Biomass Mapping by ALOS/PALSAR over Boreal Forest in Alaska Accompanied with Ground-based Forest Survey

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Abstract

To derive the biomass from satellite measurement, it is inevitable to acquire *in situ* biomass by ground-based survey. We applied a way that is a combination of Bitterlich Angle Count Sampling method and Sampled-tree Measuring (BACS-STM) method as a quick method for biomass measrement. In July 2007, a forest survey was carried out in the south-north transect (about 300km) along the Trans-Alaska Pipeline which profiles the ecotone from boreal forest to tundra in Alaska. Biomass at 29 forests in the transect were measured by the BACS-STM method. It was revealed that the forest biomass distribute from 5 to 100 ton/ha (dried matter).

Keywords: *Ecotone, Carbon Cycle, Bitterlich method*

1. BACKGROUND

For the better understanding of the carbon cycle in the global ecosystem, investigations on the spatio-temporal variation of the carbon stock which is stored as vegetation biomass is important. An international framework, Global Earth Observation System of Systems (GEOSS), also mentions the observation requirement of the biomass in its 10-year implementation plan. The observation by ALOS/PALSAR has an inestimable potential to provide us the biomass information of the vegetation that widely covers the land surface.

To derive the biomass from the ALOS/PALSAR measurement, it is inevitable to acquire *in situ* biomass by ground-based survey. Moreover, such ground-based

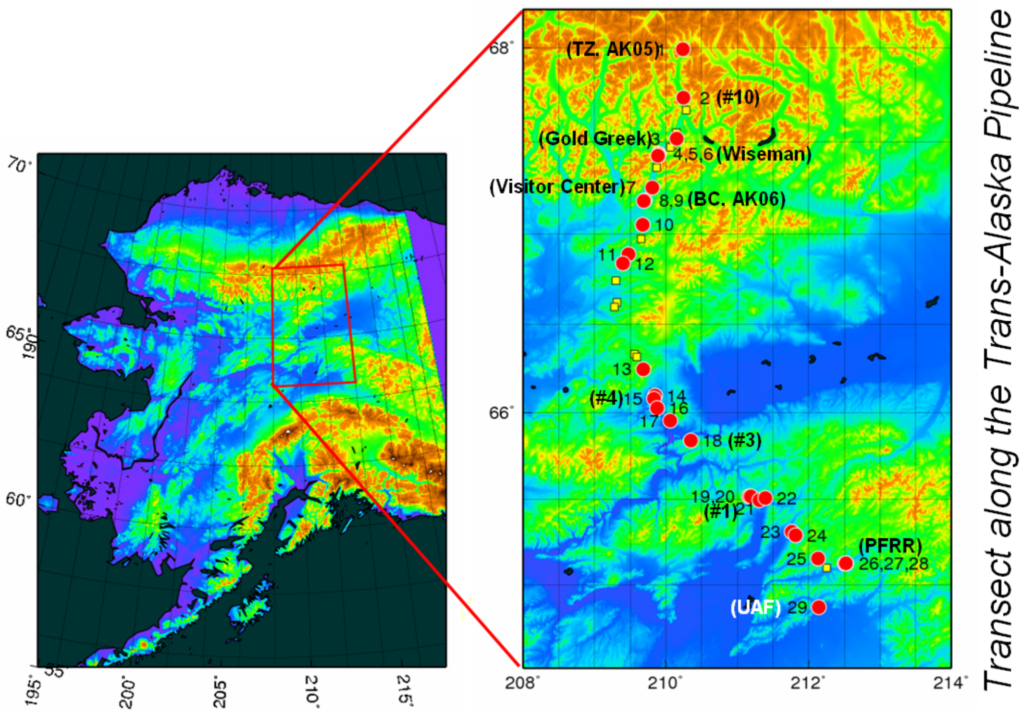

Fig. 1. Distribution of 29 forest sites (red circle) and no-forest sites (yellow square) in northern Alaska.

information has to be acquired at as possible many sites, so a quick measurement method is required. We applied a way that is a combination of Bitterlich Angle Count Sampling method and Sampled-tree Measuring (BACS-STM) method as a quick method. First, a tree which has wider trunk than a threshold viewing angle is identified by the relascope from a representative point in the target forest. Next, the biomass of the tree is estimate by the allometric equation with the tree height and diameter measurements. Through these processes, the biomass per unit area in the forest is estimated.

2. FIELD SURVEY OF FOREST BIOMASS IN ALASKA

In July 2007, a forest survey was carried out in the south-north transect (about 300 km) along the Trans-Alaska Pipeline which profiles the ecotone from boreal forest to tundra in Alaska. Since several papers reported that the recent secular change is apparent in the ecotone in Alaska [1, 2, 3, 4], this transect would be appropriate for the long term biomass monitoring.

29 forests in the transect, demonstrated in Fig. 1, were targeted for the survey. These forests were satisfied following conditions; accessible from the road, almost no slope, and wider than 100 m x 100 m. As indicated in Fig. 2, the major species of the tree is black spruce (*Picea mariana*), white spruce (*Picea glauca*). Birch (*Betula neoalaskana*) occures in some forest, but relatively rare. We used the allometric equations for those trees in Alaska derived by Yarie [5]. Following surveys were carried out in July, 2007 in Alaska.

- Above-ground forest biomasses at 29 forests (2 or 3 points measurements for each forest) by BACS-STM method. Tree height and diameter at breast height (DBH) were simultaneously measured.
- The geo-position of 17 non-forest areas for the reference of zero tree biomass.
- Hemispheric pictures of forest canopy for Plant Area Index (PAI) at 2 or 3 points in 29 forests. PAI will be used for supplemental information of the forest property.
- Soil moisture, which can effect the PALSAR measurement, at 2 or 3 points in 29 forests.
- PAIs at 3 forests in Poker Flat Research Range, University of Alaska Faibanks by the plant canopy analyzer (LAI2000) for the validation of PAI estimation by the hemispheric picture method.
- Height and DBH of every tree at 2 plots in two representative forests.

3. RESULT

Table 1 shows the biomass of 29 forests estimated by BACS-STM method. The forest biomass that had the smallest biomass values among the forests targeted were 2.2 ton/ha. The forest was very sparse white spruce forest and most of the tree height were below 10 m. On the

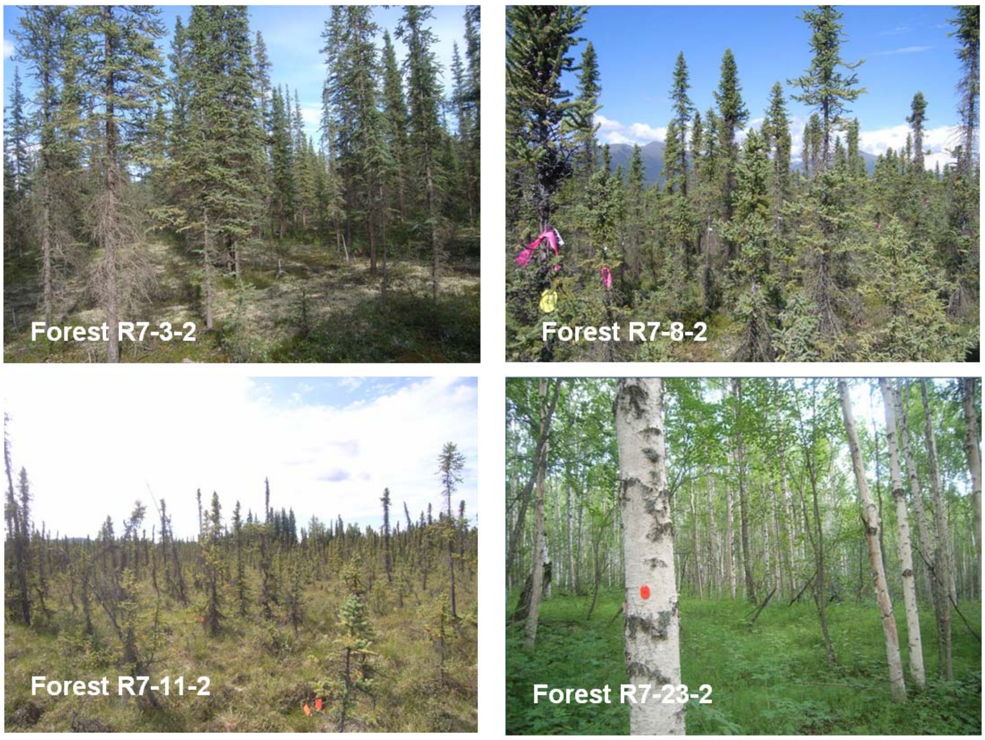

Fig. 2. Pictures of typical forests in Alaska. Sparse white spruce forest (top-left), sparse and low black spruce forest, (bottom-left), dense and low black spruce forest (top-right), high birch forest (bottom-right).

other hand, the forest biomass that had the largest biomass was 115.8 ton/ha. That forest was dense white spruce forest and the most of the tree height was around 20 m. Generally, forests with small biomass tends to be young forest which appears to experience a forest fire recently.

The forest biomass distributes from 2.2 to 115.8 ton/ha, and this means that good empirical regression will be acquired between these *in situ* biomass and the L-band radar of PALSAR without saturation of the backscattered signal (Fig. 3).

4. SUMMARY

The above-ground biomass and related land surface properties at 29 forests in the ecotone of Alaska was measured in July 2007 by a BACS-STM method. These ground-based biomass values will be used to develop the biomass estimation algorithm by ALOS/PALSAR. The elimination of topographical influence will be one of challenging tasks. Based on this algorithm, the biomass in the ecotone will be mapped. Also, similar studies will be planed at boreal forests in Mongolia and Siberia. Global biomass data base that is useful for carbon cycle modeling will be constructed in the future.

Acknowledgement

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Fig. 3. Sample image of ALOS/PASLAR around Fairbanks, Alaska.

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Table 1. Biomass (dried matter) of forests estimated by Bitterich Angle Count Sampling method and Sampled-Tree Measuring method (BACS-STM method). The unit is ton per hectare. Forest number corresponds to the map of Fig. 1.

Forest #	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Biomass (ton/ha)	4.7	31.9	27.5	25.5	2.2	20.9	5.9	22.4	35.0	12.4
Forest #	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
Biomass (ton/ha)	4.4	69.8	24.9	7.3	12.6	115.8	81.9	30.9	67.0	36.1
Forest #	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	
Biomass (ton/ha)	40.1	16.3	100.2	92.4	15.3	50.7	6.6	12.7	12.8	