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Vegetation height and cover fraction between 60° S and 60° N from ICESat GLAS data

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Abstract. We present new coarse resolution (0.5° × 0.5°) vegetation height and vegetation-cover fraction data sets between 60° S and 60° N for use in climate models and ecological models. The data sets are derived from 2003–2009 measurements collected by the Geoscience Laser Altimeter System (GLAS) on the Ice, Cloud and land Elevation Satellite (ICESat), the only LiDAR instrument that provides close to global coverage. Initial vegetation height is calculated from GLAS data using a development of the model of Rosette et al. (2008) with with further calibration on desert sites. Filters are developed to identify and eliminate spurious observations in the GLAS data, e.g. data that are affected by clouds, atmosphere and terrain and as such result in erroneous estimates of vegetation height or vegetation cover. Filtered GLAS vegetation height estimates are aggregated in histograms from 0 to 70 m in 0.5 m intervals for each 0.5° × 0.5°. The GLAS vegetation height product is evaluated in four ways. Firstly, the Vegetation height data and data filters are evaluated using aircraft LiDAR measurements of the same for ten sites in the Americas, Europe, and Australia. Application of filters to the GLAS vegetation height estimates increases the correlation with aircraft data from r = 0.33 to r = 0.78, decreases the root-mean-square error by a factor 3 to about 6 m (RMSE) or 4.5 m (68% error distribution) and decreases the bias from 5.7 m to −1.3 m. Secondly, the global aggregated GLAS vegetation height product is tested for sensitivity towards the choice of data quality filters; areas with frequent cloud cover and areas with steep terrain are the most sensitive to the choice of thresholds for the filters. The changes in height estimates by applying different filters are, for the main part, smaller than the overall uncertainty of 4.5–6 m established from the site measurements. Thirdly, the GLAS global vegetation height product is compared with a global vegetation height product typically used in a climate model, a recent global tree height product, and a vegetation greenness product and is shown to produce realistic estimates of vegetation height. Finally, the GLAS bare soil cover fraction is compared globally with the MODIS bare soil fraction (r = 0.65) and with bare soil cover fraction estimates derived from AVHRR NDVI data (r = 0.67); the GLAS tree-cover fraction is compared with the MODIS tree-cover fraction (r = 0.79). The evaluation indicates that filters applied to the GLAS data are conservative and eliminate a large proportion of spurious data, while only in a minority of cases at the cost of removing reliable data as well.

The new GLAS vegetation height product appears more realistic than previous data sets used in climate models and ecological models and hence should significantly improve simulations that involve the land surface.

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