Update after major correction to *Management induced changes of soil organic carbon on global croplands*

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In the following we will provide an update on some of our main results in comparison to the version of our initial draft to help the reader understand the implication of our changes. The following major corrections and improvements have been made, that let to substantial changes (next to smaller improvements):

- We discovered a bug in the very core of the soil model, leading to an overestimation of the transfer of carbon from active to the slow pool *just* for cropland. In regions with high carbon inputs (e.g. UK or Central EU) this let to unreasonable high SOC stocks.
- Additionally, we found unreasonable high forage crop production values for pumpkins used as fodder in our input data, we used from FAO. This led to an additional decrease of residue inputs to the soil for several countries (including, Australia, Belgium and Germany). The values were excluded and replaced by zeros.
- We moreover improved the spin-up of our model by accounting for land-use change since 1510.

Summary of main changes

The SOC debt is not decreasing anymore, but still continuously increases. Unreasonable high numbers for SOC stocks and stock change factors compared to natural vegetation stocks have vanished. The impact of management is lower but still considerably. Stock change factors for cropland SOC are now globally lower than default factor from the IPCC for all four climate zones.

In the following, we provide the comparison of updated (first) and original (second) figures for three of our main results:

- SOC distribution and depletion (Fig. 1 in the manuscript)
- Agricultural management effects on SOC debt (Fig. 3 in the manuscript)
- Modeled management effect in comparison with default IPCC Tier 1 factors (Tab. 4 in the manuscript)

SOC distribution and depletion

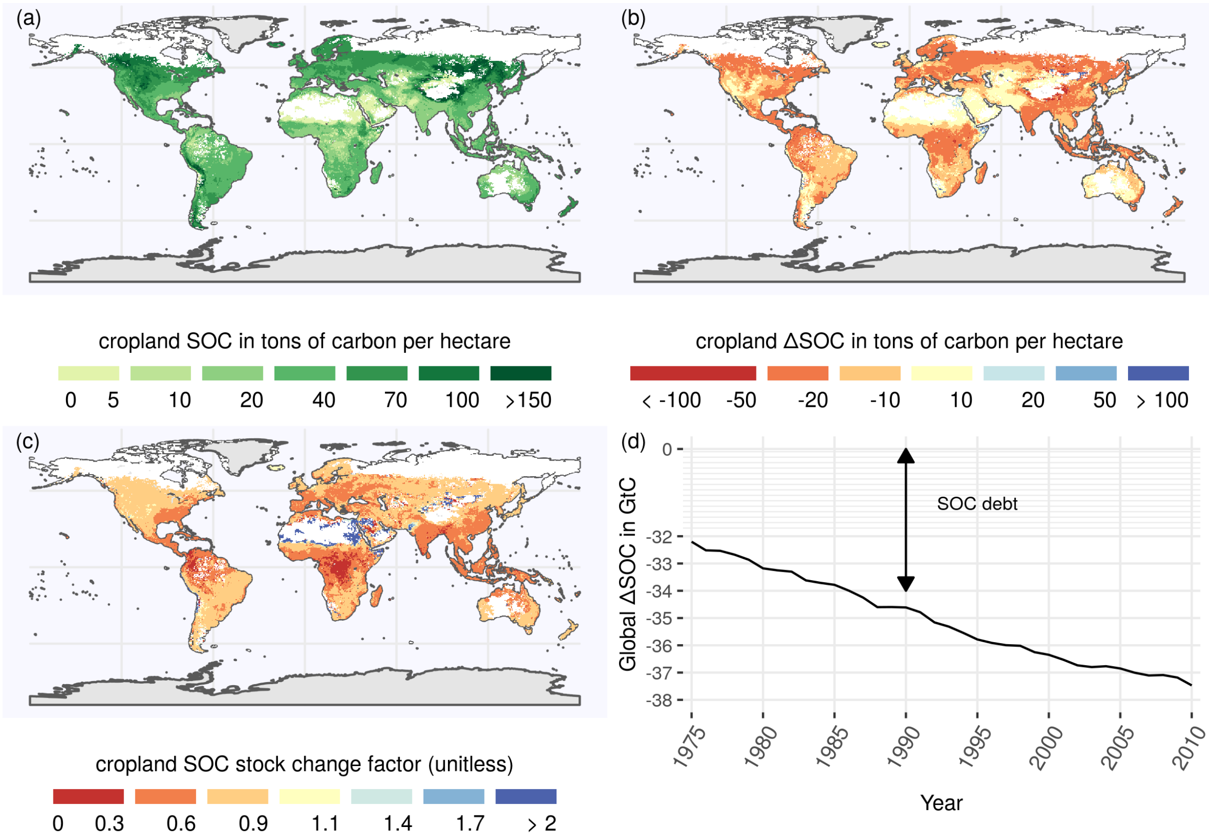

Figure 1: Updated figure! (a): Distribution of total global SOC stocks for the first 30 cm on cropland: Carbon stocks are large in high yielding areas. (b)+(c): Absolute (b) and relative (c) SOC stocks changes compared to a potential natural state identify different hot spots of SOC dynamics. Whereas absolute losses ΔSOC are often highest in temperate dry regions, relative losses F^{SCF} are often larger in tropical moist areas. (d): SOC debt is the difference between SOC under historic land use and potential natural vegetation. Within the period 1975 – 2010 the SOC debt is continuing to increase.

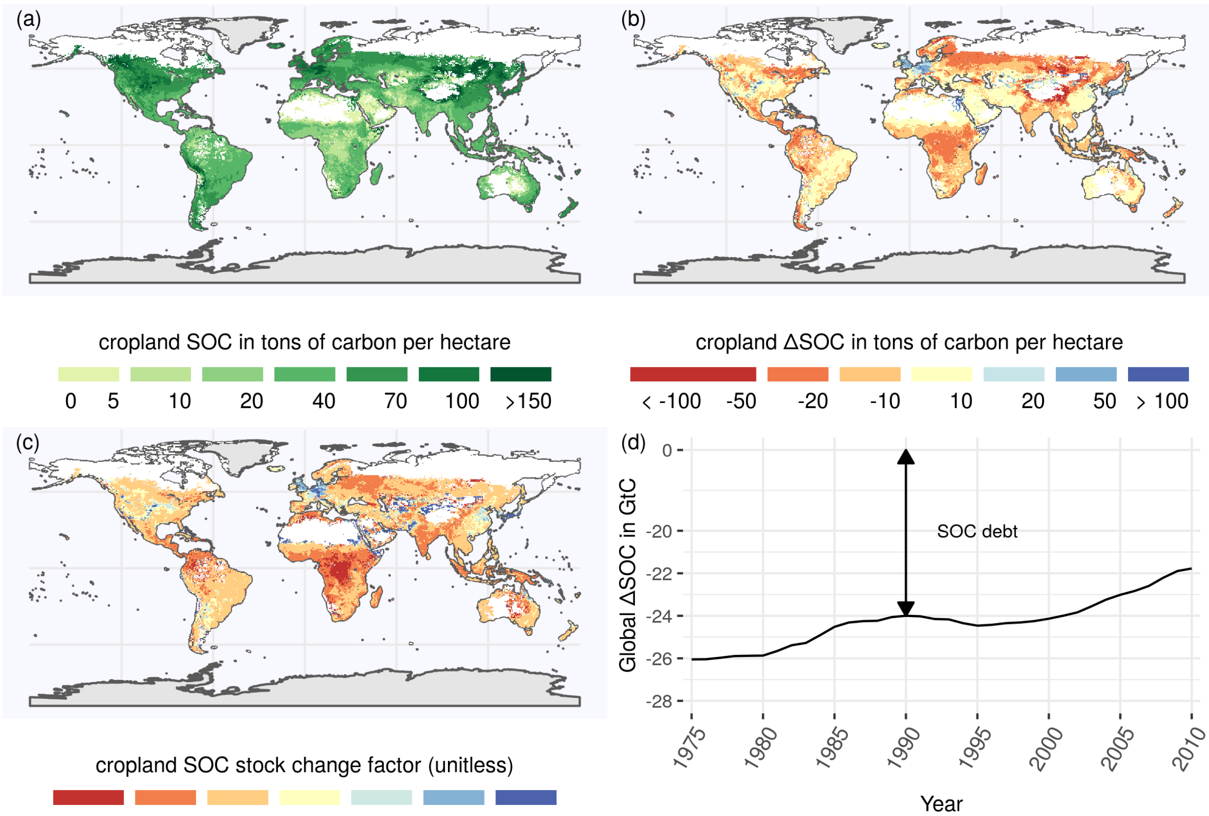

Figure 2: Original figure of the manuscript

With the figures above we provide a world map of SOC stocks for the first 30 cm on croplands considering historic management data at the global scale for the year 2010. Values ranging between well over 100tha^{-1} in northern temperate croplands to less than 5tha^{-1} for arid and semiarid croplands. The correction of to high SOC stock values is visible for all four figure parts, as it corrects the unreasonable high values in UK and Central Europe (see old figure).

Agricultural management effects on SOC debt

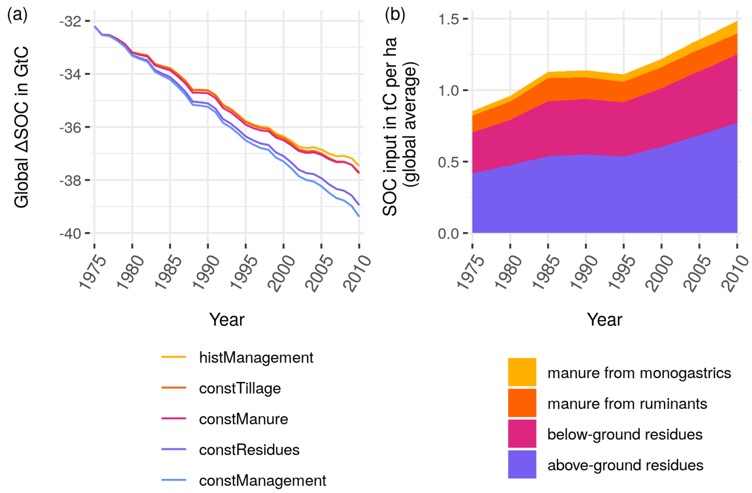

Figure 3: Updated figure! (a) Global ΔSOC in GtC for different management scenarios: The stylized scenarios deviate from historic agricultural management by holding effects of carbon inflows from residues or manure constant, or neglecting adoption of no-tillage practices. ConstManagement combines all three modifications. Note that ΔSOC is defined as the difference of SOC under land-use compared to a natural vegetation state. Figure (b) shows the carbon inflows from crop residue and manure.

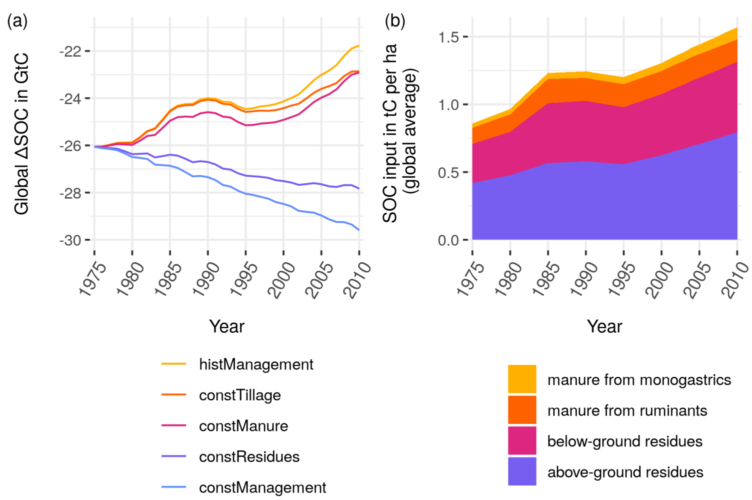

Figure 4: Original figure of the manuscript

Most notably difference is the trend of the historical reference line as well as the split between stylized constManagement and the baseline histManagement. Before we calculated a split of 8GtC, that now decreased to around 2GtC, which is still a third of the SOC loss of the period from 1975 – 2010.

Modeled management effect in comparison with default IPCC Tier 1 factors

Stock change factors $F^{mathrmSCF}$ in comparison to IPCC Tier 1 default factors: Our updated results are much smaller and still considerably lower compared to the default values of the IPCC for all four climate zones.

	Source	Input	Year	tropical moist	tropical dry	temperate dry	temperate moist
1	IPCC2006	low	invariant	0.44	0.55–0.61	0.74	0.66
2	IPCC2006	medium	invariant	0.48	0.58–0.64	0.80	0.69
3	IPCC2006	high	invariant	0.53	0.60–0.67	0.83	0.77
4	IPCC2019	low	invariant	0.76	0.87	0.70–0.71	0.66–0.67
5	IPCC2019	medium	invariant	0.83	0.92	0.76–0.77	0.69–0.70
6	IPCC2019	high	invariant	0.92	0.96	0.79–0.80	0.77–0.78
7	This Study	hist	1990	0.49	0.54	0.67	0.63
8	This Study	hist	2010	0.51	0.56	0.66	0.63

Table 1: Updated table.

	Source	Input	Year	tropical moist	tropical dry	temperate dry	temperate moist
1	IPCC2006	low	invariant	0.44	0.55–0.61	0.74	0.66
2	IPCC2006	medium	invariant	0.48	0.58–0.64	0.80	0.69
3	IPCC2006	high	invariant	0.53	0.60–0.67	0.83	0.77
4	IPCC2019	low	invariant	0.76	0.87	0.70–0.71	0.66–0.67
5	IPCC2019	medium	invariant	0.83	0.92	0.76–0.77	0.69–0.70
6	IPCC2019	high	invariant	0.92	0.96	0.79–0.80	0.77–0.78
7	This Study	hist	1990	0.57	0.61	0.78	0.76
8	This Study	hist	2010	0.64	0.68	0.83	0.83

Table 2: Original table of the manuscript.