

Web-GIS platform for monitoring and forecasting of regional climate and ecological changes

E.P. Gordov, V. Yu. Bogomolov, E. Yu. Genina, V. N. Krupchatnikov, V.N. Lykosov, Yu. V. Martynova, **I.G Okladnikov** (oig@scert.ru), A.V. Skvortsov, V.M. Stepanenko, A.G. Titov, T.M. Shulgina
 IMCES SB RAS, <http://www.imces.ru>; TB ICT SB RAS; SCERT, <http://scert.ru>; INM RAS, <http://www.inm.ras.ru>;
 TSU, <http://www.tsu.ru>; Siberian Regional Research Institute of Hydrometeorology, <http://sibnigmi.ru>



Experimental software and hardware platform "CLIMATE" providing operation of a web-oriented production and research center for regional climate change investigations which combines modern web 2.0 approach, GIS-functionality and capabilities of running climate and meteorological models, large geophysical datasets processing, visualization, joint software development by distributed research groups, scientific analysis and organization of students and post-graduate students education is presented.

Platform developed provides users with capabilities of heterogeneous geophysical data analysis, including high-resolution data, and discovering of tendencies in climatic and ecosystem changes in the framework of different multidisciplinary researches.

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Introduction

Creation of the software infrastructure based on modern information-telecommunication technologies is an important task for information support of integrated scientific researches in the area of Earth sciences, particularly for complex usage of initially heterogeneous geospatial datasets describing meteorological parameters dynamics.

In the process of development of specialized Web-GIS platform for monitoring and forecasting of regional climate changes according to the concept of geoportal of local spatial data infrastructure (SDI) an approach based on combined usage of web- and GIS-technologies that allows integrating various technological solutions for organizing and processing such information resources was used.

To implement the required software infrastructure of Web-GIS platform an architecture representing a set of basic components and corresponding interconnections has been developed. It includes:

- Structured archives of geospatial data along with corresponding metadata;
- Modular computational kernel (implemented in GDL/Python) residing on high-performance computational server, managing applied processing modules and providing command-line interface;
- Specialized web portal implementing web application logic as well as interconnections with cartographical web-services, computational kernel modules, dataset storage and climate models;
- Graphical user interface run within the framework of conventional web-browser (Mozilla Firefox, Internet Explorer, etc) and providing web mapping functionality
- Climate models **WRF** and **Planet Simulator** integrated into the platform environment
- Built-in into the platform information infrastructure providing coordination and communication of distributed research groups of specialists including forums, blogs, wiki, joint software development utilities.

Datasets

At present the following geospatial datasets are deployed at the data server and available for processing by the platform computational kernel: NCEP/NCAR reanalyses, JRA-25, ERA-40, ERA Interim, NOAA-CIRES. There are also some data archives obtained as results of climate modeling (Planet Simulator, WRF), remote sensing data archives (Landsat 4-7, Global Land Survey and MODIS) as well as meteorological station observations (GSN 9092c dataset).

Web-GIS platform

Thus, experimental software and hardware platform (Fig. 1) providing operation of a web-oriented production and research center for regional climate change investigations which combines modern web 2.0 approach, GIS-functionality and capabilities of running climate and meteorological models, large geophysical datasets processing, visualization, joint software development by distributed research groups, scientific analysis and organization of students and post-graduate students education is presented.

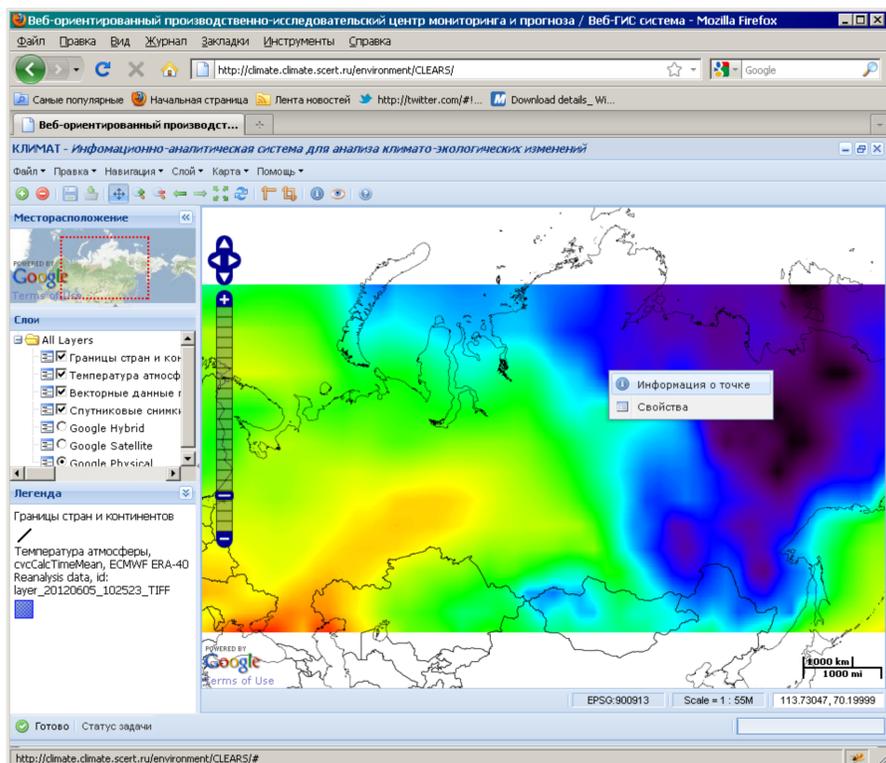


Fig. 1. Web-GIS platform user interface

Application results: selection of reliable datasets for climate change study

In this investigation the accuracy of reanalyses data describing atmosphere temperature over Siberia was assessed against observational data using Web-GIS platform computational modules. Data comparison technique include:

- 1) Interpolation methods (Bilinear, third-order polynomial, inverse distance weighted, modified Shepard's method, kriging method)
- 2) Data comparison (Mean error (ME) and root mean-square error (RMSE), Correlation coefficient, Chi-square and Wilcoxon homogeneity criteria)

Fig. 2. Seasonal mean air temperature (°C) averaged by latitude. 1979-2000.

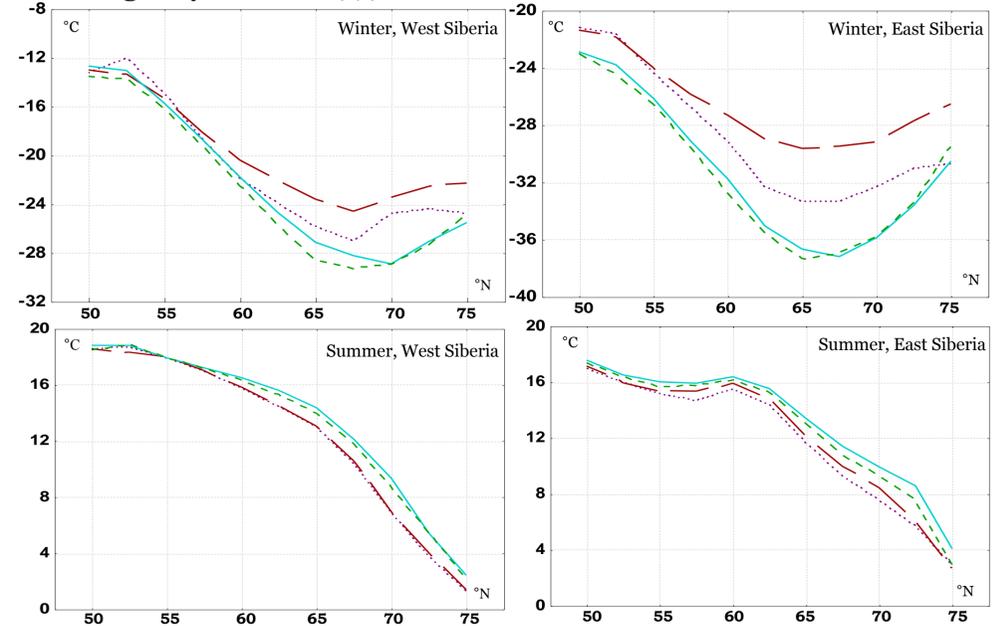
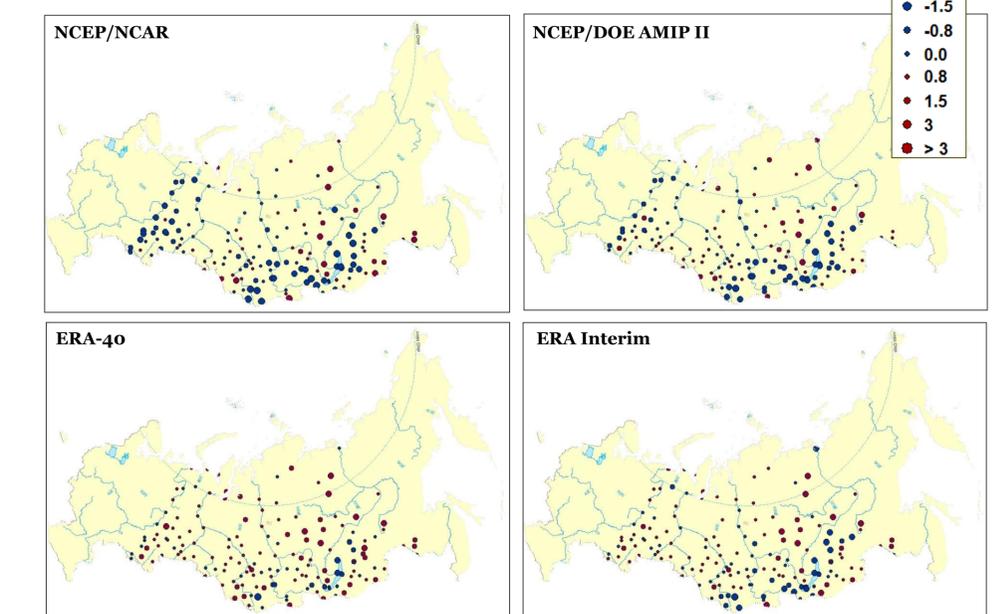


Fig. 3. Difference of annual mean temperature based on reanalyses data and station observations. 1979 – 2000.



Using the Shepard's interpolation method as the most appropriate one meteorological values from the reanalysis datasets were reconstructed at the meteorological station coordinates. Thus, the series of in-situ data and interpolated reanalysis data for each station were obtained.

Comparison of air temperatures from reanalysis datasets and selected 164 observational series has shown that data values based on ECMWF ERA Interim dataset are in a good agreement with the observations for annual mean temperature values. The statistically significant differences in compared data are revealed only for the stations located on Baikal mountain ranges (up to 1.5 °C).

Conclusion

Platform developed provides users with capabilities of heterogeneous geophysical data analysis, including high-resolution data, and discovering of tendencies in climatic and ecosystem changes in the framework of different multidisciplinary researches. Using it even unskilled user without specific knowledge can perform computational processing and visualization of large meteorological, climatological and satellite monitoring datasets through unified graphical web-interface.