A forest canopy cover estimation method based on UAV-LiDAR and Sentinel-2 remote sensing data

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Canopy cover (CC), an important index of forest resources and biodiversity, is a useful biophysical parameter for forest structure. Light Detection and Ranging (LiDAR) data have been widely used to estimate forest parameters in forest ecosystems. Because of its higher spatial resolution, flight flexibility, and lower cost, the unmanned aerial vehicle (UAV) has become an alternative remote sensing platform, and the UAV-LiDAR system has begun to gain popularity. However, it cannot be used in a large area which limits its application in the primitive forest. To estimate forest CC on a large area, we designed a new strategy that combines UAV-LiDAR data and moderate spatial resolution Sentinel-2 satellite image. Using UAV-LiDAR data as training samples for a satellite remote sensing canopy cover inversion model helps address the issue of insufficient measured data in classic inversion models, boosting canopy cover inversion accuracy. The highly accurate canopy height model (CHM) was developed, and regional CC values were extracted for use as ground truth values in our study. To estimate the CC of all areas based on Sentinel-2 image data, three regression models were used: Random Forest (RF), Support Vector Machine (SVM), and Multivariable Stepwise Regression (MSR). The results from RF regression model achieved the highest R^2 (0.71) in the validation samples, compared with MSR (R^2: 0.52) and SVM (R^2: 0.67) regression models. The RF model also has high accuracy in CC mapping, with an overall classification accuracy of 0.74 and a Kappa coefficient of 0.67. Overall, the combination of UAV-LiDAR and the Sentinel-2 image provides a low-cost and high-automation estimation method for remote sensing monitoring of forest CC.