Phytoplankton blooms in antarctic waters show a strong coherence with oceanic density fields; high biomass is observed when mixing depths are shallow. It has been hypothesized that when phytoplankton are maintained in a stable light environment, cells photoacclimate and overcome the chronic light-limitation of growth associated with deeply mixing water columns (Mitchell et al. 1991). Phytoplankton photoacclimate by increasing cellular absorption capabilities ($\bar{a}_{ph}\cdot m^{-1}$) and/or the quantum yield for carbon fixation ($\phi$: mole carbon fixed per mole photons absorbed) (Kirk 1994).
late the absorption capabilities of the phytoplankton at depth, the reconstructed phytoplankton absorption spectra (figure 2B) showed no correlation with the phytoplankton bloom (figure 3A), a finding that provides circumstantial evidence that modifications in cellular absorption capabilities do not constitute the primary mode of photoacclimation for these phytoplankton; however, it should be emphasized that if cells increased all pigments in equal molar ratios then the chlorophyll-specific $a_{ph}$ would remain relatively constant. We are currently assessing this possibility by studying the temporal variability in the accessory pigment-chlorophyll a ratios.

Values of $\phi$ were estimated from productivity rates calculated from photosynthesis-irradiance curves by using procedures described by Schofield et al. (1993). Values of $\phi$ increased prior to the phytoplankton bloom (figure 3B) and values approached theoretical maximum values as the mixed layer depth shallowed. This suggests that the regulation of $\phi$ was a primary mode of photoacclimation. Later in the season, as the mixed layer depth shallowed, the values of $\phi$ increased. These data suggest that photoacclimation in these phytoplankton was constrained by water column mixing, which is consistent...
with the hypothesis that shallow mixing depths provide a relatively stable light environment that allows algae to photoacclimate on the timescale of 1–2 days.

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References


Figure 3. Contours of (A) the chlorophyll-specific spectrally weighted absorption coefficient (m² mg ch⁻¹) and (B) the operational quantum yield for carbon fixation.