EGU21-819
https://doi.org/10.5194/egusphere-egu21-819
EGU General Assembly 2021

Carbon cycle response to temperature overshoot beyond 2 °C – an analysis of CMIP6 models

Irina Melnikova[1,2], Olivier Boucher[1], Patricia Cadule[1], Philippe Ciais[3], Thomas Gasser[4], Yann Quilcaille[4], Hideo Shiogama[2], Kaoru Tachiiri[5], Tokuta Yokohata[2], and Katsumasa Tanaka[2,3]

[1]Institut Pierre-Simon Laplace, Sorbonne Université / CNRS, France
[2]National Institute for Environmental Studies, Center for Global Environmental Research, Japan (irina.melnikova.russia@gmail.com)
[3]Laboratoire des Sciences du Climat et de l'Environnement (LSCE), Commissariat à l'énergie atomique et aux énergies alternatives (CEA CNRS UVSQ), Gif-sur-Yvette, France
[4]International Institute for Applied Systems Analysis (IIASA), Austria
[5]Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Japan

There is a substantial gap between the current emissions of greenhouse gases and levels required for achieving the 2 and 1.5 °C temperature targets of the Paris Agreement. Understanding the implications of a temperature overshoot is thus an increasingly relevant research topic. We carry out a study as part of the "Achieving the Paris Agreement Temperature Targets after Overshoot (PRATO)" project of the MOPGA programme on the 2 °C overshoot of the Paris Agreement temperature target. We explore the carbon cycle feedbacks over land and ocean in the SSP5-3.4-OS overshoot scenario by using an ensemble of Coupled Model Intercomparison Project 6 Earth system models. Models show that after the CO_2 concentration and air temperature peaks, land and ocean are decreasing carbon sinks from the 2040s and become sources for a limited time in the 22nd century. The decrease in the carbon uptake precedes the CO_2 concentration peak. The early peak of the ocean uptake stems from its dependency on the atmospheric CO_2 growth rate. The early peak of the land uptake occurs due to a larger increase in ecosystem respiration than the increase in gross primary production, as well as due to a concomitant increase in land-use change emissions primarily attributed to the wide implementation of biofuel croplands. The carbon cycle feedback parameters amplify after the CO_2 concentration and temperature peaks, so that land and ocean absorb more carbon per unit change in the atmospheric CO_2 change (stronger negative feedback) and lose more carbon per unit temperature change (stronger positive feedback) compared to if the feedbacks stayed unchanged. The increased negative CO_2 feedback outperforms the increased positive climate feedback. This feature should be investigated under other scenarios and reflected in simple climate models.