

Forest resources monitoring using spaceborne LiDAR over Borneo

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Forests serve as a primary reservoir of terrestrial carbon. Recently, the technology for forest resources monitoring at large-scale is required for the purpose of understanding the global carbon cycle or supporting REDD+ scheme. Satellite remote sensing can provide the most practical mean for the large-scale observation, and spaceborne LiDAR is particularly expected. This sensor transmits a laser pulse from space to the Earth's surface, and records the time-varying return signal intensity as a waveform. The waveform makes it possible to analyze vertical structure near the surface. ICESat/GLAS was the only spaceborne LiDAR so far, which was operated by NASA from 2003 to 2009. However, there are some future plans of spaceborne LiDAR, such as ICESat-2, GEDI, and MOLI, and they are expected to be used for forest monitoring. This study aims to clarify the potential of spaceborne LiDAR to quantitatively observe forest biomass at large-scale. We targeted Borneo as a study area, where is one of the most important areas for REDD+ because the forest area in the island has been rapidly decreasing in recent years. First, we measured above-ground biomass (AGB) by the Bitterlich method at 37 plots, where corresponded with the GLAS footprints. And, we used the field measured data as the training data to develop an empirical model for estimating AGB from the GLAS waveform parameters. As a result of cross-validation, the accuracy of this model (root-mean-square error) was 32.1 Mg ha⁻¹. Next, we applied the developed model to the 127,862 points GLAS data over Borneo to assess the forest resources in the island. As a result, some features were found as follows: (1) the average AGB in Borneo was 183.1 Mg ha⁻¹, (2) the AGB of evergreen broadleaved forest was nearly two times larger than that of mangrove forest or shrub land, and (3) the total AGB in Borneo was 9.81 Gt. Next, we developed a wall-to-wall map of forest biomass over Borneo using MODIS satellite image (see figure), because GLAS observed at only discrete points. These results indicate that spaceborne LiDAR is a suitable sensor for forest resources monitoring at large-scale.

Keywords: Forest biomass, Spaceborne LiDAR, ICESat/GLAS, Borneo

