

MIS003-01

会場:104

時間:5月26日 14:15-14:40

International studies in the East-Siberian Arctic Shelf during the last eleven years (1999-2010): An overview

International studies in the East-Siberian Arctic Shelf during the last eleven years (1999-2010): An overview

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The Arctic Ocean is surrounded by permafrost, which is being degraded at an increasing rate under conditions of warming which are most pronounced in Siberia and Alaska. A major constraint on our ability to understand linkages between the Arctic Ocean and the global climate system is the scarcity of observational data in the Siberian Arctic marginal seas where major fresh water input and terrestrial CNP fluxes exist. The East-Siberian Sea Arctic Shelf (ESAS) has never been investigated by modern techniques despite the progress that has been made in new technologies useful for measuring ocean characteristics of interest. In this multi-year international project which joins scientists from 3 nations (Russia-USA-Sweden), and in cooperation with scientists from other countries (UK, Netherlands), we focus on the ESAS which is a poorly explored area located west from the U.S.-Russia boundary. In this report we overview the main field activities and present some results obtained during the last eleven years (1999-2010).

Siberian freshwater discharge to the Arctic Ocean is expected to increase with increasing temperatures, potentially resulting in greater river export of old terrigenous organic carbon to the ocean. Our working hypothesis was that rivers integrate the variability in the components of the hydrometeorological regime, including soil conditions, permafrost seasonal thaw, and thermokarst development. All these variables determine atmospheric and ground water supply into the rivers and chemical weathering in their watershed. We found that 1) carbon dioxide and methane fluxes are significant (and non-accounted) components of the carbon cycling in the Arctic Ocean; 2) transport of eroded terrestrial material plays a major role in the accumulation of carbon in the ESAS; 3) the seabed is a major CH₄ source over the ESAS; 4) eroded carbon is biodegradable; 5) oxidation of eroded carbon onshore and offshore is a strong source of carbon dioxide. Thus, studying carbon cycling in the East Siberian Arctic shelf seas has a high scientific priority for quantification of the regional carbon budget and evaluation of the role of the Arctic in the global carbon cycling. These studies in the coastal zone are of a special importance, because there the characteristics of carbon exchange with atmosphere are not yet known and a redistribution of carbon between terrestrial and marine environments occurs. Initial scientific plan for the next decade will be presented.

Our studies have been supported by the Russian Foundation for Basic Research (since 1994), International (Soros) Scientific Foundation, ISF (1994-1995), Russian Government and ISF (1995), McArthur Foundation (2000-2001), Far Eastern Branch of the Russian Academy of Sciences (since 2003), International Arctic Research Center (since 2001), NSF (since 2003), NOAA (since 2005), Stockholm University (since 2007), and Wallenberg Foundation (since 2008).

キーワード: Arctic Ocean Shelf, carbon cycle, permafrost thaw, methane, East Siberia

Keywords: Arctic Ocean Shelf, carbon cycle, permafrost thaw, methane, East Siberia

MIS003-02

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Methane emission observations and inventory for West Siberian mires Methane emission observations and inventory for West Siberian mires

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West Siberia is one of the most paludified regions in the world with the mire area of 68.5 Mha. Since the previously published estimations of the regional CH₄ flux varied widely from 2 to 22 MtCH₄yr⁻¹, long-term and large-scale investigations of CH₄ emission were established to complement existing data. About 1900 methane flux measurements were made during the summer-autumn of 2007-2010 by a static chamber method. Seasonal variation is observed at one site with automatic chambers for various micro-landscapes. All variety of wetland types was reduced to 8 micro-landscape types: palsas, peat mats, ponds, forested bogs, fens, poor fens, oligotrophic hollows and ridges. Mire micro-landscapes of 36 key sites distributed in 7 zones of West Siberia were observed. Emission data were generalized into a spatial emission model based on a fractional area coverage map of mire micro-landscapes, methane emission periods for each zone and methane flux probability density distributions for each micro-landscape type in these zones. The methane emission map with the resolution 0.5x0.5 deg was created. It was confirmed that palsas, forested bogs and ridges had the lowest methane fluxes (1st/2nd/3rd quartiles are -0.04/0/0.05 mgCH₄m⁻²h⁻¹ for palsas, 0.06/0.26/0.7 mgCH₄m⁻²h⁻¹ for forested bogs, 0.01/0.28/0.67 mgCH₄m⁻²h⁻¹ for ridges) while the peat mats and non-forested mires had the highest ones (2.05/4.1/5.89 mgCH₄m⁻²h⁻¹ for peat mats, 1.23/2.84/5.55 mgCH₄m⁻²h⁻¹ for fens combined with poor fens and oligotrophic hollows). Very high fluxes, reaching hundreds of mgCH₄ m⁻²h⁻¹, were observed in some ponds (1.44/7.85/33.84 mgCH₄m⁻²h⁻¹). The version Bc8 of the model estimates the total flux from all Western Siberia mires at 3.91 MtCH₄yr⁻¹.

キーワード: emission inventory, methane, flux map, Siberia

Keywords: emission inventory, methane, flux map, Siberia

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MIS003-03

会場:104

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Projected Change in Hydrological Extremes in China Under Climate Change Scenarios Projected Change in Hydrological Extremes in China Under Climate Change Scenarios

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Over last 40 years, China's climate has undergone noticeable changes. It is particularly evident that North China has seen a persistent decline in annual precipitation amounts. This is accompanied by increases in flooding in South China and overall temperature increase over entire China. In this paper, we look to quantify the changes in precipitation and temperature extremes in China over the past 40 years using observations and model outputs from CMIP3 data archive. We will also investigate how these changes may manifest in the 21st century under various climate change scenarios. We will employ the Bayesian multi-model ensemble methodology developed by Duan and Phillips to obtain the expected changes as well as the uncertainty estimates. The Bayesian multi-model ensemble methodology and preliminary results will be presented at this meeting.

キーワード: Climate change, hydrological extremes, Bayesian multi-model ensemble

Keywords: Climate change, hydrological extremes, Bayesian multi-model ensemble

MIS003-04

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シベリア広域積雪観測による積雪物理量データセット Data set of physical snow parameters obtained by snow surveys in Siberia

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Snowpack conditions in Siberia are sensitive to a change in a climate because Siberia faces the Arctic Ocean and is underlain by discontinuous permafrost. The snow surveys in Siberia have been carried out for clarifying the differences of snow-cover characteristics in Siberia and Alaska, for better understanding snow processes in the Arctic Climate System and for reducing the uncertainty of reliably estimating the amount of snow in the cryosphere. The traverse lines in Siberia were set to the south of Yakutsk for Neriungri and to the east of Yakutsk for Oymyakon. The snow depth using a sounding rod, the snow water equivalent using a cylindrical snow sampler with a cross-sectional area of 0.005-m², the snow surface hardness using a push gauge, the snow type and size using a snow grain size gauge, the altitude, latitude and longitude using a handy-type GPS were measured. In addition, the maximum, the minimum, and the mean of the particle size of each snow layer were recorded, and the photograph of the snow particles of each snow layer and the snowpack view is saved. It was found that the types of the upper snow layer in Siberia are composed of decomposing and fragmented precipitation particles and faceted crystals and that of the lower snow layer is typically well-developed depth hoar. The snow water equivalents in Siberia slightly increase with an increase in altitude. The increase ratio of the snow water equivalent due to altitude in the east of Yakutsk for Oymyakon is smaller than that in the south of Yakutsk for Neriungri. This presentation will describe the progress and present preliminary results of snow surveys in Siberia, including this winter. The snow surveys in Siberia are continuously planned. These continuous snow survey data will enable us to further analyze and provide the in-situ data for calibration and validation of satellite observations and climate models.

キーワード: スノーサーベイ, シベリア, 積雪深, 積雪水量, 積雪密度, 雪質

Keywords: snow survey, Siberia, snow depth, snow water equivalent, snow density, snow type

MIS003-05

会場:104

時間:5月26日 15:40-16:00

Changes in Snow Cover Characteristics over the Asian part of Russia Changes in Snow Cover Characteristics over the Asian part of Russia

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Since 1881, the annual surface air temperature in Northern Eurasia has increased by 1.5K and in the winter season by 3K. In the Northern Asia and over the interior of the continent (in Siberia) this warming has been "slightly" weaker in winter and stronger annually and in all other seasons (e.g., during the past 130 years with standard instrumental observations in Siberia, the annual and winter surface air temperatures have increased by 1.8K and 2.4K respectively). Nearby to the north in the Arctic Ocean, the late summer sea ice extent decreased by 40% exposing a near-infinite source of water vapor for the dry Arctic atmosphere in early cold season months. Both large-scale processes, global warming and the Arctic sea ice retreat, substantially affected the cold season climate in this part of the world. Its duration, severity and frequency of cold spells, frequency of thaws and "cyclonic" days favorable for snowfall (with negative but relatively mild temperatures) have changed in the past several decades causing changes in various snow cover characteristics over the interior regions of Eurasia, first of all over the Russian Federation east of 60E (Asian Russia). Presentation will describe the contemporary changes of these characteristics for the 1966-2010 period.

For our analyses we used the NOAA snow cover satellite monitoring data from October 1966 to 2010, a standard suite of synoptic observations that for snow cover includes snow depth, snow type, state of the ground at the meteorological site and its surroundings and the national snow survey dataset archived at the Russian Institute for Hydrometeorological Information. This dataset has routine snow surveys run throughout the cold season each decade (during the intense snowmelt, each 5 days) at all meteorological stations of the former USSR, thereafter, in Russia since 1966. Prior to 1966 snow surveys are also available but the methodology of observations had substantially changed at that year. Therefore, this analysis includes only data of stations within the Asian part of Russia (i.e., east of 60E) from 1966 to 2010. Surveys run separately along all types of environment typical for the site for 1 to 2 km, describing the current snow cover properties such as snow density, depth, water equivalent, and characteristics of snow and ice crust.

During the past several decades, the following changes in snow cover characteristics over Asian Russia have been observed: (a) in autumn the dates of the onset of snow cover have not changed noticeably despite the strong temperature increase in this season; (b) in late spring, snow cover extent has decreased over most of the region (but somewhat increased in the southeastern areas of Asian Russia); (c) in the cold season, maximum snow depth and snow water equivalent (SWE) at open areas have increased, and (d) days with winter thaw became more frequent. The snowmelt process over Asian Russia can be lengthy but even the first such melt initiates a process of snow metamorphosis on its surface changing snow albedo and generating snow crust as well as on its bottom, generating basal ice crust layer. In the Asian part of Russia, the entire process of the spring snowmelt has become shorter in duration and (taking into account a parallel rise in the maximum snow depth and snow water equivalent) more intense.

キーワード: snow cover, snow water equivalent, snow depth, Siberia, climatic change

Keywords: snow cover, snow water equivalent, snow depth, Siberia, climatic change

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MIS003-06

会場:104

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Northern Eurasia Earth Science Partnership Initiative (NEESPI): An Overview of the Current Studies in Northern Asia

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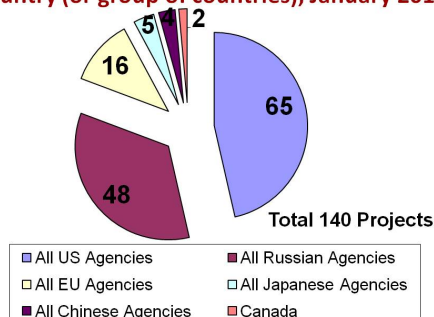
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Six years ago NEESPI was launched with the release of its Science Plan (<http://neespi.org>). Gradually, the Initiative was joined by numerous international projects launched in EU, Russia, the United States, Canada, Japan, and China. Throughout its duration, NEESPI served and is serving as an umbrella for more than 140 individual research projects (always with an international participation) with an annual budget close to 15 million US dollars (cf., Figure, where international NEESPI projects are grouped by the major national funding source). Currently, the Initiative is in full swing. A new crop of NEESPI projects was launched in 2010 to compensate for the projects that have been completed and the total number of the ongoing NEESPI projects (76) changed but slightly compared to its peak (87 in 2008). Since 2008 NEESPI has been receiving an intergovernmental level of support in Russia, the United States, and Ukraine.

The past year was extremely productive in the NEESPI outreach. In 2010, more than 100 peer-reviewed papers and/or book chapters were published or are in press (this list is still incomplete and is anticipated to nearly double). A suite of 34 peer-reviewed NEESPI articles were published in the third Special NEESPI Issue in Environmental Research Letters (ERL; 2009, No. 4, and 2010, No.1). Several books and White Papers were published by Springer (Baltzer ed., 2010; Gutman and Reissell eds., 2010), and the National Academy of Science of Ukraine (Lyalko, ed. 2010), and FAO (Matyas, ed., 2010). Two more books devoted to Siberia and Eastern Europe prepared by the members of the NEESPI team are scheduled to appear before the end of this year. Preparations have been started to complete the circle of regional monographs on Environmental Changes in the NEESPI domain with a book focusing on the dry land areas of Northern Eurasia. Submissions, reviews, and publication process for a new Special NEESPI ERL Issue "Environmental, socio-economic and climatic changes in Northern Eurasia and their feedbacks to the Global Earth System" are ongoing.

The description of the NEESPI Program will be complemented with an overview of the results presented in book "Regional Environmental Changes in Siberia and Their Global Consequences" scheduled to be submitted to Springer at the time of this Symposium.

Completed and ongoing NEESPI Projects by country (or group of countries), January 2011



キーワード: NEESPI, Northern Asia, environmental changes, climate changes, international projects
Keywords: NEESPI, Northern Asia, environmental changes, climate changes, international projects

MIS003-P01

会場: コンベンションホール

時間: 5月26日 10:30-13:00

東シベリアにおける地表面改変が領域水熱環境場に与える影響 Influence of Land Cover Change on Regional Water and Energy Field in Eastern Siberia

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IPCC 第四次報告書によると、東シベリアは将来環境変化が他地域と比較して特に大きいところと考えられている。しかし環境変化はすでに起こっており、水体面積の拡大や森林火災の増加による森林面積の減少がシベリア研究者から報告されている。気象学の立場において、地表面状態はそれを規定する地表面パラメータである地表面アルベド、蒸発効率、地表面粗度、熱容量と熱伝導率で記述することができる。地表面改変に伴って地表面パラメータ、熱収支構成要素、領域降水量が変化する。地表面蒸発散が降水量に与える影響はシベリアにおいて東へ向かうほど大きいことが報告されており、東シベリアにおける地表面改変がもたらす水熱環境への影響は大きいことが推測される。また、水蒸気の移動は地表面と大気の間で起こるため、地表面改変が水熱環境へ与える影響を明らかにするには3次元の大気モデルを用いることが望ましい。しかし、東シベリアにおいては大気モデルを用いた研究は少なく、上記の問題は未解決である。そこで、本研究はまずどの地表面パラメータが水熱環境に対して重要であるのかを明らかにし、その結果に基づいて地表面改変が東シベリアの水熱環境に与える影響を明らかにする。

どの地表面パラメータが水熱環境に対して大きな影響を持つのかを明らかにするため、5つのパラメータ(地表面アルベド、蒸発効率、地表面粗度、熱容量、熱伝導率)に対して5つあるいは6つの値を設定し、各パラメータが独立に変化した場合における水熱環境の応答を調べた。対象とした期間は2000年7月7日から17日であり、期間の選定には1986年から2004年の暖候期(6, 7, 8月)におけるステーションデータの降水量を使用して最も平均降水量に近い10日間を対象期間とした。パラメータ増分に対する潜熱フラックスおよび降水量の応答(パラメータ影響度と定義する)は、地表面アルベドと蒸発効率が支配的であり、地表面粗度、熱容量と熱伝導率のパラメータ影響度は1オーダー以上小さかった。この傾向が季節あるいは年による違いがあるかどうかを調べるため、対象期間を2000年6月、2000年8月、2001年7月、2002年8月(いずれも7日から17日)に拡張した検証も行ったが、この傾向は変わらず、地表面アルベドと蒸発効率の変動に対して潜熱フラックスと降水量が敏感に応答した。

次に、近年報告されている水体面積の拡大に対する水熱環境への変化を明らかにするため、水体を含む仮想土地データを作成して検証を行った。アラスと呼ばれる草地と水体の面積が中央シベリア低地の約20%を占めることを考慮し、標高250m以下の低地に対して(草地、水体、変化なし(=南部の多くは森林、北部は低草))=(0.2, 0.0, 0.8)の面積比から(0.1, 0.1, 0.8)、(0.0, 0.2, 0.8)への水体化を想定した地表面データを作成して数値計算を行った。その結果、水体化に伴ってレナ川流域の潜熱フラックスは1.2 W m⁻²増加し、(草地、水体、変化なし)=(0.2, 0.0, 0.8)の結果に対して2.4%の増加であった。各地表面パラメータが潜熱フラックスの造花に与えた影響を解析すると、地表面アルベドは大きなパラメータ影響度を持っていたが、水体拡大においては弱い影響であったことが明らかになった。これは水体拡大に伴う地表面パラメータの変化分が小さいことに起因していた。一方で、熱伝導率は水体拡大に伴う変化分が地表面アルベド、蒸発効率に比べ1~2桁大きかったが、パラメータ影響度が小さく、全体として支配要因とはなっていなかった。また、蒸発効率はパラメータ影響度と水体拡大に伴うパラメータ変化分の両方が大きく、水熱環境変化の主な支配要因であった。

最後に、パラメータ影響度と仮想土地利用データを用いて、近年報告されている森林面積減少と水体面積拡大によるレナ川流域における潜熱フラックスと降水量の変化を検証した。標高250m以下の低地が全て草地化した場合、領域平均した潜熱フラックスの増分は小さいが(0.1 W m⁻²)、低地における20%の草地が水体化した場合、潜熱フラックスは0.5 W m⁻²の増加を示した。これは低地が全て草地化することよりも、わずかも水体をもつ地表面へと変化したときの方が水熱環境は大きく変化することを示している。

キーワード: 東シベリア, 地表面改変, 地表面蒸発散, 降水, 熱収支

Keywords: Eastern Siberia, Land Surface Change, Evapotranspiration, Precipitation, Heatbalance

MIS003-P02

会場: コンベンションホール

時間: 5月26日 10:30-13:00

Evaluation of West Siberian wetland CH₄ emission in inverse modeling Evaluation of West Siberian wetland CH₄ emission in inverse modeling

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West Siberia contains the largest wetland area in the world with large peat deposits and the wetland area is equivalent to 27% of total area of West Siberia. Recently, Glagolev et al. (2010) published the CH₄ emission data from West Siberian wetlands at 0.5 deg resolution, using in situ measurements for each bioclimatic zone and a detailed wetland classification. Annual mean CH₄ flux from West Siberian wetlands was calculated to be 3.2 Tg/yr in the updated version of Glagolev et al. (2010) (called Bc7) with strong wetland CH₄ flux concentrated in Southern taiga. While a double magnitude of wetland CH₄ flux estimated in Bc7 inventory was calculated in GISS inventory of Fung et al. (1991) with strong wetland CH₄ flux in Northern and Middle taiga. In GISS inventory, wetland CH₄ flux was estimated by emission seasons and emission rates calculated based on the climatology of monthly surface air temperature and precipitation with the global distribution of the simplified five wetland types published in Matthews and Fung (1987).

In this study, we estimate CH₄ flux through inverse modeling for West Siberian wetlands with two different bottom-up inventories. Two airborne observations in West Siberia are used in verification for the inversed fluxes: at Surgut over wetlands in Northern taiga and at Novosibirsk near wetlands in Subtaiga. In forward simulations, the individual monthly CH₄ surface sources for each region are emitted for a single month then discontinued for the remainder of the 6-year simulation to consider the response of atmospheric CH₄, using interannually repeating OH and winds for the analysis year. The NIES transport model (Maksyutov and Inoue, 2000) simulates a total of 288 tracers for CH₄, representing a combination of 12 land regions and 12 months for two source categories.

Annual mean CH₄ flux of West Siberian wetlands is estimated to be 2.9 Tg/yr and 2.6 Tg/yr in inversions using GISS and Bc7 inventories, respectively. The inversed wetland flux well constrained is good agreement with the wetland flux in Bc7 inventory, but a large difference of the inversed flux to the wetland flux in GISS inventory. The inversed flux estimated using GISS inventory is only 45.0% of the prior flux with large decrease in June-August and it indicates the overestimated wetland flux in GISS inventory. As compared with the overestimated CH₄ concentrations in forward simulations with GISS inventory, the mismatch between observed and predicted CH₄ concentrations in inversion using GISS inventory is reduced with the decreased wetland flux by data constraint, but still higher CH₄ concentrations at Surgut than observations. Larger mismatch between observed and predicted CH₄ concentrations at Surgut is shown in inversion using GISS inventory than that for Bc7 inventory, while CH₄ concentrations closer to observations at Novosibirsk are predicted in inversion using GISS inventory. These results suggest that GISS inventory includes the overestimated wetland CH₄ flux in Northern and Middle taiga, implying that Bc7 inventory is more reasonable in the spatial distribution of West Siberian wetland CH₄ flux with stronger CH₄ flux from wetlands over Southern taiga than that for Northern and Middle taiga.

キーワード: Wetland methane emission, West Siberia, Inverse modeling

Keywords: Wetland methane emission, West Siberia, Inverse modeling

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MIS003-P03

会場: コンベンションホール

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Analysis of CH₄ and CO₂ concentrations simulated by NIES TM over Siberia Analysis of CH₄ and CO₂ concentrations simulated by NIES TM over Siberia

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¹NIES

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We simulated methane (CH₄) and carbon dioxide (CO₂) concentration using NIES (the National Institute for Environmental Studies) three-dimensional off-line Transport Model (TM). Used initial distribution, fluxes, sinks and chemical reactions are described in the Protocol for TransCom CH₄ intercomparison (Patra et al., 2010) and in the Protocol for CONTRAIL transport model intercomparison (TMI) (Niwa et al., 2008). Current version of the model (denoted as NIES-08i) is implemented on a hybrid isentropic vertical coordinate systems containing 33 levels up to a pressure level of 2 hPa and supplied with a climatological heating rate to calculate the stratospheric diabatic transport. Isentropic vertical coordinate helps to prevent extra mixing between troposphere and low stratosphere, resulting in the mean age of the air in agreement with observation and better vertical distribution simulation. Although the model phenology is driven by reanalysis data (JMA-JCDAS 6-hourly meteorology and 3-hourly planetary boundary layer height from the ECMWF Interim reanalysis (Belikov et. al., 2010)) it is reproducing seasonal cycle phase and amplitude. Tracers growth rates and tropospheric/stratospheric losses are well simulated by the model. The detailed model results analysis and intercomparisons using GLOBALVIEW-CH₄ and Siberian aircraft observation data will be shown in the meeting.

キーワード: atmospheric tracer transport modeling, carbon dioxide, methane

Keywords: atmospheric tracer transport modeling, carbon dioxide, methane

MIS003-P04

会場: コンベンションホール

時間: 5月26日 10:30-13:00

Possible new crops in southern Siberia under climate change Possible new crops in southern Siberia under climate change

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The southern portion of Siberia is a subboreal forest-steppe and steppe ecozone and is known to have high agroclimatic potential due to favorable climatic and soil resources. Potential northward forest shifts over the plains and upslope in the mountains were modeled using our Siberian bioclimatic vegetation model (SiBClim) in 2020, 2050 and 2080 coupling climate predictions from the Hadley A2 and B1 scenario projections. At the expense of forests, approximately 40% of Siberia was predicted to be covered by forest-steppe and steppe ecozones by the end of the century. Crops of food, forage, and biofuels primarily reside in steppe and forest-steppe zones in southern Siberia, and these crops are resistant to frequent droughts and the cold climate. Our goals are: 1) to evaluate ongoing climate change in southern Siberia from observed data: pre-1960; in the baseline period 1960-1990; in 1990-2010; and to predict related hot spots of potential agriculture change in the contemporary climate; 2) to predict agriculture in the future from the Hadley 2020, 2050 and 2080 climate change projections; and 3) finally, to develop a new agroclimatic zonation (agricultural regions) based on a new agroclimatic potential that may evolve as climate changes. Potential agricultural lands are modeled to appear in new forest-steppe and steppe habitats, extended and shifted northwards. A Siberian agri-crops model was developed that predicts ranges of major Siberian traditional crops (wheat, barley, vegetables, etc) and some exotic crops (melons and gourds, grapes, horticulture) currently non-existent but potentially important in a warming climate. In the model, four basic climatic constraints control crop distributions: growing degree-days and growing season length represent temperature requirements for plant growth and development, negative degree-days define winter cold tolerance, and a moisture index characterizes resistance to moisture stress. The model was applied to the pre-1960, 1960-1990, 1990-2010, 2020, 2050 and 2080 climates to predict potential distributions for both traditional and new crops in southern Central Siberia. Our analyses show that during the century traditional crops could be gradually shifted as far as 400 km northwards (about 50 km per decade) and new crops may be introduced in the very south with a significantly prolonged growing season and thus enlarged growing degree-days which may necessitate irrigation.

キーワード: southern Siberia, climate change, potential crops, traditional crops, exotic crops

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