Synthesis of Forest Growth, Response To Wildfires and Carbon Storage For Russian Forests Using A Distributed, Individual-Based Forest Model

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We propose to develop a synthesis that links advances in ecosystem modeling and remote sensing in an integrated assessment and forecasting system with rigorous testing against ground observations. Our proposed research focuses on the Russian boreal forest, the largest forest region on Earth and a tremendous repository of terrestrial organic carbon which is widely expected to undergo major transformations with climate change. Siberian summers in the past century were the warmest of the past millennium, and future climate scenarios indicate continued warming, by some accounts between 2-10°C by 2100. The available estimates of carbon storage and flux in the Russian forest are divergent and contribute significantly to uncertainty of global estimates. Our principal objective is to predict the response of the Russian boreal forest to changing climatic conditions and disturbance regimes. The proposed synthesis of results from three NASA-funded research groups working in the Russian forest will perfect our capability to estimate carbon stores and flux and assess the impact of climate change on future carbon dynamics. We will first develop a continental-scale dataset characterizing the disturbance and regeneration over the past 30 years using a combination of moderate resolution satellite data and products. An individual-based forest model that successfully simulates the species and biomass dynamics of the Eurasian boreal forest, FAREAST, will be expanded to include dynamic simulation of carbon in a coarse woody debris reservoir and multiple regeneration rates following disturbance. The new version of the model will be tested against independent ground data, and then combined with disturbance and regeneration datasets and tree cover attributes from a new MODIS-based regional land cover map (NELC) to characterize carbon stores and fluxes circa 2010 at 500 m resolution. Estimation error will be quantified using standard deviations of predictions from multiple FAREAST model runs, an accuracy assessment of disturbance and regeneration estimates against test site data and a determination of overall error in resulting carbon stores and flux estimates. Future changes will be projected from the present state using the fire occurrence model and FAREAST model outputs for future climate associated with a diverse range of emission scenarios to define the upper and lower limits of uncertainty from three General Circulation Models. This set of projections will be compared with outputs from several recent Dynamic Global Vegetation Models to evaluate the degree of agreement among models in estimating change in the dynamic carbon reservoirs contained in the Russian forest. The proposed research directly addresses the major goal of the NASA Earth Science Research Program by quantifying changes in terrestrial stocks and fluxes of CO_2 in response to human activities, natural events, land use and land cover change under the influence of climate change. It is aimed at advancing the carbon-related goals and objectives of major international programs, notably the Northern Eurasia Earth Science Partnership Initiative (NEESPI) under the International Geosphere-Biosphere Programme (IGBP) and World Climate Research Programme (WCRP). Furthermore, it will augment the efforts of the North American Carbon Program (NACP) by quantifying the uncertainty in the Northern Eurasian boreal stocks and thus improve estimates of carbon storage and fluxes globally.