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SATELLITE MEASUREMENTS AND VEGETATION MODELS FOR GLOBAL CARBON CYCLE STUDIES

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Global Terrestrial Biosphere Models (TBMs) are being developed by the scientific community to understand and forecast interactions (impacts and feedbacks) between terrestrial biosphere, soils, and climate. One specific objective is to predict the evolution of land carbon sources and sink and atmospheric CO2 concentrations under various scenarios.

TBMs have proved very useful tools for understanding the role of the terrestrial biosphere in the current carbon cycle. However intercomparisons performed under the auspices of IGBP have shown that discrepancies exist between model results such as Net Primary Productivity (NPP) and above all intermediate prognostic variables (e.g. light use efficiency, autotrophic respiration). Further improvements and validations are needed, especially for predicting biospheric carbon fluxes and budget under future environmental conditions. TBM improvement has to cope with several difficulties such as accounting for main vegetation processes, specification of space and time dependent parameters, and validation of the models.

We have developed both diagnostic and prognostic models for estimating global NPP (Ruimy et al., 1994, Ruimy et al., 1996, Kergoat, 1996). The diagnostic model is driven by satellite data: NPP is computed as the product of photosynthetically active radiation (PAR) that plant canopies absorb by radiation use efficiency. Coefficients of PAR absorption are derived weekly from NOAA/AVHRR visible and near infrared measurements. This diagnostic model, strongly constrained by satellite observations, is a useful tool for understanding the current carbon cycle and its fluctuations. Prognostic models are also needed to simulate future feedbacks between climate and the terrestrial biosphere. A satisfactory representation of plant production processes is necessary to get a realistic simulation of the evolution of global plant productivity with increased CO2 and associated climatic change.
The prognostic model we have developed incorporates main physiological processes such as photosynthesis, evapotranspiration, and assimilate allocation. In its current version, it predicts canopy development (LAI) by assuming that vegetation makes an optimal use of available ressources (water, light, ...). This model can be tested by comparing predicted variables (LAI, ETR, soil moisture, ...) to independent estimates (ground measurements or satellite retrievals).

We will first present briefly the principles of these two models, and some of our achievements, such as global mapping of NPP, LAI and evapotranspiration, and interannual fluctuations of NPP, including the consequences of El-Niño events. Then, the focus will be on the use of satellite measurements (NOAA/AVHRR, SPOT-HRV) for providing model parameters or for validating the results. Satellite based retrieval of model parameters includes “ forcing ” strategies (e.g. fPAR) and assimilation techniques. Validation of TBMs is a crucial issue, and we will discuss the comparison of model results with in-situ flux measurements, atmospheric CO2 concentration and satellite data. We will show that satellite measurements and observations of interannual variabilities could play an important role to make models more reliable, particularly if better quality data sets become available.