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Impacts of Climate Change, Land-use and CO_2 Emissions on Amazonian Hydrological Processes in 21st Century: Multi-model Projections

Ke Zhang (1), Andrea de Almeida Castanho (2), David Galbraith (3), and Paul Moorcroft (4)

(1) Hohai University, College of Hydrology and Water Resources, Nanjing, China (kzhang@hhu.edu.cn), (2) Department of Agricultural Engineering, Universidade Federal do Ceará, Ceará, Brazil, (3) School of Geography, University of Leeds, Leeds, UK, (4) Department of Organismic and Evolutionary Biology, Harvard University, Massachusetts, USA

Climate change and deforestation have imposed regional-scale perturbations on the ecohydrological regimes of the Amazon and are predicted to cause larger negative impacts on the carbon dynamics and hydrological cycles in the 21st century. However, global climate models (GCMs) vary greatly in their projections of future climate change in the Amazon, giving rise to uncertainty in the expected hydrological responses of the Amazon over the coming century. We explore the possible hydrological responses of the Amazon basin under projected climate and land-use changes in the 21st century using three state-of-the-art terrestrial biosphere models driven by three representative, bias-corrected climate projections from three IPCC GCMs (NCAR PCM1, NCAR CCSM3, and HadCM3) under the SRES A2 scenario, coupled with two land-use change scenarios (a business-as-usual and a strict governance scenario). We also analyze the relative roles of climate change, CO_2 fertilization, land-use change, and fires in driving the projected Amazonian hydrological processes. Our results indicate that the impacts of climate change depend strongly on the direction and severity of projected precipitation changes in the region. Under the most extreme climate change projected by GCMs, climate change alone may lead to evapotranspiration reduction up to 20%. The models also predict that CO_2 fertilization can substantially reduce evapotranspiration by enhancing water-use efficiency. Land-use change can cause additional evapotranspiration reduction and increase runoff partition. All results suggest that the Amazon basin will experience substantial changes in hydrological regimes under the projected climate changes and correspondingly alter water resources in this region.