In Situ Networks & Scaling

Presentations by:

- A. Robock
- S. Steele-Dunne
- J. Basara
- W. Crow
- M. Moghaddam
- M. Brogioni

456 Soil Moisture Stations with Real Time Observations

Data Set	No. of Stations	Starting Year	Sampling Interval	Top Layer	Number of Layers
UKRAINE Winter, spring cereals	141	1958	10 days	0-10 cm	10
MONGOLIA Pasture and wheat	40	1973	10 days	0-10 cm	10
CHINA Agriculture, natural	102	1981	10 days	0-5 cm	11
ILLINOIS Grass	18 17	1981 2006	10 days 1 hour	0-10 cm 5 cm	11 6
OKLAHOMA Grass	53-103	1997	30 min.	5 cm	4
NEBRASKA Grass	53	1998	1 hour	10 cm	4

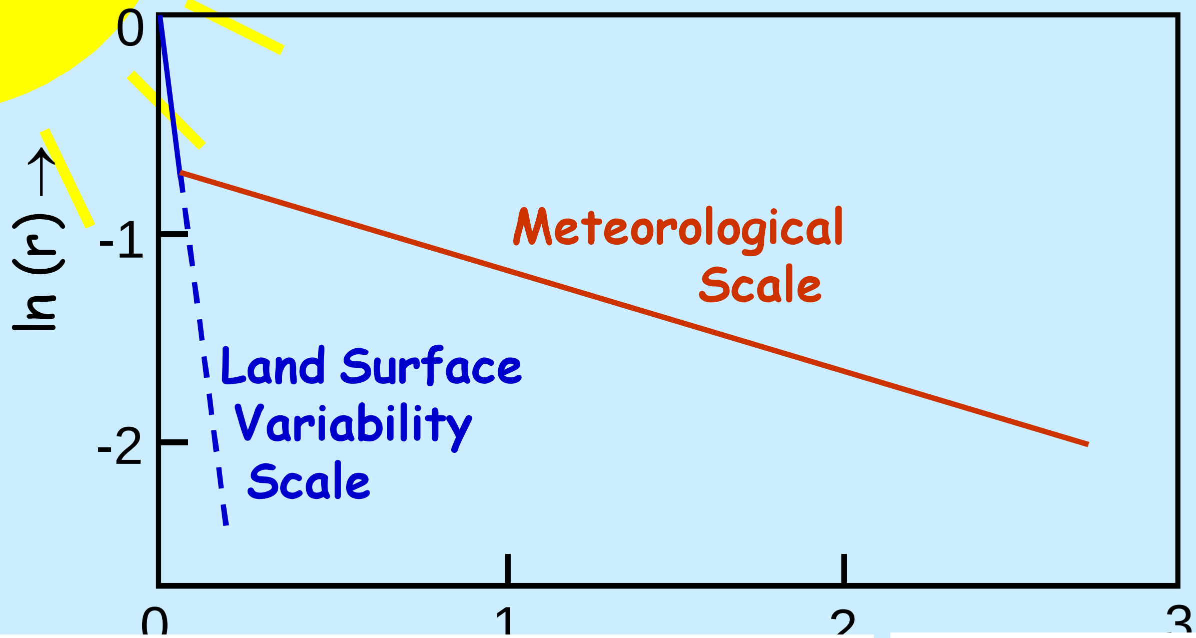
Global Soil Moisture Data Bank

Department of Environmental Sciences
Rutgers University
http://envsci.rutgers.edu/~robock

Data Collection and Distribution
Land Surface Modeling
Remote Sensing
Data Analysis

Alan Robock
Haibin Li
Konstantin Vinnikov

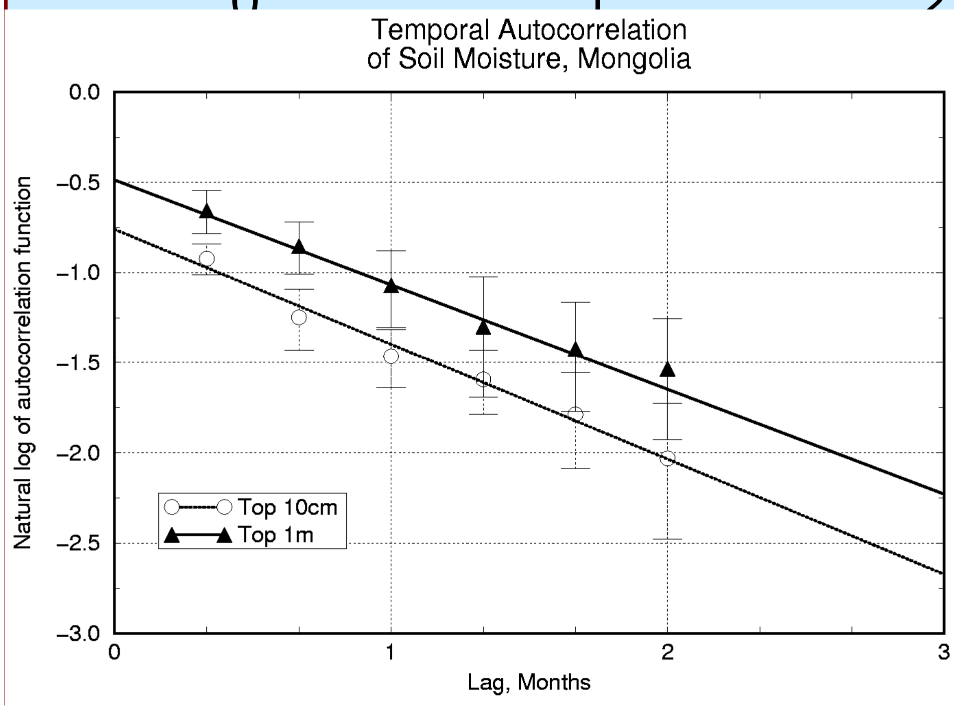
Scales of Soil Moisture Variation

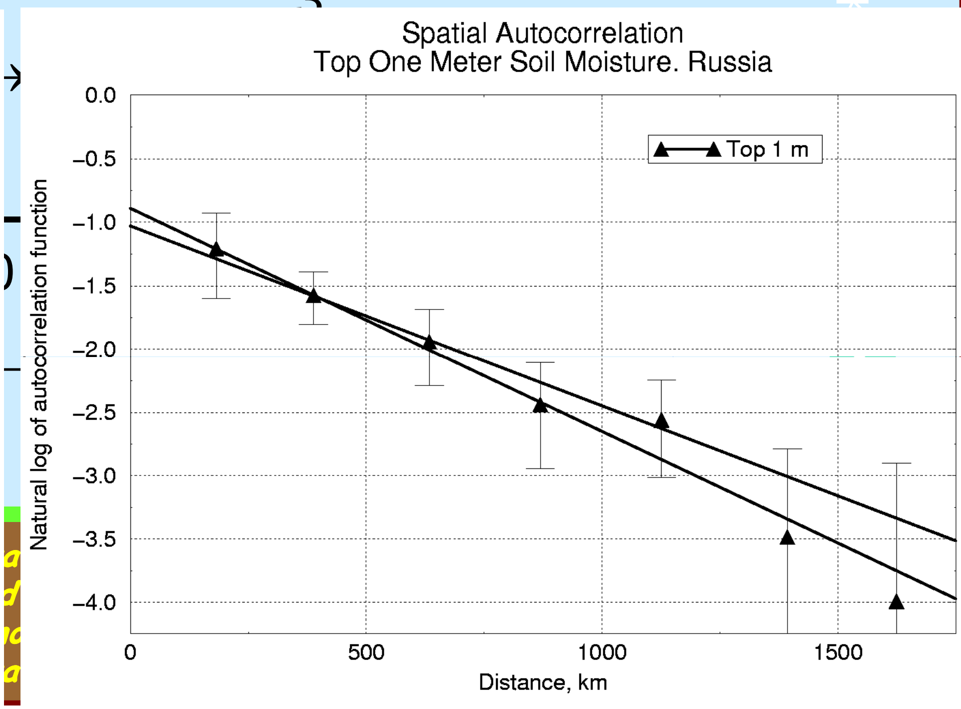


r = autocorrelation
t = time
d = distance
T = temporal scale
L = length (spatial) scale

$$r(t) = e^{-\frac{t}{T}}$$

$$r(d) = e^{-\frac{d}{L}}$$





Scales of Temporal and Spatial Variability of Soil Moisture

T = time scale, L = spatial (length) scale

Observed Spatial Scales, Entin *et al.* (2000)

	0-10 cm soil layer			0-100 cm soil layer		
	σ_o [cm]	η [%]	L_a [km]	σ_o [cm]	η [%]	L_a [km]
Illinois, US	0.85	30-35	380-490	4.0	30-35	510-670
China	0.57	45-50	500-550	3.8	55-65	475-575
Mongolia	0.51	60-80	200-400	4.7	60-80	200-400
Russia	-	-	-	3.1	55-65	500-750

σ_o *is the total variance;* η is the portion related to land surface

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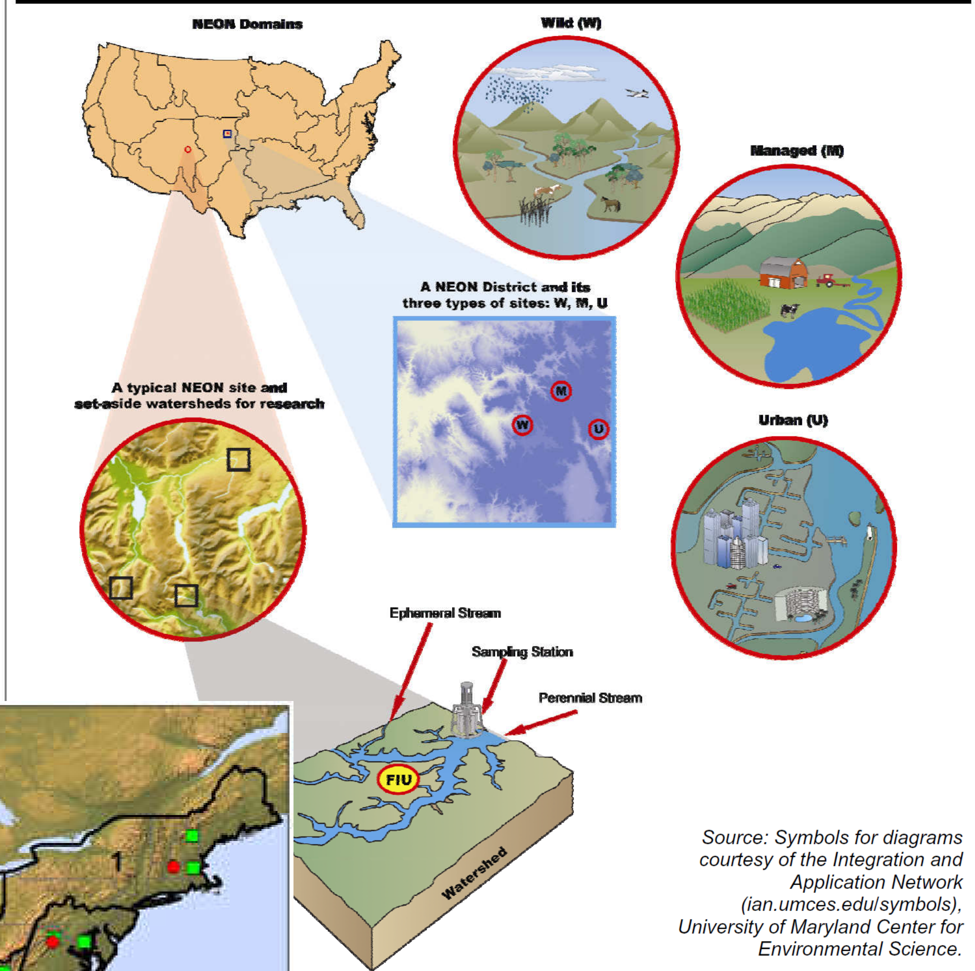
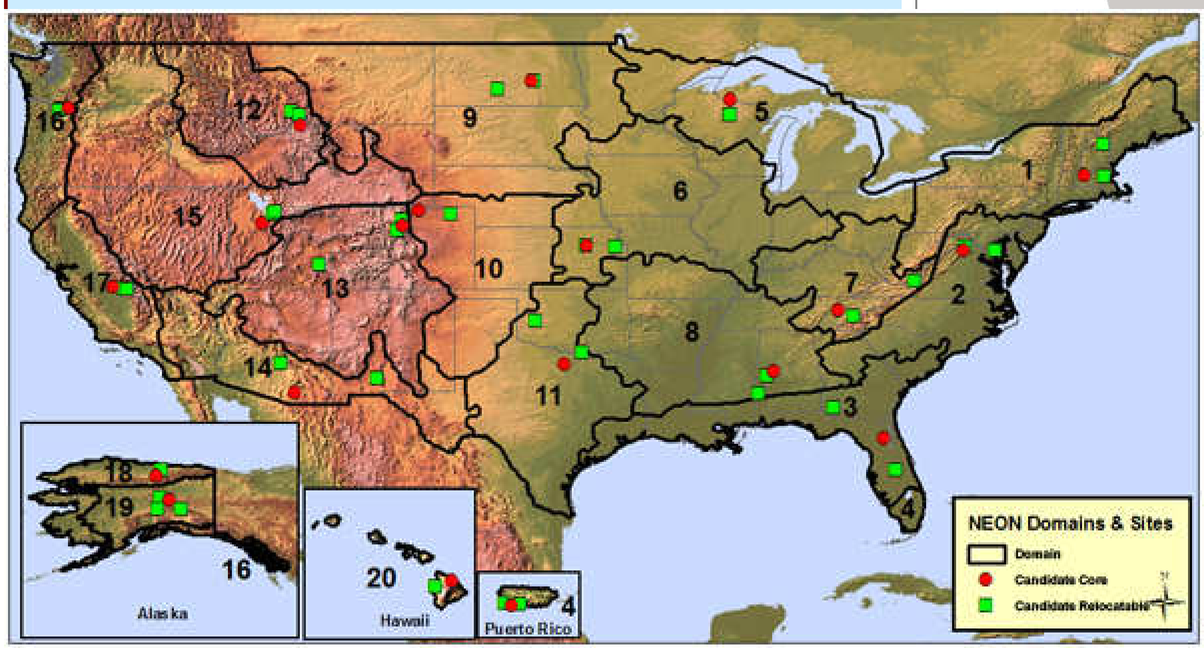
NATIONAL ECOLOGICAL OBSERVATORY NETWORK

Figure 1.3 NEON Districts



Source: Symbols for diagrams courtesy of the Integration and Application Network (ian.umces.edu/symbols), University of Maryland Center for Environmental Science.



tory climatic domains, a NEON District is established. Each District
and cover types (urban, managed lands, and wild lands), with each of
on small watersheds where transitions from terrestrial to aquatic
ensors, cyberinfrastructure, and protocols are common across the
Hawaii, Alaska, and Puerto Rico.

/ Distribution
ling

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Haibin Li
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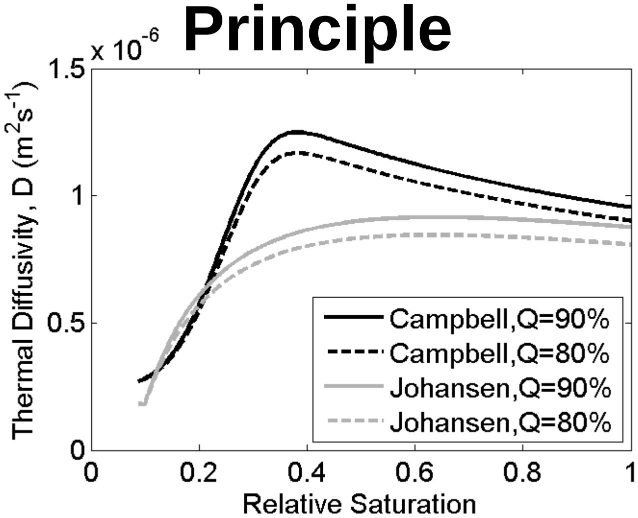
SoilDTS: Measuring soil moisture using distributed temperature sensing

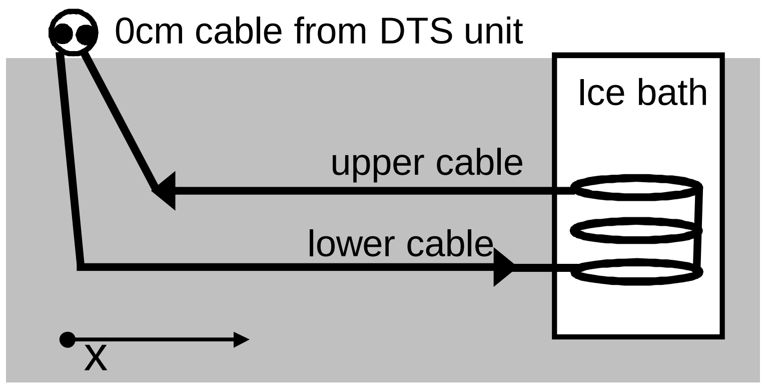
Susan Steele-Dunne et al.

TU Delft

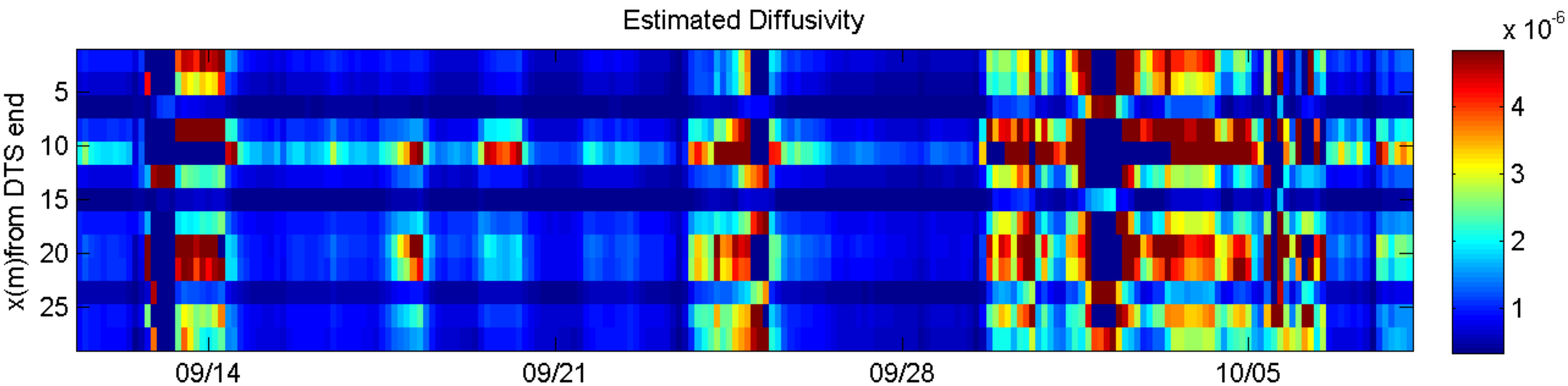
Principle



Experiment design



Results



Thoughts Concerning The Use of Oklahoma Mesonet Data for Cal/Val of SMAP

- Use Long-Term/Composite Datasets to Capture the Temporal Behavior of Soil Moisture as well as Specific Magnitudes:

  - Pathe, C., W. Wagner, D. Sabel, M. Doubkova, J. B. Basara, 2009: Using ENVISAT ASAR Global Model Data for Surface Soil Moisture Retrieval over Oklahoma. *IEEE Transactions on Geoscience and Remote Sensing*, **47**, 468-480.

  - Swenson, S., J. Famiglietti, J. Basara, and J. Wahr, 2008: Estimating Profile Soil Moisture and Groundwater Storage Variations in the Southern Great Plains Using GRACE Satellite Gravimetric and Oklahoma Mesonet Soil Moisture Data. *Water Resources Research*. **44**, W01413, doi:10.1029/2007WR006057.

- For Validation at Specific Locations, Choose "Representative" Sites:

  - Gu, Y., E. Hunt, B. Wardlow, J. B. Basara, J. F. Brown, and J. P. Verdin, 2008: Evaluation and validation of MODIS NDVI and NDWI for vegetation drought monitoring using Oklahoma Mesonet soil moisture data. *Geophys. Res. Lett.*, **35**, L22401, doi:10.1029/2008GL035772.

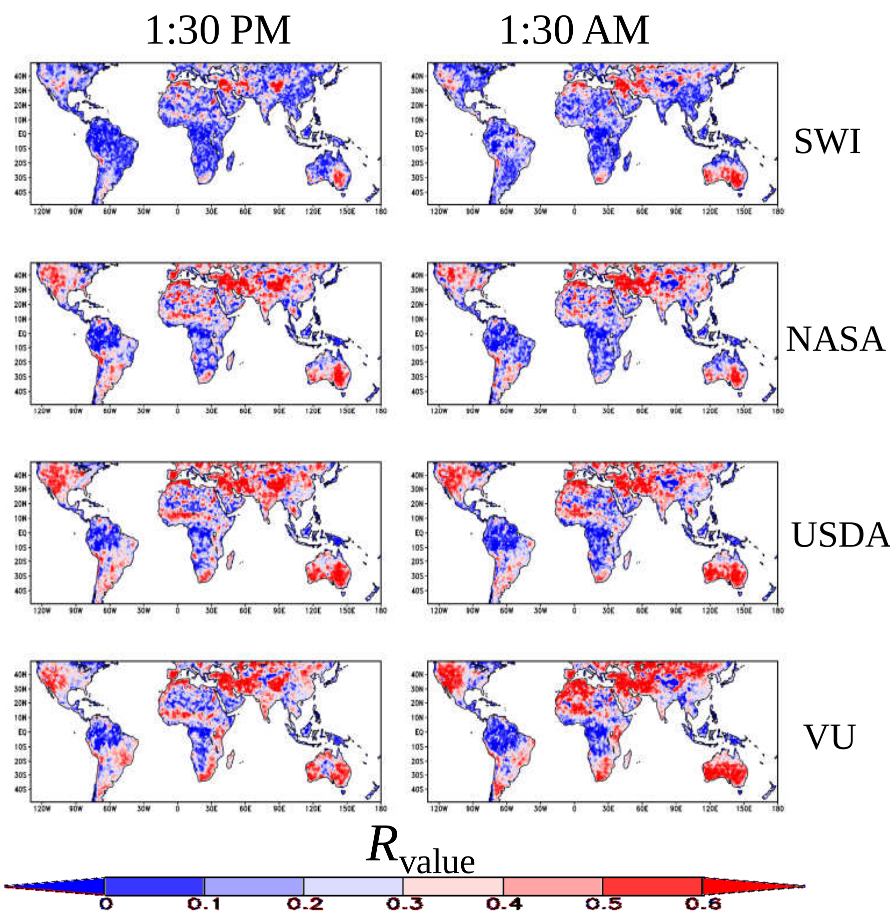
J. Basara

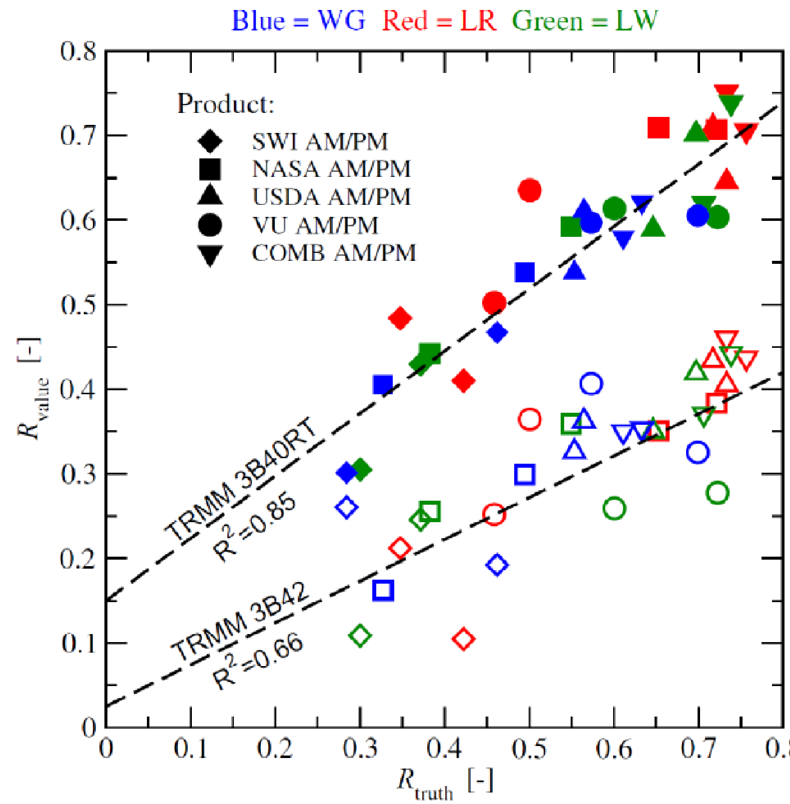
Oklahoma Mesonet

Evaluation of SMAP Soil Moisture Products via Data Assimilation

Wade Crow, Diego Mirralles and Michael Cosh

Rvalue = Correlation between analysis increments realized upon assimilation of a soil moisture retrieval into a land surface model **and** rainfall errors used to force the land model.





Crow et al., *IEEE TGRS*, in submission.

Ground Network Design and Dynamic Operation for Validation of Space-Borne Soil Moisture Measurements

Mahta Moghaddam (U of M)
D. Entekhabi (MIT), D. Teneketzis (U of M), M. Liu (U of M)

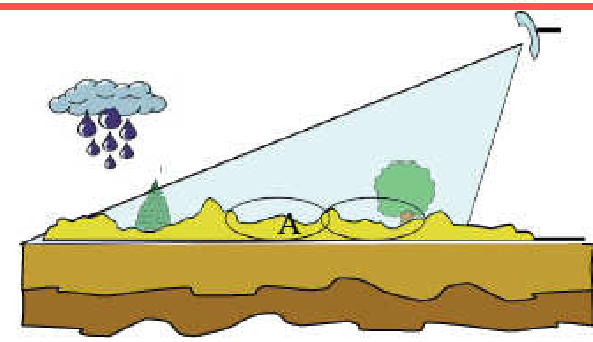
Objective

Develop technologies for dynamic validation of space-borne soil moisture (SM) measurements, by solving the joint problem of sensor placement & scheduling. Specifically:

-- Develop optimal sensor node placement policies based on nonstationary spatial statistics of soil moisture. For each node, build dynamic scheduling policies.

-- Develop physics-based spatial aggregation strategy to correlate in-situ and space-based estimates of soil moisture.

-- Develop actuation and telecommunication protocols and hardware for controlling the optimally architectured ground sensors.



Over the satellite resolution cell the landscape is typically heterogeneous, needing more sophisticated approaches to modeling satellite measurements, estimating average soil moisture on the ground for validation, and reconciling these estimates with satellite-derived ones.

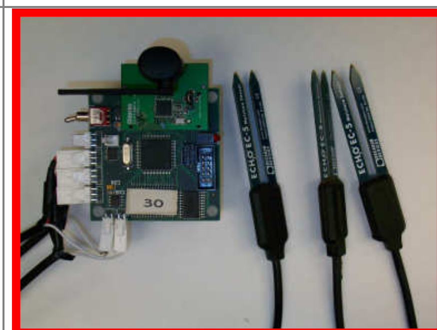
Approach

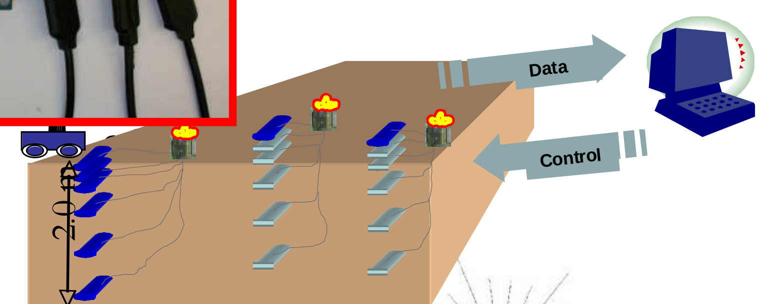
-- For placement/scheduling, derive objective function that maximizes quality of ground estimate while minimizing resource usage; investigate best computational strategies to solve this high-dimensional nonlinear joint estimation problem.

-- Use a physics-based statistical aggregation strategy to relate ground-based estimates of true mean of SM are related to their space-based estimates

-- Develop integrated comm & actuation platform to command sensors & transmit measured data to base station in real time.

-- Would like to perform field experiments in coordination with SMAP cal/val team to prototype the validation system.





Earth Science Technology Office

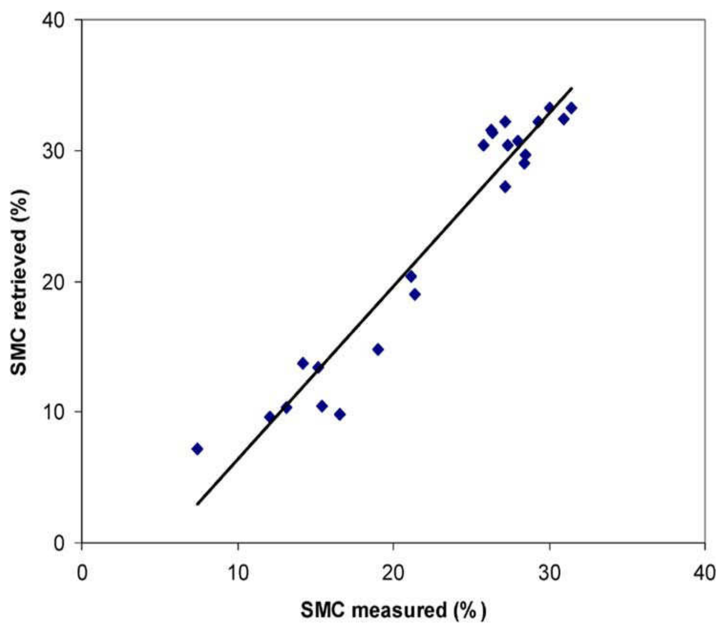
I - Validation of Soil Moisture Retrieval Algorithms in Agricultural areas over Italian Test sites

M.Brogioni, G.Macelloni, S.Paloscia, P.Pampaloni, S.Pettinato, E.Santi

IFAC-CNR (Italy)

SMC maps from AMSR-E enhanced data were validated by means of SMC maps derived from SAR data and checked also with rain data collected in the Po plain.

Check of the SMC algorithm

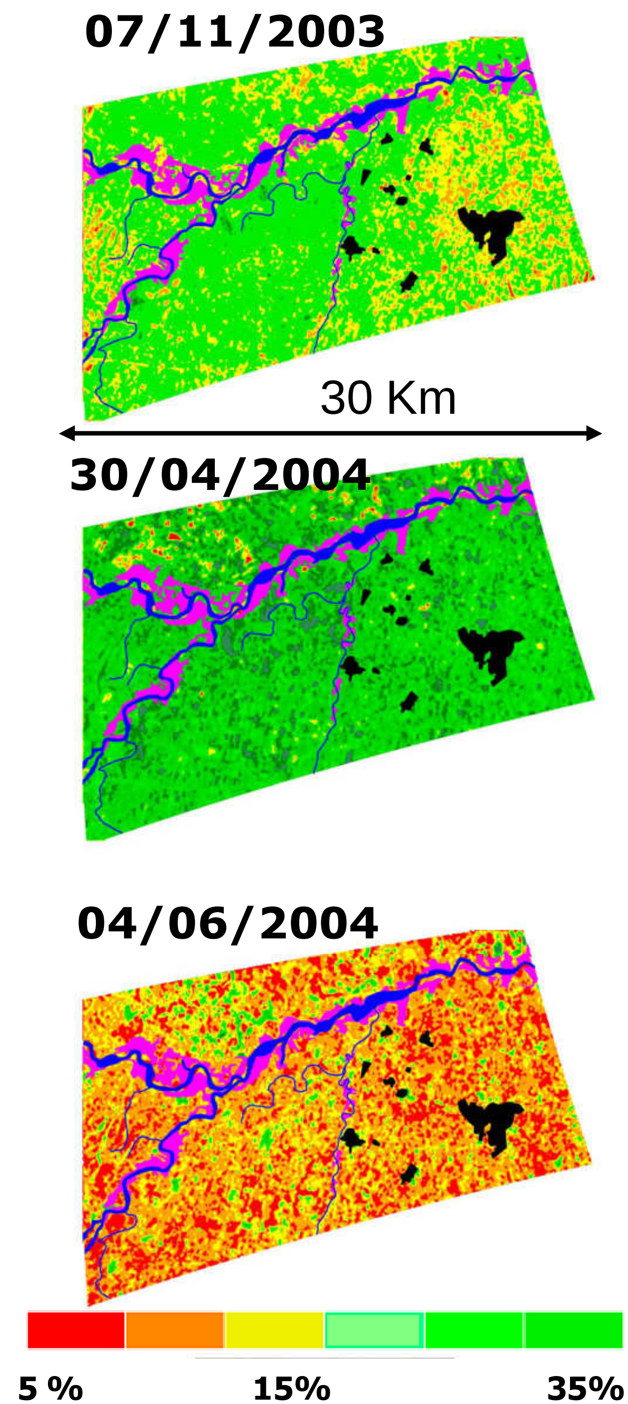


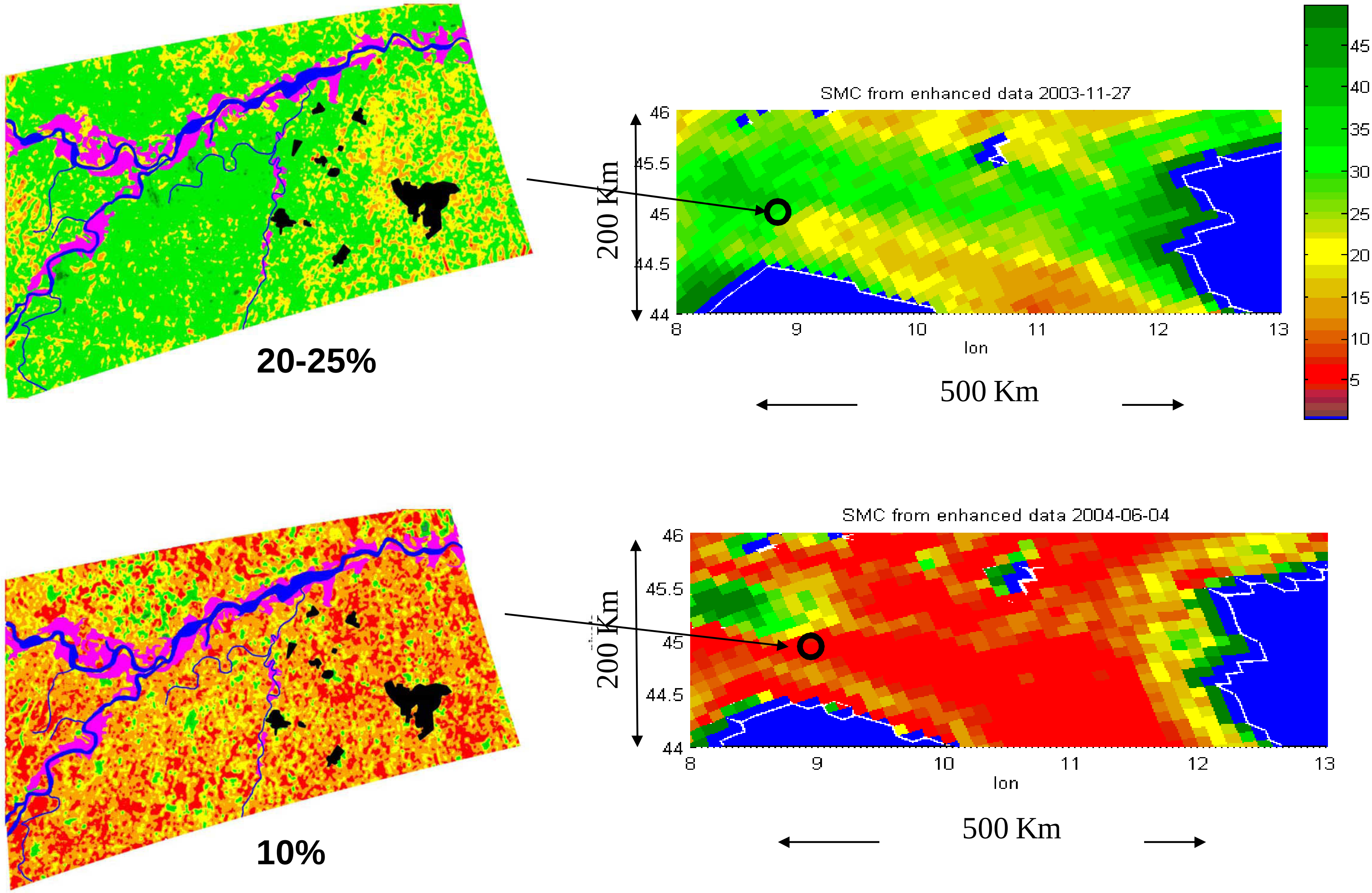
SMC estimated with SAR data

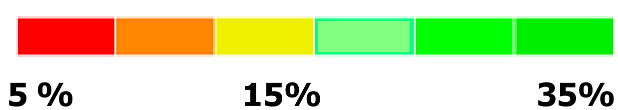
Vs

SMC measured on ground

(R^2 = 0.91, SEE = 2.16% SMC).







AMSR-E SMC maps were resampled at the resolution of 37 GHz with the SFIM algorithm

- The validation of the algorithm of SMC with AMSR-E data was carried out by using SAR (ENVISAT) images
- SAR data have been used to compute SMC field by field through an ANN algorithm and the comparison between estimated and measured SMC is very good (fig.1)
- Since the result was so good, the algorithm was extended to the whole SAR image (30kmx15km)
- SAR maps of SMC were carried for 3 dates (November, April and June, fig.2) and have been used as references for validating a small portion of the 2 AMSR-E SMC maps (fig.3). We can see that there is a good agreement between SAR and AMSR-E maps, although for a little portion. In the up-left side of the AMSR-E SMC maps is visible a moister area which corresponds to the rice fields of Vercelli. In November the rice fields are without water, whereas in June they are flooded and therefore the SMC is higher.
- The AMSR-E SMC maps (obtained at 6.8 GHz) have been resampled at the resolution of 37 GHz with the SFIM algorithm. The Garda, Como and Maggiore lakes are visible.