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Spatial variability of soil moisture retrieved by SMOS satellite

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Standard statistical methods assume that the analysed variables are independent. Since the majority of the processes observed in the nature are continuous in space and time, this assumption introduces a significant limitation for understanding the examined phenomena. In classical approach, valuable information about the locations of examined observations is completely lost. However, there is a branch of statistics, called geostatistics, which is the study of random variables, but taking into account the space where they occur. A common example of so-called "regionalized variable" is soil moisture. Using in situ methods it is difficult to estimate soil moisture distribution because it is often significantly diversified. Thanks to the geostatistical methods, by employing semivariance analysis, it is possible to get the information about the nature of spatial dependences and their lengths. Since the Soil Moisture and Ocean Salinity mission launch in 2009, the estimation of soil moisture spatial distribution for regional up to continental scale started to be much easier.
In this study, the SMOS L2 data for Central and Eastern Europe were examined. The statistical and geostatistical features of moisture distributions of this area were studied for selected natural soil phenomena for 2010-2014 including: freezing, thawing, rainfalls (wetting), drying and drought. Those soil water "states" were recognized employing ground data from the agro-meteorological network of ground-based stations SWEX and SMUDP2 data from SMOS. After pixel regularization, without any upscaling, the geostatistical methods were applied directly on Discrete Global Grid (15-km resolution) in ISEA 4H9 projection, on which SMOS observations are reported. Analysis of spatial distribution of SMOS soil moisture, carried out for each data set, in most cases did not show significant trends. It was therefore assumed that each of the examined distributions of soil moisture in the adopted scale satisfies ergodicity and quasi-stationarity assumptions, required for geostatistical analysis. The semivariograms examinations revealed that spatial dependences occurring in the surface soil moisture distributions for the selected area were more or less 200 km. The exception was the driest of the studied days, when the spatial correlations of soil moisture were not disturbed for a long time by any rainfall. Spatial correlation length on that day was about 400 km. Because of zonal character of frost, the spatial dependences in the examined surface soil moisture distributions during freezing/thawing found to be disturbed. Probably, the amount of water remains the same, but it is not detected by SMOS, hence analysing dielectric constant instead of soil moisture would be more appropriate. Some spatial relations of soil moisture and freezing distribution with existing maps of soil granulometric fractions and soil specific surface area for Poland have also been found.

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