Monthly Technical Report

(Due to AQRP Project Manager on the 8th day of the month following the last day of the reporting period.)

PROJECT TITLE	Soil Moisture Characterization for Biogenic Emissions Modeling in Texas	**PROJECT #**	14-008
PROJECT PARTICIPANTS **(Enter all institutions with Task Orders for this Project)**	The University of Texas at Austin	**DATE SUBMITTED**	10/8/14
REPORTING PERIOD	**From:** September 1, 2014 **To:** September 30, 2014	**REPORT #**	4

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 *(Include all Task actions conducted during the reporting month.)*

During September, our primary focus was towards modifying the existing MEGAN configuration so that in-situ (observed) and NLDAS-2 soil moisture datasets (Mosaic and Noah) could be used as inputs to MEGAN. Preparation and processing of other environmental datasets (e.g., PAR, temperature, leaf area index, soil moisture) was also performed.

Additionally, a modified MEGAN configuration was developed so that simulations could be conducted at individual 4km grid cell locations. Currently, testing is being done for three Texas soil moisture monitoring locations: Palestine, Prairie View, and Port Aransas. These locations were chosen for a by-site analysis because in-situ observational data are available for 2011 (record drought and heat in Texas) and the sampling depths (100cm) are sufficient to represent deep soil moisture availability for vegetation such as trees. Input soil moisture datasets for MEGAN sensitivity simulations will include in-situ observations as well as estimates provided by Mosaic and Noah. The differences in predicted isoprene emissions associated with the three soil moisture datasets will be the subject of a poster presentation at the 2014 American Geophysical Union (AGU) annual meeting in San Francisco during December 15-19, 2014. The draft poster (or if not yet completed then a summary of results) will be provided for TCEQ review in the November 8 monthly report.

To demonstrate the variability in input soil moisture for an example simulation, Figures 1-3 present hourly in-situ and interpolated NLDAS-2 soil moisture values during Mar-Oct 2011 at Palestine. These comparisons demonstrate that although the majority of precipitation events are often well-captured, there is typically a large bias in the baseline soil moisture. The finding of bias is common to other studies and may be due, in part, to the following reasons:

1) **The in-situ observations are a point measurement whereas the NLDAS-2 simulations represent average conditions over a larger region (i.e., 1/8 degree horizontal spatial resolution).** For example, soil type is critical in determining the capacity water content and actual soil properties within a given grid cell are typically highly spatially heterogeneous.
2) **The site-specific soil type differs from NLDAS-2 descriptions**. The models are often applied in regions where detailed soil surveys are not available; therefore, soil parameters are estimated from relatively coarse datasets (e.g., STATSGO). For example, the soil texture in the upper one-meter at Palestine is specified by the Climate Research Network (CRN) as "Clay" whereas the NLDAS-2 grid cell that contains the Palestine monitoring location is characterized as "Sandy".
3) **Uncertainties in the NLDAS-2 model structure and parameterizations**. The NLDAS-2 Mosaic and Noah configurations use the same atmospheric forcing data/soil texture/vegetation types; however, the physics, structure and other soil parameterizations are model-specific. For example, the vegetation characterization that establishes density, seasonality and root fraction as a function of depth can vary substantially. These differences can impact maximum total water storage capacities, infiltration and drainage, interaction of evapotranspiration and soil moisture, and seasonality of processes associated with soil moisture dynamics.
4) **There may be crucial processes that are not directly considered by NLDAS-2 but impact soil moisture at specific locations.** Examples include irrigation at agricultural sites or ground water pumping.
5) **There are uncertainties in the meteorological forcing data that drives the NLDAS-2 simulations.** For NLDAS-2, the forcing data (e.g., temperature, precipitation, radiation, etc.) are generated primarily from the North American Regional Reanalysis (NARR), which is also an assimilated product with its own set of assumptions and uncertainties.
6) **Interpolation-induced bias**. For our current analysis, a linear relationship was inherently assumed in interpolating the NLDAS-2 layer values to the in-situ depths. However, soil properties can vary dramatically over even short vertical distances often related to site-specific hydrological variability.
7) **The soil moisture conditions during 2011 occurred during an all-time record year for heat and drought in Texas**. NLDAS-2 may capture the overall directionality of year-to-year variability but may not do as well during periods with extreme environmental conditions.

Even given the above uncertainties, NLDAS-2 generally captures the broad seasonal evolution of observed soil moisture variation in addition to responses during specific precipitation events. Our initial investigation is to quantify the impact of the sometimes substantial differences in soil moisture between the three datasets (ref. Figures 1-3) to determine the impact on predicted isoprene emissions.

Figure 1. Hourly in-situ (OBS), Noah (NOAH), and Mosaic (MOS) soil moisture values at Palestine during Mar-Oct 2011 at 5cm.

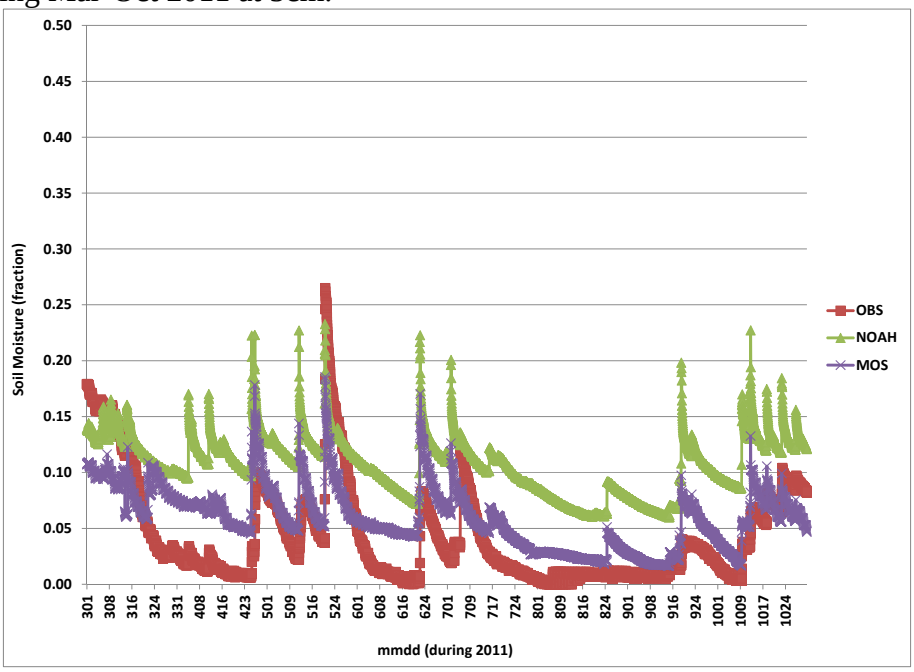


Figure 2. Hourly in-situ, Noah, and Mosaic soil moisture values at Palestine during Mar-Oct 2011 at 20cm.

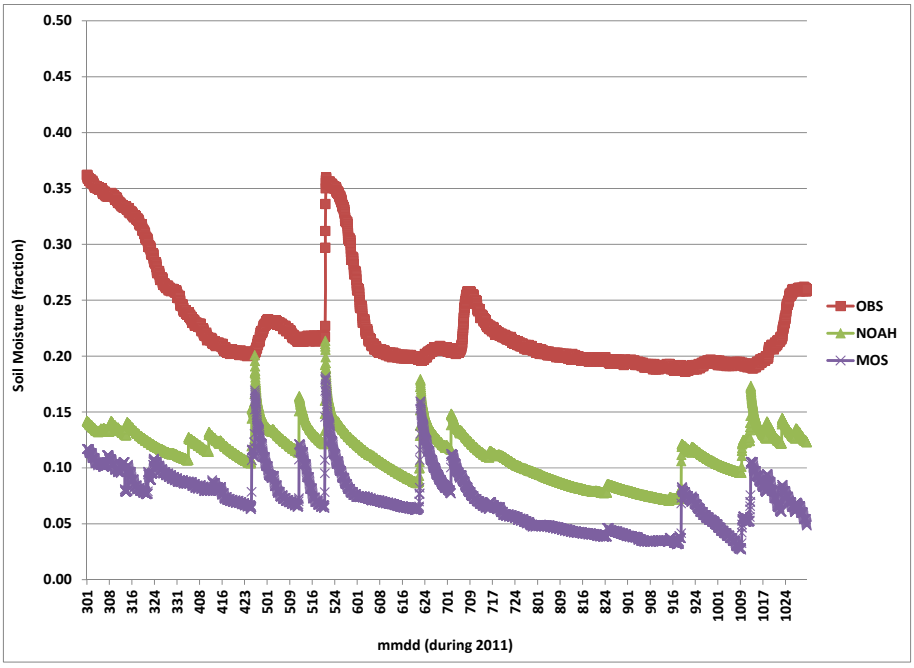
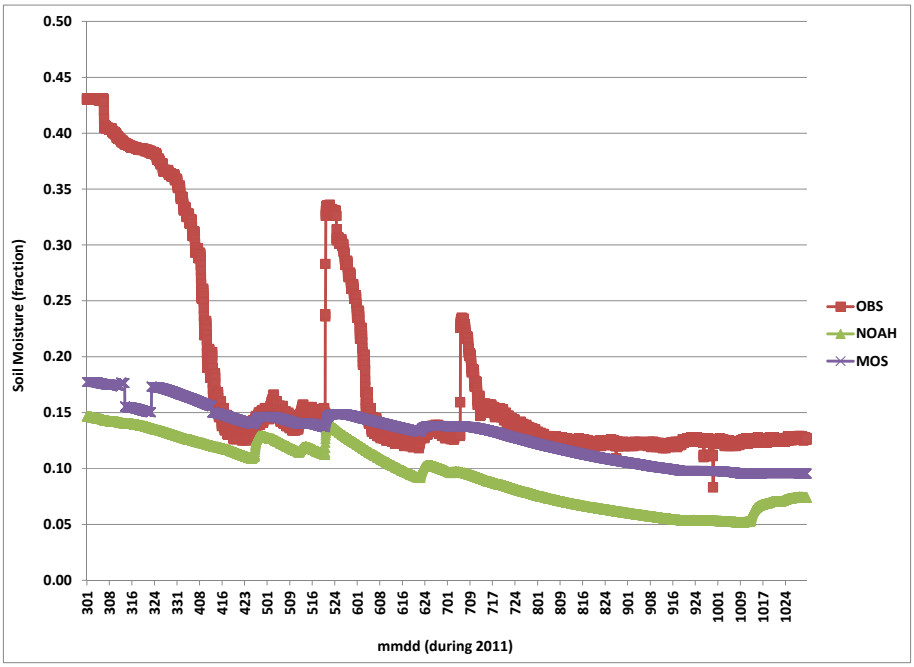


Figure 3. Hourly in-situ, Noah, and Mosaic soil moisture values at Palestine during Mar-Oct 2011 at 100cm.



Preliminary Analysis (*Include graphs and tables as necessary.)*
Initial analysis of observed and predicted soil moisture datasets for Texas as described above.

Data Collected *(Include raw and refine data.)*
MEGAN environmental input datasets will be gathered and processed for years 2006-2011 as necessary in preparation for simulations for Texas and surrounding states.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments
None this period.

Goals and Anticipated Issues for the Succeeding Reporting Period
The team will complete the MEGAN sensitivity simulations to quantify the impact of differences in soil moisture values (in-situ, NLDAS-2 Mosaic, NLDAS-2 Noah) on predicted isoprene emissions at the three Texas monitoring locations during 2011. Analysis of the NLDAS-2 datasets for Texas and surrounding states will be initiated with the goal of describing the seasonal and inter-annual variability of soil moisture by depth as well as tracking the rate of change in spatial gradients of soil moisture during representative drought periods.

Detailed Analysis of the Progress of the Task Order to Date *(Discuss the Task Order schedule, progress being made toward goals of the Work Plan, explanation for any delays in completing tasks and/or project goals. Provide justification for any milestones completed more than one (1) month later than projected.)*
Ongoing.