Geophysical Research Abstracts,
Vol. 11, EGU2009-11113, 2009
EGU General Assembly 2009

Regional modelling of water and CO2-fluxes with a one-dimensional SVAT model

M. Kuhnert and B. Köstner

TU Dresden, Institute of Hydrology und Meteorology, Tharandt, Germany (matthias.kuhnert@tu-dresden.de)

Climate change affects site conditions for vegetation and may affect changes in the distribution of plant species. Investigations of these effects are difficult, because other influences on plant performance like land use and management also need to be considered. Carbon gain can be used as a sensitive indicator for changes in the vitality of the considered vegetation types that are affected by different climate and weather patterns. The objective of the presented study is the quantification of net photosynthesis rate, respiration and transpiration of different vegetation types on the regional scale. The study regions are the Weißeritz catchment in the Ore Mountains and the region Torgau-Oschatz in the Elbe basin both located in Saxony (East Germany) but significantly differing in elevation and site conditions. The carbon and water fluxes are simulated by an ecophysiological based Soil-Vegetation-Atmosphere-Transfer model for three periods (1996-2006, 2015-2025 and 2035-2045). The considered vegetation types are forest and grassland. The used model SVAT-CN is a multi-layer model, which enables the calculation of hourly carbon gain by coupling micrometerological data with ecophysiological processes. The calculations are based on the equations of Farquhar and Ball for net photosynthesis rate and stomata conductivity, respectively. It is a one-dimensional model which also considers soil water processes. The soil is coupled with the vegetation by one factor that depends on the matric potential and steers the calculation of the stomata conductivity. The equations of the soil water processes are based on a combination of bucket model and Richard's equation. Simulations are based on measured weather data (Dept. of Meteorology at Technische Universität Dresden and LfL Sachsen) with varying levels of atmospheric CO2 concentrations up to 580 ppm. Further, climate projections (ECHAM5-OM, IPCC emission scenario A1B), with downscaling to a 18x18km grid by the regional climate model CLM (source Model & Data Group/SGA, MPI Meteorology Hamburg, German research programme klimazwei) will be used as drivers for the simulations. The soil data are derived from the conceptual soil map of Saxony (LfULG in Saxony, Germany, resolution 1:50000). The data contain values for texture, thickness and bulk density of different soil layers. Based on these data the input parameters are derived by pedotransfer functions. The land use data are based on the CORINE map. The according ecophysiological data are taken from literature or other projects (e.g. VERTIKO). On the forest sites two species were considered (Norway spruce and common beech). The spatial distributed data of land use and soil were combined to generate functional units. The results of the simulated net photosynthesis rates indicate that the connection of soil and plant compartment in the model becomes only relevant when the soil water content limits the net photosynthesis rate. Under well wetted conditions, only minor spatial differences of annual net photosynthesis rates were found within the same land-use type. While most patchiness of annual net photosynthesis rates could be attributed to land-use types. With increasing CO2 concentrations the annual net photosynthesis rate increased and transpiration decreased. At 530ppm the increase in annual net photosynthesis reached up to 20% and 10% for spruce and beech, respectively. Transpiration of spruce was less reduced (about 5%) in comparison to beech (up to 17%) for the same concentration of atmospheric CO2. In general, water-use efficiency (WUE: net photosynthesis rate divided by the transpiration rate) increased with increasing CO2-concentration but varied with weather conditions. The increase was larger for years with a low average temperature and high amounts of precipitation than for years with opposite conditions. This effect was stronger for the spruce sites than for the beech sites. For grassland, effects of management and increasing temperature on annual net photosynthesis were most pronounced. All enhancing atmospheric effects on annual net photosynthsis were compensated by drought effects. Especially, for spruce, the reduction of annual net photosynthesis rate reached up to 30%. In summary, increasing atmospheric CO2 concentrations and air temperature enhanced the annual net photosynthesis rate, but the effect was compensated by drought effects. Therefore, appropriate simulation of drought effects are a critical point to

value future carbon gain of vegetation at the regional scale. Although the studies are still ongoing there is evidence that potentially increasing carbon gain of vegetation along with increasing atmospheric CO2 concentrations could be balanced by drought effects.