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Photodegradation of dissolved organic matter (DOM) in the Baltic Sea

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Solar-radiation-induced photochemical reactions can mineralize or turn the biologically recalcitrant but photoreactive DOM to labile organic substrates in surface waters. We assessed the rates of photomineralization of dissolved organic carbon (DOC) and nitrogen (DON) as well as the bacterial biomass based on the photoproduction of labile organic substrates in the Baltic Sea through a freshwater–marine gradient.

Surface water samples were collected from five stations between the Neva Bay and the southern Baltic Sea during the July and September 2006, sterile filtered (0.2-μm), sealed without headspace in the quartz bottles (as light samples) or in borosilicate bottles wrapped in aluminium foil (as dark controls) and exposed to simulated solar radiation (Atlas CPS+ Solar simulator) for 66–68 h. Photoammonification was calculated as the difference in the NH_4^+ concentrations between light and dark samples. For the measuring of the photochemical mineralization of DOC, samples were acidified and bubbled with air to remove dissolved inorganic carbon (DIC), pH was raised back to the ambient pH level (8–8.5) and the samples were irradiated as described above. Photochemical mineralization of DOC was calculated as the difference in DIC concentrations between irradiated water and dark controls. The bacterial biomass based on the photoproduction of labile organic substrates was measured by incubating the irradiated water samples along with natural bacteria (below GF/F-filtered) and nutrient ($NH_4$and PO_4) additions in dark for 7–12 d and comparing the bacterial biomasses in light and dark water samples. To calculate the apparent quantum yield for the photoreactions, the photochemical mineralization of DON and DOC as well the photoproduction of labile organic substrates was divided by the number of absorbed photons by samples, respectively. The photoreaction rates *in situ* over the entire water column were calculated according to the apparent quantum yields and solar irradiance in July and September.

Simulated solar radiation mineralized DOM into DIC and NH_4^+ in all stations. The calculated rates of photoammonification over the entire water column increased and the rates of photomineralization of DOC decreased from the Neva Bay towards the southern Baltic Sea. Photochemical mineralization of DOC was thus highest with terrestrially dominated DOC whereas the photochemical mineralization of DON was highest with marine dominated DON. Photodegradation of DOM stimulated the growth of bacteria in irradiated water samples. This stimulated production of bacterial biomass was 6–27 % of the direct photochemical mineralization of DOC over the entire water column. Our results indicate that solar-radiation-induced photochemical reactions mineralize organic carbon, provide NH_4^+-nutrient and stimulate heterotrophic production in the Baltic Sea, but the photochemical mineralization depends on the type and origin of DOM.