AMSR-E Soil Moisture Validation Data

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1 AMSR-E VALIDATION OVERVIEW

1.1 About Validation Campaigns

The AMSR-E validation effort addressed data quality through several comprehensive calibration and validation programs. These programs characterized and documented the accuracy and precision of AMSR-E observations and their derived products.

Pre-launch activities demonstrated the stability of the instrument software and began to demonstrate the validity of the retrieved products with in situ ground truth data. Post-launch efforts concentrated on validating the retrieved products using in situ data.

The validation effort produced three types of products: cryospheric data, including snow, ice, and sea ice; rainfall data; and soil moisture data. This document describes the soil moisture validation effort.

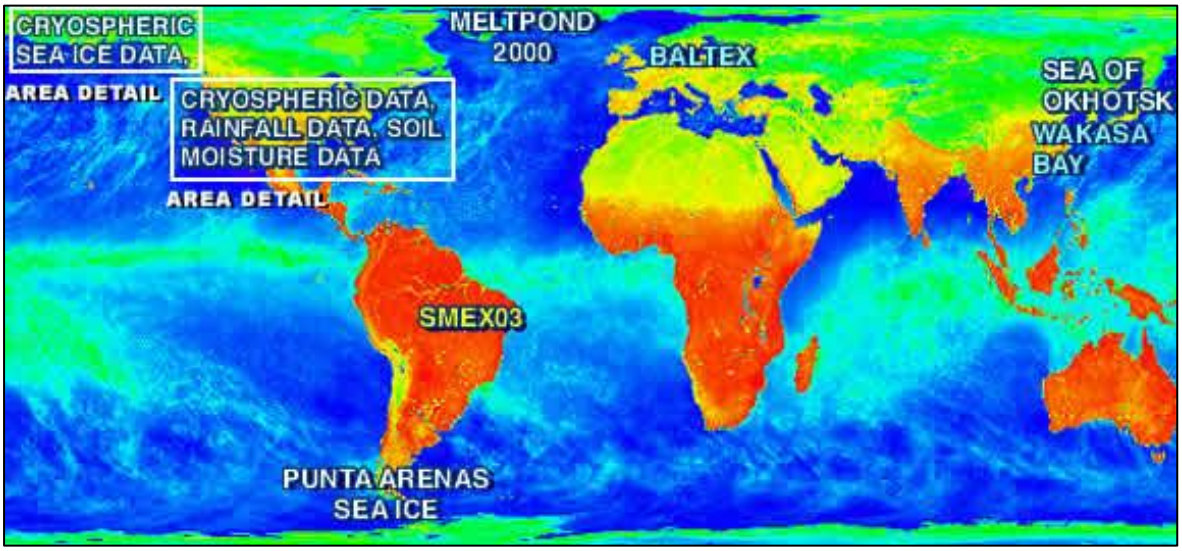

Figure 1. Global map depicting the locations of the 2002-4 AMSR-E validation campaigns, including area detail for regional study areas in North America.

1.2 Soil Moisture Validation Overview

A series of Soil Moisture Experiments (SMEX) were conducted from 2002 to 2005 to address a broad range of science and instrument questions related to soil moisture remote sensing. The objectives of these experiments were to provide data sets for studies of hydrologic processes and land/atmosphere interactions, validate spaceborne soil moisture measurements (such as from the AMSR-E instrument), and evaluate new instrument technologies.

AMSR-E validation studies linked to SMEX were designed to evaluate the accuracy of AMSR-E soil moisture data. Specific validation objectives included: assessing and refining soil moisture

algorithm performance; verifying soil moisture estimation accuracy; investigating the effects of vegetation, surface temperature, topography, and soil texture on soil moisture accuracy; and determining the regions that are particularly useful for AMSR-E soil moisture measurements.

1.3 Campaign Schedule

The AMSR-E Soil Moisture Validation campaign schedule is shown below.

- SMEX02: Iowa (US), 24 June - 15 July 2002
- SMEX03: Oklahoma, Georgia, Alabama (US): 23 June - 18 July 2003
- SMEX03: Brazil: 1 - 10 September 2003
- SMEX04 North American Monsoon Experiment (NAME):
  Mexico and Arizona: 15 July - 15 August 2004
- SMEX05: Iowa (US): 13 June – 4 July 2005

2 SOIL MOISTURE EXPERIMENT 2002 (SMEX02)

Measurements for the SMEX02 campaign were collected throughout the state of Iowa, USA. Figure 2 shows the team that worked on the SMEX02 regional watershed project and the SMEX02 Field Experiment Sites Maps (Section 2.1) display the regional distribution of all experiment sites throughout the state of Iowa, USA. The main objectives of the experiment were to: study land/atmosphere interactions and extend remote sensing observations and algorithms to more challenging vegetation conditions than previously studied; validate AMSR-E satellite brightness temperature and soil moisture measurement; and evaluate new instrument technologies for soil moisture remote sensing. For SMEX02 supporting data, collected from related NASA, NOAA, and NSF projects, visit the Southern Great Plains (SGP) and SMEX Data Archive at NCAR/EOL website.

Figure 2. The SMEX02 Regional Sampling Team in Iowa, USA.

2.1 Field Experiment Site Maps

The following, Figure 3 – Figure 9, show the regional distribution of all the SMEX02 field experiment sites

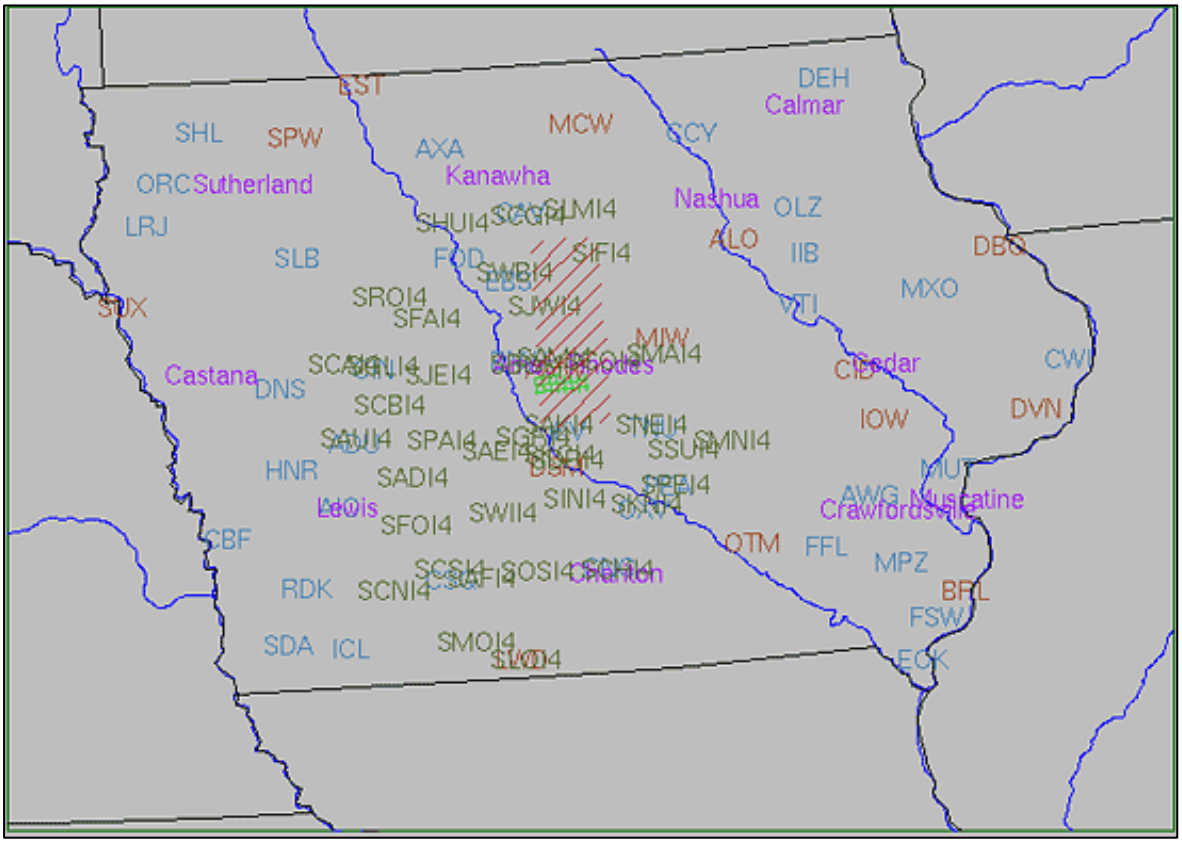

Figure 3. SMEX02 Field Experiment Sites, Iowa, USA

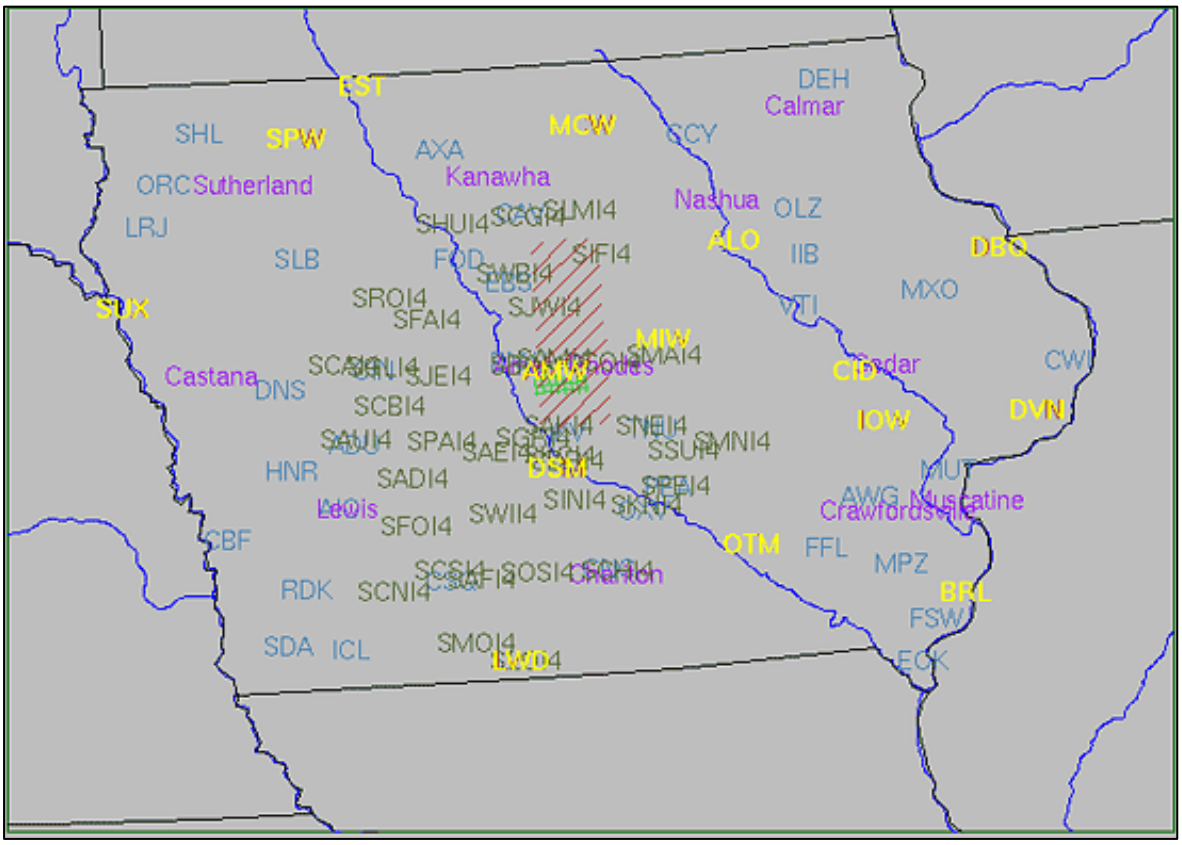

Figure 4. ASOS Stations: Automated Surface Observing System

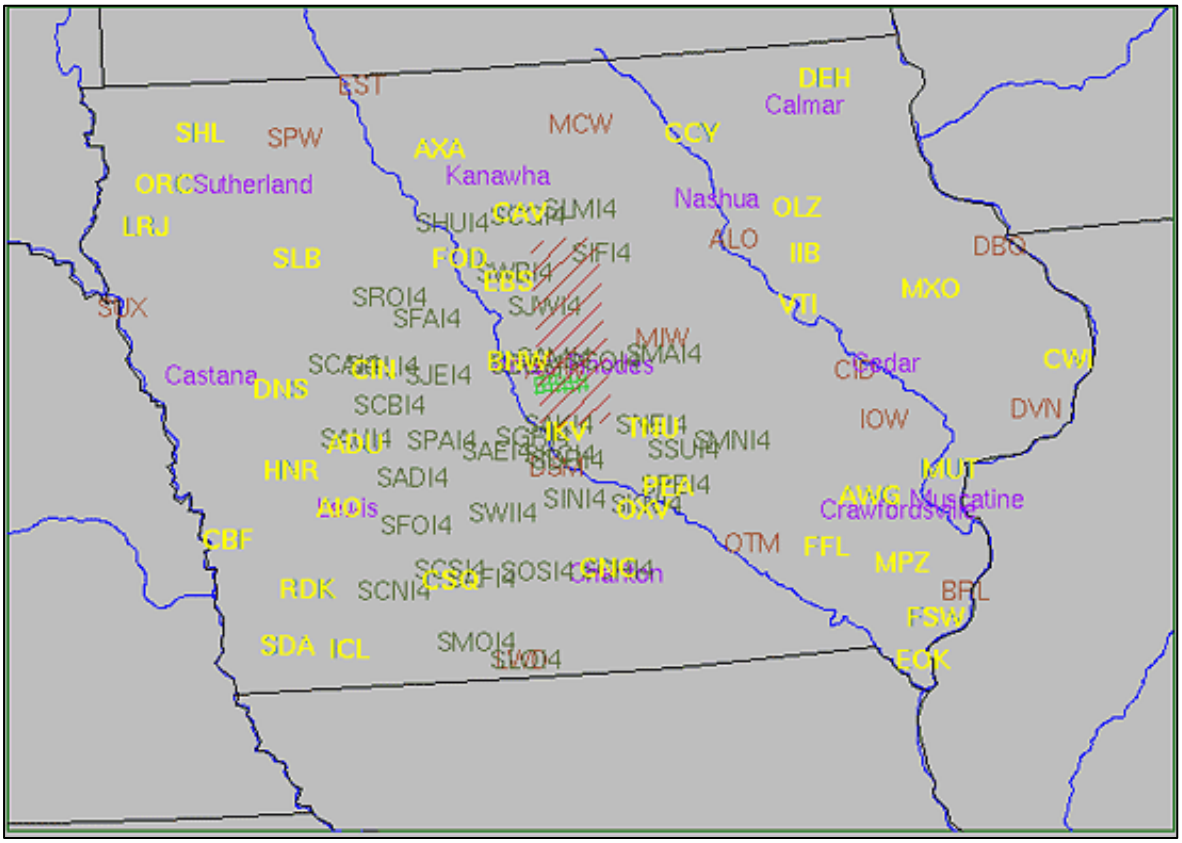

Figure 5. AWOS Stations: Automated Weather Observing System

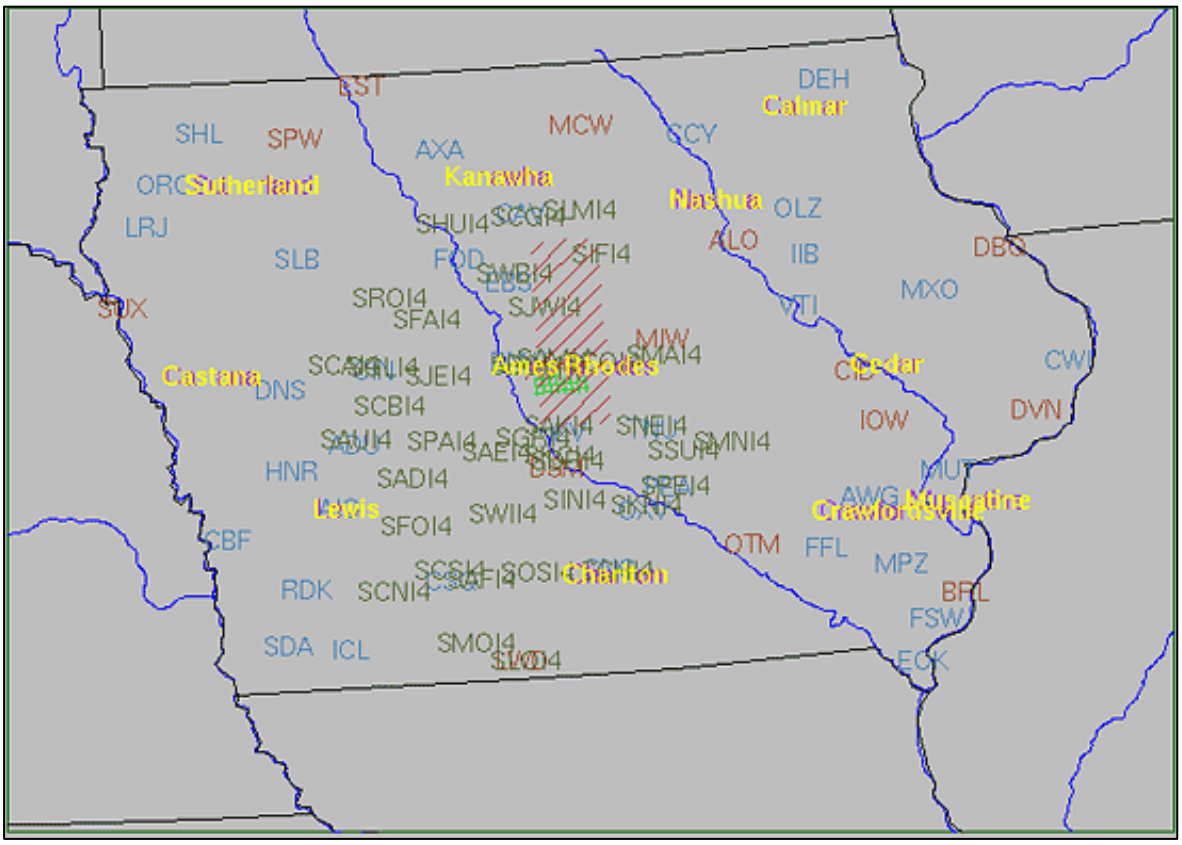

Figure 6. ISUW Stations: Iowa Agriculture Climate Network - Iowa State University Crop, Soil, and Environmental Sciences

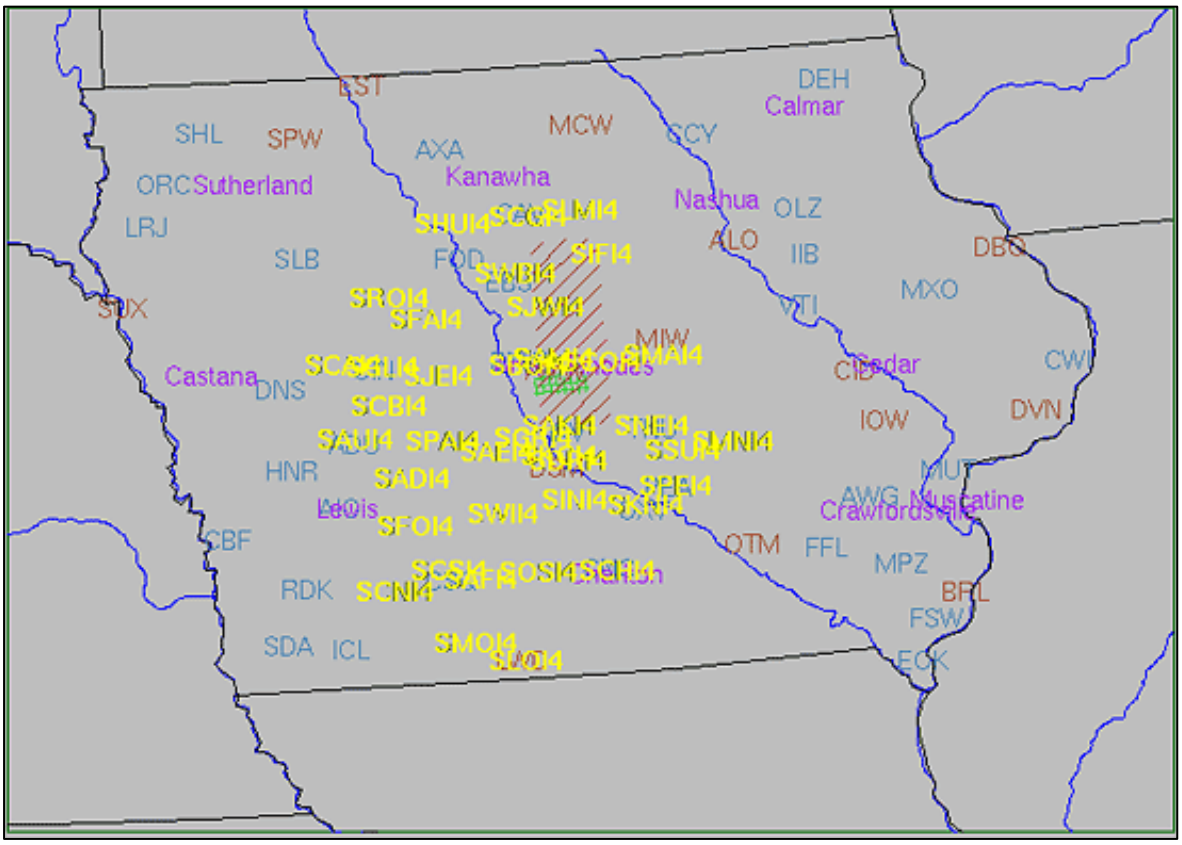

Figure 7. KCCI Stations: School Network for KCCI-TV located in Des Moines, Iowa, USA

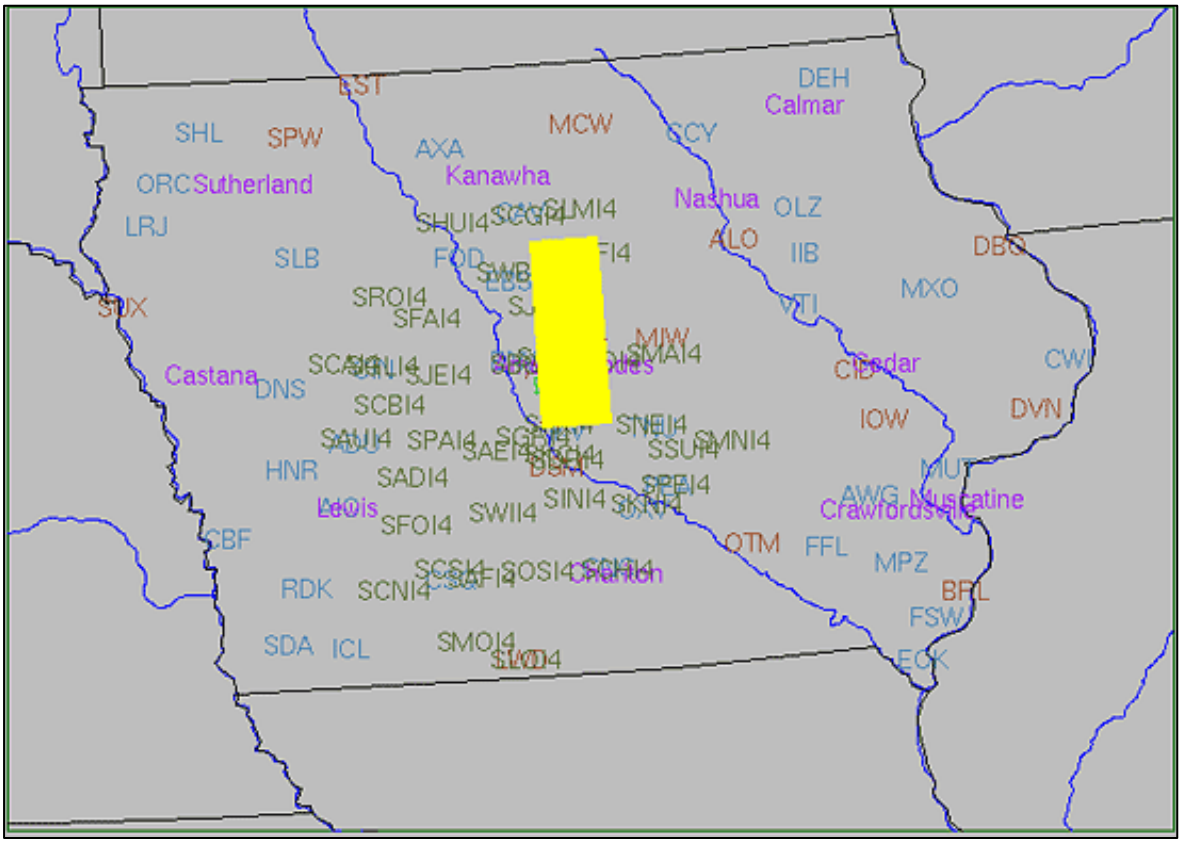

Figure 8. IA Field Region: SMEX02 Iowa Field Study Region (includes mostly crop-growing areas)

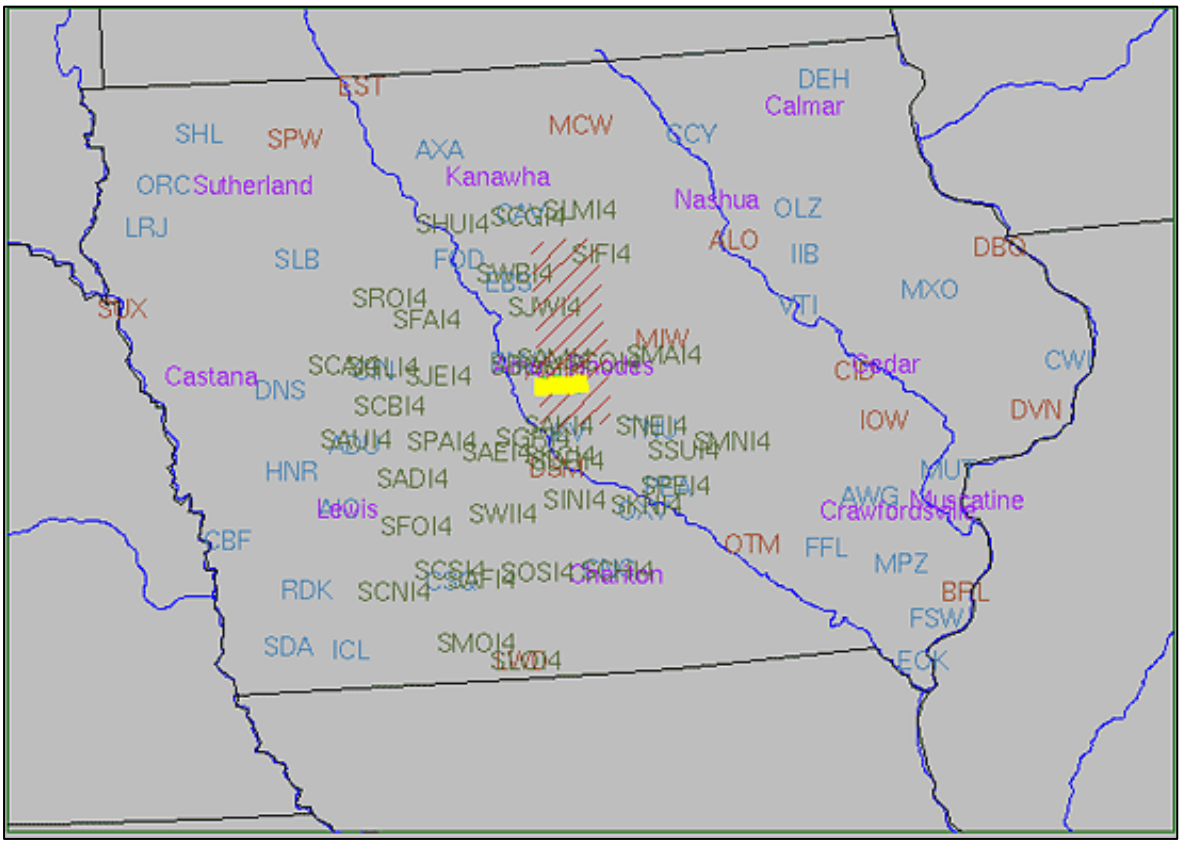

Figure 9. WC Field Region: Walnut Creek watershed study region

3 SOIL MOISTURE EXPERIMENT 2003 (SMEX03)

SMEX03 was a continuation of the SMEX02 work in different geographic areas. The SMEX03 campaign was carried out in Oklahoma, Georgia, and Alabama, USA between 23 June and 18 July 2003, and in Brazil during the first two weeks of December 2003. Figure 10 shows AMSR-E coverage (indicated by yellow circles) on 17 July 2003 while the field work was being done. The bright green areas in the image indicate the locations in situ field experiments.

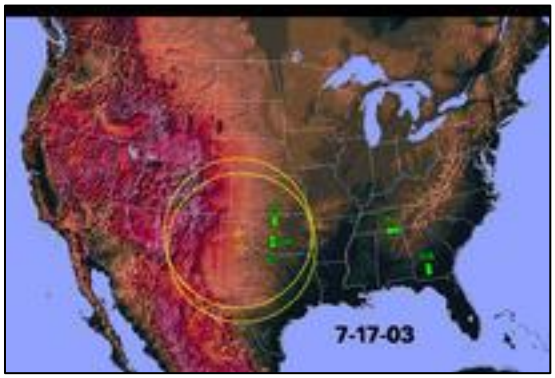

Figure 10. Approximate coverage of the AMSR-E instrument on 17 July 2003, as indicated by yellow circles. Bright green areas indicate in situ field experiments. Image courtesy of NSIDC.

Figure 11. The Georgia SMEX03 sampling team.

During SMEX03, teams of scientists, college students, and volunteers conducted soil moisture and temperature, ground cover type, and plant height measurements. In this way, students and volunteers gained both hands-on experience in field application research and soil sample analysis in the laboratory while benefitting the campaign.

In addition to the field work, SMEX03 included aircraft-based research that measured brightness temperatures. The field and airborne data were combined and used to validate data from the AMSR-E instrument. The photograph in Figure 12 shows one of the research aircraft, NASA's P-3B, a four-engine turboprop.

Figure 12. NASA's P-3B Turboprop Aircraft

For SMEX03 supporting data, collected from related NASA, NOAA, and NSF projects, visit the Southern Great Plains (SGP) and SMEX Data Archive at NCAR/EOL website.

4 SMEX04 NORTH AMERICAN MONSOON EXPERIMENT (NAME)

The parameters of the Soil Moisture Experiment 2004 (SMEX04) campaign were based on, and integrated with, the complimentary objectives of the North American Monsoon Experiment (NAME), namely the development and evaluation of remotely sensed land surface products for terrestrial hydrology.

One hypothesis of NAME was that soil moisture in the southwestern United States and northern Mexico is a land surface boundary condition that controls the onset and intensity of the North American Monsoon System (NAMS). Among the most important land surface boundary conditions that contribute to NAMS are surface wetness and temperature. Before the SMEX04-NAME campaign, however, few soil moisture observations had been conducted in the southwestern U.S. and none had been conducted in northern Mexico. In addition, precipitation measurements that could be used to derive estimates of surface wetness either did not exist or were inadequate.

As part of contemporary efforts to validate soil moisture products from the AMSR-E instrument, several watershed sites in the U.S. were established to provide continuous long-term observations of surface soil moisture and temperature. One such site was the Walnut Gulch Watershed near Tombstone, Arizona USA. For SMEX04-NAME, an in situ soil moisture network was also established in the Sonora region of Mexico. The SMEX04-NAME region encompassed heterogeneous topography and a variety of arid to semiarid surface conditions. The terrain between these regional study areas, from Tombstone, Arizona to Hermosillo, Mexico, varied from flat desert to mountains with elevations of more than 2500 meters. Owing to the relatively sparse vegetation of these study regions, as compared to other SMEX study regions, SMEX04-NAME provided ideal conditions under which to evaluate AMSR-E soil moisture products (Remote Sensing of Environment 2008). For example, Cosh et al. addressed soil moisture network validation and concluded that the SMEX04-NAME network provided highly accurate (approximately 0.01 m’/m’) estimates of the watershed average.

In addition to SMEX04-NAME data, additional measurements of soil moisture and associated parameters are available at the Southwest Research Center's (SWRC) web site. These complimentary data inform continued NAME science investigations and built upon our understanding of important land surface features and how new technologies benefit soil moisture mapping.

The photographs in Figures 13 and 13 show members of the Arizona Walnut Gulch sampling team and the United States Department of Agriculture (USDA) Soil Climate Analysis Network (SCAN) site at Lucky Hills, Arizona USA. Figures 15 and 16 are Landsat 5 images showing the Arizona Walnut Gulch and Mexico Sonora regional study areas.

Figure 13. Natural Resources Conservation Services (NRCS) Walnut Gulch SCAN site in Arizona, USA.

Figure 14. Arizona Walnut Gulch Sampling Team at the Tombstone Laboratory

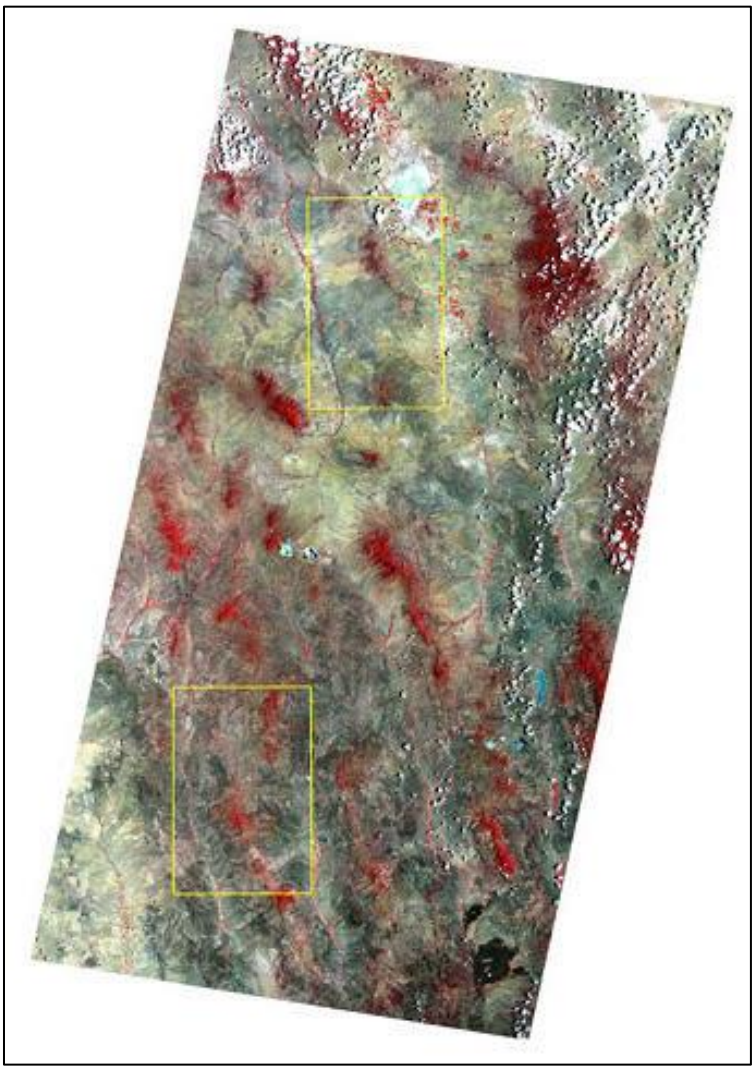

Figure 15. SMEX04-NAME Study Regions False color Landsat 5 image from 08 June 1997. The yellow boxes indicate the SMEX04-NAME regional study areas; the top box indicates Arizona Walnut Gulch Region and the bottom box indicates the Mexico Sonora Region. Image courtesy of the USDA Hydrology & Remote Sensing Laboratory.

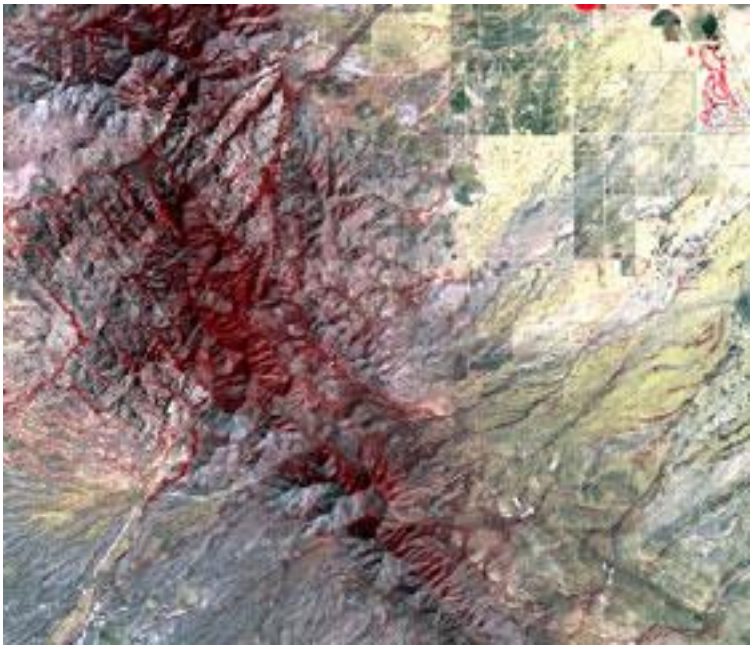

Figure 16. SMEX04 false color image developed from Landsat 5 Thematic Mapper (TM) data for studying land cover features. Shades of red indicate vegetation in southern Arizona, USA on 11 June 2004.

For the NAME data archive, visit the NAME Data Archive at NCAR/EOL. For SMEX04 supporting data sets collected from related NASA, NOAA, and NSF projects, visit the Southern Great Plains (SGP) and SMEX Data Archive at NCAR/EOL.

5 SMEX05 POLARIMETRY LAND EXPERIMENT (POLEX)

Soil moisture experiments conducted in 2005 (SMEX05) were part of a campaign called POLEX, or the Polarimetry Land Experiment. Based in Ames, Iowa USA, POLEX measurements were collected from 15 June to 3 July 2005. The experiment was intended to address algorithm development and validation related to all current and scheduled soil moisture satellite systems. Specific objectives included the following:

- Exploration of unique polarimetric information from satellites such as Windsat and CMIS for soil moisture with supporting aircraft instrumentation
- Diurnal effects associated with soil, vegetation and atmosphere at the 6 a.m. to 6 p.m. observing times of Hydros, SMOS, CMIS, and Windsat
- Enhancement of Aqua AMSR-E soil moisture validation
- Statistics and mitigation of radio frequency interference (RFI) for CMIS risk reduction

Of these objectives, polarimetric microwave studies were the primary driver for experiment design. POLEX was the first campaign designed to study the unique and unexplored information that can

be extracted for land applications using fully polarimetric observations. The Airborne Polarimetric Microwave Imaging Radiometer (APMIR), an aircraft simulator of WindSat and CMIS, facilitated replicate observations of a range of landscape features. In addition, with APMIR sub-band and emitter database, collected regional RFI statistics further evaluated the sensor capability in terms of RFI mitigation and its benefit in improving soil moisture retrieval performance. Many satellites, including WindSat, CMIS, SMOS, and Hydros, share the same diurnal observation characteristics (such as 6 a.m. to 6 p.m. coverage). Efforts during SMEX05 to focus on this timeframe offered the opportunity to understand phenomena that may be specific to these observing times. Of particular interest was the effect of dew on microwave brightness temperatures (Jackson and Moy 1999).

Figure 17. SMEX05 Images and Artist Renderings. Graphic Courtesy of USDA.

All ground and aircraft observations supported the soil moisture algorithm validation of Aqua AMSR-E. WindSat was transitioned to CMIS on the NPOESS operational platforms and AMSR to the Japanese GCOM satellites. All efforts in SMEX05 POLEX contributed to these programs.

6 RELATED WEBSITES

- AMSR-E/Aqua Data
- AMSR-E Instrument Description
- NAME Project Site at UCAR/EOL
- NRCS Soil Climate Analysis Network (SCAN)
- Southern Great Plains (SGP) and SMEX Project Supporting Data Archive
- SWRC Online Data Access
- USDA SMEX02 Web Site
- USDA SMEX03 Web Site

7 DOCUMENT INFORMATION

7.1 Publication Date

15 January 2015

7.2 Date Last Updated

01 March 2021