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Soil moisture spatial distribution at the SMOS Cal/Val Campaign POLESIE (AO-3275) in Poland

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Soil Moisture (SM) is one of important ECVs (Environmental Climate Variable) recommended for monitoring by GCOS (Global Climate Observing System) for relevance to the climate change. The ESA Mission SMOS (Soil Moisture and Ocean Salinity) takes it for a purpose. SM is measured in-situ by means of various techniques with much diverse precision depending on available hardware and methods. Validation of global scale SMOS observations by the ground based data sets being non uniform in precision within temporarily dynamic variation of the SM spatial distribution is a challenge for the ground based campaigns, and for resolving precision issues related to the exchange of water between soil, vegetation cover and atmosphere in land areas. Satellite observations provide good representation of spatial and temporary distribution of SM on large scales, but with a price of spatial resolution and moderate radiometric resolution in terms of the Brightness Temperature (BT) for the case of SMOS, or in terms of reflectivity for the case of Synthetic Aperture Radar (SAR). The problem is in a proper generalization and separation of classes in the image, which depends not only on technical conditions but essentially on scales of imaging. Large scale data provide good recognition of large scale gradients and temporary trends but introduce biasing and uncertainty in absolute measures. Therefore validating data have to provide removing this uncertainty properly to scales.

This is a practical trouble to constrain imprecision of the ground data and distinguish spatial and temporal trends from the technically deserved error contribution, which usually can cover the trends. The ground data available from a single site, or in statistically small representation in time do not suffice for large scale validation. The work reported by the paper explains motivations for a sufficiently dense sampling SM over the test area, and reach for the geostatistical method of probabilistic interpolation called krigging, to recover SM trends usually buried under systematic and random errors.

The data from two test areas are discussed in the paper, to illustrate the need of revealing large scale trends and separating them from the measurement errors. Each area was sampled in more than 200 places, taking TDR measurements and soil specimens for physical and chemical analysis. Sampling was performed with different density and different order depending on the field scale. Two sizes of test sub-fields were chosen with the area 1.25 ha and 2 ha, and each was in different shape of the coverage by samples. One with 1.25 ha was short but wide. The other one with 2 ha was long and narrow. The entire area of the commune was also characterized up to the 140 km^2 within correspondingly less density.

Space variograms obtained for the sub-fields, revealed SM distribution corresponding to local runoff flow paths, depressions and the vegetation canopy cover. It was concluded that narrow sub-fields disclosed existing exponential-like component trends, while the broad sub-fields disclosed the trend components of spherical shapes. Variation of the SM absolute measure was ranged from 0 to 0.8 m^3 m^{-3}. If the krigging was not applied on small or medium sized sub-fields, then the trends are hard to recognize and often can be taken for effects of the systematic measurement errors, caused by the limited precision of calibration. The TDR measurement technique is efficient for taking great number of samples but is very sensitive on calibration for the soil properties, varying from place to place. In effect a plan of sampling the sub-fields have been established for the aimed Cal/Val campaigns.

This kind of the ground based work is necessary to provide the in-situ data useful for the disaggregation of SMOS data pixels, which are 40×40 km. The satellite sensor of SMOS provides large scale averaging correspondingly to the global scale but in a price of biasing in absolute measures. The ground based data is usually sparse in coverage and affected by random and systematic errors, which are non-uniformly dispersed in space. Simple methods of averaging don't bring good effects especially when the sampling grid is sparse and usually also non-uniform. This is a problem of scales, and pertains referring ground based data to other types of satellite observations, not only to SMOS.

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