Impacts of land use change on atmospheric circulation and ecosystem dynamics in the Amazon from a coupled atmosphere-ecosystem model

The Amazon rainforest is amongst the largest contiguous tropical rainforest, contributing significantly to the Earth's water, energy, and carbon cycle. Over the past 40 years, about 20% of the original area has been converted to croplands and pastures directly
impacting the total carbon stored in the forest. However, deforestation may also cause important changes in the energy and water cycles, and consequently the regional climate, which could further affect the growth and maintenance of the remaining forests. In this study, we evaluate how changes in the cloudiness and precipitation due to land use change affect the dynamics of the remaining ecosystem, using a fully coupled ecosystem dynamics - atmosphere model (ED-BRAMS). ED-BRAMS provides a realistic representation of both sub-grid variability in vegetation and regional atmospheric dynamics. An equilibrium potential ecosystem structure is obtained starting from a prescribed low-density of seedlings of tropical and subtropical plant functional types and imposing meteorological conditions from an improved reanalysis product developed by Sheffield et al. (2006). Disturbance scenarios are generated using historical rates of land use change from 1940 to the current day, and then projections until 2039. The climate-ecosystem response to the different land use states is then investigated using the coupled model and the results are compared to observations and estimations from remote sensing. Preliminary results indicate that land use change spatially re-distributes precipitation across the Amazon. When cleared areas become sufficiently large, there is a significant change in the precipitation rates. Increased precipitation rates are observed along sharp transitions between heavily deforested areas and intact forests, whereas decreased rates are seen within the forested areas next to these transitions. Areas primarily impacted by selective logging showed a less consistent pattern of change. The reduction in rainfall did not always cause reduction in productivity in the remaining forests, as the ecosystem did not appear to become water stressed.

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