Dissolved organic matter biodegradation: how substrate, microbial activity and environmental conditions converge

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Because soil dissolved organic matter (DOM) can be readily processed by microorganisms and oxidized to the greenhouse gas CO_2, DOM utilization by microorganisms (=biodegradability) needs to be assessed. We hypothesize that biodegradability is a function of i) substrate composition, ii) microbial presence and iii) environmental conditions that influence microbial activity and is thus an emergent property of the entire ecosystem. Accordingly, biodegradability will be greatest in times and places where substrate composition is adequate, microbial communities are present and environmental conditions (i.e. soil moisture and water availability) are favorable for DOM oxidation. To test this hypothesis we designed a combined lab and field study in northern Vermont, USA where variations in seasons, land use and landscape position produce variability in substrate, microbial presence, and environmental conditions. We sampled replicate cores of shallow soils and performed soil extracts and assessed substrate composition (carbon and nitrogen amount and fluorescence characteristics), microbial presence as biomass and environmental conditions. We also measured % respired carbon using incubation studies. Overall our results indicate that DOM biodegradability is strongly impacted by the convergence of hypothesized conditions and not of substrate composition alone. For example, winter sample microbial biomass was highest, and % respired carbon was high at ambient temperature incubations (25 degrees C) but low T incubation (4 degree C) showed no respiration at all. Conversely, spring microbial biomass abundance and DOM amount were lower, but bioavailability was high and directly related to antecedent soil moisture and temperature conditions.