Multi-Frequency and Polarimetric Measurements of Snow Microwave Reflection and Emission by C- and Ku-Band, Combined Scatterometer-Radiometer Systems

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1. INTRODUCTION

The main obstacle to achieve unambiguous and precise solution for inverse problems of bare and vegetated soils and land snow cover's remote sensing is multi-parametric dependences of soil and snow radar backscattering coefficients and brightness temperatures. To overcome these obstacles it is necessary to synergy data of multi-frequency and multi-polarization measurements obtained by various means of sensing. In particular, spatio-temporally combined, multi-polarization, two frequency active-passive measurements of soil and snow surfaces reflective and emissive characteristics are an example of such a synergy. For precise and unambiguous retrieval of soil and snow moistures, soil and snow temperatures, that is to solve soil and snow cover's microwave remote sensing inverse problems it is necessary as well to improve radiative transfer models for soil, snow and vegetation. For this purpose it is necessary and very significant to develop and to manufacture multi-frequency and multi-polarization complex of combined radar-radiometers, suitable for short range remote sensing application and to perform field or quasi-field measurements under test-control conditions.

In this paper the results of simultaneous and spatially coincident, dual-frequency (at C- and Ku-band), multi-polarization measurements will be represented, of bare soil and snow microwave reflective (radar backscattering coefficient) and emissive (brightness temperature) characteristics angular dependences at 5.6GHz and 15GHz.

2. C- AND Ku-BAND, COMBINED SCATTEROMETER-RADIOMETER SYSTEMS

For the measurements C and Ku-band, polarimetric, combined scatterometer-radiometer systems (CSRS) were used, set together on a mobile buggy moving along the measuring platform. In this paper structures, operational features and main technical characteristics of the utilized systems will be discussed too [1-4].

The main characteristics of the used microwave sensors are presented in the Table below:

Central frequency	5.6GHz (C-band)	15GHz (Ku-band)
Antenna - Beamwidth	Parabolic - 7.2^0	Parabolic - 5.2^0
Polarization of Radar Channel	vv, vh, hh and hv	vv, vh, hh and hv

Polarization of Radiometer channel	v and h	v and h
Radar pulse duration	A train of 10 pulses of 25ns each	A train of 10 pulses of 25ns each
Radar pulse power	150mW	150mW
Radar receiver's bandwidth	~40MHz	~40MHz
Radar receivers noise factor	~2dB	~2dB
Radiometric receiver's noises	~700K	~300K
Radar channel's sensitivity at 1s	~0.1dB	~0.1dB
Radiometer receivers bandwidth	~ 0.8GHz	~1GHz
Radiometer Channel's sensitivity at 1s	~0.17K	< 0.1K

The principal peculiarities of the utilized devices are their originality in spatio-temporally combining of functionality of microwave active-passive channels of observations, under the condition of short range sensing application of the system. The minimum operational range of the systems' scatterometers is 4m, at a far zone condition of sensing.

3. A METHODOLOGY OF MEASUREMENTS AND CALIBRATION FACILITIES

The measurements were carried out from a stationary, quarter-circle shaped measuring platform of 6.5m of radius built over the experimental soil area of sizes of 10m x 3m. Both CSRS set on the mobile buggy have smoothly moved along a quarter circle shaped path of the measuring platform. A drive mechanism of the buggy allows stop it at any point of the path along the platform and perform measurements under any angle of incidence from 0-80^0. The platform allows research angular dependences of microwave reflective and emissive characteristics of the same area of the snow cover. The measurements are curried out under various conditions of snow moisture, snow depth, air, snow and soil temperatures. In this paper a methodology of experiments' performance and field calibration of the measuring system and the measured results will be discussed too.

4. MEASURED DATA

The measurements of snow and bare soil microwave characteristics angular dependences were carried out from 9 fixed positions of the buggy, corresponding to the angles of incidence from 80^0 to 0^0, by a step of 10^0. Measured data of the absolute values of soil and snow cover's radar backscattering coefficients at vv, vh, hh and hv polarizations and brightness temperatures (Antenna Temperatures) at v and h polarizations allowed estimate and research angular and polarization peculiarities of soil and vegetation microwave characteristics. Angular measurements were carried out for various values of soil moisture, snow depth, snow surface roughness parameters, soil, snow and air temperatures at various atmospheric condition.

5. REFERENCES

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