Photochemical mineralization of biologically non-labile terrigenous DOC to dissolved inorganic carbon in coastal waters

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Solar radiation photobleaches terrestrial chromophoric dissolved organic matter (tCDOM) and mineralizes terrigenous dissolved organic carbon (tDOC) to dissolved inorganic carbon (DIC) in the coastal ocean. To examine these photochemical reactions, we collected water samples from the St. Lawrence Estuary and ten major rivers. The river waters were mixed with artificial sea water and irradiated with simulated solar radiation to approximate a typical photoreactivity for tDOC (AQY) over the entire lifetime of tCDOM in the coastal ocean. In the St. Lawrence River Estuary, the AQYs decreased with increasing salinity indicating a mixing of more photoreactive tDOC with less photoreactive marine DOC. Based on AQYs and local solar irradiances, the annual areal DIC photoproduction rates from tDOC ranged from 52 ± 4 (Lena River) to 157 ± 2 mmol C m^{-2} yr^{-1} (Mississippi River). The high correlation (R^2 = 0.96) between DIC photoproduction and tCDOM photobleaching was used to estimate the amount of photoproduced DIC from the tCDOM flux of each river, which for all rivers summed up to 12.5 ± 2.1 Tg C yr^{-1} ten $rivers^{-1}$ or 18 ± 4 % of total tDOC flux. When the amount of photoproduced DIC was divided by the areal DIC photoproduction rate, ca. 9,600,000 km^2 of coastal ocean was required for the photomineralization of tDOC from the studied rivers. Extrapolation to the global coastal ocean indicates that solar radiation mineralizes 45 (23–71) Tg tDOC yr^{-1} and on average within 97 km distance of global coastline when the area required for the photochemical mineralization of tDOC (34,000,000 km^2) is divided with the length of coastline (356,000 km).