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Development of a Spatially Upscaled Soil Spectral Library (SUSSL) of cropland signatures for EO sensors data simulation and calibration/validation of topsoil organic carbon prediction models

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Optical remote sensing and in particular hyperspectral or imaging spectroscopy remote sensing has been long proved to be an adequate method to predict topsoil organic carbon (Corg) content with good accuracy when the soils are well exposed and undisturbed. Several recent studies demonstrated further in science cases the potential of multispectral Copernicus Sentinel-2 data for bare soils Corg prediction, although challenges were reported related to the impact of disturbing factors. Disturbing factors that can affect the prediction and performances of soil surface properties from optical remote sensing are several and can be e.g. due to mixing in the field-of-view with partial vegetation cover depending on the landscape fragmentation. Most pixels at the remote sensing level are composites and in croplands, mixtures of soils with trees or green plants, or mixture with crop residues after harvest are likely. Another factor might be the presence of residual soil moisture or standing water after rain events. Soil reflectance decreases with increasing soil moisture and increasing soil roughness. Soil Surface roughness changes are observed due to variations in soil texture and to variable microtopography. Possible angular and solar illumination changes may affect the soil reflectance as well.

In the frame of the ESA WORLDSOILS Project (https://www.world-soils.com) aiming at developing a pre-operational Soil Monitoring System to provide yearly estimations of soil organic carbon at global scale based on space-based EO data, we are working on the development of a spatially upscaled soil spectral library (SUSSL). The SUSSL is based on a sub-selection of the European LUCAS soil database, and includes simulation of realistic scenarios of 'landscape-like' cropland reflectance data with effect of mixture with green and dry vegetation, effect of varying soil moisture content, and effect of variable soil roughness. This database is further convoluted to the different spectral response functions of several EO sensors to simulate EO view of surface reflectances in croplands. In a next step, the SUSSL shall be used for the test and validation of different correction, disaggregation and unmixing techniques to assess the capabilities of the retrieval of undisturbed surface reflectance, to which soil prediction models can be applied with increased accuracy. In this talk, we will present the database developed, including methodological choices and parameter selections for the simulation of the different disturbing effects. Further, preliminary assessments will be shown on the uncertainties of the undisturbed vs. disturbed signal and impact on soil properties prediction.