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Retrieval of Topsoil Properties of Vegetation-Covered Terrain Using Airborne Hyperspectral Data

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Soil spectroscopy is a promising technique for topsoil analysis, and has been successfully utilized in the laboratory. When it is applied from airborne platforms, the presence of vegetation significantly affects imaging spectroscopy or hyperspectral imaging when retrieving topsoil properties. A Forced Invariance Approach has been proved to be able to effectively suppress the vegetation signal in mixed pixels. However, the approach is still mainly limited to lithological mapping. In this paper, we attempted to apply it to the retrieval of topsoil properties (soil moisture and soil salinity at depths 4 cm and 10 cm) using airborne hyperspectral data. The corresponding ground truth data was obtained from an eco-hydrological wireless sensing network in the Zhangye Oasis in the middle stream of the Heihe River Basin, China. The General Linear Model with Logit Link Function was adopted to model the relationships between measured soil properties and the spectra.

The vegetation suppression result demonstrates that the spectral response curves of hyperspectral image pixels are flattened and the shapes are rather similar to the soil endmenber spectrum. From the modelling results it can be seen that the Forced Invariance Approach is more effective for soil moisture than for soil salinity at depth 10 cm, as the salt content is comparatively lower than the water content in soil, and the corresponding spectral response is weaker. This approach did not work for soil at a depth of 4 cm. The reason for this is that surface soil is significantly influenced by exterior factors like irrigation and wind, and landscape fragmentation and cultivation activities also contribute to the high spatial heterogeneity of the surface soil properties.