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Modeling coupled dynamics of vegetation structure and carbon allocation in forest ecosystem

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The structure and function of soil-vegetation system are closely coupled to the atmosphere through multiple interactions involving exchanges of energy, momentum, moisture, and the radiatively active gas composition of the atmosphere. In addition to the physical nature, human activities and its consequent land use change are recently forcing large and pervasive changes in these interactions. To study the mechanisms, an integrated model including dynamics of vegetation as well as soil material cycle is needed, but such models are still emerging just recently. The model proposed here is composed of three sub-models describing (1) dynamics of plant size distribution, (2) microclimate within the plant canopy and (3) dynamics of organic carbon flow and stock in soil. The first sub-model describes a change in the size distribution of a plant stand as a result of growth and mortality of the individuals. This sub-model gives the canopy architecture of a stand, the amount of litter fall, standing dead and turnover rate of fine roots as inputs to the second and the third sub-models. The second sub-model predicts vertical profiles of microclimate, the photosynthetic and respiration rates of individual plants and the physical environment within soil for given atmospheric boundary conditions and canopy architecture. These outputs are linked to the first sub-model, resulting in a new size distribution at the next time step. The third sub-model describes the turnover processes of soil organic carbon after given litter fall and dead roots. These processes represent a full interaction between vegetation dynamics, microclimate within canopy and material flow in soil. In this paper, we present the structure of the above coupled model for understanding the nature of soil-vegetation system and results of model validation against real forest ecosystem. In addition, we will give some implications for the study of vegetation change impacts on carbon cycle

in terrestrial ecosystem.