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Monitoring of Antarctic moss ecosystems using a high spatial resolution imaging spectroscopy

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The most abundant photosynthetically active plants growing along the rocky Antarctic shore are mosses of three species: Schistidium antarctici, Ceratodon purpureus, and Bryum pseudotriquetrum. Even though mosses are well adapted to the extreme climate conditions, their existence in Antarctica depends strongly on availability of liquid water from snowmelt during the short summer season. Recent changes in temperature, wind speed and stratospheric ozone are stimulating faster evaporation, which in turn influences moss growing rate, health state and abundance. This makes them an ideal bio-indicator of the Antarctic climate change. Very short growing season, lasting only about three months, requires a time efficient, easily deployable and spatially resolved method for monitoring the Antarctic moss beds. Ground and/or low-altitude airborne imaging spectroscopy (called also hyperspectral remote sensing) offers a fast and spatially explicit approach to investigate an actual spatial extent and physiological state of moss turfs. A dataset of ground-based spectral images was acquired with a mini-Hyperspec imaging spectrometer (Headwall Inc., the USA) during the Antarctic summer 2012 in the surroundings of the Australian Antarctic station Casey (Windmill Islands). The collection of high spatial resolution spectral images, with pixels about 2 cm in size containing from 162 up to 324 narrow spectral bands of wavelengths between 399 and 998 nm, was accompanied with point moss reflectance measurements recorded with the ASD HandHeld-2 spectroradiometer (Analytical Spectral Devices Inc., the USA). The first spectral analysis indicates significant differences in red-edge and near-infrared reflectance of differently watered moss patches. Contrary to high plants, where the Normalized Difference Vegetation Index (NDVI) represents an estimate of green biomass, NDVI of mosses indicates mainly the actual water content. Similarly to high plants, reflectance of visible wavelengths is controlled by the composition and content of various foliar pigments (chlorophylls, xanthophylls, etc.). Additionally, the high spectral resolution reflectance together with the narrow bandwidth allows retrieving the steady state chlorophyll fluorescence, which indicates the actual moss photosynthetic activity. A first airborne imaging spectroscopy acquisition with the mini-Hyperspec sensor on-board a low-flying remote-controlled multi-rotor helicopter (known as micro Unmanned Aerial Systems – UAS) will be performed during the summer 2013. The aim of the UAS observations is to generate high spatial resolution maps of actual physiological state of several moss beds located within the Australian Antarctic Territory. The regular airborne monitoring is expected to reveal spatio-temporal changes in the Antarctic moss ecosystems, indicating the impact of the global climate change in Antarctica.