FRANKLIN CRUISES FR 8/90, 5/92 AND 8/93
DATA DOCUMENTATION
JGOFS WESTERN EQUATORIAL PACIFIC PROCESS STUDY

[1] General:

Parameter: Photosynthetic parameters and chlorophyll a for cruises FR 9008, FR 9205 and FR 9308. These parameters were obtained from fitting the models of Platt et al., 1980, to carbon uptake vs light intensity results from a small-bottle production vs light intensity experimental series.

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List of Parameters:

Depth: depth in metres that the niskin bottle was closed.
Pmax: This is the maximum carbon fixation rate at saturating irradiances. Where no beta parameter is listed, it is equivalent to P_m^B (see Platt et al. 1980). Where a beta parameter is listed, it is equivalent to P_s^B. Units are mg Carbon [mg Chlorophyll-a] $^{-1}$ hr^{-1}.

Alpha: this is the initial slope of the Production vs Irradiance curve. Units are mg Carbon [mg Chlorophyll-a] $^{-1}$ hr^{-1} (µmol m^{-2} s^{-1}) $^{-1}$.

Beta: this is the photoinhibition factor. Units are mg Carbon [mg Chlorophyll-a] $^{-1}$ hr^{-1} (µmol m^{-2} s^{-1}) $^{-1}$.

Intercept: The P-I curve is not constrained to pass through zero due to occasional high positive intercepts, usually associated with nitrite in the nutrient profiles. The intercept has been standardised by dividing by chlorophyll-a.

Chlorophyll-a: HPLC chlorophyll a values from the same niskin that the productivity samples were taken. The units were mg m^{-3}

List of Units: see above.

[2] Sampling:

Gear (e.g. CTD, pump, etc.): CTD; 10 litre niskin bottles
Standard Depths: Hydrochemistry depths: see Hydrochemistry data

Chemicals used:	none
Special Procedures:	Niskins with silicone rubber o-rings and closure rubbers. Carbon fixed vs light intensity (P vs I) incubations using ^{14}C were started within one hour of the CTD coming on deck and one hour incubations (range 55 minutes – 80 minutes) were standard. P vs I parameters were determined after fitting the models of Plattt et al., (1980) to the carbon uptake standardised by chlorophyll a (mg Carbon (mg chl a)$^{-1}$ h^{-1}.
Comments and Notes:	Sampled in dim light.

[3] Analysis:

Instrument:	Photosynthetron described in Mackey et al., (1995, 1997).
Method:	Described in Mackey et al., (1995).
Precision:	Carbon fixation in the P vs I curves: At chlorophyll levels less than about 0.04 μg l^{-1} the expected P vs I response was often not consistent, especially in surface samples (see below). Curve fitting: curves not showing photoinhibition were classifed as not able to be fitted if the standard error of the parameters exceeded 30%. Curves showing photoinhibition were classified as not be able to be fitted if the standard error from the fitting exceeded 40%.
Comments:	FR 9308: Due to loss of all pigment samples on FR 9308, chlorophyll *a* was estimated using the mean fluorescence measured as the niskin bottle closed and using the hplc chlorophyll-a: fluorometer calibration from be estimated FR 9205.

[4] Results:

Quality of Data:	FR 9008 and FR 9205: good. FR 9308: loss of HPLC pigment samples mean the chlorophyll-a was calculated using the fluorescence: chlorophyll a relationship from FR 9205, and calculating the FR 9308 chlorophyll a using the mean fluorescence measured when from each niskin bottle closed.
Known Problems:	Loss of pigment samples for FR 8/93 means there was no direct estimate of chlorophyll a using either the hplc or trichromatic equations.

[5] Brief description of analytical methods

P vs I method.
A photosynthetron (Mackey et al., 1995) was used to obtain estimates of carbon fixed per hour. The photosynthetron used on FR 9008 and FR 9205 could handle a maximum of 5 depths with 18 different light intensities plus 3 samples incubated in

the dark. On FR 9308, the photosynthetron could take 7 depths. There was a range from zero irradiance to at least 600 μmol m^{-2} s^{-1} with at least 9 intensities below 100 μmol m^{-2} s^{-1} in both incubators. These data points were standardized to chlorophyll-a, and then examined for obvious outliers, which were removed. Curves were fitted using a non-linear regression technique to fit the models of Platt et al., (1980) in the statistics package Systat. If the standard error of the estimates was greater than 30% (40% where photoinhibition was present) the data were examined for outliers and these points removed. The curve fitting routine was then run again. If the standard errors could not be reduced to these limits, the depth was not included in the results. Many of the surface samples on Fr 9008 and Ff 9205 were rejected because curves could not be fitted to the data due to low and erratic carbon uptake. Some deep samples were also rejected due to erratic carbon uptake.

Chl *a* estimation from *in situ* fluorescence:

During FR05/92, the fluorometer was calibrated against measurements of extracted Chl *a* (actually chlorophyll *a* plus divinyl-chlorophyll *a* - see Mackey *et al.,* 1995) determined by HPLC with diode array detection. The relationship was:

$$\text{Chl } a \text{ } (\mu g\ l^{-1}) = 0.01204 \times \text{Seatech}(\%) + 0.026 \qquad (r^2 = 0.698,\ n = 94)$$

with a standard error in Chl *a* of 0.06 μg l^{-1}. During FR08/90, the instrument was calibrated against Chl *a* determined spectrophotometrically and the correlation was:

$$\text{Chl } a \text{ } (\mu g\ l^{-1}) = 0.01239 \times \text{Seatech}(\%) + 0.0142 \qquad (r^2 = 0.848,\ n = 174)$$

with a standard error in Chl *a* of 0.05 μg l^{-1}. Between the two cruises, the slope had changed by only 3% and the difference in intercept was less than 20% of the standard error in the calculated concentration of Chl *a*. Unfortunately, samples collected for calibration of the fluorometer on FR08/93 had decomposed because of a faulty Dewar before they could be analysed. We therefore assumed that the calibration for FR08/93 was unchanged from that found in 1992.

References:

Mackey, D. J., Higgins, H. W., Mackey, M. D. and Holdsworth, D. (1998) Algal class abundances in the western equatorial Pacific: estimation from HPLC measurements of chloroplast pigments using CHEMTAX. *Deep-Sea Research,* **45**, 1441-1468.

Mackey, D. J., Parslow, J. S., Griffiths, F. B., Higgins, H. W. and Tilbrook, B. (1997) Phytoplankton productivity and the carbon cycle in the western equatorial Pacific under ENSO and non-ENSO conditions. *Deep-Sea Research,* **44**, 1951-1978.

Platt, T., Gallegos, C.L., and Harrison, W.G. (1980) Photoinhibition of of photosynthesis in natural assemblages of marine phytoplankton. Journal of Marine Research **38**, 687-701.

[6] Comments:

Sampling sites of P-I profiles at latitudinal sites on FR 9008, FR9205 and FR9308. A number indicates the number of P-I profiles at each site. The times at which the 4 P-I profiles at a single site were nominally 07:00, 11:00, 14:00 and 23:00 h.

	FR 08/90	FR05/92		FR08/93	
Latitude	Southbound	Northbound	Southbound	Northbound	Southbound
10 ^{0}N				1	
8 ^{0}N				4	
7 ^{0}N				1	
6 ^{0}N				1	
5 ^{0}N	1	1		4	
4 ^{0}N	1				
3 ^{0}N	1	1		4	
2 ^{0}N	1			1	1
1 ^{0}N	1	1		1	1
0 ^{0}	1	1	4	4	1
1 ^{0}S	1	1		1	
2 ^{0}S	1			1	1
3 ^{0}S	1	1	4	4	1
4 ^{0}S	1	1		1	
5 ^{0}S	1	1		4	
7 ^{0}S				1	
8 ^{0}S	1	1			
10 ^{0}S	1	1		1	
14 ^{0}S	1	1		1	