Simulating CO2 net assimilation of two grassland competing species in a tropical mountain ecosystem

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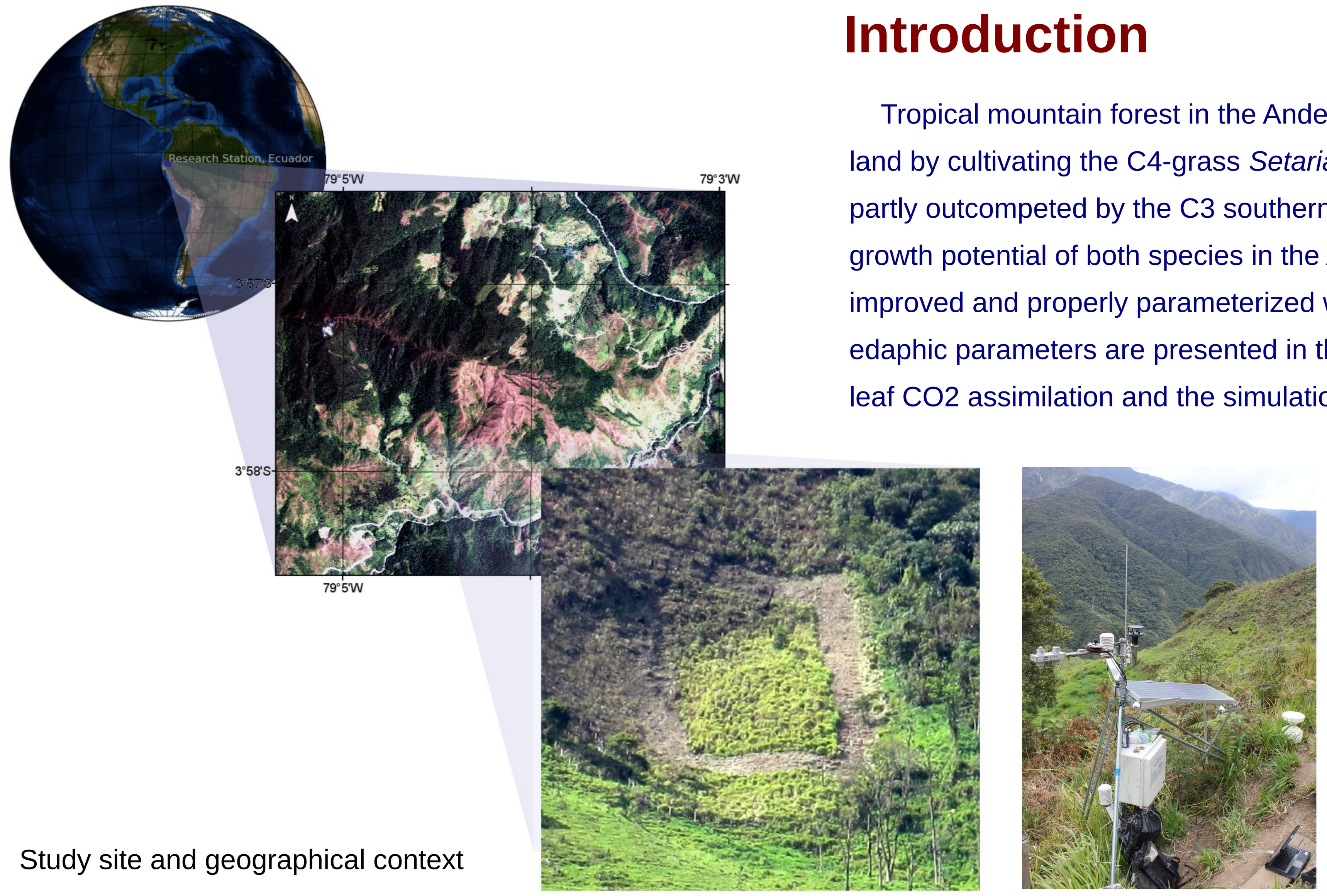
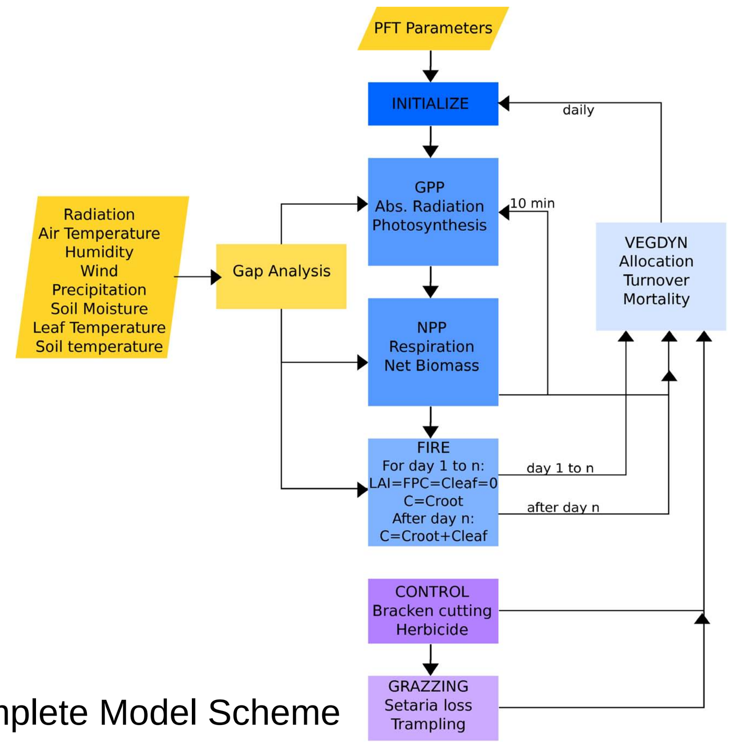


Study site and geographical context

Introduction

Tropical mountain forest in the Andes of southeastern Ecuador is regularly destroyed to gain pasture land by cultivating the C4-grass *Setaria sphacelata*. After recurrent burning of the pastures, the grass is partly outcompeted by the C3 southern bracken (*Pteridium arachnoideum*). Because no information on the growth potential of both species in the Andes of Ecuador is available, a growth simulation model has been improved and properly parameterized with field observations. The novel measured physiological and edaphic parameters are presented in this poster, as well as the model validation with field observations of leaf CO2 assimilation and the simulation for a whole year using realistic meteorological data.



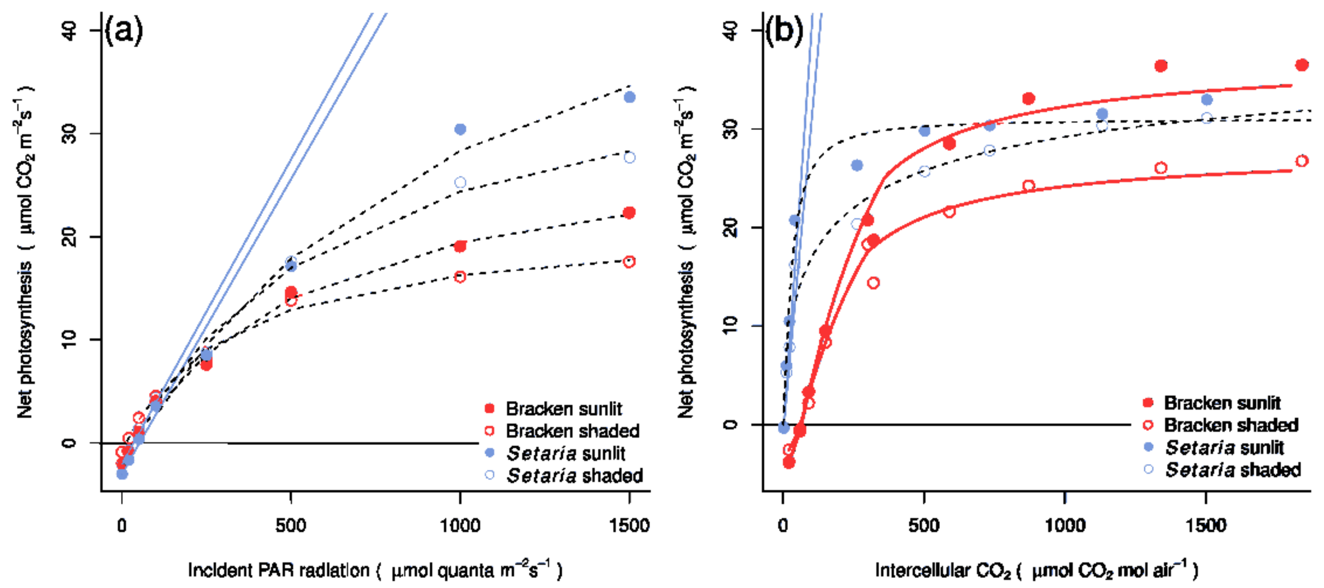
Complete Model Scheme

Methods

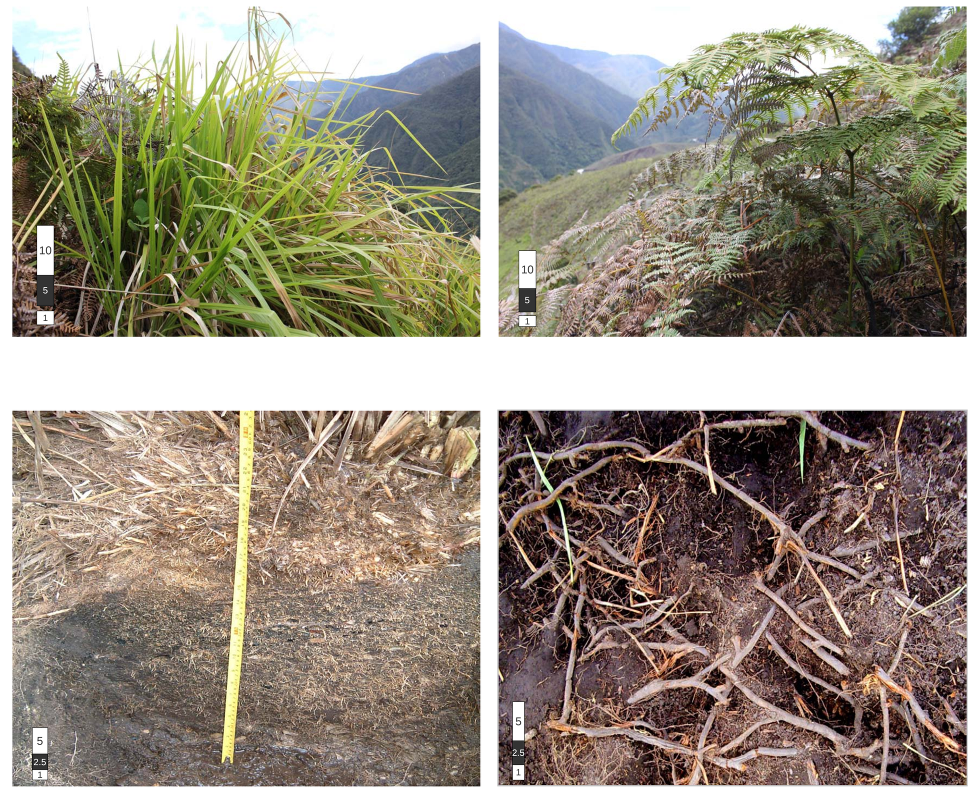
For the simulation of photosynthesis, we used the two big-leaf approach which considers sunlit and shaded leaves. Required parameters (leaf area, optical and physiological properties, including respiration, and root biomass) were obtained by field measurements, considering an average individual of each species. These measurements were supported by specialists on plant physiology. Meteorological data sets for the year 2008 with ten-minutes time resolution were acquired *in situ* for atmospheric forcing of the model. Validation was carried out by means of independent photosynthesis measurements. Results were integrated over the year and the annual productivity of the two species were compared.

Parametrization

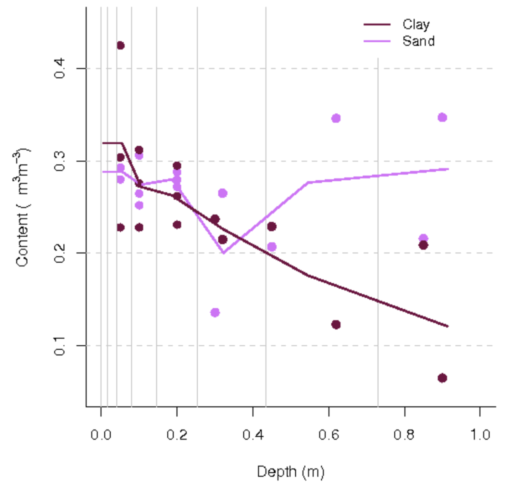
For the photosynthesis module, the quantum yield and the carboxylation rate were derived from the photosynthetic responses to incident radiation and CO2. Acclimation to shade was considered by taking samples collected under less than 20% of normal irradiance. An estimate of mitochondrial respiration had to be obtained directly from the photosynthetic light response at zero light and from CO2 net assimilation measured at night. Information on vertical profiles of soil texture and water content were also available, as well as vertical profiles of root biomass.



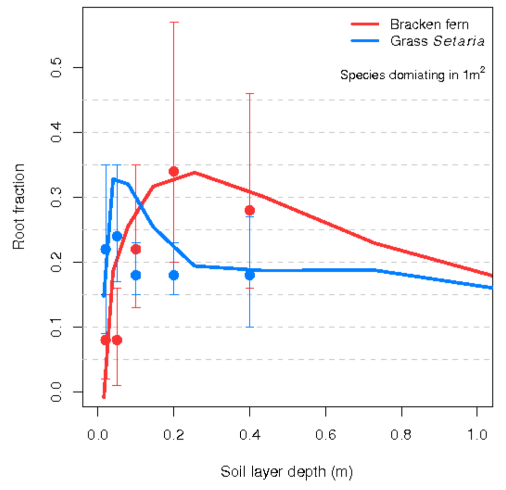
Photosynthetic responses to light (a) and CO2 (b).



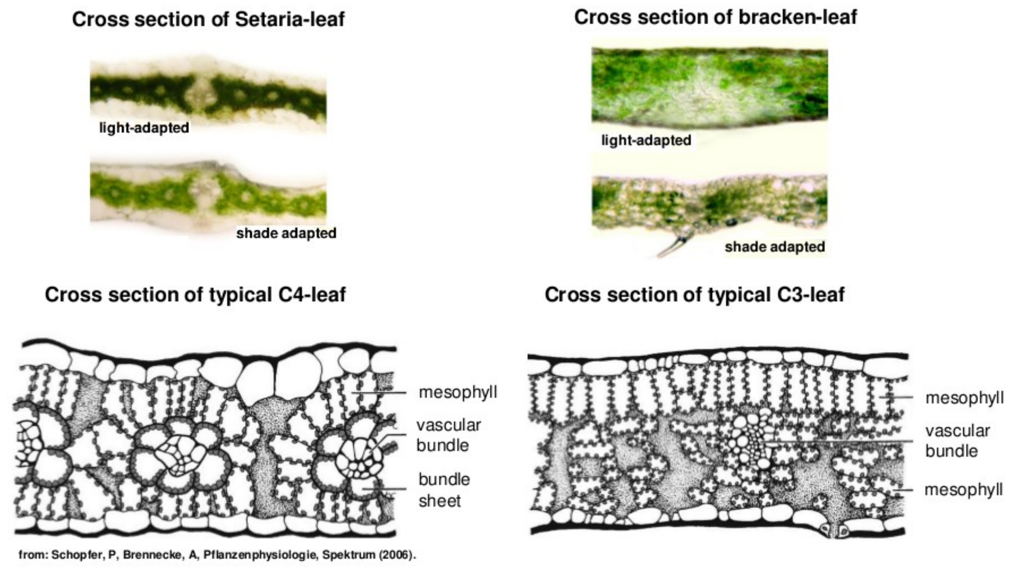
Canopy and root system from the species *Setaria sphacelata* (left) and *Pteridium arachnoideum* (right).



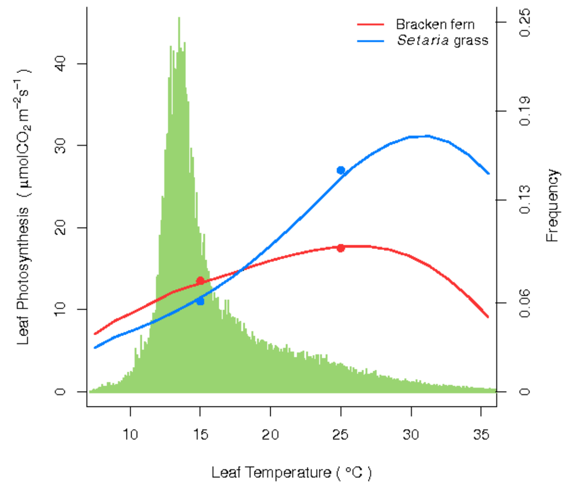
Soil texture



Root biomass distribution



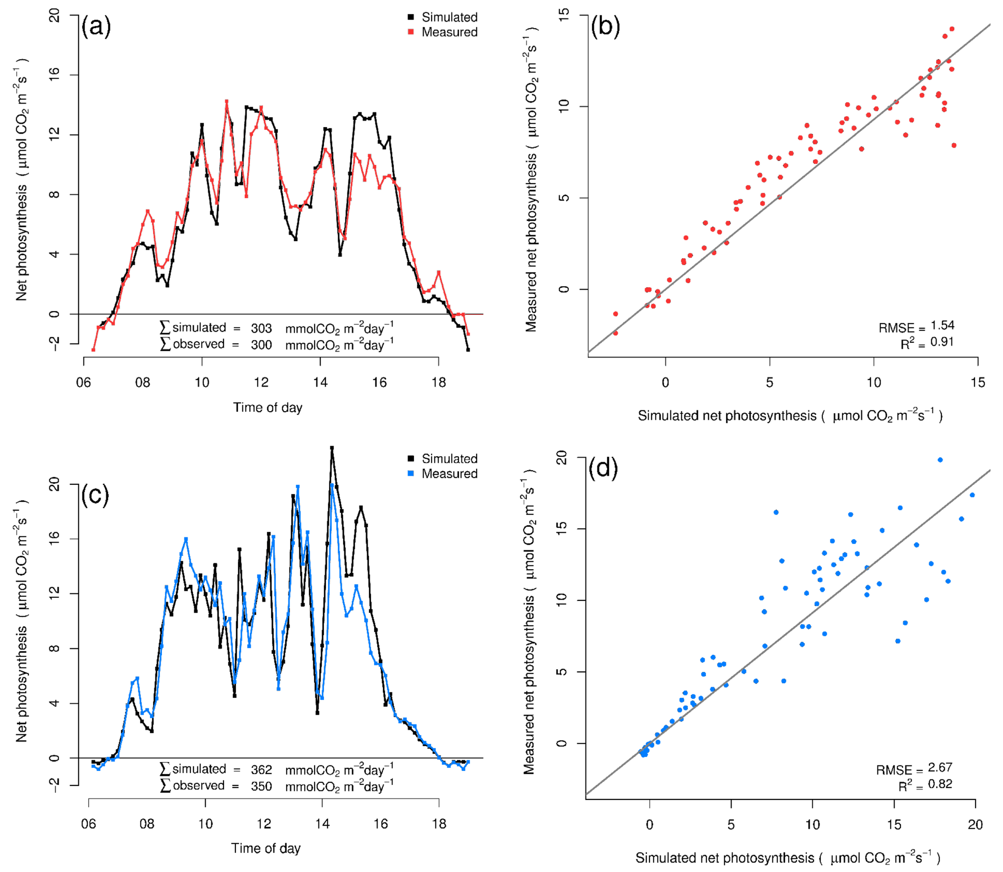
Schematic description and cross-section of sunlit and shaded adapted leaves and fronds.



Sensitivity to temperature

Results

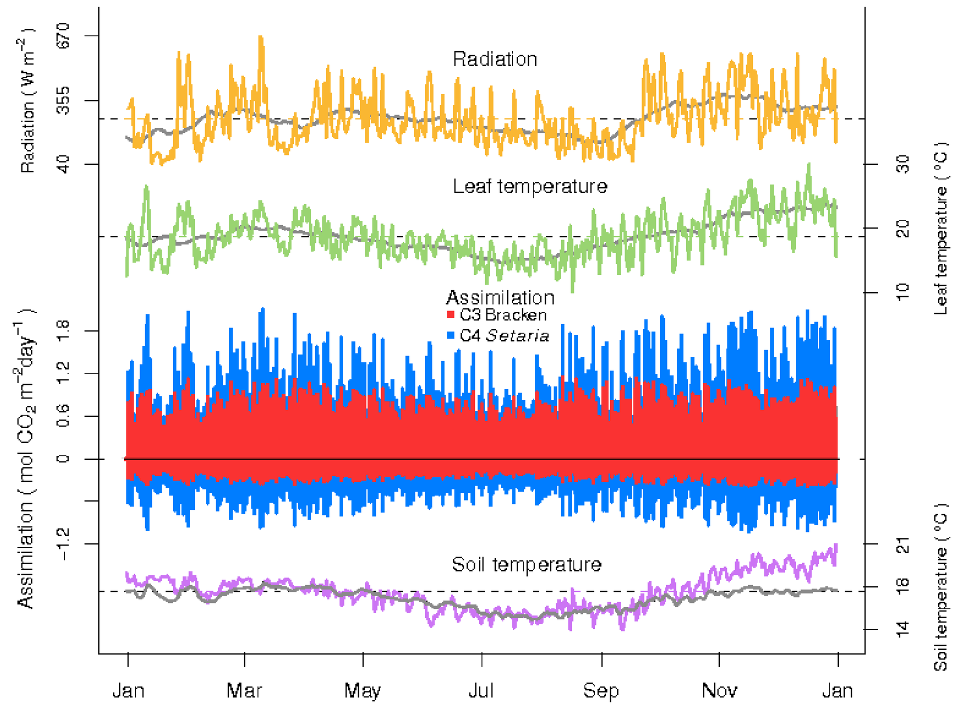
Validation



Validation has been carried out using independent photosynthesis measurements. Regarding the daily sum of net photosynthesis, less than 5% difference was observed between simulated and measured values for both bracken fern (a,b) and *Setaria* grass (c,d).

One-year simulation

The validated model was run with one year of realistic meteorological forcing. The main result points to slightly higher potential growth of *Setaria* (5.85 kg per m² per year) based on the CO2 net assimilation, which decreases with decreasing incoming solar radiation and temperature under unfavourable weather conditions. The total assimilation of bracken corresponds to a yield of 5.5 kg per m² per year.



Discussion

The competition situation as observed in the field partly points to a slight growth advantage of bracken, which contradicts the higher growth potential of *Setaria*. This might be result of the common land use practise. Furthermore, recurrent burning for rejuvenation of the grass and bracken control is also hypothesized to particularly favour the regrowth of bracken after fire. the presented photosynthesis model does not yet allow the direct simulation of competition, e.g. as a result of disturbance. Thus, future improvements of the model will consider biomass partitioning and turnover and the influence of relevant growth disturbances (fire, cattle browsing and trampling) as well as the direct above-ground radiation competition of both species.

Acknowledgement

The current study was conducted within the framework of the DFG Research Group FOR 816 “Biodiversity and sustainable management of a megadiverse mountain rain forest in south Ecuador“ funded by the German Research Foundation DFG (BE 473/38-1 and 2; SCHE 217/14-2). Support on plant physiological issues was given by Dr. Kristin Ross, Ingo Voss, Nicolas König, Prof. Renate Scheibe and Prof. Erwin Beck. We appreciate very much this support. B. Silva would like to thank the Brazilian Council of Technological and Scientific Development (CNPq) for research grants (GDE 290033/2007-1).