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Human impact on atmospheric water vapor due to land use changes

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This study investigates climate response in the atmosphere due to land use change in a climate model. Earlier studies show that the biogeophysical changes caused by land use change induce a global warming, but they also point at the regional differences by replacing trees with crops. In mid- and high latitude it is more likely that land use changes lead to a surface cooling, and that the surface albedo change effect is higher than the change in evapotranspiration, which is the driving mechanism that causes a surface warming in the tropics. Climate simulations of land use change are likely to be sensitive to the surface albedo value of cropland, and this may explain the diversity in the results among the studies.

The main focus in this work is in particular water vapor changes in the atmosphere caused by human deforestation. In additional simulations we exclude the effect of surface albedo change alone to further understand the possible impacts of land use change on climate. The climate simulations were performed with the National Center for Atmospheric Research (NCAR) Community Land Model 3.5 (CLM) coupled to the Community Atmosphere Model 3.0 (CAM) and a mixed layer ocean model. We take advantage of using the Moderate Resolution Imaging Spectroradiometer (MODIS) surface albedo product to represent surface albedo in the CLM for both present day and for the natural potential vegetation.

Results are shown as the difference between two model runs with either present day or potential natural vegetation and surface albedo. All simulations are averaged over the last 20 years of a 30 year integration and given as annual means. We find a small global warming at the surface and an increase of total available water vapor in the atmosphere. We also discover regional differences such as surface temperature changes and water vapor changes of different signs in the tropics and mid-latitudes. Between 30˚S – 30˚N, the model suggests a 0.1K increase of surface temperature, whereas in the mid-latitudes (30˚N – 60˚N) there has been a surface cooling of up to 0.2 K. Vertical profiles of atmospheric water vapor show up to 2 % more available moisture in the tropics and a reduction of approximately 2 % in mid-latitudes.