Geophysical Research Abstracts
Vol. 12, EGU2010-12135, 2010
EGU General Assembly 2010


# Light Competition and Carbon Partitioning-Allocation in an improved Forest Ecosystem Model

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In Italy about 100.000 km2 are covered by forests. This surface is the 30% of the whole national land and this shows how the forests are important both for socio-economic and for environmental aspects. Forests changes affect a delicate balance that involve not only vegetation components but also bio-geochemical cycles and global climate. The knowledge of the amount of Carbon sequestered by forests represents a precious information for their sustainable management in the framework of climate changes. Primary studies in terms of model about this important issue, has been done through Forest Ecosystem Model (FEM), well known and validated as 3PG (Landsberg et Waring, 1997; Sands 2004). It is based on light use efficiency approach at the canopy level. The present study started from the original model 3PG, producing an improved version that uses many of explicit formulations of all relevant ecophysiological processes but makes it able to be applied for natural forests. The mutual interaction of forest growth and light conditions causes vertical and horizontal differentiation in the natural forest mosaic. Only ecophysiological parameters which can be either directly measured or estimates with reasonable certainty are used. The model has been written in C language and has been created considering a tri-dimensional cell structure with different vertical layers depending on the forest type that has to be simulated. This 3PG 'improved' version enable to work on multi-layer and multi-species forests type with cell resolution of one hectare for the typical Italian forest species. The multi-layer version is the result of the implementation and development of Lambert-Beer law for the estimation of intercepted, absorbed and transmitted light through different storeys of the forest. It is possible estimates, for each storey, a Par value (Photosynthetic Active Radiation) through Leaf Area Index (LAI), Light Extinction Coefficient and cell Canopy Cover using a "Big Leaf" approach. Hence, the presence of a cohort in a storey determines the amount of light received for the photosynthetic processes. The population density (numbers of trees per cell) represents a good competition index for determining the tree crown structure and tree crown dimension within a forest population. The tree crown tend to branch out horizontally to intercept as much light as possible. The model assess the structure of the tree crown both vertically and horizontally on the base of the population density and it up-scales the result to the whole stand. The canopy depth and the percentage of horizontal coverage determines moreover a crowding competition index that lead to a specific biomass partitioning-allocation ratio among the different tree components (foliage, roots and stem) and especially for the stem affecting Height-Diameter (at breast height) ratio. In this model, Height-Diameter ratio is used as an alternative competition index in determining the vigour and the strength of competition on free growth status of trees. The forest dominant vegetative cover affects moreover the presence of a dominated layer, it influences its yield and its Carbon stocking capacity and hence it influences the forest ecosystem CO2 carbon balance. From this model it is possible to simulate the impact of Climate Change on forests, the feedback of one or more dominated layers in terms of CO2 uptake in a forest stand and the effects of forest management activities for the next years.