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MAN-INDUCED ENVIRONMENTAL RISKS: MONITORING, MANAGEMENT AND REMEDIATION OF MAN-MADE CHANGES IN SIBERIA

enviroRISKS

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Scientific Report 07-04

Enviro-RISKS: Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia

First-Year EC 6FP CA Enviro–RISKS Project Report: Overview and Progress Reports by Partners

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Abstract

The Siberian environment has been influenced by serious man-made transformations during the last 50 years. Current regional level environmental risks are: direct damages to environment caused by accidents during petroleum/gas production and transportation including their influence on water, soil, vegetation and animals; caused by deforestation (cutting and forest fires) variations in Siberian rivers' runoffs and wetland regimes; direct and indirect influence of forest fires, flambeau lights and losses of gas and petroleum during their transportation on regional atmosphere composition; deposition of hazardous species leading to risks for soil, water and consequently to risks in food-chains. These regional problems are typical for some NIS and European countries, whose territories are crossed by pipelines and/or are used for petroleum and gas production and transportation.

The strategic objectives of the Enviro-RISKS project (*Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia*) is to facilitate elaboration of solid scientific background and understanding of man-made associated environmental risks, their influence on all aspects of regional environment and optimal ways for it remediation by means of coordinated initiatives of a range of relevant RTD projects as well as to achieve improved integration of the European research giving to projects additional synergy in on-going and future activities and potential for practical applications.

Scientific background allowing to reach these objectives is formed by a number of different levels RTD projects devoted to near all aspects of the theme but in virtue of synergy lack not resulting in improvement of regional environmental situation. The set comprises coordinated/performed by partners thematic international projects (EC funded), national projects (supported by the Siberian Branch of RAS, RAS and Russian Foundation for Basic Research, RFBR), and projects performed by NIS partners (under contracts with regional/local administrations and petroleum/gas producing and transporting enterprises/companies).

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Aakjær P.D., DMI Director: Welcome speech for Project start

I am pleased to welcome you all here at DMI to the Enviro-RISKS launching meeting, and I am happy to get the opportunity to address you here today.

Human activity and its impact on the environment and climate change are of concern to all of us. Its monitoring, forecasting and research are thus of the utmost importance. Furthermore, climate change and environment pollution do not respect national borders, so international collaboration on these issues is indeed extremely important.

Here at DMI we have a long experience in climate change studies, environmental modelling and forecasting. Our activities include weather and climate modelling and modelling atmospheric dispersion, transformation and deposition of pollutants. Our weather forecasting model - DMI-HIRLAM - is run operationally for Denmark and Greenland in a 5 km horizontal resolution, and our regional climate model HIRHAM which has been developed jointly by DMI and the Max Planck Institute for Meteorology in Hamburg has been extensively run in resolutions down to 12 km.

The Danish Climate Center has been involved in several international research projects on global and regional climate modelling relevant to the present application. Mostly these projects have been funded by the EU, and we are proud that it is not only the EU-countries that participate in this new Enviro-RISKS project, but also several of our neighbouring countries to the east.

DMI has a long tradition of working on many aspects concerning air pollution, both nationally and internationally. It is not only research at DMI but we are – like many meteorological institutes also the national focal point for several emergency preparedness dealing with nuclear, bio- and veterinary emergency, pollen forecasting, risk assessments, and airborne dispersion of foot-and-mouth disease virus.

We were proud to note that among 28 models from most European countries, USA, Canada and Japan, which contributed to model validations based on the European Tracer EXperiment a few years ago, our model called DERMA was emphasised as one of the most successful. Based on this system a new probabilistic environmental risk assessment model has been developed at DMI and tested for nuclear risk assessments for Northern regions of Europe and Siberia in the bounds of the Arctic Risk Project.

An automatic computerised system has been developed providing real-time high-resolution forecast data derived from the DMI-HIRLAM system to ARGOS and RODOS for urban- and regional-scale atmospheric dispersion modelling. DMI led a big European project FUMAPEX, which developed a new generation integrated Urban Air Quality Information and Forecasting System and implemented it in 6 European cities.

I hope - and I am sure- that the collaboration in the Enviro-RISKS Coordination Action will be fruitful, and I wish you all a pleasant stay in Copenhagen.

Thank you for your attention.

Baklanov A.A. Gordov E.P.: Overview of the FP6 INCO Co-ordination Action "Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia" (Enviro-RISKS)

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Overview of the FP6 INCO Co-ordination Action project Enviro-RISKS (Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia) and its state of the art is described briefly. Special attention is paid to thematic focuses of this activity and first results obtained, in particular, recently launched Enviro–RISKS web portal (http://risks.scert.ru/) as the core element of targeted networking of key players in environmental studies and applications.

Introduction

The original idea of this project appeared in authors' minds as result of their concern with current situation in the both, Siberia environment itself and in basic and applied research activity devoted to it. It is well known that the Siberia environment has been influenced by serious man-made transformations during the last 50 years. Major contemporary regional level environmental risks include the following. At first, these are direct damages to environment caused by accidents during petroleum/gas production and transporting. It is also risks caused by deforestation variations in Siberian rivers runoffs and wetland regimes. Moreover, it includes influence of forest fires, flambeau lights and losses of gas and petroleum during their transportation on regional atmosphere composition as well as atmospheric transport and deposition of hazardous species leading to risks for soil, water and consequently for food-chains. Near all of the risks might be significantly enforced by regional manifestations of global change, which evolves dramatically in the Northern territories [1]. Regional consequences of global warming (e.g. anomalous increase of winter temperatures [4]) are strongly pronounced in Siberia. This tendency is supported by the results of climate modeling for XX-XXII centuries [5]. This process not only threatens Siberia with destruction of the most part of extractive and transport infrastructure caused by the shift of permafrost borders northwards but also can change the dynamics of the natural climatic system as a whole as a result of extrication of a large mass of greenhouse gases. Similar regional problems occur in a number of Northern countries. However, Siberia is actually a place where the synergy between natural and man-induced impacts on the environment might lead to heavier environmental damage and consequences, then their separate consequences. It also includes possible strong variations of regional feedbacks to the global system, which makes relevant study important on the global scale as well.

In spite of significant research efforts of recent years the deep understanding of the dynamics of regional environment main components is not gained yet. Although many projects supported by national (SB RAS, RAS) and international (EC, IGBP-2, NEESPI, etc.) organizations are devoted to study of modern dynamics of Siberian environment, we still know little about the behavior of main components of the regional climatic system. A review on state-of-the-art in Siberian environmental research is published in the dedicated to Siberia issue of the Bulletin of Russian National Committee on IGBP [2] and available in Internet (http://www.scert.ru/files/igbp/EngBul.pdf). Many institutes of SB RAS also work in this direction in the frameworks of their budgets and initiative themes. But taking into account their fragmentation, these studies will not lead to the emerging of the full picture of modern natural-climatic changes in Siberia.

Siberia is one of the promising regions for the development of such basic and applied regional study of environmental dynamics [3]. In spite of significant resources used, the effectiveness of the work is not high because of insufficient funding and coordination between projects. To overcome these weaknesses a special activity is necessary. In order to gather up for now scattered regional, national and international efforts in these investigations, a sort of regional concentrated activity aimed at the both basic and applied studies is required. That is why we decided to initiate relevant project namely as FP6 co-ordination action. According to the FP6 definition the Co-ordination actions (CA) are intended to promote and support the co-ordinated initiatives of a range of research and innovation operators, in order to achieve improved integration of the European research. The co-ordination action is an instrument to network or co-ordinate research organizations, initiatives or projects for a specific purpose. It provides organizational support to achieve the networking or co-ordination of the research and innovation activities of the operators involved. Namely co-ordination activities could address tasks such as establishing a roadmap for research in specific topics and performance of required preparatory work like studies, analysis and report writing, establishment of specifications for common information systems, development of such systems and the use of common information systems to facilitate exchange and dissemination of good practices and manage common activities. Additional positives of co-ordination actions are in the fact that they may contain training activities as well.

Project description

The three years FP6 CA Project "Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia" (Enviro-RISKS) has been started on 1 November 2005. Its strategic **objective** is to facilitate elaboration of solid scientific background and understanding of man-made associated environmental risks, their influence on all aspects of regional environment and optimal ways for it remediation by means of coordinated initiatives of a range of relevant RTD projects as well as to achieve improved integration of the EU research giving the projects additional synergy in current activities and potential for practical applications.
Scientific background and foundation for the project performance is formed by a number of different levels RTD projects devoted to near all aspects of the theme but in virtue of synergy lack not resulting in improvement of regional environmental situation. The set comprise coordinated/performed by partners EC funded thematic international projects, Russian national projects and other projects performed by NIS partners. List of partners includes 3 leading European research organizations: Danish Meteorological Institute (Co-ordinator; Copenhagen, Denmark), Max-Planck-Institute for Biogeochemistry (Jena, Germany) and International Institute for Applied Systems Analysis (Laxenburg, Austria); 6 leading Russian research organizations (5 - located in Siberia): Siberian Center for Environmental Research and Training (NIS Co-ordinator) and Institute of Monitoring of Climatic and Ecological Systems SB RAS, (both in Tomsk), Institute for Numerical Mathematics RAS (Moscow), SB RAS Institutes Forest SB RAS (Krasnoyarsk), Institute of Computational Mathematics and Mathematical Geophysics (Novosibirsk), Ugra Research Institute of Information Technologies (Khanty-Mansiisk) as well as the KazGeoCosmos enterprise (Almaty, Republic of Kazakhstan). Additionally to the listed above partners several research organizations joined to the Project as Associated Partners. Among those are the MEDIAS-France (Toulouse, France; http://mediasfrance.org/), and several Russian organizations - Institute of Computational Modeling SB RAS (Krasnoyarsk), Institute of Northern Environmental Problems of Kola Science Center RAS (Apatity, http://inep.ksc.ru/), Tomsk State University (http://www.tsu.ru/), and Ural Division of RAS (Ekaterinburg, http://www.uran.ru/).

List of performed projects, whose results will be included into dedicated studies in course of CA, comprises the following:
FUMAPEX (Integrated Systems for Forecasting Urban Meteorology, Air Pollution and Population Exposure, http://fumapex.dmi.dk/) Project, co-ordinated by DMI, which was aimed at improvement of meteorological forecasts for urban areas, integration and link Numerical Weather Prediction (NWP) models to Urban Air Pollution and Population Exposure models leading to an improved Urban Air Quality Information and Forecast System for application in cities in various European climates;
SIBERIA 2 (Multi-sensor concept for Greenhouse Gases Accounting in Northern Eurasia, http://www.siberia2.uni-jena.de/index.php), aimed at understanding the greenhouse gas budget and its interactions with climate change in the Eurosiberian region (**IIASA** and **IF** were its key performers);
TCOS-Siberia (Terrestrial Carbon Observing System – Siberia,

http://www.bgc.mpg.de/public/carboeur/web_TCOS/), coordinated by MPI for Bio-geochemistry (Jena) and aimed at implementation of the first components of a continental scale observing system to help determine the net carbon balance of Siberia and its variation from year to year;
ISIREMM (Integrated System for Intelligent Regional Environmental Monitoring & Management), SCERT coordinated NIS Partners activity, which addressed the problem of industrial pollution, and in particular, air pollution, and its effects on the human and natural environment.
It also includes FP6 Special Support Action **ENVIROMIS-SSA** (Environmental Observations, Modelling and Information Systems, link,) coordinated by **SCERT**, which formed coherent set of coordination, dissemination and education actions directly aimed at environment protection and stabilisation of research and development potential in Russia and other NIS countries as well as INTAS supported projects **ATMOS** (Web Portal on Atmospheric Environment, links) aimed at development a bilingual Internet portal for the domain of Atmospheric Physics and Chemistry, and the related application domain of air quality assessment and management (among key participants were **SCERT, INM and IMCES)** and "Modelling and parameterisation of the 'air-vegetation-snow-soil' system, including special aspects of the permafrost degradation" aimed at evaluation and understanding effects of the active layer of the cryosphere on climate and studying potential effects of the global climate change on the permafrost degradation (**INM** played the key role in it). Important part of the set is formed by the SB RAS Interdisciplinary Integrated Projects devoted to actual issues of Siberia environment. Among those are co-ordinated by **IMCES** projects **SGBP** ("Siberian Geosphere – Biosphere Program: integrated regional study of contemporary natural and climatic changes", link), in which efforts of 14 Institutes of SB RAS and RAS as well as 5 Universities were coherently joined to initiate relevant study of the region and **GVB** («Complex Monitoring of Great Vasyugan Bog: study of modern state and development processes», link) aimed at study of development of the unique natural-climatic complex Great Vasyugan Bog (GVB) as the natural formation of planetary importance under global and regional environmental and climate change and elaboration of remediation methods for damaged by oil producing activity parts of it territory; as well as co-ordinated by **ICMMG** project «Ecological Problems of Siberian Cities», which goal was to conduct multidisciplinary scientific research of answer the basic questions: how do cities change hydrothermodynamic behaviour and composition of atmosphere and how do these changes affect the quality of life, public health and quality of environment. Complete list of the projects also comprise the Kazakhstan Ministry of Industry and Trade projects, performed by **KGC** and set of projects performed by **URIIT** for regional petroleum and gas producing companies. More detailed description of the performed by partners' projects as well as those, recently started, can be found at the Enviro-RISKS web portal (link).

One of the project tasks is facilitation to development of Siberia Integrated Regional Study (SIRS). Accordingly to present knowledge, Siberia is the region where the most pronounced consequences of climate changes already happen and will happen. Various models have been developed to address different dimensions of this issue. Variability in space and time as well as regions of critical importance ("hotspots") have been evidenced through in situ and remote sensing measurement techniques and were forecasted by advanced climatic models. Siberia environment has been subjected to serious man-made transformations during last 50 years, whose negative consequences might be amplified by regional manifestations of global change. Say caused by deforestation (cutting and forest fires) variations in Siberian rivers runoffs and wetland regimes might interfere with change of atmospheric circulation in the region, which varies forest fires frequency, flambeau lights and losses of gas and petroleum during their transportation vary regional atmosphere composition and its radiation properties, etc. These regional problems are typical for number of NIS and for near all Northern countries.

Elaboration of solid scientific background and understanding of man-made associated environmental risks, their influence on all aspects of regional environment and optimal ways for it remediation is required to get practical results in enhancing of environment and diminish environmental risks. The region requires a new research paradigm. An overarching vision of regional aspects and its various connections to global aspects is now needed in line with the defined by the Earth System Science Partnership Integrated Regional Studies (IRS) approach, which could lead to Siberia IRS (SIRS) program. This requires bringing together scientists from several disciplines and sub-regions into a much wider approach and setting up the relevant structures (institutions, regional and trans-regional and international networks, funding) to lead such integrative studies. Results of such studies should be bridged with and acknowledged by relevant decision policy makers in order to implement proper mitigation and remediation actions at managerial and political decision levels.

The main activities, aimed at realization of the Enviro-RISKS objective and coordination of the basic and applied environmentally oriented projects comprise:

- Development and support of the Project web portal and environmental information distributed data-base;
- Gathering and systematization of information resources obtained;
- Gathering, analysis and synergy search in different level projects on Siberian environment;
- Organization of conferences and experts meetings;
- Search for synergy between the different projects on Siberian environment and elaboration of rec-ommendation for new Projects;
- Exchange of research personnel and postgraduates.

First results

The project **Launching Meeting**, which gathered key representatives of all Partners, took place in Copenha-gen during January 30-31, 2006. Additionally to typical for such meetings management issues its agenda included a special section on Coordinated Projects, where detailed descriptions of major findings were given in more than 20 presentations/reports (See Appendix 1). Complete information on this meeting including reports presentated is available in internet (http://project.risks.scert.ru/management/meetings/kick/). Major result of the meeting is in allocating all to projects to selected **Thematic Focuses** and in establishing relevant **Working Groups**.
Three Thematic Focuses/Groups consider major risks inherent to Siberia environment. These groups (with their leaders) are the following:

1. **Atmospheric Pollution and Risks** (Alexander Baklanov and Vladimir Penenko),
2. **Climate/Global Change and Risks** (Martin Heimann and Vasily Lykosov), and
3. **Terrestrial Ecosystems and Hydrology and Risks** (Michael Kabanov and Anatoly Shvidenko).

The forth Focus has a generic nature and is devoted to:

4. **Information Systems, Integration and Synthesis** (Evgeny Gordov and Edige Zakarin).

The working groups also form a basis for organization of the thematic Expert Groups, which should elabo-rate practical recommendations for coordination of new projects on Siberia environment initiated by Partners.

The next Project event, which is the **first year Interim Meeting**, took place within frameworks of the International Conference on "Environmental Observations, Modeling and Information Systems" (ENVI-ROMIS-2006) held 1-8 July 2006 (Akademgorodok, Tomsk, Russia; http://www.scert.ru/en/conferences/enviromis2006/). Firstly, the special sessions devoted the state-of-the-art of the targeted activity were run, at which representatives of Partners and Associated Partners delivered relevant reports (See Appendix 2). This meeting description as well as presentations of the reports is avail-able in Internet (http://project.risks.scert.ru/management/meetings/second/).

In between these two meetings the activities were mainly concentrated on the first and forth thematic focuses. In particular, within the activities of the group "**Atmospheric Pollution and Risks"**, the DMI performed long-term simulation of atmospheric transport and deposition patterns from sources of continuous anthropo-genic sulphates and radionuclides emissions located in the Siberian, Kazakhstan, Ural, and other geographi-cal regions (*Mahura et al., 2006*).
The Danish Emergency Response Model for Atmosphere (DERMA) was employed to perform simulations of air concentration, time integrated air concentration, dry and wet deposition patterns resulted from continu-ous emissions of chemical risk sites. The geographical locations of the Siberian chemical and metallurgical enterprises situated near the cities of Kemerovo, Norilsk, Novokuznetsk, Chelyabinsk, Ekaterinburg, Nizhniy Tagil, Krasnoyarsk, Zheleznogorsk, and others were selected as representative sources of such emissions. To perform such simulations the European Center for Medium-Range Weather Forecasts (ECMWF) 3D mete-orological fields (for years of 1985 - as climatologically typical year, and 1983 - as year with a significant deviation of atmospheric circulation patterns for the North Atlantic Oscillation) were used as input by the DERMA model. Several assumptions were applied. In particular, the hypothetical daily unit releases of sulphates at a constant rate were considered from each site. For each daily release the followed transport through the atmosphere and deposition on the underlying surface due to dry and wet removal processes were

estimated on an interval of 2 weeks.
Detailed analyses of simulated concentration and deposition fields for each site allow evaluating spatial and temporal variability of these resulted patterns on regional and hemispheric scales (example is given in Figure 1). The results of these simulations are also applicable for GIS integration as well as essential input for further evaluation of doses, impacts, risks, short- and long-term consequences for population and environment from potential sources of continuous emissions.

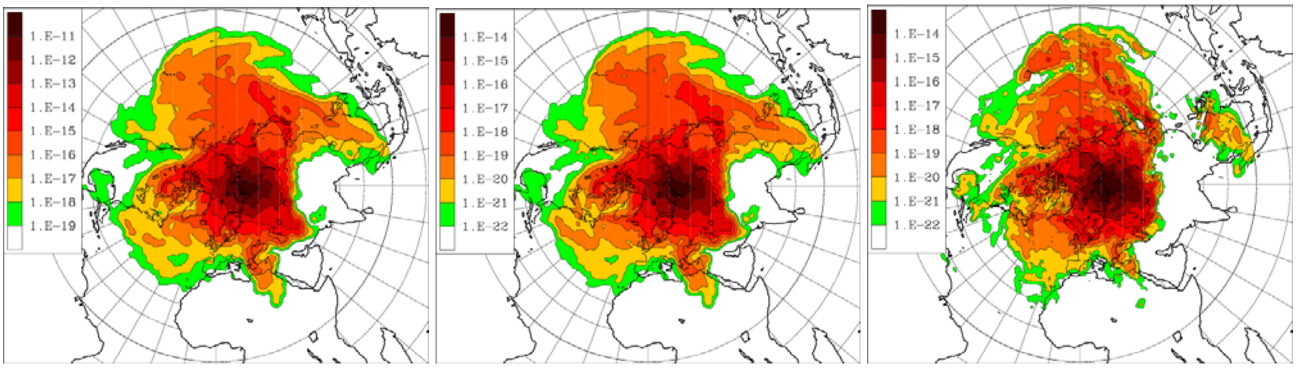
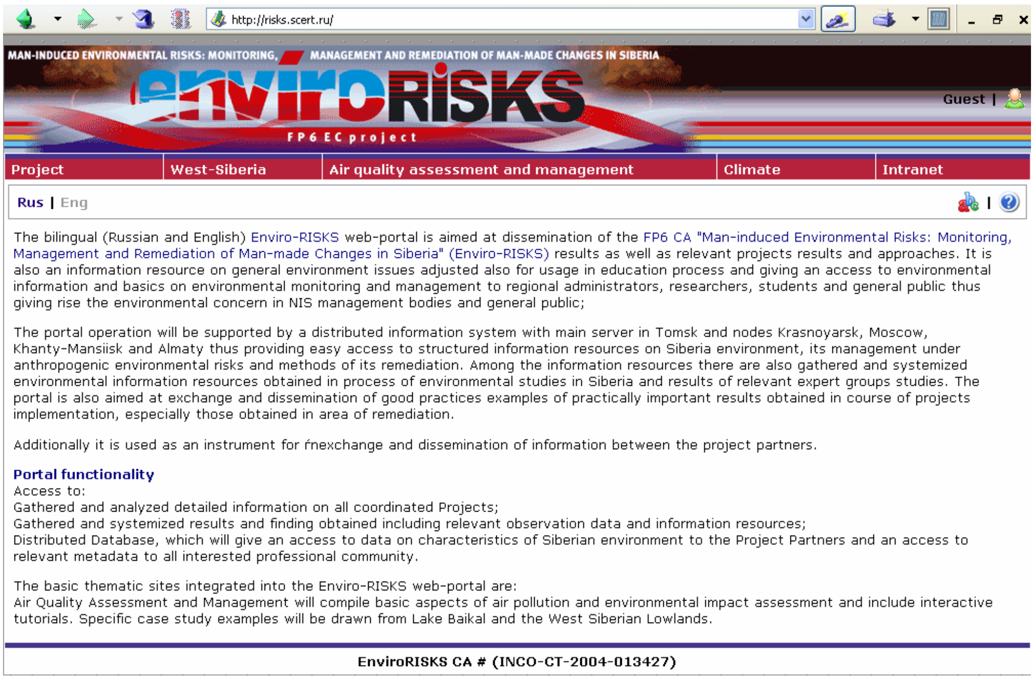


Figure 1. DERMA model results of the long-term dispersion modelling: annual time integrated air concentration, dry and wet deposition patterns from the Norils nickel plant (*Mahura et al., 2006*).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MAN-INDUCED ENVIRONMENTAL RISKS: MONITORING, MANAGEMENT AND REMEDIATION OF MAN-MADE CHANGES IN SIBERIA

enviroRISKS

FP6 EC project

Guest |

Project | West-Siberia | Air quality assessment and management | Climate | Intranet

Rus | Eng

The bilingual (Russian and English) Enviro-RISKS web-portal is aimed at dissemination of the FP6 CA "Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia" (Enviro-RISKS) results as well as relevant projects results and approaches. It is also an information resource on general environment issues adjusted also for usage in education process and giving an access to environmental information and basics on environmental monitoring and management to regional administrators, researchers, students and general public thus giving rise the environmental concern in NIS management bodies and general public;

The portal operation will be supported by a distributed information system with main server in Tomsk and nodes Krasnoyarsk, Moscow, Khanty-Mansiisk and Almaty thus providing easy access to structured information resources on Siberia environment, its management under anthropogenic environmental risks and methods of its remediation. Among the information resources there are also gathered and systemized environmental information resources obtained in process of environmental studies in Siberia and results of relevant expert groups studies. The portal is also aimed at exchange and dissemination of good practices examples of practically important results obtained in course of projects implementation, especially those obtained in area of remediation.

Additionally it is used as an instrument for ŕnexchange and dissemination of information between the project partners.

Portal functionality
Access to:
Gathered and analyzed detailed information on all coordinated Projects;
Gathered and systemized results and finding obtained including relevant observation data and information resources;
Distributed Database, which will give an access to data on characteristics of Siberian environment to the Project Partners and an access to relevant metadata to all interested professional community.

The basic thematic sites integrated into the Enviro-RISKS web-portal are:
Air Quality Assessment and Management will compile basic aspects of air pollution and environmental impact assessment and include interactive tutorials. Specific case study examples will be drawn from Lake Baikal and the West Siberian Lowlands.

EnviroRISKS CA # (INCO-CT-2004-013427)

Figure 2. The Enviro-RISKS Portal start page.

Within the group "**Information Systems, Integration and Synthesis"** the SCERT team developed and launched the Project web-portal (http://risks.scert.ru/). The bilingual (Russian and English) Enviro-RISKS web-portal is aimed at dissemination of the CA results as well as relevant projects results and approaches. The portal is organized as a set of interrelated scientific sites, which are open for external access information-computational systems realized by means of Internet technologies. It is also an information resource on general environment issues adjusted also for usage in education process and giving an access to environmental information and basics on environmental monitoring and management to regional administrators, researchers, students and general public thus giving rise the environmental concern in NIS management bodies and general public. The Portal engine employs middleware designed in course of the INTAS project ATMOS performance results. The middleware consists of a set of services and a transaction processing monitor, which performs function of a dispatcher of each user request and of some services. The dialogue system forms menu on the base of applied logic formed for each site. The user's data control system secure integrity of user's data in process of usage of the relevant site calculation part. The linguistic service is providing multi-language information presentation on site and in the dialogue system. Since till now there is no international standards on relevant middleware (see, for example, NetworkWorking Group, Request for Comments: 2768) technological choices are based of W3C recommendations. In particular, Apache web server is used as well as PHP script language and MySQL DBMS. Among the information resources there are also gathered and systemized environmental information resources obtained in process of environmental studies in Siberia and results of relevant expert groups studies. The portal is also aimed at exchange and dissemination of good practices examples of practically important results obtained in course of projects implementation, especially those obtained in area of remediation.

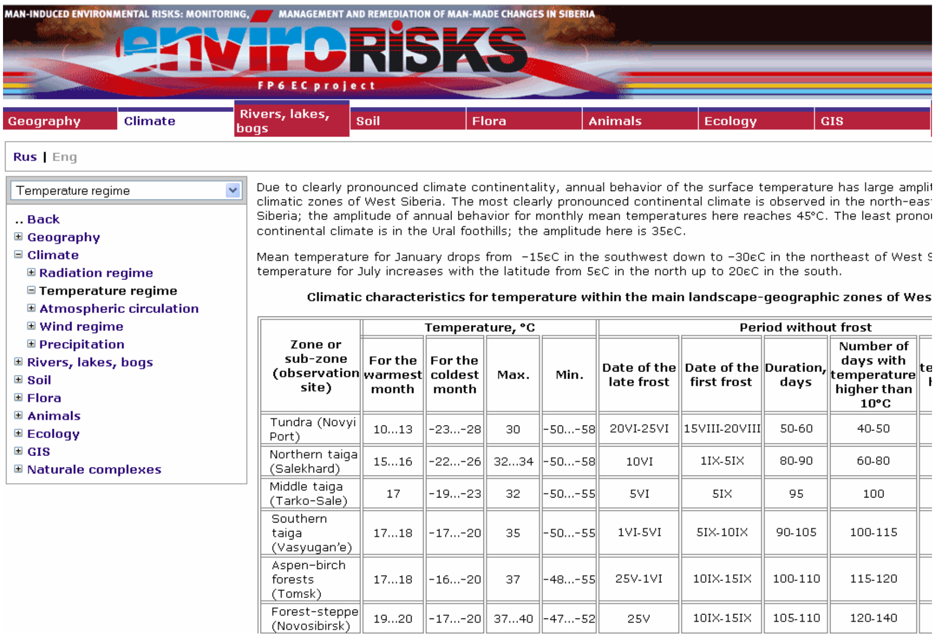

Figure 3. An example of West Siberia climate description.

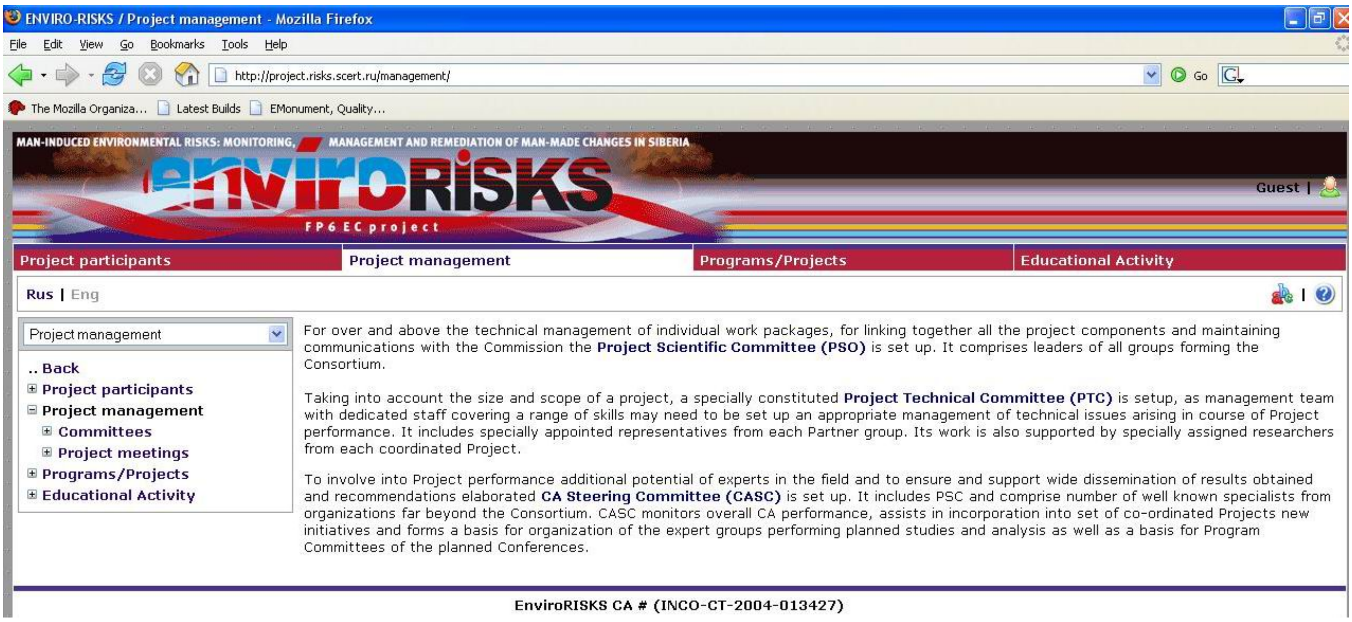

Figure 4. The Project management page.

The portal operation will be supported by a distributed information system with main server in Tomsk and nodes Krasnoyarsk, Moscow, Khanty-Mansiisk and Almaty thus providing easy access to structured infor-

mation resources on Siberia environment, its management under anthropogenic environmental risks and methods of its remediation. Additionally its Intranet part is used as an instrument for exchange and dissemination of information between the project partners. The Portal start page is shown on Figure 2.
The Portal functionality allows an access to gathered and analyzed detailed information on all coordinated Projects, gathered and systemized results and finding obtained including relevant observation data and information resources, distributed database, which will give an access to data on characteristics of Siberian environment to the Project Partners and an access to relevant metadata to all interested professional community. The basic thematic sites currently integrated into the Enviro-RISKS web-portal are Air Quality Assessment and Management, which compiles basic aspects of air pollution and environmental impact assessment and West Sibera site, which provides basic information on Siberia environment characteristics. Figure 3 shows it in more details.
The Portal site Climate, which is under development now, is aimed at an access to specially designed analytical tools allowing to get spatial pattern of selected Siberia climatic characteristics from measured or simulated data sets.
Special site is devoted to the Project management. It comprise information on the Project Partners, Project management, Projects/Program coordinated and give an access to gathered by Partners educational recourses. Figure 4 shows the page devoted the Project management.
One can see in the menu that it contains Project participants' descriptions, Project Committees as well as provides with detail description of the Project Meetings.

Conclusions (Expected results and outcomes)

Direct impact of the Project will be in elaboration of on the base of dedicated studies of the expert groups practical recommendations for regional level activities in basic and applied environmental problems solving. It should include based on satellite remote sensing methods, local measurements and numerical modeling early detection and monitoring of accidents in process of petroleum/gas production and transporting including their influence on water, soil, vegetation and animals; appearance of new forest fires and flambeau lights, variations in Siberian rivers runoffs and wetland regimes; best approaches to mitigate environmental risks in process of industrial activity in the region and modern technologies for remediation of damaged territories.

Anticipated strategic impact of the CA is in yet started via the Project Portal dissemination of effective approaches and tools for monitoring, management and remediation of man-made environmental risks in Siberia and in suffering from similar problems regions of NIS. Due synergism and synchronization in performance of recently started by the Partners projects it also should improve the state-of-the-art of Environmental Science and applications in Russia, NIS and EU. We hope that elaborated by the expert groups' practical recommendations being implemented at the Siberian federal District will lead to improvement of well being and security of local population as well.

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1. Atmospheric Pollution and Risks

1.1. Gordov E.P., A.V. Starchenko: Integrated System for Intelligent Regional Environmental Monitoring and Management (ISI-REMM)

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Abstract
The FP5 RTD INCO COPERNICUS-2 Program Project ISIREMM (ICA2-CT-1999-10159) addressed problems of industrial pollution, and in particular, air pollution and its effects on the human and natural environment

1 Introduction
The ISIREMM activity was based on the results of the FP4 Environmental Telematics Project as a starting point. These results were adapted for the specific NIS conditions and extended with a number of advanced optical and acoustical monitoring methods developed at the NIS partner institutions. As result a new environmental management information system Demonstartor was developed. The system was tested for implementation in the city of Tomsk, Siberia.
The basic approach of ISIREMM was to integrate numerical modeling of air quality with a wide range of monitoring technologies in order to fully exploit all available information resources for environmental management. The project was organized in a number of consecutive, overlapping phases of development of ISIREMM Demonstrator, its integration, implementation, and testing.
Major developments in ISIREMM include the integration of the monitoring data and satellite imagery with a new generation of 3D aerothermochemistry models based on local and remote (volumetric) sensor (stationary and mobile) data flows for city scale pollutant transport and transformation; and the integration of these components into an interactive system with a public information system component.

2 Participants
Project Coordinator:

Environmental Software & Services GmbH AT

Contractors:

- Institute of Atmospheric Optics, Siberian Branch, RAS, RU
- Institute of Computational Mathematics and Mathematical Geophysics, Siberian Branch, RAS, RU
- Aristotle University of Thessalonica, Greece
- Space Research Institute of the Ministry of Science and Higher Education, Kazakhstan
- B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Belarus
- SILOGIC, France
- Natural Resources Department, Tomsk Region, Russia

3 Objectives
The overall objective of the ISIREMM project is to develop and test a generic and easily adaptable next generation management information system for intelligent environmental monitoring and management, initially focusing on air quality at the urban and regional level that, while building on the most recent results of EU sponsored research, is appropriate for the specific situation of NIS countries.
The main scientific and technological objectives of the proposal are the following:

- To develop a next-generation effective model-based information and decision support system for environmental management, based on a flexible client-server integration of information resources such as: simulation models implemented at dedicated computing centers, on-line monitoring using both the conventional local and volumetric remote sensors, geographic information system (GIS), and multi-media user interface.

- To exploit results of the FW4 Environmental Telematics Application Programme, and in particular the results of the ECOSIM (EN 1006) project at a typical industrial city (Tomsk, Siberia) characterized by a high level of industrial pollution, but incomplete environmental monitoring data.
- To advance the state-of-the-art by integrating specially designed nested city and regional scale models relying on monitoring data and satellite imagery.
- To integrate the models developed, and to test the ISIREMM Demonstrator in a typical application situation, critically evaluating its performance and local usability.
- To provide decision makers with an effective tool for mitigation of pollution, and the local population with real and easily accessible information on current environmental conditions in order to raise environmental awareness and empower citizen groups to participate in the environmental policy making process; and thus, strengthening an emerging civic society through environmental information technology.

4 Approach

4.1 Summary of approach

The basic approach of ISIREMM is to integrate modeling with a wide range of air quality monitoring technologies in order to fully exploit all available information resources for environmental management. The central analytical element of the system, advanced simulation modeling integrated with monitoring is used for different types of analysis:

- descriptive analysis: identification of major sources and contributors of pollution;
- scenario analysis addressing WHAT IF questions;
- prescriptive analysis: design of efficient mitigation strategies.

This analytical engine is then embedded in an interface to provide decision support information to two main user groups:

- technical users in the regional and local administrations;
- various interest groups and general public.

4.2 Starting point and state-of-the-art

The starting point for ISIREMM combines the results of the FW4 Environmental Telematics Programme, and in particular, the ECOSIM (EN1006) project, with a number of advances in environmental monitoring using optical and acoustic methods in several NIS institutions. ECOSIM developed and tested in three validation sites (Athens, Greece; Berlin, Germany; and Gdansk, Poland) a client-server based environmental information system for urban environmental management integrating simulation models (predominantly for air quality) with on-line monitoring. ECOSIM used a simple client-server protocol based on TCP/IP and http, that links the main server with both the monitoring systems and dedicated simulation servers. The monitoring data are collected at a number of fixed points (locations) at regular half-hourly or hourly intervals. ECOSIM uses an embedded GIS to display all model inputs and model results as thematic maps in an easily understandable format.

4.3 Architecture and components

ISIREMM is designed as a flexible, modular system with a set of interchangeable components. The basic elements of the system are the following:

- ISIREMM core (or main server) which co-ordinates all information resources and the display clients; the core include the data base management for monitoring data and model scenarios and results, the emission inventories, the embedded expert system for parameter estimation, and the GIS tools;
- monitoring system, linked as a logical server to the core;
- simulation models components, which are either embedded with the core for simple screening-level models are implemented as computer servers;
- DSS/optimization components related to the simulation models;
- embedded web server and cgi model components for the support of Internet access and related HTML/Java components for the browser based user interface.

These components are integrated through the standard protocols TCP/IP and http.

5 Work description

5.1 Systems architecture

ISIREMM is based on a client-server architecture that uses the public domain Internet protocol (TCP/IP and http) to link the various components and information resources of the system with the central analytical engine and a range of clients.
Exploiting public domain tools under the GNU software licensing as much as possible, the implementation is based on Linux server implementation with an attached Apache web server. This supports networked clients under either the X11 protocol and display functions for high-bandwidth local clients, or an http based protocol for low-bandwidth PC based clients running standard web browsers for XML/HTML and Java based user interfaces.

5.2 Modeling and monitoring

ISIREMM involves three sets of complementary model components:

- original set of models of the ECOSIM/AirWare system, including simple Gaussian short- and long-term screening models, and a dynamic photochemical box model;
- 3D dynamic meteorological and photochemical models used for the baseline scenarios;
- advanced set of locally developed models with the full integration and utilization of monitoring data integrated into the final ISIREMM system.

The ECOSIM/AirWare system has a number of embedded and fully interactive screening level regulatory models, primarily based on the UISEPA Gaussian guideline models such as ISC-3/AERMOD, and PBM, a dynamic photochemical box model, as well as a dynamic multi-layer Eulerian code using the diagnostic wind model DWM as a pre-processor. These simple, but efficient models are coupled to the emission inventories, meteorological databases, and monitoring data, and can be run interactively and with a fully graphical user interface with embedded GIS functionality in both the short-term (episode) or long-term (to generate seasonal or annual average results) modes.

5.3 ISIREMM advanced model set

Going beyond the basic set of models described above, partners in ISIREMM developed and integrated a set of aerothermochemical models of different levels of sophistication (and for different scales) for the studies of air pollution distribution in the atmosphere over an industrial center. Simplified mathematical models of the urban atmosphere will, to a great extent, be based on the empirical data from in-situ and remote sensors. This provides the system with computationally efficient tools, when forecasting both the weather conditions and air pollution transfer in the atmosphere on the urban area scale. The core element of the simplified models is the system of the advection-diffusion equations for the indices of air quality in the urban area where the source terms describe the corresponding chemical transformations. The non-stationary spatial fields of the wind and turbulence characteristics of the atmospheric boundary layer that are needed for solving the equations of the chemical substances transport, are found from reconstructed data on the dynamics and temperature stratification of the urban atmosphere collected with a distributed network of sensors.
The set of urban forecasting models which are specially developed for further use in the ISREMM system and which use observational data collected with remote sensors. This set of models will include a 3D non-hydrostatic mesoscale model to forecast the non-stationary distributions of the wind velocity, temperature, and moisture in the air over a territory with heat sources and complex topography. The set also includes a 3D Eulerian dispersion model enabling calculations of the transport and chemical transformations of species that are indicators of the air quality. Turbulent stratification of the atmospheric boundary layer is calculated using the two-equation k-l model or the turbulence model for correlation among the pulsations of the wind velocity components, temperature, and concentration. Numerical solution is based on the implicit, or implicit-explicit, finite-difference schemes with staggered grids. Discretisation of the initial 3D nonstationary equations is performed using the control volume method in the second order approximation over time and co-ordinates. The convective terms of the transfer equations are processed by applying the QUICK procedure by Leonard. The calculations of pressure and corrections to the velocity field are performed by the discontinuity equation using SIMPLE algorithm by Patankar and Spalding. The initial and boundary conditions necessary in the set of urban forecasting models are set with the proper account of the data on meteorological quantities as well as of the data calculated numerically by applying the models developed at the Institute of Computational Mmathematics and Mathematical Geophysics . This type of 3D regional hydrothermodynamical, hydrostatic models of the pollutant transfer have been widely used in scenario calculations for analysis of the air pollu-

tion dispersal in the atmosphere over the Tomsk industrial region.

5.4 Modeling and optimization

An important objective of ISIREMM is to provide decision relevant information. This can be accomplished in a straight-forward descriptive mode by communication of monitoring results and forecasts under current conditions or results of WHAT-IF scenarios.
Alternatively, the system can be used for prescriptive analysis based on an optimization approach to find cost-efficient or budget constraints emission reduction strategies, a minimization of environmental impacts (ambient concentration) or minimum cost compliance strategies.
ISREMM can consider a set of scenarios based on a set of discrete technological and policy alternatives. Each scenario represents a different organization of the emission sources. For each emission source, a set of alternative discrete pollution control technologies is defined. These technologies can describe any technological measure or policy that reduces emissions for a cost.

6 Test case application: city of Tomsk

The city and region of Tomsk in the western Siberia has been selected as the ISIREMM validation site due to several reasons. These are the following. First, a key partner is located in its vicinity, which allows the consortium to rely on the available stationary remote sensors and relevant data archives. The second reason is an active position that both the Regional Administration and local population take in environmental issues. This active role is documented in the composition of the consortium.
The local interest in environmental matters is partly due to the existence of a nuclear plant and petrochemical enterprise in the area. In spite of the fact, that the Project did not directly address radionuclide monitoring it will be an important step in this direction. Also city streets of Tomsk are overloaded by cars, mainly used Japanese and European models which in their countries of origin are no longer in exploitation due to environmental concerns. The third reason is that in spite of its provincial status and geography, six local Universities give Tomsk a quite modern and intellectual environment which is ready to exploit modern information technologies and use the Internet for work, study, and ordinary life. This city is representative for many NIS cities that all (except Moscow) lack a sufficient local net of environmental monitoring stations to provide conventional information systems with necessary data for environmental management.
Last, but not the least, is the fact that Tomsk is under strong influence of the heavily industrialized surrounding Kuzbas Region, as well as the fact that under proper synoptic weather conditions the city pollutants easily reach arctic regions. Being situated on a complex hilly terrain and along a river, the city shows a wide range of climatic situations (summer temperature reaching +38ºC, winter minima -45ºC). Strong cyclonic and anticyclonic influence and the occurrence of temperature inversions allowed to test, validate, and evaluate the system under conditions, which are quite typical for a number of NIS industrial centers.

7 Recommendations

Results obtained forms a background for the Enviro-RISKS Coordination Action to select the city of Tomsk as a test NIS site for use/implementation of the FUMAPEX project results. Gathered scientific and educational resources, which are accessible via the ISIREMM Project site, can be used for subsequent professional activity by all participants of Enviro-RISKS.

Acknowledgements

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1.2. Mahura A.G., A.A. Baklanov, J.H. Sørensen: Assessment of Dispersion Modelling Results (AR-NARP)

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1 Introduction

Many international research projects have realized models and methods describing separate parts in risk assessment, e.g. probabilistic safety assessment, long-range transport and contamination modelling, radio-ecological sensitivity, dose estimation, etc. However, methodologies for multidisciplinary studies of risk assessment and mapping are not well developed yet. The risk assessment strategy can be realized by the following methods: using published results from real events, physical and theoretical modelling. For probabilistic analysis certain studies are based on combination of different factors and probabilities.

The “Arctic Risk” (AR-NARP, 2001-2003) networking project was funded by the Nordic Arctic Research Programme (NARP) and grants of the Nordisk Forskerutdanningsakademi (NorFA). One of its aims was focused on development and testing of methodology which included several specific approaches in optimal strategy of multidisciplinary methodology (Baklanov & Mahura, 2004; Baklanov et al., 2005a). Such methodology can be used to evaluate temporal and spatial variability of atmospheric transport and deposition patterns from selected risk sites in the selected area of concern, and use these patterns for further integration into GIS for risk and vulnerability analyses and mapping.

2 Methodology

Let us consider several stages with respect to long-term modelling for atmospheric pollutants from potential risk sites.

At the first stage, a list of risk sites (of nuclear, chemical, or biological nature) representing a potential danger for the environment and population of the considered region is selected. For example, sources like the nuclear power plants, processing plants, dumping sites, nuclear weapons testing sites, nuclear submarines, chemical and metallurgical enterprises, smelters can be identified in the selected region of interest. Note, a grouping of sources of similar nature and located geographically close to each other can be done (without consideration of accidents’ probabilities) because the individual atmospheric transport patterns will be relatively similar.

At the second stage, trajectory and dispersion models can be used to simulate long-term atmospheric transport, dispersion, and deposition of , for example, radionuclides, sulphur, heavy metals from selected risk sites on local, regional, and global scales. For example, in our studies we used the Danish Emergency Response Model of Atmosphere (DERMA) which is developed at DMI for mainly nuclear emergency preparedness purposes. It is a numerical 3-D atmospheric model of Lagrangian type (Sorensen, 1998; Baklanov & Sorensen, 2001; Baklanov et al., 2005a). Different gridded datasets can be employed in modelling, for example, the HIgh Resolution Limited Area Model (HIRLAM), ECMWF or NCAR/NCEP models of different resolution and scales. Different types of emissions can be considered – short vs. long-term or episodic/accidental vs. continuous, hypothetical scenarios vs. real events, nuclear vs. chemical, etc.

At the third stage, the trajectory modelling results can be analyzed and represented in the form of different indicators such as airflow probability fields, typical transport time (measured in days of atmospheric transport from the risk site to city); maximum reaching distance (represents possibility of event when, at least, one trajectory originating over the risk site arrives at city); maximum possible impact zone (underlines possibility of the highest impact from the risk site to city); and fast transport probability fields (shows scale of potential impact due to atmospheric transport during the first 12 and 24 hours after the accidental release at the site with respect to the area where such impact can be the highest).

The dispersion modelling results are more valuable since in addition to the trajectory related indicators these show also detailed information about potential levels of air and surface contamination. The results of the probabilistic analysis of dispersion modelling results for the risk sites can be presented as a set of indicators of the risk sites’ impacts on the geographical regions of interest, e.g. the time integrated air concentration at ground level, dry and wet deposition patterns. The first approach to construct the indicators considers the distribution of the total sum of daily continuous emissions from the sites. This type of field (summary field)

shows the most probable geographical distribution at the surface if the releases occurring during a long-term period. The second approach is simply based on calculating the average value from the summary field. This type of field (average field) shows the climatologically averaged spatial distribution during any given average day of the period studied.
Finally, the indicators can be further used for evaluation of risk/vulnerability levels separately for each potential source or group of the sources based on the atmospheric transport and deposition fields and, if available, probabilities of accidents (or continuous releases of pollutants) for each risk site.

3 Examples

Within the framework of the Arctic Risk NARP project, the assessment of the trajectory and dispersion modelling results (which are two integrated approaches of the methodological developments and testing applicability) was done, first of all, for nuclear risk sites in the Euro-Arctic (*Mahura & Baklanov, 2004; Mahura et al., 2005b*) and North-Pacific (*Mahura et al., 2005a*) regions. The developed methodology was also tested for sources of chemical nature, such as Cu-Ni smelters of the Russian North (*Mahura et al., 2005d*). In these studies the trajectory and dispersion modelling results were evaluated in the form of different indicators mentioned in Chapter 2. Examples of indicators based on trajectory and dispersion modelling can be found in a series of DMI scientific reports related to the Artic Risk NARP project and in some of the publications mentioned below.

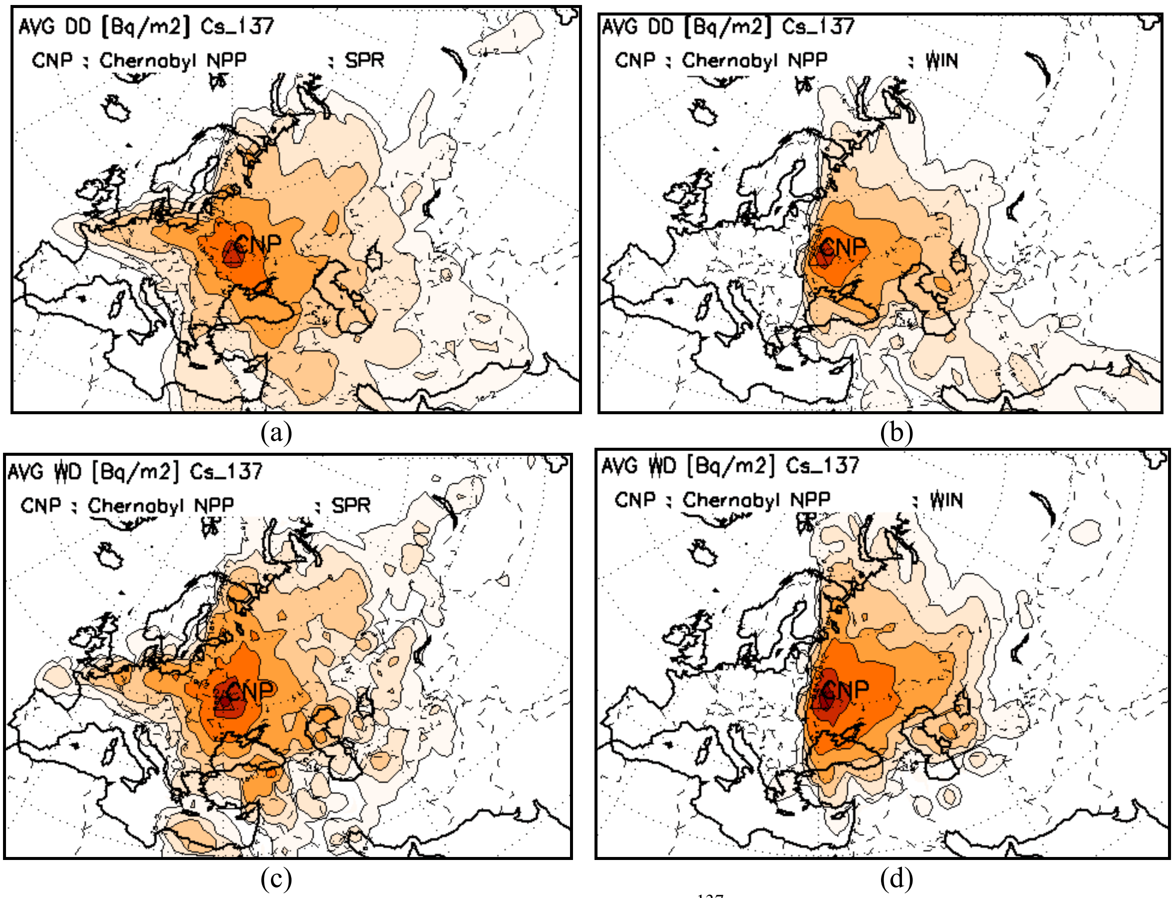
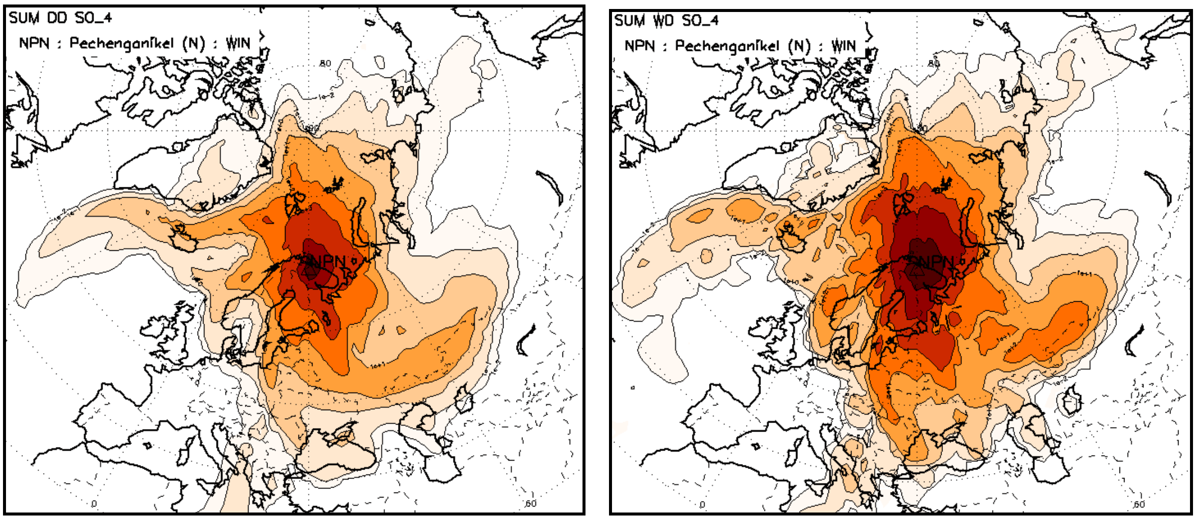


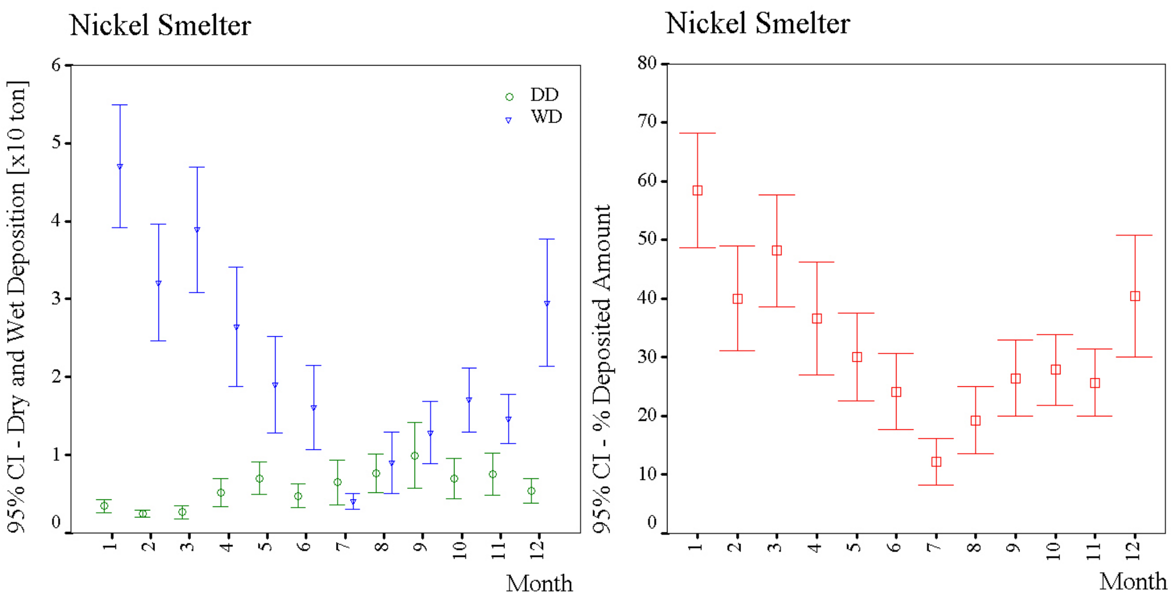
Figure 1. Average (a,b) dry and (c,d) wet deposition fields of ^{137}Cs resulting from hypothetical accidental releases at the Chernobyl nuclear power plant (CNP) during (a,c) spring and (d,e) winter.

Different approaches and models to evaluate source-receptor relationships for potential atmospheric pollutants on examples of the source and receptor points/regions can be considered for the forward-backward trajectory modelling approach combined with statistical methods of cluster analysis and probability fields. Adjoint equations approach were discussed and illustrated by the probability fields and sensitivity functions (*Baklanov et al., 2005b*). Moreover, simulation results obtained from a simple Eulerian K-model were compared with an ensemble average of long-range transport and deposition data (obtained from a numerical weather prediction model coupled to a 3-D Lagrangian dispersion model) for several sites located in different climate regions in the Northern Hemisphere (*Lauritzen et al., 2005*). Ranking of potential impact on one of the European capitals - Copenhagen, Denmark - resulting from hypothetical releases at selected nuclear risk sites in the Euro-Arctic region as a function of distance, annual average ^{137}Cs time integrated air concentration, dry, wet, and total depositions was estimated by *Mahura et al., 2005c*. These studies show that a combination of different types of analysis and using results of probabilistic long-term trajectory and dispersion modelling from the selected risk sites, can provide a more detailed level, quality, and accuracy in evaluation and ranking of potential impact on both geographical localized area (city, site, etc.) and region (country, county, etc.).



(a) (b)

Figure 2. Winter summary (a) dry and (b) wet deposition fields of SO_4 resulting from continuous releases of atmospheric pollution from the Nickel smelter (NPN) of the Pechenganickel Enterprise.

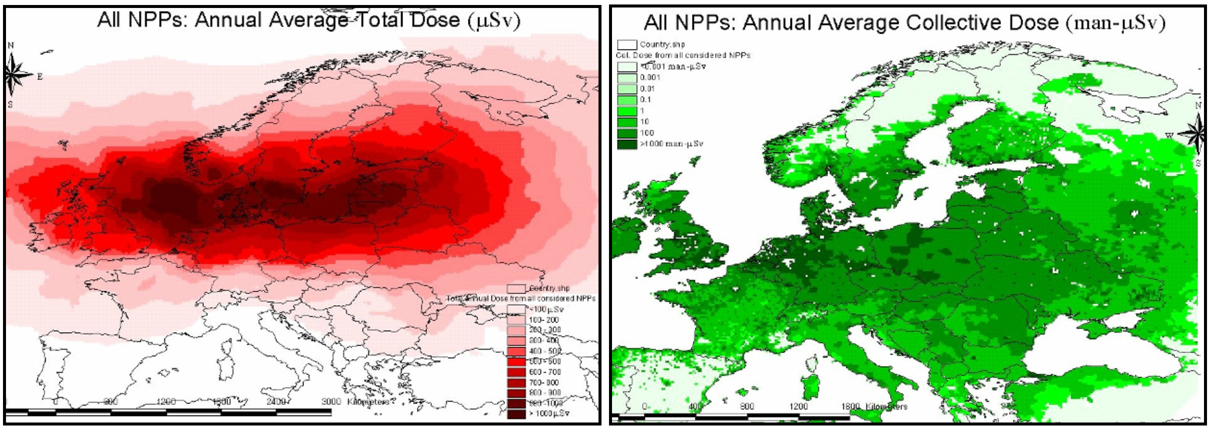


(a) (b)

Figure 3. Monthly variability of (a) dry and wet depositions and (b) deposited amount of pollution [in % from daily released] at 95% confidence interval during atmospheric transport and deposition from the Nickel plant of the Pechenganickel Enterprise.

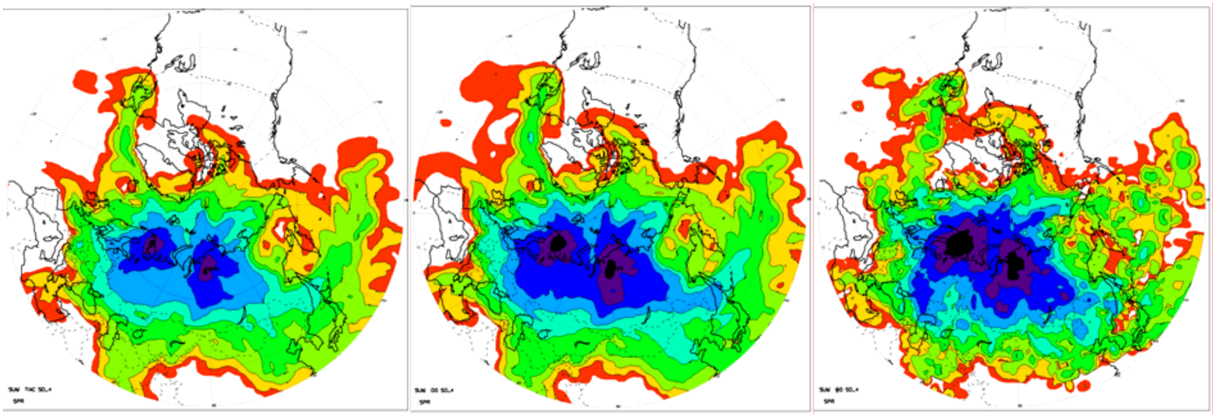
Here, several examples with respect to use and evaluation of dispersion modelling results will be shown. For example, for the source of nuclear danger such as the Chernobyl nuclear power plant (Ukraine), the average annual and seasonal (spring vs. winter) dry and wet deposition fields are shown in Figure 1. In general, the DD and TIAC have a similar structure compared with WD. Around the site both have a distribution which is closer to elliptical than circular; and moreover, the shape of these fields reflects the presence of dominating atmospheric transport patterns throughout the year. The WD field is less smooth and often has a cellular structure, because it reflects the irregularity of the rainfall patterns. Moreover, these fields have also different monthly spatial structures.
For the source of chemical pollution on example of the Cu-Ni smelter (Nickel plant) of the Pechenganickel

Enterprise (Kola Peninsula, Russia), the seasonal (winter) deposition fields are shown in Figure 2.
For example, for the Nickel smelter, the annual average daily dry deposition value is 5.9 ton. The highest average DD (10 ton) is in September, and the lowest – 2.5 ton – in February (Figure 3a). The annual average daily wet deposition is 21.6 tons, and a strong month-to-month variability is seen compared with dry deposition. The contribution of wet to the total deposition is almost similar to dry during July-September, but it is more than 13 times higher during January-March. The highest average WD (47 ton) is in January, and the lowest – 4 ton – in July. Considering the amount deposited in total from daily releases (Figure 3b), the annual average is 31.7% ranging from 12.2 to 58.5% in July and January, respectively. The lowest maximum of 29.6% is observed in July and the highest minimum of 20.7% - in February.



(a) (b)

Figure 4. Annual average (a) individual/total dose and (b) collective doses resulting from the accidental release of the selected nuclear power plants in the Euro-Arctic region.



(a) (b) (c)

Figure 5. Spring summary (a) time integrated air concentration, (b) dry deposition, and (c) wet deposition patterns resulting from the continuous emission of SO_4 from the Pechenganickel, Severonickel, and Norilsk Nickel Enterprises.

Such deposition fields can be constructed and evaluated in such a manner also for any other potential sources both individual and combined (as shown for example in Figures 4-5) for the selected nuclear risk sites of the Euro-Arctic region and Cu-Ni smelters of the Russian North. The evaluation of combined effects is done by summation of fields simulated. As shown in Figure 4, for the nuclear risk sites both the individual and collective doses for man due to several factors (inhalation, ingestion, etc.) can be estimated taking into account the population distribution and integrating simulated fields into GIS (*Mahura et al., 2006*).
Similarly, the geographical extension and levels of potential impacts due to atmospheric transport and deposition of sulphates on the population and environment resulting from continuous emission from smelters (of the Pechenganickel, Severonickel, and Norilsk Nickel Enterprises) are shown in Figure 5 (on examples of time integrated air concentration and deposition fields during spring); and these can be estimated on the regional and hemispheric scales. The monthly and seasonal variability can be also evaluated for simulated fields.

Concluding remarks

We suggest that the methodology developed and tested in this study can be successfully applied for other sites of concern such as chemical, biological, and natural hazards, for assessments of long-term impacts from existing emission/ release sources of different kinds of pollutants as well as for environmental problems of wider spectra.

Since the DMI has meteorological archives of the high resolution data, uses routinely operational and climatological simulated meteorological fields and performs simulations with modern sophisticated supercomputing facilities, the practical contribution into the Enviro-RISKS coordination activities and collaboration can be, at least, related to the following on-gong research projects: "*Studying of ecological consequences of nuclear explosions at the firmer Semipalatinsk test site*", "*Development of models and methods for revealing and studying the regions of increased ecological risk taking the Siberian region as an example*", "*Mathematical modelling of consequences of catastrophic high temperature releases*", etc. For the sites of chemical and nuclear risk considered in these studies the long-term and short-term modelling of atmospheric transport and deposition patterns can be simulated and evaluated on different temporal and spatial scales.

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1.3. Zakarin E.A., T.V. Dedova: Development of GIS Technology for Monitoring and Modeling of Dust Storm

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Abstract
Problems of analysis and control of dust storm are very important for Kazakhstan and many other countries with desert and semi-desert territories. The method combining the GIS, mathematical modeling, and remote sensing was developed. The results of space monitoring and modeling of the Aral Sea dust storm illustrate the efficiency of the method. The procedure will be used in the system of the disaster situation monitoring.

1 Introduction

The dust (sand) storms are the spontaneous natural phenomena. As well as all dangerous weather phenomena, presently they are remained poorly investigated because of complexity of measurements of large number of atmospheric parameters, which determine their occurrence and development. Extensiveness of territories and dynamism of processes dictate the use of modern methods of mathematical modeling and remote sensing [1].

At present, the works by carrying out the space monitoring and modeling of dust storms have been executed within the framework of the State Programme "Development of space activity in the Republic of Kazakhstan for 2005-2007" according to the mission "Build up Inter-brunch GIS using remote sensing and cartographic methods". The main aim of project is the observation and forecasting of meteorological natural disaster. During the project performance the program modeling complex is developed, which with a sufficient accuracy describes aerosol removal during dust storms. The developed mathematical model is adapted for real conditions and allows estimating such major factors as removal of aerosol volume, removal distance, particles quantity which deposited on a surface, etc.

2 Calculation of aerosol emission from ground surface

The modeling of aerosol emission from the ground surface proposes requires the following research works:

- ground surface classification with an exposure of potentially possible areas of sand-salt storms;
- analysis of sand surface's dispersed structure;
- wind flow ability for the particle's emission.

The sand mask and the map of capability of sand emission were built as a result of processing of remote sensing data and field work data.

The sand (or salt) surface's deflation process can spring out only at an excess of some critical threshold wind speed, u_k. For the critical dynamic velocity calculation the Bagnold's formula was taken [2]:

$$u_{*k} = 0.1\sqrt{[(\rho_s - \rho_a)/\rho_a]gd} \qquad (1)$$

where $d = x_0 \exp(-5.3\sigma^3_{\lg x})$ is the middling modal particles' dimension, $\sigma_{\lg x}$ - the standard deviation of the particles dimension's logarithms, ρ_a, ρ_s - air and sand density respectively; g – gravitational acceleration.

It is possible to define the intensity of the surface source Nw_0 by the Byutner's formula [3]:

$$Nw_0 = \alpha(u_*)^n \qquad (2)$$

where α is the dimensional coefficient, n changes from 2 to 3. Emission velocity $w_0 = 2u_*$ at $u_* > u_{*k}$ and $x_0 \le 100$ mcm.

3 Modeling of dust storms plumes

The space images visual analysis of dust storm episodes has pointed to the following features:

- wind fields are space homogeneous. It is the result of the plain terrain and the high wind velocities which smooth the influence of the temperature heterogeneity of the ground surface;
- the aerosol clouds are the plume superposition from multiple sources situated on the surface;

- it is impossible to estimate the degree of turbulent dispersion a priori, since the boundary washing out of the overall aerosol flow can be related with the joint impact of some single plumes close to the border.

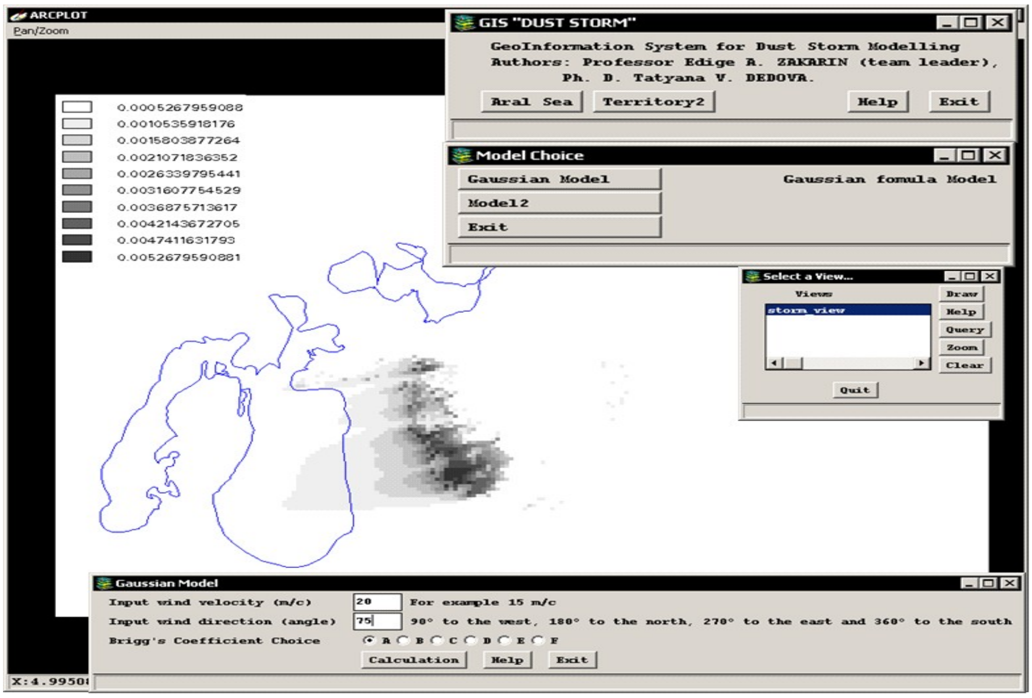

Figure 1. The example of dust storm modeling system.

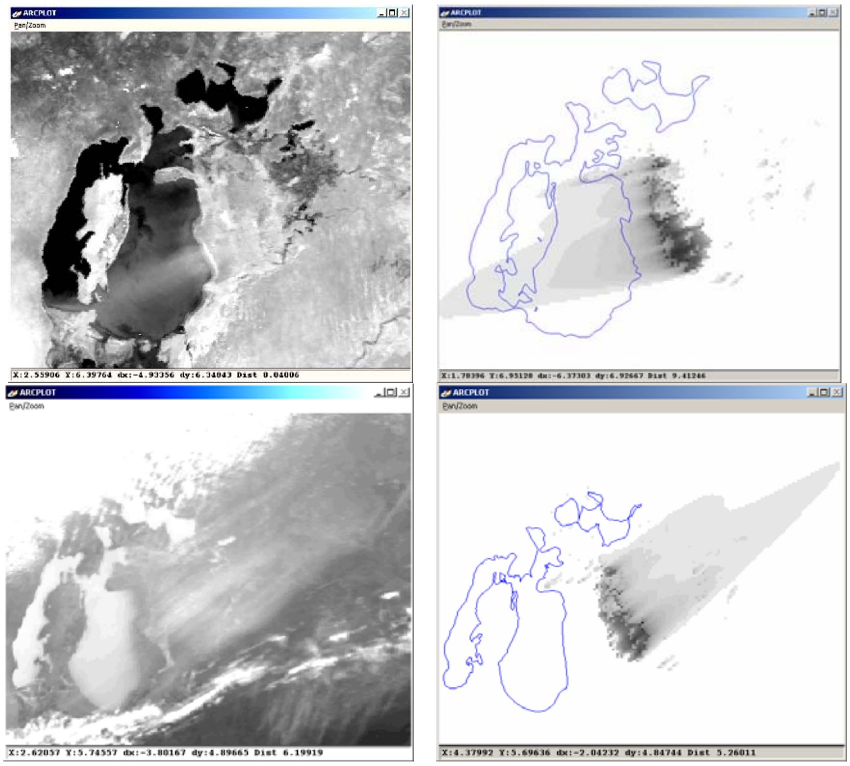

Figure 2. The comparison of modeling results with satellite remote sensing data. In the left column – images from the NOAA satellite with visible plume of sand and salt removing from the Aral Sea dried bottom, in the right column – modeling results of mass aerosol concentration's distribution in atmosphere /top – 18 September 1998; bottom – 9 April 2002/.

Such preliminary analysis and also the problem with the information support determined the choice of the Gaussian plume model as the base for the dust storms calculation. Series of suppositions were made for the

construction of calculated algorithm. First, all the sources are situated at height of the saltation layer, *h*, i.e. the particles which overcame the surface layer are involved in the airflow. Second, the whole territory is divided into two types – "dry land" (where full particles' reflection from the surface is intended) and "water" (with conditions of full absorption). Third, the plumes from multiple sources spread independently and it is possible to calculate the total aerosol concentration by a simple summation of single plumes.
These assumptions underlie for the common model of aerosol emission. It is built as a logical scheme, the main elements of which are the Gaussian formulae for different territorial conditions. The definition of dispersions σ_y and σ_z were determined by the Briggs' formulae [4] for different classes of atmospheric stability.
The described method was based on software GIS „Dust Storm"(see Figure 1), and it was applied for simulation of aerosol emission and transfer from the Aral Sea dried bottom. The fulfilled model's adaptation allowed using model for the calculation of different dust storms episodes near the Aral Sea (see Figure 2).

4 Conclusions

Thus, the GIS-technology of dust storms monitoring and modeling was developed. This technology will be adapted for different territories of Kazakhstan and will be used in the system of the disaster monitoring. We hope it will be effective and actual for development of concrete decisions for territory management.

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1.4. Mirkarimova B.M.: Geographic Information Systems Technology for Monitoring and Modeling of Air Pollution due to Burning of Hydrocarbons

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Abstract

One of the main ecological problems of the Northeast Caspian Sea is considered. This is burning of oil and oil products at planned works (i.e. burning of associated gas in flares) and accidents. Monitoring of these processes is carried out by a combination of remote sensing methods and mathematical modelling. The methodology is used for task of burning associated gas in flares and accidents on the oil pipeline, accompanying by burning of the oil pervaded ground.

1 Introduction

The Caspian Sea is a very sensitive ecosystem. Recently, the sea (especially, the northeastern part) is heavily pressed by the oil and gas industries. In solution of related environmental problems the important place belongs to monitoring. At present time in Kazakhstan within the framework of the State Programme "Development of space activity in the Republic of Kazakhstan for 2005-2007" the system of space monitoring is developed. One of the tasks of this program is development of monitoring methods of environmental pollution, including air pollution and their inclusion in structure of the Inter-Branch Geoinformation System.

2 Methodology

The procedure of space monitoring of atmospheric pollution in the burning of hydrocarbons at the objects of oil and gas extraction and oil refinery consists of the following stages:

1. The detection of the flares and fires according to space monitoring from the satellites called Terra/MODIS and Aqua/MODIS.
2. The calculation of weight and structure of the burning products entered the atmosphere.
3. The short-range forecasting (from 6 to 120 hours) of pollutant transfer and dispersion in the atmosphere.

2.1 Detection of flares and fires using remote sensing data

The detection of the flares and burning oil wells was carried out using remote sensing data from the satellite Terra/MODIS. Such space images can be obtained with a high frequency (several times per day) and a large spectral resolution (36 channels in visible area of the spectrum). Space images processing up to the level of the “Fire Masks” was carried out with using of the ScanEx Image Processor program.

2.2 Calculation of pollution emissions at burning of hydrocarbons

There are two variants of burning hydrocarbons at the oil and gas extraction: burning of associated gas in flares and burning of spilt oil forms.
For calculation of the flares emissions the certificated program called "PNG-ECOLOG” (Company "Integral", St.-Petersburg, Russia) was used.
The emissions calculation for free burning oil and oil products is made for the following situations:

- burning of oil and oil products on the surface “liquid – atmosphere”;
- burning of the oil pervaded ground;
- combined case of the burning oil and oil products.

In all listed cases, for the emissions calculation the program “BURNING of OIL” was used.

2.3 Calculation of air pollution

The calculation of pollutant transport and diffusion was carried out by the numerical solution of the equations of mass conservation on a basis of the prognostic wind fields received from ECMWF.

The equations of mass conservation describing air pollution and used as a mathematical basis for model (*Zakarin, Mirkarimova, 2000*) are the following:

$$\frac{\partial C}{\partial t} + div(C\mathbf{u}) + \sigma C = \mathbf{K} \bullet \Delta C + f \,,$$

$$\mathbf{u} = \{u, v\}, \mathbf{K} = \{K_x, K_y\}; \Delta\left\{\frac{\partial^2}{\partial x^2}, \frac{\partial^2}{\partial y^2}\right\},$$

$$\sigma = \frac{1}{H - z_0}\left[\frac{\partial H}{\partial t} - \frac{V_d K_{z_0} \mu_0'}{K_{z_0}\mu_0' + V_d(\mu - \mu_0)}\right], \qquad (1)$$

$$f = \frac{\alpha}{H - z_0}\left[1 - \frac{V_d(\mu - \mu_0)}{K_{z_0}\mu_0' + V_d(\mu - \mu_0)}\right] + Q$$

$$C\big|_\Gamma = 0, \quad at \ V_n < 0 \qquad (2)$$
$$C(0, x, y) = C^0(x, y), \quad at \ t = 0$$

These equations were obtained by averaging over height. All symbols are taken from (*Zakarin & Mirkarimova, 2000).*
While constructing the algorithm of solution, as a rule, a number of difficulties occur, such as development of a proper numerical method that could adequately reproduce real processes of diffusion and transport. When solving the advection equation for positive-definite functions often face a problem of choosing the finite difference equation to meet the requirements of conservation and monotone convergence, and to have a small numerical viscosity and negligible phase error.
Among the great number of available finite difference approximations of the advection equation, the algorithm of *Smolarkiewicz (1984, 1986, 1990)* was chosen. By means of the iteration approach, it is possible to construct, based on the "against the flow" difference equation, a class of nonlinear, positive-definite algo-

rithms of advection. At the first iteration step, the "against the flow" algorithm is used in its classical meaning. Each subsequent correction uses the "against the flow" algorithm again; however, with a specially defined "anti-diffusion" velocity.

Using this mathematical basis the model "Industrial Air Pollution" (IAP) has been realized.

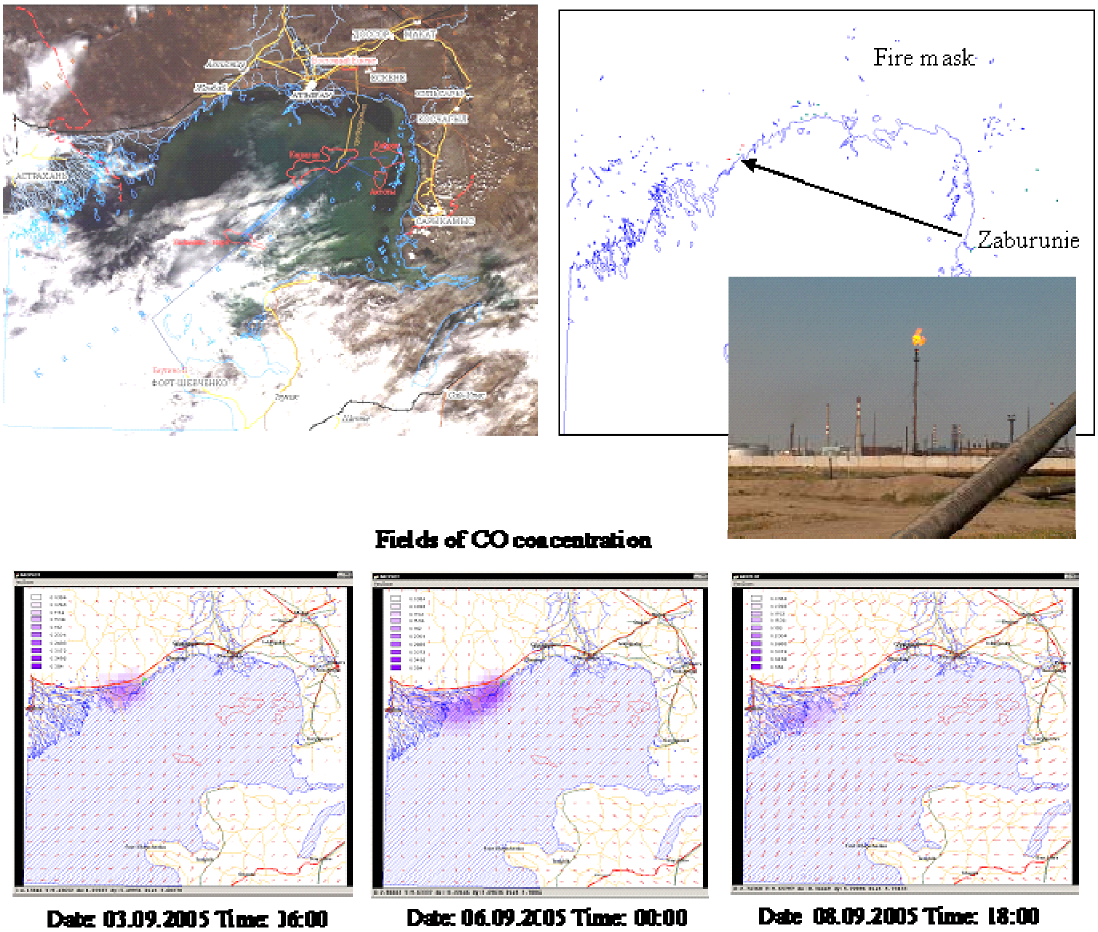

Figure 1. The forecasting of air pollution at the testing of oil well.

3 Results of calculations

At the "KAZGEOCOSMOS" Joint-Stock Company, during two years, there has been carried out the space monitoring of the Northeastern part of the Caspian Sea using the Terra and Aqua satellites (USA). In 2005 the fireplaces in this part of the sea were detected. For example, on 4 September 2005, the burning flare had been detected. The calculation of pollution transport and diffusion in the atmosphere was carried out using air pollution model IAP. In Figure 1 the results of simulation of the atmosphere pollution by carbon oxide and wind field (red arrows) are shown. The calculation was carried out for the forecasting period of 5 days.

4 Conclusions

The developed GIS-technology of air pollution monitoring during the burning of associated gas includes the following:

- space monitoring using the scanner MODIS (satellites Terra, Aqua),
- thematic image processing with purpose of flares identification,
- emissions calculation of burning products,
- forecasting of pollution atmospheric transport for the nearest 120 hours.

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1.5. Penenko V.V.: Methods and Models for Studying and Forecasting Changes in Environment

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Abstract
The project is focused on numerical aspects of problems of large dimensions and on construction of new algorithms for efficient realization of models of atmospheric and water dynamics and environment protection.

1 Introduction and project goal
This is the project N 1.3.2 of the Programme 1.3 “Numerical and informative aspects of the solution of large scale problems” of the Mathematical Division of the Russian Academy of Sciences (Co-coordinators: corresponding member of RAS Yu.P. Popov, and academician of RAS V.P. Dymnikov). The project team consists of the members of the laboratory of the mathematical modeling of hydrodynamical processes in nature of ICMMG.
The primary goals of the project are the following.

- Development of new algorithms for application of basic and adjoint equations for linear and nonlinear dynamics models and functionals;
- Development of a set of the base models for studying the processes in environment;
- Analysis of opportunity to construct the non-iterative algorithms within the frames of splitting and decomposition schemes for realization of models in the regions of complex shape;
- Development of data assimilation procedures for some models on the basis of variational principles (non-iterative procedures are preferable).

2 Methodology
The numerical schemes and algorithms are constructed on the base of variational principles. We consider different aspects of system organization for the:

- specific parallel algorithms;
- algorithms of the orthogonal decomposition of multidimensional and multicomponent fields;
- algorithms of the control and sensitivity theories.

3 Certain of the results
New effective methods are developed for the solution of inverse problems on reconstruction of spatial-temporal structure of the state functions and identification of the model parameters on the basis of the joint use of mathematical models and data of measurements in real time.
The technology of data assimilation is based on a variational principle for non-linear dynamical systems in a combination with methods of splitting and decomposition. The target functional expresses a total measure of uncertainties of models of processes and observations. Contact and remote measurements are considered. The original scheme of constructive realization within the frames of a global variational principle with the use of the local adjoint problems is offered. It provides a high efficiency of algorithms. The theoretical study of the methods is made. The comparative analysis of the efficiency is lead for the offered algorithms, traditional methods of assimilation (the variational method with the global adjoint problems) and methods of the Kalman filtering. New algorithms have shown the highest efficiency.

4 Recommendations

The developed numerical schemes and algorithms can be used for the solution of interconnected problems of the climate and environmental protection .

Acknowledgements

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1.6. Penenko V.V., B.D. Belan, Y.A. Kharitonov: Ecological Problems of Siberian Cities

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Abstract

The multi-disciplinary project concerns with urban problems for typical Siberian cities. The fundamental aspects, which are connected with diagnosis and forecast of environmental quality and human health, are considered. The air, soil, plants and trees, some biological indicators are studied and analyzed.

1 Introduction and project goal

This is the interdisciplinary project N 130 (2003-2005) of the Siberian Branch of the Russian Academy of Sciences. The project partners are the following organizations:

- Institute of Computational Mathematics and Mathematical Geophysics (ICMMG);
- Institute of Atmospheric Optics (IAO)
- Institute of Monitoring of the Climatic and Ecological System (IMCES);
- Institute of Solar-Earth Physics (ISEP);
- Institute of Thermophysics (IT);
- Institute of Theoretical and Applied Mechanics (ITAM);
- Institute of Chemical Kinetics and Combustion (ICKC);
- Institute of Biosystematics and Ecology of Animals (IBEA);
- Institute of Soil and Agrochemistry (ISA);
- Institute of Chemical Biology and Fundamental Medicine (ICBFM);
- Central Siberian Botanic Garden (CSBG);
- Siberian Center of Environmental Research and Training (SCERT)
- Baikal Institute of Nature Management (BINM);
- Central Hospital of SD RAS (CH);
- State Virology and Biotechnology Center “Vector” (SVBC “Vector”);

- West-Siberian Regional Center for Remote Sensing (WSRCRS).

The goal of the project is to fulfill the multidisciplinary research which can help to clarify the questions: how cities change hydrothermodynamical behavior and composition of atmosphere, and how these changes affect the quality of life, public health, and quality of environment.
Main objectives of the project:

- To create a methodology for integration and synthesis of multidisciplinary knowledge on the bases of information and modeling technologies;
- To create a method of conducting of multidisciplinary ecological examinations of acting and planned potentially dangerous objects;
- To develop a methodology of directed and targeted monitoring on the base of the remote sensing as well as on the air-board and ground based stationary and mobile laboratories;
- To reveal biological indicators for assessment of the environmental quality and to study their variability with respect to anthropogenic loads;
- To develop schemes of city territories zoning according to the environmental risks degree, biosphere and human fragility;
- To develop a complex of models and a system for modeling of mesoclimate and pollution transport in a typical city against a background of dynamically changing large-scale processes;
- To investigate possible changes of city mesoclimates and environmental quality following a change of land use regimes;
- To develop a method of exposure of prerequisites for environmentally negative situations under conditions of city mesoclimates;
- To develop a method of assessment of toxic transformation products for typical ranges of preceding substances in the city atmosphere.
- To develop a mathematical model of chemical block for complex environmental model of Siberian cities.

2 Methodology

Each scientific area uses its own methodology. To integrate the knowledge from different disciplines, information and modelling technologies are used. The methodology of adaptive and targeting observations is developed. The comprehensive mathematical models and specific numerical algorithms are constructed for joint use of the models and all available data. The variational approach gives the bases for construction of computational technologies.

3 Main results

The studies on development of the concept and methods of realization of the complex ecological expertise of the current state and tendencies of changes of the environment quality and life conditions in cities and industrial regions are fulfilled . Some aspects of the fundamental and applied character are considered.

- Theoretical research of the basic mechanisms of migration as well as the chemical and photochemical transformations of polluting substances in the atmosphere, in a view of sedimentation on a non-uniform underlying surface, are fulfilled for the purpose of studying their influence on ecosystem elements.
- New versions of numerical models are developed for studying the processes of hydrodynamics of the atmosphere, transport and transformation of impurity from the sources of natural or anthropogenic origins; the techniques of estimations of ecological risks are developed.
- Key elements in various ecosystem levels necessary for understanding the essence of studied processes are revealed.
- Data in all parts of the project are collected and analyzed. They describe a modern state of the environment and focus on revealing the indicators of changes in environment and human health in Siberian cities. The scenario calculations on concrete objects are added to observations.
- Some complex observational experiments were made for monitoring environment conditions in the cities of Irkutsk, Angarsk, Usolye-Siberskoye, Tulun, Nizhneudinsk, Taishet, Kansk, Krasnoyarsk, Achinsk, Tomsk, Novosibirsk, Ulan-Ude, and Norilsk. The analyses of the results have shown presence of both the common and specific features of the Siberian cities.
- Estimations of ecological prospect for Siberian Federal District (SFD) are fulfilled. In particular, ecological risks connected with an exchange of pollution between the large cities are estimated. The cities

are considered as the aggregated sources and receptors. The risk scenarios were calculated by means of regional numerical models in the inverse mode. The results of calculations were provided for the administration of the Novosibirsk region and SFD.

- For various cities of Siberia the estimations of erythema radiation doses and variability of intensity of ultra-violet radiation of the Sun are produced. The UV radiation impacts on parameters of health and ecosystem efficiency.
- For Novosibirsk and region the monitoring of the atmosphere is supplemented by a complex of the studies of the snow cover, soil, and biotopes in places with various levels of anthropogenic load. The microbiological studies of the air, ground, snow, and leaves of trees have also been done. The emission monitoring at the energy enterprises are carried out. The maps of spatial distribution and the state of the lichens were drawn. The lichens accumulate the long-term pollution; and therefore, can be considered as indicators of the pollution levels. Mathematical modelling of typical mesoclimates and quality of the city atmosphere were produced. The scenarios of possible traces of active bioaerosols into the Novosibirsk region were calculated. The scenarios of potentially possible "supernumerary" situations with distribution of pathogenic bioaerosols to the city centre were simulated.

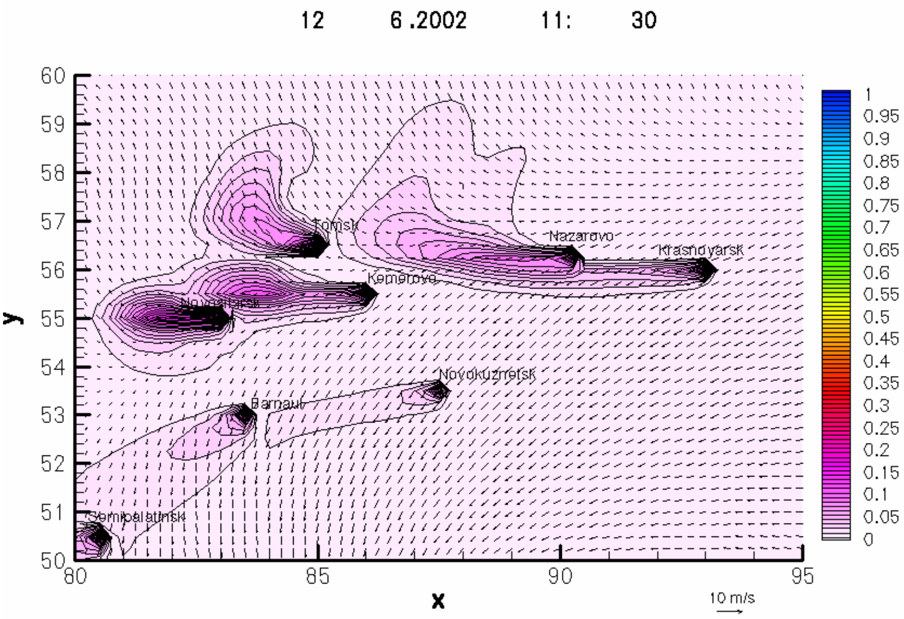

Figure 1. The fragment of the 4D risk function (relative units) and velocity vector (m/s) for the cities of Siberian Federal District. Surface level /x – longitude, y – latitude/.

- The structure of human morbidity with respect to types of illness as well as to the age groups in various districts of the Novosibirsk Academgorodok for 1996-2003 were analyzed;
- Thematic databases and some results of the research under the project can be found on the bilingual site of scientific and educational portal ATMOS "Estimation and management of the air quality" (http: // ess.atmos.scert.ru/) which is realized for the city of Tomsk taken as an example.

4 Problems and recommendations

- There is a lack of analytical tools for operational consideration of current changes in safety restriction and criteria, as well as for assimilation of data, received from the current observations and measurements, into the models of large dimensions. These are so called the "real time" problems.
- The principal difficulty in the integrated analyses of risks, socio-economical and population health problems is the limitation or even absence of general metrics for differential consideration of various agents and factors.

So, the future evolution of the project should be directed to the solution of the above mentioned problems. In this sense the variational methodology might be used for creation of new methods for management of environmental quality and risks from a point of view of sustainable development. It is a new class of problems of the multi-criteria optimization of high dimensions with multiple limitations of different character (economical, ecological, health, etc.). Because it is a multi-disciplinary task, the involvement of scientific community from different fields of research activities will be essential.

It could be useful to involve into project activity the partners from industrial cities of Kazakhstan (Ust-Kamenogorsk and Semipalatinsk) where climatic and weather conditions are similar to those of the Siberian cities.

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1.7. Penenko V.V.: Development of Models and Methods for Revealing and Studying Regions of Increased Ecological Risk taking Siberian Region as Example

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Abstract
The project is devoted to the construction of models and methods for revealing prerequisites for the occurrence of ecological disasters and prognosis of their consequences. The applications of the models are made for the Siberian region.

1 Introduction and project goal
This is the project of the Programme N13 of the Russian Academy of Sciences “Change of environment and climate: natural disasters” (Co-ordinators: academician N.P. Laverov, Vice-president of RAS, academician

of RAS G.S. Golytsin). The project team consists of the members of the laboratory of the mathematical modeling of hydrodynamical processes in nature of ICMMG.
The primary goal of the project is development of the models and methods for revealing and studying the regions of increased ecological risk taking the Siberian region as an example.

2 Methodology

The variational technique in a combination with sensitivity and control theory is applied.
A methodology for the construction of the long-term scenarios is proposed to carry out the studies of development of hydrodynamical situations in the atmosphere and estimation of the air quality in the regions in a view of global dynamics of the climatic system with use of the available actual information.

3 Main results

New effective methods for the solution of inverse problems are developed for estimation of areas of risks and vulnerability of territories in relation to pollution of a natural and anthropogenic origin. These methods are based on variational principles for nonlinear dynamic systems and methods of sensitivity theory for assessment of variations of the functionals. They give a basis for quantitative estimations of risk at the determined and stochastic fluctuations of external sources and parameters of the models, which are responsible for the formation of the observed and simulated behavior of the climatic and ecological systems. In comparison with the methods of forward modelling the basic advantage of the proposed approach consists of the fact that the data on sources of emission are not required for assessment of risk/vulnerability of the territories-receptors. At the same time, if there are data about source releases, the developed technique allows calculating the volume of pollutants which come into the zone-receptor from each source. This can be done directly through the sensitivity functions. Besides by means of special sensitivity functions it is possible to compare the risks caused by perturbations of various factors.

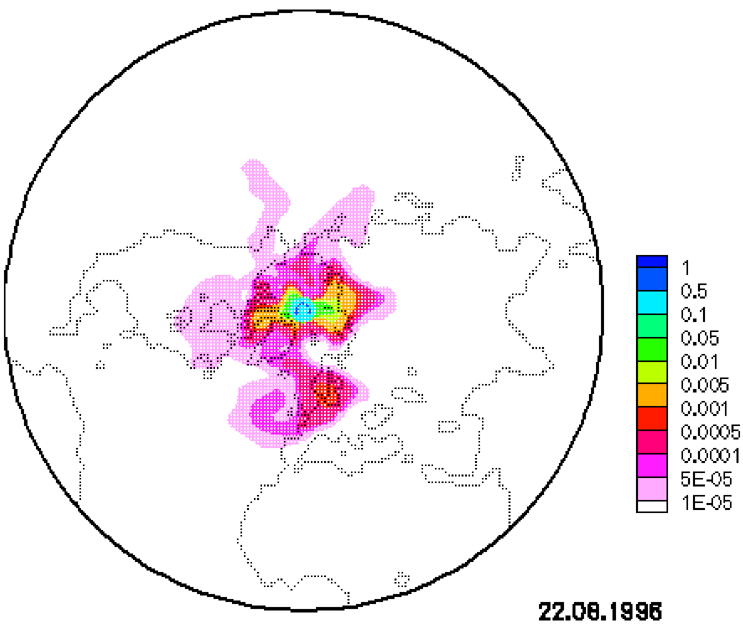

Figure 1. The fragment of 4D risk function (relative units) for the Arctic region to be polluted by the surface sources of the Northern Hemisphere.

The studies are made for the Siberian region taken as an example. Some objects playing the roles both sources and receptors of pollution are analyzed on modelling scenarios. For these purposes the set of models elaborated in ICMMG is used. The mathematical models are intended for the solution of the interconnected problems of ecology and climate on the global, regional, and mesoscales.
The territories under the study are the Arctic region, the Lake of Baikal region, and the Siberian Federal District (SFD). Estimations of the risk areas receiving pollution through the atmosphere of the Arctic region from the sources, which are located in the Northern Hemisphere, are executed (Figure 1).

The role of the Lake of Baikal as a climate-forming factor in the region is investigated. By means of the solution of forward and inverse problems the influence of this lake on change of characteristics of the hydrological cycle (water vapor, cloud water, rain water,etc.) in the atmosphere of the East–Siberian region have been studied.
The risk areas for the lake to be polluted from operating and potentially possible sources were calculated. Computer animations of scenarios were created. These demonstrated the development of situations and time-space evolution of the risk/vulnerability areas in dynamics (Figure 2).

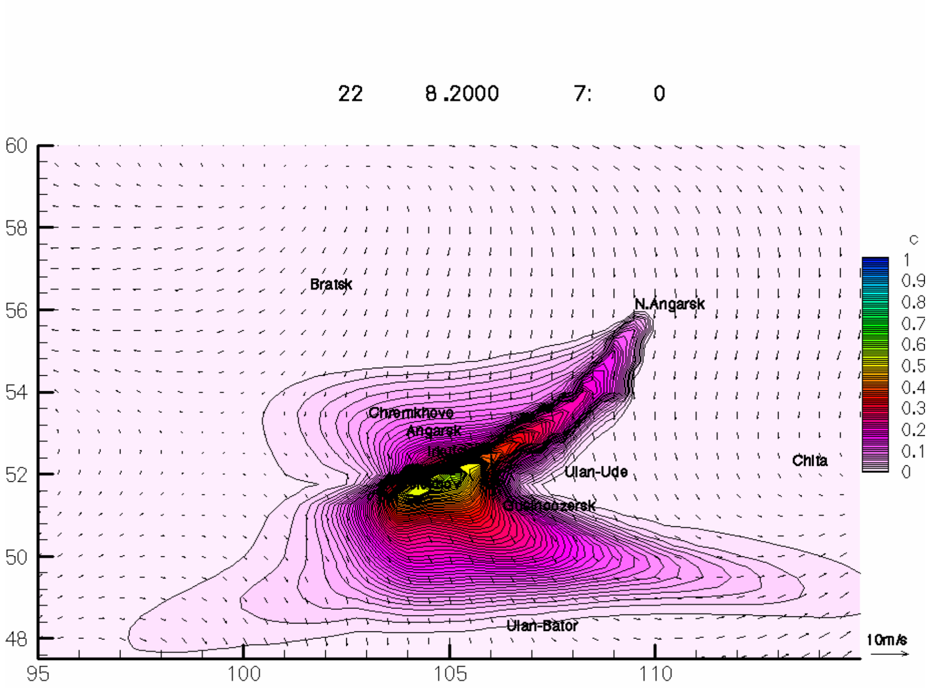

Figure 2. The fragment of the 4D risk function to receive the pollution in the atmosphere over the Lake of Baikal water area from the surface sources located in the region /Arrows show the wind field (m/s)/.

4 Recommendations

The proposed methodology for risk assessment and construction of the long-term hydrodynamical scenarios can be recommended to bring the influence of the global characteristics of the climatic system to the regional level.

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1.8. Baklanov A.A.: Integrated Systems for Forecasting Urban Meteorology, Air Pollution and Population Exposure (FUMAPEX)

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1 Introduction

The main problem in forecasting urban air pollution (UAP) is the prediction of episodes with high pollutant concentration in urban areas where most of the well-known methods and models, based on in-situ meteorological measurements, fail to realistically produce the meteorological input fields for the UAP models.

UAP models in operational Urban Air Quality Information and Forecasting Systems (UAQIFS), as a rule, use simple in-situ meteorological measurements which are fed into meteorological pre-processors. Lacking an adequate description of physical phenomena and the complex data assimilation and parameterizations of numerical weather prediction (NWP) models, these pre-processors do not achieve the potential of NWP models in providing all the meteorological fields needed by modern UAP models to improve the urban air quality forecasts. However, during the last decade substantial progress in NWP modelling and in the description of urban atmospheric processes was achieved. Modern nested NWP models are utilizing land-use databases down to hundred meters resolution or finer, and are approaching the necessary horizontal and vertical resolution to provide weather forecasts for the urban scale. In combination with the recent scientific developments in the field of urban sublayer atmospheric physics and the enhanced availability of high-resolution urban surface characteristics, the capability of the NWP models to provide high quality urban meteorological data will therefore increase.

Despite the increased resolution of existing operational NWP models, urban and non-urban areas mostly contain similar sub-surface, surface, and boundary layer formulation. These do not account for specifically urban dynamics and energetics and their impact on the numerical simulation of the atmospheric boundary layer and its various characteristics (e.g. internal boundary layers, urban heat island, precipitation patterns). Additionally, NWP models are not primarily developed for air pollution modelling and their results need to be designed as input to urban and mesoscale air quality models.

Therefore, due to the above mentioned reasons, the situation in UAQIFS is changing nowadays and requires a revision of the conventional conception of urban air pollution forecasting.

Following the above mentioned research needs, a new European Union research project "Integrated Systems for Forecasting Urban Meteorology, Air Pollution and Population Exposure" (FUMAPEX) was initiated by scientists of the COST Action 715 in the bounds of the Fifth Framework Programme (FP5), Sub-programme: Environment and Sustainable Development, Key Action 4: City of Tomorrow and Cultural Heritage. FUMAPEX is a member of the CLEAR cluster of European Urban Air Quality Research (http://www.nilu.no/clear).

2 Main objectives

The main objectives of FUMAPEX (Nov. 2002 – Nov. 2005) are to improve meteorological forecasts for urban areas, to connect numerical weather prediction models to urban air pollution and population exposure (PE) models, to build improved Urban Air Quality Information and Forecasting Systems, and to demonstrate their application in cities subject to various European climates. The FUMAPEX scheme of the improvements of meteorological forecasts in urban areas, interfaces and integration with UAP and PE models for the UAQIFS is presented in Figure 1.

The improvement of urban meteorological forecasts will also provide information to city management regarding additional hazardous or stressing urban climate (e.g. urban runoff and flooding, icing and snow accumulation, high urban winds or gusts, heat or cold stress in growing cities and/or a warming climate). Moreover, the availability of reliable urban scale weather forecasts could be of relevant support for the emergency management of fires, accidental toxic emissions, potential terrorist actions etc.

In order to achieve the innovative project goal of establishing and implementing an improved new UAQIFS to assist sustainable urban development, the following steps will be achieved:

1. improve predictions of the meteorological fields needed by UAP models by refining resolution and developing specific parameterizations of the urban effects in NWP models,
2. develop suitable interface/meteorological pre-processors from NWP to UAP models,
3. validate the improvements in NWP models and meteorological pre-processors by evaluating their effects on the UAP models against urban measurement data,
4. apply the improved meteorological data to UAQIFS, emergency preparedness and population exposure models and compare and analyze the results, and
5. successfully link meteorologists/NWP modelers with urban air pollution scientists and the 'end-users' of UAQIFS.

3 Workpackages and teams

The necessary steps are evolved in ten separate, but inter-linked Work Packages (see below) realized by 16 participants and 6 subcontractors. They represent the following NWP centers, research organizations, local/city authorities from ten European countries: Danish Meteorological Institute coordinator (A. Baklanov, A. Rasmussen), German Weather Service (B. Fay), Hamburg University (M. Schatzmann), Centro De Estudios Ambientales Del Mediterrano (M.M. Millàn), Ecole Centrale de Nantes (P. Mestayer), Finnish Meteorological Institute (J. Kukkonen), ARIANET (S. Finardi), Environmental Protection Agency of Emilia-Romagna Region (M. Deserti), Norwegian Meteorological Institute (N. Bjergene), Norwegian Institute for Air Research (L.H. Slordal), University of Hertfordshire (R. Sokhi), INSA CNRS-Universite-INSA de Rouen (CORIA, A. Coppalle), Finnish National Public Health Institute (M. Jantunen), Environmental Protection Agency of Piedmont (F. Lollobrigida), Joint Research Center (A. Skouloudis), Swiss Federal Institute of Technology (A. Clappier, M. Rotach), and subcontractors: S. Zilitinkevich (Uppsala University), G. Schayes (Université catolique de Louvain), Danish Emergency Management Agency (S.C. Hoe), Helsinki Metropolitan Area Council (P. Aarnio), Norwegian Traffic Authorities (P. Rosland), Municipality of Oslo (I. Myrtveit).

The Work Packages (WP) structure is the following:

WP 1: Analysis and evaluation of air pollution episodes in European cities (lead by J. Kukkonen, FMI)
WP 2: Assessment of different existing approaches to forecast UAP episodes (lead by R.S. Sokhi, UH)
WP 3: Testing the quality of different operational meteorological forecasting systems for urban areas (lead by B. Fay, DWD)
WP 4: Improvement of parameterisation of urban atmospheric processes and urban physiographic data classification (lead by A. Baklanov, DMI)
WP 5: Development of interface between urban-scale NWP and UAP models (lead by S. Finardi, Arianet)
WP 6: Evaluation of the suggested system (UAQIFS) to uncertainties of input data for UAP episodes (lead by N. Bjergene, DNMI)
WP 7: Development and evaluation of population exposure models in combination with UAQIFS's (lead by M. Jantunen, KTL)
WP 8: Implementation and demonstration of improved Urban Air Quality Information and Forecasting Systems (lead by L.H. Slørdal, NILU)
WP 9: Providing and dissemination of relevant information (lead by A. Skouloudis, JRC)
WP10: Project management and quality assurance (lead by A. Rasmussen, DMI).

4 Project implementation

The project is proceed through the steps given below, each of which can be considered as a separate objective providing valuable results:

CLASSIFICATION OF AIR POLLUTION EPISODES FOCUSING ON RELEVANT METEOROLOGICAL VARIABLES.

- Identification and classification of various types of air pollution episodes in cities located in different European climatic and geographic regions.
- Key pollutants relevant to EU Air Quality Directives and Daughter Directives (EC/96/62; EC/99/30) will be selected for different regions/city characteristics.
- Classification of meteorological conditions leading to pollution episodes and identification of the more relevant meteorological parameters to define these conditions in various European climatic regions.

- Compilation and analysis of existing datasets of concentration and meteorological data measured during pollution episodes in different European climatic and geographic regions.

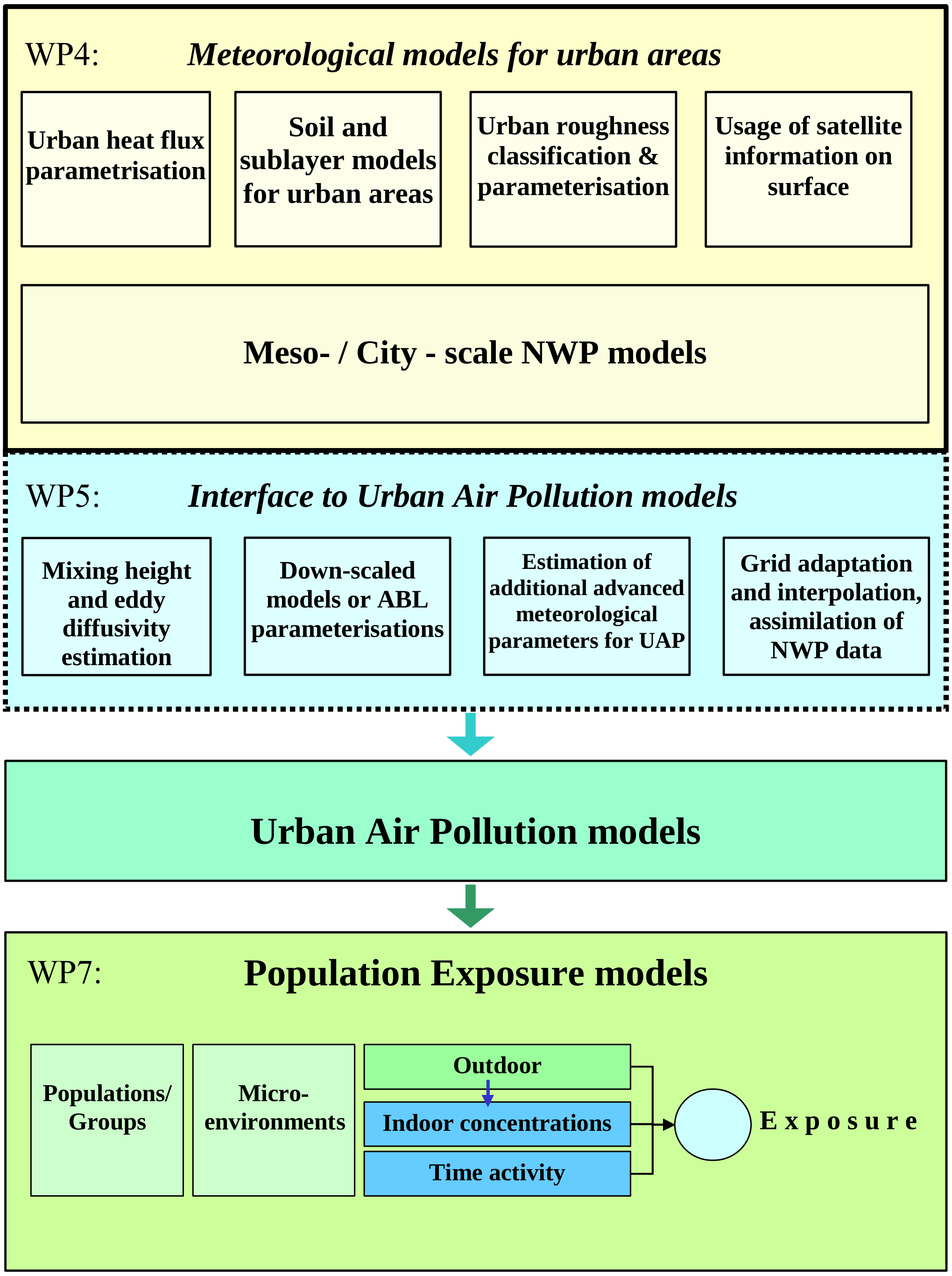

Figure 1. FUMAPEX scheme of the improvements of meteorological forecasts (NWP) in urban areas, interfaces and integration with urban air pollution (UAP) and population exposure (PE) models for the Urban Air Quality Information Forecasting and Information Systems (UAQIFS).

IMPROVEMENT OF THE QUALITY OF URBAN METEOROLOGICAL FORECASTING FOR URBAN AIR POLLUTION AND POPULATION EXPOSURE MODELS

- Improvement of urban weather forecasts and calculation of key meteorological parameters for pollution episodes. A hierarchy of NWP models from large scale global circulation models to local-scale obstacle-resolving meteorological models will be employed.
- Improvement of boundary layer formulations/parameterizations and physiographic data description for urban areas.

- Development of assimilation techniques with satellite remote sensing data in NWP models.
- Development of interfaces to connect NWP to UAP models.

VERIFICATION OF THE IMPROVED NWP, UAP, AND PE MODELS

- Evaluation of improved urban meteorological forecast models based on urban air pollution episode.
- Estimation of sensitivity of UAP models to uncertainties in meteorological input data.
- Evaluation of the impact of the improved output of the UAQ models on simulations of an urban population exposure (PE) model.

APPLICATION OF UAQIFS AND EMERGENCY SYSTEMS

- Integration of the improved NWP, UAP and PE models into UAQIFSs. Implementation of the new improved UAQIFS in air quality forecasting mode to be applied in four target cities, in urban management or public health and planning mode in one selected target city, and of the emergency preparedness system in one selected target city.

Six **target city** candidates for the improved systems implementations and corresponding end-users are the following: Oslo (Norway), Turin (Italy), Helsinki (Finland), Castellon/Valencia (Spain), Bologna (Italy), Copenhagen (Denmark).
Current status and recent achievements of the project are published in the following papers and reports.

FUMAPEX References

The complete list of FUMAPEX publications (including conference proceedings and presentations) as well as the below mentioned reports are available on the project web-site: http://fumapex.dmi.dk.

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1.9. Gross A.: Global and Regional Earth-System Monitoring Using Satellite and In-Situ Data (GEMS)

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1 Introduction

Fifteen thousand excess deaths in the heat wave of summer 2003 showed how Europe lacks operational capabilities to provide the adequate medium-range (3-7 day) warnings and adequate short-range (1-3 day) forecasts for such natural disasters.

The GEMS project started in March 2005 and will last until 2009. The project is coordinated by Dr. Anthony Hollingsworth, ECMWF. The goal with the GEMS project is to create a new European operational system. The system shall cover operational monitoring of atmospheric chemistry and dynamics, and an operational system to produce improved medium-range and short-range air-chemistry forecasts.

The project will develop and implement at ECMWF a validated, comprehensive, and operational global data assimilation / forecast system for atmospheric composition and dynamics, which combines all available remotely sensed and in-situ data to achieve global tropospheric and stratospheric monitoring of the composition and dynamics of the atmosphere from global to regional scales (50 km) and covering the troposphere and stratosphere. Operational deliverables will include current and forecast three-dimensional global distributions (four times daily with a horizontal resolution of 50 km) of key atmospheric trace constituents including. Higher resolution chemical weather forecasts will be performed at GEMS partner institutes.

2 Potential users

As illustrated in Figure 1, the GEMS project is driven by the needs of high-level policy users, by the needs of operational regional air-quality and environmental forecasters, by the needs of the GMES service element for information on which to base services, and by the needs of the scientific community. EU policies, directives and standardization initiatives are taken into account. To reach the envisaged operational capabilities for atmospheric dynamics and composition, the GEMS work programme foresees the integration and the pre-operational validation of:

(1) existing research results obtained through previous initiatives of EC, ESA, and national entities,
(2) planned research and technological development results, as they become available, within the other relevant FP6 thematic priorities, ESA, and national entities.

Existing national or international capabilities have been taken into account to develop synergies and provide unprecedented capabilities in global monitoring and forecasting of atmospheric dynamics and composition.

The GEMS consortium consists of :

1. Ten research institutes in 8 countries providing expertise in satellite and in-situ observations for assessing / validating models, expertise in developing models and assimilations of tropospheric and stratospheric chemistry & aerosol, and expertise in inversion methods to estimate sources, sinks and transports.
2. Ten regional modelling centres in 9 countries, most with operational responsibilities for national or regional air-quality forecasts
3. Two international bodies: ECMWF, a global modelling / assimilation centre, supported by 25 European countries, with extensive experience in exploiting satellite and in-situ data for forecast purposes, and the Institute for Environment and Sustainability of the EU Joint Research Centre.

The three categories of GEMS participants have roughly equal weight in the consortium. The GEMS regional centres are a key link in the chain of delivery - they are users of the GEMS global outputs, and they have operational responsibilities to deliver forecasts to provincial and city-level air-quality authorities.

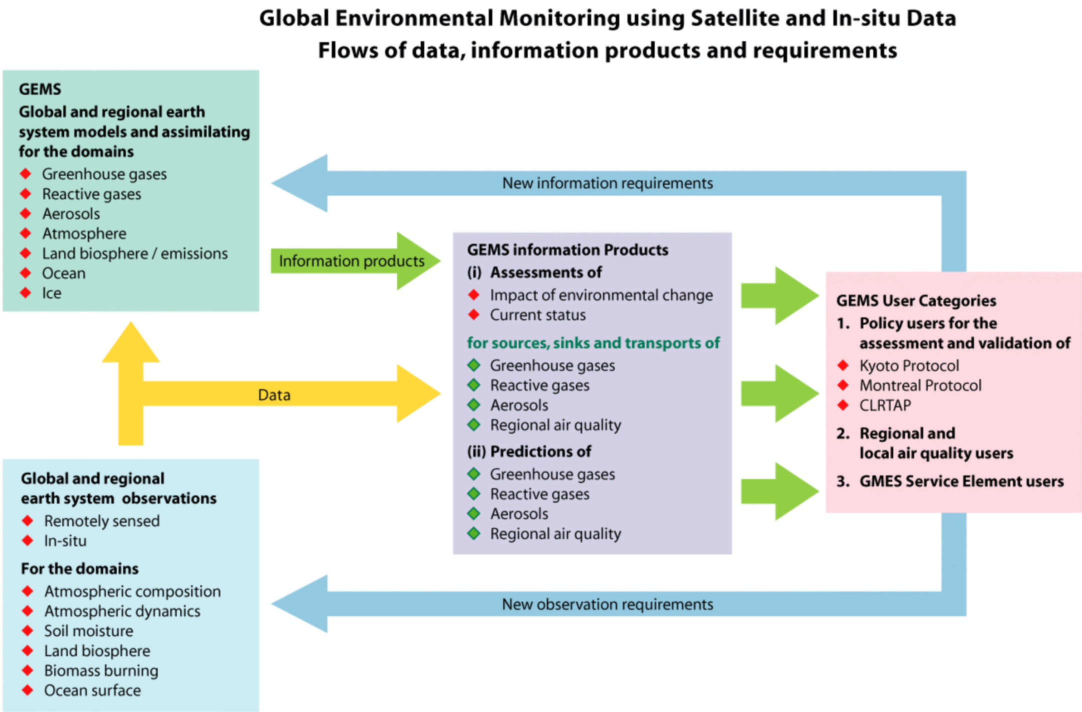

Figure 1. This schematic illustrates the flow in the GEMS project of data, information products and requirements between the Earth Observation systems (lower left), the Earth -system modelling / assimilation systems (top left), the information generation systems (centre) and the Users (right) in the areas of Policy, Regional air quality and the GMES Service Element.

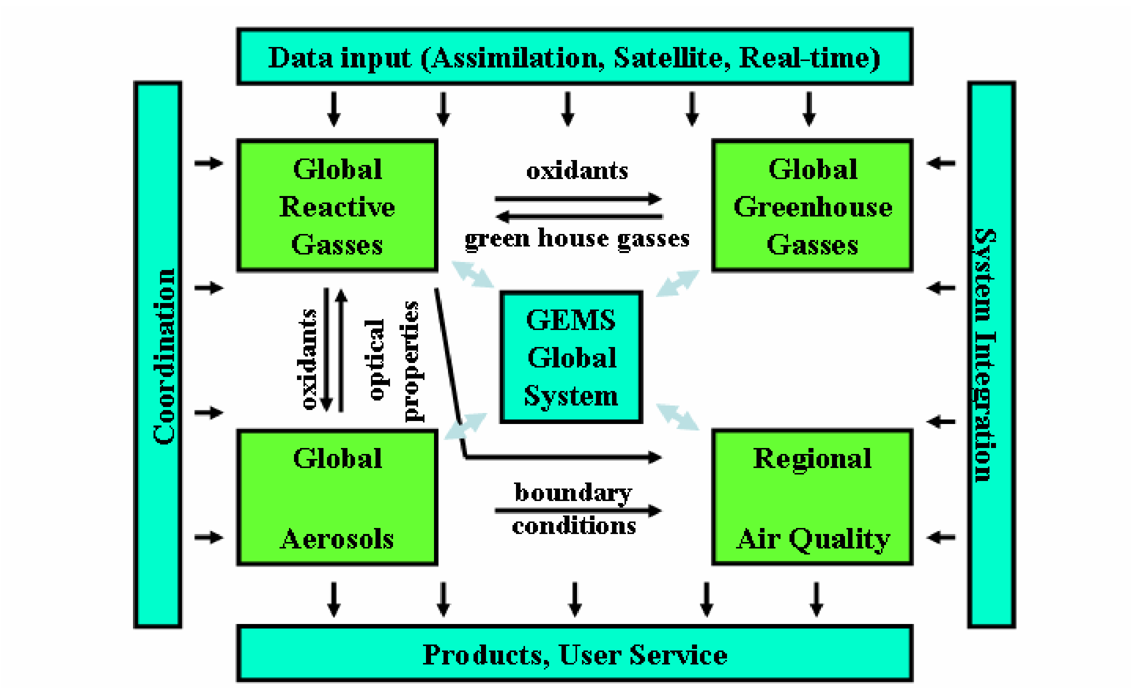

Figure 2. Schematic illustrating the links and the flow of data and information between the main elements of the GEMS system: Greenhouse Gases (GHG), Global Reactive Gases (GRG), Global Aerosol (AER), Regional Air Quality (RAQ) and the global atmospheric assimilation system at ECMWF.

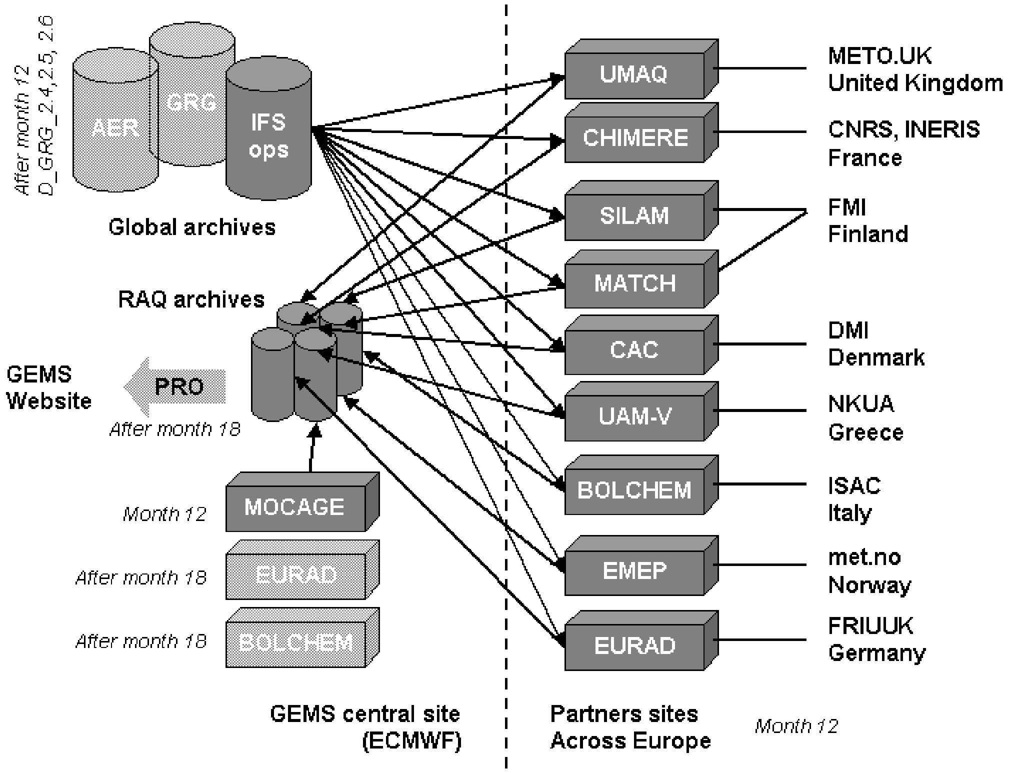

Figure 3. Schematic illustrating the links and the flow of data between RAQ partners and ECMWF.

3 Strategy to advance the state-of-the-art

There has been extensive discussion in the international community on the way forward in studies of atmospheric composition and dynamics, leading to the publication in the last two years of key reference documents including the:

- GCOS second adequacy report (2003),
- forthcoming report of the IGOS_P Theme on Atmospheric Chemistry (*IGACO, 2004*),
- report of the IGOS_P Carbon Theme (2003),
- first report of the Global Carbon Programme (2003).

These documents contain broadly-based and peer-reviewed statements of the consensus of the international community on the way forward. The GEMS strategy implements key recommendations from these reports on data assimilation and forecasting. The strategy proposed here therefore has excellent prospects for meeting its users' needs.

Figure 2 illustrates the main strands of the GEMS strategy to build an integrated operational system for monitoring and forecasting the atmospheric chemistry environment: Global Reactive Gases (GRG), Greenhouse Gases (GHG), Global Aerosol (AER), Regional Air Quality (RAQ), and the GEMS global atmospheric assimilation system at ECMWF. The building blocks of the separate elements of the system already exist. The schematic also illustrates the scientific interactions between the strands of development, which will develop and mature as the integration of the system proceeds.

4 Involvement of DMI air pollution group

The DMI Air Pollution (DAP) group will contribute with high resolution chemical weather forecast for Europe using the Eulerian off-line model CAC. In the first stage of the project the forecasts will involve ozone and particular matter, other chemical compounds will follow.

At present the CAC model is used to make operational ozone forecast four time a day with a horizontal resolution of 50 × 50 km^2 and a vertical resolution of 17 layers. The European model domain is from 15ºE to 35ºW and from 35ºN to 70ºN. The horizontal resolution will be increased during the project period.

As illustrated in Figure 3 data from ECMWF will be used to drive the high resolution numerical weather forecasting model DMI-HIRLAM, and meteorological data from DMI-HIRLAM will be used to drive the CAC model.

1.10 Nuterman R.B., A.V. Starchenko and A.A. Baklanov: Micro-scale model for urban environment

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1 Introduction

In the last decades episodes with air pollution in urban areas have become one of the major hazards to public health. The building aggregates, placed within the atmospheric surface and boundary layer, act as artificial obstacles to the wind flow and cause stagnant conditions in the cities, even for relatively high ambient wind conditions. Full-scale measurements, wind-tunnel studies and mathematical models are usually used for investigation of aerodynamics and pollution transport inside urban canopy (*Gailis, R,* 2004; *Louka, P. et al.,* 2001; *Yee, E. and C.A. Biltoft*, 2004). Air flow and pollutant dispersion data obtained from the field and wind-tunnel experiments are important to validate the numerical models.
The purpose of this study is development and validation of micro-scale meteorological model using field and wind-tunnel data. Besides, the estimation of influence of additional turbulent sources (traffic induced turbulence) on flow pattern is considered.

2 Governing equations and numerical procedure

Three-dimensional microscale meteorological model based on system of the Reynolds equations is written with use of closing relations of Boussinesq, two-equation "k-ε"-model of turbulence and the "advection-diffusion" equation to simulate pollution transport (*Launder, B.E. and D.B. Spalding,* 1974). Furthermore, all the thermo-physical properties of medium are constants. Thus the governing equations are the follows:

$$\frac{\partial (U_j \Phi)}{\partial x_j} = \frac{\partial}{\partial x_j}\left(\Gamma \frac{\partial \Phi}{\partial x_j} \right) + S_\Phi , \qquad (1)$$

where j varies from 1 to 3 and the sum convention is used, U_j - mean velocity, x_j - Cartesian coordinates. The source term S_Φ, variable Φ and diffusion coefficient Γ in this equation take a certain form depending on the equation under consideration. Reynolds stress and turbulent fluxes of mass are modeled with the closing relations of Boussinesq. Traffic induced turbulence is predicted by additional sources (*Louka, P,* 2000) in kinetic energy $C_{car} V_{car}^2 Q_{car}$ and dissipation $C_{car} V_{car}^2 Q_{car} \frac{\varepsilon}{k}$ equations, respectively, where $C_{car} = 0.0015$ - empirical constant, V_{car} - speed of cars and Q_{car} - amount of vehicles per second (in computations $V_{car} = 8.333 m/s$ and $Q_{car} = 0.347$). The inlet boundary conditions (BC) based on field or wind-tunnel data, outlet and lateral BC are zero gradients. Interaction of stream with obstacles and solid surfaces is taken into account with Launder-Spalding method of wall functions (*Launder, B.E. and D.B. Spalding,* 1974).
The problem is solved numerically, and differential equations are discretized by the finite-volume method (*Patankar, S.V*, 1980). The convective terms of the transport equations are approximated with the use of MLU second order van Leer scheme (*Noll, B*, 1992). To calculate the integrals, piecewise-linear profiles, describing the function variation between nodes, are used (*Esaulov, A.O. and A.V. Starchenko*, 1999). This discretization yields the grid equations, which are solved by the Buleev's explicit method of incomplete factorization (*Ilin, V.P,* 1995). To match the pressure and velocity fields, Patankar–Spalding SIMPLE algorithm (*Patankar, S.V*, 1980) is used. Calculation of parameters in the domain of complex geometry is executed within the method of fictitious domains.

3 Results and discussion

There were two cases considered in the investigation. The first one is devoted to comparison of filed data for Göttinger Straße obtained in the framework of TRAPOS (Optimisation of Modelling Methods for Traffic Pollution in Streets) project (http://www.dmu.dk/AtmosphericEnvironment/trapos/cfd-wg.htm) and numerical results for the same complex geometry. Vector fields and distribution of the normalized concentration $c^* = CV_{ref} H / Q / L$, are given in Figure 1 (where $V_{ref} = 10\, m/s$, the reference velocity at the height 100 m,

H = 20 m - mean building height, Q and L=180 m - the intensity and length of source respectively). The detail description of this case, including boundary conditions and aerodynamic roughness is obtained from the public TRAPOS database. The approaching flow has direction from the south to the north.

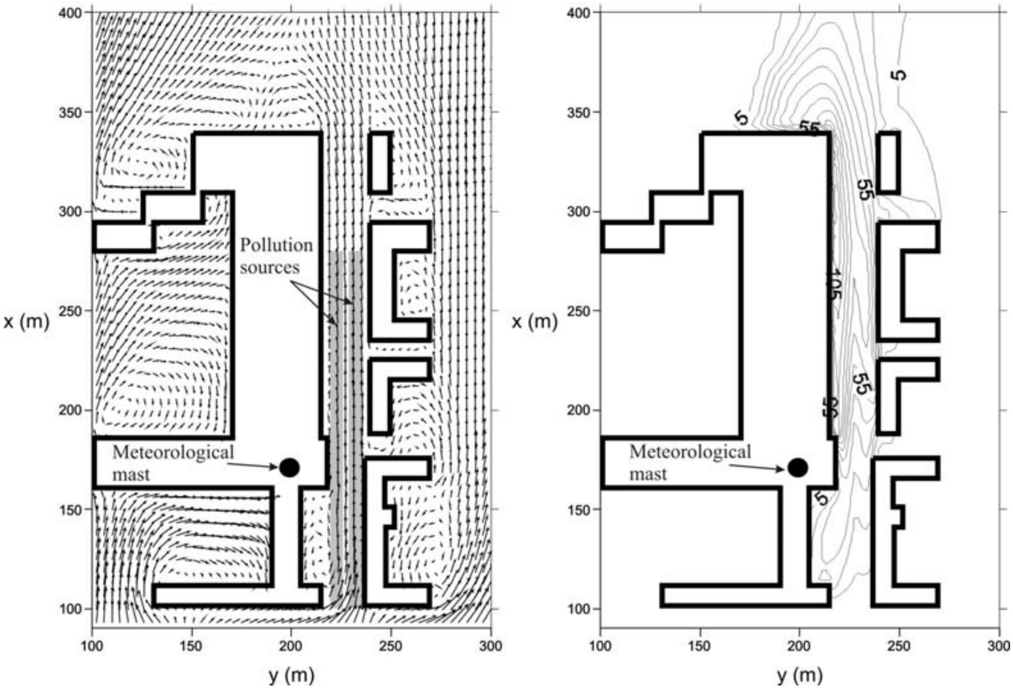

Figure 1. Near surface velocity field (left) and concentration of an impurity (right) in the Göttinger Straße; • - meteorological mast (*Liedtke, J. et al., 1999*).

Computational results show a complex structure of the turbulent flow (Figure 1). It's seen a formation of eddy structures in the corners of buildings as well as drawing of air flow in recycling motion from the opposite side of the street and as follows increasing of pollution concentration from vehicles. However, the flow in the north of street canyon is fully parallel with the street.
Furthermore, the comparison between computed and measured components of velocity vector and turbulent kinetic energy above meteorological tower is presented in Figure 2. As seen from the figures, there exists modest overestimation of w vector component, whereas the others two are virtually coincide with the measurements.
The underestimation of calculated kinetic energy is observed near the region of the highest building roof (Figure 2, a). The addition of source terms, which help to predict the car-induced turbulence, leads to increasing of total budget of k, but the underestimation of energy on lowest levels still remains (Figure 2, b). It's due to the property of two-equation models to underestimate the energy at the areas with rapid change of strain rate.
The second test based on the common data set in the framework of COST Action 732. MUST (Mock Urban Setting Test) experiment is used. The main point of the experiment is to simulate the real urban obstacles and to measure the flow field and turbulence parameters in case of different meteorological conditions (*Yee, E. and C.A. Biltoft*, 2004). The geometry of area in question is a large domain 100 m × 100 m with array of containers 10 × 12, each of which has size 12.2 m × 2.42 m × 2.54 m. The boundary conditions are: inflow - $U_x = U_{ref}(z/8.78)^{0.16}$, $U_{ref} = 5.5$ m s^{-1}; k = 1.448 m^{2}s^{-2}; ε = 0.2 m^{2}s^{-3}; outflow and side boundaries are $\partial\Phi/\partial n = 0$, where Φ is U, V, W, k, ε, and $\vec{n}$ is normal to boundary vector. In this study we will consider the approaching flow perpendicular to container arrangement.

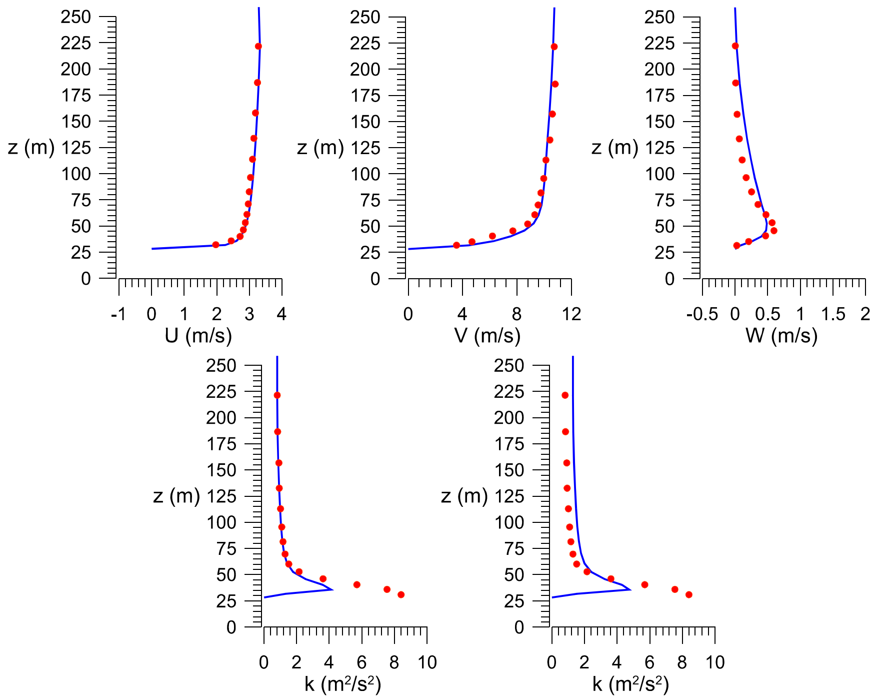

Figure 2. Components of velocity vector and TKE; — - numerical model,
• - field data (*Liedtke, J. et al., 1999*); a) without car induced turbulence, b) with car induced turbulence.

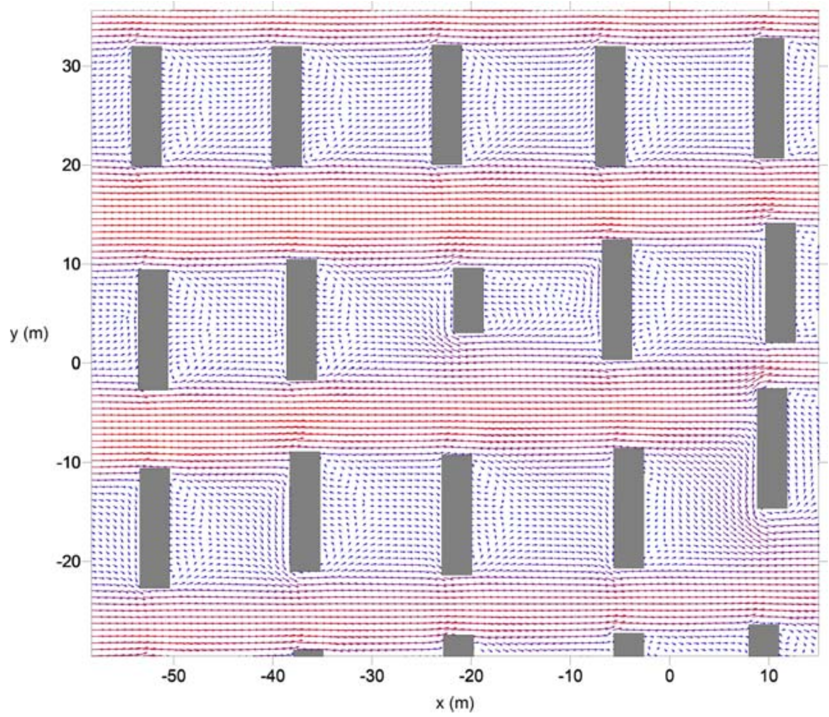

Figure 3. Simulated near surface velocity field for MUST experiment at z=1.275 m.

The results of comparison of numerical model results and field date indicate the formation of multiple recycling zones and secondary vortexes which potentially can lead to pollution accumulation (Figure 3). Due to complexity of air motions, the standard "k-ε"-model cannot satisfactory predict of flow parameters (especially turbulence) as seen in Figure 4 and furthermore, it tends to overpredict the kinetic energy in stagnation regions (*Wilcox, D.C,* 1998) and therefore the coefficient of diffusion is increased. It can dramatically affect on air quality forecasting in urban regions. The solution of this problem is a further model modification, e.g. by including some improved turbulence closure schemes such as (*Bartzis, J.G,* 2005), RNG (*Yakhot, V. and L.M. Smith,* 1992) and realizable "*k-ε*"-model (*Shih, T.-H. et al.,* 1995) or Non-Linear Eddy Viscosity Models (*Ehrhard, J. and N. Moussiopoulos,* 2000).

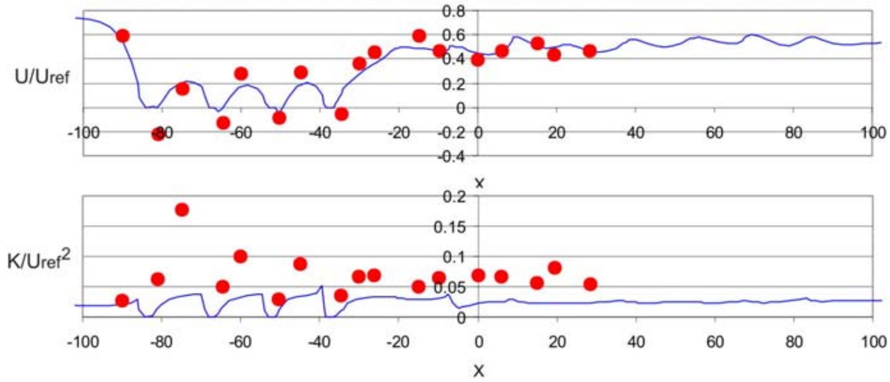

Figure 4. Non-dimensional stream wise component of velocity (top) and turbulent kinetic energy (bottom) at y = 0 m, z = 1.275 m; — - numerical model, • - field data (*Gailis, R, 2004*).

4 Conclusion

The microscale mathematical model of aerodynamics and pollution transport in urban canopy based on two-equation "*k-ε*"-model is presented. There are two test cases considered in the frameworks of this study. The first concerns prediction of real aerodynamics and impurity dispersion in city canyon and the second one is devoted to COST action 732 and MUST experiment. The results show in general realistic modelled wind fields for the considered urban conditions. However, it is also shown that in specific cases the model can incorrectly predict complex air flow (especially turbulent structure of flow), which take place between urban obstacles and hence it can influence pollution transport. Some ways of modification of the model are suggested. Besides, the influence of car-induced turbulence on flow structure is considered; these additional sources lead to increasing the kinetic energy budget and therefore coefficient of pollution diffusion.

Acknowledgements

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2. Climate/Global Change and Risks

2.1. Kabanov M.V., E.P. Gordov: Siberian Geosphere-Bioshere Program -- Integrated Regional Study of Modern Natural and Climatic Changes (SGBP)

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Abstract
The project SGBP is an integrated interdisciplinary project of the Siberian Branch (SB) of Russian Academy of Science (RAS) performed in 2003-2005. The project joined the efforts of 20 organizations of RAS from Siberia and Moscow, and it was directed toward studying of dynamics of regional system.

1 Introduction
For many years the Siberian region has been a theme and a testing area for fundamental and applied research for many institutions of RAS and primary for its Siberian Branch and also for regional and central institutes of higher education.. In previous years new approaches were developed and extensive material was collected here including the results of observations of physical, chemical, and biological characteristics of main subsystems of the regional climatic system. Based on the results of basic research carried out in SB RAS the Program is, as a matter of fact, a Siberian block of formed by SGBP international project on integration research of all aspects of natural-climatic changes in Northern Siberia.

2 Participants
- Institute of Monitoring of Climatic and Ecological Systems SB RAS,
- Institute of Water and Ecological Problems SB RAS,
- Institute of Soil Science and Agricultural Chemistry SB RAS,
- Institute of Forest SB RAS,
- Tomsk affiliation of the Institute of Oil and Gas Geology SB RAS,
- Institute of Computational Mathematics and Mathematical Geophysics SB RAS,
- Institute of Computational Modeling SB RAS,
- Institute of Geography SB RAS,
- Institute of Solar-Terrestrial Physics SB RAS,
- Institute of Catalysis SB RAS,
- Institute of Chemical Kinetics and Combustion SB RAS,
- Siberian Center for Environmental Research and Training,
- Institute of Numerical Mathematics RAS,
- Altai State University,
- Tomsk State University,
- Tomsk Polytechnic University,
- Tomsk University of Control Systems and Radioelectronics,
- Ugra State University,
- Ugra Research Institute of Information Technologies.

3 Project objectives
Main objectives of the project:
1. Development of a system for monitoring of Siberian meso-scale natural-territorial complexes and a supporting informational infrastructure.
2. Preparation of scientific-methodological and computational basis for modeling of main processes of regional natural-territorial complexes development taking into account the interaction between their

main components and for forecasting of geosphere-biosphere changes in Siberia in a context of the regional sustainable development.
3. Study the regional climate changes caused by natural and anthropogenic factors and the influence of the region on global processes.
4. Preparation of a scientific-organizational basis and a scientific group for an appropriate presentation of the program and its parts in large international projects.

4 Results of first three-year period of project implementation

First set of a net for monitoring of atmosphere and lithosphere electricity in three climatic zones (near the lake of Baikal, cities of Krasnoyarsk and Tomsk) is developed to investigate the impact of the Earth magnetic field on climatic, biotic and seismic characteristics.
Trends of temperature and precipitations in different Siberian regions are discovered on the basis of the analysis of long-term series of measurements of hydrometeorological characteristics. The work is started to find out a set of climatic parameters of the highest influence on Siberian biocenoses. In particular, statistical analyses of Siberian temperature regime based on the last century instrumental measurements data show that an increased rate of Siberian warming has clear spatial inhomogeneity (up to 0.5ºC in 10 years in some regions).
Based on a coupled model of atmospheric circulation and surface processes, the first stage of modeling of Siberian regional climate and hydrology is performed. A 1D model of surface processes takes into account exchange of energy, water, greenhouse gases, and momentum between atmosphere and surface covered with vegetation, lakes, wetlands (e.g. bogs), or ice. It was shown that if the dynamics of vegetation is changed by doubling of CO_2, the surface flow and drainage of Siberian rivers will be increased by 10 - 15%.
An interactive GIS is developed to work with geo-informational resources using Internet. A server allows working with maps (using vector method of spatial data storage and transfer) and provides with acceptable access time to spatial data while working on-line with electronic map. It also allows performing a selective principle of data protection (data access) on the level of separate cartographic layer.
Types of sources and capacity of atmospheric aerosol emission are identified on a basis of simultaneous measurements of changes in microphysical parameters and chemistry of atmospheric aerosols performed in different soil and climatic zones of Western Siberia in different seasons. Spatial-temporal changes of mass concentration and chemistry of aerosols on background territories and in the regions of Western Siberia influenced by technogenic load are discovered. The composition of a biogenic component of Siberian atmospheric aerosols and of typical gas-aerosol emissions from forest fires is defined.
Methods of the usage of ecological-geographical data, space images and GIS-technologies are developed and applied to analyze the structure of forest-bog complexes of Western Siberia. A high degree of susceptibility to pollution (oil, gas) and mechanical effect produced by construction and usage of highways and hydromorphic objects are found.
An international workshop “Towards integrated multidisciplinary study of the Northern Eurasia climatic Hot Spots” (http://scert.ru/ru/conference/enviromis2004/workshop_rus/) and a Workgroup on Siberia Integrated Regional Study development (http://scert.ru/ru/conference/cites2005/group/) were held to develop the organizational basis for project inclusion in thematic international programs.

5 Recommendations

Gathered scientific and educational resources, which are accessible via the SGBP project site can be used for subsequent professional activity by all participants of the Enviro-RISKS project.

Acknowledgements

The project was performed with the support of the SB RAS (Integrated Project 138).

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Project web site (http://sgbp.scert.ru/en/about/).

2.2. Penenko V.V.: Study of Relations Between Energy Activity Centers in Climatic System and Ecological Risk/Vulnerability Zones

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Abstract
The project is directed to development of a technique for studying the time-space dynamics and intensity of the risk/vulnerability areas depending on their arrangement in relation to the centers of action of the climatic system.

1 Introduction and project goal
This is the project N 04-05-64562 (2004-2006) of the Russian Foundation of Basic Research. The project team consists of the members of the laboratory of the mathematical modeling of hydrodynamical processes in nature of ICMMG.

The project is devoted to the further development of the complex approach to research of interrelations between natural and anthropogenic factors in the climatic-ecological system. Structurally, the offered approach consists in development of a technique for a joint use of mathematical models and data of observations on the basis of variational principles. The models of atmospheric dynamics, transport and transformation of substances in gas and aerosol states are meant. The approach is intended for diagnostic and prognostic purposes. It is realized by means of a combination of the methods for the solution of the forward, adjoint and inverse problems, methods of the sensitivity theory of the models and functionals, and methods of the multi-dimensional and multi-component orthogonal decomposition.

The primary goals of the project are the following:

- Identification and research of interrelations of energetically active centers of the climatic system and areas of the increased risk/vulnerability in relation to anthropogenic influences in a context of global changes and their regional displays;
- Revealing the tendencies and estimating the scales of the changes under influence of variations of different factors;
- Development of a multipurpose set of models of hydrothermodynamics, transport and transformation of pollutants in gas and aerosol states;
- Creation of a specialized complex of models for studying the territories of the Siberian Federal District as sources and receptors of disturbances in the climatic-ecological system;
- from these positions, studying the territories of the Altai-Sayan region and the region of Lake Baikal characterized by a high intensity of cyclogenesis .

2 Methodology
The project tasks are solved by methods of numerical modelling at a joint use of models and accessible actual information. We apply a complex approach uniting methods of forward and inverse modelling, including solutions of the forward, adjoint, and inverse problems, methods of sensitivity theory for the models and functionals, and methods of the multivariate multicomponent factor analysis of the fields of the space-time structure. Integration of all these elements is carried out by means of variational principles.

3 Main results
Based on the ideas of the factor analysis and the sensitivity theory, the technique of orthogonal decomposition is developed for identification of energy active zones and the centers of action of the climatic system. The database of the NCEP/NCAR reanalysis on long-term dynamics of atmospheric processes for 53 years is used for these purposes. The elements of orthogonal decomposition are used to separate the processes of the climatic scale from weather noise and to reveal the typical and extreme situations.

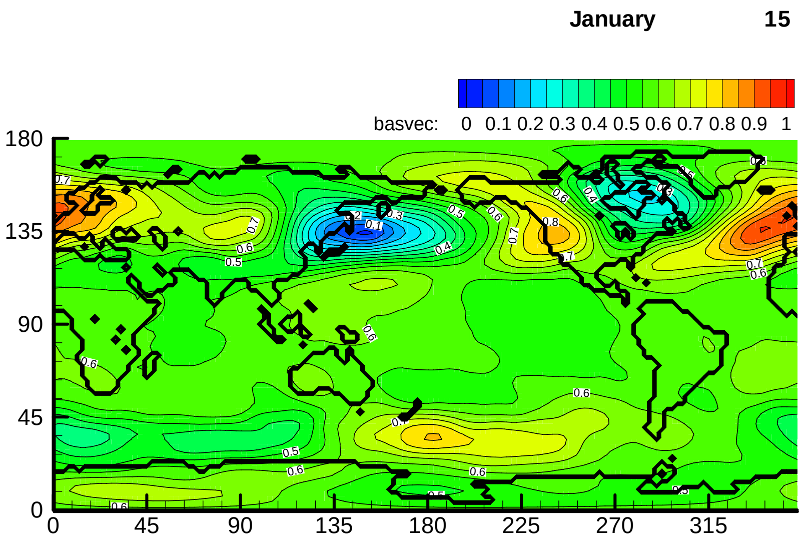

Figure 1. Centers of action in the global atmosphere defined by the first dominant orthogonal subspace for geopotential at 500 hPa /fragment for 00:00 GMT, January, 15/. The basis is constructed from the reanalysis data for 1950-2002.

Essentially new element in the developed set of models is introduction of the leading phase spaces. This allows us to expand the intervals of predictability and to take into account the change of global processes in regional models. The leading phase spaces are constructed as a combination of the dominant orthogonal vector subspaces and the principle components correspondent them. The use of the developed procedures of fast data assimilation provides interconnecting the models of various scales.

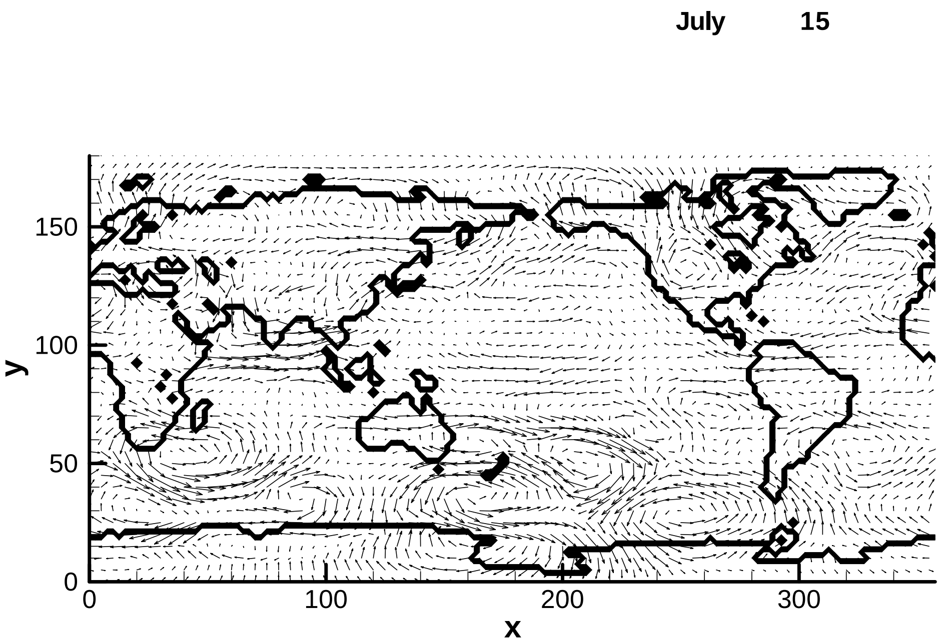

Figure 2. Active zones defined by the first dominant orthogonal subspace for horizontal velocities at 500 hPa /fragment for 00:00 GMT, July, 15/. The basis is constructed from the reanalysis data for 1950-2002.

4 Recommendations

The methodology of orthogonal decompositions can be used for diagnosis and prognosis of the behavior of the complex dynamical systems describing the processes in the atmosphere and water objects.

Acknowledgements

The project is funded by the Russian Foundation of Basic Research and ICMMG.

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2.3. Lykosov V.N.: Mathematical Modelling of Natural and Anthropogenic Changes of Siberian Climate and Environment

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Abstract

Results recently achieved at the Institute for Numerical Mathematics (INM) in development of modelling tools to study climate change and its impact on environment are briefly reviewed with respect to the Enviro-RISKS project goals. The accumulated experience of climatic research allows to suggest possible ways of scientific cooperation to study problems related to natural and anthropogenic climate-environment changes in Siberia.

1 Introduction

Rising concern on regional consequences of the global change together with anthropogenic changes stimulates research activity aimed at development of comprehensive models with proper regional feedbacks (*ACIA, 2001*). Obvious interrelationship between regional climatic modeling and environmental impact issues, which can be approached on the basis of outputs of these models, makes the problem also practically important. Siberia is recognized as the region of the world, where the climate change is likely to be the largest. Permafrost, representing the solid phase of the hydrosphere, and a dense net of inland waters (especially, in Western Siberia) are unique features of this region. There is a strong relation of climate changes to the river floods in permafrost basins. It is also very important that once thawed, the ground becomes unstable, promoting substantial amounts of greenhouse gases (especially, methane). In general, this process depends on the following factors: how much is increased the temperature of the organic upper soil layer; how intensively is deepening of the soil active layer; how long is the period of positive soil temperatures on an annual cycle. Some other factors may be essential as well: possible extension of bog areas due to the additional thawing and ground settlement; possible changes of the thermodynamic regime of lakes and wetlands. The role of inland waters in the land-atmosphere interactions, water and gas exchange are still poorly understood. In most numerical modelling systems for environmental applications, and most notably numerical weather prediction and climate modelling systems, the effect of inland waters (e.g., lakes and wetlands) is either entirely ignored or it is parameterized very crudely. Development of more accurate models as well as the assessment of the climatological effects of the “hydrological” heterogeneity demand deeper consideration. In particular, it is due to the increase of the horizontal resolution in most numerical modelling systems that are envisaged in the near future. In the paper, some results, recently achieved at the Institute for Numerical Mathematics (INM) in developing modelling tools to study climate change and its impact on environment are briefly reviewed with respect to the Enviro-RISKS project goals. More details can be found in the cited papers.

2 Methodology

Global climate models based on coupled atmosphere-ocean circulation models are probably the most powerful tools for understanding present-day climate and estimating future climate variations. There are many scientific groups in different countries, e.g. the INM team, which develop such models and co-operate, for example, within the Atmospheric Model Intercomparison Project (AMIP) and the Coupled Model Intercomparison Project (CMIP). Since the current global climate models have a coarse spatial resolution and can not provide many of the climate elements needed for impact studies, the combined use of such models and regional climate models is likely to be a powerful resource for assessing regional climate impacts (*ACIA, 2001*), e.g. for the Siberian region. In order to reduce predictions of climate change from a global or regional model's grid scale to a much smaller spatial scale, mesoscale and large-eddy simulation models are constructed, as well as statistical downscaling methods have been developed. Finally, it is necessarily to mention that a useful tool for assessing climate change impact on regional environment is a model of heat and moisture transport in the "air-snow-ice-inland water-ground" system.

3 Basic results

1. Due to specific features of the climatic system as a physical object, the method of mathematical modeling is currently a primary tool for studying the sensitivity of the climatic system to small perturbations of external forcing. Recognizing the great progress in this field (especially, in modeling the actual climate), it should be noted that a fundamental problem has yet been practically open up to now. The problem is what parameters and in what accuracy must be reproduced by a mathematical model of the climatic system to make its sensitivity to small perturbations of external forcing close to the sensitivity of the actual climatic system. In this work, the emphasis is on the sensitivity of the climatic system to variations in the concentration of carbon dioxide in the atmosphere. At present, the Coupled Model Intercomparison Project (CMIP) provides an ongoing international effort in comparing coupled ocean–atmospheric general circulation models, which are the basis of climate models. The INM climate model is a part to the second phase (CMIP-2) of this project. The coupling between the atmospheric and oceanic modules of the model is performed by setting heat and water balance conditions on the boundary of the atmosphere–ocean partitioning. In so doing, the surface heat flux correction scheme designed for removing the "climate drift" is not used.
In line with the CMIP requirements, each model was run in two experiments. The first (control) experiment reproduces the actual climate. The concentration of all radiatively active gases was fixed at a level observed late in the XX century. The second experiment was conducted to model the global warming; to this end, an increase in the CO_2 concentration of 1% per year of the current value at the start of the experiment was assumed. This is nearly twice that of the observed rate of CO_2 increase. Climatic characteristics simulated by the coupled model were compared with characteristics obtained from the community of models participating in the project CMIP. The coupled atmosphere and ocean model response to increase of the atmospheric CO_2 concentration is analyzed. It is found that the maximal warming about 2-3.5ºK takes place in the centre of Eurasia, in particular, in West Siberia. Approximately one third of the cold season warming in Eurasia (1-2ºK) is explained by a change of the atmospheric dynamics, namely, by the increase of the Arctic Oscillation index. It was found that the surface temperature response in climate models on increased atmospheric carbon dioxide is mainly determined by the amount of heat consumed to warm the ocean as well as by variability of the Earth's radiation balance due to climate change. The value of global warming calculated by the INM climate model is 1ºK. The expected value of global warming of the real climatic system at increasing CO_2 was estimated to be 1.3 to 1.5ºK. To illustrate results, the spatial distributions of the annual-mean model response for surface temperature, sea-level pressure, and precipitation are given in Figure 1.

2. The results of numerical experiments with the climate model showed that a significant part of the winter warming in northern Eurasia is governed by variations in the atmospheric dynamics (namely, by increased vales of the Arctic Oscillation index). At the same time, it turned out that, for the Earth as a whole, the global warming rate is dictated by the radiative response to increased CO_2. In this connection, it is worthwhile to consider first the problem of how the model heat source must be in form to ensure that the response projection onto the AO is a maximum, as well as to compare the form of this source with that of the heat source obtained from observational data processing. With this aim, a method for calculating the operator of dynamical response for climate models and the real climatic system to this external forcing (calculation of the first-moment perturbation) has been suggested (*Gritsoun et al., 2002*). It was shown that the approximate response operator makes it possible to reproduce with a high accuracy both the magnitude and the spatial structure of the linear part of dynamical response of the atmospheric general circulation model. From observational data and modeling results, a forcing that optimally perturbs the Arctic Oscillation has been constructed.

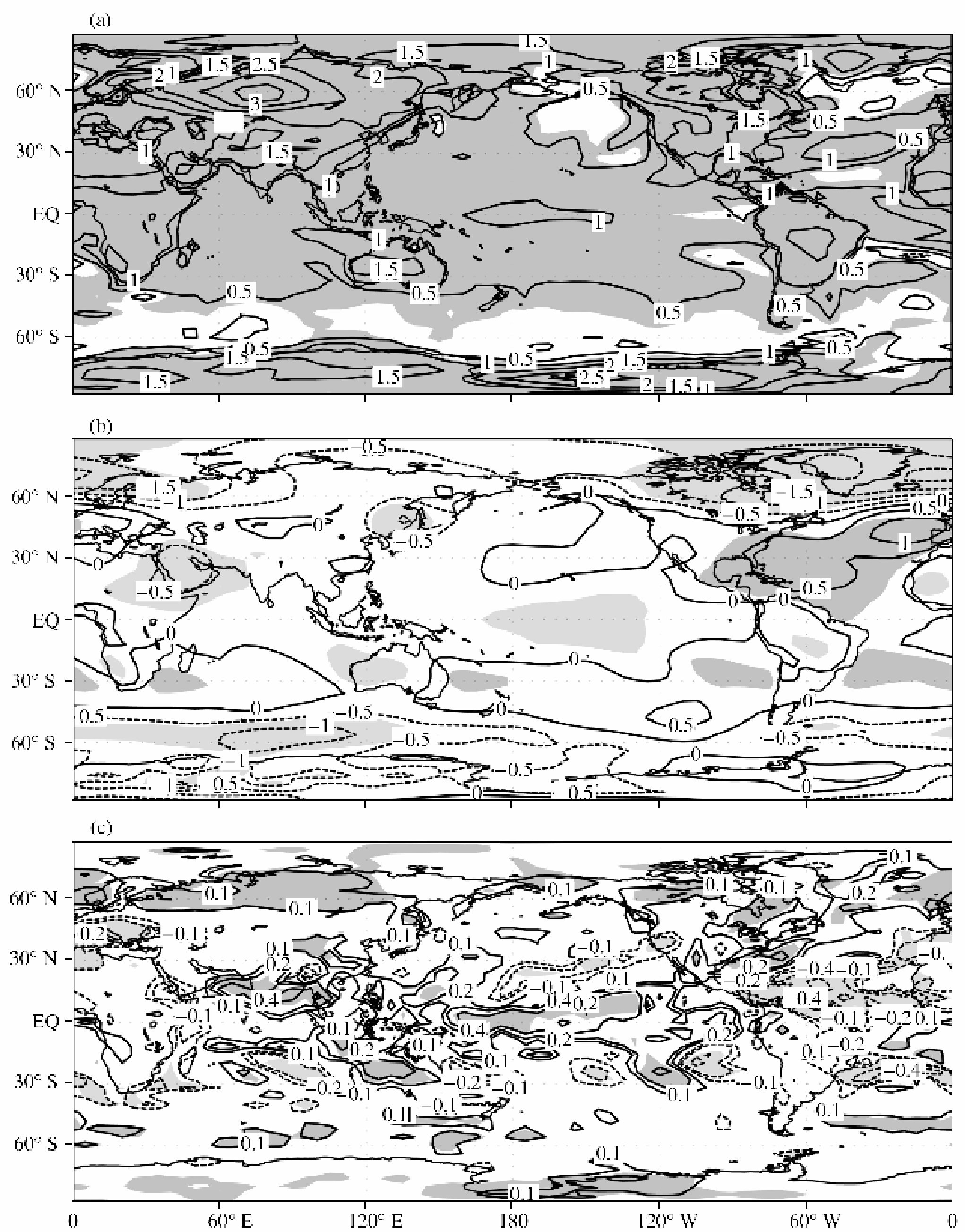

Figure 1. Annual-mean response for surface temperature (a), sea-level pressure (b), and precipitation (c). The contours are depicted at periods of 0.5 ºK for temperature and 0.5 hPa for pressure. For precipitation, the contours values are –0.8, –0.4, –0.2, –0.1, 0.1, 0.2, 0.4, and 0.8 mm/day.

3. Non-hydrostatic three-dimensional models of the upper-ocean layer and atmospheric boundary layer are developed (*Glazunov & Lykosov, 2003*). These models are able to reproduce large-scale (comparable with the mixed layer depth) eddy structures which are caused both by the thermal convection and the wind stress at the air-water interface. Models are combined into the coupled model of interacting boundary layers. To construct models, the large-eddy simulation methodology is used. The differential formulation of models includes the Reynolds-type equations to describe an evolution of momentum, heat and salt (or moisture), the continuity equation and the state equation for the water and air. To close these equations, additional equations for the turbulent kinetic energy of small-scale eddies and its dissipation rate are used. A number of numerical experiments have been carried out to reproduce eddy motions, which are similar to observed ones in the atmosphere and ocean. The upper ocean model is modified to simulate dynamics of warm water reservoirs, including that with the bottom topography. The Internet-accessible non-hydrostatic mesoscale model Nh3d (*Miranda, 1990*) is adapted to the West-Siberian region with the extremely inhomogeneous surface hydrology (lakes, wetlands, rivers, etc.). This model is chosen to study effects of the surface hydrological heterogeneity

on the atmosphere-land interaction processes to correctly describe them in numerical models for environmental applications.

4. A model of the heat and moisture transport in the "air – (snow) - (ice) - lake – ground" system is recently developed (*Stepanenko & Lykosov, 2005*) in frame of the INTAS project "Representation of lakes in numerical models for environmental applications".
For the warm season, the model calculates the temperature profile in the water and soil, the water current velocity (the Ekman equations are used), the turbulent kinetic energy and its dissipation rate, the lake depth and the soil moisture. For the cold season, processes of the snow pack and ice formation as well as processes of their melting during the warm period are taken into account. As the atmospheric forcing, routine long-term meteorological observations in Siberia (in particular, in the permafrost area) are used. This atmospheric data (e.g., wind velocity and direction, temperature, relative humidity, surface pressure, precipitation) are taken from Khanty-Mansiisk, Kolpashevo and Yakutat regions which are known as territories with a lot of lakes. From the results of numerical experiments with the model one can conclude that such a model is perspective for the developing parameterization schemes of interaction between the air surface layer and wetland/lake landscape. In particular, the model simulates talik beneath a lake in permafrost region, which existence is confirmed by observations. This model is implemented into the mesoscale model Nh3d as a modified block of the atmosphere-land interaction.

4 Conclusion

The experience of climate investigations, accumulated up to present time in the Institute for Numerical Mathematics, allows to conclude that there are both theoretical and technological possibilities to study problems related to climate-environment change, including those due to anthropogenic activity. In wide cooperation with the Enviro-RISKS project partners, mathematical models of land-atmosphere exchanges in Northern Siberia (boreal forests, peat lands, lakes, rivers and permafrost) will be used for varying climatic conditions and together with information resources will form a basis for development of the integrated modeling regional climatic and environmental assessment system based on the models of particular physical processes forming regional climate and climate - environment interaction. This computational platform will be used to investigate on this basis the global climate change (under different scenarios for future emissions of greenhouse gases) impact on the Siberian environment. In particular, it will be used to assess climate impacts on the land surface state and to provide regional interpretation of large-scale climate change estimations for the Siberian landscapes. Special attention will be paid to critical phenomena, related with possible water exchange regime variations, like droughts (including assessing the forest fire hazard probability grows) and floods. Mesoscale models and large-eddy simulation models will be used to estimate direct damages to environment caused by accidents in process of petroleum/gas production and transporting, as well as by flambeau lights. Since INM is the base Institute for the Chair of Mathematical Modeling of Physical Processes at the Moscow Institute of Physics and Technology and for the Chair of Computational Technologies and Modeling at the Moscow State University, students and post-graduate students will actively participate in above mentioned scientific work under supervision of the INM staff. The INM will also participate in organization of two conferences, which will be collocated with the full format multidisciplinary international Conferences-Schools on environmental sciences.

Acknowledgements

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2.4. Stendel M., J.H. Christensen: Carbon Budget Studies and Permafrost Modelling in Northern Russia

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Summary
We present recent and planned activities in modelling polar issues performed at the Danish Climate Centre, which is a part of the Danish Meteorological Institute. In particular, an overview of the new EU project CARBO-North will be given, and we will report on recent permafrost modelling activities for a region in the north-eastern Siberia.

1 Introduction
There is a long tradition at the Danish Meteorological Institute for modelling of issues related to polar research. Here, we report about two new initiatives both focused on the northern regions of Russia.

2 Carbon budget modelling
The Danish Meteorological Institute is one of the partners in the new FP6 project called “CARBO-North”, which is coordinated by Prof. Kuhry (Stockholm University, Sweden). The aim of this project is to quantify the carbon budget in the Northern Russia across the temporal and spatial scales. Recent research on the impacts of climate change in high latitudes has mostly assessed the “equilibrium” response of ecosystems. An example is the question what the “potential” location of the Arctic tree-line or the southern limit of permafrost would be under conditions of global warming. However, of much greater importance, not least from a political perspective, are transient responses of the climate system. Examples of such questions are: How quickly will the Arctic tree-line migrate? How quickly will permafrost thaw? How quickly will enhanced soil organic matter decay result in increased greenhouse gas emissions? Different time lags in these processes will cause significant deviations from the equilibrium response.
In the framework of the project, field studies will be conducted in the north-east European Russia (Figure 1), It is a region, which is characterized by the gradual lowland transitions in vegetation and permafrost conditions. The DMI will contribute with dedicated climate model simulations and provide the requested variables and time slices needed as input for detailed ecosystem studies. We will analyze the sensitivity of climate models to a whole suite of land cover, soil and permafrost schemes and use proxy data to evaluate rates of ecosystem change und past climatic variability. These activities will go along with detailed monitoring and mapping of vegetation, soil and permafrost, which will give input for process-oriented studies, such as tree-line patch dynamics, tundra/forest/river carbon fluxes and ground subsidence, and to GIS-based up-scaling to the regional or pan-Arctic level.
We will here provide an overview of some of the numerous activities planned in CARBO-North.
The CARBO-North consortium consists of 17 partners. Four of them are from Russia. The main partner, the Komi Science Centre in Syktyvkar, participates as contractor; two other organizations (from Moscow, Syktyvkar) are involved as sub-contractors; and the fourth is a SME based in Syktyvkar. The project will be funded for a period of 42 months with an envisaged starting date in January 2007.

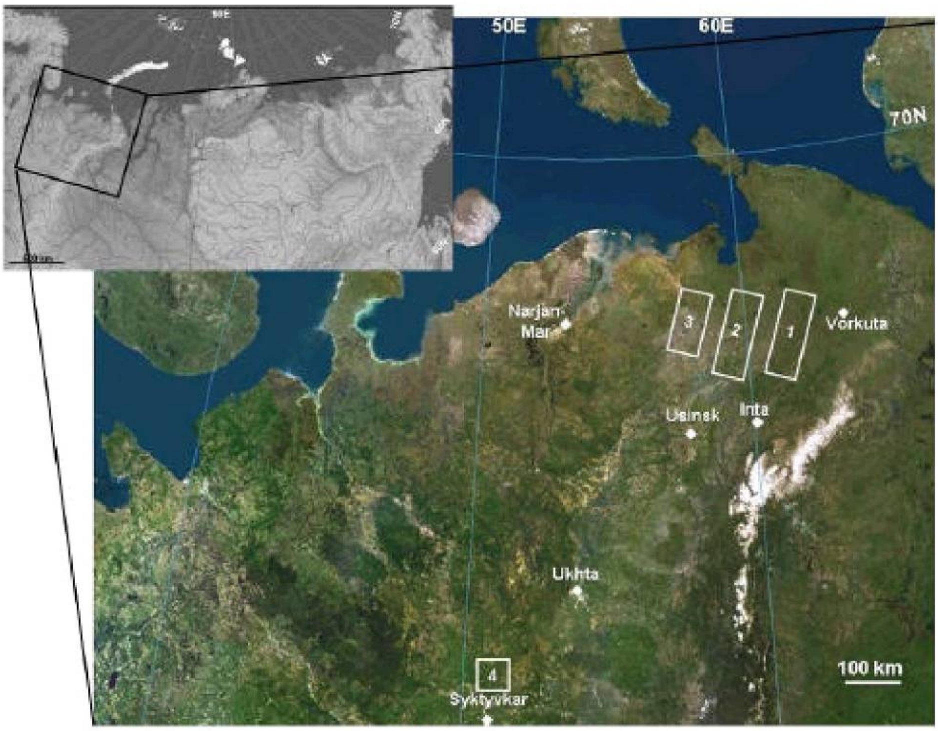

Figure 1. Satellite composite of north-east European Russia, with a general location map and major towns in the region. The approximate locations of selected study areas in treeline-tundra and in taiga are indicated. (1: Bolshoya Rogovaya, 2: Adzva, 3: Upper Kolva, 4: Achym).

4 Permafrost modelling

The Danish Meteorological Institute also has a long tradition in permafrost modelling. The zonation of present-day permafrost can be estimated from deep-soil temperatures obtained from global coupled atmosphere-ocean general circulation models (*Stendel & Christensen, 2002*) by accounting for heat conduction in the frozen soil. But it is impossible to explicitly resolve soil properties, vegetation cover and ice contents in reasonable details. The coarse resolution of contemporary general circulation models (GCMs) that prevents a realistic description of soil characteristics, vegetation, and topography within a model grid box is the major limitation for use in permafrost modelling. On the local scale, descriptions of the heterogeneous soil structure in the Arctic exist only for limited areas. Furthermore, if we want to model the future fate of permafrost, we have to use dedicated scenarios, which, due to computer limitations, so far only exist for global models.

In principle, semi-empirical approaches, e.g. based on the *Stefan (1891)* formula, can give a more realistic depiction of permafrost temperatures and active layer thicknesses while at the same time avoiding problems inevitably associated with the explicit treatment of soil freezing and thawing in climate models.

In order to narrow the gap between typical GCMs on one hand and local permafrost models on the other, we have used as an intermediate step a high resolution regional climate model (RCM) to downscale surface climate characteristics to a scale comparable to that of a detailed permafrost model (*Stendel et al., 2006*). The global model we have used is the coupled ECHAM4-OPYC in a horizontal resolution of T42, the RCM is HIRHAM4, run at 50 km resolution and the permafrost model (GIPL) is from the University of Alaska, Fairbanks with a resolution of 0.5 degrees. This means that we can force the permafrost model directly with RCM output.

Such an introduction of dynamical downscaling in permafrost modelling results in a more realistic depiction of present-day mean annual ground temperature and active layer depth, in particular in mountainous regions. By using global climate change scenarios as driving fields, one can obtain permafrost dynamics in high temporal resolution on the order of years. For the 21st century under the IPCC SRES scenarios A2 and B2, we find an increase of mean annual ground temperature by up to 6 K (Figure 2) and of active layer depth by up to 2 m within the East Siberian transect. According to these simulations, a significant part of the transect will suffer from permafrost degradation by the end of the century.

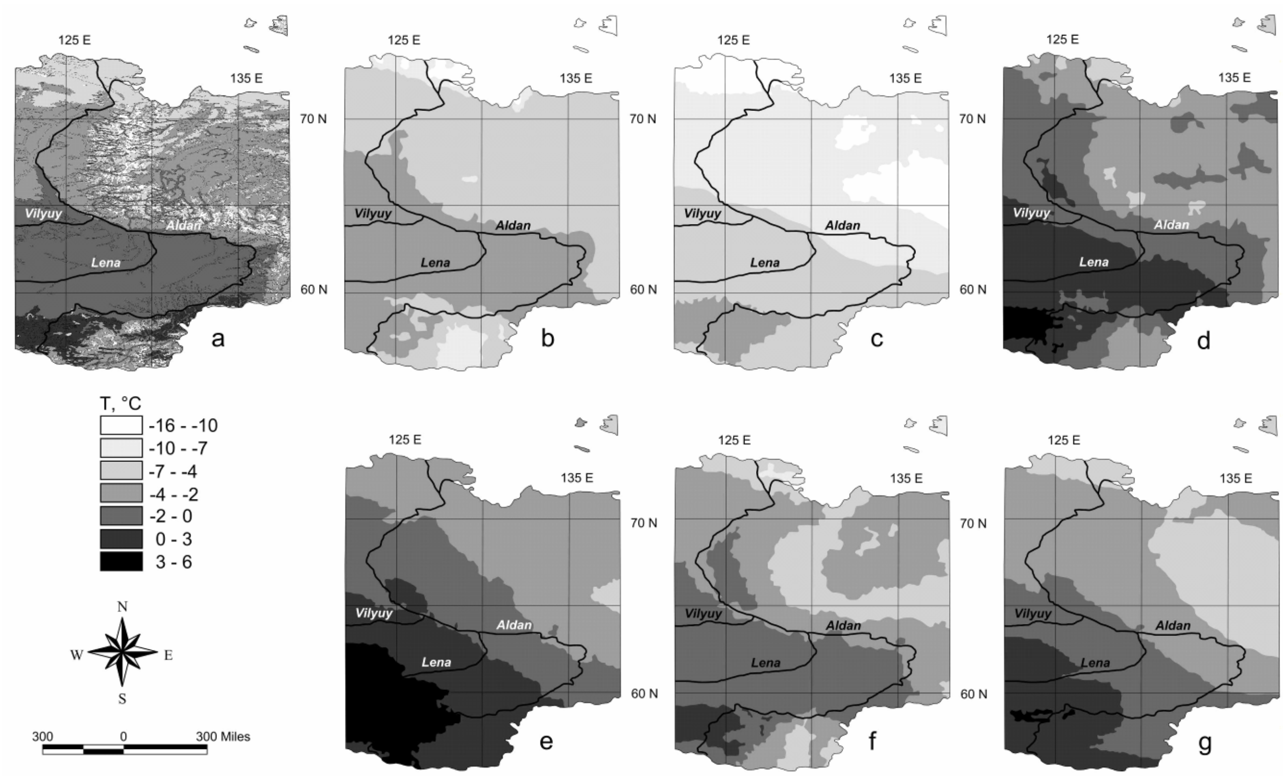

Figure 2. Temporal change of mean annual ground temperature [°C] (a) derived from the Map of Landscapes and Permafrost Conditions in Yakutia (scale 1:2,500,000) (Melnikov, 1988) , GIPL model forced with (b) HIRHAM control run, (c) ECHAM control run, (d) HIRHAM, scenario A2, average 2071-2100, (e) ECHAM, scenario A2, average 2071-2100, (f) as (d) and (g) as (e), for scenario B2.

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2.5. Heimann M., M. Schumacher: Observing Biogeochemical Processes in Eurasia

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Abstract

The Siberian boreal forest is a significant component of the global carbon cycle, since it stores about 10% of the global terrestrial carbon in vegetation and soils, whereby about 65% of the Siberian forests contain permafrost with a carbon storage assumed to be in the order of roughly 400 PgC. Environmental risks, i.e. affections by anthropogenic influences via global climate change, as well as direct impacts on the local / regional scale will provoke changes and adaptations of the present ecosystems. The MPI-BGC is involved in several projects focusing on these anticipated changes in Eurasia.

1 Introduction

Implications of global climatic change to Siberia and Siberian contributions to global climate change are two sides of one medal. Globally effective anthropogenic influences are of relevance on local scales, while local response to these implications on the global scale. Linked with this anticipated changes are potential risks or unknowns, which are related for example with changes in land cover / land use (fires, forest logging, transition steppe ⇆ agriculture), changing permafrost conditions (deepening of active layer, destruction of frozen soil C stores) or changes in snow cover, sea ice extension, etc. which might provoke alterations in atmospheric circulation schemes. One aim of the MPI-BGC is therefore the qualification and the quantification of the occurring processes and their effects on ecosystems and the atmospheric composition and circulation patterns. This goal needs at least a description the previous conditions, the acquisition of the actual status and predictions regarding the future development.

2 Methodology

The MPI-BGC is involved in several projects focusing on causes for and effects on climate change in Eurasia. Most prominent current activities are the ZOTTO project (Zotino Tall Tower Observatory), the YAK-AEROSIB study and the TCOS-Siberia (Terrestrial Carbon Observing System – Siberia).
Aims of TCOS-Siberia were the development and establishment of scientific strategies and a continental scale monitoring system for the determination of the net carbon balance in Siberia and its variations from year to year. Involved in this project were 12 institutes (4 of them from the Russian Federation) from 7 countries, which carried out intensive field measurements for data acquisition and detailed modelling studies. The strength of the project was the combination of bottom-up and top-down approaches:

- Surface flux measurements in key ecosystems, combined with in situ process studies
- Regular lower tropospheric profiling for biogeochemical trace gases,
- Implementation of continental scale integrative modelling framework.

The YAK-AEROSIB study is initiated by 8 institutes from France, Russia, and Germany. Topic of the project is the performance of trans-Siberian airborne greenhouse gas observations. The triangle shaped transects across the Central and Eastern Siberia encloses also some of the monitoring sites of the TCOS-Siberia project. In 2006 main attention will be given to data acquisition of a suite of tracer by in situ measurements, flask sampling and the record of meteorological parameters. This program shall be extended after 2007 by the implementation of high resolution atmospheric transport / chemical models and by the use of remote sensing data to infer ecosystem fluxes and fires.

3 Some results and requirements

From the data obtained so far from the TCOS-Siberia project the expected high inter-annual variability of terrestrial carbon fluxes became clearly obvious, that is driven by the large variability of climate and fire occurrence. A very interesting finding was that Siberia seems to be a smaller sink than generally assumed: the amount of the carbon sequestration of Siberia is only less than 20% of the fossil fuel emissions from the Russian Federation. Thus, the question if Siberia acts on a long-term scale as source or sink for carbon is still unsolved.
In consequence, the continuation of measurements is mandatory, with broadening the focus on additional effects due to climate change for example on permafrost and ecosystem migration, and on effects of local and regional anthropogenic impacts. Globally effective anthropogenic influences are affecting directly the local scale, while local contamination and exhaustive cultivation are responsible vice versa for global impacts.
Currently near the village of Zotino (~60°N / ~90°E) a 300 m tall tower observatory (ZOTTO) is build up which should be in fully operation by 1 October 2006. The scheduled measurement programme includes continuous measurements of long lived, primarily biogeochemical trace gases at different heights, regular flask sampling and continuous meteorology observation (MPI-BGC; for CO the MPI for Chemistry). An update of the forest inventory in the footprint area of the tower will be performed by the Russian core partner IFOR-RAS.

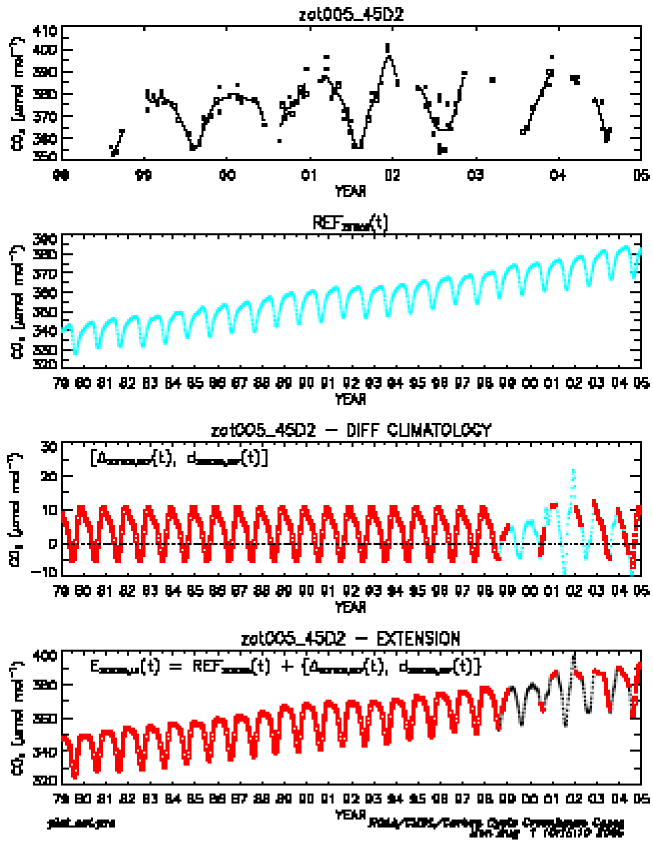

Figure 1. CO_2 data from the lowest flight level at Zotino profile site (implemented in NOAA/CMDL GLOBALVIEW-CO_2 database). [Panels from top to bottom : top - Time series of CO_2 mixing ratios; middle - Reference marine boundary layer time series; bottom - Difference between measurement and reference (blue circles; interpolated *red circles* and extrapolated *red squares* differences) and extended record including smoothed measurement data and interpolated and extrapolated values derived from data extension procedure].

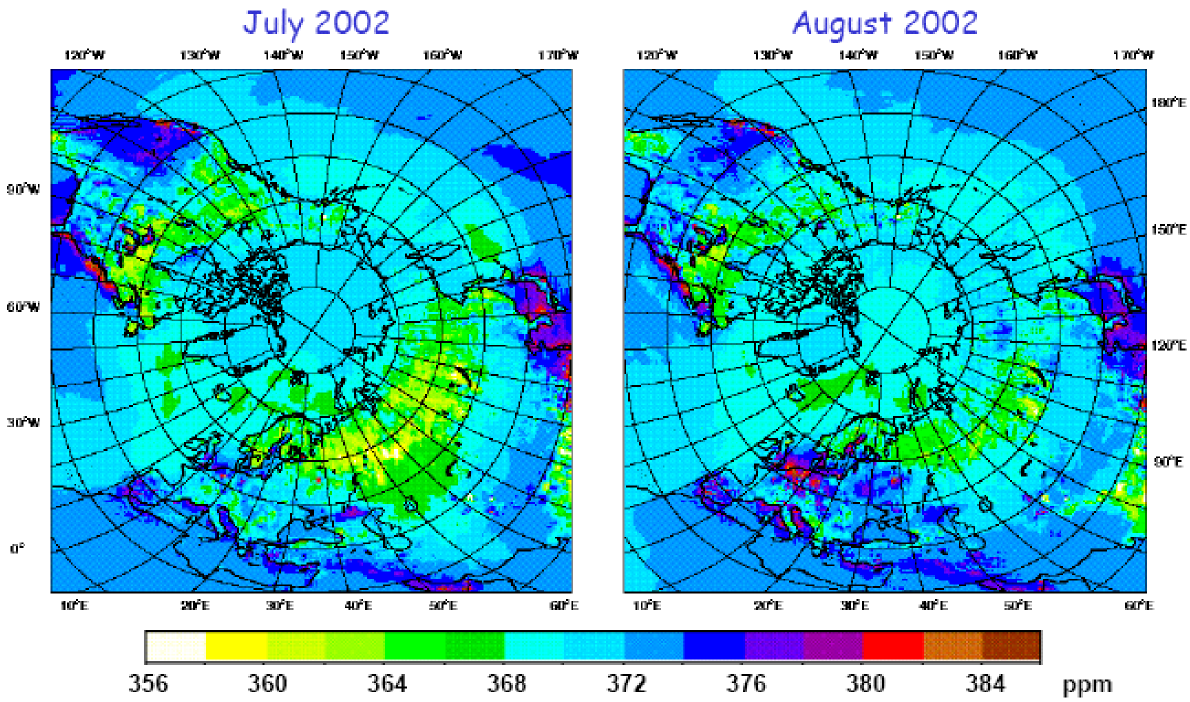

Figure 2. CO_2 concentration at 30 m (with daytime sampling). REMO-Modelling: U. Karstens (MPI-BGC).

4 Contribution to Enviro-RISKS

MPI-BGC has a great experience in ecological and atmospheric scientific research and conducts several projects focusing on Siberian key ecosystems and atmospheric research with respect to climate change. From these studies status information of environmental conditions and their response to global and local impacts can be provided, information will become available also from on going activities.

TCOS website: http://www.bgc-jena.mpg.de/bgc-systmes/projects/web_TCOS/index.html
ZOTTO website: http://www.bgc-jena.mpg.de/bgc-systmes/projects/zotto/index.shtml.

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3. Terrestrial Ecosystems/Hydrology and Risks

3.1. Onuchin A.A., M.A. Korets, A.S. Shishkin, N.A. Mikheyeva: Some Aspects of Environmental After-Effects of Natural Resources Using in Siberian Taiga

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Abstract
The use of natural resources is connected with environmental risks, which can not be evaluated impartially. Foundations of the nature management must be based on functions of different levels ecosystems. Development of evaluation methods is complicated by methodical, economic and law problems. Using of GIS-technologies and other methods allows to solve these problems.

1 Introduction

Most of ecological problems of Siberia are connected with the natural resources use and forests disturbance. It result from disforest, forest fires, minerals' mining, building of highways, service lines, and hydroelectric power stations.
Environmental man-made impact result in landscape transformation, modification of forest types, hydro - climatic conditions. This could be global scale. It is necessary developing of methods for evaluating of environmental risks to establish system of ecological monitoring and algorithm of checking and managements on the basis of GIS – technologies.
The purpose of the project is to evaluate the environmental man-made impacts on the basis of GIS – technologies and ecological information gathering.

2 Methods

Search of appropriate criteria is necessary to assess the ecosystem management results. Elaboration of a mechanism of criteria application is the most important organizational and methodical problem of the international forest policy (*Strakhov et al., 2001*).
Appropriate methods are required for both standard of forest management effectiveness and estimation of environmental man-made activity. The methods must be able to compare quantitative indicators of different ecological functions and forest state. These methods include numerical score of forest functions and cost characteristics of environmental risks.
For example, area of soil erosion may be used as a criterion of erosion-preventive function. The quantitative estimation methods can be use, taking into account regeneration period of erosion preventive forest functions (*Onuchin et al., 2003*). Presently, the damage cost estimation methods have been elaborating for evaluating of water quality loss resulting of deforestation of water protective strips (*Onuchin & Sokolov, 2002*). There are methods for evaluation of oxygen producing and other ecological forest functions (*Lebedev, 1998*).
The use of GIS-technologies for solving problems of nature management is important taking into account the spatial-temporal dynamics of ecological priorities. Ability of modern GIS allows to create a geographically correct spatial background for ecological modeling. GIS functions allow to use both the primary orographic characteristics (altitude, slope, exposition) and more complicated index of relief by 3D analysis and digital elevation models (DEM). These characteristics, different subject maps (geomorphologic, soil, climatic, etc.) and remote sensing data are input data for spatial models of keyword parameter evaluating and environmental risks forecasting.

3 Preliminary results

A biosphere role of forests (as compared with other plant associations on land) is determined by scales of their spreading, stocks and structure of living substances (*Protopopov, 1975; Shvidenko, 1997; Moiseyev, 2005*). Thus, the forests should be assessed as natural "factories" of ecological production (*Onuchin &*

Sokolov, 2005). Work efficiency of the green "factories" depends on forest conditions and human economical activity.

We propose a varied approach for choice of evaluate criteria of nature management consequences and forest disturbance for ecosystem management principles (*Onuchin & Sokolov, 2005*). The most important criteria of ecosystem management at the biogeocenosis level are parameters taking into account the erosion preventive, soil protective, sanitary and hygienic, climate regulating (microclimate), environmental, recreational and aesthetic functions of forest ecosystems.

Investigations of man-made dynamics of erosion preventive and water protective functions of mountain taiga forests in Siberia showed that soil erosion activity rises as a total moistening and degree of mineralization of felling and fire-site increase. The obtained results suggest that after intensive activity of erosion on the latest felling, the processes of erosion decrease after 1-2 years. Further (from 3 to 5 years after felling) erosion process is decreased continuously at both the high and low initial mineralization (Figure 1).

It should be noted, that duration of erosion-preventive recovery period depends on a complex of forest conditions and man-made impact intension (Figure 2). If the slope is fewer than 5º and initial mineralization of felling is under 2%, then the erosion-preventive function will restore after 5 year. If the initial mineralization is 60%, then the recovery duration is 17 years. The recovery takes place between 15 – 25 and 22 – 35 years in cases of the slopes steepness of 10 and 20º, respectively, depending on a degree of initial mineralization.

The criteria of natural ecosystem state and functioning at the regional and subregional levels should be considered the water protective, water and climate regulating, environmental (habitat of forest animals), recreational and aesthetic functions. The criteria at the global (biosphere) level should be considered the ability of forests to deposit carbon, to produce oxygen, to maintain an optimal gas composition of the atmospheric air. It is necessary to consider forest properties which determine hydrological regime of large rivers and reservoirs which have effect on the redistribution of water balance components between evaporation and runoff and reflected on global geochemical processes in the system "land – ocean".

Apparently that changing of all ecosystem parts (terrain, microclimate, soil, vegetation and function structure modification), their structure and functions are affected by man-caused impact. Strategy of reconstruction of disturbed areas and possibility of return used plot to initial state depend on ecosystem steadiness. Steadiness should be understood as a permanency of ecosystem characteristics in time, their ability to stay unchanged under the exposure and rehabilitate quickly (*Shishkanakova, 2001*).

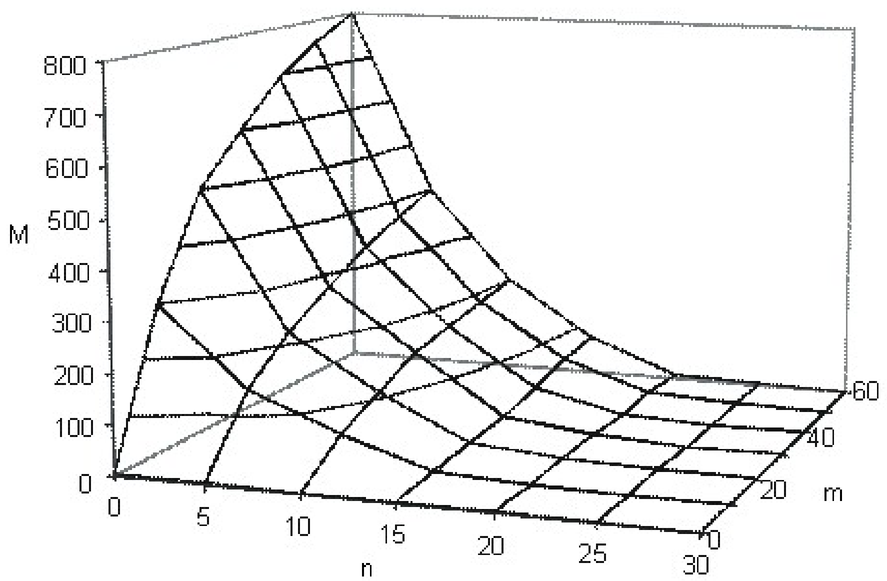

Figure 1. Relationship between soil erosion and man's impact duration and initial mineralization degree. *M* – flood of solid matter [t·km^{-2}]; *N* – man's impact duration (felling, fire) [year]; *m* – initial mineralization degree [%].

In some cases, practice of nature management shows that self-recovery of disturbed areas result in the man-made high-productive landscapes which do not have nature analogues (*Shishikin, 1999*). Forming of such man-made landscapes and increase of biodiversity and productivity has positive meaning for ecosystems. So, we can not suppose that the strategy of man-made area return to natural state is proved ecologically. Therefore, methods of disturbed area recovery should be developed particularly taking into account a character of influence and economical basing.

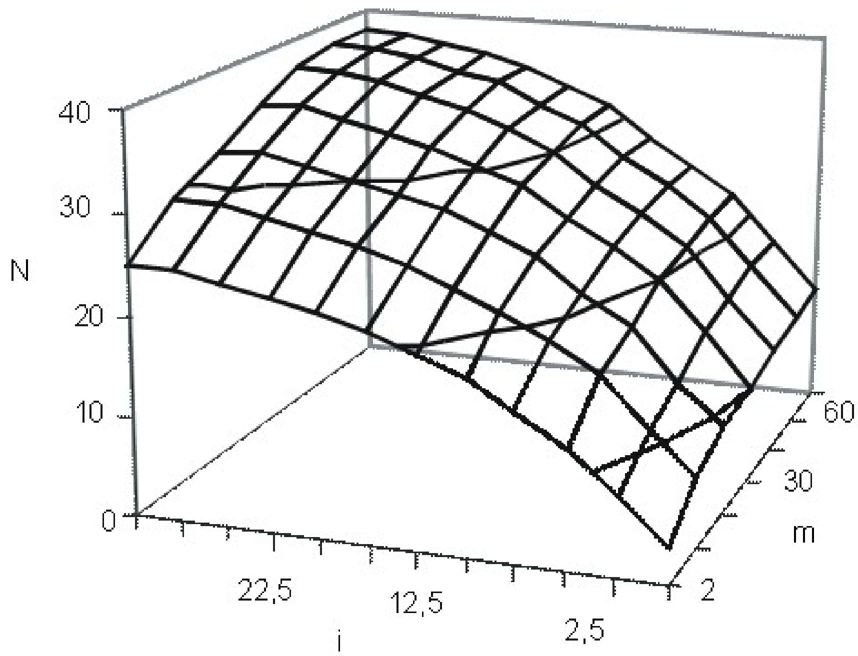

Figure 2. Relationship between regeneration period of erosion-preventive forest function and slope steepness and initial mineralization degree. *N* – regeneration period of erosion-preventive forest function [year]; *i* – slope [degree]; *m* – initial mineralization degree [%].

The intersecting character complicates the problem of estimation of nature management ecological man-made impact. The recovery of water balance after forest cuts may result in changing the atmospheric water transfer both in timber-felling sites and adjacent regions. The carbon- depositing role of forests is more complicated. In some regions increase of carbon dioxide concentration results in catastrophic events, in others – it can give a positive ecological effect (*Zavarzin, 2003*).

4 Conclusion

The estimation of man-made impact is complicated by guidance, economical, lawful problems. Their solutions in the near future are not simple. Elaboration and practical realization of proposed methods of quantitative assessment by GIS- technologies will give a reliable instrument for specialists. Prediction of ecology dangers will allow to make the true solutions concerning nature management strategy and organization of post-disastrous actions.

We need to exchange information and compare our researches with ones of other project partners who study climatic change and disturbance of forest dynamics.

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3.2. Evtyushkin A.V.: Space Monitoring of Khanty-Mansiysk Autonomous Okrug – Ugra Territory

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Abstract
The paper gives an account of purposes and current results of URIIT work on space monitoring of the environment and industrial objects at oil production license plots and pipeline transport on the territory of Khanty-Mansiysk Autonomous Okrug – Ugra.

1 Introduction

The project work objective is to create a database and information technologies for long-term monitoring of the environment and industrial objects at oil production license plots and technological pipelines; with the use of diverse high and middle-scale spatial resolution satellite images. Monitoring is being carried out on a basis of multi-temporal analysis of current and retrospective data of remote sensing and land surface observations with the use of GIS-technologies. It aims at finding out directivity an intensity of land cover changes. At present, the following archive and up-to-date scanned images are available: those received from satellites “Kosmos-1939”, “Resurs-O”, “Meteor-3M”, LANDSAT/ETM, SPOT, TERRA/ASTER; photo cameras CA-20M, KATE-140 и MK-4 of “Resurs-F” satellite, radars with synthetic aperture ENVISAT/ASAR, ERS-2, RADARSAT. For some territories, interval of satellite photograph covering makes up to 30 years. Large-scale satellite images allow evaluating impartially the total longstanding changes of natural complexes and man-made objects and to exclude the subjective factor.
URIIT archives satellite images received by its own receiving antennas and other pictures bought while performing individual projects. Processing and storage are fulfilled on the basis of supercomputer SUN FIRE 15K.
The Research and Production Centre “Monitoring” (Khanty-Mansiysk) creates a map on oil pollution of the KhMAO-Ugra territory, by means of the LANDSAT-7 images automatic classification. At the same time, frame binding and montage has been performed, with 15 m resolution and covering of the whole Okrug territory by satellite photographs made in 1999-2001.
Real-time satellite images received by the Remote Sensing Centre (RSC) of URIIT, show all critical natural and man-made structures: trunk and field pipelines, cluster wells, transmission lines, roads, ravines and temporary waterways, lakes, bogs, different types of forest, etc.

2 Current real-time processing of middle-scale resolution satellite images

A depository of ERS-2 radar satellite images on KhMAO-Ugra territory received in 2005 by RSC of URIIT is being created. All-weather SAR scanner span makes 100 km, resolution 12.5 m, interval between overlapping bands – 3 days, sub satellite rerouting interval – 35 days. All-weather radar data allow raising reliability of land cover classification and efficiency of ecological monitoring on large territories.
The technology of building mosaic covering form various remote sensing systems has been worked through, by the example of the KhMAO-Ugra western part. Satellite pictures mosaic from URIIT archives (1987-2005) has been built up: LANDSAT-5\TM, LANDSAT-7\ETM, TERRA\ASTER, ERS-2\SAR, METEOR-

3M\MCY-E, RESURS-F2M\MK-4. Images obtained are used for geological-geophysical study and environmental analysis, in connection with the upcoming industrial development of the Subpolar Urals.
A depository of TERRA\ASTER satellite photographs on the KhMAO-Ugra and Yamal-Nenetskiy AO territories (2000-2005) is being created, on the basis of products supplied by the United States Geological Service (USGS): atmospherically corrected data of 3 optical, 11 infrared channels and underlying surface temperature.
High resolution satellite photography has been ordered and already performed by SPOT-5 satellite (France); for regions with intense load on trunk and field pipelines. Photography mode is panchromatic, frame size 60 x 60 km, resolution 5 m, dates of photography the 20th and 24th of July, 2005. Panchromatic channel possesses high decoding properties for mapping lakes, swamps, modern temporary waterways, vegetation-free soils, bushes, automobile roads, transmission lines cuttings and other natural and man-made objects. After geo-binding, photographs have topographic accuracy of 1 : 25000 scale.

3 Real-time monitoring of fires in trunk pipelines areas on basis of low resolution satellite images

RSC of URIIT receives AVHRR scanner data (from satellites of the NOAA series) in an automatic mode by means of OPTEX universal receiving complex with antenna of 0.9 m in diameter. It receives data from AVHRR scanner (from satellites NOAA-12, 15, 16, 18) up to 30 times per day. AVHRR scanner span makes up to 3000 km, number of spectral channels is 5, and spatial resolution is 1000 m. Data from NOAA-18 (launched in May 2005) have been used for preparing color-generated images in the process of smoke tails visual deciphering. Interval on the KhMAO-Ugra territory photography by various NOAA series satellites makes from 20 minutes up to 4 hours, depending on a time of a day.

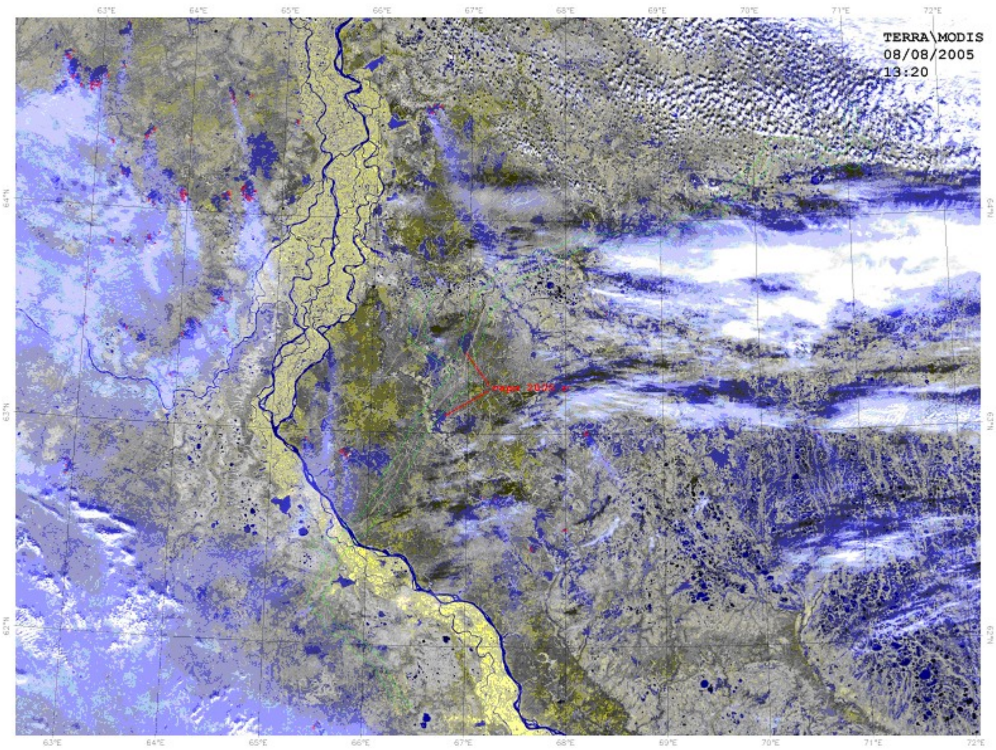

Figure 1. Notification of fire with enclosed color-generated TERRA\MODIS satellite image at a resolution of 250 m.

Photography of KhMAO-Ugra territory by the MODIS\TERRA scanner is carried out up to 8 times per day. MODIS scanner span is 2300 km, it has 36 spectral channels, and spatial resolutions of 250, 500, and 1000 m. Utility software elaborated by URIIT synchronizes data acquisition from the THA-9, «OPTEX» and «SKANEX-M» antenna complexes and data transfer to SUN FIRE 15K (for further processing), AVIALES-SOKHRANA server and archive RAID. Automatic preprocessing of received images in IMAPP package and detection of fire sources by MOD14 algorithm are carried out on the SUN FIRE 15K supercomputer. Processing results are saved as HDF-format files available for all URIIT local network users via TCP/IP protocol

through FTP server.
In 2004-2005, daily monitoring of 650 km long trunk pipeline “Sredniy Hulym – Oil Pumping Station Krasnoleninskaya” was carried out on a basis of satellite photography at a resolutions of 250\500\1000 m.
To provide end users with comprehensive fire location data (according to the TERRA\MODIS and NOAA\AVHRR satellite images), the following layers of subject electronic maps have been prepared in the form of SHP-format layers for GIS:

- KhMAO forest grid with administrative division;
- Borders of AVIALESSOKHRANA air divisions;
- Technological corridor of 650 km long trunk pipeline “Sredniy Hulym – Oil Pumping Station Krasnoleninskaya”.

Satellite images and air divisions chart with compartment forest grid in GIF-format, along with fire location data in pipeline corridor (in text format) are sent up to 28 times per day in real-time mode via e-mail to “RITEKBeloyarskneft” company and “AVIALESSOKHRANA” (Aviation Forest Protection Service) of KhMAO-Ugra, for decision support on risk evaluation. Preparation of color-generated satellite images with fire sources marking and smoke tails contrasting was carried out in an interactive mode.
Notifications of detected inflammation sources in the stored limit profiles (according to TERRA\MODIS and NOAA\AVHRR data), with enclosed forest grid, were sent automatically around-the-clock (up to 30 minutes after receiving satellite images), during the whole fire risk period. In 2005, overall number of notifications totaled 4800. Examples of e-mail notifications of detected inflammations with color-generated satellite images, charts and SHP-format files enclosed are shown in the Figures 1-2.

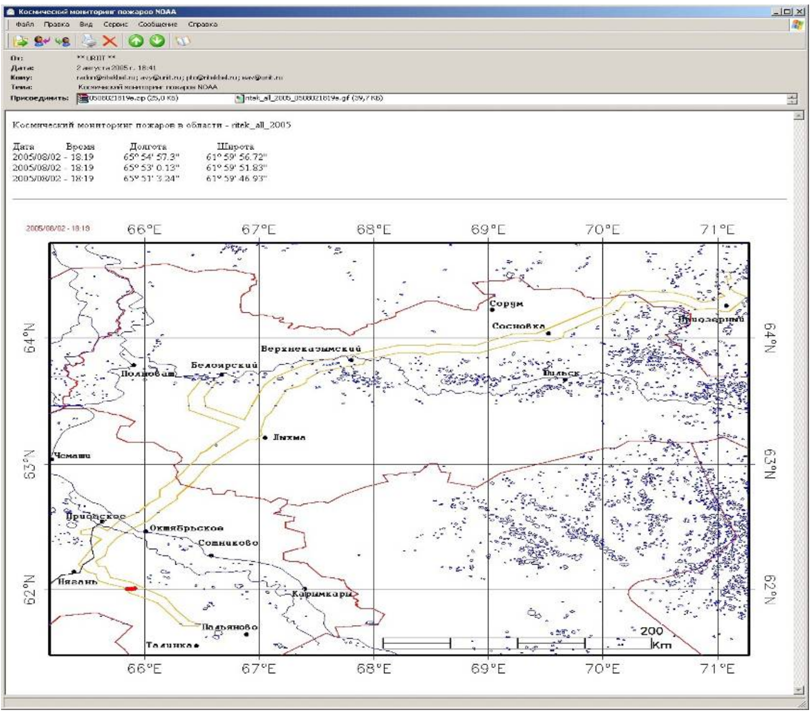

Figure 2. Notification of fire in the pipeline corridor, with enclosed chart, fire location data and SHP-format file in ZIP archive.

4 Conclusion

Automation of remote sensing data real-time processing will allow excluding a human factor while deciphering satellite images for the purposes of ecological monitoring, prevention of natural and technological emergency situations at large territories. From the systematic standpoint, it is possible to single out two perspective investigation lines of oil pollution monitoring: 1. Comparative analysis of the territory condition before the snow cover sets in with the territory condition shortly before the snow cover intensive melting; 2. Analysis of pollution sources in the period of active vegetation.
The base spectral channel for detecting oil pollution is the near infrared channel. The first investigation line is based on substantial spectral differences of fresh and polluted snow covers and on melting mode differences of pure and oil-polluted snow. The second line is based on spectral peculiarities of oil pollution spots reflection in the infrared and ultraviolet spectrum.

Acknowledgements
The author expresses his thanks to Prof. G.N. Erokhin and Dr. V.N. Kopylov for useful discussions.

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3.3. Pushistov P. Yu., M. N. Vtorushin: Conservation and Management of Lower Ob and Irtysh Basin Water Bodies on Basis of Information-Simulating Hydrodynamics and Water Quality Systems

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Abstract
The creation of information-modeling hydrodynamic and water quality systems for decision support purposes in the field of efficient consumption and protection of the northern rivers' water resources bearing heavy man-caused load is considered. The simulation results on within-year dynamics of hydrological and ice regimes of the Severnaya Sosva river section (Khanty-Mansiysk Autonomous Okrug – Ugra) are summarized.

1 Introduction
The problem of water resources quality has become one of the most important but still hardly solvable issues during the last decades. Since 2000, the European Union has been carrying out the Framework Water Directive 2000/60/EU (FWD). Its main purpose is to achieve an acceptable quality level of natural waters, to limit anthropogenic pollution on the basis of information-simulating systems (ISS) securing the use of economic and administrative methods of river basins water quality control. Various concepts and practical implementation methods are known related to development of information-simulating systems of surface water hydrodynamics and water quality. Thus, the Swedish Environmental Research Institute in the framework of the FWD realization, develops the WATSHMAN project "A system tool for river basin management". WATSHMAN consists of the data control module, the module simulating hydrological processes and diffuse discharge and transport of nitrogen and phosphorus, and the scenario analysis module of water resources management results [1].
Use of complex ecosystem mathematical models for solving water quality and water consumption problems has become a common practice in USA, in the field of environmental management and judicial practice on the state and federal levels. Number of simulated water bodies (river systems with hydroelectric power stations, reservoirs/lakes, estuaries) counts many hundreds. Division of models into investigation and management ones becomes relative, because management models are based on the most modern scientific theories and observations. The author [2] has carried out a comparative analysis of the most often used

hydrodynamic and water quality models. One of the best models for practical application is the CE-QUAL-W2 hydrodynamic and water quality model [3]. It was successfully tested for solving management tasks on protection and consumption of more than 400 river systems, reservoirs, and estuaries. An expert group of the Russian Academy of Sciences has come to the analogous conclusion.

The given project objective is the creation and practical application of modern ISS of hydrological and ecological monitoring of the Lower Ob and the Lower Irtysh basin water bodies, which are characterized by high pollutant concentrations, substantial disruption of water ecosystem biological productivity and high risks of dangerous hydrological phenomena [4]. The main body of the Base Simulating Complex (BSC) on water ecosystems dynamics (that is being elaborated in URIIT) is the unsteady numerical 2.5-D Hydrodynamic and Water Quality Model CE-QUAL-W2 [http://www.ce.pdx.edu/w2]. The first version of the given model was created in 1975. The 3.1 and 3.2 model versions (created in 2002 and 2005, correspondingly) are working models included into BSC.

2 Preparation of ecosystem data and simulation results of detailed within-year hydrodynamics of a northern river

A section of the big river Severnaya Sosva (between Sosva and Sartynia settlements, latitude - 61ºN, longitude - 62ºE) was chosen as a pilot application. The Severnaya Sosva river has a unique natural ecosystem with endemics among aquatic fauna (including the Coregonus tugun) – the famous "sosvinskaya herring") and, simultaneously, very high concentration of iron, copper, zinc and manganese compounds (many times higher than the maximum permissible concentration).

For applying BSC to the given river section, dimensional data were prepared for generating the computational grid model. Pilot charts and shore topographic maps were digitized, and 3D model of the given section was built using the ArcGIS system. A 3D model fragment of the shore and the river channel section of the Severnaya Sosva river is shown in Figure 1.

The procedure of creating the computational grid model was elaborated on the basis of given materials. Basing on this procedure, the BSC bathymetry file was formed. Figure 2 illustrates the computational grid model characteristics: it shows the arrangement of segments into which the section of the Severnaya Sosva river is divided (the section length is 70800 m, the segment length is 400 m, the layer thickness is 0.2 m, see also Figure 3).

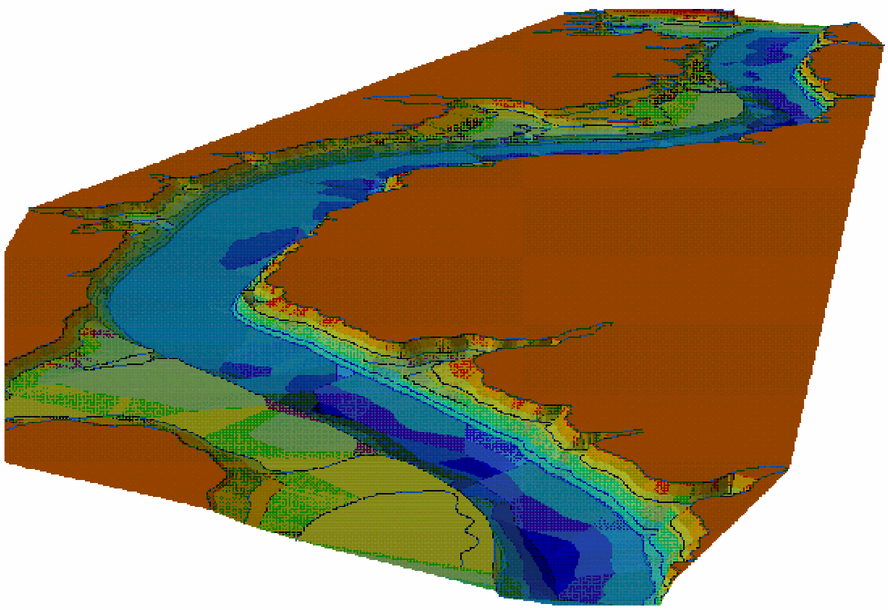

Figure 1. 3D model of shore and the riverbed section of the Severnaya Sosva river created using ArcGIS.

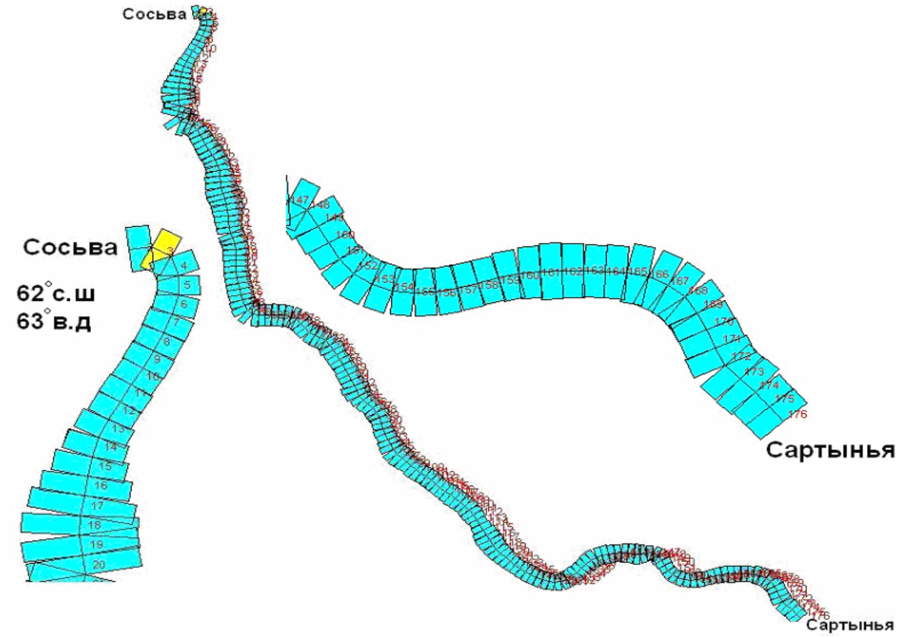

Figure 2. Arrangement of the computational grid segments in the S. Sosva river section chart.

Initial conditions such as water level, temperature, ice thickness, and boundary conditions upstream and downstream, as well as data for atmospheric forcing simulation were prepared with the use of date of meteorological observations (8 times per day) and hydrological observations (2 times per day) obtained by the Sosva and Sartynia stations during period from January 1st till December 31st, 2005.

Hydraulic characteristics (Chezy coefficient of bottom friction, light extinction coefficient, etc.) are averaged out of advised ranges of observed characteristics for sub-polar rivers. Figure 4 gives an overview of spatial-temporal within-year level mode dynamics (h) and longitudinal velocity fields (u) at the river section under investigation in 2003.

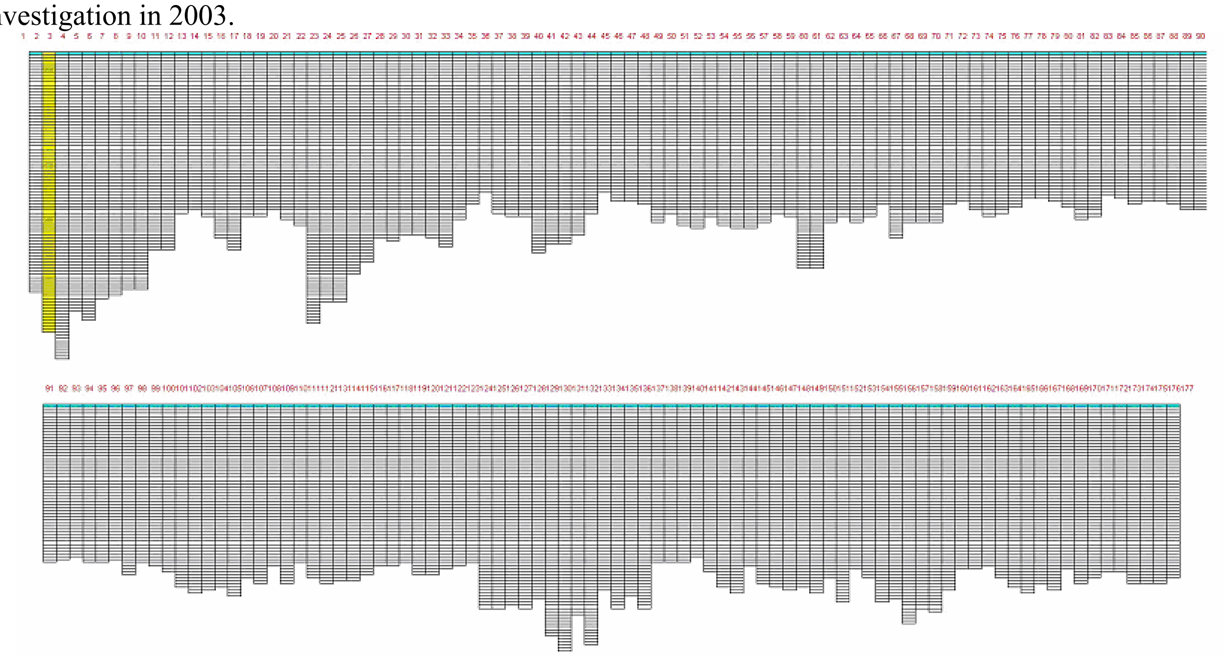

Figure 3. Computational grid chart in X-Z plane at the S. Sosva section (L = 400м, Z = 0.2м).

It is impossible to conduct a detailed comparison of h and u variability along the river section due to absence of observational results. Nevertheless, BSC description of phase change dynamics of the river hydrological mode in 2003 is qualitatively correct, including the spring-summer tide (May-June), the low-water summer period (the first part of August), the autumn flood (the end of August – the first part of September), and the low-flow ice season (October-April).

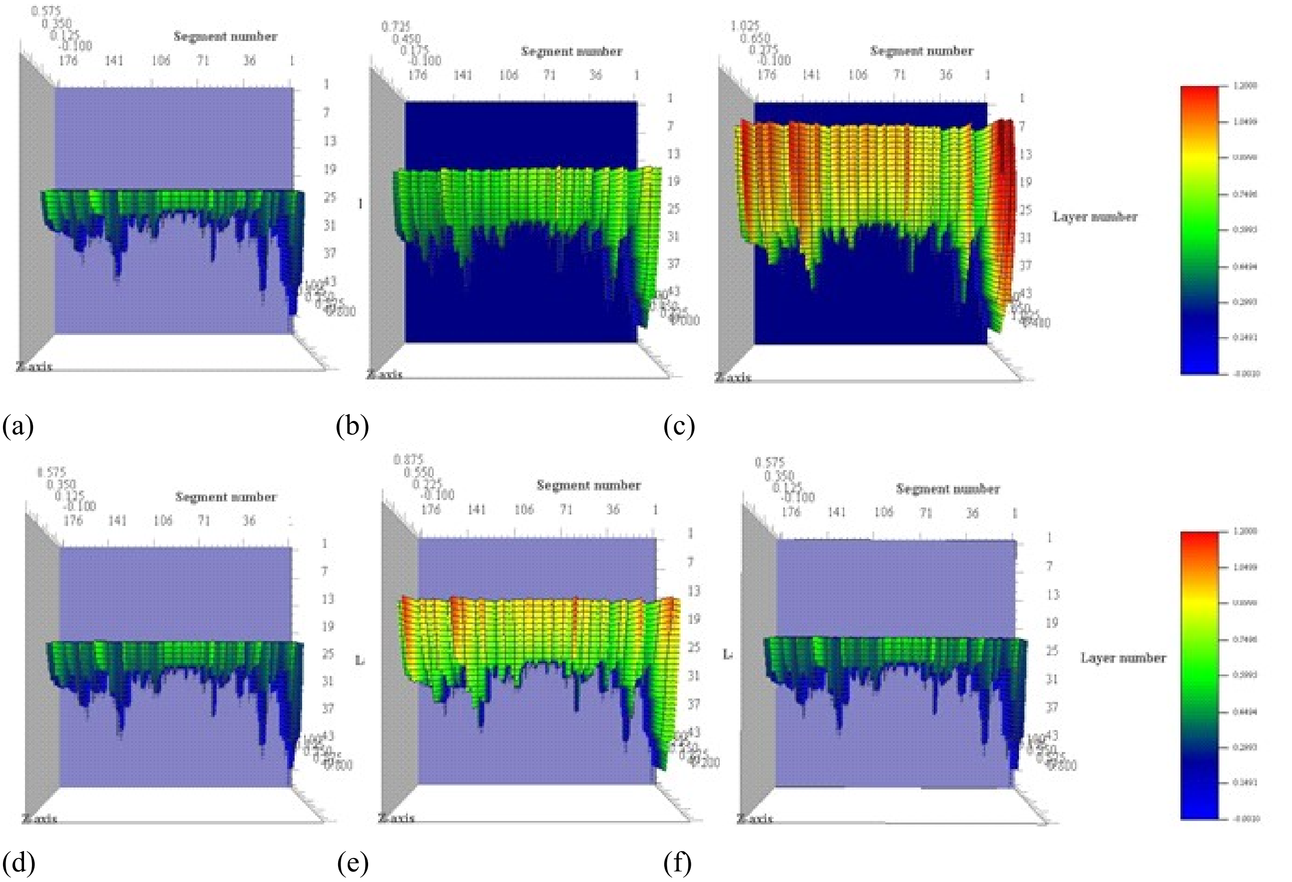

Figure 4. Simulation results of within-year variability of the stream longitudinal velocity and water level in the following periods: low-water winter period (01.04.03,a), beginning of spring tide (09.05.03,b), spring tide peak (28.05.03,c), low-water summer period (07.08.03,d), autumn flood (23.08.03,e) and freeze-up beginning (28.10.03,f).

Statistical analysis allows making a conclusion that measurement results extensively coincide with calculated water temperature in the surface water layer of the simulated river section. The correlation coefficient is high (R=0.99), but there is a slight computational systematic error. Its cause should be determined in the process of further efforts.

3 Conclusion

Findings described are obtained by means of the system approach to solving tasks of efficient consumption and protection of the regional water resources. Under development there are databases and the Base Simulating Complex that are designed for creating high performance information-simulating systems of hydrological and ecological monitoring of rivers and water bodies bearing heavy man-caused load, including the West-Siberian oil and gas complex. As a specific product of the given approach, we have worked out the regional scientific-technical project “Complex research of hydrological mode, chemical and radiation contamination, biological productivity of the Irtysh river lower reach and creation of an information-simulating system for the river water resources consumption and conservation”.

Discussion of the given program is desirable in the framework of the Enviro-RISKS project Coordination Action plan.

Acknowledgements

The authors express their gratitude to Prof. O.F. Vasiliev, Prof. V.N. Lykosov, Head of Board on Environmental protection of KhMAO-Ugra S.V. Pikunov and Director of Civil Defense Department of KhMAO-Ugra, Dr. V.I. Migunov for their support and useful discussions.

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3.4. Lopatin K.I., A.V. Nikolaeva, A.V. Soromotin: Remediation of Lands and Water Bodies Polluted with Oil and Formation Waters on the Territory of Khanty-Mansiysk Autonomous Okrug – Ugra

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Abstract
The article describes environmental problems related to oil and highly mineralized formation waters pollution on the territory of KhMAO – Ugra. There is an overview of techniques on decontamination and remediation of polluted territories. The article gives an account of various organizations' projects aimed at solving the stated problems.

1 Introduction
The Khanty-Mansiysk Autonomous Okrug – Ugra is located in the central part of the West-Siberian Plain. It extends 900 km from the North to the South and 1400 km from the West to the East, it covers the area of 534.8 thousands square kilometers. Swamps make up 34.6% of the Okrug territory, together with waterlogged grounds they cover half of the region territory. There are more than 250 thousand lakes among forests and swamps; floodplain of the Ob river covers about 5% of the Okrug territory.
At present the Okrug is the main oil and gas producing region of the Russian Federation. Oil production is carried out by 53 enterprises, including 14 enterprises with foreign investments. There are 215 oil fields in operation, yearly oil production totals 260-270 million tons (57% of the overall Russian Federation oil production and 6.9 % of the world oil production). About 100 million tons of oil is exported to the European Union.
KhMAO is the world leader in the quantity of accidents counting on 1 km of pipelines. Total area of territories polluted with oil and mineralized formation waters amounts from 240 to 700 square kilometers, which makes 0.005-0.013 % of the Okrug territory.
Considerable technogenic load of oil and gas production results in negative stability, and often in irreversible transformations of natural ecosystems functioning that affect life quality at large territories.
To reduce the oil production impact on ecosystems, oil producing companies take the following measures: first – replacement of obsolete and badness equipment (primarily the replacement of pipes) and second – carrying out restoration works.

2 Ranking and inventory of oil polluted lands according to ecological risk degree
About 90 % of the region oil spill falls on swamps and intra-swamp lakes which are characterized by small surface loading capacity, oligotrophy, excessive watering and acidity, and also low intra-soil temperatures. The bulk residual oil mass (up to 98%) is attached, as a rule, to the upper 5-10 centimeters thick horizon. Swamps covering a great part of the region territory play an important role in the process of climate forma-

tion, carbonic gas pickup and, especially, formation of river flow and its chemical composition. Concentration of oil products in the Ob waters (the Ob is the main river of the region falling into the Arctic Ocean) multiplies by 64 after passing through the Okrug territory.

There are no officially approved methods for determination of pollution and ecological risk degree of polluted lands, swamps and water bodies. In practice, most often the percentage of oil product in the soil is used; some authors recommend determining the pollution factor by the quantity of oil per unit square. But for all that, current statutory acts do not take into account either the fractional composition of the residual oil and oil products or the location and remoteness of the oil spill.

As for lands polluted with highly mineralized formation waters, reference and legal base is totally absent, just as any positive experience of their restoration.

Evaluation (passportization) mechanism of the existing polluted (saline) lands and water bodies is not worked through; which hinders in their accurate registration and acquisition of comprehensive input data necessary for planning further remediation works.

3 Methods used in oil polluted lands decontamination and remediation techniques

All decontamination techniques of oil polluted lands are divided into two large groups: "ex situ" – techniques including topsoil breaking and extraction of soil for further cleansing; "in situ" - techniques may include or not topsoil breaking, but they do not include polluted soil extraction.

According to polluted soil treatment mechanism, all remediation methods may be classified as mechanical, physico-mechanical, physicochemical, chemical, and biological.

3.1 Mechanical methods

- Mechanical division and extraction or mechanical gathering of oil from the surface. Used as an obligatory stage in liquidation accident after-effects. Various oil-gathering equipment by the "Lamor", "Vicoma", "Elastek" and some Russian companies is used.
- Excavation (removal) of polluted soil for further decontamination in process installations. Most often used at processing plants in cases of high pollution degree.

3.2 Physico-mechanical methods

- Polluted area burnout. This method used to be widely spread but nowadays it is prohibited.
- Thermal desorption and polluted soil burnout. Used in soil decontamination installations. For example, "Surgutneftepromkhim" department of Joint-Stock Company "Surgutneftegaz" performs works on polluted soil and oil slime processing in "Desorber" and "Burner" installations. Organic waste neutralization by the thermal method is used in the mobile "Smart Ash" plant by "Elastek", USA.
- Steam extraction of soil. Used in soil decontamination plants.
- Rinse of soil by hot water or dissolvent. Used in soil decontamination plants. For instance, in the "Lamor" plants (Joint-Stock Company "Sibneft-Noyabrskneftegaz").
- Baking or stabilization (capsulation). Used for neutralization of oil containing drilling waste (drill cuttings).

3.3 Chemical methods

- Polymerization of oil products. Experimental method, not used at present.

3.4 Physico-chemical methods

- Adsorption with the use of organic and inorganic adsorbents. Widely spread techniques with the use of various organic, inorganic and synthetical adsorbents ("Unipolymer", "Supersorbent", "Primesorb", "Ecosorb" and many others). One of the latest perspective methods – the use of adsorbents on thermo-cracked graphite base ("STRG" sorbent by "GeoLineGroup" Limited Liability Company).
- Soil decontamination technique with the use of "high pressure jet" method. Based on the use of water solutions of biological surface-active substances (Joint Stock Company "Tibet" Bureau of Ecological Problems" under the Ministry on Emergency Situations of Russian Federation). Experimental technique.
- Soil loosening for stimulating natural physico-chemical processes of the soil self-purification (by means of agricultural machines, explosions, etc.).

3.5 Biological methods

- Stimulation of natural oil bio-destruction processes by agricultural (agro-technical) means with introduction of fertilizers and sowing of oil-resistant grass.
- Use of bacterial preparation.
- Introduction of bioactive compounds for stimulating the local hydrocarbon oxidizing microflora.

For instance, “Farizime” preparation has shown a high efficiency (“Uganskneftegaz” and “Sibneft-Noyabrskneft” Joint-Stock Companies).

It is necessary to note that far from all described methods are used in remediation practice. Moreover, a complex of methods is used for every single plot remediation, starting, as a rule, with the mechanical oil gathering and soil loosening and finishing by grass sowing and bacterial preparation introduction.

4 Methods and projects on remediation of oil polluted territories supposed by various organizations

The following ways seem to be perspective for solving remediation problems:

- Elimination of shortcomings in the current reference and legal base regarding the evaluation of territories polluted with oil and formation waters;
- Reorientation of the existing approaches to lands restoration from quantitative to qualitative characteristics;
- Creation of conditions for application to practice of more progressive (from the ecological standpoint), scientifically grounded, and sparing remediation techniques;
- Creation of conditions for application to practice of efficient techniques on oil polluted water bodies purification and saline territories restoration;
- Elaboration and application to practice of evaluation methods related to oil and formation waters spill risks and damages, along with evaluation methods related to ecological and economical efficiency of polluted territories remediation techniques.

Figure 1-2. A fragment of an intensively polluted head swamp (as a result of accidental oil spill of 1985) (left) and Oil burnout (right)

Figure 3-4. 7 years after the oil burnout (left) and ЭМ-2М miller on the base of “Haski” cross-swamp vehicle (right).

A great number of research teams are investigating remediation techniques. Let us mention only the projects elaborated under the direction of the authors. First, it is the project of the "Siberian Research and Design Institute on Efficient Nature Management" Limited Liability Company.
The project objectives are:

- Elaboration of the polluted territory evaluation model corresponding to the local conditions;
- Preparation of the methodology base for elaboration and application to local practice of the sparing remediation techniques;
- Preparation of the methodology base for elaboration and application to local practice of saline soils restoration techniques;
- Preparation of the methodology base for elaboration and application to local practice of water bodies purification techniques;
- Project results dissemination at the regional level and elaboration of methodology and legal base for management of ecology risk related to soil and water bodies pollution with oil and formation waters.

Project description is given at website: www.ecooil.far.ru.
Second, it is the project of Khanty-Mansiysk Regional Branch of Russian Academy of Sciences. The project objectives are:

- Working out a single approach to evaluation of territories polluted with oil and oil products, highly mineralized formation waters, flambeau lights pollutants;
- Suggestion of evaluation principles on ecological and economical efficiency of the existing remediation methods.

This work is described in [1].
Third, it is the project of Research Institute on Ecology and Efficient Nature Management of the Tyumen State University. Project description is given at websites: www.utmn.ru and www.ecooil.far.ru.

5 Conclusion

Analysis of the existing at present ecological situation shows that the most crucial environmental problem of Khanty-Mansiysk Autonomous Okrug – Ugra is oil pollution of operating oil fields.
Projects worked out by various research teams embrace a wide range of problems related to remediation of territories suffering the impact of oil and gas complex, including risk evaluation, monitoring, management, methods and techniques of soil and water bodies remediation. The projects stated above may be recommended for inclusion into the Enviro-RISKS Coordination Action plans.

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3.5. Kabanov M.V.: Complex Monitoring of Great Vasyugan Bog: Modern State and Development Processes Research

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Abstract

Results of interdisciplinary integration project «Complex Monitoring of Great Vasyugan Bog: modern state and development processes research» are presented.

1 Introduction
Interdisciplinary studies of regional climate peculiarities based on complex monitoring of natural complexes are important component in investigation of global and regional environmental changes. Natural complexes with undisturbed natural ecosystems are of peculiar interest and considered as priority objects for fundamental interdisciplinary studies. Great Vasyugan Bog (GVB) is the largest bog on the globe with an area of 53 thou. km^2. This bog is a unique natural complex that has been chosen as an object for multidisciplinary studies in the frameworks of project «Complex Monitoring of Great Vasyugan Bog: modern state and development processes research».
All investigations have been grouped into four main blocks:

1. Investigation of climate and ecological changes on the GVB territory
Supervisors: Corr. member of RAS M.V. Kabanov, Doctor of Phys-Math Sci. I.I. Ippolitov
2. Investigation of hydrological and ecological changes on the GVB territory
Supervisors: Academician O.F. Vasiliev, Doctor of Geol-Mineral. Sci.S.L. Shvartsev
3. Investigation of biogeochemical and natural resort changes on GVB territory
Supervisors: Corr. member of RAS I.M. Gadzhiev, Corr. member of RAS L.I. Inisheva
4. Development of facilities for geoinformation provision of monitoring and modeling GVB geosystems
Supervisors: Corr member of RAS V.V. Shaidurov, Doctor of Phys-Math. Sci. V.A. Krutikov.

2 Participants
- IMCES is Institute of Monitoring of Climatic and Ecological Systems SB RAS,
- ASU is Altai State University,
- SibR&D of Peat is Siberian R&D Institute of Peat,
- TSU is Tomsk State University,
- ICMMG is Institute of Computational Mathematics and Mathematical Geophysics SB RAS,
- IPC is Institute of Petroleum Chemistry,
- TA IOGG is Tomsk Affiliation of Institute of Oil and Gas Geology,
- TPU is Tomsk Polytechnic University,
- IWEP is Institute of Water and Ecological Problems,
- ISSA is Institute of Soil Science and Agriculture,
- IG is Institute of Geology.

3 Project main goals
- To show the role, importance and scientifically grounded ways of development of the unique natural-climatic complex Great Vasyugan Bog (GVB) as the natural formation of planetary importance for global and regional environmental and climate change. This will be done on the basis of basic and applied multidisciplinary research of GVB.
- To assure further development of technologies of GVB monitoring on biological, physical, chemical, technogenic components and methods of multifactor analysis and forecast of regional changes under the influence of natural and anthropogenic factors in addition to traditional technologies of monitoring and forecasting of regional environment and climate state.

4 Project main objectives
- To create a database on characteristics of biological, physical, chemical and technogenic processes proceeding on the GVB territory.
- To investigate the GVB evolution scenario in the interactive connection with the published scenarios of the climate global change.
- To investigate functional patterns of bog geosystem GVB under the influence of natural and anthropogenic factors.
- To study modern rhythm of the earth's crust movement in the Western and Eastern Siberia and on this basis to find out the peculiarities of geodynamic processes on the GVB territory.

5 Methodology
The developed methodology of complex monitoring combines principles and statements of different methodological approaches (geosystem, system-evolutionary, landscape-ecological), as well as analysis technology. The monitoring technique is based on geoinformation technologies, computational methods, and multivariate statistical analysis of aggregated heterogeneous data (satellite, ground-based, etc.).

6 Results for Great Vasyugan Bog

Investigations under this project have been carried out in accordance with the declared program taking into account the results obtained in the frameworks of the previous project (2000-2002) that have been published in collected papers "Great Vasyugan Bog. Modern state and development processes" (Tomsk, 2002).
The investigations performed revealed a number of regularities concerning evolvement processes of physical, chemical, geochemical, and biological components of GVB.

6.1 Mesoscale peculiarities of temperature regime

Increased monthly mean temperatures in winter and decreased in summer are characteristic for the GVB territory. Profiles of area-averaged monthly mean temperatures over 1988-2002 were plotted on the base of the Sage satellite data. Characteristic temperature field distribution above GVB territory keeps up to height of tropopause (≈10 km) (more than data processing errors). At that seasonal regimes of emission fluxes do not coincide with seasonal changes of temperature regime.
Unexpected result is that the heat island structure is reproduced at all standard pressure levels up to 400 mb (7.5 km), i.e., practically through all tropospheric column. At 300 mb level (≈9.6 km) this structure is not observed. In summer this structure is destroyed at altitude of 200 mb (≈12 km). Some of the possible mechanisms are considered of appearance of anomalous temperature regime above the bog.
Based on the NCEP/NCAR reanalysis data the surface heat imbalance has been determined. The imbalance annual behavior both inside/outside of the GVB territory makes a physical basis for correction of quantitative description of heat transfer in the atmosphere taking into account heat advection due to atmospheric circulation.

6.2 Carbon balance based on ground observations

Results of instrumented observations revealed time dynamics of CO_2 emission at the most typical GVB biogeocenose. As it was found, CO_2 emission correlates with meteorological conditions and hydrothermal regime of the peat deposit (IMCES).
Fluxes of greenhouse gases (CO_2 and CH_4) and peat surface temperature at GVB sites studied have high correlation coefficient (0.75 for CO_2 and 0.92 for CH_4). Carbon balance at different GVB sites substantially depends on landscape characteristics (for CO_2 fluxes it is not less than 2.3 times). Therefore, to estimate the GVB total carbon flux, we need a multilayer landscape map (IMCES, SibR&DI of Peat, TSU).
A 1D model has been developed of methane emission from over-wetted soils. This model reproduces and explains important features of CH_4 vertical distribution inside the soil layer. This model, being incorporated into biosphere block of the underlying surface model, allows studying the methane global cycle and its influence on climate. As a result of simulation, estimates have been obtained for spatial and seasonal variations of CH_4 fluxes from over-wetted soils (ICMMG).

6.3 Multilayer landscape mapping

Results for the key sites are verified fragments for distribution and changes of the GVB land cover. More than 50% of GVB territory has been mapped, mainly in the eastern part (IMCES, IPC, TSU).

6.4 Hydrological and geochemical changes

A landscape-hydrological approach has been developed for studying processes of runoff formation at boggy territories based on combination of ground-based and space-based monitoring techniques. The topographic maps of catchments have been made with a scale of 1:25 000, as well as digital terrain of the GVB territory with a scale of 1:100 000. Software has been created on the base of ArcView (SnipCalc) for automatic determination of morphometric parameters of catchments.
Accumulation of water (up to 15-25% of annual precipitation) is an essential retail stock in the GVB annual water balance. In this case runoff makes up to 25% of annual precipitation (IWEP).
New data on the GVB water composition have been obtained. A microflora has been identified in GVB water and peat, where bacteria pertinent for carbon and nitrogen geochemical cycles predominate. An oligotrophic index ranges from 4.2 to 0.98 for transitory and lowland bogs, respectively. Mineral composition of bog water in the eastern part of GVB varies within the natural limits. Content of the main chemical elements in bog waters (in mg/l): Fe (0.3-12.5), Si (2-2.5), Al (0.02-0.12), Mn (0.04-0.09), etc. (TA IOGG, TPU).

Four total water content cycles with duration of 12-14 years have been revealed for large GVB rivers (more than 20 thou. km^2) in the second half of XX century. For small GVB rivers (up to 10 thou. km^2) a high-water period in 1940-50th changed into 30-year shallowness with short-term (3-5 years) water content «bursts» (IWEP).

6.5 Biogeochemical and natural resort changes

As follows from ground-based observations, changes of concentrations of heavy metals, chlorides, sulphates, nitrates, phosphates, phenols, as well as pH at the Vasyugan plateau are within their natural variations (ISSA, IPC).
Modern method has been used for investigation of polygenetic processes of peat accumulation by means of depth sampling of peat and lake sediments with subsequent analysis of botanic and mineral composition of the samples (IMCES, IG).

6.6 Wavelet analysis of bog-forming process based on dating results

Dating of stratigraphic records has been made by ^{137}Cs (40 years), ^{210}Pв (100 years), and ^{14}C (100 years). Pine dendroindication method has been used as well. Quantitative characteristic of bog-forming process cyclicity has been determined by humidity index and carbon and peat accumulation rates. The cycles with periodicity of 1500-1000, 1000-750, and 500 years are similar to bog cycles in other regions on the globe.

7 Conclusion

1. Investigations of modern state and development processes at GVB allowed us to reveal: heat regime peculiarities at GVB; hydrological cycles of river runoff and GVB water balance; biogeochemical composition of GVB waters and soils; to adapt and develop geoinformation technologies for GVB monitoring.
2. Future expeditions to GVB have been coordinated with Russian and foreign colleagues (The Netherlands, Finland, Germany) in the frameworks of bilateral agreements on cooperation and within EC SIXTH FRAMEWORK PROGRAMME
3. Based on investigation results obtained within this project**,** as well as within other integration projects, a new volume of collective monograph «Modern natural and climatic changes in Siberia» is under preparation; organization of preserve on the GVB territory has been well grounded and now this work is in the progress.
4. New integration project of SB RAS «Complex monitoring of climatic and ecosystem changes in West Siberia» was submitted for consideration. This project provides for investigations of both the GVB and adjacent territories.

3.6. Balakay L.A.: Modeling of Oil Pollution Spreading on Sea

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Abstract

Oil spills on the sea is a cause of huge material damage. The oil leaks take place on the all workflow during marine production and transportation. This paper is dedicated to this problem and describes a space monitoring and transport modeling technology of oil contamination on the sea.

1 Introduction

It is undoubtedly that the problem of accidental oil spills and regular leaks is one of the important among the others, which arise during hydrocarbon region developing on the shelf of the Caspian Sea. The first stage towards solving this problem is the shelf oil pollution monitoring and analysis. In the frame of the State Programme "Development of space activity in the Republic of Kazakhstan for 2005-2007" according to the mission "Build up inter-brunch GIS using remote sensing and cartographic methods" preliminary works for space monitoring and modeling of spreading of oil patches have been implemented.

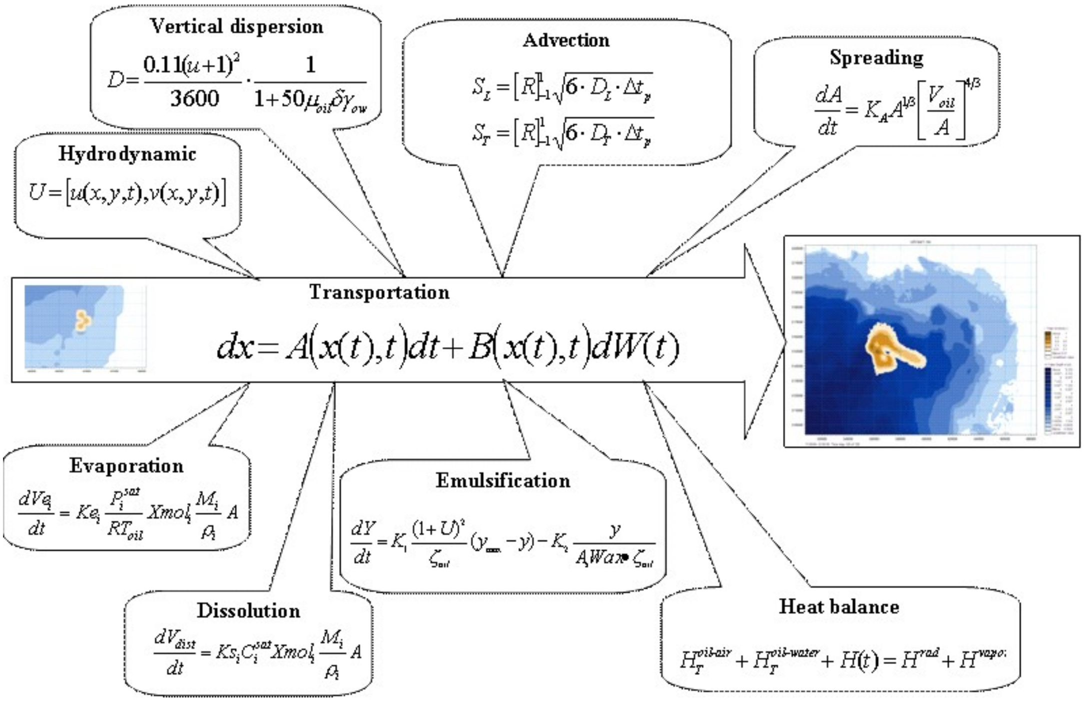

Figure 1. Mathematical model of sea oil contamination.

2 Methodology

Developed technology includes two stages:

1. Satellite monitoring and image processing from the Terra, Aqua (MODIS) and Radarsat platforms, etc. Identification of oil slicks from satellite images and definition of source location, area and volume of discharged oil [1,2,3];
2. The forecast of the oil slicks spreading for 120 hours using the MIKE 21 SA module [4];

Oil spill spreading modeling is conducted by the following:

1. Current fluxes and water depth calculation in Hydrodynamic module MIKE 21 [5,6] for 120 hours using the ECMWF forecasted pressure and wind speed data;
2. Input data preparation for Spill Analysis module;
3. Oil spreading calculation in SA module influenced by meteorological data and hydrodynamic fields for 120 hours. Here, the physical and chemical oil properties, dispersion, advection, evaporation, emulsification, heat balance and other processes (Figure 1) were taken into account [7,8,9].

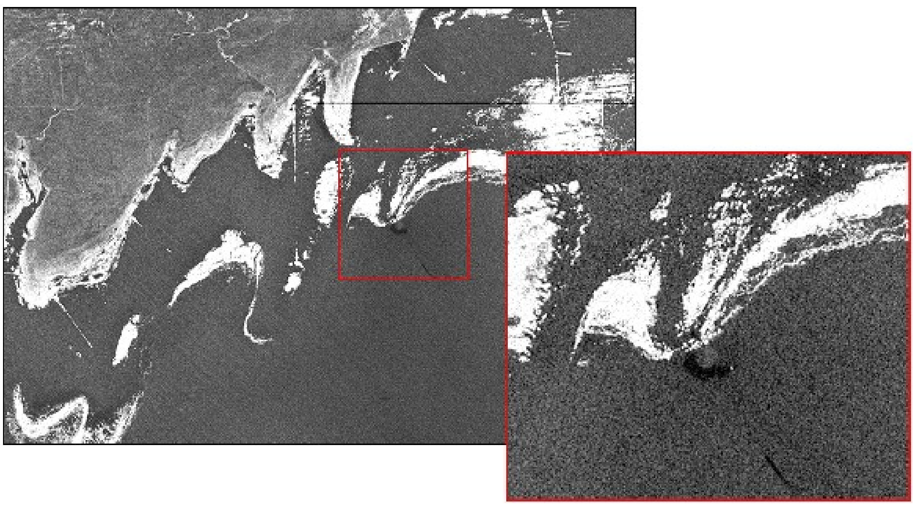

Figure 2. Space image from satellite RADARSAT-1 at 22.04.2005.

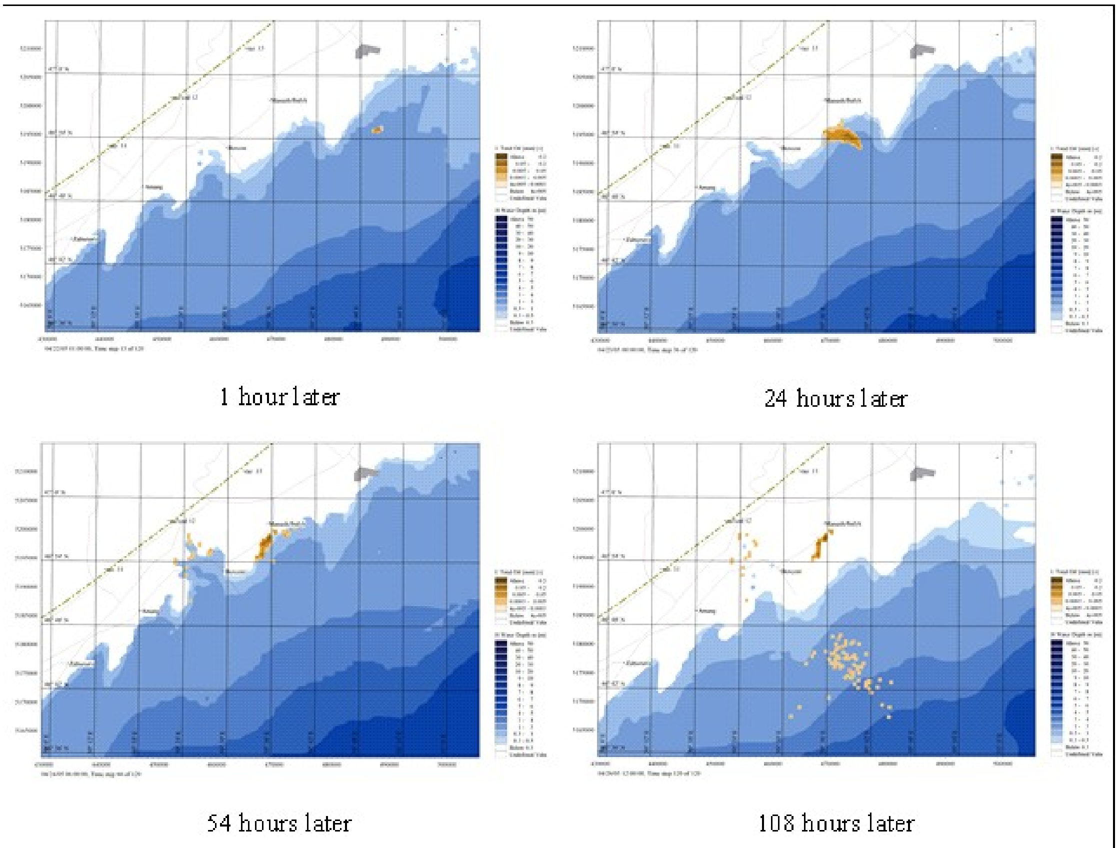

Figure 3. Results of calculation using SA MIKE21.

3 Example

The oil slick was detected at 22.04.2005 on the satellite image (Figure 2) from the RADARSAT-1 satellite in the northern part of the Caspian Sea. This area was approximate 0.4 km^2. SA module MIKE21 was used to forecast the oil slick spreading. The volume of the oil-polluted sea was equal to 0.0056 m^3/sec, the action time of the source was equal to 2 hours.

Calculation results of spatial distribution of the oil pollution after 1, 24, 54, and 108 hours after the oil flood had started are shown in Figure 3. It is visible from this figure that oil pollution reached the coast due to strong storm flood.

4 Conclusions

The technology of monitoring and the forecast of the oil spill distribution in the northern part of the Caspian Sea was developed. These results will be further used in the Inter-Branch GIS of the Republic of Kazakhstan.

Acknowledgements

The author is thankful to Prof. E.A. Zakarin, Drs. B.M. Mirkarimova and T.V. Dedova for help and support.

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3.7. Shvidenko A., S. Nilsson, C. Schmullius: Terrestrial Biota Regional Full Greenhouse Gas Account: Understanding Impacts of Man-made Changes in Siberia

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Summary
The Terrestrial Biota Full Greenhouse Gas Account (FGGA) presents comprehensive information about the condition and functioning of vegetation ecosystems including both human and climate change impacts. This paper describes major features of the regional FGGA developed by a number of international projects in Siberia and the links of the FGGA to ecological monitoring and natural resources management. A strict necessity of mutual coordination of regional projects is illustrated on different types of monitoring (ecological, fire etc.), resource (particularly forest) management, remote sensing applications, global change impacts etc.

1 Introduction

At least, two major features define the importance of the Terrestrial Biota Full Greenhouse Gas Account (FGGA): (1) only the FGGA satisfies the eventual goals of the UN FCCC and the Kyoto Protocol, and (2) the FGGA is an integrated and comprehensive characteristic of the condition and functioning of terrestrial ecosystems including human impacts and possible risks. Thus, the FGGA is considered as an intrinsic part and consequence of any monitoring or integrated observing system. Validation of the accounting results is an obligatory part of any scientifically solid FGGA. The latest developments of the post Kyoto international negotiation processes assume a transition to a *verified* FGGA that means that (1) completeness of the account is provided in all ramifications, at all stages and for all modules of the FCA; (2) uncertainties are assessed in a comprehensive and transparent way and do not exceed a preliminary defined level; and (3) the methodology used presents explicit guidance which is the optimal way to manage the uncertainties. Keep in mind that the FGGA is a typical fuzzy system that defines a number of systems' requirements to the FGGA, specific features of expedient methodologies of the FGGA and ways in which the uncertainties should be assessed.
Several international and national projects in recent years considered the philosophy, methodology and modeling basis of the FGGA from a regional to continental scale in Northern Eurasia. The findings and results which are briefly considered below with respect to the objectives of the ENVIRO-RISK project mostly follow from: IIASA's project on the Russian terrestrial biota full carbon account (1996–2000, Nilsson *et al.*, 2000); EU-funded project SIBERIA (SAR Imaging for Boreal Ecology and Radar Interferometry Applications, 1998–2001); EU-funded project SIBERIA-II (Multi-Sensor Concepts for Greenhouse Gas Accounting of Northern Eurasia, 2001–2005); ongoing project IRIS (Irkutsk Regional Information System); and other ongoing and expected projects. The first project above covered all vegetation classes of Russia at the national level and was based mostly on available data. The second project was devoted to studying prospects for using advanced radar technologies in terrestrial biota monitoring. The scientific objective of the third project was to integrate Earth observation and ecological models of different types such that a FGGA within a significant part of the biosphere may be quantified to a much greater degree of certainty than even before. This research covered a large (above 3 million km^2) area of Central Siberia (Figure 1), which includes all major bio-climatic zones of Northern Eurasia (from arctic deserts through tundra, taiga and the temperate zone to semi-deserts in the south). The region is typical for polar and boreal domains and is experiencing increasing anthropogenic impacts (oil and gas extraction, harvest, air pollution) and accelerated

regimes of natural disturbances. The most dramatic climatic change over the globe is expected in this region.

2 Major features of methodology

The most important features of the methodology developed by the projects above are *inter alia*: (1) a comprehensive as possible systems approach is used as an overall methodological basis; (2) the need to fuse ground data, remotely sensed indicators, results of measurements *in situ* and regional ecological models; (3) the need to assess the uncertainties at all stages of the account; and (4) the relevance of using a combination of various approaches and ecological models of different types. The information base is presented by (1) an Integrated Land Information System in the form of a multi-layer geographic information system (GIS; the basic scale is 1:1 Million), which contains a comprehensive description of individual ecosystems and landscapes and numerous attributive databases; (2) multi-sensor remotely sensed data of different types and resolutions; a spectrally and temporally diverse set of 15 Earth observation instruments on 8 satellites have been examined; (3) results of physical measurements in situ; (3) and sets of semi-empirical models, e.g., which are able to connect remotely sensed indicators and "hidden" ecological parameters. A relevant combination of these sources resulted in a GIS layer "relevant for the FGGA". The project SIBERIA-II also examined two well known Dynamic Global Vegetation Models (DGVMs) — the Sheffield model and LPJ, which have been regionalized to its maximum extent.

3 Some important results

The major conclusions resulting from the projects above are: (1) a landscape-ecosystem approach should be considered as a relevant overall methodological basis of the FGGA; (2) the terrestrial biota full carbon account is used as an information and modeling basis of the FGGA; (3) only integration in all ramifications allows to reliably assess uncertainties of the intermediate and final results of the FGGA; (4) application of RS methods is crucial for the FGGA of large territories in Siberia, particularly for assessment of rapid man-made changes; however, there are substantial gaps in technical capabilities of current RS instruments, and, consequently, in RS information which is crucially important for the FGGA; (5) inter-annual variability is very high; thus any snapshot estimates are not satisfactory for long-term conclusions; (5) no individual model or method is able to present a comprehensive and reliable estimation of the uncertainties; (6) a relevant combination of bottom-up and top-down estimates is the most appropriate way to constrain the uncertainties; it requires the involvement of atmospheric concentration measurements and the results of inverse modeling; (7) following the major systems' requirements to the FGGA allows to substantially decrease the uncertainties; however, still there are no international agreed requirements that indicate which level of uncertainties should be targeted for different spatial and temporal patterns of the FGGA; (8) integrated observing systems are the most appropriate tools of ecological monitoring, resource management and the FGGA; (9) man-made transformation of vegetation, such as air pollution and soil/water contamination, and land-use land-cover change crucially impact the terrestrial biota in Siberia and are an intrinsic feature of FGGA; (10) possible risks are mostly generated by global change impacts including climatic anomalies, cryogenic processes due to global warming, and the anthropogenic transformation of landscapes.

It has been shown that large regions in Siberia serve as a carbon sink although disturbances (mostly fire) substantially impact the total budget (Table 1). On average, 15% of NPP is allocated in AGW, 43% in GP, and 32% in BG LB, although the structure of NPP greatlydepends on land classes. Average NEP for the region is rather high and comprises 23.6% of NPP. However, 2003 was a year of high disturbances (e.g., wild fire enveloped an area of 3.137×10^6 ha and consumed 43.3 Tg C, of which 37.8 Tg C was emitted into the atmosphere in gaseous form, 2.6 Tg C as particles and 2.9 Tg C was stored as charcoal). A complete account for fluxes due to consumption (including import/export of major vegetation products) and disturbances estimated an overall average NBP at 0.333 Mg C ha^{-1} yr^{-1}, or ~13% of the total NPP. Vegetation of the region served as a carbon sink of 99.8 Tg C yr^{-1} in 2003. Substantial seasonal variability (up to 30%) of the carbon sink in 1988–2003 was mostly driven by natural disturbances. The impacts of seasonal weather specifics and land use change were substantially lower. The uncertainties of the results were estimated taking into account the fuzzy character of the FCA (Nilsson *et al.*, 2004). The uncertainties of major fluxes of the FCA for 2003 are 7–10% (confidential interval is 0.9). NBP is estimated to be about 25%, assuming that the data and models used have no unrecognized biases.

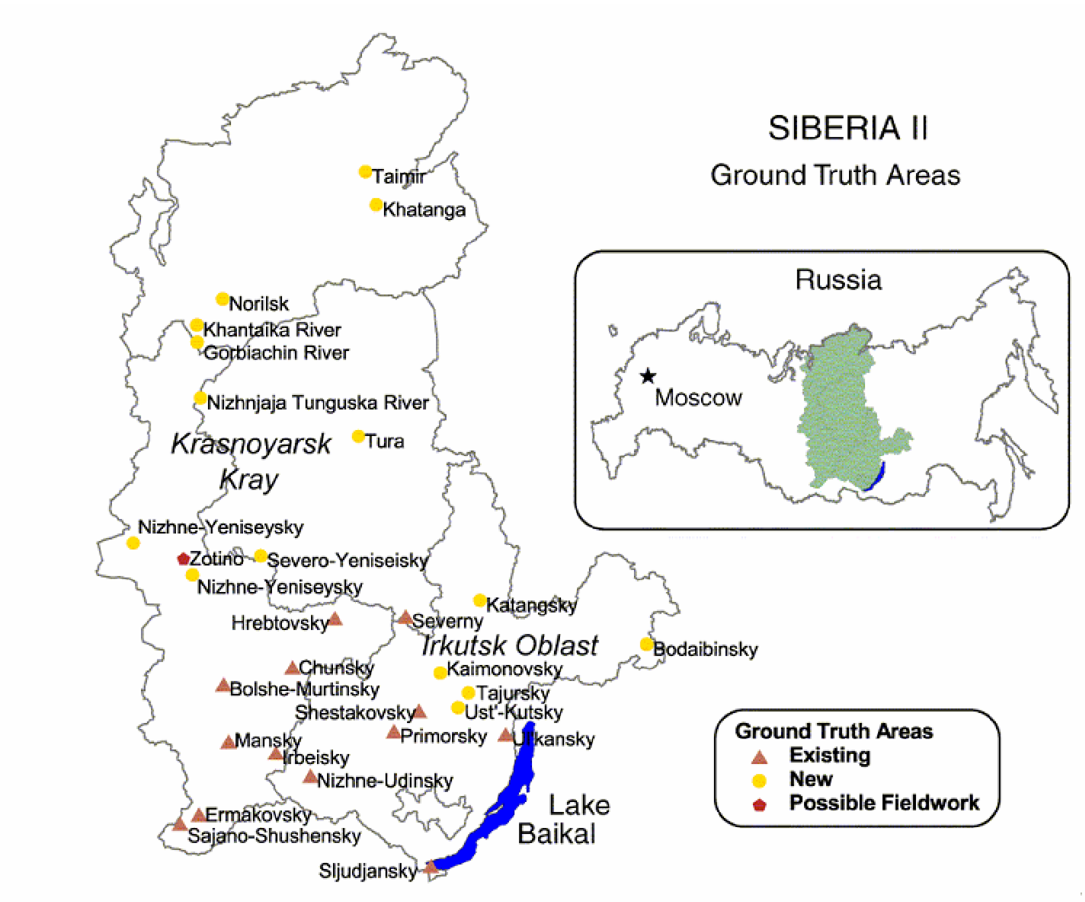

Figure 1. Region covered by research of the project SIBERIA-II and Sib-ESS-C.

It has been also indicated that the processes of acclimation of boreal terrestrial biota to climate change is already observed, particularly, for forests (Lapenis *et al*., 2005).

Table 1. Major carbon fluxes for 2003 (average values, Mg C $ha^{-1}yr^{-1}$, by major land classes).

Land Classes	NPP-AGW	NPP-GP	NPP-BG	NPP-Total	HR	DEC	FHYD	FLIT	NEP
total for region	0.365	1.083	1.043	2.491	1.679	0.151	0.053	0.019	0.589
including forest	0.553	1.323	1.251	3.137	2.120	0.224	0.050	0.018	0.725
disturbed forest	0.175	1.038	0.491	1.704	1.375	0.338	0.050	0.018	0.076
grassland	0.027	0.345	0.597	0.969	0.613	0.001	0.057	0.018	0.280
wetland	0.163	1.009	0.867	2.039	1.417	0.001	0.064	0.022	0.534
shrubs	0.216	0.829	0.947	1.992	1.413	0.001	0.064	0.023	0.491
agricul. land	0.063	2.617	2.258	4.938	2.649	0.001	0.037	0.010	2.240

Abbreviation in Table 1: NPP – Net Primary Production, AGW – above ground wood, GP – green parts, BG – below ground phytomass, , HR – heterotrophic soil respiration, DEC – flux due to decomposition of above ground and below ground detritus, FHYD – flux to the hydrosphere, FLIT – flux to the lithosphere, NEP – Net Ecosystem Production.

4 Concluding remarks and coordination actions

Any relevantly organized research to assess man-made changes in Siberia requires (1) keeping the information accumulated by different projects; (2) sharing the methodological finding, models of different types, and results received; (3) integration of methods and results received in different fields of knowledge. Practically all projects of the region need to have background information presented in the form of multi-layer GIS. For Central Siberia, such a GIS has been generated at scale 1:1 Million. The GIS contains a comprehensive description of landscapes and ecosystems in the region by polygon (about 30,000 polygons are delineated). Each polygon has about 100 ecological indicators. The FSU in Jena in cooperation with SIBERIA-II partners is establishing a special database of collected data and value-added products in the framework of the project

Sib – ESS – C (Siberia – II Earth System Science Cluster) which will maintain the existing and collect new remote sensing information for the region (Table 2). Numerous data and data sets of different types collected and received by IIASA and its Russian partners is planned to be presented in CD-Rom format (results of measurements of heterotrophic respirations and phytomass, empirical models of growth and biological production of Siberian tree species etc.). The important element of coordination is harmonizing technical elements such as the use of (1) compatible definitions; (2) a unified cartographical components (projections etc.); (3) common protocols of experiments etc.

Table 2. SIBERIA-II Database.

EO Product	Temporal coverage	EO Sensor	Spatial resolution	Partner responsible	Use in GHG accounting models
Land cover	2001-2004	MODIS MERIS	500m	UWS	IIASA (I) SDGVM (I) LPJ (I)
FPAR, LAI	2002 & 2003 8 day and monthly	MODIS	1 km	DLR	SDGVM (C) LPJ (C)
Biomass	2003	ASAR WS	75m	CESBIO	
Phenology	2000-2003	SPOT-VGT NOAA/AVHRR	1km & 10km	CESBIO	SDGVM (I)
Freeze/ Thaw	2000-2003	QuikSCAT	10km	IPF	
Water bodies	(2003/2004)	ASAR WS	75m	IPF	IIASA (I)
Snow Depth & Snowmelt	2000-2003	SSM/I	25km	CESBIO	SDGVM (C) LPJ (C)
Disturbances	1992-2003 on yearly basis (except 94-95)	MODIS, AVHRR ATSR-2	1 km	CEH	IIASA (I)
Topography	2000	SRTM	3arcsec<60° N I km > 60° N	Gamma	-

In order to provide any substantial progress in the regional science on global change and to generate a reliable basis for assessing man-induced environmental risks, it is crucially important to organize free access to existing databases and to provide the most comprehensive as possible coordination between all the projects indicated in the DoW of Enviro-RISKS and other relevant national and international projects.

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4. Information Systems, Integration and Synthesis

4.1. Gordov E.P., Yu.E. Gordova: Environmental Observations, Modelling and Information Systems (FP6 Specific Support Action ENVIROMIS)

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Abstract
The ENVIROMIS Specific Support Action (SSA) was performed by the sole participant: Siberian Center for Environmental Research and Training (SCERT). The presentation briefly describes a methodology used and results received during eighteen months of the project performance.

1 Introduction
ENVIROMIS-SSA formed coherent set of coordination, dissemination, and education actions directly aimed at environment and health protection and related safety aspects, stabilization of research and development potential in Russia and other NIS countries.

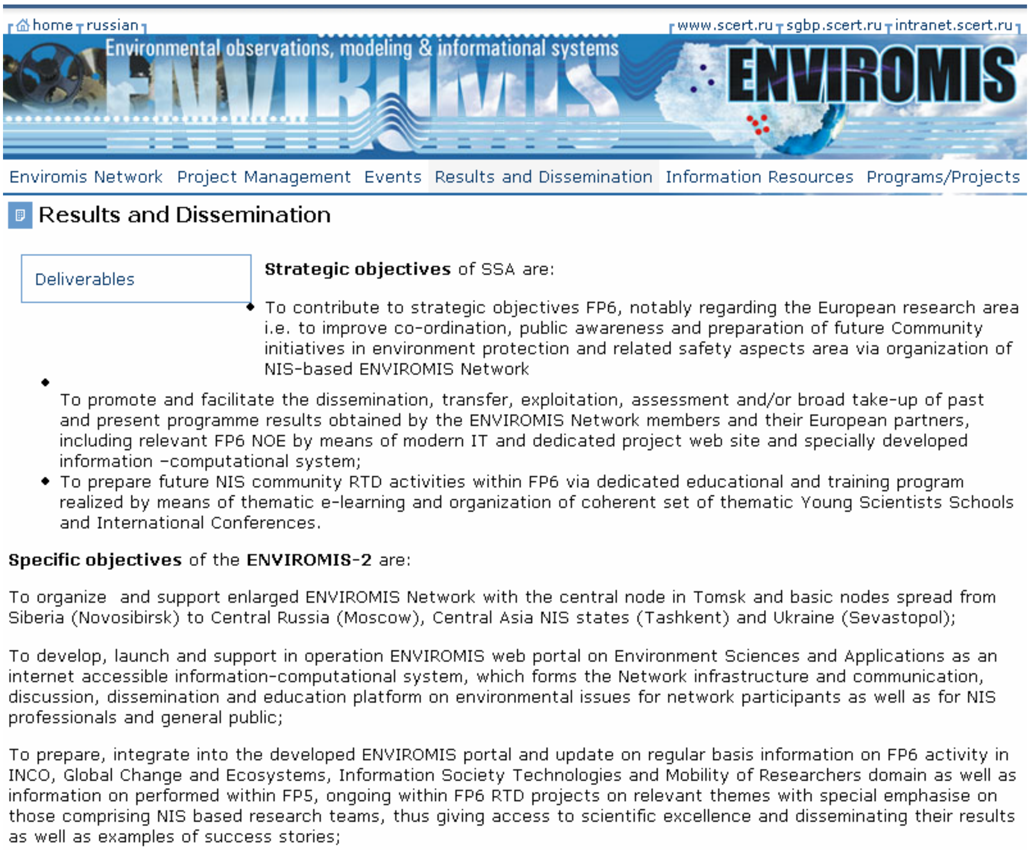
2 Methodology and approaches
To reach the Project objectives (Figure 1) a threefold approach was used:

- Networking of leading environmental research organizations in Belarus, Russia, Kazakhstan, Ukraine and Uzbekistan, which was aimed at research cooperation and dissemination, transfer, exploitation, assessment and/or broad use of past and present programme results obtained by the network members and their European partners;
- Support of special information system opening a free Internet access to gained information resources in area of environmental sciences for professionals, students, and general public, and thus, providing an opportunity for information dissemination, continuous distant e-learning, and public awareness;
- Organization of multidisciplinary and thematic Young Scientist Schools collocated with International conferences on environmental sciences. Each event included a special session devoted to presentation of recent results and ongoing FP5 and FP6 projects performed within the INCO, ESD, and IST Programmes.

Recent NIS graduate and postgraduate training in modern information and computation technologies forming a backbone of environmental sciences at international schools and conferences and by means of IT and dissemination to the targeted audience information on FP6 opportunities should lead to growing a generation of researches able to assess current state of environment, to understand and forecast the basic tendencies of its evolution under pressure of natural and anthropogenic processes and ready to be a part of the European Research Area in this domain.

3 Work performed
Activity has been started from setting up the ENVIROMIS-SSA Technical Committee from authorities representing the networking leading research organizations working in environmental sciences in Belarus, Russia, Kazakhstan, Ukraine and Uzbekistan. Also the Project Steering Committee from recognized NIS and European researchers in area of environmental sciences had been set up. It was done during the first 3 project months

After it the ENVIROMIS network structure was elaborated and the network comprising selected leading research organizations working in environmental sciences in mentioned countries was organized. Its activity was aimed at research cooperation and dissemination.



Results and Dissemination

Deliverables

Strategic objectives of SSA are:

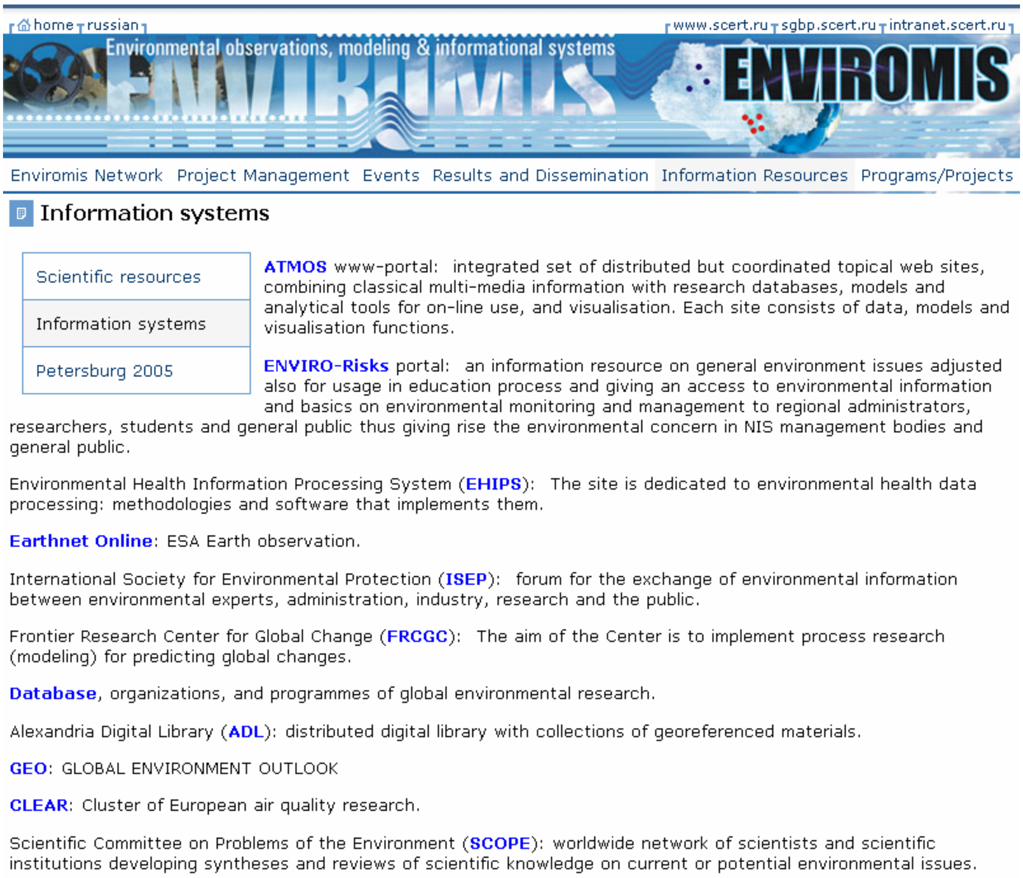
- To contribute to strategic objectives FP6, notably regarding the European research area i.e. to improve co-ordination, public awareness and preparation of future Community initiatives in environment protection and related safety aspects area via organization of NIS-based ENVIROMIS Network
- To promote and facilitate the dissemination, transfer, exploitation, assessment and/or broad take-up of past and present programme results obtained by the ENVIROMIS Network members and their European partners, including relevant FP6 NOE by means of modern IT and dedicated project web site and specially developed information –computational system;
- To prepare future NIS community RTD activities within FP6 via dedicated educational and training program realized by means of thematic e-learning and organization of coherent set of thematic Young Scientists Schools and International Conferences.

Specific objectives of the **ENVIROMIS-2** are:

To organize and support enlarged ENVIROMIS Network with the central node in Tomsk and basic nodes spread from Siberia (Novosibirsk) to Central Russia (Moscow), Central Asia NIS states (Tashkent) and Ukraine (Sevastopol);

To develop, launch and support in operation ENVIROMIS web portal on Environment Sciences and Applications as an internet accessible information-computational system, which forms the Network infrastructure and communication, discussion, dissemination and education platform on environmental issues for network participants as well as for NIS professionals and general public;

To prepare, integrate into the developed ENVIROMIS portal and update on regular basis information on FP6 activity in INCO, Global Change and Ecosystems, Information Society Technologies and Mobility of Researchers domain as well as information on performed within FP5, ongoing within FP6 RTD projects on relevant themes with special emphasise on those comprising NIS based research teams, thus giving access to scientific excellence and disseminating their results as well as examples of success stories;



Information systems

Scientific resources
Information systems
Petersburg 2005

ATMOS www-portal: integrated set of distributed but coordinated topical web sites, combining classical multi-media information with research databases, models and analytical tools for on-line use, and visualisation. Each site consists of data, models and visualisation functions.

ENVIRO-Risks portal: an information resource on general environment issues adjusted also for usage in education process and giving an access to environmental information and basics on environmental monitoring and management to regional administrators, researchers, students and general public thus giving rise the environmental concern in NIS management bodies and general public.

Environmental Health Information Processing System (**EHIPS**): The site is dedicated to environmental health data processing: methodologies and software that implements them.

Earthnet Online: ESA Earth observation.

International Society for Environmental Protection (**ISEP**): forum for the exchange of environmental information between environmental experts, administration, industry, research and the public.

Frontier Research Center for Global Change (**FRCGC**): The aim of the Center is to implement process research (modeling) for predicting global changes.

Database, organizations, and programmes of global environmental research.

Alexandria Digital Library (**ADL**): distributed digital library with collections of georeferenced materials.

GEO: GLOBAL ENVIRONMENT OUTLOOK

CLEAR: Cluster of European air quality research.

Scientific Committee on Problems of the Environment (**SCOPE**): worldwide network of scientists and scientific institutions developing syntheses and reviews of scientific knowledge on current or potential environmental issues.

Figure 1. Project web site (http://enviromis.scert.ru/en/) – strategic and specific objectives of the ENVIROMIS-SSA, and information systems.

At the next stage, the ENVIROMIS network site as an internet accessible information system was launched. It forms communication, discussion, and dissemination platform on environmental issues for network participants as well as for NIS professionals and general public and support it in operation during and beyond the project lifetime. The site (http://enviromis.scert.ru/en/) is provided with a sophisticated intranet allowing the network participants share and enlarge all common information resources and to use it as a supporting management tool. After launching, the site permanent operation support, maintenance, and updating are performed continuously. Available in e-form education resources on the basics and application of environmental sciences, with a special emphasize on geography specifics inherent to different NIS states, compiled by the Network nodes holders at their location were placed at the ENVIROMIS SSA web site. It included basics on the Atmospheric Physics and Chemistry, Physics of Climate, Environmental Monitoring and Management, Air Quality Assessment, Pollutants Transport and Transformations. Available official reports on the environmental state of relevant regions are included here as well. Special attention was paid to orientation of educational resources toward needs of the Central Asia states as less developed part of NIS, which usually has gotten educational support from Siberia. It gave an opportunity for students and young scientists to improve their professional skills and to help spreading the awareness and knowledge to general public in order to explore wider societal implications of the applications of environmental sciences.

In parallel a core element of ENVIROMIS SSA as well as a part of its dissemination and educational strategy, the full format 10 day multidisciplinary international Conference-School ENVIROMIS 2004 on environmental sciences and applications (with near 200 participants including 79 young scientists) from Belarus, Georgia, Russia, Kazakhstan, Ukraine, Uzbekistan and Europe was organized in Tomsk in July 2004. The 3-day thematic conference on Control and Rehabilitation of Environment and the INTAS Strategic Scientific Workshop “Towards integrated multidisciplinary study of the Northern Eurasia climatic Hot Spot” were embedded into the ENVIROMIS Conference. After the event e-versions of available educational recourses on basics and applications of environmental sciences and e-versions of Proceedings of the ENVIROMIS 2004 Conference-School and Power Point presentations of key lectures delivered at the event were integrated into the ENVIROMIS site.

Also as the next core element of ENVIROMIS SSA as well as a part of its dissemination and educational strategy the International Young Scientist School and allocated Conference within the full format 11 day international event CITES 2005 comprising school and conference on Computational Information Technologies for environmental sciences was organized in Novosibirsk in March 2005. The 7 day school with the lecture courses and training sessions was held for 90 participants from the NIS countries. After it the attendees took part in the CITES conference whose audience was enlarged by a number of prominent scientists and decision-makers form the NIS and European leading environmentally oriented research organizations. At the conference young participants presented their poster papers, while key NIS and European specialists in the area delivered 15 lectures on the «hot topics» of environmental sciences and presented 20 invited papers. The Workgroup meeting on the Siberia Integrated Regional Study development also took place where the state-of-the-art in Siberian environmental research and perspectives of integrated regional study of Siberian environment were discussed. The total number of participants was 120. After the event e-versions of the Lecture Notes and Proceedings of the organized and of the CITES 2005 Young Scientists School - Conference were integrated into the SSA web site. The Proceedings were also published in a special edition of a peer-reviewed Journal “Computational Technologies”.

4 Results achieved

- Operational and efficient ENVIROMIS network, full scale participating in the project result and information dissemination;
- Appearance of efficient IT based tool for professional and relevant information exchange (which opens results obtained by the network members to national public), and thus, rising public awareness and stimulating environment protection and to international research community; and thus, giving an access for EU researchers to unique information resources on NIS environment;
- Better knowledge of open by FP6 for NIS scientists opportunities for their RTD activity and their more active involvement into the European Research Area, improvement of professional skills of NIS young researchers, better understanding of their regional environmental situation, which should lead to better environment protection and health safety in the targeted regions;
- Strengthening NIS research potential in this domain, wider usage of results obtained in FP5 Programme and higher level of potential involvement into environmental decision-making at their regions;
- Organization of two full format scientific and educational events, namely the ENVIROMIS 2004

Conference-School and CITES 2005 Young Scientists School and Conference, with a total number of participants 320 (among them - 155 young scientists);
- Preparation and making accessible to professional community and general public extensive information resources on environmental sciences and applications in targeted regions;
- Strengthening of NIS research potential in this domain, to get dipper professional training of young scientists, wider usage of results obtained in Framework Programmes and higher level of potential involvement of researchers into environmental decision-making at their regions;
- Enhancement of cooperation between EU and NIS researchers and assistance in appearance of new joint RTD initiatives, including those within FP6 and coming FP7;
- Moving the scientific community towards clusterization of corresponding integrated projects of SB RAS and netting with profile national and international programs to form SIRS.

5 Recommendations

Gathered scientific and educational resources, which are and will be accessible via the ENVIROMIS Project www-site can be used for subsequent professional activity by all participants of the Enviro-RISKS Coordination Action.

Acknowledgements

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4.2. Zakarin E.A., B.M. Mirkarimova, N. N. Abdrakhmanova: Development of GIS-technology for Solution of Agricultural Tasks

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Abstract

The problem of development of GIS-technology of crop growth and agricultural lands monitoring is considered. This technology is constructed on the basis of remote sensing data and mathematical modeling for the evaluation and forecasting of weather and climatic conditions influence on the efficiency of crops. For monitoring agricultural lands and evaluations of their efficiency WOFOST (WOrld FOod STudy) and CGMS (Crop Growth Monitoring System) models, successfully applied in Europe will be used.

1 Introduction

The agriculture is the important branch of national economy of the Republic of Kazakhstan. The agrarian sector carries out one of the most important problems in system of national priorities. This problem is a maintenance of the food safety. At present time in the Kazakhstan within the framework of the State Programme «Development of Space Activity in the Republic of Kazakhstan for 2005-2007 years» the system of space monitoring is developed. One of items of this Programme is development of GIS-technology for agricultural lands monitoring on an example of the Akmola region (Kazakhstan).

2 Methodology

The GIS-technology of crop growth and agricultural lands monitoring includes:
- recognition of fields condition usage remote sensing data on the basis of the synchronic fields works and space monitoring;
- establishment of correlation dependences between the space and field works measurements;
- inventory of the information flows (meteorology, agrometeorology, land-use and etc.);

- adaptation and verification of geoinformation model of agricultural lands monitoring to conditions of concrete testing area of farmland in the Akmola region of Kazakhstan.

2.1 GIS technology of remote monitoring for agrotechnological processes

The GIG-technology of remote monitoring agrotechnology for cultivate crops has been constructed according to technological operations of crop production which follow from natural laws of agriculture. Field works and remote sensing data give an objective pattern of the work cycle of crop production. The efficient algorithms of remote sensing data processing and analysis are main stages in this GIS-technology.
The scheme of development of the GIG-technology for agrotechnological processes is given in Figure 1. In the beginning synchronic space monitoring and field works are carried out. At the same time the agrotechnological operations of an annual cycle should be enveloped. Technological line is drawn up after the remote sensing data and field works processing.
The users will use output products such as vegetation maps, soil maps, land use maps and etc.

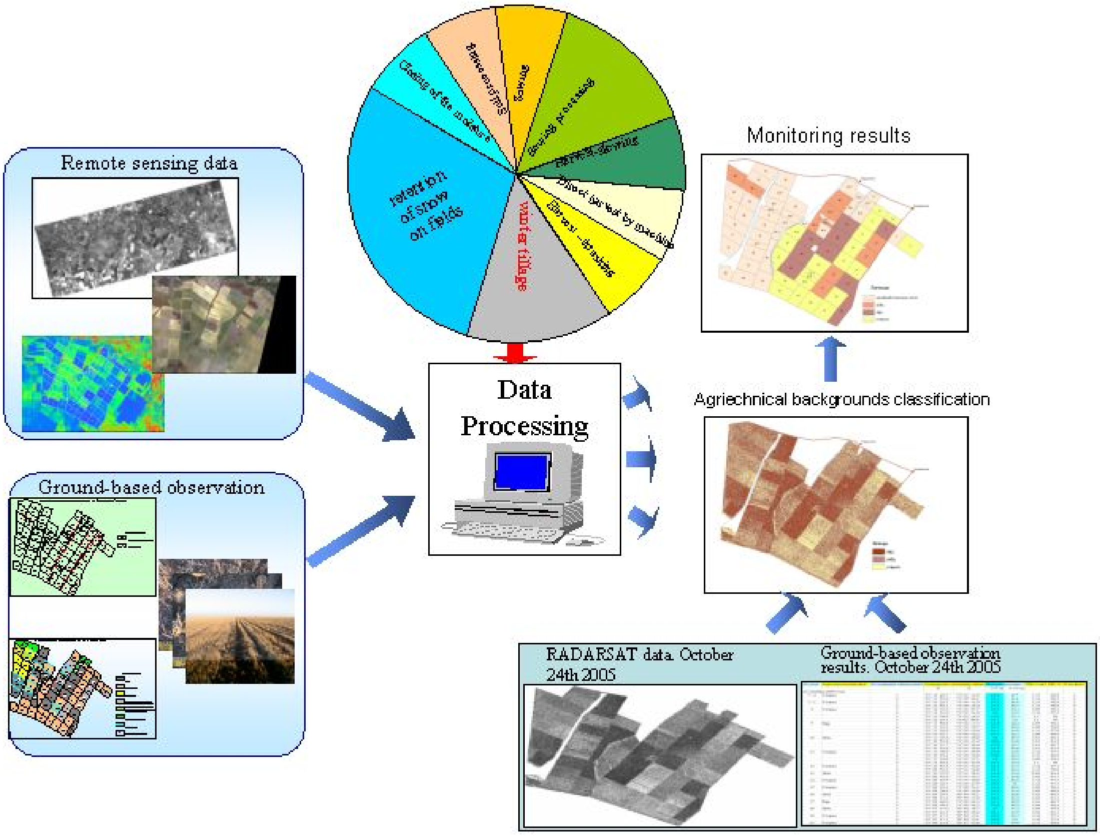

Figure 1. GIS technology of remote monitoring for agrotechnological processes.

2.2 Functional scheme of agricultural lands growth monitoring

The technology has been organized in two levels (see Figure 2). At the first level the weather system is constructed. Historical and actual weather data are collected and corrected in the database. These data are interpolated into grid cells to use them in model. Remote sensing data should be considered as an alternative source of data. The following parameters could be derived from remote sensing:

- Snow cover extent over time, especially date of snow disappearance;
- Parameter NDVI characterized plant cover;
- Estimation of rain amount from cloud cover;
- Estimation of soil humidity from radar signal;
- Estimation of temperature at the earth surface.

Output data of the weather system are decadal and monthly maps. Examples of weather indicators are the excess of rainfall above normal, evaporation deficit, and temperature sum.
At the second level the crop growth simulation is conducted. WOFOST is a tool for quantitative analysis of the growth and production of annual field crops (*Boogaard et al., 1998*). CGMS has been designed as an

agro-meteorological information system for monitoring the quality of the cropping season over large regions on the basis of indicators characterizing weather and crop growth conditions (*Supit et al., 1994*). The monitoring consists of comparing the indicator values of the current year with those on the previous year, or on the long term average values. CGMS uses two kinds of indicators: weather indicators and crop indicators. Examples of crop indicators are the total biomass, grain yield, leaf area index, and crop phenological stage. All indicators can be mapped on basis of their values for the current year, or as their deviation from normal conditions, or from a given previous year. The deviation can be expressed as absolute value or as relative percentage difference (*Mirkarimova et al., 2001*).
GIS-technology of crop growth and agricultural lands monitoring would be tested for farmland in northern part of Kazakhstan. In the capacity of this testing area of farmland was chosen the "Aktyk" LLC of State Enterprise "Research-and-production center" named A.I. Baraev of the Ministry of Agriculture. The application to the testing area of farmland should form a basis for evaluation of its usefulness in general, and its thematic and technical applicability, in particular.

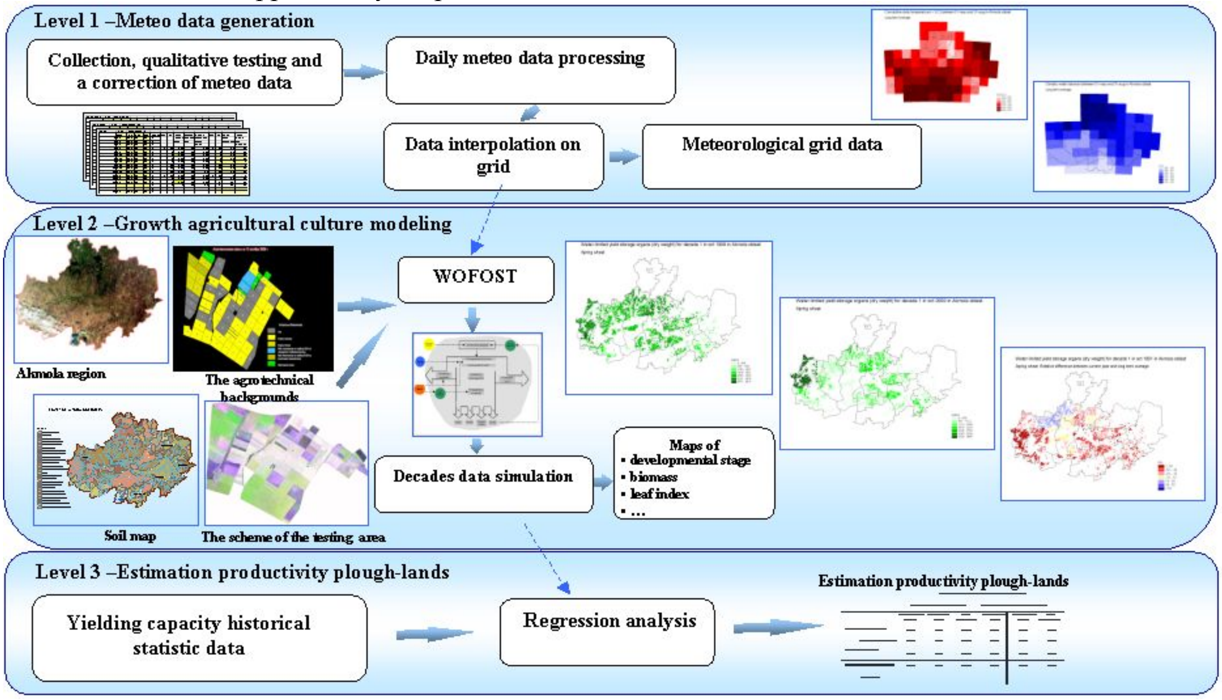

Figure 2. Structure of GIS-technology for complex estimation of crop-lands productivity.

3 Conclusions

The rural economy is the most effective area for application of remote sensing data. But for real use this data it is necessary to built "the bridge" from image to practical result. GIS-technology developed in this work intends for this aim and we hope that it will be widely used for control of agricultural fields treatment.

Acknowledgements

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4.3. Gordov E.P., V.N. Lykosov, A.Z. Fazliev: Web Portal on Environmental Sciences (ATMOS)

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Abstract
The developed under INTAS grant web portal ATMOS (http://atmos.iao.ru and http://atmos.scert.ru) makes available to the international research community, environmental managers, and the interested public, a bilingual information source for the domain of Atmospheric Physics and Chemistry, and the related application domain of air quality assessment and management.
It offers access to integrated thematic information, experimental data, analytical tools and models, case studies, and related information and educational resources compiled, structured, and edited by the partners into a coherent and consistent thematic information resource. While offering the usual components of a thematic site such as link collections, user group registration, discussion forum, news section etc., the site is distinguished by its scientific information services and tools: on-line models and analytical tools, and data collections and case studies together with tutorial material.
The portal is organized as a set of interrelated scientific sites, which addressed basic branches of Atmospheric Sciences and Climate Modeling as well as the applied domains of Air Quality Assessment and Management, Modeling, and Environmental Impact Assessment. Each scientific site is open for external access information-computational system realized by means of Internet technologies. The main basic science topics are devoted to Atmospheric Chemistry, Atmospheric Spectroscopy and Radiation, Atmospheric Aerosols, Atmospheric Dynamics and Atmospheric Models, including climate models.
The portal ATMOS reflects current tendency of Environmental Sciences transformation into exact (quantitative) sciences and is quite effective example of modern Information Technologies and Environmental Sciences integration. It makes the portal both an auxiliary instrument to support interdisciplinary projects of regional environment and extensive educational resource in this important domain

1 Introduction
The Internet increasingly functions as the backbone of interdisciplinary collaborative research in area of environment, and becomes a tool for the efficient access to, and exchange of research data and tools. Among a set of project aimed at development of environment for cooperative work with Earth system science information resources and mathematical models most promising are described in http://www.enes.org, http://www.esmf.ucar.edu, http://www.earthsystemgrid.org. The central technical problem there is to give researchers opportunity to integrate mathematical models of weather or climate forming from compound for different subsystem behavior and save them from tedious tasks related with harmonization of input and output data of different models developed by different groups. At the same time models for each subsystem comprise a number of physical and chemical processes, which are studied by hundreds research groups. Thus there appears a problem of detailed comparative study of these models and multivariate construction of research integrative models, which is not solved on the current stage of development of cooperative modeling within Internet. Below an approach to this problem used at development of the web portal on Atmospheric Sciences ATMOS is presented.
The bilingual ATMOS web portal comprises information resources on physics and chemistry of atmosphere (http://atmos.iao.ru) as well as those on air quality issues and two Siberian territorial objects, which are West Siberia and Lake Baikal (http://atmos.scert.ru). Design of an information resource implies development of different level models describing the chosen thematic area. In our case Siberia is an object of investigations

and its properties under investigation are weather and climate. Their description is based on atmospheric dynamics, which requires knowledge of atmospheric radiation and subsequently of major chemical cycles in different atmospheric layers. To calculate radiation fluxes in atmosphere one has to deal with spectral properties of atmospheric gases and aerosols, whose concentrations are determined by photo-chemical transformations. Investigation of those properties is domain on a set of basic sciences including atmospheric spectroscopy, atmospheric chemistry, atmospheric radiation and atmospheric aerosols. The major concern in process of the portal design was to provide a qualified user with opportunity to get relevant information on all levels of relevant physical and chemical processes descriptions. Say, in the portal part dealing with atmospheric processes major part of calculation tasks are decomposed into elemental stages, which can be controlled by user. Below the two groups of the portal are described briefly. It should be noted that the thematic domains presented in the system cover the area of basic atmospheric science and it applications, in which either project partners or their collaborators group have professional expertise. The collaborators, mainly belonging to SB RAS research institutions, also formed a user group, whose requirements were taken into account in process of the system design and development.

2 Thematic Sites of Atmospheric Physics and Chemistry group

Each site of this group is based on databases or data sets inherent to its thematic domain. Computational models accessible in the portal after registration include the 3-D atmospheric circulation (climate) model of INM RAS (*Alekseev, 1998*), land cover-atmosphere interaction INM RAS model (*Volodin, 1998*), model of light scattering on spherical particles (*Vasiliev, 1996, 1997*), model describing short and long wave radiation in atmosphere (*Barker, 2003*), etc. The group comprises six sites, four of which are described below.

2.1 Atmospheric spectroscopy (http://saga.atmos.iao.ru/)

This information system is based on the Hitran (*Rothman, 1998*) and Geisa (*Jacquinet-Husson, 1999*) spectral data banks. Within it user can simulate spectral properties of an isolated molecule as well as of homogeneous or inhomogeneous molecular gas. Calculated data can be presented in table or graphical form. Graphical data presentation can be done by low end graphic, when only relevant plot is available to user, or by high resolution end graphic. In this case, user is provided with data massive and relevant web services allowing him different presentations, scales, sets of curves, etc.
This information-computational system is provided with other services as well. Its information part contains in particular some text books on molecular spectroscopy (Sinitsa, 2003; Tonkov , 2000). More detail description of the site is given in (Bykov, 2004; Fazliev, 2005; Kozodoev, 2005).

2.2 Atmospheric aerosol (http://aerosol.atmos.iao.ru/)

Information part of this site comprises two editions of three volumes of M.V. Kabanov monograph “Optics of disperse media”, L.S. Ivlev monograph “Physics of atmospheric aerosols systems” and materials of nine annual Workshops "Siberian Aerosols".
Computational component of the site includes a version of the aerosol calculator (Aerosol Measurement. Principle, 2001), which performs algebraic computations of aerosol physical characteristics, the Andreev-Ivlev model (Kozodoeva, Lavrentiev, 2005) for calculations of near – earth layer aerosols characteristics on horizontal paths and relevant extinction/absorption factors as well as for calculations of scattering matrix elements for radiation scattered on single or two layer particle and ensemble of particles.
Atmospheric chemistry (http://atchem.atmos.iao.ru/)
This information-computational system is aimed at organization of access to atmospheric chemical reactions database, derivation of kinetic equations for a chosen by user reaction set and qualitative analysis of the derived kinetic equations. Within it local chemical processes occurred at atmospheric conditions are analyzed in the following order:

1. Chemical reactions/cycles choice from the database (chemical system forming);
2. Kinetic equations derivation (closed or open systems);
3. Choice of atmospheric conditions for subsequent analysis (altitude, temperature, pressure, statistical model of atmosphere, albedo of surface, etc.);
4. Calculation of reactions coefficients;
5. Determination of the chemical system steady states and relevant time constants;
6. Determination of atmospheric compounds concentrations time behavior;
7. Determination of the chemical system phase portraits and analysis of scenario for its possible dynamical behavior.

The above steps are supported by a specially developed dialog system. This site is described in details in monograph (Gordov, 2002).

2.3 Atmospheric radiation (http://atrad.atmos.iao.ru/)

This site supports calculations of radiation fluxes in cloudless cloud atmosphere. Here accessible are the model (Barker H.W., et al, 2003), the Frolkis model (Frolkis, 1993) as well as a software support for atmospheric transmittance function calculations (Kozodoeva, Firsov, 2005). The information part of the site contains data on two statistical models of atmosphere (Anderson, 1986, Zuev, 1986) and monograph by A.V. Vasiliev and I.N. Mel'nikova "Shortwave solar radiation in the Earth atmosphere: Calculations, measurements and interpretation".

3 The second group of the sites

Each site of this group is an information system devoted to relevant environmental issues, including atmospheric pollutions and environmental characteristics of two geographic objects of Siberia, namely Lake Baikal and West Siberia Plain.

3.1 Air quality assessment and management (http://air.atmos.scert.ru/)

Here an access to information resources on air quality monitoring and management and general description of Siberia environment state is given as well as to the AIR-EIA system, which was designed by a project partner to provide improved access to state-of-the-art mutli media information resources on Air Pollution aspects of Environmental Impact Assessment.

3.2 Lake Baikal (http://baikal.atmos.scert.ru/)

The site contains the first results of scientific assessment of the environmental and climatic situation in the Lake Baikal area. It is based on the book "Ecologically oriented land use planning in the Baikal region" by A.N. Antipov, V.M. Plusnin, O.I. Bashenova and others – Irkutsk: Published by the Institute of Geography SB RAS, 2002 – 103 p. and gives an access to relevant descriptions, maps and photos.

3.3 West Siberia (http://west-sib.atmos.scert.ru/)

The site contains the first results of scientific assessment of the environmental and climatic situation in the region important for climatic variations under natural and anthropogenic pressure. Descriptions of regional climate, hydrology, vegetation and other environmental characteristics are given. It also includes a book summarizing recent findings on Great Vasyugan Bog state and dynamics.

4 Development of Software Tools

To support portal operation a special middleware was designed (Akhloystin, 2003). Based on it portal operates as an Internet accessible multi-user system oriented on applied problems solving. In it user can solve typical problems from the thematic domains, save intermediate of final results on the server side, compare results with stored in the system experimental or computational data (this functionality is supported for molecular spectroscopy only), etc.

An apparatus part comprises three components, which are database server, applications server and computational cluster oriented to atmospheric chemistry and climate problems solving. The middleware consists of a set of services and a transaction processing monitor, which performs function of a dispatcher of each user request and of some services. The dialogue system forms menu on the base of applied logic formed for each site. The user's data control system secure integrity of user's data in process of usage of the relevant site calculation part. The linguistic service is providing multi-language information presentation on site and in the dialogue system. It should be also added that to make the information-computational system open via Internet to professional community we used a multilevel client-server architecture.

5 Conclusions

The portal ATMOS reflects current tendency of Environmental Sciences transformation into exact (quantitative) sciences and is quite effective example of modern Information Technologies and Environmental Sciences integration. It makes the portal both an auxiliary instrument to support interdisciplinary projects on Siberia regional environment and extensive educational resource providing an access to number of textbooks and monographs in the targeted domains of atmospheric sciences and their applications. It should be added

that middleware developed to construct and support the portal sites allows one to design a management system for such projects as a part of relevant information computational site. In virtue of limited resources, currently it can be achieved on project to project basis only. First steps in this directed were done within the interdisciplinary project of SB RAS No 138 “Siberian Geosphere-Biosphere Program”, see for example the project site http://sgbp.scert.ru/en/.
Given above brief description of the ATMOS portal structure and gathered information resources indicates possible ways of its development. The first one is in integration into the portal new sites oriented on description of specific processes of land-atmosphere interactions. Here sites devoted to atmosphere - vegetation and atmosphere – hydrologic system (bogs, rivers, and lakes) are among the first candidates for development and integration. Development of a site devoted to atmospheric boundary layer is in process at now with a support from RFBR. The second way is in compilation and classification of results of measurements or computations of physical characteristics of objects included into consideration. To this end additional technical tools should be developed. In particular, it includes a middleware for distributed information-computational systems, tools to work with knowledge bases formed on the base of relevant measurements and/or calculations, provided with machine-read metadata. Development of a distributed system on molecular spectroscopy supported by RFBR grant is a first step in this direction.

Recommendations

Overall approach and software tools developed in course of the ATMOS project implementation might be used as a backbone for the Enviro-RISKS project web portal.

Acknowledgements

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4.4. Zakarin E., K. Pak, S. Grinkov: Interbranch Geoinformation System

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1 Introduction

The Interbranch Geoinformation System (IGIS) is created as a complex for processing and interpretation of the remote sensing (RS) data, results of digital processing of these data, results of field works, and modelling of territorial processes. The complex technological process solved in IGIS will allow carrying out the effective support of the environmental monitoring and acceptance of administrative decisions.

2 Architecture of interbranch geoinformation system

The usage of «Internet/Intranet» architecture is supposed for IGIS information network construction. The given architecture is a type of "client-server" architecture, but it realizes more fully the local networks interaction with the global network, Internet. The principle of “the open architecture” lays in the heart of corporate information systems realization on this basis. The software of such systems is realized in the applets, servlets form (programs written using JAVA language) or in the *cgi* form of modules (programs written using Perl or C languages). Such decision allows creating the corporate GIS with unlimited number of full-function client places, and the client can be both the desktop and web applications. The number of simultaneously working clients is limited only by the computer’s capacity on which the system server part is established. Conformity to IT standards provides simplicity of IGIS integration with other corporate systems. Thus, the needs for installation requirements for desktop application on the client machine will be minimal. Charges on versions synchronization of the application and their maintenance will decrease considerably (Figure 1).
The basic economic advantages of the given architecture are the following:

- Low expenses for installation and operation;
- High ability for integration of existing heterogeneous information resources of corporations;
- Increase of equipment usage coefficient (preservation of investments);
- Applied software are accessible from any workplace with corresponding access rights;
- Minimal software and hardware structure on a client workplace (only web browser and operating system are necessary);
- Minimal expenses for adjustment and support of client workplaces.

Effective functioning of IGIS is provided and realized by experts of different levels (with functions) such as:

- *WEB - server administrators* (functions - management and configuration of server objects used by desktop and web-applications);
- *Developers of application and web - services* (creating and duplicating; *Net* and *Java* web-applications, web-services and desktop applications including additional GIS functionality, i.e. ArcObjects);
- *Executors IGIS* (production a request reporting for specific problem decision and information filling IGIS by work GIS-technologies and modeling results);

Users and customers IGIS (formation of requests or query using Internet - browsers for communication with IGIS web-server).

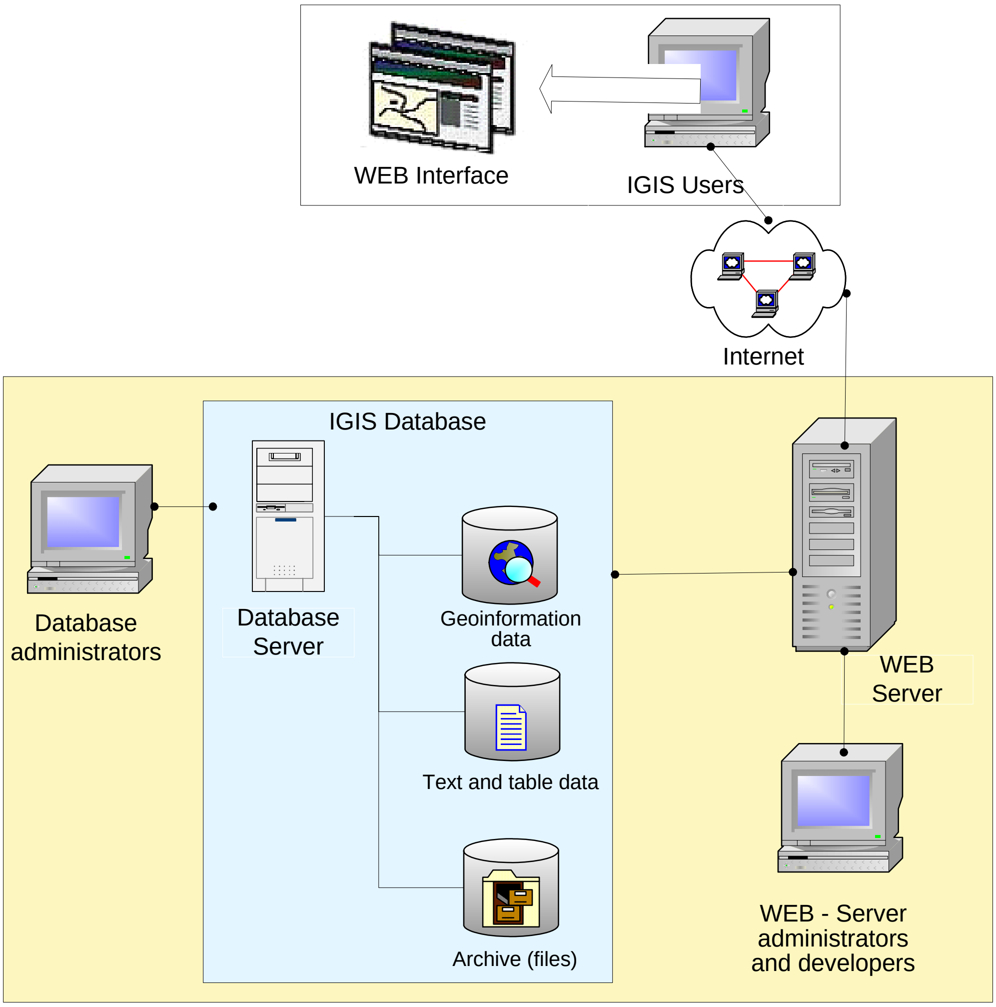

Figure 1. Provisional structure of Interbranch Geoinformation System (IGIS).

Geoinformation data and electronic cartographical bases are placed on the GIS-server. But corporate database is placed on the SQL-server of IGIS network under relational database control. The block diagram of the IGIS administration center is presented in Figure 2.

The basic components reflected in this scheme are:

Web-server carries out the following basic functions of:

- Web-server for support of Internet-site;
- Remote access server for control of remote or mobile users' access over Internet-server;
- E-mail server for work with external and internal post correspondence;
- File-server for management of user's access to shared files;

In the future, the Internet-server will be developed up to the Internet-portal.

The gateway screen is applied to protect the Internet-server (firewall) between the server and Internet. The login and password will be protected by hashing algorithm MD5 (Message Digest Algorithm 5 - messages processing). The messages' processing is the text algorithmic operations that make a unique signature for that text. MD5 represents a reliable algorithm hashing, developed by company RSA Data Security Inc /1/.

Server of application carries out following functions:

- Accepts and transfers requests, users reports and packages of data;
- Adjusts access of client requests to database servers controlling database server loading.

Users' requests will be accepted and processed by means of Internet-technologies (Web-service). It will provide an open access to general information, authorized access to detailed information resources and analytical functions of the system/2/. The use of application servers allows creating the scaled decisions that are capable to serve simultaneously the big number of transactions.

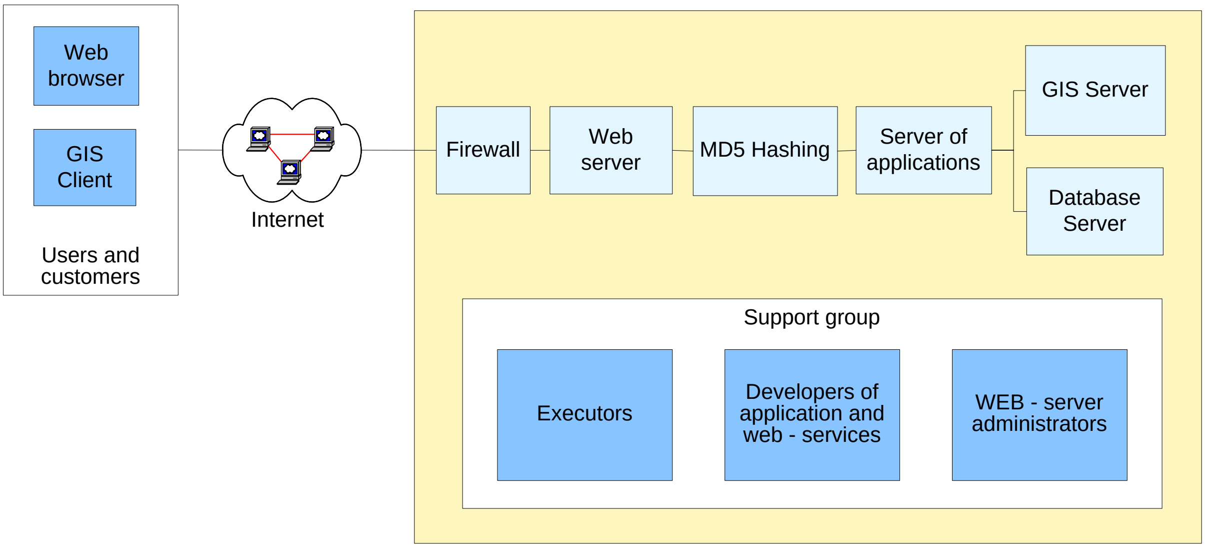

Figure 2. The technological block diagram of IGIS administration center.

The introduction of the given technology will allow:
- To use direct connection with the database through the Internet protocol HTTP (port 80). It will allow using the storage and data management system as a multi-user without breaking the safety of protected computer networks on the client side;
- To develop the mechanism for the loading of files in parts with an opportunity of the renewal of loading after connection breaks with the database to prevent the information losses in the system;
- To increase the speed of data transfer by means of a total bandwidth between server (database) and the client host using the archivation.

The database server is intended for storing and managing archive and operative data including geoinformation database (under control of Arc SDE), metadata database, requests database, etc. The server realizes the logic of requests and reports processing, integrity support functions, data protection, reserve copying.
- Storage organization of electronic versions factographic materials, documents and registration information;
- The organization of documents' search;
- Securing access to registration information and electronic documents according to access rights;
- Logging of users' work with an electronic archive;

Relational database will be developed for each type of information on a basis of the Ms SQL Database.
GIS server – is designed on the ArcGIS server basis (new product of ESRI). It includes the root library – ArcObjects, and it gives a convenient platform for creation of GIS functionality /3/. It can be used for web-application creation, web-services, and other corporate applications. Besides, the ArcGIS server is useful for development of desktop applications that will work with the ArcGIS server in a client-server mode. It allows providing the centralized management of the geographical resources such as cards, services of geocoding, and program objects involved in IGIS.

3 Conclusion

Thus, IGIS approach in the sphere of integration of information technologies, gathering, accumulation of data, and consumers' services consists in development and applications for:
- Uniform system of classification and data coding on the IGIS subject domain;
- Integration of servers with web-services placed in the center of IGIS administration.

On the basis of the application of the listed means, the IGIS forms an infrastructure of the integration:
- Uniform normative and information space;
- Set of legal and organizational norms in the field of access regulation and information distribution;
- Use of uniform data models, spatial and time binding of information;
- Use of uniform conceptually-terminological, linguistic, and semantic base, classification system and information coding, formats and rules of data presentation.

The functioning of IGIS is provided on the basis of applied GIS technologies for decision of various monitoring problems while sharing the uniform archive of space images, unified base of geoinformational data, and previous projects materials base.

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APPENDIX 1: Enviro-RISKS CA Kick-Off Meeting

The kick-off meeting took place in Danish Meteorological Institute (Copenhagen) on ***30th and 31st of January 2006.***

Agenda of the Enviro-RISKS CA Kick-off Meeting

30 January, Monday

10:00 - 10:10 Official opening by Peter D. Aakjaer, DMI Director General

10:10 - 10:20 Welcome from Dmitry B. Ryurikov, the Ambassador of Russia in Denmark

10:20 - 10:30 Introducing Enviro-RISKS participants
10:30 - 10:50 Introduction of the CA items and goals (A. Baklanov)
10:50 - 11:10 Coffee break
11:10 - 11:40 Overview of the Description of Work (E. Gordov)
11:40 - 12:00 Special session on co-ordinated projects (All partners, 10-15 min each)

12:00 - 13:00 Lunch
13:00 - 15:00 Special session on co-ordinated projects (continuation)

15:00 - 15:20 Coffee break
15:20 - 16:00 Special session on co-ordinated projects (DMI projects)
16:00 - 17:00 Defining break out task groups, interacting projects and CA activities
17:00 - 18:00 Informal discussions; DMI tour

19:00 Official dinner

31 January, Tuesday

09:00 - 10:00 Introduction Handbook (management/controlling tools, legal aspects) (A. Baklanov, E. Gordov, team)

10:00 - 10:50 Presentation of WPs/Tasks (WP and Task Leaders)

10:50 - 11:10 Coffee break
11:10 - 12:00 Presentation of WPs/Tasks (continuation)

12:00 - 13:00 Lunch
13:00 - 13:30 First year: Duties and responsibilities – Timeframe, Meeting schedule (A. Baklanov)

13:30 - 14:00 Deliverables and their integration (E. Gordov)

14:00 - 14:30 Case co-ordination: Tomsk as a test NIS site for usage of FUMAPEX results (A. Baklanov, A. Starchenko)

14:30 – 14:50 Coffee break

14:50 - 15:40 Work by groups for specific topics, PhD student exchange (all participants)
15:40 - 16:00 Wrap up and general discussion (A. Baklanov)

16:00 - 16:20 Management and coordination questions (E. Gordov)

16:20 - 16:30 Final comments and meeting closing

17:00 - 18:30 Reception in the Russian Embassy given by the Ambassador of the Russian Federation to the Kingdom of Denmark

List of participants in the Kick-Off Meeting:

Guests/Partners:
1. Mr. Dmitry B. Ryurikov, the Ambassador of the Russian Federation to the Kingdom of Denmark
2. Prof. Yevgeny Gordov, Director of Siberian Center for Environment Research and Training, Russia
3. Prof. Anatoly Shvidenko, International Institute for Applied Systems Analysis (IIASA), Austria
4. Dr. Marcus Schumacher, Max-Planck-Institute for Biogeochemistry, Jena (MPI), Germany
5. Prof. Vladimir Penenko, Head of Department, Institute of Computational Mathematics and Mathematical Geophysics, SB of Russian Academy of Sciences (RAS) (ICMMG), Russia
6. Prof. Michael Kabanov, Director of the Institute of Monitoring of Climatic and Ecological Systems SB RAS (IMCES), Russia
7. Prof. Edige Zakarin, Remote Sensing Department, KazGeoCosmos, Kazakhstan
8. Prof. Petr Pushistov, Head of Department, Ugra Research Institute of Information Technologies (URIIT), Russia
9. Prof. Alexander Onuchin, Director Deputy of the Institute of Forest SB RAS (IF), Russia
10. Dr. Bibigul Mirkarimova, Remote Sensing Department, KazGeoCosmos, Kazakhstan
11. Prof. Alexander Starchenko, Tomsk State University, Russia
12. Prof. Vasily Lykosov, Principal Scientist at the Institute for Numerical Mathematics of RAS, Moscow

From DMI:
13. Dr. Peter D. Aakjaer DMI Director General
14. Dr. Erik Bodtker, DMI Director Research
15. Prof. Eigil Kaas, DMI section leader / Professor Meteorology, Copenhagen University
16. Dr. Anne Mette Jørgensen, Director of Danish Climate Center
17. Dr. Alexander Baklanov, DMI senior scientist, Enviro-RISKS project leader
18. Mr. Aix Rasmussen, DMI senior scientist
19. Dr. Jens Havskov Sørensen, DMI senior scientist
20. Dr. Allan Gross, DMI senior scientist
21. Dr. Alexander Mahura, DMI researcher
22. Dr. Martin Stendel, senior scientist, DMI/Danish Climate Center

LIST OF AVAILABLE PRESENTATIONS AT

http://project.risks.scert.ru/management/meetings/kick/presentations/

Introduction to the kick-off meeting - Alexander A. Baklanov (DMI)

Overview of the EU Project FUMAPEX: "Integrated Systems for Forecasting Urban Meteorology, Air Pollution and Population Exposure" - Alexander A. Baklanov (DMI)

GEMS: Global and regional Earth-system Monitoring using satellite and in-situ data - Allan Gross (DMI)

Complex Monitoring of Great Vasyugan Bog: modern state and development processes research – Mikhail Kabanov (IMCES SB RAS)

Arctic-Risk Project "Atmospheric Transport Pathways, Vulnerability and Possible Accidental Consequences from the Nuclear Risk Sites in the European Arctic" – Alexander Mahura (DMI)

Some aspects of environmental after-effects of natural resources using in Siberian taiga – Alexander Onuchin (IF SB RAS)

Concept of environmental modeling – Vladimir Penenko (ICMMG SB RAS)

Possible contribution of Ugra Scientific-Educational Complex into the project – Petr Pushistov (URIIT)

Observing Biogeochemical Processes in Eurasia - Marcus Schumacher (MPI BGC)

Terrestrial Biota Regional Full Greenhouse Gas Account: understanding the impacts of man-made changes in Siberia – Anatoly Shvidenko (IIASA)

Danish emergency preparedness for hazardous releases to the atmosphere - Jens Havskov Sorensen (DMI)

Carbon budget studies and permafrost modelling in Northern Russia - Martin Stendel (DMI)

Development of GIS modelling for ecological processes using remote sensing data – Edige Zakarin (KazGeoCosmos)

Web portal on environmental sciences "ATMOS" – Evgeny Gordov (SCERT)

Integrated information systems for air quality monitoring: NIS-adapted ISIREMM system and city of Tomsk case study – Evgeny Gordov (SCERT)

On background for Siberia environment Integrated Regional Study (SIRS) – Evgeny Gordov (SCERT)

SB RAS state-of-the-art in climate impacts and adaptation research – Evgeny Gordov (SCERT)

APPENDIX 2: Enviro-RISKS CA middle-point 1st year meeting

The middle-point meeting took place in Institute of Monitoring of Climatic and Ecological Systems SB RAS (Tomsk, Russia) on ***July, 8, 2006*** in the framework of the special session devoted to the Project during ENVIROMIS-2006 Conference.

http://project.risks.scert.ru/management/meetings/second/

Agenda of the Enviro-RISKS CA middle-point meeting

1. Baklanov A., Gordov E. Overview of the Enviro-RISKS state of the art

2. Lykosov V. “Geophysical boundary layers: modelling and environmental applications”

3. Penenko V. “Environment quality and emission control in industrial regions“

4. Zakarin E. “Risk mapping of the consequences of oil pipeline accident”

5. Pushistov P. “Development and application of information-modeling system for hydrodynamics, chemical and biological characteristics of water bodies with consideration of man-made impact and hydraulic structures, for diagnosis and forecast tasks of hazardous hydrological and ecological situations risks”

6. Pushistov P.Yu. Alsynbaev K.S., Chemlyakov N.V., Vtorushin M.N., Ermakov I.S., Danilin A.N., Bolgova V.M., Kazarina O.P., Lisovskiy D.A. “Problems and results of numerical modeling of a detailed spatial-temporal structure of hydrological mode and water quality characteristics of a Large Northern River (by the example of the Northern Sos’va River, Khanty-Mansiysk Autonomous Okrug – Yugra)”

7. Mahura A., Baklanov A., Sorensen J.H. “Long-term simulation of atmospheric transport and deposition patterns from Siberian sources of continuous anthropogenic sulphates emissions”

8. Shor E.L., Zubaidullin A.A., Ovechkin F.Yu., Vershinin Yu.A., Lopatin K.I., Soromotin A.V. “Experience of oil pollution reclaiming in Khanty-Mansiysky region”

9. Zemtsov V. “Hydrological risks in West Siberia”

10. Shishikin A.S. “Transformation of Middle Siberian Landscapes at field development of minerals”

Poster Papers

1. Lyapina E.E., Golovatskaya E.A. “Mercury concentration in soils of Tomsk”

2. Podnebesnyh N.V., Ippolitov I.I., Gorbatenko V.P. “Large-scale atmosphere circulation over Western Siberia”

3. Nicheporchuk V., Tridvornov A. “Analysis of sources of industrial danger in Krasnoyarsk region and risk assessment"

4. **Goryaeva V., Tolkacheva G., Shardakova L.** "Issues of investigation of chemical composition of precipitation at urban agglomerations"

5. **Rakhmatova N., Chub V.E., Vidineeva E.M., Vereshagina S.G.** "Assessment of anthropogenic impact on water quality in the irrigation network of the Tashkent city and the ways of its rehabilitation"

Wrap-up discussion and open meeting of Enviro-RISKS team

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Overview of the Enviro-RISKS state of the art - Alexander Baklanov (DMI), Evgeny Gordov (SCERT, IMCES SB RAS)

Geophysical Geophysical Boundary Layers: Modeling and Environmental Applications - V.N. Lykosov (INM RAS)

Environmental quality and emission control in industrial regions - V.V. Penenko (ICMMG SB RAS)

Risk mapping of consequences of oil pipeline accident - E.A. Zakarin (KazGeoCosmos)

Development and application of information-modeling system for hydrodynamics, chemical and biological characteristics of water bodies with consideration of man-made impact and hydraulic structures, for diagnosis and forecast tasks of hazardous hydrological and ecological situations risks - P.Yu. Pushistov (URIIT)

Long-term simulation of atmospheric transport and deposition patterns from Siberian sources of continuous anthropogenic sulphates emissions - A. Mahura, A. Baklanov, J. Sørensen (DMI)

Application experience of modern measuring systems to hydrodynamic and water quality field research - Vtorushin M.N. (USU), Pushistov P.Yu. (URIIT)

Hydrological risks in West Siberia – V. Zemtsov (TSU)

Transformation of Middle Siberian Landscapes at field development of minerals - Shishikin A.S., Kosmakov V.I., Oreshkov .D.N., Uglova E.S. (IF SB RAS)