Geophysical Research Abstracts
Vol. 14, EGU2012-5028-5, 2012
EGU General Assembly 2012

Modeling approaches to describe H_2O and CO_2 exchange in mare ecosystems

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The modern climatic conditions is strongly influenced by both internal variability of climatic system, and various external natural and anthropogenic factors (IPCC 2007). Significant increase of concentration of greenhouse gases in the atmosphere and especially the growth of atmospheric CO_2 due to human activity are considered as the main factors that are responsible for global warming and climate changes. A significant part of anthropogenic CO_2 is absorbed from the atmosphere by land biota and especially by vegetation cover. However, it is still not completely clear what is the role of different land ecosystems and especially forests and mares in global cycles of H_2O and CO_2 and what is a sensitivity of these ecosystems to climate changes.

Within the frameworks of this study the spatial and temporal variability of H_2O and CO_2 fluxes in different types of mare ecosystems of the forest-steppe zone in European part of Russia was described using modeling approaches and results of field measurements. For this modeling and experimental study the mare ecosystems of Tula region were selected. The Tula region is located mostly in the forest-steppe zone and it is unique area for such studies because almost all existed types of mare ecosystems of Northern Eurasia distinguished by a geomorphological position, water and mineral supply can be found there. Most mares in Tula region have a relatively small size and surrounded by very heterogeneous forests that make not possible an application of the classical measuring and modeling approaches e.g. an eddy covariance technique or one-dimensional H_2O and CO_2 exchange models for flux estimation in such sites.

In our study to describe the radiation, sensible heat, H_2O and CO_2 exchange between such heterogeneous mare ecosystems and the atmosphere a three-dimensional model Forbog-3D and one-dimensional Mixfor-SVAT were applied. The main concept used in the Forbog-3D and Mixfor-SVAT models is an aggregated description of physical and biological processes at various hierarchical levels of forest and mire ecosystems: from a single leaf to a tree and an entire ecosystem. The models consist of the several closely coupled sub-models describing: transfer of direct and diffuse solar radiation; turbulent exchange of sensible heat, H_2O and CO_2 within and above a vegetation cover; transpiration, photosynthesis and respiration of vegetation and soil; heat and moisture transfer in different soil layers. The models were validated and applied to describe the H_2O and CO_2 exchange processes in various mare ecosystems with different relief position, type of water and mineral supply as well as vegetation composition. Selected mares are located in different parts of the Tula region (both in forest and forest-steppe zones) and characterized by different microclimatic conditions.

The study was supported by grants (11-04-97538-r_center_a, 11-04-01622-a and 11-05-00557-a) of the Russian Foundation for Basic Research (RFBR) and by grant of Government of Russian Federation N 11.G34.31.0079.