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Towards a more comprehensive modelling framework to quantify vertical and lateral carbon fluxes in the agricultural soils of the EU

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Under the international protocols aiming at reducing the climate change impact, the land use sector is, likely, one of most complex to be accounted for greenhouse gas (GHG) emission and removal. This is related to its fragmentation and the complex biogeochemical feedbacks interacting with the human activity. Among those feedbacks, the role of erosion in the global carbon (C) cycle is not totally disentangled, leading to disagreement whether this process induces lands to be a source or sink of CO_2. To investigate this issue, we coupled soil erosion into a biogeochemistry model, running at 1 km2 resolution across the agricultural soils of the European Union (EU). Based on data-driven assumptions, the simulation took into account also soil deposition within grid cells and the potential C export to riverine systems, in a way to be conservative in a mass balance. We estimated that 143 out of 187 Mha have C erosion rates <0.05 Mg C ha-1 yr-1, although some hot-spot areas showed eroded soil organic C >0.45 Mg C ha-1 yr-1.

Exploring different assumptions on short-term enhancement C mineralization during soil displacement/transport, enrichment factor of eroded C and sub-soil organic C composition, we estimated an average net CO_2 flux ranging from -2.28 (source) to +3.73 (sink) Tg yr-1 of CO_2eq, in comparison with a baseline without erosion. Moreover, the erosion-induced sink of atmospheric carbon was comprised between 0 to 50% of the carbon transported by erosion and varied markedly across the EU.

While we first integrated most of all relevant processes and C fluxes in a comprehensive model framework, additional experimental data need to be collected for representing specific processes in a more mechanistic way.