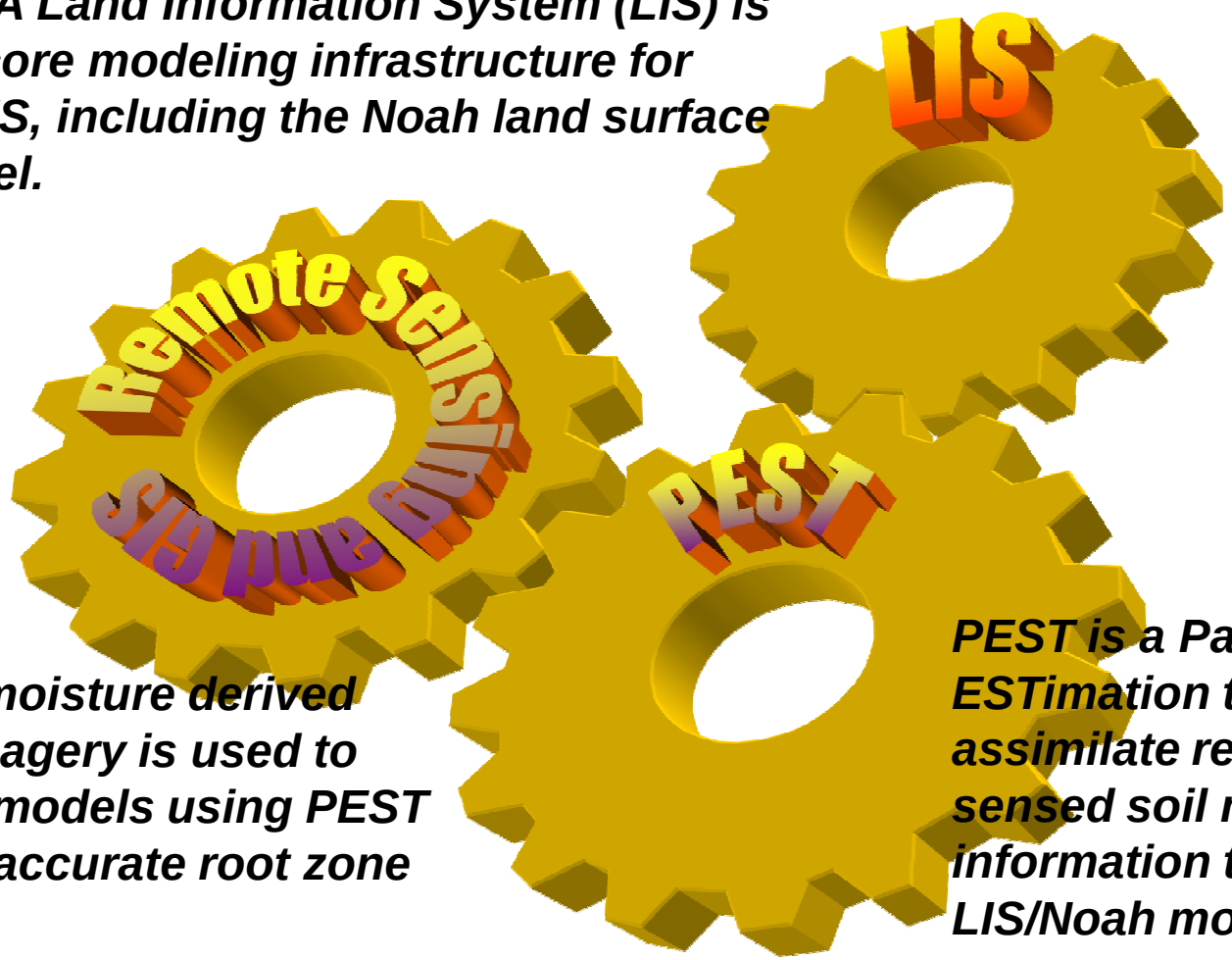

ARMS
Army Remote Moisture System
Partners: USDA, NASA,
Corp of Engineers, and
University of Wyoming

ARMS is an ArcGIS extension that calculates past and future soil moisture conditions remotely and automatically.
It is specifically designed for application in data-poor, potentially hostile, locations.

NASA Land Information System (LIS) is the core modeling infrastructure for ARMS, including the Noah land surface model.



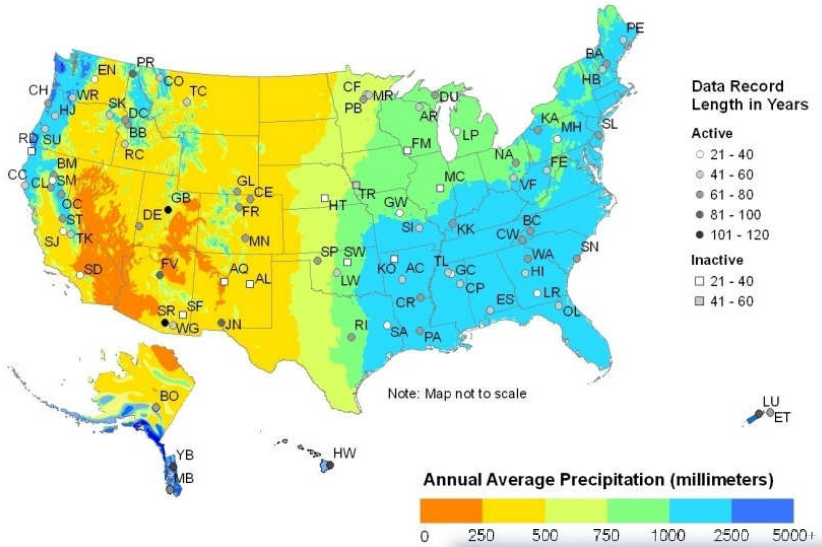
Surface soil moisture derived from radar imagery is used to calibrate LIS models using PEST to determine accurate root zone soil moisture.

PEST is a Parameter ESTimation tool used to assimilate remotely sensed soil moisture information to optimize LIS/Noah model parameters.

ARMS provides upper-layer (to 30 cm) soil moisture at moderate resolution (100s of meters) over large areas (10,000 km2) based on internationally available data (Table 1).
The approach is being validated at three watersheds in AZ, OK and GA to determine accuracy and ensure operational application.
The prototype has been demonstrated to Army staff and is being considered for incorporation into the Future Combat System.

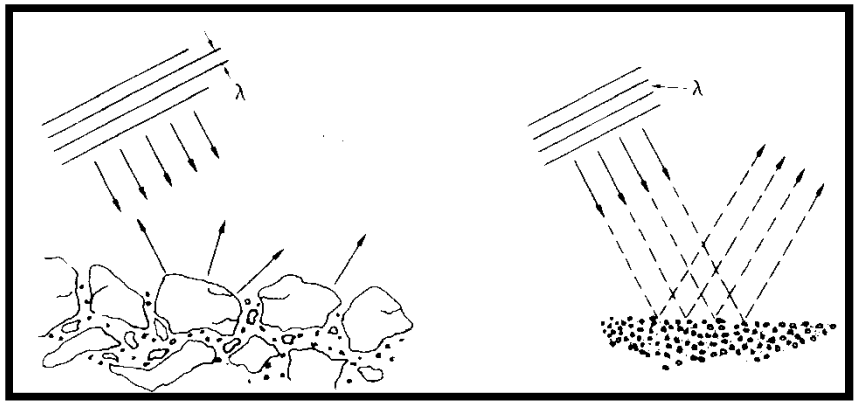
Table 1. Mapping Parameter	**ARMS Requirement**
Spatial Resolution	*10 to 100 m*
Vertical Resolution	*15 cm to 1 m; Upper Layer*
Spatial Coverage	*1000 to 25000 km^2*
Quantization	*3–4 levels; ranging from dry to very wet*
Accuracy	*Moderate, ~75%*
Product Delivery	*Upon request; to within 3–4 days of request*

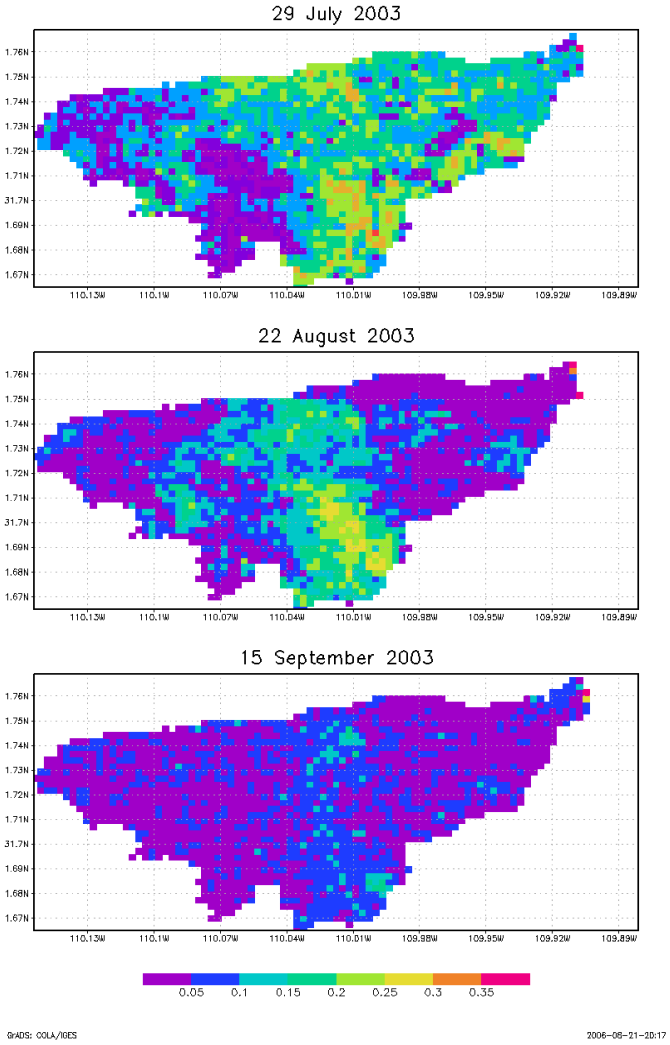
Study Sites:



Key Scientific Advances from ARMS Research

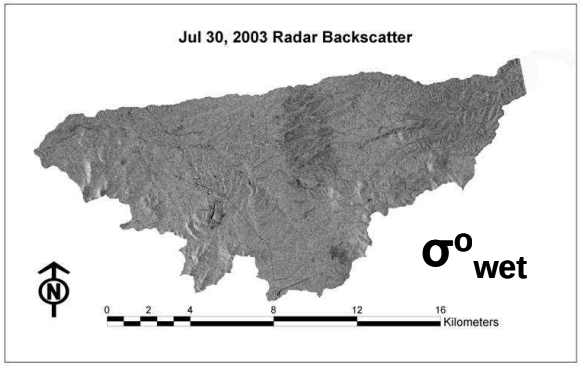
Image-only methods were developed for retrieving surface soil moisture and surface roughness from radar imagery

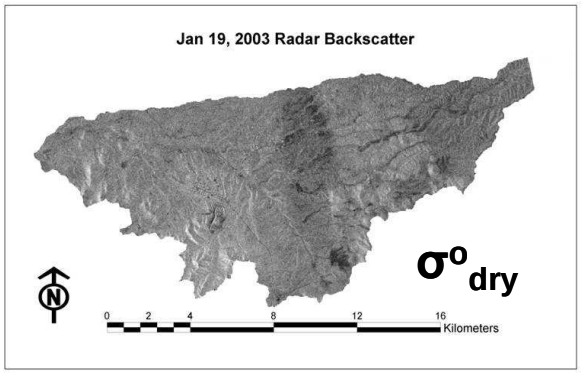


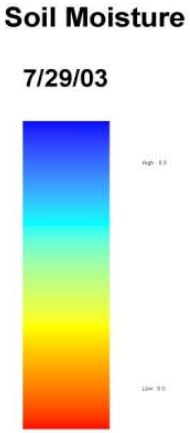


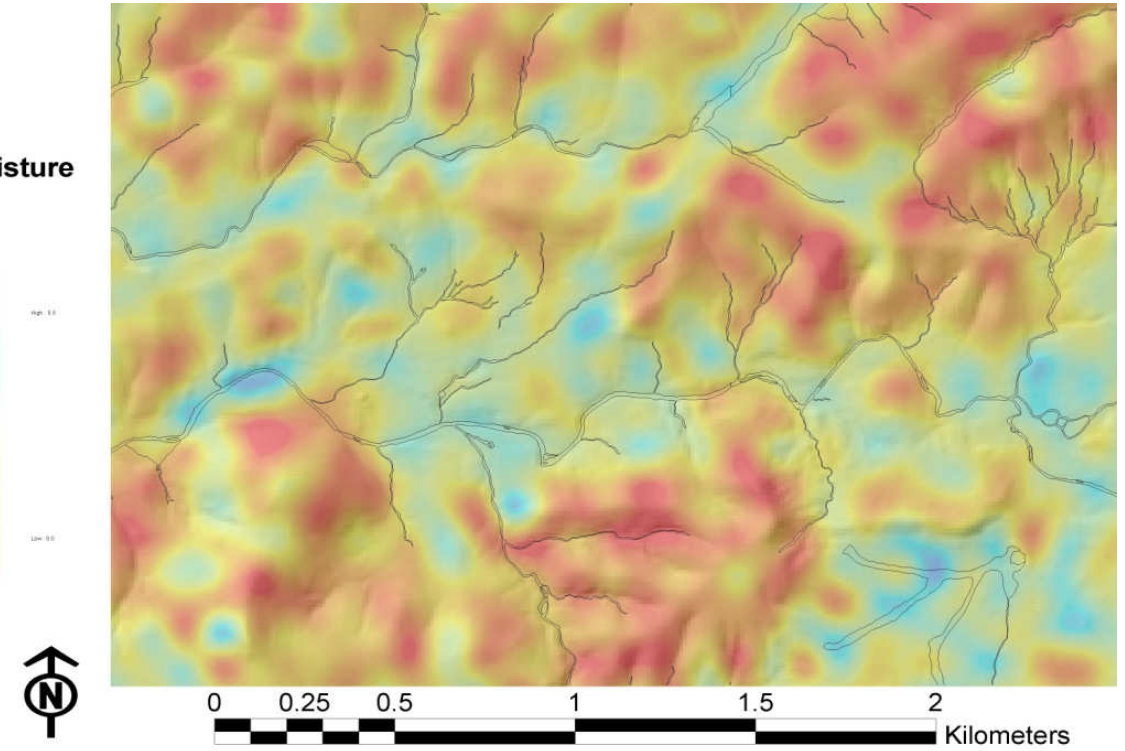
Soil moisture was estimated from RADARSAT-1 active microwave measurements over the Walnut Gulch Experimental Watershed on a) 29 July, b) 22 August and c) 15 September 2003. Backscatter was aggregated from 7 to 280 m to reduce the effects of speckle.

A radar backscatter model was used with image-based calibration to retrieve surface soil moisture from radar imagery.





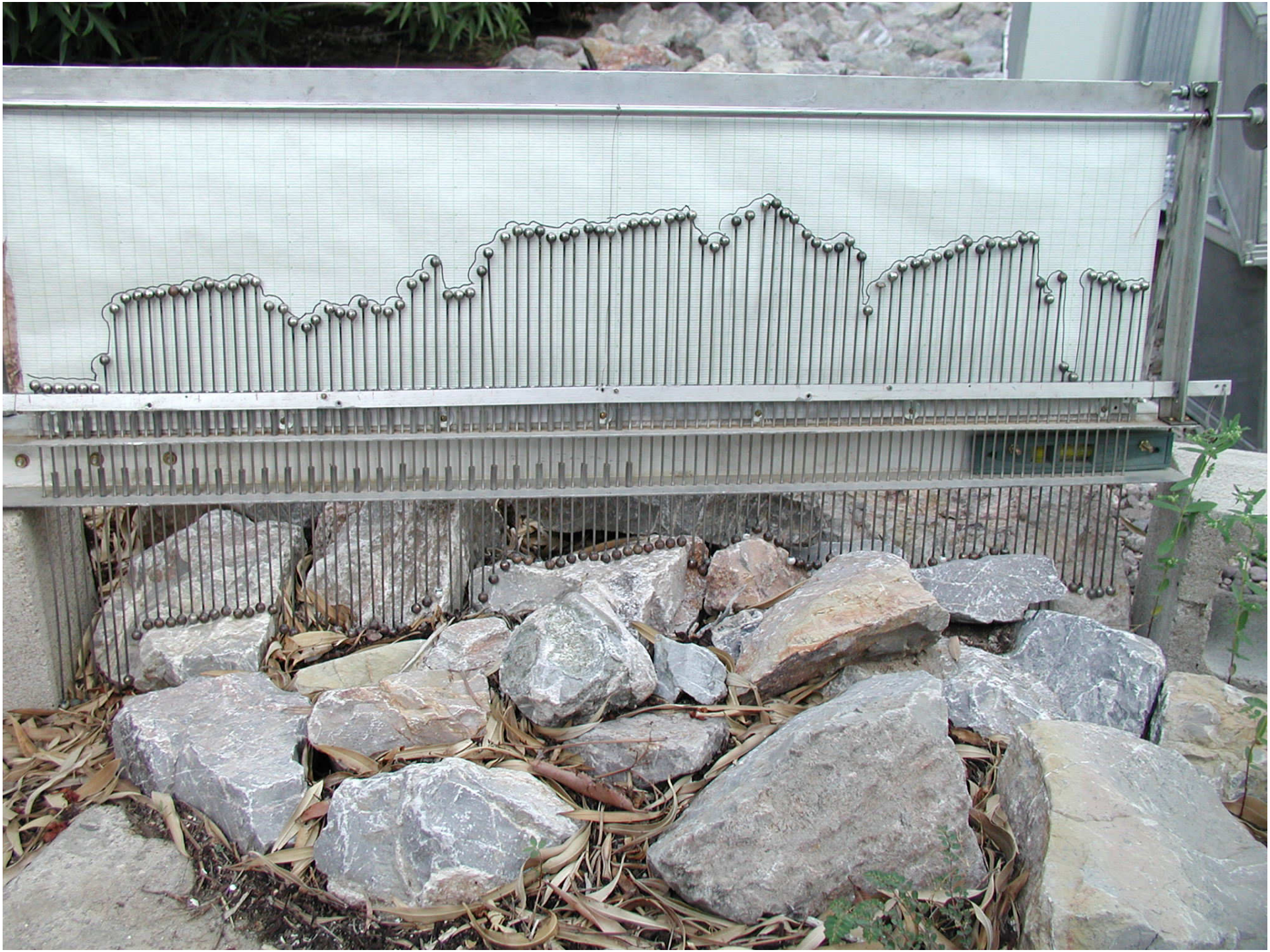


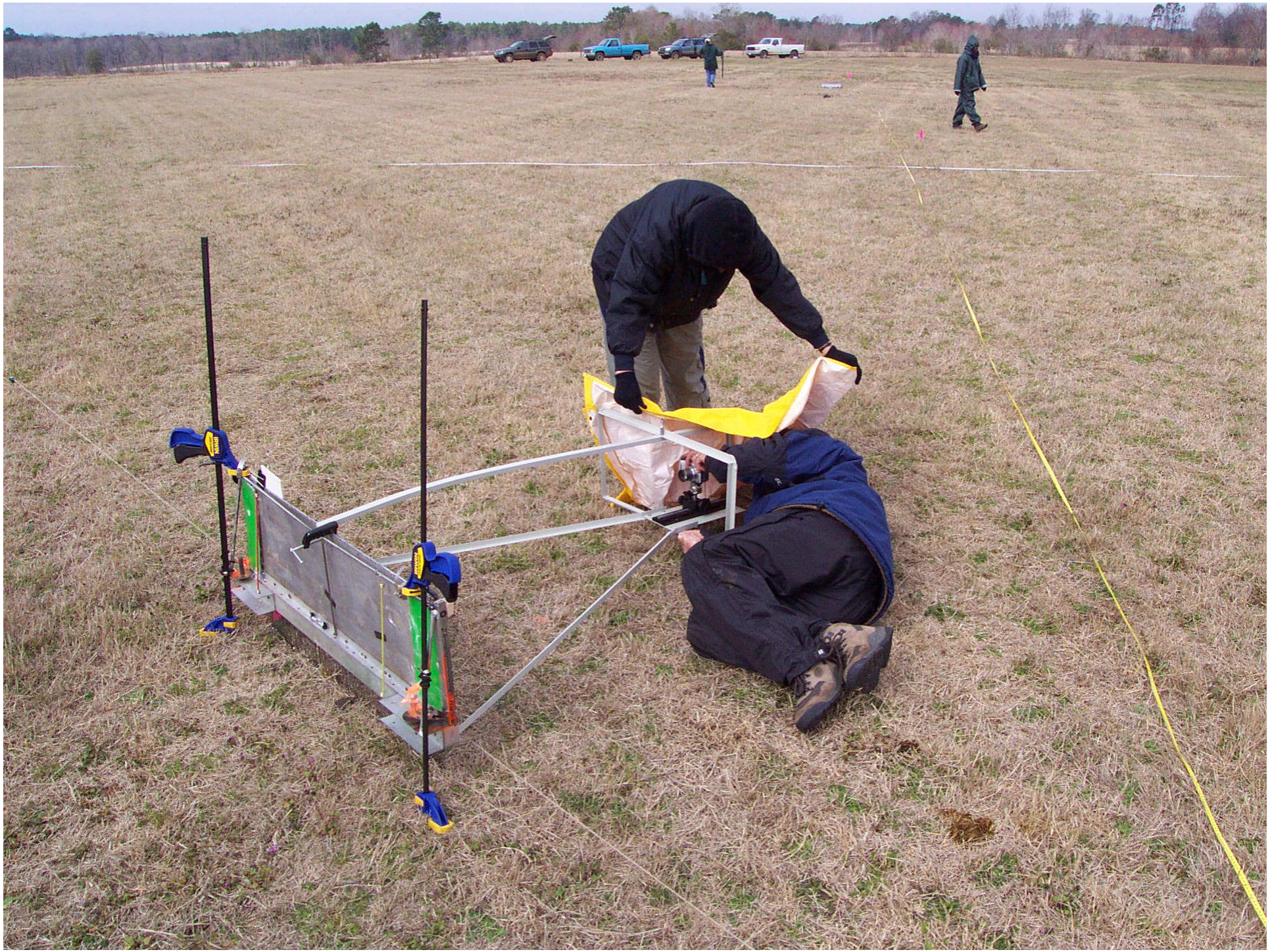


Soil moisture was derived from radar images by the use of the Integrated Equation Model (IEM) formulated with multi-temporal, multi-angle radar images with wet and dry soil conditions.

Suggestions were made for resolving problems encountered when parameterizing soil roughness for soil moisture retrieval from radar images.

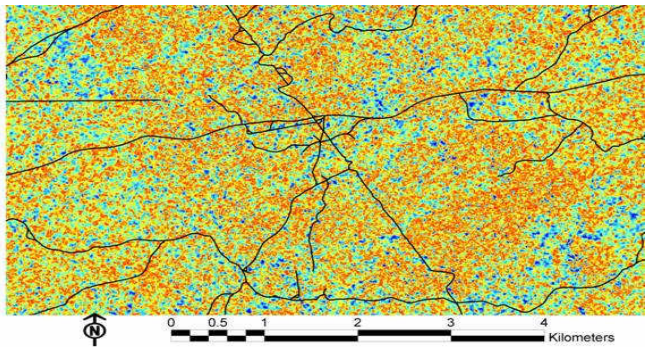
A pinmeter measured surface roughness with 100 metal pins spaced 1 cm apart for a total transect length of 1 m.

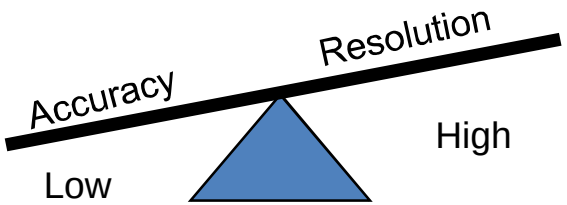


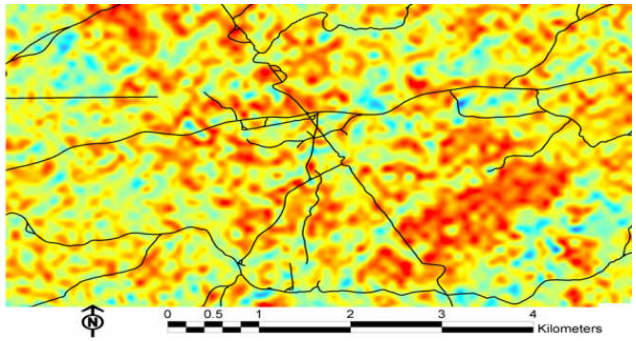


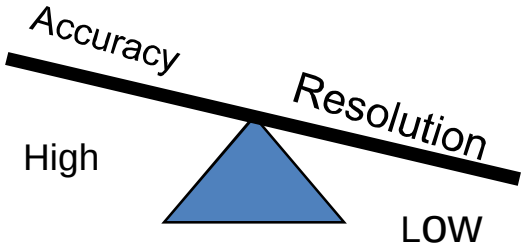

3304
5263
3263

An operational approach was developed to determine the optimal spatial resolution for soil moisture retrieval from radar imagery.



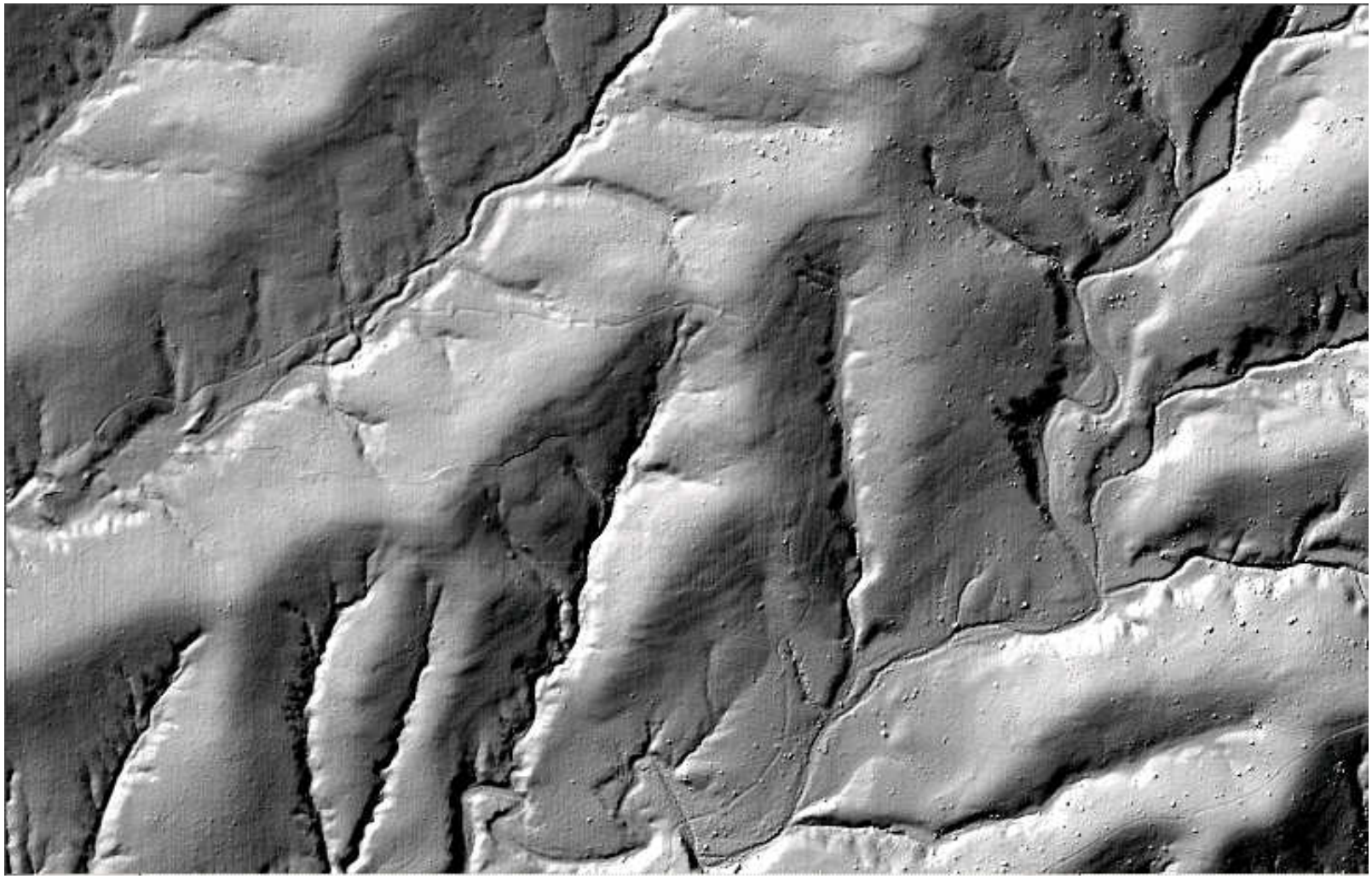






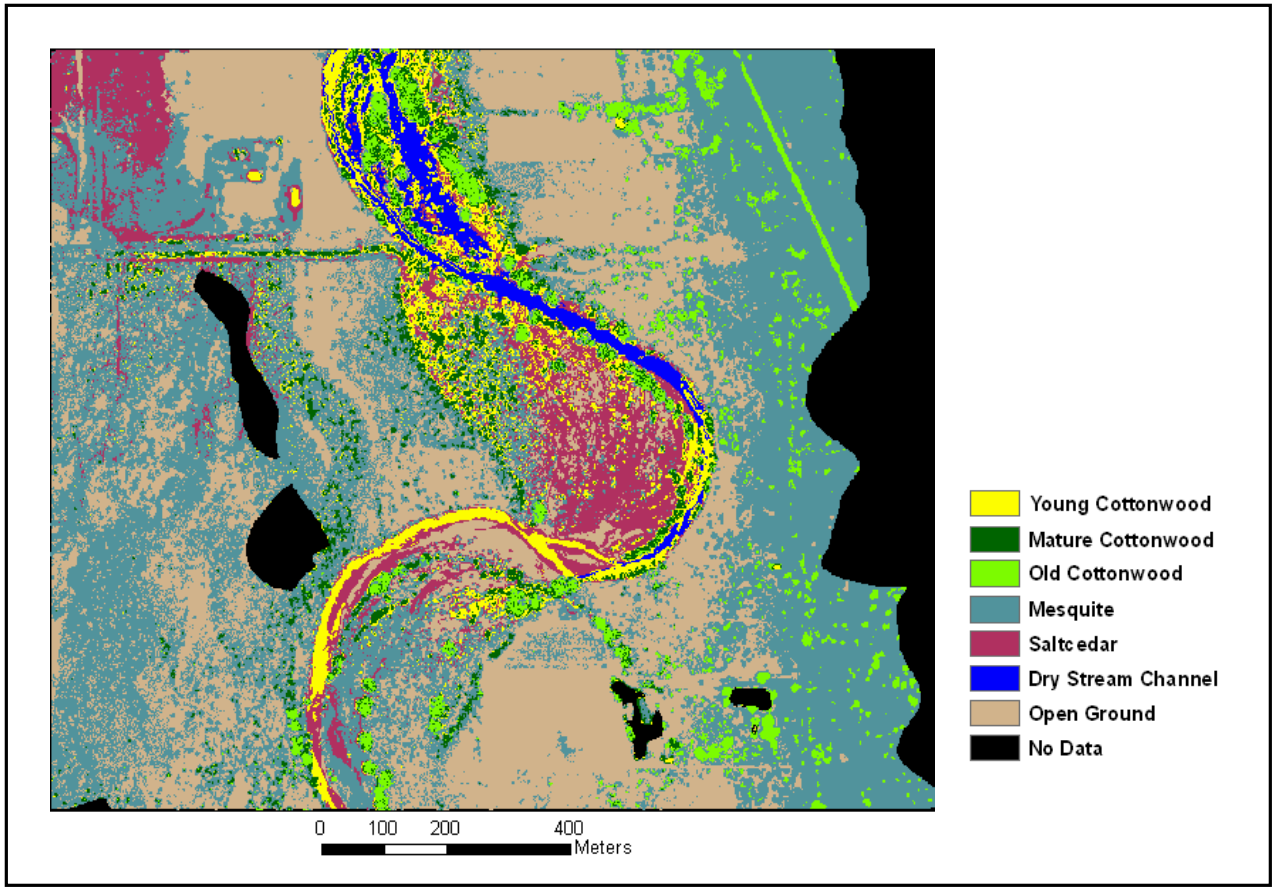
For soil moisture retrieval with 95% confidence, optimum ground resolutions for AZ, OK and GA study sites were 162 m, 310 m, and 1131 m, respectively.

Impact of Median Filtering

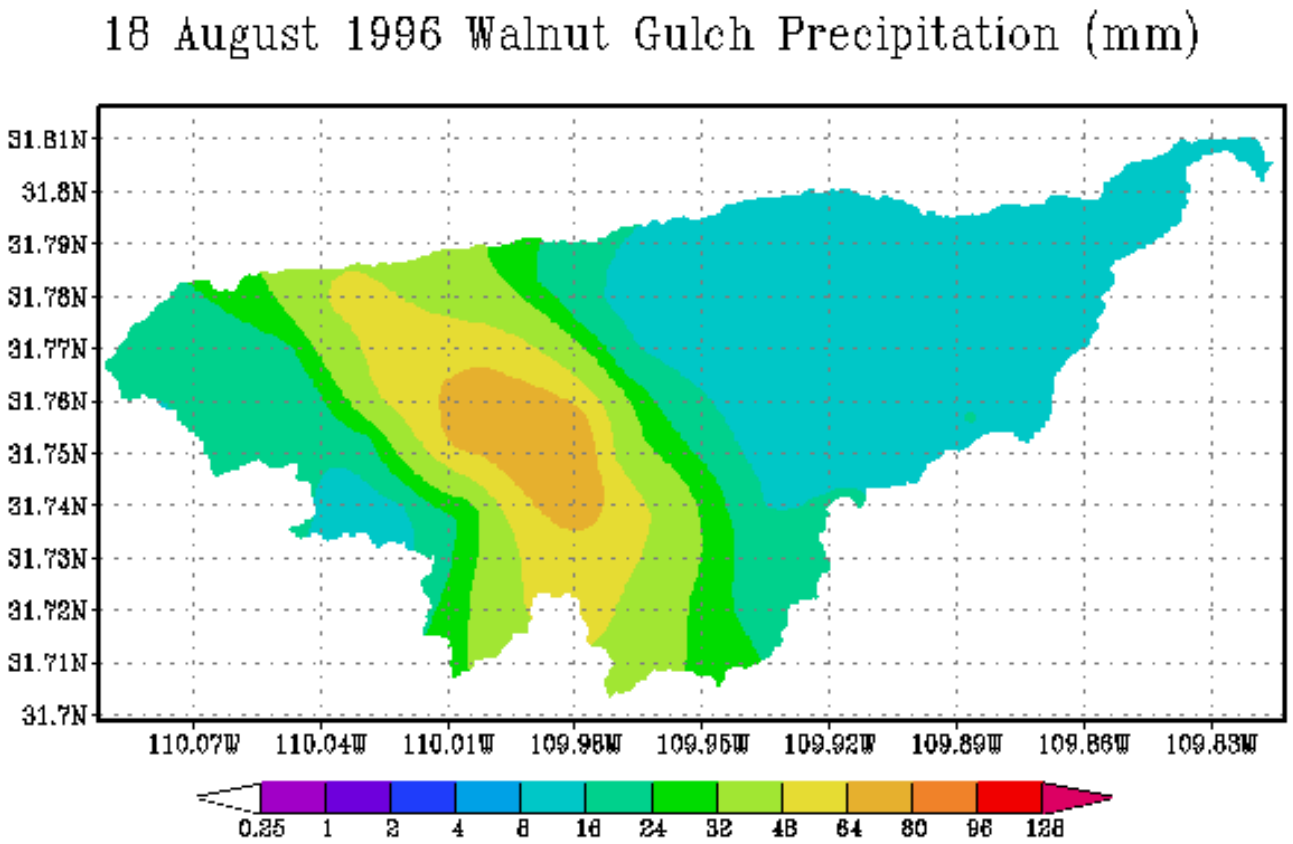


High-spatial-resolution LIDAR imagery and digital elevation models (DEM) improved estimates of channel morphologies and vegetation classes to increase the accuracy of hydrologic models.

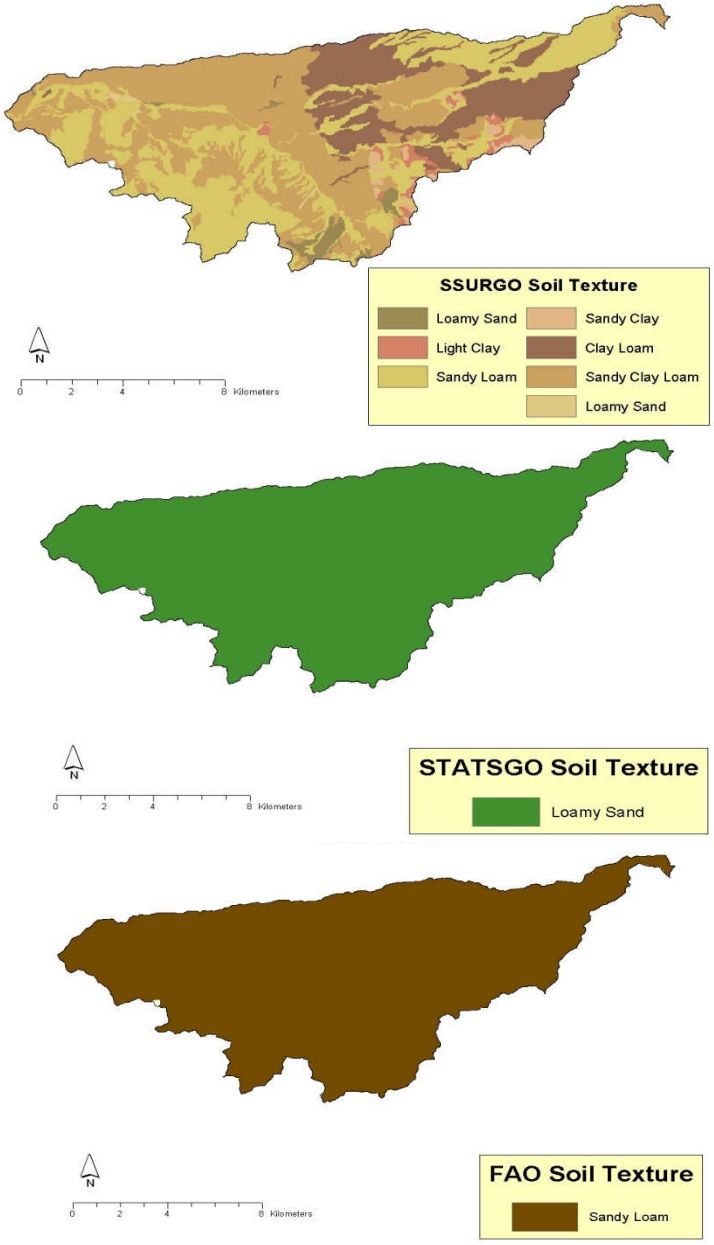
A classified lidar image of the San Pedro River in SE Arizona shows three cottonwood age classes, mesquite, saltcedar, dry stream channel and open ground.



Interpolation methods were used to produce spatially distributed precipitation fields from rain gauge networks for land surface modeling.



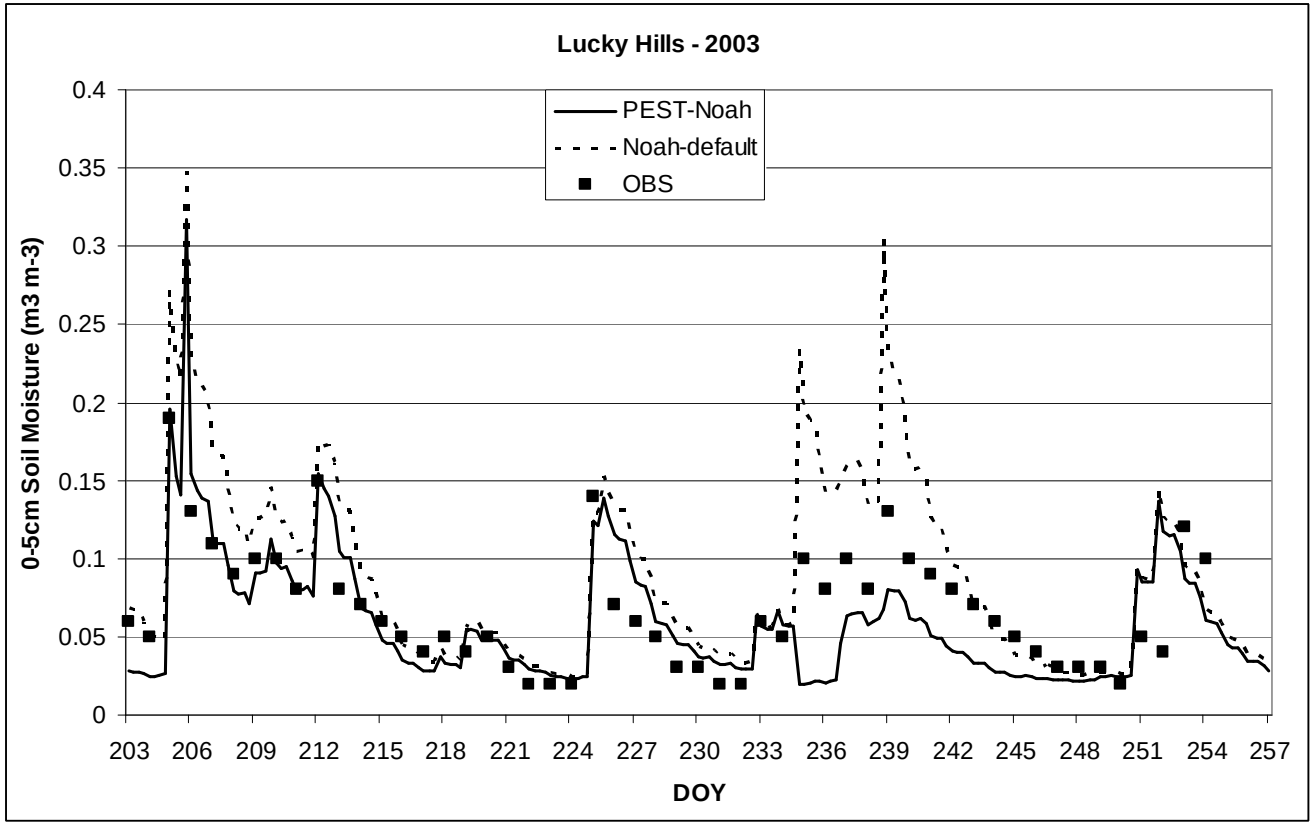
The total precipitation from a rainfall event on 18 August 1996 over Walnut Gulch Experimental Watershed was derived using the inverse-distance-cubed interpolation method.



The LIS/Noah land surface model was run with inputs at multiple scales from multiple sources to determine accuracy requirements for soils, land cover and precipitation data.

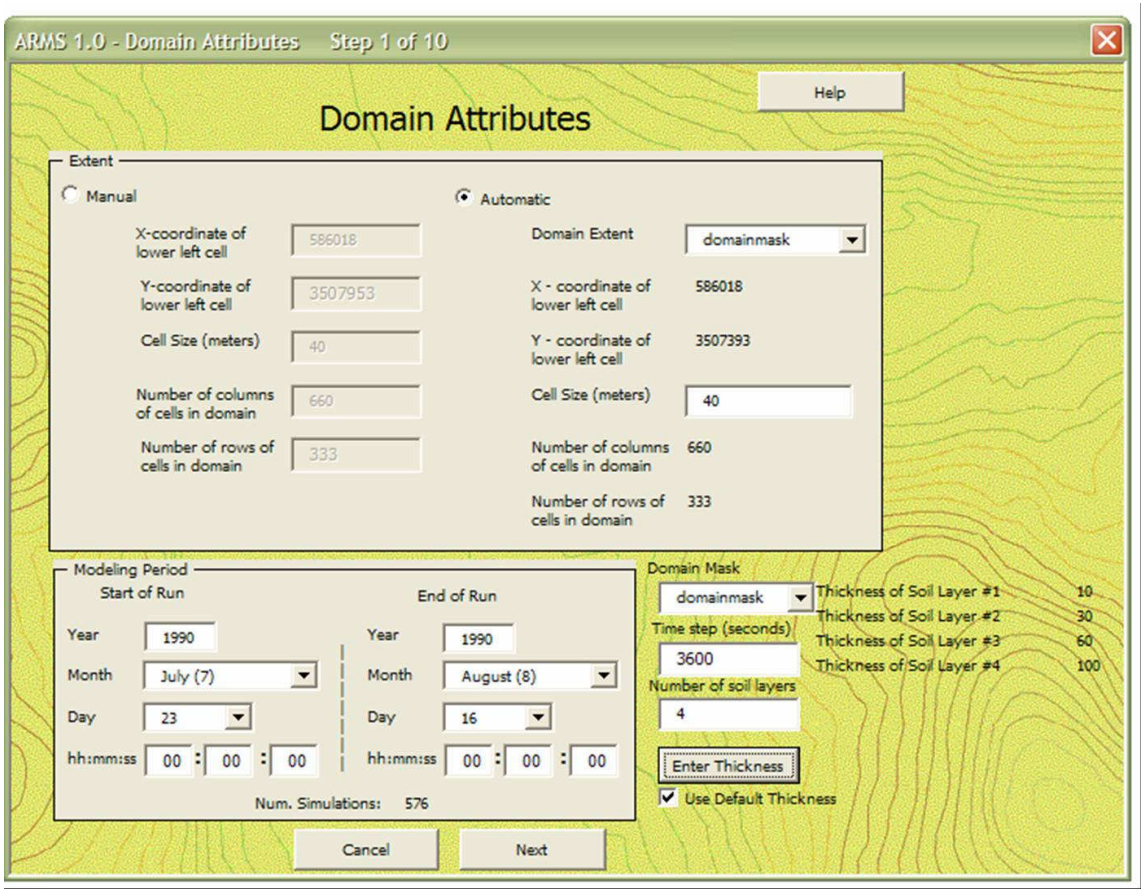
Soil texture data for Walnut Gulch Experimental Watershed from the Soil Survey Geographic Dataset (SSURGO), the State Soil Geographic Soil Database (STATSGO), and the Food and Agricultural Organization of United Nations (FAO).

The LIS/Noah model was integrated with the PEST parameter estimation algorithm to calibrate Noah with remotely sensed surface soil moisture estimates.

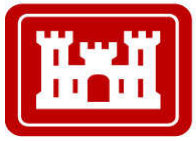


Near surface soil moisture simulated by Noah using PEST-derived soil properties and default soil parameters (SSURGO) compared against Vitel probe observations at the Lucky Hills site in Walnut Gulch Experimental Watershed in 2003.

A GIS framework for ARMS linked NASA LIS with remotely sensed measurements of surface soil moisture to provide a high resolution estimation of upper-layer soil moisture for Army applications.

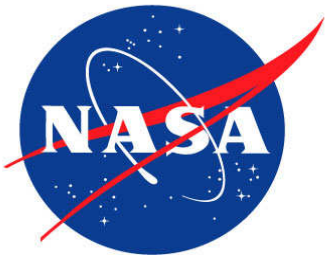


An example of the ARMS Graphic User Interface (GUI) showing domain attributes and control variables for parameterizing the LIS/Noah modeling run.



US Army Corps of Engineers®
Topographic Engineering Center

University of Wyoming



M.S. Moran, C.D. Peters-Lidard, M.A. Tischler, D.C. Goodrich, S.N. Miller, D. Thoma, M.M. Rahman, R. Bryant, J.A. Santanello Jr., M. Garcia and A. Farid

This work was supported by the U.S. Army Corps of Engineers, Engineer Research and Development Center, Topographic Engineering Center (USACE-ERDC-TEC) with contributed efforts of additional USDA-ARS, NASA-GSFC and University scientists.


Download manuscripts from
http://www.tucson.ars.ag.gov/unit/ARMS