Spatial and diurnal dynamics of dissolved organic matter (DOM) fluorescence and H2O2 and the photochemical oxygen demand of surface water DOM across the subtropical Atlantic Ocean

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ABSTRACT: Diurnal dynamics of dissolved organic matter (DOM) fluorescence and hydrogen peroxide (H_2O_2) concentrations were followed in the upper 100 m of the water column at five stations across the subtropical Atlantic Ocean in July and August 1996. The 10% levels of surface solar radiation for the ultraviolet (UV) B range (at 305- and 320-nm wavelengths) were at 16 and 23 m in depth and for the UVA range (at 340- and 380-nm wavelengths) were at 35 and 63 m in depth, respectively. The DOM fluorescence decreased over the course of the day, whereas H_2O_2 concentrations increased, especially in the diurnally stratified surface water layers extending to 10-50-m depth. In situ H_2O_2 net production varied between 5.5 nmol L^{-1} h^{-1} at 5-m depth and 1 nmol L^{-1} h^{-1} at 40-m depth, resulting in an H_2O_2 net production of ~38 µmol m^{-2} d^{-1} in the upper 50 m of the water column. Photochemical oxygen (O_2) demand of water collected at 10-m depth in the early morning and exposed to surface solar radiation varied between 0.9 and 2.8 µmol O_2 L^{-1} d^{-1} and was found to be consistently higher (by a 1.3-8.3-fold measure) than bacterial respiration (measured in 0.8 µm-filtered seawater in the dark). UVB radiation was responsible for 0-30% of the photochemical O_2 demand. A simple one-dimensional physical model was combined with a photochemical/biological model in order to describe the photochemical production of H_2O_2 at different depth layers over the course of the day and to determine the contribution of physical versus biological processes in terms of the loss of H_2O_2 from the surface layers in the late afternoon. The model reflects well the observed diurnal H_2O_2 dynamics. It further provides evidence that mainly biological breakdown determines the loss of H_2O_2 in the upper 50 m of the water column during the day; however, in the late afternoon, vertical mixing is important in transporting H_2O_2 from the uppermost 5-m layer to the 10-20-m layers.

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