Multi-Frequency and Polarimetric Measurements of Bare and Vegetated Soils 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 the Earth (sea, land) remote sensing is multi-parametric dependences of the observed surfaces 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 observed surfaces reflective and emissive characteristics are an example of such a synergy. For precise and unambiguous solution of bare and vegetated soils microwave remote sensing inverse problems it is necessary as well to improve radiative transfer models for soil 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 of bare and vegetated soils microwave reflective (radar backscattering coefficient) and emissive (brightness temperature) characteristics angular dependences at 5.6GHz and 15GHz will be represented.

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 Polarization of Radiometer channel	vv, vh, hh and hv v and h	vv, vh, hh and hv 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 $0\text{-}80^0$. The platform allows research angular dependences of microwave reflective and emissive characteristics of the same area of the observed surface. The measurements are curried out under various conditions of soil moistures, vegetation and surface roughness parameters, air 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 bare and vegetated soils microwave characteristics angular peculiarities 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 vegetation covers 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 dependences of soil and vegetation microwave characteristics. Angular measurements were carried out for various values of soil moisture, soil surface roughness parameters, soil and air temperature, vegetation dryness, etc, at clear air (atmospheric) condition.

A unique measured data of the changes of dry vegetated soil reflectance and emittance were obtained at an appearance of fire, under the angle of incidence 30^0 and at "vv" and "vh" polarizations of scatterometric observation and at "v" and "h" polarizations of radiometric observations simultaneously at

two frequency bands, when. The measurements were carried out for a while ~5min, when the fire destroyed entirely the vegetation.

5. REFERENCES

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