SMAP Algorithms and Cal/Val Workshop

Oxnard, CA, USA

June 9-11, 2009

SMAP Core Validation Site Design

SMAP Core Validation Site Design

- Establishing Core sites
- Design
- Requirements
- Considerations
- Timeline
- Combine SM and FT?

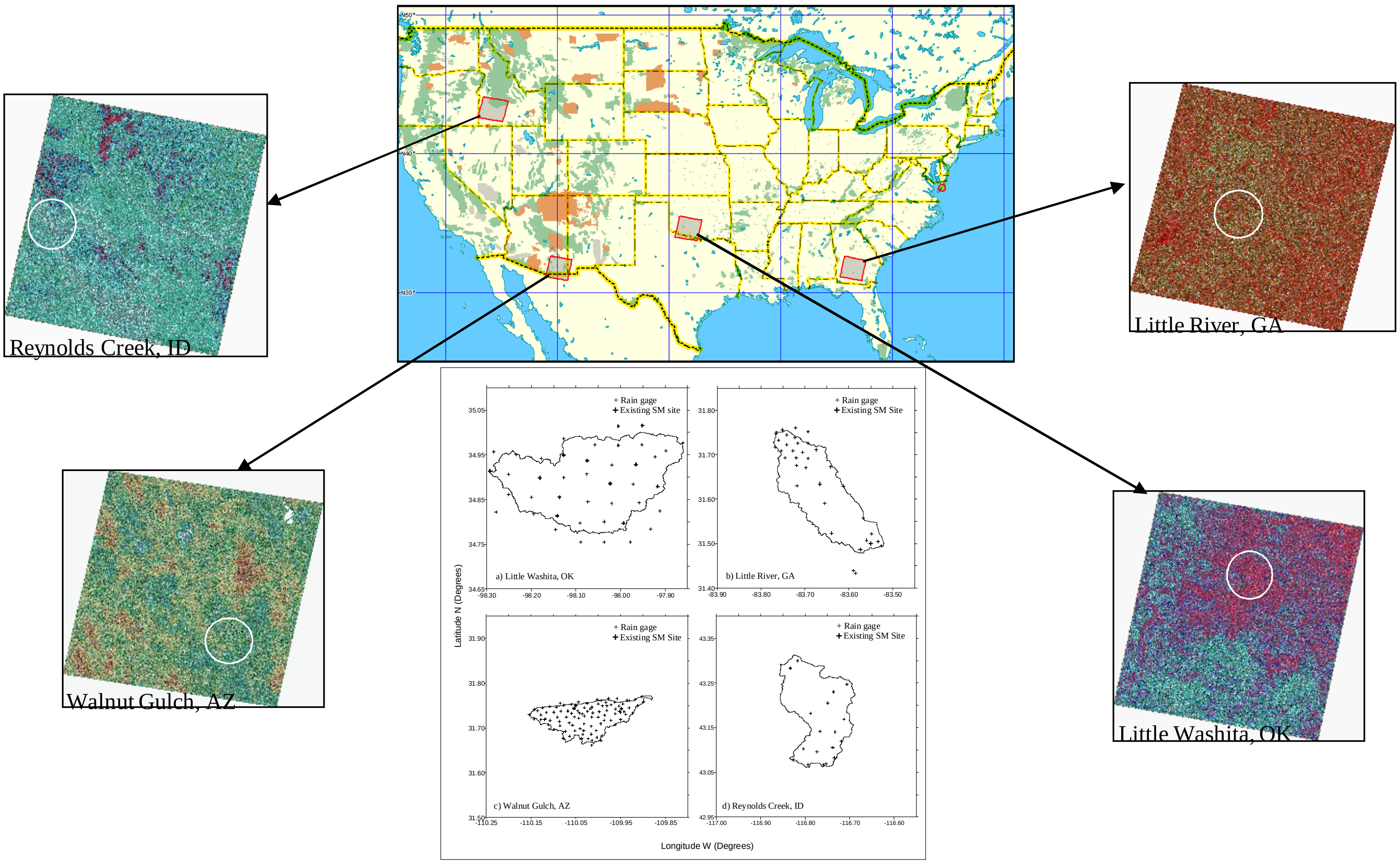
Core Site Definition

- A network of sensors with adequate replication
- Three nested levels of extent (3, 9, and 36 km)
- Sensor and scaling verified using gravimetric method
- Infrastructure support through 2016
- Formal arrangement with the SMAP project

SMAP Core Validation Site Design

- Establishing Core sites
  - -Infrastructure
    - •US
    - •Formal mission partners
  - -Regional representation
  - -Geographic/climate diversity
  - -How many?
- Design
- Requirements
- Considerations
- Timeline

Example: AMSR-E U.S. Soil Moisture Validation Sites

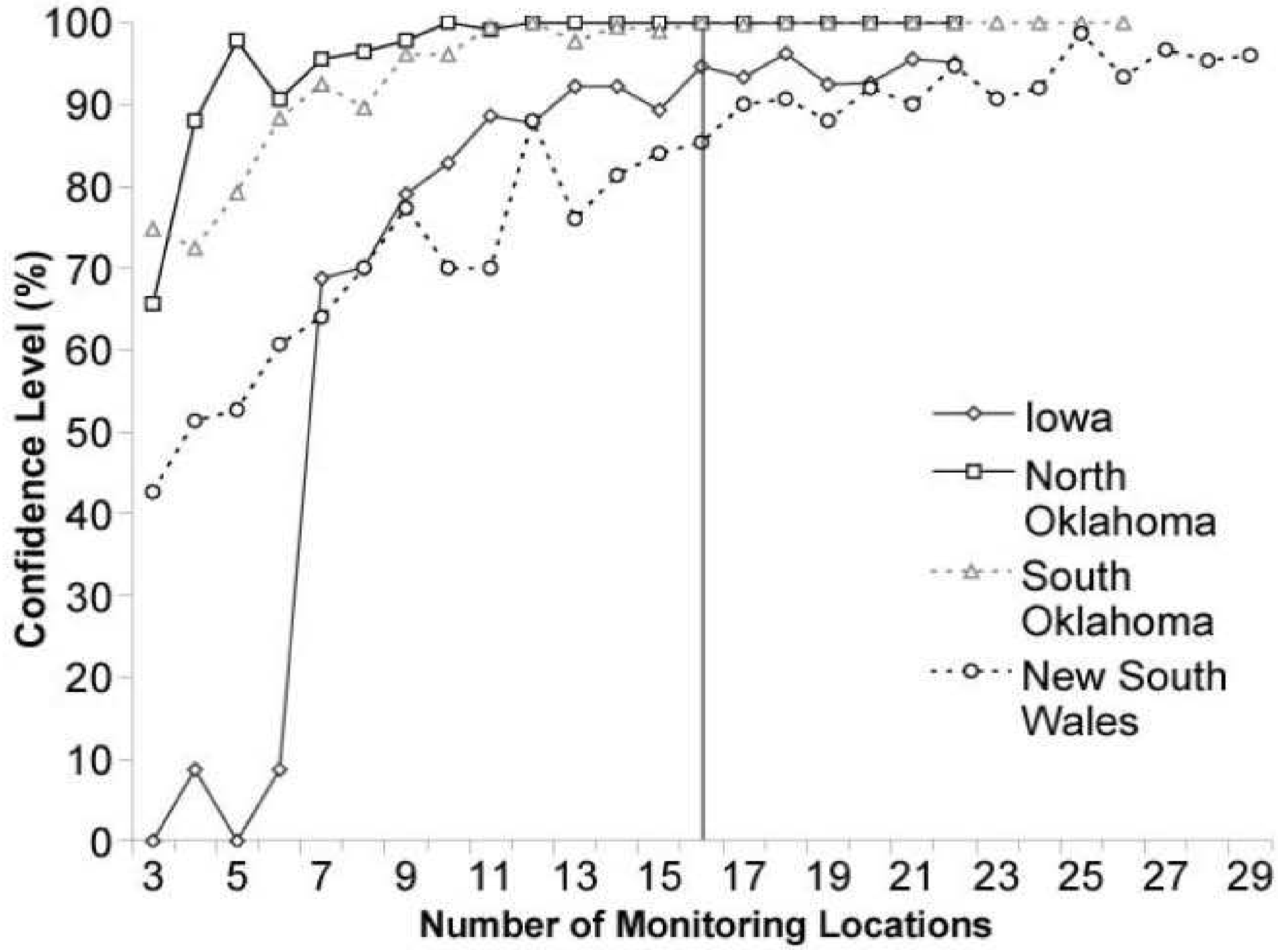


SMAP Core Validation Site Design

- Establishing Core sites
- Design
  - -Replication
  - -Multiple/nested scales (3, 9, 36 km?)
  - -Grids and products
- Requirements
- Considerations
- Timeline

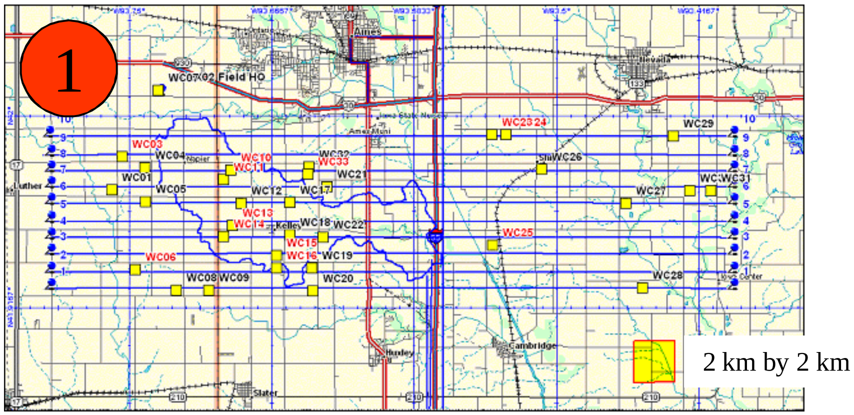
Development of Paired Soil Moisture Sampling Networks for Satellite and Model Validation

How Many Sensors?

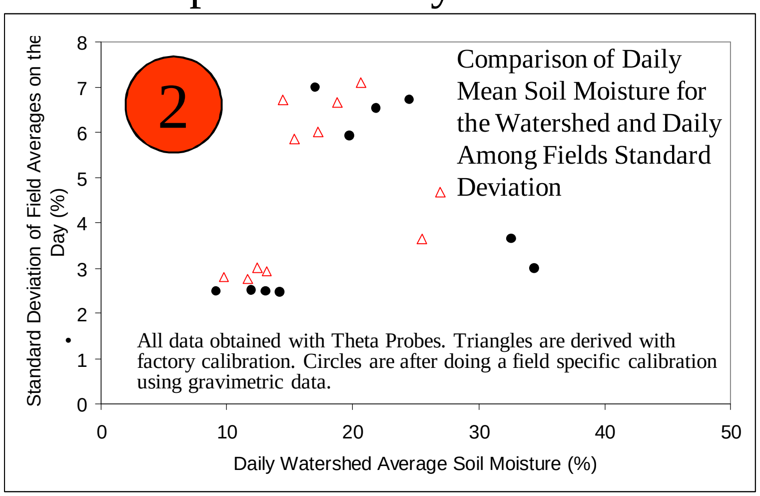


Source: A. Berg

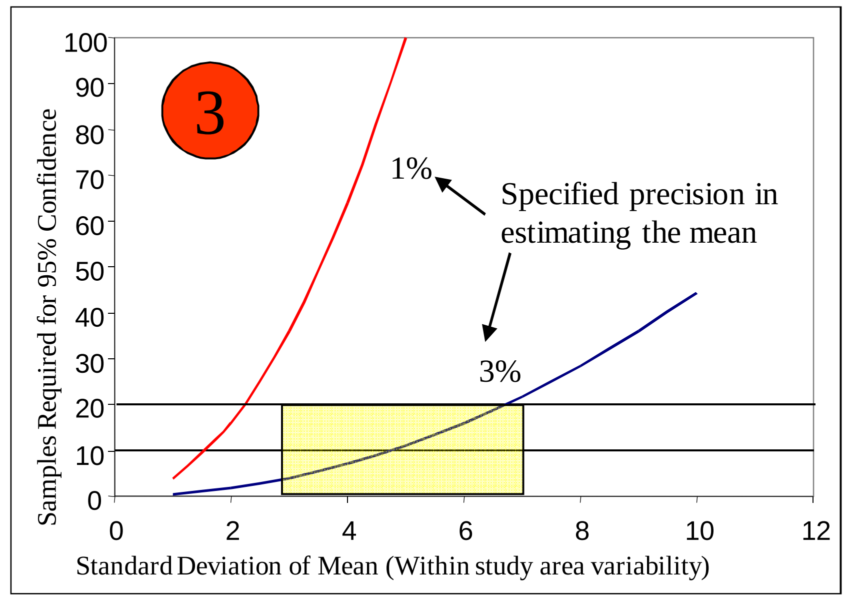
Example: Characterizing the Walnut Creek Watershed Area in SMEX02



Yellow squares (~31) indicate intensive soil moisture sampling sites with 14 points sampled each day.



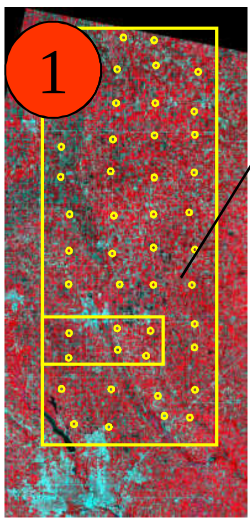
For simple random sampling with data from an approximately normal distribution, a 95% confidence interval on the mean with width 2δ requires $N=4\sigma^2/\delta^2$



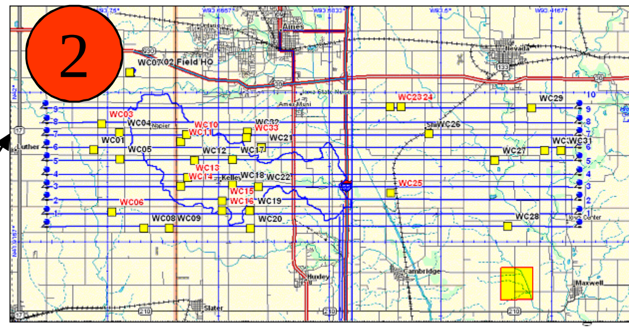
If we specify that the expected standard deviation is (3-7)% then it is a matter of deciding on the precision.

Example: Are 6 Points Enough? Regional Sampling Strategy in SMEX02

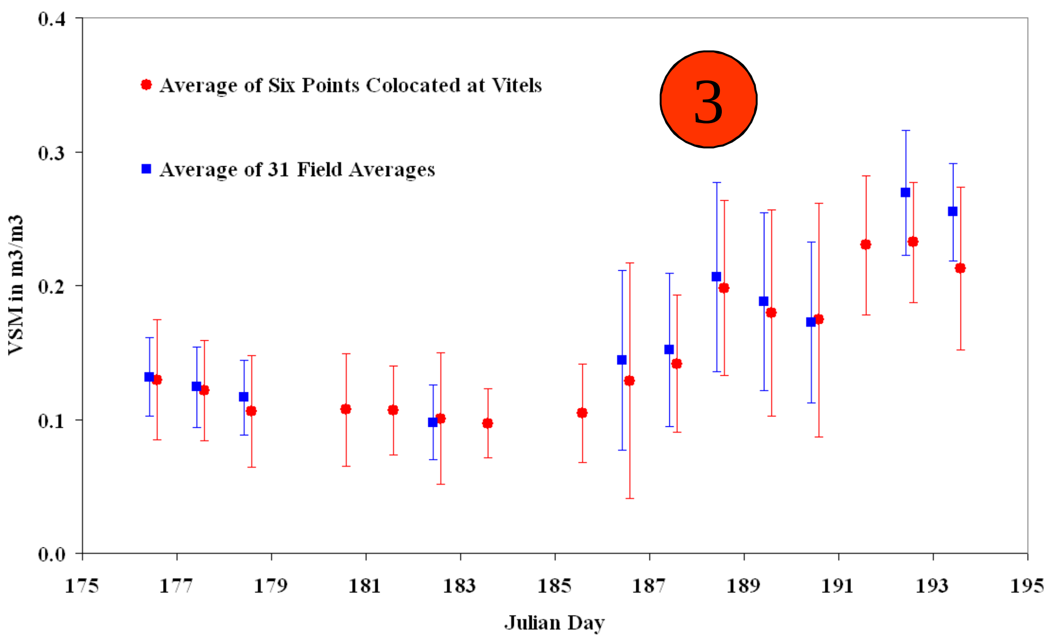
SMEX02 Regional Study Area (50 km by 150 km)



SMEX02 Watershed Study Area



How well do the 6 regional sites (1) point per site compare to the average of 31 watershed sites with (14) points per site?



When computing the average over the area, little is gained by extensive replication within individual sites or by many sites.

SMAP Core Validation Site Design

- Establishing Core sites
- Design

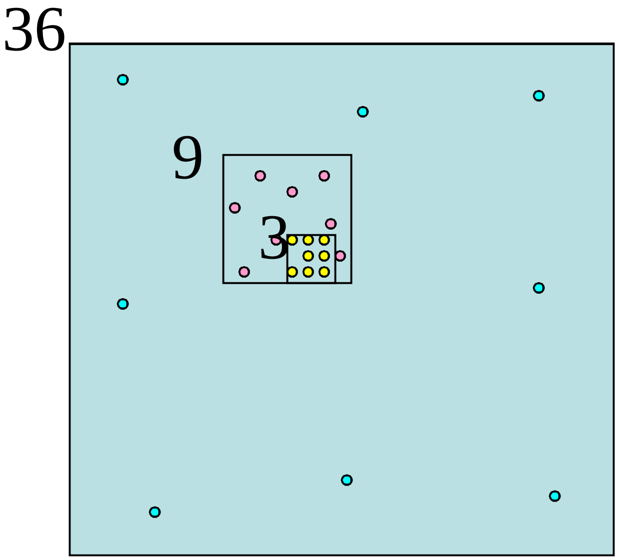
  -Replication: More than 1! *How many depends upon variability and precision. Considering costs and logistics, 6-9 may be a reasonable* ***minimum****.*

  -Multiple/nested scales (3, 9, 36 km?)

  -Grids and products
- Requirements
- Considerations
- Timeline

SMAP Core Validation Site Design

- Establishing Core sites
- Design
  - -Replication
  - -Multiple/nested scales (3, 9, 36 km?)
  - -Grids and products
- Requirements
- Considerations
- Timeline



SMAP Core Validation Site Design

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  - -Replication
  - -Multiple/nested scales (3, 9, 36 km?)
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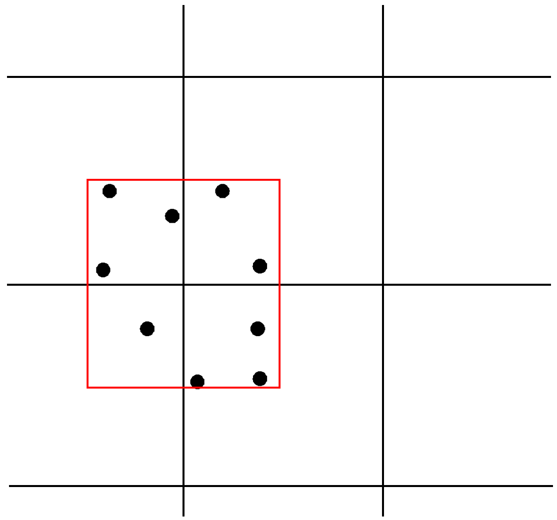
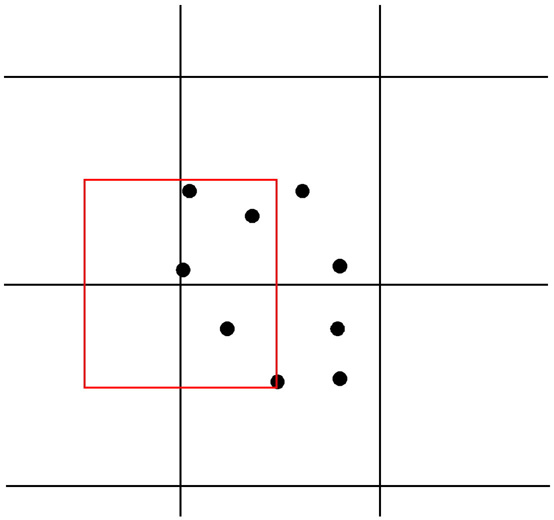


SMAP Core Validation Site Design

- Establishing Core sites
- Design
  - -Replication
  - -Multiple/nested scales (3, 9, 36 km?)
  - -Grids and products
- Requirements
- Considerations
- Timeline



For validation, should we know the grid before we initiate new sites and start to scale existing networks?

SMAP Core Validation Site Design

- Establishing Core sites
- Design
- Requirements
  - -Verified estimate (gravimetric standard) of the 0-5 cm soil moisture and temperature
  - -Verified estimate of the 0-100 cm soil moisture
  - -Near real time
  - -All data available to the validation team
- Considerations
- Timeline

SMAP Core Validation Site Design

- Establishing Core sites
- Design
- Requirements
- Considerations
  - -Co-location with other networks
  - -Measurement testbed
- Timeline

SMAP Core Validation Site Design

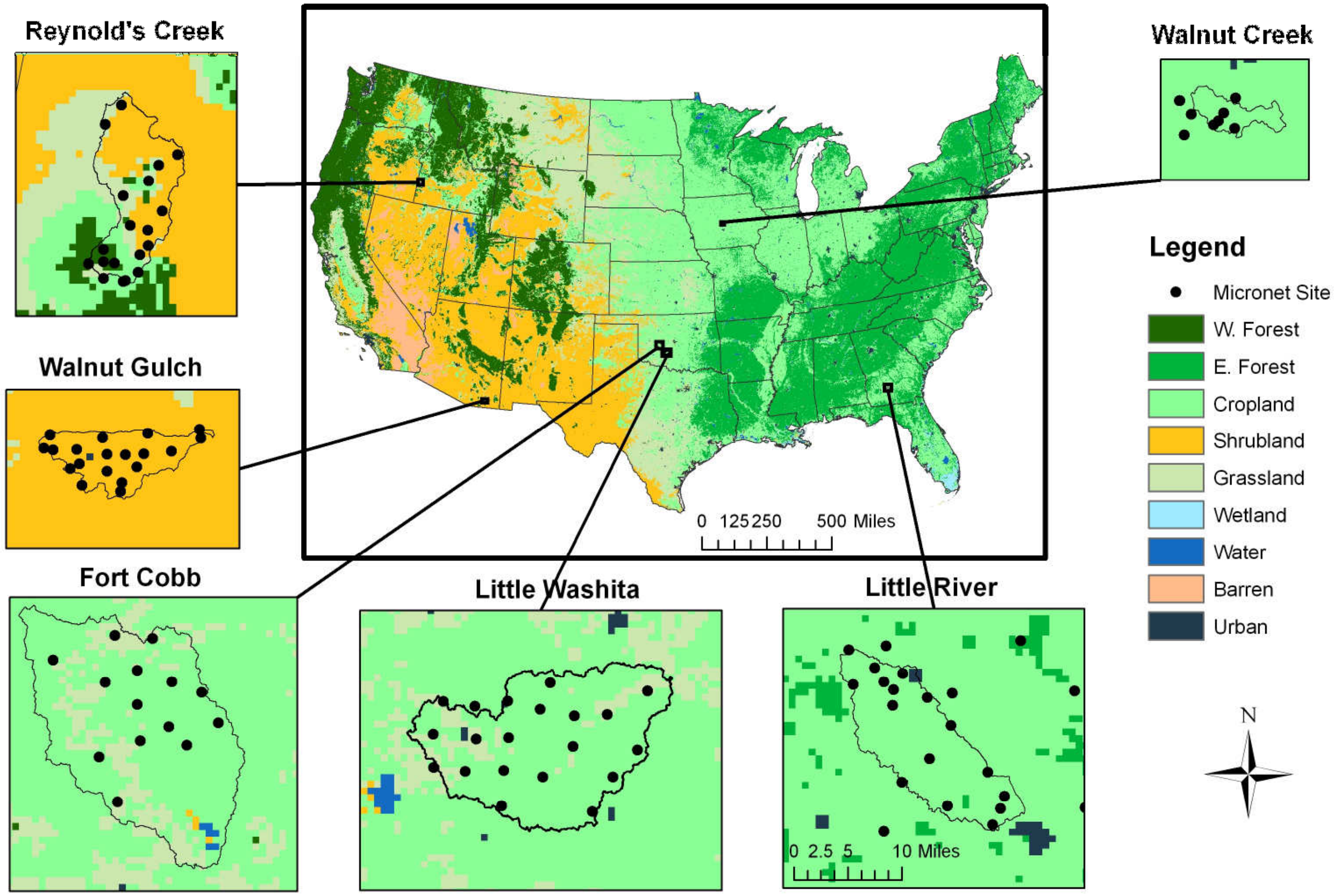
- Establishing Core sites
- Design
- Requirements
- Considerations
- Timeline
  - -June 2010: 40 km scale established for all sites
  - -June 2010: SMAPVEX site(s) fully instrumented
  - -Fall 2012: All installations verified

SMAP Core Validation Site Design

- Establishing Core sites
- Design
- Requirements
- Considerations
- Timeline
- Other?
- Candidates?

Possible Core Sites for SM

ARS Watersheds



SMAP L3_F/T & L4_C Cal/Val Optimal Validation Site

Cal/Val activities address algorithm accuracy requirements

L3_F/T:

Obtain measurements of binary F/T transitions in boreal (≥45N) zones with ≥80% spatial classification accuracy (baseline); capture F/T constraints of boreal C fluxes consistent with tower flux measurements.

L4_Carbon:

Obtain estimates of land-atmosphere CO_2 exchange (NEE) at accuracy level commensurate with tower based CO_2 Obs. (RMSE ≤ 30 g C m^{-2} yr^{-1}).

Priorities for L3_F/T & L4_C Cal/Val

Pre-launch:

- Define domain & conditions where products meet accuracy requirements;
- Define candidate sites, tradeoffs for product validation;
- Final selection, justification of baseline algorithms;
- Define L-band dB reference states & temporal stability over product domain for L3_F/T algorithm implementation;
- Calibrate L4_C algorithm parameters;

Post-launch:

- Product validation relative to accuracy requirements;
- Re-calibrate & define model parameters & reference states using SMAP inputs;
- Carbon model assimilation of L4_C products to quantify boreal carbon source/sink activity (NRC objective);

Optimal L3_F/T validation site design

- **Represent major land cover, climate regimes for northern (>45°N) land areas**
  - Boreal evergreen needle-leaf forest, tundra, grassland
  - Disturbance and stand succession impacts

- **Capture microclimate heterogeneity within 1-3 km sensor FOV**
  - Select sites with relatively homogeneous land cover, terrain conditions.
  - Distributed measurements to capture sub-grid scale temperature variability
  - Continuous measurements to characterize diurnal and daily variability

- **Represent F/T transitions of major landscape elements**
  - Snow, vegetation and surface soil layer

- **Coincident measurements of surface meteorology & H_20, CO_2 fluxes**
  - Enable freeze-thaw & water, energy & carbon cycle linkages

Optimal L4_C validation site design

- **Characterize major biomes within northern land areas**
  - Boreal evergreen needle-leaf forest, tundra, grassland
  - Disturbance & stand succession impacts

- **Representative conditions within 10 km grid cell**
  - Select sites with relatively homogeneous land cover, terrain conditions;
  - Continuous measurements to characterize daily variability & cumulative annual C fluxes;

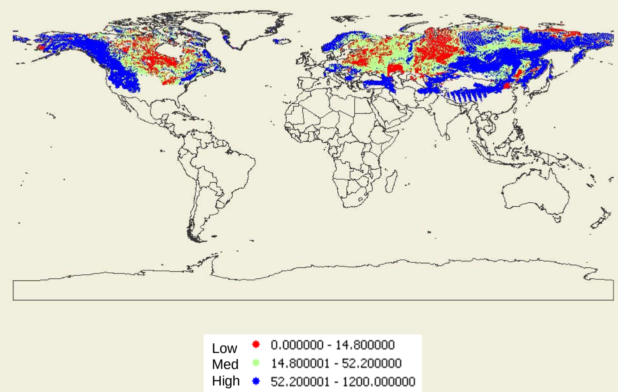
- **Documented uncertainty (systematic & random error) in C flux measurements**
  - Established and well defined protocols for correction & gap filling to establish complete annual C flux time series;
  - Multi-year time series to establish average conditions & year-to-year variability;

- **Coincident measurements of surface meteorology & H_20, CO_2 fluxes**
  - Enable analysis of water, energy & carbon cycle linkages;
  - Measurements of component C fluxes (GPP, R_{eco}, NEE) & environmental controls (SM and soil T, surface SOC).

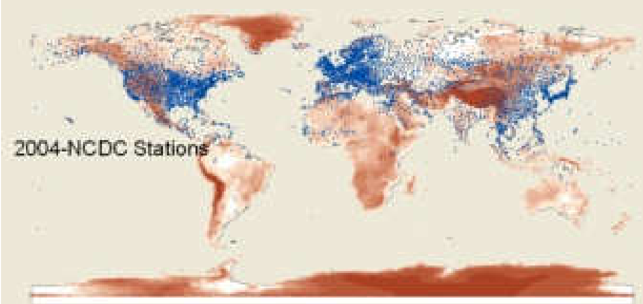
Application of WMO Global Station Network for L3_F/T Validation

- **Assumes T_a is effective surrogate for F/T & land cover & terrain primarily influence microclimate variability within grid cell;**
- **Numerous (>1500) sample sites; standardized global data collection/formatting; widely available, low cost & low latency;**
- **Limited array of measurement variables.**

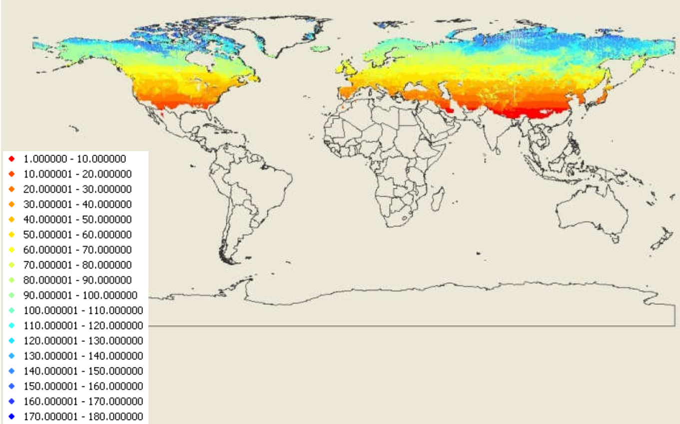
Terrain Heterogeneity within 25km grid cell



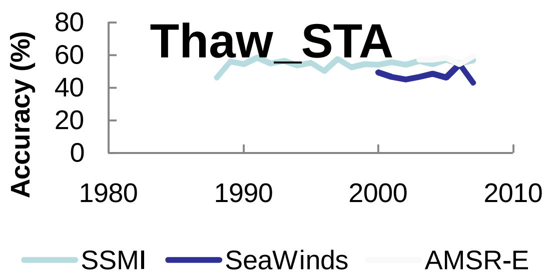
Global WMO Station Network

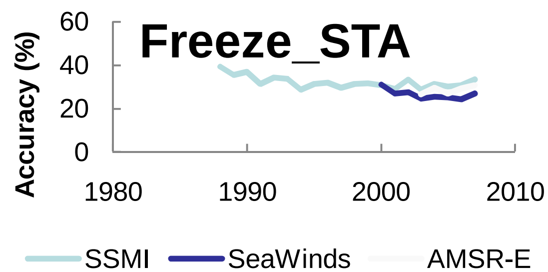


2004 Primary Thaw Day (SeaWinds)

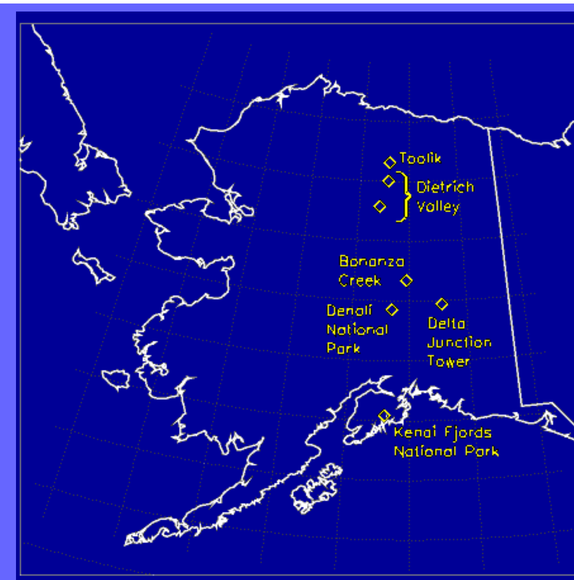


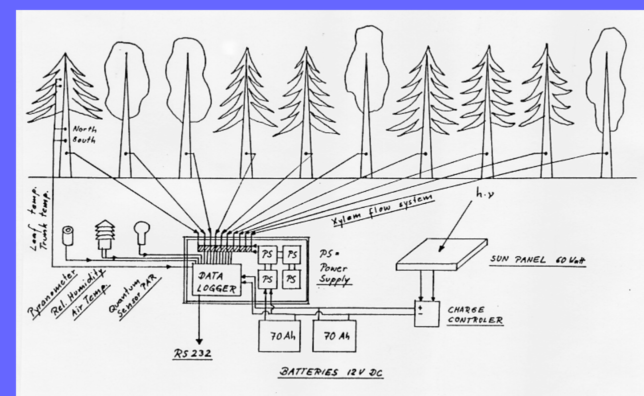
Mean multi-year F/T classification accuracy (seasonal threshold Alg: STA)
Relative to in situ temperature network observations within F/T domain

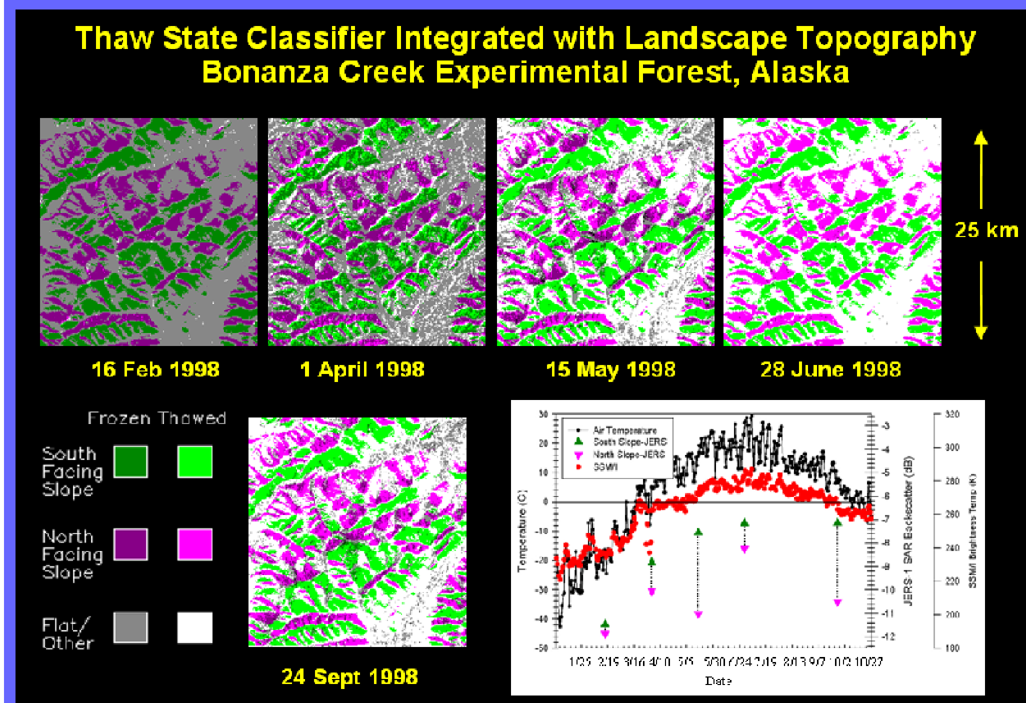


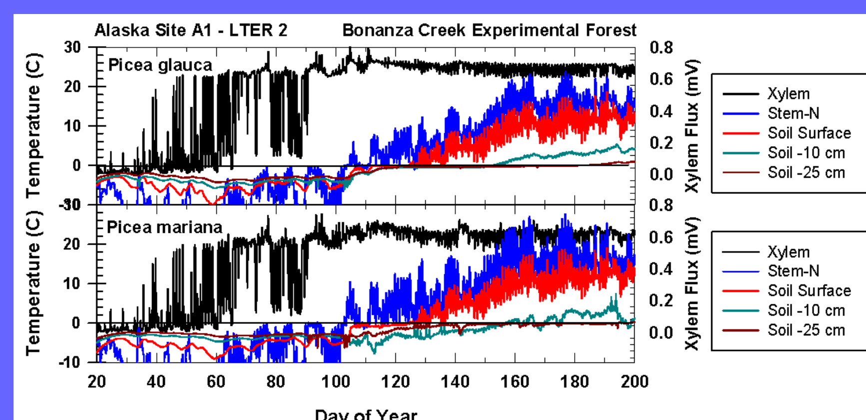


Alaska Ecological Transect (ALECTRA)

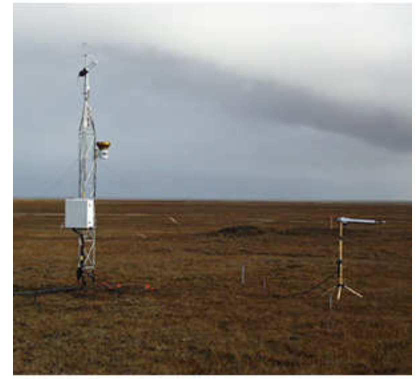








FLUXNET: Global tower eddy covariance measurement network



- **Regional representation of CO_2, H_20 fluxes approaching scale of satellite observations;**

- **Supporting biophysical measurements of critical variables (SM, soil T, meteorology, energy budget) ;**

- **~ 215 site years representing major northern (>45N) biomes;**

- **~7 of these are EOS core land validation sites;**

- **Disturbance (fire) and succession processes represented;**

- **Well defined measurement protocols & accuracy with regional consistency;**

- **Online data archival and distribution through NASA DAAC: http://daac.ornl.gov/FLUXNET.**