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Understanding the long-term concentration, flux, composition and processing of dissolved organic carbon in UK rivers

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Dissolved organic carbon (DOC) represents an important component of the terrestrial and fluvial carbon cycle as it represents a flux from terrestrial carbon stores and while it transfers through the fluvial network it can be processed to release greenhouse gases to the atmosphere. Furthermore, DOC is a major water resource limitation as the dissolved organic matter has to be removed prior to treatment. Therefore, we need to understand the concentration and fluxes of DOC and they change across a landscape between the terrestrial source and the tidal limit.

Our ability to understand the processing of terrestrial and fluvial carbon has been limited by the range of catchments that have been considered and the time scale over which they have been considered. Studies focused on similar catchment types and very little means of comparing between catchments. However, if we can access and understand large datasets we can find general principles which control DOC and the relative importance of these controls. In this study we use two datasets. The first, is a dataset sampled across the UK for major rivers (270 catchments) from 1974 and this dataset is ideal for understanding flux to the continental shelf and this dataset has over 50000 datapoints. Secondly, many of these sites are monitored for a range of other parameters that are related to the composition of the dissolved organic matter. The important covariates for DOM composition are BOD, which is a measure of DOM decomposition, and COD which is measure of the oxidation state of the DOM. All the study catchments could be characterised by a range of covariate information, eg. soil cover, land use, hydro-climatology. To make maximum use of this data the dataset was considered within a Bayesian hierarchical framework.

The concentrations of DOC from the UK rose for the 1974 on to the late 1990s before a decline to 2007-08. The decline was driven by changes in urban sources, particular by improvements in sewage treatment. The DOC flux from the UK has declined since a peak in 2000 and in 2017 was 767 ktonnes C/yr (95% credible interval 644 – 909 ktonnesC/yr). Modelling composition turnover gives the DOC flux from source as 3.5 Mtonnes C/yr with 2.6 Mtonnes C/yr lost to atmosphere (14 Mtonnes CO_{2eq}/yr = 59 tonnes CO_{2eq}/km²/yr).