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The role of agricultural management in historic soil C changes, a case study from Belgium

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Although the agricultural sector is considered to have one of the greatest greenhouse gas mitigation potential, largely via soil organic carbon (SOC) sequestration, it remains a challenge to accurately quantify SOC stock changes at regional to national scales. SOC stock changes resulting from SOC inventory systems vary widely between studies, even for a single country. Process-based models can provide insight in the drivers of SOC changes, but accurate input data, in particular historic data, is currently not available at these spatial scales. Here we utilize measurements from an inventory dating from the 1960s and re-sampled in 2006 covering the major soil types and agricultural regions in Belgium together with region-specific land use and management data and a process-based model. The largest decreases in SOC stocks occurred in poorly drained grassland soils (-25 to -40 Mg C ha-1 in clays and floodplain soils), consistent with drainage improvements post-1960. Large increases in SOC in well-drained grassland soils (+ 12 Mg C ha-1) appear to be a legacy effect of widespread conversion of cropland to grassland prior to 1960. SOC in cropland increased only in sandy lowland soils (+ 10 Mg C ha-1), driven by increasing manure additions. Modelled land use and management impacts accounted for more than 70% of the variation in observed SOC changes. There was no significant effect of climate trends since 1960 on observed SOC changes. SOC monitoring networks are being established in many countries. Our results demonstrate that detailed and long-term land management data is crucial to explain the observed SOC changes for such networks.