

Historical carbon dioxide emissions caused by land-use changes are possibly larger than assumed

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1 **Historical carbon dioxide emissions due to land use changes possibly larger than assumed**

2 **Supplementary Material**

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4 **Supplementary Table 1**



5 Model components relevant for the calculation of F_{LULCC} . All models include deforestation
6 and regrowth after abandonment; all models respond to observed changes in climate and
7 atmospheric CO₂ concentration. For further details on individual models and simulations, see
8 methods.

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	JSBACH	JULES	LPJ	LPJ- GUESS	LPJmL	LPX	OCN	ORCHIDEE	OSCAR	VISIT
<i>Wood removal through harvest</i>	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
<i>Shifting cultivation</i>	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes
<i>Managed land represented by harvested grass</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes (cropland area only)
<i>Crop functional types and other cropland management features</i>	No	No	No	Yes	Yes	No	Yes	No	Yes	No
<i>Wildfire</i>	Yes	No	Yes	Yes	Yes	Yes	No	No WH)/ Yes (SC)	Yes	Yes
<i>CN interaction</i>	Yes	No	No	Yes	No	Yes	Yes	No	No	No

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14 **Supplementary Table 2:** Cumulative fluxes from 1901 to 2014 (exceptions: LPJ, finish in
15 2013; LPJ-GUESS for the *MC* and *GH* cases, which finish in 2012; see methods). Data are
16 adopted from ¹⁻³, and from additional simulations (see methods). F_{LULCC} is the difference
17 between a simulation in which land use, climate and atmospheric CO₂ levels vary through time
18 compared to a reference simulation with land use fixed at pre-industrial levels. Individual
19 models differ in the degree to which they represent the processes of interest and therefore not
20 all processes are included in all models. For modelling groups that include *SC*, *WH* and/or *MC*
21 in their current standard model version $F_{LULCC,0}$ was calculated by subtracting the individual
22 contributions, assuming additivity. Likewise, for models that do not include these, $F_{LULCC,1}$ was
23 approximated by adding the individual component fluxes.

24 *SC*: shifting cultivation in tropical regions (gross vs. net area transitions); *WH*: wood harvest;
25 *GH*: harvest aboveground biomass in cropped and pasture areas, with crop vegetation
26 represented by grass functional types; *MC*: managed crop parameterisation (compared to
27 harvested grass); for all models see methods on details about implementation.

28 $F_{LULCC,0}$: “Baseline” land-use change related fluxes (net transitions, no wood harvest, crops
29 represented by the grass PFT).

30 $F_{LULCC,1}$: Land-use change related fluxes accounting for new processes; 1 stands for either
31 *SC*, *WH*, *GH* or *MC*. In case of LPJ-GUESS, and OSCAR values for $F_{LULCC,0}$ in *MC* are
32 similar to $F_{LULCC,1}$ in the *GH* case due to the factorial nature of the simulation experiment.

33 Units: Pg C a⁻¹ except for the ratio in the last column (unitless).

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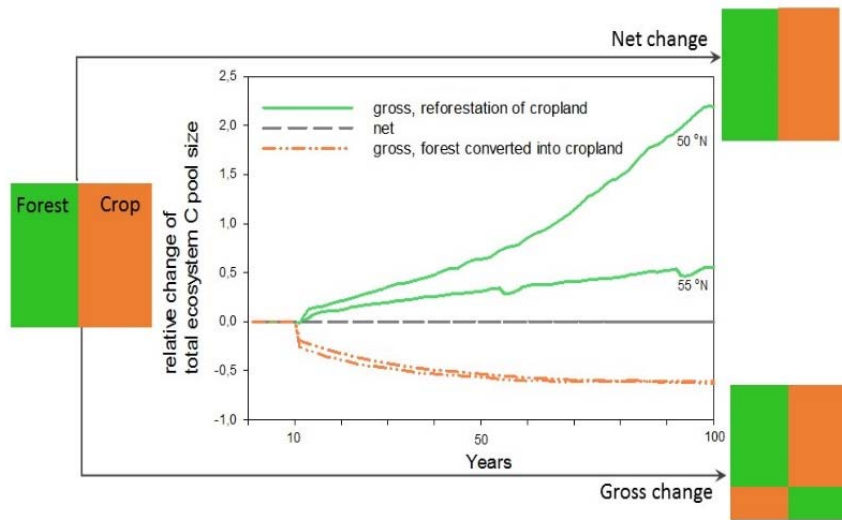
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Model	Process	$FLULCC,0$	$FLULCC,1$	Delta $FLULCC$	$FLULCC,1 : FLULCC,0$
JSBACH	SC	67.2	98.5	31.3	1.5
LPJ	SC	175.4	207.4	32.1	1.2
LPJ-GUESS	SC	156.1	201.3	45.3	1.3
LPX	SC	91.3	137.2	45.9	1.5
OSCAR	SC	37.0	47.7	10.7	1.3
ORCHIDEE	SC	92.2	121.9	29.7	1.3
VISIT	SC	53.2	110.5	57.3	2.1
<i>Average</i>		<i>96.1</i>	<i>132.7</i>	<i>36.0</i>	
JSBACH	WH	67.2	80.4	13.2	1.2
LPJ	WH	175.4	213.9	38.6	1.2
LPX	WH	91.3	115.1	23.8	1.3
OCN	WH	139.8	163.7	23.9	1.2
ORCHIDEE	WH	162.4	200.2	37.8	1.2
OSCAR	WH	37.0	47.4	10.4	1.3
VISIT	WH	53.2	124.7	71.5	2.3
<i>Average</i>		<i>103.8</i>	<i>135.1</i>	<i>31.3</i>	
JULES	GH	95.8	103.6	8.7	1.1
LPJ-GUESS	GH	100.4	153.5	53.1	1.5
OSCAR	GH	37.0	112.2	74.2	3.3
<i>Average</i>		<i>77.6</i>	<i>123.2</i>	<i>45.0</i>	
LPJ-GUESS	MC	153.5	183.7	30.3	1.2
LPJmL	MC	197.9	196.7	-1.3	1.0
OSCAR	MC	112.2	123.9	12.7	1.3
<i>Average</i>		<i>154.5</i>	<i>168.1</i>	<i>13.9</i>	

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40 **Supplementary Figure:** Gross vs. net Changes. Example is for a gridcell that at time $t=0$ has
 41 50% crop and 50% natural forest cover and undergoes in the next time-step $t=1$ (arrows) about
 42 20% conversion of forest area to cropland, and 20% of cropland is reforested. The time series
 43 of simulated changes in carbon pools shows an example simulation from LPJ-GUESS for two
 44 temperate forest grid locations, for 100 years with constant climate (repeated every 30 years)
 45 and CO_2 concentration, and land-cover change imposed after 10 years. If only net-transition are
 46 considered, the total area changes and land-cover change related emission flux (grey line) will
 47 be zero. In the gross-transition case, deforestation will result in a rapid initial loss of carbon
 48 from above ground biomass and litter, followed by smaller losses from soil legacy fluxes
 49 (orange lines, values < 1 indicate a loss of C compared to $t=0$), while the deforested area will
 50 begin to accumulate carbon more slowly (green lines).

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