EGU22-12669
https://doi.org/10.5194/egusphere-egu22-12669
EGU General Assembly 2022

Diverging simulated effects of future drought stress on the Amazon rainforest

Phillip Papastefanou[1,2], Thomas Pugh[1], Allan Buras[2], Annemarie Eckes-Shephard[1], Katrin Fleischer[3], Thorsten Grams[2], Konstantin Gregor[2], Thomas Hickler[4], Andreas Krause[2], David Lapola[5], Daijun Liu[6], Christian Zang[7], and Anja Rammig[2]

[1]Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden
[2]Technical University of Munich, Germany
[3]Max Planck Institute for Biogeochemistry, Jena, Germany
[4]Senckenberg Biodiversity and Climate Research Centre (BiK-F), Frankfurt/Main, Germany
[5]University of Campinas – UNICAMP, Campinas, Brazil
[6]University of Vienna, Vienna, Austria
[7]Weihenstephan-Triesdorf University of Applied Sciences, Freising, Germany

The Amazon rainforest is the largest intact tropical forest ecosystem and stores about 120 Pg of carbon. To this day, it acts as a carbon sink by taking up carbon from the atmosphere, however, long-term observations show a decline in strength of this carbon sink, a trend that at current rates would likely lead to the Amazon basin becoming a carbon source around year 2050. The reasons for this declining trend are disputed, increasing temperatures and more frequent and intense droughts are becoming the potential drivers. Vegetation modelling offers a possibility to disentangle the effects of these drivers, however, most Dynamic Global Vegetation Models (DGVMs) or Earth System Models (ESMs) are still not able to reproduce this observed carbon sink decline and the correct response of vegetation to drought stress. Here, we apply a new version of the DGVM LPJ-GUESS with improved plant hydraulics. It is one of the few state-of-the-art DGVMs that can successfully (1) capture the carbon dynamics under severe drought stress and (2) reproduce the current observed declining trend of the carbon sink. We investigate whether the Amazon rainforest will recover its sink strength or turn into a carbon when driven by climate projection source from the latest Inter-Sectoral Impact Model Intercomparison Project (ISIMIP 3a), using multiple forcing datasets. The simulations show strongly diverging response patterns of the Amazon rainforest that depend on both the selected emission scenario (e.g. SSP5-8.5 or 1-2.6) and the climate model (e.g. UKESM vs. ESM4). Using the SSP5-8.5 scenarios we find higher drought-induced carbon losses in the second half of the 21st century compared to the first half of the century. However, these losses are partly (e.g. ESM4) or completely (e.g. UKESM) outweighed by higher carbon gains induced by higher CO_2 concentrations. Our findings highlight the complex interplay of CO_2 fertilization, higher atmospheric dryness (more negative vapour pressure deficit) and its effects on stomatal conductance.