UAV-Lidar Data Combined with Multispectral and Thermal Infrared Imagery May Increase the Accuracy of Water Vapor Flux Estimates in Heterogeneous Vegetated Areas.

Katerina Trepekli[1], Andreas Westergaard-Nielsen[2], and Thomas Friborg[3]

[1]University of Copenhagen
[2]Københavns Universitet,University of Tasmania,University of Copenhagen
[3]Københavns Universitet

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Abstract

Advances in remote sensing technology, notably in UAV Light Detection and Ranging (Lidar), may yield to better predictions of the implications of land cover alterations on greenhouse gas (GHG) exchanges by facilitating the acquisition of high-resolution information on surface topography and vegetation structure. Although surface morphology is fundamentally related to the magnitude of aerodynamic roughness length (zo) and zero place displacement height (d), assigning appropriate values to estimate energy and GHG fluxes remains challenging. In this study, we evaluate the effectiveness of a workflow for processing small-footprint point clouds from a UAV-Lidar system, multispectral and thermal infrared data in order to obtain necessitated parameters for calculation of water vapor fluxes over a mixed canopy, populated by agricultural vegetation and evergreen trees in Denmark. Point cloud data are classified into ground and vegetation using the progressive triangulated irregular network densification algorithm, and are interpolated with the kriging method to generate canopy height models (CHMs) with 0.5 m pixel resolution. CHMs are then delineated using the watershed algorithm to extract geometrical characteristics, orientation and spacing of the low and high vegetation and assign them to four morphometric roughness models that calculate zo and d. The rasterized aerodynamic resistance maps are rectified with thermal and multispectral orthomosaics to obtain the spatial distribution of available energy, sensible heat and water vapor fluxes by incorporating these terms into a surface energy balance model. The Lidar-derived geometric attributes are validated with selected ground truth data and the modeled water vapor fluxes are compared with eddy covariance measurements. Derivation of more precise high-resolution aerodynamic parameters and reflectance characteristics from UAV-based instrumentation can increase the accuracy of water flux estimates of a canopy under surface heterogeneity conditions and may confine the uncertainty in describing the propagation of their long-term effects on ecosystem's resilience.

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KaterinaTrepekli, Andreas Westeergard-Nielsen, Thomas Friborg

Department of Geosciences and Natural Resource Management, University of Copenhagen, Øster Voldgade 10,1350 Copenhagen, Denmark

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