International Conferences and Young Scientists Schools on Computational Information Technologies for **Environmental Sciences (CITES) as a professional growth** instrument

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Abstract. The paper describes a regular events CITES consisting of young scientists school and international conference as a tool for training and professional growth. The events address the most pressing issues of application of information-computational technologies in environmental sciences and young scientists' training, diminishing a gap between university graduates' skill and concurrent challenges. The viability of the approach to the CITES organization is proved by the fact that single event organized in 2001 turned into a series, quite a few young participants successfully defended their PhD thesis and a number of researchers became Doctors of Science during these years. Young researchers from Russia and foreign countries show undiminishing interest to these events.

1. Introduction

At present, environmental science is rapidly developing. Their conceptual and mathematical apparatus are expanded, models are developing, investigations have become complex and multidisciplinary. They are transforming into exact sciences and this process is proceeding in three rapidly developing areas: 1) the development of new tools for instrumental observations and data storage technologies; 2) creation of mathematical models describing Earth as a whole system and numerical analysis of its dynamics; 3) organization of all available information about the environment (large arrays of observational data and the results of numerical experiments, models and algorithms, and ways to display this information) in information-computational and information systems. The MODAS conference held in Irkutsk in 2001 was one of the first conferences dedicated to the problems facing the environmental sciences. One of the most important results of this conference was the realization of the necessity to train young scientists who can meet the above challenges of the contemporary environmental sciences and work in multidisciplinary teams.

The main driver to elaborated new approaches was the fact that university graduates have no skill in working with contemporary climate models, large data archives and computational resources. The concept has been developed and implemented that uses the "two-component" approach to training young scientists in the field of environmental sciences (http://www.scert.ru/en/conferences/cites/). Thanks to suggestion of academician V.P. Dymnikov, the first component is an event consisting of a thematic school for early carrier students with courses of general lectures on 2-3 selected specific topics in the field of information-computational technology and the implementation of practical

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training for one of the courses, then - a scientific conference in which highly-qualified specialists, including invited lecturers, take part together with young scientists. The second component is a multidisciplinary conference comprising traditional elements of early carrier scientist's school [1].

Experience in the implementation of the developed concept [2] has shown that young scientists who have completed such an educational "cycle" acquire the experience necessary to meet the challenges of modern environmental sciences, and are quickly included in multidisciplinary studies carried out by national and international teams. We believe that this experience can be useful and applicable in other topical areas.

2. Approach

The CITES scientific event is held every two years in different cities of Russia, mainly in its Siberian part. It gives an opportunity to those students in regions who have no travel grants to receive first-hand knowledge and practice. Its first part is a thematic school for early carrier students with courses of general lectures on selected specific topics and practical training for one of the courses. The second component is a conference in which highly-qualified specialists take part together with young scientists.

Every school starts with a day of deep immersion in a school subject from the selected area of informational computational technologies. It is called an "Academicians day", during which several members of the Russian Academy of Sciences deliver hour-and-a-half lectures on key "hot" topics of the domain. During following days invited lecturers deliver their lecture courses to school participants and one of these courses is supported by a specially designed training, which consists of a set of small research projects devoted to topical environmental science problems. Solving training tasks requires competent usage of selected modern computation and information technologies. All calculations needed to complete the training tasks are performed on supercomputers of a network of Russian computational centers, e.g. in Novosibirsk, Tomsk and Moscow. In this way young scientists have an opportunity to use modern high-performance computing systems that are necessary at present to process large datasets.

To perform their practical tasks, school participants are divided into small groups of 3-4 persons. The persons in such a group are usually from different fields of science, e.g. meteorology, geography, computer sciences, mathematics, and often with a different level of expertise. It gives them an experience of a team work and cooperation that is an important skill at present, when scientific projects are implemented by large interdisciplinary consortia. During this team work personal and professional links are established which may be useful for school participants in future. After performing their small research project each group prepares a short presentation of results obtained and presents them during the subsequent conference. It gives them an experience in public reporting of their results. In addition to the school reports the students of the school present reports on their main work. All students who attended lectures and completed practical assignments receive personal certificates.

The conference CITES is usually devoted to the-state-of-the-art of topical modern modeling tools and information technologies developed for Earth System Sciences applications. The Conference is run as a set of consequent sessions with invited lectures, invited oral and contributed poster paper presentations so participants have an opportunity to attend any report without overlapping sessions. Some of these conferences included special workshops on current international research projects to give young scientists an impression of new scientific frontiers. Such workshops were devoted to following topics: Siberia Integrated Regional Study development, Atmospheric Composition and Air Quality, Man-made Environmental Risks in Siberia, Northern Eurasia Earth Science Partnership Initiative, etc.

Even the first CITES event set the bar high and the students rose to meet it. School participants are selected on the basis of specially developed questionnaires containing the following items: education, publications, research interest areas and supervising scientist's recommendations. The level of a proposed conference report is also important.

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Due to its high standards, the CITES event was highly appreciated by national and international science support organizations. It resulted in several grants of INTAS (The International Association for the Promotion of Co-operation with Scientists from the New Independent States of the Former Soviet Union) and RFBR (Russian Foundation for Basic Research). It also was put on the INTAS list of permanent supported young scientist school just before its closure.

3. Results

CITES events trace their origin to 2003. Subjects of the school are determined each time by the most pressing issues of environmental sciences.

Thus, CITES-2003 (held in Tomsk) was devoted to the state and basic fundamental and applied problems of climate modeling and its changes, CITES-2005 (Novosibirsk) paid special attention to methods of data assimilation and methods of remote sensing of the environment, CITES-2007 (Tomsk) – to transport of impurities in the atmosphere, CITES-2009 (Krasnovarsk) was devoted to statistical methods in the environmental tasks, CITES-2011 (Tomsk) - to monitoring and diagnosis of modern climate changes on regional scale, CITES-2013 (Petrozavodsk) focused on the study of the ocean and climate interrelations, the main topic of CITES-2015 (Tomsk) was aerosols, small gas impurities and climate and CITES-2017 (Tarusa/Zvenigorod) considered mathematical models of weather and climate forecasting. Practical courses correspond to general school topics. At the first event (CITES-2003) the students were acquainted with accessible information resources, statement of computing tasks, working on them. Then practical courses were the following: data assimilation and environmental processes modeling (CITES-2005); numerical methods of solving transport equation, modeling of chemically interacting atmospheric gases (CITES-2007); statistical methods in problems of atmospheric and ocean physics, data assimilation: dynamic-stochastic approach [3] and Kalman filter [4] (CITES-2009); modeling of atmospheric mesoscale processes on the basis of modern parallel computing technologies, numerical methods for calculating regional impurity transport (CITES-2011); long-term variability in the climate system (CITES-2013); chemical data assimilation [5] (CITES-2015); investigation of the influence of various parameters in the global SLAV model on a long-term weather forecast [6, 7], climate modeling with the INM RAS climatic model [8, 9] (CITES-2017).

It should be noted that the lectures delivered at the CITES schools, as well as practical courses specially developed for these schools, laid the basis for courses that currently are included in the curricula of the Lomonosov Moscow State University, the Moscow Institute of Physics and Technology and Tomsk State University. In addition, the lectures on the interaction of the atmosphere and the hydrosphere delivered during the CITES-2013 held in Petrozavodsk became the basis of a collective monograph [10]. Lectures are presented in the form of separate chapters, which consider the following topics: the role of the ocean in the observed and possible in the future climate variability; models and methods used in large-scale atmospheric-ocean interactions; the problem of assimilation of observational data in models of ocean and sea circulation; short-period response of the upper layer of the ocean to the atmospheric effect; sensitivity of climatic models to small perturbations; regional and local aspects of the interaction of the atmosphere and the hydrosphere (lakes and climate, wind waves on the oceans and seas, hydrological processes on land); computational-information technologies for the analysis of climatic changes and game-theoretic models of cooperation in the management of marine bioresources. The final chapter of the monograph presents the results obtained by the school participants during practical courses on climate change modeling. This practical course has been prepared and implemented by Doctor of Sciences in Physics and Mathematics E.M. Volodin, a leading scientist of the Institute of Numerical Mathematics of the Russian Academy of Sciences, with a team of 12 young school participants. They considered the following tasks: 1) determination of the equilibrium sensitivity of the climate model to quadrupling the concentration of CO_2 ; 2) modeling climate changes when large amounts of fresh water enter the North Atlantic; 3) modeling climate change due to a change in the inclination of the Earth's rotation axis to the ecliptic plane; 4) modeling effect of compensation for global warming by introducing into the stratosphere sulfur-containing

substances. Reports prepared by school participants and presented at the conference made this final chapter.

It became a good tradition of the CITES events to organize a competition of young scientist's reports. The Program Committee members assess presentations and posters and choose three winners. These persons granted an opportunity to publish their papers in high-ranked journals. For example, winners of CITES-2015 and CITES-2017 events were invited to publish papers in Russian Meteorology and Hydrology journal.

One on the main goals of CITES events is training young scientists and contribute to their professional skill growth. Within CITES history, quite a few young participants (more than 25 persons), who were students and post-graduates, successfully defended thereafter their PhD theses. Now they participate in the events as lecturers and training instructors. A number of researchers (7 persons) became Doctors of Science. Chosen approach to forming groups is also proved its success, which is confirmed by several research projects realized by the consortia made on the basis of such school groups.

This biannual CITES event, consisting of Early Career Scientists School and scientific conference, became well-known not only in Russia but also abroad. Scientists from such leading foreign centers as US NOAA, US Environmental Protection Agency (EPA), Massachusetts Institute of Technology, University of New Hampshire, National Institute for Environmental Studies (Japan), Potsdam Institute for Climate Impact Research (Germany), Danish Meteorological Institute (Denmark)) regularly participate in CITES conferences, where they deliver lectures and present studies carried out at these organizations. Russian leading organizations also always have participating in organization of the CITES events. First of all, Institute of Numerical Mathematics RAS, Research Computing Center of the Lomonosov Moscow State University, Institute of Monitoring of Climatic and Ecological Systems SB RAS are permanent organizers of the event. Among other regular participants there are scientists form Hydrometeorological Center of Russian Federation, P.P Shirshov Institute of Oceanology RAS, A.M. Obukhov Institute of Atmospheric Physics RAS, Institute of Computational Mathematics and Mathematical Geophysics SB RAS, Siberian Federal University, V.E. Zuev Institute of Atmospheric Optics, Tomsk State University and other organizations. Computing resources of high-performance computers of Tomsk State University, Institute of Computational Mathematics and Mathematical Geophysics, Lomonosov Moscow State University and Institute of Numerical Mathematics RAS have been used for practical courses.

About 1070 researchers took part in CITES conferences, among them there were 95 foreigners. Half of the CITES conferences participants have been young scientists.

From the very beginning CITES event had been supported by various funds. Thus, CITES-2003 and CITES-2005 have been financed by EC grants. CITES-2007 event was supported within the APN Project "Capacity Building to Study Interrelations between Atmospheric Composition, Anthropogenic Load and Climate Change in Northern Asia" (http://project.enviromis.scert.ru/apn/). This project encompassed regional activity oriented to the Northern Asia territory and had been fulfilled by institutions of four countries: Russia, Japan, Kazakhstan, and Uzbekistan. 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. A number of young scientists from APN target countries had been financially supported to participate in this scientificeducational event. The 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.

In order to disseminate research results among researchers and public, we publish CITES conferences proceedings. Electronic versions of these proceedings are posted on the conference website (<u>http://www.scert.ru/en/conferences/cites/</u>) and selected papers are published in special issues of journal "Computational Technologies", 2008 [11]. Presentations of lectures delivered at schools and reports made at conferences are also posted on the relevant conference web-site (<u>http://www.scert.ru/ru/conferences/</u>).

4. Conclusion

The described above approach has shown its viability and proved that the CITES events comprising International Conference and Young Scientists School on Computational Information Technologies for Environmental Sciences are contributing a process of young scientists professional skill growth. This year, CITES-2017 conference was the 8th in the series and some delivered papers are presented in this Proceedings volume.

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

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