Phytoplankton Absorption and Assimilation Numbers

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The Assimilation Number is defined as

\[ AN = \frac{PP_{\text{nearsur}} \cdot (\text{Chl}_{\text{nearsur}})^{-1}}{\text{mol} \cdot \text{m}^{-2}} \]

Near-surface primary productivity (y-axis) plotted against chlorophyll-a measured by HPLC using data from the equatorial Pacific (TT08, TT02), the Arabian Sea (TT03-4), the Ross Sea (NP09-7, NP08-8) and the Southern Ocean south of New Zealand (Kiwi-7, -9). The line segments correspond to Assimilation Numbers (AN) of 7, 1.5, and 0.9 mg C (mg Chl \text{a} \cdot h^{-1}) (To improve visualization of these data, three high data points from TT08 are not plotted, but correspond to an AN = 7).

A comparison between spectrally-averaged absorption by phytoplankton (\(a_p\)), based on pigment reconstruction (PIG) and the filter-pair technique (FPT), from near-surface values. The solid line is a trend-line, with an intercept at zero, and where \(y = 0.62x\) the dashed line is the 1:1 relationship. Theoretically, \(a_p\) (PIG) should always be greater than \(a_p\) (FPT) because of the package effect, indicating that, on average, the FPT method is biased high by about 38%.

Conclusions:

1. Productivity in the ocean varies with phytoplankton absorption, and not always with the quantity of chlorophyll-a.
2. How pigments are packaged in cells is important in many ocean regimes, and more important than the quantity of chlorophyll-a and
3. Phytoplankton absorption integrates, to a large extent, variability in nutrients, temperature, and irradiance.

Primary production (y-axis) plotted against \(a_p\). A linear regression line has replaced the data from the equatorial Pacific and Arabian Sea. The open circles are \(a_p\) from pigment reconstruction. The **blue** filled circles are \(a_p\) data from the FPT method. The smaller **dark blue** circles are \(a_p\) (FPT) data corrected for excess absorption, according to Fig. 2 (i.e., a reduction of 40%). The data needed for the PIG/FPT comparisons were only available for NP09-7.

Productivity (24 h rate) normalized to \(a_p\) as a function of optical depth. Data were binned to 0-1, 1-2, ... optical depths. The approximate factor of 2 difference near the surface we believe is caused by differences in quantum efficiency. These three cruises show a good range of environmental variability from low temperature, high nutrients (Kiwi-7) to high-temperature, low nutrients (TT049), to high temperature, high nutrients (TN049).