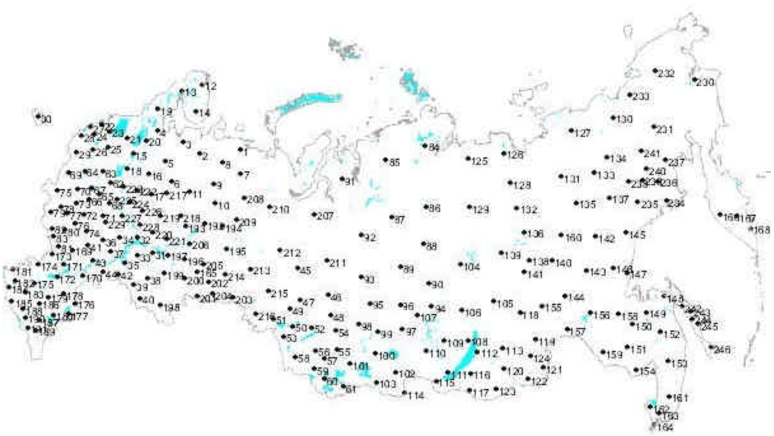
Friedrich- Schiller University Jena
Institute of Geography
Department for Geoinformatics

GMES-RUSSIA

Establishing a Thematic Network in Russia for Priority Themes A, B, C and E for GMES Strand 2 Assessment Activities

Annual Report 2003



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Foreword of Coordinator

This report presents the results of the GMES RUSSIA Project that have been received by October 2003. The project started in January 2003 and it still continues till July 2004. In accordance to project's methodology all work is broken down into Work packages that comprise the different aspects of the project's tasks. The time schedule prescribes for this year 2003 the work basically within **Work packages 2000, 5000**. The latter presume not only the introducing to the Russian partners the GMES concepts and ideas and some preliminary introductory activities but the real intensive work in the field of technical/scientific assessments with regard to both chosen GMES thematic priorities: A, B, C, E and GMES assessment issues such as: "Users and User requirements", "Environmental Monitoring Infrastructures and Instruments", "Data quality and data policy", "Supporting Information Technologies" and others.

Thus we present here the results of our 9 month intensive work that cover the majority of tasks formulated in our Work program within corresponding Work packages. Since simultaneously with this project the cross-cutting assessment studies:

- "BICEPS", Building an Information Capacity for Environmental Protection an Security

- "DPAG", Data Policy Assessment for GMES

under guidance of EC started as well, we attempted not only follow the requirements and methodological principles of the latter but closely communicate with leaders of these projects Dr. Barry Wyatt and Prof. Ray Harris in order to receive much helpful advice and provide information exchange. The investigation of the socio-economic, institutional and organisational issues is planned for next year. We suppose to do this work maintaining the close contact with Dr. Nina Costa: leader of the project "**GSeS" GMES Socio-economic Study.**

Our project partners are prominent Russian organisations and Institutes having a great deal of expertise and experience in the field of Earth Observation and environmental sciences. To enable this expertise to benefit our project tasks it took some time to introduce and explain the peculiarity of GMES principles, objectives and commitments.

The GMES FORUMS in Noordwjik and Athens and participation of the Russian partners in these conferences (as a result of coordinating activities of Friedrich Schiller University – Jena) played the crucial role in their understanding of what GMES means and how to cope with project's tasks.

List of Abbreviations

AARI – Arctic and Antarctic Research Institute
AIISA - Automated Ice Information System for the Arctic
AFTN - Aviation Federal Telegraph Network;
AMCS – Aviation Meteorology Civil Station;
ASDT - Automated System of Data Transfer;
AVC – Aerological Automated Computing Complex;
"AVIALESOKHRANA" - Aviation Forest Protection Office
BAMD - Bank of Aviation Meteorological Data;
BICEPS – Building an Information Capacity for Environmental Protection and Security;
DPAG – Data Policy Assessment for GMES
EMERCOM - Russian Emergency Committee
FKTs "ZEMLYA" - Federal Cadastral Centre "ZEMLYA"
GGI - State Hydrological Institute
GGO - Central Geophysics Observatory
GIPE – State Institute of Applied Environment
GMB – Hydrometeorology Bureau;
Goskomhydromet USSR - State Committee for Hydro Meteorology of the former USSR;
GOSKOMZEM - Russian Federal State Committee on Land Resources
HMTs - Hydro meteorological Centre of Russian Federation
IAO SB RAS – Institute of Atmospheric Optics, Siberian Branch of the Russian Academy of Sciences;
ICAO - International Civil Aviation Organization;
ICKC SB RAS - Institute of Chemical Kinetics and Combustion, Siberian Branch of the Russian
Academy of Sciences;
IGAN - Institute of Geography of Russian Academy of Science
IGCE - Global Climate and Ecology;
IGKE - Institute of Global Climate and Ecology
IKI – Institute of Space Research
KGI-4S — Heliogeophysical measurement instrumentation
MAMC - Main Aviation Meteorological Centre;
MD - Ministry of Defence;
MH - Ministry of Health;
MGO - Main Geophysical Observatory;
MIL - International Institute of Forest
MIVZA — Microwave radiometer for integral humidity sounding
MPR - Russian Ministry of Natural Resources
MOH - Marine Operations Headquarters
MSGI-5EI — Multi-channel system for measuring geo-active radiation
MSU-E — Multi-band optical-electronic scanner of high-resolution
MSU-SM — Multi-band scanner of medium resolution
MSU - Moscow State University;
MTVZA — Microwave radiometer for temperature and humidity sounding of atmosphere
NITs "PLANETA" – Research Scientific Centre "Planeta"
NPO "Tayfun"- Research Production Organization "Tayfun"
NRTsPOD - Novosibirsk Regional Centre for Data Acquisition and Processing
NSR – Northern Sea Route
NSRA - Northern Sea Route Administraiton
RAN – Russian Academy of Science
RF – Russian Federation
RFI - Russian Information Fund on Nature Management and Environmental Control
RIATs – Regional Information-Analytical Centre
ROSAVIAKOSMOS - Russian Aviation and Space Agency

ROSHYDROMET - Russian Federal Service for Hydrometeorology and Environmental Monitoring
RSBD - Regional Special-purpose Data Banks
SAGE-3 (US) – Instrument for measuring small gas components of the atmosphere
SFM-2 — Spectrophotometer for vertical distribution of ozone and other small gas components of the atmosphere
SSMAP - State Service for Monitoring of Atmospheric Pollution;
SES - Sanitary Epidemic Stations;
TsAO - Central Aerological Observatory
TsGMC – Territory Department of Hydrometeorology;
TSEM – Territorial Systems of Environment Monitoring
TsEPL - Centre of Ecology and Forest Productivity
TCCN - Transport Corporate Computer Network;
UGMC – Region Department of Hydrometeorology;
VNIIGMI-MTsD - All-Russian Research Institute of Hydro meteorological Data – World Data Centre
VNII of EMERCOM - All-Russian Research Institute of Emergency
VNIISKhM - All-Russian Research Institute of Agricultural Meteorology
WMO – World Meteorological Organisation

I. Introduction

GMES-RUSSIA establishes a first network of key data providers and users between the European component of GMES and Russia and contributes thus to the implementation of this specific EC programme.
GMES-RUSSIA will produce a current assessment of EO and in-situ data capabilities, on-going research emphases and modelling approaches in Russia with respect to the GMES-tasks.
GMES-RUSSIA is a contribution of Russian expertise concerning technical and scientific issues for GMES cooperation and is assessing scientific-technical, socio-economic and institutional aspects. GMES-RUSSIA contributes to on-going European-Russian cooperation projects and is designed to meet the needs of long-term monitoring. The project will establish therefore a basis for future cooperation in the fields of environmental monitoring and climate impact studies.

II. The Consortium

The consortium consists of seven multi-disciplinary partners from Germany and Russia, who are linked to GMES-RUSSIA through their own interest. The team has a good spread of institutions: 1 university, 2 institutes of the Russian Academy of Sciences, 1 institute of the Russian Space Agency Rosaviakosmos, 2 SMEs, 1 governmental agency.

GMES-RUSSIA is coordinated by the Department of Geoinformatics & Remote Sensing of the Friedrich-Schiller-University Jena which also maintains EU contacts. The FSU Jena established over many years well-known experience in coordination of large and complex projects (SIBERIA, SIBERIA-II, ARSGISIP) as well as EO missions (involvement in SRTM and airborne campaigns, e.g. TerraDew for TerrSAR).

The participation of the Russian institutions is critical for the successful implementation of GMES-RUSSIA and is hence in conformity with the interest of the Community policies.

The Russian participants are well recognised in their fields and are top-level specialists. Their institutions add substantial value to implement the EC´s GMES programme and are essential for achieving the objectives of the project.

FSU (Coordinator)	Friedrich-Schiller-University, Institute of Geography, Dept. of Geoinformatics and Remote Sensing Jena, Germany
NRCGIT	Novosibirsk Regional Center of Geoinformation Technologies, Akademgorodok, Novosibirsk, Russia
NIERSC	Nansen International Environmental and Remote Sensing Center, St. Petersburg
IAO	Institute of Atmospheric Optics, Russian Academy of Sciences, Tomsk, Russia
URIIT	UGRA Research Institute of Information Technologies, Khanty-Mansiysk, Russia
NTSOMZ	Research Centre for Earth Operative Monitoring, Russian Space Agency Rosaviakosmos, Moscow, Russia
ISZF	Institute of Solar-Terrestrial Physics , Russian Academy of Sciences, Irkutsk, Russia

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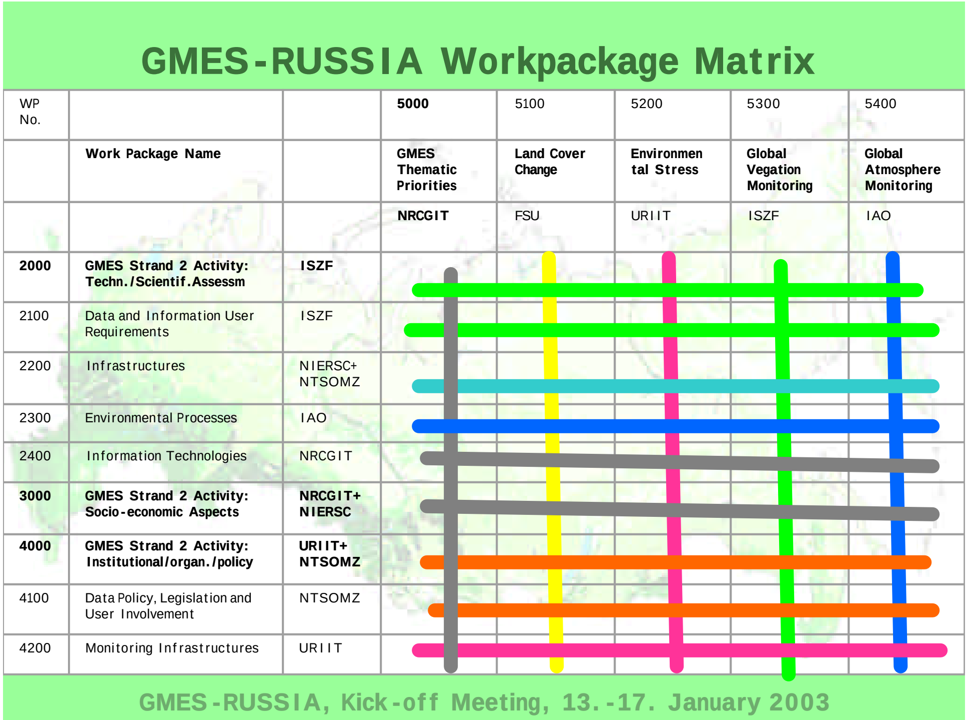
III. Working Methods (Project's methodology)

We arranged our project tasks in a **Work package Matrix** (see Fig.3.1).
This matrix reflects the philosophy of GMES commitment and fixes the responsibilities within project partners. It also depicts our thematic priorities A, B, C, and E.
It is presumed that project partners perform very close interaction with each other and attempt to extend the number of organisations to collect necessary information as well.



GMES-RUSSIA Workpackage Matrix

WP No.	Work Package Name		5000 GMES Thematic Priorities NRCGIT	5100 Land Cover Change FSU	5200 Environmental Stress URIIT	5300 Global Vegation Monitoring ISZF	5400 Global Atmosphere Monitoring IAO
2000	**GMES Strand 2 Activity: Techn./Scientif.Assessm**	**ISZF**					
2100	Data and Information User Requirements	ISZF					
2200	Infrastructures	NIERSC+ NTSOMZ					
2300	Environmental Processes	IAO					
2400	Information Technologies	NRCGIT					
3000	**GMES Strand 2 Activity: Socio-economic Aspects**	**NRCGIT+ NIERSC**					
4000	**GMES Strand 2 Activity: Institutional/organ./policy**	**URIIT+ NTSOMZ**					
4100	Data Policy, Legislation and User Involvement	NTSOMZ					
4200	Monitoring Infrastructures	URIIT					

GMES-RUSSIA, Kick-off Meeting, 13.-17. January 2003

Fig. 3.1

The chapters IV and V of this report describe the common issues of the environmental monitoring infrastructure in Russia. Here we present not only which ministries, agencies and particular organisations and institutes are involved in this sort of activities but consider types of monitoring being done under guidance of particular ministry. Chapter V presents summary of user requirements to satellite sensors and instruments to provide effective high-quality monitoring of environment. Organisational features and the leading role of ROSAVIAKOSMOS in satellite remote sensing in Russia are pointed out.

The consequent chapters present state-of-the-art with monitoring of the particular environmental components: atmosphere, oil pollution, soil degradation, forest fires, sea ice. These thematic problems in our case are projected onto "assessment coordinates". Practically in every task we attempted to estimate users and user requirements to data and information, data quality and data quality control, data types and standards, data archives and data policy issues in accordance with DPAG methodology.

The final chapter of the report introduces the design principles of the GMES RUSSIA WEB site. The latter is designed as a distributed open database with sophisticated navigation and search mechanisms. It is supposed to put this WEB site and database in operation by GMES FORUM in Baveno Italy which will take place on 26.11 – 28.11.2003. It is difficult to overestimate the importance of this part of job. The operation of this WEB site will allow not only collecting new information and information sources in RUSSIA but establishing the effective communication mechanism between Russian and European GMES components.

In this way we achieve one of the main objectives of the current project.

IV. Environmental Monitoring Infrastructure in Russia

IV.1 Organisational Structure

Monitoring infrastructure in Russia has multistep administrative structure (See Fig.4.1) The monitoring process is under the control of the corresponding ministry. The offices and departments of ministries are responsible for the particular monitoring type. The implementation of the monitoring is being done by the subordinated organisations and/or institutes that are responsible for collection, accumulation, processing, analysis and distribution of the monitoring data.
Five ministries and Russian Academy of Science (RAS) are involved in the Monitoring of Environment in Russia.
The ministries under the consideration are:

- Russian Aviation and Space Agency (**ROSAVIAKOSMOS**)
- Russian Ministry of Natural Resources (**MPR)**
- Russian Federal Service for Hydrometeorology and Environmental Monitoring (**ROSHYDROMET**)
- Russian Emergency Committee (**EMERCOM**)
- Russian Federal State Committee on Land Resources (**GOSKOMZEM**)

Some 31 Organisations and Institutes are involved in the development, production and exploitation of the monitoring networks and instruments. Fig.4.2 and Tables 4.1 – 4.3 give detailed description of these organisations and their subordination to the corresponding ministry.

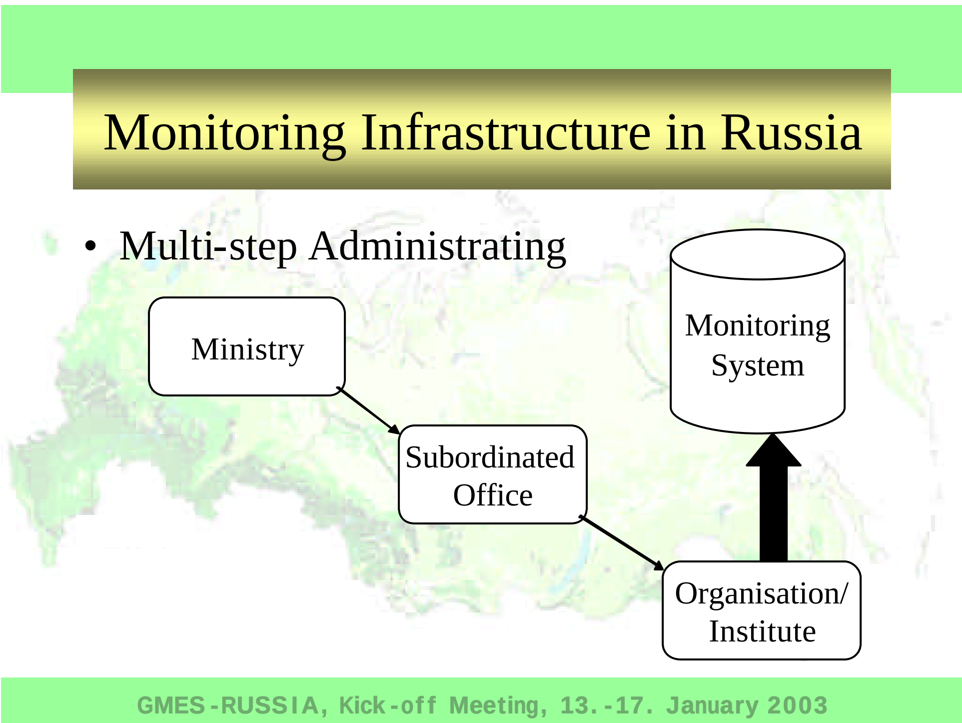


Fig.4.1 Monitoring Infrastructure in Russia

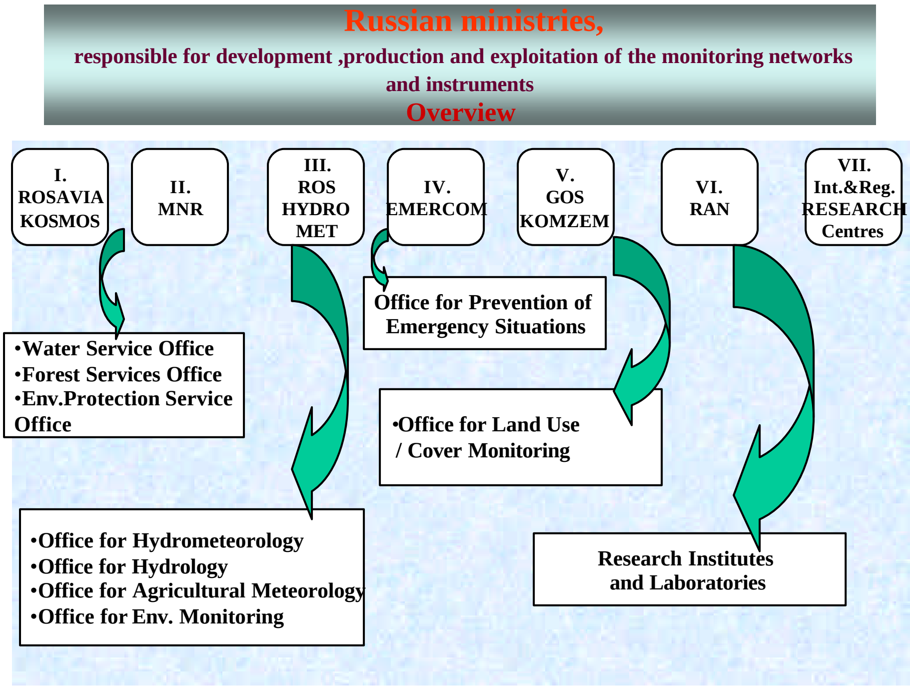


Fig.4.2 Overview of Russian Ministries

Russian organisations, agencies and ministries, responsible for development, production and exploitation of the monitoring networks and instruments

Ministry and Department	Subordinate Offices	Organizations and Institutes	Monitoring Systems
Russian Aviation and Space Agency (Rosaviakomos)	Office of Space Systems for Earth Remote Sensing	**Research Centre for Earth Operative Monitoring, NTs OMZ (Moscow)**	**Space monitoring of :** **- Environment,** **- Floods,** **- Forest vegetation and forest fires,** **- Agricultural vegetation,** **- Ecological situation.**
Russian Federal Ministry of Natural Resources (MPR)	State Water Service	Regional Watershed Offices	Monitoring of water quality
	State Forest Service	Forest Foundation Office, "AVIALESOKHRANA"- Forest Foundation Protection Office, (Pushkin)	Monitoring of forest resources, forest cadastre. Vegetation monitoring. Forest fire monitoring.
	State Environmental Protection Service	Environmental Activity Office, GIPE (Moscow)	Ecological monitoring
		Ecological Control Office, Research Institute of Atmosphere (St. Petersburg)	Monitoring of ambient air quality
		Environmental Activity Office, Ecological Control Office	Ecological monitoring and control
		Territorial Systems of Ecological Monitoring (TSEM) and Regional Information-Analytical Centres (RIATs).	

Table 4.1

Ministry and Department	Subordinate Offices	Organizations and Institutes	Monitoring Systems
Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet)	Hydrometeorological Supply Office	NITs PLANETA (Moscow), Novosibirsk Regional Centre of Data Acquisition and Processing (NRTsPOD)	Space monitoring of hydrometeorological state of the Environment
	Agricultural Meteorology Supply Office	Hydrometeorological Centre of Russian Federation (HMTs), Moscow All-Russian Research Institute of Agricultural Meteorology (VNIISKhM), Obninsk	Monitoring of agricultural lands Monitoring of agricultural vegetation, yield prediction
	Hydrological Supply Office	HMC State Hydrological Institute (GGI), St. Petersburg	Surface water monitoring Water cadastre
	Environmental Monitoring Office	Central Aerological Observatory (TsAO), Dolgoprudny HMC, Central Geophysics Observatory (GGO), St. Petersburg Institute of Global Climate and Ecology (IGKE), Moscow	Techniques and facilities of upper-air sounding and monitoring Aerological and actinometrical monitoring Environment background monitoring
EMERCOM (Emergency Committee, Russia)	Office for Emergency Prevention	All-Russian Research Institute (VNII of EMERCOM), Moscow Regional Centres of EMEERCOM	Monitoring of fires, floods, and earthquakes
Russian Federal State Committee on Land Resources (GOSKOMZEM)	Office for Land Monitoring	Federal Cadastral Centre (FKTs) "ZEMLYA"	Land use / cover monitoring

Table 4.2

Ministry and Department	Subordinate Offices	Organizations and Institutes	Monitoring Systems
Russian Academy of Sciences (RAN)	RAN Department on Geosciences	Institute of Geography (IGAN), Moscow	Monitoring of land cover
	RAN Department on Geosciences	Centre of Ecology and Forest Productivity (TsEPL), Moscow International Institute of Forest (MIL), Moscow	Monitoring of forest vegetation, Inventory of Russian forest resources and assessment of current changes in forests
	Siberian Branch of RAN	Institute of Forest, Krasnoyarsk	Monitoring of forest vegetation, forest resources
	Siberian Branch of RAN	**Institute of Solar-** **Terrestrial Physics** **(ISZF), Irkutsk,**	**Forest fire monitoring**
	Siberian Branch of RAN	**Institute of Atmospheric Optics (IAO), Tomsk**	**Research of the atmospheric state**
	Siberian Branch of RAN	**Centre of Geoinformation Technologies, (NRCGIT), Novosibirsk**	**Geo-ecological monitoring**
International Centre	**Nansen Environmental and Remote Sensing Centre (NERSC),** **Bergen, Norway**	**Branch of NERSC, Nansen International Environmental and Remote Sensing Centre (NIERSC), St. Petersburg**	**Monitoring of forest vegetation, Monitoring of the Arctic Region environment**
Regional Centre	**West Siberia, Khanty-Mansyisk**	**Ugra Research Institute of Information Technologies (URIIT), Khanty-Mansyisk,**	**Ecological monitoring**

Table 4.3

IV.2 Space Monitoring under guidance of ROSAVIAKOSMOS

The space monitoring as well as other space activities in Russia is being done under guidance and control of **ROSAVIAKOSMOS** ministry. The operative environment monitoring from space (Table 4.1) is coordinated by Office of Space Systems for Earth Remote Sensing of **ROSAVIAKOSMOS** and is carried out by Research Centre for Earth Operative Monitoring **(NTs OMZ**). The space instruments for the monitoring of environment that are under operation now and those expected in the nearest future are developed in accordance to the official *document "The Concept of Development of the Space Systems for monitoring of Environment"*. Here the main goals and objectives are grouped and categorized:

- Weather forecast and climate exploration
- Ecological monitoring
- Monitoring of emergency and risk situations
- Monitoring for sustainable development of natural resources
- Monitoring for Earth sciences and Atmospheric research

Naturally every group has different tasks and these tasks put different requirements to the parameters of the space instruments and sensors:

- Spatial resolution
- Radiometric accuracy
- Spectral content
- Timeliness/currency

As a result of thorough analysis of the monitoring tasks and objectives **ROSAVIAKOSMOS** specialists have developed the launch program of remote sensing satellites for the monitoring of environment. This program is presented in Fig.4.3

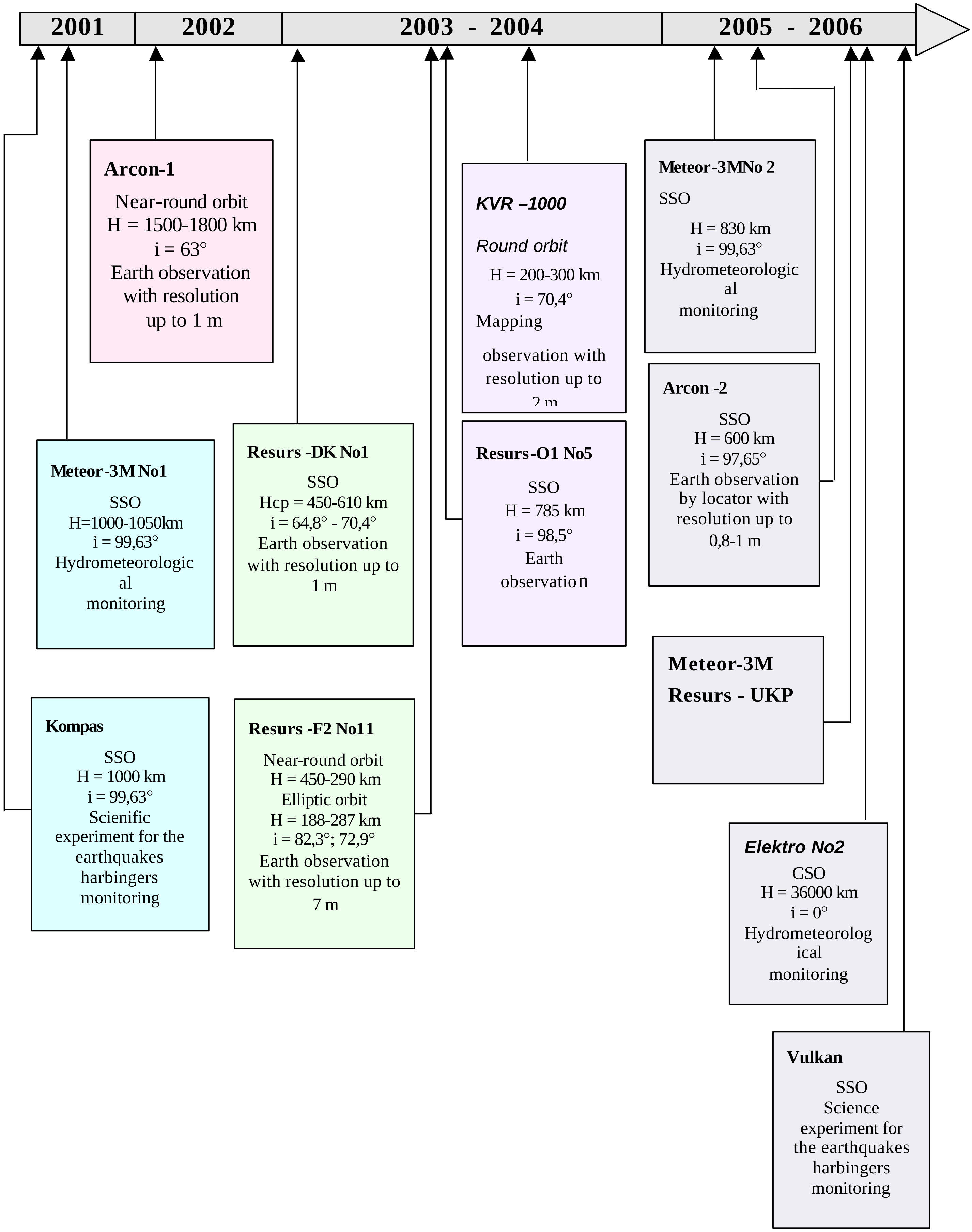


Fig. 4.3. The launch program of the remote sensing satellites for the 2001-2006.

At present the main space satellite for the environmental monitoring in Russia is Meteor-3M ? 1. Its characteristics are presented below.

«METEOR-3M» No1

Mission objectives:

"Meteor-3M" No1 is a multi-mission spacecraft designed for natural resources study, the environmental monitoring, and hydro meteorological and heliogeophysical support.

Tasks being performed:

The "Meteor-3M" No1 instrument payload allows a wide range of problems related to the hydro meteorological support, monitoring of the "Ocean-atmosphere" system, natural resource study and use, ecological monitoring, control of emergencies, heliogeophysical support.

Consumers:

Organizations of federal and governmental services (Roshydromet, Minprirody and others), central and regional nature-management organizations and other services, administrative, economic, and commercial organizations.

Special features

Global imaging of the illuminated and shaded sides of the Earth in IR region, acquiring the radiation environment data, and measurements of vertical distribution of the atmospheric small gas components and temperature and humidity sounding of the atmosphere.

Launch Date: 10 December 2001
Spacecraft Mass 2500 kg
Payload Mass: 800 kg
Launch Vehicle: Zenit-2
Cosmodrome: Baiconur
Orbital Parameters:
Altitude 1018±10 km Inclination 99.64??
Active Life: 3 years
Developer: Research and Production Enterprise Pan-Russian Research Institute for Electro mechanics (NPP VNIIEM)

Parameters	MTVZA	SAGE-3	MSU-E	MSU-SM	MIVZA
Ground Resolution, km	12-75	1-2 (vertical resolution)	32 m	600 m	25-110
Swath Width, km	2600		at nadir -76 at the boundary of viewing field - 84	2240	1500
Spectral range, μm	18.7-183.3 MHz	0.29-1.55	0.5-0.6, 0.6-0.7, 0.8-0.9	0.5-0.7, 0.7-0.9	20-94 GHz
Band number	26	9	3	2	5
Mass, kg	100	88	33	7.3	50

Table 4.4 Performance Characteristics of Airborne Equipment

SFM-2 — Spectrophotometer for vertical distribution of ozone and other small gas components of the atmosphere

MSU-E — Multi-band optical-electronic scanner of high-resolution
MSU-SM — Multi-band scanner of medium resolution
The "Meteor-3M" No1 instrument payload also comprises the following instruments:
MIVZA — Microwave radiometer for integral humidity sounding
KGI-4S — Heliogeophysical measurement instrumentation
MSGI-5EI — Multi-channel system for measuring geo-active radiation
MTVZA — Microwave radiometer for temperature and humidity sounding of atmosphere
SAGE-3 (US) – Instrument for measuring small gas components of the atmosphere.

In coming year the "Resurs-DK1" satellite for environmental monitoring promise to substitute "Meteor 3M". The "Resurs-DK1"characteristics are given below as well.

"Resurs-DK1" General Characteristics

Resolution on ground (m):	
• In panchromatic range	not worse than 1m
• In narrow spectral ranges	2 – 3 m
Scan width (at nadir), km	from 4, 7 to 28, 3
Scan width when spacecraft turns away by roll, km	up to 40
Swath width, km	448
Spectral bands, µm	
• Panchromatic	0,58 – 0,8
• Three narrow spectral bands	0,5 – 0,6 0, 6 – 0, 7 0, 7 – 0, 8
Number of spectral bands readable simultaneously	1-3

The more detailed description of the satellite environmental monitoring in Russia including deployment of the receiving stations over territory of Russia, data control, user requirements, archiving and data policy are given in the next chapter.

IV.3 Environmental monitoring under guidance of the Ministry of Natural Resources

Ministry of Natural Resources (MPR) carries out the coordinating functions to create complex system for monitoring of environment and use of the natural resources. It performs also the state control over water bodies, forests, land use, biosphere on the territory of Russia and together with other federal governmental executive organs regulates the activities of the third parties in the field of environmental policy.
It is the primary MPR commitment to coordinate the functioning of the different monitoring systems, to provide the communications and information exchange between monitoring systems belonging to other ministries and departments and guarantee the archiving of the monitoring data.
As it shown in Fig.4.2 and Table 4.2 the MPR administrative structure has 3 levels.
The lowest level is the level of individual organisations; the territorial level is presented by special territorial offices subordinated to the local authorities and the federal level is presented by special analytical centres(within MPR) and other offices to form data banks on environmental monitoring and support decision making on environmental problems. Here recently was created the so called "Situational Centre" to support the decision making in environmental policy.
The information transfer between levels mentioned above is being carried out on a base of:

- Legislative acts and legal regulations
- Interdepartmental agreements

- Agreements between MPR and territorial bodies and authorities
- Licensing

The development and exploitation of the monitoring networks is being funded through interested organisations and institutes from:

- State federal budget
- Local budget (the budgets of subjects of Russian Federation)
- Free funds
- Commercial and non-state assets

In accordance with monitoring infrastructure (Fig.4.2 and Table 4.1) MPR has corresponding monitoring information infrastructure presented in Table 4.6.

Ministry and Department	Subordinate Offices	Organizations and Institutes	Archives and Data Banks
Russian Federation Ministry of Natural Resources (MPR of Russia)	MPR of Russia Emergency Centre	Russian Information Fund on Nature Management and Environmental Control (RFI)	Integrated Analysis Information System of Nature Management and Environmental Control (EISP) – MPR of Russia Data Library
	State Water Service	Regional Watershed Offices	MPR of Russia Water Data Library Regional Archives
	State Forest Service	Forest Resources Office, Forest Resources Protection Office, Territorial Offices	MPR of Russia Forest Data Library Territorial Information Resources
	State Environmental Protection Service	Environmental Activity Office, Ecological Control Office. Territorial TSEMs and Regional RIATs .	MPR of Russia Ecological Data Library, MPR of Russia State Control Data Library, Territorial Information Funds Regional Information Archives

Table 4.5 MPR Archives and Data Banks

As it follows from table 4.5 every MPR service has data library and archive on regional and territorial levels. Besides every MPR service (State Water Service, State Forest Service, and State Environmental Protection Service) has its own data library. The main organization that possesses the environmental information is Russian Information Fund on Nature Management and Environmental Control (RFI).

IV.4. Environmental monitoring under guidance of ROSHYDROMET

The **ROSHYDROMET** - Russian Federal Service for Hydrometeorology and Environmental Monitoring- is responsible for monitoring hydro and meteo parameters of the environment and atmosphere. In Chapter 6 the detailed information about the Atmospheric monitoring, that is being done under **ROSHYDROMET** guidance, is presented.

Organizational structure of hydrometeorology and environmental monitoring under guidance of **ROSHYDROMET** is given in Table 4.2. **ROSHYDROMET** system for acquisition of hydrometeorologal and environmental information is broken down into terrestrial, aerological and space subsystems.

The monitoring of the hydro-meteo-parameters from space is coordinated by Hydro meteorological Office of the ROSHYDROMET and is carried out by "NITs PLANETA" (Moscow) and Regional Centre for Data Acquisition and Processing "NTs RTsPOD" (Novosibirsk).

Territorial subsystems of ROSHYDROMET are based on network organizations:

- Centres for hydrometeorology and environmental monitoring (CHMS);
- Hydrometeorological observatories (HMO);
- Hydro meteorological bureau (HMB);
- Hydrological stations and posts;
- Environmental centres.

Territorial metrology is implemented on a base of uniform techniques and instruments being applied at specified time.

ROSHYDROMET has the corresponding monitoring information infrastructure presented in Table 4.6.

Ministry and Department	Subordinate Offices	Organizations and Institutes	Archives, Funds, and Data Banks
Russian Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET)	Hydro meteorological Data Supply Office	NITs PLANETA (Moscow) Regional Centre for Data Acquisition and Processing (NTs RTsPOD), Novosibirsk	Hydro meteorological Archive of space data from NOAA, METEOSAT, RESURS-O1, OKEAN-O1, METEOR, TERRA
	Hydro meteorological Data Supply Office	All-Russian Research Institute of Hydro meteorological Data – World Data Centre (VNIIGMI-MTsD): RSBD owners: 1.HMTs 2. VNIISKhM 3.GGI 4.TsAO 6.IGKE 6. NPO “Tayfun”	State Fund – Archive of hydro meteorological environmental data consisting of special-purpose data banks (RSBD) on: 1.Meteorology and climate 2.Agrometeorology 3. Hydrology 4. Aerology 6.Background environmental pollution

Table 4.6 ROSHYDROMET Archives and Data Banks

All terrestrial data are recorded into special-purpose data banks (RSBD). Every RSBD has its own data types and belongs to one of **ROSHYDROMET** organization (Table 4.6). RSBD system was created on a base of unique techniques, instruction structure and language. All RSBD data is sampled and filled out by All-Russian Research Institute of Hydro meteorological Data – World Data Centre **(VNIIGMI-MTsD**).

Data quality control is carried out in accordance to **ROSHYDROMET** and Metrological Instrument Inspection techniques and instructions for all kinds of earth-based observations. Data processing is carried out also on a base of **ROSHYDROMET** techniques. The processing results are controlled on the base of permissible discrepancies. The processing results are presented in formats compatible with World Meteorological Organization (**WMO**) demands and requirements and being transferred to VNIIGMI-MTsD.

User Requirements depend on monitoring type and change with regard to region peculiarities, degree of details and time intervals. They must correspond to those published in “Primary sector of national economics and Weather Service demands to hydro meteorological data compound and spatial resolution” [GUGMS USSR, Obninsk, 1971].

Archive politics is realized in accordance to **WMO** demands [WMO-No784, 1992]. Data archiving is fulfilled in table letter-digital structure for easy access and satisfying customer needs.

Pricing policy of ROSHYDROMET

State Services are provided along with hydro meteorological data free of charge.

Scientific and research centres pay for software products only. Other customers could have hydro meteorological data and information on the conditions of transaction price.

IV.5 Environmental Monitoring under guidance of EMERCOM

EMERCOM: the Ministry of Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters is a federal executive authority specially accredited for problem salvation in the fields of Civil Defence, the population and territories protection from natural and technological emergency situations. EMERCOM implements general state policy and state administration in the field of Civil Defence, emergency prevention and response, and coordination of federal executive authority's activities on the population and territories protection from emergency situations.

EMERCOM principal activities in field of environment monitoring are the following:

- To ensure the Unified Emergency Prevention and Response State System (UEPRSS) operation;
- To control works on large accidents, disasters and other emergencies elimination;
- Coordination of federal executive authorities activities during search-and-rescue operations, oil and petrochemicals spills, harmful chemicals and radioactive substances emissions elimination on the sea and inland reservoirs.

Environmental monitoring is carried out by EMERCOM for the following purposes:

- for emergencies forecast;
- during a period of emergency situations;
- during a period of elimination of the aftermath of the emergencies.

The framework of emergencies and disasters forecast monitoring system is given in Fig.4.4

The information is transferred and processed at EMERCOM Agency on Emergencies Monitoring and Forecast established on the base of the All-Russian Research Institute for the problems of Civil Protection and Emergency Situations (VNII GOCHS, Moscow).

Floods and fires forecasts are based on the information given by the **ROSHYDROMET** and **"AVIALESOKHRANA"** (the Central Base for Forest Protection Aviation).

In emergency situations resulted in chemical, biological or radioactive environment pollution, the monitoring is carried out by the Observation and Laboratory Control System which comprises laboratories of other Ministries : MPR, ROSHYDROMET, Ministry of Health. The All-Russia Centre of Laboratory Control (VCNLC) is responsible for requirements to data measurements and measuring equipment.
There is a constantly working air-space monitoring system in EMERCOM that comprises satellite data receiving stations in Moscow, Krasnoyarsk and Vladivostok.

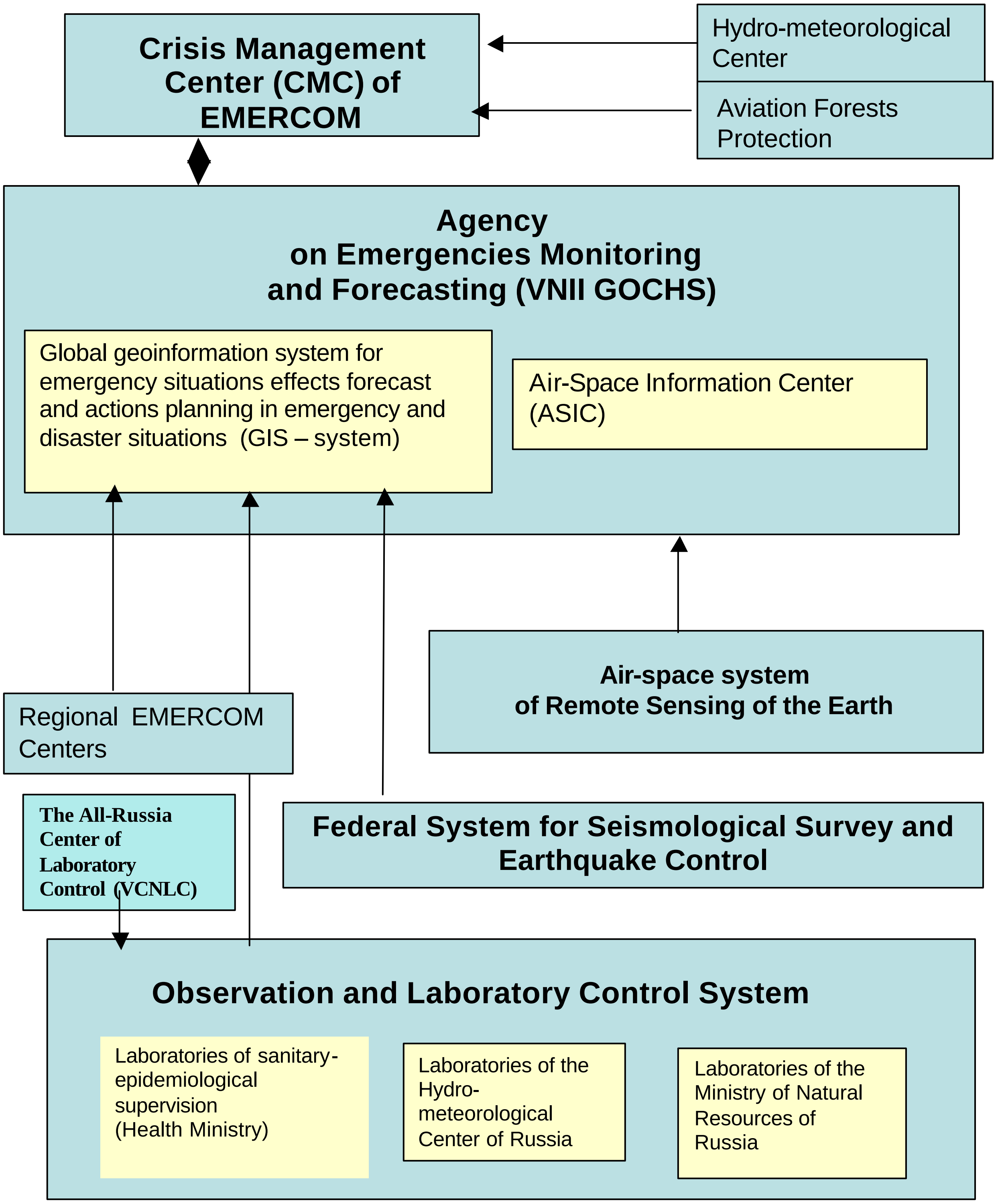


Fig. 4.4 A monitoring system for emergencies and disasters forecast

IV.6 Research in the field of Environmental Monitoring under guidance of Russian Academy of Science (RAN).

The research in the field of Environmental Monitoring is being done in the research Institutes of the Russian Academy of Science in the corresponding departments such as: Department of Earth Sciences.
RAN preliminary infrastructure of Environmental Monitoring Research is given in Table 4.3. Research funding goes on a base of research projects and grants.

RAN satellite data base and archive for research projects is given in Table 4.7.
The accumulation of the data of space monitoring in RAN is being done by special "Unified Information System of the Fundamental Space Research "(UISFSR). The System developers are IRE and IKI RAN.
This system has three levels:

- common catalogue and basic archive of space data
- catalogues and basic archives of individual Institutes (such as Institute of Space research, Institute of Radio electronics and other)
- catalogues and archives of the individual research projects

Ministry and Department	Subordinated Offices	Organizations and Institutes	Archives, Funds, and Data Banks
Russian Academy of Sciences (RAN) and Russian Aviation and Space Agency (Rosaviakomos)	Department of Physical Sciences Office of Space Systems for Earth Remote Sensing	Institute for Radio Engineering and Electronics (IRE), Fryazino, Space Research Institute (IKI), Moscow Research Centre for Earth Operative Monitoring, NTsOMZ (Moscow)	Integrated Information System of Basic Space Research (EIS FKI) consisting of Russian Catalogue and Basic Space Data Archive for Russian scientific space projects

Table 4.7 RAN satellite data Archives and Data Banks

The Institute of Geography (Moscow) performs the monitoring of the land cover on the territory of RF and makes inventories of the forest resources. The regular activity on forest monitoring performs The International Forest Institute (Moscow), Sukachev Forest Institute (Krasnoyarsk), Institute of Solar-Terrestrial Physics (Irkutsk). More detailed information on forestry monitoring in Russia is given in Chapter 7 of this report.

V. Satellite Environmental Monitoring in Russia

V.I Preliminaries

In this chapter the analysis of satellite remote sensing of environment is given. Taking into account the variety of environmental thematic tasks, multifaceted requirements to satellite sensors and instruments and different types of Earth surface under investigation, it seemed us reasonable to bring together and generalise the corresponding issues. The second objective was to make our analysis as close to topics relevant to GMES priorities as possible. That is why the chapter includes issues on "users and user requirements", "data quality", "data policy", " data archives and standards" etc. We attempted to emphasise the peculiarities of Russian situation, concerning management and administration points and specific geographical conditions.

V.2 Satellite receiving stations

As it was pointed out in chapter 4 all kinds of space activities in Russia are being done under guidance and control of **ROSAVIAKOSMOS**. The main Operator of the remote sensing space systems is ***Space Observation Centre*** that guides programming and control of the systems and interacts with Mission Control Centre (TsUP) of **ROSAVIAKOSMOS** (see Fig. 5.1). Operative environmental monitoring from space is coordinated by Office of Space Systems for Earth Remote Sensing of ROSAVIAKOSMOS and is carried out by Research Centre for Earth Operative Monitoring (NTs OMZ), which is the branch of Space Observation Centre. The role of NTs OMZ is receiving, processing, archiving and distributing of Russian and foreign satellite data.

The receiving stations of the remote sensing data in Russia belong to different ministries, agencies, organisations. Every station should receive the license from **ROSAVIACOSMOS** for its activity. The leading role here belongs to receiving station of NTsOMZ.
ROSHYDROMET has three big stations for receiving the remote sensing data, that are located in Moscow, Novosibirsk and Khabarovsk and several small stations in Russian regions.
Ministry of Natural Resources (MNR) became recently one of the active participants of Space data acquisition process. **EMERCOM** is one of the active remote sense data users and now has several small acquisition stations.
Russian Academy of Science is traditionally among other agencies that develop new techniques and methods for remote sensing data utilisation in the filed of environmental problems.
Locations of Russian receiving stations are shown on Fig.5.2. The brief analysis of the deployment of the receiving stations over the territory of Russia allows draw the conclusion that huge territory of North Siberia is covered with receiving stations insufficiently.

V.3 User requirements to remote sensing data

To create the document *"The Concept of Development of the Space Systems for monitoring of Environment"* the thorough analysis of the "end user" requirements has been done by ROSAVIAKOSMOS specialists. These user requirements with regard to some environmental tasks are given below.

<u>Monitoring of floods, snow and ice cover</u>
The following requirements to Earth Observation data should be fulfilled.

Spatial resolution:	10 – 100 m
Spectral content:	0, 01 – 0, 04 µm (optical, IR)
Radiometric resolution:	0,1 – 1,0% (optical band); 0,1 -0,2K (IR); 1-2 DB (UHF)

Frequency: 1- 6 hrs
Timeliness: 0,5 – 1 hrs

<u>Monitoring of forests</u>
Spatial resolution: 2 – 3 m
Spectral content: 1- 20 nm (optical, IR)
Radiometric resolution: 1 – 5% (optical band); 0,1 -0,5K (IR);
Frequency: 1- 6 months
Timeliness: 10 – 20 days

<u>Monitoring of agricultural fields and control of the field work</u>
Spatial resolution: 10 – 20 m
Spectral content: 10- 20 nm (optical, IR)
Radiometric resolution: 1 – 5% (optical band); 0,1 -0,5K (IR); 0,5-1 DB (UHF)
Frequency: 10-20 days for agriculture
Timeliness: 5 -7 days

The user requirements relevant to GMES RUSSIA Project thematic priorities are summarised in the Tabl. 5.1

No	**GMES Thematic Priorities**	**Resolution**			**Spectral Range**	**Data Updating Period**	**Time of Data Delivery**
		Spatial	Spectral	Radiometric			
A 1	Land cover change observations (earth surface albedo, vegetation index)	0.5-1 km (VIS), 1-2 km (IR), 5-10 km (MCW)	0.01-0.05 µm (VIS, IR)	0.1-0.5% (VIS), 0.1-0.2K (IR), 1-2 dB (MCW)	VIS, IR, MCW	3-6 hours	0.5-1 hours
A 2	Snow and ice cover state monitoring	10-100 m (VIS, IR)	0.01-0.04 µm (VIS, IR)	0.1-1% (VIS), 0.1-0.2K (IR), 1-2 ?? (MCW)	VIS, IR, MCW	1-6 hours	3-6 hours
E 1	Atmospheric emission sources monitoring (smoke, thermal emissions)	1-10 m (VIS), 5-20 m (IR)	2-10 nm (VIS, ULV), 10-20 nm (IR)	0.1-0.5% (VIS), 0.5-1K (IR)	(0.5-0.6, 0.6-0.7, 0.8-0.9, 1.5-1.8, 2.1-2.4 3.0-5.0, 8.0-10.0, 10.5-12.5) µm	6-12 hours	1-3 hours
B 1	Soil pollution monitoring (dumps, oil spills, etc.)	1-10 m	2-10 nm (VIS, ULV),	0.1-1%	0.4-1.1 µm 0.4-	6-12 hours	1-3 hours

			10-20 nm (IR)		2.4 µm		
B 2	Monitoring of vegetation cover stress	5-100 m	2-10 nm (VIS, ULV), 10-20 nm (IR)	0.1-1%	0.4-1.1 µm 0.4-2.4 µm	5-10 days	1-3 days
B 3	Ecological disaster zones: extent assessing and characterizing	5-100 m (VIS, IR, MCW)	2-10 nm (VIS), 10-4-nm (IR)	0.5% (VIS) K (IR) 0.3-1 dB (MCW)	VIS, IR, MCW	3-6 hours	2-3 hours
B 4	Emergency assessment: fires, destructions, chemical and biological contamination, floods	1-100 m (VIS, IR, MCW)	5-20 nm (VIS, IR)	0.1-1% (VIS), 0.1-1K (IR), 0.1-1 dB (MCW)	VIS, IR, MCW	1-6 hours (over areas of emergency)	0.5-1 hours
B 5	Forest fire risk monitoring; forest fire detection	10-100 m (VIS, IR)	10-20 nm	1-5% (VIS), 0.1-0.5K (IR)	VIS, IR	6-24 hours	1-3 hours
C 1	Monitoring of crops during vegetative season; area determination of crops affected by pests, diseases, and adverse wintering conditions	10-20 m (VIS, IR, MCW)	10-20 nm (VIS, IR)	1-5% (VIS), 0.1-0.5K (IR), 0.5-1 dB (MCW)	VIS, IR, MCW	10-20 days	5-7 days
C 2	Forest state monitoring; acquiring initial data needed for forest management	5-20 m (VIS), 5-100 (IR)	10-20 nm (VIS, IR)	1-5% (VIS), 0.1-0.5K (IR)	VIS, IR	1-6 months	10-20 days
A 3	Soil and land condition monitoring	5-100 m (VIS, IR, MCW)	10-20 nm (VIS, IR)	1-5% (VIS), 0.1-0.5K (IR), 0.5-1 dB (MCW)	VIS, IR, MCW	7-10 days	1-3 days

Thematic Priorities for “GMES RUSSIA Project”:
A — Land cover change, B — Environmental stress,
C — Global vegetation monitoring, E — Global atmospheric monitoring

Table 5.1 Space Data Requirements for GMES Thematic Priorities

V.4 Data quality control

The BRS (Bitmap ReSource) file format is used for storage and processing of remote sensing data from Russian satellites: RESURS-O1, OKEAN-01, OKEAN-O, METEOR-3M No1. BRS format is an extension of standard BMP format. In addition the BRS file has a header for metadata storage. Software to handle the BRS files has functions for image import/export from/to BMP, GIF, LAN and other formats.

The purpose of data quality control is a verification of the received information with existing standards. Data quality control is divided on two basic groups: metrological certification and control of spacecraft orbital parameters.

Metrological certification

Metrological certification is a control of parameters which are recorded in a header of BRS-file and matching the latter with the same parameters that are obtained from operating mode monitoring data of MSU-E, MSU-SM, MSU-SK scanners. The aim of the processing of the monitoring data is an implementation of two types of control:

- comparison of actual equipment operating modes with pre-scheduled ones
- comparison of actual parameters of MSU-E, MSU-SM, MSU-SK scanners with spacecraft orientation parameters

Scanners variables under control are:

- amplification in each spectral band
- scanner mirror turning angle
- on/off calibration control and calibration levels

Spacecraft orientation variables under control are:

- Spacecraft angle of bank
- Spacecraft angle of pitch
- Spacecraft yaw angle
- Spacecraft velocity angle of bank
- Spacecraft velocity angle of pitch
- Spacecraft velocity yaw angle

Orbital data control.

Orbital data control aimed at more accurate rectification of scanner image gridding. The gridding accuracy improvement is implemented by means correction of some ballistic and spacecraft orientation parameters. For more accurate gridding rectification the following technological steps are foreseen:

- Displaying of vector map as a layer and scanner image as background one
- Ground control point entering
- Automatic correction of orbital parameters
- Automatic correction of a scanner mirror rotate angel
- Automatic correction of spacecraft orientation angels
- Saving the corrected values to a header of BRS-file

V.5 Archives and data standards

V.5.1 NTs OMZ archive infrastructure and data standards

Hardware Servers:

SUN FIRE 280R (RDBMS, Web Server, Common User Interface system), 2CPU 850 MHz, RAM 2 GB, HDD 72 GB, 2 TP 100 Mbps cards - 1 unit,

Intel P4 (Mail Server, archive manager), P4 CPU 2.5 GHz, RAM 512 MB, HDD 120 - 480 GB, 1 TP 100 Mbps card, 1 TP 1 Gbps card, - 3 units,

Client workstations:

Intel P3-P4, CPU 1.5-2.5 GHz,, RAM 256-512, HDD 80-120 GB-10 units;

Tape drives:

DLT7000, LVD, external - 2 units

DLT8000, LVD, external - 2 units,
LTO ITANIUM, LVD, external - 1 unit
Software -
OS:
Solaris 8.x (SUN server),
RedHat Linux (P4 server),
MS Windows 98/ME/2000/XP (client workstations),
RDBMS:
Oracle for Solaris 9.x;
Development software:
MS Visual Studio 6
Borland C Builder
GCC development kit
PL/SQL developer
Perl interpreter with DBI and CGI modules
Web Server
Apache
LAN Topology
Workstation-sever links via TP 100 Mbps,
Server-server links via TP 1 Gbps links, 100 Mbps switches and hubs;
WAN Connection
Last-mile connection via 128 kbps copper cabling (bottleneck),
Gateway on CISCO 26xx router.

V.5.2 Data structures and compatibility with international standards

Archive structure.
Archive is constituted from Data Collections that includes data retrieved within defined space mission by means of defined scientific instrument (remote sensing sensor) or group of instruments (sensors).
Archive Media.
All data is stored on magnetic tapes (as a rule DLT IV type) or CDs (CD-R, CD-RW).
Archive Utility.
The most part of existing collections is written by using CA ARC serve backup utilities in MS Windows environment. Therefore, to get access to data sets on these archive types in UNIX environment one should use additional utility (available by optional request for SOLARIS environment). Data from current project (such as TERRA MODIS, acquired by NTs OMZ receiving station) is stored on archive tapes by using standard UNIX tar utility. In addition the HDF as basic file format is being used.
File Format.
The most usable file format for early conducted missions (especially for RESURS and METEOR) is so called BRS format (extension of BMP format with additional specific set of tagged data objects which are necessary for describing multidimensional data sets obtained in multi-channel visible/IR observations).
Catalogue content
Catalogues contain descriptors of individual Granules (atomic, i.e. undivided, data set), Data Collections (data sets' aggregations), Browse Images (images, requested for data set browsing), File Descriptions (describing data set location vs file structure), Tape Descriptions (containing descriptions of tape as a whole).
Searchable attributes.
Searchable attributes include Date, Coordinates, Parameter, Sensor, Platform, Mission, and Data Centre attributes (similar to those used in EOSDIS and INFEO information systems).
International Standard Compatibility
Developed catalogue system complies with ISO 19115 requirements and could be considered as ISO 19115 profile. In addition it complies the requirements of CEOS Catalogue Interoperability Protocol (CIP) Specifications (V.2.4, June1998).

User service system

User public interface

User interface is integrated in NTs OMZ information portal (http://sun.ntsomz.ru) and could be used for data search and/order purposes, supported by guide services.

Catalogue Access

Remote on-line 24x7 for data search, estimation and ordering via public Internet, no authorization is required.

Massive data set distribution.

Off-line exchanges using tape or CD media (over 100 MB per day)

Medium or small data set distribution

On-line exchanges using ftp (up to 100 MB per day).

V.6 Data policy issues for satellite remote sensing data

V.6.1 Archive Politics and Pricing Policy of ROSAVIACOSMOS (NTs OMZ)

In Russia all kinds of space activities are under **ROSAVIACOSMOS** control. That is why all acquisition ground stations should have **ROSAVIACOSMOS** license for such activities. In accordance to these licenses the organizations could have rights for archiving and distribution of satellite data. In this way the organizations are owners of their archives with shared participation of **ROSAVIACOSMOS**. In accordance to these regulations NTs **OMZ** implements its data policy.

NTs OMZ Satellite data archive content

NTs OMZ has the archives of data obtained from the following remote-sensing systems:

Russian:

RESURS-O1- archive data sets, descriptors, and browse images (MSU-SK, MSU-E, SRRB (France) instruments);

OKEAN-O - archive data sets, descriptors, and browse images (MSU-SK, MSU-V, RLSBO, RM-08, Delta instruments);

KOMETA - archive data sets (KVR-1000 and TK-350 cameras);

METEOR-3M No1- in progress (MSU-E, MTVZA, KGI, SAGE-3 (US) instruments)

Foreign:

TERRA -in progress (MODIS instrument) archives data sets, descriptors, and browse images;

ERS -in progress (SAR instrument) archive sampled data sets, descriptors, and browse images;

NOAA -in progress (AVHR instrument) archives data sets, descriptors, and browse images,

- Goscentr PRIRODA (over 24000 descriptors) - only granule (frame) descriptors.

The digital archive of images from the RESURS-O1 series spacecraft No2, 3, 4 that is generated by the NTsOMZ, contains more than 600.0 gigabytes of data from MSU-E (of 35 m in resolution) and MSU-SK (of 150 m in resolution). The archived 200.0 gigabytes of OKEAN-O data are presented as radar images (RLSBO — 2 km in resolution, RM 08 — 15 km in resolution), microwave images (DELTA), and optical images (MSU-V — 50 m in resolution, MSU-SK — 160 m in resolution) of the Earth.

The KOMETA KVR-1000 pictures have a 2-3-m linear resolution on ground and cover territories of 3 million square km in area. The TK-350 pictures have a 10-m linear resolution on ground. The TK-350 images archived at NTs OMZ provide a 5 million sq km coverage subject to overlapping.

The KVR-100 and TK-350 images are archived in a digital form. Moreover the NTs OMZ has access to all KVR-1000 and TK-350 archive images stored in other Russian organizations.

To enable obtaining data for ecological, hydrometeorological, and heliogeophysical monitoring the METEOR-3M No1 spacecraft is in operation now. METEOR-3M No1

launched on 10 December 2001 is a unified spacecraft equipped with on-board natural-resources instruments (MSU-E, MSU-SM), scientific instruments (MTVZA microwave scanning radiometer for temperature and humidity sounding of the atmosphere, MIVZA microwave scanning radiometer for integral humidity sounding of the atmosphere, KGI geophysical measurement complex, MSGI multi-channel system of geo-active radiation), and hydrometeorological instruments (MR-700m).
The METEOR-3M No1 data-based archive comprises 1000.0 gigabytes of optical images and about 180.0 gigabytes of scientific data.

The data from KGI geophysical measurement complex and MSGI multi-channel system of geo-active radiation are displayed on the NTs OMZ's website (www.ntsomz.ru\spacedata\ipg\index.html) in 30 minutes after the receipt session.
Within the framework of international agreements the NTs OMZ provides acquisition and archiving of data from foreign equipment installed on board Russian spacecraft. Today the data from SAGE instrument (USA) installed on METEOR-3M No1 are acquired and archived.
The TERRA MODIS data archive is under generation since 2003 based on operational data from the NTs OMZ receiving station.
The ERS SAR image data that have been acquired by the NTsOMZ within the framework of pilot projects are available as well.

NTs OMZ archive policy

The existing archiving system provides the following opportunities:
- Maintenance of operational magnetic disc archive and long-term DLT magnetic tape archive;
- Data cataloguing in an operational mode, their geographical referencing, "reduced" image generation, entering the information attributes and reduced images into the catalogue data base.
Consumer required data retrieval is made by means of the catalogue that provides computer-aided image selection from the archive using the geographical co-ordinates of a region required. At the same time the consumer requirements for such image attributes and quality indices as season and period of imaging, the Earth's surface cloud cover, fail presence, etc. are allowed for. For quick overview and selection of images, quick-look tools are used.
Consumers may handle with catalogues via both the NTs OMz terminal and Internet communication links using the remote access to www.ntsomz.ru site.
Using the NTs OMZ's catalogue consumer may draw up a request for purchasing copies of space data available in the archive.
The servicing system provides standard processing of data (Fig. 5.3) by consumer requests , digital data recording on magnetic media (tapes, discs and others), as well as image and graphical data preparation and printing on paper or film.
In addition to data products of standard processing levels, consumers may be provided with data products underwent value-added processing as an option.

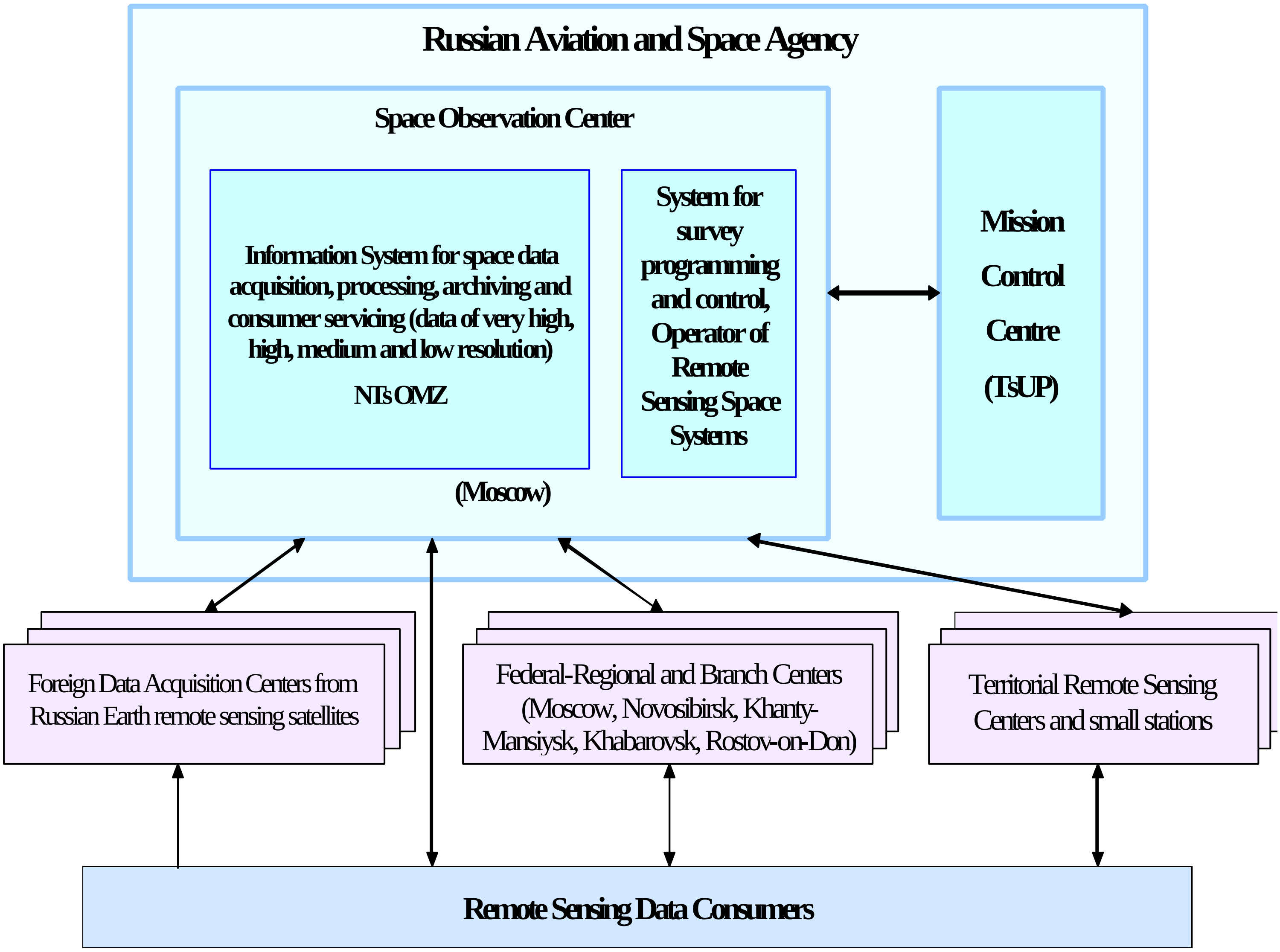


Fig. 5.1. Russian Ground Information System for Space Environmental Monitoring

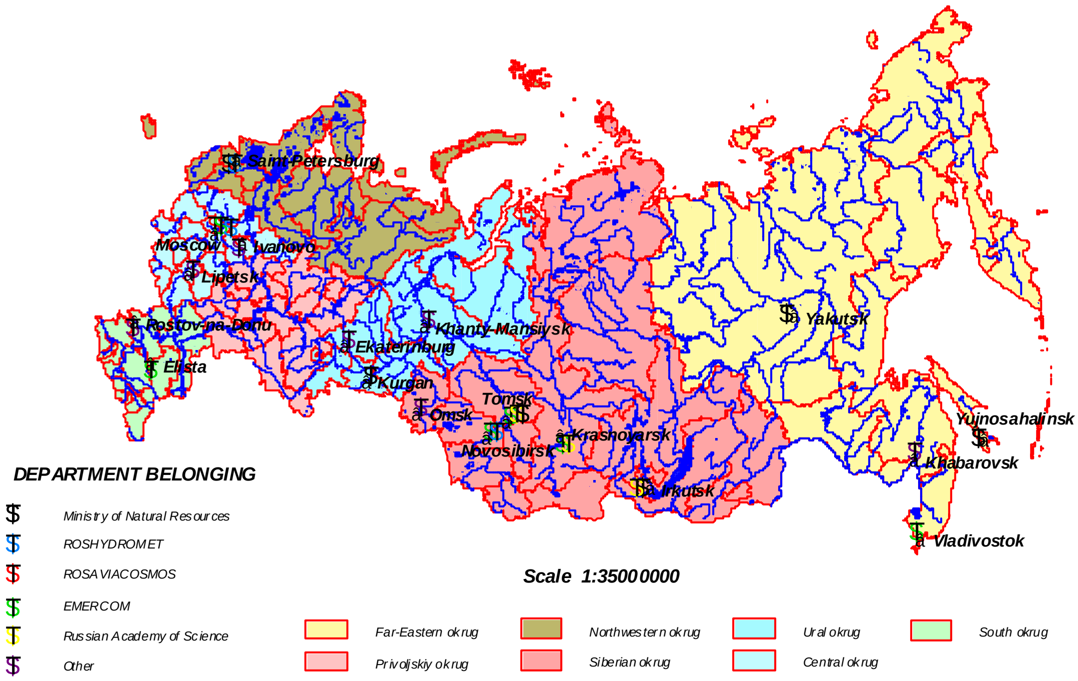


Fig. 5.2 Remote Sensing Data Receiving Stations in Russia

Processing Level 0

Provides:

- **Pulse noise filtering;**
- **Distorted and missed line correction and recovery;**
- **Text annotation generation.**

Processing Level – 0

Processing Level 1

Includes Processing Level 0, provides in addition:

- **Photometric correction using statistical method;**
- **Geographical referencing with orbital and telemetric data;**
- **Annotation generation in the form of raster.**

Processing Level 2

Includes Processing Level 1, provides in addition:

- **Geometric distortions elimination with bilinear brightness interpolation;**
- **Image transformation into a cartographic projection;**
- **Geometric matching of MSU-E bands with an increased accuracy.**

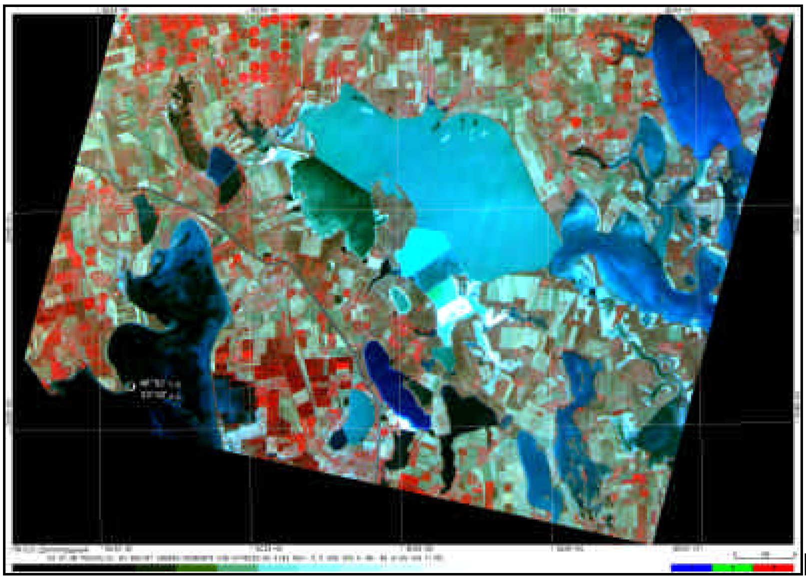
Processing Level 3 **Includes Processing Level 1 or 2, provides in addition geographical referencing and/or geometric correction using ground control points.**
 **Processing Level – 3** ***Transformation of an original scene onto Gauss-Grueger projection***

Fig. 5.3. DATA PRODUCTS OF FOUR STANDARD PROCESSING LEVELS

VI. Atmospheric Monitoring

VI.1 Users of the Atmospheric Monitoring

All the branches of economy of the Russian Federation use the results of atmospheric monitoring. Some users have a need for urgent (actual) information and for short-term or long-term prediction of the state of air basin. The other users employ climatic (averaged, probabilistic and minimax) characteristics. In this section the basic "User" categories are enumerated:

- **Aviation.**

For this branch the actual information about the weather is necessary in the airport of departure, the weather forecast along the flying route - in the airport of landing and in the reserve airfield. To select a place or location of the new air enterprise the long term climatic characteristics are being used. When designing this enterprise the entire set of climatic characteristics is under consideration.

- **Building and ground transport.**

Climatic characteristics are mainly used here. Actual information involves the forecast of dangerous weather phenomena (gusty wind, ice-crusted ground, downpour, etc.).

- **Power engineering and communication.**

When designing objects and communications the different climatic characteristics are employed. Operative information includes the short-term weather forecast. This makes possible to choose the optimal temperature for the heat-transport medium and for a system of central heating, to dump in time the water from reservoirs of hydroelectric power stations. Naturally, this branch has a need for the forecast of the dangerous environmental phenomena.

- **Agriculture.**

Climatic characteristics are necessary for planning crop rotation. Prediction of dangerous nature phenomena makes possible to avoid the crop losses. In the present situation semi-operational characteristics such as: the sum of temperatures or solar radiation during decade, month, season- are being used. Today the air pollution is taken into account as well.

- **Industry.**

Earlier only climatic characteristics have been used for purpose of designing and constructing enterprises. Now-a-days the interest raised to the atmosphere operative temperature and wind stratifications that determine the scatter of pollutants emitted by plants.

- **Municipal services.**

All kinds of information about the state of air basin are being used in these services. For example, in the case of heavy snow forecast the cleaning of the territory should be prepared. The short-term forecast is necessary for subdivisions exploiting different city communications. The long-term forecast is necessary for planning seasonal repair measures. The actual air pollution is taken into account in control of traffic and work of plants located in the city territory. Climatic characteristics are being used when designing and creating new municipal projects.

As a rule, for solving most of problems in every branch the same parameters characterizing the state of air are used. Therefore it is convenient to classify these characteristics according to the goals, to which they are being used:

- long-term planning of the development of branches and planning of the arrangement of production resources;
- technical designing of the specific projects and specific measures;
- use of objects of national economy;
- forecasts of all types.

VI.2 Demands and requirements to atmospheric information

At long-term planning the information is necessary about the future (for several decades or years) state of the environment, about expected standard values of hydro meteorological elements and about the probability of appearance of extreme or critical values of separate elements and their combinations.

The information is required for any "geographical point", region, water area or route on the territory of the Russian Federation. In this case the concepts of "geographical point", water area or route will be different for different branches of national economy. For example, the planning of the installation of a mast for radio retransmission requires the information about the region of an area of 0.01 km^2; the planning of agricultural production requires the information about the territory from several hundred to several thousand km^2; the planning of plants and towns requires the information about the territory of hundreds thousands km^2.

In technical design of the specific projects there is an urgent need for the same information as for the problems of long-term planning. However, there is significant difference in the requirements. Basically higher degree of spatial and temporal resolution and higher accuracy of measurements are required. The degree of measurement accuracy should correspond to the accuracy of project specifications.

The information must refer to definite and limited (not arbitrary) "geographical points", regions, water areas and routes on the territory of the Russian Federation, for which the projects are planned. The information can be based both on the accumulated statistics and on the observations collected specially during the limited time periods (2-3 years). The exploitation of the objects of national economy requires the following information:

a) specific expected in the future hydro meteorological phenomena for planning the certain actions and arrangements (flight of aircraft, sowing of agricultural crops, etc.) in the routine activity of industrial enterprises, building projects, transport and agriculture;
b) significance of several hydro meteorological elements or their combinations, actually taking place at definite locations, at definite instants and points in time. For example, whether or not the hailing is possible or the wind rush >25 m/s is observed, and so on. These data are necessary for estimation of efficiency, analysis of losses, etc.
c) critical values of hydro meteorological elements (wind velocity at a building area, water level at a dam during heavy shower, the visibility on the take-off and landing runway), occurring in the regions of activity of national economic objects, for immediate action.

The main and most important part of this information consists of short-term and long-term forecasts; consequently, the requirements to this information are the requirements to the forecasts.

The tables below contain the numerical criteria for the meteorological data used for designing and exploitation of the objects of national economy or for weather forecast. The criteria have been developed by State Committee for Hydro Meteorology of the former USSR **(*Goskomhydromet USSR*)** in accordance to the instructions of the Worldwide Meteorological Organization **(WMO)** and are still in operation.

Requirements to meteorological information for long-term planning and preliminary stage of designing

Type of information	Unit	Repetition, ranges of averaging	Limiting error	
			By a point	By a territory
Wind: Possible maximal velocities once a year, 5, 10, 15 and 20 years. Mean velocity. Repetition of calm and wind directions	m/s m/s %	Month, season, year Month,-year -«-	±(1+0.15 V_{max}) ±(1+0.25 V) ±15%	±(1+0.25 V_{max}) ±(1+0.35 V) ±20%
Air temperature: Mean Absolute, Maximum and minimum	°C °C	-«- -«-	±1 ±2	±2 ±4
Air Humidity: Mean Relative	%	-«-	±5	±10
Precipitation (sum)	mm	-«-	±15%	±30%
Mean and maximal height of snow cover	cm	Decade	±20	±30%
Visibility, repetition 100-1000 m	%		±20	±30%
Height low cloud boundary	m	month	±20	±30%
Repetition of dangerous weather phenomena	%	-«-	±20	±40%
Air pressure	gPa	Month, year	±1	±2
Temperature of soil: Surface At a depth of 20 cm At depths 20-600 cm	°C °C °C	-«- -«- -«-	±2 ±1 ±0.5	±3 ±2 ±1

Table 6.1

Requirements to meteorological information for designing

Type of information	Units	Repetition, ranges of averaging	Limiting error	
			At a point	On a territory
Wind: Possible maximum velocities, once a year, 5, 10, 15 and 20 years. Mean velocity. Calculated possible maximum velocities once a year, 5, 10, 15, 20 in directions. Repetition of different velocity in directions. Mean continuous duration of winds ≤ 4 m/s, ≥12 m/s. Repetition of calms.	m/s m/s m/s % hour %	Month, period, day, sea-son, year Month, period, day, sea-son, year -«- month, season -»-	±(1+0.1 V_{max}) ±(1+0.15 V) ±(1+0.1 V_{max}) 10% ±20% ±10%	±(1+0.2 V_{max}) ±(1+0.25 V) ±(1+0.25 V_{max}) ±10% ±30% ±20%
Air temperature:				
Mean	°C	Month	±1	±2
Absolute maximum and minimum	°C	year	±2	±4
Mean maximum and minimum.	°C	-«-	±2	±4
Air humidity:		Month	±0.5	±1
Mean absolute.	gPa	Year		
Mean relative.	%	-«-	±5	±10
Sum of different precipitation	mm	Month, season, year	±15	±25
Snow cover:				
Snow decade height.	cm	decade	±15%	±25%
Water equivalent of snow.	mm	season	±20%	±30%

snow. Repetition of winters at different height of snow cover	%	-«-	±15	±30%
Repetition of visibility, 2000, 1500, 1000, 800 and 400 m. Daily variation of visibility.	% %	Month, year 1 hour, 3 hours.	±15% ±20%	±25% ±30%
Cloudiness: Repetition of low cloudiness 0-2, 3-7, and 8-10cloud amounts. Repetition of height of low cloud boundary to 30, 60, 100, 200, 300 and 500 m. Daily variation of repetition of height of low cloud boundary.	% % %	Month, year -«- 3 hours, month, year	±10% ±15% ±20%	±15% ±25% ±30%
Fogs, thunderstorms, hail and other dangerous weather phenomena	%	Month, Year	±15%	±25%
Air pressure	gPa	Month, year	±0.5	±1
Illumination and solar radiation. Illumination. Direct radiation, sum. Net radiation, sum. Duration of solar radiation.	lx kcal/ month kcal/ month hour	Month, hour, year -«- -«-	±10% ±10% ±10% ±10%	±15% ±20% ±20% ±20%
Soil temperature: surface at depths up 20 cm at depths 20-320 cm Depth of isotherm 0°C	 °C °c °C cm	Month, year -«- -«- year	 ±2 ±1 ±0.5 ±20%	 ±3 ±2 ±1 ±30%

Table 6.2

Requirements to meteorological information for exploitation of objects of national economy

Type of information, units	Repeated intervals of averaging	Range of values	Percent error at a point
Wind: Maximum velocity at rushes of wind, m/s Mean velocity the time interval of 2 min, m/s. Direction (averaging is 2 min.), hail. Vertical shift of wind vector. Wind direction and velocity at the circle height.	3 hrs, 1 hr., 30, 15, 5 min. -"- -"- -"- -"-	≤10; >10 ≥2.5M/c/30M ≤10 M/c, >10 M/c	±(1+0.07V_{max}) ±0.1V ±10° ±10°; ±0.1V
Air temperature: Mean (averaging 3 min), °C Absolute maximum and minimum, °C Shift through 0°C Soil surface, °C	3 hrs, 1 hr, 30, 15, 5 min. 3 hrs time day	-5…+5	±1 ±1 ±1
Cloudiness: Cloudiness of low cloud level, cloud amounts Height of low cloud boundary, m Cloud shapes: Cloudiness of middle and upper level, cloud amounts. Height of upper boundary, m	3 hrs, 1 hr, 30, 15, 5 min. -"- -"- 3 h -"-	≤200 m; >200 m ≤3000	±1 ±0.1h ±1 ±0.2h
Visibility: Horizontal, m Vertical at fogs, m	3 hrs, 1 hr., 30, 15, 5 min. -«-	<800 m 800-2000 m >2000 m ≤150 m	±50 ±0.1h ±1 ±0.2h
Air pressure, gPa	3 hrs., 1 hr., 30, 15, 5 min.		±0.5
Humidity:	3 hrs, 1 hr, 30, 15, 5 min.	>0°C	±5

relative, %	15, 5 min	<0°C	±10
precipitation: total amount, mm Critical velocity (0.07-0.10 mm/min) Solid and liquid, 20 mm/h	 12 hrs as upper 12 hrs		 ±20 % ±0.01 ±20 %
Snow cover: Daily height increase, cm Daily mass increase, kg/m^2	 12 hrs -“-		 ±3 ±2
Dangerous and very dangerous phenomena	As they come		
Negative air temperature at different wind velocity	Complex determining the operation regime on the open air		±2°?
Twilight illumination of horizontal surface (≤5 klx)	3 hrs		±0.5

Table 6.3

Requirements to the information necessary for prompt weather forecast

Type of information, units	Accuracy of definition	Resolution	
		Spatial, rm	Temporal, hrs
Atmospheric pressure (sea level), gPa	0.5	100-150	6
Baric trend, gPa/3 hrs	0.2	-“-	-“-
Wind velocity at height 10-12 m	1±0.1 V	-“-	-“-
Direction of wind, degree	10	-“-	-“-
Air temperature in the ground layer, degree.	0.5	-“-	-“-
Extreme values of temperature in the ground layer, °C	0.5	-“-	-“-
Deficit of dew point, °C	0.5	-“-	-“-
Cloudiness: Cloudiness, cloud amount. Lower boundary, m Upper boundary, m Cloud water content, g/m^3	 1 0.1h+10 0.1h+150 0.1Q+0.1	 -“- -“- -“- -“-	 -“- -“- -“- -“-
Phase water condition	-«-	-“-	-“-
Amount of precipitation, mm	0.5+0.1R	-“-	-“-
Boundary of snow cover, km	50	-	24 ?.
Height of isobaric surfaces, Up to 5 km 5-10 km 10-16 km	 1 2	 300 -“-	 6 -“-

	4	-"-	-"-
Wind velocity at heights, m/s <20m/s >20m/s	 2 0.1V	 300 -"-	 6 -"-
Wind direction at heights, degree. Air temperature at heights Up to 500 gPa >500 gPa	5 0.4 0.7	-"- 150 200-300	-"- 6 -"-
Degree of soil moistening	5 degrees	100	24
Degree of soil breezing	4 degrees	-"-	-"-
Condition of snow cover	4 degrees	-"-	-"-

Table 6.4

Additional information about dangerous convective weather phenomena

Phenomena	Forecast done in advance, hrs	Determination accuracy of horizontal coordinates	Determination accuracy of moment of appearance and life time of phenomena, hrs	Radius of data accumulation, km
Cumulonimbus -bus clouds	0.5-1	2-5	0.1-02	25-50
Showers	1-2	5-10	0.2-0.4	50-100
Thunderstorms	2-6	10-20	0.4-1.0	100-300
Hail	6-12	20-60	1-2	300-600
Squall	12-24	60-120	2-4	600-1200

Table 6.5

VI.3 Atmospheric Monitoring Infrastructure

The monitoring of the air quality in Russia is performed by the following ministries:

- Russian Federal Service fro Hydrometeorology and Environmental Monitoring ***(Roshydromet),***
- Ministry of Natural Resources ***(MNR),***
- Ministry of Emergency Situations ***(MES),***
- Ministry of Defence***(MD),***
- Ministry of Health ***(MH),***
- and the Institutes of the Russian Academy of Sciences ***(RAS)***

The overwhelming majority of data is obtained by ***Roshydromet*** and this information is the most accessible for a wide range of users. That is why in this section we consider the problem of the atmospheric monitoring in the system of ***Roshydromet.***

At present several measuring networks have been developed for the atmospheric monitoring. A basic network is the network of meteorological stations that are located relatively uniformly over the entire territory of Russia. This network includes: *actinometrical, ozonometric and agro meteorological networks*. In parallel with the *meteorological one* the *aerological network* is set up for radio sounding of the atmosphere. For monitoring the air quality three types of measurements were implemented in Russia:

- o determination of the level of air pollution in the cities,
- o system of background monitoring and
- o system of acid precipitation.

Besides, taking into account the specificity of the aviation demands, each airport has its own *avia* meteorological stations (***AMS***) and as a rule the meteorological radars. The information from all stations comes without delay to the ***Roshydromet*** local and central offices and to the corresponding department where the data are processed and accumulated. This does not happen with the data from other Ministries and departments.

Fig 6.1 gives the overview of the organisational structure of the Atmospheric Monitoring in Russia

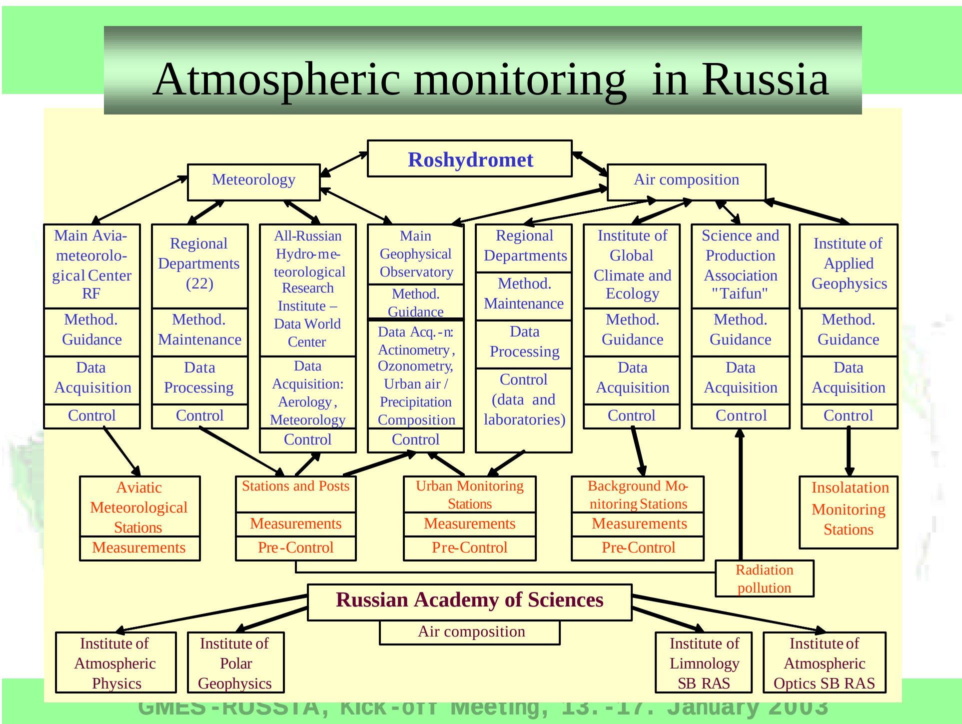


Fig. 6.1

Figure 6.1 shows that the atmospheric monitoring in Russia consists of two basic components: a “state component” headed by the ***Roshydromet*** and a “scientific” one organized in the Russian Academy of Sciences.

The “state component” of monitoring is strictly centralized. Each type of monitoring is checked by the appropriate office, which executes the scientific-methodological management of the entire system of data acquisition, collection and transfer. Fig. 6.1 shows that there are two such basic offices. One is engaged in all the kinds of meteorological measurements, another one monitors the air composition.

The next level of organization of state monitoring of the atmosphere is represented by the regional departments (22), head institutes of the ***Roshydromet*** branch centres. Their functions are the development of methodological instructions in the particular types of data transfer and in the particular types of data measurements, collection and transmission to regional data users, control of data quality, creation of data bases and banks.

At the low level of the state monitoring there are stations and posts, which perform the measurements and observations. From Fig. 6.1 it follows that these stations and posts can be subdivided into 5 categories. The aviatic meteorological stations located at airports carry out the measurements using the particular own program and provide operative data at the disposal of both their own enterprise and other airports, using the data channels. Due to the operative character of such stations, the original data control at these stations is only subjective. The full control is performed at the head AviaMeteoCentre ***(AMC***).

The second type denoted as ‘stations and posts’, unites a wide range of measuring stations: meteorological, aerological, hydrological etc., which carry out the measurements of physical air parameters, and in some cases, the characteristics of radio active contamination of the environment. The information received at this type of stations is being used for weather forecast, risk management and calculation of climate parameters. The preliminary data quality control is introduced here.

The urban monitoring stations work in accordance with specific program and perform basically the inspection of air composition. As a rule this is the collection of air samples followed by determination of ingredients by analytical techniques. 1-2 gas components and main meteo parameters are being measured in operative mode.

There are only few of background monitoring stations that located in the regions free from anthropogenic stress. These stations work in accordance with program developed in the Institute of Global Climate and Ecology. The latter performs also the acquisition, accumulation, testing and distribution of the information.

Finally the network of insolation monitoring stations carries out the tracking of the solar activity and consists of a few stations. These stations were developed in the Institute of Applied Geophysics and work in accordance with programs of this Institute.

The state network of atmospheric monitoring of the ***Roshydromet*** is a component of the global network of the World Meteorological Organization. Since the ***WMO*** regulations with regard to national networks dictate conformity with international standards, the Russian systems of observations meet all these requirements. The obtained information is used by the entire world community.

The disadvantage of this network is its ineffectiveness in operative monitoring of air composition. Therefore in a series of institutes of the Russian Academy of Sciences their own measuring networks have been developed. As a rule, the foreign instruments that are well recognised and employed in the monitoring of the environment, or domestic instruments with intercalibration with the best world standards are used here. Each this station works in accordance with its own program without centralized guidance. Sometimes the Institutes transmit the data to the Geophysical Committee at the Presidium of Russian Academy of Science and provide the free access to information through the Internet.

The difficult economical situation in Russia during last decades affects drastically the functioning of the atmospheric monitoring networks. Some stations work constantly, several stations work in regular intervals and some stations work irregularly. That is why it is difficult to estimate the state-of-the-art of the density of the functioning stations over the territory of Russian Federation.

VI. 3.1 Meteorological measurements

The currently available meteorological stations could be broken down into classes 1, 2, 3 and meteorological and agro meteorological posts, according to the work being carried out, staff and instrumentation. For comparison and unity all meteorological measurements, are being done at all the stations at unified time at 00, 03, 06, 09, 12, 15, 18 and 21:00 of Moscow time, by unified techniques, using 11 instructions and instruments of one type. Instruments, used in the network, are calibrated at the departments accredited by the Russian State Committee of Standards.

Measured parameters, instruments, range and errors

Parameter	Type of instrument	Range	Error	Note
Temperature air, °c, Soil, °C	Series TM Savinkov Type 54	-70…+50 -50…+30 -50…+50	±0.3 ±1 1±	
Pressure, GPa Baric Tendency	Mercury barometer. Calculation	870…1070	±0.2 ±0.4	
Relative Humidity, % Elasticity, GPa Dew point, °C	Psychrometer, Hydrometer MV-1, Calculation	10…100 10…100 0…100 -90…+50	±3…±35 ±4 on average ±7 ±0.2 ±1	Depending on values of humidity and temperature
Wind: Velocity, m/s Direction, degree.	Wind vane M-47, M-63 -«-	0…40 0…40 0…60 0…360	±2 ±1 ±1 ±10°	
Precipitations: Quantity, mm Intensity, mm/min Snow density, g/cm^3 Height, cm Ice-covered ground: density, g/cm^3 Sedimentation g/m^3 Dew, mm Duration	A Tretiakov, precipitation gauge, pluviograph P-2, Weight snow gauge, rods, Beaker, Machine Dosimeter M-35 visually	- - - -	±12% ±23% ±0.4 mm/min ±0.05 g/cm^3 ±3-7 ±0.1 g/cm^3 ±0.1 g/m ±1 min	Liquid, Solid

(beginning, end)		Is not normalized		
Cloudiness: amount, amounts of cloud Shape Height of lower boundary, m	visually visually IVO	0…10 0…200 0…2000	±1 ±20% 15%	
Visibility, km	M53A M71 PDV-2	0…100 -«- -«- -«-	20% 10% 15% ±7	Day time Night time
Solar radiation, duration	Heliograh GU-2		±2 min	Day time

Table 6.6

Atmospheric phenomena and the weather changes between the observation periods are recorded by observer.

Since there is a lot of hand-operated functions that may cause the subjective errors, the multistage control and testing of the measurements is foreseen. The first check is performed at the station. After that the table of observations is aggregated and directed to the regional department. At this department the second level of testing is being done by comparison the measurements from neighbouring stations. Finally, at the third level, the information comes to the World Data Centre - Russian Research Institute of Hydrometeorological Information located in Obninsk, (Kaluga region), where the total data control is carried out. Only after these steps the data can be put down into the archives.

Meteorological information from 280 stations of Russia is available on-line on the server of Central Radiometcentre of ***Roshydromet:*** http://grmc.mecom.ru/info/index.html. Here the products of preliminary processing are presented. Russian Research Institute of Hydrometeorological Information is a **holder** of a long-term archive: http://www.meteo.ru/data.htm.

VI. 3.1.1 Actinometrical measurements

At a series of meteorological stations, along with meteorological measurements, the observations of the intensity of incoming solar radiation are made. The observations are performed every hour at day-time and at principal meteorological periods at night time. For these measurements an actinometer AT-50, a pyranometer M-80 and a national instrument - radiation balance gauge M-10- are used. The latter instruments are unified and being checked every year.

The following parameters are being measured every hour:

- *direct solar radiation* (integral over the spectrum) in the range 0-1400 W/m^2 within an error of ±5% (AT-50) ;
- *total (0-1400 W/m^2), scattered (0-1400 W/m^2) solar radiation* and short-wave (λ=0.4-2.3 μm) balance within an error ±5% using a pyranometer M-80 –;

- *a radiation balance* gauge M-10 enables to determine at day-time the radiation balance (±600 W/m^2) in the spectral range λ=0.4-14 μm within an error of ±15% and at night the effective radiation within an error ±20%.

Data holder: the World Centre of Radiation Data of the Main Geophysical Observatory ***(MGO):*** http://www.mgo.rssi.ru/nev/mgo-ru.htm.

At this Centre the control of the measurements results is performed.

VI. 3.1.2 Ozonometric network.

The ozonometric network measures the total ozone content and spectral atmospheric transmittance at 6 spectral intervals λ=344; 369; 463; 530; 572 and 627 nm. The network consists of more than 30 stations on the entire territory of Russia and equipped by a national ozonometer M-124. The measurements are being done by the sun or by the scattered radiation in zenith. For measurements reliability and compatibility all the instruments are compared with the Dobson auxanometer every year. It is presumed that measurement error does not exceed 5 %.

The data are promptly passed to Hydrometcentre of Russian Federation where the daily map of total ozone content over the Russian territory is formed.

Data holder: the World Centre of Radiation data of the ***MGO***. This Centre controls the data quality.

VI. 3.2 Aerological Measurements

The network consists of more than 100 stations intended to determine vertical profiles of pressure, temperature and humidity of the air and the wind direction and velocity using a radiosondes.

The traceability of measurements is achieved by a launching the weather balloon-sonde at the same dates and time and by common processing technique of the telemetric information with preliminary calibration of its sensors.

The network is equipped with different instruments. In the distant regions of ***RF*** the systems "Malakhit-A-22" are used. The other stations use the Systems "Meteor-RKZ" and "Titan-Mar2". In the last few years the Aerological Automated Computing Complex (AVC) was developed, whose characteristics are close to those of the complex Vaisala "Digi Cora".

Along with the producer calibrations the intercalibration tests with the foreign systems were made using this network. Table 7 shows the results of these tests as well as the measurement errors at the network of aerological stations.

The results of intercalibration tests

Height range, km	Temperature, °C	Humidity, %	Pressure, GPa	Velocity, m/s	Direction, degree
0-5	±0.5	±5	±0.4	±1	±5
5-10	±1	±7	±0.6	±2	±5
>10	±2	±15	±0.6	±4	±5

Table 6.7

The multistage monitoring is implemented in this network.

Data holder: World Data Centre of Russian Research Institute of Hydrometeorological Data ***(WDC ARSRIHD).***

Due to the expensive character of these observations the network is in the moment in deplorable condition. Instead of sounding 4 times a day as it is required for many problems, only two times sounding is being done. To preserve the equipment and staff, one radiosonde per day is launched at each station. The stations and time of launching vary within the regional department. For example, at the West-Siberian Department six stations operate as follows. At 00-00 of Moscow time the radiosondes are launched in Barnaul, Novosibirsk and Kolpashevo. During 12hrs the closely located stations of Kosh-Agach, Barabinsk, and

Aleksandrovskoye launch their radiosondes. As a result of the described situation, there is a lack of information for the detailed analysis of the altitude weather maps.

VI. 3.3 Support for Aviation.

The support for aviation is implemented at all large airports of Russia using the techniques agreed in the aviation. The **data holder** is the Main Aviation Meteorological Centre ***(MAMC):***http://www.mecom.ru/roshydro/pub/servers/game.
To ensure the ***MAMC*** activities the Bank of Aviation Meteorological Data ***(BAMD)*** plays a crucial role. The data for more than 2000 airports of Russia and abroad is available in this bank. The information involves: the actual weather at the airport for the last three hours *(code MSTAR),* the latest weather forecast for the airport *(code TAF).*

The ***BAMD*** makes it possible to obtain, accumulate and distribute the aerometeorological data in real time.

This technology has developed for a qualitative and immediate meteorological service of aircraft flights. The structure of data bank and types of data processing correspond to the Russian and international meteorological standards.

The users are connected to the bank by direct communications through local and remote modems and also through the communications of ***Roshydromet*** (Automated System of Data Transfer, ***ASDT***) and civil aviation (Aviation Federal Telegraph Network, ***AFTN***).

The bank services are at full disposal for all countries - members of **WMO** and ***ICAO*** (International Civilian Aviation Organization)**.** Access is gained by ***AFTN*** according to the international communication procedures.

Our attempts to obtain any information from this databank by direct access through Internet have failed. Evidently the databank maintaince and services are carried out on a commercial basis. There is also uncertainty about data quality control.

VI. 3.4 Network of monitoring urban air quality

In 2000 the regular network of the State Service for Monitoring of Atmospheric Pollution ***(SSMAP)*** of ***Roshydromet*** on the territory of Russia consisted of 621 stations and was deployed in 220 cities. Together with services of the departments of industrial enterprises and services of sanitary epidemic stations ***(SES)*** the atmospheric pollution monitoring have been done in 253 cities with the help of 685 stations. The stations were located in housing estates, near highways and large industrial objects. According to the location of the station the latter are subdivided to the city background stations in the housing estates – 35%; industrial stations in the impact area of an enterprise – 32%, motor stations (close to large highways) – 28% and regional stations – 5%.
Today this network uses:

- the “POST-1” and “POST-2” stations equipped with the sampling units for gas components M-822 and EA-1;
- samplers for suspended matters EA-2C and EA-2;
- automatic sampler “Component”;
- gas analyzers “Palladii-3”; GMK-3;
- gas counters RG-7000 and GCB-400;
- meteosystem M-49.

As a result, only two gases SO_2 and CO, and their “meteovalues” at a point of measurements, pressure, temperature and air humidity, the wind velocity and direction are determined operationally. The other ingredients are determined either at peripheral or central *(“Taifun”)* laboratories. According to general instructions (PD5204186-89, Hydrometeo Publ., 1991’), the following requirements can be imposed upon the instruments and techniques for monitoring the atmospheric pollution. The detection threshold of any compound must be $\leq$0.8 of maximum permissible concentration of i-impurity. The error of its extraction must not exceed 25%.
The quantity of the determined substances at different stations varies and depends on the equipment of the analytical laboratory. At all stations only the mass concentrations

suspensions (aerosol) as well as nitrogen dioxide and oxide, sulphur dioxide, carbon monoxide are determined. The measurements at the stations must be made 4 times per day at 01-00, 06-00, 13-00 and 19-00 of local time. In practice only 12% of posts operated on total program in 2000, 80% of posts operated three times per day and 8% of posts worked according to a limited program – 2 times per day. The data obtained in this network went through multiple control. To ensure the reliability and quality of the information, the Main Geophysical Observatory as a methodological centre performs every year analysis and estimates the quality of work of the network based on the check of calibration charts to determine the impurity concentrations, to fulfil the external control of the measurement quality, methodological inspections and analysis of the quality of information materials.

In the network laboratories the interior control of the measurement accuracy and the content of main and specific impurities in accordance to the requirements of RD 52.04.186-89 are performed. Besides, almost in all chemical laboratories the control of rough errors and the statistical control in accordance to the instruction ? 2335-95 are carried out.

The exterior periodic control of the measurement accuracy is carried out by central laboratories of regional departments by sending to network laboratories standard samples, check solutions and periodic testing of calibration diagrams. The same exterior control is carried out periodically by the MGO. In such a rigorous approach it is natural that all the network laboratories are accredited by the Russian State Committee of Standards. The instruments are regularly checked either by the department inspection or by local departments of the State Standard Committee.

As a rule, the information obtained using the network is not prompt. It is collected at the MGO, generalized, and then published in the year-book "State of Atmospheric Pollution in Cities on the Territory of Russia". More information can be found on a site of the Service of Environmental Protection of Ministry of Natural Resources of Russia: http://www.eco/net.ru.
The main drawback of the described network is that it is bad deployed. 60% of all stations are located either in the vicinity of enterprises or along highways. Consequently, the obtained data show mainly not the condition of the city environment but the power of sources of industrial pollution.

VI. 3.5 Background monitoring

The *background state* of the environment means the state of ecological system at vast, not urban territories, under moderate anthropogenic impact due to contaminants from near and distant emission sources in the atmosphere.

For monitoring of *background atmospheric conditions* a network of background monitoring has been developed under the leadership of the Institute of Global Climate and Ecology ***(IGCE).*** At present this network consists of 18 stations at different regions of Russia. But not all of them perform the measurements in full. For example, only three stations: *Bering Island, Kotelnyi Island, and Teriberka* – measure carbon dioxide.

The program of measurements must include:

- the measurement of heavy metal concentration – Pb, CD, Hd;
- suspensions;
- chlororganic pesticides;
- sulphur and nitrogen dioxides;
- sulphates;
- nitrates, carbon dioxides and methane,
- total ozone content;
- atmospheric transmittance;
- electric characteristics of the atmospheric boundary layer.

In this case the analytical (not routine) methods of analysis are used. The data obtained are not routine. The data are collected and generalized at the ***IGCE***: http://www.igce.comcor.ru.

Based on these generalized results the yearbook "Overview of Back-ground State of the Environment on the territory of CIS countries" is issued in St-Petersburg, by Hydrometeo publishers. More detailed information was not found so far.

VI.3.6 Monitoring of the Chemical Composition of Precipitation

In the 1990's, the sampling of precipitation for chemical analysis or for measuring the acidity have been performed in Russia using more than 200 stations ,including 45 stations of the federal network of ***Roshydromet.*** The stations of the federal network are located outside the cities and they are far removed from the enterprises. The international system of the ***WMO*** includes 11 stations of the federal network. The selected samples are subdivided into the overall monthly, weekly and single. To single samples refer the single or daily precipitation.
At 114 points the value of pH is measured in a period of rainfall. The network is served by seven laboratories. From these laboratories the tables with the results of chemical analysis are being sent to the ***MGO***. Sampling and chemical analysis of samples are carried out using the unique methods with the use of samples from the State Committee of Standards. In the precipitation we determine $SO_4^{2-}, Cl^-, NO_3^-, HCO_3^-, NH_4^+, Na^+, Ca^{2+}, Mg^{2+}, Zn^{2+}$ the sum, PH. The measurement error for mean values is 5%. The **data holder** is the ***MGO***. The summarized data are published periodically. For example, the latest data were published in "Annual data on chemical composition of Atmospheric Precipitation for 1991-1995". St.-Petersburg, "Hydrometeoizdat" Publ., 1998.

VI. 3.7 Supporting Monitoring Networks

This is the type of atmospheric monitoring which presents additional information about the atmospheric conditions. The Institute of applied Geophysics (http://www.mtcjVI.ru/roshydro/pub/servers/ipg_0303/ipg_home.htm) controls and summarizes the impact of heliogeophysical factors on the atmospheric conditions. Unfortunately, there is a lack of the description of the control system. The federal analytical centre "Taifun" (http://www.typhoon.obninsk.ru) controls the state of the radiation situation in the territory of Russia. The prompt information from this network arrives, apart from central departments of ***Roshydromet***, to MNR and to **MES** (Ministry of Emergency Situations) of Russia for undertaking urgent efforts to prevent emergencies.
The holder of information is Centre "Taifun". The summarized information is published in the year-books "Radiation Situation in the territory of the CIS".

VI. 3.8 Research in the field of Atmospheric Monitoring

Due to the fact that the national networks practically do not provide the information about the air composition in the vast territories of Russia, some organizations in early 1990's, have developed the monitoring of the atmospheric state in background regions. All these organisations /institutes belong to the Russian Academy of Sciences (RAS).

VI. 3.8.1 Institute of Atmospheric Physics

The Institute of Atmospheric Physics carries out the monitoring of atmospheric composition using three stations:

- in Moscow - (the Lenin hills –Moscow State University ***(MSU)*** observatory);
- near Kislovodsk - the background station at 2000 m height;
- close to Zvenigorod, Moscow region – measurement site of the Institute of Atmospheric Physics

For monitoring the gas composition the foreign instruments are used. Aerosol and meteorological characteristics are determined by the instruments of national production.

VI. 3.8.2 Polar Geophysical Institute

The Polar Geophysical Institute carries out the monitoring of air composition on the Kola Peninsula. The idea of monitoring is the same as at the Institute of Atmospheric Physics.

VI. 3.8.3 Limnological Institute

The Limnological Institute carries out regular measurements of aerosol composition in the Baikal region and along the Baikal shore. The Limnological Institute has organized the background monitoring in the settlement Mondy (at the Mongolia border) and the gas and aerosol monitoring. The foreign instruments are used.

VI. 3.8.4 Institute of Atmospheric Optics

There are several instruments and installations being used in the Institute of Atmospheric Optics (Tomsk) in the monitoring regime.

1. Automatic post measuring the air composition (TOR-station).
An automatic post is intended for measuring gas and aerosol air composition and meteorological characteristics and it is mounted at a 5 tons railway container.

<u>*Technical characteristics of the post:*</u>

Gases: sulphur dioxide 0.002…40.0 mg/m3±20%;
Nitrogen peroxide 0.001…10 mg/ m3±15%;
Nitric oxide 0.001…10.0 mg/ m3±15%.
Carbon monoxide 0.10…20.0 mg/ m3±20%,
Carbon dioxide 100…2000 ppm ±20%,
Ozone 0.001…1.0 mg/ m3±12%.
Suspensions:
Dispersed composition 0.4…10.0 μm in 12 channels,
Chemical composition: filter sampling – and laboratory analysis;
Mass concentration 0.01…60 mg/ m3.
Meteorological characteristics:
Air temperature -50…+50°C±0.2°C,
Air humidity 10…100%±3%,
Wind direction 0…360°±10%,
Wind velocity 1…40 m/S±1m/S,
Total solar radiation 0…1400 w/m2±20%,
Precipitation yes/no,
Data access: http://meteo.iao.ru

<u>*2. Aircraft-laboratory AN-30 “Optic-E”*</u>

Figure 6.2 shows the location of instruments on the board of aircraft-laboratory. This aircraft-laboratory can be used to solve a wide range of problems: from sounding the atmosphere and water and ground surface to determining the state of biological objects, detecting fish shoals and so on.

<u>The deploying of instrumentation on the board of the aircraft-laboratory AN-30 (Optik-E)</u>

1 – blocks of air intake pipes and contact gauges;
2 – solar spectrophotometer;
3 – post for mounting of primary converters of gas-analysis and aerosol complexes;
4 – chromatograph;
5 – nephelometer with agents of thermo – and hydro optics;
6 – central computer;
7 – spectrophotometer meter;
8 – lidar meter;
9 - lidar;
10 – spectrophotometer;

11 – radiometer;
12 – infrared imager;
13 infrared imager recorder;
14 – board of airborne operator;
15 – navigation complex.

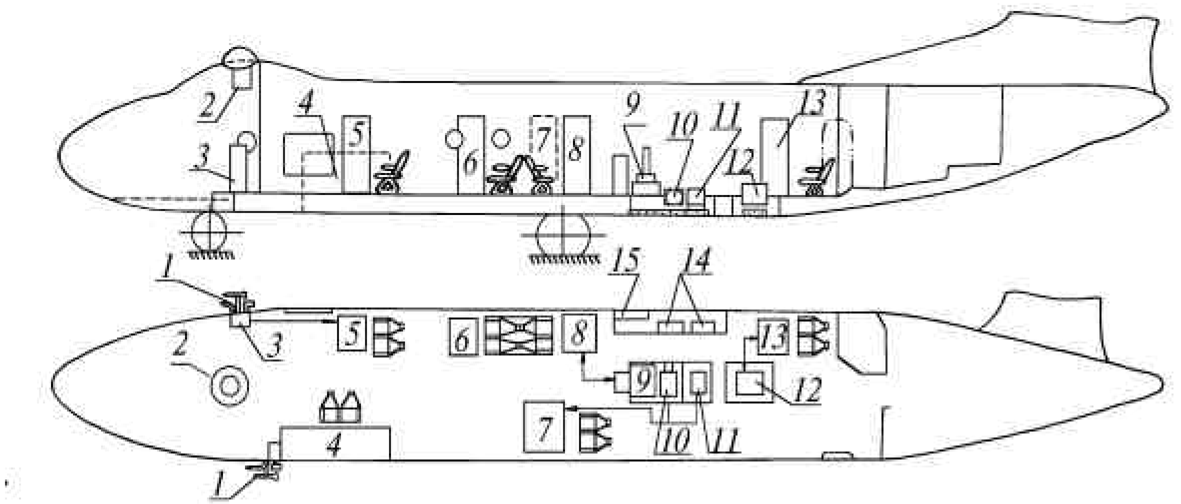


Fig. 6.2

To measure the gas composition the gas-analyzers ZAO "OPTEK" were used. These gas-analyzers were certified and checked at the D.S. Mendeleev Research Metrological Institute. Their technical characteristics are given in Table 6.8.

Instrument	Parameter	Principle of measurement	Range, error	Date of check	Next check
C310	SO_2	Chemiluminescent	0…2000 mkg/m3, ±25%	24.11.2001	24.11.2002
P310	NO	-"-	0…1000 mkg/m3, ±25%	16.04.2002	16.04.2003
	NO_2	-"-	0…1000 mkg/m3, ±25%	16.04.2002	16.04.2003
P-02P	O_3	-"-	0…1000 mkg/m3, ±15%	07.02.2002	07.02.2003
GS-024 – (generator)	O_3	Optical	0…500 mkg/m3 , ±7%	07.02.2002	07.02.2003
S-061-02	CO	Optical, nondispersive	0…10000 mg/m3, ±20%	20.06.2002	20.06.2003
	CO_2	Optical, nondispersive	0…10000 mln , ±20%	20.06.2002	20.06.2003

Table 6.8

The aerosol composition was measured using two methods. The dispersed composition was determined using a photoelectric counter PK-GTA, produced at "Priborostroitel" (Vyborg) enterprise and having factory calibration. The second method uses diffusion aerosol spectrometer developed and calibrated at ***I?K?*** SB RAS (Institute of

Chemical Kinetics and Combustion, Siberian Branch of the Russian Academy of Sciences). The photoelectric counter measures the particle quantity per unit volume in the range 0.4-10 μm using 12 channels of a combined nonlinear scale. A diffusion aerosol spectrometer measures the particle quantity per unit volume using 10 channels in the range of 3-200 nm. The chemical aerosol composition was determined by the preliminary concentrated samples on the filters of AEA-20 type of mark NEL. The air flow rate through the filter was controlled using a counter SYBd4-1 produced by the company "Signal" (Engels) and having factory calibration. During a flight simultaneously three filters were in use. The Characteristics of instruments are given in Table 6.9.

Instru-ment	Parameter	Principle of measurement	Range, error	Calibration date	Next calibration
PK-GFA	Dispersed composition	Photo-electric	0…300 cm3, ±25%	21.11.2002	21.11.2002
DSA	Dispersed composition	Diffusion	0…1000 cm3, ±25%	16.06.2002	16.06.2003
SYBd4-1	Air flow rate	Rotatio-nal	0…6 m3/hr ±3%	31.03.2001	31.03.2006

Table 6.9

The aerosol sample processing is carried out at the laboratory of Environment Monitoring of the Tomsk State University (certified by the State Committee Standards RF ? 510338) using the techniques "Atomic-Emission Spectral analysis" and "Ion Chromatography" examined by metrological experts at the State Metrological Centre in Ekaterinburg ? 08-48/031 and ? 08-48/032 on 20.12.1994. The measurement errors are given in Table 6.10

Component	Method	Limit of dete-ction mg/filter	Error, %
Br-, SO42-	Ion chromatography	0.6	8
NO3-	- « -	0.6	8
Cl-	- « -	0.1	12
F-, NH4+, NO3-	Ionometry with selective electrodes	0.2	10
Na+, K+	Flame photometry	0.2	10
Al, Co, Cr, Mo, Ni, Ti, Zn, B, Si	Atomic-emission spectroscopy	0.02	20
Ag, Ba, Cu, Pb, Sn, V, Mg, Mn	- « -	0.01	20
Fe, Ga, W	- « -	0.1	20
Ca, Cd	- « -	0.2	20

Table 6.10

The georeferencing of the data have been done using GPS.

A lidar "ATMARIL" is used for remote sensing of the atmosphere, including aerosols, optically dense formations, such as clouds, industrial pollutions and the upper sea layer.

Technical characteristics of lidar

Wavelength, nm	532
Pulse energy, mT	up to 50
Pulse duration, ns	5

Pulse repetition rate, Hz	1…25
Centre of a fluorescence band, nm	680
Beam radiation divergence-no more than 3 (angular minutes)	
Polarization of transmitter radiation	linear
Focal length of a receiver objective, nm	750
Diameter of a field aperture of a receiver, nm	1-10
Transmission band of a filter of polarized channel, nm	1.5
Diameter of a field aperture of a luminescent channel, nm	4
Supply voltage of photomultipliers, B	1500-1800

Lidar consists of the following units:

A receiving-transmitting system is supplied with a telescope, filters, polarization optics, three photomultipliers and a laser. Each system of this installation is located in housing or a post. The operating altitude range is 0-7000 m, the flight velocity is 250-450 km/hr, the range is 2400 km, and the required length of runway is 1300 m.

Automated station of IAO SB RAS for monitoring of the ground aerosol characteristics (aerosol station)

1). Aerosol complex:

- nephelometer FAN (the coefficient of directed scattering of dry particle base at an angle of 45° at a wavelength of 0.51 µm, the sensitivity is 0.001 km-1 sr-1),
- aetalometer (mass soot concentration in the air, the sensitivity is 0.1 mg/m3);
- photoelectric particle counter of PKGTA type (concentration and particle size distribution in the diameter range 0.4-10 µm, concentration up to 300 cm3).

2. Setup of active polarization nephelometry:

- nephelometer FAN and devices for aerosol moistening up to the humidity 95% and heating up to 300°C for determining the parameter of condensation activity and content of highly volatile compounds in aerosol (measurements one time a day at three wavelengths 0.41, 0.51, 0.63 µm and polarization components at wavelengths 0.41 µm and 0.51µm).

3. Meteorological complex (sensors for measuring the relative humidity and temperature of the air).

At the aerosol station the 24 hrs measurements are made in automatic regime in a local air volume every hour.

The station operates in the routine regime since 1997 and since 1999 the station is connected to INTERNET: http://aerosol.iao.ru/.

The station for measuring aerosol optical thickness (Tomck)

General characteristics

The station is intended for measuring the spectral transmittance of the entire atmospheric thickness for subsequent determining the aerosol optical thicknesses τ (in the spectral windows of the spectral range 0.35-1.06 µm) and total moisture content of the atmosphere W (the absorption band 0.94 µm). The process of measurements (after the photometer guidance) and the primary processing of data are automated and the data are recorded using a computer.

The measurement error τ is 0.01 and the measurement error of atmospheric moisture content is 0.07 g/cm2.

Main technical data of the photometer:

Angle of a field of vision, degree	1.46
Total spectral range, µm	0.35-1.06
The number of measuring channels	12
Time of a single cycle of measurements is no more than	1 min
Photometric measurement error is no more than	0.5%
Error of solar tracking, degree	0.2

Operating wavelengths:

No channel	λmax, nm	Δλ0,5, nm	Notes
1	---	---	"damping" – noise measurement
2	349	32	
3	370	23	
4	438	7	
5	485	8	
6	520	25	
7	560	17	
8	634	9	
9	697	12	
10	933	11	Water vapour absorption band
11	869	12	
12	1059	20	

The measurements have been carried out since 1996 as separate series and since 2001 the measurements are being done in routine regime. Similar measurements are organized in Irkutsk in the territory of the Institute of Solar-Terrestrial Physics.

Since October 2002 the network "AERONET" has started its work in the territory of Siberia.

The first observation point was organized in Tomsk.

Technical characteristics and the list of measured parameters are close to those shown in the table.

VI. 4 Understanding of Atmospheric Processes

In the 1980's when the meteorological and aerological networks worked in a full and all city posts and background monitoring of pollutions operated entirely, the correctness of short-term forecasts of weather exceeded 90% and the complete list of the most polluted USSR cities was made up.

The decrease of the station network and the observation programs in the 1990's has resulted in the reduction of the correctness of short-term weather forecasts up to 70% and the list of cities where the monitoring of atmospheric pollution takes place have been also reduced. It doesn't mean that the investigation and understanding of meteorological and weather processes became less. Simply there is a lack of initial data for the current atmospheric models and latter affects in turn the final product – the weather forecast.

Two ways to resolve the problem are possible:

- o gradual reconstruction of the monitoring network;
- o transit to other types of data, sensors and instruments (for example utilization of the space remote sensing data, updating current and developing new atmospheric models).

The understanding of the processes that determine the air composition in the territory of Russia (especially outside the cities), was not high in the 1980's. The reason - insufficient number of stations of background monitoring for the area of 22 million km2 (territory of the former USSR). This network could reflect only the most global changes of the air composition, since there exist vast regions where the information source on the air composition was not available.

In recent years the situation was not improved. If we exclude from consideration the network of air monitoring in the cities (these data are very much polluted in the information sense), then the data on gas and aerosol composition can't be representative for the background conditions at two or three points in Russia. Evidently the use of such data doesn't allow saying much about atmospheric processes.

The lack of input data resulted in the fact that there is no specific and precise model for the forecast of air composition in the territory of Russia. The current existing models developed to describe a single source of pollution (case of accident) or for a specific city can not encompass the whole problem. <u>In this sense the problem of global climate change and environmental changes in the territory of Russia requires more efforts and resources that should be incorporated into the investigation of the atmospheric models.</u>

The way out is either in the creation of several mobile laboratories operating in its region and providing information about the air composition or in the creation of several tens of stationary ground stations of monitoring outside the cities in different regions. Otherwise we can obtain inadequate models of atmospheric processes.

If we compare the state-of-the-art of atmospheric monitoring in Russia with those in Europe (see BICEPS 2 Interim report), we can recognise the commonalities and distinguish the differences.

The important role of modelling to study the environmental processes is pointed out in BICEPS 2. For Russia it is only possible when study the meteohydrological processes. The modern models that are supported by data from monitoring networks exist for this field in Russia. In the field of air quality the approach on a base of models as a method of exploration looks at the moment inappropriate due to the lack of data from the vast territories of ***RF*** that significantly exceeds the territory of Europe. It doesn't mean that models of atmospheric processes are not under development in Russia. They are definitely under extensive development. However they have pure theoretical flavour and mainly based on data parameterisation, obtained in some few short-term experiments. That is why for GMES this modelling data could serve as evaluation trials rather than information source.

To fulfil the Kyoto protocol agreements it is suggested in BICEPS the modelling approach and direct measurements of emissions from big pollution sources. The modelling of this sort of emissions is being done in Russia as well, whereas the direct measuring of emissions is an open question. More over Russia with its huge forest funds represent on a global scale rather the <u>flow</u> of green gases than their <u>source</u>. The absorption coefficient of

the Russian forests is estimated up to now with a big inaccuracy. Therefore GMES structure for Russian conditions should take into account this inaccuracy and for environmental monitoring and for modelling the global processes. At present the Siberian branch of Russian Academy of Science together with National Institute of Environmental Research (Japan) deploys 5 high altitude masts for estimating the $C0_2$ balance on the territory of the Western Siberia. In the future these masts could become basic instruments for modelling the global changes in environment.
Since huge funding is necessary for creating the really advanced air quality monitoring network in Russia and since this funding is not available, we have to find out non-standard approaches. The combination of the satellite remote sensing and small number of the good-equipped ground stations looks like a realistic and reasonable approach. Such a combination could allow a good verification of satellite data, followed by using this data for modelling the atmospheric processes.

VI.5 Quality Control of the Atmospheric Data

The data quality of any monitoring type depends on:

- measurement techniques and instrumentation
- subjective errors of the attendants
- malfunctions in the transmission and communication channels

To exclude the random and systematic errors the multistep data quality system is set up in ***ROSHYDROMET***.

Firstly, all measurements are being done in accordance to ***WMO*** instructions in the same time, with the same techniques and unified instruments. In this way the comparability and synchronism of the observations is achieved.

Secondly, there exists the Main Technical–Scientific Office in ***ROSHYDROMET*** that defines the list of instruments admitted for exploitation, the rules and instructions of instruments utilization and periodicity of the instruments checking. Every *regional department* of ***ROSHYDROMET*** has special laboratory for instrument periodic checking. Every device that is under exploitation in the measurement network is being checked. The time interval for this checking varies and could be from 1 to 5 years. It is strongly prohibited to use the unchecked instruments in the state atmospheric monitoring network.

To exclude subjective errors of attendants the multiple testing of data is arranged. The first stage of testing is carried out on the station where this data is obtained. This is so called technical control. The particular operator and the head of the station perform this control. Next step is *regional department* where data go through critical control. The checking staff here estimates not only the absolute values of the parameters, their admissible limits and temporal variability but makes matching of the particular parameter with values received at all the stations within the region. Sometimes, when the station location has been chosen inappropriate, this station receives the status of “microclimatic”. It means that its measurements reflect only local climate conditions. Finally data are directed to the central Institutes of ***ROSHYDROMET***, where sophisticated evaluation methods are used to decide if data from ground stations could be used in the global monitoring network. Only after performing all control procedures the data could be inserted in the corresponding archive and/ or data bank.

Along with subjective and instrumentation errors the errors from transmission and communication channels could arise in the data. To avoid this sort of errors the special international compressing transmission codes are used: code KH-01 for meteorological data, code KH-04 for aerological data for example. On one hand these codes provide the reduction of the information to be transmitted and therefore the reduction of the transmission time, on the other – saving the costs on communication services.
On the receiving end the information is decoded and is tested with the help of the special software. This quality control system practically excludes the probability of the erroneous data in the output.
Fig.6.3 represents in graphic form the described system and main data flows.

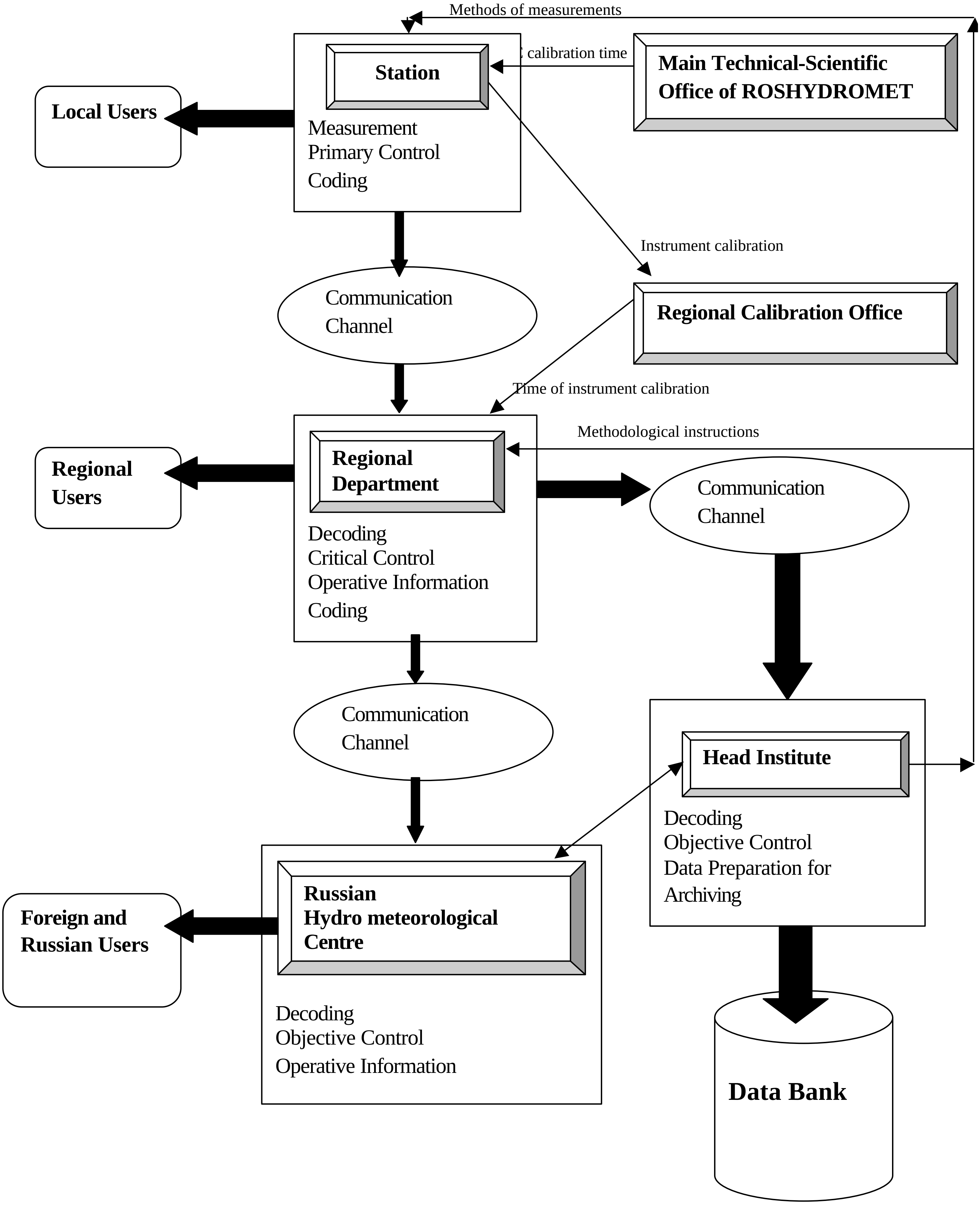


Fig.6.3 System for Quality Control of Atmospheric Data

VI. 6. Access and Distribution of Atmospheric Data

At present the network of ***Roshydromet*** telecommunications is open. This network is intended to solve main problems on the collection and distribution of the atmospheric data. The following technological systems were created and are under exploitation in this network:

- the information collection system;
- transport corporate computer network **(TCCN) MEKOM;**
- automated system of data transmission **(ASDT)** of ***Roshydromet;***
- system of circular data distribution ***"TV-Inform-Meteo";***
- network of electronic mail **(EM) MEKOM**.

The structure of the telecommunication network in **Roshydromet** consists of 3 district, 21 territory and 68 regional centres. Every higher centre fulfils the functions of lower-ranking centre within its responsibility. Besides, the available telecommunication centres in *NTU, AMCS, GMB, AMCS and GMB* can be referred to the level of regional centres. The hierarchy of centres is caused by the administrative division of the territories, organization of the production of hydrometeodata and conditions of their distribution.
Besides, radial communication hub topology of the **Roshydromet** network is dictated by the topology of rented telecommunication channels.
TCCN MEKOM was a spin-off of ***ASDT*** as a result of its evolution. According to the seven-level ISO model this network fulfils the functions of the first four levels: physical, channel, networking and transport. The basic protocol in the framework of **TCCN MEKOM** is the set of protocols TCP/IP, therefore the network is constructed on a base of INTERNET technologies that favours its further development.
The telephone channels equipped with modems or ISDN digital channels are used for data transmission. The speed varies within 2.4 Kbit/s to 2 Mbit/s. Most frequently at telephone channels the rates from 9.6 to 19.2 Kbit/s are established. In this case the modems at good quality of channels and communication lines enable data transfer with the speed 33.6 Kbit/s. At present the ***TCCN*** covers the entire main network including all regional and territorial centres. Some of Institutes belonging to **TGMS, AMCG** are included into this network.
ASDT solves mainly the problems of communication such as:
data transmission on a principle of message switching,
transformation of data transmission rates,
transformation of message formats and codes,
collecting and organization of metadata bases,
collecting meteorological reports,
control and query for information,
interface of users with transport network and some other tasks.

ASDT consists of message switching centres (MSC) of different levels, whose functions are supported by the complexes MTS, uni- MAS and Trans Met. MSC interact with each other through ***TKKC MEKOM.***
The system of data collection is mainly based on manual technologies and therefore is expensive and ineffective. The basic technology of data collection in **Roshydromet** is the telegram transmission through TG-OP. In all UGMC and some TsGMC the telegrams are taken by ASDT system where they are completed to bulletins and distributed to users. In the remaining TsGMC this process is carried out manually. The time of data collection varies from 10 to 20 minutes and more.
The other technologies of data collection are being used. The latter are for example the radio-collection and AT. At present the modern computer technologies are being introduced. This enables to remove the above difficulties and to decrease drastically the cost of data collection job.
The data collection system includes the broadcast, telecommunication and telephone and telegraph channels for data transmission. The biggest system today with regard to volume of transmitted data and territory cover is the system "TV-Inform-Meteo", which substituted the earlier system of circular propagation of radio-information. The system "TV-Inform-Meteo" made possible increasing the quality and volume of transmitted information. However, the

potential of this system have is being rapidly exhausted and at present this potential **doesn't satisfy the needs of users.**

VI.7 Data policy issues for atmospheric data

Here we consider data policy with regard to atmospheric data that exists today in **Russia.** Our considerations follow the approach introduced in Data Policy Assessment study for GMES (DPAG cross-cutting assessment study and DPAG Interim report). That is why we take six data policy characteristics

- Ownership, privacy and confidentiality
- Intellectual property rights and associated legal frameworks
- Standards and metadata
- Licensing, distribution and dissemination
- Pricing policy
- Archiving policy

and attempt to trace them with regard to atmospheric data.

1. Ownership, privacy and confidentiality

All data that has been received in ***ROSHYDROMET*** is the state property and in accordance with legislative act: "Law of Russian Federation on Protection of Environment" this data is open. The results of measurements being done in the Institutes/Organizations of ***ROSHYDROMET are the property of*** the corresponding Institute/Organization and have as a rule the confidential character.

2. Intellectual property rights and associated legal frameworks

The intellectual rights with regard to atmospheric data belong to ***ROSHYDROMET.*** If data have been processed, analysed and generalized in some particular Institute, the property rights on these results belong to this particular Institute. The intellectual rights on a data, received in the Institutes of Russian Academy of Science belong to laboratories and groups that carried out the measurements and processing.

3. Standards and metadata

Roshydromet follows international standards recommended by World Meteorological Organisation **(WMO), ECOMET and ECMWF**. Such a policy ensures that weather observations and products are standardised. The latter is important and essential for effective monitoring of the global meteorological processes. The data produced by other environmental monitoring organisations cover a variety of environmental fields and topics, but not always correspond to international standards. The importance of metadata is also recognised by environmental organisations, and the majority of them maintain some type of metadata system.

4. Licensing, distribution and dissemination

Licensing and distribution of meteorological data and products is influenced by international agreements and organisations, basically by World Meteorological Organisations (***WMO***). Resolution No.40 is one of the key agreements of the ***WMO***, which requires that its members provide, on a free and unrestricted basis, 'essential data and products required to describe and forecast weather and climate, and to support WMO programmes'. ***WMO*** members must also provide data to the research and education communities on a free and unrestricted basis. In Russia only operative information such as weather forecasts, emergency warnings are distributed for free. Reference and hand-books are distributed on queries of organisations.

The organizations of Russian Academy of Science which receive funding from government and act in the public interest generally make their information and data as much available as possible. Many such organisations distribute their data free to interested parties with little or no licensing restrictions.

5. Pricing policy

The price for meteorological data is affected by international organisations and agreements. The ***WMO*** considers the meteorological data as essential component of humanity well being, and much of the data should therefore be exchangeable on a free and unrestricted basis. Practically, this means that basic meteorological information such as warnings, forecasts and observation data should be free for a wide range of public users. ***WMO*** Resolution No.40 also ensures that some meteorological data and products are provided free of charge to non-commercial research and educational users.
In other cases the prise depends on the service type:

- Information services (for example the weather forecast for some enterprise)
- Preparation of the reference data (for example data about climate and or air contamination in the spot of the future factory constructing)
- Providing data from archives
- Payment for communication services

As a rule the Institute of the Russian Academy of science distribute their data free within common research projects or sell this data within commercial projects.

6. Archiving policy

ROSHYDROMET as well as foreign partners create the data archives.Meteorological data is recognised as valuable historical and climate record, and most agencies have therefore compiled archives over many years. This has been in digital format over recent years. At the same time many meteorological organisations keep records and information in hard copy format dating back to many decades. The same situation is in the Institutes of ***RAS.***

VI.8 Conclusions

In this chapter the system of atmospheric monitoring in Russia is presented. We attempted to track different aspects of this particular monitoring type taking into account the GMES key principles and focuses. We also attempted to link our considerations with cross-cutting assessment studies being recently done within BICEPS and DPAG projects.
The main conclusion that could be drawn is that advanced atmospheric monitoring system exists and is under operation in Russia. This system basically meets end user requirements to data and information and is a part of global international monitoring network under guidance ***WMO.***
The modern information technologies are used for data transfer, distribution and archiving. These technologies match the international standards.
Essential drawback of the atmospheric monitoring in Russia is insufficient density of background monitoring stations over territory of a country.
The way out is the transit to combination of satellite remote sensing observations and creation of supporting ground stations.

VII. Environmental Stress Monitoring in Russia

VII.1 Preliminaries

In this chapter the problem of Environmental Stress Monitoring in Russia is considered with regard to particular region of Russian Federation – namely Khanty Mansiysk Autonomous Okrug
(KhMAO)- where the environmental problems are strongly pronounced and where all significant environmental impacts are presented.
KhMAO is located in Western Siberia and is stretched from $59^0$50' to $86^0$02' longitude and from $58^0$53' to $65^0$54' latitude.

The area of the Khanty-Mansiysk autonomous region is 534.8 thousand km2, what is almost equal to the territory of France. Total population constitutes 1401.9 thousands.

The economic potential of the Khanty-Mansiysk autonomous region is one of the top ten in the Russian Federation and it holds the first position in oil production, the second - in electric-power generation, and the third - in gas production. Extracted oil output constitutes 58 % of the gross oil production in Russia. In sectional structure of industrial production of the region the petroleum extraction industry constitutes 80.5 %, power industry – 12.6 %, gas-processing industry – 5.6%, wood and wood processing industries – 0.4 %, building materials production – 0.4%.
There are immense resources of hydrocarbons, fresh and mineralized underwater. On the eastern slope and in the piedmonts of the Northern and Sub-polar Urals there are numerous deposits and prospects of minerals.

The oil production complex is the basis of the regional economy. During last decades, intensive exploitation of the natural resources has been accompanied by unprecedented environmental anthropogenic impact. Over 10 modern cities and dozens of small towns have been built, over thousand kilometres of railways and over 5 000 kilometres of roads, thousands kilometres of oil and gas pipe-lines, electric-power lines, etc. have been constructed.
That is why, the multifaceted problem of environmental stress monitoring can be considered for this region as a "representative example" of the common situation, existing at the moment in this field in Russia.

Fig. 7.1 presents the geographical location of the Khanty-Mansyisk Autonomous Region within the Northern Russia territory. The city of Khanty Mansiysk is the regional centre and the UGRA Research Institute of Information Technologies (URIIT) is the leading organization, responsible for GIS and Remote Sensing applications development and for Rational Use of local Entrails.

Fig.7.1 The territory of the North of Russia (European part and Western Siberia)

VII.2. Soil degradation monitoring

Soils and land resources

Since Khanty-Mansiysk autonomous region is located in the central part of the West Siberian plain, the climate of the region's territory is sharp continental and is formed under influence of air masses of the Asian continent. The main features of the climate are:

- precipitation exceeds evaporation and
- insufficient warmth.

According to geographic and soils zonation, the territory of the Khanty-Mansiysk autonomous region belongs to the central taiga and mixed forest zone of the West Siberian province of gley-podsolic and podsolic alluvial-humus soils. A dense drainage system (Ob and Irtysh river basins) and a great number of lakes and bogs are the characteristic features of the landscapes. In general, the conditions of the natural environment can be characterized as rather severe for human activity of any kind and for land use.

The land cover/land use of the territory can be categorized as follows:

- Forests occupy 90.9 % (or 48602.2 thousand ha) of the total region area;
- Agricultural lands occupy 687.9 thousand ha (or 1.2 %);
- Urban territories – 487.4 thousand ha (or 0.9 %);
- Industrial, transport, communication lands – 130.8 thousand ha (or 0.3 %);
- Natural reserves lands – 874.4 thousand ha (or 1.6 %);
- Water bodies – 501.8 thousand ha (or 0.9 %)
- Stock lands – 2195.6 thousand ha (or 4.2 %)

The infrastructure of the land use management is depicted in graphic form in the diagram of Fig. 7.2

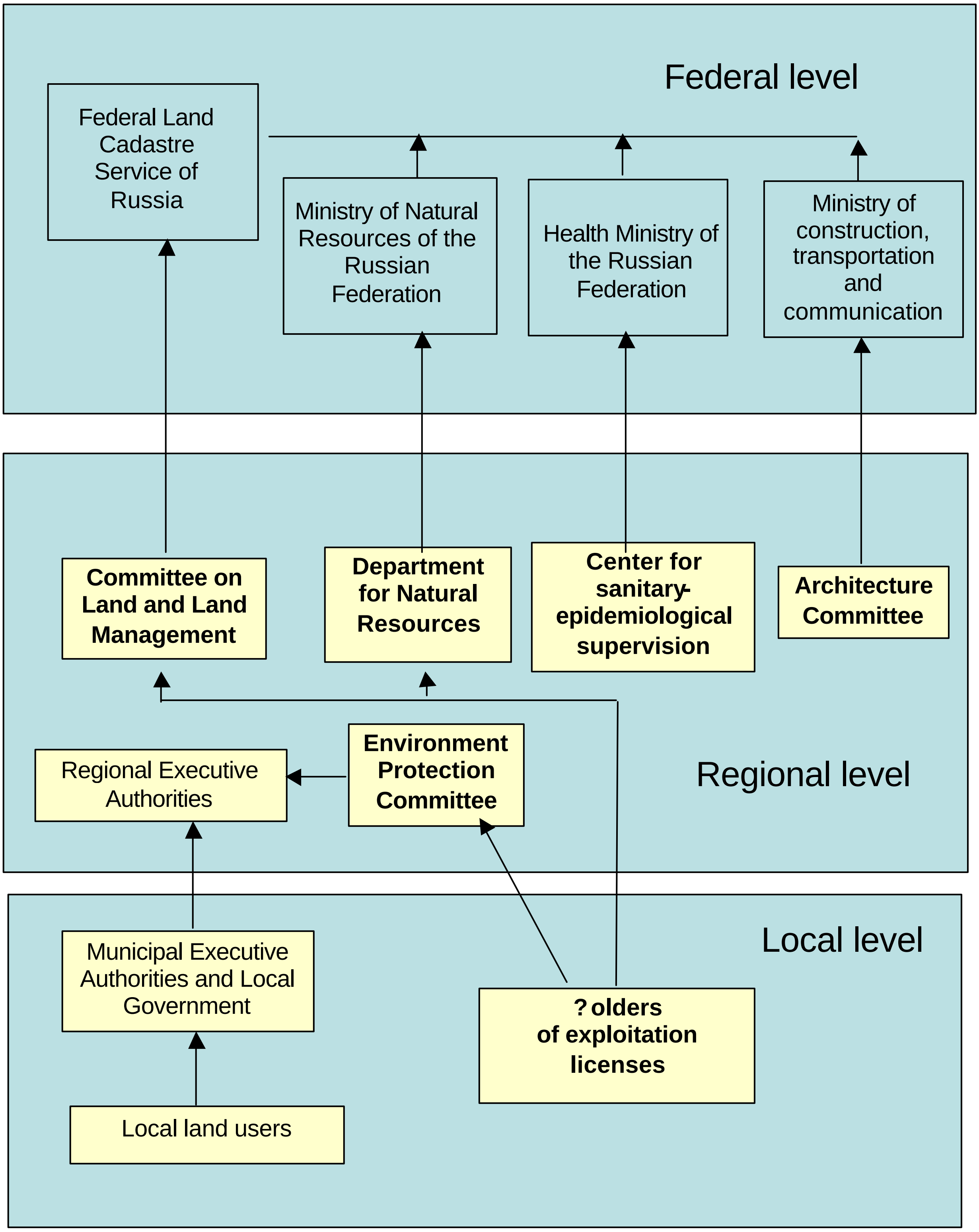


Fig.7.2 Land use management and monitoring in KhMAO

According to the valid state and regional environmental legislation, minerals and petroleum exploiters (holders of exploitation licenses) should develop systems for regular environmental observations (atmospheric air quality, surface water and underwater, soils) of the licensed areas and should carry out an environmental monitoring. Environmental monitoring of the licensed areas has the following objectives:

- Environmental control based on chemical, physical and biological characteristics for determination of the source of pollutants, a pollution level and the estimation o fenvironment protection effectiveness;
- To provide special accredited environment protection and resources exploitation supervising organizations with regular data on environment pollution level, forecast of its possible changes, and emergency information on abrupt increase in pollutant level in the environment.

Environmental monitoring of the areas under control should be a complex of connected, temporally and spatially synchronized observations of the environment and their quality assessment.

Development of local environmental monitoring systems should to be based on the results of previous studies of the oilfield areas and initial (background) pollution, regulated by the document:

"The main requirements for licensed areas initial (background) pollution appraisal of oilfields, gas-fields and other mineral resources of the Khanty-Mansiysk Autonomous Okrug".

As a result of this directive certain characteristics have been specified on the basis of a data analysis of sources and scale of technological impacts:

- Number and location of the environmental observation stations
- The list of quality indices to estimate the environmental stress
- Observation intervals for various environmental components and indices.

The set of ingredients and observation intervals (sampling intervals) for various observation stations for a monitoring network can differ, and they should be proved on a base of actual measurements in the area of initial pollution. The systematic control is required for all types of pollutants with concentration that exceeds environmental standards.

VII.2.1 Requirements for an observation network of local area monitoring

The observations of the environmental conditions are carried out through the observation network designed on the basis of a preliminary study of initial background pollutions, the nomenclature of pollutants and evaluation parameters.

The observation network is intended to provide the possibility for an all-round evaluation of all environmental components. The observation network project, comprising deployment of sampling and express-analysis stations, the list of controlled ingredients and observation intervals, is the subject for coordination with specially accredited environment protection and resources exploitation supervising organizations of the Khanty-Mansiysk Autonomous Okrug. The latter are responsible for termination of the observation process, change of the station location, change of the list of parameters and ingredients to be measured and so on. An unauthorized change of the location of sampling spots, observation intervals and controlled parameters is strongly prohibited. Sampling should be carried out according to the State Standards for atmospheric air and soils, surface water and underwater. The copies of the certificates are produced by "Specialized Inspection for Analytical Control of Khanty-Mansiysk Autonomous Okrug".

VII.2.2 Requirements for soil monitoring

System of ecological observations of soil condition should be designed on the basis of landscape-geophysical differentiation of the territory taking into account the geochemical barriers and the most probable ways of the ground (under-soil) migration of pollutants.

Every year soil sampling is carried out on the previously chosen spots or profiles of the territory and the distribution of the principal pollutants is calculated. The observations should be done on unpolluted territories as well, for the estimation of the background conditions. Together with chemical analysis, the control of hazardous land pollution sources is recommended to carry out through biological tests. Biological objects for testing are chosen on a base of natural and climatic conditions of the region.

Within ecological monitoring, an exploiter is forced to carry out, at least once in three years, remote sensing of the whole licensed area (air survey or spectrozonal high resolution snapshot from space) for evaluation of the spatially differentiated technological impacts on environment under intensive industrial exploration, in other cases – once in five years.

In the case of oil spills on regional or territorial scale the exploiters must immediately carry out an air survey or a snapshot from space of the adjacent territory. The exploiter of the territory should submit the report with the results of ecological monitoring to the corresponding authority. Information on pollutants and emissions (their volumes, location, and time) is immediately reported to the special accredited environment protection and resources exploitation supervising organizations.

The information obligatory to be reported by the land users on results of ecological monitoring:

1. For soils conditions – once a year;
2. For surface water and underwater – once a quarter;
3. For air – once a quarter (snow sampling – once a year);

The main components that should me obligatory measured are shown in Table 7.1

Chemical substances and soils parameters	**Indices of surface water and underwater chemical pollution**	**Indices of sediments from chemical pollution**	**Chemical substances to be obligatory measured in air samples**	**Polluting chemical substances to be obligatory studied in snow (melt-water) samples**
	pH	pH	Hydrocarbons	
Nitrates	Suspended substances		Carbon monoxide (CO)	Suspended substances
Phosphates	Dry residual		Sulphur dioxide	Sulphates
Iron	Electric conduction		Nitrogen oxides	
	Biological oxygen consumption			
Lead	Lead	Lead	Soot	Lead
Zink	Zink	Zink		Zink
Manganese	Manganese	Manganese		Manganese
Mercury	Mercury	Mercury	Dust	Mercury
hromium	Chromium	Chromium		Chromium
Chlorides	Iron	Iron		Iron
Nickel	Nickel	Nickel		Nickel
pH	Ammonia nitrogen			Ammonia nitrogen
Humus	Phosphates			
	Sulphates		Benzapilene	Benzapilene
	Synthetic surface active substances			
Oil and petrochemicals	Oil and petrochemicals	Oil and petrochemicals		Oil and petrochemicals
	Phenol			Phenols
•	Chlorides	Chlorides		

Tabl.7.1 Main chemical components to be measured for soil monitoring

The basic results of ecological monitoring are being produced for oil, gas and other mineral resources of the license areas on a base of data of contractor; accredited laboratories carry out air, water, sediments and soils samples analysis. All sampling sites should be shown on the maps attached to the report; for all sampling sites there should be geographical (or plane) coordinates.

4. The area map drawn at the 1:50 000 scale with observation points.
5. Table of observation points (sampling places) position data (in geographical values of 1942).
The results of sample analysis
6. Information on environmental technological load being done once a year (see Table 7.2)

Licence area: Licence number:			
Parameter	**quantity**	**Parameter**	**quantity**
Extracted oil output, ml. tons		Land surface area polluted during oil spills, ha	
Extracted gas output, ml. Tons		Land surface area polluted during oil spills, ha	
Coefficient of petroleum gas recovery, %		Land surface area recuperated after oil spills, ha	
Total number of oil wells,		Land surface area in use, ha	
Total length of pipelines, km		Arrears of lands recovery, ha	
Length of pipelines requiring replacement, km		Number of building materials borrow pits	
Roads length, km		Extracted building materials output, thousand m3	
Length of power lines, km		Number of atmospheric emissions sources, including: a) fixed-site,	
Number of well clusters,		Amount of atmospheric emissions, tons including: a) fixed-site, tons	
Number of pumping stations,		Number of purification systems, total:	
Number of central pumping stations		Sewage purification works, number/capacity	
Number of mud pits,		Number of flares (with schedule)	
Quantity of drilling wastes, thousand tons		Number of waste sites:	
Total number of breakdowns with ecological impact,		for solid domestic waste disposal, number for industrial waste disposal, numb.	
Number of breakdowns on the pipelines, corrosion construction and equipment reject mechanical damage other causes		Biological cleaner number/capacity for normative purification: a) Sewage purification works, number/capacity b) Biological cleaner number/capacity	
Information on environmental technological load		Amount of water disposal, thousand m3 including: a) unpurified water discharged, thousand m3	
Quantity of pollutants emitted into: water bodies, tons land surface, tons atmosphere, tons including: a) oil and petrochemicals, tons b) strata water, tons		Amount of water consumption, thousand m3, including: from surface reservoirs, thousand m3 from underground aquifers, thousand m3 for household needs, thousand m3	

c) oil-gases, thousand tons		for production operations support, thousand m3	
Environment expenditures, thousand rubles			

Tabl.7.2 Information on environmental technological load

The information that should be obligatory reported by the land users on results of ecological monitoring (seeTable 7.1 and Table 7.2)is the base for Environmental Stress Monitoring.

Space monitoring of soil degradation

Monitoring of soil with remote sensing techniques was developed by some organizations both governmental, scientific and commercial. The problem is that remote sensing data could not be used widely, because there are no techniques for data interpretation, authorized by the normative acts. There are some organizations that have been working successfully in the field of soil monitoring. A large amount of work have been done by Moscow State University, Institute of Edaphology and Agricultural Chemistry of Siberian branch of Russian Academy of Sciences (Novosibirsk), Institute of Land Monitoring of Federal Land Cadastre Service of Russia (Voronezh) and some non-governmental organizations.

VII.3. Oil pollution monitoring

The framework of oil pollution monitoring is presented in Fig.7.3

In 2000 the laboratory research has been done in KhMAO with regard to biological activity of soils. The results of this research program allow establishing the precise correlation between the growth of contamination of soil and the petroleum concentration and how this concentration modifies the microbiological parameters. It was detected that in a range of petroleum concentration from 50 up to 300 ml/kgs the sharp modifications in microbiological system of soil take place.

The analysis of obtained outcomes allows to make the following conclusions:

- Floods of petroleum, burning of gas, the wood fires suppress biological activity and promote manifestation of toxicosis of soils.
- In the greater degree the biological activity of soils is suppressed by influence of floods of petroleum and wood fires. A little bit less the plume affects the soil parameters. It is connected, probably, to small factions of petroleum acting in aerosols.
- Due to the effect of the described factors the biological performance (mainly in upper horizons of soils) is worse, especially because of the effect of plumes and wood fires.

The research of the petroleum spills influence on soil contamination has shown that the majority of sectional platforms have high concentration of heavy liquid oil fraction. The traces of floods of petroleum at nearby territory had been observed. The big squares of contamination of ground happened to be from malfunctions and incidents on international oil pipelines.

The main results were achieved in the investigations of correlation between negative factors (pollutants) and real pollutions. Oil pollution monitoring should be based on steady flow of information.

The only regular information sources are reports from oil extractive companies.

These reports include:

- the date and time of accident;
- the volume of outflow of oil;
- the square of territory damaged.

During the next years the extractive company should give reports about soil and vegetation restoring. The real picture of oil pollution can be only done with the use of remote sensing monitoring. Global remote sensing monitoring of oil pollution is necessary in the development of methodological recommendations and data processing on a base of GIS technologies. The research on oil pollution detection is being done in Governmental Enterprise NPC “Monitoring”. Ugra Research Institute on Information Technologies (URIIT) is involved in this sort of activities as well. The laboratories of URI IT work the following fields:

- Development of methods, algorithms and software for remote sensing image processing
- Development and creation of geoinformation systems (GIS)
- Fundamental and applied research on evaluation of environmental conditions by means of remote sensing technologies
- Modelling of processes of transposition of substances and pollution in environment
- Development of methods for the interpretation of ground measurements to estimate the condition of environment
- Development of the set of numerical models for water and ground surface ecosystems with high spatial and temporal resolution. Development of the scenario and prognostic estimation of natural and man-caused variability of the territory.

Fig.7.4 presents the result of oil pollution detection with using of GIS technologies.
All experiments have been done using ERDAS IMAGINE 8.5 software. The initial information includes:
- The image from satellite “Landsat 7” (Fig 7.4.a) that represents the territory near Samotlor lake);
- The usual reports from oil companies;
- Vector maps of the territory under investigation.
After multi-step processing, the territories with oil pollution were detected (Fig 7.4.b) .

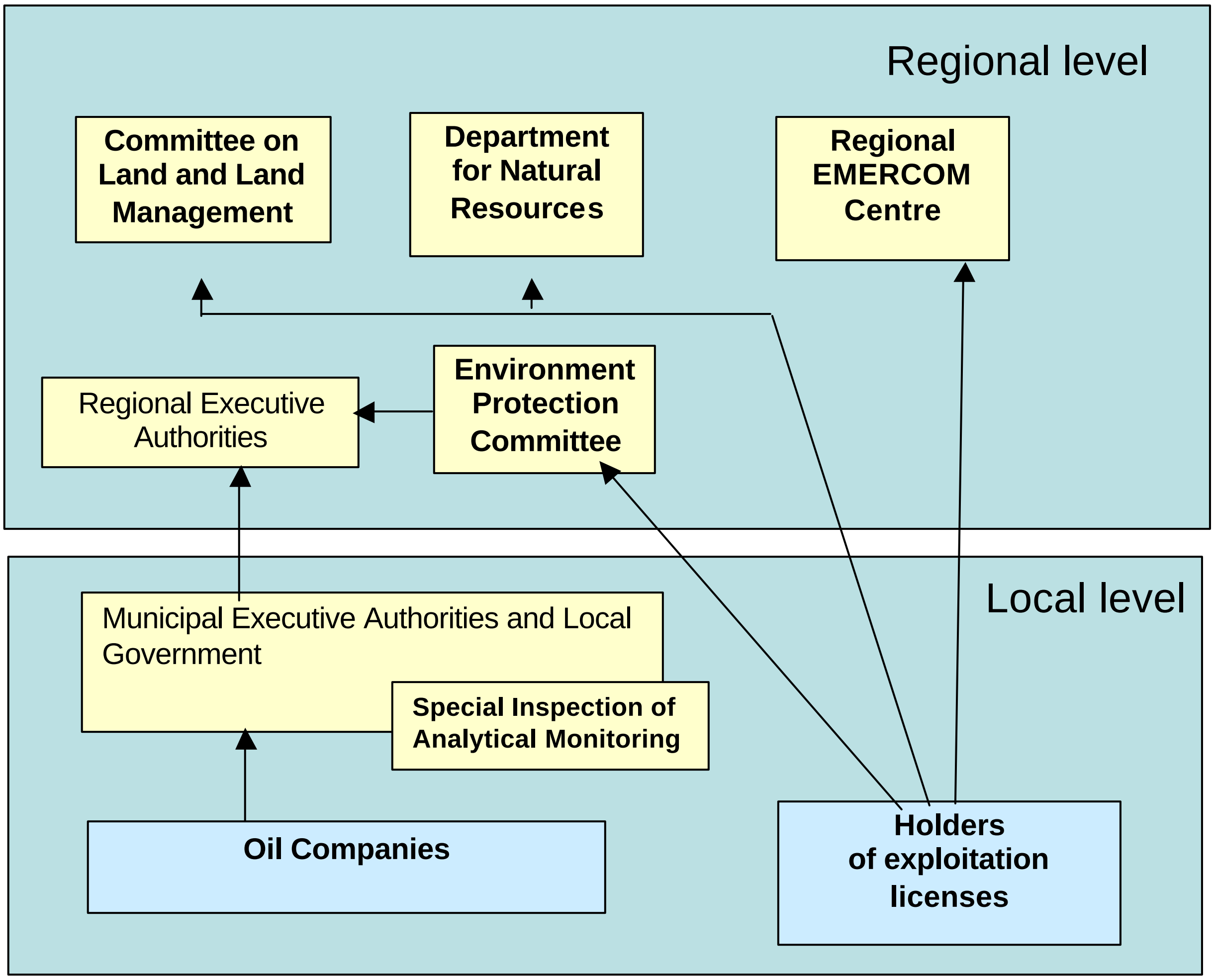
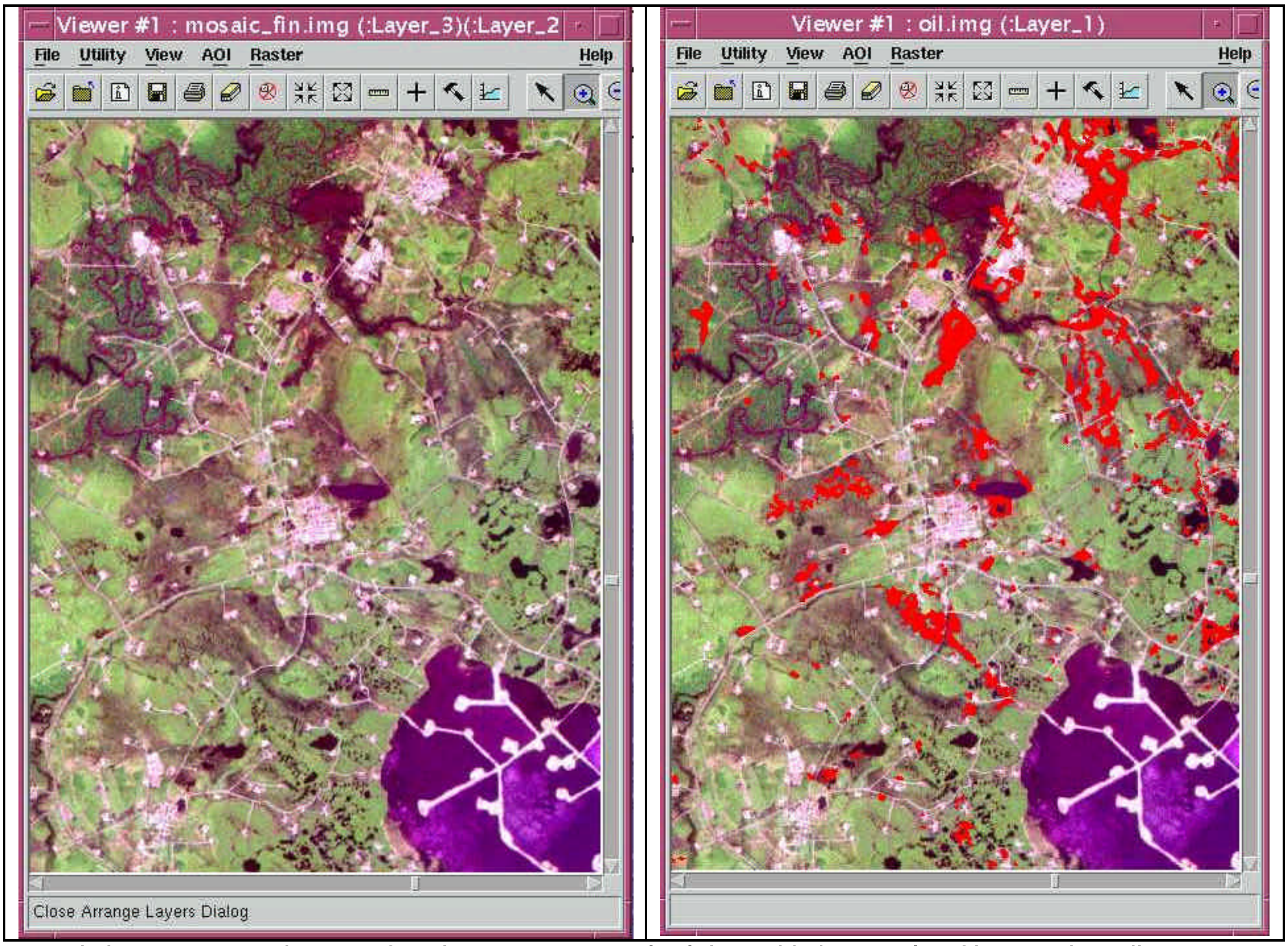


Fig. 7.3 Structure of the Oil pollution monitoring in KhMAO



a) the LANDSAT image of territory near Samotlor lake b) the result of image decoding.

Fig.7.4 Results on oil pollution detection with the use of remote sensing imagery

VII.4. Atmosphere pollution through gas fire

Every year about 20 billions m3 of way petroleum gas is produced and more then 3, 5 billions were burned in gas plumes in KhMAO.

The reasons of contamination of an atmospheric air – errors in design solutions and absence of funding of the programs connected with the reduction of ejections in atmosphere of polluting substances.

The negative effect of plumes on an environment is caused by consumption of a huge amount of oxygen, heat radiation, and contamination of atmosphere, vegetation and soils by products of partial combustion of hydrocarbon, carbon oxide and nitrogen and other harmful substances. With regard to amounts of ejections the plumes can conditionally be divided on *average* (for local pump stations, Fig7.5 a) and *high-power* (for central pump stations, Fig. 7.5 b))

a). Plume at pump-station

Fig b) Plume at central pump-station

Fig. 7.5 Two types of gas fires:
a) Plume at local pump-station,
b) Plume at central pump-station

The plumes are intended for burning a gaseous mixture, however periodically the liquid factions of petroleum appear in plumes, resulting in an apart from all other to fall-out of heavy liquid oil fraction . The formation of an oxide of carbon is an intermediate stage of burning of gaseous fuel. Therefore defect of oxygen and the supercoolings of a zone of burning cause growth of CO concentration in products of combustion. The oxides of nitrogen in products of combustion of gaseous fuel have mainly thermal origin. If there are enough high temperatures (more than 1800 C) it should be the oxidation of nitrogen of an air up to a monooxide of nitrogen (~ 97-98 % volumetric NO). Then in atmosphere is oxidized up to NO_2, and their total concentration is recalculated on oxides of nitrogen frequently represented by a numeral NOx.

A source of thermal oxides of nitrogen is the high-temperature zones of a gas plume. Other component in volume of ejections of oxides of nitrogen is so-called «fast» oxides, which source is the active zone of fuel and oxidizer (described by high concentration of active radicals) due to the lack of the latter. The temperature level of process of formation of «fast» oxides of nitrogen (~ 1 200 C) is much lower, than thermal. Therefore it is impossible to avoid their formation.

The limits of extreme admissible ejections are placed for the extractive enterprises. It is the basis for payments. It is impossible to check up an actual condition by means of ground measurements.

The technique for calculation of the degree of contamination of atmosphere on a base of remote sensing data was developed in **URI IT**. Data for calculations are regularly obtained from satellites NOAA (sensor AVHRR) and TERRA (sensor MODIS).

The results of satellite data processing were incorporated in GIS (see Fig.7.6; Fig.7.7)

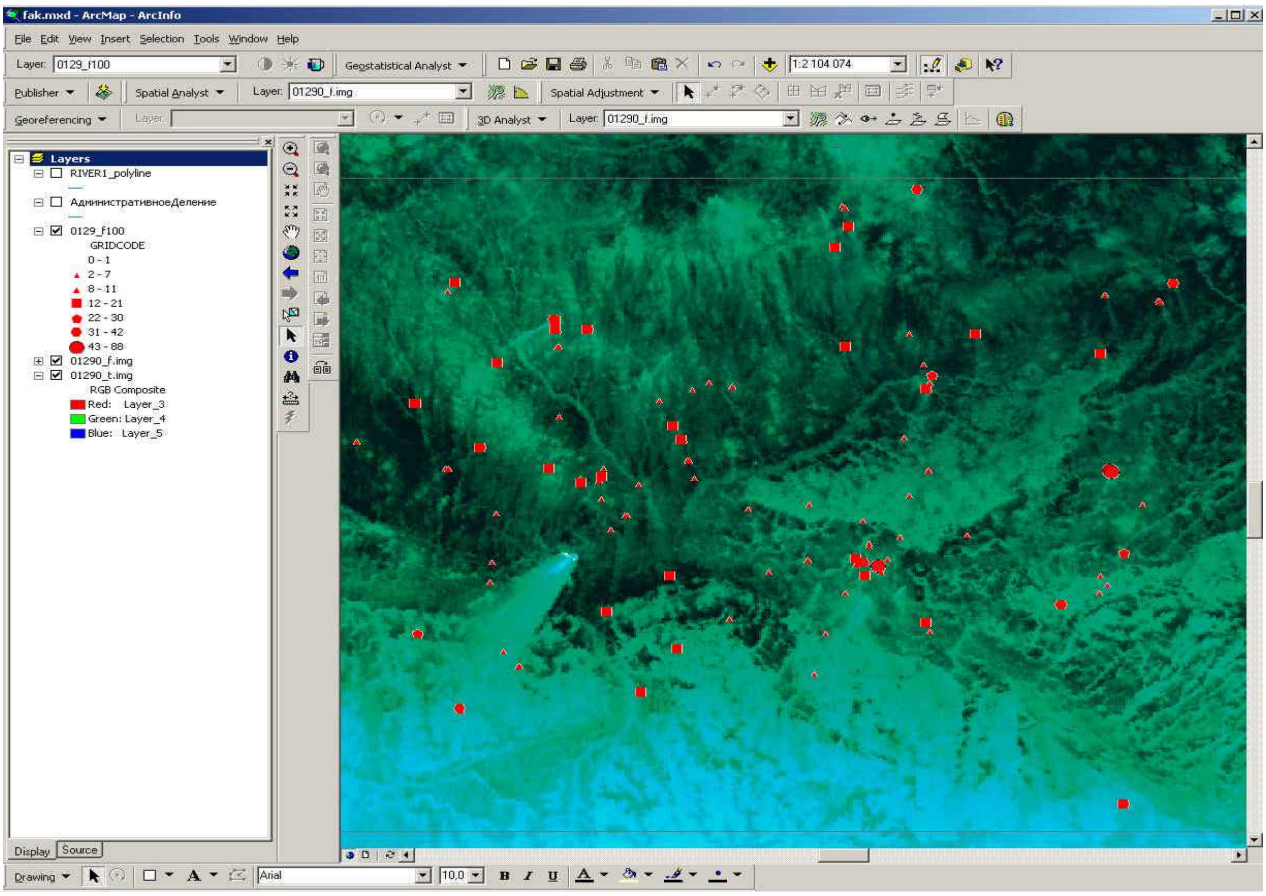


Fig.7.6 The result of gas plumes detection in GIS

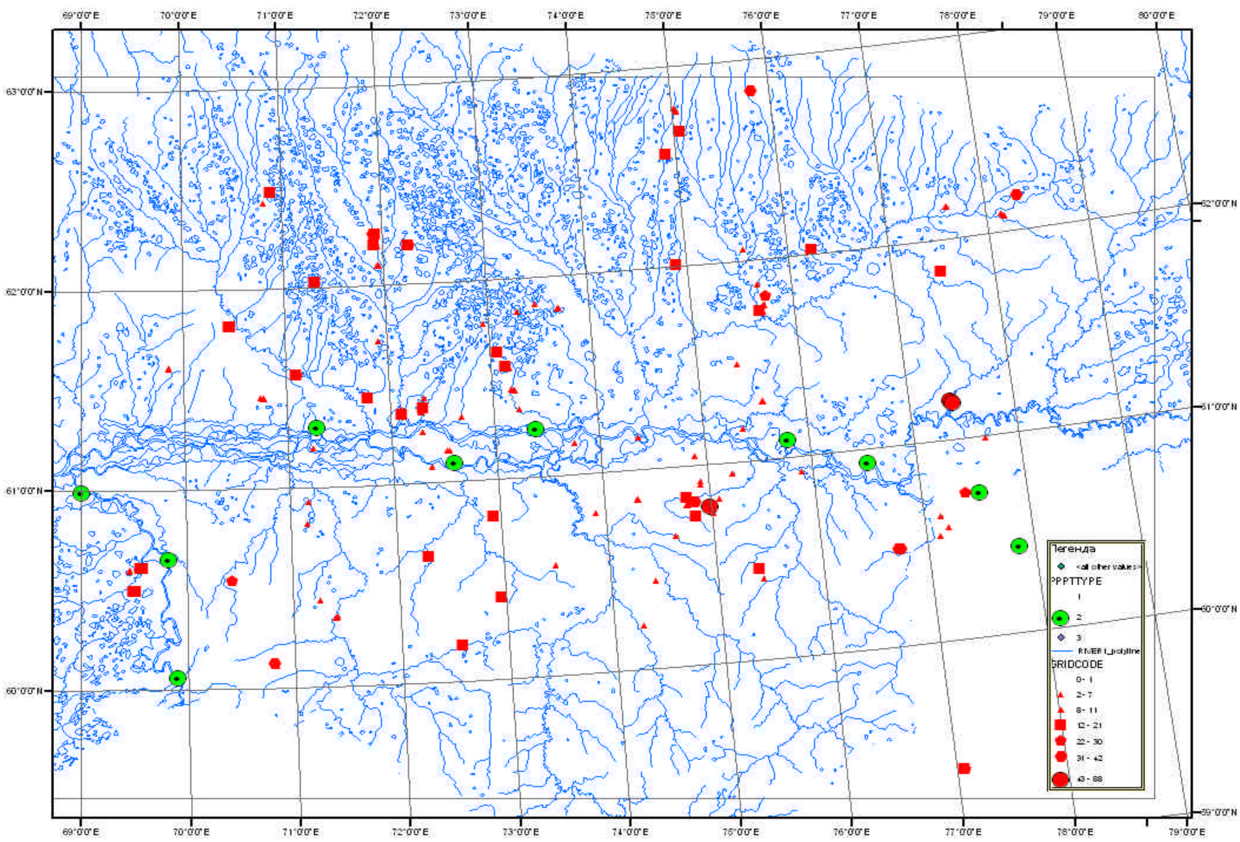


Fig.7.7 Mapping of gas plumes and classification of their intensity.

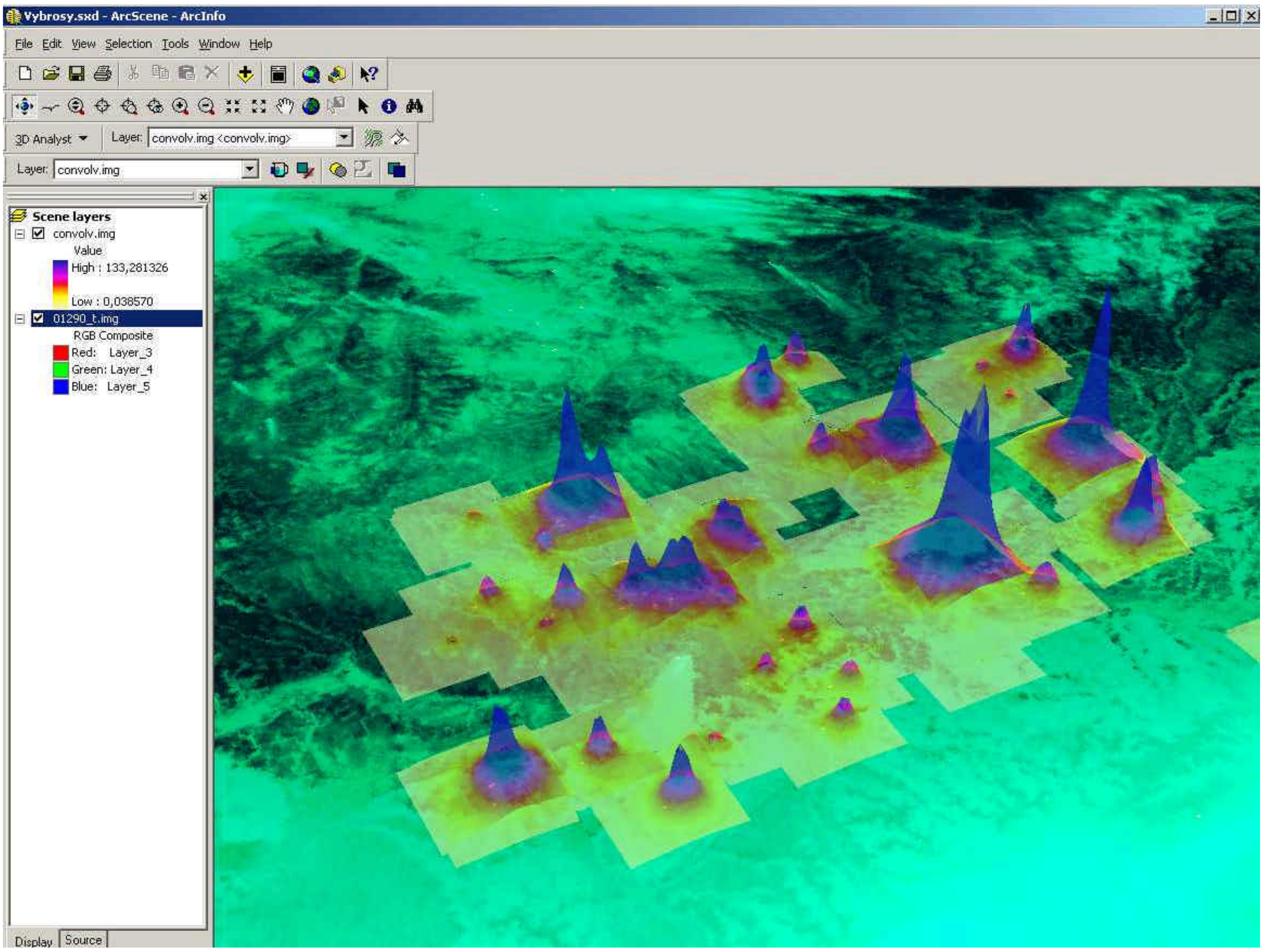


Fig.7.8 The result of data processing. Evaluation of atmosphere pollution through gas fire in GIS

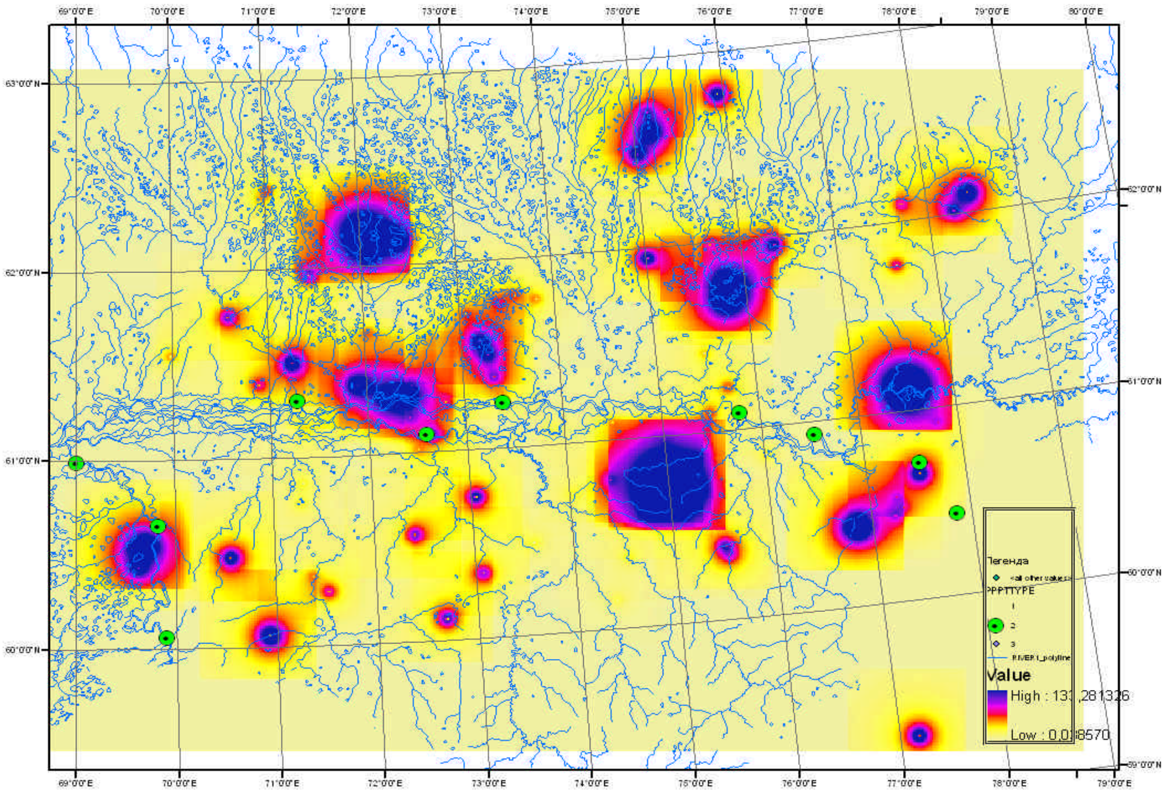


Fig.7.9 Mapping of atmosphere pollution through gas fire in GIS

Fig. 7.6 shows the result of gas plumes detection from satellite image (NOAA -16). Algorithm of processing was developed in **URIIT**. The outcome is the raster image in any admissible coordinate system, where every "hot" spot have magnitude equal to the emissive energy of pixel. Raster image may be transformed in vector form and then gas plumes may be mapped and classified on their intensity (Fig. 7.7). Atmosphere pollution through gas fire was calculated by modelling aerosol and gas propagations (Fig 7.8 and 7.9).

Global monitoring system of atmosphere pollution through gas fire may be constructed on the base of new information technologies with remote sensing data processing. The technologies, shown above, are developed in **URIIT** and after validation the latter could be disseminated over Russian regions with corresponding receiving station.

VII.5. Data types for environmental stress monitoring

This data varies with respect to time character, timeliness requirements, form of submissions, level of privacy and source of reception. In this way the data could be divided into:

on a time character: -planned; not planned.
on timeliness requirements: current; operative; results
by the form of submissions: tables; raster; vectors; maps; reports.
on a level of privacy: open; confidential;classified.
on a source of reception: Federal level;Region level;Local level;level of particular Organization.

At the moment the uniform structure of a system of monitoring does not exist. The various transfer protocols of information and different data formats are used. The initial data depends on the object of measurement and the types of characteristics that have to be measured. The data obtained by means of ground measurements include physical, chemical, biological probes, tables and texts and the results of compararison of methods of investigations. The data obtained by means of air-space remote sensing may be accumulated in vector and raster formats, depending on software available.

Software for processing remote sensing data

The software for processing the remote sensing data allows making the preliminary and thematic data processing, development of applied modules, as well as the interactive work of users. The software packages ERDAS IMAGINE Pro 8.5 for SUN ? ENVI (UNIX) are used for automation of the process of RS data processing, cataloging and storage. ENVI allows to process data in multiprocessor regime that speeds up the work. The ENVI IDL language and Imagine Developers Toolkit are being used for the development of software modules.

The license software ENVI, ERDAS IMAGINE Pro 8.5, ErMapper 6.2 is being used at the moment in URIIT and other organisaitons.

GIS software

Geoinformation systems and special-purpose applied packages are widely used in RUSSIA.

In **URIIT** the basic software is the full set of ArcGIS products by ESRI. This set of products includes the floating licenses of ArcMap, ArcCatalog, ArcTools, ArcEditor, as well as the fixed licenses of ArcMap, ArcCatalog, ArcTools. Additional modules are:

- 3D Analyst,
- Spatial Analist,
- Geostatistical Analyst,
- fully-functional GIS ArcInfoWorkStation for Windows and Solaris,
- programs for client-server and internet-solutions ArcSDE and ArcIMS.

VII.6 On-going Projects on Environmental Stress Monitoring

An ENVISAT-AO Project (ID 635) *"Environmental pollution monitoring over the oil and gas exploitation regions (northern parts of Russia) using ENVISAT data"* has started in October 2002 and will be finished until December 2004. Along with NIERSC and URIIT teams, the following research institutes and organizations are involved in the project:

- Nansen Environmental and Remote Sensing Center (NERSC, Bergen, Norway);
- Scientific-Research Centre of Space Hydrometeorology "PLANETA" (Moscow, Russia);
- Centre for Space Monitoring of Siberia (CSMS, Novosibirsk, Russia);
- Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (IZMIRAN) of Russian Academy of Sciences (Troitsk, Russia);
- and Yamal-Nenetz State Committee of Environmental Protection (YNSCEP, Salekhard, Russia).

The overall objective of the project is to demonstrate ENVISAT data applications for operational monitoring of the state of environment and its contamination in the regions of oil and gas exploration in Northern Russia (Hanty-Mansi and Yamal-Nenets Autonomous Districts).

The Northern Russian territories undergo now the peak of business activity due to exploration of oil and gas deposits by Russian and foreign companies. This region is characterized by extreme climatic conditions and under-developed infrastructure, as well as by very long time of nature's self-cleaning. Soil and water bodies contamination, degradation of vegetation cover, changes in soil chemical composition and permafrost structure, thermocarst and thermo erosion, changes in ground water level and hydrological regime, grave or irreversible changes in natural ecosystems **are consequences of anthropogenic industrial stress in these regions**. Today there is a need to fully assess the state of environment in the existing regions and to develop methodology for environmental protection.

Extensive coverage area and hard accessibility of the territory under study stipulate the use of remote sensing techniques as one of the main instruments for environmental monitoring for Northern Russia. Among potential users of such kind of information will be oil and gas companies, local and regional authorities, environmental protection agencies as well as many others. New approaches for study and monitoring of environmental conditions in the named regions are under development in the framework of ongoing project. Simultaneously the development of methods for synergistic use of

- data from various ENVISAT sensors (ASAR, MERIS, AATSR),
- sensors from other satellites
- field observations for environmental monitoring

is being done as well. The collection of in situ and remote sensing data will be done through exploitation of existing archives and databases, as well as by field surveys. New algorithms and methods of synergistic use of various ENVISAT and other satellites sensors having different spectral, temporal and spatial resolution will be elaborated. The remotely sensed parameters will be validated by field surveys data. All this will result in demonstration of benefits of use of ENVISAT data for environmental monitoring. The market analysis of potential users for such data and the development of strategy of operational monitoring of environmental pollution will be also done .

In the course of the project implementation historical in-situ data on natural parameters and data on industrial infrastructure for several regions of existing and planned oil and gas deposits exploration will be collected. All the information collected will provide the base for the analysis of current state of the environment for chosen regions. Seasonal and year-to-year variability of natural parameters will be taken into account. Special attention will be paid to the assessment and ranging of contamination risks under normal and accidental operating conditions. Such goal will be achieved through complex analysis of

- land cover and land use type,
- regional topography,
- pathways of pollution transport,
- ranging the territory from the viewpoint of promoting/hindering pollution transport,
- potential risk of accidents on the existing industrial oil and gas infrastructure.

Qualitative and quantitative changes in vegetation cover and forest landscapes, deforestation, changes in forest composition, biomass production variability are factors that will allow to estimate anthropogenic impact on surrounding nature.

The results of study such as :

- influence of oil and gas exploration on the environmental conditions
- assessment of pollution risks and transport pathways

will provide base for development of environmental and pollution monitoring strategy. Operational monitoring of petroleum release into the environment can be successfully made using high-resolution ASAR imagery. Regular mapping of “hot spots” areas and discrimination of radiometric changes within serial images will give information on potential release of hydrocarbons,that will be validated by utilization of additional information from other remote sensing and in situ data. If the identification of leak of contaminants or release will be approved, this information should be transferred to local and regional authorities. Project will demonstrate possibilities of ENVISAT data for pollution risk management assessment in such areas as:

- contaminant release identification;
- prediction of pollution transport and spreading;
- assessment of potential environmental impact and damage assessment;
- development of monitoring strategy and mitigation scenarios;
- study of changes in environmental conditions and self-cleaning processes after contaminants release;

The RFBR (Russian Foundation for Basic Research) Project no. 03-05-96831 “*Development of methodology of ENVISAT satellite data processing for monitoring of Northern Regions of Russia”* has started in 2003 and will be finished by the end of 2004. Along with NIERSC and URIIT teams, the following research institutes are involved in the project:

- IZMIRAN and Ugra State University (USU, Knanty-Mansijsk, Russia).

The project objectives are in many respects similar to those mentioned above but special emphasis will be done on satellite monitoring of environmental pollution by metallic trash. ASAR images with different polarizations will be used for the purpose of development of methodology of operational environmental monitoring.

VIII. The Forest Fund Monitoring in Russia

VIII.1 Introduction

The Russian Federation possesses vast forested areas, containing about 23% of the world's closed forest [1]. The Forest Fund, which consists of both forested and non-forested land, takes up about 12 mln. km2 .

VIII.2 Overview of the Forestry in Russia

VIII.2.1 Organizational structure of forest management

The history of forest management in Russia stretches for more than 200 year. According to the current legislation, the state forest administration includes forest use, monitoring and control activities, as well as protection and reforestation throughout the country. Management and administration functions are carried out by the President of the Russian Federation, the Government of the Russian Federation, executive bodies of the subjects of the Russian Federation, and specially authorized state forest administration bodies.

Specially authorized state forest administration bodies are represented by the Ministry of Natural Resources (MPR Russia) and the Federal Forest Service (FFS). The following departments constitute the FFS:

- Department of Forest Use;
- Department of the Forest Fund;
- Department of Control, Protection and Reforestation of the Forest Fund;
- Regional Forest Management Bodies in the subjects of the Russian Federation as well as Forest Management Units (leskhozes);

Also, the MPR Russia consists of:

- State Forest Planning and Inventory Enterprises (that were reorganized in the year 2002 and are currently titled "Forest Inventory and Planning Institutes");
- Airborne Forest Protection Service **("Avialesokhrana");**
- Science and Research ("Department of Research and Interaction with the Scientific Community");
- Education Institutes

VIII.2.2 Property rights on Forestry Fund

According to the Forest Code of the Russian Federation (1997). Forest Fund lands, including all forest, located on the defence lands, are under Federal jurisdiction. The federal law allows property rights transfer in favour of the subjects of the Russian Federation. Both the civil legislation and the Forest code guarantee the free access to the forest. There are Forest Fund allotments, which are available for lease by citizens and juridical persons. In addition to this, there is shot-term use; concession use and use of forest lands free of charge, which are all widely practiced. The Forest Fund and other lands constitute almost 69% of the total land area of the Russian Federation. MNR Russia controls and governs 95.83% of the Forest Fund area is governed and controlled by MNR Russia while other ministries and agencies manage the rest of the forest.

VIII.3 Forest resources assessment

At present, the structure of forest resource assessment includes:

- State Forest Fund Account
- State forestry Cadastre;
- Forest Management and Planning;
- Forest pathology and other inspections;
- Inventory of current changes in the Forest Fund;
- Forest monitoring;

VIII.3.1 State Forest Fund Account (SFFA)

The primary responsibilities of the State Forest Fund Account (SFFA) are to ensure that there is:
- sustainable forest management;
- forest guard and protection;
- forest reproduction;
- systematic quality and quantity control;

Also, SFFA is required to provide federal and regional authorities, juridical persons, and other concerned parties the reasonable data and reliable information.

Up to the year 1999, the SFFA was carried out every five years. It was crucial to get region based summarized forestry characteristics and to present them by the start of each five-year plan. Presently, taking into account the dynamic character of civil society development and, also, the demand for actual and updated information, the State Forest Fund Account is conducted **annually.**

SFFA data is used for keeping the State forest cadastre.

VIII.3.2 State Forest cadastre

The State Forest cadastre data is used for:
- state forest management;
- the practical implementation of forest management plans;
- the conversion of forest lands into non-forest lands to be used for purposes that not related to forest management and Forest Fund use;
- Forest Fund lands withdrawal;
- the establishment of timber prices and other forest payments;
- assessment of the forest user's economic activity

VIII.3.3 Forest inventory and Planning

An account of the forest in Russia is based on a periodic Forest Fund inventory conducted in accordance with forest inventory and planning procedures. Each territory must be inventoried every 10-15 years. The actual area of annual forest inventory and planning is about 30 mln.ha, which covers 3% of the Forest Fund area at the most. Thus, both the area and the quantity of sites that exceed the inspection period required by the guidelines are accumulating (Fig.6).

Forest inventory and planning has been carried on 61.4 % of the Forest Fund area. About 32.6% of the forest area has been thoroughly studied, while 6% of the area was inventoried by using simplified methods, such as aerial-visual inspection and remote sensing. Information about the scope and level of forest inventory and planning throughout Russia is presented in the Figure VIII.

At present, basic forest account information is gained from forest inventory and planning. Reliability of the data presented by administrative regions, regions of the Russian Federation and by the federal district is strongly dependent on the volume and quality of the forest account. Forest inventory and planning is comprised of a system of measures providing for sustainable Forest Fund use, higher efficiency in management, and common and unified policies in science, technology and research.

Forest inventory and planning throughout all the territories of the Forest Fund in Russia is conducted by state forest inventory and planning institutions that follow common and unified rules and approaches, which are established by the federal forest management body. The following parameters are taken into account by inventory and planning operations:

- species composition;
- age distribution;
- the health and condition of the forest;
- other quality and quantity indices;

In the year 2001, 108 forest management units located in 31 subjects of the Russian Federation were involved with the inventory and covered a total area of 28.3 mil. ha, while aerial photography covered an area of 16.8 mil. ha.

VIII.3.4 Inventory of Preserved Forest

Inventory of the preserved forest in Siberia and the Far East is conducted using aerial-visual inspection and remote sensing methods and covers the areas where there is no scheduled exploitation for the coming 15 – 20 years. These forests are mainly used for local needs in contrast with forest inventory and planning, the preserved forest inventory does not conduct forest management and state planning. All the boundaries are marked and determined by natural borders such as watersheds and rivers. In the year 2001, the preserved forest inventory covered an area of 5.1. mill.ha.

VIII.3.5 Forest pathology inspection

Forest pathology inspection is carried out to detect pests, diseases and other pathological damage and aims to assess the health and conduction of the Forest Fund. Forest pathology experts, working for the forest protection divisions of the MNR, implement the above-mentioned inspections. The inventory is conducted in:

- the areas which are under the mass outbreaks of pests and diseases;
- the sites damaged by windfalls, fires and other natural calamities;
- forest suffering from industrial pollution;

Efficient and flexible monitoring and control is annually performed over an area 7-9 mill. ha. In addition, forest pathology expeditions conduct surveys in the areas where there are complex and unfavourable pathology conditions (almost 8 mill.ha). These expeditions are conducted in order to verify the size of outbreaks and look deeper into the influencing factors, as well as to define the forest protection measures, which are necessary to be implemented.

VIII.3.6 Inventory of current changes in the Forest Fund

An inventory of current changes in the Forest Fund is a permanent duty of the forest management until staff. The idea id to monitor the occurring changes resulting from both forestry measures and natural calamities and to reflect them in the reporting documentation. Documentation of the inventory of current changes consists of the basic statistic reported by the forest management units. It is annually submitted to the regional divisions of the MNR. The data can be obtained by using ground methods (regular surveys, sampling plots) or remote sensing.

For an inventory of the current changes in the presented forest, space and aerial photography of different scales is utilized.

Remote sensing interpretation is used in the forest management and planning procedures to reflect the spotted changes and trends.

Documentation of the current changes in the Forest Fund is widely used in monitoring and controlling the Forest Fund and is extensively employed in forest management and planning

VIII.4 Forest monitoring

Forest monitoring is a system to observe, assess, and forecast the Forest Fund dynamics and its condition for the purpose of the state forest management, guard and protection, which is aimed at the increase of the forest's ecological value.

In accordance to various goals and structural divisions, monitoring consists of different methods:

- forest resource monitoring;
- Forest Fund lands monitoring;
- forest fire monitoring;
- purpose-oriented, specific monitoring (including monitoring of the forest, subjected to industrial emissions and radioactive pollution);
- monitoring of remote and insufficient investigated forest (by means remote sensing);

- forest monitoring conducted within a framework of international agreements and conventions.

Taken as a whole, the structure of forest monitoring is reliable enough and meets the requirements, but its technical provision is quite low.

We shall not examine here the ground-based data that carry information on what has been said above. We can say with reasonable confidence that most ground-based information available to date does not correspond to the actual situation in RF forests. The source of new, unbiased information can be provided by satellite data [ ] of both high and low spatial resolution. It is necessary and, most importantly, possible modernize the system for monitoring and inventory of forests in the RF, based on existing information obtained through ground-based and aerovisual interpretation. [Malysheva N., Shvidenko A., 2000].

In next paragraphs we will overview briefly the actual state-of-the-art in applied satellite remote sensing.

VIII.5 Satellite remote sensing for Forestry Monitoring

The difficult economic situation that emerged in Russia in the early 1990s has led to the fact that today only two orbiting Russian satellites are in operation: "Meteor-3M" (meteorological and natural-resource exploring spacecraft) and "Arkon" (dual-purpose spacecraft). The orbiting cluster of small spacecraft will" cover" the Earth in real time Anatoly Kiselev]. Furthermore, this information is virtually unused in forestry. One way out would be to make operational the "Monitor" program that was developed by specialists of the SM.V.Khrunichev Scientific and Production centre. This program provides the creation of an orbiting cluster of small spacecraft (four optico-electronic, and two radio locating) to acquire natural-resources information in real time. It is planned to incorporate in the "Monitor" system small regional sites for reception of information that would ensure direct reception of remotely sensed data on the Earth directly by customers using relatively small receiving stations [V. V. Lebedev, Problems of Creating Geoinformation Complexe, in Russian].Companies of the USA, Canada, EU, and Japan have the leading role in the development of natural resources exploring satellites today.

With the advent and evolution of small regional sites for reception of satellite information in Russia, there emerged a tendency for the subjects of the RF to be independent as regards the acquisition and processing of satellite data. These sites are mostly equipped with receiving stations developed at the "Scanex" ITC; they also use existing stations located in the Regional Centres for Receiving and Processing Satellite Data in Moscow, Obninsk, Novosibirsk) and Khabarovsk. Today there exist about 30 operational sites in Russia for receiving and processing of satellite data. The bulk of operations correspond to reception of data from four satellite systems: METEOR 3M, NOAA, EOS, and IRS. In this case the data from NOAA and EOS are disseminated gratis. Data from the aforementioned satellites are received in real time.

Another method of acquiring real-time information is by making an order for a picture from the operational archive of organizations that disseminate remote sensing data. The RF-largest supplier of Russian and foreign remote sensing data is «SOVINFORMSPUTNIK Thus, on 4 June 2003, «SOVINFORNSPUTNIK» and the company «Space Imaging Eurasia» signed a memorandum about the dissemination, on the territory of the Russian Federation, of remotely sensed data on the Earth acquired by the ICONOS spacecraft. On the other hand, the company «DigitalGlobe» granted «SOVINFORNSPUTNIK» the rights for the dissemination of remotely sensed data space images in the Russian market. In addition to «SOVINFORMSPUTNIK», we must mention a young Russian commercial organization, «SOVZOND»

All archival and real-time satellite data of high spatial resolution (over 30 meters) are disseminated on a commercial basis. Below we give the list of the main satellite systems that are used in forestry of the RF and in a number of foreign countries.

VIII.5.1 Current satellite systems for forestry monitoring

NOAA AVHRR

With ~20 years of data record, the Advanced Very High Resolution Radiometer offers a unique opportunity for retrospective processing of 1-km data into time series of active fires and burned areas. AVHRR continues to provide useful information on board the current POES series. However, its instrument characteristics are inferior to the recent experimental and semi-operational systems. On the future NPOESS series AVHRR will be replaced by VIIRS.

EOS AM/PM (Terra/Aqua) MODIS

The Moderate Resolution Imaging Spectroradiometer is currently providing global, medium-resolution near-real time measurements useful for fire mapping. The improved geolocation accuracy and more suitable radiometric characteristics allow the production of higher accuracy active fire and burned area products.

DMSP OLS

Night-time visible data from the Operational Linescan System on board the Defence Meteorological Satellite Program can be used for global fire mapping at medium resolution.

TRMM VIRS

The Tropical Rainfall Measuring Mission Visible and Infrared Scanner provide medium resolution VIS, NIR, SWIR and IR measurements from a low inclination orbit. It can be used for the sampling of the burning activity in the tropical and sub-tropical regions at various local times.

ERS ATSR and ENVISAT AATSR

The Along Track Scanning Radiometer on board the ERS-1 and -2 satellites, and the Advanced ATSR on board ENVISAT are dual-view medium resolution sensors, which provide VIS, NIR and SWIR measurements for burnt area mapping and active fire detection.

ENVISAT MERIS

The Medium Resolution Imaging Spectrometer has 15 programmable channels to measure the reflected solar radiation in the VIS and NIR spectral region at 300 m resolution. Potential applications include burned area mapping.

SPOT VGT

The VEGETATION instrument provides medium-resolution, global VIS and NIR, high-quality measurements that are useful for burned area mapping.

LANDSAT TM, ETM+

The Thematic Mapper, which was replaced by the Enhanced Thematic Mapper Plus, provide high resolution imagery for burned area mapping and for the validation of medium-resolution burned area products.

EOS AM (Terra) ASTER

The Advanced Spaceborne Thermal Emission and Reflection Radiometer provides high resolution VIS, NIR and SWIR data coincident with MODIS observations near the centre of the swath. ASTER is a valuable tool for the validation of MODIS active fire products and burned area maps from various satellite systems.

BIRD satellite

The Bi-spectral Infrared Detection is a small satellite that provides VIS, NIR and SWIR data for burned area mapping and active fire detection at 185 m and 370 m respectively.

OrbView -2 , OrbView-3

The VHR satellite that provide 1 and 2 meter panchromatic resolution images and 4 meter multispectral resolution images on real-time basis worldwide.

Some of the uses for ORBIMAGE imagery include pipeline routing, new construction planning, farming, forestry, and travel planning, to name a few. Imagery adds an additional data layer for today's GIS systems to help organizations manage facilities and resources, make better decisions and save money. Applications for our imagery products detailed here include National Security, Commercial and Environmental. Also the OrbView-2 satellite carries the SeaWiFS sensor which provides 1km resolution data in 8 spectral bands.

IKONOS

The satellite equipped with very high resolution (VHR) optical sensor. It have both cross-track and along-track viewing instruments which will enable flexible data acquisition and frequent revisiting capability: 3 day at 1 meter resolution (for look angles < 260) and 1.5 days at 1.5 meter resolution. The near real-time programming capability will make possible to program acquisitions while taken the current weather conditions into account. The nominal width at nadir is 11 km.

QuickBird

The QuickBird satellite is intended for producing digital images of Earth cover at 0.64 meter in panchromatic resolution and 2.5 meter multispectral resolution images. The nominal width at nadir is 16.5 km. (scene size is 16,5 x 16,5 km) and very high metric accuracy.

VIII.5.2 Coming in the nearest future satellite systems for forestry monitoring

NPP/NPOESS VIIRS

The Visible/Infrared Imager Radiometer Suite will be first flown aboard the NPOESS Preparatory Project (NPP) and then on board the National Polar-orbiting Operational Satellite System (NPOESS). It will provide similar measurements to MODIS at higher resolution.

ADEOS-II GLI

The Global Imager on board the Advanced Earth Observation Satellite has 36 bands in the VIS, NIR, SWIR, MIR and TIR spectral regions which are useful for burned area mapping and active fire detection.

In Table 8.1 below we collected the mentioned above satellites and their capabilities.

Satellite	Bands (mkm)	Resolution (meter)	Width (Km)	Time resolution (Day)	Assess
NOAA/AVHRR	0.58 -0.68 0.725- 1.1 1.58 -1.65 3.55 -3.93 10.5 -11.5 11.5 -12.5	1100 m	2048	4-6 times/day	Free
EOSAM/PM (Terra/Aqua) /MODIS	Chanells 1,2 0.62 – 0.876 Chanells 3-7 0.45 – 2.155 Chanells 8-36 0.405 – 14.3 mkm.	250 500 1000	2048	2-4 times/day	Free
LANDSAT/ TM, ETM+	0,52-0,90 PAN 0,45-0,52; 0,52-0,61; 0,63-0,69; 0,75-0,90; 1,55-1,75; 2,09-2,35; 10,4-12,5	30 m VIS 60 m IR	183x172	16 days	Commerce
SPOT 5	0,50-0,59; 0,61-0,68; 0,78-0,89; 1,58-1,758	PAN - 5 m MS – 10 m Super PAN – 2.5 m	60	26 days	Commerce
SPOT 4	0,50-0,59; 0,61-0,68; 0,78-0,89; 1,58-1,758	PAN - 10 m MS - 20 m	60	26 days	Commerce
EOS AM (Terra) /ASTER	0,56; 0,66; 0,81 1,65; 2,17; 2,21; 2,26;	15 m 30 m 90 m	60	16 days	Commerce/free

	2,33; 2,40 8,30; 8,65; 9,10; 10,6; 11,3				
BIRD					
IRS-1D	0,50-0,75 PAN 0,52-0,59; 0,62-0,68; 0,77-0,86 1,55-1,75	6 m 24 m 71 m	70 142 810	24 days	
OrbView -2 , OrbView-3	0,40-0,42; 0,43-0,45; 0,48-0,50; 0,50-0,52; 0,55-0,57; 0,66-0,68; 0,75-0,79	PAN – 1m MS – 4 m			Commerce
IKONOS	0,45-090 PAN 0,45-052; 052-0,61; 0,64-0,72 0,77-0,88	1 m 4	11 km	2.9 days for getting ithe images with spatial resolution 1 m; and 1.5 days for 1.5 m resolution	Commerce
QuickBird	0,45-0,90 PAN 0,45-0,52; 0,52-0,59; 0,63-0,69; 0,76-0,89	0,5-1,25 2,5-3,3	16.5 km	1 – 3,5 days	Commerce

Table 8.1 The Capabilities of remote sensing based systems for forest monitoring

VIII.6. Demands and requirements to remote sensing data for forest monitoring

VIII.6.1 The classification of Users

We use some of the results and recommendations about users requirements for remote sensing information from [Malysheva N., Shvidenko A., 2000].
Major users of remote sensing data for forestry analysis in Russia could be classified as follows:

- Local level (scales from 1:1000 to 1:50000): managers and professionals of forest enterprises, Nature Protection Committees of the administrative districts, etc.
- Regional level (scales 1:50000 to 1:1000000): regional bodies of Federal Forest Service, regional forest inventory and planning enterprises, regional offices of “Avialesookhrana”, regional Nature Protection Committees, regional governments, and NGOs.
- Federal level (scales 1:1000000 to 10000000): Federal Forest Service of Russia, other federal ministries, “Avialesokhrana”, Universities, and NGOs;
- Continental and global level (all Russia territory, scales above 1:2500000 to 1:5000000, but local to regional scale requirements could arise at the individual

project level):international organizations and long-term scientific programs (such as IGBP, GOFC etc.,), global and continental environment studies, different companies, national and international financial institutions (e.g. in the framework of the post-Kyoto negotiation process), etc.

VIII.6.1 Organizations developing remote sensing methods for forestry monitoring

List of organizations developing and applying Remote Sensing Methods for forest monitoring is given in **Tabl.8.2** [2]

Organization	
1	Centre on Problems of Ecology and Productivity of Forest RAS, Moscow
2	V. N. Sukachev Forest Institute, SB RAS, Krasnoyarsk
3	V. N. Sukachev Forest Institute Western Siberian Department, RAS Novosibirsk
4	Geographic Institute SB RAS, Irkutsk
5	Remote sensing centre, Institute of solar – terrestrial physics SB RAS, Irkutsk
6	Laboratory of remote sensing supply, Space Research Institute, RAS Moscow
7	Radiotechnic and Electronic Institute RAS, Moscow
8	Geographic Institute RAS, Moscow
9	Nansen International Environmental and Remote Sensing Center("Nansen-Center", St. Peterburg)
10	M. V. Lomonosov Moscow State University (MSU) geographic Department. Laboratory of Aerospace Methods, Moscow
11	Institute of Space Analysis of Forest attached to Moscow
12	St. Petersburg Scientific-research Institute of Forestry, St. Petersburg
13	All Russian Scientific-research and Information Centre for Forest Resource (VNIICLesresurs), Moscow
14	All –Russian Scientific-research Institute of Fire-Prevention Protection of Forest and Mechanization of Forestry (VNIIPMLeshoz), Krasnoyarsk

Tabl.8.2 List of organizations developing and applying Remote Sensing Methods for forest monitoring

VIII.7 Domestic and International projects and programs for forest monitoring

VIII.7.1 GOFC/GOLD

Several international programs have been established towards the goal of gaining complete information on fire activity around the world using satellite sensors. These include the International Geosphere Biosphere Program, Data and Information System's (IGBP-DIS) Global Fire Product initiative (Justice and Malingreau, 1993, 1996), the World Fire Web, the ASTR World Fire Atlas (Arino and Rosaz, 1999), the MODIS Fire Product (Kaufman et al., 1998a), and many other national and regional fire programs as summarized in Gregoire et al. (2000). These activities are among those endorsed by the Global Observation of Forest Cover program (Ahern et al. 1998).

The overall objective of GOFC is to improve our understanding of the impact of forest dynamics and forest fires on the global carbon budget. Since forest fires affect forest dynamics and the carbon budget, monitoring and mapping forest fire is a major component of GOFC. GOFC has two requirements 1) near-real-time detection and monitoring of fires during the fire season and 2) post-fire season mapping of the burnt areas. These requirements respond to the needs of three fire user groups: the global change research community, policy and decision-makers, and fire managers (Ahern 2000). Specific needs for fire information are diverse among these groups. For active fire detection, the main difference in request of fire information lies in the promptness of information delivery, with fire managers and climate research community being the most and least demanding user groups, respectively.

GOFC/GOLD (Global Observations of Forest and Land Cover Dynamics) is a project of the Global Terrestrial Observing System (GTOS) program, which is sponsored by the Integrated Global Observing Strategy (IGOS). The main goal of GOFC/GOLD is to provide a forum for international information exchange, observation and data coordination, and a framework for establishing the necessary long-term monitoring systems.

The GOFC/GOLD-Fire Mapping and Monitoring Theme is aimed at refining and articulating the international observation requirements and making the best possible use of fire products from the existing and future satellite observing systems, for fire management, policy decision-making and global change research.

GOFC/GOLD is promoting self-organized regional networks of data users, data brokers and providers, where closer linkages and collaborations are established with emphasis on an improved understanding of user requirements and product quality. GOFC/GOLD-Fire is pursuing, in a joint effort with the Committee on Earth Observing Satellites (CEOS) Working Group on Calibration and Validation (WGCV) Land Product Validation (LPV) subgroup, the coordinated validation of fire products by standardized protocols.

GOFC/GOLD-Fire is partnering with the Global Fire Monitoring Centre (GFMC), and the United Nations International Strategy for Disaster Reduction (ISDR) Working Group 4 on Wildland Fire

The speed of obtaining and disseminating fire information is dictated, to a large extent, by the fire monitoring systems that are reviewed in a separate paper in this book (Gregoire et al. 2000). The accuracy of fire information is a common concern for all user groups that is determined primarily by fire detection algorithms, which are the subject of this paper. The accuracy is measured in terms of levels of both commission and omission errors and the location of fires detected that should be well defined and documented.
Remote sensing of fires has been achieved using a variety of space-borne systems/sensors. The most widely used sensor for long-term and large-scale fire monitoring is the Advanced Very High Resolution Radiometer (AVHRR) aboard the National Oceanic and Atmospheric Administration's (NOAA) polar orbiting satellites [Flannigan and Vonder Haar 1986; Kaufman et al., 1990a; Arino and Mellinotte 1998; Justice et al. 1996; Li et al. 1997]. Measurements from many other sensors have also been employed such as GOES [Menzel et al., 1991; Prins and Menzel, 1994], LANDSAT [Chuvieco and Congalton, 1988], DMSP [Cahoon et al., 1992], ATSR (Arino and Rosaz, 1999), and in the recently launched MODIS (Kaufman et al., 1998a).

VIII.7.2 Developing of real-time monitoring systems of forest fire detection and forecast

The satellite remote sensing of fire began in the late 1970s (Croft, 1978; Matson et al., 1987). Since this time the global importance of fire has become internationally recognized. Fire has also escalated to the forefront in the global carbon budget discussions (e.g. Kurz et al., 1995; Kasischke et al., 1995; Stocks et al., 1998).

Based on experience of a large amount of work on the creation of regional sites for reception and processing of satellite information for purposes of a real-time monitoring of forest fires, the RF Ministry of Natural Resources (MPR) supported the project of the development and trial of the forest fire real-time monitoring system on the territory of the RF. The principal project participants are:

- Space Research Institute RAS;
- Centre for problems of ecology and productivity of forests RAS;
- Institute of Solar-Terrestrial Physics SB RAS;

The main goal of the project is: to create a single unified system for satellite monitoring of forest fires and their consequences on the territory of the RF as an ancillary tool among the traditional methods for detection, monitoring and management of forest fires. It is planned to use results from the project on both a regional and Federal level.

Today, to achieve the goal of the project, both ground-based data of aviation patrol and satellite data are used. Satellite information is represented by data from the NOAA weather satellites, as well as data from the EOS satellites (Terra and Aqua). The sites for reception and processing of satellite information are located in Moscow (Roshydromet), Moscow (SRI RAS, CB "Avialesookhrana), Irkutsk (Irkutsk Base of Aviation Protection of Forests), and Khabarovsk (FE RCRPSD). The meteorological data and the data on thunderstorm activity obtained recently in (**MSU**, Moscow) are used as well as. .

The main ministry that uses the information about forest fires in Russia is the Ministry of Natural Resources (MPR) (http://www.pripoda.ru).

The state forest departments and ministries together with branches of national economy that use the forest resources and/or being engaged in this activity are responsible for the forest fire protection functions in RF. Traditionally forest fire protection is being done in forest fire service, non-specialized branches of timber cutting, forest management and other enterprises.

A special place has been taken by specialized service – Aviation of forest fires protection **(“AVIALESOOKHRANA**”) (Pushkino) http://www.pushkino.aviales.ru.
Aviation forest protection is the composite part of the whole complex of activities on forest fire and insect protection. The 60% of the territory of Russia is under protection of “AVIALESOOKHRANA”. Aviation is used on the main part of this territory. Here aviation detects about 50% of fires and takes part in smoothing and removing of more then 30% of fires.
The structure of “AVIALESOOKHRANA” is as follows: 245 departments (avia branches, avia groups) and 9 mechanized detachments. The forest area of about 637,0 bln. is protected by the branches of „AVIALESOOKHRANA“. Each avia-branch serves one definite territory of forest (appr. 6 bln. hectare).

- Local subdivisions (aviabranches) of „AVIALESOOKHRANA“ ;
- Federal subdivisions (Regional avia-bases) „AVIALESOOKHRANA“ ;
- Central avia-base „AVIALESOOKHRANA“.

All data about forest fires received by aviation and ground methods are transferred to all organizations, which are interested in extinguishing the fires. They are:

- regional authorities,
- regional branches of Ministry for Emergency Situations (EMERCOM)
- Hydrometeocenter and
- mass media.

In Federal system of operational forest fire monitoring are two receiving stations (TACIS project). One station is located in Central base of Avia protection (Pushkino) and the second is located in Federal subdivisions (Irkutsk). All L1A, L1B satellite information belongs to these organizations. All the rights for thematic and results processing are reserved by designers from RAN, ISFZ, IKI.

VIII. 8 Data Policy Issues

In this paragraph we consider the data policy issues not only with respect to forest fire satellite and ground data, but with respect to more wide areas including vegetation and land use maps.

Satellite NOAA data

Ownership, privacy and confidentiality

Formally the data belong to NOAA (USA). But NOAA data are free for all users who have ground receiving station. The receiving telemetry belongs to users who got these data.
Ground stations are distributed among the following ministries and organisations:

- **ROSHYDROMET** (5 stations including: Moscow, Obninsk, Dolgoprudniy, Novosibirsk, Khabarovsk)
- Ministry of Natural Recourses (**MPR**):
  - (5 stations: Moscow, Yakutsk, Ekaterinburg, Astrakhan', Yuzno-Sakhalinsk)
  - 2 receiving stations in **"AVIALESOOKHRANA"** (Moscow, Irkutsk)
- Russian Academy of Sciences **(RAN**)
- Institute of Space Research(**IKI)**(Moscow)
- Institute of solar-terrestrial physics SB RAS **(ISFZ**) (Irkutsk)
- Institute of Atmospheric Optics SB RAS (**IAO**)(Tomsk)

and other commercial and educational institutions such as for example SCANEX and Tomsk state University.

In the Federal system of forest fire monitoring are two receiving stations (TACIS project). One station is located in **Central base of AVIALESOOKHRANA" (Pushkino)** and the second - in its **Federal subdivisions (Irkutsk).** All L1A, L1B satellite information belongs to these organizations. All the rights for the results of thematic processing are reserved by designers from RAN, ISFZ, and IKI.

<u>Standards and metadata</u>
Institute of solar terrestrial physics (Irkutsk) and Institute of Space Research (Moscow) using the L1B format have the biggest archive of NOAA telemetry in Russia. For fire detection AVHRR radiometer should have a spectral band in 3.75 mkm such as NOAA 12, 15, 16. The fire database is collected starting year 1994.

<u>Licensing and distribution</u>
NOAA users must have **ROSAVIACOSMOS** licence to deal with satellite information. The thematic results (maps of fire location) are distributed free to all users having emails and access to Internet.

<u>Pricing policy</u>
Overwhelming majority of NOAA users distribute NOAA telemetry (L1B) data free of charge. The cost on thematic processing (for example detecting forest fires) depends on data offers. The forest fires database of Russian territory produced by NOAA within 1994 –2002 distributed on a commercial base.

<u>Satellite EOS (MODIS) data</u>

<u>Ownership, privacy and confidentiality</u>
In case of MODIS, NOAA data are free and no restrictions on their use. In Federal operational system the MODIS "hot spots" received from NASA and University of Maryland, USA (WWW site - http://rapidresponse.umd.edu/) are used. The reference is obligatory on the source of data.

<u>Standards and metadata</u>
Standards on thematic results of EOS/MODIS produced by NASA & University of Maryland, (USA).

<u>Licensing and distribution</u>
The data are transfer on base of agreement included in the document «Development of an Integrated System of Ground-, Air- and Space-based Observations of Biomass Burning in Northern Eurasia». The latter is submitted to NASA Land Cover Land Use Change Program in support of the Northern Eurasian Earth Science Partnership Initiative (NEESPI).

<u>Pricing policy</u>
The data are free. But the payment is only for using NET.

<u>Forest fires ground base data</u>

<u>Ownership, privacy and confidentiality</u>

There is no free access to this data. There has been archive on the whole territory of Russia since 50-es last century. The authenticity of such characteristics as burned area, starting and finishing fire data is the reason for re-examination according to other sources. Data representation is 80%.

Standards and metadata

All ground information about fixed forest fires is gathered daily in central control spot of **"AVIALESOOKHRANA"** and is transferred to Emergency situation centres **of MPR** and to **EMERCOM**. Each fire has an identification number. The information is added daily during all forest fire season. The accuracy of fire location is determined during fire observation by avia navigation appliances and also by ground descriptions.
Table 8.3 gives an example of records in fire database in **"AVIALESOOKHRANA"**

GOD	BZO	ROLH	LESN	OKPO	PRINAD	ZONA	REGION	SGF	SN	DGF	DN	TI	NP	ME	DE	CH	MI	S	PLOB		VE	K	P	RASTN	RASTM	RASTP	P	P	[illegible]
2002	120101	0122	0	00977858	7	2	0	52	16	104	25		14	6	7	18	15	3		0.01	3	2	4	3.0	0.1	0.2	0	1	1
2002	120101		0	00977858	7	2	0	52	16	104	26		31	9	24	14	15	3		0.10	10	2	4	2.0	0.0	0.0	0	1	1
2002	120101		0	00977858	7	2	0	52	16	104	26		32	9	25	9	0	3		0.01	4	2	4	2.0	0.0	0.0	0	1	1
2002	120101		0	00977858	7	2	0	52	16	104	26		33	9	25	12	10	3		0.04	4	2	4	2.0	0.0	0.0	0	1	1
2002	120101		0	00977858	7	2	0	52	16	104	26		34	9	25	17	10	3		0.03	4	2	4	2.0	0.0	0.0	0	1	1

Table 8.3
The fire database exists both in digital and hard copy formats.

Licensing and distribution

The Data can be spread to all organizations dealing with extinguishing and to all authorities.

Meteorological data

Ownership, privacy and confidentiality

All rights are reserved by ROSHYDROMET (regional centres - **HYDROMETCENTERs).** There exist several Internet sites where meteorological data are free.
http://meteo.infospace.ru
http://www.gismeteo.ru
http://hmc.hydromet.ru/
The reference to using data is necessary. To receive forecast for more that 10 days special registration and permission of **HYDROMETCENTER** is necessary.

Standards and metadata:

The meteo standards data correspond to WMO. The data of lightning direction finder are spread in the formed of ASCII format through the Internet. The data are not certified.

Pricing policy

The pricing policy of meteodata distribution is not clear. For example, there exists license fee for meteorological data (current data without time delay, 3 days forecast, 10 days forecast). At the same time this data are available free through Internet!

Vegetation, Land use maps

Ownership, privacy and confidentiality

The vegetation cover on Russia territory is done on the base of SPOT Vegetation data by Institute of Environment and Sustainability of JRC, Italy (http://www.gvm.sai.jrc.it/) in 1:1000000 scale.

Standards and metadata

The vegetation cover is classified into 22 types according to LCCS (Land Cover Classification
System - Antonio Di Gregorio, FAO)

Licensing and distribution

Data are available through Internet.

Forestry plans

Ownership, privacy and confidentiality

The system of presentation is forestry quarters. The representation is in map and plans in paper standard in the scale 1:10000, 1:50000. The statute of limitation of these data is from 10 to 20 years. All the information in 1:100000 scales can be found in the Central archive of Forest Department. The maps of smaller scales are kept in regional forestry.

Standards and metadata

The digital formats of forestry quarters are done in different formats by different organizations. The digital cover of Russia territory is done not evenly. The largest part of the material is done in logical coordinates. All forestry information corresponds ROSKARTGRAPHIA standards.

Licensing and distribution

To do this work on renewing forest husbandry license of ROSKARTGRAPHIA and 5 years experience are demanded.

Topographic/population maps

Ownership, privacy and confidentiality

All topographical information in Russia above 1:200000 scale is available not free. The scales 1:500000, 1:1000000 ? 1:2500000 are usually used. The digital maps don't have the information about the number of population or suffer form inaccuracies.

Standards and metadata

All topographical information is represented in digital formats together with any GIS.

Pricing policy

All information is available for fee.

Shared Information system of forest fires observation from satellites

Institute of Space Research (Moscow), Institute of solar-terrestrial physics (Irkutsk), International forest Institute and Maryland University have designed and are developing at the moment the system on **Operative forest fire monitoring on a base of satellite data**.
http://www.irkutsk.aviales.ru/engl/main.htm
All information that presented on this site is free.

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IX. Sea Ice Monitoring

IX.1. The Northern Sea Route

An extensive ice monitoring and forecasting service has been built up in Russia over the last 50 years with a main objective to support navigation in the Northern Sea Route (**NSR**), offshore operations, climatic studies etc.

The **NSR** is a national Russian transport communication in the Arctic, lying in the inner sea waters or in the economic zone adjacent to the northern coastline of Russia and the archipelagos and the islands of the Russian Arctic. The NSR includes the routes suitable for the ice navigation confined in the west to the entries to the Novaya Zemlya straits and to the meridian north of Cape Desire; in the east, in the region of the Bering Strait. It extends over a distance of between 2200 and 2900 nautical miles along Russia's northern coastline. Transit distances between North Pacific and European ports are 35-60% less than the traditional southerly routes [Mulherin et al., 1996].

At present, the different ship routes in the **NSR** are classified into coastal, high-sea, high-latitude and near-pole routes (See Fig. 9.1 from Mulherin et al., 1996).

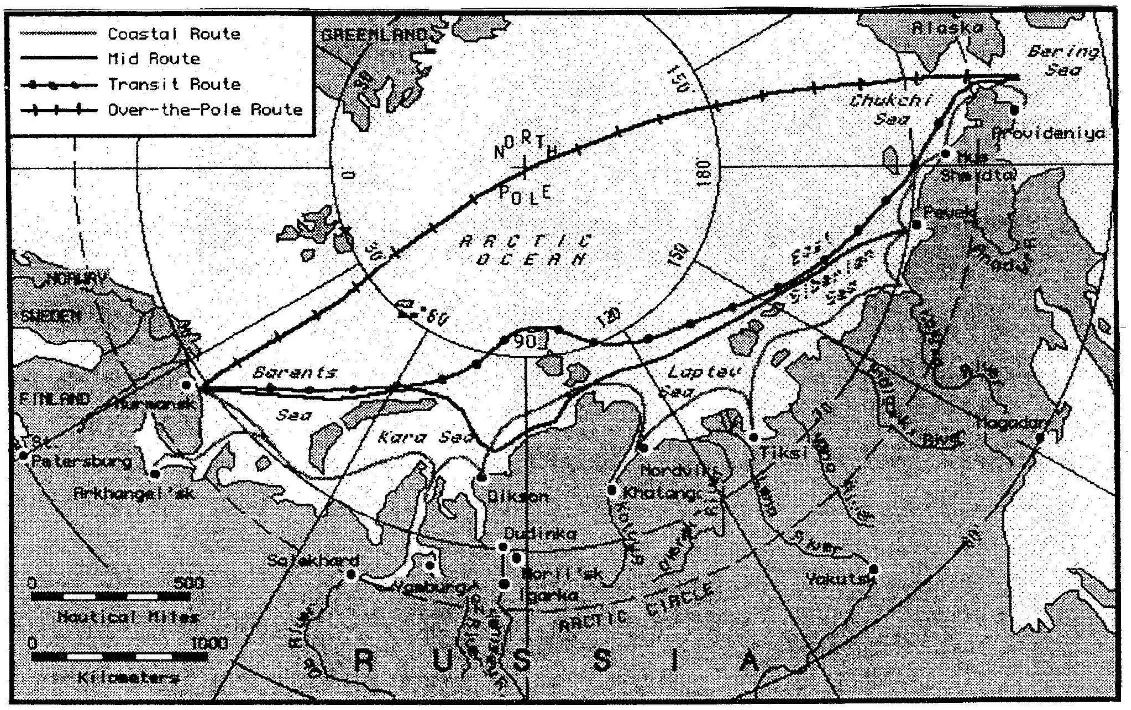

Fig.9.1 Map of the Northern Sea Route with the main sailing routes.

Of the various legs, only the westernmost to the port of Dudinka in Yenisey are normally used in late winter and spring. This route is kept open for transport of nickel from the major mining town of Norilsk. In years with difficult ice conditions, navigation along the whole NSR is only possible from about June to November, maybe until somewhat later (until February) in the western part.

The state supervision of the rational use of the NSR is realised by the **NSR** Administration (NSRA) of the Russian Federation Ministry of Transport. The NSRA executes its functions both directly and through special navigation services of the Murmansk and Far-East Shipping Companies - the so-called Marine Operations Headquarters (**MOH**) of the Western and Eastern regions of the Arctic respectively. The **MOH** directly carries out all sea ice operations along the **NSR**. For ensuring of safe and efficient navigation, protection of human life on the sea, prevention of marine environment from pollution by ships accurate and timely hydro meteorological information is required. Ensuring of safety in the arctic navigation stipulates for special demands for information about the distribution, conditions and dynamics of ice cover and on sea ice forecasts.

IX.2. Sea ice monitoring in the Northern Sea Route

Hydro meteorological and sea ice observations in the Northern Sea Route are very important for Russia because of the ship traffic that requires icebreaker support. The possibility to obtain integral ice distribution and ice dynamics pattern of the Arctic Ocean appeared after the beginning of the Arctic study from the aircrafts. In 1932, after establishment of the **NSRA**, the system of hydro meteorological navigation support was formed, including a Polar Aviation group for navigational air reconnaissance and the net of Polar stations. In 1938 a significant part of the Arctic seas was covered with visual air reconnaissance. The observations and mapping of sea ice in that period were carried out by means of visual methods. Ice observers estimated the main sea ice parameters, built ice chart onboard the aircraft and delivered them to serviced icebreakers and ships. Visual ice observations are subjective and quantitative estimates of sea ice parameters were not quite accurate. As a rule only 10-20% of studied area was observed, which leaded to significant errors in interpolation and extrapolation of sea ice boundaries.

Several major technological improvements of the ice observation capability were achieved in the 1960s. Side-Looking Airborne Radar (SLAR) "Toros", with a swath width of about 60 km, was constructed in 1968 especially for ice survey. SLAR surveys in the Arctic seas were carried out regularly since 1969 until 1991. In 1978 SLAR "Toros" was modernized: four polarizations (HH, VV, HV, VH) could be used for ice reconnaissance, and a special communication link for transmission of sea ice imagery to icebreakers was mounted. Experiments with multifrequency radar which operates in Ka, X, L, and UHF bands, conducted in 1992, revealed that use of these bands widens the radar capabilities for sea ice observations [Alexandrov et al., 1992].

Visible satellite images from the experimental system of meteorological satellites "Meteor" were used in sea ice monitoring since 1967. These images were received and processed in the regional centres for receiving, processing and transmission of meteorological information (Moscow, Novosibirsk, Khabarovsk), as well as in several autonomous centres. Since 1975 data from scanning visible (0.5-0.7 µµm) and IR (8-12 µm) radiometers mounted onboard meteorological satellites of the second generation "Meteor-2" were used for mapping sea ice in the Arctic. These images covered a swath of 2000 km wide, with a 2 km resolution for visible and 8 km for IR images. Information received in regime of direct transmission was used for operative tasks. "Meteor-3" system has been launched since 1987. Scanning visual radiometer (0.5 – 0,7 µm) with swath width of 2600 km was mounted onboard these satellites.

Side-Looking Radar images from the "Okean" satellites were widely used in sea ice monitoring since 1983 until 2000. A radio physical equipment which included side-looking radar with resolution of 2 km and wavelength 3.15 cm, and scanning microwave radiometer with resolution of 25 km and wavelength 0.8 cm, was mounted onboard these satellites together with a four-channel low resolution visible scanning radiometer [Mitnik, Viktorov, 1990]. The superposition of swaths for all sensors, formation, storage and transmission of all images as a joint still in APT mode are the main features of this facility. Radar satellite images were received in three regional centres (Moscow, Novosibirsk, and Khabarovsk) and in a number of receiving stations, located in different regions of the country and the Arctic coast.

Significant attention was paid to elaboration of image interpretation techniques and ice chart composition from various remote sensing data. The techniques of image interpretation were developed using subsatellite field experiments, when the results of image interpretation were compared with real sea ice conditions. The manuals on interpretation of sea ice conditions in Side-Looking Airborne and satellite radar, visible and Infra-Red images were issued [Bushuev, Bychenkov, 1976; Bushuev et al., 1983]. The techniques and technologies of preliminary and thematic processing of various satellite images and sea ice chart composition were elaborated, based on interactive image processing. The specialized software for interactive image interpretation and ice chart composition was elaborated at **AARI** (Arctic and Antarctic research Institute, St. Petersburg). The methodology of composition of photo mosaics from several sequential satellite images was elaborated at NPO “Planeta” [Mitnik, Viktorov, 1990].

A reorganization of the system of hydro meteorological support in the Arctic was done by means of putting “*Automated Ice Information System for the Arctic* (**AIISA)**” into operation. In 1983 the Commission of the Presidium of the Cabinet Council of USSR adopted a decision on creating this system, and appointed the State Committee of Hydrometeorology of USSR as a system customer, with AARI as a prime developer of the system [Frolov, 2002]. A conception of AIISA system envisaged unification, coordinated elaboration and functioning of the following main systems of hydro meteorological support:

information collection and receiving,

processing, analysis, hindcasts and forecasts,

distribution and transmission of information to users.

In 1986 the **AIISA** was put into pre-production operation, and the Centre of sea ice and hydro meteorological information was organized at **AARI**. In 1989 the first stage of the **AIISA** system was put into an operation and maintenance phase. Organizationally, the ice information system is based on a spatially-shared, regionally organized network for the collection, analysis and operational use of ice information with centres in Dikson, Tiksi and Pevek, and **AARI** engaged in studying problems with methodological supervision and coordination of efforts for problem-solving.

The composite sea ice charts of the Arctic Ocean are issued by the Ice Centre of **AARI** once per week. Their composition is based on a complex approach, when all available sea ice information is used, including data from satellite images, ships, icebreakers, drifting buoys and others. This information is analyzed by experienced ice experts with the use of modern hardware and special software developed at AARI [Smirnov et al., 2000]. AVHRR NOAA images in visible and IR bands with 1.1 km resolution regularly received by the Ice Centre, as well as visible band images from TERRA satellite (250 m resolution), are used in ice chart composition. The detailed ice maps are composed for selected regions to support concrete marine operations. RADARSAT and ERS SAR images were occasionally used during the implementation of several demonstration projects.

The **AIISA** system has a module for analysis and forecasting sea ice and hydro meteorological conditions. Stochastic and hydrodynamic models for predicting ice cover distribution from 1-7 days up to 3-6 months have been developed and are currently in use. Short-term (1-3 days) and medium-term (7-8 days) meteorological and ice forecasts are prepared. Ice data are presented in digital form in the regular grid points to solve operative and research tasks of forecast and analysis with the help of numerical methods. A numerical model for the evaluation of ice-routing, with due regard to actual or predicted ice information and technical characteristics of icebreakers and ships, has also been developed [Mironov et al., 2002].

Nevertheless, the contemporary state of hydro meteorological support in the Arctic is characterized by significant **negative tendencies**. The following negative changes happened in the main system for receiving information [Frolov, 2002]:

- the regular aerial ice surveys in the Arctic are absent since 1992;
- the drifting stations “North Pole” were not organized in the period since 1991 until 2002;
- the state budget practically does not fund organization of the complex Arctic marine expeditions;
- at present time the information from Russian satellites, which is necessary for mapping sea ice conditions in the Arctic and Antarctic, is completely absent,
- total amount of ground-based Polar Stations in the Arctic was reduced more than twice;
- the funding for supporting technical equipment of the Polar Stations is absent.

The negative changes in the Northern Sea Route also include absence of the coordinating power structure, which would be responsible for the development of the Arctic region (liquidation of Goskomsever, uncertainty in the areas of responsibility in the Ministry of

Marine Fleet, between the Northern Sea Route Administration and joint-stock shipping companies, the abolishment of the Arctic and Antarctic Marine Administration in the State Committee for Hydrometeorology, an abeyance of operation of the Interdepartmental Committee on the Arctic and Antarctic, and others).

IX.3. User requirements to sea ice information

The most important part of the navigation ice information is the navigation ice reconnaissance and mapping of sea ice. The Marine Operations Headquarters, depending on the purpose, tasks and objectives, divides the navigation ice reconnaissance into [Johannessen et al., 1997]:

- strategic (survey);
- operative;
- tactical.

The strategic (survey) ice information is used by the NSRA and MOHs to plan the fleet operation. The basic means of the strategic ice reconnaissance are space-borne devices with a low resolution (~5-10 km local) and maximum viewing bandwidth. The satellite data of higher resolution as well as the data from other sources can be used as additional information to obtain more detailed estimates of sea ice parameters. The strategic (survey) ice reconnaissance covers all water basins of the NSR routes, including the Barents and Bering Seas as well as the near-pole regions. Maps of different scales (1:5 mill, 1:7 mill, 1:2 mill) in azimuthal or conical projection are used as cartographic basis for plotting of the survey ice maps. The survey ice maps are usually plotted with a frequency of once in 10 days, in winter they may be drawn with the frequency once in a month.

These maps contain information on the location of the ice boundary and that of the open water, the boundaries of the fast ice zone and recurring flaw polynyas, the boundaries of ice massives and fields of different age (thickness) and concentration. In accordance with the scale of the chosen cartographic basis, the data of the survey ice maps should be averaged. The spatial scale of averaging of the ice cover characteristics constitutes from several thousand to tens of thousand square miles. The distance between the graphic elements (location of the boundaries of inhomogeneous ice and open water areas) on the map usually reaches from ten to hundreds of miles.

The operative ice maps and ice forecasts are transmitted to all the icebreakers and ships in relation to the region of their work. With the help of this information the navigators correct the routes, plan and take measures to ensure the safety of ice navigation. The finished-off operative maps are used in plotting of the composite ice maps, and for scientific-research purposes - to systematise the data on the regime characteristics of the navigation routes, to study general and regional laws of the ice regime.

Data sources of the operative ice reconnaissance are: satellites with an increased resolution (within tens or hundreds of meters local), the data of observations at polar stations, ships, and the data of expeditions. The contribution of the data of ice observations from polar stations and expeditions is quite negligible. The additional information includes weather forecasts from 1-3 to 7-10 days in advance; ice forecasts - the ice re-distribution, drifting and compression - 3 to 7 days in advance.

The operative ice reconnaissance is carried out in the period of navigation. This reconnaissance covers the areas of the arctic seas within the NSR routes on which concrete sea operations are executed. The results of the operative ice reconnaissance are formed as operative ice maps. Maps of the scale from 1: 2 mill to 1:7 mill of Mercator's or conical projection serve the cartographic basis for the operative ice maps. The operative ice maps are usually plotted with the periodicity once every 2-3 days, 5 days at most. The operative ice maps contain much more navigation-significant characteristics of the ice cover compared to the composite ice maps and include the following information: location of the ice and open water boundaries; the fast ice boundaries with an allocation of the areas of ice of different age (thickness), hummocking and destruction; flaw polynyas and clearings; the boundaries of ice fields of different thickness (age) and concentration; fractures and diffusion in more compact ice masses; orientation and extent of fractures, systems of cracks as well as individual cracks; the amount of prevailing forms of ice in points, separate huge or vast ice fields among smaller ice forms; local sites of increased hummocking, hummock ridges, grounded hummocks and icebergs; localisation of the zones of various orientation and compression in the ice cover; characteristics of the snow cover or destruction of the ice cover; man-made canals in the ice.

Major customers and users of the data of the tactical ice reconnaissance are the navigators of the icebreakers and ships. The tactical ice reconnaissance is carried out episodically in the process of accomplishment of each concrete sea operation - ship or convoy steering, autonomous voyage of the ice-breaker, cargo operations away from the ports (ship - shore, ship - ship). The main goal of the tactical ice reconnaissance is to choose an optimal route of ice navigation, that is, the route which with the lowest expenditures of time and power resources provides the utmost safety of ice navigation.

At present time the major source of the data for the tactical ice reconnaissance could be high-resolution SAR imagery. The best result from the realisation of the data of the tactic ice reconnaissance is reached when it coincides with the accomplishment of sea operation in real time. Permissible delays in the data delivery should not exceed several hours. An experience in using of the images of the SLR “Nit’ “ and high-resolution satellites (from several meters to hundreds of meters local) has shown that the original images supplemented with the co-ordinate grid and shore outlines are sufficient to solve most of the tactical problems of navigation. The efficient use of such images depends on the resolution of the source of data and the quality of data receiving.

The requirements to strategic, operative and tactical sea ice information are summarised in Table 9.1.

	Strategic	Operative	Tactical
Users	NSRA, MOH	MOH, captains	Captains
Coverage	Global (the whole NSR)	Regional	Local
Spatial resolution	~ 10 km	< 1 - 2 km	< 100 m
Time delay	10 days	2 - 3 days	2 - 3 hours
Scale of ice chart	1:7 000 000 1:5 000 000 1:2 000 000	1:7 000 000 1:5 000 000 1:2 000 000	1:500 000 1:200 000

Table 9.1 Summary of requirements to sea ice information for ice navigation

Satellite imagery is the main source of information for obtaining strategic and operative sea ice information. Composite ice charts of the Arctic Ocean for strategic purposes are issued by AARI once per week. The main source of information for their composition is images from Meteor and NOAA satellites. From the formal point of view these charts satisfy user requirements for strategic ice information due to their coverage, spatial and temporal resolution. Nevertheless, in practice some areas of the Arctic Ocean cannot be covered with satellite images because of the following reasons:

- Sea ice information cannot be retrieved from Meteor and NOAA images in cloud conditions;
- Information from visible images cannot be obtained in winter due to lack of visibility;
- Information from IR images can be retrieved only when the temperature falls below (-10) degrees Centigrade;

The operative ice charts are characterised by the same disadvantages as strategic ice charts. User requirements to spatial and temporal resolution for operative ice charts are more strict than that for strategic ones. In our opinion, at present time these requirements can be satisfied with the use of Radarsat ScanSAR images.

During the last years **NERSC in Bergen**, **NIERSC in St.Petersburg** and **Murmansk Shipping Company** carried out pilot projects aimed at using high-resolution satellite SAR images for support of icebreakers with tactical sea ice information [Johannessen and Sandven, 1992; Johannessen et al., 1994; Johannessen et al., 1995; Alexandrov et al., 1998; Pettersson et al., 1999]. In these projects geolocated SAR images with overlaid grid of geographical co-ordinates were transmitted to the icebreakers of Murmansk Shipping Company in quasi-real time and proved high effectiveness for selection of optimal ship route. Nevertheless, it is impossible to supply all ships in the Northern Sea Route with quasi-real time SAR images because of the gaps in spatial coverage of ERS SAR images.
Radarsat ScanSAR images should be used for the tactical purposes, but even these images cannot support all ships in the Northern Sea Route with 2 - 3 hours time delay. Therefore during subsatellite experiment it will be useful to estimate the possibility of using Radarsat ScanSAR images for the tactical purposes with larger time delay after satellite overpass.
The possibilities of different satellites to satisfy user requirements for strategic, operative and tactical ice information are presented in Table 9.2 [Sandven et al., 1999].

Sensor	Strategic	Operative	Tactical
SSM/I	Satisfy requirements	Poor spatial resolution	Can be used if there is no other possibility
Visible / IR (NOAA, Meteor)	Satisfy requirements	Satisfy requirements	Can be useful when received onboard the ship
ERS SAR	Can be used for detalisation of ice charts	Can be used if sufficient coverage is supplied	Satisfy requirements if transmitted to icebreaker in real time
RADARSAT SAR	Scansar satisfies all requirements	Scansar satisfies all requirements	Satisfy all requirements if transmitted to icebreaker in real time

Table 9.2 Use of satellite images for obtaining strategic, operative and tactical sea ice information

The major use of sea ice information is to optimize ship operations, both with respect to time and energy consumed by operations, to obtain the safest possible navigation and hence to reduce the risk for damage of escorted vessels. There is a need for detailed information in particular on the most hazardous sea ice phenomenon. This information includes ice edge location, ice type (or age) classification, ice movement, shear zones, leads, ice roughness and icebergs etc.

IX.4. Application of SAR data to sea ice monitoring

SAR images have proven to be capable of delivering much more information on sea ice conditions than currently used visible and IR images. Since 1991 ERS-1 SAR data have been introduced in ice monitoring in many research and demonstration projects around the world. The SAR has proven to be a very powerful instrument for sea ice observations and is at the stage to become the main instrument in operational sea ice monitoring. Systematic use of satellite SAR data can bring the quality of local and regional ice charts to a higher level and reduce the risks of damage and accidents caused by sea ice. Our previous studies have also shown that significant economical benefits could be obtained by using SAR images in Ice Routing. Estimated increase of the convoy speed in this case amounted to 20-30%.

SAR ice monitoring for the whole Arctic has been demonstrated by R. Kwok, showing unique results on ice convergence, divergence, freezing ice thickness distribution and seasonal ice growth. Operational ice services using SAR have been established on regional basis, but there are large areas of the Arctic Ocean that are not covered by such a service yet. There is no service in Europe that provides SAR data and derived products from the whole Arctic region. The Canadian RADARSAT, operational from 1996, was the first satellite with sea ice monitoring as a prime objective. It provides SAR data for operational ice services in countries like Canada, USA, Denmark/Greenland and Finland/Sweden. With RADARSAT data, a new era in operational ice monitoring by satellites has begun. ENVISAT will contribute with more SAR data, improving the SAR data supply for navigation support.

In Russia, there is a pressing demand for cloud and daylight independent, high resolution SAR data, to support sea ice monitoring, and other environmental studies. The European Commission financed the Project for the implementation of the ERS data acquisition and processing station at Research Centre for Earth Operative Monitoring (NtsOMZ), Moscow, which lasted for 6 months from June to December 2001. During this period the ERS SAR ground station was installed at NTs OMZ quarters in Moscow. After the Project is finished, the system became operational and the antenna coverage reaches mid-Novaya Zemlya in the North, river Ob in the east, northern Caspian Sea in the south and France in the west (Fig. 9.2).

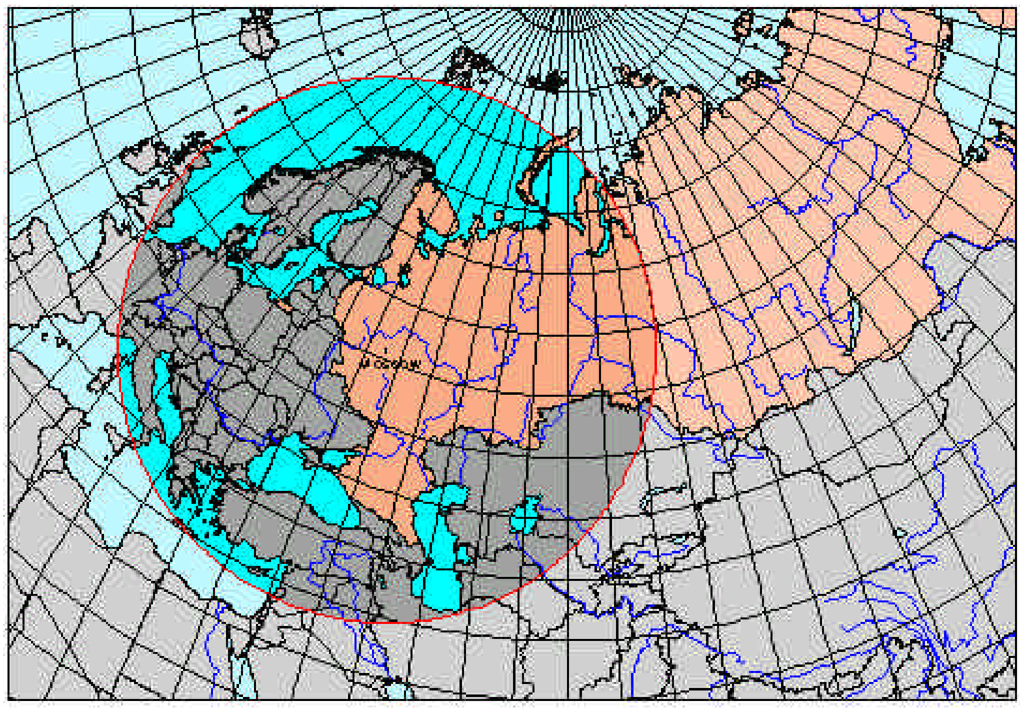

Fig. 9.2 Moscow ERS ground station antenna coverage

The proposal for ERS station deployment in Siberia was elaborated. In 2002 the scientific pilot project"Monitoring sea ice conditions in the NSR" has been fulfilled. During the project implementation series of ERS-2 SAR images have been acquired by Moscow receiving station, processed and transmitted to MOH of Murmansk Shipping Company.

It is foreseen that SAR images can be received directly by customers working at sea provided that the images are processed onboard the satellite, and derived products can be transmitted to the vessels and platforms in near-real time. The benefits of using SAR data onboard ships are not only related to safety but also can improve efficiency and time saving which has considerable economic importance. It is the requirement from several captains that future ice information should be included into electronic charts and be displayed together with bathimetric data and other relevant information on one terminal on the bridge.

The focus of the development of sea ice monitoring service should include implementation of SAR data as an addition to satellite data in visible and IR bands. The Main EO data will be SAR from ENVISAT and RADARSAT, supported by scatterometer products and other EO-data. Based on SAR data from ENVISAT/RADARSAT a number of products can be provided such as high-resolution maps of ice extent, concentration, age, freezing rate, deformation/ridging, drift, leads, and polynyas as well as processes in the marginal ice zone related to wind, waves, eddies, freezing and melting. The scheme of data flow in the operational system of sea ice monitoring with inclusion of SAR data is presented in Fig. 9.3. The maps can be provided for the whole Arctic Ocean, on regional and local scale at time intervals from daily to weekly coverage. The scatterometer products from Quickscat allow monitoring of the multiyear ice boundary. When CRYOSAT data becomes available in 2004-2005, Arctic ice thickness data will be incorporated as a new element in ice monitoring. The microwave satellite products will be integrated with existing marine and climate observing and modelling systems.

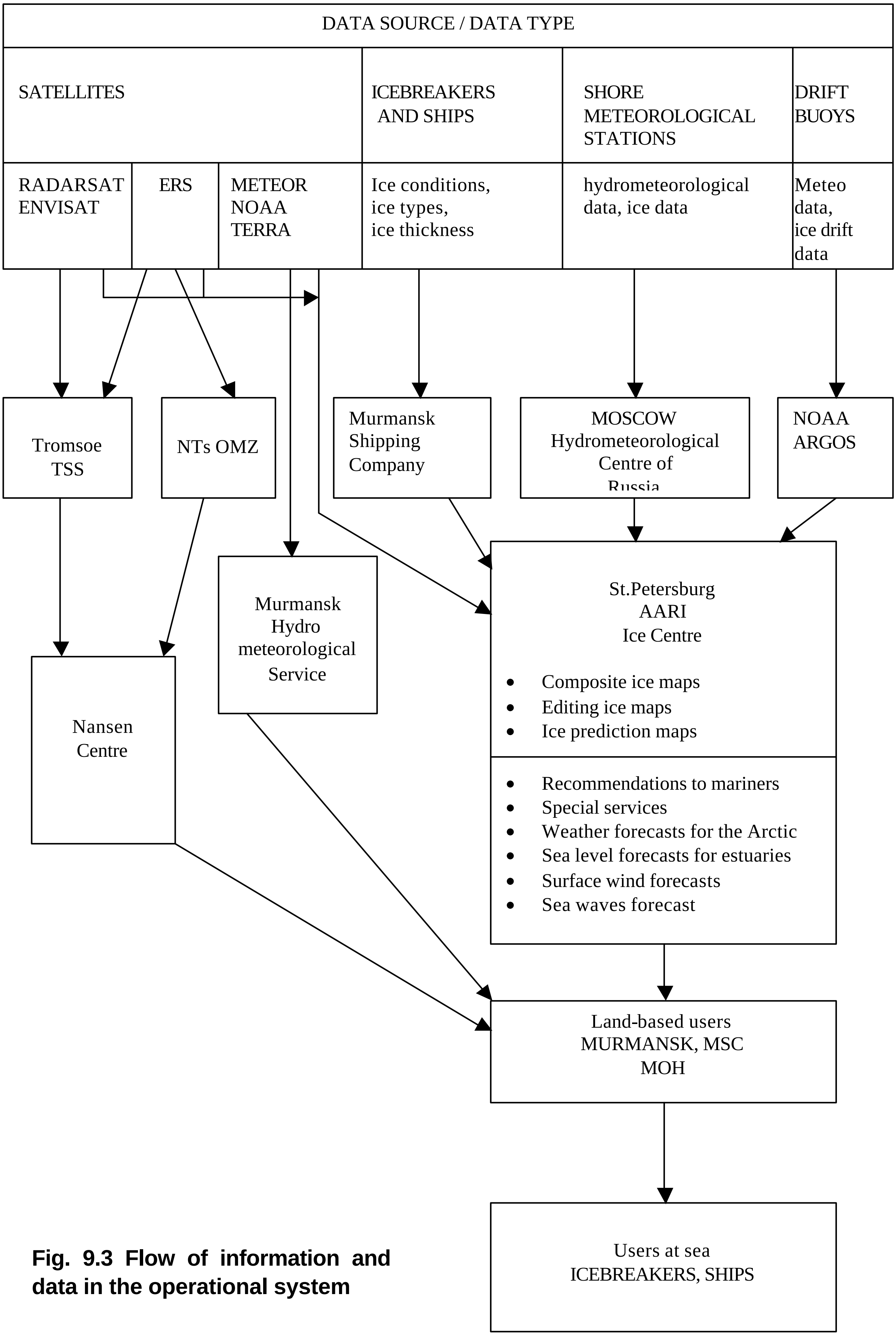

Fig. 9.3 Flow of information and data in the operational system

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X. GMES-Russia network component

X.1 Preliminaries

One of the critical topics existing at the moment between Russia and EU is the problem of miscommunication. Most people and research & technology organizations from both sides don't know the real expertise of each other. While the main goal of the GMES RUSSIA Project is to establish the first network of key data providers and users between the European component of GMES and Russia then the real networking mechanism is important. It was initially suggested that the results of GMES-Russia Project will be published in the printed form and then distributed between both Russian and European organizations. However, the results and public discussions in the last GMES Forum (Athens, Greece, June 2003) have shown the great interest to closer communication and detailed information about data providers in Russia, results of their research, existing monitoring systems, etc. This actual information can be given only by the data providers themselves. That is why the idea to establish self sufficient networking between different organizations was discussed during the GMES-Russia Project meeting which took place in September, 2003 (St. Petersburg, Russia).

The GMES RUSSIA project partners agreed to establish one or few Internet portals where data providers and interested organizations could send information to store it as open database.

The **GMES-Russia Database** and server should provide information about both GMES activities and the goals of the GMES-Russia Project. Russian WEB site portal should be localized to be understood by Russians. The role of the WEB site is to promote EU and GMES activities between Russian organizations and help them in understanding of the role of GMES as a whole. Each organization and or single researcher could provide information about their activity, data and information products they have and the complete addressing information as well. The first version of the GMES-Russia Database server was established in Novosibirsk, Russia, and can be reached under the URL address:

http://www.giscenter.ru/GMES

Fig.10.1 shows how the home page looks like

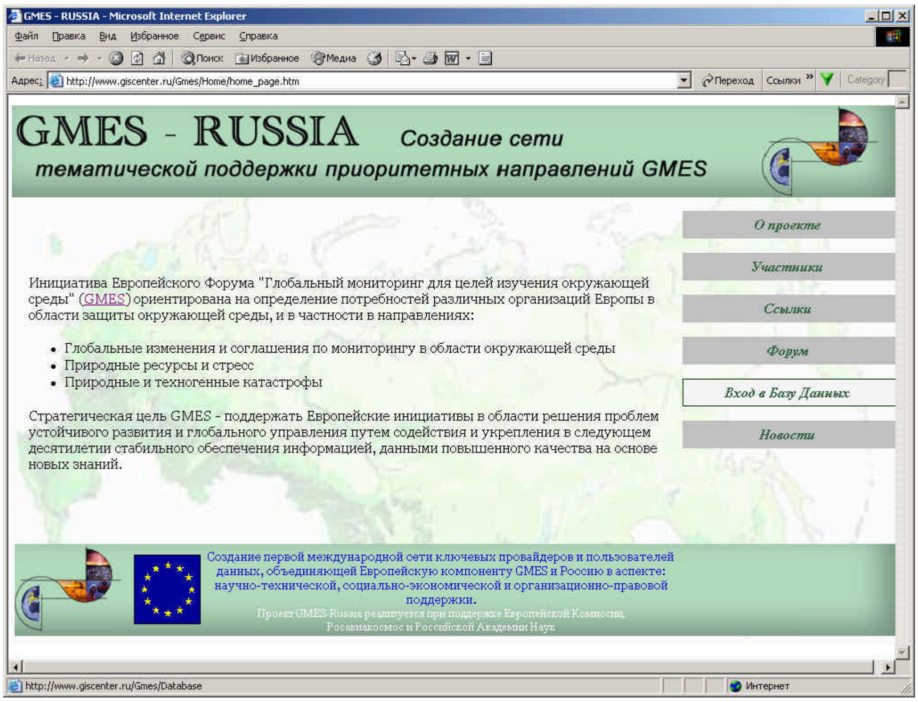

Fig.10.1 GMES RUSSIA Home page(Russian)

The Database contains records in a metadata form (according to the ISO 23950 Standard). There are three main blocks of data collected in the database: (see Fig.10.2)

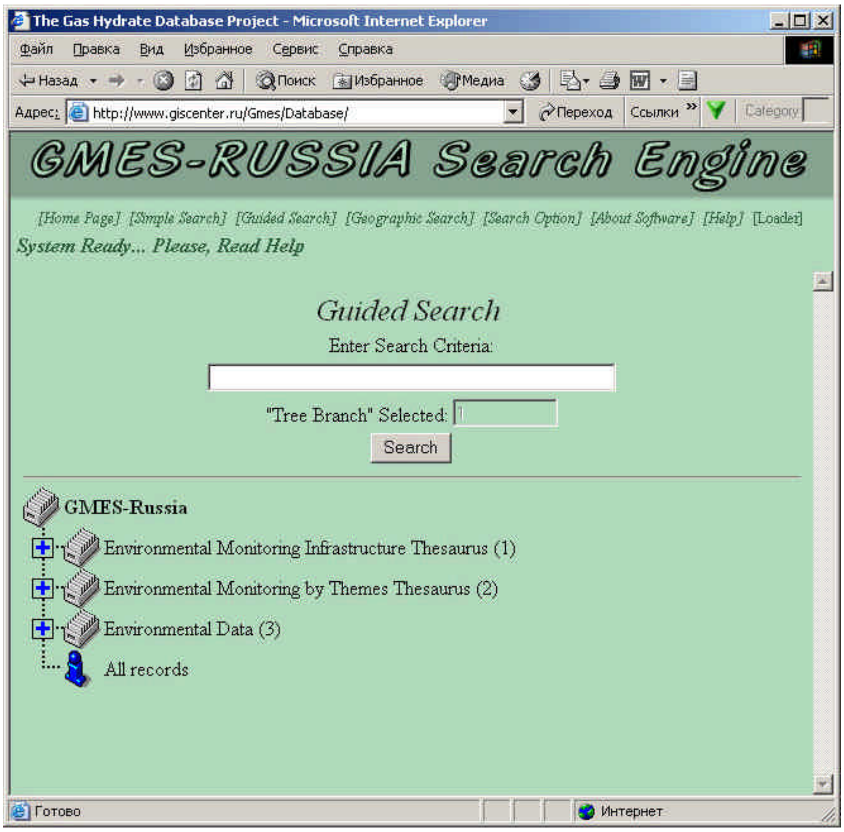

Fig.10.2 Main blocks of data collection

- Environmental Monitoring Infrastructure
- Environmental Monitoring by Specific Areas of the Research and Technology
- Environmental Data

The simple and flexible metadata protocol (see detail description below) allows enter all required information to the database. The remote (client-side) interface allows enter records for the registered Database users. The registration is allowed for free for any research, commercial, etc. organization. The language of the User Interface is English, and the link to Database could be established in any European WEB site:
http://www.giscenter.ru/Gmes/Database/

X.2 General information about the Database system

The GMES-Russia Database is operational on a so-called "fully relational, client-server system". It means that the installed server software assures the access to the database from any computer connected to the internet and having a web browser.

The design of the system is based on distributed database concept, best described as "hub and spoke". The advantages of this conceptual system could be formulated as follows:

- The data input is open for everybody, although standardized. The data will consequently be submitted from the entire scientific community.
- The distributed structure of the database system, linking several remote data collection sites is an optimal system for interactive data retrieval and exchange.
- The term "hub and spoke" refers to how the conceptual system components interact to create the distributed database system. Just as in the case of a wheel, there is the need to have a central "hub" or portal where the information that should be managed

is coordinated. This portal essentially contains the connections (links) to the individual "spokes" or participating data providers. Fig.10.3 illustrates the idea of the "hub and spoke" design principle

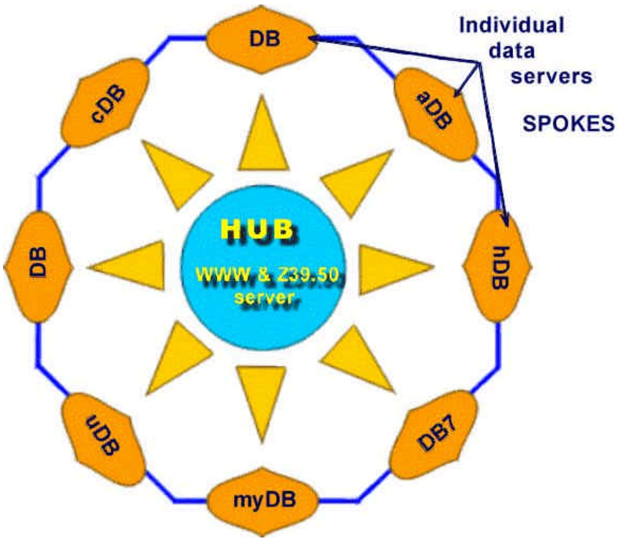

Fig. 10.3 The 'hub and spoke" design principle.

The central portal ("hub") that coordinates the information at meta-data level combines WWW. It is hosted by the Novosibirsk Regional Centre of GI Technologies for SB RAS (Novosibirsk, Russia) and some mirrors are to be established soon in both Russia and Europe.

Individual data components ("spokes") that contain [meta]database(s) are located on the remote systems of each partner; the latter being responsible for the data provided to the system, for local data entry and quality assurance. Each spoke operator populates the database and whenever new data sets are introduced or updated, the meta information is automatically being sent to the hub portal.

X.3 Navigating through the Database

The structure of the GMES-Russia Database allows navigate through the data in different ways, making it convenient for a wide range of users. When entering the Database Search Engine, the user can choose between the following three options:

permits to search the whole Database by entering criteria

allows navigating through the index-tree structure of the Database

is a GIS based search of data for a specific area

- The "Simple search" is intended for the user who knows what he is looking for, and who wants to do a sampling of all data using a specific keyword, or to search by criteria - a combination of several keywords or a name of a geographic location.
- The "Guided search" allows the user to navigate through the index-tree structure of the Database. The user will be guided towards the data along different GMES related research disciplines and subsidiary research topics up to records stored in the deepest level. It offers also searching by criteria within records of the selected structural level.
- The "Geographic search" is based on a specially designed Geographical Information System (GIS) where the spatially related data records and locations of

the referenced organizations are shown. It offers a wide range of map tools as zooming, dragging, moving of the map centre etc. and allows searching of data within a chosen area or single point.

The result of the search will tell how many datasets on the requested topic have been found in the GMES-Russia Database displaying them in series of ten by title only as it's shown below. The user can then browse the records describing the tagged datasets, and select and retrieve the data of interest to him. Fig.10.4 illustrates how search results could be displayed.

	Title	
1	Thermodynamic properties of gas hydrates.	View
2	......	View
10	......	View

Next

Fig.10.4 Example of the search results displaying

There is an opportunity to Refine Search within the Dataset by entering additional criteria.

<u>Format of the stored data</u>

The data stored in the GMES-Russia Database are of a very heterogeneous type, emanating from three main topics: infrastructure, thematic research, and data. The structure of the database allows this diversity, and at the same time it will confront the user with a single record format. All datasets are represented by a uniform record (metadata record), which contains basic information such as producers of data, description, reference to publication, etc.

When pushing the "View" button, the record is displayed by default option of "Main info" (see below) or the full record information by choosing "Full info". Fig.10.5 illustrates the "View" function.

Main info fields:	***Full info fields:***
1. Record title: **Title** 2. Data description: **Abstract** 3. DATASET: **Links** 4. Producer of the data 5. Original date of data production 6. Reference to primary publication	1. Record title: **Title** 2. Data description: **Abstract** 3. DATASET: **Links** 4. Producer of the data 5. Original date of data production 6. Reference to primary publication 7. Language of Resource 8. Terms in tree structure 9. Keywords 10. Geographic information: • Bounding Coordinates • Name of geographic location 11. Reference to primary publication 12. Range of analysed variables 13. Constraints on usage of data

	14. Creator of this record 15. Reference publication used as record source 16. Date of Last Modification 17. Date of Review

Fig.10.5 The "View" function of the database

X.4 Data Search Interfaces

X.4.1 Simple Search

"Simple Search" Engine allows to search Database by entering one or few search criteria. It works similar to many well known Internet search engines (http://www.google.com http://www.yahoo.com , etc.), except the search is performed in predefined Database.

The main advantages of the Simple Search option are:
- User doesn't need to know: "How database works?" "How and where data are stored?" "What field the database contains?", and so on …
- User doesn't need to know: "How to build query?"
- User uses simple, intuitive and vivid interface …

We omit enumerating of the possible disadvantages. Simple is simply …
There is one active window to start search. It contains one field to enter Your query (see, Fig.10.6)

Fig.10.6 Query Input Interface

... and two search options:

- Search within the whole record (by Default)
- Search within KeyWords, only (if checked)

By Default, the entered criteria will be used to search within the all fields of record available (All: Title, Abstract, etc.).
However, if you want to search fast, choose "Keywords" option. Case of this option, only specific field "Keywords" will be searched.
There are many ways to enter search criteria you want use. The most simple is "One word" or "One Phrase" search query.
Just type word or phrase you want, and push the Search button. System will try to find exact phrase you entered.
Another option is to use logical search. Current version of the Search Engine supports the logical "AND".
Just use + symbol in front of each word/phrase You entered.

X.4.2 Guided Search

One of the most useful and flexible engines of the GMES-Russia Database is the Guided Search Interface. It allows query information by the exact theme defined by the database hierarchy tree. Fig.10.7 – Fig.10.10 illustrate Guided Search Interface

Fig. 10.7 Guided Search Interface (organisations)

There are three levels of data hierarchy supported:
Environmental Monitoring Infrastructure, which contains the list of Russian organizations by the status:

- State Organizations of the Federal Level (Ministries, etc.)
- Regional Organizations
- Public Organizations (Foundations, Committees, etc.)
- Private Organizations (Companies)

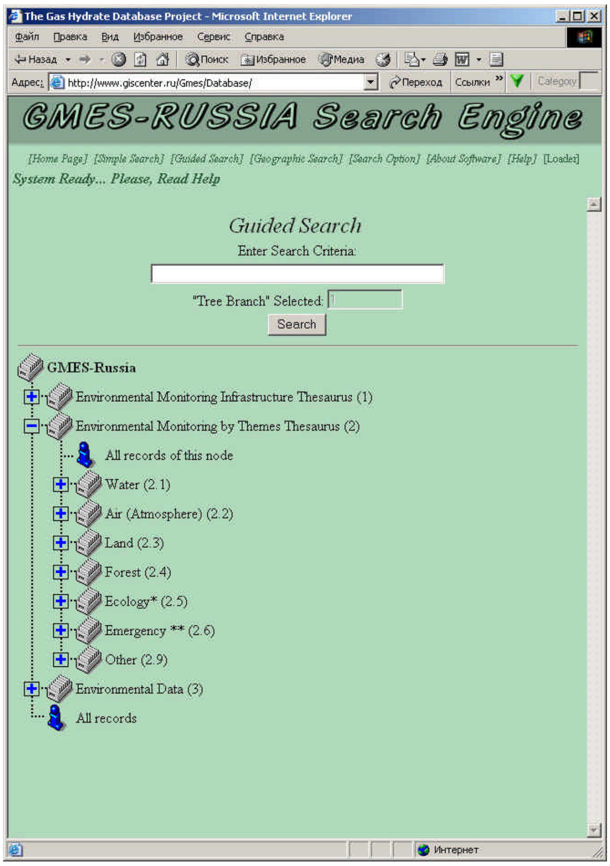

Fig.10.8 Guided Search Interface (Thematic areas)

Environmental Monitoring & Researches by the field and/or theme:

- Water related Researches and Monitoring
- Air (Atmosphere) related Researches and Monitoring
- Land (Land cover) related Researches and Monitoring
- Forest related Researches and Monitoring
- Ecology related Researches and Monitoring
- Emergency (catastrophic events) related Researches and Monitoring

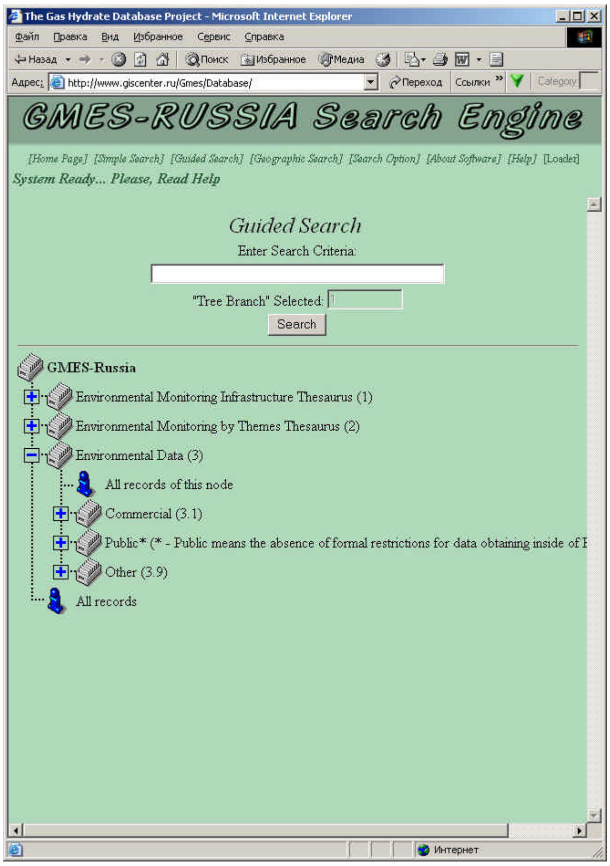

Fig.10.9 Guided Search Interface (Resources)

Environmental Monitoring Data:

- Commercial resources
- Public domain resources
- Other resources

The interface window allows check any appropriate branch of the Database hierarchy tree and then enter the search criteria. The search will be performed within the chosen branch only:

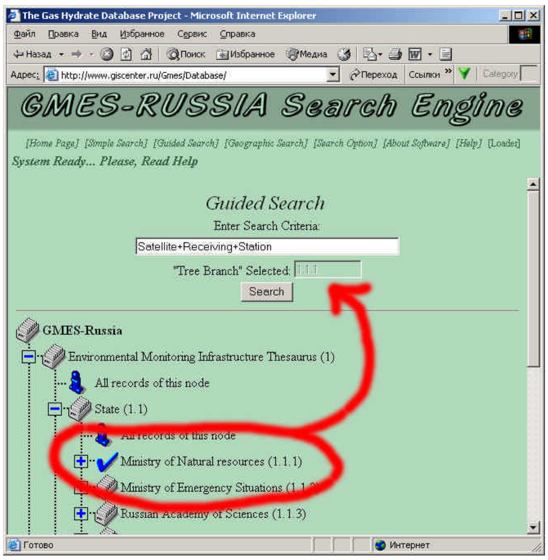

Fig.10.10 Guided Search Interface (choosing the tree branch)

X.4.3 Geographic Search

Any distributed network system with databases related to spatial data needs to perform the search by geographical parameters (spatial queries). The problem is how the query is "constructed" and how each database processes that query. The first means some step of processing which could be not strictly related to the searched data.

The traditional solution is to develop either geographical search "engine" within the each concrete database (GIS approach), or use exact fields with the spatial attributes within the database to answer query from external search.

Both solutions are quite complex case of existing database use. For example, there are many databases contained geographical names, only.

The appropriate solution could be to split the processes of spatial query formation and its transfer to real database. It means performing three major stages of querying (in general sense):

1. All complex procedures of navigation, overlaying, logical operations should be done within the separate tool (engine), which has some GIS functionality;
2. Generated Query should be "simplified" to either list of geographical names, or to the coordinates string;
3. "Simplified query" is to be send to the database directly or via specified Gateway Engine which is responsible for both query's compatibility (translation) and for the answer.

(See Fig.10.11)

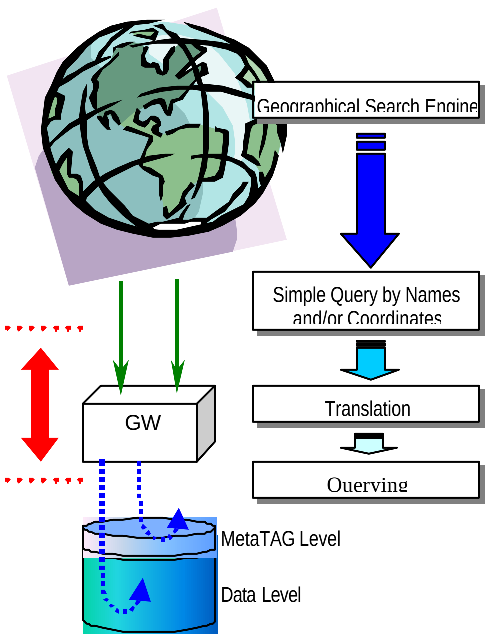

Fig. 10.11 Schematic "Data Query" Chart Flow

The conceptual advantages of the system are the following:

- System allows to make so complex spatial query as well as within geographic search engine functionality;
- System needs NO to be compatible with both each concrete DBMS and database structure (data formats, etc.).
- The Query result doesn't return to the initial search engine, so there are no problems with the "backward" compatibility. Query can be totally redirected.

The predicted disadvantages of the system could be:

- The independence of both GIS data and searched database data can produce the problem of synchronization;
- Each search operation performed by the two stages of query generation and processing.

Geographic Search Engine Technology

Client-Side system loads all map data once and processes it locally. The query is generated locally, also.

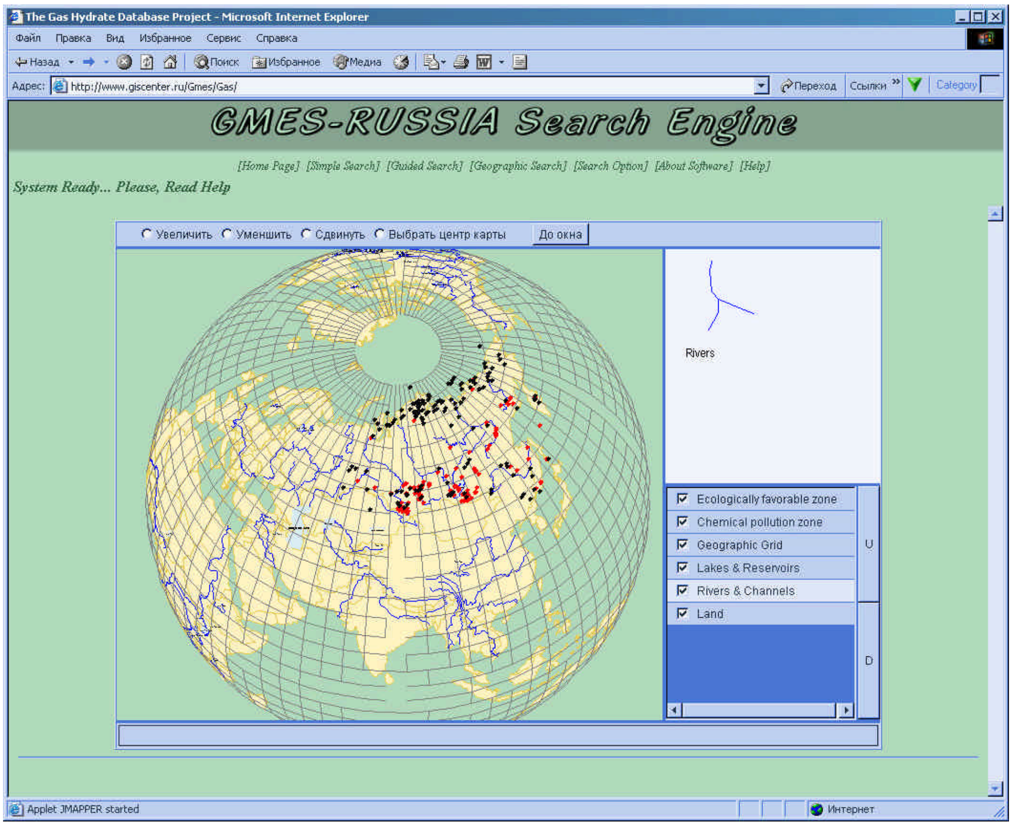

Fig.10.12 Geographic search (main menu)

Platform - Java Applet (JDK 1.1);
Data - ArcView GIS compressed Shape files (*.shp);
Technology - "Load Once";
Query Generation - Both coordinates & names based scripts;
Client- Standard MSIE or Netscape compatible Internet Browsers.

The following example illustrates the coordinates based query script:
http://www.giscenter.ru/Gas/Gas/geo/allres.asp?FRec=1&x1=30.122241333966425&y1=46.5147807529803&x2=41.672378180180985&y2=40.512561974536645

The interface describes local settings and changes language, automatically. If the local settings are unknown, then the default language is English.
The currently supported languages are:

- English
- Russian
- French
- Flemish

Any other European language could be supported also.
Figure 10.13 illustrates the automatic support with different languages during the geographic search.

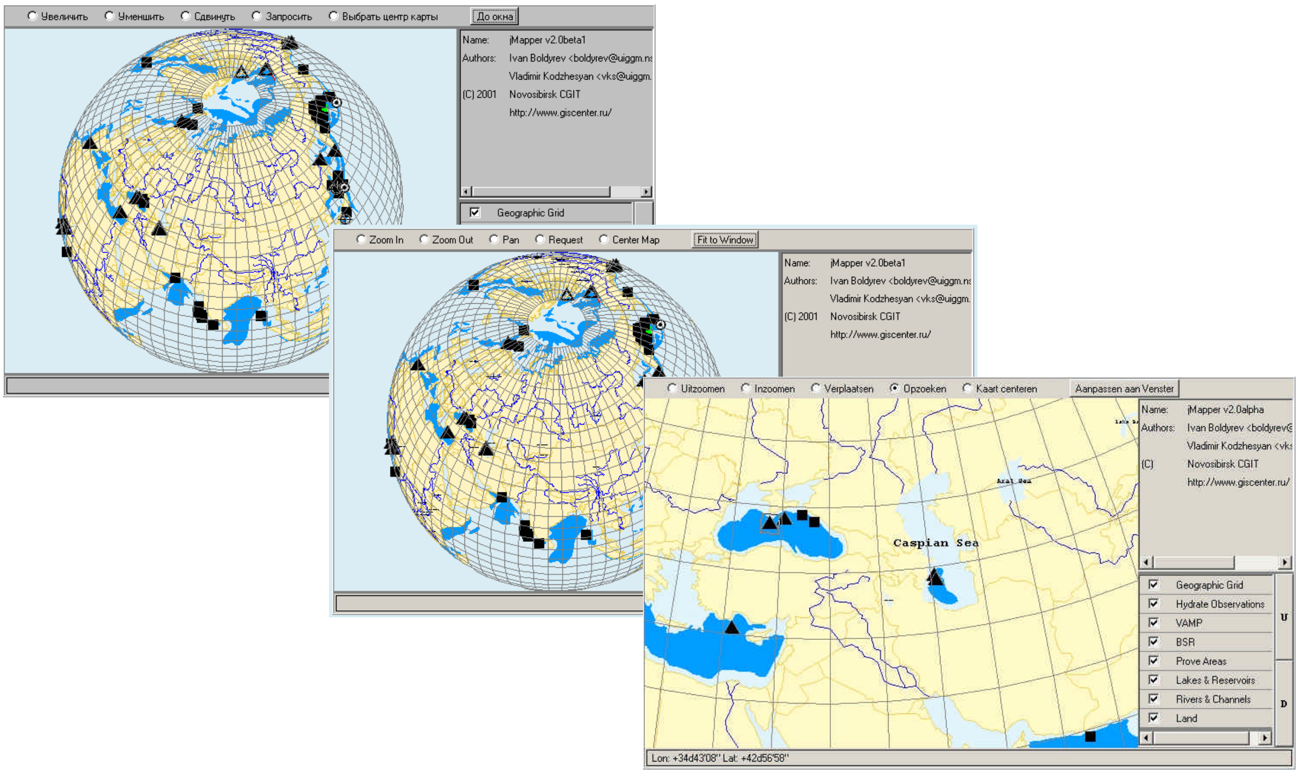

Fig.10.13 Geographic Search (Multilingual Interfaces)

X.5 Data Record Structure

Each database record consists of three main informational blocks:

- Record metadata file;
- Auxiliary documents and files;
- Linkages to the external resources;

Record metadata file:

This file contains following record's descriptive fields:

Record Title

Unique title of the record naming the general content of it;
Give in about 10-20 words the general content and topic of the data entered, and a geographic location if relevant. This Object Title should contain sufficient information to allow users to make an initial decision on likely relevance.

Record Description

Narrative description (50-200 words) containing information on the:
(1) general content of the dataset,
(2) how and when it was obtained,
(3) all parameters/attributes analyzed as data,
(4) specific features and characteristics related to the dataset, and
(5) results as it appears in the original data delivered (publication,)

Tree structure categories

Hierarchical tree of all thematic categories included to the Database.
Choose a category in each tree-structure level as a flow chart that best directs the user towards the considered dataset.
For example,
LEVEL 1:
(1) Environmental Monitoring Infrastructure
(2) Environmental Monitoring by Theme
(3) Environmental Data

Keywords

2 to 10 words (formally, You are not limited by number of keywords) or word groups that best describes the considered dataset randomly.

Producers of the Data

The name and affiliation of the persons or institutes that have produced the data originally (collected in the field, obtained in laboratory).
Name = family name and initial of first name
Affiliation (optional) = name of working place, address, phone and fax numbers, e-mail address

Other Persons associated with the Data

The name of persons associated to the dataset in any important way, but not belonging to the producers of the data.

Reference to the Primary Publication

In case the data have fully or partially been published, give the reference of the source publication.

Type of the Original data Resource

Description of the medium used for storage of the original and/or raw data. This can be a computer file, a tape, a computer database, and in some cases the primary publication (thesis, report, paper, etc.)

Original date of Data Production

The year (month and day too, if known) when the data was originally produced. This date is not the date of publication.

Language of the Data Resource

The language used in the resource-file containing the complete raw data and possibly linked to database. This is not (necessarily) the same as the language used in the journal where the data was published.

Range of analyzed variables (optional)

The range of the main variables (pressure, temperature, etc.) analyzed in the data resource.

Constraints on usage of data

Any constraints of usage of the provided data such as: "only with permission of data producer", "with mentioning of author name" and so on.

Creator of this record

The name and affiliation of the person or institute that prepared that filled in all the fields of this metadata record. This person is not necessarily the same as the producer of the data itself.

Reference to the Source

In case not the original publication was used for creating this meta-data record, give the reference of the publication (such as a book with compiled data) used directly for deriving the data.

Available Datasets

Linkages to the auxiliary files or links to the external sources of information

Bounding Coordinates

If the record relates to the spatial data (sample, observation, etc.) give bounding coordinates of the area. Coordinates are in decimal degrees.

Geographic Place name

The geographic name of the data location place

Language of the Record

The language in which the record is written

XI. Summary and Conclusions

The considerations of environmental monitoring infrastructure given in Chapter IV allow to make the following conclusions:

1. The current Russian monitoring systems provide monitoring of the basic environmental components such as:

- Water
- Air
- Forests
- Land resources
- Ecological situations

2. The monitoring of water bodies aiming at detection and prediction of floods and creating water cadastre, estimating of water quality performs State Water Service of MPR, the State Hydrological Institute (GGI)-St.Petersburg and Hydrometeocentre (Moscow) of **Roshydromet.**

3. The accumulation of the data of space monitoring in RAN is being done by special "Unified Information System of the Fundamental Space Research "(UISFSR).

This system has three levels:

a) common catalogue and basic archive of space data

b) catalogues and basic archives of individual Institutes (such as Institute of Space research, Institute of Radio electronics and other)

c) catalogues and archives of the individual research projects

4. All Russian monitoring systems are thought up as complex systems that use space, ground, airborne and aerological information in combination.

The data integration from these different information strata is being done on the base GIS technologies. The commercial software products ARC/INFO, ARC/VIEW, ENVI, ERDAS/IMAGINE, MAP/INFO are intensively used in the corresponding organisations.

The analysis of users and user requirements to satellite remote sensing sensors and instruments presented in Chapter 5 gives a good overlook with regard to different sensor characteristics such as spatial, spectral and radiometric resolution, spectral range, data updating process and time of data delivery. The details on archives and archiving policy allow to realise the explicit picture of existing in Russia at the moment archives and data banks.

The main conclusion that could be drawn with regard to Atmospheric monitoring is that advanced atmospheric monitoring system exists and is under operation in Russia. This system basically meets end user requirements to data and information and is a part of global international monitoring network under guidance ***WMO.*** The modern information technologies are used for data transfer, distribution and archiving. These technologies match the international standards. Essential drawback of the atmospheric monitoring in Russia is insufficient density of background monitoring stations over territory of a country. The way out is the transit to combination of satellite remote sensing observations and creation of supporting ground stations.

The information for monitoring of environmental stress is being collected both by governmental and non-governmental organizations. Data that come to governmental structures has

a) periodical character (from holders of exploitation licenses)
b) irregular character (from state inspections).

The official databases include the results of ground and underground measurements existing in the form of in tables and text files.

Environmental stress monitoring system can be constructed on the base of new information technologies with intensive utilisation of remote sensing data. Some of Russian organizations are ready to develop such a system. The latter are:

- Moscow State University (methodological base of soil degradation problem),
- Ugra Research Institute of Information Technologies (methodological base of gas fire pollution, super calculations, data storage, GIS technologies)

- NPC “Monitoring” (ground measurement collection and mapping).

The uniform structure of a System for Environmental Stress Monitoring in RUSSIA does not exist but all necessary information can be obtained from existing monitoring systems by means of collecting the data from regional centers. It might be reasonable the next stage of GMES RUSSIA activities to direct toward implementation of pilot projects with focus on environmental stress monitoring on a regional scale.

The whole situation in Russia with satellite information for operational monitoring of forest can be considered as rather satisfactory. However, the questions on fire forecast, independence of weather conditions, early fire detection when the fires are small are still not solved so far. There exists an idea of broadening satellite data. It means the simultaneous utilisation of all-weather survey and forest fire controlling satellite systems. These systems must have supplementary radar sensors, that can also detect big forest fires, and theirs burned scars.

It should be stated that recently new developments in the field of portable satellites for forest fire observation («BIRD» of DLR, Germany) have been created. A steady operation of satellites “BIRD” with increased spatial resolution in IR spectral bands and practically with non-restricted temperature threshold is of great interest for Russia.

In monitoring of big fires the problem of fire propagation is still open. There are no good models of forest fires propagation that went through practical testing. This is the result of the fact that it is very difficult in Russia to make experiments with applying a wide range of ground data and foreign satellite systems. There is no good feedback to do the work on validation of satellite and ground information. Annual ground data about registered forest fires taken from Federal and regional subdivisions are very often falsified. The practical collaboration with Airbases in feedback regime shows that real area characteristics of fires may differ from reported several times.

The compact description of the administrative and organisational structure of the sea ice monitoring in Russia is given in Chapter IX. The experience gained in the process of operation of AIIA (Automated Ice Information System for Arctic) enabled to formulate user requirements to sea ice information. The latter are presented in the report as well.

The significant step forward in the designing the effective communication tools is described in Chapter X. The proposed concept of interactive database with sophisticated but user’s friendly search mechanisms will allow to bridge the gap existing in the communication and information exchange between Russia and Europe.