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Simulating human induced land cover change in the NCAR GCMs

J. Feddema (1), K. Oleson (2), G. Bonan (2), L. Mearns (2), G. Meehl (2) and W. Washington (2)

(1) Department of Geography, University of Kansas, Kansas, USA, (2) Center for Atmospheric Research, USA (feddema@ku.edu / Phone +01 785 864 5534)

Although a number of studies have shown that human land cover impacts can be simulated in GCMs, significant questions remain with respect to land cover change and its effects on climate. One question relates to the potential of land cover impacts in one region affecting the climate of other regions through teleconnection processes. A second question that complicates the understanding of integrated land cover change impacts on climate is that similar human impacts can result in different climate outcomes depending on the nature of the vegetation and surfaces impacted. We have begun to address these questions using the fully coupled NCAR Parallel Climate Model (PCM). Using an IPCC SRES framework to simulate past and future land cover for a number of scenarios, we show that there are significant impacts associated with human induced land cover change.

Historical and future deforestation in mid-latitudes affects daily maximum temperatures in mid-latitudes and is simulated to have a significant impact of mean daily temperature ranges. These changes are largely related to land cover impacts on albedo and the subsequent impacts on the energy balance. Tropical deforestation tends to lead to warmer surface temperatures and typically affects the energy balance by altering the water cycle and the disposition of energy from the surface. While these generalities hold true to some degree, we also found that similar impacts, such as tropical deforestation, can have different climate outcomes in different regions. For example, deforestation in the Amazon lead to significantly greater local climate responses compared to the same process in Indonesia and Southeast Asia. This differential response is in part related to the difference in circulation regimes over these regions. Our results also suggest that land cover changes in one region can potentially lead to teleconnec-

tions and climate impacts in other locations. In particular deforestation in the Amazon appears to impact the climate of the southwestern US, and tropical Ocean temperatures over the Atlantic and Pacific Oceans. Additionally, land cover impacts in Africa, Australia and southern Asia appear to affect the Asian monsoon circulation.

While these results are promising and suggest that land cover change is an important component of the human impact on climate, ours, and most other studies, have only focuses on land cover conversion from natural vegetation types to generic agricultural parameterizations. In order to obtain a better understanding of the human land cover impacts more sophisticated models need to be introduced to simulate such impacts as urbanization and human impacts on soils and hydrology. We plan to incorporate other human impacts in future work using the CCSM. As a first step in this process we have introduced an urban model. We will show some preliminary results of these efforts and some of our work to develop high resolution datasets that allow the effective simulation of urbanization and other human impacts.