

The Distribution and Fate of Tire Rubber-Derived Chemicals in Galveston Bay

Michael Shields and Yina Liu



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The Halo-Carbon Lab



- We study organic chemistry in natural waters.
- Novel extraction methods for trace chemicals.
- High-resolution mass spectrometry to understand the fate of organic compounds.
- Data Science – Compound identification algorithm for previously unknown transformation products.



GEOCHEMICAL AND ENVIRONMENTAL RESEARCH GROUP
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Persistent organic pollutants (POPs)
– PAHs, PCBs, Dioxins/Furans, PBDEs, etc.
Dissolved Nutrients
Total Mercury



Background

Coho Salmon fish kills in urban streams (1990s to Present)

- Anomalous behaviors and high pre-spawn mortality rates (60-100%) in urban streams
- Urban runoff mortality syndrome



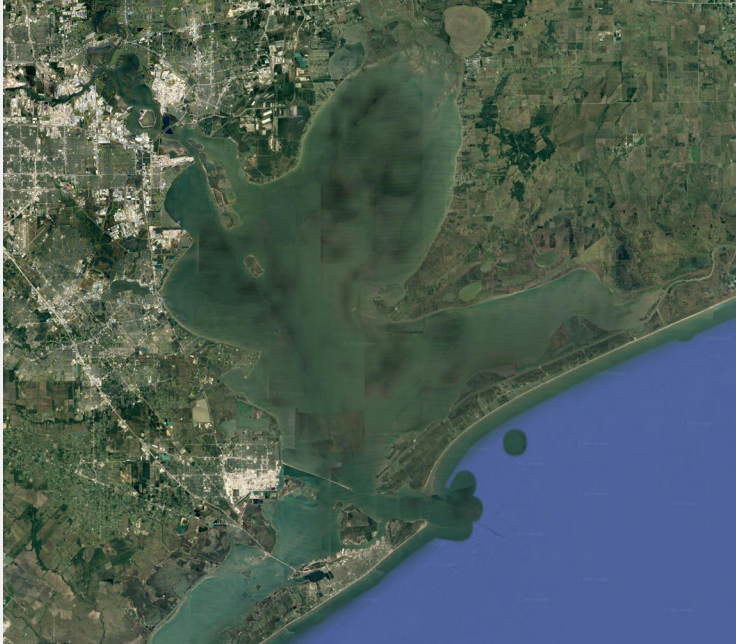
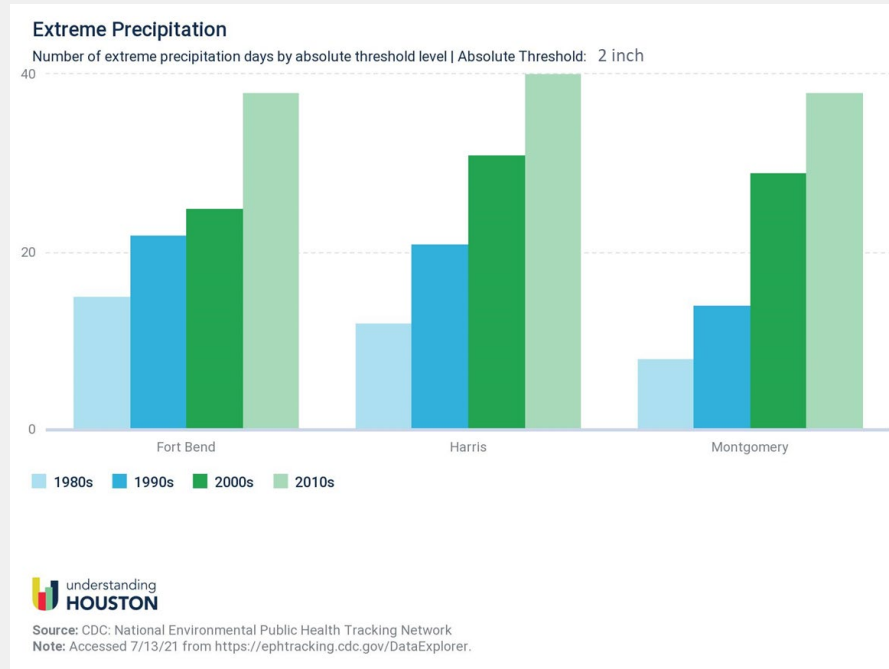
Image: (Scholz et al., 2011; PNAS)

6PPD-quinone (6PPD-Q)

- Derived from tire rubber
- Product of 6PPD degradation
 - Prevents your tires from becoming brittle
- 6PPD constitutes significant portion (0.4-2.0%) of tire rubber
- Acutely toxic at very low concentrations (ppt range)
 - EPA report released in May 2024 suggests a screening value of 11 ppt.
- High concentrations coincide with storm events
- Data in estuarine/marine waters are extremely limited (EPA report, May 2024)

Background

- 6PPD-Q considered ubiquitous in our waterways
- Galveston Bay is the receiving basin of two major metropolitan areas
- Average traffic on I10 near Lynchburg was 126K vehicles per day in 2021 (TxDot)
- The frequency of extreme precipitation events is increasing



Objectives

Proposed Work

- Leverage a multi-year Galveston Bay time series (2021-2023)
 - 12 quarterly cruises
- Measure 6PPD, 6PPD-Q, and transformation products in water and sediments
 - We have sediments dating back to 2018 that we are examining, as well.
- Investigate the partitioning and transformation of 6PPD-Q in Galveston Bay
 - Sediment sorption/desorption experiments
 - Photooxidation experiments

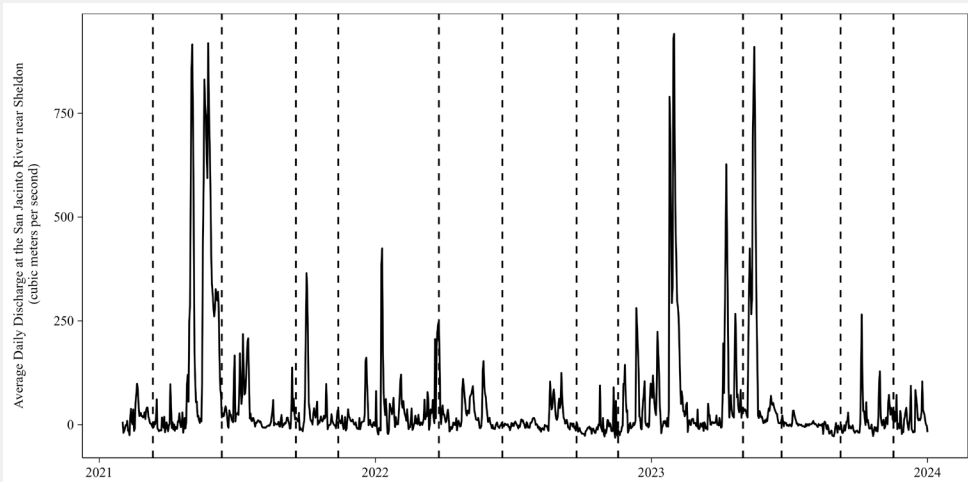
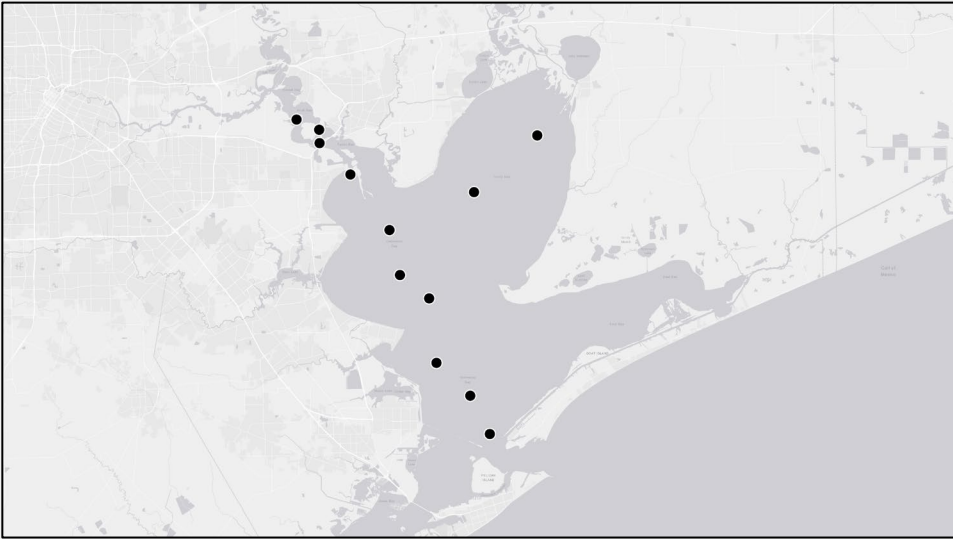
Expected Outcomes

Ensure Safe Human and Aquatic Life Use

- The toxicity of 6PPD-Q to Galveston Bay fish and shellfish species is unknown
 - This project will help inform future toxicity studies by providing a time series of environmentally relevant concentrations under different hydrographic regimes

Inform Science-Based Decision Making

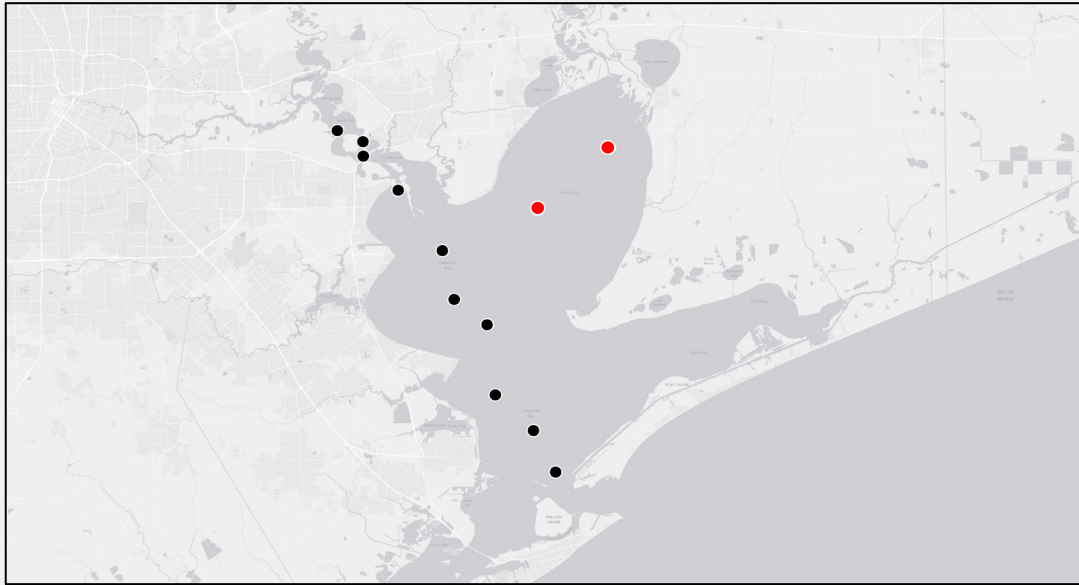
- Better understand the fate of 6PPD-Q in the Galveston Bay estuary



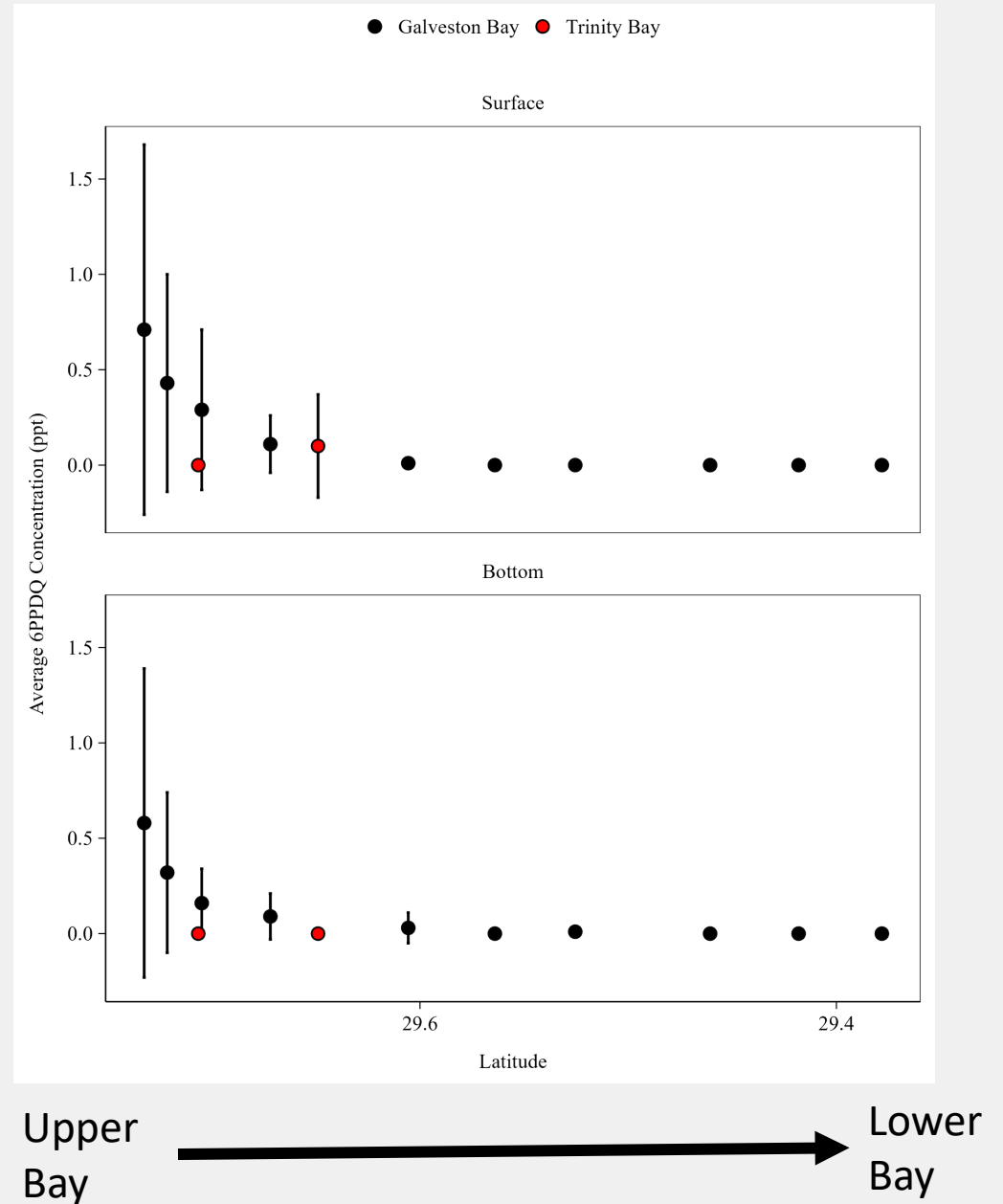
Project Update Takeaways

- 6PPD-Quinone (6PPD-Q) is a contaminant of emerging concern that forms during the breakdown of tire rubber
- 6PPD-Q is detected in water from stations near or in the Houston Ship Channel
- Sediments follow a similar pattern with higher concentrations in the Ship Channel
- 6PPD-Q is photo-degraded in sunlight, but also forms transformation products
- The previously funded work from GBEP will allow us to examine these degradation products in archived field samples

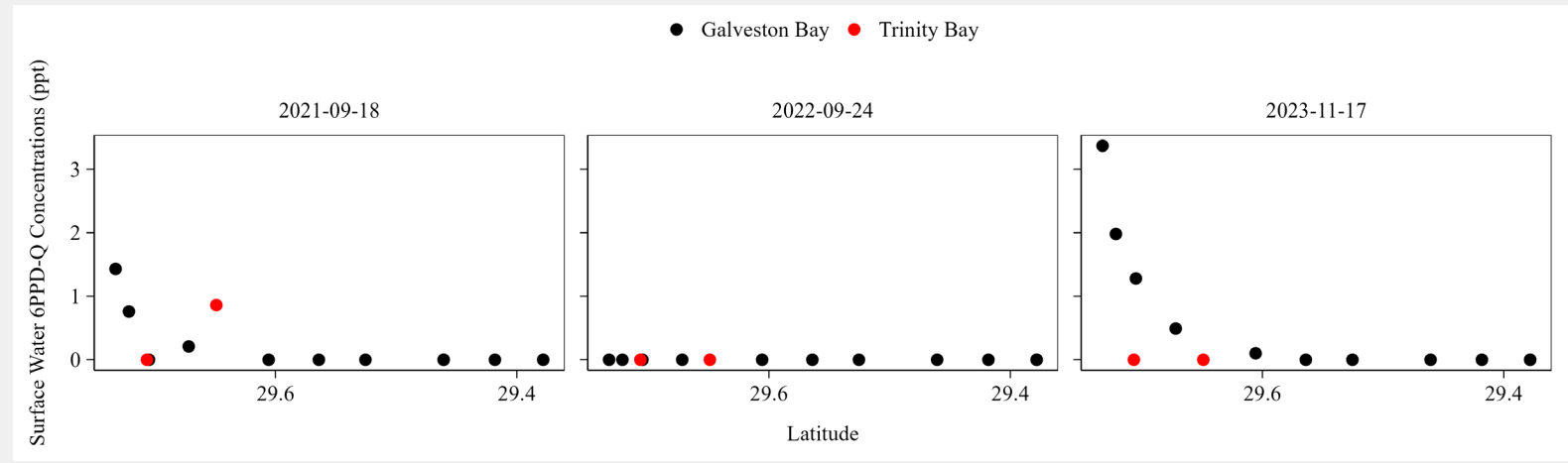
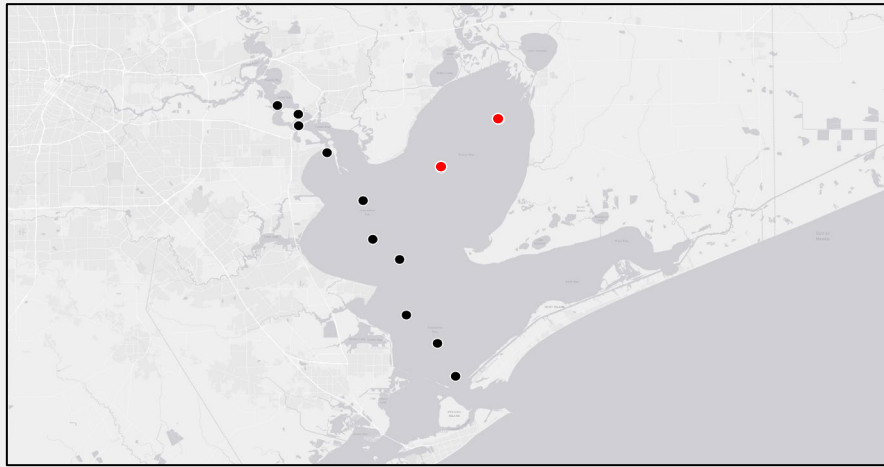
Average 6PPD-Q Conc. in Galveston Bay Water



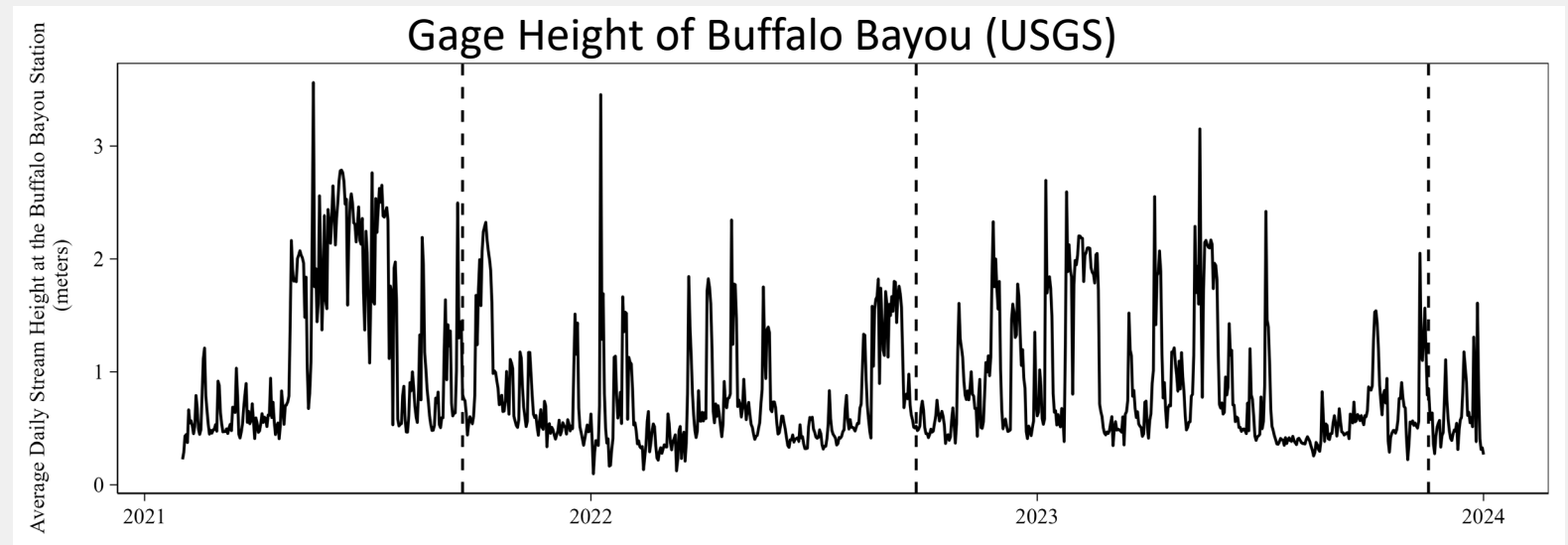
- 6PPD-Q concentrations are highest in the Houston Ship Channel and decrease towards the lower bay
- High temporal variability in the Houston Ship Channel



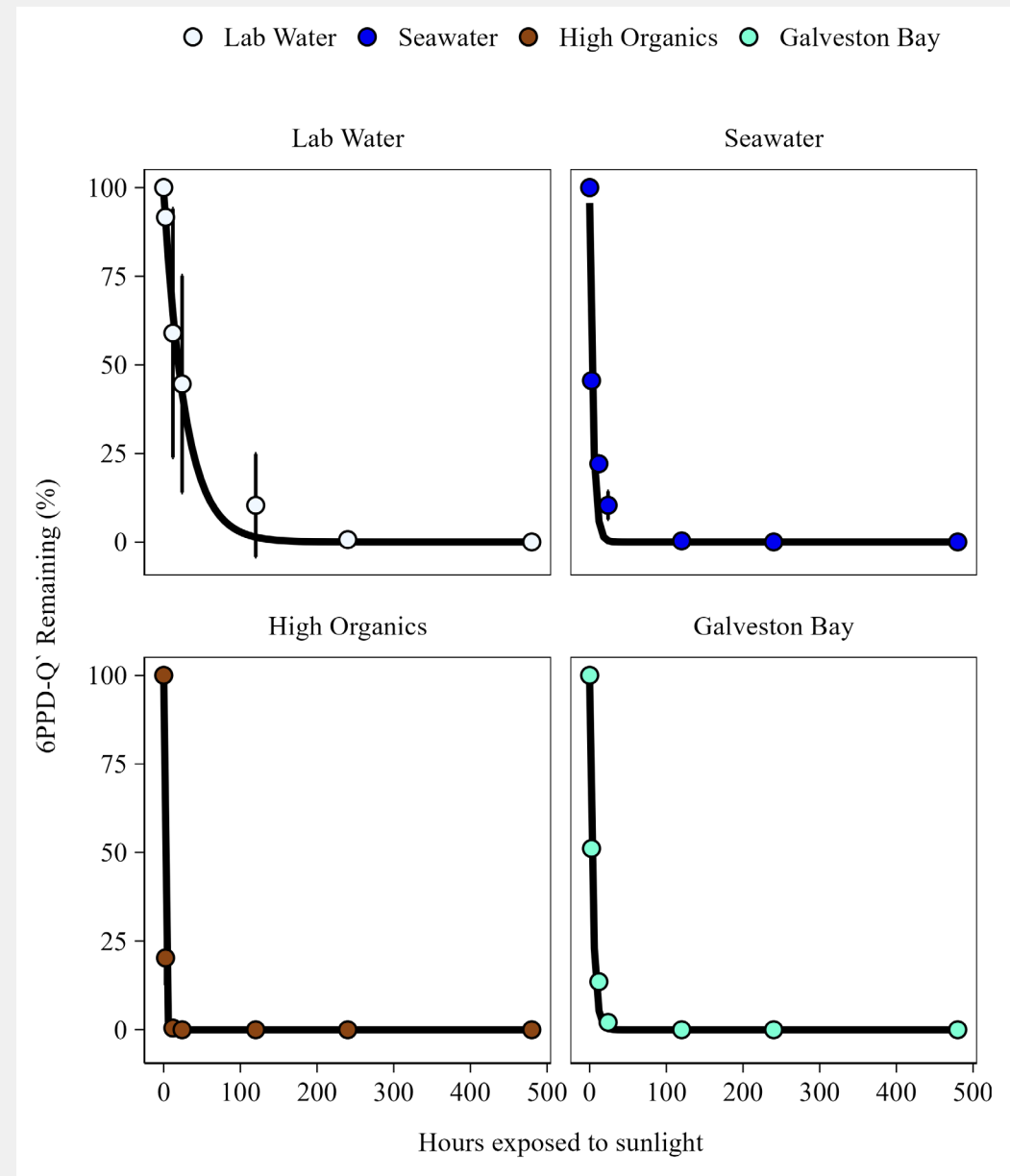
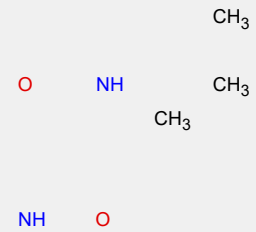
6PPD-Q in Surface Waters (Variability with Discharge)



- 6PPD-Q not quantifiable during low river discharge
- 6PPD-Q in the Houston Ship Channel may be more related to discharge from Buffalo Bayou

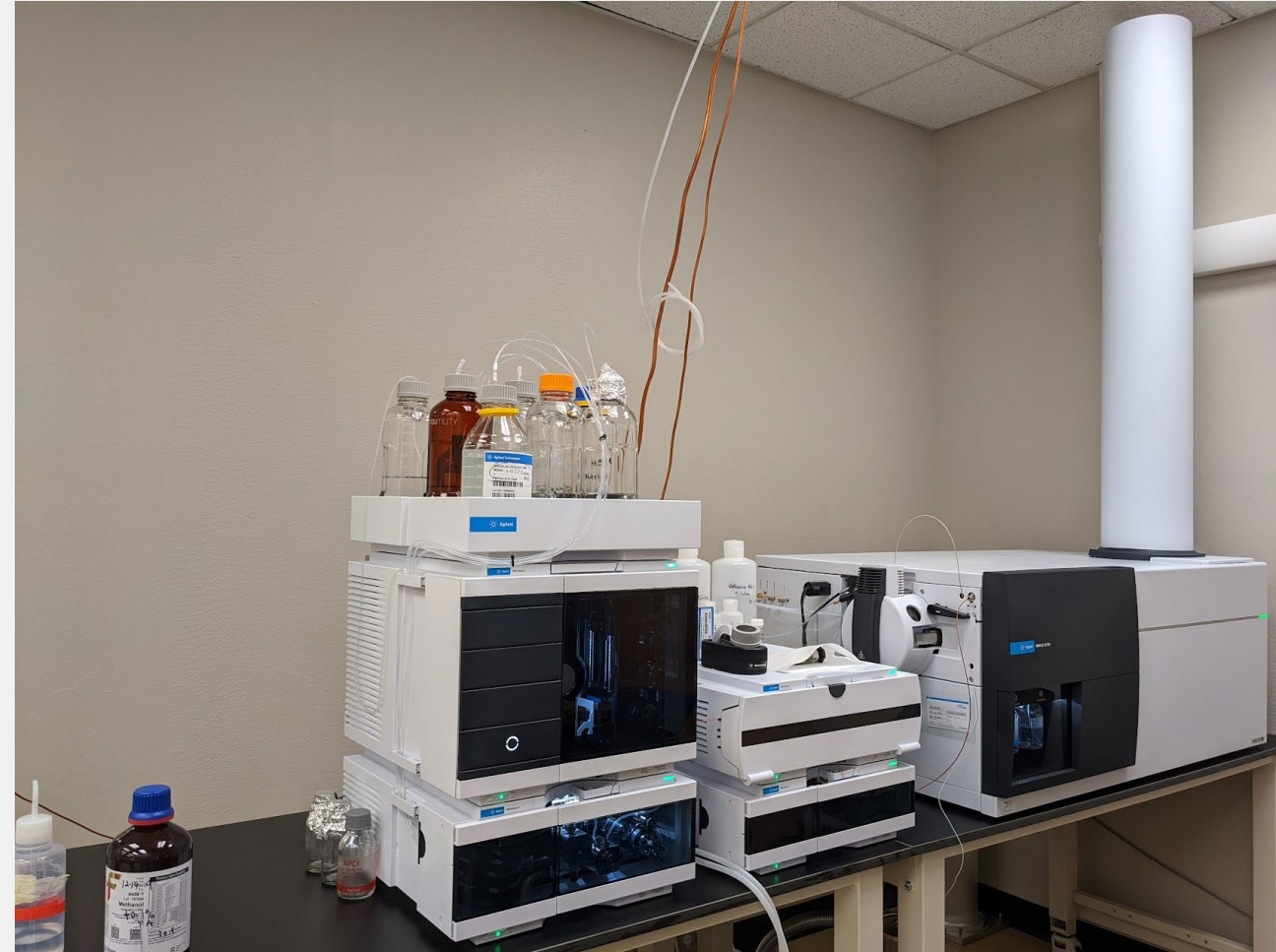


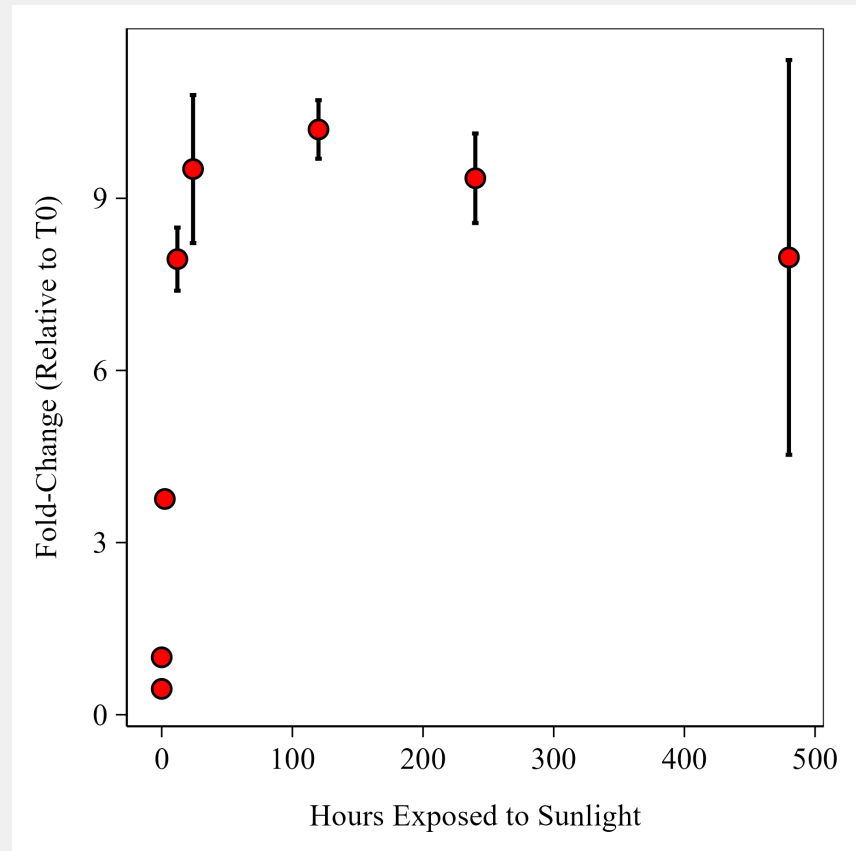
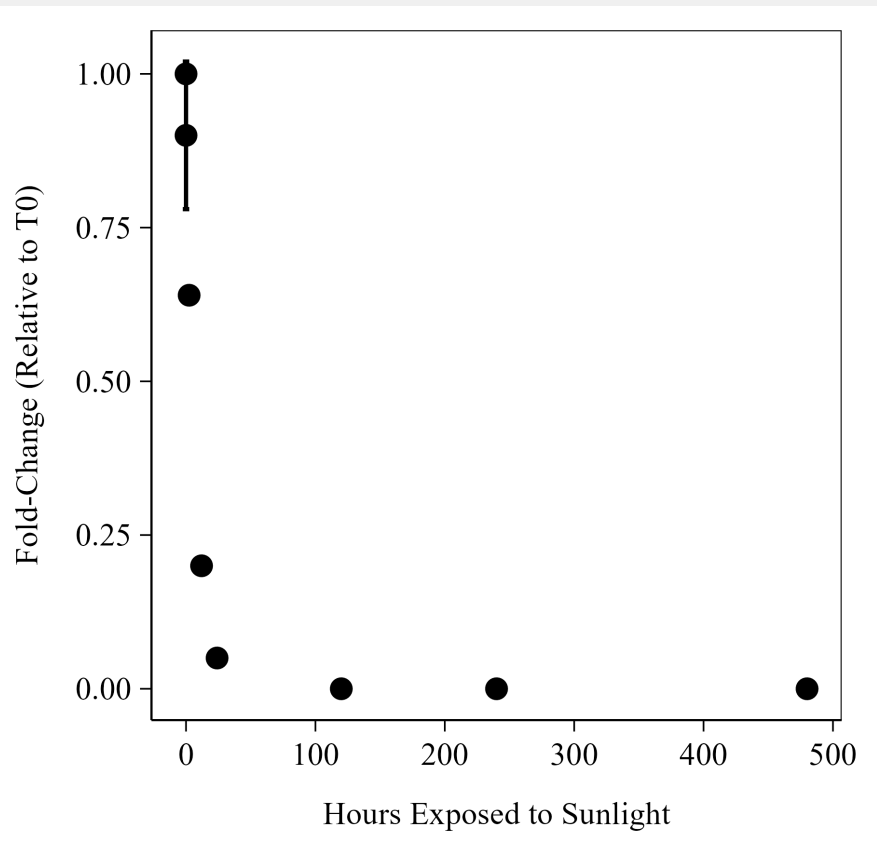
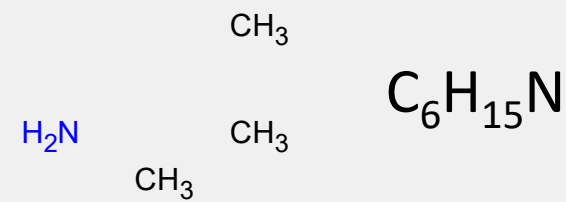
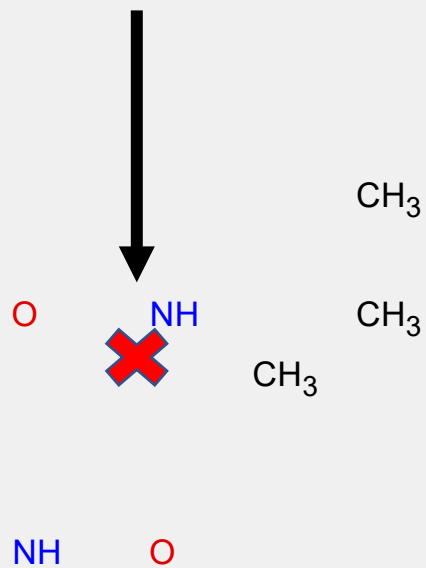
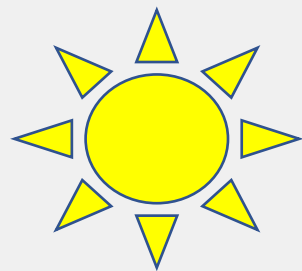
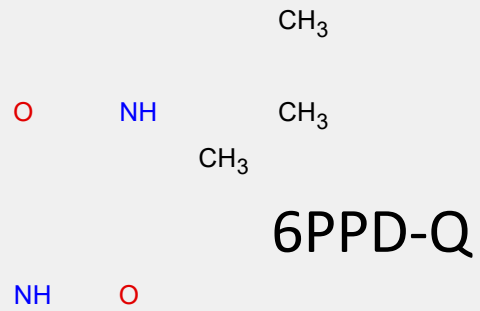
6PPD-Q and Sunlight



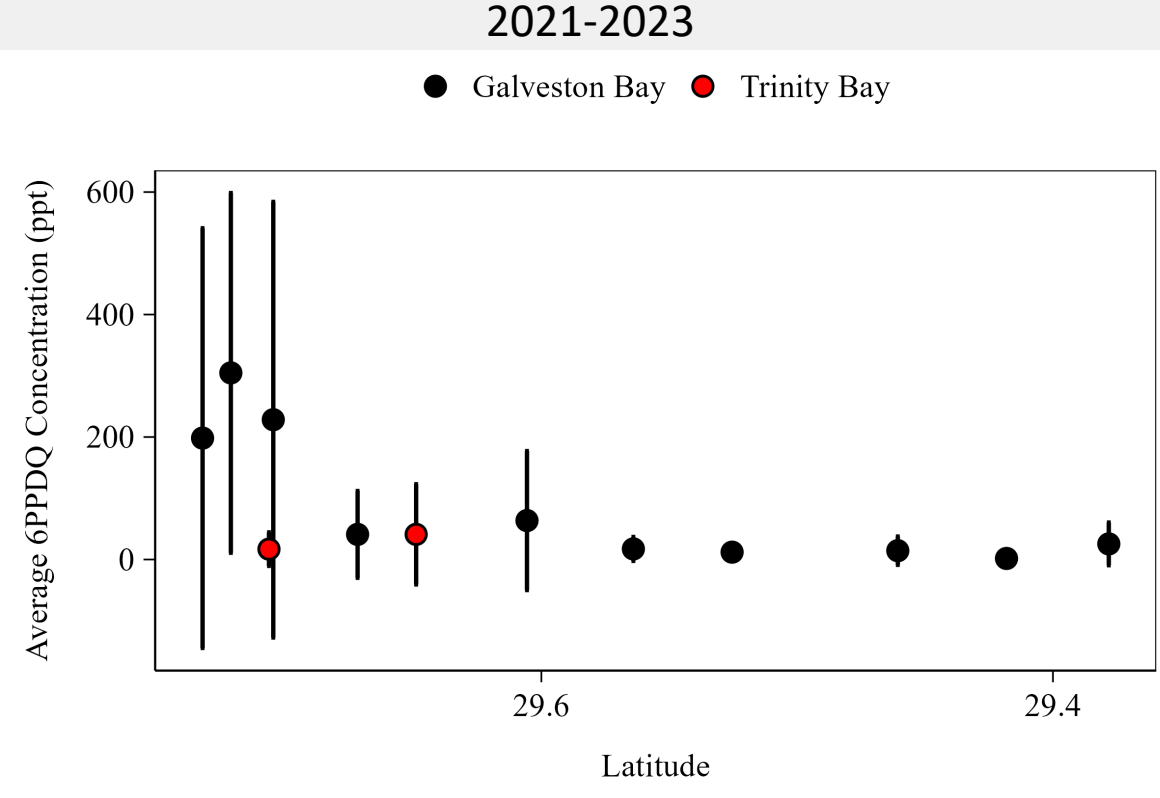
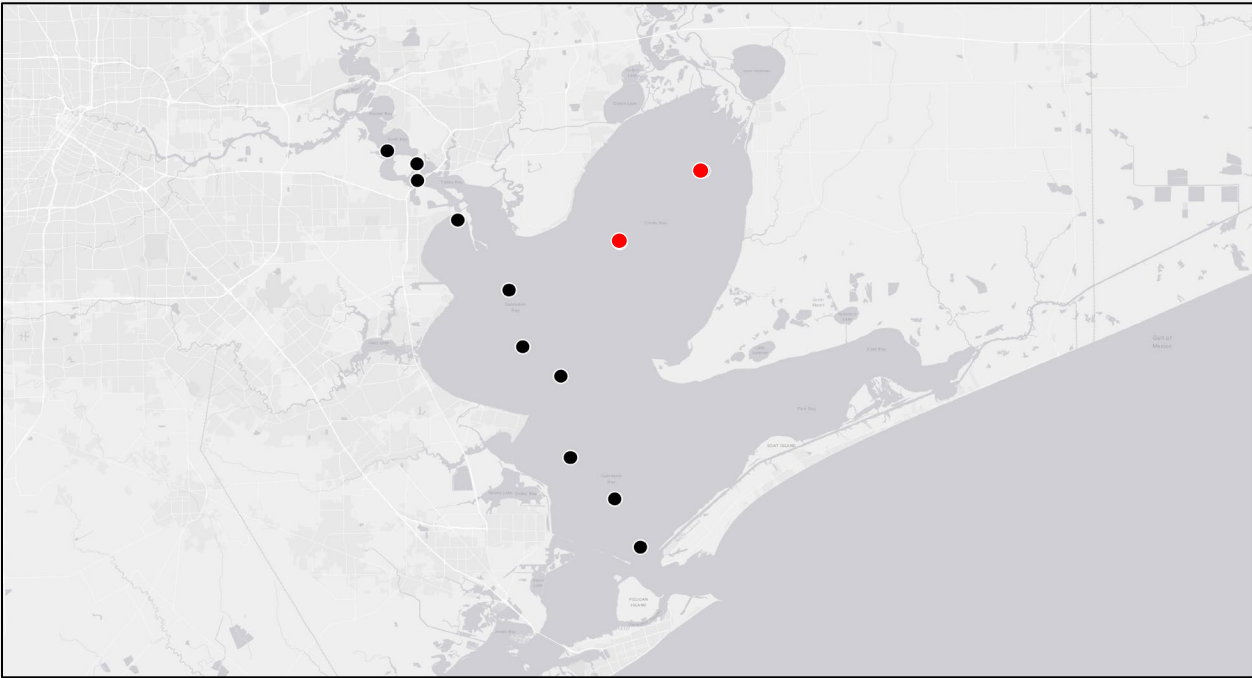
Did 6PPD-Q Break Down Completely?

- Ultrahigh-resolution mass spectrometry enables the detection of **previously unknown** reaction byproducts





Average 6PPD-Q Conc. in Sediments



- 6PPD-Q concentrations are greater in sediments vs. the water, showing preferential binding to sediments.
- 6PPD-Q concentrations are highest in the Houston Ship Channel and decrease towards the lower bay
- High temporal variability



What's next:

- Sediment sorption/desorption experiment
 - Determine the kinetics of 6PPD-Q sorption to sediments from Galveston Bay
- Continue exploring photo-transformation products



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