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Natural and anthropogenic impacts on biogeochemical cycle in Yangtze River basin: Source, transformation and fate of dissolved organic matter (DOM) characterized by 3-D fluorescence spectroscopy

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Inland waters play an important role in the global carbon cycle as reactors for DOM cycling, transformation and transportation. With large amounts of terrestrial DOM, the Yangtze River is vital for coastal environment and ecosystem. In the context of climate change, it's critical to evaluate both hydrodynamic conditions and increasing human activities' impacts on biogeochemical cycle of DOM in Yangtze River across different climatic and hydrologic regions which are poorly understood. What's more, the hydrologic condition changes caused by the Three Gorges Dam (TGD, world's largest power station in terms of installed capacity) have recently proven to be a partition factor for fluvial particle. However, it's still an enigma for dissolved matter cycle.

To address those issues, this study applies EEMs combined with bulk characteristics, chlorophyll and absorption spectrum in an attempt to assess characteristics and dynamics of DOM in Yangtze River. It's a novel optical approach that could 'see' molecular structure of DOM without the limits of time-consuming and laborious molecular measurements. Combined with parallel factor analysis, 5 individual fluorescent components have been identified: 3 humic-like (H_1, H_2, H_3) and 2 protein-like components (P_1, P_2). With typical bioavailability and photo-reactivity, these components suggest different sources and dynamics. On the whole, both DOC and the sum of all 5 components ($\sum$Fluo) increased remarkably from the upper reach especially to the Three Gorge Dam and thereafter remained constant (R^2between DOC and $\sum$Fluo: 0.92). The protein-like components ($\sum$P) accounted for 1/4 of $\sum$Fluo with apparently weak correlations with DOC and chlorophyll, which implied that the DOM is not dominated by autochthonous production, especially for the upper reach with high concentration of total suspended matter. As for Humic-like component, increasing H_1 and DOC in the TGD reservoir area implied impacts from human activities there with intercept of sewage rather than an enabling environment for degradation. While in the lower reach where H_3(Ex/Em:250/450$\sim$485nm) was accumulated, the other components (H_1, H_2) and a_{350} (absorption coefficient at 350nm) seemed to be degraded faster than H_3 indicating that DOM might be subjected to selective biological and photochemical degradation processes, combined with remarkably higher Sr (absorption coefficient slope ratio, indicator of the degradation degree and aromatic property) in the lower reach after TGD, these facts suggests that the contrasting hydrology before and after TGD has led to a more significant composition differences and selective degradation of DOM. In case of any biased views, we conducted both dark and light incubations which showed consistency with the conclusion above. Besides, a comparison of Yangtze River and the other large rivers shows that the EEMs and a_{350} vary with land use, latitude and human activities, which verified their potential to trace the source and fate of fluvial DOM, even for different regions and water masses. Such knowledge on compositional differences of DOM resulting from variations in DOM sources and local environmental conditions (different photo-/bio-reactivity associated re-mineralization potential) during fluvial transport, would undoubtedly assist in predicting the consequences of global change and its relationship to global carbon cycling.