EGU21-15708
https://doi.org/10.5194/egusphere-egu21-15708
EGU General Assembly 2021

Prediction of above ground biomass and C-stocks based on UAV-LiDAR,multispectral imagery and machine learning methods.

Jaime Caballer Revenga[1], Katerina Trepekli[1], Stefan Oehmcke[2], Fabian Gieseke[2], Christian Igel[2], Rasmus Jensen[1], and Thomas Friborg[1]
[1]Copenhagen university, Department of Geoscience & Natural Resources Management, Terrestrial Ecosystem Analysis, Denmark.
[2]Copenhagen University, Department of Computer Science, Denmark.

Current efforts to enhance the understanding of global carbon (C) cycle rely on novel monitoring campaigns of C sequestration in terrestrial ecosystems.The successful outcome of such efforts will be relevant to sectors ranging from climate change and land use studies (global scale) to precision agriculture and land management consultancy (local scale).To that end, current investigations apply recently developed scientific instrumentation - e.g. Light detection and Ranging (LiDAR) - and computational methods - e.g. Machine Learning (ML). Near-field remote sensing - i.e. Unmanned Aerial Vehicle (UAV)-LiDAR -, can provide high resolution LiDAR data, increasing the monitoring accuracy of C stocks estimates and biophysical variables at the ecosystem scale. In contrast to previous approaches (e.g. image-derived vegetation indices), UAV-LiDAR provides a true 3D description of the canopy vertical structure. In order to evaluate the potential of new approaches towards precise C stock quantification in an agricultural field of Denmark (13 ha.), using near-field remote sensed data, we compare the results based on using 3D canopy metrics - derived from UAV-LiDAR - against the well-established multispectral image based metrics. Then, the performance of six different machine learning (ML) models - two Random Forest variations, KNN, AdaBoost, ElasticNet, Support Vector, and Linear regression - designed to predict above ground biomass (AGB) based on a set of features derived from (i) UAV-LiDAR point cloud data (PCD), and (ii) multispectral imagery is evaluated. Their prediction quality are tested against unseen data from the same species, and sampling campaigns. Also, the sources of uncertainty are assessed as well as the importance of each predicting feature. The field work was conducted within the footprint of an Integrated Carbon Observation System (ICOS) class 1 station site, facilitating ecosystem traits monitoring in real time. The aerial and biomass sampling campaigns have been operated at 15-days frequency during the crops' growing period, in which, simultaneously, UAV-LiDAR and multispectral image data as well as ground truth biomass data were collected. By means of laboratory analysis, C and nutrient content in the crops' biomass was also determined. Based on arithmetic and morphological methods, the PCD were pre-processed to remove noise and classify them to ground and vegetation points. By means of the methods described, we demonstrate that UAV-LiDAR combined with multispectral data and ML methods can be used to accurately estimate AGB, 3D ecosystem structure as well as C-stocks in agricultural ecosystems.