The Role of Fire on Water and Carbon Cycling Across Two Contrasting Terra Firme Amazonian Forests

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November 22, 2022

Abstract

Recently intensified forest fires in the Amazon region have led to large-scale forest losses, particularly in Brazil, after more than a decade of effective forest conservation policy. Analysis of the time course of fire impacts on water and carbon cycling is required for accurate measurement of changes in the forest-atmosphere interactions. Moreover, measurements must also account for natural variations associated with vegetation phenology, and generally direct and indirect effects of environmental changes at annual, seasonal and sub-annual time scales. Here, we study the recovery of two contrasting terra firme forests affected by fire in eastern (sub-montane ombrophile forests) and western (bamboo dominated forests) Amazonia in terms of water and carbon fluxes utilizing remote sensing (Moderate Resolution Imaging Spectroradiometer, MODIS) and climate reanalysis data (Global Land Data Assimilation System, GLDAS). Our results showed that fires significantly increased land surface temperature and air temperature in the forests over different time scales. However, the forests showed an ability to recover their original states in terms of coupling between the carbon and water cycles based on the comparison of the periods before and after the fires. Results from a wavelet analysis showed an intensification in annual and seasonal fluctuations, and in some cases (e.g., evapotranspiration) sub-annual fluctuations. Understanding the mechanisms controlling the forest-atmosphere interactions are essential for assessing how forest fires will influence the exchanges of water and carbon in the future. Improving data and theory about the impacts of fire and other disturbances on the energy balance is essential to improve earth systems models for forecasting the role of tropical forest fires in climate change. Within this context, our approach and, consequently, the results obtained here will help improve the understanding of how fires in terra firme Amazonian forests impact land-atmosphere coupling at different spatial and temporal scales.

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