THE SCIENTIFIC EVOLUTION OF RIVERINE INVISIBLE DISSOLVED ORGANIC MATTER

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In 2013, Pereira et al. made a big step in characterisation of dissolved organic matter (DOM) as they found that rivers situated in the lowland tropical rainforest of central Guyana contain a component of riverine DOM that is non-humic and non-chromophoric, thus optically invisible to UV absorbance spectroscopy, characterised as invisible DOM (iDOM). Moreover, they found that the dissolved organic carbon (DOC) pool in small tropical headwater rivers is primarily driven by supply of iDOM, as observed during rainstorm events with high resolution (~30 min) sampling. The detection of iDOM in tropical headwater rivers has since sparked further research to assess the importance of iDOM in the global carbon cycle and its resilience during transport downstream.

Since 2017, we investigated iDOM in tropical and temperate rivers across Amazonia and Scotland using the next-generation liquid chromatography organic carbon detection – organic nitrogen detection system utilised by Pereira et al. (2014). Monthly sampling of rivers including the Cree, the Clyde and the Forth show evidence for iDOM mobilisation, but no clear quantitative relationship between DOC and iDOM. Humic compounds are the dominant DOC fraction (40 to 80%), contrasting with observations from tropical rivers. In order to get a better understanding of short-term temporal changes of iDOM and its mobilisation in headwaters we studied the DOM composition and changes in a small headwater stream of the River Forth in Scotland, the Menstrie Burn. The river catchment, Menstrie Glen, is dominated by peaty soils which incorporate large amounts of OM which is readily mobilised into headwater rivers. Our 2-year record of monthly resolved DOM (2017 to 2018) support the results from the main stems of our Scottish river sites, showing that iDOM is a relevant fraction of DOC (10-50% contribution to the total DOM pool), but not the driving force. Nevertheless, high frequent (30 min) data collection during the dry summer (June-July) 2018 and the wet winter (November) 2018 demonstrates a short-term mobilisation of iDOM with contributions of 40-60% of total DOM occurring over 30 to 60 minutes. These latter high temporally resolved records are comparable to observations made for the tropical headwater rivers.

Our new observation from Scottish rivers support the hypothesis that iDOM mobilisation is of wider relevance and controlled by different mechanisms, dependent on the climate regime (e.g. tropical versus temperate), local geology, vegetation and soils, and hydrological response to precipitation patterns. This contrasting behaviour between climate zones with significantly different environmental controls emphasises the importance of further research to better understand the importance of terrestrial aquatic interfaces during hot moments of carbon mobilisation (McClain et al. 2003) and its propagation in larger river systems. Moreover, the potential of photo-oxidation and microbial availability of iDOM due to its lability needs to be further investigated, as it could well provide another substantial component of riverine CO₂ outgassing that is not well quantified at present. At this point, the scale and importance of our new iDOM observations for global carbon models and future carbon simulations is unclear; however, our new results indicate this to be a globally relevant and potentially large contribution to inland carbon cycling.
References
