EGU2020-8031
https://doi.org/10.5194/egusphere-egu2020-8031
EGU General Assembly 2020

Legacy effects from historical environmental changes dominate future terrestrial carbon uptake

Andreas Krause[1], Almut Arneth[2], and Anja Rammig[1]
[1]TUM School of Life Sciences Weihenstephan, Technical University of Munich, 85354 Freising, Germany (andy.krause@tum.de)
[2]Institute of Meteorology and Climate Research, Atmospheric Environmental Research, Karlsruhe Institute of Technology, 82467 Garmisch-Partenkirchen, Germany.

The carbon balance of terrestrial ecosystems is determined by environmental drivers (chiefly related to climate and land use) which interact with each other and change over time. In particular, ecosystems are presently still affected by past environmental changes because they have not yet reached equilibrium with their environment. However, the magnitude and drivers of this legacy effect for the upcoming decades are still unclear. Here, we use the dynamic global vegetation model LPJ-GUESS to calculate the effects of historical (1850-2015) and future (2015-2099, exemplarily for the high emission/moderate deforestation scenario SSP5-8.5) environmental changes on historical and future terrestrial carbon cycling and to quantify the contributions of the following environmental drivers: climate change, CO_2 fertilization, agricultural expansion, shifting cultivation frequency, wood harvest, nitrogen deposition, and nitrogen fertilization.

According to our simulations, the land represented a cumulative net carbon source (-154 GtC) over the historical period mainly due to deforestation, wood harvest, and negative climate change impacts partly offset by carbon uptake via increased CO_2 levels and nitrogen input. In contrast, the land is simulated to act as a net carbon sink (+118 GtC) over the 21st century. This is mostly a result of historical environmental changes as ecosystems still adapt to present-day CO_2 and nitrogen availability as well as long-term vegetation regrowth following agricultural abandonment and wood harvest. The net impact of future environmental changes on future carbon cycling is much smaller because effects from individual environmental drivers largely compensate. Historical environmental changes dominate future terrestrial carbon cycling at least until mid-century when legacy effects gradually diminish and future environmental changes start to trigger carbon accumulation. Our results suggest that legacy effects persist even many decades after environmental changes occurred and need to be considered when interpreting alterations of the terrestrial carbon cycle.