PROJECT OVERVIEW
Soil moisture is an important hydrologic parameter. It has critical role in subsurface – land surface – atmosphere interactions. Characterization of spatial and temporal variation of this hydrologic parameter is very useful to drought analysis, crop yield forecasting, irrigation planning, flood protection, and forest fire prevention. Remote sensing has been widely used to detect and monitor soil moisture for so many years. However, the study of the variation of soil moisture at both high spatial and temporal resolution has not been possible due to the lack of satellite sensors with both high spatial and temporal resolution. We hypothesize that NASA’s Moderate Resolution Imaging Spectroradiometer (MODIS) can be transformed to virtual soil moisture sensors (VSMS) for mapping soil moisture at high spatial and temporal resolution by: (1) fusion with currently operating high resolution synthetic aperture radar (SAR) data (VSMS1) and (2) disaggregation model (VSMS2). We designed a RPC project to evaluate the potential of Visible Infrared Imager Radiometer Suite (VIIRS) to replace MODIS to improve monitoring soil moisture by generating VSMS.

DECISION SUPPORT TOOLS AND DATA USED
The imagery data used in the VSMS:
- MODIS,
- simulated VIIRS,
- Advance Microwave Scanning Radiometer – Earth Observing System (AMSR-E) and
- Radarsat 1 SAR Fine

Decision support tools to be used in the development of the VSMS include:
- land surface models (LSM) including Vegetation Index (VI)-Land Surface Temperature (LST) Triangle model
- Regression and Artificial Neural Network (ANN) based models
- a neural network-based disaggregation model DisaggNet
- a Simulator for Hydrology and Energy Exchange at the Land Surface (SHEELS)
- a microwave Radiative Transfer Model (RTM).

RPC EXPERIMENTS CONDUCTED
We identified three RPC experiments in our project (Fig. 3). In the first experiment we are evaluating VIIRS to replace MODIS in soil moisture estimation using VI-LST Triangle Model. The second experiment evaluates VIIRS to replace MODIS in virtual soil moisture sensor (VSMS) generation using multiple regression and artificial neural networks (ANN) with SAR. The third experiment evaluates VIIRS to replace MODIS in VSMS generation using SHEELS, RTM and DisaggNet.

STUDY SITE
The study site for the project is a semi-environment in Nash Draw, NM (Fig. 1). Nash Draw is a karst valley that developed in response to subsurface dissolution of evaporites and subsidence of the overlying strata. The hydrologic system of Nash Draw is poorly understood. To assist in understanding the existing processes modifying Nash Draw by solution it is critical to identify the distribution and amount of recharge in Nash Draw. To identify the recharge zones we need to monitor the variation of soil moisture at high spatial and temporal resolution. Nash Draw is a suitable field site to test the VIIRS-generated virtual soil moisture sensors (VSMS) to estimate and monitor variation in soil moisture. The study site at Nash Draw covers an area of 400 sq. km.

Fig. 1. Study site (Nash Draw, NM) of the project
Evaluating Next Generation NASA Earth Science Observations for Image Fusion to Enable Mapping Variation in Soil Moisture at High Resolution:
Easson, Holt and Hossain

PROJECT STATUS AND PRELIMINARY RESULT
The project began in the second week of March 2007. The project has four subcontracts in place; Stennis Team, Alaska Satellite Facility, Sandia National Laboratories and Dr. Dennis Powers. Currently ‘Task 1’, soil moisture estimation using MODIS/VIIRS and SAR imagery is in progress. Using the radar imagery acquired on August 2, 2006 we compared soil water, using linear regression, to radar backscatter values to develop an empirical model of the relationship. We focused on the simple linear regression between field derived soil moisture data and radar backscatter values calibrated as Beta-naught ($\beta^o$).

We did not find strong relationship between the ground measured soil moisture and SAR backscatter values by simple linear regression for the entire study site. However, we found good agreement between soil moisture and backscatter values in most of the high and low moist area in the study site (Fig. 4). For more accurate soil moisture mapping in the study site we have begun investigation of multiple regressions modeling incorporating sensor parameters and terrain characteristics.

Fig. 3. Flow chart explaining the methodology of the RPC experiments being conducted

Fig. 4. Soil moisture estimated using SAR imagery and in-situ soil moisture measurements