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**	12/10/2024
REPORTING PERIOD	**From:** 11/01/2024 **To:** 11/30/2024	**REPORT #**	3

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 3:

- For baseline WRF simulations, we selected 12 months having mobile observations in more than 10 days over Galveston Bay and the Gulf of Mexico (**Table 1**).

Table 1. 12 months selected for baseline WRF simulations.

Year	Months
2021	July, August, September, and October
2022	August and September
2023	May, June, July, August, September, and October

- We finalized WRF Preprocessing system (WPS) simulations for 2021, 2022, and 2023.
- We have been conducting baseline WRF (version 4.6.0) simulations for 2021, 2022, and 2023.
  - Completed months (8 months): July-August 2021, August-September 2022, May-August 2023.
  - The simulations for the remaining 4 months are being conducted.

- We conducted preliminary analysis on the model PBL evaluation based on the completed baseline WRF simulations.

Preliminary Analysis

We identified that the modeled PBL from the new baseline WRF simulation (version 4.6.0) was improved compared to that from the older version of WRF (version 3.9.1.1) under the consistent model configuration. As shown in **Figure 1**, PBL from the new baseline simulation (**Figure 1b**) had higher correlation coefficient with the observed PBL ($r = 0.47$) than that from the older version (**Figure 1a**; $r = 0.08$), which indicated the better diurnal variation in the new baseline simulation. Despite this, the model still tended to underestimate PBL with a mean bias of -218.91 m in the new baseline simulation.

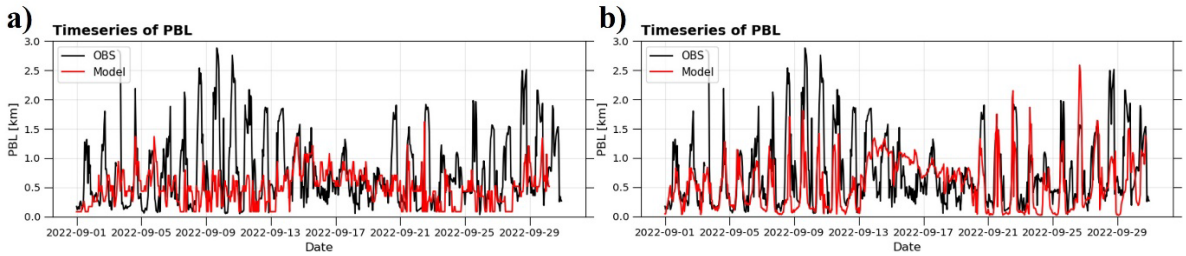

Figure 1. (a) The timeseries of the observed PBL (black) and the modeled PBL from older version of WRF (version 3.9.1.1; red) over Galveston Bay in September 2022. (b) Same as (a) but the modeled PBL from the new version of WRF (version 4.6.0).

To further evaluate the modeled PBL height from the new baseline simulation, we compared the diurnal variations of PBL based on the different boat observation routes over Galveston Bay and the Gulf of Mexico. In Galveston Bay (**Figure 2**), the model underestimated the PBL, and the magnitude of the underestimation was larger in the afternoon (12:00 CDT – 18:00 CDT). The mean PBL biases in the afternoon were -0.48 km in NW_GB, and -1.21 km in SW_GB, while those in the morning (07:00 CDT – 12:00 CDT) were -0.30 km in NE_GB, -0.12 km in NW_GB, and -0.24 km in SW_GB. The model was found to have the worst simulation performance on the diurnal variation of PBL in SW_GB.

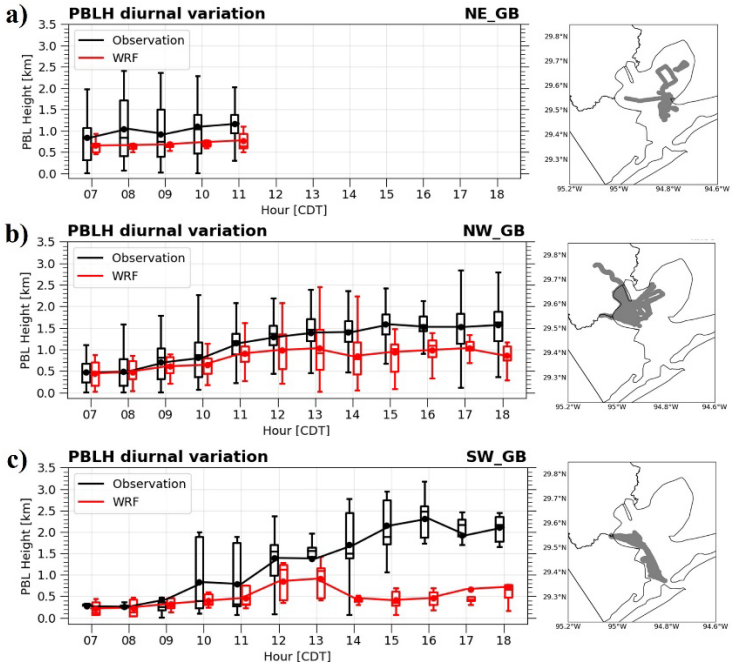

Figure 2. The diurnal variations of the observed PBL (black) and the modeled PBL (red) over (a) northeastern Galveston Bay (NE_GB), (b) northwestern Galveston Bay (NW_GB), and (c) southwestern Galveston Bay (SW_GB). Each boat observation route is presented on the right panel.

In the Gulf of Mexico (**Figure 3**), the weaker diurnal variation was found in the observed PBL compared to Galveston Bay (**Figure 2**). As consistent with Galveston Bay, the model underestimated the PBL, but the magnitude of the underestimation was smaller than that in Galveston Bay. The worse performance in the afternoon than in the morning was not found in the Gulf of Mexico. The mean PBL biases in the morning were -0.00 km in NB_GoM, -0.25 km in S_GoM, and -0.18 km in E_GoM, and those in the afternoon were -0.01 km in NB_GoM, and -

0.21 km in S_GoM. The model was found to have better simulation performance in the Gulf of Mexico than in Galveston Bay. This preliminary analysis offers insights into the simulation characteristics of diurnal variations of PBL which will guide the perturbed physical ensembles (PPE) experiments for the model improvement in the project.

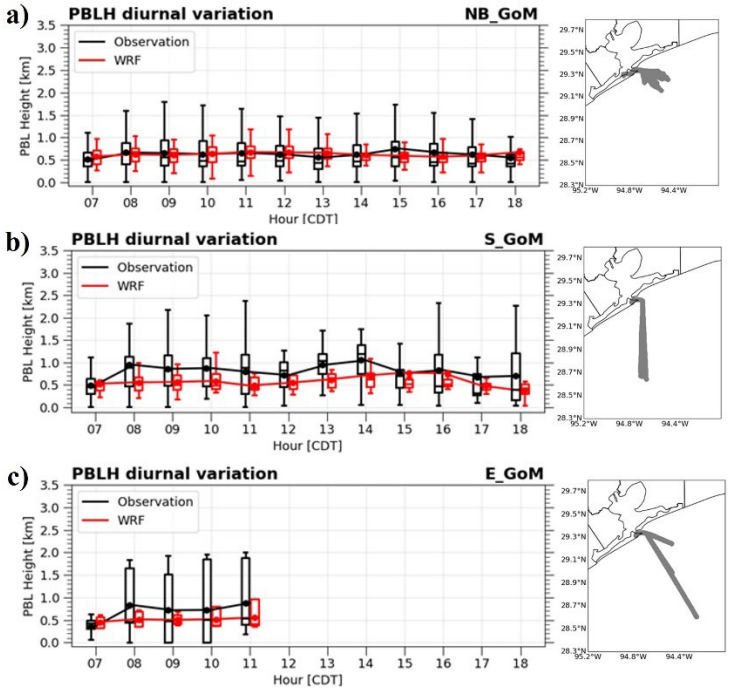

Figure 3. The diurnal variations of the observed PBL (black) and the modeled PBL (red) over (a) the near-bay Gulf of Mexico (NB_GoM), (b) southern Gulf of Mexico (S_GoM), and (c) eastern Gulf of Mexico (E_GoM). Each boat observation route is presented on the right panel.

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: Finish conducting the baseline WRF simulations and model evaluation and compile a preliminary list of physical parameters in WRF for used by the PPEs in Task 4.

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