TABLE I
Classification System for Daily Net Primary Productivity (NPP) Models Based on Implicit Levels of Integration[a]

I.	Wavelength-resolved models (WRMs)
	$\mathrm{NPP} = \int_{\lambda=400}^{700} \int_{t=\mathrm{sunrise}}^{\mathrm{sunset}} \int_{z=0}^{Z_{eu}} \Phi(\lambda, t, z) \cdot \mathrm{PAR}(\lambda, t, z) \cdot a^*(\lambda, z) \cdot \mathrm{Chl}(z)\, d\lambda\, dt\, dz - R$
II.	Wavelength-integrated models
	$\mathrm{NPP} = \int_{t=\mathrm{sunrise}}^{\mathrm{sunset}} \int_{z=0}^{Z_{eu}} \varphi(z, t) \cdot \mathrm{PAR}(t, z) \cdot \mathrm{Chl}(z)\, dt\, dz - R$
III.	Time-integrated models
	$\mathrm{NPP} = \int_{z=0}^{Z_{eu}} P^B(z) \cdot \mathrm{PAR}(z) \cdot \mathrm{DL} \cdot \mathrm{Chl}(z)\, dz$
IV.	Depth-integrated models
	$\mathrm{NPP} = P^B_{\mathrm{opt}} \cdot f[\mathrm{PAR}(0)] \cdot \mathrm{DL} \cdot \mathrm{Chl} \cdot Z_{eu}$

Source: Behrenfeld and Falkowski (1997a).

[a] Each category includes a photoadaptive variable [i.e., φ, Φ, $P^B(z)$, P^B] corresponding to the resolution of the described light field. The variables Φ and φ are chlorophyll-specific quantum yields for absorbed and available photosynthetically active radiation, respectively. Wavelength-resolved models and wavelength-integrated models are parameterized using measurements of net photosynthesis and require subtraction of daily photoautotrophic respiration (R) to calculate NPP. $P^B(z)$ and P^B_{opt} are chlorophyll-specific rates obtained from measurements of daily primary production and thus do not require subtraction of respiration. DL, day length (hours).

4. Examples of Biological–Physical Coupling Influenced by Light

4.1. Variability of Inherent Optical Properties

The observed temporal and spatial variabilities of bulk inherent optical properties (IOPs), such as the total absorption and scattering coefficients, $a_t(\lambda)$ and $b_t(\lambda)$, are caused by physical, chemical, and biological processes. For example, water parcels, which encompass particulate and dissolved materials, move in response to physical forcing over a broad spectrum of time and space scales (e.g., covering over 10 orders of magnitude; see Dickey, 1991): small-scale molecular and turbulent motions (millimeters to centimeters) to frontal and mesoscale eddy scales (roughly tens of kilometers to 200 km) to gyre scales (thousands of kilometers). Processes such as advection and mixing are important for redistributing IOPs, but there is more to the story, as IOPs are not strictly conservative. If IOPs were, we would expect to be able to trace their distributions as we do salinity. However, it has been suggested that dissolved and particulate materials may be used as approximate passive tracers of water masses under particular circumstances and over limited time and space scales (e.g., Pegau, personal communication). To explore this interesting prospect, each IOP component needs to be considered. The variability in the absorption and scattering coefficients of pure ocean water, $a_w(\lambda)$ and $b_w(\lambda)$ are usually considered to be invariant in the upper ocean, and much effort has been made to determine these values to a high accuracy (Smith and Baker, 1981; Buiteveld et al., 1994; Pope and Fry, 1997). Variability due to gelbstoff or colored dissolved organic material (CDOM), as represented in absorption coefficients, $a_g(\lambda)$, can be great in nearshore waters because of terrigenous sources as discussed earlier. The dynamic range of variability in $a_g(\lambda)$ is considerably smaller in the open ocean. However, it has been reported that on seasonal time scales (with depth dependence as well), the variability in a related quantity, diffuse light attenuation coefficient due to both CDOM and detrital materials (CDM)