Determination of apparent quantum yield spectra for the formation of biologically labile photoproducts

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Limnol. Oceanogr., 47(2), 2002, 343-352 | DOI: 10.4319/lo.2002.47.2.0343

ABSTRACT: Quantum yield spectra for the photochemical formation of biologically labile photoproducts from dissolved organic matter (DOM) have not been available previously, although they would greatly facilitate attempts to model photoproduct formation rates across latitudinal, seasonal, and depth-related changes in spectral irradiance. Apparent quantum yield spectra were calculated for two coastal environments from the southeastern United States using postirradiation bacterial respiration as a measure of total labile photoproduct formation and a cutoff filter method to model spectral dependence. As has been the case for previously studied classes of DOM photoproducts (i.e., dissolved inorganic carbon, CO, and H_2O_2), ultraviolet (UV)-B irradiance was significantly more efficient at forming labile photoproducts (i.e., compounds readily assimilated by marine bacterioplankton) than UV-A and visible irradiance. Calculations of DOM photoproduct formation in southeastern U.S. coastal surface waters indicate a formation ratio for biologically labile photoproducts :CO of 13 : 1. The slope of a natural log plot of the apparent quantum yield spectrum obtained for biologically labile photoproducts was similar to that for CO (0.028 nm^{-1} vs. 0.034 nm^{-1}). Modeled kinetic rates therefore indicate that the production ratio of these photoproduct classes is approximately maintained despite variations in the solar spectrum that occur with depth in a water column or distance from shore. Application of the apparent quantum yield to coastal regions worldwide predicts an annual formation rate of biologically labile photoproducts in coastal waters of 206×10^{12} g C.