EGU22-7120
https://doi.org/10.5194/egusphere-egu22-7120
EGU General Assembly 2022

The effect of differing drought-heat signatures on terrestrial carbon dynamics and vegetation composition: a multi-model comparison

Elisabeth Tschumi[1], Sebastian Lienert[1], Ana Bastos[2], Konstantin Gregor[3], Fortunat Joos[1], Jürgen Knauer[4], Julia Pongratz[5,6], Anja Rammig[3], Wim Thiery[7], Karin van der Wiel[8], Hao-wei Wey[9], Karina Williams[10], Yi Yao[7], Sönke Zaehle[2], and Jakob Zscheischler[1,11]

[1]University of Bern, Climate and Environmental Physics, Bern, Switzerland
[2]Department Biogeochemical Integration, Max Planck Institute for Biogeochemistry, Jena, Germany
[3]TUM School of Life Sciences, Technical University of Munich, Freising, Germany
[4]Hawkesbury Institute for the Environment, Western Sydney University, Sydney, Australia
[5]Department of Geography, Ludwig-Maximilians-Universität München, Munich, Germany
[6]Max Planck Institute for Meteorology, Hamburg, Germany
[7]Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Brussels, Belgium
[8]Royal Netherlands Meteorological Institute, De Bilt, The Netherlands
[9]GEOMAR, Helmholtz Centre for Ocean Research, Kiel, Germany
[10]College of Life and Environmental Sciences, Geography, University of Exeter, Exeter, Great Britain
[11]Department of Computational Hydrosystems, Helmholtz Centre for Environmental Research -- UFZ, Leipzig, Germany

The frequency and severity of droughts and heatwaves are projected to increase under global warming. However, their impacts on the terrestrial biosphere and the anthropogenic CO_2 sink remain poorly understood. Here we analyse the effects of six hypothetical climate scenarios with stationary climate but differing drought-heat signatures on vegetation distribution and land carbon dynamics, as modelled by seven state-of-the-art dynamic global vegetation models. The six forcing scenarios are sampled from a long climate model simulation and consist of a control scenario representing a natural climate, a scenario with no hot and dry extremes, one with no compound hot and dry extremes but univariate extremes are possible, one with only hot extremes, one with only dry extremes, and one with both hot and dry extremes. Models show substantial differences in their vegetation coverage response to the different scenarios. While in some models, climate with no droughts and heatwaves favours tree growth, this is not the case for other models, where grasses benefit. Similarly, climates with frequent droughts promote grasses in some models and reduce forest growth in others. Models tend to agree that a climate with frequent concurrent droughts and heatwaves leads to reduced tree cover and increased grass cover. The changes in coverage are mirrored by changes in gross and net carbon fluxes. The stark differences among model responses illustrate the different modelling processes dealing with heat and drought stress and how they are differently affected by the extremes. Overall, this comparison helps quantify model uncertainties and process differences that are important for how vegetation behaves under extreme climate events.

Our study illustrates how factorial model experiments can be employed to disentangle the impacts from single and compound extremes. The findings from this model comparison may also help to identify sources of uncertainty in carbon cycle projections.