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TRACER-BC2-SP2 Field Campaign Report

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ARM

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Acronyms and Abbreviations

ARM	Atmospheric Radiation Measurement
BB	biomass burning
BC	black carbon
BNL	Brookhaven National Laboratory
BU	Baylor University
MAC	mass absorption cross-section
PM	particulate matter
rBC	refractory black carbon
SP2	single-particle soot photometer
TAP	tricolor absorption photometer
TEOM	tapered-element oscillating microbalance
TRACER	Tracking Aerosol Convection Interactions Experiment
TRACER-BC2-SP2	TRACER-Black Carbon 2-single-particle soot photometer
TRACER-MAP	TRACER-Mapping Aerosol across Houston
UH	University of Houston

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1.0 Summary

The focus of this project was to assess black carbon and brown carbon aerosol in Houston, Texas during the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) user facility Tracking Aerosol Convection Interactions Experiment (TRACER) through the co-located deployment of a single-particle soot photometer (SP2) with the University of Houston/Baylor aerosol optical instrumentation in the Texas (BC)2 network in and around Houston. The deployment of the SP2 enables us to expand the spatial assessment of black carbon (BC) in Houston during TRACER by permitting a more thorough characterization of BC, including sources, transport, and potential processing. BC is well known to undergo physical and chemical changes during local and long-range transport that will impact its optical properties. By deploying multiple SP2s in the Houston area, the impacts of local and long-range transport can be assessed. The TRACER-BC2-SP2 campaign will expand spatial and temporal characterization of BC in the Houston area during TRACER and link the TRACER-carbon analysis to ongoing black and brown carbon monitoring (Texas [BC]2 network) in Houston.

The major scientific goals of this project are:

A. To understand urban processing of fresh black carbon emissions:

1. Conduct measurements of refractory BC at multiple sites in Houston to assess spatial variability; and
2. Calculate the BC mass absorption cross-sections (MACs) at multiple sites in Houston to assess both the temporal and spatial variability in and around the Houston area.

B. To elucidate the processing of black carbon from biomass burning during both local and long-range transport:

1. Identify and intercompare with tricolor absorption photometers (TAPs) for wavelength dependence of absorption;
2. Determine size distribution of BC;
3. Determine changes in size distribution in local versus long-range plumes;
4. Assess biomass burning (BB)-BC mixing state in the boundary layer;
5. Calculate MAC during different BB plumes.

During the TRACER IOP in June-September 2022, the ARM SP2 was deployed at Aldine (urban site north of downtown Houston) by Art Sedlacek, who trained Fangzhou Guo, Manisha Mehra, and Krishna AP on maintenance, data retrieval, and analysis of the results. They had initial issues with humidity in the inlet lines for the SP2. The routine deployment techniques were not sufficient for the humidity and heat encountered at Aldine. Sedlacek and Guo worked to reduce the humidity via increasing the Nafion drier lines, adding a dehumidifier in the trailer itself, and increasing the size of the Drierite to minimize the frequency of the exchanges. These initial problems were the cause of the data gap in May.

For the ARM SP2, data reduction was accomplished by ARM. The results of the deployment will be presented here. A day of detailed analysis is also presented here.

In addition, the Brookhaven National Laboratory (BNL) SP2 was deployed at Galveston (coastal site southeast of Houston) for July-August. These two SP2s were deployed in (BC)2 trailers with co-located TAPs, nephelometer, carbon monoxide measurement, and tapered-element oscillating microbalance (TEOM) for PM2.5 (Figure 1). Additional select PM2.5 filters were collected at each site.

The TRACER-Mapping Aerosol across Houston (TRACER-MAP) campaign collocated with the BC2-SP2 at Aldine three times during its July-August intensive operational period. This collocation will provide additional opportunities for more detailed analysis of black carbon aerosol (Figure 1).

Figure 1. Left: SP2 integrated into the BC2 inlet line that splits flow to two TAPS and a three-wavelength nephelometer. Right: The BC2 trailer co-located with the TRACER-MAP trailer at Aldine during the TRACER intensive operational period.

2.0 Results

The time series of the refractory black carbon (rBC) data from Aldine is included in Figures 2–5 below.

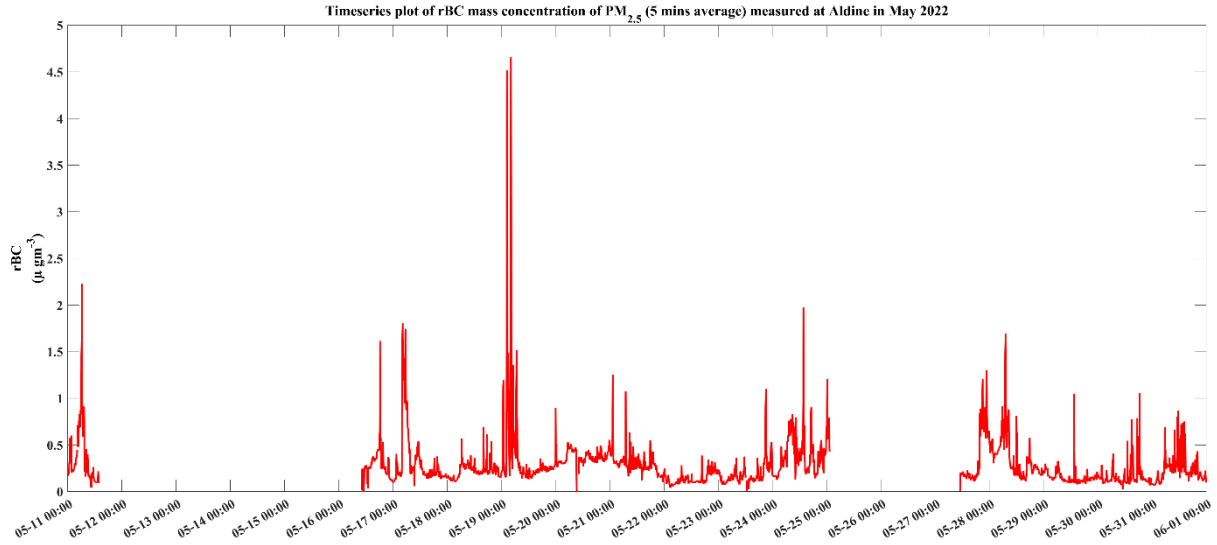

Figure 2. Time series of rBC ambient concentration at Aldine in May 2022.

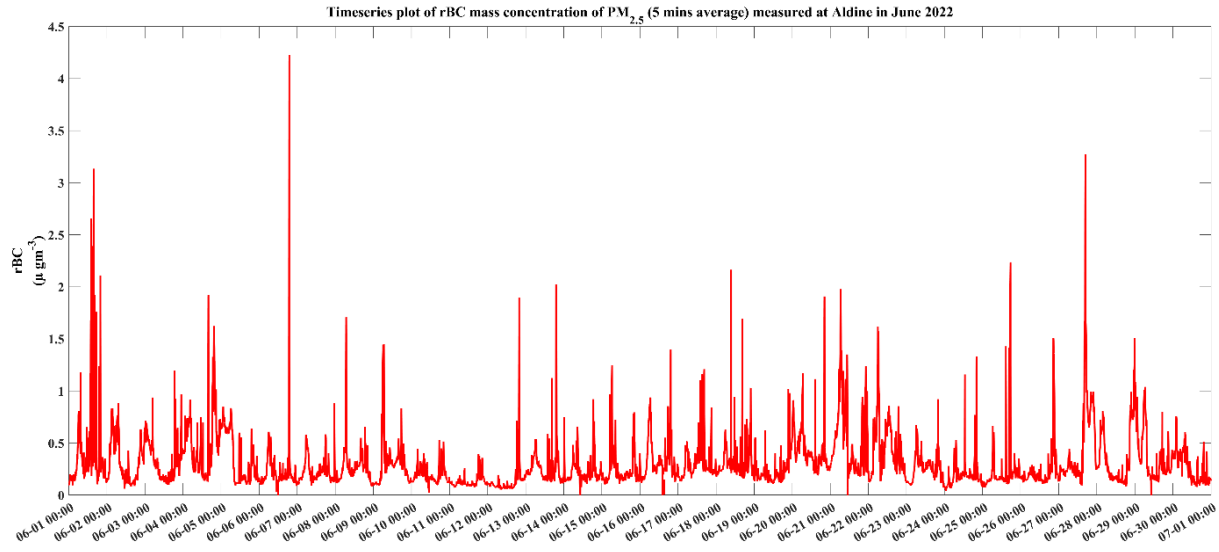

Figure 3. Time series of rBC ambient concentration at Aldine in June 2022.

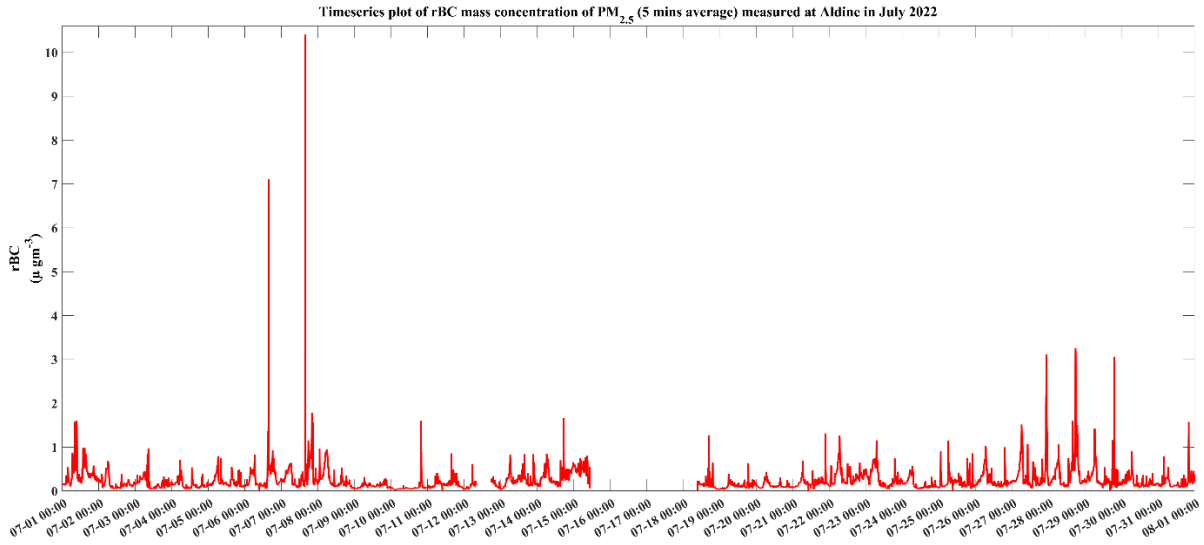

Figure 4. Time series of rBC ambient concentration at Aldine in July 2022.

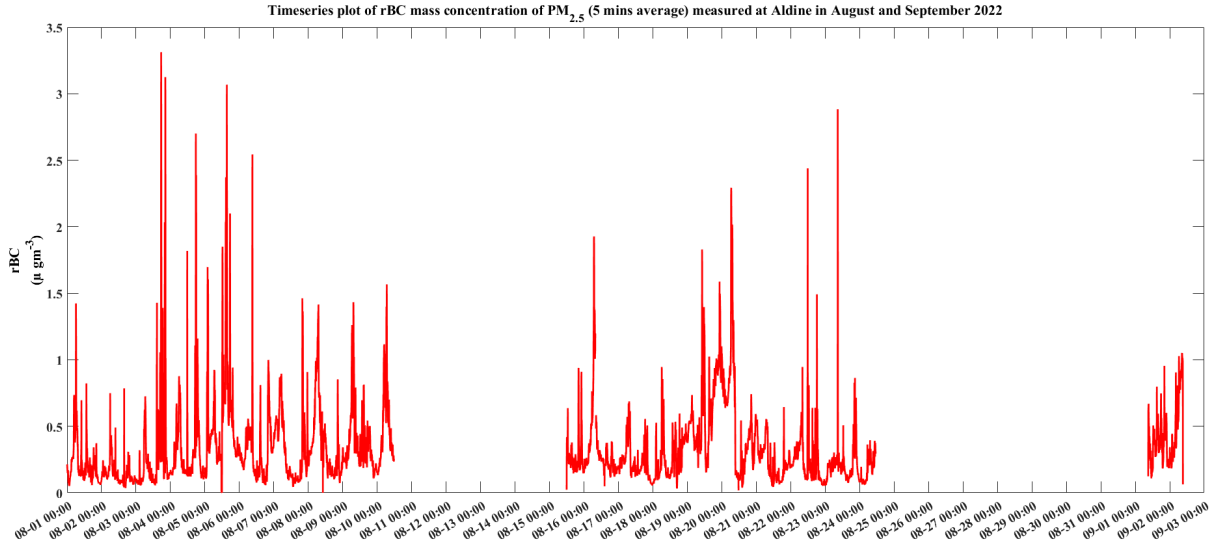

Figure 5. Time series of rBC ambient concentration at Aldine in September 2022.

As an example of the BC particles that we sampled during the campaign, we have plotted the number concentration and size for 9/2/22 (Figure 6).

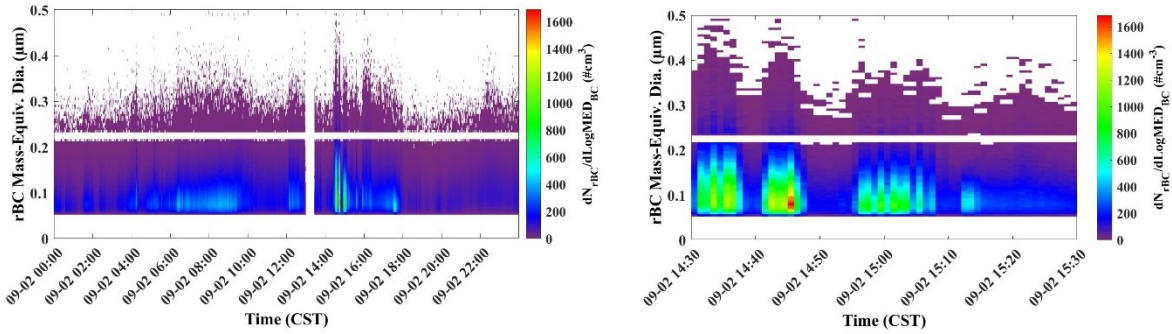

Figure 6. The left plot is rBC mass equivalent diameter for 9/2/22 with the number concentration by color. The right plot is the same but highlights the 14:30-15:30 period.

3.0 Publications and References

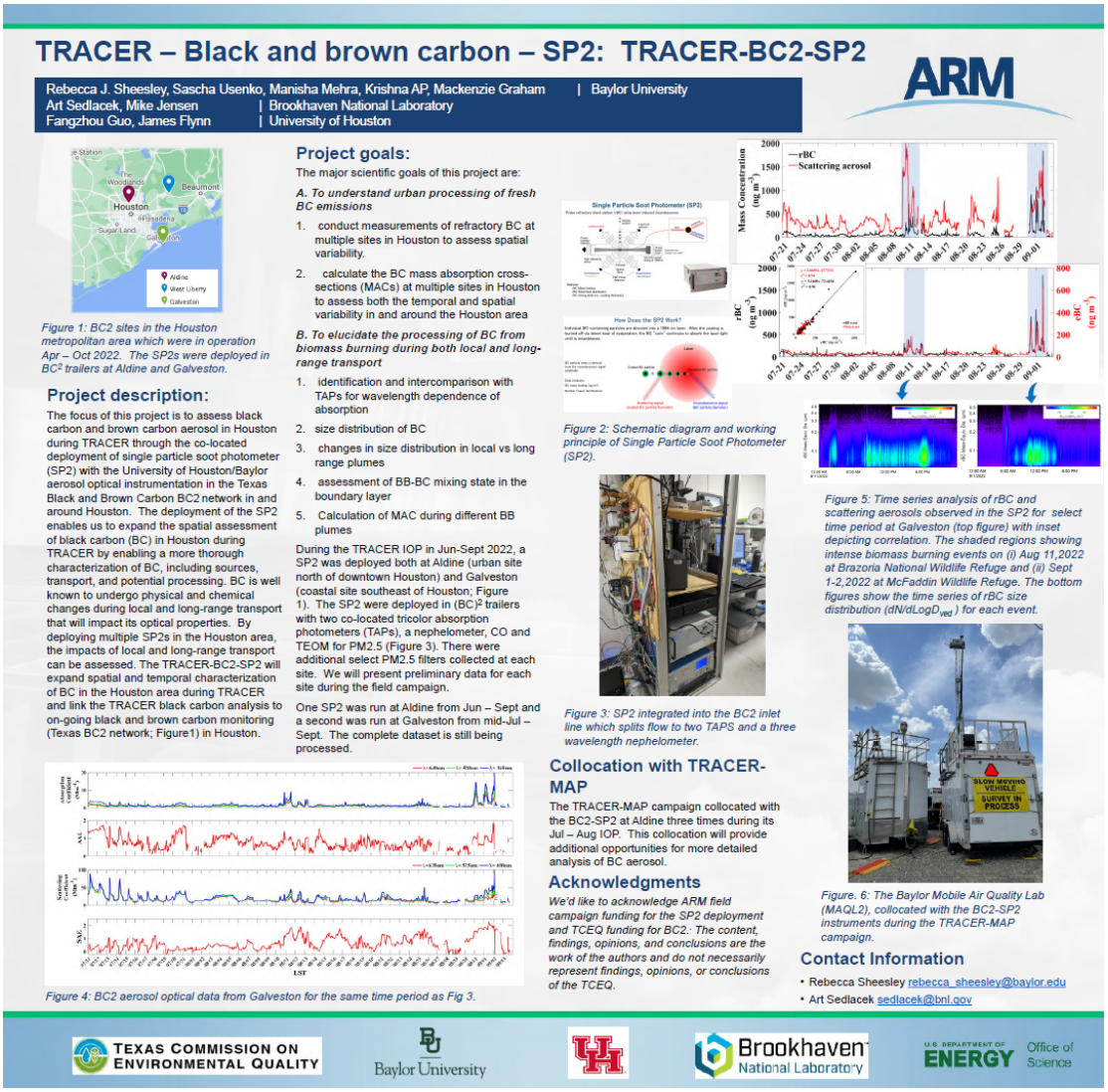

Figure 7. Poster from ARM/Atmospheric System Research Principal Investigator meeting, 2022.

4.0 Lessons Learned

This field deployment tested the limits of dehumidification in the inlet lines but confirmed the importance of the instrument mentor in making these campaigns successful. Art Sedlacek's expertise was invaluable in training researchers at Baylor and UH, not only in the operation of the instrument, but in the data analysis and interpretation.

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