Dynamics of Short Sea Wave Spectrum Estimated From Microwave Radiometric Measurements

Ilya N. Sadovsky, Alexey V. Kuzmin, and Michael N. Pospelov, *Member, IEEE*

***Abstract*—This paper presents some results of the experiment CAPMOS'05 performed on an oceanographic research platform in the Black Sea. The platform, located 600 m offshore, was equipped with a set of contact and remote sensing instruments. Conventional contact sensors were used for direct measurements of atmosphere and sea boundary layer parameters (wind speed and direction, air temperature, water temperature and salinity profiles, etc.), whereas microwave and infrared band radiometers were used for remote sensing measurements of surface temperature and wave parameters. In particular, microwave Ka-band radiometer measurements were applied for gravity-capillary wave spectrum retrieval using the original techniques based on angular measurements. The spectrum component evolution under unstable wind conditions has been investigated. It has been demonstrated that the spectral components in the vicinity of the maximum of the wave curvature are the most sensitive to the wind-velocity variations.**

***Index Terms*—Microwave radiometry, remote sensing, sea surface.**

I. Introduction

SHORT gravity and gravity-capillary waves play a very important role in ocean–atmosphere interaction, affecting the momentum exchange through wind-wave generation and dissipation. At the same time, short waves affect the electromagnetic wave emission and scattering from the sea surface, and this effect is used in satellite radiometers and scatterometers for remote measurements of winds over ocean. The relations between wind, waves, and emitted/scattered signals are extremely complicated and can hardly be described unambiguously by any theoretical model. Therefore, experimental measurements of the ocean–atmosphere interaction parameters under various meteorological conditions are of high importance.

In an ideal case, an experiment should combine synchronous and collocated remote sensing (radiometer, radar, etc.) and *in situ* measurements. The oceanographic platforms are of particular importance because they provide a unique opportunity of long-term measurements of sea and atmosphere parameters in a fixed point using various kinds of sensors, both remote sensing and contact instruments [1], [2].

This paper presents the results of the Combined Active/Passive Microwave Measurements of Wind Waves for Global Ocean Salinity Monitoring (CAPMOS'05) experiment performed on an offshore oceanographic platform in the Black Sea in June 2005. The experiment, aimed at air–sea coupling investigations by means of direct and remote measurements, was carried out in the frames of the project CAPMOS sponsored by the International Association for the promotion of cooperation with scientists from the New Independent States of the former Soviet Union (INTAS). The project joined several research teams from Russia, Ukraine, Denmark, and Italy experienced in the experimental study of ocean and atmosphere. The major goal of the experiments was to compare the results of synchronous active and passive microwave measurements of waved sea surface, focusing on the ocean wave spectrum retrieval.

The task of measuring the wave parameters in the open sea is a considerable challenge, particularly for short gravity-capillary waves. Traditional wave gauges are not usable for very short wave measurements because of the disturbances introduced by a gauge itself. The problem may be solved by applying remote techniques, either optical or microwave radar. A number of various models of wind-wave spectrum have been proposed to date by various authors; [3]–[5] are only some of them. It is worthy of note that most of these models agree, more or less, at the range of long waves, whereas at the range of short gravity-capillary waves, the disagreement can be of an order of magnitude.

In the following sections, a novel approach for the short gravity-capillary wave spectrum retrieval from radiometric measurements is described. The dynamics of retrieved spectral components under unstable wind is traced.

II. Experiment

The experiment CAPMOS'05 was performed on an offshore oceanographic platform located about 600 m to the south of the Crimea coast near Katsiveli, Ukraine. The sea depth at the site is 28–32 m; therefore, the deep water and long fetch conditions were ensured for prevailing winds from the south, southeast, and southwest. The platform (Fig. 1) has several working levels. The lowest deck at 4 m above the surface is used for various instrument installation. At the main deck at 14 m above the sea level, the living rooms and laboratories are situated. The mast

Manuscript received October 1, 2008; revised January 13, 2009. First published May 15, 2009; current version published August 28, 2009. This work was supported in part by the International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union (INTAS) under Project 03-51-4789 and in part by the Russian Foundation for Basic Research under Projects 08-05-00890 and 09-02-00780.

I. N. Sadovsky is with the Microwave Radiometry Laboratory, Space Research Institute, Russian Academy of Sciences, 117997 Moscow, Russia, and also with the Radio Engineering and Radio System Department, Vladimir State University, 600000 Vladimir, Russia (e-mail: Ilya_Nik_Sad@mail.ru).

A. V. Kuzmin is with the Microwave Radiometry Laboratory, Space Research Institute, Russian Academy of Sciences, 117997 Moscow, Russia (e-mail: alexey.kuzmin@asp.iki.rssi.ru).

M. N. Pospelov is with the Space Research Institute, Russian Academy of Sciences, 117997 Moscow, Russia (e-mail: Michael.Pospelov@iki.rssi.ru).

Digital Object Identifier 10.1109/TGRS.2009.2019635