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Simulating water vapor, sensible heat and carbon dioxide fluxes over typical terrestrial ecosystems in northeast China based on modified integrated biosphere simulator (IBIS)

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Terrestrial ecosystems affect climate through exchanges of energy, water, momentum, CO_2, trace gases, and mineral aerosols. Changes in community composition and ecosystem structure alter the fluxes and in doing so alter climate. It is essential to improve our understanding of the terrestrial biosphere, not only in terms of the possible impacts of climate change, but also in terms of the interactive role that biospheric processes play in the functioning of the Earth system as a whole. A wide variety of numerical models have emerged in the last decade in an attempt to elucidate global biogeophysical processes related to energy and water. The integrated biopshere simulator (IBIS) of Foley et al. (1996) is designed to simulate such processes. It is designed to integrate a variety of terrestrial ecosystem phenomena within a single, physically consistent model that can be directly incorporated within atmospheric general circulation models (AGCMs). To facilitate this integration, the model is designed around a hierarchical, modular structure and uses a common state description throughout. However, the accuracy of flux estimations from IBIS is restricted due to the constants of maximum capacity of Ribisco to perform the carboxylase function and carbon allocation. Here, we propose a modified IBIS model from the effects of soil nutrients on photosynthesis and the carbon allocation, in order to understand and improve esti-

mates of water vapor, sensible heat and carbon dioxide fluxes over typical terrestrial ecosystems in northeast China.

The effects of soil carbon and nitrogen on leaf photosynthesis are described by the maximum rate of carboxylation V_{cmax} based on a biochemical processes developed by woodward et al.(1995). For a given availability of light (L), water (W), and nitrogen (N), the allocations of carbon to roots (ρ), stem (σ), and leaves (λ) are modified from the allocation scheme for global terrestrial carbon models given by Friedlingstein (1999). In order to validate the performance of modified IBIS, long term observation data of aboveground biomass in meadow steppe from Grassland Research Station of Northeast Normal University (1981-1990), typical steppe from Inner Mongolia Grassland Ecosystem Research Station, the Chinese Academy of Sciences (CAS) (1981-1994), and alpine meadow steppe from Haibei Research Station of Alpine Meadow Ecosystem, CAS (1981-1994), as well as flux observation from Inner Mongolia Typical Grassland Ecosystem Field Observation Station, Jinzhou Agricultural Ecosystem Field Observation Station, Panjin Wetland Ecosystem Field Observation Station, and Changbai Mountains Temperate Forest Ecosystem Field Observation Station from August 2004 to December 2006.

The resulted indicated that the modified IBIS could greatly improve the estimate of aboveground grassland biomass in China, and also simulated the dynamic fluxes of water, heat and carbon fluxes over grassland ecosystems very well.

The results indicated that the accuracy of aboveground biomass and flux estimations from IBIS is serious affected due to the constants of maximum capacity of Ribisco to perform the carboxylase function and carbon allocation. The modified IBIS could greatly improve the estimate of aboveground grassland biomass and fluxes of water, heat and carbon fluxes over typical terrestrial ecosystems in northeast China, including temperate grassland, maize farmland, reed wetland, and forest ecosystems. This study provides a key tool for carbon cycle studies and evaluations of terrestrial ecosystems as it represents processes and provides detailed information as to the workings of the terrestrial carbon system.

Key words: Water vapor flux, sensible heat flux, Carbon dioxide flux, Terrestrial ecosystems, China Modified integrated biosphere simulator (IBIS)