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The impact of subgrid-scale vegetation distribution on the results of terrestrial carbon cycle modeling

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To understand the behavior of the terrestrial carbon cycle under changing atmospheric carbon dioxide levels and climate it is essential to integrate and improve an interactive carbon cycle in all climate models, including Earth system models of intermediate complexity (EMICs). Vegetation distribution and dynamics in each grid cell of these models due to their coarse resolution remains the key area of uncertainty. The present paper focuses on the impact of different mosaic approaches implemented in climate model on the main carbon cycle parameters, such as primary production and carbon stocks.

In this study we use the new version of the A. M. Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences (IAP RAS) climate model (CM) [1], which terrestrial carbon cycle module was improved by implementing subgrid-scale heterogeneity of plant functional types (PFT). Moreover, two additional PFTs were added: natural wetlands and bare land/deserts. The model was also extended by including the nitrogen limitation for plant photosynthesis. Different scenarios of natural and anthropogenic climate forcing described in the EMIC AR5 protocol [http://climate.uvic.ca/EMICAR5], were considered in simulations for the period of time from 850 to 2300 yr. In the 21st-23rd centuries simulations external forcing was prescribed according to the RCP (Representative Concentration Pathways) scenarios [2]. Natural vegetation in each $4.5^\circ \times 6^\circ$ grid cell was arranged in two different ways: 1) with a dominant PFT, spread on the whole grid cell space (mosaic-1), and 2) with all PFTs that are may be present in a grid cell (mosaic-2). In addition to natural vegetation, changes in agricultural area prescribed by CMIP5 scenarios were taken into account.

Numerical experiments show that consideration of subgrid-scale PFT inhomogeneities results in 3 PgC yr-1 increase in global gross primary production (GPP) during the preindustrial period and the early 20th century. This growth is more prominent in grass-dominated areas, while woodlands exhibit a strong decrease in GPP. In the twenty-first century the value of GPP increases showing the strongest growth in tropical forests (0.5 kgC m-2 yr-1 in the RCP8.5 simulation). Taken into account the PFT subgrid-scale distribution this flux weakens by nearly 1/5. In the 22nd-23rd centuries difference between global GPP diminishes due to climate changes that alter from one RCP scenario to another. Despite the GPP enhancement, the experiments with mosaic-2 exhibits smaller carbon stock in terrestrial vegetation throughout the whole model run. The difference varies from -3 PgC yr-1 to -23 PgC yr-1 with respect of RCP scenario. CO_2 emissions from natural fires turned out to be the most sensitive to the subgrid-scale PFT consideration, and just the results of mosaic-2 experiments fit into realistic range. The IAPRASCM model also simulates the switch from a terrestrial carbon sink to a source during the 21st century.

Reference

1. Eliseev, A.V., Mokhov, I.I., Uncertainty of climate response to natural and anthropogenic forcings due to different land use scenarios, Adv. Atmos. Sci., 2011, vol. 28, № 5, p. 1215–1232.

2. Moss, R.H. et al., The next generation of scenarios for climate change research and assessment, Nature, 2010, vol. 463, p. 747-756.