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SPECIAL ISSUE «CLIMATE-VEGETATION INTERACTION: NATURAL PROCESSES VERSUS HUMAN IMPACT»

With the last decades of globally documented climate change, concern is growing that it will have widespread impact on the world's environments and human populations (IPCC 2014). Comprehensive studies of vegetation–atmosphere interaction at different spatial (from ecosystem to regional and global scales) and temporal scales are nowadays an important challenge in geography, ecology and climatology. There are numerous factors and multiple pathways that control the interaction of land surface, vegetation and the atmosphere. It is well known that the weather and climatic characteristics (e.g. air temperature, solar radiation and precipitation) influence significantly plant growth and primary production (Woodward, 1987). In turn, the vegetation via various feedback mechanisms (e.g. CO_2 uptake and release, surface albedo, evapotranspiration) affect the local, regional, and, to some extent, global weather and climate conditions (Bonan et al. 1992; Bathiany et al. 2010). Despite the many available studies and reports documenting the various pathways of climate-vegetation interactions, there is a broad spectrum of unresolved scientific questions. In particular it is still not clear

- how the different vegetation types respond to changes of environmental conditions (including anomalous weather conditions) in different geographical regions;
- how plants have responded in the past to changing climates and how the different vegetation types will respond to projected climate change in the 21st century;
- how forest disturbances influence the local and regional climate conditions;
- what is the effect of deforestation and afforestation processes on regional and global climate and weather conditions.

Looking for the answers to these crucial research questions was the main goal of the experimental and modeling studies presented in the session of the IGU Commission of Environment Evolution at the Thematic Conference of the International Geographical Union (IGU) that was held 4-6 June 2018 in Moscow, Russia and dedicated to the centennial of the Institute of Geography of the Russian Academy of Sciences.

The special issue «Climate-vegetation interaction: natural processes versus human impact» discusses a wide range of scientific problems presented in this meeting including the human–vegetation and vegetation–climate interactions in the past, present and future, natural and anthropogenic impacts on forest and grassland ecosystems, effects of forest disturbances on green house gas (GHG) fluxes and the climate system, long-term variability of GHG exchange in forest ecosystems, etc.

Four papers presented in this special issue introduce the novel research achievements in Holocene landscape dynamics, climate changes and human activity in different regions. They show a diversity of Northern Eurasian landscapes from Central Europe to the Russian Far East. Considering landscape and vegetation variability across a broad array of geographical conditions allows us to gain insight into past climate–vegetation interactions from a global perspective.

New evidences of the Late glacial and Early Holocene environments and human occupation in Brandenburg (eastern Germany) are presented in the paper of Kobe et al. (this issue). The authors suggest that climate changes during the Younger Dryas interval (12.9–11.7 ka BP) led neither to substantial deforestation nor spread of tundra vegetation. This idea supports the concept that the Younger Dryas cooling was mainly observed over the winter months, while summers remained comparably warm and allowed a much broader (than initially believed) spread of cold-tolerant boreal tree species.

The paper of Novenko et al. (this issue) provides a reconstruction of the Holocene climatic moisture conditions in the central part of European Russia. Surface moisture conditions were reconstructed using the climate moisture index, aridity index and dryness index of Budyko based on evidence for the mean annual temperature and precipitation in the north-west of the Mid-Russian Upland inferred from pollen records. The authors show that the surface moisture conditions in the study region during the Holocene are characterized by a large variability. Periods of mild temperature and moderately wet conditions were followed by dry periods, which resulted in significant changes in palaeoenvironments.

Borisova and Panin (this issue) investigated in their project a peat-lacustrine sedimentary section on the shore of Lake Tere-Khol (Tuva, southern Siberia). The late Holocene climatic changes in the Tere-Khol basin were reconstructed using pollen records. The authors suggest that the general tendency towards climate cooling and aridification included alternation of dry-wet and cold-warm epochs with a duration of several centuries. An overview of a large number of regional and global climatic reconstructions inferred from different proxies presented in this article show that climate variability in the Tere-Khol basin largely corresponds to the Holocene climate dynamics in the Altai-Sayan region and activity of the Asian monsoon.

Environmental history and climate changes in the southern Sikhote-Alin Mountains (Russian Far East) over the past 5.4 ka are discussed in the paper of Razjigaeva et al. (this issue). The authors demonstrate the response of regional vegetation and fire frequencies to minor climatic fluctuations. The cooling and warming phases revealed from pollen and diatom data of the studied peatland are in good agreement with global paleoclimatic events.

The study of Mor-Mussery et al. (this issue) examines the grazing system of the northern Negev desert in Israel. The authors suggest a new approach for sustainable and profitable grazing systems in arid open lands that is based on soil, vegetation, landscape and the indigenous farmer patterns. The key principles and suggested management plan could be obviously adopted for most of the open arid regions across the globe.

Several papers in the Special Issue are dealing with the temporal variability of the carbon dioxide (CO_2) and water vapor fluxes between tropical and boreal forest ecosystems and the atmosphere. In the paper of Avilov et al. (this issue) the CO_2 emission from the soil surface in a seasonally dry tropical forest in southern Vietnam was investigated. It shows significant soil heterogeneity caused mainly by different biotic factors including the distribution of fine roots and amount of decaying residues and litter on the soil surface. Detected spots with extremely high CO_2 emission can be explained by local insect activity in the upper soil horizons.

The paper of Gushchina et al. (this issue) shows new experimental results illustrating the influence of the very strong El Niño Southern Oscillation (ENSO) event of 2015–16 on local and regional meteorological conditions, as well as on energy and CO_2 fluxes in a mountainous primary tropical rainforest in Indonesia. The study is based on ERA-Interim reanalysis data as well as long-term meteorological and eddy covariance flux measurements in the tropical rainforest in the southern part of the Lore Lindu National Park in Central Sulawesi, Indonesia. Results showed that the El Niño event led to a strong increase of incoming monthly solar radiation and air temperature and consequently to a strong increase of surface evapotranspiration and decrease of net CO_2 uptake. Taking into account a very high contribution of tropical rainforests to the global budget of atmospheric GHG, the detected strong influence of ENSO on water and carbon dioxide exchange between tropical forests and the atmosphere can help to better understand the modern dynamics of GHG in the atmosphere and to improve our ability to predict their possible future changes.

The effect of clear-cutting on forest microclimate, energy, water and CO_2 fluxes in boreal forests is investigated in the paper of Mamkin et al. (this issue). Continuous three-year-long flux measurements at a recently clear-cut area situated at the southern boundary of the boreal forest zone in the western part of Russia showed a relatively low interannual variability of energy fluxes and net CO_2 exchange that were governed mainly by both local weather conditions and amount of regenerated vegetation in the clear-cut area. The energy budget is characterized by higher daily and monthly latent heat fluxes throughout the entire period of measurements. The obtained rates of net ecosystem exchange of CO_2 are consistent with the hypothesis that clear-cutting turns forest ecosystems from a CO_2 sink to a CO_2 source for the atmosphere for several years after logging. Results of modeling experiments using a three-dimensional model showed a very strong influence of vegetation heterogeneity on spatial air flow patterns and atmospheric fluxes that should be taken into account in any flux measurement campaigns conducted over or within a non-uniform plant canopy.

The paper of Sukhoveeva and Karelin (this issue) provides the retrospective analysis of the major components of the carbon cycle in agrolandscapes under land use changes in the Central Forest zone of European Russia. For the analysis six administrative regions (three areas with unchanged arable land structure in the Kaluga, Moscow and Yaroslavl regions, and three areas with changed crop rotation in the Kostroma, Smolensk and Twer regions) were selected. The results provided by using the process-based DNDC (DeNitrification-DeComposition) model showed that all investigated agrolandscapes functioned over the growing season as a net carbon sink and accumulated carbon from the atmosphere into plant biomass. The dynamics of organic carbon in soil under growing crops is also depended on organic fertilizers. It is shown that the cumulative rates of net ecosystem exchange and soil respiration had decreased during the last 30 years mainly due to reduction of arable land area.

The net ecosystem exchange (NEE) of CO_2, gross primary production and ecosystem respiration variability of a ridge-hollow oligotrophic Mukhrino peat bog situated in the Middle Taiga Zone in West Siberia (Russia) were investigated in the paper of Dyukarev et al. (this issue). The model of NEE to describe the influence of different ambient factors on NEE and to estimate the total carbon budget of the peat bog over the growing season was also suggested. Results showed that the Mukhrino peat bog acted over the growing seasons of 2017-2018 as a carbon sink. Moreover, it was found that the monthly NEE rates at the hollows exceeded the NEE rates at the ridge sites.

The study provided by Tiralla et al. (this issue) shows the importance of adequate estimations of surface emissivity for the appropriate model parameterization of energy and matter fluxes between the forest and the atmosphere. In this study, the emissivity of the five broadleaf tree species *Acer pseudoplatanus, Fagus sylvatica, Fraxinus excelsior, Populus simonii* and *Populus candicans* were determined under laboratory conditions in a controlled-climate chamber. The data were used to examine the effects of surface emissivity changes on radiative, sensible and latent energy fluxes of the Hainich forest in Central Germany. The results showed that the energy fluxes and surface temperature increased with a decrease in emissivity, whereas net CO_2 exchange decreased, due to respiration losses resulting from the temperature increase. Overall, the findings indicate that the dependency of energy and matter fluxes on surface emissivity changes is non-linear. The study therefore provides important basics for the correct application of variable leaf emissivity in energy budget modeling and thus to a better estimation of the contribution of forest ecosystems to the climate.

Effects of land use and forest cover changes in the central part of the East European plain on regional weather conditions was investigated in the study provided by Nikitin et al. (this issue). For the modeling experiments two extreme land-use change scenarios imitating total deforestation and afforestation were used. Modeling results conducted for the year 2016 showed that deforestation results in an increase of the annual temperature range by 0.6º C and in reduction of the annual precipitation amount by 35 mm. On the other hand, afforestation leads to decrease of annual temperature range by 0.3° C and growth of precipitation amount by 15 mm. Moreover, it was shown that the deforestation led to higher frequencies of stronger wind speeds, whereas the afforestation had opposite effects.

The last paper of Ivanova et al (this issue) analyses the phenological development of the bird cherry (*Prunus padus L.*) in the Yekaterinburg city as a part of the large-scale project "A Single Phenological Day". It was revealed the slowing of the bird cherry development in the city areas situated close to large water reservoirs. Moreover, it was shown that the bird cherry trees growing inside large industrial areas, on the contrary, developed much faster.

All results presented in the special issue can be considered as a basis for fruitful collaboration of different research teams within the international scientific community investigating environment evolution and interaction of plant ecosystems and the atmosphere in different geographical regions.

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