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«ҒЫЛЫМ ЖӘНЕ БІЛІМ - 2018»
XIII Халықаралық ғылыми конференциясы

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The proceedings are the papers of students, undergraduates, doctoral students and young researchers on topical issues of natural and technical sciences and humanities.

В сборник вошли доклады студентов, магистрантов, докторантов и молодых ученых по актуальным вопросам естественно-технических и гуманитарных наук.

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Finally, protecting the space environment will benefit all humankind. Despite the fact that certain nations are only looking to dominate space in order to serve their national interest and political gain, it is the duty of all nations to join in a peaceful effortand look at space as our future arena for scientific and technological exploration to benefit all humanity.

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SPACE TECHNOLOGIES FOR MODELING ECOLOGICAL SYSTEMS

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One of the important both in the scientific and in the applied plan of tasks of modern ecology is environmental monitoring. To implement it, you need:

- monitoring of negative impact factors and the state of the environment;
- monitoring and evaluation of the actual state, forecasting changes in the state of the environment under the influence of natural and anthropogenic factors;
- identification of potential environmental hazards, including assessment of natural and man-made factors of possible emergencies with negative environmental consequences.

The implementation of these activities is impossible without the use of space research methods in the framework of environmental monitoring. Environmental monitoring is considered as a system of observations and assessment of the state of the environment, and as a means of informing the process of preparation and adoption of managerial decisions. The newest scientific and technical directions in the ecology required knowledge of the detailed spatial and temporal characteristics of the atmosphere, which led to the need to develop and use new means of measurement. At the present time, space methods for assessing the state of the environment are quite successfully used.

Environmental monitoring is understood as an integrated system for monitoring the state of the environment, assessing and forecasting changes in the state of the environment under the influence of natural and anthropogenic factors.

As you know, the first automatic systems for tracking the parameters of the external environment were created in military and space programs. In the 1950s.the US air defense system already used seven echelons of automatic buoys floating in the Pacific, but the most impressive automatic system for monitoring environmental quality was undoubtedly realized in “Луноход”. One of the main sources of data for environmental monitoring are remote sensing materials (RS). They combine all types of data received from carriers:

• space (manned orbital stations, reusable ships, autonomous satellite imagery systems, etc.);

• aviation basing and make up a significant part of remote data (remotely sensed data) as an antonym of contact types of surveys, methods of obtaining data by measuring systems in conditions of physical contact with the subject;

• remote methods of shooting, in addition to aerospace, include a variety of methods of sea and land based.

Throughout the world, Earth exploration from outer space is becoming more comprehensive. The most informative method for solving problems of remote investigation of the Earth's surface from space is the use and thematic analysis of images obtained by instrument complexes of different frequency ranges installed on space vehicles. A number of satellites equipped with remote sensing instruments were put into orbit specifically to obtain a variety of geophysical information necessary for assessing the state of the environment and for natural resource research [1].

For space-based environmental monitoring, it is advisable to focus primarily on polar-orbiting meteorological satellites. Meteorological satellites of the NOAA series are equipped with multi-zone optical and infrared equipment, in particular a high-resolution AVHRR radiometer (Advanced Very High Resolution Radiometer). NOAA spacecraft are launched into polar orbits with a height of about 700 km above the Earth's surface with an inclination of 98.89 degrees. A high-resolution radiometer conducts surveys of the Earth's surface in five spectral ranges: 580-680 nm, 725-1100 nm, 3550-3930 nm, 10300-11300 nm and 11400-12400 nm. Space surveys are conducted with a spatial resolution of 1100 m and provide a 2700 km wide viewing range.

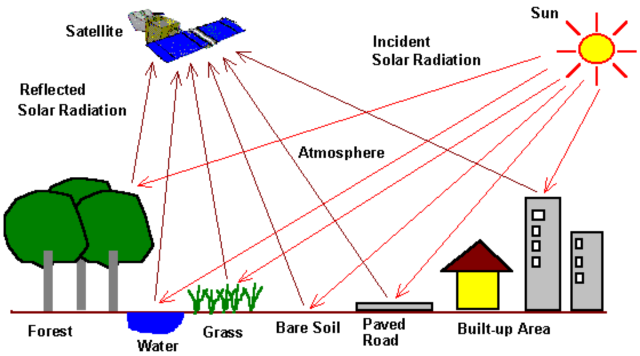

Fig. 1 – Principles of Remote Sensing [1].

Satellite remote sensing data allow to solve the following tasks of environmental monitoring:

1. definition of meteorological characteristics;
2. monitoring the dynamics of atmospheric fronts, hurricanes, obtaining maps of major natural disasters;
3. Determination of the temperature of the underlying surface, operational control and classification of soil and water surface contamination;
4. Detection of large or permanent emissions of industrial enterprises;
5. Control of technogenic influence on the state of forest park zones;
6. Detection of large fires and the release of fire danger zones in forests;
7. Identification of thermal anomalies and thermal emissions of large industries;
8. Registration of smoky plumes from pipes;
9. Monitoring and forecasting of seasonal floods and river spills;
10. Detection and assessment of the magnitude of major flood zones;
11. Control of the dynamics of snow cover and snow cover contamination in the zones of influence of industrial enterprises.

The main useful load of the satellite is a panchromatic optoelectronic system that allows to obtain images with a spatial resolution of 1 m. The satellite can perform highly detailed surveys of the same terrain every three days, and can obtain several images of the same story on one turn. Let us give a number of spectral channels distribution and the range of application of these channels:

Channel 1 (blue):

• It is most sensitive to atmospheric gases, and, consequently, the image can be low contrast;

• has the highest water permeability (long waves are more absorbed), that is optimal for detection of underwater vegetation, emission flares, turbidity of water and water sediments;
• useful for detecting smoke flares (since short waves are more easily scattered by small particles);
• Well distinguishes clouds from snow and rocks, as well as bare soil from vegetation.

Channel 2 (green):
• sensitive to differences in water turbidity, sediment plumes and emission flares;
• covers the peak of the reflectivity of leaf surfaces, can be useful for distinguishing between extensive classes of vegetation;
• Also useful for detecting underwater vegetation.

Channel 3 (red):
• sensitive in the zone of strong absorption of chlorophyll;
• sensitive in the zone of high reflectivity for most soils;
• useful for outlining snow cover.

Channel 4 (near infrared):
• distinguishes between plant diversity;
• It can be used for delineating water bodies and separating dry and wet soils, as water absorbs near infrared waves.

Channel 5 (medium or shortwave infrared):
• sensitive to changes in water content in leaf tissues (swelling);
• sensitive to variations in moisture in vegetation and soils (reflectivity decreases with increasing water content);
• useful for determining the energy of plants and separating succulents from woody vegetation;
• is particularly sensitive to the presence / absence of trivalent iron in rocks (the reflectivity increases with increasing amount of ferric iron);
• distinguishes between ice and snow (light tone) from clouds (dark tone).

Channel 6 (long-wave infrared or thermal):
• The sensors are designed to measure the temperature of the radiating surface from -100°C-150°C;
• Suitable for day and night use;
• application of thermal imaging: analysis of soil moisture, rock types, identification of thermal water pollution, household heat accumulation, sources of urban heat production, inventory of wildlife, identification of geothermal zones.

Channel 7 (medium, or shortwave infrared):
• coincides with the absorption band of radiation by hydro mineral (clayey shales, some oxides and sulfates), due to which they appear dark;
• useful for lithological surveying;
• Like the 5th channel, it is sensitive to the variation of moisture in vegetation and soils.

Channel 8(panchromatic - 4,3,2):
• The most typical combination of channels used in remote sensing for analysis of vegetation, crops, land use and wetlands.

The purpose of processing remote sensing data (RS) is to obtain images or images with the required radiometric and geometric characteristics. Let's consider the basic stages of data processing.

Radiometric accuracy is provided by internal and external calibration systems. The information necessary for the final calibration of the data must be contained in the structure of the signal transmitted to the ground and taken into account in subsequent processing. The ground-based data processing system is designed to extract useful information from multispectral RS data and transfer it to consumers. The processing system is an intermediate link between the remote sensor and the user. Therefore, its characteristics largely depend on the nature of the data, and largely on the requirements of consumers of information from the RS [2].

In general, remote sensing data processing involves three steps:
- Pre-treatment;
- Primary processing;

- Secondary (thematic) processing.

At the first stage, after receiving satellite data, recording them on a magnetic carrier, and performing the necessary decoding and correcting operations, the data (taking into account calibrations) transferred from the spacecraft is converted directly into an image or a space image (for example, the synthesis of radar images from radio holograms transmitted over the radio link), as well as converting them into formats suitable for subsequent processing.

At the second stage, radiometric and geometric transformations (corrections) are performed to correct radiometric and geometric distortions caused by the instability of the spacecraft and sensor operation, as well as geo-referencing of the image with a co-ordinate grid applied to it, zooming in and imagining the image in the required geographic projection (geocoding). The first and second stages of processing can now be performed onboard the spacecraft.

The third stage - thematic processing - includes both digital analysis with the use of statistical processing methods (cluster analysis, methods for distinguishing features and classification for quantitative estimates, etc.), and visual interpretation and interpretation. Thematic processing is advisable to conduct in an interactive or fully automated mode. For these purposes, various types of software for thematic processing with the use of specialized computer equipment, mainly foreign production, have been developed [3].

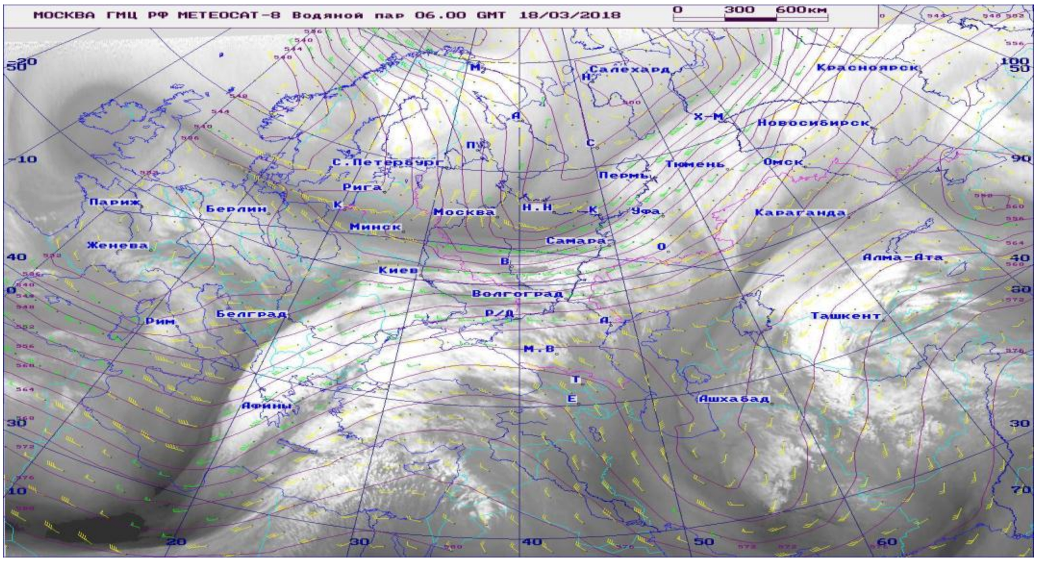

Fig. 2 – Operational satellite data from geostationary satellites MeteoSat

Radiometric transformations are used to transfer raw multispectral data to a radiometric correct and compatible set of measurements. Often these transformations are used to correct certain types of distortion in the data collection system, such as uncompensated instability of electronic devices. Sometimes corrections are introduced for changes in the parameters of the medium during sounding (the state of the atmosphere, change in illumination, etc.). Radiometric conversions are also used for absolute data calibration, i.e. to convert the intensity of the image measured by the sensor to the value of the measured physical parameters (for example, translating the color of the image into chlorophyll content values).

With the help of geometric transformations, the geometry of the image is changed or the geometrical distortions introduced by the RS equipment are corrected. Distortions arise as a result of the limited resolution of each RS system, as well as due to defects or errors in the data logging system. Geometric distortions can be eliminated or significantly reduced by appropriate processing if data are available that characterize the position of the sensor in space at the time of shooting and the geometry of the underlying surface. "Alignment" and "data overlay" are terms that denote the processes of geometric alignment of one set of data relative to another. For example, one set may be data from the RS of the ocean, another - maps. Note that there is a wide variety of data that can be combined or superimposed on each other. For example, the distribution of ocean-surface data in the form of an image or a snapshot can be superimposed on data on underwater topography, on contact sub-satellite measurements, on meteorological parameters, etc. Scaling, transforming projections, correcting systematic distortions are procedures necessary to obtain an image on a scale or geographical projection and to eliminate the various distortions that have arisen due to the instability of the spacecraft platform.

The presentation of data is one of the important types of data processing and analysis. Forms of data representation largely depend on the nature of the applications and the processing procedure used. Compression and data archiving is the most important element of processing, since in the RS procedure you have to process huge data flows and store the processed information. By reducing the format or volume of data in communication systems, data transmission, storage and processing requirements can be reduced, which ultimately leads to a reduction in the cost of the processing system as a whole.

The improvement of images in a broad sense is understood as the procedures for improving any kind of data represented in the form of an image, and in a narrow way, procedures that improve the visual perception of data represented as an image. All image enhancement procedures can be useful regardless of whether or not RS data should be visualized. For example, filtering that improves the selection of contours or boundaries can be part of a more complex procedure. Other operations are designed to reduce various types of instrument noise and thus can be used to improve subsequent classification analysis.

Statistical methods are used to recognize certain objects of the RS and classify data using numerical methods. These methods are effective for quantitative assessments in the remote sensing procedure. The results obtained after the processing and analysis of RS data are presented in a specific form and format (tables, data sets, graphs, charts, maps) [4].

Today, data processing systems have become the standard for workstations and personal computers with high-speed processors and high-capacity storage devices, which imposes corresponding requirements for data processing procedures. A lot of software packages of various levels have been developed for the processing of RS data and images - from distributed free of charge to expensive ones.Space monitoring is divided into two qualitative types: complex and diversified. By the method of analyzing the object of monitoring, space monitoring is divided into monitoring of direct measurements and monitoring based on the application of models or model monitoring. Among model monitoring monitoring is based on modeling not only the object, but also information fields reflecting the nature of physical, chemical and other processes. The basis for integration of space monitoring is geoinformation monitoring.

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