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How well do we know Russia's carbon budget for 1988-1992? Critical look from uncertainty study of IIASA's Full Carbon Account

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How much improvement in the carbon budget estimates for the past period can we expect if investing more efforts in the study? A target can be set by Shvidenko and Nilsson (2007), who concluded the uncertainty for NBP from the thorough study of the Siberia-II region 84% (90% confidence interval hereafter). In principle, such an improvement could be reached for the whole Russia. But the improvement is a bit tricky because not much new direct knowledge can be added to the past period. Major information is added from applying new studies to reprocessing old data (e.g., fine root net primary production (NPP), soil respiration measurement inter-comparison) and development of new mathematical models. Critical point is heterotrophic soil respiration, which suffer from lack of measurements over vast Siberian territories.

We studied uncertainties in estimates of major CO_2 fluxes between the atmosphere and terrestrial ecosystems for 1988-1992. Our study was centered around the Full Carbon Account for Russia (Nilsson al., 2000) and used a number of recent studies. Much attention was paid to NPP and heterotrophic soil respiration (HR) as they determine the uncertainty of the atmospheric CO_2 budget. The fluxes were estimated by bioclimatic zones (BCZ) and land-use classes (LU). Systematic errors were identified (to the extent possible) while uncertainties were estimated from a conservative point of view. Under the given data, uncertainties determined at the spatial scale of BCZs appear robust. HR and NPP uncertainties exceed 100% at finer resolutions.

Our NPP estimate for Russia's arable land is 739 TgC/yr with an uncertainty of 25%.

Major reasons of uncertainty are uncertain yield (at oblast level) and yield losses. We used a revised forest NPP estimate by Shvidenko et al. (2006), which is 36% greater than the estimate by Nilsson et al. (2000) (2,329 TgC/yr). The major reason for the shift is additional knowledge of fine root NPP. Uncertainty of the forest NPP is 14%. The re-derived NPP estimates for Russia's wetlands and grasslands & shrubs are 539 TgC/yr $\pm$ 53% and 1055 TgC/yr $\pm$ 40%, respectively.

The new estimate of the HR is 2,920 TgC/yr and the uncertainty 24%. The major reason of this high uncertainty is lack of spatial and temporal coverage of measurements of total soil respiration and root contribution. Some improvement is achieved by adding knowledge on soil respiration measurement biases, recent studies of root contribution and structuring the measurements by soil divisions, BCZ and LU.

Uncertainty of national totals of fluxes caused by disturbances (240 TgC/yr) and consumption (545 TgC/yr) are 21% and 18% respectively. National total components of disturbances and consumption are distributed among BCZs proportionally to population, actual harvest and 'insect index' spatial data.

The uncertainty of Russia's net atmospheric balance is approximately 100% centering around 957 TgC/yr.

For comparison with top-down estimates we upscaled the net atmospheric CO_2 flux to Eurasia (-2.1 PgC/yr) and Extratropical Northern Hemisphere (-3.3 PgC/yr). The re-estimated net fluxes are about two times smaller than the top-down estimate by House et al. (2003) (-0.94 and -1.45 PgC/yr for Eurasia and Extratropical Northern Hemisphere, respectively). But respective new upscaled uncertainty intervals contain averages of the estimates by House et al. (2003) and their uncertainty intervals (except for one point). Our upscaled value and its uncertainty for the Northern Hemisphere overlaps well with the corresponding interval (-0.4 – -0.23 PgC/yr) given by Denman et al. (2007) for 1992-1996. For Northern Asia our uncertainty interval is in the same order as given by top-down estimates.

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