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Modelling impacts of temperature, and acidifying and eutrophying deposition on DOC trends

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Surface water dissolved organic carbon (DOC) concentrations in large parts of the northern hemisphere have risen over the past three decades, raising concern about enhanced contributions of carbon to the atmosphere and seas and oceans. The effect of declining acid deposition has been identified as a key control on DOC trends in soil and surface waters, since pH and ionic strength affect sorption and desorption of DOC. However, since DOC is derived mainly from recently-fixed carbon, and organic matter decomposition rates are considered sensitive to temperature, uncertainty persists regarding the extent to the relative importance of different drivers that affect these upward trends. We ran the dynamic model MADOC (Model of Acidity and Soil Organic Carbon) for a range of UK soils (podzols, gleysols and peatland), for which the time-series were available, to consider the likely relative importance of decreased deposition of sulphate and chloride, accumulation of reactive N, and higher temperatures, on DOC production in different soils. Modelled patterns of DOC change generally agreed favourably with measurements collated over 10-20 years, but differed markedly between sites. While the acidifying effect of sulphur deposition appeared to be the predominant control on the observed soil water DOC trends in all the soils considered other than a blanket peat, the model suggested that over the long term, the effects of nitrogen deposition on N-limited soils may have been sufficient to elevate the DOC recovery trajectory significantly. The second most influential cause of rising DOC in the model simulations was N deposition in ecosystems that are N-limited and respond with stimulated plant growth. Although non-marine chloride deposition made some contribution to acidification and recovery, it was not amongst the main drivers of DOC change. Warming had almost no effect on modelled historic DOC trends, but may prove to be a significant driver of DOC in future via its influence on nutrient availability and productivity. This suggests that current and future DOC concentrations could also exceed preindustrial levels due to the increased productivity of N enriched ecosystems, having important implications for drinking water catchment management and the setting and pursuit of appropriate restoration targets.