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Vertical water and DOC/DIC flux estimates in a hummocky soil landscape – from pedon to field scale

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Arable hummocky soil landscapes of formerly glaciated terrains are characterized by 3D spatial patterns of soil types resulting from tillage and water erosion. Erosion and deposition processes have implication for the water and carbon (C) balance of the hummocky soil landscape. The objective of this study was to estimate the leaching of dissolved C as a crucial component to the terrestrial net ecosystem C balance for (i) pedon scale at different terrain positions and (ii) field scale. At pedon scale, the interactions between erosion affected soil properties, the water balances, and the crop growth and feedback effects of erosion on the leaching rates were studied. The 1D water movements were described using the Richards equation as implemented using the numerical solution in the HYDRUS program. Measured DOC/DIC concentrations were combined with calculated water fluxes to obtain the solute fluxes for certain depth and positions. For the field scale estimation dissolved carbon fluxes a weight average per soil type was chosen, whereas soil types were determined by characteristic multi-parameter delineating landform units and by soil soundings. For a typical section of the hummocky soil landscape, i.e. the CarboZALF-D plot, the average seepage water flux for the three years period 2010-2012 was 96 mm yr-1, the average leaching of DOC 0.6 g m-2 yr-1 and of DIC 7.0 g m-2 yr-1 below the root zone at approximately 200 cm depth. The water and dissolved carbon fluxes varied in direction and magnitude depending on terrain position and erosion history. The depth of the water table was identified as a major influential factor. The temporal variations of dissolved carbon fluxes seem to be dominantly controlled by water fluxes rather than by temporal varying dissolved carbon concentrations. The consideration of soil-crop interactions lead to more spatial differences of water and dissolved carbon fluxes as well as to faster soil development.