In situ determination of the quantum yield of phytoplankton chlorophyll a fluorescence: A simple algorithm, observations, and a model

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ABSTRACT: Vertical profiles of the in situ quantum yield of fluorescence of chlorophyll *a*, φ_f, were derived with an algorithm from spectral underwater radiometer measurements. Select inherent optical properties were obtained from an initial radiance reflectance inversion that was optimized by comparing retrieved estimates of phytoplankton absorption with independent measurements. The comparison of chlorophyll concentrations produced by the algorithm to measured values allowed validation of the inversion. Fluorescence quantum yield values were calculated from the retrieved phytoplankton absorption and the upwelling radiance corrected for elastic and inelastic scattering. Raman scattered light was found to be a significant component of the upwelling light field at wavelengths of Chl *a* fluorescence. Values of φ_f determined using the algorithm, and therefore derived solely from the radiometer measurements, were not significantly different from those estimated using independent measurements of absorption by phytoplankton ($r^2 = 0.86$). The profiles of φ_f were characterized by an initial increase with depth to a subsurface maximum followed by a subsequent decrease. The irradiances of the subsurface maxima and φ_f at high irradiances appeared to be well conserved. An irradiance-based model including photochemical and nonphotochemical quenching was developed to explain variations in the quantum yield.