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Fifty years dynamics of Russian forests: Impacts on the earth system

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The paper presents a succinct history of Russian forests during the time period of 1960-2010 and reanalysis of their impacts on global carbon and nitrogen cycles. We present dynamics of land cover change (including major categories of forest land) and biometric characteristics of forests (species composition, age structure, growing stock volume etc.) based on reconciling all relevant information (data of forest and land inventories, official forest management statistics, multi-sensor remote sensing products, data of forest pathological monitoring etc.). Completeness and reliability of background information was different during the period of the study. Forest inventory data and official statistics were partially modified based on relevant auxiliary information and used for 1960-2000. The analysis for 2001-2010 was provided with a crucial use of multi-sensor remote sensing data. For this last period a hybrid forest mask was developed at resolution of 230m by integration of 8 remote sensing products and using geographical weighted regression and data of crowdsourcing. During the considered 50 years forested areas of Russia substantially increased by middle of 1990s and slightly declined (at about 5%) after. Indicators needed for assessment of carbon and nitrogen cycles of forest ecosystems were defined for the entire period (aggregated estimates by decades for 1960-2000 and yearly for 2001-2010) based on unified methodology with some peculiarities following from availability of information. Major results were obtained by landscape-ecosystem method that uses as comprehensive as possible empirical and semi-empirical information on ecosystems and landscapes in form of an Integrated Land Information System and complimentary combines pool- and flux-based methods. We discuss and quantify major drivers of forest cover change (socio-economic, environmental and climatic) including forest management (harvest, reforestation and afforestation), impacts of seasonal weather on carbon fluxes (Net Primary Production, Heterotrophic Respiration), disturbances (fire, outbreaks of insects and diseases), and industrial pressure (land change, air pollution, water and soil contamination). During the entire period Russian forests provided the net carbon sink in range from 350-700 Tg C yr-1 with inter-annual variability in limits of 10-15% for the entire country. The overall sink is a result of superposition of trends of major carbon fluxes (caused by removal of harvested wood and use of forest products; land cover change; impact of climatic trends; change of disturbance regimes) and inter-annual variation of seasonal weather. Major indicators of the nitrogen cycle are assessed and discussed in connection with the carbon cycle. We provide comparative analysis of other results published for the considered period taken into account successive improvements of information and methodology used for studying the major biogeochemical cycles.