S1: Supplementary material 1

A1. JSBACH simulations

Simulations were conducted with revision 7277 of cosmos-landveg-fom, a svn branch of revision 7215 of cosmos-landveg, the former JSBACH development branch of the department "The Land in the Earth System" of the Max Planck Institute for Meteorology.

Simulations were executed on the IBM Power 6 machine BLIZZARD at the German Climate Computing Center (DKRZ).

Growth-based (GB) forest harvesting is implemented in this model version as described in the methods section of the main text. A modification over earlier JSBACH versions is that wood harvest applies just to harvesting from all woody PFTs and specifically from the above-ground wood carbon pool. To isolate the effects of different wood harvest rules, we do not apply land-cover change and dynamic biogeographic vegetation shifts for our future scenarios. We take into account changes in wood carbon pool, natural mortality and forest disturbances to determine the net annual increment of the above-ground wood carbon pool as the maximum amount to be harvested from forest areas.

A1.1 Initial state in 2006

All simulations described in the paper started in 2006 from the same initial conditions. These conditions base on a spin-up of the terrestrial system state using the MPI-ESM climate from the historical (1850-2005) CMIP5 experiment (Giorgetta et al., 2013) and land-use change and wood harvest data from Hurtt et al. (2011).

The initial state was derived carrying out three consecutive simulations. (I) An initial simulation with JSBACH to spin-up photosynthesis, phenology, hydrology and running climatic means required by the disturbance module of JSBACH. This simulation was forced

by cycling the first 30 years (1850-1879) of the historical CMIP5 experiment for four times. Wood harvest was fixed to the level of the initial year 1850 and no land-use change was applied. (II) A simulation with the stand-alone carbon cycle module of JSBACH to equilibrate the carbon pools with respect to the driving climate. This simulation was forced by NPP, LAI and climatic means, resulting from the preceding JSBACH simulation. (III) A second JSBACH simulation resuming the first JSBACH simulation, but starting from the equilibrated carbon pools. In this second simulation the full transient (1850-2005) climate from the historical CMIP5 experiment was used and land-use change and wood harvest were prescribed according to the data from Hurtt et al. (2011).

A1.2 Reference level for GB

An important decision for our study is the definition of the reference level of the wood carbon pool to be kept constant in the future applying GB. As one of the main goals of our study is to estimate potentials for wood harvesting under future climate scenarios, consistent with the historic past, we refer to the current level of wood carbon pools. The reference level for the GB simulations was therefore derived from the maximum simulated wood carbon per grid-cell and PFT in the period from 1996 to 2005 under the historical JSBACH simulation (see A1.1 simulation III). Because the historical JSBACH simulation was subject to land-use and land-cover changes maximum wood carbon densities were used instead of wood carbon stocks.

A1.3 Simulation of GB and MF under present-day climate

These simulations (GBpd and MFpd) keep the current level of wood carbon pools constant as described above in A1.2 and apply the GB harvest rule to global and managed forest area.

However, they are not forced by a transient but a cycled detrended present-day climate of the period 1991-2020 with a constant CO_2 concentration (381 ppm) as the average value of the period (1991-2020). Figure S1 shows the development of wood carbon pool and harvested amount resulting in the simulation GBpd compared to the 6 simulations described in the main text. GBpd realizes a higher wood harvest (+3.2 PgC) than RCPs (~1.2 PgC) at the beginning of the simulations and equals the RCP8.5 wood harvest at the end of the century. GBpd diverges from the GB2.6, GB4.5, and GB8.5 wood harvest amounts largely towards the end of the century and remains below these figures. The geographical allocation of realized wood harvest amount as shown below in GBpd in Figure S2 resembles largely the other GBs (see Figure 2 in the manuscript), however, the amount of harvested wood is lower. Values for the simulated wood harvest from MFpd is lower than GBpd because of limiting forest harvest to managed forest area (excluding primary forest area). Figure S3 shows the net mitigation of MF forced by present day climate. Logically, the annual harvest amount stay more or less constant (~3.2 PgC) in the 21st century. This is exactly resembling the concept of sustained yield if no changes in forest growth is expected. As a result, MFpd would result in a lower net mitigation potential (~150 PgC) than GB and MF (see Figure 4 in text for details), applying the same life cycle analysis described in section 2.6.

Figure S1 Development of global standing wood carbon pools forced by three different RCP scenarios and a present-day (pd) forcing, subject to the harvesting rules of the representative concentration pathways (RCP2.6, RCP4.5 and RCP8.5) or subject to growth-based harvesting (GB2.6, GB4.5, GB8.5, and GBpd) (1a). Development of RCP wood harvest rates, of the growth potential of forests under GB and of the harvest potential under GB limited to global managed forest area (MF2.6, MF4.5, MF8.5, and MFpd) (1b). All lines are smoothed over 10 years.

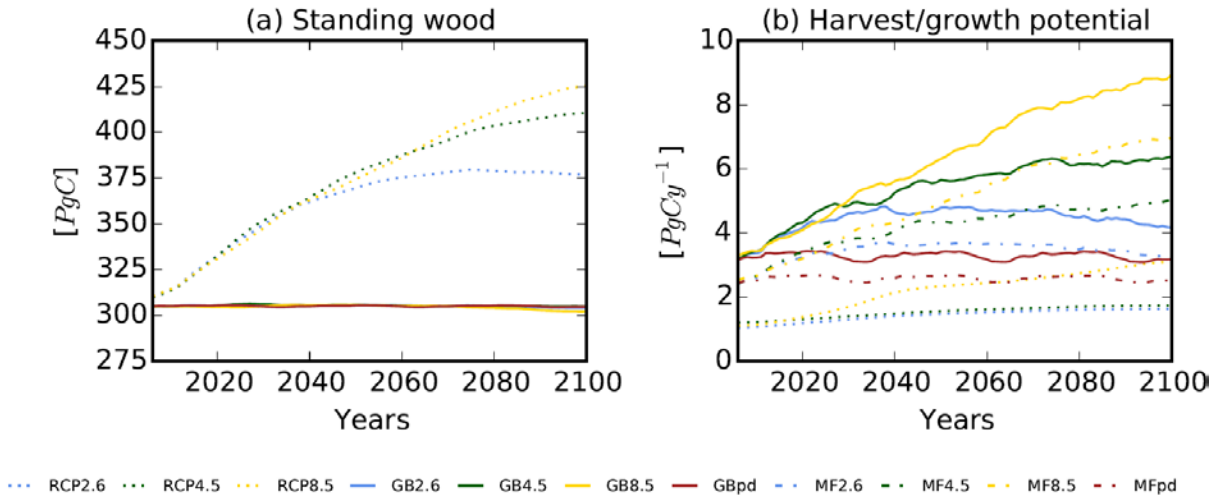


Figure S2 Allocation of wood harvest applying growth-based harvesting rule to the global forest area (GB) and limited to managed forest area (MF) under present-day forcing summed over the entire simulated period (2006-2100).

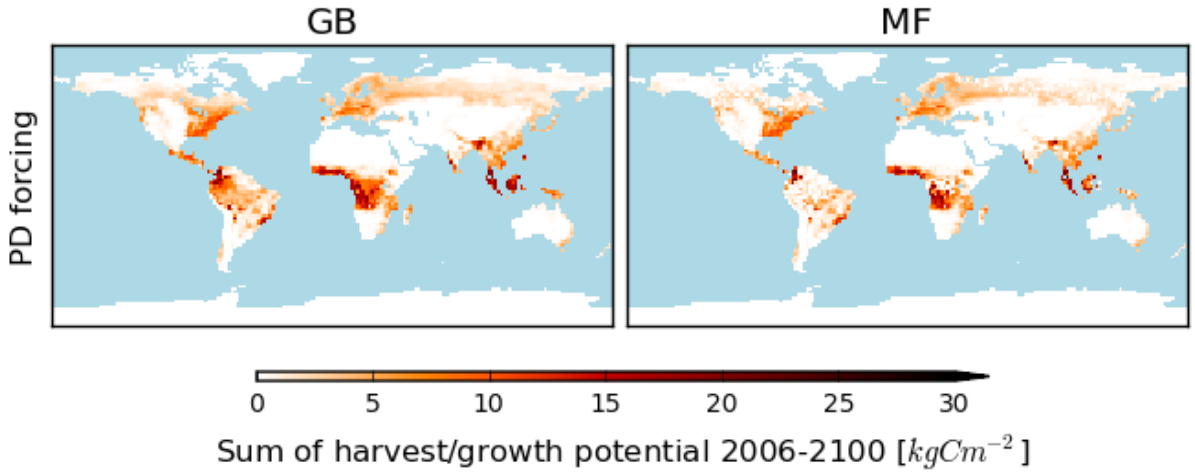
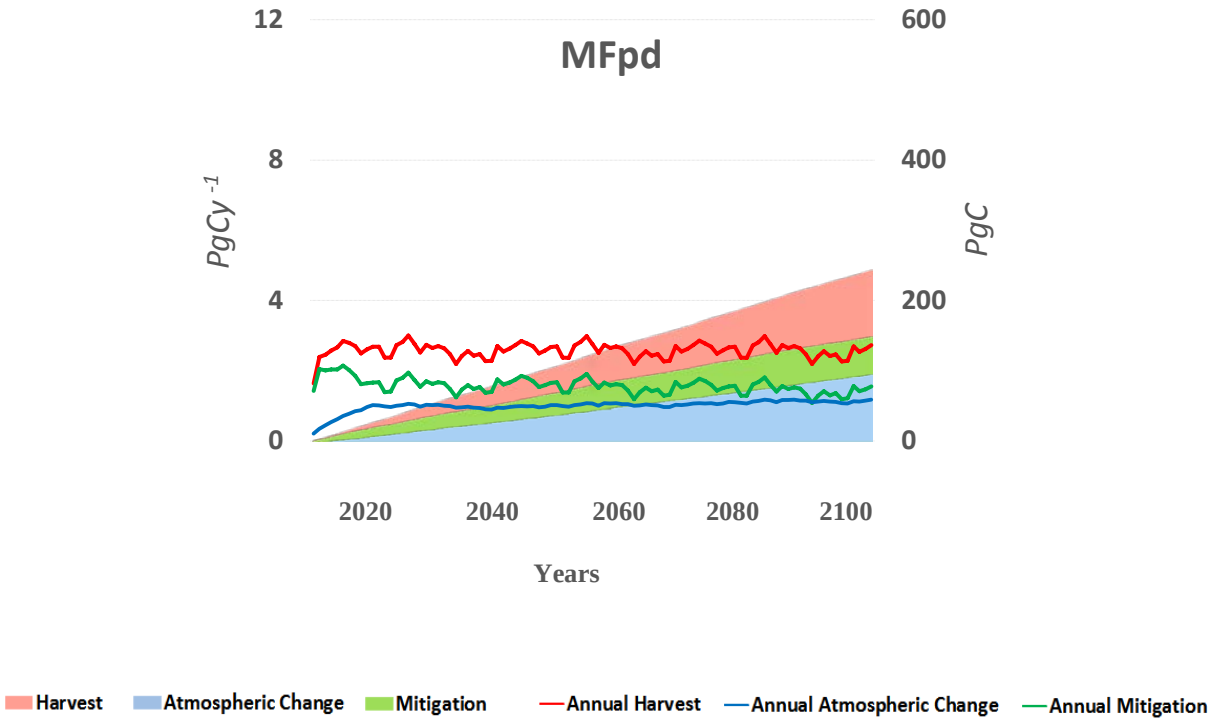


Figure S3 Net mitigation potentials of simulated wood harvest from growth-based harvest rule applied to managed forest area under cycled present day forcing (MFpd). Left axis shows the annual carbon fluxes due to harvested material and product decay changing atmospheric CO_2 concentration, and the mitigation potential of wood products as the difference of both. Right axis accumulates the annual figures over time.



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