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Relationships between MODIS black-sky shortwave albedo and airborne lidar based forest canopy structure

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Albedo is one of the essential climate variables affecting the Earth's radiation balance. It is however not well understood how changes in forest canopy structure influence the albedo. Canopy structure can be mapped consistently for fairly large areas using airborne lidar sensors. Our objective was to study the relationships between MODIS shortwave black sky albedo product and lidar-based estimates of canopy structure in different biomes ranging from arctic to tropical. Our study is based on six structurally different forest sites located in Finland, Estonia, USA and Laos. Lidar-based mean height of the canopy, canopy cover and their transformations were used as predictor variables to describe the canopy structure. Tree species composition was also included for the three sites where it was available. We noticed that the variables predicting albedo best were different in open and closed canopy forests. In closed canopy forests, the species information was more important than canopy structure variables (R2=0.31-0.32) and using only structural variables resulted in poor R2 (0.13-0.15). If the 500 m MODIS pixel contained a mixture of forests and other land cover types, the albedo was strongly related to the forest area percent. In open canopy forests, structural variables such as canopy cover or height explained albedo well, but species information still improved the models (R2=0.27-0.52). We obtained the highest R2=0.52 using only structural variables in Laos on a partially degraded tropical forest with large variation in canopy cover. The different canopy structure variables were often correlated and the one that provided the best model changed from site to site.