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Multiscale assessment of northern forest characteristics based on ultra-high resolution data

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Abstract:

The algorithms for quantitative estimates of various structural and functional parameters of forest ecosystems, particularly boreal forests, on high resolution remote sensing data are actively developing since the mid-2000s. For monitoring of forest ecosystems located at the Northern limit of distribution, effective not only lidar data but also the optical data obtained by unmanned aerial vehicles (UAV's) with ultra-low altitude photography and derived products resulting from modern algorithms for the photogrammetric processing.

High-detail remote sensing from UAV's is a key level of monitoring of Northern forests at a large-scale level, ensuring the correct transition from sub - satellite ground-based studies to thematic products obtained from multi-time Hyper-and multispectral data of medium and relatively high resolution (MODIS, LANDSAT, Sentinel-2).

When planning and conducting specific case studies based on UAV data, special attention should be paid to the justification of the survey methodology. In particular, the choice of a strictly defined high-altitude echelon of the survey determines the recognition of the objects of study and the possibility of reliable determination of its properties and features. To study the parameters of forest ecosystems at the level of individual trees and at the level of forest plantations, we selected two different-height echelons of survey from ultra-low altitudes: from 50 m, which allowed us to obtain ultra-high-detailed data for each sample area provided by detailed ground-based studies with sub-tree account, and from 100 m-to obtain derived characteristics of forest communities within the area equivalent to 3 pixels of thematic MODIS products with a spatial resolution of 250 m. The data of optical survey with UAV were obtained in July 2018 for 22 plots located in the central part of the Kola Peninsula and representative of different types of North taiga stands and their dynamics under climate change.

At the stage of preprocessing images were obtained dense point clouds, characterizing both vertical and horizontal structure of stands. Digital terrain and terrain models and tree canopy models were obtained after cloud filtering and classification. Algorithms of automated segmentation and classification have been developed and tested to obtain such characteristics of stands as the height of individual trees, the area of crown projections, the projective cover of the tree-shrub layer. The obtained characteristics are aggregated by cells of a regular network with the dimension corresponding to the spatial resolution of Sentinel-2 and Landsat -8 data.

The main results of the works are digital spatial datasets for 22 sample plots: raw data with very high resolution imagery (optical images with very high resolution, dense point clouds, RGB-orthophoto) and create based on a thematic derivative products (digital terrain model, topography, tree canopy cover; map of the heights and projections of the crowns of trees, percent cover of tree and shrub vegetation).

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