7.11 SCALING CARBON AND ENERGY EXCHANGES WITH VEGETATION / LAND SURFACE PROCESS MODELS

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We discuss the role of scaling from leaf to canopy scale using three different approaches; for three different vegetation / land surface models. The models include: Wesely's radiation based canopy resistance model; the Jarvis – type transpiration scheme; and a photosynthesis model. The scaling approaches include testing the effect of: (i) LAI scaling; (ii) light extension based scaling; and (iii) sun – shade model. The impact of such scaling methodologies for the vegetation schemes is tested both for the uncoupled and the coupled mode in SSiB and the MM5 modeling system.

In SSiB, a simplified photosynthesis based vegetation scheme was developed and the initial results of the simulations using this scheme over the Amazonian region were evaluated. The original vegetation scheme within SSiB followed a diagnostic Jarvis - type stomatal model. Such a scheme by design relies on the prescription of a so - called minimum stomatal resistance, and can simulate limited interactions within the complex ecosystem dynamics. This stomatal scheme was replaced by a semi-analytical stomatal resistance - photosynthesis model with radiation, biochemical (Rubisco), and CO_2 based couplings. As that, humidity, rather than CO_2 concentration (as in traditional photosynthesis models) is assumed to be a known factor, and six limiting conditions (three each for a C3 or C4 photosynthesis pathway) are analytically balanced to yield gross and net primary productivity. A scaling method, which considers the leaf shading effect, is developed and tested. The biophysical changes in the canopy environment affect the surface environment through CO_2, water vapor and heat exchange. Thus a more interactive feedback between the surface, vegetation, atmospheric forcing, and the carbon and hydrological cycles are introduced. We present results from three sets of simulations: first involving the original Jarvis - type scheme, the second related to the semi – analytical photosynthesis scheme, and the third based on shading and radiation attenuation based scaling of the photosynthesis scheme. The model results are compared with tower observations dataset comprising of temperature, humidity, wind, radiation, precipitation, and the fluxes of heat, momentum, and CO_2 from the large - scale biosphere experiment in Amazonia (LBA) whose objective is to understand the climatological and hydrological functioning of Amazon. A comparison of the model results and discussion of the surface - atmosphere exchange as depicted through the photosynthesis and non - photosynthesis pathways is also discussed.

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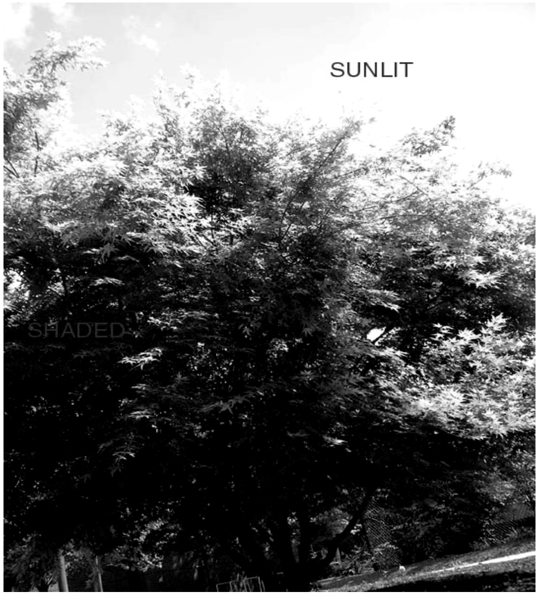

Fig. 1 Example of the sun-shade being considered in the modeling study. The model has to explicitly account for the fraction of the LAI being sunlit and shaded. Though several formulations exist for developing this shading, their representation into an efficient modeling system requires tests with different observations, and is being performed in our present study.

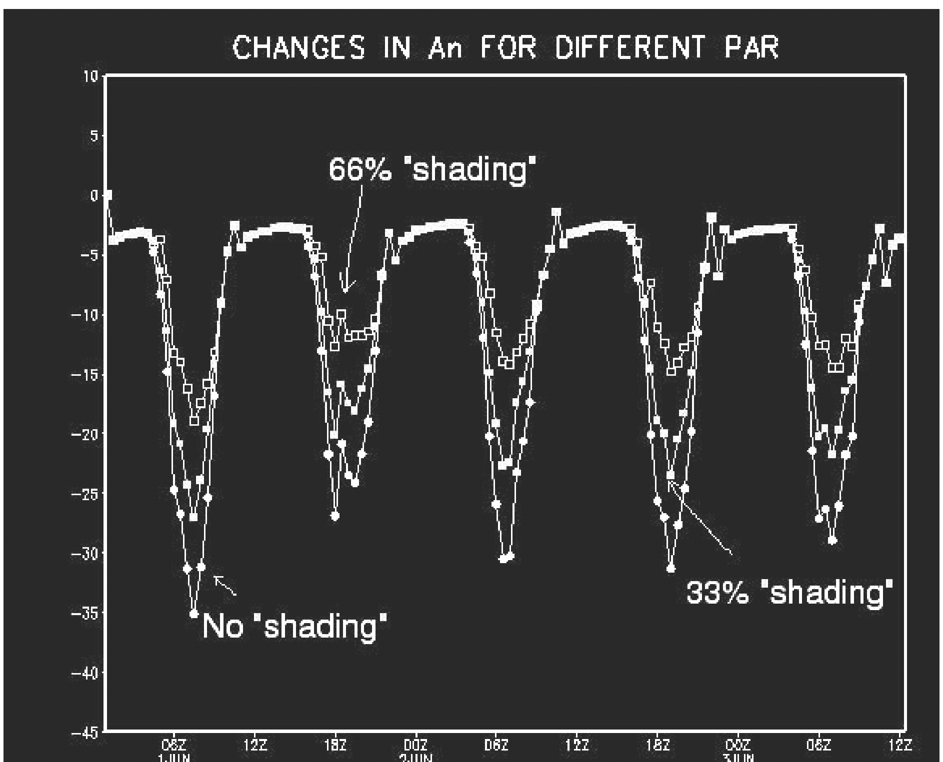

Fig 2. Example plot for the effect of the shading on the carbon assimilation rate in the photosynthesis model.