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Atmosphere-vegetation modelling and assessment of photosynthesis for two grassland competing species

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An enhanced numerical model for primary productivity based on atmosphere-vegetation exchange has been developed to investigate the competition of two species (bracken and pasture grass) in the Southern Andes of Ecuador. In this work modelling issues are presented concerning the radiation environment, the biochemistry of photosynthesis and the plant rooting systems. Regarding the radiation environment, a function was derived for the decomposition of the solar radiation to calculate the absorbed direct and diffuse radiation separately. For the simulation of photosynthesis an improvement was made to the two big-leaf approach at leaf level. It makes reference to the structural changes in the photosystems due to the acclimation to shade, as observed by gas exchange measurements and pigment analysis. Root distribution by depth and sand and clay content in soil were assigned to eight soil layers to calculate water absorption and evaporation.

A set of twelve meteorological variables with ten-minutes time step was exclusively acquired as input for the model calculations. Quality control and gaps filling were performed before starting simulations. First a sensitivity analysis was carried out to observe the influence of incoming radiation, soil water and leaf temperature and their numerical importance for the model results. Then gross and net primary productivity were simulated over one year. Results were integrated over the whole period and the annual productivity of two competing species were compared.

In conclusion, the competition situation of both species with regard to primary production under current climatic oscillations is presented. Furthermore, limitations of the model are discussed and future improvements are suggested.