AQRP Monthly Technical Report

PROJECT TITLE	Improved Land Cover and Emission Factor Inputs for Estimating Biogenic Isoprene and Monoterpene Emissions for Texas Air Quality Simulations	**PROJECT #**	14-016
PROJECT PARTICIPANTS	Alex Guenther (Battelle/PNNL) Joost de Gouw (NOAA) Greg Yarwood, Sue Kemball-Cook (ENVIRON)	**DATE SUBMITTED**	12/8/2014
REPORTING PERIOD	**From:** November 1, 2014 **To:** November 30, 2014	**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

Task 1: Estimation of Terpenoid Emission Fluxes from Aircraft Data

NOAA used the measurements of isoprene onboard the NOAA WP-3D and NCAR C-130 during SAS to estimate isoprene emission fluxes using the mass balance approach published previously [Warneke et al., 2010]. The results were compared vs. the eddy fluxes determined from the C-130 measurements. Good agreement was obtained in some cases. In other cases, the mass balance approach yields higher values than the eddy fluxes. Research is in progress to understand the differences between those cases. Fluxes according to the mass balance approach were also compared with the emissions according to the BEIS 3.13 and MEGAN 2.0 inventories using the aircraft measured temperature and photoactive radiation to calculate the emissions. Preliminary findings include that (1) BEIS 3.13 captures the variability in emissions better than MEGAN 2.0, (2) BEIS 3.13 gives lower emissions than estimated from the measurements, and (3) MEGAN 2.0 gives higher emissions than those estimated from the measurements. These findings qualitatively agree with those from a previous study that used data from the SOS99, TexAQS 2000 and 2006, and ICARTT 2004 campaigns.

Work is in progress to prepare a presentation on the preliminary findings for the Fall Meeting of the American Geophysical Union.

PNNL has finished flux estimation of isoprene and total monoterpene for all C-130 research flights (when data quality permits) of the Southeast Atmosphere Study (SAS) field campaign. Previously, PBL heights as simulated by the WRF model were applied. In this second version of terpenoid flux data product, PBL heights were derived from vertical profiles of temperature, water vapor mixing ratio and VOC concentrations measured on each research flight.

Figure 1 shows an example of the estimated isoprene flux for research flight #5. Generally, isoprene fluxes are higher at lower altitude and decreased with increasing altitude as expected. Flux values also vary substantially along each flight leg. This observation justified the use of wavelet based flux estimation approach, which has the capability to generate flux results at high spatial resolution.

Subsampling was also performed for select C-130 flight legs to simulate VOC observations as collected on the P-3 aircraft, which used a much longer sampling interval. The results confirmed that P-3 measurements alone are less suitable for direct eddy-covariance determination of terpenoid fluxes.

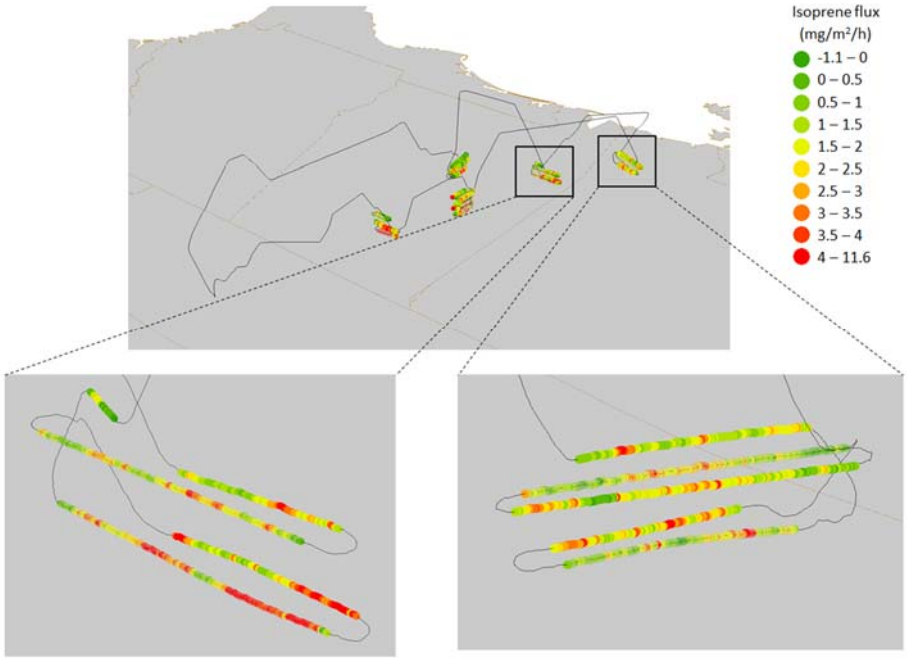

Figure 1. Example of calculated isoprene flux for research flight #5. The entire flight track is shown in black line.

Task 2: Development of High Resolution Land Cover Data for MEGAN Modeling in Texas and the Southeastern U.S.

No work was performed on Task 2 during November.

Task 3: Emission Factor Database Development

No work was performed on Task 3 during November.

Task 4: Development of MEGAN Biogenic Emission Inventories and Inventory Evaluation using Regional Photochemical Modeling

ENVIRON completed evaluation of Weather Research and Forecast (WRF) Model (Skamarock et al. 2008) 12 km grid output fields for the period June 1-July 15, 2013 against CAMS station data within Texas and ds472 airport station wind, temperature and humidity data within and outside of Texas and the PRISM precipitation product. The precipitation evaluation showed the presence of an artifact around the 4 km grid focused on Houston. The 4 km grid was present in this WRF run so it could also be used by AQRP Project 14-024. The precipitation artifact was caused by the use of the 2-way nesting option on the 4 km grid. WRF was run a second time without the nested 4 km grid, and the model performance evaluation was completed. No precipitation artifact was present in the second run. An example of the resulting precipitation field for a 24-hour period is shown in Figure 2. In general, the WRF model was able to reproduce the large-scale patterns of precipitation across the 12 km domain seen in the PRISM analysis, but often overestimated the intensity of the precipitation. Overestimates of precipitation are often noted in WRF runs, especially over the southeastern U.S. (e.g., Alapaty et al., 2014).

WRF surface performance was assessed using the METSTAT program to generate statistics and graphical model-observation comparisons for winds, temperature and humidity. Bias and error statistics for wind speed, direction, temperature, and humidity were tabulated, with averages taken across geographical regions (Figure 3). Each statistical metric was compared to performance benchmarks to evaluate how well the model performed. An example of a soccer plot display containing performance benchmarks and daily and monthly model performance statistics for wind speed is shown in Figure 4.

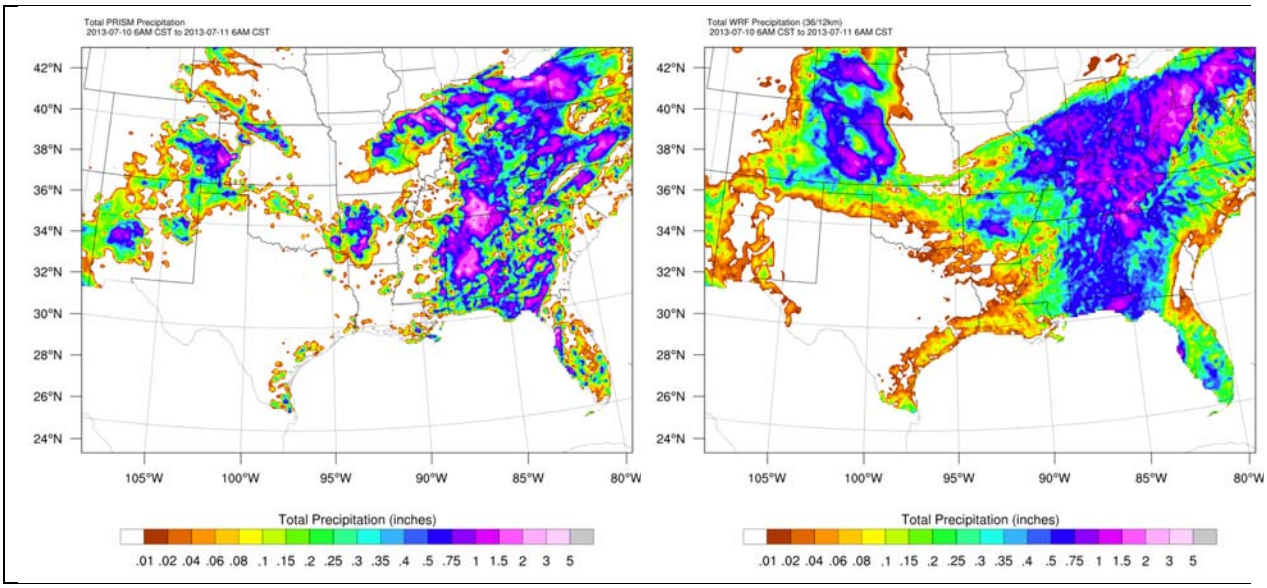

Figure 2. July 10-11, 2013 accumulated precipitation from PRISM analysis (left panel) and WRF model (right panel).

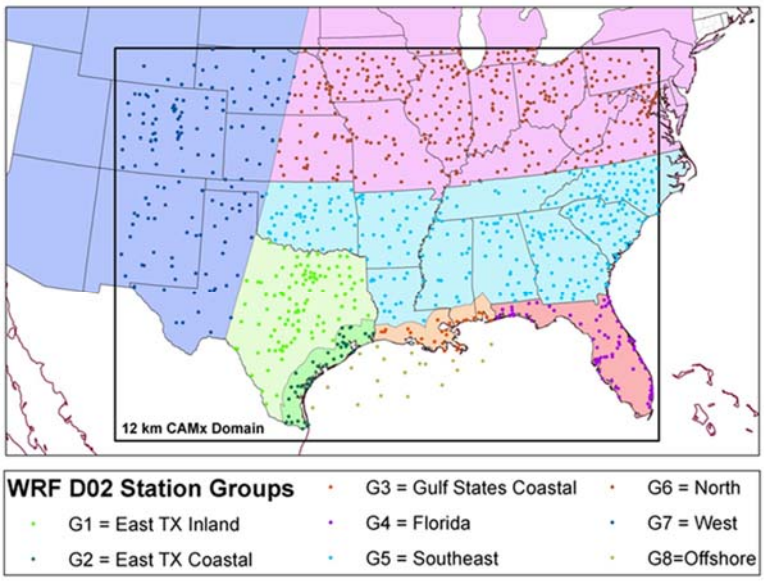

Figure 3. Subdomains for surface meteorological field model performance evaluation.

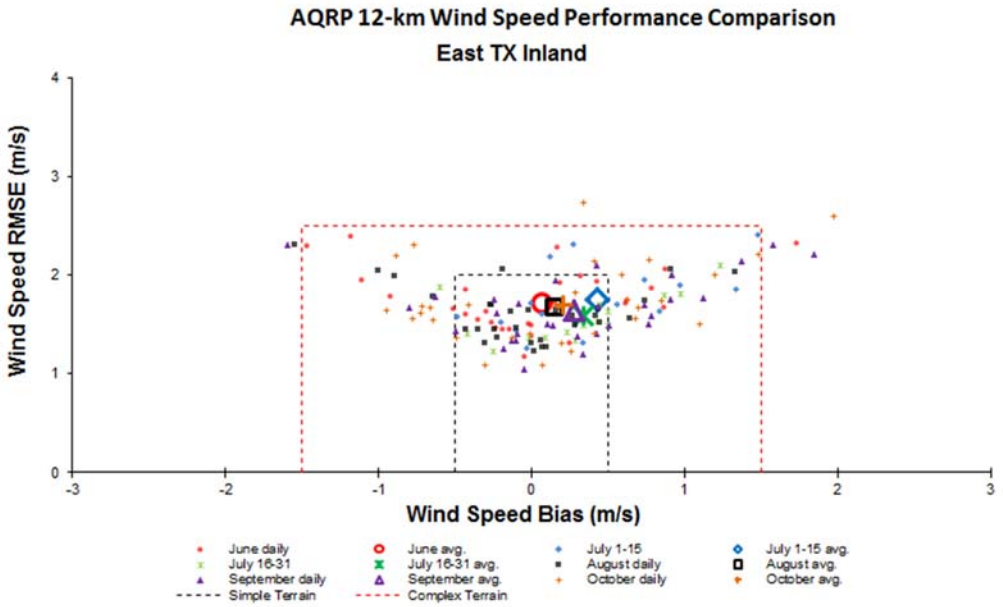

Figure 4. WRF model run soccer plot showing wind speed performance for East Texas inland region (G1) shown in Figure 5. Small icons represent performance for individual days, and large icons show monthly average performance.

Because photosynthetically active radiation is a key input to the MEGAN biogenics emissions model, we evaluated WRF model's performance in simulating clouds and downward shortwave radiation. We compared visible satellite images with WRF downward shortwave radiation (DSWR) at the surface (Figure 5). Where clouds are modeled by WRF, the amount of radiation at the surface is reduced, and these areas of reduced DSWR are indicated by lighter colors so that they may be compared with the location of the clouds in the satellite image. In genenral, the WRF model was able to reproduce the large-scale features of the observed cloud field as indicated by the DSWR field, but greatly understimates the prevalence of cumulus clouds, usch as those seen over eastern Arkansas in the satellite image in Figure 5.

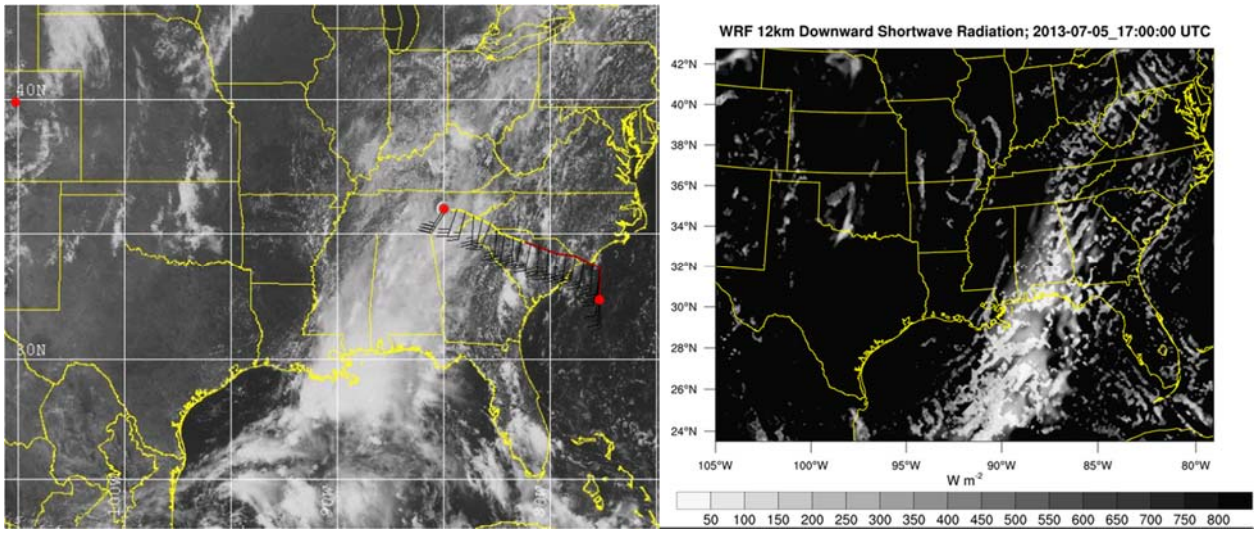

Figure 5. Comparison of GOES satellite image overlaid with the C130 flight path and measured wind vectors from the SAS data catalog web page at http://catalog.eol.ucar.edu/maps/sas (left panel) and WRF modeled downward shortwave radiation (right) for July 5, 2013, 17:00:00 UTC.

ENVIRON continued development of software to perform CAMx model performance evaluation along aircraft flight tracks and began configuring the CAMx model for the baseline run using the default MEGAN emission inventory.

Data Collected

Texas forest survey data, Cropland Data Layer 2013, Ecological Mapping Systems of Texas

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments

None to date

Goals and Anticipated Issues for the Succeeding Reporting Period

Task 1: We will extend the analysis to other data sets and biogenic VOCs. We will also incorporate emissions according to the updated MEGAN 2.1 inventory. Investigate further on potential method to correct P-3 VOC measurement data.

Task 3: Continue developing high resolution land cover database based on available datasets.

Task 4: Complete software to perform CAMx model performance evaluation along aircraft flight tracks. Rerun MEGAN with default inputs using new WRF run. Run CAMx for the period June 1 – July 15, 2013 and compare modeled and aircraft concentrations.

Detailed Analysis of the Progress of the Task Order to Date

The project remains on schedule and budget for completion and delivery of the final AQRP-reviewed report by the AQRP contract end date of June 30, 2015.

References

Karl, T., P. K. Misztal, H. H. Jonsson, S. Shertz, A. H. Goldstein, and A. B. Guenther. 2013. Airborne flux measurements of BVOCs above Californian oak forests: Experimental investigation of surface and entrainment fluxes, OH densities and Dahmköhler numbers. *J. Atmos. Sci.*, 70, 3277–3287.

Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M. Barker, W. Wang, and J. G. Powers, 2008. A description of the Advanced Research WRF Version 3. NCAR Tech Notes-475+STR. http://www.mmm.ucar.edu/wrf/users/docs/arw_v3.pdf.

Warneke, C. et al. 2010. Biogenic emission measurement and inventories determination of biogenic emissions in the eastern United States and Texas and comparison with biogenic emission inventories, *J. Geophys. Res.-Atmos.*, 115, D00F18, doi:10.1029/2009JD012445.

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