

Attribution Concepts for Sub-meter Resolution Ground Physics Models

**76th MORS Symposium
US Coast Guard Academy**

Approved for public release distribution.

Report Documentation Page

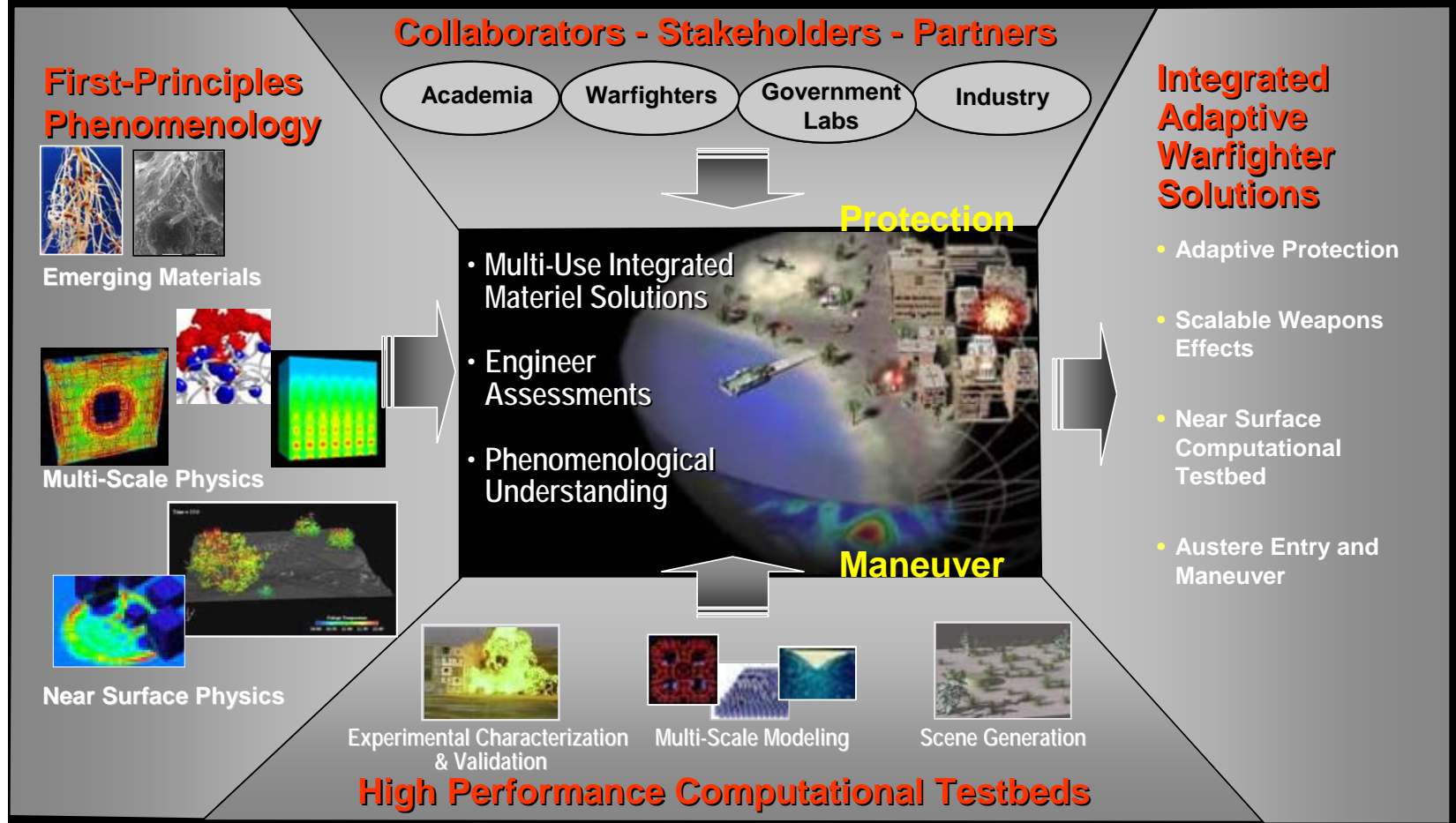
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Adaptive Maneuver and Protection

Developing Solutions Faster Than The Threat Can Adapt



Virtual Autonomous Navigation Environment (VANE)



Scene Generation Models

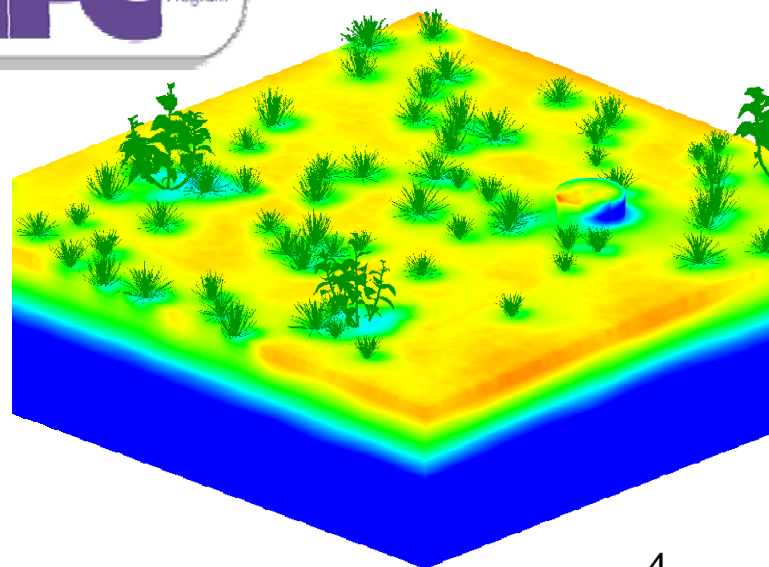
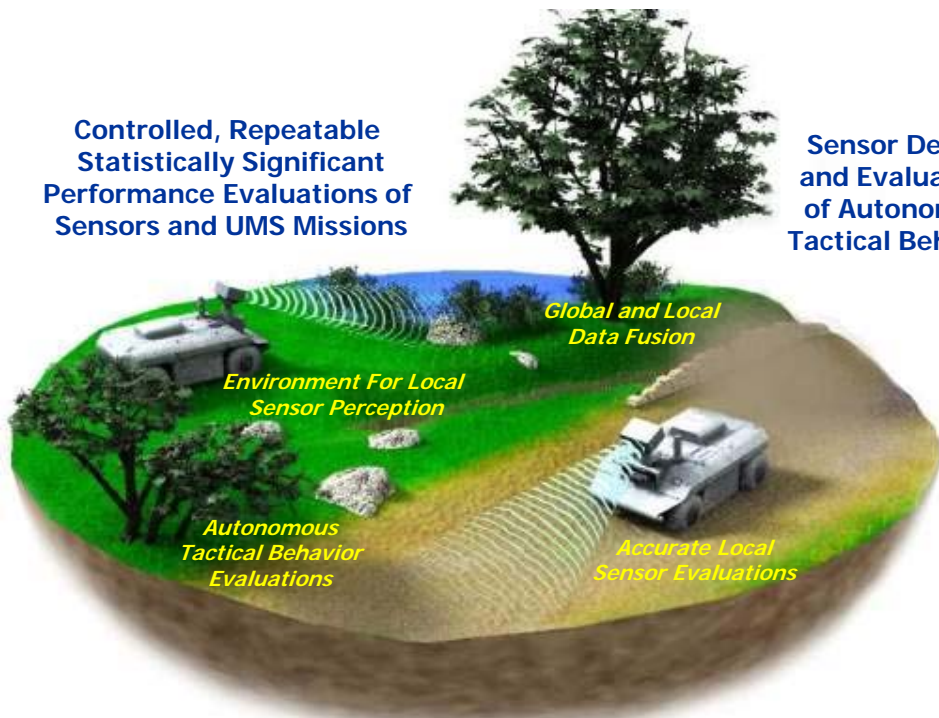
Colors, Stereo Images, Geology, Vegetation, Material Databases

Component Models

Vehicle Dynamics, Sensor, Power Requirements

Controlled, Repeatable Statistically Significant Performance Evaluations of Sensors and UMS Missions

Sensor Designs and Evaluations of Autonomous Tactical Behaviors



Vegetation Models

Thermal, Geometry, Reflectivity, Ray Casting

Soil Models

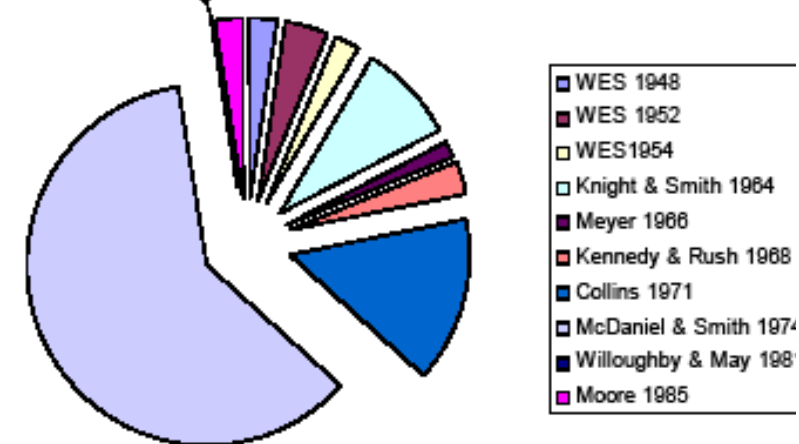
Strengths, Moistures, Thermal, Electromagnetics

Global Databases Supporting Geospatial Attribution



Historic Soils Dataset TR-08-2
 14000 Records From 10 TR's
 Physical Properties of Soils,
 Location, Attribution Consistent
 with CTB Inputs

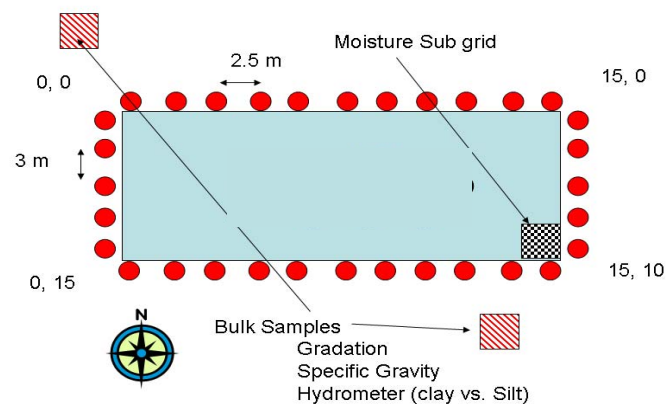
Willoughby & May



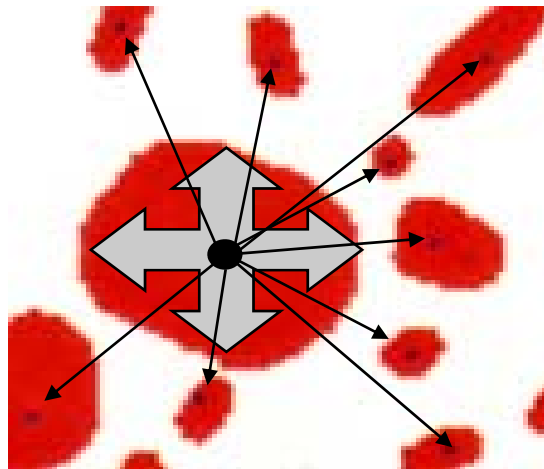
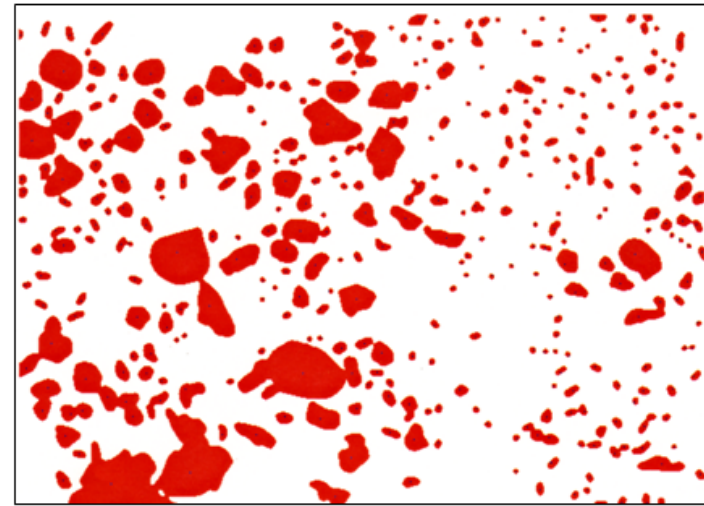
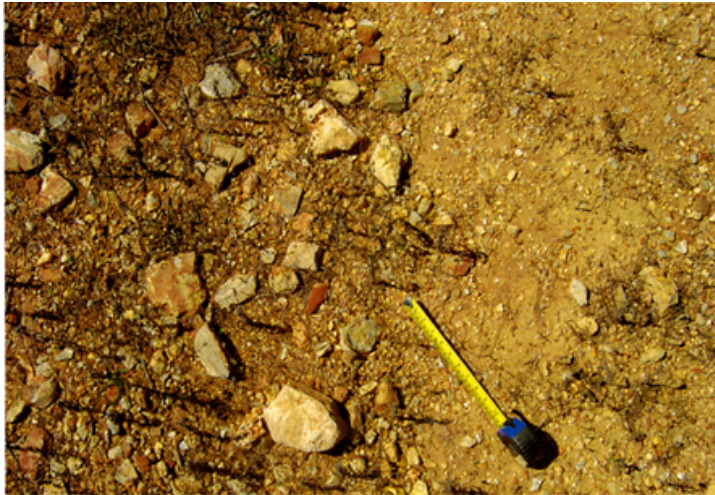
Geostatistical Data Needs



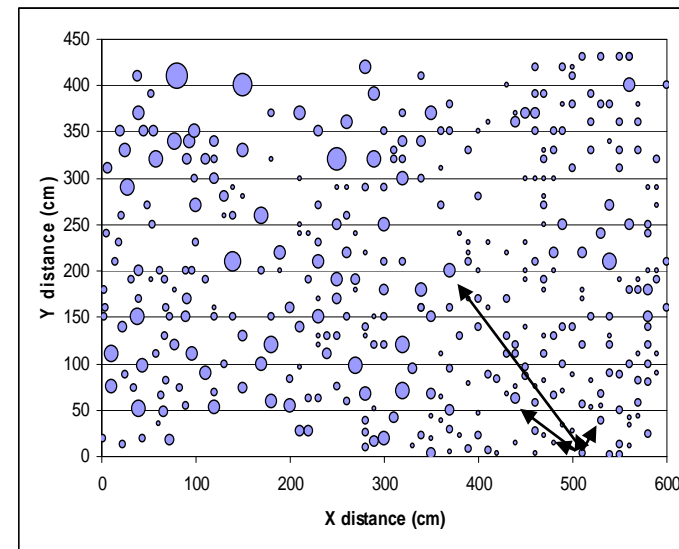
- How to Define Rocks within Strata
- Layering and Variance in Layers
- What are the Input Data correlations
- Correlations with Time and Distance



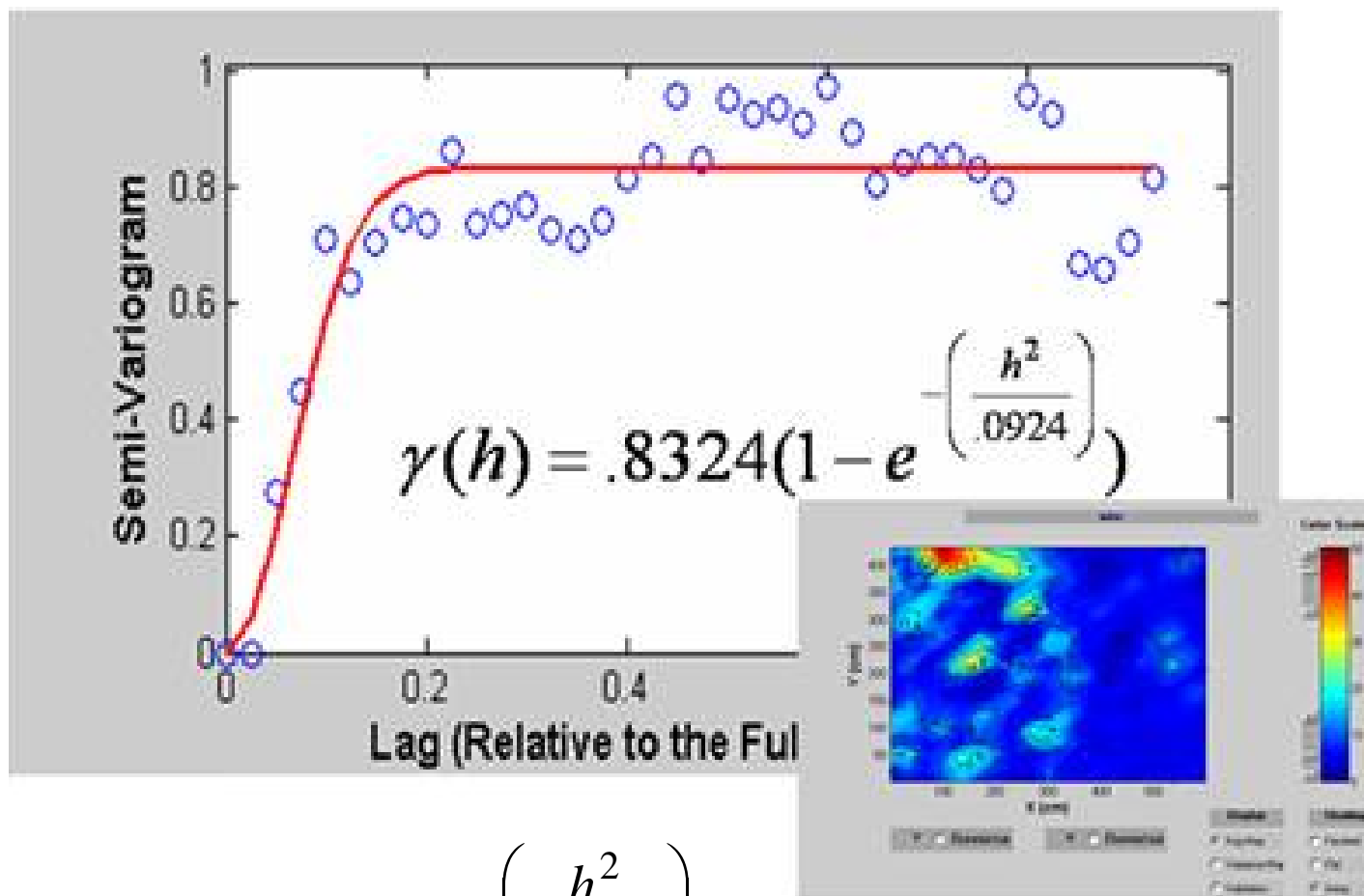
Spatial Distribution of Rocks In Soil Mass



Rocks are extracted and Highlighted in Red

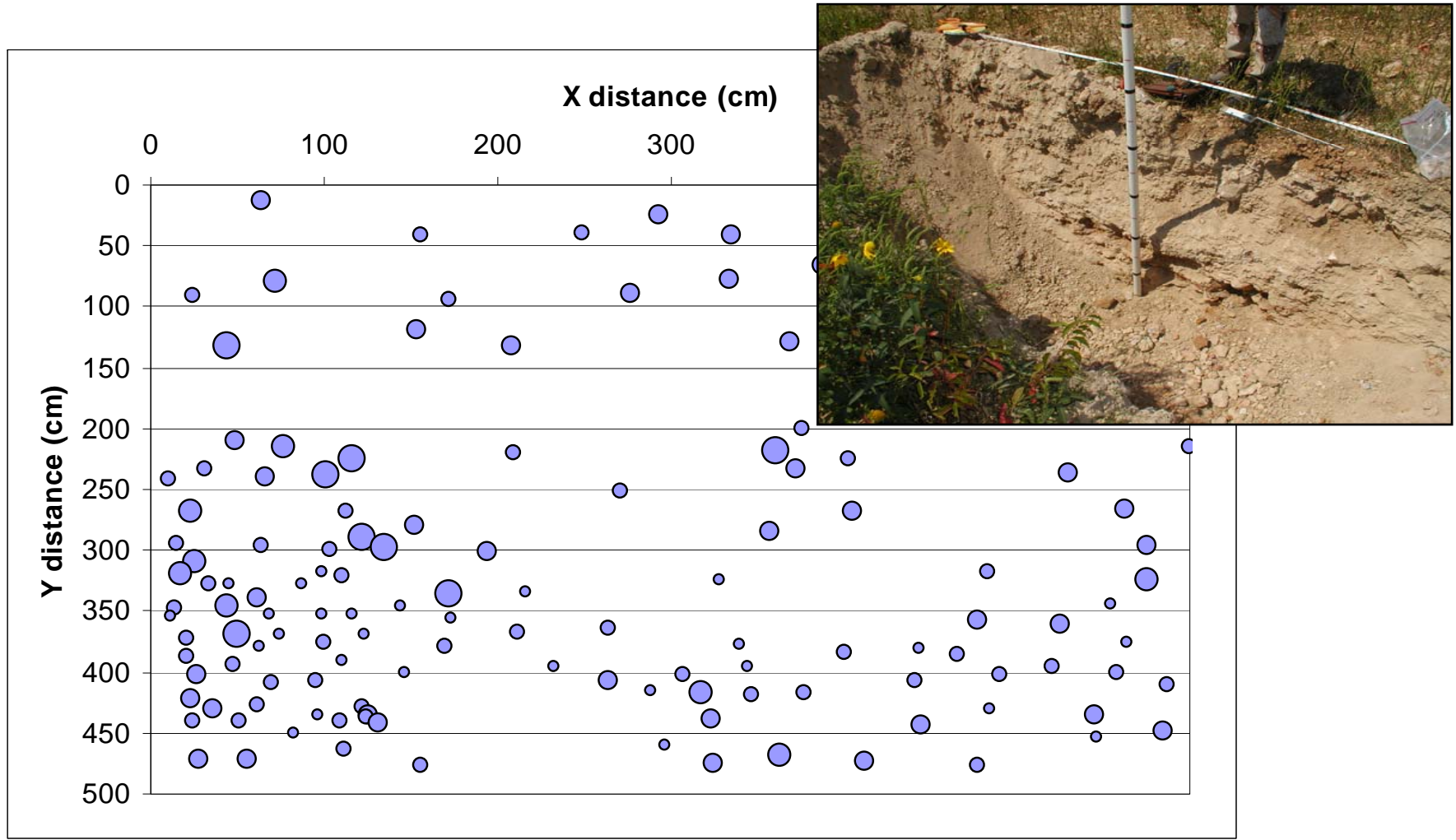


Spatial Distribution of Rocks In Soil Mass



$$\gamma(h) = .8324(1 - e^{-\left(\frac{h^2}{.0924}\right)})$$

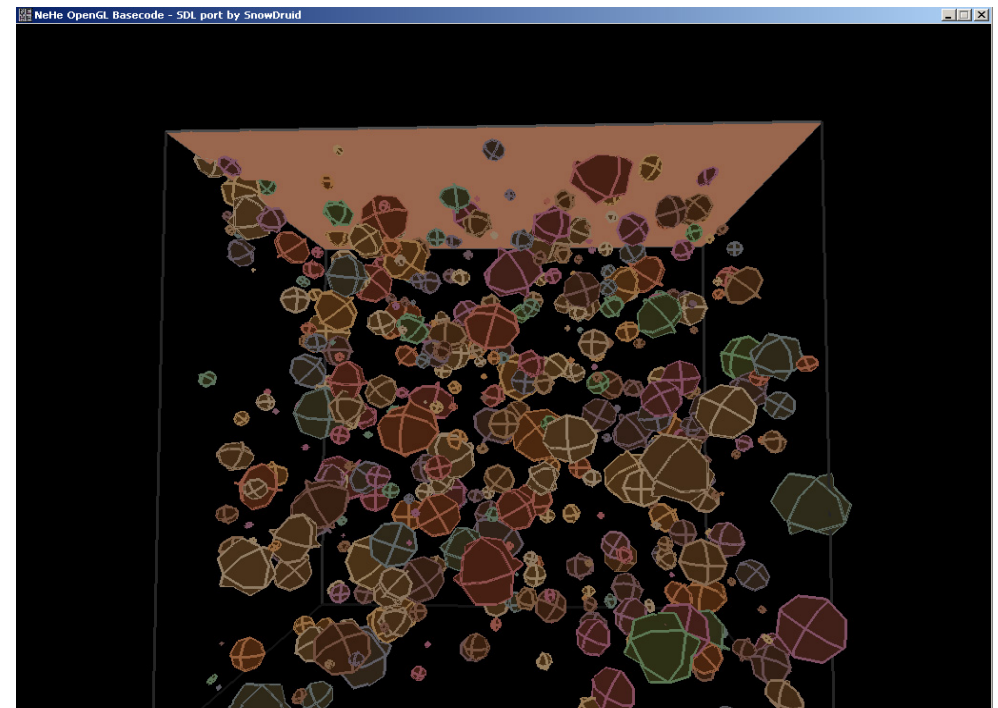
Spatial Distribution of Rocks In Soil Mass



Vertical Locations of Rocks Are Extracted in the Same Manner

Spatial Distribution of Rocks In Soil Mass

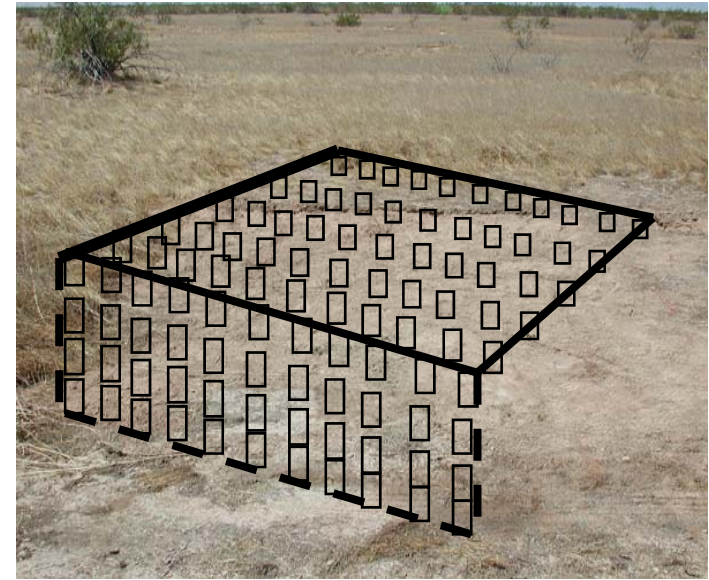
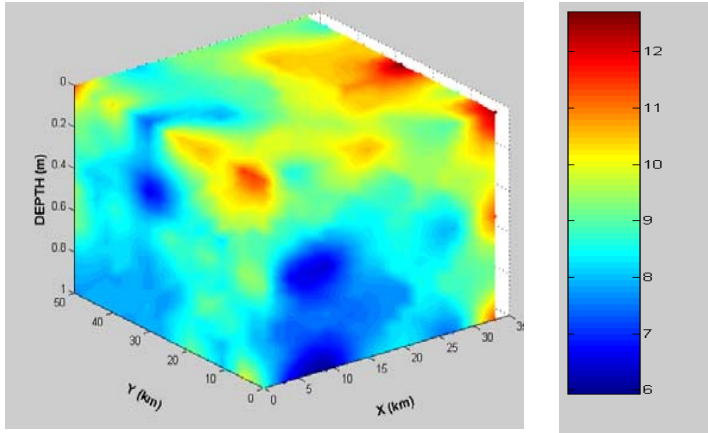
- **Program to define distribution from digital photographs**
 - **Number of Rocks**
 - **Size**
 - **Location**
 - **Orientation**



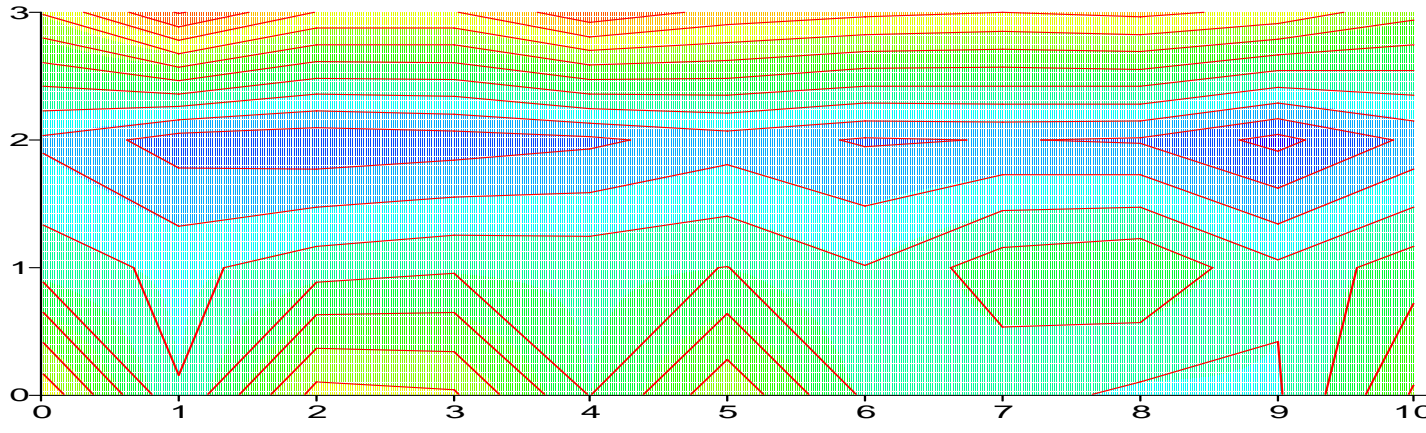
Spatial Distribution of Moisture, Density, and Porosity in Soil Mass



Low Moisture indicates Changes whose Spatial Structure is Random



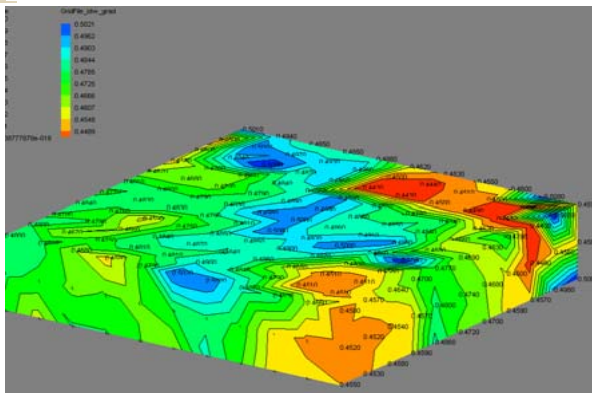
However Density Variations were predictable



Density
 Kg/m³

Red	1440
Orange	1420
Yellow	1400
Light Green	1380
Green	1360
Dark Green	1340
Cyan	1320
Light Blue	1300
Blue	1280
Dark Blue	1260
Very Dark Blue	1240

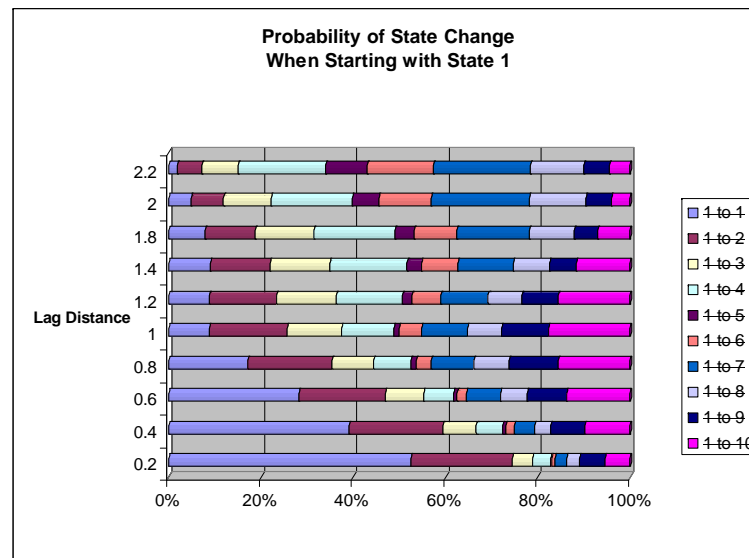
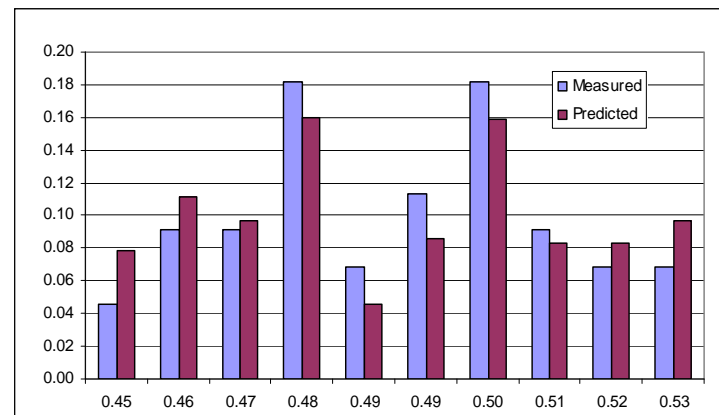
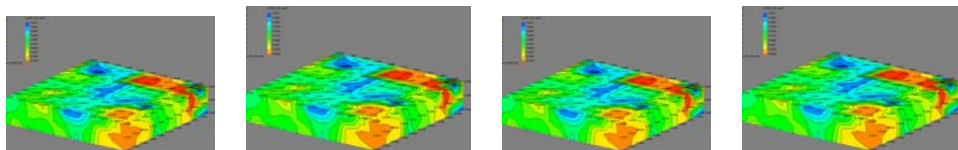
High Resolution Data



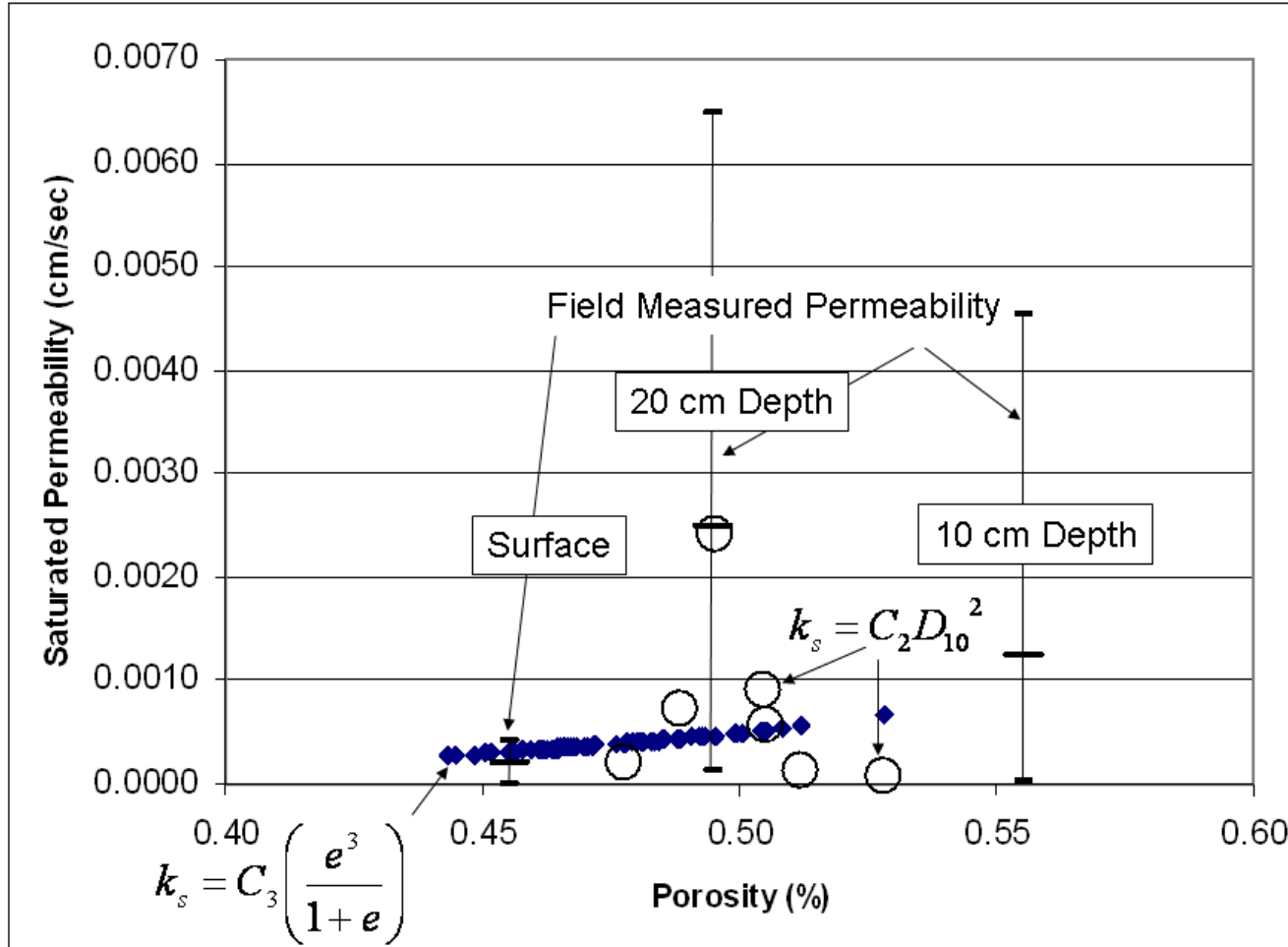
Read Field Data
 Generate Matching SemiVariance and
 Frequency For High Resolution Grid

Create Transitional Probability Matrix

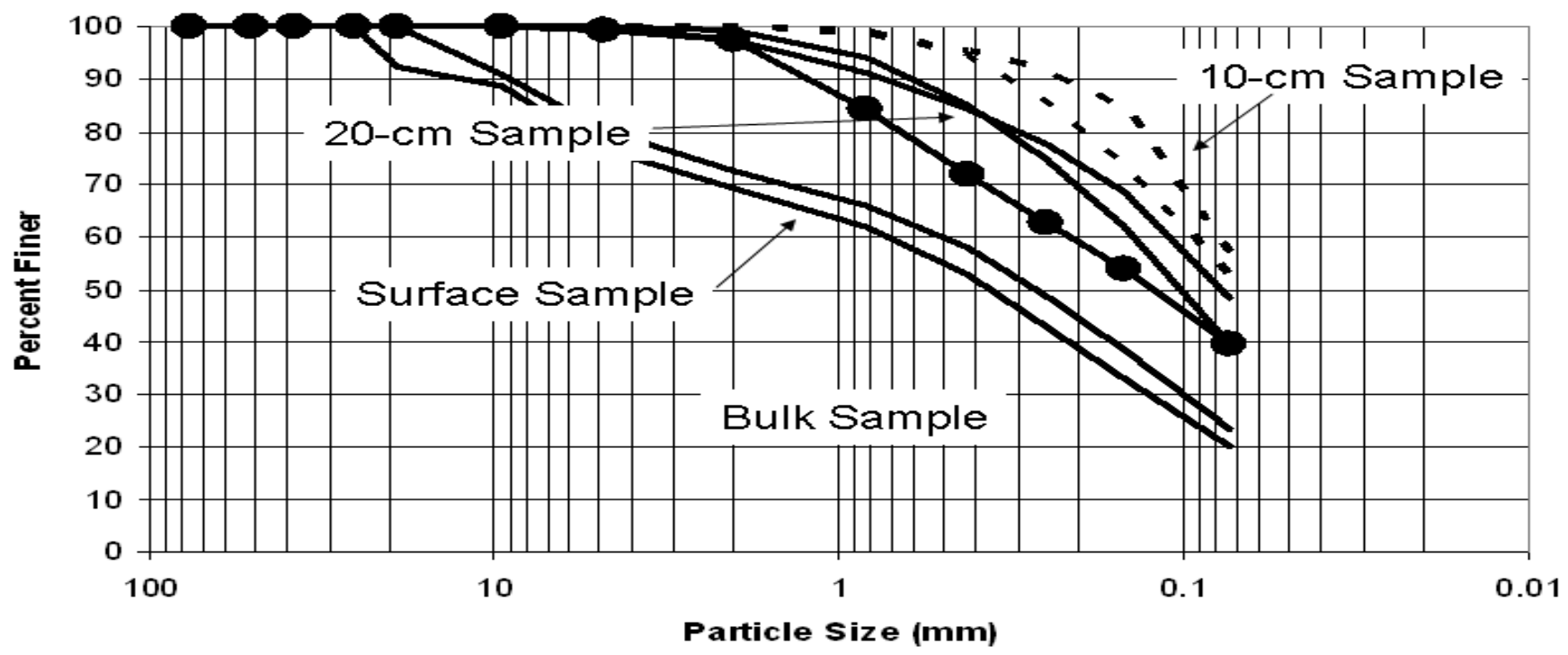
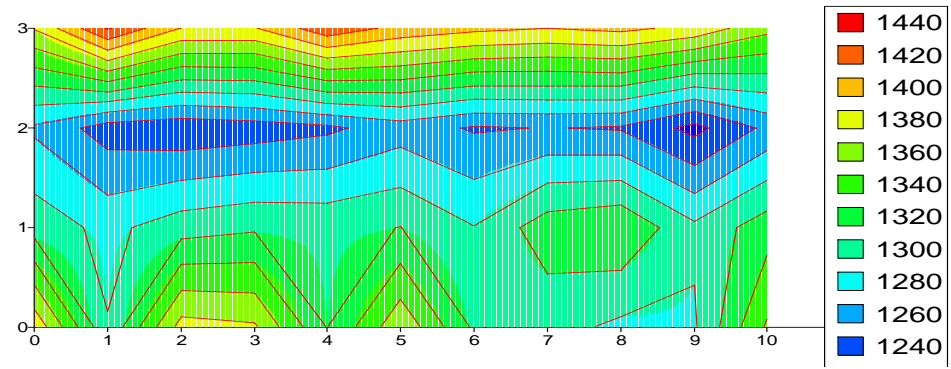
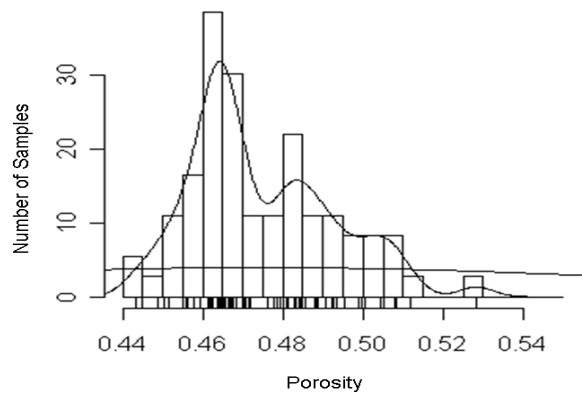
Generate Multiple Realizations



Correlations for Missing Data



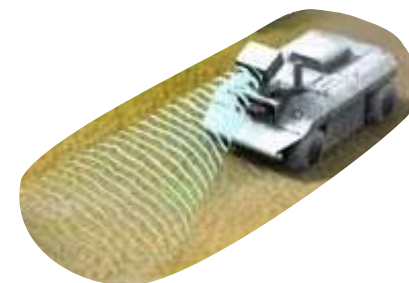
Layering Effect in Density and Porosity

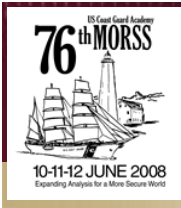


Summary



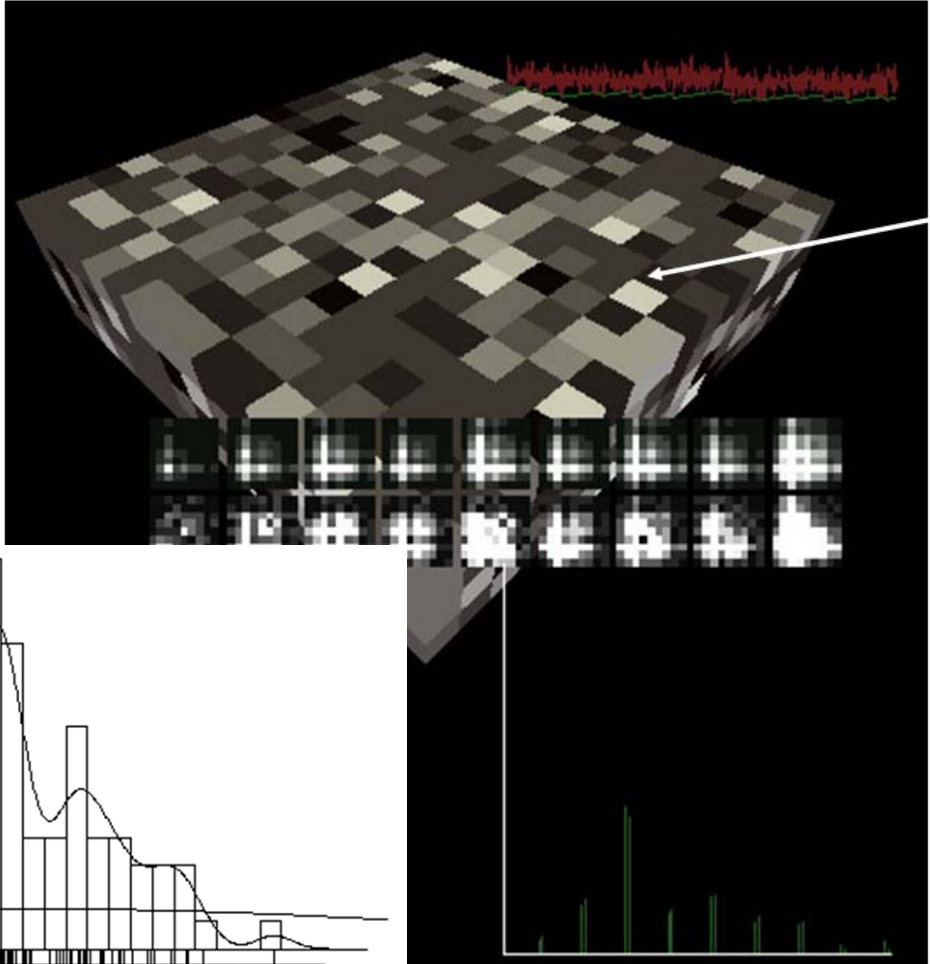
- **ERDC research is now heavily focused on using high performance computing simulation testbeds**
- **Simulations like VANE involving sensor-terrain interaction will require relevant and realistically heterogeneous attributions for large scale, high resolution, numerical models**
 - **Techniques for characterizing spatial variability at multiple scales including sub-meter resolutions**
 - **Techniques for populating sparsely measured attributions using material attribute correlations to densely measured attributions**





BACKUP SLIDES



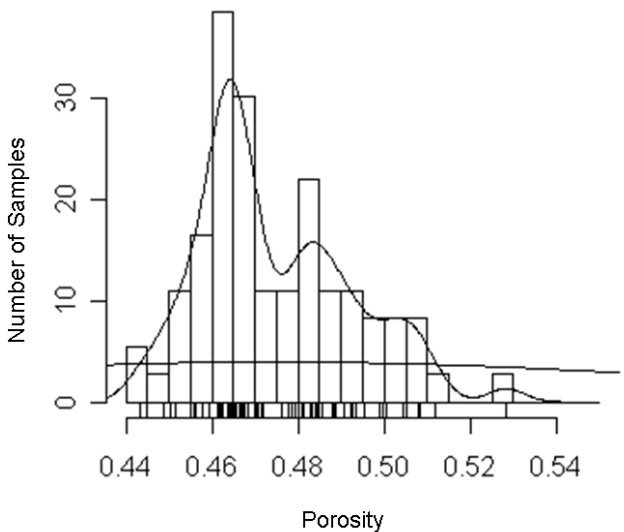


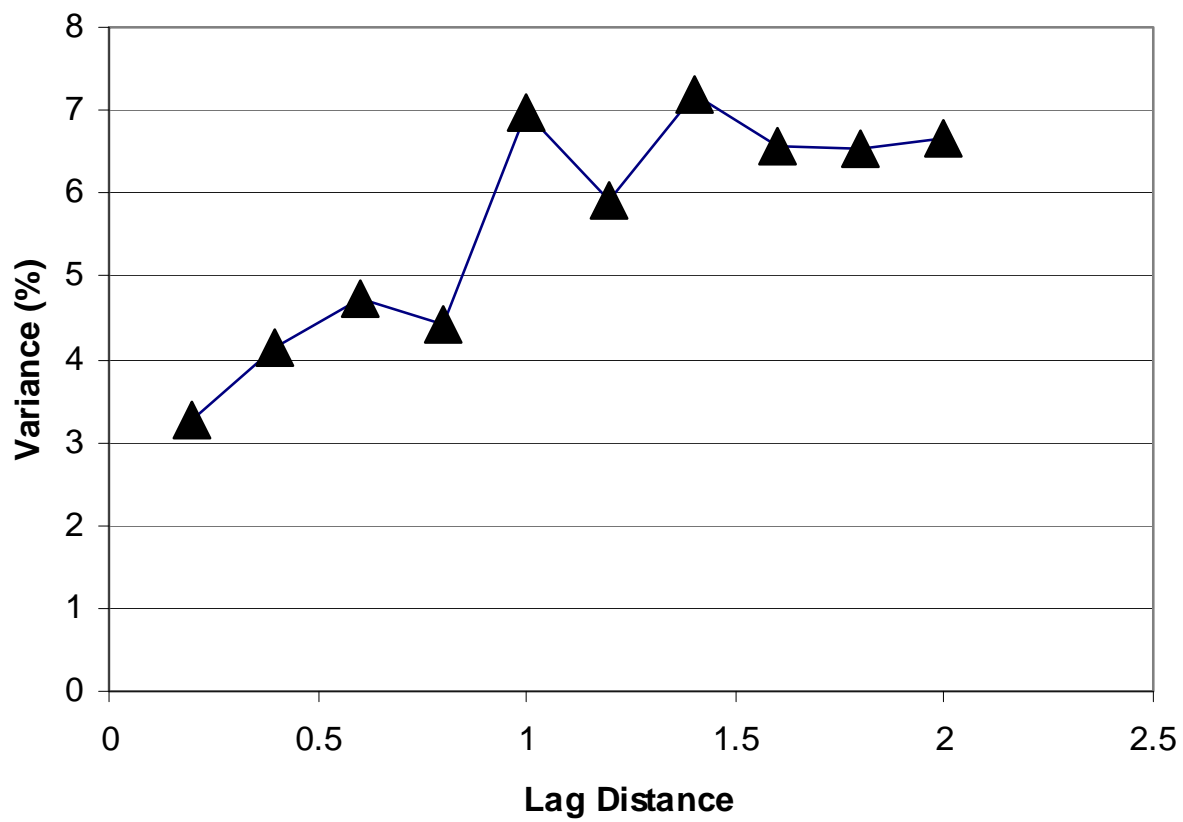
Iterations and Residuals

Final Configuration

Conditional Matrix Match

Frequency Distribution

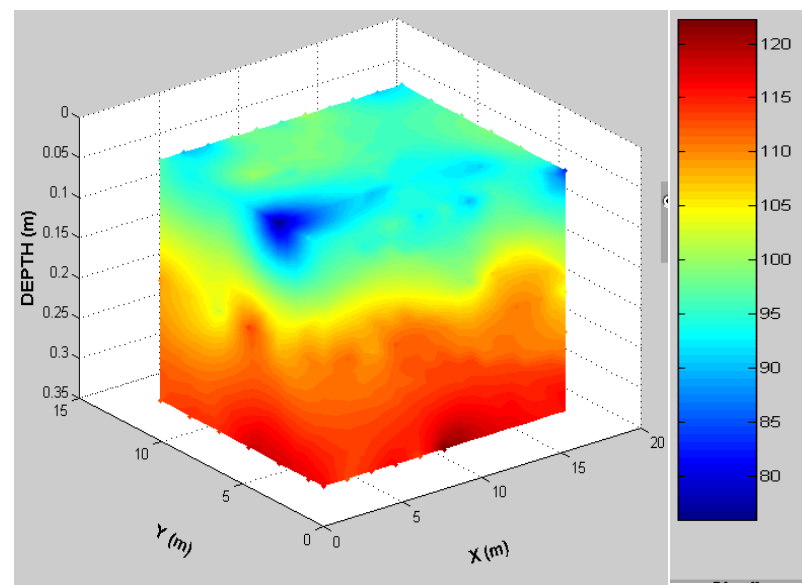
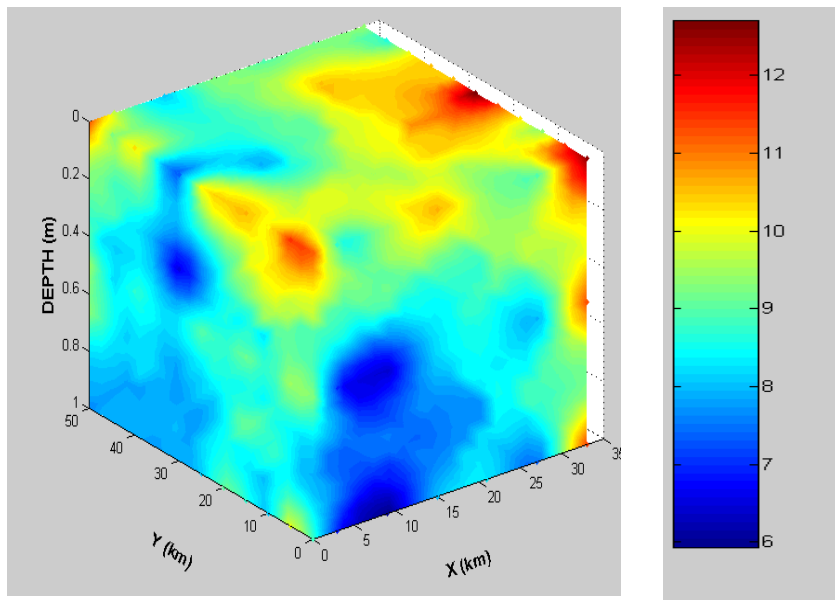


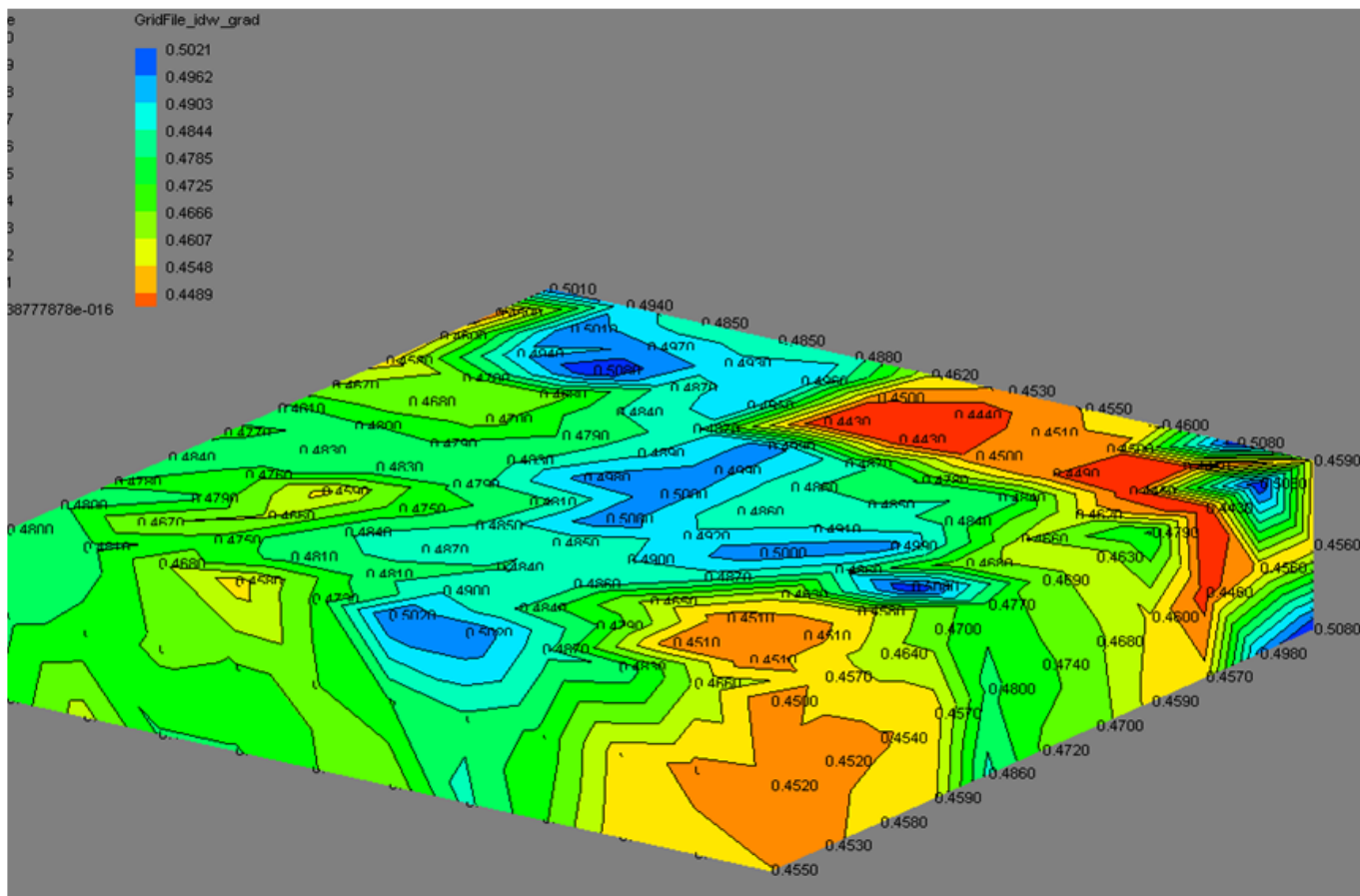


The Generation of Moisture & Density for Subsurface Changes.

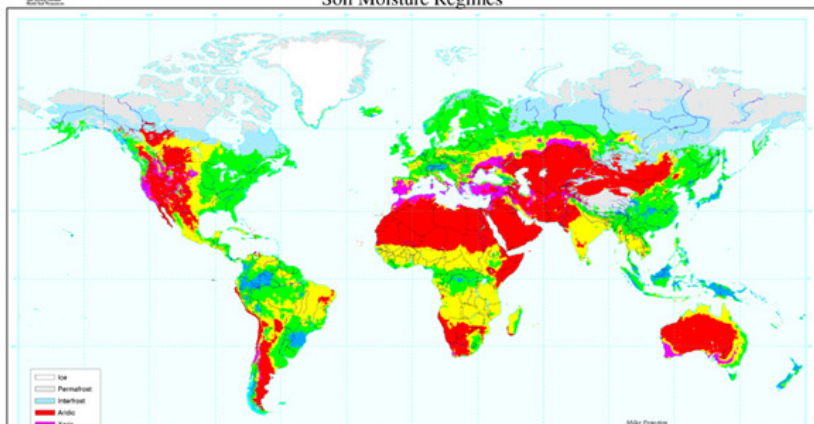
Low Moisture indicates Changes whose Spatial Structure is Random

Density & Porosity Increase with Depth

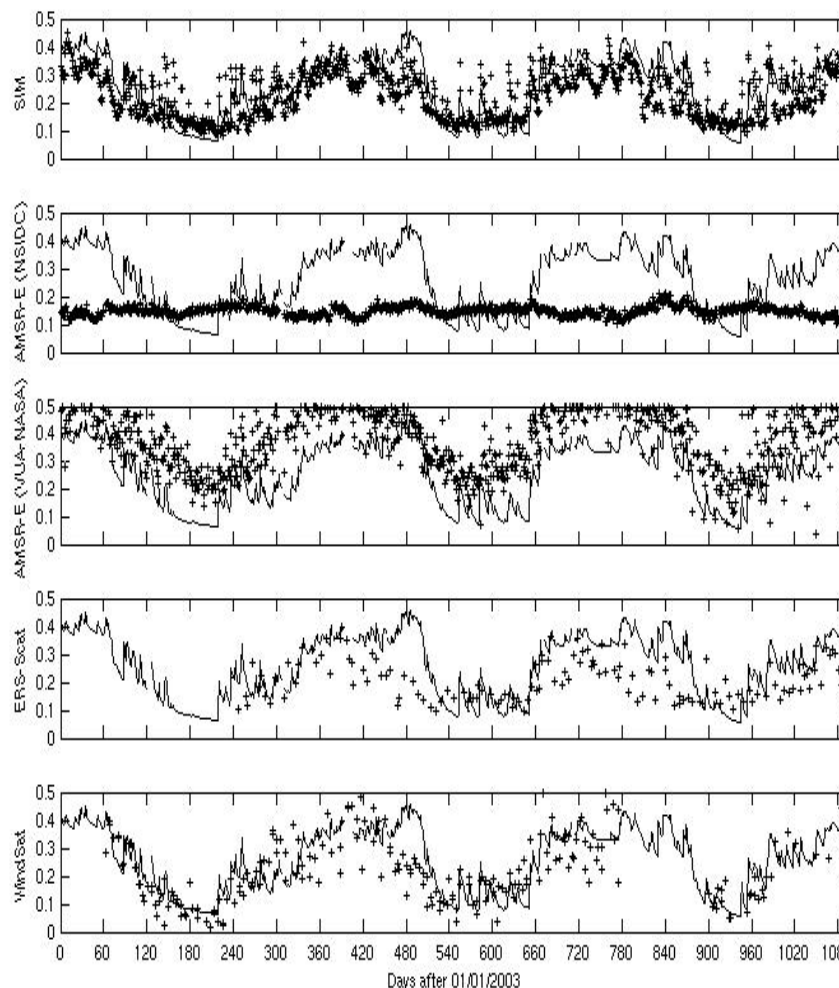
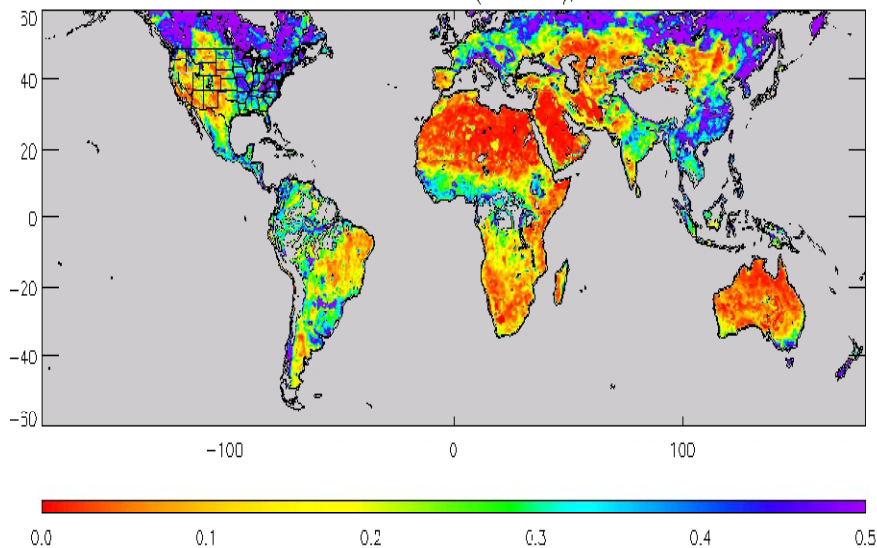




Soil Moisture Regimes



WindSat Global Soil Moisture (Fraction), d20030920-29



Initial Soil Moisture From LSM and Satellites