Using an Unmanned Aerial Vehicle (UAV) to capture micro-topography of Antarctic moss beds

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Abstract

This study is the first to use Unmanned Aerial Vehicles (UAVs) for mapping moss beds in Antarctica. Polar regions are experiencing rapid and severe climatic shifts with major changes in temperature, wind speed and UV-B radiation already observed in Antarctica. Since vegetation is isolated to the coastal fringe and climatic records only extend back 50 years, with limited spatial resolution, we urgently need new proxies to determine if coastal climate has changed over the past century. In a manner similar to trees, old growth mosses also preserve a climate record along their shoots. Mosses can therefore be used as sentinels to provide crucial information on how the Antarctic coastal climate has changed over past centuries.

The spatial scale of moss beds (tens of m²) makes satellite imagery unsuitable for mapping their extent in sufficient detail. Recent developments in the use of UAS, also known as unmanned aerial vehicles (UAVs), for remote sensing applications provide exciting new opportunities for ultra-high resolution mapping and monitoring of the environment. In this study, we used a micro-UAV consisting of an auto-piloted multi-rotor helicopter (i.e. OktoKopter) carrying three different sensors: a 6-band multispectral sensor, a high resolution visible camera, and a thermal sensor for cost-effective, efficient, and ultra-high resolution mapping of moss beds in the Windmill Islands, Antarctica.

In this presentation we will focus on the use of a new computer vision algorithm, called Structure-from-Motion (SfM), for extracting an ultra-high resolution digital surface model (DSM) (2 cm pixel size) and orthophoto mosaic (1 cm pixel size) from the UAV aerial photography. The DSM successfully captured the micro-topography of the moss beds to an accuracy of 4 cm. From the DSM the contributing upstream area was derived as a proxy for water availability from snowmelt, one of the key environmental drivers of moss health. A Monte Carlo simulation with 300 realisations was implemented to model the impact of error in the DSM on runoff direction. Significant correlations were found between these simulated water availability values and field measurements of moss health and water content. In the future ultra-high spatial resolution DSMs acquired with a UAV could thus be used to determine the impact of changing snow cover on the health and spatial distribution of polar vegetation non-destructively.