EGU21-9837
https://doi.org/10.5194/egusphere-egu21-9837
EGU General Assembly 2021

Spatio-temporal comparison of different approaches to derive land use and land cover change emissions by models

Wolfgang Obermeier[1] and the LASC task-force[*]
[1]Ludwig-Maximilians-Universität, Geosciences, Physical Geography and Land Use Systems, München, Germany
(wolfgang.obermeier@lmu.de)
[*]A full list of authors appears at the end of the abstract

The quantification of the net carbon flux from land use and land cover changes (f_{LULCC}) is essential to understand the global carbon cycle, and consequently, to support climate change mitigation. However, large-scale f_{LULCC} is not directly measurable, and can only be inferred by models, such as semi-empirical bookkeeping models, and process-based dynamic global vegetation models (DGVMs). By definition, f_{LULCC} estimates between these two model types are not directly comparable. For example, transient DGVM-based f_{LULCC} of the annual global carbon budget includes the so-called Loss of Additional Sink Capacity (LASC). The latter accounts for environmental impacts on the land carbon storage capacities of managed land compared to potential vegetation which is not included in bookkeeping models. Additionally, estimates of transient DGVM-based f_{LULCC} differ from bookkeeping model estimates, since they depend on arbitrarily chosen simulation time periods and the timing of land use and land cover changes within the historic period (which includes different accumulation periods for legacy effects). However, DGVMs enable a f_{LULCC} approximation independent of the timing of land use and land cover changes and their legacy effects by simulations run under constant pre-industrial or present-day environmental forcings.

In this study, we analyze these different DGVM-derived f_{LULCC} definitions, under transiently changing environmental conditions and fixed pre-industrial and fixed present-day conditions, within 18 regions for twelve DGVMs and quantify their differences as well as climate- and CO_2-induced components. The multi model mean under transient conditions reveals a global f_{LULCC} of 2.0±0.6 PgC yr^{-1} for 2009-2018, with ~40% stemming from the LASC (0.8±0.3 PgC yr^{-1}). Within the industrial period (1850 onward), cumulative f_{LULCC} reached 189±56 PgC with 40±15 PgC from the LASC.

Regional hotspots of high LASC values exist in the USA, China, Brazil, Equatorial Africa and Southeast Asia, which we mainly relate to deforestation for cropland. Distinct negative LASC estimates were observed in Europe (early reforestation) and from 2000 onward in the Ukraine (recultivation of post-Soviet abandoned agricultural land). Negative LASC estimates indicate that fLULCC estimates in these regions are lower in transient DGVM simulations compared to bookkeeping-approaches. By unraveling the spatio-temporal variability of the different DGVM-

derived f_{LULCC} estimates, our study calls for a harmonized attribution of model-derived f_{LULCC}. We propose an approach that bridges bookkeeping and DGVM approaches for f_{LULCC} estimation by adopting a mean DGVM-ensemble LASC for a defined reference period.

LASC task-force: Wolfgang A. Obermeier, Julia E.M.S. Nabel, Tammas Loughran, Kerstin Hartung , Ana Bastos, Felix Havermann, Peter Anthoni, Almut Arneth, Daniel S. Goll, Sebastian Lienert, Danica Lombardozzi, Sebastiaan Luyssaert, Patrick C. McGuire, Joe R. Melton, Benjamin Poulter, Stephen Sitch, Michael O. Sullivan, Hanqin Tian, Anthony P. Walker, Andrew J. Wiltshire, Soenke Zaehle and Julia Pongratz