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A modelling approach for simulation of vertical H_2O and CO_2 fluxes in tropical rain forests

A.Olchev, A. Ibrom, T.Ross, H.Kreilein, G.Gravenhorst

Institute of Bioclimatology, Georg-August University, Goettingen, Germany

aoltche@gwdg.de / Fax: +49-551-399619 / Phone: +49-551-393374

The energy, water and CO_2 fluxes in a tropical rain forest in Indonesia (Central Sulawesi) were modelled using an one-dimensional multi-layer SVAT model "MixFor-SVAT" within the frameworks of the German-Indonesian project "The stability of rainforest margins in Indonesia" (STORMA, SFB 552) supported by DFG.

MixFor-SVAT was developed to describe the vertical turbulent energy, water and CO_2 exchanges within and above forest stands represented by one or by many different tree species.

Each tree species in a forest can be characterised in the model by individual sets of morphological (e.g. height, LAD, stem diameter, root depth), physical (e.g. optical properties of the leaves and bark, hydraulic conductance and storage capacity) and physiological (e.g. maximal stomatal conductance, maximal Rubisco carboxylation capacity, maximal rate of photosynthetic electron transport) parameters. It is assumed that different trees of different tree species are uniformly distributed over some homogeneous ground surface area, and there are no differences in structural and physiological properties between the same tree species.

Parameterisation of forest evapotranspiration in the model includes description of overstorey and understorey transpiration, evaporation of rain water intercepted by overstorey and understorey vegetation and direct evaporation of water from the soil surface. Water uptake and transpiration rates of each individual tree species are modelled separately and total canopy transpiration is calculated as a sum of transpiration of individual species.

NEP of a forest ecosystem is calculated as a sum of GPP of green leaves (photosynthesis and photo-respiration) and autotrophic respiration (leaves, stems, branches, roots) of different tree species, heterotrophic respiration of soil biota, respiration of dead wood biomass, and canopy CO_2 storage.

Comparisons of modelled H_2O and CO_2 fluxes with eddy covariance measurements above a forest stand showed a very good agreement between modelled and measured fluxes under different meteorological and soil moisture conditions.