USE OF THE COMPUTATIONAL-INFORMATIONAL WEB-GIS FOR THE DEVELOPMENT OF CLIMATOLOGY STUDENTS' SKILLS IN MODELING AND MONITORING OF CLIMATE CHANGE

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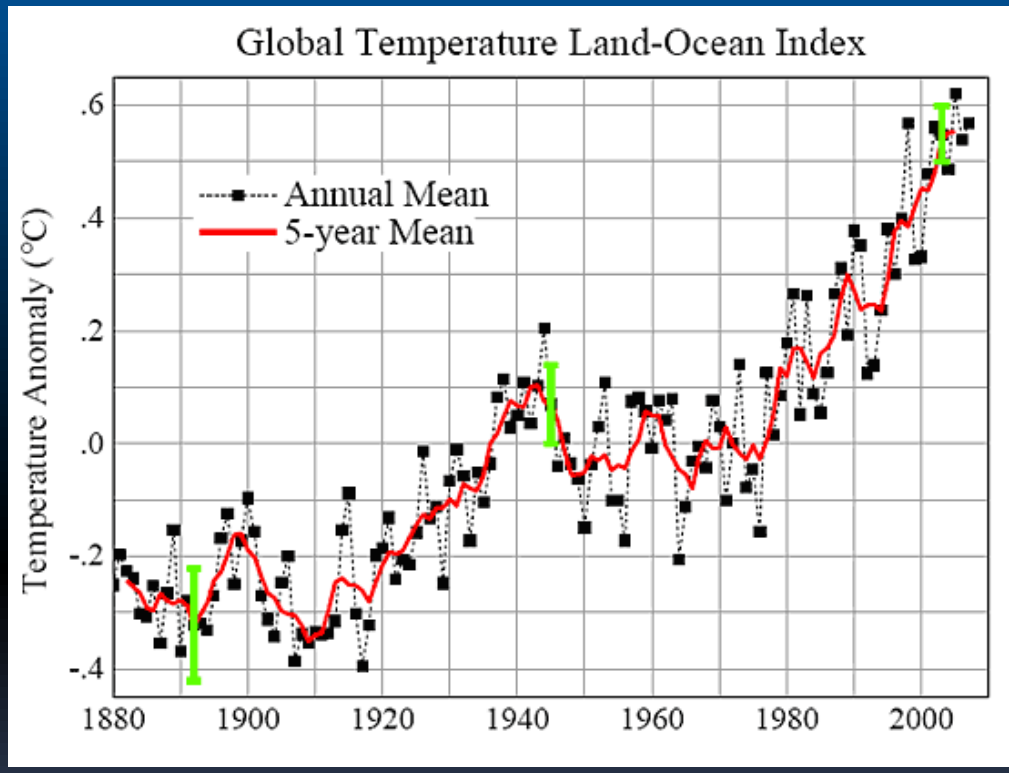
Current situation in the domain

Scientific field itself is experiencing a period of rapid development!

Global climate change is confirmed by scientific observations and the problem of climate change today is extremely urgent. The climate of our planet is changing fast and these concerns have caused the development of measurement technologies and simulation, accompanied by an expansion of the conceptual and mathematical apparatus. Understanding and forecasting processes in the Earth system require extensive use of advanced information-computational technologies.



Knowledge massive in the discipline grows quickly and requires new tools and approaches to make it available for future specialists in environmental sciences.

Training of future specialists in environmental sciences

Existing training programs in the disciplines of environmental sciences, as a rule, do not have time to adapt to such rapid change in the content domain.
As a result graduates of faculties :

- have only superficial knowledge of mathematical modeling of processes in the environment
- do not have the required skills in modeling, data processing and analysis of observations and modeling
- do not know how to work with the environmental data fields.

Two groups of graduates:

- Want to do but don't know how!
- What am I doing here???

WASTE OF TIME!

Implementation of "research" paradigm in education.

- Training of such specialists should be done not in an artificial learning environment, but based on actual operating instruments used in environment studies, in the so-called virtual research environment (VRE).

- A **virtual research environment** (VRE) or **virtual laboratory** is an online system helping researchers collaborate. Features usually include collaboration support (Web forums and wikis), document hosting, and some discipline-specific tools, such as data analysis, visualisation, or simulation management. In some instances, teaching tools such as presentations and slides may be included. VREs have become important in fields where research is primarily carried out in teams which span institutions and even countries: the ability to easily share information and research results is valuable. (From Wikipedia, the free encyclopedia)

Web-GIS information-computational platform "Climate" (http://climate.scert.ru/)

- developed by a joint team of the Institute of Monitoring of Climatic and Ecological Systems SB RAS and Tomsk State University
- aimed at monitoring and analysis of ongoing and future regional climate changes
- used as a basis for elaboration of relevant Virtual Learning Laboratory (VLL) - a specially designed virtual research environment targeted to educational needs.

Educational module of "Climate" (http://climate.scert.ru/)

The educational process in the framework of "Climate" system is supported by the thematic educational materials organized on the basis of distance learning system Moodle (Modular Object-Oriented Dynamic Learning Environment).

Why Moodle?

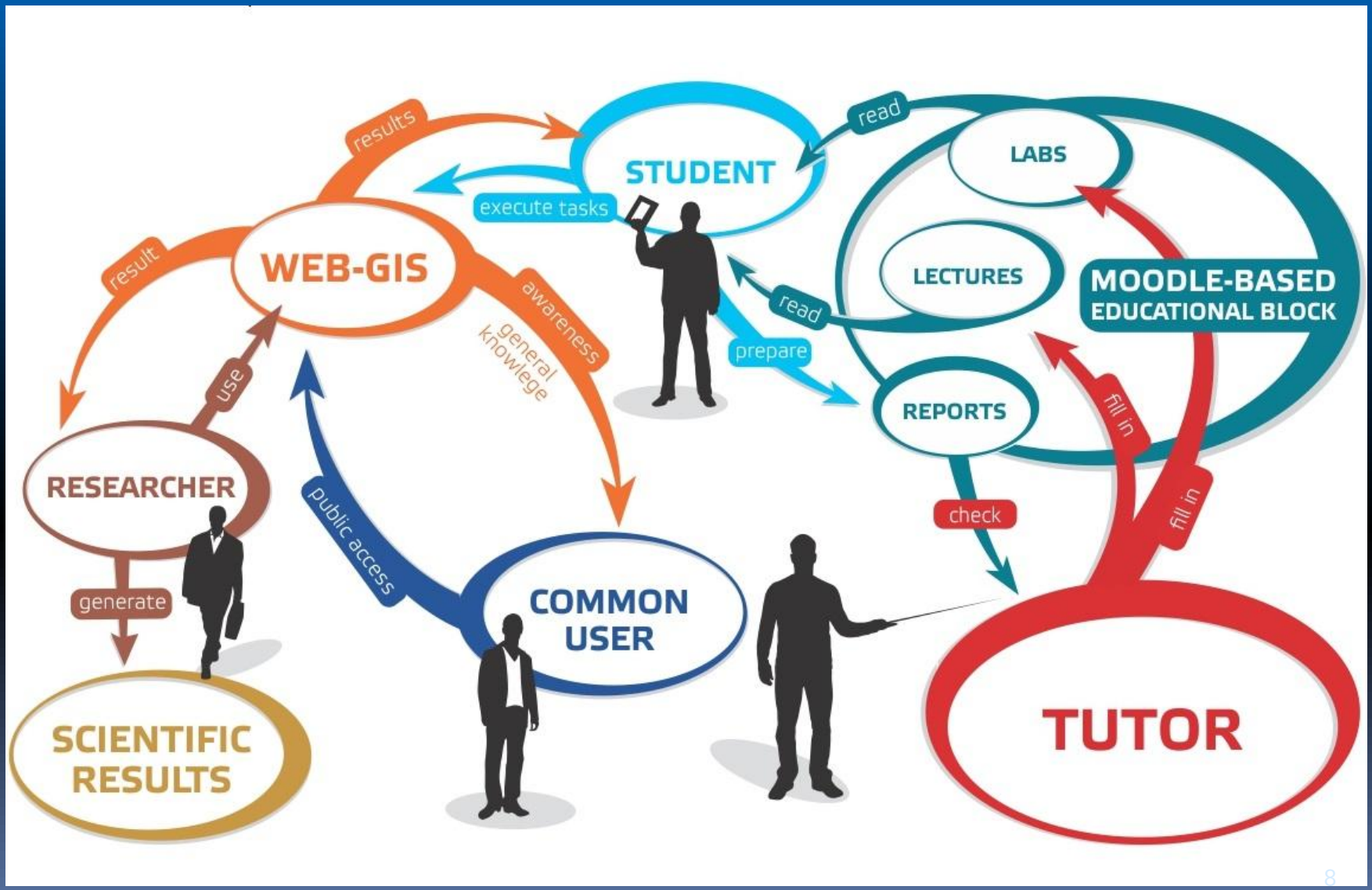
- options of formation and presentation of educational material
- options of examination and monitoring of progress
- easy organization of the modular approach to learning
- easy feedback between teachers and students, which allows students to pass the work in electronic form on the server, obtain a review of the teacher, correct mistakes and re-send documents for review, get the necessary consultation remotely.

Educational module of "Climate" (http://climate.scert.ru/)

Moodle advantages

- - intuitive web-based interface;
- - differentiation of access modes and rights (teacher, tutor, student);
- - the opportunity to edit own accounts (personal details, etc.);
- - support of the various course structures (calendar – a course is organized on the basis of work schedules with precise start and end dates, forum - a course is organized on the basis of one of the forums, tree - a course is organized as a collection of thematic modules without reference to the schedule);
- - availability of a large set of modules-components for courses (forum, notebook, test, resource, glossary, survey questionnaire, homework, etc.);
- - possibility of obtaining a full report on the occurrence of a user in the system and his/her work on different modules;
- - support of different types of content (HTML - text, link - a link to an article or a book, uploaded file - displays any file that is uploaded to the course, etc.);
- - ability to create a database of questions for repeated use in various tests;
- - support of different types of questions ('yes-no' questions, multiple choice questions, essay questions, file response questions, etc.)

Educational module of "Climate" (http://climate.scert.ru/)



Educational module of “Climate” (http://climate.scert.ru/)

“Monitoring and forecasting climate changes” module is a part of the discipline "Hydrometeorological basis for the environmental protection” for bachelors of the Faculty of Geology and Geography of Tomsk State University:

- a set of lectures on the subject, devoted to the basic aspects of modern climatology, including analysis of current climate change and its possible impacts;
- special course on geophysical hydrodynamics;
- Sets of computing labs with specific tasks on monitoring and simulation of climate and climate change;
- information kit: list of recommended reading, but also contains files of many publications, the distribution of which is not restricted by a copyright law.

Educational module of “Climate” (http://climate.scert.ru/)

Trainings which are performed within the course: “Analysis of regional climate changes”, “Analysis of future climate”, "Analysis of climate extreme indices on the regional scale“.

Connection of the learning system Moodle with elements of “Climate” system software allows to perform computational laboratory works using information-computational tools of the system and improve students skills of their usage simultaneously with mastering the subject.

Educational module of “Climate” (http://climate.scert.ru/)

Main purpose of association of the educational block and computational information system -

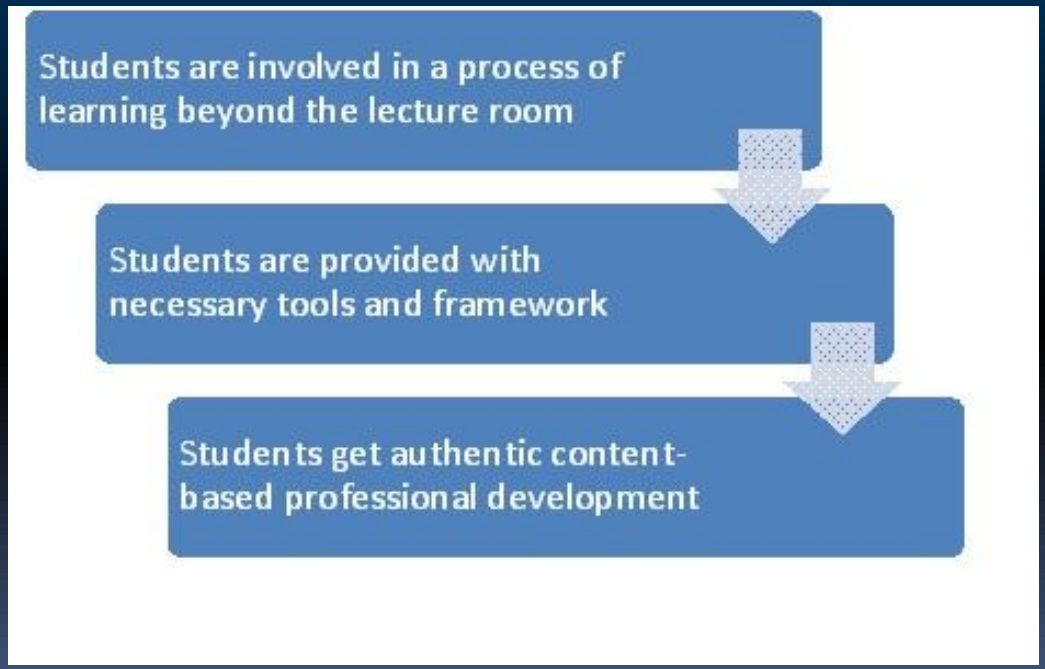
to **familiarize students with the real existing technologies** for monitoring and analysis of data on the state of the climate.

As a part of the laboratory exercises students perform their computational tasks on climate modeling and evaluation and assessment of climate change using the typical tools of the "Climate", which are usually used by real-life practitioners performing such kind of research. Trainings are based on technologies and procedures typical for Earth system sciences.

Educational module of "Climate" (http://climate.scert.ru/)

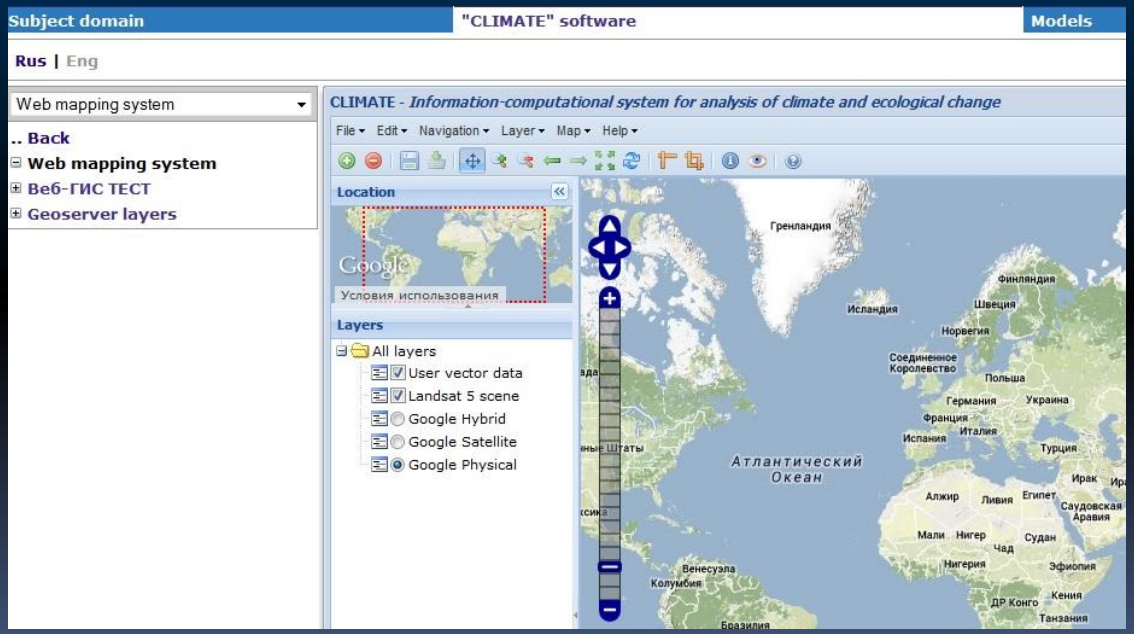
The courses are designed to permit students to conduct their own investigations of ongoing and future climate changes in a manner that is essentially identical to the techniques used by national and international climate research organizations.

Students work through a multi-stage process that requires them to plan several steps ahead. Through data processing, analysis and interpretation, they learn how to do a research in addition to improving their understanding of climate change.



Educational module of “Climate” (http://climate.scert.ru/)

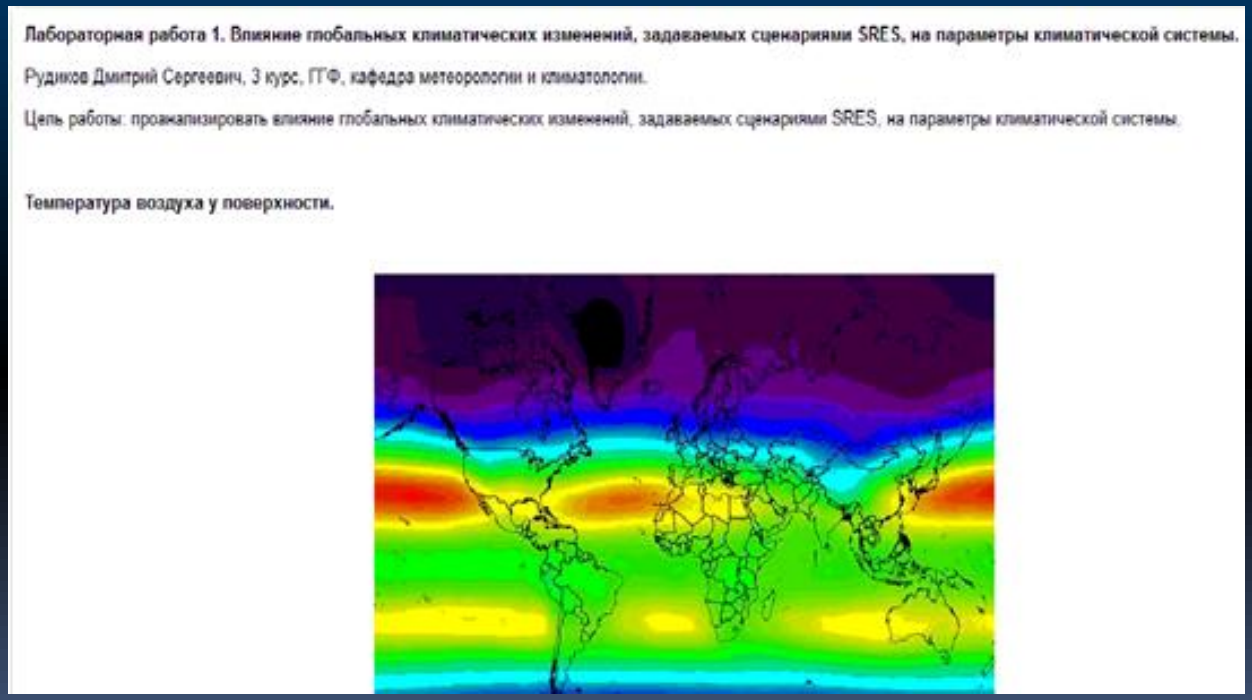
Tab "Web-GIS system”.
Here scenario, time period and the area of research could be chosen and new layers for calculated characteristics could be added to preinstalled ones.



Laboratory practice "Analysis of the future climate" is designed to study climatic projections possible under different future scenarios as well as the interaction of the individual components of the climate system, and statistical methods to assess the impact of global climate change on some of the parameters of the climate system. Basic skills of mathematical modeling and analysis of climate change are trained while performing the tasks.

Educational module of “Climate” (http://climate.scert.ru/)

Results obtained are presented as reports with the statement of the problem, the results of calculations and logically justified conclusion.



Assessment

Elements of Kirkpatrick's Four-Level Training Evaluation Model

1. **Reaction** – measure reaction.

Questionnaire to detect whether the material was thought-inspiring, demanding, worth, etc. Thus, the course is usually modified and improved, based on students' feedback and suggestions.

2. Learning - measure the increase in students' knowledge.

To identify changes in knowledge, skills, and attitude we developed a special survey, which is given to students prior to and after the course. Such testing is helpful in assessing the progress.

3. **Behavior -** evaluate changes in students' behavior, based on the training they experienced.

This is a long-term activity and we conduct our observations over time to find out if our former students put their knowledge into practice.

4. Results –not used.

Assessment

- Tests show that the course, developed and applied within the framework of the virtual research and learning laboratory, is an effective way to familiarize students with the actual situation in climate science and promote the use of modern information and communication tools.

- Using computational-information web-GIS "Climate", future professionals acquire practical skills of processing and analysis of observational data, which significantly increase their competence and give them a competitive advantage in future employment at both national and international levels.

- In addition, the skills of individual remote work are practiced that are currently in demand due to the increasing number of researches conducted by large teams of researchers who are geographically distributed.

Intermediate results

- The developed courses have been used to prepare bachelors of meteorology and hydrology in Tomsk State University for two years now.
- The results received show that the proposed educational approach allows making students acquainted with the basics of actual climatic science and offers experience, increases students involvement, advances the use of modern information and communication tools. Next generation of scientists is prepared to grapple with complex climate issues.
- While passing their trainings within the virtual learning laboratory students acquire knowledge about the IPCC database, master modern methods of statistical processing of climate data, improve their understanding of the specifics of climate change in a selected region and its impact on ecosystems, and familiarize with the forecasts of possible changes in global climatic characteristics in the XXI century.

Plans

The approach is quite general and can be used in areas where the work with georeferenced environmental data is needed.
"Climate" can be further developed by adding new training courses which can be easily shared with other universities providing nexus of international and national educational programs.

Nearest future

- computational tasks for modeling future climate on the basis of regional climate model with dynamic land surface model and global climate model CM_4 (INM RAS).

- course for students on hydrology inc. computational tasks on the basis of modern hydrological models of rivers and lakes.

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