Geostatistical Method for Analysis of Large Scale Spatial Variability of Soil Moisture

Tarendra Lakhankar, Andrew Jones, Cynthia Combs, Manajit Sengupta and Thomas H. Vonder Haar
Cooperative Institute for Research in the Atmosphere, Colorado State University

Abstract. The spatial pattern of soil moisture varies at different scales due to evapo-transpiration and precipitation which are transformed by topography, soil texture, and vegetation. The mapping of soil moisture by remote sensing has several advantages over conventional field measurement techniques especially in the case of heterogeneous landscapes. However, validation of a soil moisture product such as those from the AMSR, WindSAT and SSM/I at larger footprints is difficult using only field point measurements. One validation approach is to use existing soil moisture measurement networks and scale these point observations up to the resolution of remote sensing footprints. This is possible by characterizing the variability of soil moisture data using a geostatistical approach. The prediction of a point soil moisture value has higher uncertainty due to its stochastic sampling nature. Therefore, it is interesting to relate point-based field measurements with averaged pixel measurements from satellite remote sensing by using block kriging for interpolation between scales. The aim of this study is twofold. First, the characteristics of the in-situ OK Mesonet data variogram are compared to AGRMET (Agricultural Meteorology model) and WindSAT soil moisture and precipitation data using Bias, RMSE, and variance ratio. Second, the kriging prediction is cross-validated at sampling locations not used in kriging analysis. This paper aims to use 100+ Oklahoma Mesonet field soil moisture data points to compare to the AGRMET and WindSAT soil moisture products. AGRMET is a near real-time global land surface analysis model generate soil moisture at 47 km spatial resolution based on NOAH community land-surface soil hydrology module operated by the U.S. Air Force. WindSAT is the first spaceborne high-precision passive microwave imager measures partially polarized energy emitted, scattered, and reflected form the earth's atmosphere and surfaces. The soil moisture values from WindSAT microwave brightness temperature were retrieved using Microwave Land Surface Model. For the study, the time period of September 2003 was chosen. A strong front with associated precipitation crossed the Midwest during this month, allowing a view of soil moisture both before and after a heavy rain event, plus periods of drying. Many locations had two significant rain events during this period. The spatial distribution of the above data sets is suitable for this type of kriging analysis. The variogram analysis indicates that the de-correlation length is higher for AGRMET compared to the OK Mesonet data. This could be due to a smoothing effect in soil moisture estimation using the AGRMET model, as higher smoothing leads to larger de-correlation length. We also found that the effect of precipitation via change in soil moisture on de-correlation length at higher average soil moisture leads to lower de-correlation length for both AGRMET and OK Mesonet data. The variance of the variogram (sill) is higher at wet soil moisture conditions. The average RMSE value of estimated soil moisture at 11 sampling locations not used in the kriging analysis is found to be 3.5% of the soil moisture value. Variances of OK Mesonet soil moisture values are low during the dry season and high during the wet season.