Information-computational platform for collaborative multidisciplinary investigations of regional climatic changes and their impacts

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Recently developed experimental software and hardware platform Climate (http://climate.scert.ru/) providing environment for regional climate change related investigations is presented. The platform combines modern web 2.0 approach, GIS-functionality and capabilities to run climate and meteorological models, process large geophysical datasets and support relevant analysis. It also supports joint software development by distributed research groups, and organization of thematic education for students and post-graduate students.

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

Experimental software and hardware Climate platform (Fig. 1) providing operation of a web-oriented production and research center for regional climate change investigations 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.
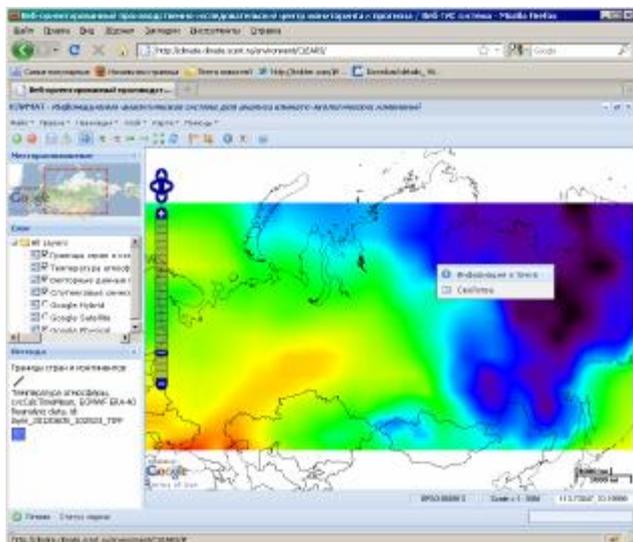

Fig. 1. Web-GIS platform user interface

Usage of the system: Investigation of ongoing dynamics of surface temperature and precipitation over Siberia

In this investigation general and extreme dynamics of surface temperature and precipitation in the region was analyzed by linear trend values for the following climatic characteristics:
1) annual and seasonal means, grows season length, sum of growing degree days, precipitation totals warm period of a year (May-October);
2) Count of days with daily minimum (maximum) temperature less (greater) than 10th (90th) percentile, calculated for 5-day window centered on each calendar day of the investigated season in the basic period 1961-1990. Percentile values for the basic period was calculated based on ERA-40 Reanalysis.

Trend of (a) Growth season length (days/10 years, ERA Interim data, 1979-2007) and (b) precipitation totals (mm/10 years, APHRODITE JMA data, May-October, 1979-2007).
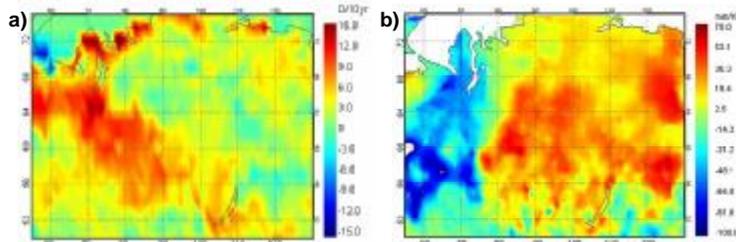
Trend of count of days with (c) daily minimum temperature less than 10th percentile (cold nights, Spring), (d) daily maximum temperature less than 10th percentile (cold day-times, Autumn), (e) daily minimum temperature greater than 90th percentile (warm nights, Spring) and (f) daily maximum temperature greater than 90th percentile (warm day-times, Summer), 1991-2010, Days/10 years. ERA Interim data.
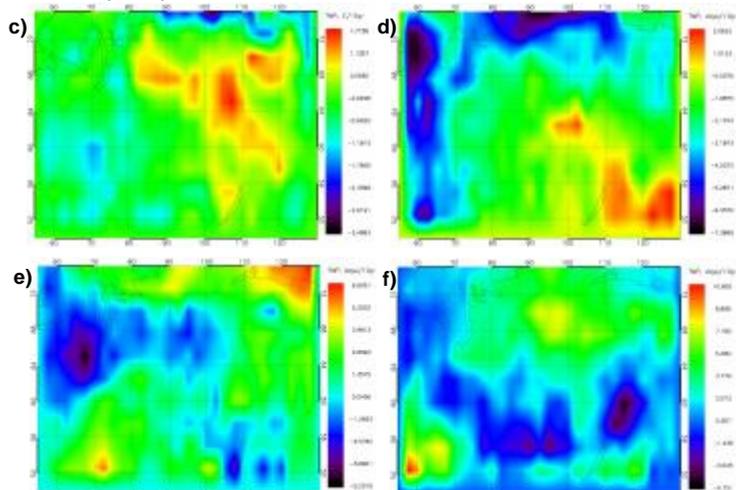
Observed positive trends of growing season length (up to 6 days/10 years) and precipitation totals (up to 36 mm/10 years, warm period of a year) over East Siberia can influence vegetation cover dynamics.

Last decades max-min daily temperature dynamics in compared with its dynamics over the basic period (1961-1990) have shown weak decrease of cold nights count during spring and slight increase of warm day-times over the southern area of West Siberia (up to 4 days/10 years). At the same time the count of autumn cold day-times have reduced over this area.

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.