

AQRP Monthly Technical Report

PROJECT TITLE	Galveston Offshore Ozone Observations (GO3)	PROJECT #	20-004
PROJECT PARTICIPANTS	James Flynn (UH) Yuxuan Wang (UH) Paul Walter (St. Edward's University) Gary Morris (St. Edward's University)	DATE SUBMITTED	10/19/2021
REPORTING PERIOD	From: September 1, 2021 To: September 30, 2021	REPORT #	15

A Financial Status Report (FSR) and Invoice will be submitted separately from each of the Project Participants reflecting charges for this Reporting Period. I understand that the FSR and Invoice are due to the AQRP by the 14th of the month following the reporting period shown above.

Detailed Accomplishments by Task for reporting period

- Launched 12 ozonesondes during September, one of which was from a park at the Texas City Dike when the pontoon was unable to be out in the Bay.
- Conducted 11 measurement outings with the pontoon boat
- Continued monitoring with the Shrimp Boat and Red Eagle measurement cases.
- Removed pontoon from marina for Hurricane Nicholas
- Added Ox measurement to the pontoon boat prior to redeployment after Nicholas.
- Calibrated O3 and Ox instruments with O3 generator and NO2 dilution system.
- Conducted WRF-GC simulation for August and early September 2021 over Houston-Galveston region.
- Compared three sets of boat data with WRF-GC model for the “wet week” (September 1 to September 6) and “dry week” (September 7 to September 11)

- Note: WRF-GC v2.0 is a regional air quality model (Feng et al., 2021) that couples the Weather Research and Forecasting (WRF) meteorological model (v3.9.1.1) and the GEOS-Chem atmospheric chemistry model (v12.7.2).

Data Collected

In September 2021, 12 ozonesondes were launched from Galveston Bay, 11 of which were from the UH pontoon boat and the other was from a park adjacent to the Texas City Dike. The following entries are from the daily logs of pontoon activities during GO3/TRACER-AQ.

September 1st, 2021

Met at the Portofino Marina at 8:00am. Planned to go to the Morgan's Point launch location for an 11:00am launch to coincide with the NASA flyover. The UPS in the blue case died and I had to rewire everything to bypass the UPS. The throttle linkage engaging the 2 secondary cylinders came loose again and we needed to circle back to the Marina to fix it. Anchored at the launch location at 10:10am and released the balloon at 11:00am sharp.

Travis Griggs (UH), Michael Comas (UH), Claudia Bernier (UH)

September 3rd, 2021

Met at the Portofino Harbor Marina at 8:00am - pushed off at 8:25am. The NASA aircraft delayed takeoff slightly so we called an audible and went after the 9:30am launch. Got off a 600g balloon cleanly. Crossed the Bayport Channel at 10:00 am directly behind a large vessel - saw a good ozone titration dip.

Travis Griggs (UH), Michael Comas (UH)

September 4th, 2021

Received the engine board from Vaisala the night before and came into the lab to swap it out on the CL51 that had failed. Followed the instructions to swap out the engine boards and powered up the CL51. As soon as it was powered up I saw a spark on an adjacent board at the ribbon connector and then received the same error via the LED troubleshoot light that the new engine board had a failure. Emailed the Vaisala Helpdesk right away, however it is Labor Day weekend and we may not hear back until 9/7/2021.

September 7th, 2021 *Ozone Action Day

Met at the marina at 8:30am - just Michael and I today. Planning to go North to do a gradient sample and launch a 350g brown balloon near Morgans point at 2:00pm. The boat battery had gone bad and I went to West Marine to swap it out. New battery helped the starting greatly!

Travis Griggs (UH), Michael Comas (UH)

September 8th, 2021 *Ozone Action Day

Michael and I met at the marina at 8:00am. Planning to go South towards the Texas City Dike initially - launch a balloon in the center of the Bay - Go in for fuel - then return to the NW quadrant of the Bay for an afternoon launch and more sampling. The plane was delayed ~20 minutes and the trip down south was rough near Redfish Island. After getting beat-up going down and back we made it to the launch location in time for the afternoon launch. Headed back in for fuel and then back to the Northwest quadrant of the bay for the afternoon launch. Today was the first trip out with the Red Eagle and it was successful!

Travis Griggs (UH), Michael Comas (UH)

September 9th, 2021 *Ozone Action Day

Met at the Marina at 8:00am. Planned to replace the boat motor starter before taking off. After removing the old starter, it became apparent we had been shipped the wrong starter for our boat:(I reinstalled the old starter and was able to get the motor started. We initially went South and made a gradient run and launched our first balloon near the Texas City Dike. There was a good amount of ship traffic this morning and a noticeable 'haze' layer near the surface. Surface ozone reached roughly 70ppb on the trip down. After the launch we started working our way North back to the Kemah to refuel. After refueling we headed North to near Morgan's Point for the afternoon launch and gradient sampling. The Red Eagle made its big trip out to the lightering area with Paul to launch 3 balloons (2 at anchorages and 1 at the lightering area). After we docked a rapid ozone increase was observed at ~ 4:45pm. The KHGX radar shows a bay breeze feature coming across Galveston bay and a cloud front is visible.

Travis Griggs (UH), Michael Comas (UH)

September 10th, 2021

Met at the Marina at 8:15am. Planned to take the pontoon out to the West side of the Bay for some surface sampling. The Bay was forecast to be 10-15 knots and slightly choppy. There was an East wind today however and the bay waters on the West side piled up and became choppier than we could sustain for an outing, so we circled back to the Marina. Punched in the paneling of the front entrance door.

Travis Griggs (UH), Michael Comas (UH)

September 12th, 2021

Pulled the pontoon boat out of the Portofino Harbor Marina in preparation of Tropical Storm Nicholas. Jimmy met me at the Clear Lake Park boat ramp with his truck and trailer.

September 17th, 2021

The UH pontoon was redeployed on Galveston Bay via Sylvan Beach park after the passing of TS Nicholas (Briefly a Cat 1 Hurricane). The pontoon underwent some repairs/maintenance/cleaning while in the warehouse. Also, an additional instrument was added to the package to capture an NO₂ concentration with a Blue Light Converter (BLC) in a 49i Thermo ozone analyzer. Once launched, we observed the O₃ was in the 70ppb range and climbing rapidly, peaking around 105ppb on the W/NW side of the Bay.

Travis Griggs (UH), Jimmy Flynn (UH), Sergio Alvarez (UH)

September 20th, 2021

Met at the marina at 8:45am for a shorter day. Planned to only use 1 tank of gas and survey the NW portion of the Bay. Saw an interesting Bay Breeze feature a little before 2:00 near the Bayport Channel. Ozone jumped from ~40ppb to ~60ppb

Travis Griggs (UH), Michael Comas (UH)

September 21st, 2021

Met at the Portofino Harbor Marina at 8:10am. Planning to go South towards the Texas City Dike to compare measurements with Jimmy and MAQL-1. Also did a down and back parallel pass on the Dike from ~11:45 - 12:20.

Travis Griggs (UH), Michael Comas (UH), Angelique Demitillo (UVA)

September 23rd, 2021

Pontoon stayed in port due to poor bay conditions (choppy) following the cold front we had the night before. Took my truck out to the SW side of town, at Kitty Hollow Park, for two ozonesonde launches on Raster 2 & 3.

September 24th, 2021

The Pontoon Boat was called off due to choppy conditions in the Bay. Michael and I mobilized in my Pickup and launched at Battleground (San Jacinto Monument) for Raster 1 (~9:45am) and then met back at the Texas City Dike for another Launch on Raster 3 (~4:45pm).

September 25th, 2021

Met at the Marina at 8:15am. Planning to head out for launches on the 1st and 3rd Rasters and to collect Resin Tube Samples for Baylor. Bay conditions are smooth to slightly choppy with an ENE wind of around 7 knots. Made it up to the NW quadrant of the Bay without issue and anchored for the launch just North of Bayport channel. Released the balloon at 10:01 with the plane directly overhead. Ozone was reading ~45-50ppb. Made a gradient pattern in the North Bay and came back to just south of Bayport Channel to collect VOC resin tubes for Baylor. Collected those successfully and headed back for Kemah to refuel. Refueled and sampled in the NW quadrant of the Bay in the afternoon.

Travis Griggs (UH), Michael Comas (UH)

September 26th, 2021

Met at the Marina at 8:30am with Angelique and Hieu (NASA fellowship recipients). This is the last NASA flight day over Houston, and we plan to launch 2 ozonesondes in the NW quadrant of the Bay. The first launch was at 10:00am (coincided with Raster 1 flyover) and the second launch was for 2:00pm (Not a coordinated flyover launch). Ozone was not observed at high levels over the Bay in our surveying today (~60ppb). Noticeable uptick in recreational boat traffic (Nice day/Sunday).

Travis Griggs (UH), Angelique Demitillo (UVA), Hieu (NASA Fellow)

Preliminary Analysis

During the month there were two main ozone episodes: 7-11 September and 23-26 September. During one day of particular interest, nine ozonesondes were launched on 9 September 2021: 2 from the UH pontoon boat in Galveston Bay, 2 from La Porte, 2 from the University of Houston, and 3 from the Gulf of Mexico. The map of the launch locations is shown in Figure 1.

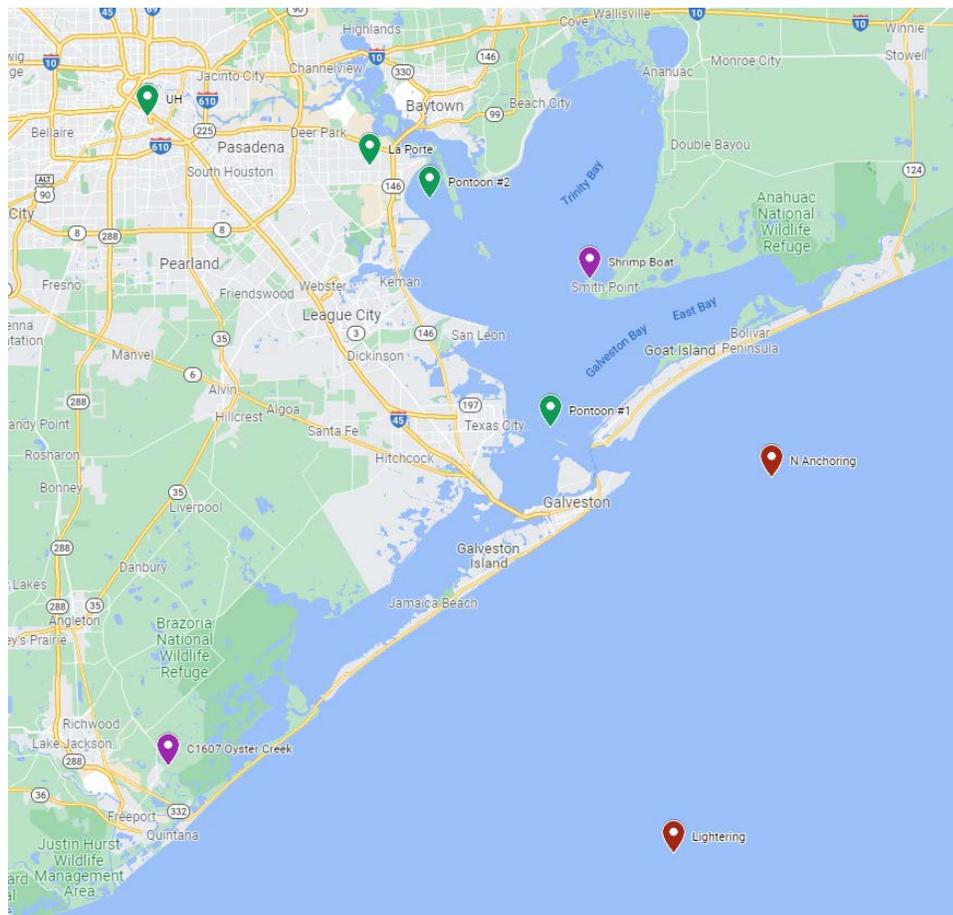


Figure 1. Map showing the TCEQ C1607 Oyster Creek monitor (purple) the ozonesonde launch locations from Galveston Bay (pontoon, green), La Porte (green), University of Houston - Main campus (green), and from aboard the Red Eagle (red) operating in the Gulf of Mexico.

The four profiles from Galveston Bay and La Porte are shown in Figure 2 where each launch from La Porte occurred about an hour after a launch from the UH pontoon boat. The morning launch from the UH pontoon boat was from near the Texas City Dike whereas the afternoon launch was in the NW quadrant of Galveston Bay approximately 10 km SE of the launch site of La Porte.

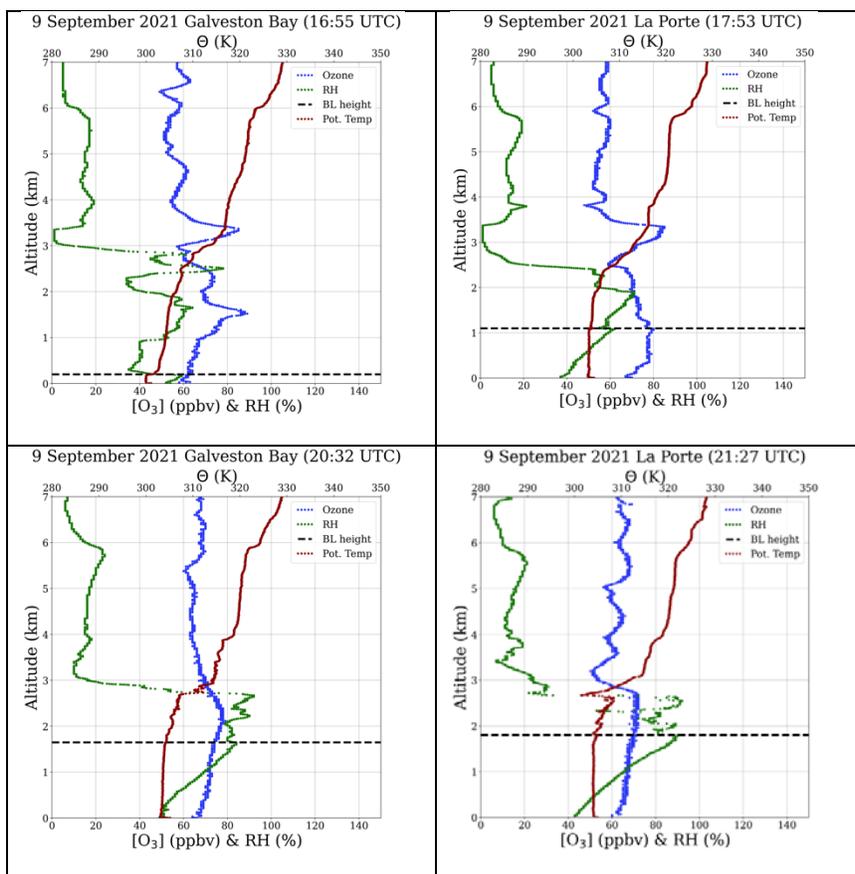


Figure 2. Ozonesonde profiles on 9 September 2021 from the pontoon boat in Galveston Bay (top-left and bottom-left panels), La Porte (top-right and bottom-right panels).

The first ozonesonde profile (launched near the Texas City Dike at 10:55 am CST; top-left panel of Figure 2 from Galveston Bay shows a marine layer at 0.2 km. Ceilometer data from the pontoon boat (Figure 3) shows general agreement with an aerosol layer at 0.25 km at the same time. The ceilometer data shows a second layer at 1.8 km, which lies just above an ozone enhancement observed in the ozonesonde profile.

The second ozonesonde profile from the pontoon boat in Galveston Bay (launched in the NW quadrant of Galveston Bay at 2:32 pm CST; bottom-left panel of Figure 2) shows features between 1.7 km and 2.8 km AMSL that are also observed in the pontoon boat ceilometer data (Figure 3). The ozonesonde launch occurred approximately 10 km east of La Porte where an ozonesonde was also launched an hour later at 3:27 pm CST (profile shown in bottom-right panel of Figure 2).

UH 09 September 21

Algorithm method = 0; Algorithm sensitivity = 10; Height averaging = Default; Time averaging = Default; BL height range (30 m - 4000 m); E

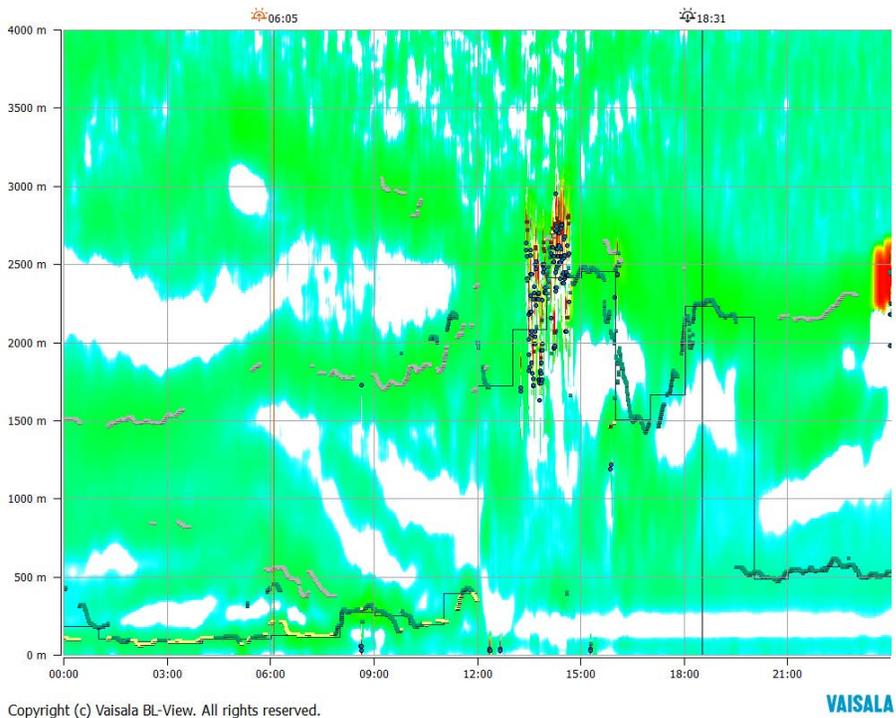


Figure 3. Ceilometer data from the UH pontoon boat on 9 September 2021.

The C1607 Oyster Creek monitor had the highest MDA8 [O₃] (81 ppbv) in the HGB area. The 24-hour wind run for that monitor is shown in Figure 4. In the morning the winds were out the NNW before becoming easterly in the afternoon. That wind pattern is consistent with ozone and its precursors being transported from the Houston area to out over the Gulf in the morning. The Lightering area in the Gulf of Mexico, where measured ozone concentrations from the Red Eagle were observed to be 100 ppbv in the afternoon, is east of the C1607 Oyster Creek monitor. The afternoon wind speeds were high enough that it is unlikely that the higher ozone concentrations observed by the C1607 monitor were produced locally but were instead transported from nearby in the Gulf of Mexico.

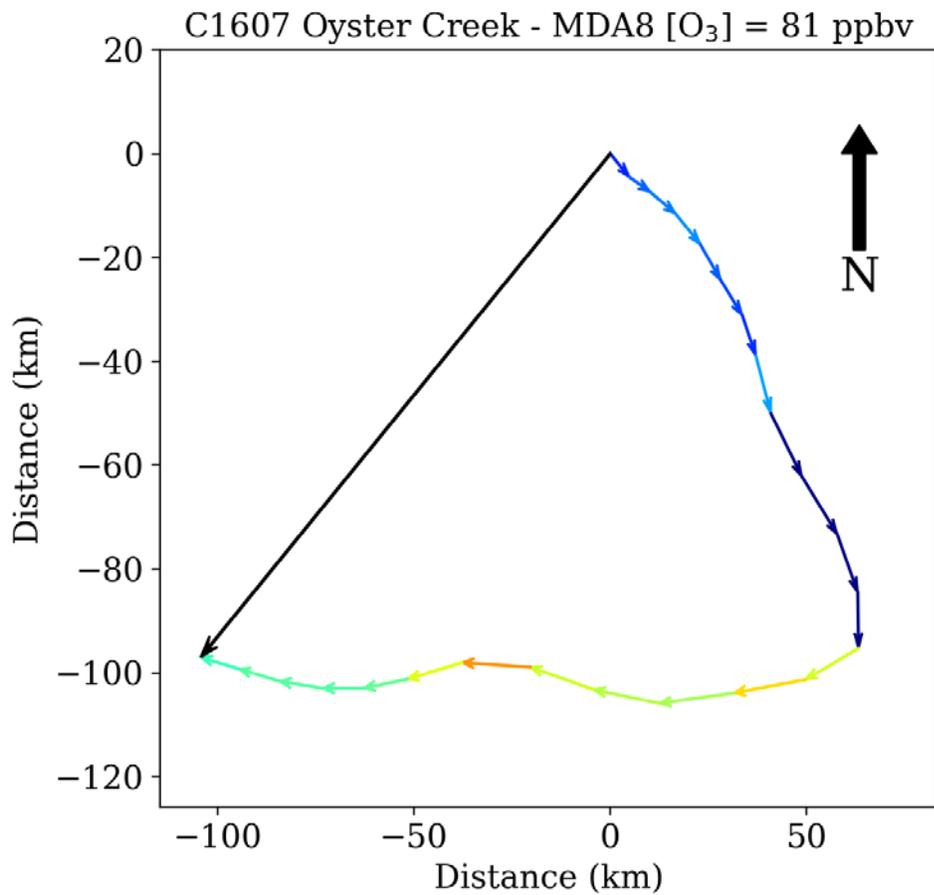


Figure 4. The 24-hour wind run for C1607 Oyster Creek for 9 September 2021.

Three sets of boat data were compared with WRF-GC model results for the “wet week” (September 1 to September 6) and “dry week” (September 7 to September 11). The model is consistent with observations in terms of relative trends over the two weeks however the model has a systematically overestimates ozone, as seen in Figure 5.

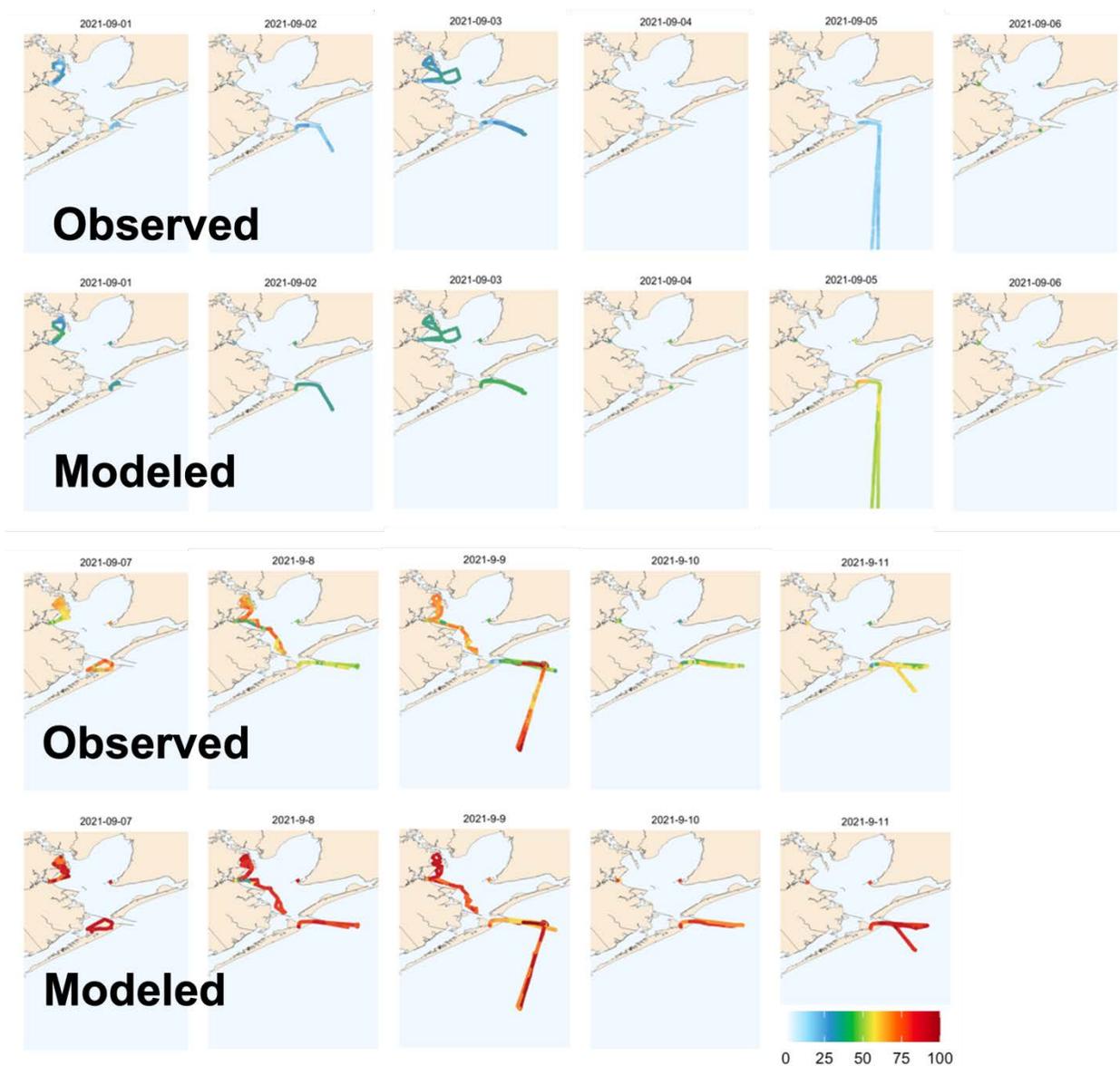


Figure 5. Comparison of WRF-GC and boats data between wet week from September 1 to September 6, 2021 (upper panel) and dry week from September 7 to September 11, 2021 (lower panel).

Gradients of ozone, temperature, relative humidity, and planetary boundary layer height over urban Houston, Galveston Bay and The Gulf between wet week (September 1 to September 6) and dry week (September 7 to September 11) were analyzed as shown in Figure 6. The model predicted a large ozone increase by 30 ppbv occurred over the Gulf during the dry week. Planetary boundary layer heights are also predicted to increase over the Gulf and Galveston Bay during the dry week.

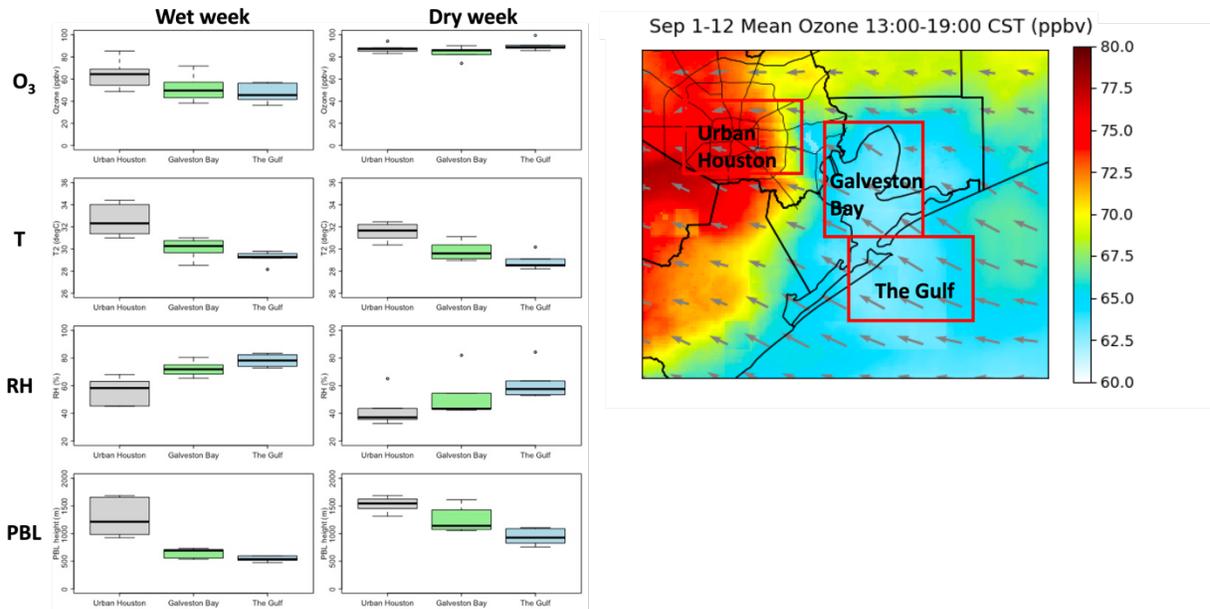


Figure 6. Left panel shows land-water gradients of ozone, temperature, relative humidity, and planetary boundary layer height over three regions of urban Houston, Galveston Bay and the Gulf. Right panel shows the three regions on a mean ozone concentration map averaged over 13:00–19:00 CST from September 1 to September 12, 2021.

Identify Any Problems or Issues Encountered and Proposed Solutions or Adjustments

Several problems were encountered as described above, including battery, starter, and throttle linkage issues on the pontoon boat as well as a failure of the CL-51. The battery, starter, and throttle linkage was either replaced, repaired, or adjusted in the field to resolve the problem. The decision was made to remove the CL-51 from the Shrimp Boat and install it on the pontoon for the completion of the project since the Shrimp Boat was not as active as had been hoped. The CL-51 engine driver board on the faulty instrument was replaced with a new board from Vaisala however that did not resolve the problem and indicated a short elsewhere in the instrument. Preparations were made to send the instrument back to Vaisala for warranty repairs. As noted the Shrimp Boat operations continued to be underwhelming, particularly in comparison to the Red Eagle and pontoon boat. There were limited options during September however if this project continues in future years we would likely explore using a second boat from the Red Eagle operator.

Goals and Anticipated Issues for the Succeeding Reporting Period

Measurement aboard all three boats will continue in October, however we anticipate fewer trips with the pontoon boat as fewer ozone events are expected and the water conditions are likely to be trending to rougher seas given the frequency of frontal passages. Towards the end of the month the pontoon and instruments aboard the Shrimp Boat and Red Eagle will be removed to avoid incurring charges in November. Additionally, analysis and work on the Draft Final and Final Reports will occur, with the Draft Final Report due October 15th.

Detailed Analysis of the Progress of the Task Order to Date

September marked one of the most intense months for GO3 due to coordination with the TRACER-AQ campaign. Other than a few mechanical and instrument problems on the pontoon boat the data collected there continues to show significant results. Although very much delayed, the Ox measurement capability added to the pontoon after Hurricane Nicholas showed that there is NO₂ over the Bay and that some of the variability in ozone seen earlier in the project may in fact be due to O₃:NO₂ partitioning. While the Red Eagle activity level is quite pleasing, the Shrimp Boat activity is equally disappointing, even though it is understandable due to a poor shrimping season and health issues of the owner/operator. In all, to date the team feels that the project has generally been highly successful and is excited to dig deeper into the results in the future.

Do you have any publications related to this project currently under development? If so, please provide a working title, and the journals you plan to submit to.

Yes No

Do you have any publications related to this project currently under review by a journal? If so, what is the working title and the journal name? Have you sent a copy of the article to your AQRP Project Manager and your TCEQ Liaison?

Yes No

Do you have any bibliographic publications (ie: publications that cite the project) related to this project that have been published? If so, please list the reference information. List all items for the lifetime of the project.

Yes No

Do you have any presentations related to this project currently under development? If so, please provide working title, and the conference you plan to present it (this does not include presentations for the AQRP Workshop).

Yes No

Travis Griggs has applied to present results from this project at the AMS meeting in Houston in January 2022. The current working title is “Galveston Offshore Ozone Observations (GO3) Field Campaign: Unique Surface and Vertical Profiles of Ozone and Boundary Layer Measurements in Galveston Bay and the Gulf of Mexico” however preparation of the material has yet to formally begin as measurements are still ongoing.

Do you have any presentations related to this project that have been published? If so, please list reference information. List all items for the lifetime of the project.

Yes No

Have any personnel changes occurred that were not listed in the original proposal? If so, please include a detailed description of the personnel change(s) below.

Yes No

Are any delays expected in the progress of the research? If so, please include a detailed description of the potential delay below.

Yes No

The AQRP and TCEQ have requested the deployment to be delayed into CY2021.

Describe any possible concerns/issues (technical or non-technical) that AQRP should be made aware of.

Yes No

Are you anticipating using all the available funds allocated to this project by the end date? If not, why and approximately what is the amount to be returned?

Yes No

Acronyms/Abbreviations:

MAQL: Mobile Air Quality Lab
ppbv: Parts per billion by volume
UTC: Universal Time Coordinated

Submitted to AQRP by

James Flynn