J8.12 SIMULATING CARBON AND ENERGY EXCHANGES OVER THE AMAZONIA USING A PHOTOSYNTHESIS MODEL WITHIN SSIB

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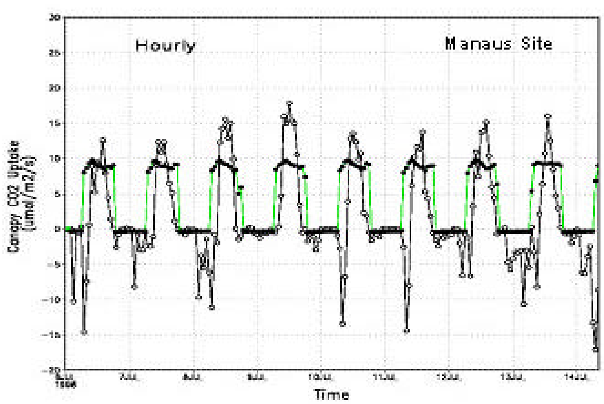
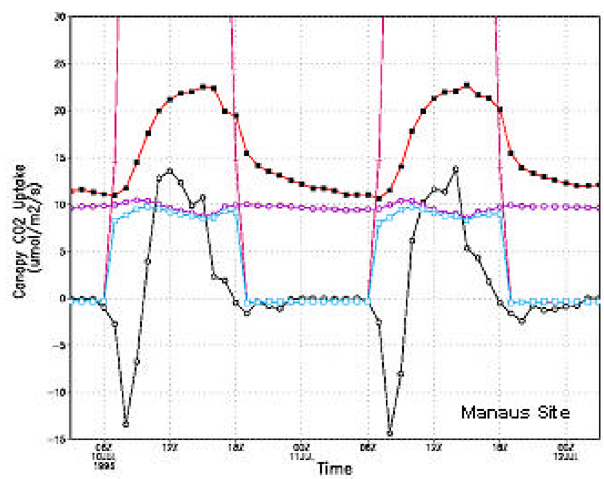
One of the major goals of the large-scale biosphere experiment in Amazonia (LBA) is to understand the climatological and hydrological functioning of Amazon. We discuss the development of a simplified photosynthesis based vegetation scheme embedded within SSiB, and the initial results of the simulations using this scheme over the Amazonian region. 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 (Niyogi and Raman, 1997). To realistically simulate the surface CO_2 and water budget, it is necessary to estimate stomatal conductance and photosynthesis rate of leaves simultaneously with numerically stable solutions. For this a stomatal resistance - photosynthesis model with radiation, biochemical (Rubisco), and CO_2 based couplings was devised. In this, humidity, rather than CO2 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 GPP and NPP estimates.
Initial results with the scheme showed numerically consistent results for the leaf photosynthesis rates (Zhan, Xue, Collatz, 2000). However at the canopy scale the model showed higher weightage for the radiation limited carbon assimilation rates. This is illustrated from a sample plot shown below.





Hence, a scaling method, which considers the leaf shading effect, is being coupled with the modified SSiB and tested. The biophysical changes in the canopy environment affect the surface environment through CO2, 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

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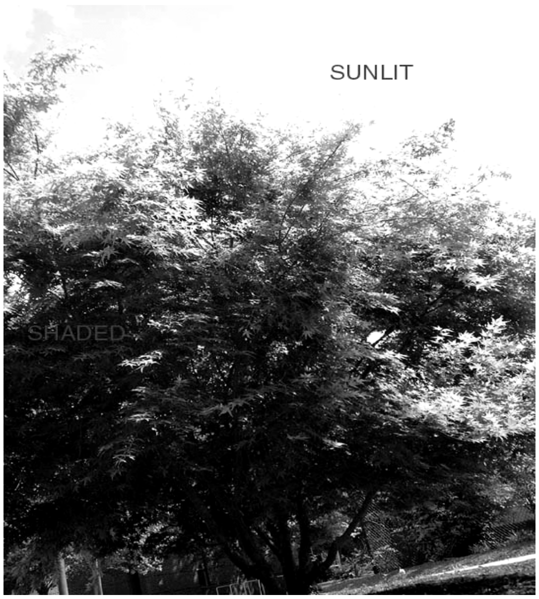
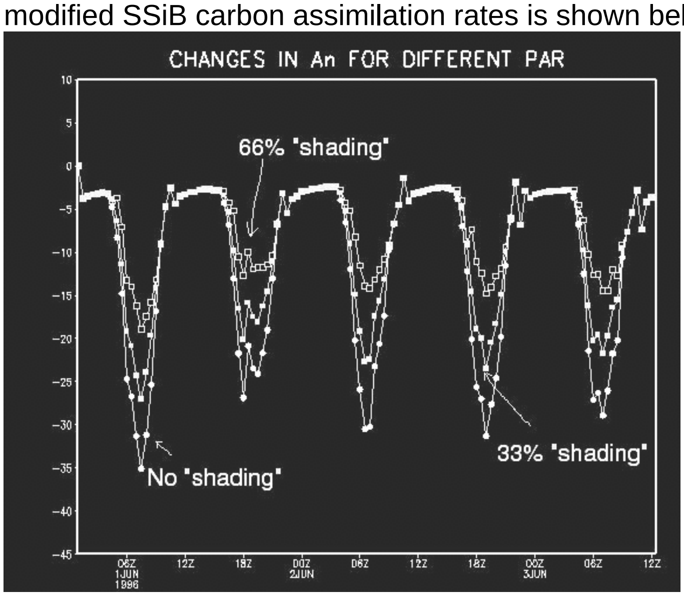
are compared with tower observations dataset comprising of temperature, humidity, wind, radiation, precipitation, and the fluxes of heat, momentum, and CO_2. A comparison of the model results and discussion of the surface - atmosphere exchange as depicted through the photosynthesis and non - photosynthesis pathways is also discussed.

The picture below shows the sun lit / shaded combination used in the SSiB scaling.



The approach adopts radiative effects as scaled in SiB2 using the **p** function for the different biophysical variables. Additionally a big-leaf based sun / shade scaling developed by DePury and Farquhar is also being tested. An example plot of the impact of the shading consideration for the modified SSiB carbon assimilation rates is shown below.



Zhan, X., Y. Xue, and G. J. Collatz, 2000: Enhancing the Simplified Biosphere Model (SSiB) to estimate carbon fluxes of terrestrial ecosystems for regional climate studies. Preprint of 15th AMS Conference of Hydrology, 59-60.

Niyogi D., and Raman S., 1997: Comparison of four different stomatal resistance schemes using FIFE observations, J. Appl. Meteorol., 36, 903 – 917.