Boreal environment measurements by using L-band polarimetric SAR data

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Abstract

We performed simultaneous field experiments with PALSAR in Sendai/Japan, Ulaanbaatar/Mongolia, and Alaska/US and measured soil moisture value and surface roughness in each place. We report activities of field experiments in those places and show some preliminary analysis results derived from the Alaska data.

Keywords: Polarimetry, L-band SAR, soil moisture.

1. INTRODUCTION

ALOS/PALSAR, which was launched in 2006, has polarimetry mode. The PALSAR data is expected to be used for many application and one of the prospective applications is estimating soil moisture value (Mv) and RMS height (ks) of the soil surface. Several models for estimating Mv and ks are suggested and the one of the simplest model is Small Perturbation Model (SPM). This is the model, in which the electro-magnetic wave is scattered on the random surface roughness and Bragg scattering are taken into consider. But only the behavior of σ^0_{HH} and σ^0_{VV} can be described this model and the range of the model is up to ~20% in Mv and 1.1cm in ks. On the other hands, Hajnsek et al [1] suggested the X-bragg model, on which SPM model was based and Entropy (H)/α/Anisotropy (A) were used as parameters. The characteristics of this model is to derive Mv from H and α, and ks from A, independently. The range of the model is extended to 35% in Mv. Oh [2] suggested a semi-empirical model and some parameters are tuned by using GB-polarimetric scattorometers and AIRSAR data taken over various soil conditions. The range of the model is less than 29% in Mv and 3cm in ks. Since no trees are covered on the ground in test sites, where we measured the surface parameters, we applied the model, which is not taken into consider the vegetation. In this paper, we report the activity of simultaneous field measurement in the three placees and give some preliminary results derived from the analysis of Alaska data.

2. TEST SITES AND DATA

We performed three field experiments with PALSAR observations in Sendai/ Japan, Ulaanbaatar/ Mongolia, and Arctic National Wildlife Region (ANWR/Alaska)/ US. The summary of the observations and the field experiments are presented in Table 1.

Two of the three test sites in Sendai are riverbanks and the other is a vacant covered with small pebbles. We deployed small Corner Reflectors (CRs) in two of three sites to identify the test sites and to use the geometric correction.

Two of the four test sites in Ulaanbaatar are riverbanks and the other two are vacant covered with sand. We deployed two CRs in one of the vacant site.

Table 1. The summary of the observation and the field experiments

Place		Sendai	Ulaanbaatar	ANWR
PAL-SAR	Obs. date	14, Apr., 2007	4, May, 2007	29, July, 2007
	Mode	Polarimetry, 21.5deg.		
	Direction	Ascending		
Field exper-iment	Term	14, Apr., 2007	2-7, May, 2007	28, July-4,Aug., 2007
	Num. of test site	3	4	6
	Measure-ment	Soil moisture Roughness		Soil moisture Roughness Thermal conductivity Biomass Etc.

Due to a high latitude of about 70 degree, there are no threes in ANWR area and covered with permafrost and small shrubs. The dry aboveground biomass of the shrubs was measured to be 4 tons/ha and it doesn't seem to affect the L-band data. Organic layer are appeared to 10cm in depth and many moss and litter are included there. On the other hand, silt and sand are dominant component in the deeper layer. Frozen layer is appeared around 10cm to 50cm from the surface, as of the July 2007. Three small CRs are put in two separate places. The test sites have characteristics shown below.

T-site: Covered with low center polygon made by permafrost.

P-site: Covered with high center polygon.

F, C, W, K-site: No polygon structure are seen.

W-site: Very wet place

K-site: Biomass were measured.

PALSAR polarimetry observations had been done for five times over ANWR before the field experiment: 10 Jun., 26 Jul., 10 Sep. in 2006, 13 Jun. and 29 Jul. in 2007. Then, we analyzed the five data sets.

3. Results

Parameters derived from the field measurements and from analysis of the satellite data are summarized in Table 2. Surface parameters are calculated from the field data, whose measurement length is 2~3m and total number of measurements are 66. The values in the table are averages in each site. The soil moisture values are calculated from total 135 field measurements. While the soil moisture value show very high value of 63.8 and 83.1% in P and W site, the other sites also show relatively high value of 35 to 50%. Average RMS height ranges from 1.7cm to 4.0cm and correlation length ranges from 7.8cm to 12.4cm. H/α/A values are calculated from the PALSAR polarimetry data after applying Lee-filter.

Table 2 Parameters derived from the field measurements and from analysis of the satellite data

	Field measurement			Satellite			
Site	Soil mois-Ture (%)	RMS hei-Ght (cm)	Cor. Len (cm)	H	α (°)	A	RMS heigh t (cm)
T	34.7	3.0	8.9	0.48	17.5	0.25	2.7
F	39.8	2.6	8.9	0.41	15.3	0.32	2.5
C	41.8	1.7	12.3	0.39	15.1	0.37	2.3
K	47.7	2.4	9.1	0.38	13.9	0.34	2.4
P	63.8	1.9	7. 8	0.41	15.6	0.30	2.6
W	83.1	4.0	12. 4	0.54	20.8	0.25	2.8

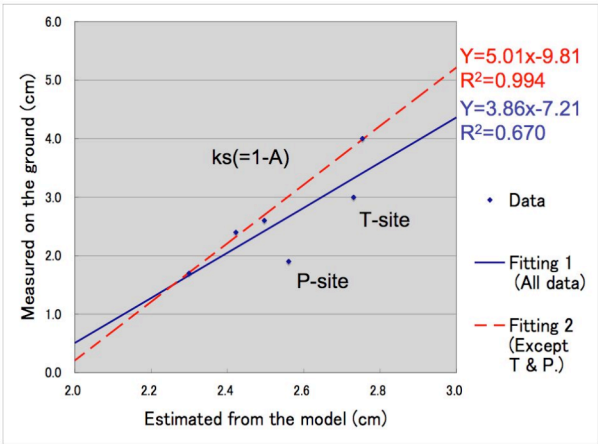

Fig. 2 Comparison of surface roughness derived from ground measurements and estimations from the X-bragg model.

Average value of the H/α/A over five polarization observations in each site are also summarized in Table 2. The RMS height estimated from X-bragg model is also presented there.

4. Discussion

The ks estimated from X-bragg model are plotted against the one derived from the field measurements in Fig. 2. Correlation coefficient between two parameters becomes 0.67. On the other hand, if we exclude the P and the T site data, the plot shows good correlation, where correlation coefficient is 0.994. Since the P and the T site are covered with polygon structure, the structure seems to be the main reason why the P and the T site data are apart from the other data. On the other hands, we could not estimate the soil moisture values from the X-bragg model. This may be due to the high soil moisture value in the sites, which is out of the model range.

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