Aurora Australis JGOFS Cruises in the Southern Ocean
DATA DOCUMENTATION
Primary Production Modelling

Cruises AU 9101, AU9303, AU 9404, AU9407, AU9501, AU 9604, and AU 9706

[1] General:

Parameter:	Primary production modelling
Principal Investigator:	Brian Griffiths
Institute Address:	CSIRO Division of Marine Research
E-Mail Address:	Brian.Griffiths@csiro.au
List of Parameters:	Water column modelled primary production estimates.
List of Units	Cloud: adjustment of the theoretical clear-sky irradiance to match the mean monthly short-wave radiation estimates from Bishop and Rossow (1991). Daily PAR: Calculated surface irradiance (Mole m^{-2} d^{-1}). Chlorophyll a in the mixed layer, and in the below mixed layer as mg Chl a m^{-2}. Gross and net daily production: mg Carbon m^{-2} d^{-1} Assimilation number: mg Carbon (mg Chl a) $^{-1}$ averaged for the depth of the mixed layer or below the mixed layer, or for the water column. Net production calculated using a 10% respiration figure.

[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. Chlorophyll-a samples on Whatman GFF filters, stored in liquid nitrogen until analysed by hplc. Carbon fixed vs light intensity (P vs I) incubations (one hour standard) done in a photosynthetron, using ^{14}C and incubations were started within one hour of the CTD coming on deck.

Units:

Mixed_layer_depth	metres
Maximum_depth	metres
Cloud_cover	Percent clear sky
PAR	Moles PAR day^{-1}
Chl_in_ml	Chlorophyll-a, mg m^{-2}
Gross_production_in_ml	Mg Carbon m^{-2} d^{-1}
Net_production_in_mixed_layer	Mg Carbon m^{-2} d^{-1} assuming a 10% respiration rate
Mixed_Layer_Assimilation_number	Mg Carbon/ Mg Chlorophyll-a

Chl_below_mixed layer	Chlorophyll-a, mg m^{-2}
Gross_production_below_ml	Mg Carbon m^{-2} d^{-1}
Net_production_below_mixed_layer	Mg Carbon m^{-2} d^{-1} assuming a 10% respiration rate
Below_mixed_layer_Assimilation_number	Mg Carbon/ Mg Chlorophyll-a
Column_chlorophyll	Chlorophyll-a, mg m^{-2}
Column_gross_production	Mg Carbon m^{-2} d^{-1}
Column_net_production	Mg Carbon m^{-2} d^{-1} assuming a 10% respiration rate
Column_Assimilation_number	Mg Carbon/ Mg Chlorophyll-a

[3] Analysis:

Instrument: None
Method: Modelling described in Mackey et al., 1995, 1997.
Precision: Estimated as ± 30% (see Clementson et al, 1998).
Comments:

[4] Results:

Quality of Data:
Known Problems:

AU9101: none. Fluorometric profiles made separately to but within ± 30 minutes the CTD and water sampling cast.

AU9303: none. Fluorometric profiles made separately to but within ± 30 minutes the CTD and water sampling cast.

AU9404: none

AU9407: none

AU9501: rough cruise, few stations able to be worked

AU9604: fluorometer flooded on second station. Chlorophyll profiles for production modelling constructed by linear interpolation between adjacent depths using HPLC chlorophylls from these depths. The difference between profiles constructed this way, and from fluorometer profiles converted to chlorophyll-a ranged between –11% to +23%, with a mean difference of +8.7% (data from AU 9704 and using 15 profiles).

AU9706: none.

[5] Brief description of analytical methods

The production vs light intensity estimates were obtained using a photosynthetron (see Mackey et al., 1995, 1997) and the photosynthetic parameters were obtained using a non-linear curve fitting program (Systat) to fit the models of Platt et al., (1980). The gross, daily integrated water-column production at 1 m intervals to various depths between 124 and 150m was estimated using a simple model incorporating the photosynthetic parameters (alpha, P_m^B, P_s^B beta), attenuation coefficients, fluorescence profiles (converted to chlorophyll-a profiles) and surface irradiance. The fluorescence profiles were converted to chlorophyll-a profiles using a regression between fluorescence and chlorophyll-a from niskin bottle samples. On AU9604, the fluorometer flooded, and chlorophyll profiles were constructed by a

linear interpolation between HPLC chlorophyll-a results from each niskin bottle on a cast by cast basis. During production modelling, the photosynthetic parameters were linearly interpolated between sampling depths. Depth-integrated production was calculated in two ranges: from the surface to the upper boundary of the deep chlorophyll maximum (the chlorophyll mixed layer) and from the upped boundary of the deep chlorophyll maximum to 150m including the deep chlorophyl maximum (below the mixed layer). The gross production estimates do not include the intercept, and make no allowance for respiration. A net production value is also calculated, and this assumes a 10% respiration figure. Vertically integrated daily production was calculated. Surface irradiance as function of time of day was calculated for clear-sky irradiance following Kirk (1983), and the effects of cloud cover were incorporated by adjusting the theoretical clear-sky irradiance to match the monthly mean irradiance estimates for the station latitude and longitude produced by Bishop and Rossow (1991). Photosynthetically active radiation (PAR) was calculated as 50% of the surface irradiance.

References:

Bishop, J.K. and W.B. Rossow, Spatial and temporal variability of global surface solar irradiance, *J. Geophys. Res. 99*, 16839-16858, 1991.

Griffiths, F.B., T.S. Bates, P.K. Quinn, L.A. Clementson, and J.S. Parslow, Oceanographic context of the first aerosol characterization experiment (ACE-1): A physical, chemical and biological overview, *J. Geophys. Res.*, *104*, 21649-21671, 1999.

Kirk, J. T. O. (1983) Light and photosynthesis in aquatic ecosystems. Cambridge University Press, Cambrige, U.K.

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:

The photosynthetic rates calculated are believed to be closer to gross photosynthesis that net photosynthesis because of the very short incubation times (one hour) used. Results of the modelling have been presented for both as a mixed layer, below mixed layer, and column total (Modelled column primary production estimates) data set.