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VNIR-SWIR-TIR hyperspectral airborne campaign for soil and sediment mapping in semi-arid south african environments

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Airborne hyperspectral remote sensing techniques has been proven to offer efficient procedures for soil and sediment mineralogical mapping in arid areas on larger scales. Optical methods based on traditional remote sensing windows using the solar reflective spectral wavelength range from the visible-near infrared (VNIR: 0.4-1.1 μm) to the short-wave infrared region (SWIR: 1.1-2.5 μm) allow mapping of common soil properties such as iron oxides, textural characteristics and organic carbon. However, soil mapping in semi-arid environments using VNIR-SWIR is currently limited due to specific spectral characteristics. Challenges appear in such environments due to the common presence of sandy soils (coarse textured) which grain size distribution is driven by the dominant mineral, quartz (SiO_2), and which lacks any distinctive Si–O bond related spectral features within the VNIR-SWIR. Furthermore, another challenge is represented by the common presence of other specific spectral features due to different salts (gypsum, halite) or coatings of different forms (cyanobacteria, iron-oxides and/or –oxyhydroxides) for which few studies exists or that oft prevent detection of any other potential spectral feature of e.g. soil organics. In this context, more methodological developments are needed to overcome current limitations of hyperspectral remote sensing for arid areas, and to extent its scope using the thermal infrared (TIR) wavelength region within the atmospheric window between 8 and 14 μm (longwave infrared).
In 2015 an extensive VNIR-SWIR-TIR airborne hyperspectral dataset consisting of HySpex-VNIR, HySpex-SWIR (NEO) and Hyper-Cam (TELOPS) data has been acquired in various Namibian and South African landscapes part of the Dimap/GFZ campaign in the frame of the BMBF-SPACES Geoarchive project. Research goals are 1) to demonstrate the capabilities to extract information from such a dataset and 2) to demonstrate the potential of advanced hyperspectral remote sensing techniques for the characterisation of semi-arid and arid areas using both VNIR-SWIR and TIR spectral data. The sites of interest include salt and clay pans, dry river valleys, sand dune savanna of the Kalahari, and feature a wide range of complex mineralogical mixtures at the surface. For data calibration and validation extensive field campaigns took place to characterise the surfaces chemical composition. In this paper we will present the imagery acquired, challenges for the processing and analyses of this exceptional dataset, and preliminary results in terms of mineralogical mapping.