Homogenisation of structural breaks in a global multi-satellite soil moisture data record

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The blending of soil moisture (SM) time series derived from different active and passive remote sensing instruments with varying sensor characteristics (frequency, polarization, radiometric accuracy) in the global ESA CCI SM climate data record (CDR), can potentially lead to artificial, structural breaks at transition times between sensor products, which may negatively affect long term studies on climate changes or risk assessments, which make use of 40 years of SM observations provided in the dataset.

We detect relative inhomogeneities in mean and variance between sensor periods using non-parametric statistical tests with homogeneous reference SM from MERRA2 land surface model simulations and adjust breaks with respect to corrections from models derived from observations within homogeneous sub-periods of ESA CCI and reference SM.

We compare different methods for adjusting inhomogeneities (relative adjustment based on matching linear regression models, higher order moments adjustment based on predictions from (non-linear) regression models and adjustment by matching quantile categories of empirical distributions) and rate them in terms of their usability on ESA CCI SM.

We use in-situ SM observations from the international soil moisture network (ISMN) and surface model SM for validation to investigate the impact of break correction methods on satellite SM and define a modular, extendable framework to test and adjust multiple breaks in a single observation series, taking into account seasonality, correlations between ESA CCI and reference SM, varying spatial and temporal coverage of satellite SM as well as different lengths of homogeneous sub-periods. We examine the impact of adjustment on long term climate dynamics in ESA CCI SM by detecting monotonic, significant trends using a non-parametric Mann-Kendall test and compare our results to trends in other soil moisture data sets and recommend the use of future versions of ESA CCI SM, for which the number of breaks will be reduced.