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Hyperspectral remote sensing for soil organic carbon mapping

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Satellite and airborne hyperspectral remote sensing is increasingly investigated as a fast and convenient tool to map soil properties. However, several research have pointed out the difficulty to obtain good calibration results over large areas due to spatial variation in soil types and surface soil conditions (moisture content, roughness, vegetation cover). These effects induce a spectral variability not directly related to the property studied and decrease the accuracy of predictions. A flight campaign was organized on 4-9th October 2007 using the AHS-160 airborne spectrometer to predict Soil Organic Carbon (SOC) in bare cropland soils in Grand-Duchy of Luxembourg. The study area consisted in a north-south transect of $\tilde{7}$ km width and $\tilde{6}0$ km length and crossed 4 of the 5 agro-geological regions of Luxembourg, characterized by various soil types such as Cambisols, Luvisols, Arenosols and Calcisols. After collecting more than 300 soil samples of the soil surface, spectral data was related with SOC content using several standard multivariate calibration techniques (Partial Least Square Regression, Penalized-spline Regression, Support Vector Machine). It is shown that calibrations yield reasonably accurate predictions over large areas as long as secondary information (e.g. soil types, agro-pedological regions) are included in the models (Root Mean Square Error of Prediction: $\tilde{3}$ g C kg-1). Such calibration models could be applied to every soil pixel of the hyperspectral image to produce a SOC map of the area. However, predictions have been realized using statistical relationships based on a set of calibration randomly chosen from a set of samples collected during a field campaign, the rest being used for validation purposes. It means that the validation set is not completely independent from the calibration set. As a consequence, a true independent validation (over fields not covered by the calibration/validation sets) would probably give lower accuracies than the ones calculated from calibration/validation sets taken from the same set of fields. While the SOC mapping of some selected fields have been realized, it raises several issues which precludes, for the time being, the use of hyperspectral remote sensing as an operational tool for the large-scale mapping of soils.