# Vegetation Lidar

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The purpose of the MOLI (Multi-footprint Observation Lidar and Imager) mission is to demonstrate Japan's first space lidar and to obtain canopy height / three-dimensional forest structure information required for the evaluation of Above Ground Biomass (AGB), which plays an important role in the carbon cycle and climate change mechanisms. Furthermore, it is to establish an algorithm for the fusion analysis with L-band SAR (ALOS-2 / PALSAR-2, etc.) data and passive spectral data such as GCOM-C / SGLI in order to contribute to remarkable improvement. The results obtained with MOLI will provide guidelines for the future global vegetation observation satellite.
The characteristics of MOLI are described in the following; (1) It operates as a laser altimeter that can obtain highly accurate ground surface information (DSM, DEM /DTM, vegetation distribution, albedo at the laser wavelength). Transmitting laser is 20mJ/pulse/foot print, 150Hz, pulse width 7nsec. the receiving diameter 0.45m, two-dimensional Si-APD, A/D converter 500MHz, 12bit resolution. (2) The lidar has a significant function of self-determining the inclination angle and the azimuth angle for reducing the error in the canopy height measurement induced by the ground surface inclination. Its slope angle and azimuth angle are determined from differences of the round trip time between MOLI and ground for three closest footprints in the along-track direction. (3) High resolution imager consists of R/G/NIR band, swath width 1,000m, ground resolution 5m, and it acquires information on the size, height, and field data of the canopy.
Due to these characteristics, the canopy height measurement accuracy will be within ±3m (<forest height of 15m) or <±20% (>forest height of 15m) at a ground slope <30deg. The accuracy of AGB observation can be estimated±25 t/ha (<100 t /ha) or ±25% (> 100t /ha). Furthermore, the lidar has an apparent advantage that the received light intensity does not saturate even from high density tropical forests, more than AGB of 150t/ha, in the Amazon River basin, Africa-Congo region and Southeast Asia region. It is well known, on the other hand, that returned signals of L-band SAR mostly indicate saturation phenomena there though it is capable of all-weather observation and is excellent at extracting changes in real time. Therefore, if the MOLI lidar are effectively applied with the L-band SAR to complement the weaknesses of each sensor, it will be able to achieve more accurate AGB estimation.
Next, we would discuss the benefits of MOLI data in terms of actual use. Field survey is an important task for forest management (ledgering), but it often faces many difficulties in tropical forests. If the MOLI data help to support field surveys, the number of survey fields and survey costs could be cut by 1/2 (when $\rho 2 = 0.5$, $\rho 2$: a coefficient of determination in two phase regression from ground survey to MOLI estimation) to 1/10 ($\rho 2 = 0.9$). As a result, MOLI can be expected the most powerful sensor for (1) REDD + (an international mechanism for controlling climate change through measures to reduce and degrade tropical forests). (2) A combination of JJ-FAST (an early warning system for preventing illegal logging of forests by JICA-JAXA) and the lidar will be enable more accurate illegal activities. This deforestation detection system focuses on the measurement of deforested area and does not have AGB measurement function.

 

Merging with MOLI data will allow accurate calculation of carbon emissions at logging locations. (3) It can be used as a mean of monitoring by private enterprise activities.
Finally, we will also describe on the future prospects of this mission proposal. First of all, if the utility of MOLI is confirmed, we would like to contribute to international contribution by developing a full-fledged and continuous vegetation observation mission as a successor to MOLI. In addition, MOLI mission will provide a foothold for application development to Doppler lidar aiming at global three-dimensional observation of wind vectors, the scanning lidar realizing precision DEM, and H2O DIAL for water vapor profiling.

Keywords: Lidar, Canopy height, Forest structure, Forest biomass, L-band SAR, Imager

 