U.S. Climate Reference Network Soil Moisture / Soil Temperature Observations for Drought Monitoring

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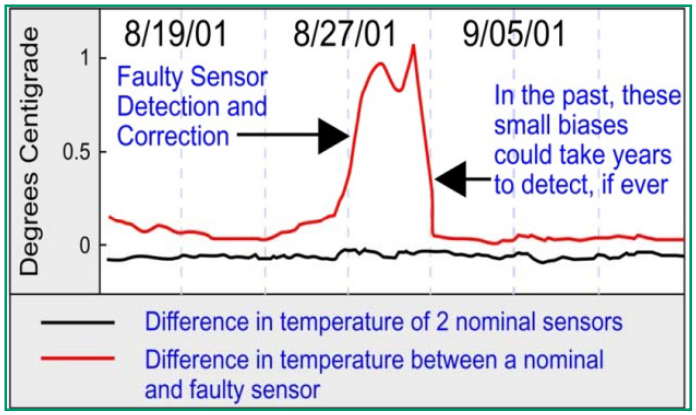
USCRN Goals

- Making science quality climate observations adhering to the Ten Climate Monitoring Principles of GCOS, NRC/NAS, and CCSP
- Serving as a reference standard for other networks, while evaluating new technology
- Leveraging USCRN knowledge and infrastructure to support new missions

The Basics: How USCRN Works

Primary variables are measured with triplicate configurations that allow for intercomparisons:

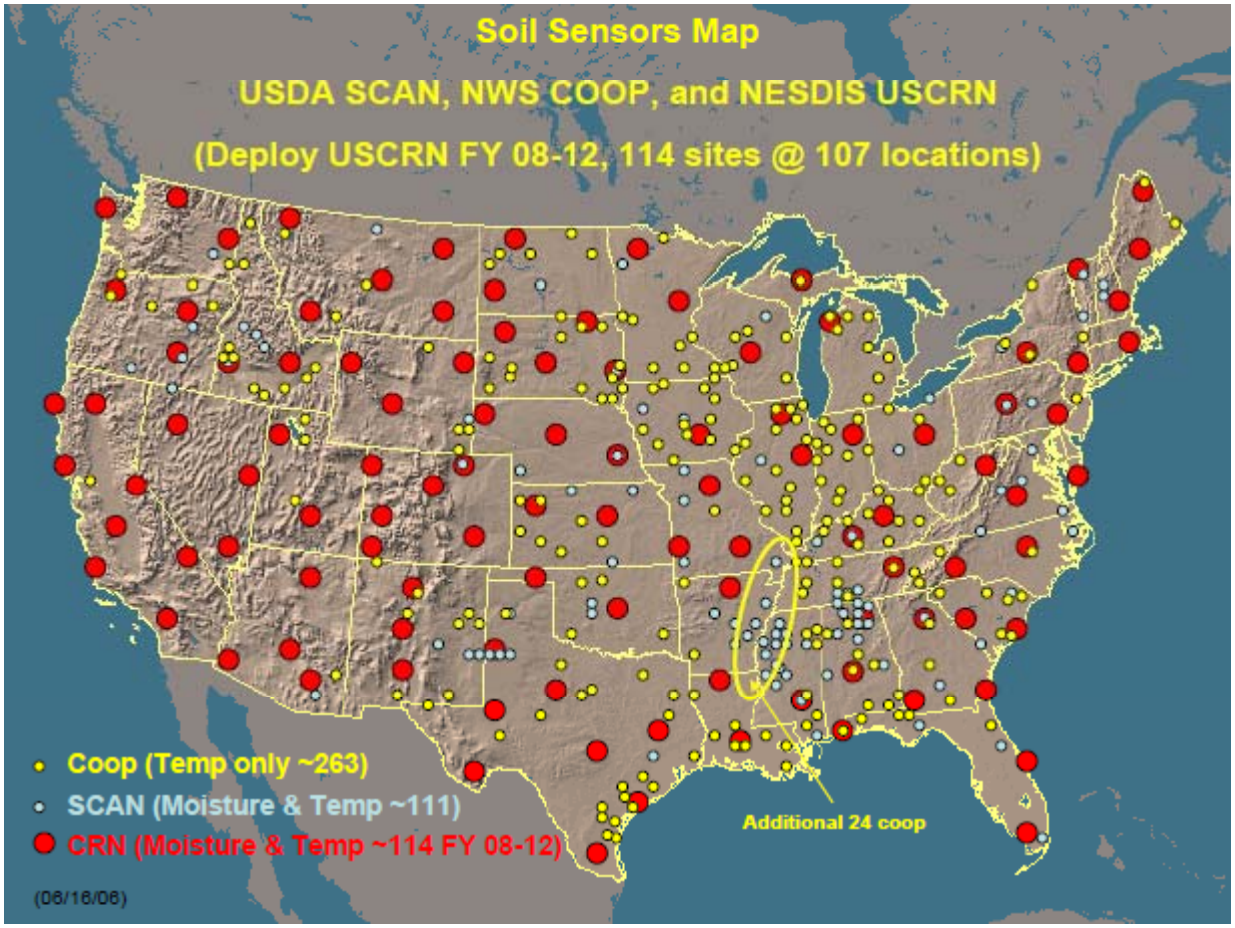
- 3 PRTs measure T
- 3 wires measure P



New Directions for USCRN

- Build out the USCRN in Alaska over the next 5 years and collaborate with GCOS in placing instruments in underrepresented areas
- Assist the US Historical Climatology Network – Modernization Program by leveraging the USCRN experience and infrastructure
- Deploy soil moisture / temperature probes and RH instruments across the USCRN network in cooperation with the National Integrated Drought Information System (NIDIS) program

USCRN Locations Compared to USDA SCAN SM/ST and NWS COOP ST



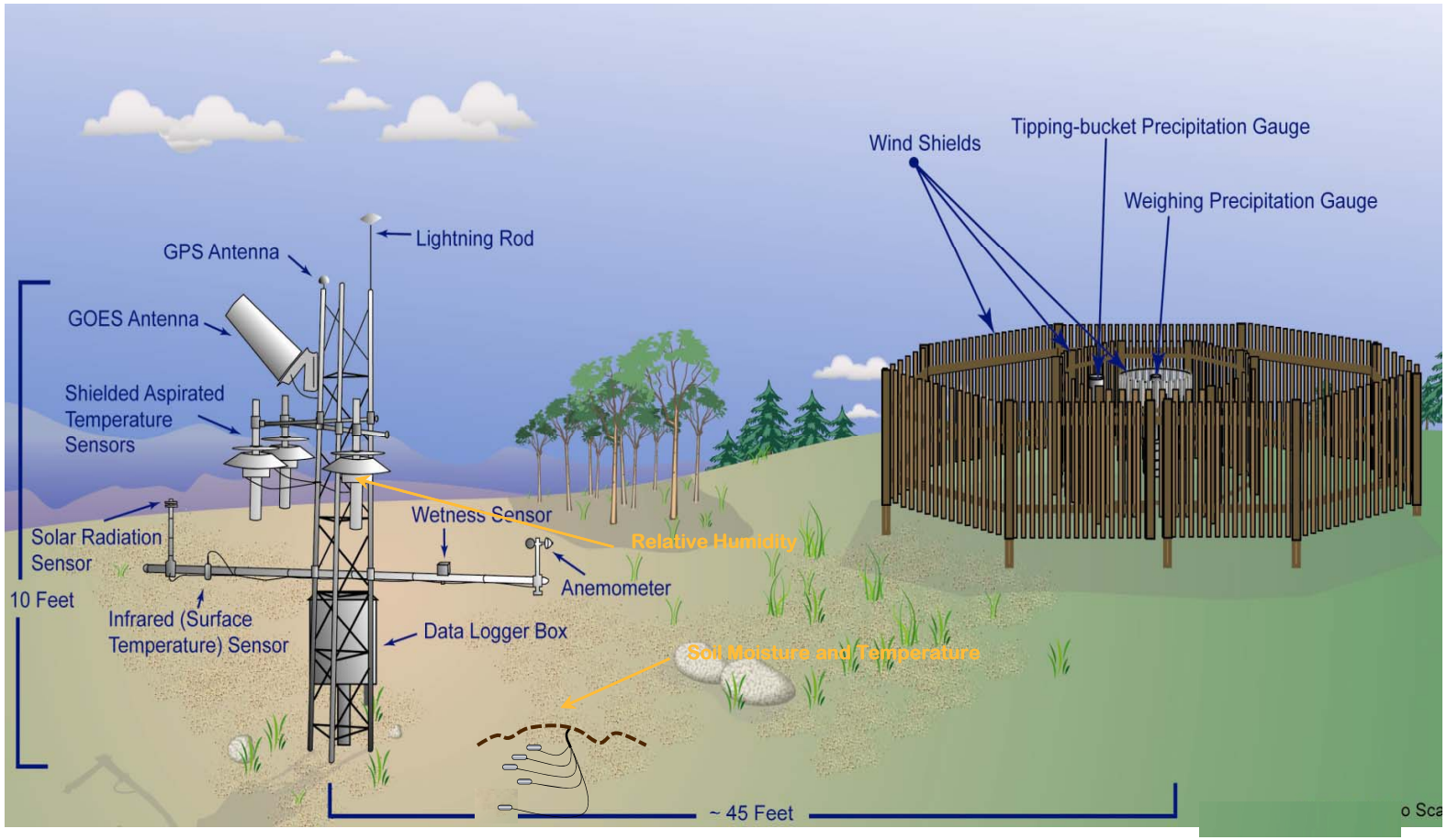
USCRN Soil Moisture/Temperature

- Advantages
  - Existing infrastructure
  - Base funding
  - National distribution
- Disadvantages
  - Lack of experience
  - Coarse spatial resolution
  - Fixed locations

Joint NIDIS Knowledge Assessment - USCRN Soil Moisture and Temperature Observations and Applications Workshop

- Workshop on March 3-5, 2009, brought together 25 national experts on soil climate measurements and their applications
- Extensive input received, altering draft deployment plans
- Critical advice:
  - Placement of three separate sets of SM/ST probes in three plots around each station location
  - Selection of 5, 10, 20, 50, 100 cm depth levels
  - Installation procedures
  - Temporal sampling and quality control
  - Identification of soil sampling and soil metadata needs
  - Involvement in community testbeds and satellite cal/val

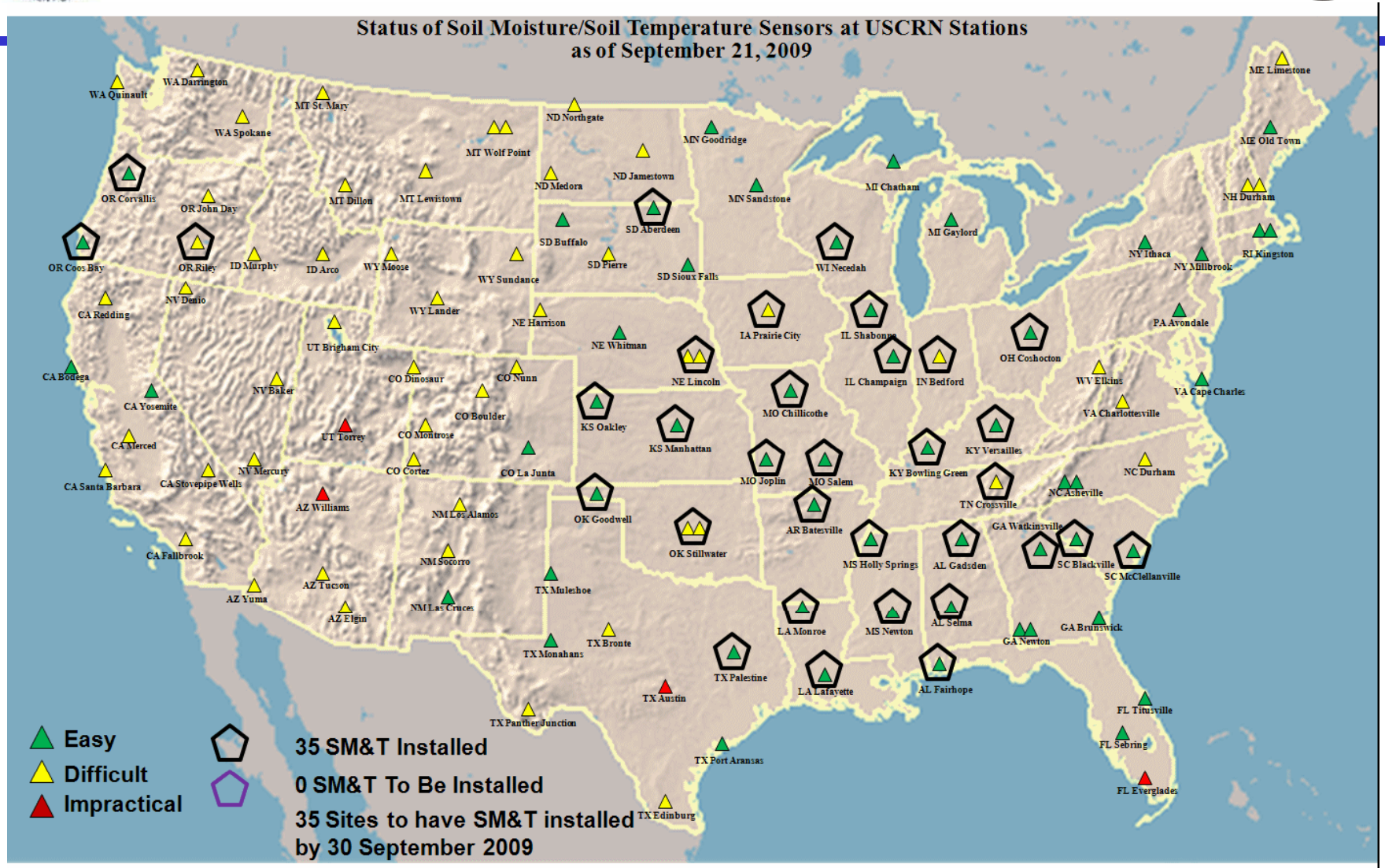
CRN Station Model



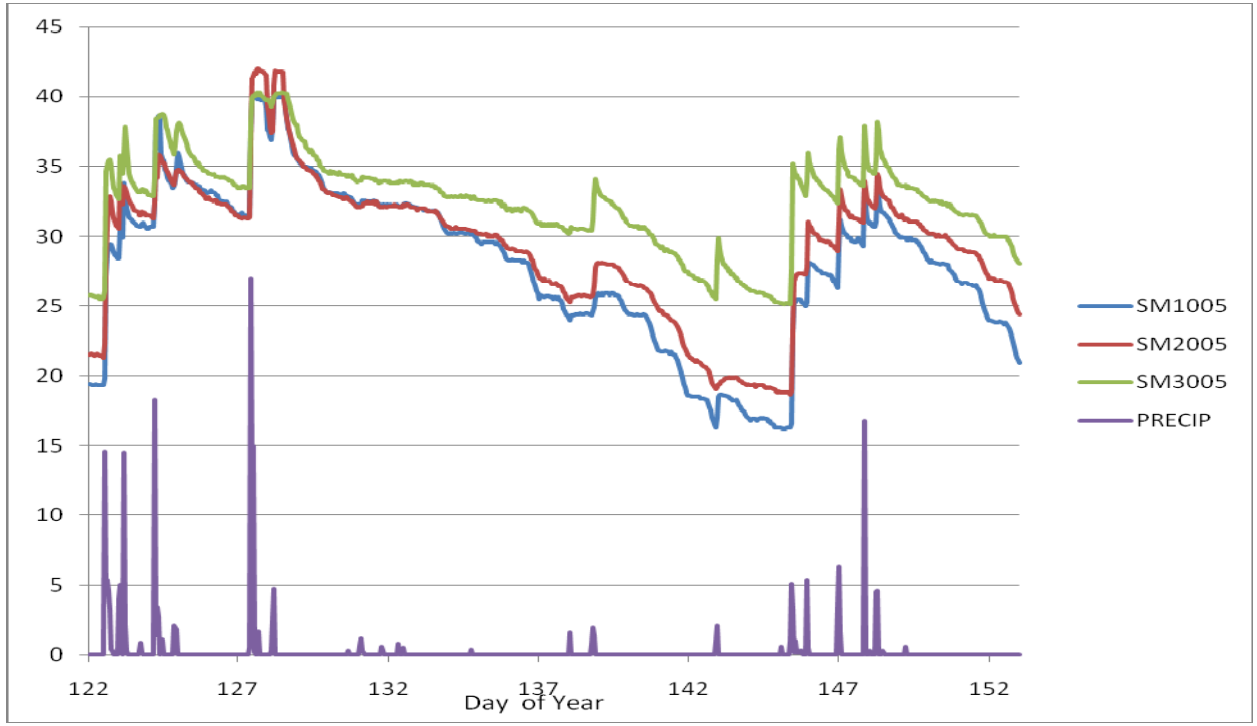
Crossville, TN, first official USCRN installation of soil probes, April 2009

- Engineering, installation, and maintenance by USCRN partners at the Atmospheric Turbulence and Diffusion Division, NOAA/OAR/ARL.

Installation Progress to Date

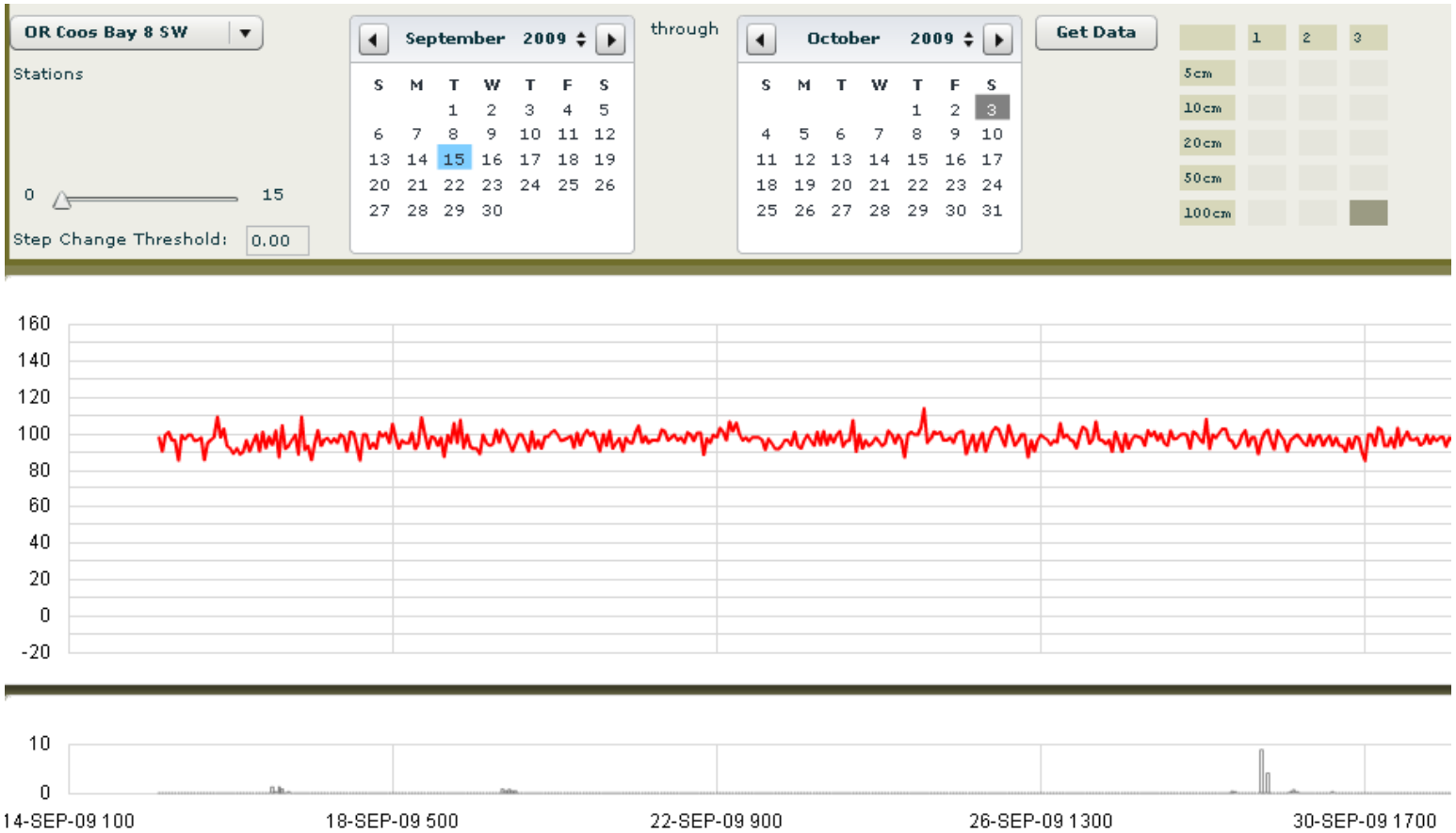


QC Issues – Variability Between Plots



- Even within a 7 meter distance, soil characteristics vary
- Between sensor comparison is not straightforward, and will not be part of initial QC suite

QC Issues – Salinity and high cation exchange clay



- The selected probe model does not yield correct soil moisture in soils with high salinity or cation exchange

Working on the QA/QC Suite: First Generation by end of Calendar 2009

- Identify correctly functioning soil probes; flag incorrectly functioning probes
- Develop first generation QC tests
  - Range checks
    - Moisture: Soil porosity plus a buffer
    - Temperature: Climate extreme expectations and equipment limits
  - Spike tests and step tests
  - Freezing condition (SM only)
  - Runs of constant values
- Calculate representative layer values – Simple mean of plots where QC has been passed

Working on the QA/QC Suite: Second Generation by end of FY 2010

- Automate notification to engineers of malfunctions
- Develop second generation QC tests
  - Intercomparisons with precipitation timing
  - Evolution of state by vertical layer
  - Between-plot comparisons
- Calculate representative layer values – Complex methods for weighting and combining 3 plot observations into a layer value for each station
- Evaluate simple soil moisture/soil temperature models for observation QC
- Determine the utility of between-plot variance as a new variable for input to soil modeling and cal/val

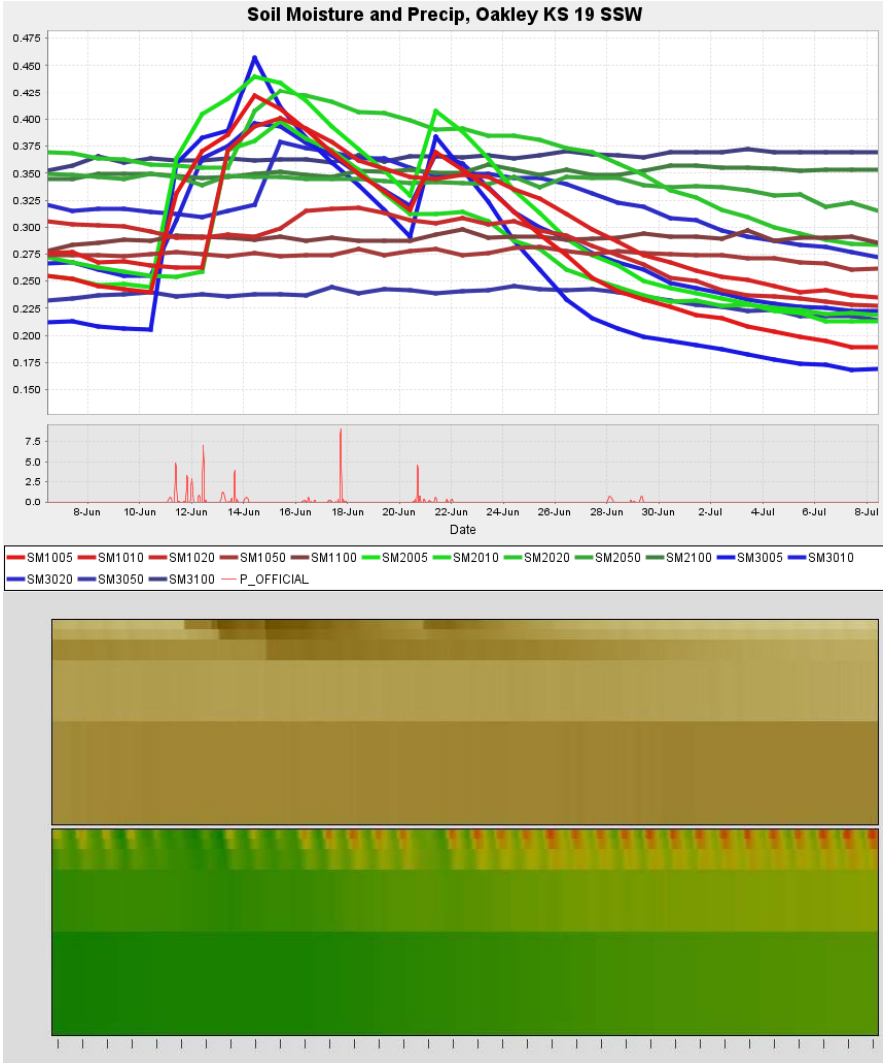
Data Types

- Raw data: 3 plots x 5 levels soil dielectric and soil temperature with a simple flag (good = 0; bad = 1) [These data will not initially be available except by request to USCRN program]
- Calculated volumetric water content for 3 plots x 5 levels (will be set missing if associated dielectric is flagged) [These data will not initially be available except by request to USCRN program]
- Calculated layer average temperature (°C) and soil moisture (volumetric water content) for each of 5 levels (will be set missing if all layer observations are flagged) [Available on Web site and ftp site initially]

Data Access

- USCRN Web Site – Early December 2009
  - Calculated Level Data – Hourly and Daily
  - Some data visualization capabilities
  - http://www.ncdc.noaa.gov/crn/
- U.S. Drought Portal – Mid December 2009
  - http://www.drought.gov/
- The Data.gov Portal – Late December 2009
  - http://www.data.gov/

Data Visualization

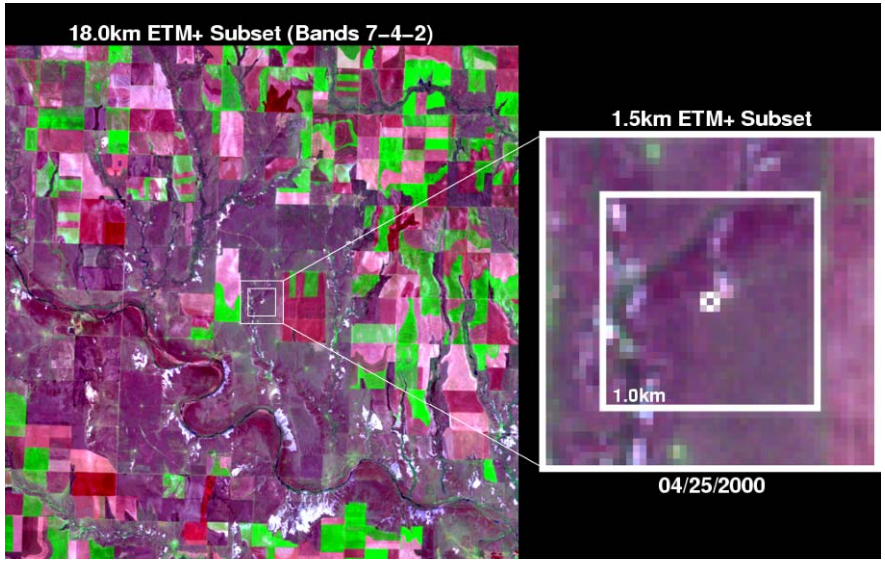


- Build data maps and visualizations for complicated variable sets
- Use visualization in evaluating QC

Satellite Calibration/Validation

- USCRN has been cooperating with satellite climatology efforts, including the SMAP soil moisture testbed and SMAP calibration/validation and applications workshops
- Areal heterogeneity and station representativeness studies have begun to support this effort

KS_Oakley_19_SSW: Homogeneous Grass



USCRN: Meeting the Needs of Climate Stakeholders in the United States With New Soil Measurements

- Accurate, real time, climate science quality observations of temperature, precipitation, and soil moisture/temperature
- Unique triplicate measurement approach
- Primary climate change detection mission continues
- Operational mission expands (weather prediction, drought monitoring, agriculture, horticulture)
- Science mission expands (satellite calibration/validation, soil moisture modeling, soil moisture/temperature trend detection)

http://www.ncdc.noaa.gov/oa/climate/uscrn/