Determination of the Siberian carbon balance by means of «top-down» and «bottom-up» approaches

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Only about 40% of the CO2 emitted by anthropogenic activities accumulates currently in the atmosphere, the remainder is being absorbed by oceans and the terrestrial biosphere. The question as to where and by which mechanism this absorption of excess CO2 takes place constitutes a priority topic of global carbon cycle research. Several observational and model-based methods allow the global partitioning of the decadal average sinks between ocean and land within relatively narrow uncertainty margins. Regional estimates such as the carbon balance of Siberia, however, are more difficult to establish and unavoidably are associated with higher uncertainties. By means of the «top-down» approach one can infer magnitude, location and temporal variability of regional net surface-atmosphere fluxes by inverse modeling of observed variations of the atmospheric CO2 concentration. Estimates by this method exhibit interannual highly variable terrestrial net CO2 fluxes, which can be related to anomalous climate forcing factors, e.g. El Nino-Southern Oscillation events, or other phenomena such as wide-spread Siberian forest fires. Alternatively, on can estimate regional carbon budgets by the «bottom-up» approach: (1) from extrapolations of in situ flux or carbon stock change measurements, or (2) by means of scaling up with process models driven e.g. by remote sensing data. Ultimately techniques have to be developed to merge in a consistent way the «top-down» and the «bottom-up» approach within a data assimilation framework, similar to the methods employed in numerical weather forecasting. A first prototype of such a modeling system exhibits promising results. Within the EU-funded project «EUROSIBERIAN CARBONFLUX» and its successor «Terrestrial Carbon Observation System Siberia» (TCOS-Siberia, 2002-2004), an extensive dataset of in situ and atmospheric measurements is being obtained, which permits an application of the top-down and bottom-up methods for the determination of the carbon balance of Siberia and which also allows a cross-check for consistency of the different estimates.