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Projected soil organic carbon stocks in German croplands under different climate change scenarios

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Mineralization of soil organic carbon (SOC) is driven by temperature and soil moisture. Thus, climate change might affect future SOC stocks with implications for greenhouse gas fluxes from soils and soil fertility of arable land. We used a model ensemble of different SOC models and climate projections to project SOC stocks in German croplands up to 2099 under different climate change scenarios of the Intergovernmental Panel of Climate Change. Current SOC stocks and management data were derived from the German Agricultural Soil Inventory. We estimated the increase in carbon (C) input required to preserve or increase recent SOC stocks. The model ensemble projected declining SOC stocks in German croplands under current management and yield levels. This was true for a scenario with no future climate change ($-0.065 \text{ Mg ha}^{-1} \text{ a}^{-1}$) as well as for the climate change scenarios ($-0.070 \text{ Mg ha}^{-1} \text{ a}^{-1}$ to $-0.120 \text{ Mg ha}^{-1} \text{ a}^{-1}$). Thereby, preserving current SOC stocks would require an increase in current C input to the soil of between 51 % ($+1.3 \text{ Mg ha}^{-1}$) and 93 % ($+2.3 \text{ Mg ha}^{-1}$). We further estimated that a C input increase of between 221 % and 283 % would be required to increase SOC stocks by 34.4 % in 2099 (4 ‰ a^{-1}). The results of this study indicate that increasing SOC stocks under climate change by a noticeable amount will be challenging since SOC losses need to be overcompensated.