Geophysical Research Abstracts
Vol. 20, EGU2018-15518, 2018
EGU General Assembly 2018

Importance of carbon dioxide physiological forcing on projected Amazonian precipitation change

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The Amazon rainforest is a key component of the global climate system accounting for 40% of global tropical forest area. Vegetation and the carbon balance of the Amazon are sensitive to changes in precipitation patterns. Future projections of east Amazonian precipitation indicate drying, but they are uncertain and poorly understood. In this study we analyse the precipitation response over the Amazon region to individual atmospheric forcings using ten global climate models participating in the Precipitation Driver Response Model Intercomparison Project (PDRMIP). Black carbon is found to drive reduced precipitation over the Amazon due to temperature-driven circulation changes, but the magnitude is uncertain. Carbon dioxide drives reductions in precipitation concentrated in the eastern Amazon, mainly due to a robustly negative, but highly variable in magnitude, fast response. Increasing carbon dioxide concentration significantly reduces evaporation over the Amazon due to reduced stomatal opening of plants (physiological effect). We find that the physiological effect of carbon dioxide is the dominant driver of the fast precipitation response and also contributes to the large model spread. Using a simple model we show that carbon dioxide physiological effects dominate future multi-model mean projections over the Amazon. However, in individual models temperature-driven changes can be large, but due to little agreement, they largely cancel out in the model mean. Our findings outline the importance of reducing uncertainties associated with vegetation schemes in global climate models.