AQRP Monthly Technical Report

PROJECT TITLE	Emission source region contribution to a high surface ozone episode during DISCOVER-AQ	**PROJECT #**	14-004
PROJECT PARTICIPANTS	Christopher P. Loughner and Melanie Follette-Cook	**DATE SUBMITTED**	2/8/2015
REPORTING PERIOD	**From:** January 1, 2015 **To:** January 31, 2015	**REPORT #**	7

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

We completed re-running WRF to improve the model representation of sea and bay breezes using a new modeling technique, higher resolution meteorological initial and boundary conditions (North American Mesoscale 12 km model), and the inclusion of a 1 km horizontal resolution domain. We performed observational nudging on all model domains and ran WRF iteratively. For the iterative simulation, we first ran WRF performing analysis nudging based on the NAM 12 km, and then re-ran WRF performing analysis nudging based on the previous WRF simulation. This modeling technique prevented the relatively coarse NAM 12 km model from degrading the high resolution (4 km and 1 km) WRF modeling domains.

MCIP was run to create meteorological input files for CMAQ for all four domains (36, 12, 4 and 1 km).

We analyzed WRF model output alongside temperature and wind velocity observations.

Preliminary Analysis

The final iterative 1 km horizontal resolution WRF simulation did a better job capturing the sea and bay breeze circulations than our initial 4 km simulation (Figures 1 and 2). The following statistics were calculated to evaluate the model diagnosed 2 m temperature and 10 m wind speed and direction for the September 24-26, 2013 period and are shown in Table 1: mean bias, normalized mean bias, normalized mean error, and root mean square error. A statistical analysis between the observations and the original 4km simulation and the initial and final iterative 1 km and 4 km simulations are shown in Tables 2-4. The final iterative 1 km WRF run produced the lowest mean bias and normalized mean bias for temperature and wind speed than the other simulations. The first iterative 1 km simulation produced the lowest mean bias and normalized mean bias for wind direction.

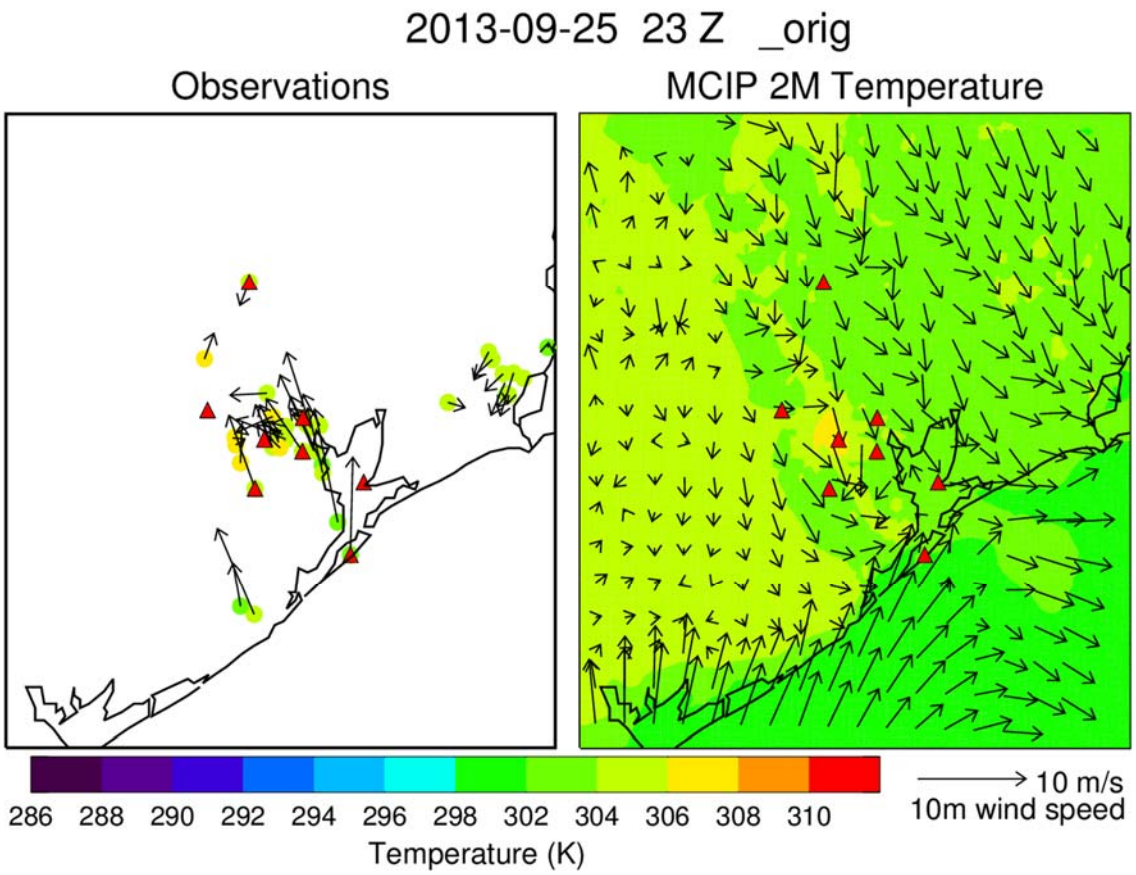

Figure 1. Observed (left) and WRF diagnosed (right) 2 m temperature and 10 m wind velocity at 23 UTC 25 September 2013 from the original 4 km WRF simulation. WRF simulated weaker sea and bay breezes than observed.

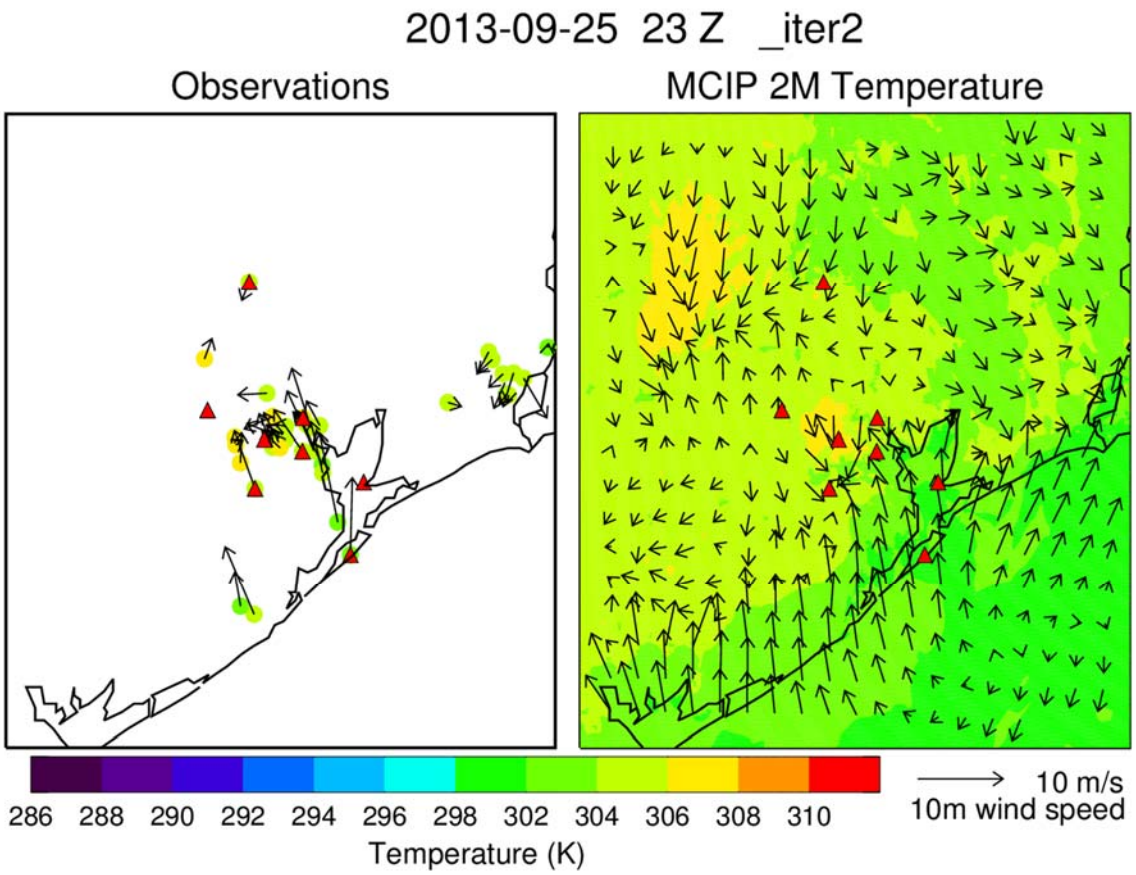

Figure 2. Observed (left) and WRF diagnosed (right) 2 m temperature and 10 m wind velocity at 23 UTC 25 September 2013 from the new 1 km WRF simulation. Strength of WRF simulated bay and sea breezes are in better agreement than in the original simulation (Figure 1).

Statistic	**Equation**
Mean Bias	$MB = \frac{1}{N}\sum_{i=1}^{N}(M_i - O_i)$
Normalized Mean Bias	$NMB = \frac{\sum_{i=1}^{N}(M_i - O_i)}{\sum_{i=1}^{N} O_i} \times 100\%$
Normalized Mean Error	$NME = \frac{\sum_{i=1}^{N}\lvert M_i - O_i\rvert}{\sum_{i=1}^{N} O_i} \times 100\%$
Root Mean-Square Error	$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(M_i - O_i)^2}$

Table 1. Definition of the statistics calculated in Tables 2-4. In these equations M represents the model results, O represents the observations, and N is the number of data points.

Temperature					
Stat	Iter 2 1 km	Iter 2 4 km	Iter 1 1 km	Iter 1 4 km	Original 4km
MB (K)	-0.134	-0.574	-0.193	-0.528	0.805
NMB	-0.045	-.191	-0.064	-0.176	0.268
NME	-0.366	0.382	0.361	0.377	0.410
RMSE	1.40	1.472	1.39	1.45	1.56

Table 2. Temperature mean bias (MB), normalized mean bias (NMB), normalized mean error (NME), and root mean square error (RMSE) for the original 4 km simulation, the 4 and 1 km simulations for the initial iterative WRF simulation (Iter 1) and the final iterative WRF simulation (Iter 2) based on observations from ~40 sites in the Houston metropolitan area on September 24, 25, and 26.

Wind Speed					
Stat	Iter 2 1 km	Iter 2 4 km	Iter 1 1 km	Iter 1 4 km	Original 4km
MB(m/s)	-0.467	-0.518	-0.511	-0.514	-0.677
NMB	-13.9	-15.5	-15.2	-15.3	-20.2
NME	44.1	43.6	44.4	43.3	50.2
RMSE	1.93	1.90	1.96	1.90	2.22

Table 3. Same as Table 1, but for wind speed.

Wind Direction					
Stat	Iter 2 1 km	Iter 2 4 km	Iter 1 1 km	Iter 1 4 km	Original 4km
MB (deg)	-3.27	2.5	-2.39	3.32	-39.6
NMB	-51.5	40.7	-37.5	52.3	-623
NME	850	825	874	813	1109
RMSE	90.0	87.7	92.7	87.0	100

Table 4. Same as Table 1, but for wind direction.

Data Collected
None.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments
No problems encountered.

Goals and Anticipated Issues for the Succeeding Reporting Period
Begin CMAQ simulations and re-do the trajectory analysis based on the new WRF output.

Detailed Analysis of the Progress of the Task Order to Date
We don't anticipate delays in the completion of this project.

Submitted to AQRP by: Chris Loughner

Principal Investigator: Chris Loughner