Ground Measurements in Remote Sensing

R. Kancheva[1], D. Petkov[1], G. Georgiev[1], D. Borisova[1],
V.P. Savorskiy[2], M.T. Smirnov[2], Yu.G. Tishchenko[2]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences
Sofia 1113, Acad. G. Bonchev Str., bl.3 BULGARIA
E-mail: rumik@abv.bg
[2]Fryazino Department, Institute of Radioengineering and Electronics RAS,
Fryazino Vvedenskogo sq., 1
E-mail: tishchen@ire.rssi.ru

Necessity of the ground truth measurements in remote sensing is discussed. Compositions of possible scientific equipment and main tasks are presented. The results of ground truth observations of the Black Sea region are shown.

Hazard situations, ecological risks and destructive processes on our planet caused by natural disasters or anthropogenic activity are in the focus of scientific research and occupy the attention of state and government authorities. Recently, numerous projects on the environment study and control have been developed and carried out in different countries. In most of these projects a first and essential step is land cover change monitoring at a regional scale. Remote sensing is the main source of information covering large territories, often being predictive and in this way giving possibilities for an appropriate and on-time decision making. The necessary data can be provided by a complex of instruments installed on satellite platforms thus implementing the multiscale, multipurpose and multitemporal approach. Such an insight on data acquisition and application approach is dictated by the interrelated nature of many environmental problems which determines the need of data integration and information sharing between different databases. On the other hand, since environmental situations are most often site-specific, the regional monitoring is a reasonable approach to begin with.

For the correct solution of remote sensing satellite tasks it is necessary to perform accompanying ground truth measurements of various parameters of observed objects. Such measurements are necessary for:

- remote sensing satellite devices calibration, control over their ability to work when operating,
- data validation and evaluation of remote sensing data informativity,
- working out new methods, improvement and testing existing ones for geophysical parameters retrieving,
- development of methods of joint remote sensing data interpretation, these data being obtained in various spectral intervals, together with synchronous ground truth measurements,
- complex exploration of natural objects, among them ecologically dangerous regions, by using information, being obtained from different levels with different spatial resolution.

Since the environmental situation varies from site to site it is necessary to begin with regional monitoring and then to cover larger territory. Land cover state will be controlled by using equipment in visible, infrared and microwave spectral bands.

The compositions of possible scientific equipment and main tasks are presented below.

Visible Spectrometers

- soil erosion, overmoistening, swamping, underflooding, soil ferility;
- state of inland waters (pollution, overgrowth with water-plants);
- state of vegetative canopy (volume of phytomass, changes in plant type, plant disease);
- state of agricultural crop fields (agricultural plant state, germination, vegetation phase, volume of phytomass);
- chemical content of the air.

Infrared Spectrometers

- state of snow cover (pollution, boundaries);
- soil and water surface pollution;
- revealing fire sites (localization and boundaries);
- areas with shallow water and flooding.

Microwave Radiometers

- soil moisture, mineralization, overmoistening, swamping;
- state of irrigation and drainage constructions;
- depth to water table;
- land surface temperature contrasts;
- state of inland waters (pollution, mineralization, overgrowth with water-plants);
- state of vegetation (volume of biomass, changes in plant type, diseases);
- state of agricultural crop fields (agricultural plant state, germination, vegetation phase, volume of phytomass);
- state of snow cover (water equivalent, pollution, boundaries);
- ice sheet on inland waters and road covers;
- revealing fire sites (localization and boundaries);
- shallow water and flooding;
- underground irregularities detection (structure and localization of buried objects and industrial waste detection);
- revealing geoecologically and epidemiologically dangerous zones зоны and providing risk assessment.

Radars

- soil erosion;
- land surface topography (relief and sliding);
- state of forested areas (changes in tree types, glades and cuttings in a forest, plant diseases);
- pollution and boundaries of inland waters;
- ice sheet on inland waters;
- boundaries of snow cover;
- underground irregularities detection (structure and localization of communication network, buried objects and industrial waste detection).

Important note: There exists the instrumentation mentioned above and the software is available for resolving the tasks described above.

Ground truth observations of the Black Sea region were made near Gelendzhik, and in the South part of Crimea from MHI NANU sea platform.

The example of ground truth observations of the Black Sea region near Gelendzhik, held together with IKI RAS, is given on Fig. 1.

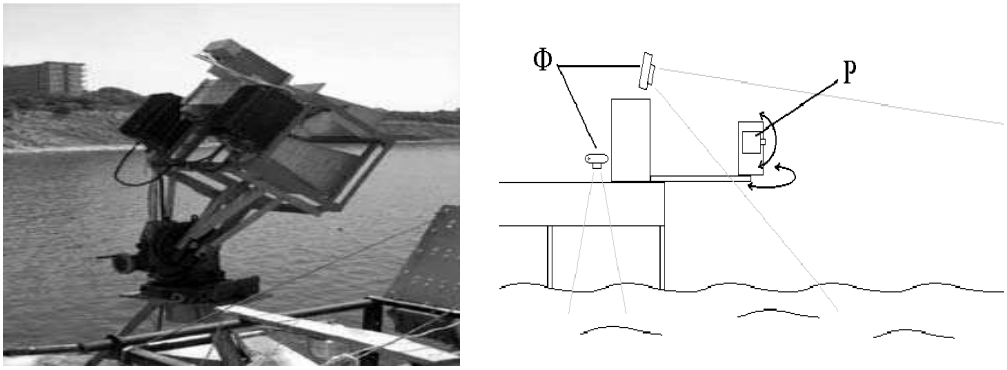

Fig. 1. Black Sea ground truth measurements

The measurements were carried out by microwave radiometers and polarimeters in wavelength range from 0.3 to 27 cm, and by 3 cm radar and 0.8 cm scatterometer. The objectives of experiments were: diagnostics of coastal area and atmosphere, processes of ocean- atmosphere interaction in a coastal area, ecological monitoring of a coastal area, etc. Remote measurements were accompanied by *in situ* measurements of meteorological and hydrological parameters.

Field measurements with radiometer in a promising range of electromagnetic waves ($\lambda \approx 21$ cm) were performed during the campaign held in Katsiveli (Crimea), August, 2007 together with IKI RAS team. One of the main goals of experiment was to investigate an influence of sea roughness on measured microwave emission of the sea. Measurements were made from the marine platform, placed in distance about 500 m from the seashore. There were made some long term series of measurement of sea surface emission at fixed elevation angle about 60°. In this case the horn antenna was used. Results of these measurements allowed us to analyze the natural variability of registered emission in different whether conditions during a day and night times. It is suggested to realize polarimetric measurements of all four Stokes vector components by vector summation of signals having 2 orthogonal polarizations with different phase shift. Microwave polarimetric measurements were experimentally modelled by time sequential switching the different combination of signals from antenna feed to summation unit with phase shift and without it. In this experiment a dish antenna with a special feed containing splitter on two orthogonal polarizations was used. This experiment allowed us to examine the principal problems in vector summation and further data interpretation.

Photo of platform with scientific equipment is presented in Fig. 2. The objectives of experiments were: diagnostics of coastal area and atmosphere, processes of ocean- atmosphere interaction in a coastal area, ecological monitoring of a coastal area, etc. Remote measurements were accompanied by *in situ* measurements of meteorological and hydrological parameters.

Fig. 2. Black Sea ground truth measurements

The measurements were carried out by microwave radiometers and polarimeters in wavelength range from 0.3 to 8 cm. In addition to microwave measurements digital photographs of sea surface were regularly made. Digital processing of these photos allows distinguishing the different states of sea

waving. In Fig. 3 an example of dependence of so called spatial color parameter (ratio of the correlation radii of image in blue and red channels R_b / R_r) on a wind speed is presented.

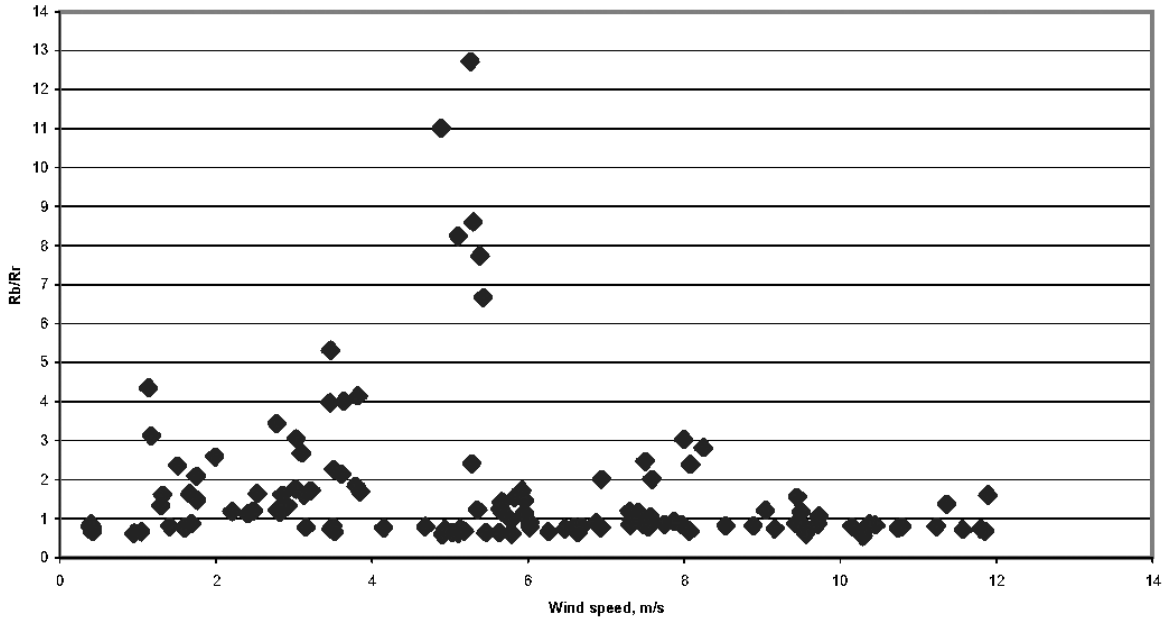

Fig. 3. The example of dependence of spatial color parameter on a wind speed

Performing ground truth measurements enables to obtain the evaluation of accuracy and reliability of space remote sensing data processing methods being worked out and developed, to study functional links between spectral characteristics of observed objects.

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