each field intensive, an ARI scientist will travel to the site for 3 days for instrument integration, initial calibrations, in-situ performance assessment, and training. ARI and Baylor will work together to integrate the HCN measurements into the $(BC)^2$ network data infrastructure, such that the live raw HCN data can be viewed alongside aerosol optical measurements. Baylor staff will see to any required instrument maintenance, such as swapping out cylinders, or managing power or heat issues. They will also de-integrate the instrument at the end of each field intensive for return shipping.

One floating visit of an Aerodyne scientist is planned. This floating visit will guard against any unforeseen instrument emergency that cannot be solved remotely. If not needed during the field campaign, this visit will be used for dis-integration and a data meeting at the conclusion of the project.

- **Deliverable:** Preliminary live dataset of hydrogen cyanide concentrations. Due Date: Live data stream during ambient measurements to be available in Oct/Nov 2022 and Spring 2023. See next task for delivery of quality assured datasets.

Task 3. Data analysis

Data from the HCN TILDAS will be analyzed and quality-assured after each field campaign, following procedures laid out in this project's Quality Assurance Project Plan (QAPP). The core data will consist of HCN mixing ratios as a function of time at a 1-second data rate. Secondary parameters include water vapor and acetylene (C_2H_2). Other collected data that will be used for quality assurance (QA) but not produced as deliverables include instrument parameters like ambient temperature, instrument cell pressure, and laser light level.

A second level of data QA will focus on investigating and separating the impact of vehicle exhaust from biomass burning (BB). An extreme example of this type of data QA is shown in Figure 5. This data was taken by the Aerodyne Mobile Laboratory during the 2018 FIREX campaign. It shows a strong background of BB HCN (up to 4 ppb), with short spikes due to on-road traffic. The HCN/CO ratio in BB emissions is seen to be significantly higher than from traffic, providing a chemical signature of BB independent of the AAE analysis currently in use at the $(BC)^2$ site. Traffic sources of HCN will be filtered from the Dallas-Fort Worth dataset based on their short duration, and their ratio with other traffic emissions.

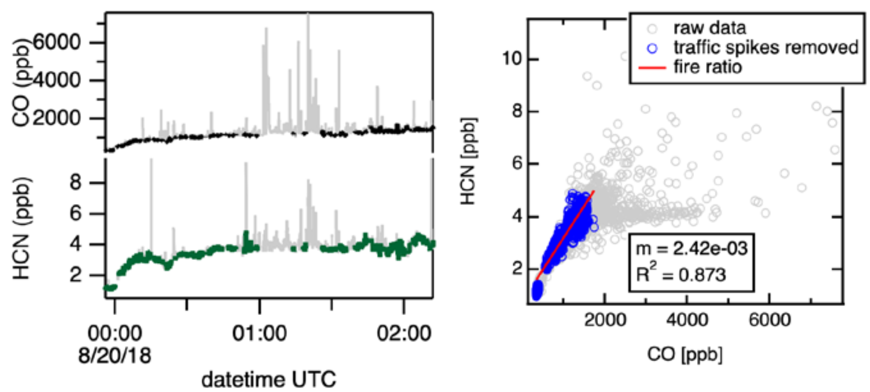

Figure 5. HCN and CO measurements during the 2018 FIREX campaign showing smoke-impacted enhancements along with spikes from traffic.

CO was the traffic species used in prior campaign traffic explorations but is not measured directly by the TILDAS instrument. Its availability at the Dallas-Fort Worth $(BC)^2$ site is pending. Acetylene is a secondary traffic tracer that can measured by the TILDAS instrument itself. This species may have advantages over CO in a traffic filtering procedure since its time response, data frequency, data coverage, and inlet lag will be identical to HCN. C_2H_2 will be assessed alongside other available tracers like CO during the traffic filtering QA.

Baylor University Co-PIs Rebecca Sheesley and Sascha Usenko will direct advanced data analysis beyond the HCN QA described previously. This analysis is focused on improved identification of BB emissions.

The influence and apportioning of BB emissions vs long-range traffic emissions will be investigated using the HCN/CO or HCN/C_2H_2. Other relevant ratios, such as HCN/Black Carbon will be considered.

BB events identified using the HCN/CO ratio will be compared to events identified using the existing AAE methodology, which investigates the ratio of brown (BrC) to black carbon (BC) using aerosol optical properties. New BB event identification algorithms will be developed using the complete set of sensor data available at the Dallas-Fort Worth site, and these improved metrics compared to the BrC/BC method alone. This will allow for an assessment of the usefulness of HCN monitoring in long-term BB experiments in Texas. This final advanced analysis will contribute to the central science question of this proposal: **Improving smoke plume characterization with the addition of hydrogen cyanide, a gas-phase fire tracer, to the $(BC)^2$ network**.

With the addition of the co-located HCN measurement, an assessment of plume chemistry can be accomplished. Combustion conditions during the wildfire and aging of the plume during transport can both impact the chemical composition and the optical properties of the smoke plume. The addition of the real time gas phase HCN tracer will enable improved characterization of the chemistry of the plumes that impact the Dallas-Fort Worth area. For example, this can include investigation of differences across BB events in HCN:AAE ratios, and assessment of any differences in peak shape and timing between HCN and AAE for BB events.

Deliverables:

- Finalized dataset including quality assured and calibrated HCN and expanded list of tracers (acetaldehyde, water vapor).
  Due Date: Each campaign dataset to be delivered 1 month after final measurement day (November 2022 and Spring/Summer 2023).
- Enhanced fire plume characterization to be shared in technical and final reports. Due Date: Final analysis due with Final Report, August 1, 2023. Incremental analysis or updates to be reported in monthly technical reports starting 2 months after receipt of each quality assured dataset (Jan/Feb 2023; Summer 2023 and beyond)

5.0 Project Participants and Responsibilities

The roles and responsibilities for each participant of this project are outlined below:

Tara Yacovitch, Project PI, Aerodyne Research, Inc.

- Overall direction of the project
- Field measurement planning and execution
- Project management and reporting
- Data Quality Manager, performing audit of HCN results.
- Contribute to data QA of HCN results
- Lead remote instrument checks during field campaign
- PI duties to be transferred to Conner Daube 12/2022 – 4/2023 during leave

Conner Daube, Aerodyne Research, Inc.

- Assist with field measurement planning and logistics
- Instrument integration at the field site and training of Baylor University graduate student on instrument upkeep
- Backup project PI during Dr. Yacovitch's leave, 12/2022 – 4/2023
- Assist with remote instrument checks during field campaign
- Contribute to data QA of HCN results

Scott Herndon, Aerodyne Research, Inc.

- Contribute to writing of reports
- Provide fire emissions expertise and consulting
- Assist with remote instrument checks during field campaign

Engineer, Aerodyne Research, Inc.

- HCN TILDAS instrument configuration prior to campaigns

Ed Fortner, Aerodyne Research, Inc.

- Project PI for AQRP project 20-010, a mobile laboratory project to coincide with the springtime HCN deployment (Fortner does not receive funding from 20-006)
- Coordinate with Yacovitch and Daube on logistics, integration and staffing during spring field deployment.

Rebecca Sheesley, Co-PI, Baylor University

- Provide CO and other TCEQ data to ARI scientists for traffic data QA
- Contribute to the advanced analysis including advanced identification of BB events using a combination of HCN sensor data and $(BC)^2$ network data

Sascha Usenko, Co-PI, Baylor University

- See to Dallas-Fort Worth site readiness for HCN sensor
- Optional integration of HCN live data stream into $(BC)^2$ network computers
- Direct and perform advanced analysis including advanced identification of BB events using a combination of HCN sensor data and $(BC)^2$ network data

Graduate Student, Baylor University

- Be present and assist with instrument integration during the fall and spring campaigns
- See to consumable replacement at field site (UZA cylinders)
- Perform in-person instrument status checks during the fall campaign.
- Perform in-person site maintenance (e.g., power or air conditioner problems) or instrument maintenance (e.g., filter or inlet checks) as needed.

6.0 Timeline

A schedule of project activities and key deliverables is shown below. This schedule assumes that the first field campaign begins in October 2022 and last 45 days. The second field campaign will overlap with Project 22-010, a 3-week mobile laboratory field study based out of Dallas-Fort Worth, and led by Dr. Fortner at Aerodyne Research, Inc. The spring measurement window will be 3 weeks in March-May 2023 window.

Full project deliverables and their due dates are listed Section 7. Deliverables.

Table 2.2. Timeline of project tasks and deliverables. Exact measurement windows are subject to change as campaign planning progresses.

Deliverable/Milestone	Year and Month of the Project												
	2022					2023							
Task \ Timing	8	9	10	11	12	1	2	3	4	5	6	7	8
Work Plan, including QAPP	■												
Campaign Planning Document		■											
Instrument Integration at Texas Site			■						■				
Measurements			■	■					■				
Live Raw Measurement Dataset			■	■					■				
Finalized Dataset including HCN and BB events					■						■		
Monthly Reports		■	■	■	■	■	■	■	■	■	■	■	■
Presentation at AQRP workshop												■	
Draft Final Report												■	
Final Report													■

7.0 Deliverables

AQRP requires the regular and timely submission of monthly technical, monthly financial status and quarterly reports as well as an abstract at project initiation and, near the end of the project, submission of the draft final and final reports.

Additionally, at least one member of the project team will attend and present at the AQRP data workshop.

Dr. Yacovitch will lead the project reporting activities with contributions from Co-PIs Dr. Sheesley and Dr. Usenko at Baylor University. Dr. Yacovitch (or her designee) will electronically submit each report to both the AQRP and TCEQ liaisons and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources. The report templates and accessibility guidelines found on the AQRP website at http://aqrp.ceer.utexas.edu/ will be followed. ****Draft copies of any planned presentations (such as at technical conferences) or manuscripts to be submitted for publication resulting from this project will be provided to both the AQRP and TCEQ liaisons per the Publication/Publicity Guidelines included in Attachment G of the subaward.**** Final project data and associated metadata will be prepared and submitted to the AQRP archive.

Project-specific deliverables by task are listed below, along with the responsible party and their due dates. Additional AQRP reporting requirements (including monthly, quarterly, draft final and final reports are listed separately.

Project deliverables

Project-specific deliverables by task are listed below, along with the responsible party and their due dates. Additional AQRP reporting requirements (including monthly, quarterly, draft final and final reports are listed separately.

Table 1. Project-specific deliverables

Task	Deliverable	Due Date	Responsible Party
Task 1. Design Measurement Campaign	Campaign planning document including chosen site(s) and integration plan	1 week prior to shipment/transit of instrument to Dallas-Fort Worth (Sept/Oct 2022)	Yacovitch, with contributions from Daube, Sheesley and Usenko
Task 2. Execute Field Campaign	Preliminary live dataset of hydrogen cyanide concentrations	Live data during fall and spring campaigns (Oct-Nov 2022; Spring 2023)	Yacovitch and Daube to provide data stream, with Sheesley and Usenko to provide optional integration into $(BC)^2$ network computers.
Task 3. Data Analysis	Finalized dataset including quality assured and calibrated HCN and expanded list of tracers (acetaldehyde, water vapor).	1 month after completion of field campaigns (Dec 2022 & Spring/Summer 2023)	Yacovitch and Daube
Task 3. Data Analysis	Enhanced fire plume characterization to be shared in technical and final reports.	2 months after receipt of quality assured dataset (Jan/Feb 2023; Summer 2023 and beyond)	Sheesley and Usenko

AQRP requires certain reports to be submitted on a timely basis and at regular intervals. A description of the specific reports to be submitted and their due dates are outlined below. One report per project will be submitted (collaborators will not submit separate reports), except for the Financial Status Reports (FSRs). The lead PI will submit the reports, unless that responsibility is otherwise delegated with the approval of the AQRP Project Manager. All reports will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources. Report templates and accessibility guidelines found on the AQRP website at http://aqrp.ceer.utexas.edu/ will be followed.

Abstract: At the beginning of the project, an Abstract will be submitted to the AQRP Project Manager for use on the AQRP website. The Abstract will provide a brief description of the planned project activities and will be written for a non-technical audience.

Abstract Due Date: Tuesday, August 16, 2022

Quarterly Reports: Each Quarterly Report will provide a summary of the project status for each reporting period. It will be submitted to the AQRP Project Manager as a Microsoft Word file. It will not exceed 2 pages and will be text only. No cover page is required. This document will be inserted into an AQRP compiled report to the TCEQ.

Quarterly Report Due Dates:

Report	Period Covered	Due Date
Quarterly Report #1	August, September, October 2022	October 31, 2022
Quarterly Report #2	November, December 2022, January 2023	January 31, 2023
Quarterly Report #3	February, March, April 2023	April 30, 2023
Quarterly Report #4	May, June, July 2023	July 31, 2023

Monthly Technical Reports (MTRs): Technical Reports will be submitted monthly to the AQRP Project Manager and TCEQ Liaison in Microsoft Word format using the MTR Template found on the AQRP website.

MTR Due Dates:

Report	Period Covered	Due Date
Technical Report #1	Project Start - August 31, 2022	September 10, 2022
Technical Report #2	September 1 - 30, 2022	October 10, 2022
Technical Report #3	October 1 - 31, 2022	November 10, 2022
Technical Report #4	November 1 - 30, 2022	December 10, 2022
Technical Report #5	December 1 - 31, 2022	January 10, 2023
Technical Report #6	January 1 - 31, 2023	February 10, 2023
Technical Report #7	February 1 - 28, 2023	March 10, 2023
Technical Report #8	March 1 - 31, 2023	April 10, 2023
Technical Report #9	April 1 - 30, 2023	May 10, 2023
Technical Report #10	May 1 - 31, 2023	June 10, 2023
Technical Report #11	June 1 - 30, 2023	July 10, 2023
Technical Report #12	July 1 - 31, 2023	August 10, 2023

DUE TO AQRP PROJECT MANAGER

Financial Status Reports (FSRs): Financial Status Reports will be submitted monthly to the AQRP Grant Manager (RoseAnna Goewey, r.goewey@ceer.utexas.edu) by each institution on the project using the FSR Template found on the AQRP website.

FSR Due Dates:

Report	Period Covered	Due Date
FSR #1	Project Start - August 31, 2022	September 15, 2022
FSR #2	September 1 - 30, 2022	October 15, 2022
FSR #3	October 1 - 31, 2022	November 15, 2022
FSR #4	November 1 - 30, 2022	December 15, 2022
FSR #5	December 1 - 31, 2022	January 15, 2023
FSR #6	January 1 - 31, 2023	February 15, 2023
FSR #7	February 1 - 28, 2023	March 15, 2023
FSR #8	March 1 - 31, 2023	April 15, 2023
FSR #9	April 1 - 30, 2023	May 15, 2023
FSR #10	May 1 - 31, 2023	June 15, 2023
FSR #11	June 1 - 30, 2023	July 15, 2023
FSR #12	July 1 - 31, 2023	August 15, 2023
FSR #13	August 1 -31, 2023	September 15, 2023
FSR #14	Final FSR	October 15, 2023

DUE TO GRANT MANAGER

Draft Final Report: A Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will include an Executive Summary. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources. It will also include a report of the QA findings.

Draft Final Report Due Date: August 1, 2023

Final Report: A Final Report incorporating comments from the AQRP and TCEQ review of the Draft Final Report will be submitted to the AQRP Project Manager and the TCEQ Liaison. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources.

Final Report Due Date: August 31, 2023

Project Data: All project data including but not limited to QA/QC measurement data, metadata, databases, modeling inputs and outputs, etc., will be submitted to the AQRP Project Manager within 30 days of project completion. The data will be submitted in a format that will allow AQRP or TCEQ or other outside parties to utilize the information. It will also include a report of the QA findings.

AQRP Workshop: A representative from the project will present at the AQRP Workshop in the first half of August 2023.

Presentations and Publications/Posters: All data and other information developed under this project, which is included in published papers, symposia, presentations, press releases, websites and/or other publications shall be submitted to the AQRP Project Manager and the TCEQ Liaison per the Publication/Publicity Guidelines included in Attachment G of the Subaward.

Expected final product(s) prepared for the project

We expect that the final products resulting from this project will be the final quality assured HCN dataset, the final project report and at least one journal article that describes the most noteworthy results from this project. The most likely target journals are *Environmental Chemistry and Technology*, *Atmospheric Chemistry and Physics*, Science of the Total Environment and *Journal of the Air and Waste Management Association*. These will be prepared and submitted following the Publication/Publicity Guidelines included in Attachment G of the Subaward.

8.0 References

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