

Soil Moisture
Active Passive
Mission
SMAP

Cal/Val Workshop #9
October 22-23, 2018



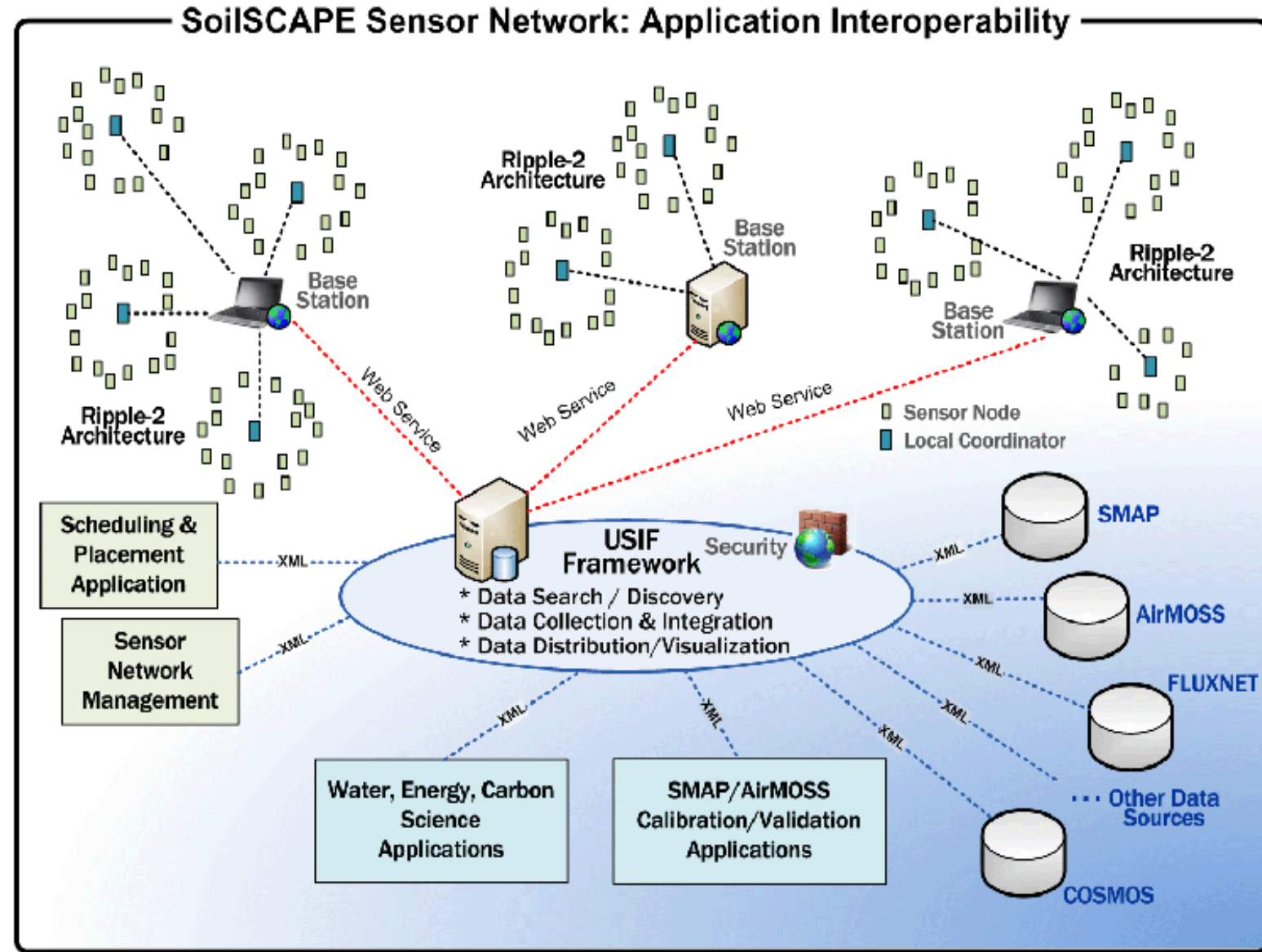
SoilSCAPE Network for km-Scale Validation

D. Clewley, A. Silva, R. Chen, R.
Akbar, J. Whitcomb, A. Colliander,
D. Entekhabi, M. Moghaddam

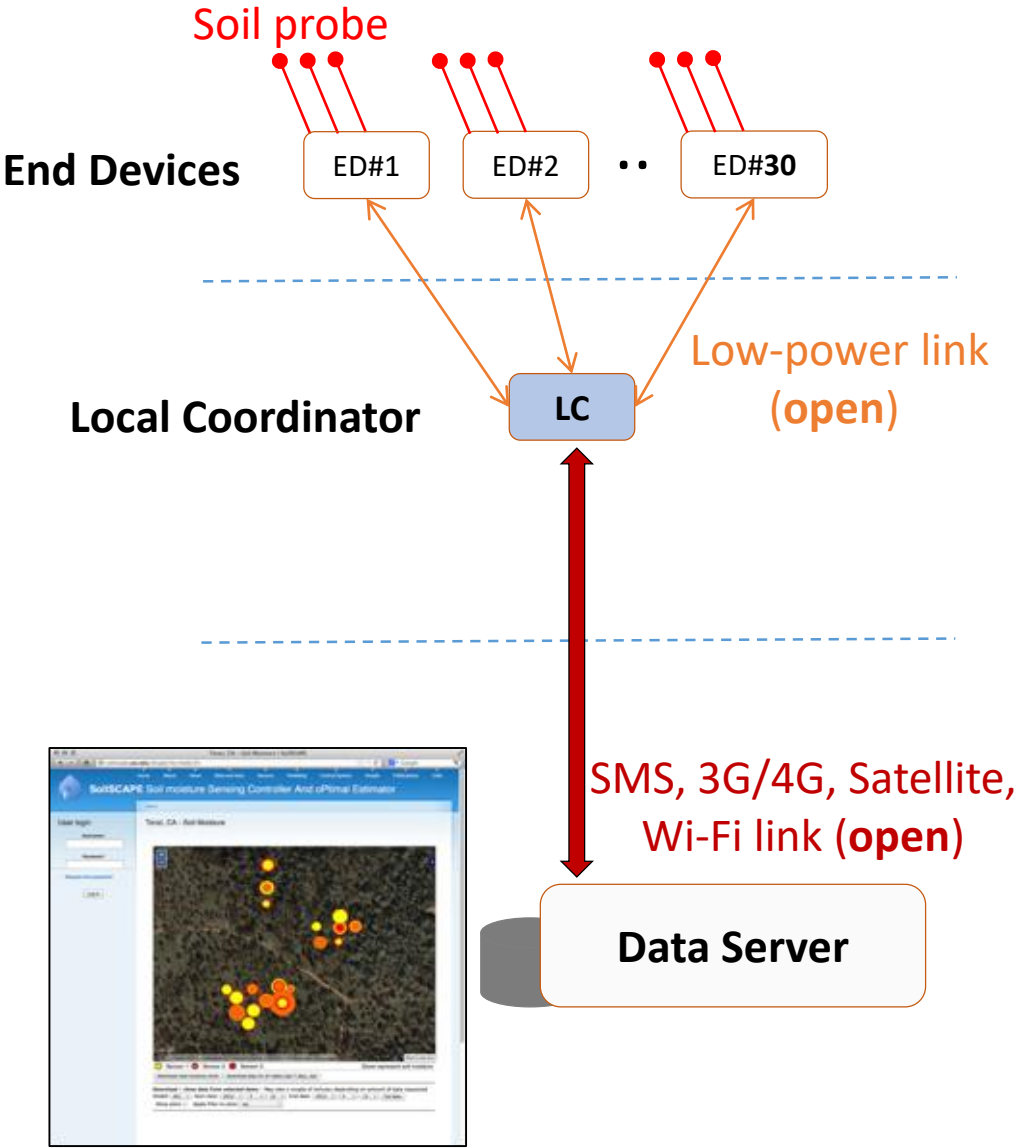
SoilSCAPE Background



- Wireless sensor network technology developed through ESTO-AIST support
- Highly energy-efficient, can operate unattended months to years (depending on environmental conditions)
- Distributed and open architecture; no proprietary protocols
- Each local coordinator can run 30 nodes
- Each node can operate 4-8 sensors



SoilSCAPE Network Components

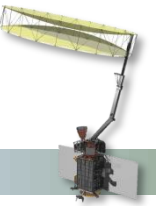


ED: no solar panel

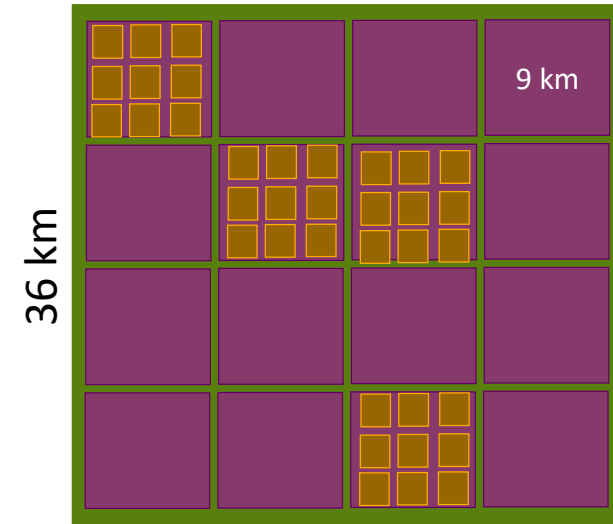


LC: with solar panel; custom hardware and software with open architecture

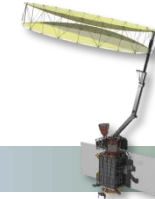
Original Sampling Design



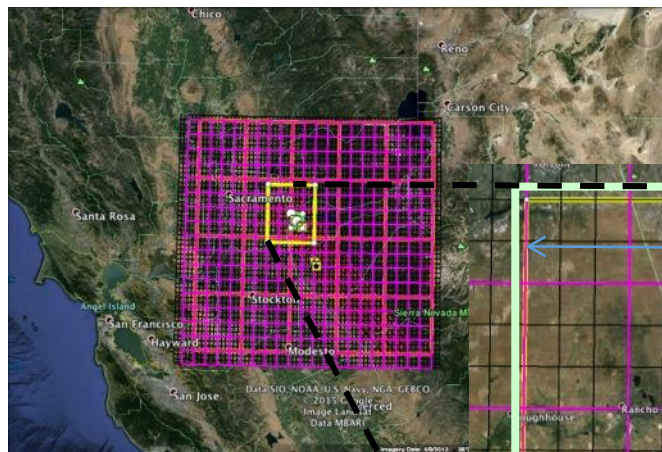
- Designed to fit in with initial SMAP Cal/Val requirements: two 3 km cells and two 9 km cells within a 36 km cell; 3 km and 9 km cells not mutually exclusive
- 36 km grid placed to fit within airborne flight lines (IUAVSAR or AirMOSS)
- Location of two 9 km cells within 36 km grid chosen to maximize land cover, topography, and soil class diversity within both cells
- 3 km cells and node locations within these defined using class weights



SoilSCAPE Deployment Example (1)



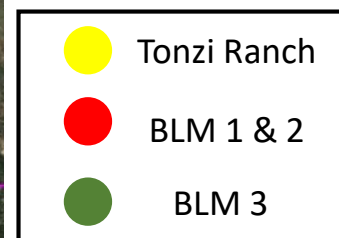
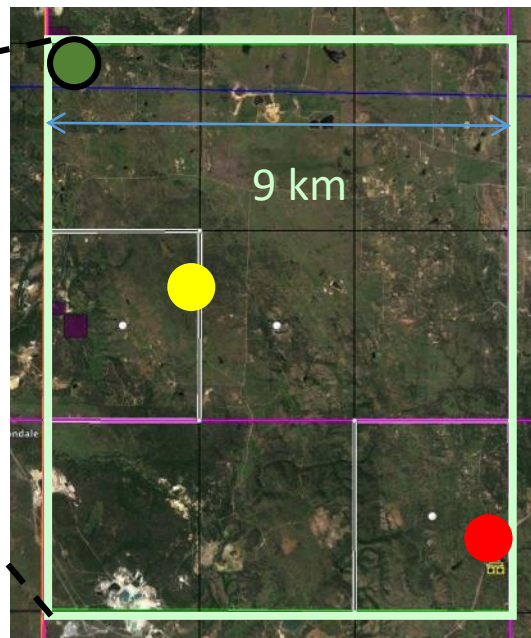
- Central CA site, generally known as “Tonzi Ranch”
- Original 36 km pixel shown



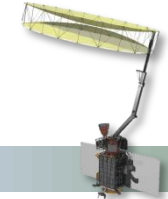
SMAP original 36 km Validation Grid
over Tonzi Ranch Area



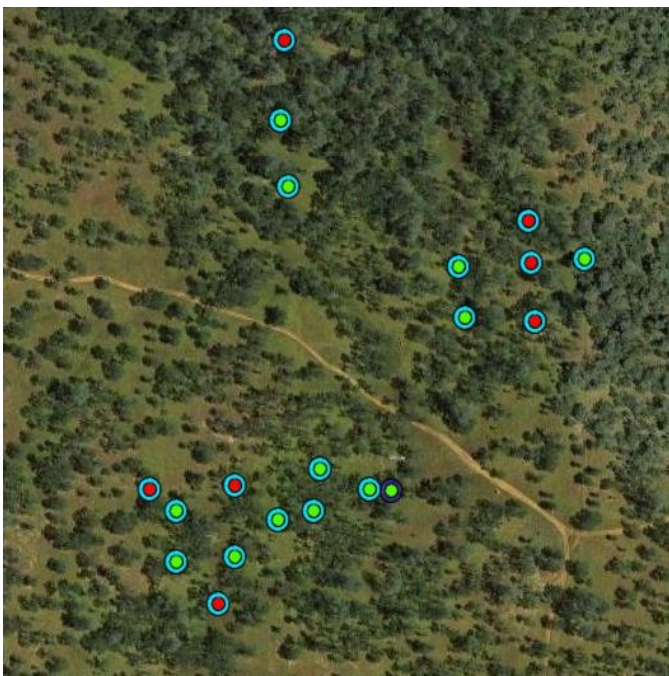
SMAP 9km Validation Focus
(Tonzi Ranch, BLM1 & 2, BLM3)



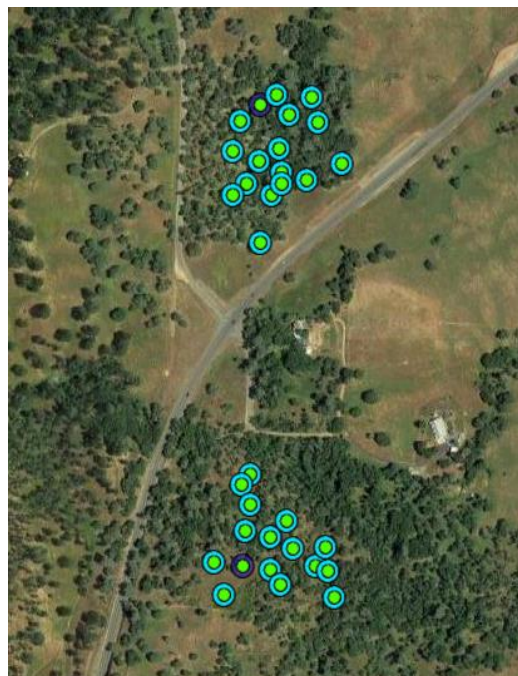
SoilSCAPE Deployment Example (2)



- Green box (bottom right panel) shows a 9-km pixel within the larger central CA site; includes nine 3-km pixels
- Each site can also be used for 1-3 km scale validation
- Total number of nodes in the area shown is 54
- Each node is a profile of 3 or 4 sensors, depths reaching 50-60 cm



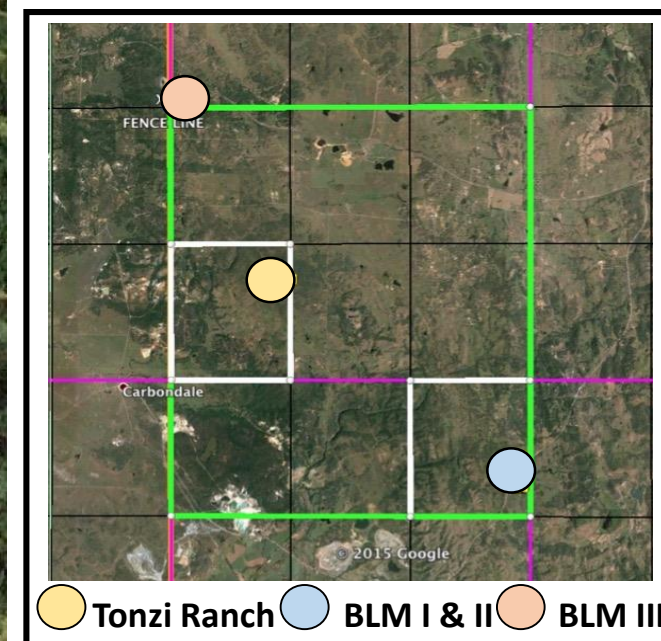
Tonzi



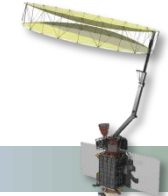
BLM 1&2



BLM 3



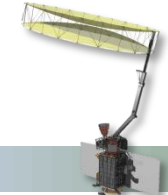
Subnetworks (1)



Tonzi Ranch

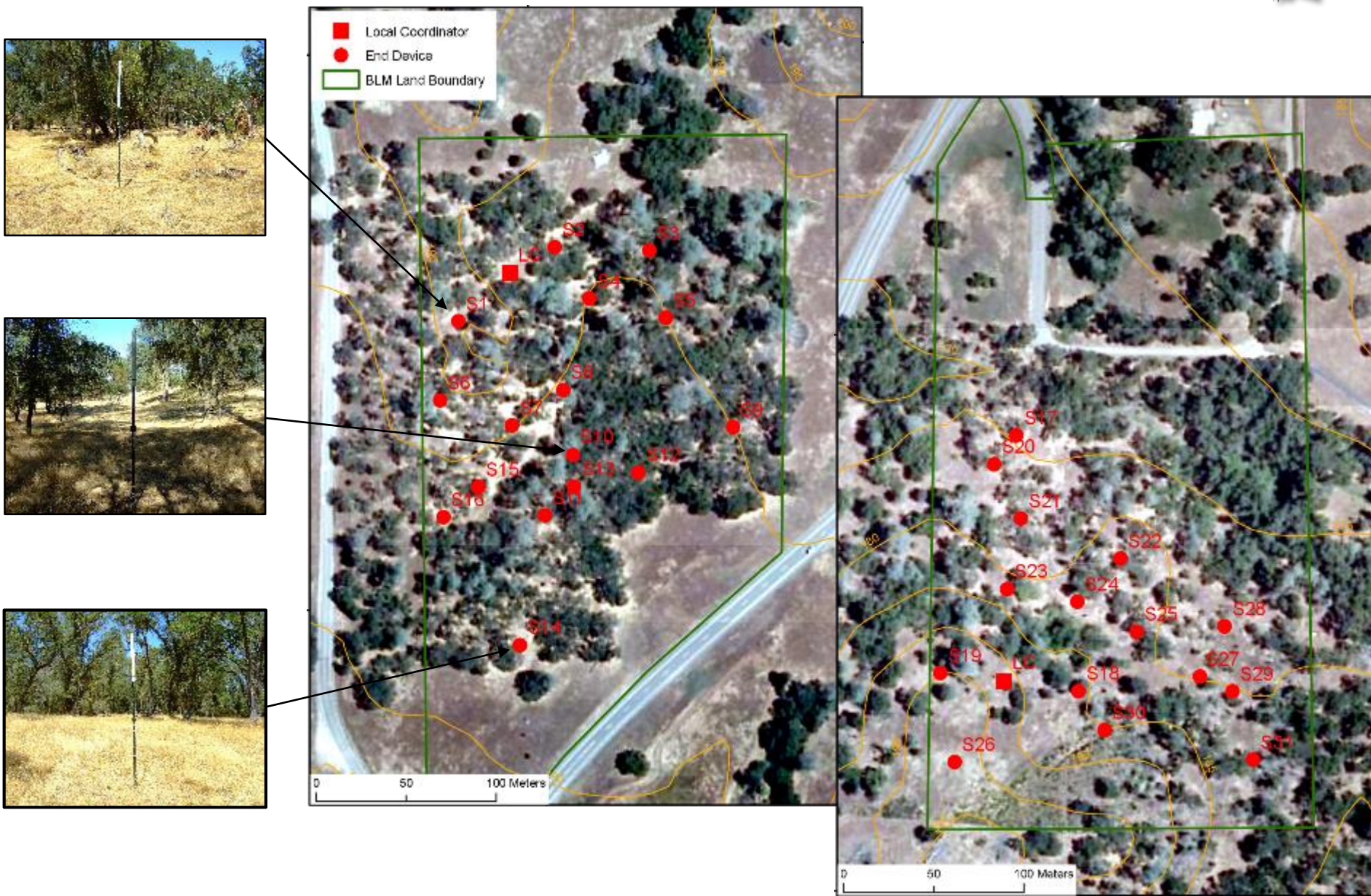
- Private land
- Woody savannah with pine and oak
Deployed summer 2012
- 20 nodes
- Locations determined based on diversifying landcover, soils, and topography

Subnetworks (2)

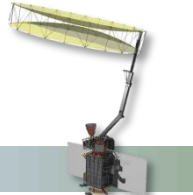


BLM 1 & 2

- Owned by Bureau of Land Management
- 31 nodes
- Deployed in 2013
- Node locations determined based on diversifying soils, landcover, and topography



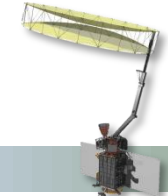
SoilSCAPE Deployment Tally



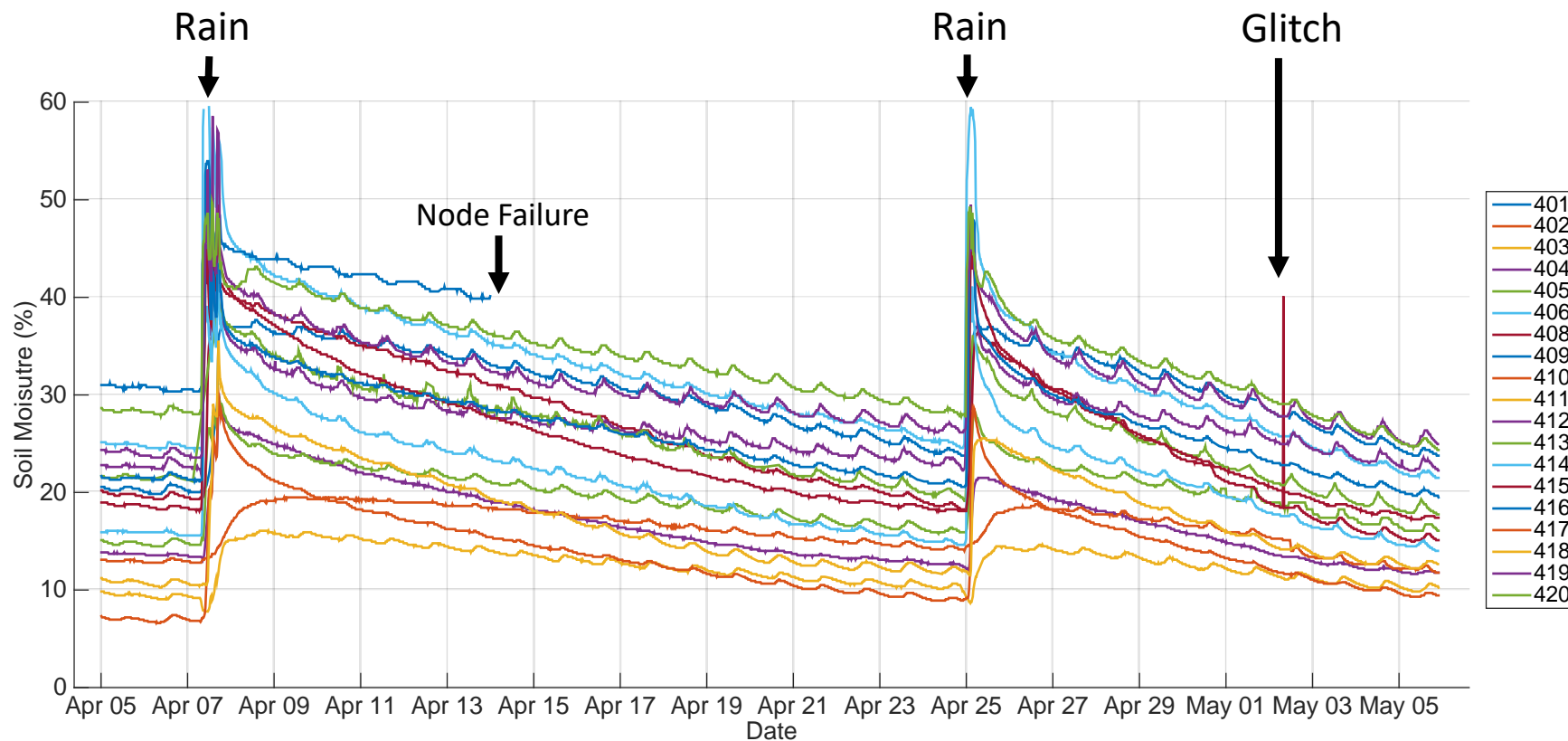
Site	Location	# of Sensors	Land Cover*
Tonzi Ranch	North-Central California	18	Savanna/Oak, pine
BLM I		17	Woody Savanna
BLM II		14	Woody Savanna
BLM III		5	Woody Savanna
New Hogan I		19	Open Shrubland
New Hogan II		14	Savanna/Grass
Terra d’Oro		28	Vineyard (nodes down)
Lucky Hills	Southern Arizona	8	Open Shrubland
Kendall		10	Grassland
Santa Rita		Legacy nodes w/ SoilSCAPE LC	

} Deployed at hillslope scale, 0.5-1 km coverage

Sample Data from Tonzi Ranch



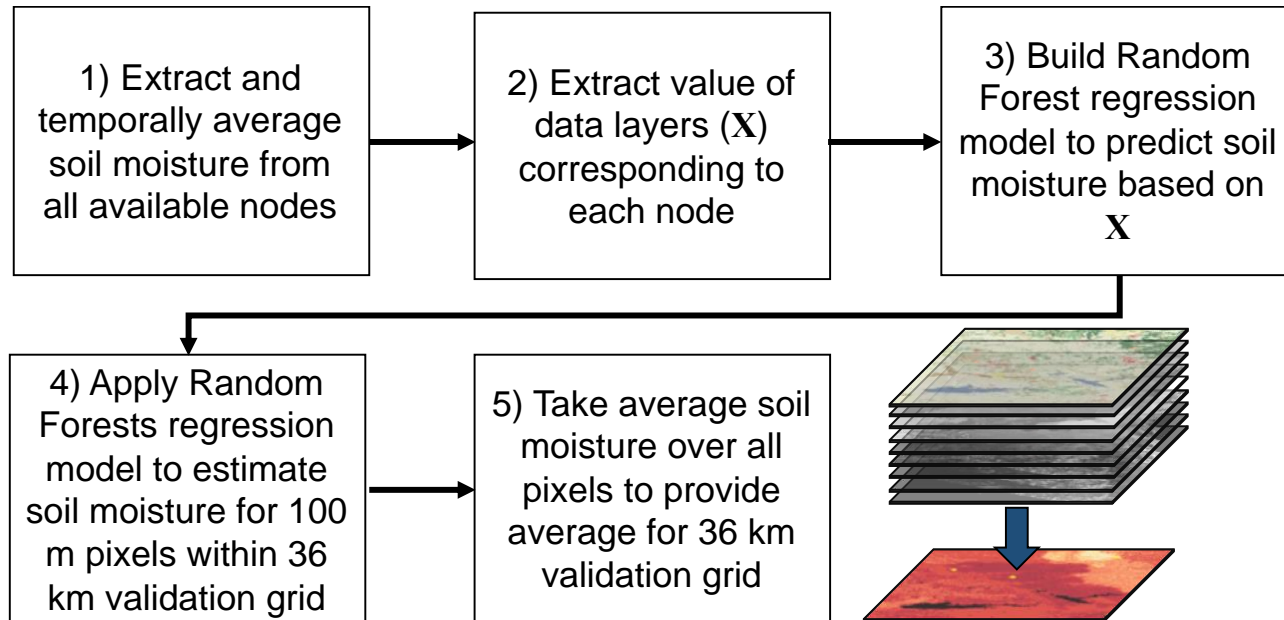
- Twenty nodes, top sensor in profile at 5 cm depth is shown
- Significant spatial variability is observed



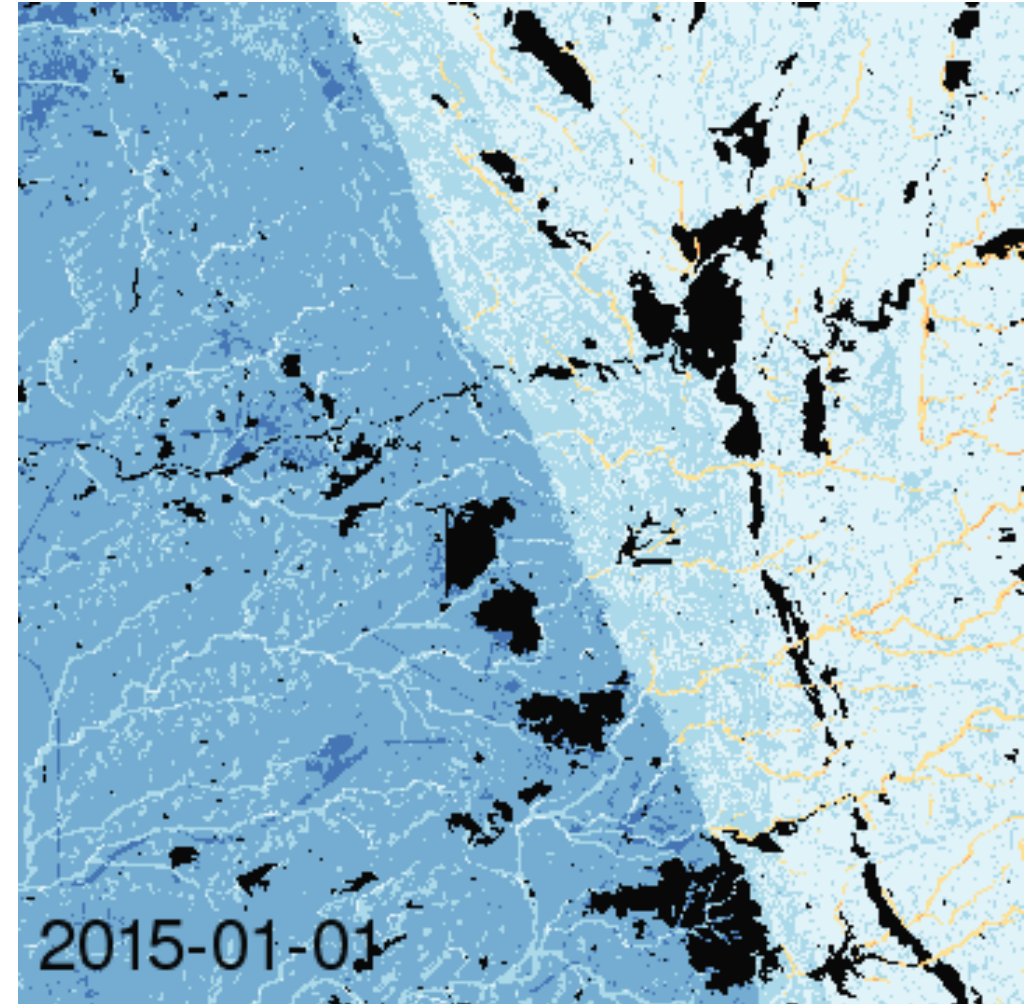
Upscaling



Accomplished via the Random Forests machine learning algorithm



Tonzi Ranch soil moisture estimates
at 100 m resolution



SoilSCAPE data archived at ORNL DAAC





- 20-minute data from all sites from 2011-08-03 to present are archived in NetCDF v4 format
- Newly collected data added quarterly
- Also includes site-level daily average soil moisture and soil temperature at six sites
- Data set landing page: http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1339
- Documentation: http://daac.ornl.gov/LAND_VAL/guides/SoilSCAPE.html
- Citation and DOI:
 - Moghaddam, M., A.R. Silva, D. Clewley, R. Akbar, S.A. Hussaini, J. Whitcomb, R. Devarakonda, R. Shrestha, R.B. Cook, G. Prakash, S.K. Santhana Vannan, and A.G. Boyer. 2016. Soil Moisture Profiles and Temperature Data from SoilSCAPE Sites, USA. ORNL DAAC, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/1339>

SoilSCAPE data set landing page at ORNL



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Soil Moisture Profiles and Temperature Data from SoilSCAPE Sites, USA

Download Data

Data Set Overview

Data set	Soil Moisture Profiles and Temperature Data from SoilSCAPE Sites, USA
DOI	10.3334/ORNLDAAC/1339
Release date	2016-09-06
Project	EOS Land Validation
Time Period	2011-08-03 to 2016-07-14



Data set bounding box.
Lat: 42.30N to 31.74N, Long: 120.99W to 83.66W

Description

This data set contains in-situ soil moisture profile and soil temperature data collected at 20-minute intervals at SoilSCAPE (Soil moisture Sensing Controller and oPtimal Estimator) project sites in four states (California, Arizona, Oklahoma, and Michigan) in the United States. SoilSCAPE used wireless sensor technology to acquire high temporal resolution soil moisture and temperature data at up to 12 sites over varying durations since August 2011. At its maximum, the network consisted of over 200 wireless sensor installations (nodes), with a range of 6 to 27 nodes per site. The soil moisture sensors (EC-5 and 5-TM from Decagon Devices) were installed at three to four depths, nominally at 5, 20, and 50 cm below the surface. Soil conditions (e.g., hard soil or rocks) may have limited sensor placement. Temperature sensors were installed at 5 cm depth at six of the sites. Data collection started in August 2011 and continues at eight sites through late 2016. The data enables estimation of local-scale soil moisture at high temporal resolution and validation of remote sensing estimates of soil moisture at regional (airborne, e.g. NASA's Airborne Microwave Observation of Subcanopy and Subsurface Mission - AirMOSS) and national (spaceborne, e.g. NASA's Soil Moisture Active Passive - SMAP) scales.

Documentation

[Data set reference document](#)

Citation

Moghaddam, M., A.R. Silva, D. Clewley, R. Akbar, S.A. Hussaini, J. Whitcomb, R. Devarakonda, R. Shrestha, R.B. Cook, G. Prakash, S.K. Santhana Vannan, and A.G. Boyer. 2016. Soil Moisture Profiles and Temperature Data from SoilSCAPE Sites, USA. ORNL DAAC, Oak Ridge, Tennessee, USA.
<http://dx.doi.org/10.3334/ORNLDAAC/1339>

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Project

EOS Land Validation: In-situ and aircraft measurements for validating satellite products

[Project data set list](#) for EOS Land Validation.

Companion Files

Display and save these companion files.

- SoilSCAPE_Fig1.png
- SoilScape_CantonOK.pdf
- SoilSCAPE.pdf
- SoilScape_VairsCA.pdf
- SoilScape_BLM_Land3NTonzi_CA.pdf
- NodePhotos.zip
- SoilScape_BLM_Land_STonzi_CA.pdf
- SoilScape_LuckyHillsAZ.pdf
- SoilScape_KendallIAZ.pdf
- SoilScape_NewHoganLakeCA.pdf
- SoilScape_Terra_dOro_VineyardCA.pdf
- SoilScape_MatthaeiGardensMI.pdf
- SoilScape_TonziCA.pdf

Interactive visualization of SoilSCAPE data at ORNL (1)



Visualization on a map and time series of soil moisture
This tool replaces the older visualizations created in 2015.

Includes:

SoilSCAPE nodes

SMAP L4 root zone soil moisture products

AirMOSS in-ground soil moisture sensors

AirMOSS flights (L2/3 data) – blue dots on time series chart

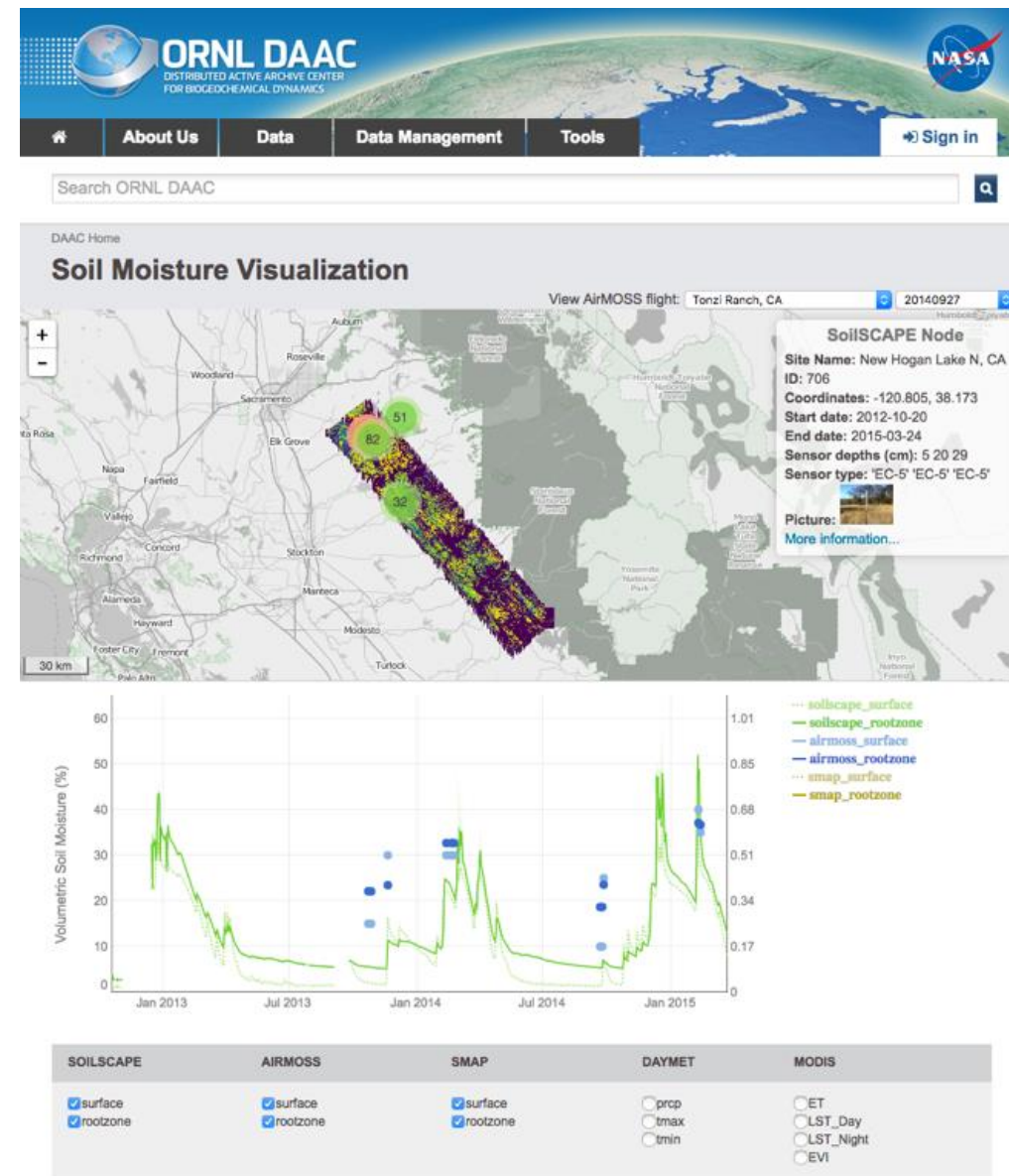
AirMOSS L4 root zone soil moisture products

COSMOS soil moisture

Daymet precipitation

MODIS ET, LST, and EVI

Released: November 2016.



Interactive visualization of SoilSCAPE data at ORNL (2)



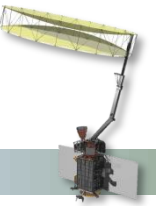
Zoom in on the map and click on one SoilSCAPE node (512 at New Hogan Lake)
 Plot shows SMAP, SoilSCAPE, and AirMOSS products superimposed

Radio buttons below the plot allow a user to select which data to view.



Volumetric surface soil moisture is the daily average of measurements at 0-5 cm depth, and volumetric root zone soil moisture (RZSM) is the daily

Summary



- SoilSCAPE network has several subnetworks that can be used for 1-3 km scale validation
- All data transfer, archiving, and upscaling machinery already in place
- SoilSCAPE project has officially ended; central CA sites have been operating for several years, now gradually in need of basic maintenance