Multidisciplinary ENVIROMIS conferences as a tool connecting climate information producers and users

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Abstract. The paper describes a regular multidisciplinary conference and early carrier scientists' school ENVIROMIS as a tool for facilitation of cooperation of specialists in different fields of environmental sciences and users of research results. The conference addresses critically important issues occurring in environmental sciences, namely, crossing disciplinary borders of this multidisciplinary research area, young scientists' training and diminishing a gap between science and decision-making. The viability of the approach to the Schools organization is proved by the fact that single event turned into a series, quite a few young participants successfully defended their PhD thesis and a number of researchers became Doctors of Science, several international multidisciplinary projects, initiated at these conferences, have been successfully carried out. Researchers from Russia and foreign countries show undiminishing interest to these conferences.

1. Introduction

Environmental sciences, that study the Earth system, cover all spheres that provide human habitat, namely, atmosphere, hydrosphere, and lithosphere. Nowadays the most urgent tasks for environmental sciences are ongoing and projected climate changes and their consequences [1]. Global impact of warming is presented in the Intergovernmental Panel on Climate Changes (IPCC) Reports [1, 2]. As for the Russian territory, due to its size and location in high and polar latitudes within the largest continental mass of Eurasia, the country belongs to the Earth's regions with the highest observed and projected climate changes [3]. This warrants a need to study these changes in order to elaborate mitigation and adaptation measures in response to them as well as to quantify their feedbacks to the other parts of the Earth System.

Hydrometeorological Center of Russian Federation issued a report "Strategic outlook of climate change in Russian Federation for the period up to 2010-2015, and its impact on sectors of the economy of Russia" [4] which comprises the research result of 14 leading research institutions in Russia. According to this report there is an increase in the magnitude and frequency of extreme weather events (heat waves, cold periods, heavy rains or snow, storms, floods or drought), which leads to the increasing damage to ecosystems and infrastructure. All this together causes enormous economic damage and needs to be thoroughly studied.

Since environmental sciences have very large research scope, they face many problems. Among them the main ones are a need of multidisciplinarity in research and gaps between science and decision-making.

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First problem arises from the fact that Earth system includes a great variety of components, processes and interactions, which, if investigating separately, should be studied by methods from physics, chemistry, hydro- and gas dynamics, biology, ecology, etc. Specialists in different environmental areas use different approaches and data storage formats. At the same time, new instruments and data acquisition technologies are introduced into practice, new climate models and climate projection scenarios are created, and various information-computational systems for environmental studies are developed. Such diversity poses in front of the scientific community a challenge: specialists working in different environmental fields have to unite and cooperate in order to get insight into the environmental processes, to understand their mechanisms, and to apply into practice their findings. Multidisciplinarity of problems under consideration demands a development of common terminology, which is clearly understood by scientific community. Thoughtful study of environmental processes requires a synergy of approaches that would create the entire pattern of the Earth system functioning (including its dynamics) in all its diversity. Moreover, there is a need to train young scientists to apply new technologies and to work within multidisciplinary teams. So, it is necessary to find a way to overcome these problems. Addressing the multidisciplinarity, was among the major motivations behind the ENVIROMIS Events organization

The second problem is in the shortage of professionals, who can implement the research results into practice. Very often decision-makers and stakeholders, who have to execute adequate measures to adapt to or to mitigate the adverse effects of climate change, do not have skills and knowledge to intelligently assess the accumulated data from climate analysis and to use them for strategy development. Thus, there is an acute need to make a bridge between scientific results and recommendations and their implementation into practical measures.

There are several ways to solve these problems on both global and national levels. Those are organization of specialized conferences and seminars, issue of dedicated journals and reports, educational activities, training of the users. At the global scale activity of IPCC was aimed at informing governments on the ongoing and future climate changes in order to let them make proper decisions [2]. For user training purposes, many courses are developed including short-term private participation courses and e-learning [5, 6].

Along with comprehensive multidisciplinary environmental studies, it is clear now that urgent actions should be undertaken to adapt to climate change and mitigate its negative effects. Climate change is a process that occurs gradually. This makes it possible to adapt and minimize its negative impact, to organize activities to adapt to changing conditions. Assessments of environmental, economic, political and social consequences of global climate change to each specific region should be a priority.

According to the accepted terminology of the IPCC, the "adaptation" process is "The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention facilitate adjustment to expected climate and effects" mav its (http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf p. 5). Adaptation actions imply a wide range of measures, such as economical use of scarce water resources, modification of existing building codes by new calculations of the buildings' stability that account for future climate conditions and extreme weather events, carrying out flood control works to protect against rising sea levels, design drought-resistant crops, etc. Other methods of adaptation include improving seasonal weather forecasts, early warning about weather-related emergencies, improved risk management, accumulation of sufficient insurance funds, and extra-efforts to secure fresh water supply.

According to the IPCC, future vulnerability depends not only on climate change but also on the selected ways of societal development. Sustainable development can reduce vulnerability. To be successful, adaptation should be a part of sustainable development plans at the international and national levels. At the national level development of effective adaptation strategies should include: improving the scientific basis for decision-making; development of educational programs; improvement of practical training and raising public awareness of the environmental change problems,

especially among young people. In addition, possible adaptation measures could include development of appropriate legislation and regulatory frameworks to sustain adaptation activities.

The present paper highlights an approach, our contribution to address the above problems. It had been developed and tested during past 15 years.. The approach consists in organization of a multidisciplinary conferences and early carrier scientists' schools, which could be a midpoint for get-togethers and cooperation of specialists in different fields of environmental sciences and users of their research results, (e.g., decision makers, local authorities, and stakeholders.

2. Approach

At present in Russia the Climate Doctrine of the Russian Federation (http://www.lse.ac.uk/GranthamInstitute/law/climate-doctrine-of-the-russian-federation/) is adopted and implemented, which is the basis for the formation and implementation of climate policy.

A necessary condition for the climate policy is a government support to ensure compliance with the world standards in: systematic climate observations; fundamental and applied research in the field of climate science and related fields; application of research results to assess the risks and benefits associated with the effects of climate change and to adapt to these effects.

According to the Doctrine a threefold approach should be realized. First of all, young specialists in climate sciences should be expansively trained. Global changes have caused the development of techniques of measurement and simulation characteristics of the environment, accompanied by an extension of the conceptual and mathematical apparatus. Available training programs in environmental science, as a rule, do not have time to adapt to such rapid changes in the content of the subject area [7]. Specialists need to create large databases of observations and / or modeling results, to develop and use computational models, and to be able to quickly exchange the information within the scientific team. And scientific teams become interdisciplinary for a broader outlook in climatic issues.

The lag in training programs leads to the situation when graduates of the environmental faculties superficially know mathematical modeling of environmental processes, do not have required skills in modeling, processing and analysis of observational data, are not able to work with the data fields of meteorological variables and be useful teammates within interdisciplinary research groups.

The second line of adaptation and mitigation measures noted in the Doctrine is a preparation of skilled decision-makers, who will develop and implement adaptation measures. The goal is not only to provide these groups with tools, skills, thematic information but to give them knowledge for understanding climate processes occurring in the region.

The third proposed line in the Doctrine requires rising of public awareness of processes that occurs and could occur in their habitat. Therefore, special internet-based resources and e-learning courses should be developed for the general public. Evidence-based information about current and expected climate changes in the region of residence will help the entire society to prepare to the expected consequences and stimulate the search for ways to adapt to them.

ENVIROMIS multidisciplinary conferences had been designed and were considered as sites for meetings and cooperation of specialists in different areas of environmental sciences and end-users: decision makers, local authorities, and stakeholders. At these conferences the state-of-the-art usage of modern environmental observation techniques, computational and information technologies for assessment, modeling and mitigation of environment variations under natural and anthropogenic pressures have been presented. They have been aimed at filling the gap between basic science achievements and their practical applications in the study domain (mostly Siberia)

Usually four types of report are delivered on ENVIROMIS conferences, namely, invited lectures that present state-of-the-art in the corresponding environmental science topics, invited reports that present recent achievements, as well as oral and poster reports, where scientists present results of particular studies. As a rule, lectures are given in the manner that is clearly understandable for all conference participants. Successive sessions allow participants to listen all reports they are interested in and take part in the poster sessions.

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Besides, representatives of international funds and organizations have taken part in ENVIROMIS conferences. They present current international calls and terms of participation for Russian scientists. We have also invited leaders and officers of local ecological services who are interested in implementing new technologies in their practical work.

In the context of the Doctrine, ENVIROMIS conferences address a critically important issue – a generation gap occurring in Russia in Environmental Sciences. To mitigate this gap and its consequences and to facilitate professional skill growth of young scientists, a number of invited lectures by leading specialists are usually presented at the ENVIROMIS Conferences. The lectures are devoted to the novelty in the environmental research and allow young participants to get first-hand information on hot topics in the Earth System Sciences attracting them professionally to this very important research area. Supplementary educational component, which is routinely implemented at the Conferences, is to teach young scientists to clearly lay out their own results during short oral presentations of their posters and during the follow-up course of poster sessions.

In the framework of adaptation strategy, each ENVIROMIS Conference program includes a Workshop dedicated to one or another international program on environmental studies. Among them have been Northern Eurasia Earth Science Partner Initiative / Northern Eurasia Future Initiative (NEESPI/NEFI)), large regional programs (Siberian Integrated Regional Study), large international projects (Project Enviro–RISKS of 6th EC Framework Program, project NELDA by NASA, and several projects of Asia-Pacific Network for Global Change (APN)). Project partners and all participants of the Conference get acquainted with projects' state and its results, discuss perspectives and initiate new ideas. Regional decision-makers and stakeholders are especially invited to participate in these Workshops.

3. Results

ENVIROMIS conferences have a quite long history. The first conference was organized in 2000. That was the first attempt to gather specialists from different environmental fields and establish interdisciplinary relations, as well as to enhance professional skills of early carrier scientists within interdisciplinary teamwork. Although information-computational technologies in environmental sciences were the core of the first conference program, its sections were devoted to different researches starting from field measurements in atmospheric sciences to modeling and monitoring processes in soil and vegetation. When organizing this event, the following approaches were tested:

- the conference as a set of successive sessions;

- a logical order through the conference program (not simply added sessions' programs);

- embedding in the conference program for each session hourly invited lectures presented by prominent authors on one of the actual problems of the Session topic.

Next conference, ENVIROMIS-2002, refined earlier approaches and allowed to develop the best way for organization of a multidisciplinary conference together with an early carrier scientists school in environmental sciences. When preparing this conference, a minimum set of thematic sections has been defined in the program. This allowed us to cover multidisciplinary areas and at the same time to eliminate the contradiction between the thematic breadth and depth of subjects' coverages. This approach was tested, refined, and put into practice of organization of all consequent ENVIROMIS conferences.

Follow the event trends, we can identify the major research areas and leading organizations in these areas, which have been always present at the ENVIROMIS conferences. These research areas are:

- hydrology (Lomonosov Moscow State University, Research Computing Center; P.P Shirshov Institute of Oceanology RAS, Moscow; Institute of Water and Ecological Problems SB RAS, Barnaul);

- climate changes, meteorology (Institute of Monitoring of Climatic and Ecological Systems SB RAS; V.E. Zuev Institute of Atmospheric Optics, Tomsk; V.B. Sochava Institute of Geography SB RAS, Irkutsk);

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- climatic and meteorological modeling (Institute of Numerical Mathematics RAS, Moscow; Lomonosov Moscow State University, Research Computing Center; Siberian Regional Hydrometeorological Research Institute, Institute of Computational Mathematics and Mathematical Geophysics, Novosibirsk; Hydrometeorological Center of Russian Federation, Moscow);

- pollution transport (Institute of Computational Mathematics and Mathematical Geophysics, Novosibirsk; Novosibirsk State University; Tomsk State University);

- vegetation cover, biochemical cycles (Siberian Research Institute of Agriculture and Peat, Tomsk; V.N. Sukachev Institute of Forest SB RAS, Krasnoyarsk; A.M. Obukhov Institute of Atmospheric Physics RAS, Moscow; Department of Mathematics Komi SC UrD RAS, Syktyvkar);

- information-computational and instrumental infrastructure for environmental studies (Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk; Institute of Numerical Mathematics RAS, Moscow; Institute of Computational Technologies SB RAS, Novosibirsk; Institute of Computational Modeling SB RAS, Krasnoyarsk).

This biannual event organization, comprising elements of Early Career Scientists School and scientific conference, became well-known not only in Russia but also abroad. Scientists from leading foreign centers (for instance, NOAA, MIT Center for the Global Change Science, etc. (USA), National Institute of Polar Research (Japan), Potsdam Institute for Climate Impact Research (Germany), Danish Meteorological Institute (Denmark)) regularly participate in ENVIROMIS conferences, where they present studies carried out at these organizations. About 1400 researchers took part in ENVIROMIS conferences, among them there were 120 foreigners. Half of the ENVIROMIS conferences participants have been young scientists.

As already has been mentioned above, ENVIROMIS events contribute to professional skill growth. Within ENVIROMIS conferences' history, quite a few young participants, who were students and post-graduates, successfully defended thereafter their PhD theses and a number of researchers became Doctors of Science.

Besides, during ENVIROMIS events, several international multidisciplinary projects have been initiated. These are:

- Project EC INCO "Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia" (Enviro-RISKS);

- SB RAS supported "Siberia Integrated Regional Study" Project (SIRS);

- APN Project "Capacity Building to Study Interrelations between Atmospheric Composition, Anthropogenic Load and Climate Change in Northern Asia";

APN Project: «Human Impact on Land-Cover Changes in the Heart of Asia»; and

- APN Project "Capacity building to study and address climate change induced extremes in Northern Asia".

Project EC INCO "Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia" (Enviro-RISKS) (http://project.risks.scert.ru/) was one of the largest projects discussed and initiated at one of the ENVIROMIS conferences. The project has been implemented by a consortium of 10 organizations:Danish Meteorological Institute (coordinator), Siberian Center for Environmental Research and Training, International Institute of Applied Systems Analysis, MPI for biogeochemistry, Institute of Numerical Mathematics RAS, V.N. Sukachev Institute of Forest SB RAS, "KAZGEOCOSMOS" Joint Stock Company, Ugra Research Institute of Information Technologies, Institute of Monitoring of Climatic and Ecological Systems SB RAS, and Institute of Computational Mathematics and Mathematical Geophysics SB RAS. The project target were revealing of anthropogenic risks in Siberian environment, understanding their influence on all ecosystem components, and development of recommendations for these risks mitigation by means of coordinating relevant projects and commensing integrated research focused on interrelations between global climate changes and Siberian environment dynamics. The project implementation resulted in development of a computational infrastructure, creation of data storage and thematic information-computational web-systems. Danish Meteorological Institute published five project report volumes

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(http://project.risks.scert.ru/project_results/project_reports/). Three academic events (ENVIROMIS-2006, CITES-2007, ENVIROMIS-2008) had been financially supported by this project.

SIRS (http://sirs.scert.ru/) Project had four lines of investigation foci:

- quantification of the terrestrial biota full greenhouse gas budget; in particular, documenting 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 a regional strategy of adaptation to and mitigation of the negative consequences of global change.

APN Project "Capacity Building to Study Interrelations between Atmospheric Composition, Anthropogenic Load and Climate Change in Northern Asia" (<u>http://project.enviromis.scert.ru/apn/</u>) encompassed regional activity oriented to the Northern Asia territory and had been fulfilled by institutions of four countries, Russia, Japan, Kazakhstan, and Uzbekistan. The project was relevant to the APN Science Agenda. It enhanced involvement of regional young scientists into this important study and assisted to their further career development. The Project contributed to the regional capacity building activities and to sustainable development in the region by its assertive data and scientific results dissemination activity. Within the project, a number of young scientists from APN target countries had been financially supported to participate in scientific-educational event CITES-2007.

APN Project «Human Impact on Land-Cover Changes in the Heart of Asia» (http://project.enviromis.scert.ru/asia/) was fulfilled by organizations from Russia, USA, and Mongolia. This project was focused only on four (though quite typical) regions in West Siberia and Mongolia in the light of investigation of human impact on land-cover change. Within the Project, land-cover change and disturbance indices maps were developed for the study regions. Investigations were carried out using satellite image analysis and field observations. Project results were disseminated at several international conferences, including CITES-2009, ENVIROMIS-2010, European Geoscience Union General Assembly 2010 and American Geophysical Union Fall Meeting 2010. Participation of the project team members in these events was financially supported.

The activity within the APN Project "Capacity building to study and address climate change induced extremes in Northern Asia" (http://project.enviromis.scert.ru/Capacity/) was aimed at involvement of regional research community, especially young scientists, in the studies of climatic and environmental changes focused on extremes with a special emphasis on their manifestations in Northern Asia. The project was carried out by organizations from Russia, USA, and China. Two international actions, namely, MAIRS/NEESPI/SIRS APN Workshop «Climate Change induced extremes in Northern Asia» and NEESPI/SIRS Workshop "Different aspects of the Northern Eurasia regional climate dynamics and its interrelations with global processes" were organized. Participation of project team members in these events was financially supported.

In order to disseminate research results among researchers and public, we publish ENVIROMIS conferences proceedings. Electronic versions of these proceedings are posted on the conference website (<u>http://www.scert.ru/en/conferences/enviro/</u>) and selected papers are published in special issues of journals "Computational Technologies", 2006 [8]; "Atmospheric and Oceanic Optics", 2006 [9]. Presentations of lectures and reports made at conferences are also posted on the relevant conference web-site (http://www.scert.ru/ru/conference/). Besides, all completed Projects have websites, where ENVIROMIS educational materials are posted.

4. Conclusion

The described above approach has shown its viability and proved that multidisciplinary ENVIROMIS conferences can contribute to a process of establishing relations between Earth Sciences Informatics (observations, models and infrastructure development), data producers, and users (analysis and climate change forecast, extreme phenomena prediction, decision making). This year, ENVIROMIS-2016

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conference was the 9th in the series and some delivered papers are presented in this volume Proceedings.

It should be added that at different periods of time, these conferences were financially supported by INTAS, European Commission, WMO, and the Asia-Pacific Network for Global Change. They are also supported by the Russian Foundation for Basic Research. Despite the fact that this financial support is modest, researchers show undiminishing interest to these conferences. This allows us to hope that the conferences' organizers are on the right path.

The ENVIROMIS conference series is instrumental to strengthen interdisciplinary connections. At the same time, the efficiency of the decision-makers involvement leaves much to be desired. We plan a two-step approach to solve this problem. The first step will be in organizing dedicated workshops and trainings for decision-makers. The second step will be a development of supporting topical manuals for their e-learning. Key specialists – participants of ENVIROMIS conferences will be involved in preparation of these manuals.

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