Large scale evaluation of decadal forest biomass changes using repeated airborne LiDAR observations in northern Japan.

Kojiro Hirayama[1], *Kentaro Takagi[1], Nobuko Saigusa[2], Keiji Okada[1], Ryoji Sameshima[1], Hiroyuki Oguma[2]

1.Hokkaido University, 2.National Institute for Environmental Studies

Valid estimation of terrestrial carbon cycle depends strongly on the accurate estimation of changes of global forest carbon stock. To estimate forest biomass changes, its vertical structure is critical information, and airborne light detection and ranging (LiDAR) is expected to be an effective method to measure. We examined the feasibility of estimating forest biomass changes using two airborne LiDAR measurements of forest height acquired 10 yr apart (2004 and 2014) over the Teshio Experimental Forest (225 km^2) of Hokkaido University in northern Japan. Whole the area of the experimental forest was divided into 23,502 cells having 1 ha cell size, and the decadal change of the mean canopy height (ΔMCH) was obtained for each cell using the two digital surface models observed in 2004 and 2014, then the ΔMCH was converted into the biomass changes using a linear relationship obtained from the relationship between MCH and the biomass for the experimental forest (Takagi et al., 2015). Estimated decadal biomass change was validated using the ground observation obtained from long-term forest biomass observation plots and artificially logged-plots during the period.
Decadal net biomass change had large spatial variation ranging from +35 to - 50 MgC ha^{-1}, even after excluding the artificially logged plots during the period. The average was 4.06±6.44 (SD) MgC ha^{-1}, where the photosynthetic biomass increase was 11.7±4.79 MgC ha^{-1} and the tree carbon decrease, caused by coarse woody litter or tree falling, was 8.71±4.08 MgC ha^{-1}. These values were comparable with the results obtained from ground surveys or tower flux observations operated in Hokkaido, northern Japan. The decadal net biomass change was significantly lower at high elevation, north facing slope, large tree height variance, and coniferous forest, and significantly higher at south facing slope, deciduous forest, and secondary forest. The photosynthetic biomass increase was linearly correlated with the decadal average of the MODIS Vegetation Indices, with r^2=0.64 for NDVI and 0.52 for Green ratio, which implies the application of MODIS Vegetation Indices to further large scale estimation of forest biomass change using satellite observation.

Keywords: Airborne LiDAR, Forest, Biomass change

