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The long-term impact of transgressing planetary boundaries on biophysical atmosphere–land interactions

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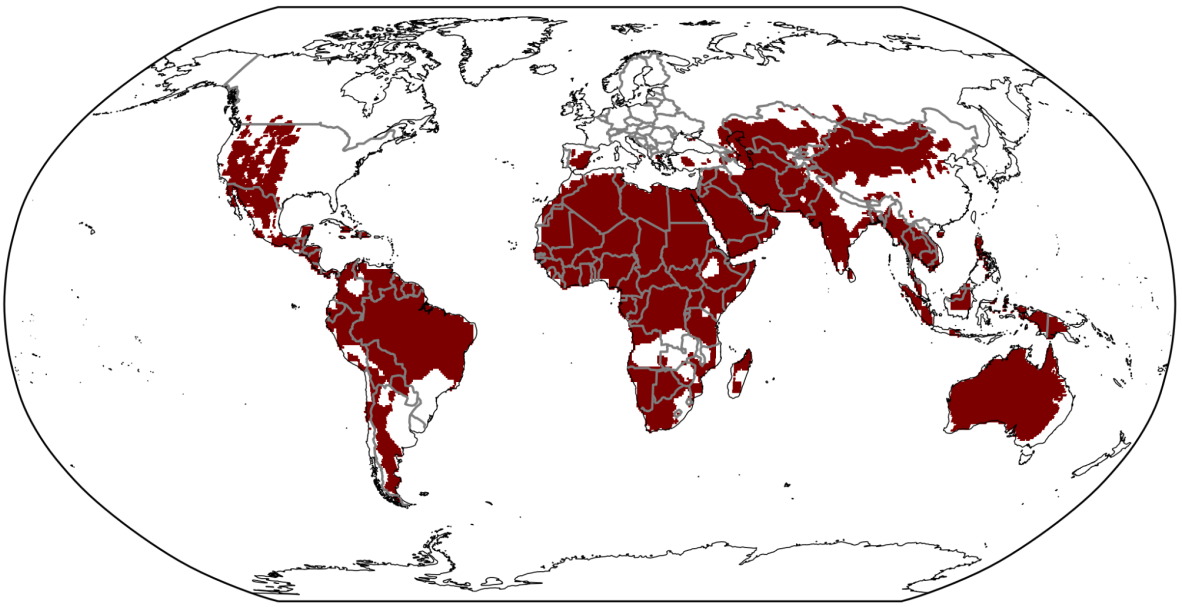

Figure S1. Tropical ecosystems according to Köppen and Geiger (Kottek et al. 2006)

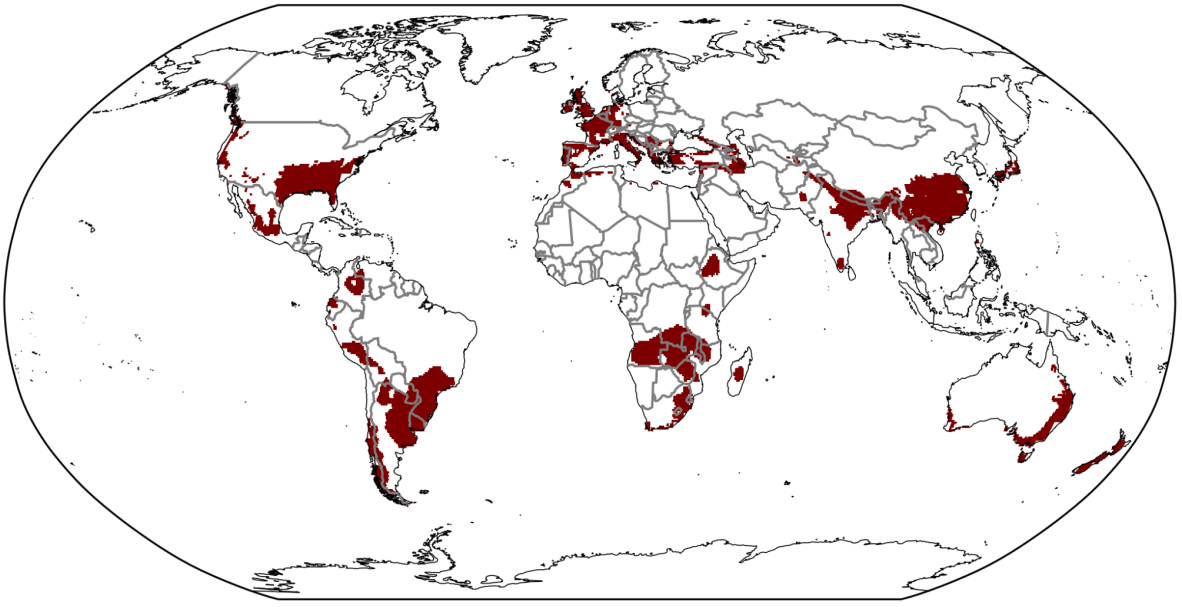

Figure S2. Temperate ecosystems according to Köppen and Geiger (Kottek et al. 2006)

Figure S3. Boreal ecosystems according to Köppen and Geiger (Kottek et al. 2006)

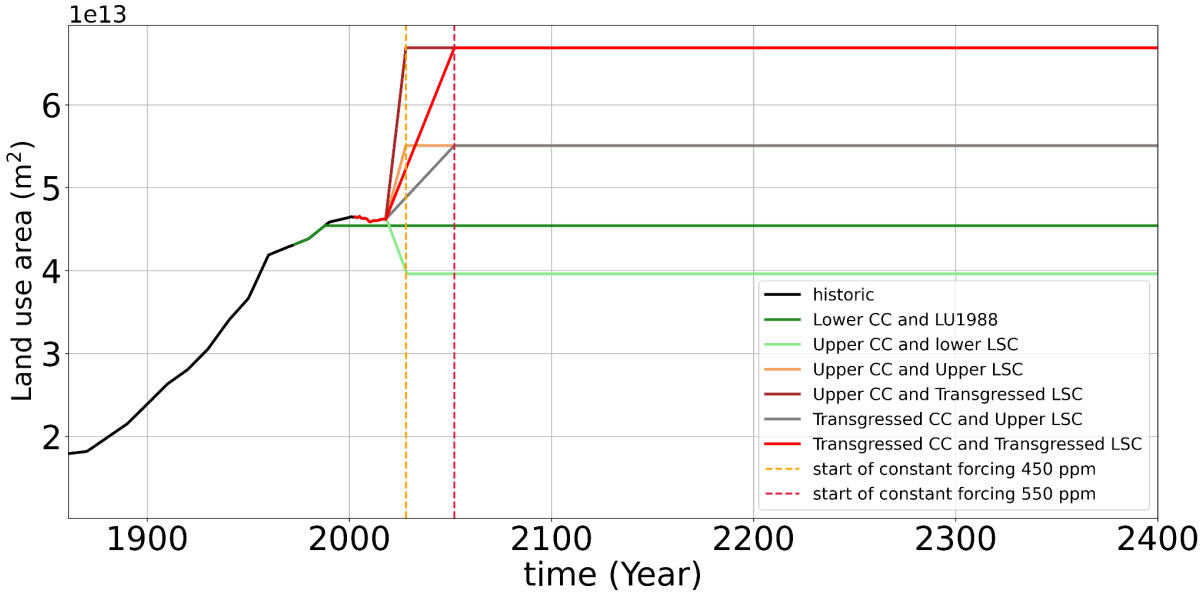

Figure S4. Land use area for the historic period and the different scenarios. For the LU1988 experiment, land use is constant from 1988. For all Upper CC experiments, land use is constant from 2029 and for all Transgressed CC experiments, land us is constant from 2052.

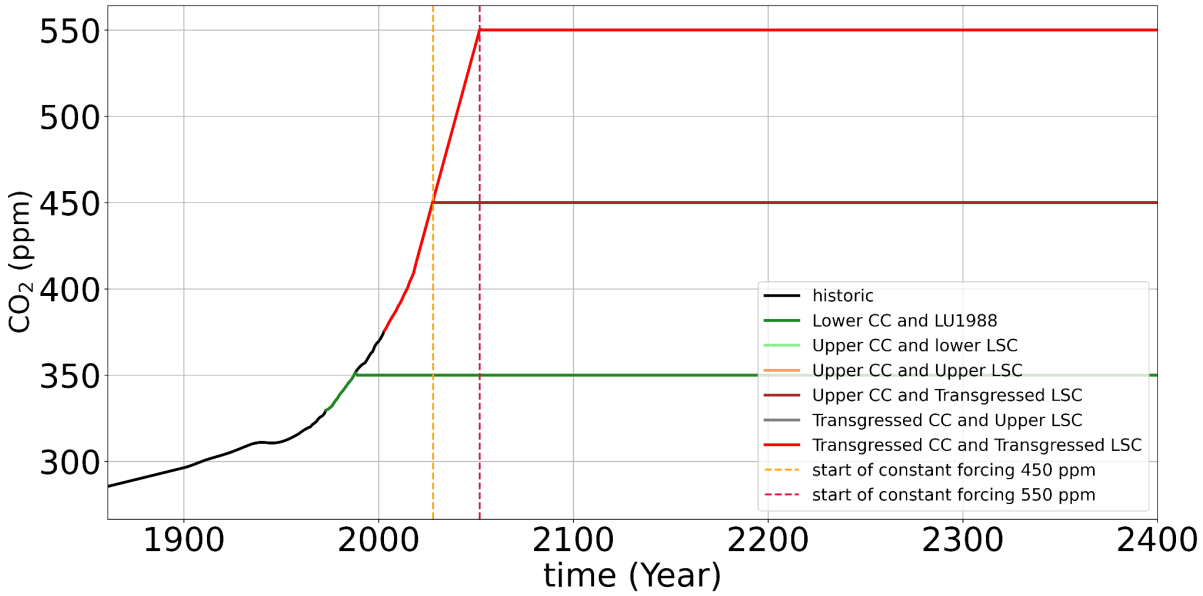

Figure S5. Atmospheric CO_2 concentration for the historic period and the different scenarios. For the Lower CC experiment, CO2 is constant from 1988 at 350 ppm. For all Upper CC experiments, CO2 is constant from 2029 at 450 ppm and for all Transgressed CC experiments, land us is constant from 2052 at 550 ppm.

Zone	Continent	Current natural land	Lower LSC	Upper LSC	Transgressed LSC
Temperate	Africa	0.35	0.5	0.3	0.2
Temperate	America	0.48	0.5	0.3	0.2
Temperate	Asia	0.59	0.5	0.3	0.2
Temperate	Europe	0.47	0.5	0.3	0.2
Temperate	Oceania	0.66	0.5	0.3	0.2
Boreal	America	0.86	0.85	0.6	0.4
Boreal	Asia	0.79	0.85	0.6	0.4
Boreal	Europe	0.78	0.85	0.6	0.4
Tropical	Africa	0.63	0.85	0.6	0.4
Tropical	America	0.73	0.85	0.6	0.4
Tropical	Asia	0.63	0.85	0.6	0.4
Tropical	Oceania	0.4	0.85	0.6	0.4

Table S1: Current fraction of natural land for the major climate zones on different continents and their respective lower, upper, and transgressed planetary boundaries.

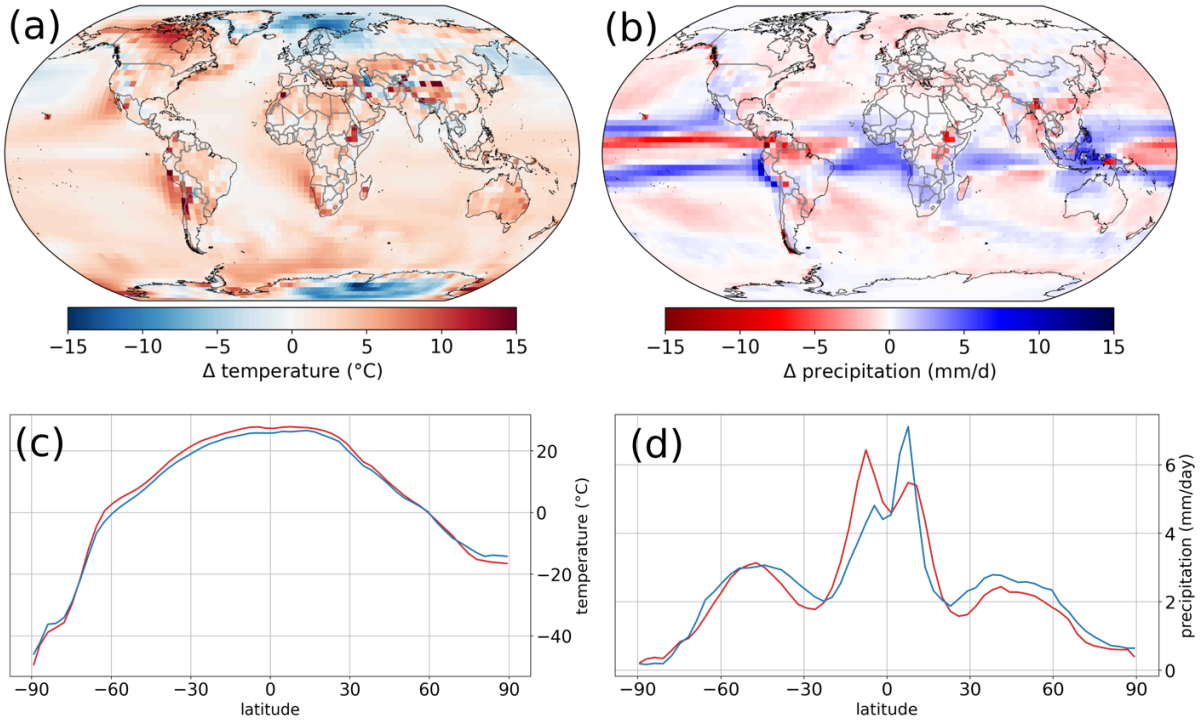

Fig. S6: (a) Global surface temperature from CM2Mc-LPJmL averaged over the period 1994–2003, (b) global precipitation from CM2Mc-LPJmL averaged over the period 1994–2003, (c) zonal mean temperature from CM2Mc-LPJmL (red line) and ERA5 data (blue line) averaged over the period 1994–2003, (d) zonal mean temperature from CM2Mc-LPJmL (red line) and ERA5 data (blue line) averaged over the period 1994–2003. Plot is analogous to Drüke et al. 2021.

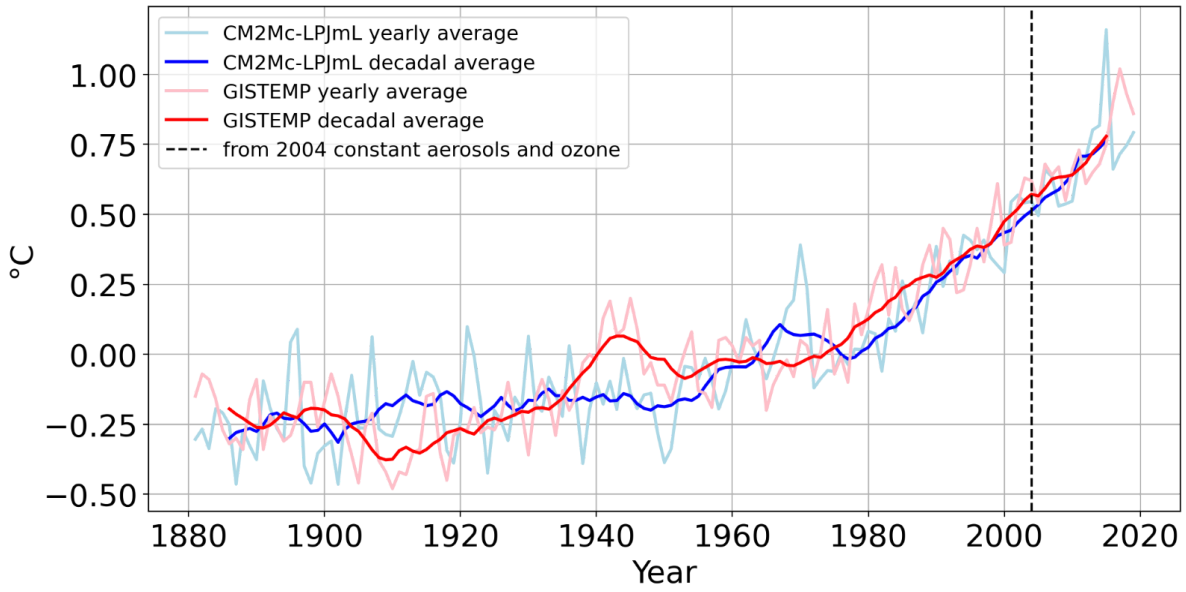

Fig. S7: Yearly and decadal global mean temperature anomaly (relative to the reference period 1951–1980) of CM2Mc-LPJmL compared to GISTEMP data from 1880–2018. Note that, from 2004 on, only greenhouse gas forcing remains, while aerosols, solar radiation and ozone are set to their corresponding 2003 values. Plot is analogous to Drüke et al. 2021.

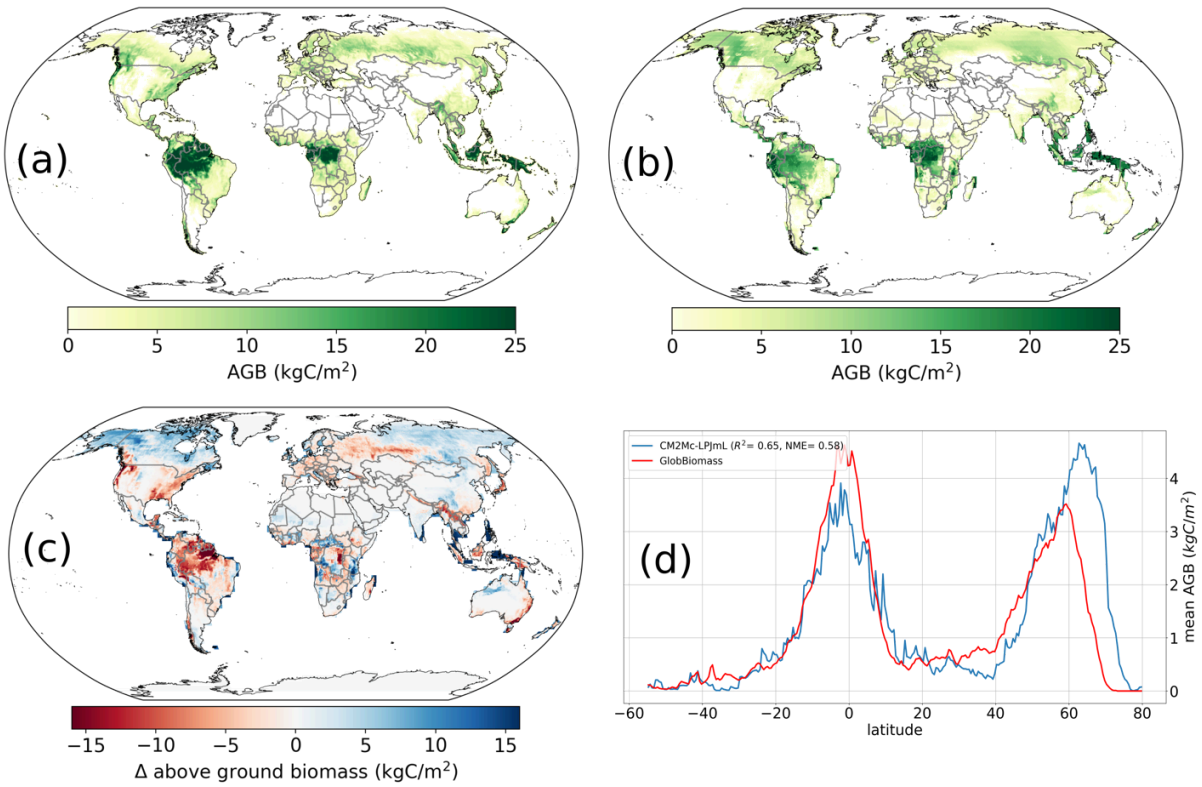

Fig. S8: (a) Mean global above-ground biomass of GlobBiomass (Santoro et al., 2020) evaluation data. (b) Mean global above-ground biomass of CM2Mc-LPJmL over the period 2006-2015. (c) Difference of the above-ground biomass between CM2Mc-LPJmL and GlobBiomass evaluation data. Blue/red colors denote an overestimation/underestimation of biomass by CM2Mc-LPJmL. (d) Latitudinal sum of above-ground biomass from CM2Mc-LPJmL (blue line, R2=0.65, NME=0.58) and GlobBiomass evaluation data (red line). Plot is analogous to Drüke et al. 2021.