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Modern Challenges of Ecological Meteorology and Climatology

*Special Composite Book
Dedicated to 85th Anniversary of*

Academician

**Mikhail Ivanovich
BUDYKO**

(1920-2001)

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Academician M. I. BUDYKO

Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85 Anniversary of Academician Mikhail Ivanovich Budyko (1920-2001). – Saint Petersburg, INENCO Center of RAS, “NAUKA”, 2005. 247p.

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The composite book contains the papers prepared by leading experts of St.Petersburg scientific establishments of Russian Academy of Sciences, Federal Hydrometeorological Service and St.Petersburg University et 85th Anniversary of the first Russian climatologist of XX century academician M.I.Budyko (1920-2001). The topic of the papers including to this composite book is given over to ecological problems of modern meteorology and climatology and cover of the M.I.Budyko’s scientific avocations. Issuing of this collective book its authors continue the series of publications, which is begun in 2002 by the monograph “Climate Changes ant its Consequences” dedicated to the memory of this excellent scientist.

The book is intended for a wide range of the scientists engaged in questions of climate changes, experts in ecological hydrometeorology and climatology, as well as for decision support makers interested by climatic substantiation of the long-term social - economic prospects.

Editor-in-Chief
Prof. G. V. MENZHULIN

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A b s t r a c t s

Budyko M.I. Climate and Biosphere. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.9-24.

In this paper recomposed by the editor using of academician M.I.Budyko's last publications in popular-science journals and books, the problems of climate changes influence on the Earth's biosphere and Human is offered in the accessible for wide range readers statement. The editor believes that in the last years in connection of public interest growth to the problems of climate changes the popular statement of M.I.Budyko's scientific ideas will be reasonably useful for that group of the readers, which by virtue of different circumstances have not opportunities to address to the special publications or, working in other scientific fields, yet have not made the complete opinion on these problems. Academician M.I.Budyko being the leading climatologist of the last century had as a well a considerable talent of the popular writer, therefore his own statement of modern problems of global climatology and ecology can represent the apparent interest.

Meleshko V.P., Kattsov V.M., Govorkova V.F., Malevsky-Malevich S.P., Nadezhina E.D., Sporyshev P.V. Anthropogenic Climate Changes in Eurasia in XXI Century. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.25-54.

Projection of climate changes due to anthropogenic forcing is considered in XXI century over Northern Eurasia. Evaluation was undertaken from runs of an ensemble of the coupled ocean-atmosphere climate models for IPCC A2 and B2 scenarios. Analysis was made for major watersheds of Russia and adjacent regions. The changes of surface thermal regimes and hydrological characteristics for mid and end of the XXI century are discussed. The changes of permafrost and sea-ice extent in Arctic Ocean are also considered.

This research has been supported by Russian Federal Target Programme «World Ocean» and Russian Foundation of Fundamental Researches, projects N 02-05-65242, 02-05-64929, 03-05-64955, 03-05-65200, 03-05-64764, NSH-1845.2003.5.

Menzhulin G.V., Shamsurin V.I., Savvateyev S.P. On the Accuracy of Model Climate Changes Scenarios IPCC Recommended for Global Warming Impacts Assessments. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.55-85.

The estimates of reproduction accuracy for climatic normals of monthly mean surface air temperature and the sum of atmospheric precipitation over the Former Soviet Union territory by seven general circulation of atmosphere and ocean model used for climatic scenarios development presented in the third IPCC Report are received. The rating parameters for each tested model describing their position in the line of comparison their results on the one hand and the empirical data calculated using the actual meteorological information on the other hand are designed.

Paper contains the results of investigations supported by US Civil Research and Development Foundation (CRDF) project N RU-G1-2606-ST-04).

Shkolnik I.M., Meleshko V.P., Gavrilina V.M. The Characteristics of Heat-and-Water Balance over the European Russia Calculated Using the Regional Climate Model of the Main Geophysical Observatory. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.86-101.

Present-day regional climate simulation over Russia has been validated using Main Geophysical Observatory (MGO) Regional Climate Model (RCM) with 50 km horizontal resolution. Two six year climate simulations have been performed using different types of lateral boundary conditions derived from NCEP/NCAR reanalysis and MGO global climate model (GCM) simulation for the time slice from 1982 to 1987. All the simulations included observed distributions of SST and sea ice concentrations. It has been shown the skill of the RCM to reproduce, surface temperature and precipitation distributions depend on the errors in the large-scale circulations produced by the driving global model. As compared against RCM driven by GCM, the regional model driven by the reanalysis produces seasonalities of surface air

temperature and precipitation closer to that observed over large terrestrial watersheds. The RCM tends to undersimulate the observed runoff over the watersheds. The modeled inter-annual and intra-annual variations of monthly mean temperature and precipitation are in agreement with observations suggesting a reasonable response of the RCM to mesoscale forcings.

Research has been supported by Russian Foundation of Fundamental Researches, projects N 02-05-64929 and 01-05-64902.

Kiselyev A.A., Karol I.L. Possible Climate Change Consequences of Methane Release under Russian Permafrost Melting. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS.SPb, "NAUKA", 2005, p.102-113.

The changes of tropospheric composition within the northern moderate belt because of possible additional methane emission due to permafrost thawing are considered. The estimations of methane various background current source intensities in above belt are indicated and discussed previously. The Russian contribution of these sources is considered separately.

Paper includes the results obtained in the researches supported by Russian Foundation of Fundamental Researches, projects N 02-05-65399 и NSH-1845.2003.05.

Anisimov O.A., Lavrov S.A., Renyeva S.A. Assessments of Greenhouse Gases Emission from Frozen Bogs of Russian Permafrost Area under Global Warming. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS.SPb, "NAUKA", 2005, p.114-138.

Decomposition of the organic material under warmer climatic conditions will lead to the enhanced release of soil carbon to the atmosphere in the form of either CO₂ (typical for dry soils with high ventilation), or CH₄ (typical for wetlands where decomposition takes place under anaerobic conditions). The goal of this paper is to calculate the changes in the volume of seasonal thawing of organic material in the Arctic wetlands of Russia and to evaluate associated with these changes release of CH₄ under the predicted for the future climatic conditions. We have developed model of the processes leading to methane emission from peatland. The model simulates process of CH₄ oxidation (methanotrophy) as well as CH₄ production (methanogenesis) and the transport of the gas from the soil and through plant to the atmosphere. Fluxes of methane between soils and the atmosphere depend on temperature, water table and thaw depth. More detailed studies are necessary to better understand future changes in the hydrological conditions that control the balance between the CO₂ and CH₄ emissions from the Arctic wetlands.

Paper includes the results obtained in the researches supported by Russian Foundation of Fundamental Researches, project N 04-05-64488, and by Dutch—Russian Project RFFR—NWO N 047.011.2001.003.

Borzenkova I.I., Zhiltsova E.L., Lobanov V.F. Rapid Climatic Variations in the Late Glacial – Holocene. Analysis of Empirical Data and Possible Causes. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.139-151.

High - resolution empirical records (pollen, marine, ice-core and tree-ring) at a scale from several decades to several centuries allow to reveal about 30 global climatic events (warmings and coolings) during the last 18 kiloyears. The most interest from them is the rapid climatic fluctuations in time interval from 14.5 to 9.0 kiloyears B.P. Throughout this time there were at least three time intervals during which the rate of global temperature changes are comparable with that of present time (about 1.0-1.5 °C/100 years). The first considerable warming event is dated about 12.7-11.9 kiloyears (¹⁴C data) or 14.67 kiloyears B.P. Most interesting of these events is the transition from the strong cooling spell (the Younger Dryas) to the Early Holocene warming when the air temperature increased on 5 -7 °C in high latitudes in several decades only. Ice-core data shows that the carbon dioxide and methane concentrations rapidly changed during about one century. Analysis of the empirical data characterized the tome boundary between the Younger Dryas and the Early Holocene allows to solve some important problems. These problems include the questions how rapidly the terrestrial and marine biota changed, the vegetation areas and vegetation zones shifted, and how the ancient human reacted on these rapid warmings?

Paper includes the results obtained in the researches supported by the Russian Foundation of Fundamental Researches, project N 04-05-65140, and by the Dutch - Russian Project RFFR-NOW N 047.011.2001.003.

Lobanov V.A., Anisimov O.A. Empirical - Statistical Modeling of Temporal and Spatial Changes of Meteorological Characteristics. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.152-169.

In the paper the seasonal and interannual variations of the air temperature are approximated by the numerical function, which is further used for climatic regionalization over the territory of Europe. Century-scale time series from "GeoInf" database are used to calculate the mean monthly air temperature and parameters of the seasonal function for 118 locations. Parameters of the seasonal function are used as criteria for the delineation of regions with similar signal of climatic change. Climatic regionalization is compared with the results derived from conventional methods based on spatial and temporal averaging.

Paper includes the results obtained in the researches supported by Russian Foundation of Fundamental Researches, projects N 04-05-64488, 04-05-65241, and by the Dutch—Russian Project RFFR—NWO N047.011.2001.003.

Efimova N.A., Zhiltsova E.L., Lemeshko N.A., Strokina L.A. Regional Changes of Surface Air Temperature in 1981-2000 over Northern Hemisphere Continents by Comparison with Paleoanalogs of Global Warming. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.170-176.

The main features of regional climate changes in all seasons of 1990's characterized by the record increasing of global mean annual surface temperature are analyzed. The results obtained are compared with the same characteristics for winter, spring and autumn seasons of 1980's. It was shown that in both decades compared the most significant changes of surface temperature are occurred in the same geographical regions. At this takes place in 1990's the positive temperature anomalies increased and the areas of this increasing expanded. The estimates of climatic parameters changes in 1981-2000 were collated with the paleoanalogs of modern warming. The conclusion was obtained that the estimates for winter temperature increasing for large Eurasian and North American areas calculated by two independent techniques be almost equal.

Research was partly carried out with financial support by Russian Foundation of Fundamental Researches, project N 02-05-65249-a.

Mirvis V.M. On the Frost - Free Season Changes over Russia and Neighbor Countries in XX Century. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.177-187.

The changes of the frost-free period defined as a time-stage inside the warm season of the year during that the mean air temperature is above 5 °C in XX century are analyzed. It was shown that on the background of warm season increase in many regions the tendencies to frost-free stage rising not manifested. This situation has the extremely negative consequences concerned with crops affection by frosts in the active vegetation phase period in the flowering time as well as when harvesting.

Sogachev A.F., Menzhulin G.V., Sogacheva L.M. Investigation of the Sources - Sinks Inputs to Scalar Substance Concentration Using the Three Dimensional Non-stationary Model of Energy and Matter Transport in "Vegetation - Atmospheric Boundary Layer" System: "Footprint" Problem. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.188-206.

The question of interpretation of instrumental measurements information of the scalars substances exchange (heat, water vapor, carbon dioxide) in non-uniform vegetation in the case of non-stationary turbulent air flow in it interleaf space and in atmospheric boundary layer is discussed. The technique of the "footprint" problem solution for the calculation of the contribution of scalar substances sources (or sinks) distributed in the phytocenosis to the total signal registered by differently located sensors is offered. The 3D-model of energy-matter transport and turbulence in "vegetation – atmospheric boundary layer" system, earlier developed by the authors, is applied to its decision. In numerical experiments with the model, which has been carried out using the technique of "sources switching-off" in consecutive model cells of vegetation space, the features of the "footprint" function for various sensor positions as well as for different weather conditions and vegetation structure are analyzed.

Poluektov R.A., Topazh A.G. Using Crop Productivity Models in Agrometeorological Forecasting. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.207-217.

The new method for developing applied agrometeorological forecasts of crop productivity was proposed. It is grounded on application of dynamic computer models of agroecosystem and stochastic generator of simulated weather scenarios. The cornerstone of the approach is the fitting of effective integral curve of weather favorableness to final yield for the considered vegetation season. Dynamical character of the forecast allows taking into account the temporal distribution of important meteorological factors during crop life cycle. The latter must increase significantly the precision of corresponding agronomic predictions.

Paper includes the results obtained in the researches supported by the Russian Foundation of Fundamental Researches (Project #04-05-64980).

Shiklomanov I.A., Georgiyevsky V.Yu., Shalygin A.L. Climate Change Impact on the Water Runoff in Lena River Basin. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.218-231.

The results of special assessments of climate changes impacts on water resources and hydrological regime of Lena river basin are discussed. The modern tendencies in the changes of air temperature and atmospheric precipitation as well as the annual and seasonal runoff in Lena river basin in context of expected global warming are discussed. The possible development of existing methodological approaches are proposed.

Paper includes the results obtained in the researches supported by Russian Foundation of Fundamental Researches, project N 04-05-65241a.

Kobak K.I., Kondrashova N.Yu., Toropova A.A. Russian Forest Biomass Changes in the Last Decades and Their Possible Correlation with Climatic Variations. Modern Challenges of Ecological Meteorology and Climatology. Special Composite Book Dedicated to 85th Anniversary of Academician M.I.Budyko. (Ed. G.V.Menzhulin). INENCO Center of RAS. SPb, "NAUKA", 2005, p.232-244.

The Russian forest biomass changes in 1961-1998 were analyzed using forest inventory data. During this period the areas covered by forests increased by 8-10%, but their biomass decreased about 1.5% (the coniferous forests mostly). The results obtained did not confirm a large carbon net-sink in Russian forests. Some regions, for example, Northwestern European Russia area characterized with small atmospheric carbon sink caused by some air temperature and precipitation increase and forests exploitation decrease.