AQRP Monthly Technical Report

PROJECT TITLE	Improving WRF representation of coastal, marine, and residual boundary layers and quantifying the effects on ozone prediction	**PROJECT #**	24-021
PROJECT PARTICIPANTS	Yuxuan Wang, James Flynn	**DATE SUBMITTED**	03/10/2025
REPORTING PERIOD	**From:** 02/01/2025 **To:** 02/28/2025	**REPORT #**	6

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 15th of the month following the reporting period shown above.

Detailed Accomplishments by Task for reporting period

Task 4:

- Selected the days for the Weather Research and Forecasting (WRF) model perturbation.
- Compiled a list of the physics parameters and their expected perturbation values.
- Performed more than 200+ simulations and compared with the base run.
- Identified the optimal physics parameters and schemes.
- Working on Task 4 report.

Preliminary Analysis

We have performed the perturbed runs for major physics parameters and schemes for the selected days to identify the parameters which can optimize the WRF planetary boundary layer height (PBLH). The WRF simulation is conducted by perturbing each parameter to its minimum, maximum, and mid-values. Table 1 lists the cases and the values perturbed for the WRF run.

Simulation Name	Perturbations
PBL_base	None
PBLH1	B1 = 36, B2 = 22.5
PBLH2	B1= 30, B2 = 18.5
PBLH3	$\alpha 1 = 0.27$
PBLH4	$\alpha 1 = 0.50$
PBLH5	C3 = 0.50
PBLH6	C3 = 0.42
PBLH7	Pr = 2
PBLH8	Pr = 1.37

Table 1: Summary of WRF simulation cases highlighting the perturbed parameter and their values for each run.

We compared the output of the multiple perturbed runs with the base run and observations over Galveston Bay using the frequency distribution curve, as shown in Figure 1a for September 09, 2021, as a representative day. The frequency distributions for perturbation simulations PBLH5 and PBLH4 are closer than observed ones compared to other runs, and PBLH5 is verified as being the best simulation based on hourly box plot (Figure 1c). The box plot shows that the daytime PBLH for each hour is higher in the perturbed run (PBLH5) than the base run and appears to be close to the observations. PBLH5 is related to the closure constant C3 which is sensitive to boundary layer evolution and vertical mixing. The values of C3 = 0.5 generally refer to the evolution of convective boundary layer.

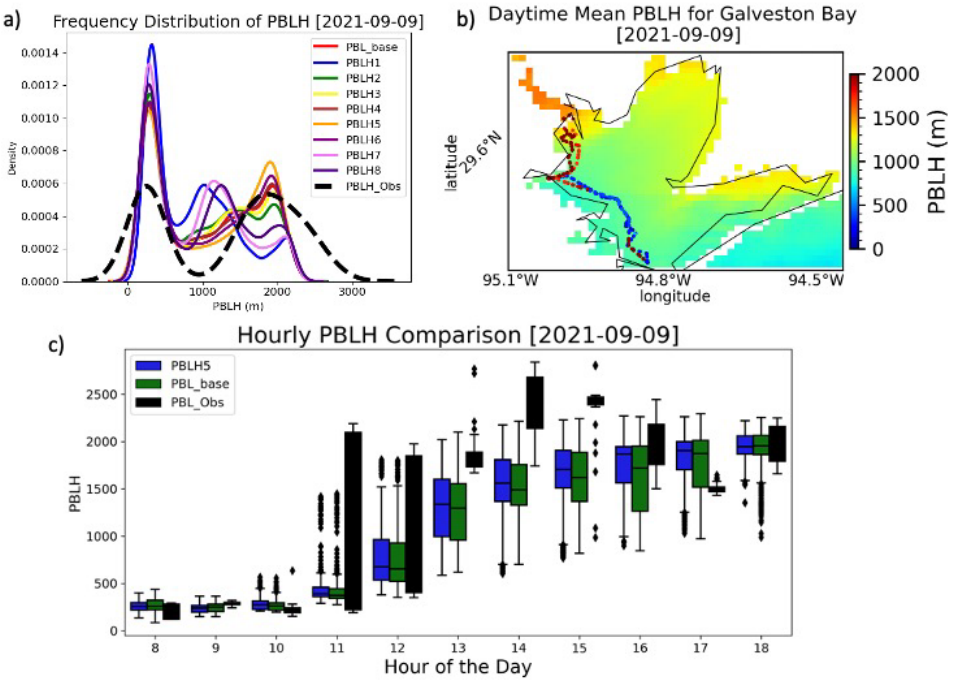

Figure 1: a) The frequency distribution of daytime (08-18:00 CDT) PBLH over Galveston Bay b) Model daytime mean PBLH along with the boat observations overlaid (denoted by dots) c) Box plot of Hourly PBLH for Observations, Base run and PBLH5.

We also compared the spatial distribution of daytime (08:00-18:00 CDT) mean PBLH for the entire domain from the better-performing perturbed run (PBLH5) with the base run, as shown in Figures 2a and 2b, respectively. The difference between the perturbed and base runs (Figure 2c) shows that the increase in daytime mean PBLH is observed over the water up to 200 m as a result of the perturbation. It is important to note that the PBLH over the land has not been significantly impacted by the perturbation. Detailed analysis of the perturbation simulations will be described in the Task 4 Report, which is due March 15, 2025.

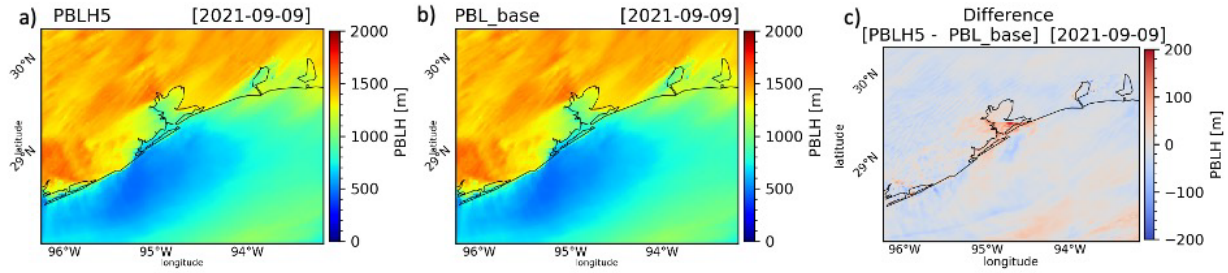

Figure 2: Daytime (08:00-18:00 CDT) mean PBL for a) perturbed run b) base run c) differences between perturbed and base run.

Data Collected

None

Identify Any Problems or Issues Encountered and Proposed Solutions or Adjustments

None

Goals and Anticipated Issues for the Succeeding Reporting Period

Goals: Continue with Task 4. Analyze the results for all the selected days. Submit Task 4 Report

Anticipated Issues: None.

Detailed Analysis of the Progress of the Task Order to Date

None

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**

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**

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

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**

Submitted to AQRP by
Yuxuan Wang