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Sensitivity of soil property prediction obtained from Hyperspectral VNIR-SWIR imagery to atmospheric effects and degradation in image spatial resolutions

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Visible and near-infrared (VNIR, 400-1000 nm) and short-wave infrared (SWIR, 1000-2500 nm) hyperspectral satellite imaging is one of the most promising tools for soil property mapping because i) it is derived from a lab technique that has proven to be a good alternative to costly physical and chemical laboratory soil analysis for estimating a large range of soil properties; ii) it can benefit from the increasing number of methodologies developed for VNIR-SWIR hyperspectral airborne imaging; and iii) it provides a synoptic view of the area under study. Despite the great potential of VNIR-SWIR hyperspectral airborne data for soil property mapping, the transposition to satellite data must be evaluated. The objective of this study was to test the sensitivity of soil property prediction results to atmospheric effects and to degradation in image spatial resolutions. This may offer a first analysis of the potential of future hyperspectral satellite sensors (HYPXIM, PRIMSA, ENMAP and HyspIRI) for Soil applications. This study employed VNIR-SWIR AISA-DUAL hyperspectral airborne data acquired in the Mediterranean region over a large area (300 km^2) with an initial spatial resolution of 5 m. These airborne data were simulated at the top of atmosphere, aggregated at 7 spatial resolutions (5, 10, 15, 20, 30, 60 and 90m) and then atmospherically corrected, to fit with future hyperspectral satellite sensors. The predicted soil property maps were obtained using the partial least squares regression (PLSR) method, and the studied soil property was the clay content. The large area of the studied region allows us to analyze different pedological patterns in terms of soil composition and spatial structures. Our results showed that (i) PLSR models had robust performances from images at 5 to 30m and were inaccurate from images at 60 and 90m; (ii) when a correct compensation of the atmosphere effects was done, no differences were detected between the clay maps retrieved from airborne imagery and the ones from spaceborne imagery; (iii) the spatial aggregation of the images meant a loss of the variance of the clay prediction from 15 m of spatial resolution and a loss of information on soil spatial structures from 30 m of spatial resolution.