

**Development of a technique for regional climate probabilistic projections over the territory of Russia aimed at building scenarios of climate impacts on economy sectors. Part 1: Task definition and numerical experiments.** Kattsov V. M., Shkolnik I. M., Efimov S. V., Konstantinov A. V., Pavlova V. N., Pavlova T. V., Khlebnikova E. I., Pikaleva A. A., Baidin A. V., Borisenko V. A. . Proceedings of MGO. 2016. V. 583. P. 7–29.

As the first stage of a multipurpose research of current and projected climate changes over the territory of Russia and corresponding impacts on conditions of the economic activity and development perspectives of major economy sectors, a task is set of detailed quantification of the projections in the geographical and probability spaces. A solution of this task can be achieved through massive ensemble simulations using high-resolution system of climate and climate impact models. The central component of the system is the MGO regional climate model providing the full coverage of the territory of Russia with the 25-km horizontal resolution and using as boundary conditions results of ensemble simulations with MGO atmospheric general circulation model for different distributions of sea surface temperature and sea ice. As a result of the simulations detailed quantitative projections are obtained. The most important of them, from the view point of the objectives of this study, are projections of indices characterizing the climate system extremity.

*Key words:* climate change, regional climate model, ensemble, climate system extremity.

Fig.7. Ref. 11.

**Assessment of the efficiency of semi-lagrangian and eulerian approaches to the moisture advection calculation in an atmospheric limited area model.** Shkolnik I. M., Efimov S. V., Zubov V. A. Proceedings of MGO. 2016. V. 583. P. 30–44.

In the framework of the MGO regional model for Russian territory (25 km resolution), the two most common methods of the advective transport (a finite-difference Eulerian and semi-Lagrangian) have been implemented and tested. As the lateral boundary conditions for the regional model, the reanalysis ERA-Interim for the period of 1990-1999 has been used. It has been shown that the use of semi-Lagrangian method leads to some reduction in moisture content differences between the model and reanalysis at the levels aloft, as compared with Eulerian model. Precipitation biases for all seasons are smaller in the semi-Lagrangian model over the most part of the region, implying the potential of using semi-Lagrangian method of moisture transport in improving the calculation of the water balance components.

*Keywords:* regional model, moisture advection, precipitation.

Tab. 1. Fig. 3. Ref. 18.

**Arctic temperature evolution: model simulation validity and near-term probabilistic prediction.** Sporyshev P. V., Kattsov V. M., Govorkova V. A. Proceedings of MGO. 2016. V. 583. P. 45–84.

Ensemble simulations are considered with state-of-the-art global climate models (CMIP5), with different external forcings on the Earth climate system. For each model ensemble, statistical correspondence is estimated of the simulated and observed surface air temperature changes in the Arctic continental subregions in the 20<sup>th</sup> – early 21<sup>st</sup> centuries – accounting for unforced variability of the climate system. Ability of the models is analyzed to reproduce temporal evolution of the Arctic temperature, as well as a spatial correspondence between the simulated and observed changes. Based on this, a near-term (2021–2040) probabilistic forecast is given of the surface air temperature change over the continental Arctic.

*Keywords:* climate change in Arctic, climate modeling, the CMIP5 global climate model ensemble, probabilistic climate prediction.

Tab. 8. Fig. 11. Ref. 13.

**Model estimation of the ecological loading sensitivity to climate changes over the territory of Russia.** Genikhovich E., Gracheva I., Rumyantsev D., Yakovleva E., Kattsov V., Shkolnik I., Efimov S. Proceedings of MGO. 2016. V. 583. P. 85–98.

A methodology is developed of estimating the ecological loading over the territory of Russia due to deposition of atmospheric pollutants emitted into the atmosphere from anthropogenic sources. Results are demonstrated of calculations of the deposition fields under different climate conditions. Possible climate changes over the Northern Eurasia in the first half of the 21<sup>st</sup> century were estimated using the MGO Regional Climate Model (MGO RCM) with the horizontal resolution of 25 km. The ecological loading was characterized using the total (dry plus wet) deposition of pollutants on the underlying surface. The deposition was calculated using the MGO Source-Receptor Model (MGO SRM). The results of climate simulations were used as an input to MGO SRM. Calculations of the acid deposition of sulfur and nitrogen compounds in 1990–1999 and 2050–2059 were carried out using the anthropogenic emissions over the territory of Russia for the period of 1990–1999. Spatial distribution of those depositions and their sensitivity to possible climate changes were estimated. In particular, it was shown that possible climate changes in the first half of the 21<sup>st</sup> century could result in approximately 10% increase in the total deposition of atmospheric pollutants.

*Key words:* climate changes, pollutant, ecological loading, underlying surface, deposition, sensitivity

Fig. 4. Ref. 18.

**On development of the methodology of setting the emission standards limiting the anthropogenic impact on the environment.** Rummyantsev D., Gracheva I., Yakovleva E., Genikhovich E. Proceedings of MGO. 2016. V. 583. P. 99–111.

The general methodology of setting the emission standards for atmospheric pollutants is developed, which is aimed to limiting the anthropogenic impact on the environment. The last one is characterized by the fluxes (deposition) of pollutants on the underlying surface. It is shown that the mathematical formalism to be used for setting these standards resembles the one, which is in use in Russia for establishing the maximum permissible emissions (MPE) aimed to limiting concentrations of atmospheric pollutants. The examples of the cost functions are given in this paper, which could be used for determining the emission standard from solution of the optimizing problems.

*Key words:* emission standard, pollutant, maximum permissible emission (MPE), deposition, underlying surface, critical loading, transportation problem, cost function

Ref. 14.

**Observed climate change and dynamic of agroclimatic resources in 20<sup>th</sup>–21<sup>st</sup> centuries in the territory of Volga federal district.** Pavlova V. N., Karachenkova A. A. Proceedings of MGO. 2016. V. 583. P. 112–128.

The authors analyse trends of real productivity of main grain crops in Volga federal district in the period 1986–2015. Assessments of linear trends turn out to be positive in the major part of the territory. Maximum linear trend-based depression reaches 40%. Indicators of climate change are presented via a system of indexes characterizing heat and water supply in the territory. It is shown that the rate of growth of heat resources has decreased in last two decades yet is still positive. Map-schemes of zones with unfavorable agrometeorological events "draught" and "water logging" are provided for the territory of Volga federal district.

*Keywords:* climate change, agroclimatic resources, heat and water supply, grain crops productivity, bioclimatic potential, hazards.

Tab. 3. Fig. 5. Ref. 14.

**Forecast experiments based on MGO coupled ocean-atmosphere model.** Mirvis V. M., Meleshko V. P., Lvova T. Yu., Matyugin V. A., Baidin A. V. Proceedings of MGO. 2016. V. 583. P. 129–148.

The first results of the use of coupled ocean-atmosphere model created in MGO for the purposes of meteorological seasonal forecasting are considered. MGO atmospheric global circulation model (version T42L25) combined with the ocean circulation model INM RAS (INMCM4). A data set of atmosphere and ocean reanalysis for a 22-year period (1981-2002) is used as a basis for calculating the archive of historical forecasts for up to 4 months for all seasons. The skill comparison of coupled model (CM) forecast and forecast based on the atmospheric global model with different setting options of boundary conditions for ocean surface temperature is presented. It is shown that the use of developed coupled ocean-atmosphere model in most cases can improve the skills of forecasts for the season including on Russian territory.

*Keywords:* coupled ocean-atmosphere model, seasonal forecasts, skills of hindcasts

Tabl. 2. Fig. 5. Ref. 11.

**Weighted cubic and bicubic splines in hydrological and meteorological problems.** Petrova A. V., Vager B. G. Proceedings of MGO. 2016. V. 583. P. 149–161.

In this article we consider one of the algorithms for constructing the weighted cubic and bicubic splines, which preserve the properties of convexity of the interpolating function in any data grid segment. We also describe a software application which was developed in the framework of the task – to solve interpolation problems by means of weighted cubic and bicubic splines. The application allows user to choose weighting parameters using the GUI. As an example of practical use of the weighted cubic and bicubic spline, the problems of hydrometeorological data interpolation are considered.

The analysis of using of the weighted splines as an interpolating instrument in the problems of hydrology and meteorology shows that in almost all cases considered the weighted spline can give more efficient results than other interpolation methods.

*Keywords:* interpolation, weighted cubic spline, weighted bicubic spline, weighting parameters, convexity, C#.

Tab. 2. Fig. 4. Ref. 6.

**Influence of aerosol particles on the electrical state of the surface layer.** Morozov V. N. Proceeding MGO. 2016. V. 583. P. 162–181.

On the basis of a one-dimensional, steady-state model of the turbulent surface of the electrode layer, the problem of the influence of aerosol particles of submicron diapason on the distribution of the concentration of light ions and the electric field depending on the height above the Earth's surface. Analytical solutions for stable and neutral stratification of the surface layer are obtained on which the numerical calculations presented in the tables. These theoretical results can be used for the interpretation of the observational data obtained at the atmospheric-electric stations of Roshydromet.

*Keywords:* aerosol particles, surface layer, concentration of light ions, electrical field.

Tabl. 5. Ref. 24.

**An estimate of air-sea gas exchange through the sea ice.** Bortkovski R. S. Proceedings of MGO. 2016. Vol. 583. P. 182–196.

From the ice formed at freezing of fresh water the sea ice differs by presence of many pores which are filled or by brain or by air. Gas permeability of pores significantly exceeds the gas permeability of compact ice having no pores. Expressions, which determine coefficients of oxygen and CO<sub>2</sub> diffusion through sea ice with known temperature and salinity are obtained. Calculations of gas transfer in the Chukchi sea central part are fulfilled. Numerical experiments have shown that gas fluxes through thin ice aren't negligible small. They decrease noticeable only when one-year old ice thickness gets over about 100 cm.

*Key words:* sea ice gas permeability, porosity, brain

Tab. 1. Fig. 2. Ref. 28.

**The method of determining a typical concentration of contaminants in precipitation (according to the chemical precipitation data of stations in St. Petersburg and Voeikovo).** Semenets E. C. Proceedings of MGO. 2016. V. 583. P. 197–208.

For the first time the concept of "typical" concentrations of contaminants in precipitation is introduced. The typical concentration determines the relative level of atmospheric precipitation pollution, influenced by local pollution sources and represents the level at which it is possible to estimate the degree of atmospheric precipitation pollution at the station.

The method of calculating the typical concentration of contaminants in precipitation are presented.

*Keywords:* precipitation, chemical precipitation composition, typical concentration.

Tab. 4 Ref. 10.

**Aethalometer AE-33 use in atmospheric aerosol's research.** Uspensky A. A., Makhotkin A.N., Volberg N. Sh., Stepanov A. V. Proceedings of MGO, 2016. V. 583. P. 209–226.

This article deals with instrumental methods for analysis of carbonaceous and total atmospheric aerosols. Obviously, especially in recent time, researchers showed the impacts of aerosol's pollution on human health and biosphere in general. Furthermore, climate changes take place due to presence in atmosphere such compounds as carbon dioxide, methane and black carbon. The main purpose of this work was to show the correlation between total atmospheric and black carbon aerosol, comparison the contents of organic compounds in carbonaceous aerosol in different periods throughout the year. Also we conclude that black carbon concentration depends on traffic's intensity. We use Aethalometer Ae-33, based on the method of optical attenuation in different wavelengths and aerosol monitor Dusttrack 8533.

*Keywords:* black carbon, aethalometer, absorption, organic carbon, particulate matter.

Fig. 10. Ref. 35.

**Method and instrument for direct measurement of effective radiation divergence in atmosphere surface layer.** Eliseev A. A., Mayboroda L. A. Proceedings of MGO. 2016. V. 583. P. 227–250.

A method and original technique of optical-acoustic type that, for the first time, allowing direct measurements for the divergence of the longwave radiation flux at levels of 0.1; 0.5; 2; 6 meters. Measured in the summer time in the surface layer of the atmosphere with a resolution of 5 cm. Description of receiver, laboratory studies, numerical experiments, including line by line absorption calculation. The methodology of calibration, problems, estimation errors and prospects for the development of the method of direct measurement of heat flux divergence describes.

*Keywords:* Surface layer, heat balance, opto-acoustic measurement, radiation flux divergence.

Fig. 4. Ref. 33.

**Comparing of the data of terrestrial and satellite monitoring for aerosol optical thickness of the atmosphere over Russia.** Pankratova N. A., Plakhina I. N., Makhotkin A. N. Proceedings of MGO. 2016. V. 583. P. 251–264.

The first stage of the aerosol optical thickness of the atmosphere (AOT) combined archive of daily values is formed on the basis of inventory and synchronization data of AERONET network, terrestrial solar radiation observations on the territory of Russia and Terra satellite. Differences of AOT values obtained by the various supervisory systems have been estimated.

*Keywords:* AOT, aerosol, actinometrical observations, satellite monitoring.

Tabl. 2. Fig. 5. Ref. 26.