AQRP Monthly Technical Report

PROJECT TITLE	Improving Modeled Biogenic Isoprene Emissions under Drought Conditions and Evaluating Their Impact on Ozone Formation	**PROJECT #**	14-030
PROJECT PARTICIPANTS	Qi Ying, Gunnar W. Schade, John Nielsen-Gammon, Huilin Gao	**DATE SUBMITTED**	5/12/2015
REPORTING PERIOD	**From:** April 1, 2015 **To:** April 30, 2015	**REPORT #**	10

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

Task 1: Meteorology simulation with WRF.

We performed additional WRF simulations to try to improve performance of the meteorological variables and model performance of ozone. Previously, all simulations were done in segments of 8-days (including one day spin-up). As an alternative, we performed simulations in 1-day segments with 3-hour spin-up. We have completed year 2011 and model performance analysis.

Task 2: Perform field and laboratory measurements on common Texas tree species

Note: Due to an additional project start delay from June to July and the unanticipated need to move all our seedlings to a different greenhouse in July, all monthly milestones described in the QAPP had to be moved by one month ahead

The spring 2015 milestones were addressed as follows:

a. analyze drought response relationships: could not be addressed yet since measurements so far have been unsuccessful (see previous monthly reports).
   new growth that has emerged in the first few months of 2015 has been monitored and the results are summarized in Figures 1 and 2. While emissions are present, they are low. Photosynthesis rates are lower than from mature leaves of these species, so leaf physiology is still developing. A high variability is observed, meaning the leaves' physiology has not yet reached a stage where a high reproducibility is achieved.

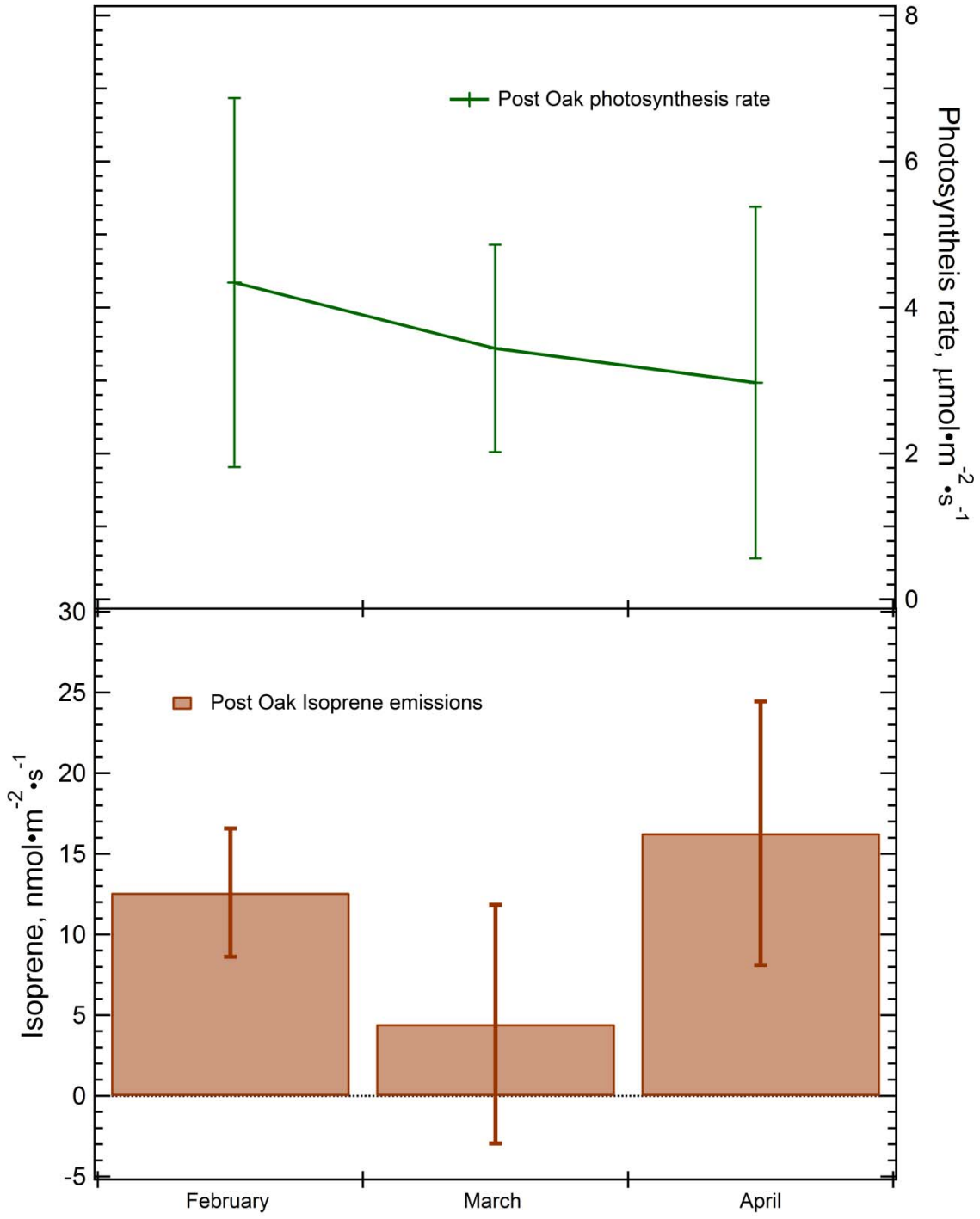

Figure 1: Photosynthesis rates and isoprene emission rates from post oak seedlings in spring 2015. Error bars show one standard deviation.

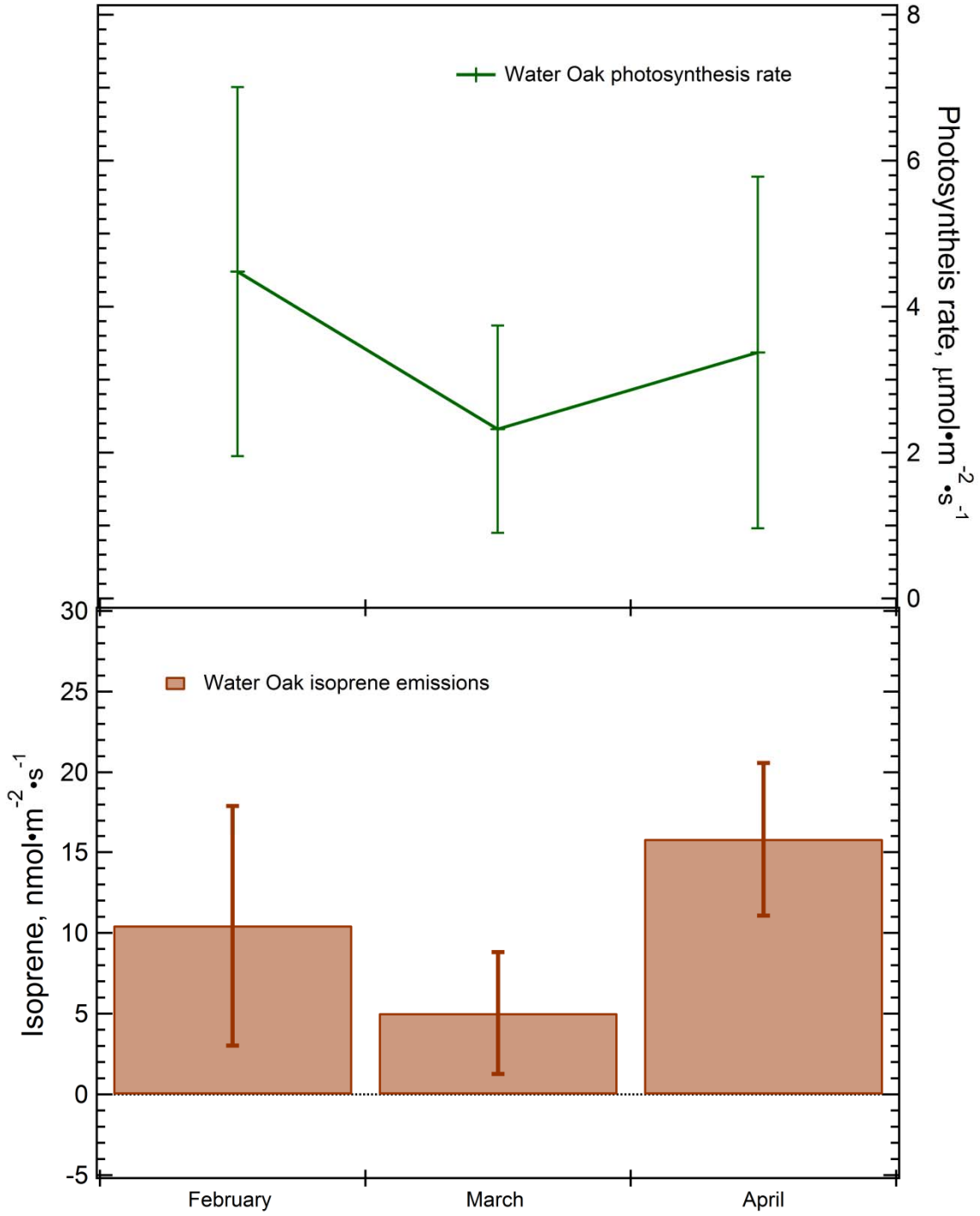

Figure 2: Same as Fig. 1, but for water oak seedlings

b. provide final drought response parameterization: could not be addressed yet due to inconclusive data collected on seedlings last summer/fall; see previous monthly report
c. submit data files to UT: we refer to the new data format submitted for approval with our January monthly report

Task 3: Evaluate drought parameterization for isoprene emissions

No additional progress is made on this task in this month.

Task 4: Perform regional BVOC modeling using MEGAN

We have regenerated year 2011 BVOC emissions using MEGAN and the new meteorological simulation results as reported in Task 1.

Task 5: Perform regional air quality simulations

Mobile and point source emissions for anthropogenic sources were regenerated using the new meteorology data from Task 1. No additional air quality simulations were conducted this month. We will start 2011 and 2007 simulations with the new meteorological and emission inputs next month. Model performance for other months is quite similar and thus is not repeated.

Preliminary Analysis

Task 1: Model performance analysis for 2011 is completed. Table 1 shows a summary of the model performance using July 2011 as an example. Model performance of wind speed at 10 meters (WSPD) meets the performance criteria (MB≤ ±0.5, GE and RMSE ≤ 2.0). MB for wind direction (WDIR) also meets the model performance criteria of MB≤ ±10 º, although the GE values slightly exceed the benchmark value of GE≤ 30º. However, this is similar to model performance of WDIR in other studies that did not apply observation nudging. Temperature at 2 meters (TEMP) is significantly over-predicted. The model performance benchmarks are MB≤ ±0.5K and GE≤2K. The larger MB value indicates an obvious over-prediction in the temperature that could lead to over-prediction of isoprene emissions. The GE value, although is slightly higher than the model performance criteria, agrees with the values reported in other studies.

Table 1 Model performance statistics for meteorological variables (July 2011)

	TEMP (K)	**RAINS (mm/h)**	**WSPD (m/s)**	**WDIR (º)**	**RH (%)**
avg_obs	304.52	1.26	3.87	166.99	51.46
avg_pre	306.48	0.27	4.03	162.84	44.33
MB	2.05	-1	0.19	-2.97	-7.52
RMSE	3.63	1.77	1.91	64.58	16.28
GE	2.76	1.18	1.5	47.26	12.01

Soil moisture measurements were taken from the TAMU North American Soil Moisture Database (soilmoisture.tamu.edu). The WRF/Noah predictions were interpolated to the points where the measurements were made using piecewise linear interpolation. Most of the measurements are available at 7 depth levels (0.05, 0.10, 0.20, 0.25, 0.50, 0.60, 1.00 m). The model performance statistics for daily soil moisture July 2011 are shown in Table 2, as an example. It should be noted that most of the measurement sites are in Oklahoma, and there are fewer data points available in Texas. Thus, the evaluation might not fully describe the bias in the predicted soil moisture. Overall the predicted soil moisture values at monitoring sites are lower

than observations. This is likely due to the fact that rainfall amount was under-predicted in the current WRF simulation.

Table 2 Model performance statistics for daily soil moisture for July 2011 at all available sites in the TAMU North American Soil Moisture Database.

Depth	**0.05m**	**0.1m**	**0.2m**	**0.25m**	**0.5m**	**0.6m**	**1m**
avg_obs (m^3 m^{-3})	0.165	0.141	0.135	0.243	0.161	0.199	0.169
avg_pre (m^3 m^{-3})	0.131	0.109	0.129	0.158	0.119	0.141	0.116
MB	-0.03	-0.03	-0.01	-0.09	-0.04	-0.06	-0.05
RMSE (m^3 m^{-3})	0.05	0.07	0.06	0.09	0.05	0.06	0.10
GE (m^3 m^{-3})	0.04	0.06	0.06	0.09	0.05	0.06	0.09
MNB	-0.17	-0.02	0.24	-0.34	-0.21	-0.29	-0.08

Task 2: Figures 1 and 2 show that the seedlings are developing during spring but that they have not yet reached the point where we can expect a reproducible result to be obtained in drought experiments. Since variability is high, we cannot guarantee that useful results can be obtain before the end of the funding period

Data Collected

1. several sets of measurements on new leaves in spring on greenhouse-based seedlings

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments

Goals and Anticipated Issues for the Succeeding Reporting Period

<u>Goals</u>

Task 1: Finish 2007 simulations next month.

Task 2: Continue caretaking of the greenhouse-based seedlings, monitoring the new leaf growth as ambient insolation increases; monitor newly acquired and potted post oak and other seedling for leaf growth, including routine physiology and isoprene emissions sampling begun in March 2015. Begin drought experiments in mid May.

Task 3: Finish evaluating the drought parametrization using 2011 isoprene emissions and top soil moisture measurements in east Texas as well as soil moisture data from model simulations.

Task 4: Finish biogenic emission modeling with new met data.

Task 5: Finish generating all anthropogenic emissions and complete all AQ simulations for 2007 and 2011.

Detailed Analysis of the Progress of the Task Order to Date

Task 1: Should be able to finish as scheduled next month.

Task 2: Major delay on task 2 due to inconclusive data last summer/fall. Commencing new measurements this spring.

Task 3: Should be able to finish next month.

Task 4: No delay expected.

Task 5: No delay expected.

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