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Representation of Dissolved Organic Carbon in the JULES Dynamic Global Vegetation Model

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Current global models of the carbon cycle consider only vertical gas exchanges between terrestrial or oceanic reservoirs and the atmosphere, hence not considering lateral transport of carbon from the continent to the oceans. This also means that such models implicitly consider that all the CO_2 which is not respired to the atmosphere is stored on land, hence overestimating the land sink of carbon.
Moving toward a boundless carbon cycle that is integrating the whole continuum from land to ocean to atmosphere is needed in order to better understand Earth's carbon cycle and to make more reliable projection of its future.
Here we present an original representation of Dissolved Organic Carbon (DOC) processes in the Joint UK Land Environment Simulator (JULES). The standard version of JULES represent energy, water and carbon cycles and exchanges with the atmosphere, but only account for water run-off, not including export of carbon from terrestrial ecosystems to the aquatic environments.
The aim of the project is to include in JULES a representation of DOC production in terrestrial soils, due to incomplete decomposition of organic matter, its decomposition to the atmosphere, and its export to the river network by leaching.
In new developed version of JULES (JULES-DOCM), DOC pools, based on their decomposition rate, are classified into labile and recalcitrant within 3 meters of soil. Based on turnover rate, DOC coming from plant material pools and microbial biomass is directed to labile pool, while DOC from humus is directed to recalcitrant pool. Both of these pools have free (dissolved) and locked (adsorbed) form where just the free pool is subjected to decomposition and leaching. DOC production and decomposition are controlled by rate modifiers (moisture, temperature, vegetation fraction and decomposition rate) at each soil layer. Decomposed DOC is released to the atmosphere following a fixed carbon use efficiency. Leaching accounts for both surface (runoff) and subsurface (groundwater) components and is parameterized as Top soil leaching (from top 20cm) and Bottom soil leaching (down to 3 meters) depending on DOC concentration and runoff leaving that layer.
The model parameters are calibrated against specific sites (Brasschaat, Hainich and Carlow) for which observations of DOC concentration and leaching are available. Tuning is performed optimizing parameters such as DOC labile and recalcitrant resident time, DOC vertical distribution and CUE.
Once this calibration has been performed at the site level, the model is used for global simulations with the major historical forcing (climate, atmospheric CO_2 and land-use changes) in order to estimate the changes of DOC export and their attribution to anthropogenic activities.