TWO-WAY BIOSPHERE-ATMOSPHERE INTERACTIONS: THEIR IMPLICATIONS FOR SATELLITE OBSERVATIONS OF REGIONAL LAND COVER CHANGES

FINAL REPORT
From: Professor Elfatih Eltahir, MIT
TO: Dr. Jared Entin, Land Surface Hydrology Program, NASA

This final report describes accomplishments of the project (NAG5-8617) (1999-2002): "TWO-WAY BIOSPHERE-ATMOSPHERE INTERACTIONS: THEIR IMPLICATIONS FOR SATELLITE OBSERVATIONS OF REGIONAL LAND COVER CHANGES".

(1) PROGRESS IN THE FIRST YEAR
Significant progress has been achieved during the first year of this project. A new zonally-symmetric model of the coupled biosphere-atmosphere system was developed and validated by comparing to observations. This model not only includes representation of atmospheric dynamics but also new representations of biospheric dynamics. The region of West Africa has been selected as the focus of our research. The atmospheric model is zonally symmetric, and includes representation of atmospheric dynamics, a radiation scheme, a moist convection scheme, a boundary layer scheme, and a cloud parameterization scheme. The biospheric model is the Integrated BIosphere Simulator (IBIS), which includes representation of the water, energy, momentum, and carbon balance, vegetation phenology, and vegetation dynamics. We modified the representation of canopy hydrology in IBIS to account for the impact of rainfall sub-grid variability. The biospheric model and atmospheric model are separately tested against observations. The synchronously coupled model is then used to simulate the biosphere atmosphere system of West Africa.

(2) PROGRESS IN THE SECOND YEAR
Significant progress has been achieved in the second year of the project. The new model has been used to study climate equilibria of the coupled system, long-term natural variability of the coupled system, and response to local anthropogenic forcing as well as remote oceanic forcing. Using a synchronously coupled biosphere-atmosphere model which includes explicit representation of ecosystem dynamics, we show that the equilibrium state of the model is sensitive to initial vegetation distribution. This modeling result supports the existence of multiple climate equilibria. Using the same model, further experiments are carried out to investigate how the coupled system responds to non-permanent vegetation perturbations. Our results demonstrate how transitions between different climate equilibria can take place when governed by the two way biosphere-atmosphere feedback. These findings advance our understanding regarding the mechanisms of climate variability over West Africa. The results of these studies are documented in the several publications that are listed in this report.

(2) PROGRESS IN THE THIRD & FOURTH YEAR

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During the third year, we continued our efforts in this project towards understanding the two-way biosphere-atmosphere interactions. Some of our efforts focussed on the improvement of the representation of land surface hydrology in climate models, in particular the role groundwater aquifers in providing the lower boundary condition of the system. We also looked at the role of sub-grid heterogeneity in shaping the dynamics of biospheric processes at large scales. The third area of investigation involved coupling the biosphere-atmosphere model to a mixed ocean model and investigation of the dynamic behavior of the coupled biosphere-atmosphere-ocean system. We also investigated the role of small scale topographic variability in shaping the African savanna. Another area of investigation was the role of the biosphere in the mid-Holocene climate over West Africa.

During the fourth year we continued some of our efforts on the improvement of the representation of land surface hydrology in climate models, in particular the role groundwater aquifers in providing the lower boundary condition of the system. A Doctoral student (Pat Yeh) was funded to finish his Doctoral research on the representation of groundwater aquifers in climate models. Another Master student (Yeonjoo Kim) was supported to work on the role of micro-topography in shaping Savanna environments.

PUBLICATIONS


**CONFERENCE PRESENTATIONS**


