This study demonstrated that variability in algal community structure can be detected by means of various optical properties. These range from the causal mechanisms of particle optics such as refractive index and particle size, through mean optical efficiency factors, to the bulk absorption and backscattering coefficients. The ability to examine all aspects of the optical properties of algal assemblages allows an appreciation of cause, effect and the potential utility of algal optical signals in the interpretation of ocean colour data.

The inverse anomalous diffraction model described here has the ability, under certain conditions, to determine spectral values of both the real and imaginary part of the algal refractive index from contributions of measured particulate absorption and particle size distributions. These conditions appear to be primarily controlled by the particle size distribution as described by the effective radius \( r_{\text{eff}} \) and effective variance \( v_{\text{eff}} \). The model operates most effectively if the particle population is not widely dispersed (\( v_{\text{eff}} \) is relatively low at <2.3) and is more likely to produce unequivocal returns if the mean particle size is relatively small (\( r_{\text{eff}} < 5 \mu \text{m} \)). These findings are consistent with previous studies. The utility of the KK relations in quantifying the relationship between the real and imaginary parts of the refractive index was also demonstrated: the essentially simple expression:

\[
1 + r_{\text{eff}}^2 v_{\text{eff}} = \frac{Q_{\text{eff}}}{Q_{\text{r}}} \quad \text{and thus from the equivalent ratio of } b_{\alpha}/a.
\]

This has potential application in inverse reflectance models and offers the possibility of distinguishing algal communities, based on refractive index, from ocean colour data.

The numerical expression derived here for the \((1 + r_{\text{eff}}) b_{\alpha}/a\) relationship is only of relevance to the small data set analysed in this study. A robust relationship is also observed between gross particulate absorption and chlorophyll \( a \) concentrations.

Conclusions

![Graph showing particulate absorption and chlorophyll a concentrations](image)

**Fig. 8.** Particulate absorption and chlorophyll \( a \) concentrations: a, power law relationships between particulate absorption \( a_p(\lambda) \) and chlorophyll \( a \) concentrations at 622 nm (circles) and 674 nm (filled triangles), for all samples; b, chlorophyll \( a \)-specific phytoplankton absorption \( a_p^a, \lambda \) for the two illustrative stations. These spectra have been corrected for detrital absorption.

(Table 3). The decrease in \( a_p^a(\lambda) \) values as trophic state changes from offshore waters to inshore coastal waters has been demonstrated elsewhere. As discussed previously, the probable effects of phycocyanin absorption can be seen at \(-550 \text{ nm}\) in the offshore samples. The magnitude of \( a_p^a(674) \) allows some analysis of the methods used to determine absorption as a theoretical maximum for this value can be determined. Johnsen et al. measured a maximal value of \( a_p^a(675) = 0.27 \) for unpacked, intact chl \( a \) containing chromoproteins; this value can be considered to represent a theoretical maximum for \( a_p^a(674) \) with no package effect, in a spectral region where there is minimal absorption from other pigments. The range of \( a_p^a(674) \) values in this data set (0.015-0.053 \( \text{m}^2 \text{mg}^{-1} \text{chl}^a \), mean = 0.036 \( \text{m}^2 \text{mg}^{-1} \text{chl}^a \), s.d. = 0.011) indicates that many \( a_p^a(674) \) values reported here surpass this theoretical maximum (17 of the 23 samples). The effects of chlorophyll \( b \) at this wavelength is small and there is little evidence of significant phaeopigment absorption in any of the samples (R.G. Barlow, unpubl. obs.). The high \( a_p^a(674) \) values seen here are thus indicative of some methodological uncertainties: previous publications also displayed such a phenomenon, which is ascribed to uncertainties in the pathlength amplification factor.

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