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Constraining Amazonian ecosystem and biogeochemical responses to variability from IPCC AR4 climate scenarios

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The Amazon Basin is a global hotspot for biogeochemistry, climatic-teleconnections, and biodiversity. Recent research has shown that the tropical rainforests in the Basin are sensitive to interannual fluctuations in climate which is strongly coupled to feedbacks from land-use change and ecophysiological adaptations to atmospheric CO_2. A primary concern is that large-scale Amazonian dieback and conversion of rainforest to savanna will occur this century in response to climate and land-use change, and rising CO_2. To address the uncertainty of projected Amazon climate and ecosystem dynamics we evaluated the suite of recent IPCC AR4 scenarios using an offline-terrestrial biosphere model (Lund-Potsdam-Jena Dynamic Global Vegetation Model). Two indices were developed to compare the variability between GCM scenarios, 1) An index describing the magnitude of change in plant functional type (PFT) composition from 2000 to 2100, and 2) An index describing drought stress based on modeled potential to actual stomatal conductance. Secondly, we evaluated which temperature and precipitation patterns most likely lead to Amazonian dieback and generalize what the prerequisite conditions for dieback include. The stability of the Amazon rainforest to climate change is uncertain in part due to challenges of modeling large-scale tropical vegetation dynamics but also because of variability between GCM scenarios. While offline-models are unable to simulate feedbacks to regional climate from changing land cover, this analysis provides a reasonable constraint on the variability of Amazonian ecosystem dynamics to 62 AR4 climate scenarios.