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Paper Session II-B - Principles of Forming the Ground/ Space System for the Forecast of Natural and Technogenic Dangers

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PRINCIPLES OF FORMING THE GROUND/SPACE SYSTEM
FOR THE FORECAST OF NATURAL AND TECHNOGENIC
DANGERS

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It is known, that an essential impact on natural, technogenic, social and other processes on the Earth is made by phenomena occurring on the Sun and within the Earth's near space environment. This is the so called "space weather", that causes natural calamities, accidents and disasters, thus influencing the health and people's psychology, etc. [1,2].

As an illustration we refer to the results of the solar burst of March 13, 1989, when the power supply was stopped during nine hours in the province Quebec (Canada), and a few transformers were broken in New Jersey (USA) causing a damage equal to \$10 million [3]. We know facts of pipeline damages (due to the strain, appearing from the sharply geomagnetic field change), explosions of transformers at telephone exchange stations and computer system failures, associated with changes in the Earth's near space environment, produced by solar bursts [2]. The Earth's near space conditions and, in particular, conditions of the ionosphere, have influence on the reliable work of communication, navigation and radar systems.

In addition, the Earth's near space environment, in its turn, is rather sensitive to the processes going on the Earth's surface and in its entrails, in particular, to earthquakes, as well as to many anthropogenic factors to the operation of powerful radio transmitting systems, rocket launches, chemical pollution, etc.

This list (which is far from complete) shows the importance of creating a special service for reliable forecast and prevention of accidents and disasters, caused by both natural and anthropogenic factors.

The vital necessity of solving the problem is justified by widening the construction scale of such potentially dangerous objects, as atomic stations, chemical plants, reservoirs, dangerous waste repository, pipelines, electrical power lines, defense structures etc., the accidents on which may lead to great loss of human lives, material resources losses and heavy results for the natural environment.

Scientists, public and politicians increasingly realize the fact of existence of a real threat to mankind and the Earth's biosphere from natural spacegeophysical factors and technology that can lead the world to the global ecological disaster.

In this connection, the Lavochkin Association jointly with the Institute of Applied Geophysics (IAG), IZMIRAN and other organizations have developed the "Proposals on the Creation of Ground/Space System for Global Heliogeophysical Monitoring" (SGHM) [4]. The SGHM will collect appropriate statistical data of solar activity, magnetosphere, ionosphere and upper atmosphere conditions, as well as the Earth's entrails in the interests of national economy branches, ecology, science, forecast of natural disasters and international treaties verification in the field of arms limitation.

PRINCIPLES OF THE SGHM CREATION

Underlying the concept of the SGHM creation is the idea of multi-layer organization of its components which should meet the following general requirements to provide its effectiveness:

1. The SGHM should use the already existing ground-based and space facilities, integrity of tasks to be solved and include the working ground infrastructure, with Ministry of Defense (MOD) facilities under conversion (receiving, processing and controlcenters, communication channels, etc.).

2. Integrated approach to processing of the received data in the interests of many national economic, science and other users.

3. Step by step system's development in order to ensure it flexibility and adaptability as new tasks and technologies appear.

The fulfilment of these requirements will ensure relatively low costs, fast realization, low risk and high reliability of the system.

COMPOSITION AND FUNCTION OF THE SGHM MAIN COMPONENTS

Based on the formulated concepts of the SGHM development and the requirements on providing potential users with the needed data types [5-7], the SGHM structure must include the following (fig.1):

- ground-based/space monitoring facilities of the heliogeophysical environment;

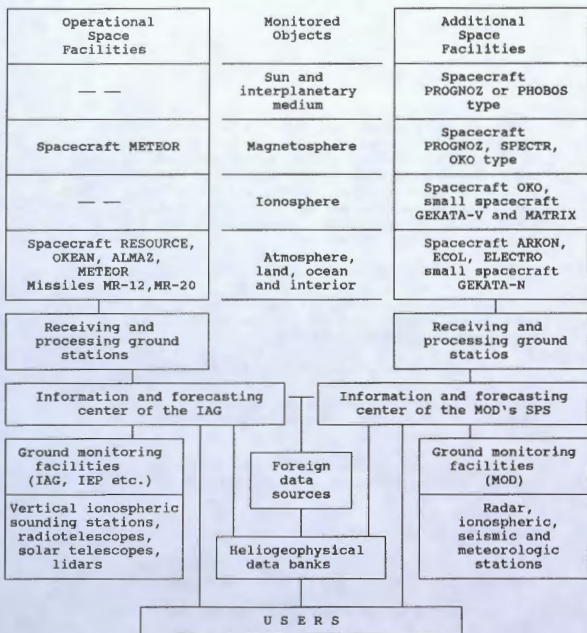


Fig.1. SGHM structure.

MOD's SPS - Department Of Defense Special Purpose System
 IAG - Institute of Applied Geophysics
 IEP - Institute of the Earth's Physics

- receiving and data processing centers;
- information/forecasting and scientific centers;
- facilities for distribution of the forecasting data among users.

The ground-based monitoring facilities will include astronomic, ionospheric, meteorologic, seismic and other stations, operational and under development, as well as the MOD ones.

The space monitoring facilities will include spacecraft for monitoring of heliogeophysical processes in a very wide range - beginning from the Sun and down to the Earth's entrails what makes it necessary to use the multi-layer spacecraft location - from interplanetary spacecraft till low orbital spacecraft, intended for the meteorologic observations, remote sensing of the Earth and MOD missions.

As the space facilities of the SGHM may be used the now operational and prepared for launch spacecraft from the Lavochkin Association type OKO, PHOBOS and PROGNOZ, advanced spacecraft like SPECTR, ARKON, ECOL and small spacecraft GEKATA, and also similar ones from other companies (METEOR, etc.), including foreign spacecraft, as well as methods and diagnosis facilities from the Institute of Applied Geophysics (IAG) of RosGidroMet and the Academy of Sciences. In addition, it is possible to use MOD facilities under conversion.

Receiving and processing of space data, as well as data from ionospheric, radar, seismic, etc. ground stations will be carried out with the aid of the joint facilities of the IAG and the MOD Special Purpose System under conversion. Besides that, an interchange of heliogeophysical data with international centers is planned.

Space monitoring subsystem of the SGHM

This subsystem is used:

- spacecraft based on the well-verified PROGNOZ or PHOBOS type spacecraft in the geocentric and heliocentric orbits for continuous solar observations, including the side invisible from the Earth, measurements of electromagnetic and corpuscular solar fluxes, magnetic field;
- already operational constellation of the high elliptical and

geostationary spacecraft OKO as well as the prospective spacecraft series SPECTR and PROGNOZ with additional sets of patrol instruments for global monitoring of the spatial-temporal pattern of interactions between magnetosphere and solar wind;

- relatively simple and cheap low-orbit small-size spacecraft GEKATA and geostationary small-size spacecraft MATRIX or spacecraft OKO with MATRIX instrument are supposed to be used for global monitoring and prediction of the ionosphere composition, degree of ionization, dynamic processes and electric fields;

- low orbit small spacecraft GEKATA, spacecraft of PROGNOZ type and geostationary spacecraft of OKO type have been supposed to be used for study of the Earth's internal structure and of the dynamic processes, occurring in its mantle by the method of measuring the thin structure of the terrestrial gravitation field;

- existing low orbital spacecraft RESOURCE, OCEAN and ALMAZ and (at the second stage) advanced high and medium orbital spacecraft ARKON and ECOL for all weather, high periodical, multispectral remote sensing of the low atmosphere, the Earth's surface and ocean monitoring.

Some parameters of the supposed spacecraft and possible set of the monitoring parameters and measuring instruments for all space echelons of the SGHM are provided in articles [8,9].

The available infrastructure, used for servicing scientific and applied-purpose spacecraft, and also MOD's facilities under conversion, are supposed to be used for receiving and processing of data from spacecraft.

EXPECTED RESULTS

Creation of this system will provide:

- increase of reliability and safety operation of complex technical systems and national-economic complexes (communication, radar and navigation systems, power supply networks, automatics of electrical power lines, oil and gas pipelines, transportation vehicles, computing centers, spacecraft, defense and other facilities sensitive to spacegeophysical factors);

- decrease and prevention of the adverse influence on man and

biosphere of the natural and artificial factors;

- monitoring and prevention of the unfavorable impact of technogenic activities on the environment;
- increase of reliability in forecasting natural phenomena (weather) and disasters - earthquakes, volcano eruptions, etc.;
- more precise knowledge of risk in insuring various objects;
- improved verification of international tests limitation treaties for some kinds of weapons, including nuclear weapons;
- solution of some fundamental problems of heliophysics and solar-terrestrial physics.

STAGES OF THE SGHM EVOLUTION

The SGHM development and creation are intended to be carried out stage-by-stage in some directions, widening its possibilities as its effectiveness is confirmed and financing support is given, based on the maximum use of the tested scientific and engineering achievements.

The first stage (1993-1996) which can be called experimental should contain the work in the following spheres:

- more precise definition of the SGHM construction concept;
- installation of experimental kits of the recording (patrol) payload instruments on board the series-produced high apogee spacecraft OKO and PROGNOZ (in development of INTERBOL and RELIKT projects) in order to find out the effectiveness of this payload for monitoring the Earth's near space environment and also to develop methods and facilities of data acquisition, processing and presentation to users on the base of operational ground-based facilities of the OKO and PROGNOZ systems;
- development and flight tests of relatively cheap and simple small spacecraft GEKATA for studying ionosphere from low altitude orbits and MATRIX - for global ionospheric monitoring and lithosphere deformations monitoring from the geostationary orbit;

At the second stage (1996-2000), there must be the full-scale putting into operation of all the ground and space SGHM facilities, including the spacecraft for monitoring and forecasting solar activity, operating on the heliocentric orbits and in the libration point L1 of the Sun-Earth system.

On condition of involvement into the formation of SGHM of

interested overseas organizations and firms, it could be a part or the core of the Global System for World Community Protection, proposed by the President of Russia on January 31, 1992 at the session of the UN Security Council, and could be implemented within the Program "International Decade on Reducing Natural Dangers".

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