Title: Phytoplankton production, photosynthetic (P vs E) parameters, and particulate organic carbon and nitrogen within distinct water masses of eastern Australian coastal and shelf waters between 29 °S and 36 °S during spring 2010

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Abstract:
The present dataset is part of an interdisciplinary project carried out on board the RV Southern Surveyor off New South Wales (Australia) from the 15th to the 31st October 2010. The main objective of the research voyage was to evaluate how the East Australian Current (EAC) affects the optical, chemical, physical, and biological water properties of the continental shelf and slope off the NSW coast.

Project overview:

The present dataset is part of an interdisciplinary project carried out on board the RV Southern Surveyor off New South Wales (NSW, Australia) from the 15th to the 31st October 2010. The main objective of the research voyage was to evaluate how the East Australian Current (EAC) affects the optical, chemical, physical, and biological water properties of the continental shelf and slope off the NSW coast. A more detailed voyage summary and objectives are given in the Marine National Facility reports (MNF, CSIRO, SS2010_v09; http://www.marine.csiro.au/nationalfacility/voyagedocs/2010/index.htm).

Specifically, the main objectives of the research voyage were to:

- Measure water structure and chemistry in a set of transects traversing the continental shelf and slope and evaluate the biogeochemical signature of the EAC
- Quantify primary productivity in different water masses associated with the EAC
- Study the impact of macronutrients and grazing on microbial diversity and productivity in contrasting oceanographic features (EAC, mesoscale eddy)
- Measure key parameters required in remote sensing algorithms and ecosystem models (Moore et al., 2007; Baird et al., 2008)
    - Estimate carbon fixation and related photosynthetic (PvsE) parameters
    - Measure particulate organic carbon (POC) and Chlorophyll *a* (Chl *a*) concentrations to evaluate C:Chla ratio
    - Characterize the underwater light field using bio-optical measurements

Methods:

Data format and instrumentation:

The format of events labels conventionally given here is two letters identifying the oceanographic vessel (i.e. SS: Southern Surveyor), four digits identifying the year of the voyage (i.e. 2010), one letter standing for the voyage followed by two digits for the number of the voyage (i.e. v09), and two numbers for the stations (i.e. 01 to 91). Table 1 summarizes the physical, chemical, and biological variables and their related units and methods, which are reported here.

Overall, a total of 91 stations were occupied, but station # 69 was disregarded due to a bottle fire issue. For each station, vertical profiles were taken using a rosette frame fitted with 24 x10L Niskin bottles and a Seabird SBE911-plus CTD. The CTD was equipped with a fluorometer (AquaTracker Mk3 (Chelsea, UK), a transmissiometer (Wetlabs C-Star (25 cm optical path)), a Photosynthetically Active Radiation sensor (PAR, Biospherical Instruments QCP-2300 Log Quantum Cosine Irradiance Sensor), and dissolved oxygen (Seabird SBE43) sensor. Temperature, salinity, dissolved oxygen, fluorescence and transmissometer and related hydrological parameters are provided by the CSIRO Marine and Atmospheric Research with details available here: https://www.cmar.csiro.au/trawler/survey_details.cfm?survey=SS2010_V09.

Depth-specific environmental conditions

To gather the depth-specific environmental conditions, we have searched for values of any physical and hydrological variables that were recorded for each station and discrete depth where corresponding measurements of phytoplankton carbon fixation and particulate organic carbon and nitrogen were made.

Measurements of particulate organic carbon and nitrogen (POC/PON), phytoplankton physiology and production (^{14}C carbon fixation), absorption, and pigments (High Performance Liquid Chromatography), were made at discrete depths. Phytoplankton pigments as well as absorption data are available through the CSIRO Marine and Atmospheric Research data portal (https://www.cmar.csiro.au/trawler/survey_details.cfm?survey=SS2010_V09).

Particulate organic carbon and nitrogen (POC/PON)

Two liters of seawater was filtered onto pre-combusted 25 mm GF/F glass-fiber filters (Whatman) at 20 stations. Filters were stored frozen at minus 80 degrees Celsius before being dried for 48 hours in an oven at 60 degrees Celsius and sent to the University of Sydney for the determination of particulate organic carbon (POC) and nitrogen (PON) concentration.

Primary productivity (carbon fixation) measurements and estimation of P vs E parameters

Seawater from the surface and fluorescence maximum was collected from 10L-Niskin bottles at 22 stations to undertake ^{14}C uptake measurements. P vs E parameters were incorrect for 2 stations and were therefore not included here. Primary productivity was estimated as described in Doblin et al. (2011) based on the small bottle 14C technique of Lewis and Smith (1983). Briefly, radiolabeled sodium bicarbonate 6.327 x 10^6 Bq (0.171 mCi) $NaH^{14}CO_3$ was added to 162 ml of sample to produce a working solution of 39.183 x 10^3 Bq per ml (1.1 µC ml^{-1}). Seven ml aliquots of working solution were then added to transparent glass scintillation vials and incubated under ambient surface (5 m) temperature for 1 hour at 7 light intensities ranging from 0 to 1500 µmol photons m^{-2} s^{-1}. After 1 hour, 250 µL of 6 M HCl was added to each vial and they were then agitated for 3 hours to ensure that all unfixed inorganic carbon was removed. For radioactive counts, 10 ml Ultima Gold™ (Perkin Elmer) scintillation fluid was added to each vial, the vial was capped and then shaken. Samples were counted using a scintillation counter (Packard TriCarb 2900 TR) with the maximum counting time set at 5 min. In addition, Time 0 counts were taken to determine background radiation and 100% counts were used to determine the specific activity of the working solution. For Time 0 counts, 7 ml aliquots of working solution were subjected to acid addition without any exposure to light, and counted after shaking for 3 hours. For 100%'s, 100 µL of working solution from each depth was added to 7 ml NaOH (0.1 M) and immediately counted following the addition of scintillation fluid.

Carbon uptake rates were normalised to *in situ* chlorophyll *a* concentrations measured using HPLC and for total dissolved inorganic carbon availability analysed using coulometric procedures (Johnson *et al.*, 1998). Carbon fixation-irradiance relationships were then plotted and the equation of Platt *et al.* (1980) was used to fit curves to data using least squares non-linear regression. Photosynthetic parameters determined included light-saturated photosynthetic rate [P_{max}, mg C (mg Chl-*a*)$^{-1}$ h^{-1}], initial slope of the light-limited section of the carbon fixation-irradiance curve [α, mg C (mg Chl-*a*)$^{-1}$ h^{-1} (µmol photons m^{-2} s^{-1})$^{-1}$], and light intensity at which carbon-uptake became maximal (calculated as $P_{max}/ \alpha = E_k$, µmol photons m^{-2} s^{-1}).

The given depth-specific primary productions were calculated following Platt et al. (1980). A first attempt to derive depth-integrated primary productions using the present reported photosynthetic parameters has recently been completed by Everett and Doblin (Deep-Sea Research I, *accepted manuscript*). Everett and Doblin used a two-box model to generate depth-integrated 14-C PP (mgC/m^2/d), which they then compared with other common primary production models (e.g. ESQRT, VGPM) using both in situ and satellite derived variable inputs.

Importance of the dataset:

This is a first comprehensive dataset including measurements of primary production and related photosynthetic parameters, particulate organic carbon and nitrogen concentrations

as well as corresponding physical and chemical characteristics for several oceanographic features along the NSW continental shelf and slope.

Furthermore, the present dataset will have direct application in satellite remote sensing of ocean color validation and the subsequent adjustment of existing global-scale primary production and carbon flux models for the NSW coastal region.

Acknowledgements:

Australian Marine National Facility (MNF), Lesley Clementson from CSIRO Marine & Atmospheric Research (CMAR) for HPLC pigment analyses.

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Table 1. Summary of the physical, biological, and chemical variables and their related units and methods reported for discrete depths at distinct stations located between 29 °S and 36 °S (Australia) during spring 2010.

#	Name	Short Name	Units	Method	Comment
1	Event label	Event			Metadata
2	Latitude	Latitude	degrees_N		Geocode
3	Longitude	Longitude	degrees_E		Geocode
4	Date/Time of event	Date/Time,	UTC, yyyy-mm-ddTHH:MM:SSZ		Metadata
5	Date/Time of event	Date/Time,	Local, yyyy-mm-ddTHH:MM:SSZ		
6	Day of the year	DOY	Julian day		
7	Daylength	Daylength	Decimal hours		
8	DEPTH, water	Depth water	m		
9	DEPTH, bottom/max	Max Depth	m		
10	Pressure, water	Press	dbar	CTD/rosette	
11	Temperature, water	Temp	°C [ITS-90]	CTD/rosette	
12	Salinity, water	Sal	PSU [PSS-78]	CTD/rosette	
13	Photosynthetic Active Radiation	PAR	µEin/m2/s	CTD attached PAR sensor (XXXX)	
14	Oxygen	O2	µM/L	CTD attached Oxygen sensor (XXXX)	
15	Fluorescence	Fluo	RU	CTD attached Fluorometer sensor (XXXX)	
16	Transmission	Trans	%	CTD attached Transmissiometer	
17	Nitrate ISUS	Nitrate	µM/l	CTD attached	
18	Silicate	Si(OH)4	µM	hydrobiology	
19	Nitrate	NO3	µM	hydrobiology	
20	Phosphate	PO4	µM	hydrobiology	
21	Ammonia	NH4	µM	hydrobiology	
22	Mixed layer depth	MLD	m	de Boyer-Montegut et al. 2004	
23	Fluorescence maximum	Fmax	m	observed	
24	Carbon, organic, particulate	POC	mg/m3	HCN	
25	Nitrogen, organic, particulate	PON	mg/m3	HCN	
26	Carbon to nitrogen molar ratio	C:N	molar ratio	calculated	
27	Carbon to chlorophyll a ratio	C:Chl-a	g C /g Chl a	calculated	
28	Chlorophyll a	Chl-a	mg/m3	HPLC	
29	Maximum light utilisation coefficient (initial slope)	alphaB	mgC/mgChla/hr/(µmol/m2/s)	calculated	
30	Photohinibition parameter	betaB	mgC/mgChla/hr/(µmol/m2/s1)	calculated	
31	Maximum photosynthetic rate of carbon per chlorophyll	PmaxB	mgC/mgChla/hr	calculated	
32	Light adaptation index	Ek	µmol/m2/s1	calculated	
33	Primary Production of carbon at specific depth (z)	PP (z)	mgC/m3/hr	14C, 1 hour in-situ incubation	