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The effects of smoke aerosols, land-use change and water vapor reduction on the shortwave radiative budget over the Amazônia

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Simultaneous CERES (Clouds and the Earth's Radiant Energy System) and MODIS (Moderate Resolution Imaging Spectrometer) sensors retrievals were used to calculate the changes in radiation fluxes resulting from deforestation in the Amazon during the peak of the biomass burning seasons from 2000 to 2009. The energy balance of the region is modified by the emission of biomass burning aerosols, changes in surface properties and in the atmospheric water vapor column.

The direct radiative forcing (RF) of biomass burning aerosols and the RF due to surface albedo changes, triggered by deforestation in the Amazonia, were calculated using two different methodologies. MODIS's bidirectional reflectance distribution functions (BRDF) product and biomass burning aerosol properties retrieved by AERONET were used in a radiative transfer code, to expand the instantaneous radiative forcing values, obtained during the satellite overpass, into 24-hour RF average.

The mean direct RF of aerosols at the TOA during the biomass burning season for the 10-year period was -8.2 $\pm$ 2.1 W/m^2 and -5.2 $\pm$ 2.6 W/m^2, depending on the methodology applied. The spatial distributions of the direct radiative forcing of aerosols over the Amazon Basin show that for high concentrations of aerosols, the daily average of the RF at the TOA can reach up to -30 W/m^2. The surface reflectance strongly influences the direct RF of aerosols. The impact of aerosols over different surface types was analyzed, indicating that the direct RF is systematically more negative over forest than over cerrado areas.

The mean annual land use change RF, due to deforestation, in Rondônia was determined as -7.4 $\pm$ 0.9 W/m^2 and -8.1 $\pm$ 1.0 W/m^2, using the two different methodologies. Biomass burning aerosols impact the radiative budget for approximately 2-3 months per year, whereas the surface albedo impact is observed throughout the year. Because of this seasonality, the estimated impact in the Amazonian annual radiative budget due to surface albedo change is much higher than the annual impact due to aerosol emissions.

The influence of deforestation in the atmospheric water vapor content, and its impact in the shortwave radiative budget, was assessed using water vapor column measurements obtained by AERONET sunphotometers. It was observed that the column water vapor is on average smaller by about 0.35 cm (around 10% of the total column water vapor) over deforested areas compared to forested areas. The effect of reducing atmospheric water vapor column contributes to an increase in the upward shortwave radiative flux at the TOA. The large radiative forcing values obtained in this work indicate that deforestation could have strong implications on convection, cloud development and the ratio of direct and diffuse radiation, which impacts the carbon uptake by the forest, therefore, changing the photosynthetic rate.