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Validation of soil organic carbon predictions based on airborne imaging spectroscopy and multivariate regressions

Antoine Stevens, Bas van Wesemael, and Isabel Miralles

Georges Lemaître Centre for Earth and Climate Research , UCLouvain, Louvain La Neuve, Belgium
(antoine.stevens@uclouvain.be)

Multivariate regressions are frequently used to predict soil properties from airborne imaging spectroscopy data. Samples are taken in the field and their properties analysed using conventional methods. The predictive ability of the models is often estimated by randomly splitting samples into a calibration and validation set. This procedure is likely to overestimate the true prediction accuracy for pixels that are spectrally different to the calibration set. Based on a hyperspectral image acquired over the Grand-Duchy of Luxembourg (flight line of 420 km^2), we propose to validate multivariate calibration models (Partial Least Square and Penalized-spline Signal regressions) of Soil Organic Carbon (SOC) content using an independent set of samples. We observed an increase in prediction error between the calibration and validation set in the order of 8 to 138 %, the best model reaching Root Mean Square Error (RMSE) of 4.5 $gCkg^{-1}$ and Ratio of Performance to Deviation (RPD) of 1.75. An analysis of the pattern of the errors revealed that this phenomenon can be related to the location of the validation samples in the score space. In order to produce a reliable SOC map, multivariate models were refitted through a cross-validation of the entire sampling database. The distributions of predicted and observed SOC were compared at both regional (difference between mean values $1\ gCkg^{-1}$) and field scales (differences $< 5gCkg^{-1}$). Finally, the potential of imaging spectroscopy for SOC monitoring were explored with a Power Analysis.