

SIBERIA INTEGRATED REGIONAL STUDY AS A BASIS FOR INTERNATIONAL SCIENTIFIC COOPERATION

E. P. GORDOV

*Siberian Center for Environmental Research and Training,
Institute of Monitoring of Climatic and Ecological Systems,
Tomsk, Russia*

e-mail: gordov@scert.ru

G. BEGNI

MEDIAS-France, Toulouse, France

e-mail: begni@medias.cnes.fr

M. HEIMANN

Max-Planck-Institute for Biogeochemistry, Jena, Germany

e-mail: martin.heimann@bgc-jena.mpg.de

M. V. KABANOV

Institute of Monitoring of Climatic and Ecological Systems, Tomsk, Russia

e-mail: kabanov@imces.ru

V. N. LYKOSOV

Institute for Numerical Mathematics RAS, Moscow, Russia

e-mail: lykossov@inm.ras.ru

A. Z. SHVIDENKO

International Institute for Applied System Analysis, Laxenburg, Austria

e-mail: shvidenk@iiasa.ac.at

E. A. VAGANOV

Institute of Forest SB RAS, Krasnoyarsk, Russia

e-mail: institute@forest.akadem.ru

Описывается состояние работ по развитию интегрированных региональных исследований Сибири.

Introduction

According to the present knowledge, Siberia is a region where the most pronounced consequences of climate changes are happening and will happen in future as follows from observations and predictions based on various models. Variability of climatic characteristics in space and time has been evidenced through in situ and remote sensing measurement techniques and were forecasted by advanced climatic models. These effects may significantly change biological, climatic and socio-economical aspects of the land use throughout this region. Environmental research of this region is of global importance not only in relation with climate change (e. g. snow and ice dynamics) and carbon cycle, but also with respect to aquatic, arid, and agricultural systems, snow and ice dynamics. In the last year the International Geosphere Biosphere Program (IGBP) reported that the circumboreal region that includes Northern Eurasia is one of the critical points in the Earth System, where even small changes may potentially lead to profound changes in the ways in which the Earth System operates. That is why national and international community is interested in studying different aspects of Siberian environment. For example, in 2003–2005 11 interdisciplinary and 7 complex integrated projects addressing studies of the regional environment were performed by institutions of the SB RAS. Large thematic projects in this field are sponsored by RAS, EC, ISTC, NASA, Max-Planck Society and other organizations. In 2003 IGBP and Earth System Science Partnership (ESSP) initiated the Program of development of international Integrated Regional Studies (IRS) in the regions with most pronounced changes of regional climate that could impact the functioning of the whole climatic system.

1. ESSP and IGBP Integrated Regional Study approach

The regional (region here is a large geographical area, which functions as a biophysical, biogeochemical and socio-economical entity) aspect of science for sustainability and of international global change research is becoming ever more important nowadays. Modern technologies in land use, industrial and economical development lead to rapid changes both at regional social-economical system and the Earth System. Consequences of these changes are very important on a regional and global scale. Regional approach to the study is also important with respect to the point of view of Earth sciences. Regional compounds of the Earth System may manifest significantly different Earth System dynamics and changes in regional biophysical, biogeochemical and anthropogenic components may produce considerably different consequences for the Earth System at the global scale. Regions are “open systems” and the interconnection between regional and global processes plays a key role. Some regions may function as choke or switch points (in both biophysical and socio-economic senses) and small changes in regional systems may lead to profound changes in the ways in which the Earth System operates.

Few years ago IGBP suggested [1] to develop in selected regions integrated regional studies of environment, which would represent a complex approach to reconstruct the Earth System dynamics from its components. It considered as a complementary effort to the thematic project approach employed so far in the international global change programs. Nowadays Integrated Regional Study (IRS) approach is developed by the Earth System Science Partnership (<http://www.essp.org/>), joining four major Programs on at global change research. IGBP initiative aimed at development of IRS in the most important regions of the planet puts a set of prerequisites for such studies:

- the concept should be developed in the context of the Earth System as a whole;

- scientific findings should support sustainable development of the region;
- qualitative and quantitative understanding of global-regional interconnections and the consequences of changes in these interconnections should be achieved.

In each region IRS should be developed lead and performed by regional scientists. It should reflect individual characteristics, interests, scientific opportunities and development priorities of the region and be unconventional. Common point of different IRS is that they answer common questions.

- What will be in the region in 50 years?
- What are the consequences of forthcoming changes for the regional common weal?
- What are the consequences for the Earth System?

It is clear, that “region” here means a large geographical zone with changes which may lead to deep consequences in the functioning of the Earth System as a whole. IRS must (i) transcend disciplinary boundaries across natural and social sciences, address all relevant aspects of marine, terrestrial, atmospheric, social, economic, cultural, historical etc. components of the Earth System; (ii) reflect the particular socio-economic and biophysical characteristics of the region and (iii) be a complementary part of the Earth sciences. The word “integrated” in IRS refers specifically to two types of integration: (i) “horizontal integration”, involving the integration of elements and processes within and across a region; and (ii) “vertical integration”, involving the two-way linkages between the region and the global system. Sustainable development is a key theme of IRS and will be supported by a group of scientists interested in this research. A role of international scientific community in study of global changes, as it is defined by ESSP, is to help studying regional and global interconnections and using the results of IRS in the analysis and synthesis of the Earth System. IRS must be developed and admitted to the international set of ESSP projects depending on a set of criteria: compliance with definitions; ability of regional scientific community to plan and perform such study and to find a financial support (with substantial sources outside the region). Each IRS should be managed by a regional administrative structure. For the purposes corresponding to global-regional interconnections and consequences for the Earth System the international administrative scientific committee should be set up including the participants of each ESSP program, of IRS itself and independent experts in Earth sciences.

Taking into account the above considerations, the number of such projects could not be large and is about 5–6. The only example of existing IRS is a large biosphere-atmosphere experiment in Amazonia. Now it joins 80 interconnected and coordinated research groups of 600 scientists from Northern and Southern America, Europe and Japan (<http://lba.cptec.inpe.br/lba/indexi.html>). Main its objectives are to understand how does Amazonia function as a regional entity (e. g., natural cycles of water, energy, aerosols, carbon, nutrient and trace-gases) as well as how will changes in land use and climate affect the biological, chemical and physical functioning of Amazonia, including its sustainability and influence on global climate. The next in the line region is Monsoon Asia and the ESSP Integrated Regional Study on Monsoon Asia (MAIRS) Science Plans and Implementation Strategies were launched at the ESSP Open Science Conference in Beijing, November 2006.

2. Siberia Integrated Regional Study

Siberia is one of the promising regions for the development of such basic and applied regional study of environmental dynamics [2]. Regional consequences of global warming (e. g. anomalous increase of winter temperatures [3]) are strongly pronounced in Siberia. This tendency is

supported by the results of climate modeling for 20–22 centuries [4]. The climate warming not only threatens Siberia with destruction of the most part of extractive and traffic infrastructure caused by the shift of permafrost borders northwards but also can change the dynamics of the natural-climatic system as a whole [5]. Although many projects supported by national (SB RAS, RAS) and international (EC, ISTC, NASA, NIES, IIASA, etc.) organizations are devoted to study modern dynamics of Siberian environment, scientists know little about the behavior of main components of the regional climatic system as well as about responses and feedbacks of terrestrial and aquatic ecosystems. A review on state-of-the-art in Siberian environmental research is available in Internet (www.scert.ru/conferences/cites/2005/presentation/Presentation/Workgroup/WG_SIRS.pdf and www.scert.ru/files/1971d.pdf). Regional budget of the most important greenhouse gases CO₂ and CH₄ still makes first steps with respect to individual land classes [e. g., 6, 7]. Measurements in situ are limited and lacking any systems basis. Responses of boreal forests and Siberian wetlands to the climate change and the emerging feedback influencing the climate dynamics through exchange of momentum, energy, water, moment, greenhouse gases and aerosol are poorly understood and almost not identified yet [8]. Variability of climatic characteristics in space and time has been evidenced through in situ and remote sensing measurement techniques and were forecasted by advanced climatic models. These effects create the prerequisites for large and significant biological, climatic and socio-economically coupled land use changes throughout this region. Science issues for Northern Eurasia are growing in global importance not only in relation to climate change (e. g. snow and ice dynamics) and carbon, but also for condition and stability of aquatic, arid, and agricultural systems, snow and ice dynamics. Some of the potential effects include impact the mechanisms that water and energy are exchanged with the atmosphere, radiatively active gases are transported to the atmosphere, and freshwater is delivered to the Arctic Ocean. IGBP reported previous year that the circumboreal region including Northern Eurasia is one of the critical “Switch and Choke” points in the Earth system, which may generate small changes in regional systems potentially leading to profound changes in the ways in which the Earth System operates. As one of the key regions of high latitude, cold climate areas, Siberia (with the area of 10 million km²) is a matter of concern for several international research programs. In Siberia, changes in landscapes/ecosystems induced by the climate warming would result in considerable shifts in the budget of major greenhouse gases (CO₂, CH₄, N₂O). It has been shown that natural processes regulating the carbon cycle favor to release more GHG gases in the boreal zone where more than 60 % of the carbon are currently in soil and peat. One of such processes involves permafrost melting. Under present day climate, the permafrost occurs in 80 % of the area. The amount of carbon is stored in permafrost is not exactly known but supposedly is very large. Although poorly understood, feedbacks between atmospheric temperatures and permafrost energy and mass content are believed to be predominantly positive. The feedbacks will certainly amplify the regional climate changes, with possible impacts at global scale.

All the above makes Siberia quite a candidate for one of ESSP IRS. That is why Will Steffen (IGBP) had suggested in 2002 to develop with assistance of SB RAS and on the base of its research infrastructure one of Integrated Regional Studies namely here. This idea to launch the Siberia Integrated Regional Study (SIRS) project as a part of implementation of IGBP and ESSP regional strategy was supported by a group of Russian scientists and some Western organizations (Max-Planck Institute for Biogeochemistry, Jena, Germany; International Institute of Applied System Analysis, Laxenburg, Austria; Medias-France, Toulouse, France) under the overall coordination of the Siberian Center for Environmental Research and Training (SCERT) and in 2003 specific activity had been began. In its course the basic objectives of the program

and ideas were defined and matured during dedicated workshops at ENVIROMIS-2004, CITES-2005 and ENVIROMIS-2006 Conferences (<http://www.scert.ru/en/conferences/>). The approach adopted was examined and endorsed by the Siberian Branch of the Russian National Committee for IGBP in 2005.

The rather short-term SIRS history has three stages: prehistory (till 2003), current history (2003–2006) and possible future. SIRS components (scientific, infrastructural, organizational and educational (capacity building)) evolution is described below. During the prehistory stage a background scientific component was formed by a number of non-correlated national and international level projects devoted to different aspects of Siberia environment in which near all of 80 research institutes of SB RAS participated. However due to fragmentation of investigations, these studies did not lead to the emerging of the full picture of modern natural-climatic changes in Siberia.

2.1. SIRS scientific component

The current history stage scientific component is characterized by appearance of number large-scale projects on Siberia environment investigations in line with SIRS objectives and very beginning of their clusterization. For example, in 2003–2005 the SB RAS Presidium financed 12 complex and 11 interdisciplinary projects, devoted in this or that way to studying the Siberian environment. In particular, Institute of Monitoring of Climatic and Ecological Systems (IMCES) coordinated the interdisciplinary integrated project “Siberian geosphere-biosphere project: integrated regional study of contemporary natural and climatic changes” (<http://sgbp.scert.ru>), which joined the efforts of 20 national organizations to study the dynamics of the regional system, as well as the integrated project “Complex monitoring of Great Vasyugan Bog: investigation of the current conditions and processes of evolution”. The later was aimed at studying the dynamics of this planetary important structure and its role in forming the regional climate and comprised 15 Siberian research organizations in. Important aspects of the study of dynamics of some components of regional atmosphere were taken into account in the integrated project “Siberian Aerosols”. Integrated project “Ecological problems of Siberian cities” was devoted to discovering the influence of cities on changes of hydrothermodynamics and components of atmosphere and the impact of these changes on the quality of life and health of regional population. Also at this period a high degree of international activity in study of different aspects of Siberian environment behavior takes place. The leading role here is played by specialists from Europe. In particular, there are several large EC projects performed in Siberia on studying the dynamics of different components of the environment, such as: “Multi-sensor concept for Greenhouse Gases Accounting in Northern Eurasia” (Siberia 2, <http://www.siberia2.uni-jena.de/index.php>), “Terrestrial Carbon Observation System — Siberia” (http://www.bgc.mpg.de/public/carboeur/web_TCOS/). Nowadays the project “Zotino Tall Tower Observation” (ZOTTO) is performed in the framework of the International Science and Technology Center (ISTC, <http://www.istc.ru/>) with the financial support by Max-Planck Society to study the exchange of greenhouse gases between vegetation and atmosphere. ISTC also supports several RTD Projects on the theme: project No. 1908 “Experimental and theoretical study of the dynamics and kinetics of gaseous and aerosol components of the atmosphere in central continental Asia”, project No. 2757 “Biogeochemical responses to fast climate changes in Eurasia”, project No. 2773 “Investigations of the composition of the atmosphere over Northern Eurasia with the mobile wagon-laboratory”, project No. B-1063 “Monitoring of atmospheric aerosol and ozone in CIS regions with the lidar station network (CIS-LiNet)”, project No. 3032 “Study of transfer of atmospheric pollution from Europe to

Pacific region using ground-based and satellite measurements”, and project No. 1235 “Study of the main sources and peculiarities of the distribution of gaseous and aerosol pollution of the atmosphere over the territory of Russia with the specialized wagon-laboratory”. International Institute of Applied System Analysis performs a work in the framework of the Forestry project (IIASA, <http://www.iiasa.ac.at/Research/FOR/index.html>). A key role in these projects is played by the institutes of SB RAS. In particular, Institute of Forest SB RAS is a responsible performer and coordinator in 14 international projects, financed by international funds and research agencies (CRDF, INTAS, NASA, NSF, EC, Max-Planck Society, USDA Forest Service, and Japan Environmental Agency). These projects are focused on the assessment of Siberian forests role in the global greenhouse gas budgets, with a special emphases to emissions from forest fires; reconstruction of climate changes with high temporal resolution (from centuries to millennia); development of new systems for satellite observations of Siberian forests state and productivity. In essence, major science topics of on-going and expected global change are of a clear inter-disciplinary nature. Any serious attempt of understanding of the Earth system’s behavior leads to development of very complicated dynamic fuzzy systems of which direct validation and verification is extremely difficult if possible at all. A typical example is the regional Terrestrial Biota Full Greenhouse Gas Accounting (FGGA) that includes data and methods from about 20 disciplines like terrestrial ecology, chemistry and physics of all components of the biosphere etc., as well as from different inventories, surveys and many fields of practical human activities. What is important, that each of these disciplines individually is not able to present sufficient information for assessing uncertainties of the FGGA in a reliable and comprehensive way. The same could be said about social and economic aspects of adaptation to, and mitigation of negative consequences of climate change, strategies of carbon management etc.

At the same time, new and larger national and international initiatives are emerging to develop a study of that kind on the territory of the whole Northern Eurasia. Few years ago the joint program of RAS (ac. A.S. Isaev) and NASA (D. Deering) called “Northern Eurasia Environment Study Partnership Initiative” (NEESPI) was established. In its framework a coordinated study of environmental dynamics and especially boreal forests in Northern Eurasia is planned. It was assumed that NASA would support financially Russian institutes taking part in joint research. For the present Russian organizations and specialists play a role of service providers only for emerging NASA projects on Siberian environment study. Now this initiative is changed (<http://www.neespi.org>). In particular, the RAS Presidium Program is prepared to support this research and the USA colleagues converted NEESPI activity into the international one based on support from several USA national agencies (NASA, NOAA, NSF, etc.). The first NEESPI Scientific Team Meeting (IIASA, Laxenburg, Austria, 22–24 February 2006) showed that NEESPI initiators are eager to construct this Program as a kind of a vertical structure coordinating the Northern Eurasia environmental research on a project level. The list of projects are currently under umbrella of NEESPI (<http://www.neespi.org/>) is quite impressive. It is supposed, that NEESPI as a whole would interact with IGBP, ESSP and other international Programs devoted to different aspects of the global change.

Summarizing the whole described above picture one can see that during this period scientific prerequisites for SIRS have been formed yet.

2.2. SIRS infrastructural component

As for the SIRS infrastructural component its evolution during the period was aimed mainly at development of a relevant informational-computational infrastructure for the study. It is the

case that multidisciplinary and “distributed” teams of specialists should perform cooperative work, exchange of data and knowledge and co-ordinate activities optimizing the usage of information-computational resources, services and applications. A very beneficial synergy effect could be achieved by closely coupling Environmental Sciences and Information-Computational Technologies (ICT). Here e-Science plays a pivotal role in developing the “underlying mechanics” of the work, leaving the earth scientists to concentrate on their important research as well as providing the environment to make research results available and understandable to everyone. To understand dynamic of regional natural and climatic system properly and perform regional environment assessment on the base of environmental monitoring and a set of developed models an information-computational infrastructure is required. Nowadays a vision that multidisciplinary management of data coming from international efforts in large regions requires new data management structures and approaches is shared by majority of researchers [9]. It should be added that listed below results on development of this infrastructure are obtained in cooperation of SB RAS specialists with their European and American partners/counterparts.

An element, which answers the above challenges and integrates modern Information Technologies and Environmental Sciences is the web portal ATMOS [10] developed by an INTAS funded consortium. The portal comprises information resources on physics and chemistry of atmosphere (<http://atmos.iao.ru>) as well as those on environment and air quality issues for two Siberian territorial objects, namely West Siberia and Lake Baikal (<http://atmos.scert.ru>). Weather and climate are two major objectives considered by the portal. Bilingual information for the domain of Atmospheric Physics and Chemistry, as well as the related application domain of air quality assessment and management are available to the international research community, environmental managers, and the interested public. The portal offers access to integrated thematic information, experimental data, analytical tools and models, and case studies. Related information and educational resources are compiled, structured, and edited into a coherent and consistent thematic information resource. While offering the usual components of a thematic site such as user group registration, discussion forum, news section etc., the portal 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. It makes the portal both an auxiliary instrument to support interdisciplinary projects on regional environment and an extensive educational resource in this important domain. It should be noted that the portal is in continuous development and new thematic sites as well as new functionality are adding to it.

The next element of the infrastructure is formed by the Enviro-RISKS project web-portal (<http://risks.scert.ru/>). This bilingual (Russian and English) resource is aimed at dissemination of information on general environment issues adjusted also for usage in education process and giving an access to regional environmental data and instruments to process them in on-line regime. The Portal engine employs middleware designed in course of the INTAS project ATMOS performance results. 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. Portals operation will be supported by a distributed information system with main server in Tomsk and nodes in Krasnoyarsk, Moscow, Khanty-Mansiisk and Almaty that will provide easy access to structured information 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 functionality allows an access to gathered and analyzed detailed information on all coordinated Projects, to systemized results and finding obtained. It includes relevant observation data and information resources, distributed database as well as relevant metadata. 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 Siberia site, which provides basic information on Siberia environment characteristics. 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 comprises information on the Project Partners, Project management, Projects/Program coordinated and give an access to gathered by Partners educational recourses.

The one more element of the infrastructure is based on the GOFC-GOLD Northern Eurasia Regional Information Network (NERIN) database (<http://www.fao.org/gtos/gofc-gold/net-NERIN.html>). Its Russian language mirror (<http://nerin.scert.ru/>) is providing an access to data and metadata describing different features of regional environment.

2.3. SIRS organizational component

A scientific-organizational basis of SIRS is not so good developed yet. As it was mentioned earlier the first proposal to develop SIRS as a joint program of SB RAS and IGBP was made by the executive director of IGBP Will Steffen in 2003 during the conference on boreal forests in Krasnoyarsk. After the discussion with him and the President of IGBP Guy Brasseur further work in this direction was conducted by Prof. E.P. Gordov and co-authors of this paper. Valuable SIRS devoted scientific-organizational activity is performed by the Siberian Center for Environmental Research and Training, operating as an International research center of SB RAS. The first significant steps on this way were done in course of implementation of the FP6 ... ENVIROMIS (Environmental Observations, Modeling and Information Systems) project in 2004–2005. In particular, the basis for interaction of leading scientific organizations of Belarus, Kazakhstan, Russia, Ukraine and Uzbekistan, working in the environmental sciences was formed, the open informational system on environmental issues (<http://enviromis.scert.ru/>) was created and two devoted SIRS development Workshops were organized within scientific-educational events ENVIROMIS-2004 and CITES-2005. The first dedicated to SIRS event was an INTAS Strategic Scientific Workshop “Towards integrated multidisciplinary study of the Northern Eurasia climatic Hot Spots” (<http://www.scert.ru/en/conferences/enviromis2004/workshop/>) held in 2004. Among its organizers were: INM RAS (Moscow), IF SB RAS (Krasnoyarsk), IMCES SB RAS, SCERT (Tomsk), and International Institute of Applied System Analysis (Laxenburg), Max Planck Institute for Biogeochemistry (Jena) and MEDIAS-France (Toulouse). The detailed discussions on performed and planned researches of current natural-climatic changes in Siberia led to elaboration of recommendations

on SIRS development as an integral part of ESSP (<http://scert.ru/en/conferences/enviromis2004/recommendations/>). In particular, it was proposed to formalize organizationally the group of specialists from RAS and other institutions which has been already involved in joint projects on Siberian environment research and to charge this group with the coordination of activities on SIRS development.

On the basis of this recommendations the Russian National Committee (RNC) of IGBP and SB RAS have created the Siberian Branch of the RNC (Evgeny Vaganov chairs it) [11], which might be considered as the first organizational step of SB RAS to the development of SIRS in the framework of the Earth System Science Partnership and IGBP. It should be noted that this body comprises not only regional (Siberian) actors, but also all members of the initiative group (that are co-authors of this paper). Namely the Committee's duty was to unite major regional environmental and climate change players to develop a backbone for SIRS. This means bringing together several disciplines, defining principal goals of scientific and societal interest, and the way in which these different research communities will work together in order to achieve inter-disciplinary goals. The Committee is structured according to five directions of its activity:

- biological — ac. E.A. Vaganov (coordination of biospheric studies);
- climatic-ecological — RAS corresponding member M.V. Kabanov (coordination of study of global changes impact);
- paleo-climatic — ac. M.I. Kuzmin (coordination of study of Siberian paleo-climate);
- permafrost — ac. V.P. Melnikov (coordination of study of Siberian cryolithosphere);
- informational infrastructure — prof. E.P. Gordov (organization of informational support of environmental research, data storage and access).

Organizational support of functioning of the Siberian Branch of Russian National Committee of IGBP (<http://scert.ru/ru/SB/>) is performed by IMCES SB RAS and SCERT. SB RNC has decided that during the first stage of SIRS development it is necessary to focus on four lines of investigation:

- quantification of the terrestrial biota full greenhouse gas budget, in particular exchange of major biophilic elements between biota and atmosphere;
- monitoring and modeling of regional climate change impact;
- development of SIRS information-computational infrastructure; and
- development of an anticipatory regional strategy of adaptation to and mitigation of the negative consequences of global change.

All these lines of investigation were discussed during the first Meeting of the Working Group on SIRS. This event took place under the auspices of SB RNC for IGBP, with the support of SCERT (<http://scert.ru/>) and MEDIAS-France (<http://medias.obs-mip.fr>). It put together regional, national and international researchers and attracted attention of representatives of institutions and funding agencies interested in the development of SIRS as a part of the ESSP and IGBP Network of Integrated Regional Studies in different regions of the globe. This brainstorming session brought together a group of regional scientists and their national and international partners, in order to deepen and strengthen the preliminary project and propel it to the international scene. It took place just after the CITES-2005 Conference, which provided a unique opportunity to gather the relevant people, get a better insight of the regional state on the regional state of the art, and have an in-depth discussion to chose the right tracks in order to achieve a fruitful synergy with endorsed global change regional programmes. The workgroup was preceded by the SIRS Scientific Background cross-disciplinary session devoted to the state of the art on environmental investigations in the region under study. Materials of this session are available on: <http://www.scert.ru/conferences/cites/2005/>

/presentation/ConferenceRus.html. Workgroup recommendations (<http://www.scert.ru/conferences/cites/2005/presentation/WorkgroupEng.html>) direct scientific community toward clusterization of corresponding integrated projects of SB RAS and netting with profile national and international programs.

The third SIRS dedicated event Workshop on SIRS Development was organized within the ENVIROMIS-2 FP6 project, which continues the ENVIROMIS action. The two days scientific Workshop took place during the ENVIROMIS-2006 International Conference. The most recent and advanced scientific results and findings related to SIRS vision and themes were presented in 13 invited and 11 contributed papers, additionally to a number of papers presented at the thematic Sessions of the ENVIROMIS International Conference. The workshop evidenced that SIRS was indeed on the right way and has already gained a strong impetus and a wide spectrum of multidisciplinary and interdisciplinary knowledge. The Workshop recommended to create an analytical survey of the state-of-art. This could be a collective report presenting results of past and on-going projects in a structured way, putting emphasis on regional climate understanding (including extreme events) and the impacts of observed and projected climate change. This would be the first duty of the SIRS Scientific Council, which would include researchers heading relevant national and international projects on Siberia environment. This report will form a basis for a detailed SIRS research plan aimed at combining individual projects into a coherent structure according to SIRS concept. Other recommendations will be briefly described in a subsequent section.

Quite a step in the SIRS development is carrying out the FP6 ... project Enviro-RISKS (Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia) that started in November 2005. It focuses on the development of scientifically-based understanding of ecological risks caused by anthropogenic factors, their impacts on the regional environment and understanding of the optimal ways of these risks mitigation. The project is coordinated by Danish Meteorological Institute with SCERT assistance and is performing by a consortium of 10 Russian and European profile organizations, 5 of them are from Siberia. Basic approach of this project is coordination of on-going and future projects devoted to Siberia environment. In more details it is described at the project site (<http://risks.scert.ru/>) and is published in this issue [12].

2.4. SIRS Educational (capacity building) component

There are three inherent to any IRS features, which form a real challenge for involved researchers. Those are multidisciplinary of study, necessity of professional use of relevant information-computational infrastructure and last but not least need to deliver messages following from the results to regional decision makers. It is clear that a special educational activity is required in order to prepare researchers, especially young scientists, to these challenges. That is why a capacity building program was elaborated with special emphasis to young scientist involvement into this area. The program is based on a “two-component” approach: annual organization of thematic schools CITES (Computational and Information Technologies for Environmental Sciences) for scientists and interdisciplinary conferences ENVIROMIS (Environmental Observations, Modeling and Information Systems) comprising elements of scientists schools. The following format is used for a narrow thematic domain: first comes a thematic school with short lecture courses on 2 selected topics of informational — computation technologies, one of which is supported by training sessions, and then comes a thematic conference where the audience is enlarged by invited specialists including regional decision makers. The second way is

organization of an interdisciplinary conference with a basic set of thematic sessions and invited lectures on each area of the considered domain. An additional educational moment in the both cases is in training young scientists in presenting their results during their poster presentations. Also targeted workshops are embedded into the conferences as well as open meetings of partners of large environmental projects belonging to SIRS area of interest.

Nowadays the CITES and ENVIROMIS events become leading regular environmental forums taking place in Russia (<http://scert.ru/en/conferences/>) gathering two hundreds of researchers and environmental decisions makers and one half of those are young scientists. It gives us a hope that qualified young specialists coming to this field will be ready to meet the mentioned challenges. Brief history of this activity allows us to see a high scientific level of papers which are proposed by young scientists who already took part in such actions, a high level of their Ph. D. thesis and appearance of new international interdisciplinary projects. In fact, it means that actions already performed became an “incubator” for new large international projects. As a whole, the experience of the developed concept realization showed that young scientists receive necessary skills to successfully join multidisciplinary research of national and international scientific groups.

3. SIRS possible future

The strategic idea lying behind SIRS is to have it endorsed by ESSP, the Earth System Science Partnership (which brings together the four programmes about global change: IGBP, IHDP, WCRP, Diversitas) as one of its Integrated Regional Studies (IRS). Up to now, two IRS have been endorsed: one about the Amazon basin, another one about the Asian Monsoon. It seems relevant if an Integrated Study over Siberia would be ranked among these IRS. The following steps to this end are foreseen and planned now. Firstly, the SIRS Scientific Council comprising Co-ordinators of SIRS projects should be created by SB RNC, which should defined the Council’s status and invite relevant persons to participate in Council’s activities. The cluster will include thematically relevant SB RAS Integrated projects (2006–2008), RAS Programs projects (2006–2008), as well as EC, ISTC and NASA funded projects thus giving them substantial added value. Then the scientific program will be developed in order to make multidisciplinary knowledge deeper, through refinement in information’s collection (a crucial field to be coordinated and improved) and theoretical modelling. Within an overarching plan, a step-by step approach starting from targeted research studies and the development of proper networks to exchange gained knowledge is planned. Suggestions to solve identified problems have to be substantiated and projects to solve specific problems have to be developed. All these elements are included into the elaborated roadmap to well established Siberia Integrated Regional Study. In particular, we plan to get the developed informational-computational infrastructure open for all researchers in two years. Mainly it will be designed and implemented by two SB RAS Integrated Projects: “Development of distributed information-computational system for investigation of ecological systems” and “Development of tools for satellite ecological monitoring of Siberia and Far East on the basis of information and telecommunication methods and technologies”, coordinated by leading SB RAS Institutes, as well as follow from results coming from GOFC-GOLD NERIN activity. The current state of the art makes SIRS quite a candidate for a large RTD project in the framework of coming in 2007 the 7th EU Framework Programme and we plan to prepare a relevant proposal during next year.

It should be added that we plan to have SIRS targeted Forum at the CITES-2007 International Young Scientists School — Conference and ENVIROMIS-2008 International Multidisciplinary Conference to be run in Tomsk, July 2007 and 2008, respectively. Relying upon previous experience we are sure that these meetings will be quite a milestone in rather brief but dynamic SIRS history.

Important issue to be solved in future is interrelations between SIRS and more ambitious NEESPI. It follows from recent NEESPI Scientific Teams Meeting (<http://www.neespi.org/>), that the initiators are planning to construct this Program as a kind of a vertical structure coordinating the Northern Eurasia environmental research on a project level. It is supposed, that NEESPI as a whole will interact with IGBP, ESSP and other international Programs which are devoted to different aspects of the global change. We suppose that SIRS will cooperate with both national and international Programs on the Northern Eurasia environmental research including NEESPI as a whole. This approach will allow SB RNC to perform its mission in the region, that is to ensure the growth of scientific knowledge on main patterns of Siberian environment and its subsystems dynamics and to develop a basis for solid strategy of remediation and adaptation to negative consequences of global changes. Preliminary discussion of the situation shows that it is realistic to include SIRS into the planned RAS Presidium Program as an autonomous sponsored part. It is assumed, that the same will be realized with NEESPI, IGBP, ESSP and its Programs structures. Really, ambitious plans of NEESPI cannot be met without decentralized structures and one of the roles of SIRS on the international scenery could be to rank as one of them. One can see on the way to it exchange of information with NEESPI, the coordination with it and elaboration of deeper links, which should include harmonization and co-ordination of efforts (scientific and educational). Among possible steps to reach the above goals are organisation of Distributed Centers to support NEESPI activity in the region based in Krasnoyarsk (Forestry and Remote Sensing) and Tomsk (Data and Modeling) as well as co-ordination of training and educational activity performed by SCERT. SCERT also might host a regional NEESPI Project Office.

Conclusions

All the above shows that SIRS has all prerequisites which are required to become an internationally recognized and satisfactory funded research Program devoted to improve regional-global linkages, to monitor and assess global change impacts on regional level, and to provide sound recommendations for regional decision makers and authorities how to mitigate negative effects for Siberia and its population caused by climate change. In particular, Recommendations and Roadmap to a mature SIRS, elaborated by the Workshop during ENVIROMIS 2006 Conference produce a clear message to the international community that the regional scientific community, reinforced by strong international links, is quite ready and eager to work within the framework of ESSP. It should be added that having SCERT/IMCES recently included as observer in the European project CIRCLE, that brings together organisations which are managing research related to impacts of climate change, sounds like a first endorsement signal at the European level. And we hope that it makes a good start for SIRS on the international scene. Acknowledgements Valuable input of numerous participants of the SIRS devoted Meeting is appreciated. A support of a number of national and international projects coordinated by the authors is appreciated as well, especially acknowledged is a support of FP6 EC Projects ENVIROMIS-2 (INCO-CT-2006-031303) and Enviro-RISKS (INCO-CT-2005-013427) as well as SB RAS Integrated Projects 34 and 86.

References

- [1] IGBP Newsletter N 50 June, 2002 IGBP II: Special Edition Issue; Brasseur G // 3rd IGBP Congress overview. Global Change Newsletter. 2003. N 55. P. 2–4.
- [2] MURATOVA E.N., VAGANOV E.A., BERGEN K., APPS M. International conference “Environmental role of boreal forest: local, regional and global levels” and Workgroup GOFC/GOLD (Krasnoyarsk, Russia) // *Lesovedenie*. 2003. Vol. 6. P. 74–75.
- [3] IPPOLITOV I.I., KABANOV M.V., KOMAROV A.I., KUSKOV A.I. Patterns of modern natural-climatic changes in Siberia: observed changes of annual temperature and pressure // *Geography and Natural Resources*. 2004. N 3.
- [4] DYMNIKOV V.P., LYKOSOV V.N., VOLODIN E.M. ET AL. Modelling of climate and climate change // *Modern problems of numerical mathematics and mathematical modeling*. Moscow, Nauka, Vol. 2, 2005. P. 36–173.
- [5] BONY S., COLMAN R., KATOSOV V. ET AL. How well do we understand and evaluate climate change feedback processes? // *J. of Climate*. 2006. Vol. 19. P. 3445–3482.
- [6] PLESHIKOV F.I. (ED.). *Forest Ecosystems of the Yenisey Meridian*. Institute of Forest, Siberian Branch of RAS, Novosibirsk, 2002. 356 p. [in Russian].
- [7] VASCHUK L.N., SHVIDENKO A.Z. *Dynamics of Forests of Irkutsk Oblast*. Irkutsk Regional Agency of Forest Management, Irkutsk, 2006. 392 p. [in Russian].
- [8] SCHULZE E.-D., PROKUSCHKIN A.G., ARNETH A. ET AL. Net ecosystem productivity and peat accumulation in a Siberian Aapa mire // *Tellus*. 2002. Series B. Vol. 54, N 5. P. 531–536.
- [9] PARSON M., BARRY R. Interdisciplinary data management in support of the international polar year // *EOS*. July 25 2006. Vol. 87, N 30. P. 295.
- [10] GORDOV E.P., LYKOSOV V.N., FAZLIEV A.Z. Web portal on environmental sciences “ATMOS” // *Adv. Geosci*. 2006. Vol. 8. P. 30–36. www.adv-geosci.net/8/30/2006/
- [11] BULLETIN of the Russian national committee for the international geosphere biosphere programme. 2004. N 3. P. 30.
- [12] BAKLANOV A., GORDOV E. Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia // *Comp. Technologies*. 2006. Vol. 11. Special Issue. 2006.

Received for publication 19 October 2006