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Photochemical and microbial transformation of terrestrial dissolved organic matter - Lena River vs. rivers in mid and low latitudes

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The aim of this study was to assess the fate of riverine dissolved organic matter (DOM) in coastal ocean. In that environment after the sedimentation of terrestrial particulate matter and the advective mixing of river water to optically clear marine water, the photochemical transformation of riverine DOM has a large potential for decomposing riverine DOM.

For this study, we collected water samples from ten large rivers and carried out laboratory experiments with the river water samples. The potential for the photochemical decomposition of riverine dissolved organic matter was assessed by exposing sterile-filtered river waters to simulated solar radiation. Dark control samples we treated similarly but were not irradiated. The exposures were designed to decompose photochemically chromophoric dissolved organic matter, the major absorber of UV-vis radiation and the primary initiator of the direct photoreactions of DOM. In the end of irradiation, the difference in the concentration of dissolved organic carbon between the irradiated and the dark control sample corresponded to that portion of dissolved organic carbon (DOC) decomposable through direct photoreactions to carbon dioxide. In order to assess the amount of DOC phototransformed into biologically available forms, the irradiated and the dark control water samples received indigenous inoculums of riverine microbes and were incubated in the darkness. After a month, the difference in the concentration of DOC between the irradiated and dark control sample was considered to represent the photoreactive portion of DOC, while the residual DOC made up the DOC resistant to photochemical reactions. The photoreactive portion of DOC varied among rivers and was related to the amount of chromophoric dissolved organic matter in the water samples.

The biological decomposition experiments were extended to last up to one year and predictions about the biodegradability of irradiated and dark control DOM were made by fitting a biodegradability model based on a reactivity continuum to the observed biodegradation of DOC. In the dark control samples, the biodegradation of DOC was moderate, but the irradiation speeded up the decomposition of DOC a lot. The potential photodecomposition of DOM can be realized with a few hundred kilometers from the mouth of those rivers discharging to the mid- or low-latitude ocean. For the DOM of Lena River, the potential photodegradation is realized only partially in the receiving Laptev Sea having seasons with no or little solar radiation and additionally covered by sea ice over most of year.