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Carbon Budget and its Dynamics over Northern Eurasia Forest Ecosystems

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The presentation contains an overview of recent findings and results of assessment of carbon cycling of forest ecosystems of Northern Eurasia. From a methodological point of view, there is a clear tendency in understanding a need of a Full and Verified Carbon Account (FCA), i.e. in reliable assessment of uncertainties for all modules and all stages of FCA. FCA is considered as a fuzzy (underspecified) system that supposes a system integration of major methods of carbon cycling study (land-ecosystem approach, LEA; process-based models; eddy covariance; and inverse modelling). Landscape-ecosystem approach 1) serves for accumulation of all relevant knowledge of landscape and ecosystems; 2) for strict systems designing the account, 3) contains all relevant spatially distributed empirical and semi-empirical data and models, and 4) is presented in form of an Integrated Land Information System (ILIS). The ILIS includes a hybrid land cover in a spatially and temporarily explicit way and corresponding attributive databases. The forest mask is provided by utilizing multi-sensor remote sensing data, geographically weighed regression and validation within GEO-wiki platform. By-pixel parametrization of forest cover is based on a special optimization algorithms using all available knowledge and information sources (data of forest inventory and different surveys, observations in situ, official statistics of forest management etc.). Major carbon fluxes within the LEA (NPP, HR, disturbances etc.) are estimated based on fusion of empirical data and aggregations with process-based elements by sets of regionally distributed models. Uncertainties within LEA are assessed for each module and at each step of the account. Within method results of LEA and corresponding uncertainties are harmonized and mutually constrained with independent outputs received by other methods based on the Bayesian approach. The above methodology have been applied to carbon account of Russian forests for 2000-2012. It has been shown that the Net Ecosystem Carbon Budget (NECB) of Russian forests for this period was in range of 0.5-0.7 Pg C yr-1 with a slight negative trend during the period due to acceleration of disturbance regimes and negative impacts of weather extremes (heat waves etc.). Uncertainties of the FCA for individual years were estimated at about 25% (CI 0.9). It has been shown that some models (e.g. majority of DGVMs) do not describe some processes on permafrost satisfactory while results of applications of ensembles of inverse models on average are closed to empirical assessments. A most important conclusion from this experience is that future improvements of knowledge of carbon cycling of Northern Eurasia forests requires development of an integrated observing system as a unified information background, as well as systems methodological improvements of all methods of cognition of carbon cycling.