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The potential of Unmanned Aerial Vehicles (UAVs) has significantly increased over the last five years due to cost reductions and improved sensors. In addition, advanced real time kinematic GPS techniques have enabled cm-accuracy navigation and flight control for UAVs. UAVs have numerous advantages compared to other technologies: compared to field based techniques, remote sensing with UAVs is a non-destructive technique, less time consuming, ensures a reduced time between acquisition and interpretation of data and gives the possibility to access remote and unsafe areas. Compared to full-size aircrafts and spaceborne systems, environmental surveys carried out with UAVs are economically efficient, ensure a higher spatial accuracy and resolution and offer more flexibility in terms of payload design and deployment.

This study is part of the “Smart UAV” project, which is a collaboration between DTU Environment, DTU Space and the company Sky-Watch A/S. The project aims to develop an innovative prototype that will combine the different advantages of fixed wing and rotary wing UAVs. The Smart UAV will not exceed a total weight of 7 kg., including payload (external sensors) of 1.5 kg. It will be able to fly a total distance of 20 km or hover for 20 min. The prototype will carry a water level ranging sensor, a 6-band multispectral camera and a thermal camera. The water level sensor will determine the orthometric water level in rivers and reservoirs at an accuracy of 10 cm or better. The multispectral camera will be able to record the spectral signatures of water and land surfaces with a pixel resolution of around 15 cm, whereas the thermal camera will sense water and land surface temperature with a resolution of 40 cm. Post-processing of data from the thermal camera will allow retrieving vegetation and soil temperature, whereas data from the multispectral cameras will enable estimation of vegetation cover, chlorophyll-carotenoids content and plant stress indices.

The main goal is to retrieve innovative real time data to inform hydrological simulation models and land surface energy balance models over agricultural and forestry sites. The acquired data will enhance estimation of evaporation from land surfaces and transpiration from plants. Water level and actual ET observations will be assimilated to hydrological model to enhance their forecast skill. Data assimilation and model fusion will enable us to assess the water cycle at local scale, through evaluation of surface evapotranspiration, surface run-off, channel run-off and water storages. The multispectral imagery will allow retrieving indices such as NDVI, OSAVI, carotenoid contents and PRI. NDVI and OSAVI are retrieved to determine fractional vegetation cover and senescence progression, carotenoids content is useful to understand the reaction of organism to changing environmental light condition and the uptake rate of carbon dioxide by foliage and PRI is an estimation of vegetation productivity and stress. Implementations of soil–vegetation–atmosphere transfer models (SVAT) will give access to a detailed description of soil and vegetation canopy processes allowing us to estimate water and energy fluxes continuously. Moreover, our research has great potential future for phenotyping evaluations such as non-invasive and accurate identification of senescence progression, biomass estimation, nutrient deficiencies, canopy nitrogen amounts, diseases, water deficiency or surplus.