Title: Combining remote sensing and in-situ data to estimate soil moisture across mixed land cover types

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Students:

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Undergraduate		
M.S.		
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Post Doc		
Total		

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Publications:

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Wyatt, B.M., T.E. Ochsner, and C.B. Zou. 2017. Integration of remote sensing and in-situ data to estimate soil moisture across mixed land cover types. ASA-CSSA-SSSA Annual International Meeting. Tampa, FL.

Wyatt, B.M., T.E. Ochsner, and C.B. Zou. 2017. Integration of remote sensing and in-situ data to estimate soil moisture across mixed land cover types. Marena, Oklahoma In-Situ Sensor Testbed (MOISST) annual meeting. Stillwater, OK.

Wyatt, B.M., T. E. Ochsner, and C.B. Zou. 2017. Combining remote sensing and in-situ data to estimate soil moisture across mixed land cover types. Oklahoma State University Plant and Soil Sciences Department Research Symposium.

Problem and Research Objectives:

While the current long-term soil moisture record is useful for a number of applications in many research areas, a major limitation of the current data is that it has been collected exclusively in grassland ecosystems and does not reflect soil moisture conditions under other land covers. However, remote sensing by satellites has led to the availability of high-resolution vegetation indices data, and we hypothesize that these data, along with in-situ meteorological data from the Oklahoma Mesonet, may be incorporated into a simple water balance model to effectively estimate root-zone soil moisture at sites throughout Oklahoma. These estimates may then be used to train a

computational model to estimate soil moisture across the entire state, regardless of land cover.

The *long-term goal* of this project is to increase scientific understanding of the variability of soil moisture under the many cover types found throughout Oklahoma and to create a new, general method of large-scale soil moisture estimation and mapping. We will reach this goal by 1) incorporating vegetation indices (e.g., normalized difference vegetation index [NDVI] or enhanced vegetation index [EVI]) data collected by the Moderate Resolution Imaging Spectroradiometer (MODIS) sensors aboard NASA's Aqua and Terra Satellites and Mesonet meteorological data in a water balance model capable of estimating soil moisture under various land cover types found in Oklahoma, and 2) validating estimated soil moisture values using in-situ soil moisture monitoring in multiple vegetation types throughout Oklahoma.

Methodology:

Objective #1: The MODIS instruments report global high-resolution (250 m^2) vegetation index data every 8 days (Huete et al,. 1999). Daily vegetation index values will be found using a simple linear interpolation between observations (Glenn et al., 2011). These vegetation index values, along with meteorological data from the Oklahoma Mesonet, will be used in a water balance model capable of estimating soil moisture for each remote sensing pixel. Initially, we had planned to create our own model to complete this objective, but upon further research we found that a suitable model had already been developed. This model, HidroMORE, will be used to produce gridded soil moisture estimates across Oklahoma, including areas where there are no in-situ monitoring data (Sanchez et al., 2010). Model inputs include remote sensing vegetation index data and land cover type data, meteorological data, soil type data, and several other inputs.

Objective #2: In-situ soil moisture sensors will be used to validate vegetation index-estimated soil moisture in various land cover types throughout the state. Funding for this project was used to purchase sensors that will be installed under 5 vegetation types in order for a robust validation of model results across land cover types. Due to funding delays, soil moisture sensors were not able to be purchased until late 2017 and have not yet been installed in the field.

Current Progress:

The HidroMORE model was developed in Spain, and as such the model itself is in Spanish. A significant amount of time was spent translating the model into English and ensuring the translation was as correct as possible. Satellite images for the HidroMORE model have been gathered, organized, and prepared for inclusion in the model for the years 2000-2016. Meteorological data from the Oklahoma Mesonet are readily available, and SSURGO soils data are currently being collected and prepared for input into the model.

Currently we are working on an initial model run for Payne County, OK at a 250 m^2 resolution. Work is ongoing for the installation of field monitoring equipment and is

expected to be completed in Summer 2018 under grassland, winter crops, summer crops, deciduous forest, and oak forest. Soil moisture data from these in-situ monitoring stations will be used to validate the model results within Payne County and expansion of the model to the entire state of Oklahoma will be done after this initial modeling stage.

Principal Findings and Significance:

While HidroMORE model simulations have not been completed yet, the water balance method used by the model has been used to estimate soil moisture at sites under native grass at the Marena, OK Mesonet station as well as under oak forest at the Cross Timbers Experimental Range station from April 2015-April 2016. Early results indicate that this method is well-suited for estimating soil moisture (shown here as plant available water, or PAW) under different vegetation types (Figure 1).

Future work on this project includes completing HidroMORE model simulations, installing soil moisture sensors under various land cover types, and validating model results using in-situ soil moisture data. The final goal of this research is to estimate daily soil moisture at a 250 m^2 resolution for the state of Oklahoma.

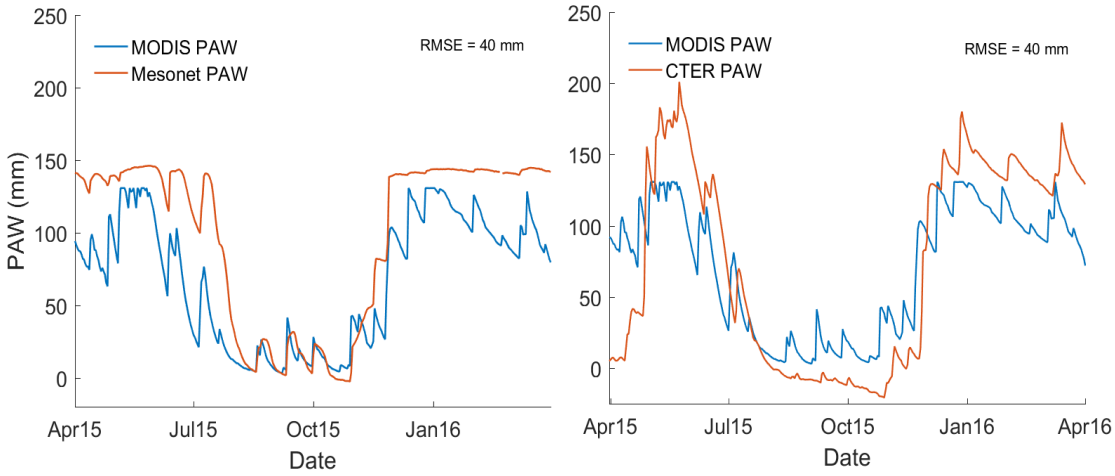

Figure 1. MODIS-estimated versus measured plant available water (PAW) for the Marena Mesonet site under grassland (left) and an oak forest site (right).

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