DIRECT AND REMOTE SENSING MEASUREMENTS DURING A SERIES OF EXPERIMENTS CAPMOS'05-07-09 ON AN OFFSHORE PLATFORM

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1. INTRODUCTION

Satellite-based measurements are broadly used in modern oceanographic research. Remote sensing satellites provide data for global operational monitoring of ocean and atmosphere. Accuracy and consistency of remote sensing data depend on the quality of models, which relate geophysical parameters to the parameters of electromagnetic waves emitted/scattered by natural environment. Detailed and highly accurate measurements are necessary for developing and testing of these models. Offshore platforms provide a unique opportunity to perform long-term measurements of oceanic and atmospheric parameters in a fixed position using various kinds of remote and contact sensors [1, 2]. Such combined direct and remote sensing measurements might be very useful for satellite sensors calibration/validation purposes.

The paper presents some results of the series of field experiments CAPMOS'05-07-09, performed at an offshore oceanographic platform in the Black Sea. The experiments aimed on investigation of air-sea coupling were carried out in framework of the INTAS (International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union) project "Combined Active / Passive Microwave Measurements of Wind Waves for Global Ocean Salinity Monitoring (CAPMOS)" and also in frameworks of a series of the Russian Foundation for Basic Research projects. The major goal of the experiments was to compare the results of synchronous direct and remote sensing measurements of waved sea surface and atmosphere boundary layer with specific emphasis on the ocean wave spectrum and wind speed retrieval [3].

Remote measurements of wave parameters are of particular importance for oceanographic studies. Whereas traditional contact sensors (like string wave gauges or pressure sensors) are still being widely used, recent trends are toward increased use of remote sensors. Several sea wave spectrum models have been constructed recently basing upon remote sensing (mainly, radar) data [4–7]. It is worth noting, however, that these models differ one from another, especially at the range of short gravity-capillary waves, justifying the necessity of field measurements of wave parameters under variety of weather and sea conditions using various kinds of sensors.

Figure 1. Map of the south coast of Crimea. The platform position is marked with an arrow

Figure 2. Oceanographic platform

2. EXPERIMENTS

The series of experiments CAPMOS'05-07-09 was carried out on a research oceanographic platform located about 600 m to the south of Crimea coast near Katsiveli, Ukraine (Fig. 1). The sea depth at the site is 28 to 32 m, so the deep water and long fetch conditions were ensured for prevailing winds from the south, south-east and south-west. The platform (Fig. 2) 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 IR radiometers were used for remote sensing measurements of surface temperature and wave parameters.

List of research instruments and equipment used in the experiment included:

- below the surface:
  - five current meters at a depth of 3, 5, 10, 15 and 20 m;

- bottom to top — CTD sections every 3 h;
- water temperature sensor at 1 m;
- water turbulence sensor at 1 m;
- CTD floating at a depth of 0.3 m;
- 6-strings wave gauge;

- above the surface:
  - 3-component sonic anemometer and air temperature sensor — at 1.5 m;
  - radio-interferometer for precise measurements of water surface (year 2005 only), a set of microwave and IR radiometers (+ video camera in 2007 and 2009) mounted on an automatic rotator, 3-component sonic anemometer and air temperature sensor, water vapor and carbon dioxide sensor — at 4 m;
  - Ku-band scatterometer (polarizations VV, HH or cross) (year 2005 only), air pressure sensor, photo camera — at 14.5 m;
  - 3-component sonic anemometer, air temperature and humidity sensor — at 21.5 m.

The measurements were carried out continuously 24 h/day from June 2 to June 20, 2005, from August 8 to August 20, 2007, and from October 17 to October 26, 2009. Continuous measurements provide an opportunity to study the sea-surface microwave radiation and backscatter dependence on the various processes in the ocean and atmosphere boundary layers. Parameters of gravity and gravity-capillary wave spectrum were measured over wide range of wind speed, up to 25 m/s. Heat and momentum flux across air-sea interface were measured using eddy covariance techniques; two upwelling events in 2005 resulted in intensification of the air-sea interaction that was quantitatively described by the fluxes.

3. CONCLUSIONS

Quantitative information on the air-sea interaction in a coastal area was obtained during the series of experiments on an offshore research platform. Spectral parameters of gravity waves were retrieved from remote sensing data. The spectral peak frequency of gravity waves varied day to day in the range from 0.2 to 0.7 Hz that corresponded to dominating wave lengths from 50 down to several meters. Comparison of the spectral parameters retrieved from passive and active microwave measurements, as well as using of two different approaches to the spectrum retrieval from scatterometers data, demonstrates good agreement.

The curvature spectrum of gravity-capillary waves was retrieved from angular radiometric measurements. It was demonstrated that spectral components in the vicinity of the maximum of the wave curvature (about 6 rad/cm) reveal maximal sensitivity to wind velocity variations.

Heat and momentum fluxes across the surface describing air-sea interaction were measured using eddy covariance technique. The interaction intensity is closely connected with physical processes occurring in both environments. It is a bi-directional process, which demonstrates a sort of a feedback. This feedback is a probable reason for the flux oscillations observed after the hydrofront passage.

Experience gained from the series of experiments on a platform permitted us to suggest using it during satellite sensors calibration/validation campaigns. Traditional procedure implies using of "ground truth" data obtained from direct measurements of sea surface temperature, wind, etc. performed at mooring buoys. There are two sorts of uncertainties in this procedure, which can hardly be separated. First, associated with a model function relating geophysical parameters to the emitted/scattered electromagnetic radiation, and second, resulted from different procedures of averaging, spatial for satellite sensors and temporal for contact sensors. When we use on a platform a set of remote sensing instruments similar to that installed on a satellite, these two uncertainties may be isolated, since in this case direct and remote sensing measurements are performed at similar spatial and temporal scales and a model function may certainly be defined.

4. REFERENCES

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