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Impact of bioenergy crop expansion on climate–carbon cycle feedbacks in overshoot scenarios

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Table S1: DOI of simulations used by each model in this study

ESM		IPSL-CM6A-LR	CNRM-ESM2-1	CanESM5	MIROC-ES2L	UKESM1-0-LL
piControl	Ensemble members	r1i1p1f1	r1i1p1f2	r1i1p1f1, r1i1p2f1	r1i1p1f2	r1i1p1f2 (parent to r4..)
	DOI	https://doi.org/10.22033/ESGF/CMIP6.5251	https://doi.org/10.22033/ESGF/CMIP6.4165	https://doi.org/10.22033/ESGF/CMIP6.3673	https://doi.org/10.22033/ESGF/CMIP6.5710	https://doi.org/10.22033/ESGF/CMIP6.6298
historical	Ensemble members	r1i1p1f1	r1i1p1f2	r1i1p1f1	r1i1p1f2	r4i1p1f2
	Branching year	1910	1850	5201	1850	1960
	DOI	https://doi.org/10.22033/ESGF/CMIP6.5195	https://doi.org/10.22033/ESGF/CMIP6.4068	https://doi.org/10.22033/ESGF/CMIP6.3610	https://doi.org/10.22033/ESGF/CMIP6.5602	https://doi.org/10.22033/ESGF/CMIP6.6113
hist-noLu (and historical)*	Ensemble members	r1i1p1f1 r2i1p1f1 r3i1p1f1 r4i1p1f1	r1i1p1f2 r2i1p1f2 r3i1p1f2 r4i1p1f1	r1i1p1f1 r2i1p1f1 r3i1p1f1 r4i1p1f1	r1i1p1f2	r1i1p1f2 r2i1p1f2 r3i1p1f2 r4i1p1f2
	DOI (hist-noLu)	http://doi.org/10.22033/ESGF/CMIP6.5189	http://doi.org/10.22033/ESGF/CMIP6.4049	http://doi.org/10.22033/ESGF/CMIP6.3602	http://doi.org/10.22033/ESGF/CMIP6.5584	http://doi.org/10.22033/ESGF/CMIP6.6060
ssp534-over	Ensemble members	r1i1p1f1	r1i1p1f2	r1i1p1f1	r1i1p1f2	r4i1p1f2
	Branching year	2040	2015	2040	2015	2040
	DOI	https://doi.org/10.22033/ESGF/CMIP6.5269	https://doi.org/10.22033/ESGF/CMIP6.4221	https://doi.org/10.22033/ESGF/CMIP6.3694	https://doi.org/10.22033/ESGF/CMIP6.5767	https://doi.org/10.22033/ESGF/CMIP6.6397
ssp585	Ensemble members	r1i1p1f1	r1i1p1f2	r1i1p1f1	r1i1p1f2	r4i1p1f2
	Branching year	2015		2015		2015
	DOI	https://doi.org/10.22033/ESGF/CMIP6.5271		https://doi.org/10.22033/ESGF/CMIP6.3696		https://doi.org/10.22033/ESGF/CMIP6.6405
hist-bgc	Ensemble members	r1i1p1f1	r1i1p1f2	r1i1p2f1	r1i1p1f2	r4i1p1f2
	Branching year	1910	1850	5550	1850	1960
	DOI		https://doi.org/10.22033/ESGF/CMIP6.4047	https://doi.org/10.22033/ESGF/CMIP6.3600	https://doi.org/10.22033/ESGF/CMIP6.5582	https://doi.org/10.22033/ESGF/CMIP6.6055
ssp534-over-bgc	Ensemble members	r1i1p1f1	r1i1p1f2	r1i1p2f1	r1i1p1f2	r4i1p1f2
	Branching year	2040	2015	2040	2015	2040
	DOI		https://doi.org/10.22033/ESGF/CMIP6.4223	https://doi.org/10.22033/ESGF/CMIP6.3695	https://doi.org/10.22033/ESGF/CMIP6.5769	https://doi.org/10.22033/ESGF/CMIP6.6401
ssp585-bgc	Ensemble members	r1i1p1f1	r1i1p1f2	r1i1p2f1	r1i1p1f2	r4i1p1f2
	Branching year	2015		2015		2015
	DOI			https://doi.org/10.22033/ESGF/CMIP6.3697		https://doi.org/10.22033/ESGF/CMIP6.6409

*While one ensemble member of historical simulations is used for the analysis, we use an ensemble mean of all available ensemble members at the time of the analysis to evaluate the historical LUC emissions.

Table S2: Cumulative carbon flux over 2000–2100 period in LUC and noLUC ecosystems given as a mean and standard deviation of three approaches and five ESMs under the SSP5-3.4-OS pathway (BGC and COU simulations). The values of IPSL-CM6A-LR and CNRM-ESM2-1 by cropland threshold approach and IPSL-CM6A-LR by two simulations since 2040 approach are excluded.

Simulation	Cumulative carbon flux over 2000–2100 (GtC)
LUC (BGC)	-42.55 ± 41.08
noLUC (BGC)	349.56± 129.43
LUC (COU – BGC)	-13.00 ± 12.27
noLUC (COU – BGC)	-88.97 ± 76.83

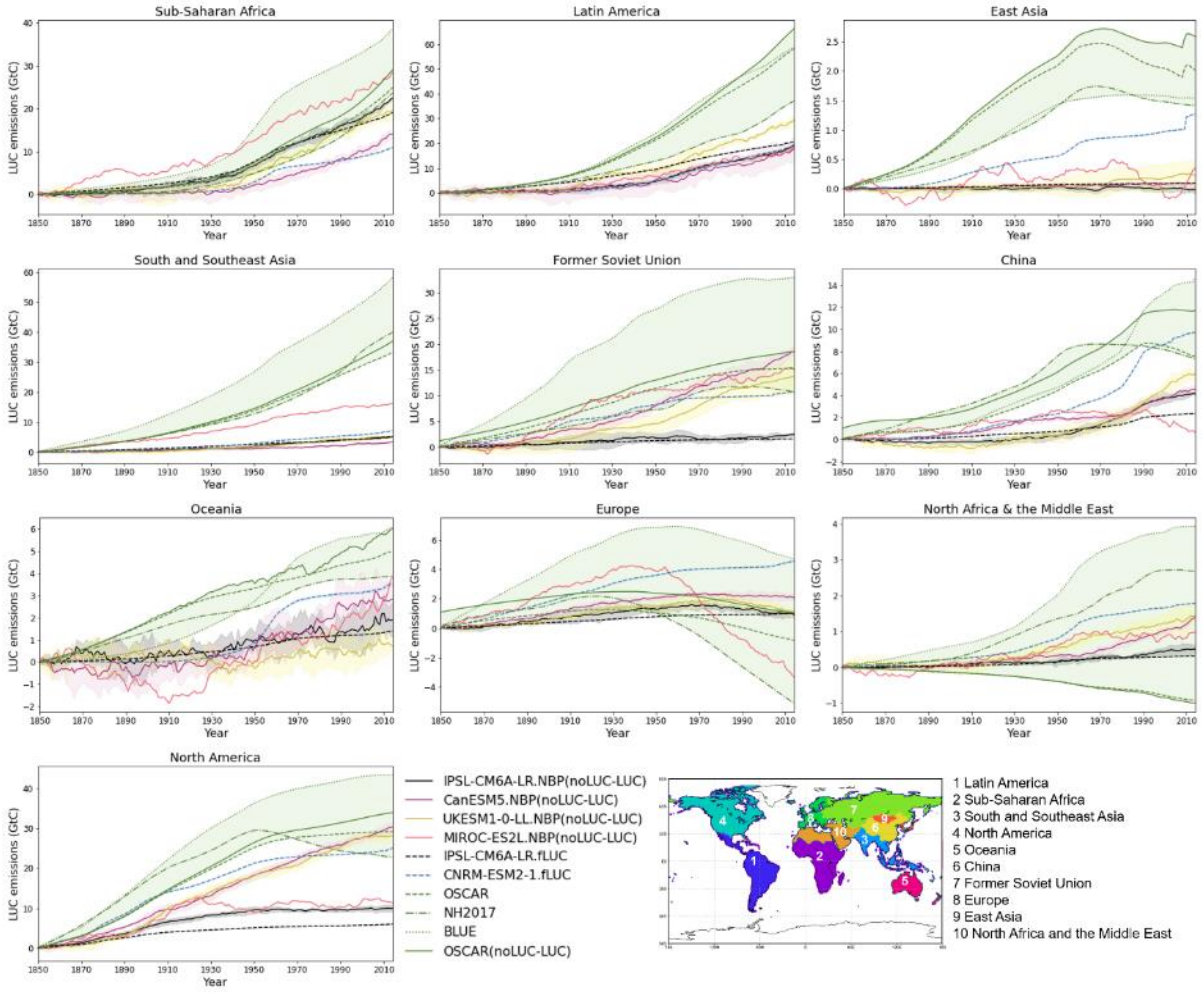

Figure S1: Evaluation of cumulative regional LUC emissions by ESMs against three bookkeeping models. LUC emissions are defined by two methods: 1) the difference in NBP between simulations with and without LUC (solid lines) and 2) the "fLuc" variable provided in CMIP6 (dashed lines). The estimates of the bookkeeping approach using OSCAR are shown for cases with (noLUC-LUC) and without LASC). The range of bookkeeping models is shaded green.

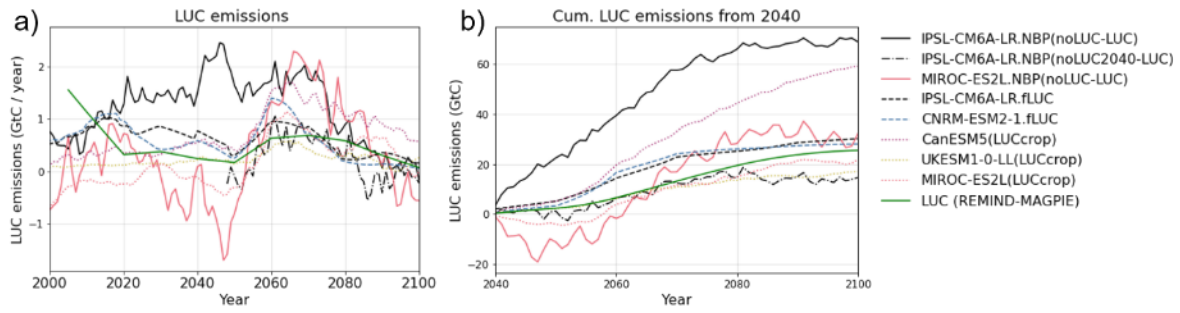

Figure S2: Comparison of (a) annual and (b) cumulative from the year 2040 global LUC emissions by ESMs (by three approaches) against REMIND-MAgPIE under SSP5-3.4-OS scenario. "LUCcrop" indicates LUC emissions estimated via the "cropland threshold" approach. The changes in LUC are given as 9-year moving averages, negative value corresponds to a land sink.

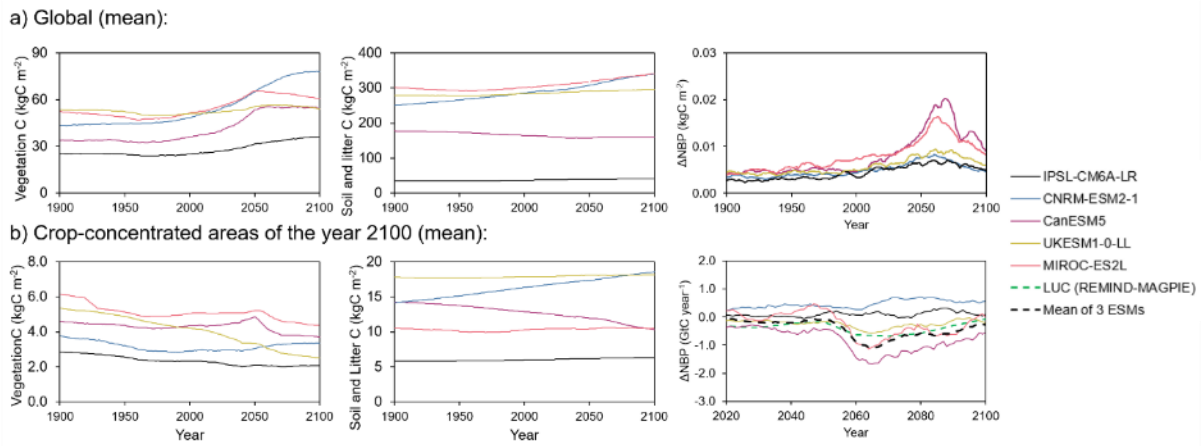

Figure S3: Time series of changes in vegetation and soil, including litter, carbon pools, and ΔNBP (a) globally and (b) in crop-concentrated areas as defined via the "cropland threshold" approach by CMIP6 ESMs. The changes in ΔNBP (relative to piControl) are given as 9-year moving averages, LUC emissions from REMIND-MAgPIE as given in the IIASA database are shown for reference. The mean of three ESMs is calculated using CanESM5, UKESM1-0-LL, and MIROC-ES2L. Positive is sink to the land.

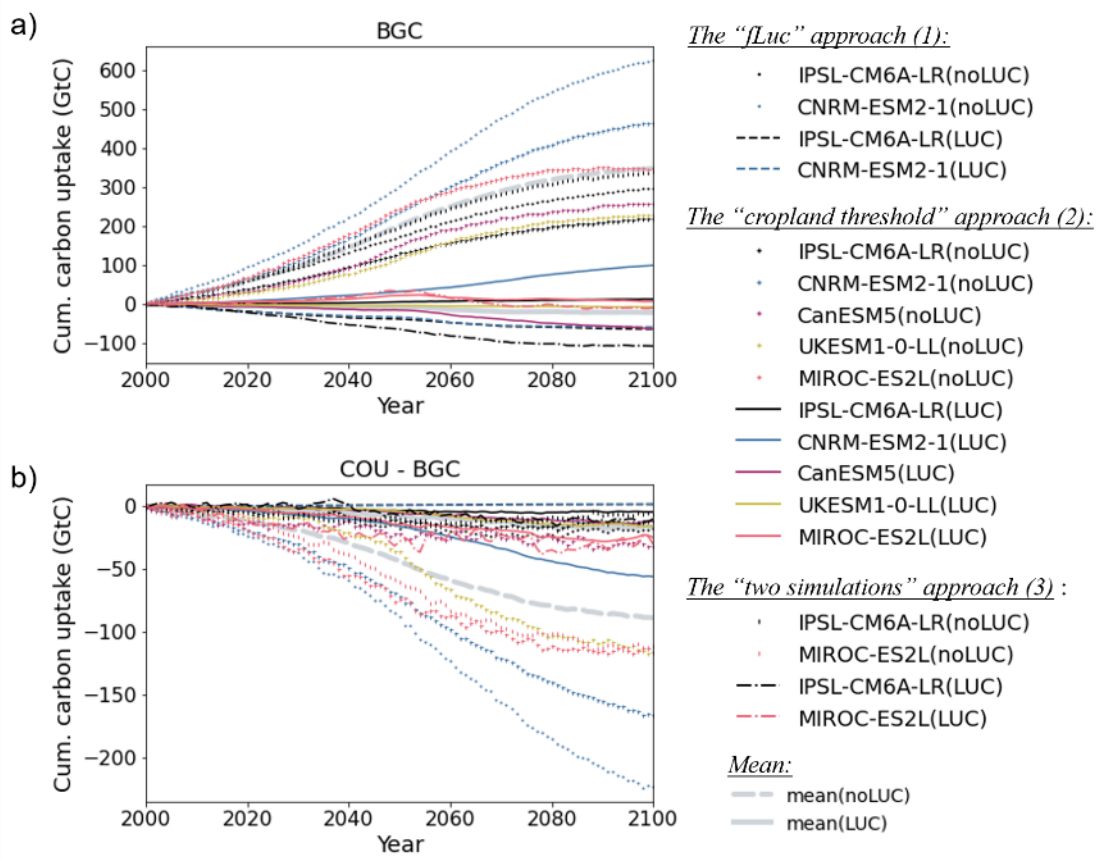

Figure S4: Cumulative carbon uptake over 2000–2100 period in (a) BGC simulation and (b) difference in COU and BGC simulations in LUC (crop-concentrated) and noLUC (no-crop) ecosystems by three approaches.