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Key Points:

- POC fluxes are highly variable in the South China Sea
- Diatoms drive POC export in the coastal area
- POC stock regulates POC fluxes in the shelf

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Role of particle stock and phytoplankton community structure in regulating particulate organic carbon export in a large marginal sea

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Abstract In this study, we utilize $^{234}Th/^{238}U$ disequilibrium to determine particulate organic carbon (POC) export from the euphotic zone in the South China Sea. Depth profiles of ^{234}Th, total chlorophyll, pigments, and POC were collected during four cruises from August 2009 to May 2011, covering an entire seasonal cycle of spring, summer, autumn, and winter. The extensive data set that was acquired allows for an evaluation of the seasonal variability of upper ocean POC export and its controls in a large marginal sea. The results show that ^{234}Th fluxes from the euphotic zone fall in the range of 528−1550, 340−2694, and 302–2647 dpm m^{-2} d^{-1} for the coastal, shelf, and basin regimes, respectively. In these regimes, POC/^{234}Th ratios at the base of the euphotic zone fall in the range of 5.7–58.2, 4.6–44.0, and 2.5–15.5 μmol dpm^{-1}, respectively. Accordingly, for the coastal, shelf, and basin regimes, the mean POC export fluxes from the euphotic zone are 24.3, 18.3, and 6.3 mmolC m^{-2} d^{-1}, respectively. Seasonal variations in POC export flux are remarkable in the study area, and POC export peaks were generally observed in autumn. We use a simple linear regression (LLS) method to examine the correlation of POC export versus POC stock and versus plankton community structure. We found a strong correlation ($R^2 = 0.73$, $p < 0.005$) between POC export flux and the fraction of diatom in the coastal area, indicating that POC export flux in this province is driven by large phytoplankton, in particular, diatoms. In the shelf area, a relatively strong correlation ($R^2 = 0.54$, $p < 0.0001$) was noted for POC export flux and POC stock in the euphotic zone. This indicates that POC export flux in the South China Sea shelf is primarily controlled by POC stock. In contrast, in the South China Sea basin, we identified a weak but intriguing correlation ($R^2 = 0.26$, $p < 0.0001$) between POC export flux and the fraction of haptophytes and prasinophytes that are typically < 5 μm in size. This suggests that mechanisms controlling POC export flux in the South China Sea basin are complicated. However, small phytoplankton may play a significant role in controlling POC export flux since they dominate the phytoplankton community structure in this region.

1. Introduction

The transport of particulate organic carbon (POC) from the euphotic zone to the deep sea is generally considered to be the key driver of the ocean's biological pump [*Boyd and Trull*, 2007]. At the global scale, the strength and efficiency of the biological pump in part modulate levels of atmospheric CO_2 [*Volk and Hoffert*, 1985]. For instance, from the paleoceanographic record there is evidence of a reduction in atmospheric CO_2 concentration during the last glacial maximum resulting from an increase in the strength of the biological pump [*Sigman and Boyle*, 2000]. Understanding the mechanisms that control the strength and efficiency of the biological pump is thus critical to assessing the impact of ongoing climate changes on the carbon sequestration in the ocean.

The controls on POC export have long been recognized to be diverse and complex [e.g., *Berger et al.*, 1989]. In early studies, primary production was thought to be the key determinant of POC export. Moreover, primary production and POC export were postulated to be well correlated, such that simple empirical relationship between the two parameters can be achieved [*Suess*, 1980; *Pace et al.*, 1987]. This early concept, however, was not pursued by later studies due to the findings of the decoupling of primary production and POC export that is characteristic of specific sites and events [e.g., *Buesseler*, 1998; *Baumann et al.*, 2013]. Later studies also highlighted plankton community structure as the dominant control on POC export [e.g., *Michaels and Silver*, 1988; *Boyd and Newton*, 1999]. The view is that large planktons, in particular diatom species, drive the bulk of POC export in the upper ocean, and their contributions to POC export are disproportionally larger than their contributions to total primary production. This conventional view framed the general paradigm that came to govern POC export studies over the last two decades. But recently, it has been challenged [e.g., *Richardson and Jackson*, 2007; *Brew et al*., 2009; *Lomas and Moran*, 2011; *Close et al*., 2013]. For instance, by analyzing data from the equatorial Pacific Ocean and Arabian Sea *Richardson and Jackson* [2007] argued that despite their small size, picoplankton can dominate POC export in the open ocean. This alternative view invokes aggregation as a mechanism for both direct and indirect sinking of picoplankton-derived particles. Ultimate controls on POC export need to be investigated in a diversity of biogeochemical provinces with strong contrasts in primary production, POC export, and plankton community structure [e.g., *Moran et al*., 2012].

An ideal site for such studies is the South China Sea (SCS). With a total area of 3.5×10^6 km^2, the sea is one of the largest marginal seas in the world. It is under the persistent influence of monsoonal winds: a strong northeast monsoon between November and April, and a weaker southwest monsoon between June and September. In response to the seasonal monsoons, the surface circulation in the SCS changes from a basin-scale cyclonic gyre in winter to an anticyclonic gyre in summer [*Hu et al*., 2000]. The basin-wide surface circulation gyres effectively reduce the influence of the land runoff on the SCS proper. As a result, the SCS basin is oligotrophic, and is characterized by low surface chlorophyll-a levels and low primary production rates [e.g., *Liu et al*., 2002]. In contrast, the coastal area and the continental shelf are highly productive [*Chen*, 2005]. POC export and plankton community structure studies, although sparse, also indicated a strong contrast between the coastal area and the basin [*Ning et al*., 2004; *Chen*, 2008; *Wei et al*., 2011].

In this study, we utilize ^{234}Th/^{238}U disequilibrium to determine POC export from the euphotic zone in the northern South China Sea. In seawater, ^{234}Th (half-life = 24.1 d) is produced via alpha-decay by ^{238}U at a known rate. But, unlike the conservative ^{238}U, ^{234}Th is highly particle-reactive. It can be effectively scavenged onto sinking particles. Consequently, a deficit of ^{234}Th with respect to ^{238}U in the upper ocean generally results. With an appropriate scavenging model, the deficit of ^{234}Th is converted into ^{234}Th fluxes. Finally, POC export rates are achieved by multiplying the ^{234}Th fluxes by the POC/^{234}Th ratio representative for the truly sinking particles at the export horizon of interest [*Buesseler et al*., 2006]. In order to assess the spatial temporal variability in POC export rate and its controls in the South China Sea, four survey cruises were conducted during 2009–2011, covering an entire seasonal cycle of spring, summer, autumn, and winter. During each survey cruise, transects extending from the coastal area to the deep basin were occupied. Along with POC export measurements, we also determined POC stock and phytoplankton community structure. The vast data set acquired from this study allows us to test two basic hypotheses regarding controls on the upper ocean POC export in a large marginal sea, namely: (1) POC stock controls POC export rates; and/or (2) phytoplankton community structure determines the mean sinking velocity of marine particles and hence is a dominant control on POC export rates. These two hypotheses originate from the general expression of POC export flux in the upper ocean: $F_{POC} = S \times C$, where S is the sinking velocity of particles and C is the concentration of POC. Yet, they remain to be tested by field observations.

2. Methods

2.1. Sample Collection

Water samples were collected during four survey cruises in the northern South China Sea from 18 July to 16 August in 2009 (summer), 6–30 January in 2010 (winter), 26 October to 24 November in 2010 (autumn), and 30 April to 24 May in 2011 (spring). The cruises were carried out in the context of a National Basic Research Program of China named "Carbon Cycling in the China Seas: Budget, Controls and Ocean Acidification (CHOICE-C)." For convenience, hereafter we neglect the interannual variability and describe the results in the seasonal succession, i.e., spring, summer, autumn, and winter. Sampling stations are indicated in Figure 1. Detailed information about the sampling stations is provided in Table A1. A total of 123 stations were occupied during the four survey cruises. Depth profiles of ^{234}Th, total chlorophyll, pigments, and POC were collected at 33 stations during the spring survey, 41 stations during the summer survey, 19 stations during the autumn survey, and 30 stations during the winter survey. For most of the stations in the basin (water depth > 200 m), water samples were collected throughout the upper 150 m at 5, 25, 50, 75, 100, 125, and

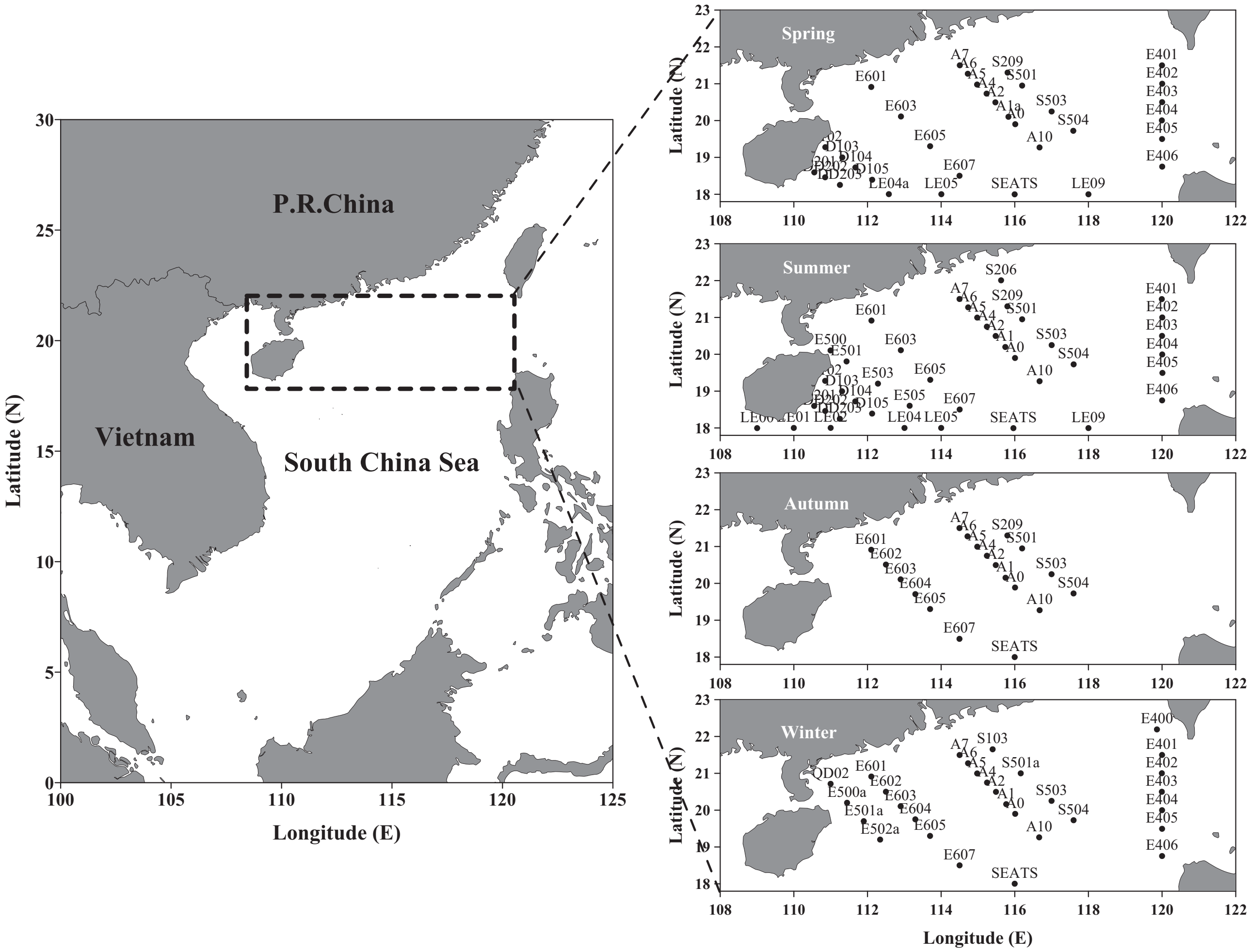

Figure 1. Map of the South China Sea (left). Sampling stations from the "CHOICE-C" cruises are indicated by solid circles (right). The coordinates of the sampling stations can be found in Table A1.

150 m. For a few exceptions, samples were collected down to 500 m (e.g., at Station A1, A10, and SEATS). For the stations located in the coastal region (water depth <50 m) and the shelf (water depth >50–200 m), water samples were collected throughout the whole water column. Samples for various analyses were collected at the same depth using Niskin bottles attached on a CTD rosette sampler.

2.2. ^{234}Th Analyses

A volume of 4L and 8L of seawater was used to determine total and particulate ^{234}Th activities, respectively. Total ^{234}Th analysis was based on the small-volume MnO_2 coprecipitation method with addition of a ^{230}Th spike [*Buesseler et al.*, 2001; *Pike et al.*, 2005; *Rutgers van der Loeff et al.*, 2006; *Cai et al.*, 2006]. Detailed description of the procedure has been provided in our prior studies [e.g., *Cai et al.*, 2010]. Similar to the total ^{234}Th samples, particulate samples were also filtered onto a 25 mm 1.0 μm QMA filter. All the samples were dried, mounted under a layer of Mylar film, and two layers of aluminum foil (7.2 mg cm^{-2}). For each sample, two measurements were conducted on the same detector of a gas flow proportional beta counter (Risø GM-25-5) within 1–2 days and in 5–6 months after sample collection to determine background counts. For particulate samples with low ^{234}Th activity, we increased counting time in the first measurement so as to achieve a minimum of 500 counts. All the total ^{234}Th samples were processed for ^{230}Th recovery measurement. Recovery of ^{230}Th was determined by inductively coupled plasma-mass spectrometry (ICP-MS) (Agilent 7700x) with addition of a ^{229}Th internal standard. Although there were a few samples with low yields, ^{230}Th recoveries were generally found to be high and stable (96.2% ± 3.4%, n = 765). All ^{234}Th data were recovery-corrected, and decay corrected to the time of collection and reported with a propagated uncertainty that includes the initial and final counting of ^{234}Th, the uncertainty on the recovery correction, and the error associated with detector calibration. Thorium-234 activities were calibrated against deep waters and/or aged seawater samples where ^{234}Th and ^{238}U are expected to be in secular equilibrium. In addition, we have participated in the GEOTRACES intercalibration for ^{234}Th [*Maiti et al*., 2012]. ^{234}Th data from our laboratory are in good agreement with those determined in other labs. Uranium-238 activities were estimated from salinity measurements using the relationship of ^{238}U (dpm L^{-1}) = 0.0686 × salinity × density [*Chen et al*., 1986]. The associated uncertainty is in the vicinity of ±3% [*Pates and Muir*, 2007] and was included when propagating the error related to total ^{234}Th activities.

2.3. Total Chl-a, Pigments, POC, PON, and TSM Analyses

Total chlorophyll a (Chl-a) and pigment concentrations were measured by High-Performance Liquid Chromatography (HPLC) according to the protocol of *Furuya et al*. [1998]. In brief, a volume of 4–16 L of seawater was filtered onto a 47 mm 0.7 μm (nominal pore size) GF/F filter under a gentle vacuum of <150 mm Hg. The filter was folded and stored in liquid nitrogen until analysis. At the land-based laboratory, the filter was completely crushed and extracted with 2 mL of DMF (N, N-dimethylformamide). To the extract ammonium, acetate (1 *M*) was added as an ion-pairing reagent. The mixture was then filtered through a 0.2 μm PTFE filter and injected into an Agilent series 1100 HPLC system through a 3.5 μm Eclipse XDB C_8 column (100×4.6mm; Agilent Technologies). A binary solvent system was used with 1 *M* ammonium acetate solution as a buffer. The flow rate was set to be 1 mL min^{-1}. The pigment identification utilized the criterion of the retention time and the absorption spectra of pigment standards purchased from Danish Hydraulic Institute (DHI) Water and Environment, Hørsholm, Denmark. Chl-a was quantified by weight from peak area calibrated against a Chl-a standard, the concentration of which was determined spectrophotometrically.

POC and PON content in the particulate samples that have been beta-counted was determined with a PE-2400 SERIES II CHNS/O analyzer according to the JGOFS protocols [*Knap et al*., 1996]. All samples were treated via acid fuming to remove the carbonate phase. Each sample was corrected for a C (or N) blank. The C blank of the filter was less than 6 μg C, which on average, accounted for ~ 5% of the POC on the QMA filters. Based on replicate analyses, the precision for the POC and PON determinations was better than 10%.

For the determination of total suspended matter (TSM) concentrations, approximately 4–8 L of seawater was filtered through a preweighed Nuclepore filter (0.45 μm). The filter was rinsed and dried at 60°C until a constant weight was reached. The concentration of TSM was calculated from the weight difference between the sample and the filter.

2.4. ^{234}Th Flux Models

Export fluxes of ^{234}Th on sinking particles can be determined by solving for the balance of its sources and sinks with the following mathematical expression,

$$\partial A_{Th}/\partial t=(A_U\text{-}A_{Th})\cdot\lambda\text{-}P+V \quad (1)$$

where $\partial A_{Th}/\partial t$ is the change in ^{234}Th activity with time, A_U is the activity of ^{238}U, A_{Th} is the activity of total ^{234}Th, λ is the decay constant for ^{234}Th (=0.0288 d^{-1}), P is the net export flux of ^{234}Th on sinking particles, and V is the sum of advective and diffusive terms. In the open ocean, the magnitude in P is determined mostly by the extent of the disequilibrium between ^{234}Th and ^{238}U. Physical terms are generally ignored and steady state (SS) is often assumed [*Savoye et al*., 2006]. In coastal and shelf areas, however, physical transport could be important in the overall ^{234}Th balance [e.g., *Benitez-Nelson et al*., 2000]. In our prior study, we have developed a regional three-dimensional (3-D) model that includes seasonal-specific and site-specific upwelling and horizontal fluxes in the overall ^{234}Th activity balance in the southern South China Sea [*Cai et al*., 2008].

Flux calculations from the model revealed that the vertical transport term and the horizontal transport term generally accounted for <1% and <10% of the overall ^{234}Th balance, and were usually below the overall uncertainty of the net ^{234}Th export flux [*Cai et al*., 2008]. In this study, we have also attempted to apply our 3-D model to ^{234}Th flux calculation. Unfortunately, flux calculations from this model showed that about half the stations were characterized by an unreasonably negative ^{234}Th flux. Sensitivity tests revealed that this was mainly a result of poorly constrained model parameters. Our inability to tightly constrain physical transport terms in space and time remains a challenge in all mass balance calculations in ocean sciences. As such, we consider that a 1-D steady state model is generally an adequate approximation for the ^{234}Th balance in the South China Sea under the "average" oceanic condition. By neglecting the physical terms, equation (1) takes the form:

$$P=(A_U\text{-}A_{Th})\cdot\lambda \tag{2}$$

From the integral disequilibrium between ^{234}Th and ^{238}U, P (in terms of dpm m^{-2} d^{-1}) can be estimated for the depth horizon of interest.

2.5. Phytoplankton Community Structure

Phytoplankton community structure in the euphotic zone of the study area was reconstructed from the HPLC pigment data using the CHEMTAX program developed by *Mackey et al*. [1996]. In this study, we used an initial pigment ratio matrix that includes 12 accessory pigments in nine phytoplankton groups. The rectification of initial pigment to Chl-a ratios followed the criteria that was widely adopted by previous studies [*Goericke and Repeta*, 1993; *Mackey et al*., 1996; *Latasa*, 2007]. Successive runs of the CHEMTAX were performed to gain the convergence between output and initial ratios. The contribution to total Chl-*a* was acquired from the CHEMTAX algorithm for the major phytoplankton groups, including dinoflagellates, diatoms, haptophytes_8, haptophytes_6, *synechococcus* spp., *prochlorococcus* spp., prasinophytes, chlorophytes, and cryptophytes.

3. Results

3.1. Three Dimensional (3-D) Distributions of Total ^{234}Th, Chl-a, and POC

Thorium-234 activity, Chl-a content, and POC concentration as well as potential temperature and salinity in the upper South China Sea are presented in Table A1. Pigment data will be published elsewhere. To examine the temporal-spatial variations in the data, we plotted the three dimensional contours using a software package (SURFER^{TM} by Golden Software), which utilizes a linear Kriging technique to grid the data. As shown in Table A1, below 100 m Chl-a and POC levels are low and ^{234}Th generally approaches secular equilibrium with ^{238}U. There do exist a few exceptions, where ^{234}Th below 100 m is found to be either in deficit ($^{234}Th/^{238}U<1$, e.g., between 100 and 500 m at SEATS during the summer survey) or in excess ($^{234}Th/^{238}U>1$, e.g., between 100 and 150 m at A0 during the spring survey) relative to ^{238}U. A ^{234}Th deficit below 100 m where particle production rate is low could be due to the lateral transport of shelf sediment, or due to deeper particle repackaging and export [e.g., *Buesseler et al*., 2008]. On the other hand, an excess of ^{234}Th relative to ^{238}U indicates rapid remineralization or consumption of sinking particles carrying ^{234}Th to depth. Aside from these, there is generally a lack of temporal-spatial variability in the ^{234}Th, Chl-a, and POC data below 100 m. As such, our attention will be focused on the seasonal and depth-related variations in the upper 100 m.

The depth distributions of total ^{234}Th share some common features in the four survey cruises (Figure 2). For all of the depth profiles, ^{234}Th deficit are evident in the upper 100 m. Moreover, in all of the survey cruises, ^{234}Th exhibits a larger depletion in the coastal region compared to the basin. The ^{234}Th depletion in the upper 100 m indicates that particle scavenging and removal rates are considerable in the upper South China Sea. The larger depletion of ^{234}Th implies that the coastal area is characterized by much higher particle scavenging and removal rates than in the basin. Along with the larger ^{234}Th depletion, Chl-a content and POC concentration are generally elevated in the coastal region (Figures 2 and 3).

The depth profiles of ^{234}Th also exhibit seasonal characteristics. During the spring and summer cruises when the wind mixed layer is shallow, a stratified structure of ^{234}Th was generally observed. The stratified ^{234}Th structure is characterized by a relatively small depletion of ^{234}Th (high $^{234}Th/^{238}U$ ratio) in the wind mixed layer (between 0 and 25 m) and near 100 m, and a relatively enhanced ^{234}Th depletion (low $^{234}Th/^{238}U$ ratio) at 25–50 m. Just below the layer where low ^{234}Th occurs, there appears to be deep chlorophyll-a maxima (DCM) at 50–75 m. The stratified ^{234}Th structure has been observed in the South

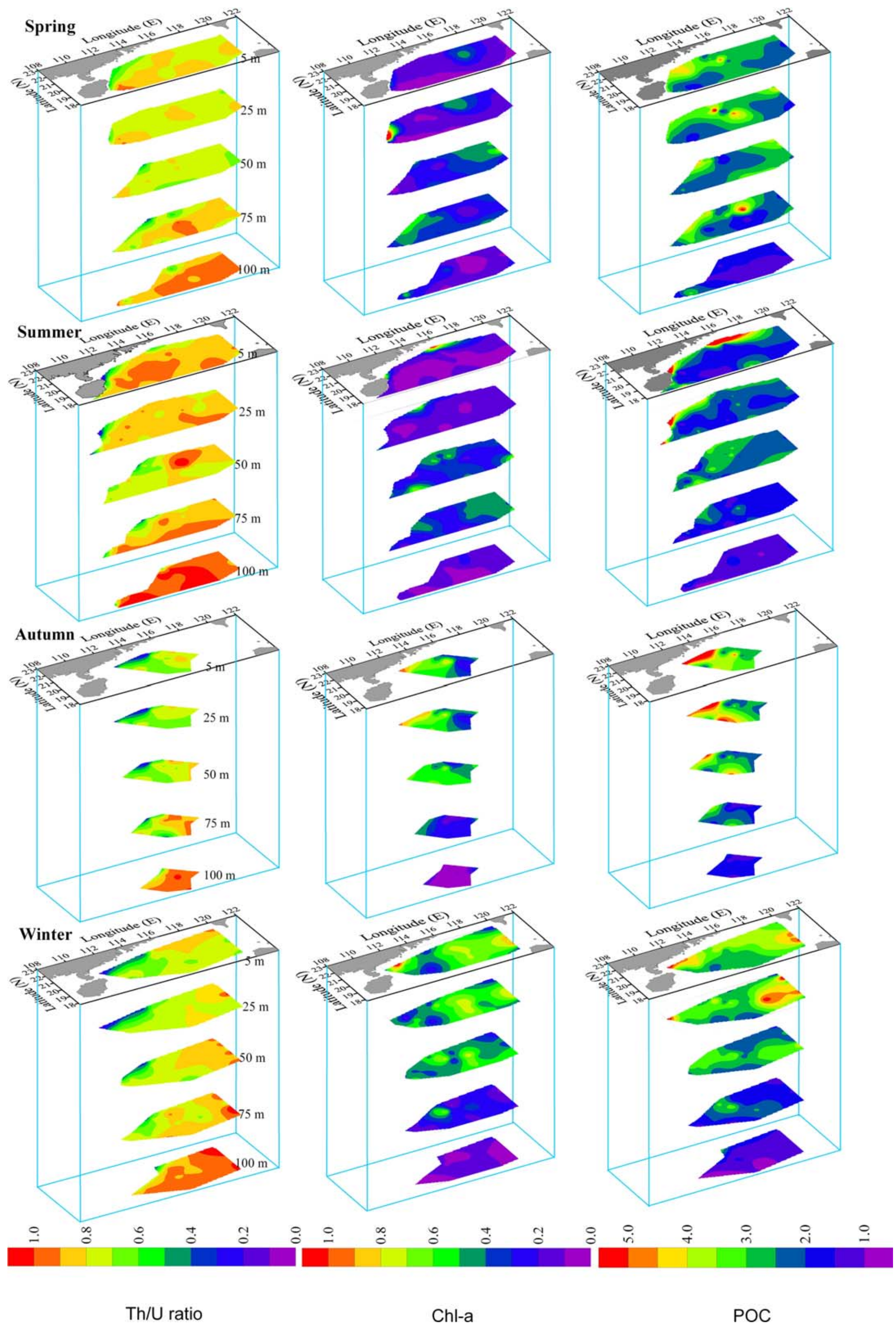

Figure 2. Seasonal succession of total $^{234}Th/^{238}U$ ratio (left), Chl-a content (unit: mg m^{-3}, middle), and POC concentration (unit: μmol l^{-1}, right) in the upper South China Sea.

China Sea by our previous study [*Cai et al*., 2008]. This implies that in the spring and summer, the euphotic zone of the South China Sea can be separated into two layers: an upper layer characterized by low particle production and export rates, and a lower layer with higher rates of particle production and export [*Coale*

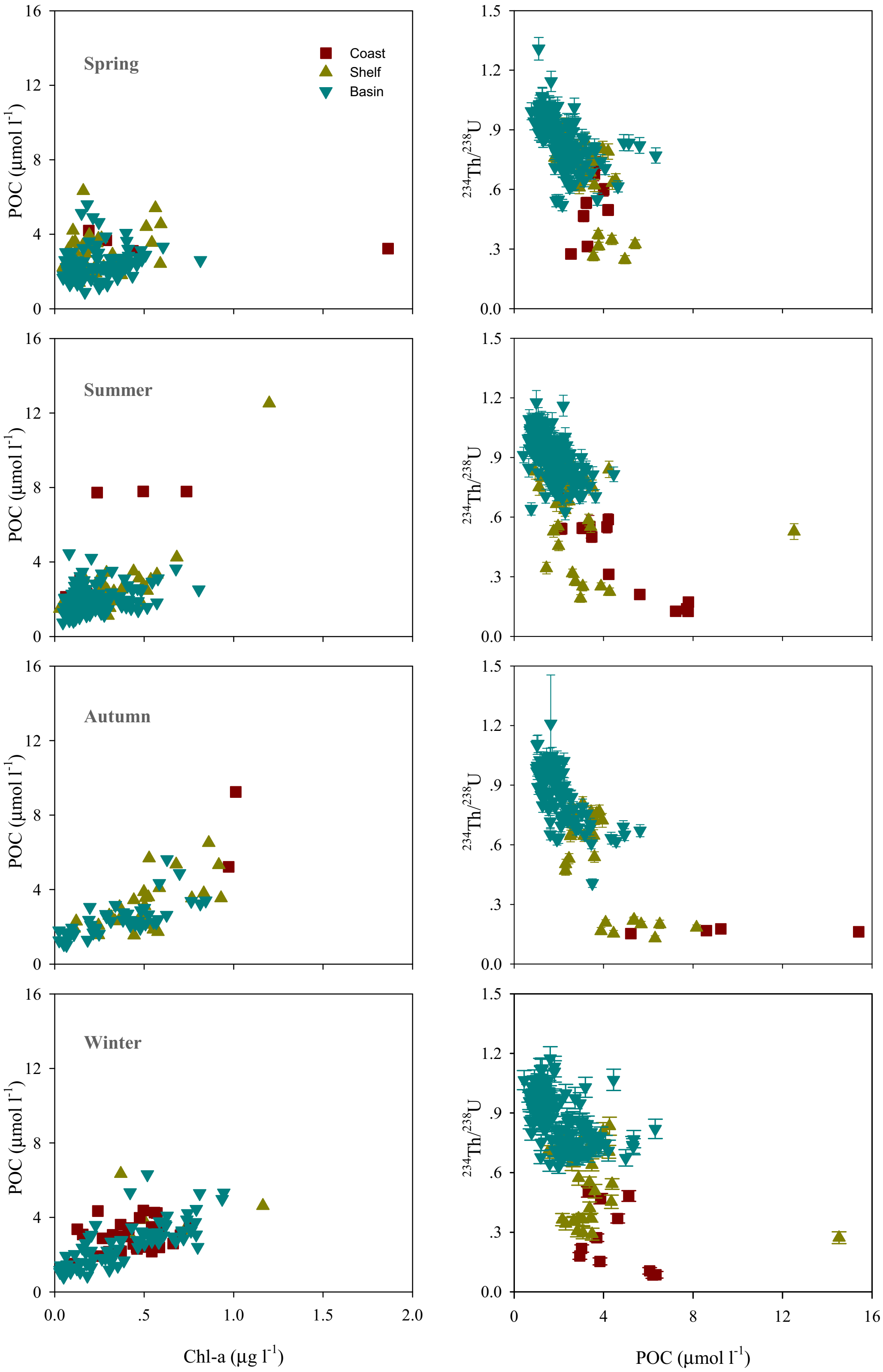

Figure 3. Plots of Chl-a content versus POC concentration (left), and of total $^{234}Th/^{238}U$ ratio versus POC concentration (right) in the upper 100 m water column during the four surveys of the South China Sea.

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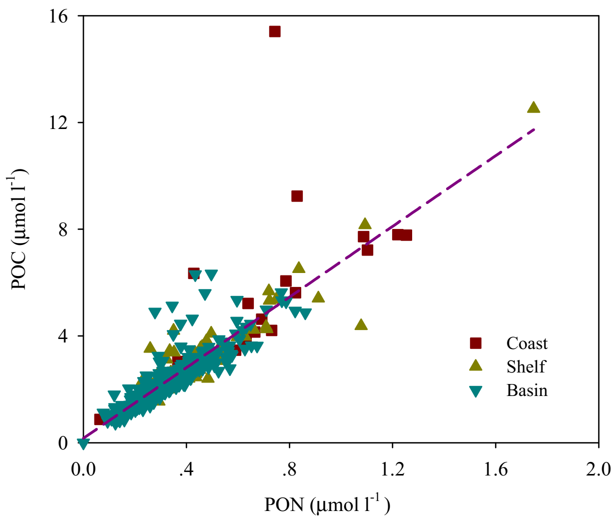

Figure 4. Scatter plot of POC concentration versus PON concentration in the upper 100 m water column derived from the four surveys of the South China Sea. A linear regression of the data gives a relationship of POC=6.62×PON+0.17 (R^2=0.75).

and Bruland, 1987]. In comparison, Chl-a maximum generally occurs at the surface during the autumn and winter surveys, when wind mixed layer extends down to 50–60 m. At most of the stations, Chl-a content decreases gradually with depth. In association with the Chl-a maximum, ^{234}Th activity is low at the surface. With the increase in depth, ^{234}Th depletion gradually diminishes and secular equilibrium between ^{234}Th and ^{238}U is generally approached at 100 m in the basin regime.

From a seasonal viewpoint, the ^{234}Th depletion in the upper 100 m is stronger in the autumn and winter than in the spring and summer ($p < 0.0001$, *t*-test). In the spring survey, the average total ^{234}Th/^{238}U ratios at 5, 25, 50, 75, and 100 m are 0.79 ± 0.11 (n = 33), 0.78 ± 0.08 (n = 33), 0.72 ± 0.12 (n = 31), 0.76 ± 0.17 (n = 30), and 0.88 ± 0.10 (n = 30), respectively. The associated error is one standard deviation for all the measurements at different stations, which reflects the horizontal variability in total ^{234}Th activity. In the summer survey, the average ^{234}Th/^{238}U ratios are 0.83±0.16 (n=41), 0.80±0.17 (n=41), 0.76±0.14 (n=37), 0.82±0.16 (n=34), and 0.95±0.16 (n=29) at the abovementioned depths. In comparison, during the autumn survey, the average ^{234}Th/^{238}U ratios are 0.65 ± 0.22 (n = 19), 0.64 ± 0.21 (n = 19), 0.69 ± 0.20 (n = 18), 0.76 ± 0.23 (n = 16), and 0.87 ± 0.16 (n = 13). During the winter survey, the average ^{234}Th/^{238}U ratios are 0.67 ± 0.17 (n = 30), 0.69 ± 0.20 (n = 30), 0.75 ± 0.18 (n = 27), 0.80 ± 0.17 (n = 25), and 0.91 ± 0.18 (n = 21). In accordance with the ^{234}Th depletion, Chl-a content and POC concentration in the upper 100 m are elevated in the autumn and winter compared to the spring and summer ($p < 0.0001$, *t*-test). The average Chl-a concentrations in the autumn and winter surveys are 0.42 ± 0.25 (n = 78) and 0.41 ± 0.25 (n = 120) μg L^{-1}, compared to 0.24 ± 0.20 (n = 152) and 0.23 ± 0.17 (n=182) μg L^{-1} in the spring and summer surveys. In the meantime, the average POC concentrations in the autumn and winter surveys are 2.9 ± 0.9 (n = 85) and 2.7 ± 1.2 (n = 133) μmol L^{-1}, slightly higher than in the spring and summer surveys (2.5 ± 0.9 (n = 153) and 2.2 ± 1.3 (n = 182) μmol L^{-1}, respectively).

The correspondence between ^{234}Th depletion and particle abundance can be examined in a more quantitative manner by comparing ^{234}Th/^{238}U ratio to Chl-a and POC levels. As shown in Figure 3, except for the spring survey there is a weak but significant correlation (R^2=0.32–0.55) between POC concentration and Chl-a level in the upper South China Sea. In an oceanographic setting where biogenic particles are dominant, this general correlation is expected as biogenic POC is the photosynthesis product of phytoplankton. In the meantime, carbon to chlorophyll ratio in phytoplankton cells is a function of irradiance, temperature, nitrate, and iron levels [e.g., *Wang et al.*, 2009]. Therefore, there are considerable variations in carbon to chlorophyll ratio, depending on region, depth, and season. This could explain why a stronger correlation between POC concentration and Chl-a level was not noted in our study area, particularly for the spring survey. In addition, the presence of appreciable amounts of terrestrial POC can also confound the relationship between POC concentration and Chl-a level. We have analyzed the C/N ratio on particles collected from the upper 100 m in our study area and found a mean ratio of 6.6 (Figure 4). This value is in excellent agreement with the Redfield ratio of 106:16 for C/N in phytoplankton cells and indicates that biogenic particles were dominant in our study area. Nonetheless, Figure 4 also shows that several data points are characterized by C/N ratios distinctly higher than the typical Redfield ratio. This reflects the influence of terrestrial POC with a characteristic C/N ratio of 22 [*Liu et al.*, 2007]. In the meantime, plots of ^{234}Th/^{238}U ratio versus POC concentration clearly demonstrate that our study area could be divided into three different regimes: a coastal regime characterized by high POC concentration and low ^{234}Th/^{238}U ratio, which was presumably caused by sinking biogenic particles, nepheloid particle resuspension and deposition, and potentially terrestrial

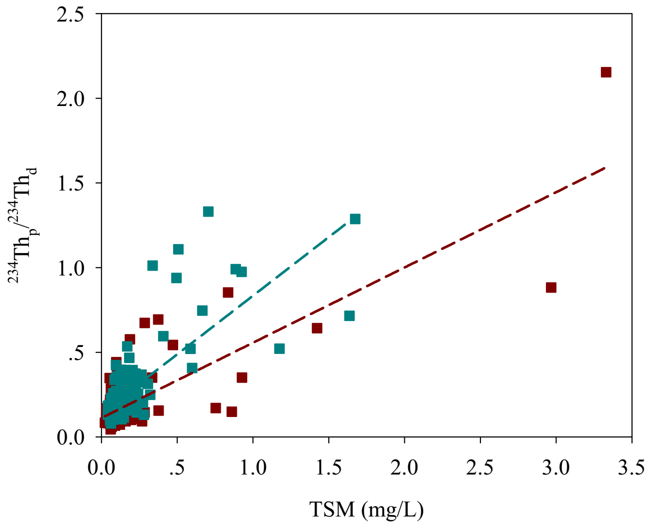

Figure 5. Plot of ratio of particulate ^{234}Th to dissolved ^{234}Th ($^{234}Th_p/^{234}Th_d$) versus TSM for the summer survey (red squares) and the winter survey (cyan squares) of the South China Sea. Line is best fit to the data based on a linear regression method (R^2=0.66 for the summer survey, and 0.58 for the winter survey).

input; an oceanic regime characterized by low POC concentration and high $^{234}Th/^{238}U$ ratio, which was essentially caused by vertical export of biogenic particles; and a shelf regime falling in between (Figure 3). Interestingly, the shelf regime seems to reflect a mixing pattern between the coastal waters and the oceanic waters.

3.2. Distributions of Particulate ^{234}Th

Particulate ^{234}Th activity falls in the range of 0.07–0.61 dpm L^{-1}. Enhanced activities of particulate ^{234}Th were observed in the winter survey ($p < 0.0001$, *t*-test). In comparison, in the autumn survey particulate ^{234}Th activity was relatively low ($p < 0.0001$, *t*-test). More specifically, for the spring, summer, autumn, and winter surveys, the average activities of particulate ^{234}Th are 0.30 ± 0.08 (n = 213), 0.27 ± 0.08 (n = 252), 0.24 ± 0.07 (n = 131), and 0.33 ± 0.08 (n = 192) dpm L^{-1}, respectively. In previous studies, particulate ^{234}Th was noted to mirror particle distribution and/or phytoplankton abundance in the surface ocean [e.g., *Rutgers van der Loeff et al*., 2011]. In this study, we have observed a similar correlation between TSM and the ratio of particulate to dissolved ^{234}Th ($^{234}Th_p/^{234}Th_d$), which is used instead of particulate ^{234}Th to account for the availability of ^{234}Th for adsorption (Figure 5). As such, we can use particulate ^{234}Th as a tracer to investigate particle distribution and its seasonal pattern in our study area. Figure 6 illustrates the depth distribution of the ratio of $^{234}Th_p/^{234}Th_d$ for the typical transect A7–A10, which extends from the continental shelf into the basin regime and was most intensively sampled in all of the four surveys. It is evident that

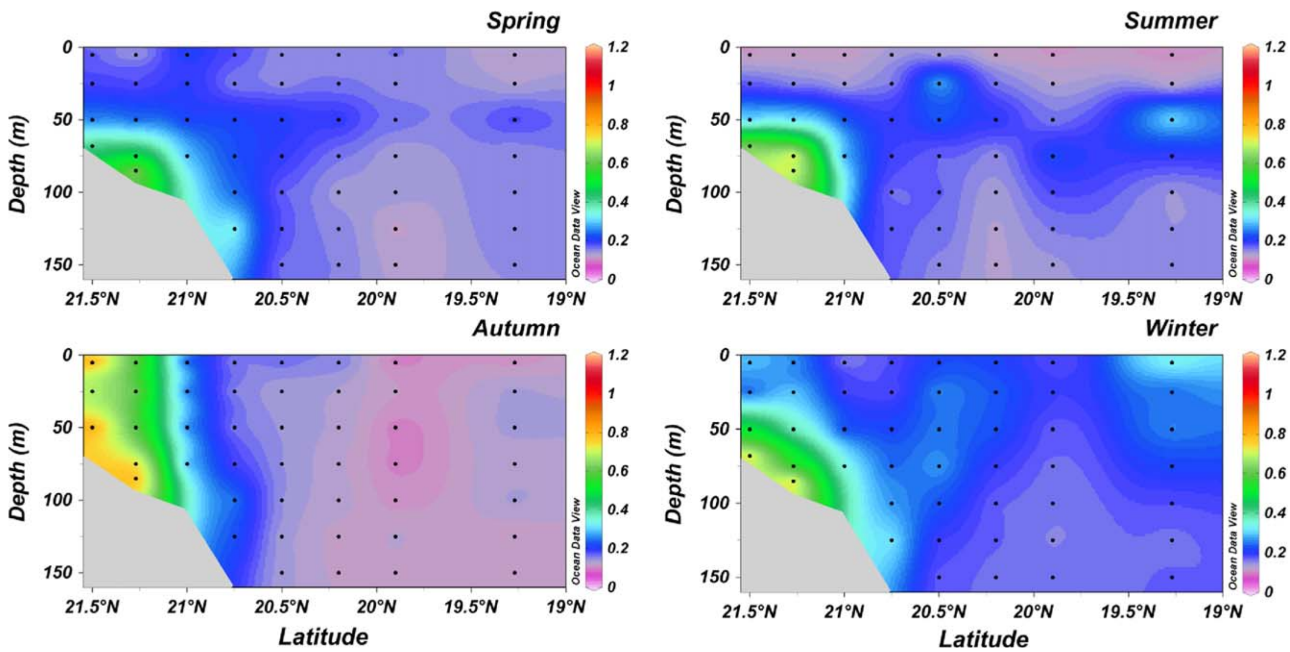

Figure 6. Seasonal variations of $^{234}Th_p/^{234}Th_d$ ratio along transect A7-A10, which extends from the continental shelf into the basin regime.

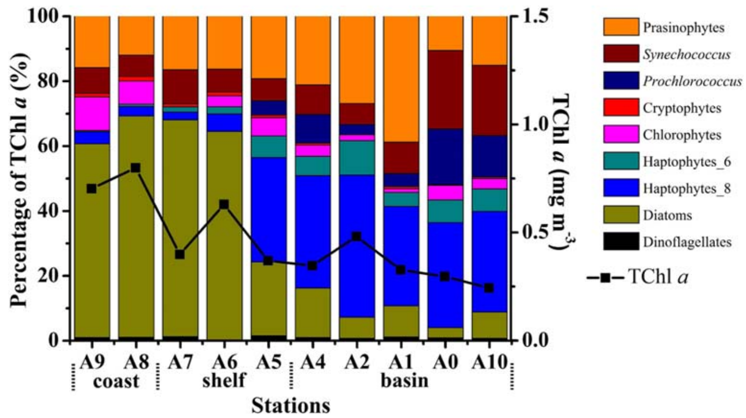

Figure 7. Average total Chl-a content and fraction of pigments in total Chl-a for nine major phytoplankton groups in the euphotic zone along transect A9-A10 collected during the autumn survey. Note that Station A9 (22°01′N, 114°00′E; Bottom depth 34 m) and A8 (21°48′N, 114°11′E; Bottom depth 46 m) in the coastal regime are not indicated in Figure 1 as ^{234}Th and POC were not measured at the two stations.

$^{234}Th_p/^{234}Th_d$ ratio decreased gradually from the continental shelf to the basin regime in all of the surveys. In particular, high $^{234}Th_p/^{234}Th_d$ ratios were noted near the bottom of the shelf area. This indicates the presence of a benthic nepheloid layer (BNL) over the continental shelf in our study area. Notably, the benthic nepheloid layer appears to be mostly confined within 10–20 m above the seafloor. In the autumn survey, however, particle resuspension seems to extend into the upper water column.

3.3. Spatial Variation of Phytoplankton Community Structure

While pigment data will be published elsewhere, pigment measurements along a typical transect in the autumn survey are used to elucidate spatial variation of phytoplankton community structure in the South China Sea. As shown in Figure 7, phytoplankton community structure in the coastal regime and in the inner shelf is dominated by diatoms. In this regime, diatoms contribute up to $>$ 50% of the total biomass. With distance offshore, however, the fraction of diatoms in the total biomass decreases, and small picophytoplanktons become more dominant. Over the outer shelf and in the basin region, haptophytes_8 and prasinophytes that are typically $<$ 5 μm in size can contribute up to $\sim$60–80% of the total biomass.

4. Discussion

4.1. Estimation of POC Export Using ^{234}Th Flux and POC/^{234}Th Ratio

In the application of the ^{234}Th method, export flux of POC is estimated by multiplying the ^{234}Th flux by the ratio of POC to ^{234}Th on sinking particles:

$$\text{POC flux} = {}^{234}\text{Th flux} \times \text{POC}/{}^{234}\text{Th} \tag{3}$$

This approach is based on the assumptions that the flux of ^{234}Th is accurately known, and that the POC/^{234}Th ratio is representative of sinking particles at the depth of interest. The inherent strengths and restrictions of the approach have been reviewed by *Buesseler et al*. [2006]. The export fluxes of ^{234}Th estimated from the 1-D steady state model are listed in Table 1. Export horizons are set to be 25, 50, and 100 m for the stations located in the coastal area, the shelf, and the basin, respectively. These export horizons are chosen in that they correspond roughly to the base of the euphotic zone (0.1% of light penetration from the sea surface) that was identified using a photosynthetically available radiation (PAR) sensor. An advantage of integrating ^{234}Th flux to the base of the euphotic zone is that it avoids the use of a single fixed depth, which can bias the comparison of biological pump efficiency across diverse biogeochemical provinces [*Buesseler and Boyd*, 2009]. On the other hand, for a specific biogeochemical province, a single fixed depth is preferred in that it would normalize the remineralization length scale and thus allow us to examine the seasonal pattern of POC export and its controlling mechanisms.

In previous studies, POC export fluxes were generally estimated using the POC/Th ratio either in sinking particles collected on traps, or in suspended particles collected using filtration [e.g., *Buesseler et al*., 2006]. Particularly, sampling particles using filtration is preferred as the ^{234}Th approach is developed partly to avoid

Table 1. Standing Stocks of Chl-a (I_{chla}) and Particulate Organic Carbon (I_{POC}), ^{234}Th Fluxes, POC/^{234}Th Ratios on Suspended Particles and POC Fluxes in the Upper South China Sea

Station	Export Depth (m)	DCM (m)	I_{Chla} (mg m^{-2})	I_{poc} (mmol m^{-2})	^{234}Th Flux (dpm m^{-2} d^{-1})	POC/^{234}Th (μmol dpm^{-1})	POC Flux (mmol m^{-2} d^{-1})
Spring (30 Apr to 24 May 2011)							
E401	100	75	30.3	301	1558 ± 97	7.6 ± 0.9	11.8 ± 1.6
E402	100	50	32.3	310	1660 ± 96	4.7 ± 0.5	7.9 ± 1.0
E403	100	75	16.0	235	1304 ± 99	3.5 ± 0.4	4.6 ± 0.6
E404	100	50	30.9	227	1821 ± 96	4.1 ± 0.4	7.4 ±0.9
E405	100	50	23.9	224	1260 ± 100	4.3 ± 0.5	5.5 ± 0.7
E406	100	75	18.1	215	1524 ± 98	4.5 ± 0.6	6.8 ± 1.0
LE09	100	75	28.7	249	1568 ± 98	5.4 ± 0.7	8.5 ± 1.2
SEATS	100	75	20.1	245	1265 ± 100	3.2 ± 0.4	4.1 ± 0.6
LE05	100	50	23.2	249	1953 ± 95	5.0 ± 0.5	9.7 ± 1.2
LE04a	100	75	17.4	239	1103 ± 98	9.3 ± 1.1	10.3± 1.5
D105	100	75	22.2	—	1587 ± 98	—	—
D104	100	100	22.2	250	1300 ± 98	6.5 ± 0.7	8.5 ± 1.1
D103	50	75	3.0	109	340 ± 73	4.6 ± 0.5	1.6 ± 0.4
D102	25	25	15.2	80	1209 ± 32	26.3 ± 4.2	27.1 ± 4.4
DD201	50	75	7.2	162	1325 ± 66	30.1 ± 6.5	39.9 ± 8.8
DD202	50	75	3.7	103	488 ± 75	4.6 ± 0.5	2.2 ± 0.4
DD203	100	75	17.8	221	907 ± 106	4.4 ± 0.5	4.0 ± 0.7
E601	25	35	5.0	95	628 ± 35	12.7 ± 1.8	8.0 ± 1.2
E603	50	75	6.4	155	770 ± 72	7.0 ± 0.9	5.4 ± 0.9
E605	100	75	22.7	192	1191 ± 104	6.6 ± 0.8	7.8 ± 1.2
E607	100	75	19.3	226	1567 ± 102	5.1 ± 0.6	8.0 ± 1.1
A7	50	50	10.5	196	1281 ± 70	44.0 ± 11.6	56.4 ± 15.2
A6	50	75	10.1	145	1080 ± 69	15.4 ± 3.6	16.6 ± 4.0
A5	50	75	7.6	165	684 ± 73	15.1 ± 2.8	10.3 ± 2.2
A4	100	75	24.1	327	1504 ± 104	5.6 ± 0.7	8.4 ± 1.2
A2	100	75	23.7	228	1569 ± 104	5.7 ± 0.7	9.0 ± 1.3
A1a	100	75	22.5	250	1413 ± 105	9.9 ± 1.3	14.1 ± 2.1
A0	100	50	28.3	283	754 ± 108	4.1 ± 0.5	3.1 ± 0.6
A10	100	50	24.1	225	1270 ± 106	4.6 ± 0.6	5.9 ± 0.9
S504	100	50	—	202	1166 ± 107	4.6 ± 0.6	5.3 ± 0.8
S503	100	5	33.3	327	1148 ± 105	6.7 ± 0.8	9.6 ± 1.4
S501	100	25	32.5	224	1998 ± 104	4.6 ± 0.6	9.2 ± 1.2
S209	50	50	12.4	142	813 ± 73	5.6 ± 0.7	4.6 ± 0.7
Summer (18 Jul to 16 Aug 2009)							
LE00	25	25	9.5	132	1178 ± 31	40.7 ± 7.2	47.9 ± 8.5
LE01	50	50	11.8	109	670 ± 81	7.9 ± 1.0	5.3 ± 0.9
LE02	100	50	21.9	256	693 ± 107	4.6 ± 0.5	3.2 ± 0.6
DD203	100	50	17.3	199	824 ± 100	5.3 ± 0.6	4.4 ±0.8
DD202	50	50	8.0	94	774 ± 77	8.1 ± 1.2	6.3 ± 1.1
DD201	50	50	11.2	138	642 ± 69	7.7 ± 0.9	5.0 ± 0.8
D102	25	35	4.0	60	526 ± 34	5.7 ± 0.7	3.0 ± 0.4
D103	50	50	7.8	97	560 ± 28	6.1 ± 0.7	3.4 ± 0.4
D104	100	50	18.1	183	753 ± 100	10.1 ± 1.2	7.6 ± 1.4
D105	100	50	29.0	225	965 ± 104	4.4 ± 0.6	4.3 ± 0.7
LE04	100	50	27.4	188	1127 ± 144	2.7 ± 0.3	3.1 ± 0.5
LE05	100	75	19.1	159	837 ± 103	3.8 ± 0.6	3.2 ± 0.6
E505	100	50	19.6	148	1075 ± 101	3.8 ± 0.4	4.1 ± 0.6
E503	100	50	16.6	193	946 ± 103	7.5 ± 0.9	7.1 ± 1.2
E501	50	50	5.6	98	789 ± 71	14.5 ± 1.7	11.5 ± 1.7
E500	25	5	14.7	187	1489 ± 31	31.8 ± 5.6	47.3 ± 8.4
E601	25	35	4.2	99	785 ± 34	31.2 ± 6.5	24.5 ± 5.2
E603	50	75	5.0	82	348 ± 74	7.6 ± 1.1	2.6 ± 0.7
E605	100	75	24.3	248	1176 ± 103	4.6 ± 0.5	5.4 ± 0.8
E607	100	75	18.7	151	920 ± 106	4.7 ± 0.6	4.4 ± 0.7
S206	50	5	31.5	261	991 ± 73	26.2 ± 5.4	26.0 ± 5.7
S209	50	75	8.0	108	577 ± 71	11.7 ± 1.5	6.8 ± 1.2
S501	100	50	26.1	216	786 ± 103	4.5 ± 0.5	3.5 ±0.6
S503	100	75	20.0	188	383 ± 107	5.1 ± 0.6	2.0 ±0.6
S504	100	75	21.7	173	1165 ± 99	3.9 ± 0.5	4.5 ± 0.7
A10	100	75	24.1	178	788 ± 112	5.3 ± 0.6	4.2 ± 1.8
A0	100	50	18.7	227	944 ± 103	4.4 ± 0.5	4.2 ± 0.7
A1	100	50	21.2	219	654 ± 106	6.5 ± 0.8	4.3 ±0.9
A2	100	75	19.8	168	1363 ± 109	3.7 ± 0.4	5.1 ± 0.7
A4	100	50	25.4	221	1358 ± 102	4.7 ± 0.6	6.4 ± 0.9
A7	50	25	26.4	171	1018 ± 72	39.1 ± 14.3	39.7 ±14.8
A6	50	50	12.3	133	434 ± 76	11.2 ± 1.5	4.8 ± 1.1

Table 1. (continued)

Station	Export Depth (m)	DCM (m)	I_{Chla} (mg m^{-2})	I_{poc} (mmol m^{-2})	^{234}Th Flux (dpm m^{-2} d^{-1})	POC/^{234}Th (μmol dpm^{-1})	POC Flux (mmol m^{-2} d^{-1})
A5	50	50	15.1	108	717 ± 74	9.4 ± 1.1	6.7 ± 1.1
SEATS	100	50	19.9	242	587 ± 103	4.9 ± 0.6	2.9 ± 0.6
LE09	100	75	20.1	219	413 ± 108	5.1 ± 0.6	2.1 ± 0.6
E406	100	50	41.2	196	1211 ± 100	5.1 ± 0.6	6.2 ± 0.9
E405	100	75	18.9	188	844 ± 101	5.1 ± 0.6	4.3 ± 0.7
E404	100	75	25.6	221	970 ± 102	5.5 ± 0.6	5.4 ± 0.8
E403	100	75	27.2	181	939 ± 104	2.5 ± 0.3	2.4 ± 0.4
E402	100	50	31.7	199	832 ± 102	3.6 ± 0.4	3.0 ±0.5
E401	100	75	25.8	220	834 ± 102	4.7 ± 0.6	3.9 ± 0.7
Autumn (26 Oct to 24 Nov 2010)							
E601	25	15	25.4	288	1407 ± 28	21.5 ± 3.0	30.3 ± 4.2
E602	50	5	42.1	184	861 ± 65	10.9 ± 1.3	9.3 ± 1.4
E603	50	25	25.7	173	1395 ± 63	10.2 ± 1.2	14.2 ± 1.8
E604	100	50	49.3	206	1077 ± 124	8.0 ± 1.0	8.7 ± 1.5
A7	50	25	—	336	2694 ± 58	24.7 ± 3.4	66.6 ± 9.2
A6	50	25	38.7	251	2647 ± 55	23.2 ± 3.6	61.5 ± 9.6
A5	50	5	20.2	139	778 ± 64	12.9 ± 1.8	10.1 ± 1.6
A4	100	5	28.0	187	1733 ± 93	5.4 ± 0.6	9.3 ± 1.1
A2	100	5	52.3	260	1444 ± 93	5.5 ± 0.6	7.9 ± 1.0
E607	100	—	—	385	2647 ± 89	6.1 ± 0.8	16.2 ± 2.1
S209	50	50	16.8	126	1259 ± 65	32.9 ± 6.9	41.4 ± 8.9
A1	100	5	35.5	249	1447 ± 93	6.3 ± 0.7	9.2 ± 1.2
E605	100	25	45.2	324	1921 ± 92	8.0 ± 1.0	15.4 ± 2.1
SEATS	100	50	33.0	230	1129 ± 96	6.4 ± 0.7	7.3 ± 1.0
A0	100	50	30.8	246	1307 ± 95	8.0 ± 0.9	10.4 ± 1.5
A10	100	50	6.3	211	1202± 97	7.1 ± 0.8	8.5 ± 1.2
S504	100	25	55.0	230	1168 ± 99	12.6 ± 1.6	14.7 ± 2.3
S503	100	25	34.6	213	1389 ± 96	4.6 ± 0.5	6.3 ± 0.9
S501	100	25	18.8	168	588 ± 99	5.5 ± 0.6	3.2 ± 0.7
Winter (6 Jan to 30 Jan 2010)							
E603	50	5	25.6	177	1111 ± 66	9.9 ± 1.3	11.0 ± 1.6
E602	50	5	14.5	182	1691 ± 62	13.4 ± 1.9	22.7 ± 3.4
E601	25	5	20.1	96	1210 ± 31	13.7 ± 2.2	16.5 ± 2.7
QD02	25	15	—	—	1550 ± 29	—	—
E500a	25	30	15.3	90	878 ± 45	16.1 ± 2.4	14.2 ± 2.2
E501a	50	25	22.5	118	826 ± 68	9.1 ± 1.4	7.5 ± 1.3
E502a	100	25	37.9	213	1704 ± 96	2.6 ± 0.3	4.4 ± 0.6
E604	100	25	—	254	2044 ± 95	2.8 ± 0.3	5.7 ± 0.7
E605	100	50	19.2	200	1664 ± 98	3.3 ± 0.4	5.5 ± 0.7
E607	100	25	38.7	203	1311 ± 99	2.9 ± 0.4	3.8 ± 0.5
SEATS	100	—	—	184	1339 ± 102	2.7 ± 0.3	3.7 ± 0.5
A10	100	25	51.1	268	1236 ± 105	2.6 ± 0.3	3.2 ± 0.5
A0	100	—	—	223	1581 ± 105	5.9 ± 0.8	9.3 ± 1.4
A1	100	5	33.5	304	1260 ± 106	5.2 ± 0.7	6.6 ± 1.0
A2	100	50	59.4	315	1808 ± 105	3.0 ± 0.4	5.5 ± 0.8
A4	100	50	54.5	238	1649 ± 111	5.2 ± 0.7	8.5 ± 1.2
A5	50	25	34.6	182	832 ± 81	15.9 ± 3.8	13.3 ± 3.4
A6	50	50	15.8	196	1871 ± 73	15.5 ± 3.4	29.0 ± 6.5
A7	50	68	22.6	140	2304 ± 73	14.6 ± 3.4	33.7 ± 8.0
S103	50	50	24.1	147	1065 ± 78	10.0 ± 1.9	10.7 ± 2.2
S501a	100	5	36.4	217	1254 ± 119	3.1 ± 0.4	3.8 ± 0.6
S503	100	50	59.6	236	1226 ± 124	4.4 ± 0.6	5.4 ± 1.0
S504	100	5	38.2	334	1600 ± 116	2.7 ± 0.4	4.4 ± 0.6
E406	100	50	32.3	238	719 ± 123	3.7 ± 0.5	2.7 ± 0.6
E405	100	5	54.0	359	858 ± 117	3.5 ± 0.5	3.0 ± 0.6
E404	100	25	40.4	239	302 ± 125	2.7 ± 0.3	0.8 ± 0.4
E403	100	5	44.3	284	1333 ± 117	4.0 ± 0.5	5.3 ± 0.8
E402	100	5	38.1	252	636 ± 128	4.2 ± 0.6	2.7 ± 0.6
E401	100	5	26.1	298	680 ± 125	3.4 ± 0.4	2.3 ± 0.5
E400	100	75	26.9	169	489 ± 130	7.6 ± 1.2	3.7 ± 1.1

the use of sediment traps. The assumption thereof is that the POC/^{234}Th ratio on filtered particles is similar to that in an "unbiased" sediment trap. *Buesseler et al.* [2009] stressed that for the ^{234}Th approach to work, ^{234}Th and POC do not have to be carried by the same particle types, but rather only collected at the same relative ratio on filters as found in settling particles. Moreover, they pointed out that this will not be an issue

Table 2. Mean Values of ^{234}Th Flux, POC/^{234}Th Ratio, and POC Flux at the Base of the Euphotic Zone in the Coastal, Shelf, and Basin Regimes for the Four Surveys in the South China Sea[a]

Province	Export Depth (m)	^{234}Th Flux (dpm m^{-2}d^{-1})				POC/^{234}Th Ratio (μmol dpm^{-1})				POC Flux (mmol m^{-2} d^{-1})			
		Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
Coast	25	829±284 (n=2)	995±425 (n=4)	1407±28 (n=1)	1213±336 (n=3)	19.5±9.6 (n=2)	27.4±15.1 (n=4)	21.5±3.0 (n=1)	14.9±1.7 (n=3)	17.5±13.5 (n=2)	30.7±21.4 (n=4)	30.3±4.2 (n=1)	15.3±1.7 (n=3)
Shelf	50	848±357 (n=8)	684±207 (n=11)	1675±939 (n=6)	1386±573 (n=7)	15.8±14.3 (n=8)	13.6±10.1 (n=11)	16.4±7.0 (n=6)	12.9±2.9 (n=7)	17.1±20.2 (n=8)	10.7±11.6 (n=11)	33.9±26.3 (n=6)	18.3±10.2 (n=7)
Basin	100	1421±301 (n=23)	899±248 (n=26)	1421±511 (n=12)	1234±478 (n=20)	5.9±2.7 (n=23)	4.9±1.5 (n=26)	7.0±2.1 (n=12)	3.8±1.3 (n=20)	7.7±2.7 (n=23)	4.3±1.4 (n=26)	9.7±4.0 (n=12)	4.5±2.0 (n=20)

[a]Numbers in the brackets refer to station number.

when POC/^{234}Th ratio does not differ between particle types. In that study, these researchers found that the POC/^{234}Th ratios in sinking particles and in suspended particles generally overlap at depths of 150 m and below. In this study, we will use the measured POC/^{234}Th ratio on total suspended particles of size >1 μm to convert the ^{234}Th fluxes into POC export rates.

4.1.1. Coastal Regime

As illustrated in Figure 6, the selected export horizons lie generally above the benthic nepheloid layer in the coastal and shelf areas. As such, the impact of particle resuspension on ^{234}Th scavenging in the upper water column was minimized. An exception is the autumn survey, when particle resuspension appears to extend into the upper water column. In such a case, bottom sediments would be partly responsible for the ^{234}Th depletion in the euphotic zone and the export flux of POC derived from the ^{234}Th approach must therefore be considered as an overestimation. For the ^{234}Th approach, an inherent difficulty is to discern the component of terrestrial and resuspended particles from bulk POC export. In addition, processes such as water/sediment interactions, submarine groundwater discharge, and riverine input could also affect ^{234}Th and ^{238}U activities in the water column, and thus bias the ^{234}Th-derived POC export estimates in the coastal regime. In fact, accurate determination of POC flux in coastal settings remains difficult with any today's methods. In this regard, our results should be treated as a first approximation of POC export rates in this regime.

The mean values of ^{234}Th flux, POC/^{234}Th ratio, and POC flux in the coastal, shelf, and basin regimes for the four surveys are listed in Table 2. In the coastal regime, ^{234}Th flux falls in the range of 528–1550 dpm m^{-2} d^{-1}. The mean ^{234}Th fluxes in the spring, summer, autumn, and winter surveys are 829 $\pm$ 284 (n = 2), 995 $\pm$ 425 (n = 4), 1407 $\pm$ 28 (n = 1), and 1213 $\pm$ 336 (n = 3) dpm m^{-2} d^{-1}, respectively. As shown in Figure 8, suspended particle POC/^{234}Th ratios in the coastal regime are high and variable, ranging from a low of 5.7 $\pm$ 0.7 μmol dpm^{-1} to a high of 70.1 $\pm$ 10.6 μmol dpm^{-1}. The mean POC/^{234}Th ratios at the export horizon (25 m) in the spring, summer, autumn, and winter surveys are 19.5 $\pm$ 9.6 (1SD, n = 2), 27.4 $\pm$ 15.1(1SD, n = 4), 21.5 $\pm$ 3.0 (n = 1), and 14.9 $\pm$ 1.7 (1SD, n = 2) μmol dpm^{-1}. In combination with the spatial and temporal resolved ^{234}Th data set, these POC/^{234}Th measurements allow us to better resolve seasonal and regional changes in POC flux. As shown in Figure 9, POC export fluxes in the coastal area and over the shelf are generally high and variable. In the coastal area, the derived export fluxes of POC during the four survey cruises range from 3.0 $\pm$ 0.4 to 47.9 $\pm$ 8.5 mmol m^{-2} d^{-1} (Table 1). On average, POC export fluxes are17.5-$\pm$ 13.5 (1SD, n = 2), 30.7 $\pm$ 21.4 (1SD, n = 4), 30.3 (n = 1), and 15.3 $\pm$ 1.7 (1SD, n = 2) mmol m^{-2} d^{-1} for the spring, summer, autumn, and winter surveys, respectively.

4.1.2. Shelf Regime

Over the shelf, ^{234}Th flux at the export horizon (50 m) varies between 340 $\pm$ 73 and 2694 $\pm$ 58 dpm m^{-2} d^{-1}. Similar to the coastal regime, the mean ^{234}Th fluxes in the autumn and winter (1675 $\pm$ 939 (n = 6) and 1386 $\pm$ 573 (n = 7) dpm m^{-2} d^{-1}) are higher than in the spring and summer (848 $\pm$ 357 (n = 8) and 684 $\pm$ 207 (n = 11) dpm m^{-2} d^{-1}). The highest ^{234}Th fluxes ($\sim$2600–2700 dpm m^{-2} d^{-1}) were observed at A7 and A6 in the autumn survey. POC/^{234}Th ratios in suspended particles fall in the range of 4.6 $\pm$ 0.5–44.7 $\pm$ 8.8 μmol dpm^{-1}. While spatial variability in POC/^{234}Th ratios is large (see Figure 8), the mean POC/^{234}Th ratios at 50 m are remarkably constant in different seasons. They are 15.8 $\pm$ 14.3 (n = 8), 13.6 $\pm$ 10.1 (n = 11), 16.4 $\pm$ 7.0 (n = 6), and 12.9 $\pm$ 2.9 (n = 7) μmol dpm^{-1} for the spring, summer, autumn, and winter surveys, respectively. Accordingly, the mean POC export fluxes during the four survey cruises

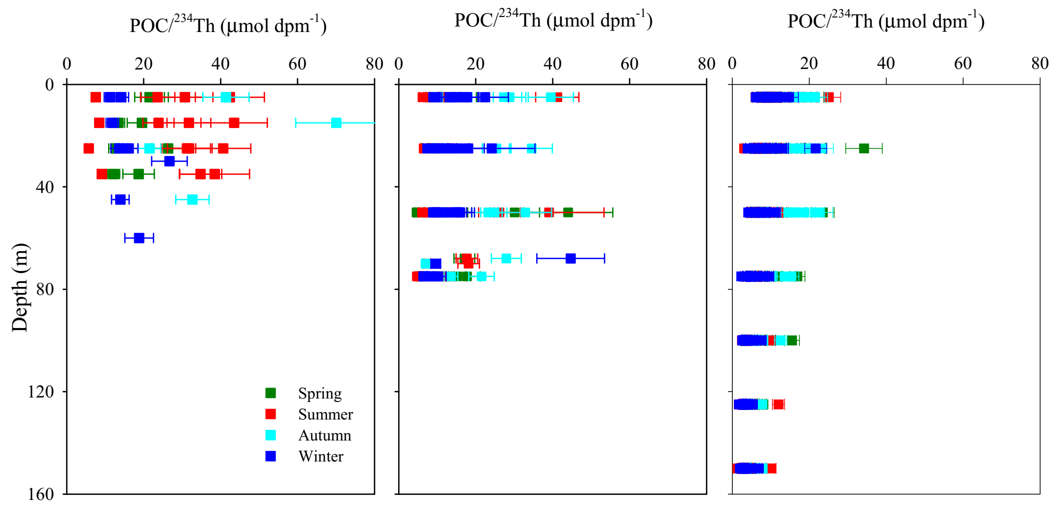

Figure 8. Ratios of POC/^{234}Th on suspended particles collected in the coastal area (left), the shelf (middle), and the basin (right) during the survey cruises to the South China Sea.

are17.1 ± 20.2 (1SD, n = 8), 10.7 ± 11.6 (1SD, n = 11), 33.9 ± 26.3 (1SD, n = 6), and 18.3 ± 10.2 (1SD, n = 7) mmol m^{-2} d^{-1}, respectively.

4.1.3. Basin Regime

In the basin regime, ^{234}Th flux at 100 m falls in the range of 302 ± 125–2647 ± 89 dpm m^{-2} d^{-1}. In contrast to the coastal and shelf regimes, seasonal variability of ^{234}Th flux is less pronounced in this regime. The mean ^{234}Th fluxes at 100 m are 1421 ± 301 (n = 23), 899 ± 248 (n = 26), 1421 ± 511 (n = 12), and 1234 ± 478 (n = 20) dpm m^{-2} d^{-1} for the four survey cruises, respectively. Suspended particle POC/^{234}Th ratios in the basin regime generally decrease with depth and are relatively constant at depths of 100 m and below (Figure 8). At the export depth (100 m), the mean POC/^{234}Th ratios are 5.9 ± 2.7 (n = 23), 4.9 ± 1.5 (n = 26), 7.0 ± 2.1 (n = 12), and 3.8 ± 1.3 (n = 20) μmol dpm^{-1}for the spring, summer, autumn, and winter surveys, respectively. These values are comparable to POC/^{234}Th ratios based on sediment traps at 100 m in the oligotrophic oceans, which are generally in the vicinity of 5.0 μmol dpm^{-1} [see *Buesseler et al.*, 2006 for review]. In addition, an average ratio of 4.0 ± 1.6 (1SD, n = 77) μmol dpm^{-1} for suspended particle POC/^{234}Th was determined at the depth of 150 m in the basin regime. This ratio is remarkably close to the trap-derived POC/^{234}Th ratios of 4.8 ± 1.8 μmol dpm^{-1} reported at the same depth horizon in this region [*Wei et al.*, 2011], despite that dissolved ^{234}Th preferentially absorbs to QMA filters during particle filtration and thus may cause a bias in POC/^{234}Th ratio reported here [e.g., *Benitez-Nelson et al.*, 2001; *Rutgers van der Loeff et al.*, 2006].Overall, POC export fluxes in the basin area are low and relatively uniform (Figure 9). The average POC export fluxes in the four surveys are 7.7 ± 2.7 (n = 22), 4.3 ± 1.4 (n = 26), 9.7 ± 4.0 (n = 12), and 4.5 ± 2.0 (n = 20) mmol m^{-2} d^{-1}, respectively. These values are within the range of POC export flux that was reported in the same region [e.g., *Chen et al.*, 2008; *Wei et al.*, 2011; *Hung et al.*, 2012]. In addition, they are also comparable to the POC export rates reported in the open oceans [e.g., *Rutgers van der Loeff et al.*, 2011]. In this regard, the South China Sea basin much resembles the open ocean.

4.2. Factors Controlling POC Export in the South China Sea

As shown in Figure 9 and Table 2, POC export fluxes in the South China Sea are highly variable, both spatially and temporally. This temporal and spatial resolved data set of POC export thus allows us to examine the mechanisms controlling POC export flux in the South China Sea. In this study, we examine the relationship between POC export flux (F_{POC}) and POC stock (I_{POC}), and between POC export flux and phytoplankton community structure in the three contrasting provinces: the coastal area (bottom depth <50 m), the shelf (bottom depth 50–200 m), and the basin (bottom depth >200 m) (Figures 10 and 11). Note that POC stock is calculated by trapezoidal integration of POC concentration from the surface to the same depth horizon of POC export. A linear least square (LLS) analysis is carried out to examine the correlations. R^2 and p are used as indication of the strength of the trends.

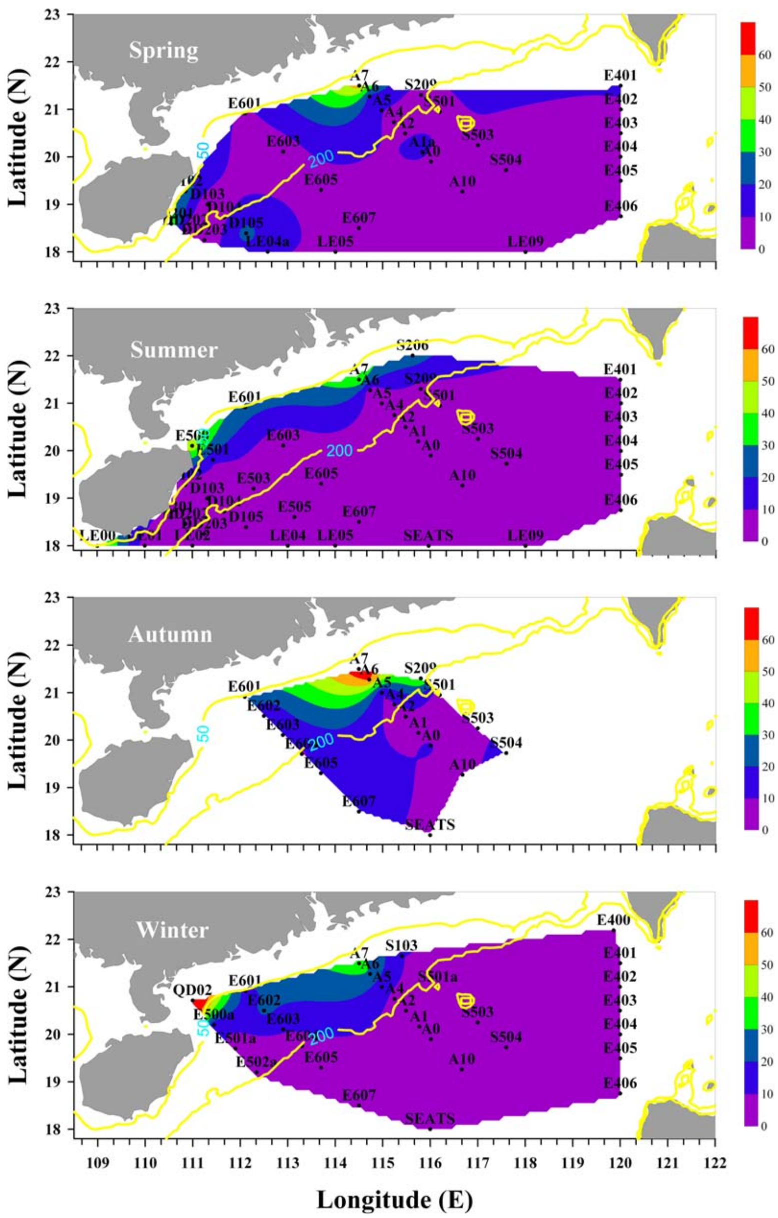

Figure 9. Seasonal succession of POC fluxes (unit: mmol m^{-2} d^{-1}) from the euphotic zone in the South China Sea. The 50 and 200 m isobaths are marked by the yellow lines, which separate our study area into three biogeochemical provinces: the coastal area, the shelf, and the basin. Depths of the euphotic zone are set to be 25, 50, and 100 m for the above three provinces, respectively. See text for the details.

4.2.1. Coastal Regime

In the coastal regime, the correlation between POC export flux and POC stock is weak (R^2=0.30) (Figure 10). As mentioned above, POC flux estimates may be subject to potential bias in this regime. Regardless, the result of LLS analyses shows a strong correlation ($R^2 = 0.73$, $p < 0.005$) between POC export flux and diatom fraction (Figure 11). The strong correlation between F_{POC} and diatom fraction indicates that POC export flux in the coastal regime is mainly driven by large phytoplankton, in particular, diatoms. This result is consistent with the traditional recognition that diatoms are the most important taxon in regulating POC export flux from the upper ocean, and high POC export flux is generally associated with blooms of diatoms [*Buesseler*, 1998].

4.2.2. Shelf Regime

In contrast to the coastal regime, the correlation between POC export flux and diatom fraction is weak over the shelf ($R^2 = 0.23$, $p = 0.005$). However, we have identified a relatively strong correlation between POC

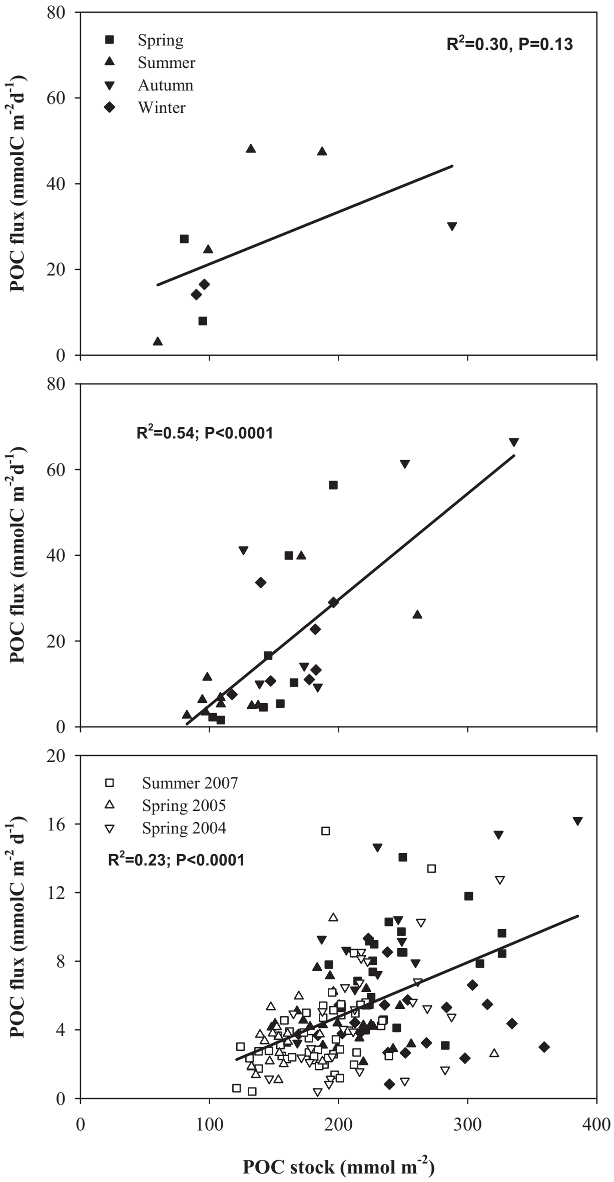

Figure 10. Correlation of POC flux versus POC stock in the coastal area (top), the shelf (middle), and the basin (bottom) of the South China Sea.

export flux and POC stock in the euphotic zone (Figure 10), where we achieved a relationship of $F_{POC}=(0.14 \pm 0.02)\times I_{POC} - (11.0 \pm 3.8)$ ($R^2 = 0.54$, $p < 0.0001$). Interestingly, this relationship is characterized by a negative *y* intercept, which represents $I_{POC} > 0$ at $F_{POC} = 0$ and may indicate existence of a nonsinking particle assemblage in the water column. The positive correlation of POC export flux and POC stock suggests that over the South China Sea shelf, POC export flux from the euphotic zone is primarily controlled by POC stock. Overall, this result is consistent with the general expression of POC export flux in the upper ocean: $F_{POC}=S \times C$, where S is the sinking velocity of particles and C is the concentration of POC. Under the circumstance that all settling particles are characterized by a similar sinking velocity, POC export flux would be simply regulated by POC concentration, or by POC stock in terms of a water column [e.g., *Buesseler et al*., 2007]. Nonetheless, there are still some scatters in the relationship between POC export flux and POC stock. This suggests that other processes, like aggregation, zooplankton grazing and repackaging, and bacterial degradation, may also play a role in regulating the POC export rates in this regime.

4.2.3. Basin Regime

In the basin regimes, the correlation between POC export flux and POC stock is weak ($R^2= 0.23$). Note that here we have incorporated into analysis the data sets from three earlier cruises in the same study region, i.e., the spring surveys in 2004 and 2005, and the summer survey in 2007 [*Cai et al*., 2008; *Chen*, 2008; *Zhou et al*., 2013]. In these prior studies, all the POC and ^{234}Th data as well as POC export fluxes were acquired in the same manner as this study.

The weak correlation of F_{POC} versus I_{POC} in the basin regime suggests that factors other than POC stock may exert a predominant effect on POC export flux in this region. Alternatively, a time lag between POC accumulation and elevated POC export flux could also cause the scatter as seen in Figure 10. In the U.S. JGOFS Arabian Sea Process Study, *Buesseler* [1998] observed a clear lag between the onset of high production in the early Southwest Monsoon and elevated export as the monsoon developed and diatoms became more abundant. As primary production represents the source function of POC stock in the euphotic zone, one might expect a similar lag between POC accumulation and elevated POC export in this season. In the Southern Ocean, *Rutgers van der Loeff et al*. [2011] identified an ice-edge bloom by analyzing Chl-a distributions from remote sensing. Based on $^{234}Th/^{238}U$ measurements, these investigators found that the ice-edge bloom was followed by an enhanced export 1–2 month later. For the South China Sea basin, remote

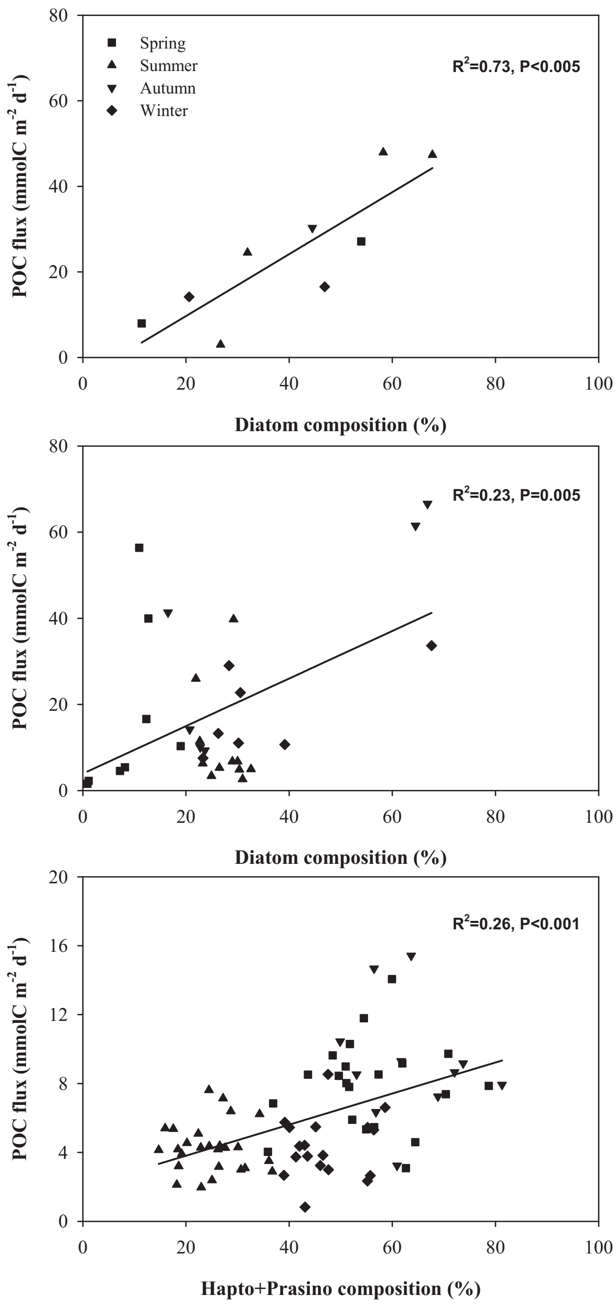

Figure 11. Correlation of POC flux versus phytoplankton composition in the coastal area (top), the shelf (middle), and the basin (bottom) of the South China Sea.

sensing and actual measurements both revealed that Chl-a level peaks in the winter [*Tseng et al.*, 2005]. In the present study, the average Chl-a stock in the basin was almost a factor of two higher in the winter than in the summer (40.7 versus 23.1 mg m^{-2}). In comparison, the average POC stock was only ~30% higher in the winter than in the summer (260 versus 200 mmol m^{-2}), though POC level also peaks in the winter. Nonetheless, the average POC export flux in the winter is comparable to the value in the summer (4.5 $\pm$ 2.0 versus 4.3 $\pm$ 1.4 mmolC m^{-2}d^{-1}), and is only about half of the average POC export flux in the spring (7.7 $\pm$ 2.7 mmolC m^{-2}d^{-1}) and in the autumn (9.7 $\pm$ 4.0 mmolC m^{-2}d^{-1}). It is thus possible that a phytoplankton bloom might be developing in the South China Sea basin during the winter survey. This bloom had resulted in elevated Chl-a level and slightly higher POC concentration, but had not yet caused enhanced POC export flux until in the following spring. In fact, if we remove the data set collected from the winter survey cruise, a LLS analysis of F_{POC} versus I_{POC} in the South China Sea basin would result in a relationship with a correlation coefficient (R^2) of 0.33. Although the correlation is still weak, this value is higher than the original number and indicates that the time lag between POC accumulation and elevated POC export flux did exert an effect.

In this regime, there is also no correlation between POC export flux and diatom fraction in the euphotic zone. Instead, here we observed a weak but intriguing correlation ($R^2 = 0.26$, $p < 0.0001$) between POC export flux and the fraction of haptophytes and prasinophytesin that are typically < 5 μm in size (Figure 11). This suggests that POC export flux in the South China Sea basin may be driven by small phytoplankton. This observation is not consistent with the traditional view, but conforms to the recent studies that highlight the role of small phytoplankton in carbon export [e.g., *Richardson and Jackson*, 2007; *Brew et al.*, 2009; *Lomas and Moran*, 2011]. For instance, *Richardson and Jackson* [2007] showed that in the equatorial Pacific and the Arabian Sea, the relative contributions of various phytoplankton size classes to carbon export are proportional to their contributions to total net primary production. Possible mechanisms by which small phytoplankton sink were supposed to include aggregation, incorporation into settling detritus, and the consumption of small phytoplankton aggregates by zooplankton. Given the weak correlation and the uncertainty associated with the POC export estimates in this study, however, we feel that it is inadequate to overinterpret the relationship of POC export flux and the fraction of haptophytes and prasinophytes depicted in Figure 11. More field work must be conducted in order to better understand the role of small phytoplankton in carbon export from the upper ocean.

5. Summary

The ocean's biological pump is an important modulator of atmospheric CO_2 levels, but the controls on its strength and efficiency remain poorly understood. In this study, we utilized $^{234}Th/^{238}U$ disequilibrium to determine POC export from the euphotic zone in a large marginal sea—the South China Sea. Along with POC export measurements, POC stock, and phytoplankton community structure were also determined. Based on this extensive data set, we used a simple linear regression (LLS) method to examine the correlation of POC export with POC stock and phytoplankton community structure. The results reveal that in the coastal area of the South China Sea, POC export flux in the euphotic zone was driven by large phytoplankton, in particular, diatoms. In the shelf regime, POC export flux appeared to be primarily controlled by POC stock. In the South China Sea basin, mechanisms controlling POC export flux in the South China Sea basin appear to be complicated. However, small phytoplankton may play a significant role in controlling POC export flux since they dominate the phytoplankton community structure in this region. More work needs to be conducted in order to better understand what are the main controls on POC export flux in the South China Sea basin.

Appendix

Potential temperature, salinity, particulate ^{234}Th, total ^{234}Th, ^{238}U, Chl-a, POC and TSM data in the upper South China Sea. These parameters are provided in Table A1.

Table A1. Potential Temperature, Salinity, Particulate ^{234}Th ($^{234}Th_p$), Total ^{234}Th ($^{234}Th_T$), and ^{238}U Activities, as Well as Chl-a, POC, and TSM Concentrations in the Upper South China Sea

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
Spring (30 Apr to 24 May 2011)								
E401, 21°30′N, 120°00′E, 2955 m								
5	25.59	34.17	0.19 ± 0.01	1.75 ± 0.06	2.40	0.10	2.5	—
25	25.38	34.27	0.20 ± 0.01	1.90 ± 0.06	2.41	0.16	3.3	—
50	24.97	34.42	0.17 ± 0.01	1.71 ± 0.06	2.42	0.40	4.1	—
75	24.95	34.53	0.23 ± 0.01	2.04 ± 0.06	2.43	0.46	2.4	—
100	23.51	34.61	0.28 ± 0.02	1.97 ± 0.06	2.43	0.29	2.1	—
125	21.06	34.51	0.28 ± 0.02	2.14 ± 0.07	2.43	0.13	1.5	—
150	19.72	34.65	0.35 ± 0.02	2.36 ± 0.07	2.44	0.06	1.4	—
E402, 21°00′N, 120°00′E, 3631 m								
5	26.62	33.95	0.17 ± 0.01	1.66 ± 0.06	2.39	0.10	3.0	—
25	25.49	34.03	0.21 ± 0.01	1.47 ± 0.05	2.39	0.25	4.6	—
50	23.98	34.19	0.26 ± 0.02	1.90 ± 0.06	2.40	0.61	3.3	—
75	22.31	34.38	0.32 ± 0.02	1.99 ± 0.07	2.42	0.34	2.1	—
100	20.04	34.63	0.33 ± 0.02	2.25 ± 0.07	2.44	0.10	1.6	—
125	18.63	34.65	0.37 ± 0.02	2.40 ± 0.08	2.44	0.04	1.6	—
150	16.87	34.65	0.36 ± 0.02	2.42 ± 0.07	2.44	0.05	1.5	—
E403, 20°30′N, 120°00′E, 3415 m								
5	28.18	33.73	0.21 ± 0.02	1.94 ± 0.06	2.37	0.08	1.9	—
25	26.40	33.75	0.22 ± 0.01	1.76 ± 0.06	2.37	0.09	2.1	—
50	22.55	34.25	0.37 ± 0.02	1.78 ± 0.06	2.41	0.29	3.9	—
75	20.22	34.52	0.43 ± 0.02	2.11 ± 0.07	2.43	0.43	1.8	—
100	18.19	34.58	0.38 ± 0.02	2.34 ± 0.07	2.43	0.14	1.3	—
125	17.21	34.56	0.35 ± 0.02	2.47 ± 0.08	2.43	0.06	1.4	—
150	15.90	34.55	0.33 ± 0.02	2.43 ± 0.09	2.43	0.12	1.9	—
E404, 20°00′N, 120°00′E, 3595 m								
5	28.54	33.71	0.21 ± 0.01	2.03 ± 0.07	2.37	0.10	1.8	—
25	26.43	33.81	0.33 ± 0.02	1.69 ± 0.06	2.38	0.13	2.6	—
50	24.44	33.97	0.38 ± 0.02	1.49 ± 0.06	2.39	0.81	2.6	—
75	22.93	34.32	0.40 ± 0.02	1.76 ± 0.06	2.41	0.22	2.2	—
100	21.40	34.53	0.41 ± 0.02	2.17 ± 0.07	2.43	0.05	1.6	—
125	17.82	34.56	0.43 ± 0.02	2.12 ± 0.07	2.43	0.02	1.2	—
150	16.52	34.53	0.30 ± 0.02	2.60 ± 0.08	2.43	0.07	1.3	—

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_P$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
E405, 19°30′N, 120°00′E, 4165 m								
5	29.00	33.69	0.25 ± 0.01	2.04 ± 0.07	2.37	0.07	2.2	—
25	27.41	33.68	0.25 ± 0.02	2.01 ± 0.07	2.37	0.18	2.0	—
50	24.10	34.01	0.38 ± 0.02	1.63 ± 0.06	2.39	0.41	2.8	—
75	22.35	34.23	0.37 ± 0.02	1.99 ± 0.07	2.41	0.23	—	—
100	21.49	34.43	0.37 ± 0.02	2.32 ± 0.07	2.42	0.20	1.6	—
125	20.53	34.58	0.40 ± 0.02	2.26 ± 0.09	2.43	—	2.4	—
150	17.85	34.58	0.46 ± 0.02	2.26 ± 0.08	2.43	0.17	1.2	—
E406, 18°45′N, 120°00′E, 2745 m								
5	28.49	33.71	0.24 ± 0.02	1.86 ± 0.06	2.37	0.07	2.1	—
25	26.04	33.74	0.37 ± 0.02	1.96 ± 0.07	2.37	0.09	1.9	—
50	24.70	33.91	0.50 ± 0.02	1.53 ± 0.06	2.38	0.11	2.3	—
75	22.28	34.38	0.34 ± 0.02	1.94 ± 0.06	2.42	0.36	2.7	—
100	19.77	34.52	0.25 ± 0.02	2.19 ± 0.08	2.43	0.25	1.1	—
125	18.09	34.57	0.31 ± 0.02	2.36 ± 0.07	2.43	0.04	1.4	—
150	17.18	34.55	0.46 ± 0.02	2.15 ± 0.07	2.43	0.04	1.1	—
LE09, 18°00′N, 118°00′E, 3885 m								
5	28.19	33.57	0.20 ± 0.01	1.86 ± 0.07	2.36	0.09	2.3	—
25	25.01	33.92	0.36 ± 0.02	1.79 ± 0.06	2.39	0.13	2.2	—
50	24.07	34.40	0.30 ± 0.02	1.76 ± 0.06	2.42	0.41	3.2	—
75	21.26	34.43	0.32 ± 0.02	1.81 ± 0.06	2.42	0.49	2.6	—
100	19.29	34.58	0.26 ± 0.02	2.31 ± 0.07	2.43	0.15	1.4	—
125	17.55	34.59	0.30 ± 0.02	2.40 ± 0.07	2.43	0.02	1.2	—
150	16.39	34.59	0.30 ± 0.02	2.42 ± 0.08	2.43	0.04	0.8	—
SEATS, 18°00′N, 116°00′E, 3846 m								
5	27.49	33.68	0.25 ± 0.02	2.04 ± 0.07	2.37	0.06	3.0	—
25	24.70	34.00	0.38 ± 0.02	1.80 ± 0.06	2.39	0.10	2.5	—
50	22.97	34.33	0.47 ± 0.02	1.65 ± 0.06	2.41	0.24	3.4	—
75	20.86	34.46	0.32 ± 0.02	2.25 ± 0.07	2.42	0.35	1.9	—
100	19.18	34.56	0.28 ± 0.02	2.29 ± 0.07	2.43	0.17	0.9	—
125	17.93	34.57	0.37 ± 0.02	2.34 ± 0.07	2.43	0.07	—	—
150	16.75	34.61	0.37 ± 0.02	2.33 ± 0.07	2.43	0.01	—	—
200	14.47	34.53	0.33 ± 0.02	2.45 ± 0.08	2.43	—	1.2	—
300	11.17	34.44	0.36 ± 0.02	2.29 ± 0.07	2.42	—	1.7	—
500	8.17	34.42	0.28 ± 0.02	2.13 ± 0.07	2.42	—	1.5	—
LE05, 18°00′N, 114°00′E, 3242 m								
5	28.35	34.03	0.18 ± 0.01	1.98 ± 0.06	2.39	0.06	2.6	—
25	25.42	34.09	0.22 ± 0.01	1.84 ± 0.06	2.40	0.09	2.4	—
50	23.67	34.10	0.30 ± 0.02	1.46 ± 0.05	2.40	0.41	2.5	—
75	21.51	34.21	0.23 ± 0.02	1.51 ± 0.06	2.41	0.36	2.7	—
100	20.14	34.44	0.41 ± 0.02	2.18 ± 0.07	2.42	0.07	2.1	—
125	18.18	34.59	0.33 ± 0.02	2.27 ± 0.07	2.43	0.01	2.6	—
150	16.67	34.57	0.37 ± 0.02	2.19 ± 0.07	2.43	0.00	1.2	—
LE04a,18°00′N, 112°35′E, 2618 m								
5	28.55	33.60	0.24 ± 0.02	2.06 ± 0.07	2.36	0.08	1.9	—
25	26.37	33.68	0.15 ± 0.01	1.94 ± 0.06	2.37	0.07	2.2	—
50	23.43	34.14	0.33 ± 0.02	1.79 ± 0.06	2.40	0.16	2.5	—
75	22.01	34.33	0.28 ± 0.02	2.27 ± 0.07	2.41	0.33	2.7	—
100	20.73	34.45	0.24 ± 0.01	2.01 ± 0.06	2.42	0.21	2.2	—
125	19.23	34.51	0.38 ± 0.02	2.16 ± 0.07	2.42	0.03	2.6	—
150	18.32	34.57	0.33 ± 0.02	2.49 ± 0.07	2.43	0.01	1.6	—
D105, 18°24′N, 112°08′E, 1202 m								
5	28.29	33.60	0.16 ± 0.01	2.07 ± 0.07	2.36	0.11	1.7	—
25	25.29	33.94	0.25 ± 0.02	2.11 ± 0.07	2.39	0.09	1.4	—
50	23.48	34.17	0.43 ± 0.02	1.66 ± 0.06	2.40	0.15	2.2	—
75	22.53	34.30	0.33 ± 0.03	1.56 ± 0.06	2.41	0.48	3.1	—
100	20.99	34.45	0.20 ± 0.02	2.06 ± 0.07	2.42	0.22	—	—
125	19.76	34.51	0.31 ± 0.02	2.21 ± 0.07	2.43	0.09	1.9	—
150	18.74	34.58	0.23 ± 0.02	2.37 ± 0.07	2.43	0.01	1.2	—
D104, 18°44′N, 111°40′E, 199 m								
5	29.04	33.55	0.21 ± 0.01	2.02 ± 0.07	2.36	0.06	2.1	—
25	26.64	33.47	0.14 ± 0.02	2.01 ± 0.06	2.35	0.06	2.4	—
50	24.90	33.74	0.40 ± 0.02	2.12 ± 0.07	2.37	0.10	2.6	—
75	23.19	34.11	0.33 ± 0.02	1.78 ± 0.06	2.40	0.41	2.8	—
100	21.33	34.34	0.37 ± 0.02	1.57 ± 0.06	2.41	0.59	2.4	—
125	20.92	34.36	0.40 ± 0.02	1.32 ± 0.05	2.42	0.10	2.0	—
150	19.69	34.47	0.39 ± 0.02	2.10 ± 0.07	2.42	0.02	1.9	—

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
D103, 19°00′N, 111°19′E, 128 m								
5	29.18	33.45	0.19 ± 0.01	2.15 ± 0.08	2.35	0.05	2.2	—
25	26.53	33.49	0.26 ± 0.02	2.16 ± 0.07	2.35	0.06	2.2	—
50	24.63	33.84	0.43 ± 0.02	2.01 ± 0.07	2.38	0.07	2.0	—
75	23.17	34.06	0.35 ± 0.02	1.84 ± 0.07	2.39	0.35	2.4	—
100	21.07	34.39	0.28 ± 0.02	2.37 ± 0.07	2.42	0.14	1.4	—
D102, 19°27′N, 110°51′E, 49 m								
5	26.99	33.86	0.14 ± 0.02	1.11 ± 0.06	2.38	0.44	3.1	—
15	23.78	34.11	0.24 ± 0.02	0.75 ± 0.04	2.40	0.21	3.3	—
25	21.72	34.33	0.12 ± 0.02	1.28 ± 0.06	2.41	1.86	3.2	—
35	20.88	34.43	0.21 ± 0.02	0.67 ± 0.04	2.42	0.56	2.5	—
DD201, 18°36′N, 110°33′E, 100 m								
5	28.87	33.53	0.28 ± 0.03	1.46 ± 0.06	2.36	0.11	3.6	—
25	24.57	33.95	0.41 ± 0.03	1.74 ± 0.06	2.39	0.11	2.8	—
50	22.94	34.10	0.12 ± 0.02	0.89 ± 0.04	2.40	0.24	3.8	—
75	20.30	34.51	0.31 ± 0.03	0.76 ± 0.04	2.43	0.26	3.8	—
DD202, 18°28′N, 110°51′E, 141 m								
5	28.99	33.27	0.23 ± 0.02	2.08 ± 0.07	2.34	0.07	2.3	—
25	27.24	33.55	0.22 ± 0.02	2.02 ± 0.08	2.36	0.06	1.9	—
50	24.79	33.95	0.44 ± 0.02	1.97 ± 0.08	2.39	0.10	2.0	—
75	23.27	34.38	0.38 ± 0.02	1.98 ± 0.08	2.42	0.23	2.2	—
100	21.15	34.33	0.29 ± 0.02	2.33 ± 0.08	2.41	0.22	1.7	—
DD203, 18°15′N, 111°15′E, 1315 m								
5	28.74	33.46	0.24 ± 0.02	2.38 ± 0.08	2.35	0.09	2.7	—
25	26.80	33.49	0.23 ± 0.02	2.14 ± 0.08	2.35	0.09	2.4	—
50	24.67	33.83	0.46 ± 0.02	1.97 ± 0.07	2.38	0.14	2.5	—
75	23.11	34.21	0.43 ± 0.02	1.92 ± 0.07	2.41	0.30	1.8	—
100	21.84	34.29	0.32 ± 0.02	2.08 ± 0.07	2.41	0.27	1.4	—
125	20.84	34.35	0.30 ± 0.02	2.23 ± 0.08	2.42	0.13	1.2	—
150	20.00	34.39	0.31 ± 0.02	2.15 ± 0.10	2.42	0.06	1.2	—
E601, 20°55′N, 112°06′E, 54 m								
5	27.91	33.93	0.20 ± 0.03	1.18 ± 0.06	2.39	0.19	4.2	—
15	26.67	33.89	0.18 ± 0.03	1.61 ± 0.06	2.38	0.17	3.6	—
25	24.21	34.11	0.29 ± 0.03	1.75 ± 0.06	2.40	0.29	3.7	—
35	22.49	34.21	0.21 ± 0.04	1.44 ± 0.06	2.41	0.46	4.0	—
E603, 20°07′N, 112°55′E, 94 m								
5	28.49	33.77	0.24 ± 0.03	1.88 ± 0.07	2.37	0.10	4.2	—
25	24.92	34.08	0.37 ± 0.03	1.80 ± 0.07	2.40	0.12	2.6	—
50	24.00	33.88	0.42 ± 0.03	1.93 ± 0.07	2.38	0.17	3.0	—
75	22.08	34.24	0.45 ± 0.03	1.56 ± 0.06	2.41	0.59	4.5	—
E605, 19°18′N, 113°42′E, 544 m								
5	28.85	33.90	0.22 ± 0.02	1.96 ± 0.07	2.38	0.11	2.0	—
25	25.37	34.11	0.24 ± 0.02	1.90 ± 0.07	2.40	0.14	2.1	—
50	24.13	34.42	0.41 ± 0.02	1.85 ± 0.07	2.42	0.24	2.2	—
75	22.18	34.52	0.20 ± 0.02	2.18 ± 0.08	2.43	0.35	1.6	—
100	20.63	34.57	0.22 ± 0.02	2.17 ± 0.07	2.43	0.26	1.5	—
125	19.49	34.54	0.26 ± 0.02	2.34 ± 0.08	2.43	0.14	1.8	—
150	17.78	34.55	0.30 ± 0.02	2.35 ± 0.08	2.43	0.03	1.1	—
E607, 18°30′N, 114°30′E, 3583 m								
5	29.25	34.22	0.28 ± 0.02	1.83 ± 0.07	2.41	0.08	2.4	—
25	25.48	34.12	0.36 ± 0.02	1.83 ± 0.07	2.40	0.11	2.5	—
50	23.49	34.21	0.44 ± 0.02	1.67 ± 0.06	2.41	0.29	2.3	—
75	21.16	34.38	0.29 ± 0.02	1.91 ± 0.07	2.42	0.29	2.3	—
100	19.01	34.53	0.31 ± 0.02	2.28 ± 0.08	2.43	0.10	1.6	—
125	17.71	34.58	0.31 ± 0.02	2.33 ± 0.08	2.43	0.02	1.8	—
150	16.53	34.55	0.32 ± 0.02	2.46 ± 0.08	2.43	0.01	1.1	—
A7, 21°30′N, 114°30′E, 73 m								
5	28.01	33.65	0.24 ± 0.02	1.55 ± 0.06	2.37	0.08	3.2	—
25	24.33	34.10	0.28 ± 0.04	1.84 ± 0.07	2.40	0.10	3.5	—
50	21.03	34.34	0.12 ± 0.03	0.78 ± 0.05	2.41	0.56	5.4	—
68	20.90	34.35	0.26 ± 0.03	0.84 ± 0.05	2.42	0.47	4.4	—
A6, 21°16′N, 114°43′E, 90 m								
5	28.00	33.70	0.15 ± 0.03	1.79 ± 0.07	2.37	0.17	1.9	—
25	28.00	33.70	0.21 ± 0.03	1.62 ± 0.02	2.37	0.16	3.4	—
50	23.75	33.99	0.19 ± 0.04	1.46 ± 0.06	2.39	0.32	2.9	—
75	20.93	34.34	0.20 ± 0.03	0.63 ± 0.05	2.41	0.54	3.5	—
85	20.84	34.34	0.29 ± 0.04	0.60 ± 0.05	2.41	0.42	5.0	—

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_P$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
A5, 20°59′N, 114°59′E, 105 m								
5	28.02	33.96	0.40 ± 0.03	2.01 ± 0.07	2.39	0.18	3.2	—
25	27.58	33.99	0.33 ± 0.03	1.86 ± 0.07	2.39	0.12	3.0	—
50	24.83	34.05	0.26 ± 0.04	1.92 ± 0.08	2.39	0.19	4.0	—
75	22.15	34.27	0.29 ± 0.03	1.52 ± 0.06	2.41	0.51	4.4	—
A4, 20°44′N, 115°14′E, 188 m								
5	27.67	34.00	0.29 ± 0.02	1.92 ± 0.07	2.39	0.16	2.5	—
25	25.39	34.14	0.18 ± 0.02	1.85 ± 0.07	2.40	0.16	6.3	—
50	24.00	34.23	0.34 ± 0.02	1.78 ± 0.07	2.41	0.27	2.2	—
75	22.53	34.29	0.35 ± 0.02	2.00 ± 0.07	2.41	0.33	2.3	—
100	21.49	34.32	0.34 ± 0.02	1.88 ± 0.07	2.41	0.23	1.9	—
125	20.33	34.39	0.51 ± 0.02	1.69 ± 0.07	2.42	0.14	2.2	—
A2, 20°30′N, 115°28′E, 395 m								
5	26.74	34.10	0.24 ± 0.02	2.00 ± 0.08	2.40	0.15	5.1	—
25	25.53	34.14	0.21 ± 0.02	1.94 ± 0.07	2.40	0.14	1.8	—
50	24.69	34.26	0.32 ± 0.02	1.71 ± 0.07	2.41	0.17	1.8	—
75	24.33	34.28	0.29 ± 0.02	1.76 ± 0.07	2.41	0.42	2.3	—
100	22.25	34.42	0.23 ± 0.02	2.06 ± 0.08	2.42	0.30	1.3	—
125	20.80	34.54	0.31 ± 0.02	2.28 ± 0.08	2.43	0.11	2.4	—
150	19.27	34.67	0.29 ± 0.02	2.47 ± 0.08	2.44	0.03	1.6	—
A1a, 20°06′N, 115°50′E, 984 m								
5	27.82	34.18	0.23 ± 0.02	1.90 ± 0.07	2.40	0.15	1.9	—
25	25.80	34.24	0.25 ± 0.02	1.94 ± 0.07	2.41	0.13	2.4	—
50	25.09	34.26	0.36 ± 0.02	1.90 ± 0.07	2.41	0.11	2.1	—
75	24.16	34.37	0.25 ± 0.02	1.93 ± 0.07	2.42	0.40	3.6	—
100	21.92	34.41	0.20 ± 0.02	1.93 ± 0.07	2.42	0.37	1.9	—
125	19.33	34.60	0.34 ± 0.03	2.45 ± 0.09	2.43	0.06	1.2	—
150	17.64	34.64	0.33 ± 0.02	2.40 ± 0.08	2.44	0.01	1.5	—
A0, 19°54′N, 116°01′E, 1441 m								
5	28.14	33.90	0.25 ± 0.02	1.84 ± 0.07	2.38	0.25	3.0	—
25	25.24	34.16	0.23 ± 0.02	2.01 ± 0.08	2.40	0.21	4.9	—
50	24.04	34.31	0.29 ± 0.02	1.98 ± 0.07	2.41	0.37	2.3	—
75	22.42	34.44	0.25 ± 0.02	2.47 ± 0.08	2.42	0.36	1.9	—
100	20.30	34.58	0.33 ± 0.02	2.43 ± 0.08	2.43	0.13	1.3	—
125	17.87	34.61	0.26 ± 0.02	3.18 ± 0.10	2.43	0.02	1.1	—
150	16.90	34.62	0.33 ± 0.02	2.78 ± 0.09	2.43	0.01	1.7	—
A10, 19°16′N, 116°40′E, 2841 m								
5	28.02	33.93	0.21 ± 0.02	1.97 ± 0.08	2.39	0.26	2.2	—
25	25.28	34.09	0.21 ± 0.02	1.95 ± 0.07	2.40	0.19	3.6	—
50	23.72	34.24	0.29 ± 0.02	1.72 ± 0.07	2.41	0.35	2.3	—
75	21.61	34.52	0.24 ± 0.02	2.18 ± 0.08	2.43	0.25	1.4	—
100	19.50	34.59	0.28 ± 0.02	2.07 ± 0.08	2.43	0.09	1.3	—
125	18.42	34.59	0.32 ± 0.02	2.50 ± 0.08	2.43	0.03	1.1	—
150	17.18	34.61	0.30 ± 0.02	2.47 ± 0.08	2.43	0.01	1.2	—
200	14.34	34.53	0.33 ± 0.02	2.39 ± 0.08	2.43	—	1.1	—
300	11.53	34.46	0.34 ± 0.03	2.57 ± 0.09	2.57	—	1.3	—
500	8.25	34.43	0.28 ± 0.02	2.41 ± 0.08	2.41	—	1.1	—
S504, 19°43′N, 117°35′E, 3103 m								
5	27.74	33.86	0.20 ± 0.02	1.84 ± 0.07	2.38	0.24	2.7	—
25	25.78	34.16	0.18 ± 0.02	1.85 ± 0.07	2.40	0.27	2.2	—
50	23.21	34.41	0.24 ± 0.02	1.95 ± 0.08	2.42	0.39	2.2	—
75	21.55	34.56	0.28 ± 0.02	2.16 ± 0.08	2.43	0.13	1.7	—
100	19.09	34.64	0.28 ± 0.02	2.30 ± 0.08	2.44	—	1.3	—
125	16.44	34.59	0.28 ± 0.02	2.47 ± 0.08	2.43	0.01	1.6	—
150	14.73	34.54	0.27 ± 0.02	2.48 ± 0.08	2.43	0.00	1.4	—
S503, 20°15′N, 117°00′E, 748 m								
5	26.16	33.94	0.22 ± 0.02	1.80 ± 0.07	2.39	0.51	2.9	—
25	26.04	33.98	0.18 ± 0.02	1.86 ± 0.07	2.39	0.47	2.8	—
50	23.68	34.14	0.29 ± 0.02	1.68 ± 0.07	2.40	0.39	2.4	—
75	20.51	34.44	0.33 ± 0.02	1.99 ± 0.08	2.42	0.18	5.6	—
100	18.16	34.54	0.27 ± 0.02	2.35 ± 0.08	2.43	0.05	1.8	—
125	17.18	34.57	0.32 ± 0.02	2.34 ± 0.08	2.43	0.02	1.6	—
150	16.76	34.57	0.32 ± 0.03	2.39 ± 0.08	2.43	0.01	1.2	—
S501, 20°57′N, 116°12′E, 322 m								
5	25.79	33.99	0.33 ± 0.02	1.94 ± 0.08	2.39	0.31	2.7	—
25	24.12	34.18	0.37 ± 0.02	1.95 ± 0.07	2.40	0.47	2.5	—
50	22.71	34.38	0.29 ± 0.02	2.02 ± 0.09	2.42	0.30	2.0	—

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
75	20.78	34.30	0.31 ± 0.02	1.26 ± 0.06	2.41	0.31	2.2	—
100	19.56	34.45	0.41 ± 0.03	1.31 ± 0.06	2.42	0.14	1.9	—
125	19.65	34.45	0.46 ± 0.03	1.33 ± 0.06	2.42	0.14	3.7	—
150	19.35	34.47	0.48 ± 0.03	1.31 ± 0.06	2.42	0.09	—	—
S209, 21°18′N, 115°48′E, 134 m								
5	26.56	34.11	0.18 ± 0.02	1.96 ± 0.08	2.40	0.15	2.5	—
25	25.50	34.13	0.34 ± 0.02	1.78 ± 0.07	2.40	0.24	3.5	—
50	22.73	34.21	0.32 ± 0.03	1.83 ± 0.07	2.41	0.37	1.8	—
75	20.74	34.46	0.35 ± 0.02	2.09 ± 0.08	2.42	0.17	1.9	—
100	20.15	34.52	0.41 ± 0.02	2.04 ± 0.08	2.43	0.13	1.9	—
Summer (18 Jul to 16 Aug 2009)								
LE00, 18°00′N, 109°00′E, 45 m								
5	29.11	32.80	0.13 ± 0.02	1.26 ± 0.05	2.31	0.14	3.0	0.21
15	25.29	33.58	0.13 ± 0.02	0.50 ± 0.04	2.36	0.48	5.6	0.93
25	24.52	33.70	0.19 ± 0.03	0.41 ± 0.04	2.37	0.49	7.8	3.0
35	24.11	33.79	0.22 ± 0.03	0.33 ± 0.04	2.38	0.39	7.8	3.3
LE01, 18°00′N, 110°00′E, 97 m								
5	29.60	33.25	0.21 ± 0.02	2.10 ± 0.06	2.34	0.16	2.0	0.22
25	28.87	33.50	0.30 ± 0.02	1.88 ± 0.06	2.36	0.23	2.2	0.11
50	23.79	34.18	0.31 ± 0.02	1.73 ± 0.14	2.40	0.33	2.4	0.20
75	20.42	34.43	0.35 ± 0.02	1.34 ± 0.15	2.42	0.28	2.0	0.34
LE02, 18°00′N, 111°00′E, 1462 m								
5	29.95	33.49	0.18 ± 0.01	1.92 ± 0.07	2.35	0.08	4.5	0.13
25	29.59	33.49	0.32 ± 0.02	2.12 ± 0.07	2.35	0.16	3.0	0.11
50	23.69	34.21	0.52 ± 0.02	1.87 ± 0.06	2.41	0.41	2.7	0.14
75	20.17	34.38	0.33 ± 0.02	2.23 ± 0.08	2.42	0.22	1.8	0.07
100	18.69	34.47	0.22 ± 0.01	2.85 ± 0.12	2.42	0.09	1.0	0.06
125	17.32	34.54	0.27 ± 0.01	2.39 ± 0.08	2.43	0.03	0.9	0.06
150	16.25	34.54	0.26 ± 0.01	2.41 ± 0.07	2.43	0.01	1.1	0.08
DD203, 18°15′N, 111°15′E, 1250 m								
5	29.89	33.42	0.18 ± 0.01	2.02 ± 0.07	2.35	0.08	2.0	0.10
25	29.19	33.46	0.31 ± 0.02	2.03 ± 0.07	2.35	0.10	2.0	0.10
50	23.75	34.02	0.36 ± 0.02	1.85 ± 0.06	2.39	0.39	3.1	0.10
75	20.25	34.39	0.30 ± 0.01	2.20 ± 0.07	2.42	0.07	1.3	0.05
100	18.48	34.48	0.21 ± 0.01	2.62 ± 0.08	2.42	0.18	1.1	0.07
125	16.92	34.55	0.30 ± 0.02	2.41 ± 0.08	2.43	0.02	1.2	0.07
150	15.64	34.55	0.12 ± 0.01	2.22 ± 0.07	2.43	0.00	0.4	0.06
DD202, 18°28′N, 110°51′E, 139 m								
5	29.79	33.49	0.25 ± 0.02	1.91 ± 0.07	2.35	0.07	1.5	0.10
25	29.65	33.49	0.31 ± 0.03	1.90 ± 0.09	2.35	0.12	2.1	0.10
50	23.36	34.03	0.23 ± 0.02	1.59 ± 0.08	2.39	0.32	1.9	0.11
75	21.01	34.39	0.24 ± 0.02	1.82 ± 0.08	2.42	0.30	1.1	0.14
100	18.30	34.53	0.34 ± 0.03	0.83 ± 0.07	2.43	0.06	1.4	0.29
DD201, 18°36′N, 110°33′E, 101 m								
5	29.67	33.37	0.22 ± 0.02	1.87 ± 0.07	2.35	0.16	3.2	—
25	27.72	33.76	0.24 ± 0.02	1.98 ± 0.07	2.37	0.13	2.4	—
50	22.79	34.26	0.41 ± 0.03	1.88 ± 0.07	2.41	0.47	3.1	—
75	20.49	34.42	0.39 ± 0.03	1.10 ± 0.05	2.42	0.33	2.0	—
D102, 19°17′N, 110°51′E, 49 m								
5	28.77	33.25	0.28 ± 0.03	1.27 ± 0.06	2.34	0.13	2.1	—
15	27.15	33.82	0.31 ± 0.03	1.85 ± 0.07	2.38	0.18	2.6	—
25	25.03	34.07	0.40 ± 0.03	1.67 ± 0.06	2.40	0.18	2.3	—
35	23.48	34.21	0.37 ± 0.03	1.33 ± 0.13	2.41	0.41	3.4	—
D103, 19°00′N, 111°19′E, 128 m								
5	29.52	33.42	0.23 ± 0.01	2.16 ± 0.07	2.35	0.09	1.7	0.11
25	28.33	33.61	0.24 ± 0.01	1.93 ± 0.07	2.36	0.13	2.0	0.09
50	24.59	34.11	0.35 ± 0.02	1.89 ± 0.06	2.40	0.27	2.1	0.13
75	20.64	34.40	0.34 ± 0.02	1.88 ± 0.07	2.42	0.27	1.9	0.15
100	13.38	34.54	0.40 ± 0.02	1.94 ± 0.15	2.43	0.18	1.2	0.20
D104, 18°43′N, 111°40′E, 199 m								
5	29.70	33.48	0.15 ± 0.01	2.22 ± 0.07	2.35	0.07	2.0	0.12
25	29.16	33.47	0.18 ± 0.01	2.14 ± 0.07	2.35	0.09	1.5	0.07
50	24.27	34.07	0.38 ± 0.02	1.84 ± 0.06	2.40	0.29	1.6	0.12
75	21.27	34.37	0.33 ± 0.01	2.27 ± 0.07	2.42	0.27	2.1	0.09
100	19.54	34.47	0.21 ± 0.01	2.31 ± 0.07	2.42	0.10	2.1	0.20
125	18.50	34.52	0.30 ± 0.02	2.26 ± 0.08	2.43	0.07	1.1	0.09
150	16.06	34.54	0.57 ± 0.02	1.56 ± 0.06	2.43	0.01	0.8	0.19

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
D105, 18°23′N, 112°07′E, 474 m								
5	29.56	33.52	0.15 ± 0.01	2.21 ± 0.07	2.36	0.08	1.5	0.06
25	28.60	33.64	0.40 ± 0.02	2.02 ± 0.07	2.37	0.14	2.6	0.07
50	23.41	34.07	0.46 ± 0.02	1.69 ± 0.06	2.40	0.68	3.6	0.14
75	21.00	34.25	0.35 ± 0.02	2.16 ± 0.08	2.41	0.24	1.6	0.08
100	19.04	34.44	0.19 ± 0.01	2.47 ± 0.08	2.42	0.11	0.8	0.07
125	17.34	34.53	0.28 ± 0.02	2.46 ± 0.08	2.43	0.07	0.9	0.05
150	16.34	34.54	0.31 ± 0.02	2.38 ± 0.07	2.43	0.11	0.8	0.05
LE04, 18°00′N, 113°00′E, 2090 m								
5	29.58	33.53	0.17 ± 0.01	1.98 ± 0.07	2.36	0.14	1.6	0.06
25	29.49	33.53	0.20 ± 0.01	1.74 ± 0.06	2.36	0.16	2.0	0.05
50	24.42	33.97	0.31 ± 0.02	1.67 ± 0.06	2.39	0.55	2.9	0.11
75	21.05	34.26	0.29 ± 0.02	2.27 ± 0.22	2.41	0.30	1.5	0.08
100	18.47	34.50	0.27 ± 0.02	2.62 ± 0.08	2.43	0.05	0.7	0.06
125	17.48	34.52	0.30 ± 0.02	2.64 ± 0.08	2.43	0.02	1.2	0.08
150	15.78	34.51	0.30 ± 0.02	2.52 ± 0.08	2.43	0.01	0.8	0.10
LE05, 18°00′N, 114°00′E, 3238 m								
5	29.64	33.26	0.18 ± 0.01	2.12 ± 0.07	2.34	0.09	1.1	0.07
25	29.52	33.53	0.25 ± 0.02	2.04 ± 0.07	2.36	0.10	2.0	0.04
50	25.51	34.03	0.42 ± 0.02	1.80 ± 0.07	2.39	0.20	1.8	0.07
75	22.89	34.26	0.28 ± 0.02	2.26 ± 0.07	2.41	0.38	1.7	0.09
100	19.82	34.48	0.23 ± 0.02	2.42 ± 0.08	2.42	0.08	0.9	0.05
125	18.04	34.57	0.29 ± 0.02	2.42 ± 0.08	2.43	0.03	0.6	0.10
150	16.19	34.56	0.26 ± 0.02	2.57 ± 0.09	2.43	0.00	0.9	0.07
E505, 18°36′N, 113°09′E, 1496 m								
5	29.68	33.53	0.09 ± 0.01	2.15 ± 0.07	2.36	0.14	1.0	0.06
25	29.64	33.52	0.20 ± 0.01	1.89 ± 0.07	2.36	0.14	1.4	0.04
50	27.27	33.57	0.39 ± 0.02	1.76 ± 0.06	2.36	0.38	1.9	0.06
75	21.87	34.28	0.35 ± 0.02	2.04 ± 0.07	2.41	0.17	1.5	0.07
100	20.04	34.44	0.29 ± 0.02	2.52 ± 0.08	2.42	0.06	1.1	0.06
125	18.02	34.53	0.28 ± 0.02	2.22 ± 0.07	2.43	0.02	1.0	—
150	16.52	34.56	0.29 ± 0.02	2.29 ± 0.07	2.43	0.00	0.9	0.29
E503, 19°12′N, 112°16′E, 184 m								
5	29.77	33.53	0.17 ± 0.01	2.05 ± 0.08	2.36	0.05	1.8	0.08
25	29.43	33.54	0.22 ± 0.02	2.11 ± 0.07	2.36	0.08	1.9	0.14
50	23.47	34.14	0.31 ± 0.02	1.76 ± 0.06	2.40	0.28	2.6	0.10
75	21.80	34.32	0.26 ± 0.02	2.14 ± 0.07	2.41	0.23	1.4	0.03
100	20.50	34.43	0.24 ± 0.02	2.40 ± 0.08	2.42	0.09	1.8	0.08
125	18.65	34.53	0.30 ± 0.02	2.39 ± 0.08	2.43	0.05	1.0	0.06
150	16.59	34.55	0.23 ± 0.02	2.01 ± 0.07	2.43	0.01	2.4	0.25
E501, 19°48′N, 111°26′E, 79 m								
5	29.74	33.31	0.18 ± 0.01	2.09 ± 0.07	2.34	0.03	1.5	0.14
25	26.51	33.94	0.23 ± 0.02	1.95 ± 0.07	2.39	0.06	1.5	0.08
50	23.37	34.21	0.24 ± 0.02	1.33 ± 0.06	2.41	0.29	3.4	0.22
70	20.38	34.43	0.35 ± 0.02	0.77 ± 0.05	2.42	0.24	2.6	0.84
E500, 20°06′N, 111°00′E, 37 m								
5	26.51	33.50	0.18 ± 0.03	0.30 ± 0.04	2.36	0.74	7.8	—
15	25.57	33.81	0.23 ± 0.03	0.30 ± 0.05	2.38	0.64	7.2	—
25	22.10	34.24	0.24 ± 0.04	0.33 ± 0.05	2.41	0.24	7.7	—
E601, 20°55′N, 112°06′E, 53 m								
5	28.57	33.79	0.11 ± 0.02	1.19 ± 0.06	2.38	0.15	3.5	0.15
15	25.20	33.97	0.17 ± 0.02	1.31 ± 0.06	2.39	0.16	4.1	0.13
25	23.95	34.21	0.13 ± 0.02	1.41 ± 0.06	2.41	0.21	4.2	0.20
35	21.65	34.32	0.11 ± 0.02	0.75 ± 0.05	2.41	0.35	4.2	0.75
E603, 20°07′N, 112°54′E, 95 m								
5	28.98	33.62	0.17 ± 0.01	2.19 ± 0.08	2.36	0.06	2.1	0.09
25	28.96	33.66	0.19 ± 0.01	2.17 ± 0.07	2.37	0.11	1.8	0.06
50	27.15	33.82	0.12 ± 0.01	1.97 ± 0.07	2.38	0.12	0.9	0.09
75	22.22	34..30	0.35 ± 0.02	1.86 ± 0.07	2.41	0.48	2.5	0.12
E605, 19°18′N, 113°42′E, 541 m								
5	29.43	33.54	0.31 ± 0.02	2.31 ± 0.08	2.36	0.06	2.0	0.06
25	28.19	33.68	0.32 ± 0.02	1.91 ± 0.07	2.37	0.12	2.3	0.06
50	25.58	33.90	0.43 ± 0.02	1.80 ± 0.07	2.38	0.26	3.4	0.13
75	23.06	34.19	0.38 ± 0.02	1.88 ± 0.07	2.40	0.46	2.6	0.10
100	19.99	34.42	0.29 ± 0.02	2.34 ± 0.08	2.42	0.19	1.3	0.08
125	17.80	34.53	0.24 ± 0.02	2.42 ± 0.08	2.43	0.02	1.2	0.04
150	16.71	34.55	0.27 ± 0.02	2.54 ± 0.08	2.43	0.01	0.9	0.04

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_P$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
E607, 18°30′N, 114°30′E, 3581 m								
5	29.52	33.44	0.18 ± 0.02	2.16 ± 0.08	2.35	0.09	1.3	0.06
25	27.56	33.84	0.24 ± 0.02	2.07 ± 0.07	2.38	0.08	1.4	0.05
50	23.58	34.22	0.31 ± 0.02	1.85 ± 0.08	2.41	0.27	2.1	0.07
75	21.17	34.39	0.25 ± 0.02	2.22 ± 0.07	2.42	0.28	1.2	0.07
100	19.45	34.49	0.29 ± 0.02	2.18 ± 0.08	2.43	0.14	1.4	0.05
125	18.82	34.52	0.33 ± 0.02	2.33 ± 0.08	2.43	0.04	0.8	0.07
150	17.55	34.56	0.30 ± 0.02	2.58 ± 0.12	2.43	0.01	1.0	0.14
S206, 22°00′N, 115°38′E, 83 m								
5	29.81	31.36	0.30 ± 0.03	1.16 ± 0.08	2.20	1.20	12.5	0.60
25	27.99	33.72	0.22 ± 0.03	2.01 ± 0.08	2.37	0.38	2.5	0.08
50	23.72	34.17	0.13 ± 0.02	1.41 ± 0.06	2.40	0.57	3.3	0.13
70	20.50	34.43	0.21 ± 0.03	0.61 ± 0.04	2.42	0.46	3.9	0.47
S209, 21°18′N, 115°48′E, 134 m								
5	29.45	33.56	0.21 ± 0.02	2.03 ± 0.07	2.36	0.11	2.0	0.10
25	28.34	33.56	0.21 ± 0.01	2.01 ± 0.07	2.36	0.12	2.1	0.07
50	25.92	33.91	0.21 ± 0.02	1.80 ± 0.06	2.38	0.29	2.5	0.07
75	23.18	34.15	0.21 ± 0.01	1.53 ± 0.06	2.40	0.49	2.3	0.11
100	20.89	34.36	0.24 ± 0.02	1.28 ± 0.06	2.42	0.28	1.8	0.23
S501, 20°57′N, 116°12′E, 325 m								
5	29.56	33.40	0.21 ± 0.02	2.16 ± 0.07	2.35	0.14	2.1	0.11
25	28.42	33.51	0.27 ± 0.02	1.95 ± 0.07	2.36	0.18	2.5	0.08
50	25.22	33.86	0.46 ± 0.02	2.03 ± 0.07	2.38	0.58	3.1	0.17
75	21.11	34.31	0.32 ± 0.02	2.16 ± 0.07	2.41	0.17	1.3	0.07
100	19.11	34.44	0.29 ± 0.02	2.44 ± 0.07	2.42	0.10	1.3	0.06
125	17.88	34.49	0.36 ± 0.02	2.29 ± 0.08	2.43	0.08	1.1	0.10
150	16.75	34.53	0.33 ± 0.02	2.60 ± 0.08	2.43	0.02	0.8	0.10
S503, 20°15′N, 117°00′E, 749 m								
5	29.79	33.47	0.17 ± 0.01	1.86 ± 0.07	2.35	0.05	1.6	0.06
25	29.59	33.46	0.24 ± 0.02	2.14 ± 0.07	2.35	0.06	2.1	0.15
50	25.91	33.99	0.36 ± 0.02	2.77 ± 0.09	2.39	0.16	2.2	0.06
75	22.58	34.26	0.31 ± 0.02	1.90 ± 0.07	2.41	0.42	1.8	0.14
100	20.21	34.44	0.24 ± 0.02	2.53 ± 0.08	2.42	0.26	1.3	0.04
125	18.63	34.53	0.22 ± 0.02	2.52 ± 0.08	2.43	0.04	0.7	0.03
150	16.88	34.56	0.26 ± 0.02	2.55 ± 0.08	2.43	0.02	0.7	0.04
S504, 19°44′N, 117°36′E, 3100 m								
5	29.68	33.27	0.20± 0.02	2.05 ± 0.07	2.34	0.10	2.0	0.05
25	28.72	33.16	0.25 ± 0.02	1.72 ± 0.06	2.33	0.13	1.7	0.03
50	25.98	33.85	0.47 ± 0.02	1.81 ± 0.06	2.38	0.24	2.1	0.06
75	22.01	34.21	0.34 ± 0.02	2.08 ± 0.07	2.41	0.40	1.6	0.06
100	20.22	34.40	0.24 ± 0.02	2.49 ± 0.08	2.42	0.11	0.9	0.04
125	18.32	34.49	0.22 ± 0.02	2.65 ± 0.09	2.42	0.06	0.7	0.04
150	16.86	34.54	0.25 ± 0.02	2.43 ± 0.08	2.43	0.01	0.7	0.03
A10, 19°16′N, 116°40′E, 2848 m								
5	29.69	33.38	0.19 ± 0.02	2.05 ± 0.07	2.35	0.07	2.0	0.05
25	24.95	33.87	0.20 ± 0.02	2.31 ± 0.11	2.38	0.10	1.8	0.07
50	21.89	34.15	0.45 ± 0.02	1.67 ± 0.07	2.40	0.36	2.2	0.10
75	19.52	34.38	0.34 ± 0.02	2.24 ± 0.07	2.42	0.43	1.5	0.06
100	17.66	34.54	0.26 ± 0.02	2.49 ± 0.08	2.43	0.07	1.4	0.05
150	15.81	34.55	0.30 ± 0.02	2.37 ± 0.08	2.43	0.01	1.9	0.06
200	13.86	34.51	0.26 ± 0.02	2.34 ± 0.08	2.43	—	1.5	0.04
300	12.07	34.47	0.27 ± 0.02	2.56 ± 0.08	2.42	—	0.8	0.05
500	8.61	34.42	0.33 ± 0.02	2.51 ± 0.08	2.42	—	1.6	0.07
A0, 19°54′N, 116°00′E, 1458 m								
5	29.69	33.63	0.20 ± 0.02	2.18 ± 0.08	2.36	0.12	1.6	0.10
25	29.68	33.63	0.22 ± 0.02	1.99 ± 0.07	2.36	0.11	2.7	0.08
50	26.45	33.95	0.25 ± 0.02	2.15 ± 0.07	2.39	0.30	1.9	0.10
75	22.79	34.18	0.40 ± 0.02	1.90 ± 0.07	2.40	0.23	2.8	0.18
100	20.18	34.46	0.35 ± 0.02	2.22 ± 0.08	2.42	0.09	1.5	0.06
125	18.28	34.54	0.33 ± 0.02	2.42 ± 0.10	2.43	0.06	1.1	0.13
150	17.10	34.56	0.27 ± 0.02	2.41 ± 0.09	2.43	0.02	1.0	—
A1, 20°12′N, 115°45′E, 743 m								
5	29.28	33.52	0.18 ± 0.01	2.10 ± 0.07	2.36	0.10	1.9	—
25	28.74	33.58	0.25 ± 0.02	1.98 ± 0.07	2.36	0.20	2.0	—
50	23.54	34.08	0.36 ± 0.02	1.95 ± 0.07	2.40	0.32	3.5	—
75	21.06	34.34	0.24 ± 0.02	2.37 ± 0.08	2.41	0.23	1.4	—
100	18.93	34.47	0.26 ± 0.02	2.61 ± 0.09	2.42	0.09	1.7	—

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_P$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
125	17.65	34.53	0.25 ± 0.02	2.55 ± 0.08	2.43	0.10	1.2	—
150	16.27	34.56	0.28 ± 0.02	2.59 ± 0.09	2.43	0.02	1.4	—
200	14.31	34.51	0.29 ± 0.02	2.68 ± 0.08	2.43	—	1.1	—
500	8.24	34.42	0.28 ± 0.02	2.28 ± 0.07	2.42	—	1.0	—
A2, 20°30′N, 115°29′E, 395 m								
5	29.34	33.46	0.19 ± 0.02	2.04 ± 0.07	2.35	0.14	1.9	0.12
25	29.33	33.47	0.46 ± 0.02	1.66 ± 0.07	2.35	0.14	1.4	0.09
50	25.12	34.00	0.32 ± 0.02	1.50 ± 0.09	2.39	0.25	2.3	0.10
75	21.17	34.33	0.28 ± 0.02	2.24 ± 0.08	2.41	0.28	1.4	0.12
100	18.43	34.48	0.38 ± 0.02	2.45 ± 0.08	2.42	0.11	1.4	0.07
125	17.14	34.55	0.36 ± 0.02	2.30 ± 0.08	2.43	0.03	1.3	0.08
150	16.06	34.55	0.32 ± 0.02	2.62 ± 0.09	2.43	0.01	1.5	0.09
A4, 20°45′N, 115°15′E, 187 m								
5	29.30	33.48	0.24 ± 0.02	2.13 ± 0.08	2.35	0.11	2.1	0.18
25	29.07	33.51	0.21 ± 0.02	1.94 ± 0.07	2.36	0.14	2.2	0.15
50	25.93	33.87	0.24 ± 0.02	1.69 ± 0.07	2.38	0.54	3.0	0.14
75	22.78	34.19	0.26 ± 0.02	1.73 ± 0.07	2.40	0.22	2.0	0.19
100	20.27	34.43	0.26 ± 0.02	2.40 ± 0.08	2.42	0.13	1.2	0.09
125	17.51	34.56	0.35 ± 0.02	2.33 ± 0.08	2.43	—	2.4	0.14
A7, 21°30′N, 114°30′E, 72 m								
5	28.55	33.62	0.17 ± 0.03	2.04 ± 0.07	2.36	0.25	2.5	0.13
25	27.25	33.82	0.27 ± 0.03	2.00 ± 0.08	2.38	0.68	4.2	0.27
50	23.07	34.24	0.07 ± 0.02	0.66 ± 0.05	2.41	0.50	2.7	0.38
68	21.66	34.34	0.24 ± 0.03	0.54 ± 0.04	2.41	0.33	4.3	0.86
A6, 21°16′N, 114°44′E, 88 m								
5	28.82	33.57	0.20 ± 0.03	2.10 ± 0.08	2.36	0.18	2.5	0.15
25	28.70	33.64	0.21 ± 0.02	2.19 ± 0.08	2.37	0.18	2.3	0.10
50	25.23	34.00	0.31 ± 0.03	1.79 ± 0.07	2.39	0.44	3.5	0.13
75	21.94	34.31	0.24 ± 0.03	0.46 ± 0.04	2.41	0.24	3.0	0.65
85	21.91	34.31	0.26 ± 0.03	0.60 ± 0.05	2.41	0.30	3.1	1.4
A5, 21°00′N, 114°59′E, 104 m								
5	28.25	33.53	0.18 ± 0.02	1.94 ± 0.08	2.36	0.18	2.3	0.16
25	28.25	33.59	0.16 ± 0.01	1.95 ± 0.07	2.36	0.26	1.9	0.08
50	26.38	33.80	0.26 ± 0.02	1.62 ± 0.07	2.38	0.52	2.5	0.24
75	23.54	34.06	0.24 ± 0.02	1.92 ± 0.07	2.39	0.31	1.5	0.12
SEATS, 18°00′N, 115°58′E, 3846 m								
5	28.62	33.25	0.19 ± 0.01	1.97 ± 0.08	2.34	0.14	3.2	0.10
25	28.62	33.24	0.23 ± 0.02	1.90 ± 0.07	2.34	0.14	2.8	0.14
50	23.15	34.05	0.27 ± 0.02	2.20 ± 0.07	2.39	0.43	2.5	0.88
75	20.98	34.26	0.29 ± 0.02	2.34 ± 0.07	2.41	0.12	2.2	0.07
100	19.30	34.43	0.26 ± 0.02	2.56 ± 0.08	2.42	0.05	1.3	0.06
125	17.95	34.50	0.24 ± 0.02	2.19 ± 0.07	2.43	0.01	1.5	0.09
150	16.21	34.55	0.25 ± 0.02	2.00 ± 0.07	2.43	0.00	1.1	0.05
200	14.49	34.54	0.29 ± 0.02	2.06 ± 0.09	2.43	0.00	0.7	0.08
300	12.80	34.49	0.29 ± 0.02	1.94 ± 0.07	2.43	—	2.1	0.06
500	9.17	34.42	0.31 ± 0.02	2.12 ± 0.08	2.42	—	1.7	0.07
LE09, 18°00′N, 118°00′E, 3885 m								
5	28.80	33.41	0.19 ± 0.01	2.30 ± 0.08	2.35	0.09	1.7	0.11
25	28.57	33.39	0.23 ± 0.01	2.36 ± 0.08	2.35	0.10	2.3	0.07
50	25.19	33.87	0.51 ± 0.02	1.92 ± 0.07	2.38	0.26	3.0	0.10
75	22.24	34.19	0.28 ± 0.02	2.31 ± 0.08	2.40	0.35	2.1	0.08
100	19.54	34.44	0.23 ± 0.02	2.43 ± 0.09	2.42	0.10	1.2	0.06
125	19.28	34.46	0.21 ± 0.02	2.23 ± 0.07	2.42	0.16	1.2	0.05
150	17.48	34.51	0.22 ± 0.02	2.28 ± 0.07	2.43	0.01	0.9	0.07
E406, 18°45′N, 120°00′E, 2744 m								
5	29.26	32.79	0.25 ± 0.02	1.65 ± 0.06	2.31	0.11	1.9	0.04
25	29.16	32.82	0.21 ± 0.01	1.98 ± 0.07	2.31	0.12	1.8	0.06
50	28.59	33.16	0.34 ± 0.02	1.65 ± 0.06	2.33	0.81	2.5	0.11
75	26.52	33.80	0.28 ± 0.02	2.11 ± 0.07	2.38	0.57	1.8	0.14
100	23.50	34.11	0.28 ± 0.02	2.25 ± 0.08	2.40	0.18	1.5	0.08
125	20.70	34.35	0.20 ± 0.02	2.49 ± 0.08	2.42	0.09	0.9	0.05
150	18.93	34.47	0.22 ± 0.02	2.60 ± 0.08	2.42	0.03	0.8	0.02
E405, 19°30′N, 120°01′E, 4167 m								
5	29.33	33.14	0.18 ± 0.01	2.22 ± 0.07	2.33	0.06	1.9	0.06
25	28.94	33.21	0.19 ± 0.01	1.98 ± 0.07	2.34	0.09	2.1	0.12
50	29.09	33.38	0.17 ± 0.01	2.08 ± 0.07	2.35	0.16	2.0	0.08
75	28.18	33.55	0.31 ± 0.02	2.01 ± 0.07	2.36	0.37	1.7	0.09

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_P$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
100	25.16	34.34	0.31 ± 0.02	2.12 ± 0.07	2.41	0.21	1.6	0.09
125	23.30	34.39	0.18 ± 0.01	2.18 ± 0.08	2.42	0.08	1.4	0.09
150	21.10	34.69	0.31 ± 0.02	2.31 ± 0.07	2.44	0.05	0.7	0.07
E404, 20°00′N, 120°00′E, 3595 m								
5	29.30	33.31	0.17 ± 0.01	1.88 ± 0.07	2.34	0.13	2.4	0.07
25	29.00	33.32	0.19 ± 0.01	2.00 ± 0.07	2.34	0.16	2.7	0.16
50	28.85	33.32	0.19 ± 0.02	2.09 ± 0.07	2.34	0.29	2.1	0.10
75	28.74	33.46	0.23 ± 0.02	2.00 ± 0.08	2.35	0.41	2.0	0.08
100	27.19	34.21	0.30 ± 0.02	2.08 ± 0.07	2.41	0.19	1.7	0.07
125	24.46	34.54	0.36 ± 0.02	2.19 ± 0.08	2.43	0.10	0.9	0.05
150	21.08	34.61	0.40 ± 0.02	2.41 ± 0.08	2.43	0.04	0.7	0.06
E403, 20°30′N, 120°00′E, 3409 m								
5	29.17	33.23	0.15 ± 0.01	2.06 ± 0.07	2.34	0.09	2.0	0.10
25	28.91	33.26	0.21 ± 0.01	1.98 ± 0.08	2.34	0.20	2.3	0.07
50	28.82	33.26	0.16 ± 0.01	2.01 ± 0.07	2.34	0.27	1.9	0.12
75	27.55	33.83	0.25 ± 0.02	1.92 ± 0.07	2.38	0.52	1.6	0.07
100	23.37	34.62	0.38 ± 0.02	2.41 ± 0.09	2.43	0.11	1.0	0.07
125	21.78	34.69	0.47 ± 0.02	2.36 ± 0.08	2.44	0.07	0.8	0.08
150	19.67	34.65	0.42 ± 0.02	2.40 ± 0.07	2.44	0.02	0.7	0.08
E402, 21°00′N, 120°00′E, 3635 m								
5	29.13	33.38	0.16 ± 0.02	2.12 ± 0.07	2.35	0.11	2.4	0.10
25	28.83	33.38	0.21 ± 0.01	1.93 ± 0.07	2.35	0.16	2.2	0.08
50	28.37	33.61	0.24 ± 0.02	2.13 ± 0.07	2.36	0.48	2.5	0.09
75	26.26	34.32	0.25 ± 0.02	2.17 ± 0.07	2.41	0.47	1.4	0.09
100	24.41	34.59	0.33 ± 0.02	2.15 ± 0.07	2.43	0.20	1.2	0.05
125	22.20	34.66	0.40 ± 0.02	2.55 ± 0.08	2.44	0.09	0.8	0.05
150	20.68	34.56	0.27 ± 0.02	2.39 ± 0.08	2.43	0.04	1.4	0.06
E401, 21°30′N, 120°00′E, 2973 m								
5	28.87	33.39	0.16 ± 0.01	2.07 ± 0.07	2.35	0.14	1.9	0.08
25	28.59	33.38	0.26 ± 0.02	1.79 ± 0.07	2.35	0.11	3.0	0.07
50	28.34	33.33	0.28 ± 0.02	2.10 ± 0.07	2.34	0.32	2.4	0.09
75	25.97	33.91	0.28 ± 0.02	2.23 ± 0.08	2.38	0.47	1.9	0.10
100	23.10	34.18	0.27 ± 0.02	2.27 ± 0.07	2.40	0.12	1.2	0.07
125	21.31	34.33	0.18 ± 0.02	2.32 ± 0.07	2.41	0.08	2.1	0.11
150	19.99	34.45	0.20 ± 0.02	2.33 ± 0.07	2.42	0.03	0.8	0.04
Autumn (26 Oct to 24 Nov 2010)								
E601, 20°55′N, 112°06′E, 53 m								
5	26.17	33.31	0.22 ± 0.02	0.41 ± 0.04	2.34	1.01	9.2	—
15	26.17	33.31	0.22 ± 0.02	0.38 ± 0.03	2.34	1.03	15.4	—
25	26.17	33.31	0.24 ± 0.02	0.36 ± 0.03	2.34	0.97	5.2	—
45	26.17	33.31	0.26 ± 0.02	0.39 ± 0.03	2.34	0.93	8.6	—
E602, 20°31′N, 112°30′E, 76 m								
5	26.26	33.75	0.35 ± 0.02	1.71 ± 0.06	2.37	0.93	3.5	—
25	26.28	33.75	0.37 ± 0.02	1.82 ± 0.06	2.37	0.83	3.8	—
50	26.29	33.75	0.33 ± 0.02	1.75 ± 0.05	2.37	0.77	3.5	—
70	26.29	33.75	0.57 ± 0.03	1.72 ± 0.06	2.37	0.78	3.9	—
E603, 20°06′N, 112°54′E, 94 m								
5	26.29	33.82	0.32 ± 0.02	1.53 ± 0.05	2.38	0.50	3.1	—
25	26.30	33.82	0.36 ± 0.02	1.28 ± 0.05	2.38	0.52	3.6	—
50	26.31	33.82	0.35 ± 0.02	1.54 ± 0.05	2.38	0.51	3.6	—
75	26.32	33.82	0.29 ± 0.02	1.56 ± 0.05	2.38	0.48	2.6	—
E604, 19°42′N, 113°18′E, 195 m								
5	26.45	33.77	0.20 ± 0.01	2.11 ± 0.06	2.37	0.55	1.9	—
25	26.46	33.77	0.19 ± 0.01	2.00 ± 0.06	2.37	0.51	2.6	—
50	26.46	33.77	0.20 ± 0.01	1.94 ± 0.06	2.37	0.58	1.7	—
75	26.44	33.77	0.22 ± 0.01	2.05 ± 0.17	2.37	0.49	2.2	—
100	26.37	33.85	0.20 ± 0.02	1.91 ± 0.06	2.38	0.25	1.6	—
125	24.05	34.28	0.24 ± 0.01	2.09 ± 0.06	2.41	0.10	1.7	—
150	21.34	34.37	0.17 ± 0.01	2.16 ± 0.06	2.42	0.05	1.3	—
A7, 21°30′N, 114°30′E, 72 m								
5	23.39	33.11	0.21 ± 0.02	0.43 ± 0.03	2.33	—	8.2	—
25	23.40	33.13	0.19 ± 0.02	0.47 ± 0.05	2.33	0.86	6.5	—
50	23.08	33.17	0.23 ± 0.02	0.47 ± 0.03	2.33	0.53	5.7	—
68	23.27	33.29	0.23 ± 0.02	0.30 ± 0.03	2.34	0.52	6.3	—
A6, 21°17′N, 114°43′E, 87 m								
5	23.39	33.34	0.20 ± 0.03	0.52 ± 0.03	2.34	0.68	5.4	—
25	23.88	33.39	0.21 ± 0.02	0.51 ± 0.03	2.35	0.92	5.3	—

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
50	23.44	33.52	0.18 ± 0.02	0.49 ± 0.03	2.36	0.58	4.1	—
75	23.79	33.59	0.18 ± 0.02	0.39 ± 0.04	2.36	0.50	3.9	—
85	23.75	33.64	0.18 ± 0.02	0.36 ± 0.03	2.37	0.55	4.4	—
A5, 21°00′N, 115°00′E, 103 m								
5	24.72	33.90	0.21 ± 0.03	1.82 ± 0.05	2.38	0.44	3.4	—
25	24.72	33.90	0.22 ± 0.02	1.85 ± 0.05	2.38	0.40	2.5	—
50	24.73	33.90	0.20 ± 0.02	1.83 ± 0.05	2.38	0.38	2.6	—
75	24.74	33.90	0.23 ± 0.02	1.92 ± 0.06	2.38	0.36	3.1	—
95	24.75	33.87	0.29 ± 0.02	1.80 ± 0.05	2.38	—	3.7	—
A4, 20°45′N, 115°15′E, 185 m								
5	25.53	34.14	0.19 ± 0.01	1.75 ± 0.06	2.40	0.52	2.1	—
25	25.59	34.14	0.20 ± 0.01	1.90 ± 0.06	2.40	—	1.8	—
50	25.54	34.14	0.20 ± 0.01	1.87 ± 0.06	2.40	0.44	1.5	—
75	25.47	34.09	0.24 ± 0.01	1.79 ± 0.06	2.40	0.25	2.1	—
100	23.80	34.10	0.36 ± 0.01	1.50 ± 0.05	2.40	0.11	1.9	—
125	22.45	34.30	0.30 ± 0.02	1.53 ± 0.05	2.41	0.12	2.0	—
150	19.71	34.44	0.37 ± 0.02	1.58 ± 0.05	2.42	0.29	1.6	—
A2, 20°30′N, 115°29′E, 396 m								
5	25.64	33.89	0.24 ± 0.01	1.68 ± 0.05	2.38	0.84	3.4	—
25	25.64	33.89	0.19 ± 0.01	1.80 ± 0.06	2.38	0.81	3.2	—
50	25.55	33.89	0.19 ± 0.01	1.62 ± 0.05	2.38	0.76	3.4	—
75	24.51	34.35	0.25 ± 0.02	2.23 ± 0.06	2.42	0.08	1.4	—
100	22.07	34.55	0.23 ± 0.01	2.17 ± 0.06	2.43	0.03	1.3	—
125	19.61	34.61	0.24 ± 0.01	2.43 ± 0.08	2.43	0.03	1.0	—
150	18.40	34.60	0.29 ± 0.01	2.48 ± 0.06	2.43	0.03	2.2	—
200	15.12	34.56	0.29 ± 0.01	2.38 ± 0.06	2.43	—	2.0	—
300	11.47	34.42	0.47 ± 0.02	1.93 ± 0.06	2.42	—	1.3	—
E607, 18°30′N, 114°30′E, 3581 m								
5	25.35	33.75	0.16 ± 0.02	1.44 ± 0.05	2.37	—	3.4	—
25	25.37	33.76	0.24 ± 0.02	1.47 ± 0.05	2.37	—	4.6	—
50	25.36	33.76	0.23 ± 0.01	1.55 ± 0.05	2.37	—	4.9	—
75	24.35	33.92	0.36 ± 0.01	0.97 ± 0.04	2.39	—	3.5	—
100	19.51	34.40	0.22 ± 0.02	2.29 ± 0.06	2.42	—	1.4	—
150	16.23	34.54	0.25 ± 0.01	2.48 ± 0.08	2.43	—	1.3	—
500	8.57	34.40	0.29 ± 0.02	2.29 ± 0.07	2.42	—	1.4	—
S209, 21°18′N, 115°48′E, 132 m								
5	25.96	33.67	0.09 ± 0.01	1.67 ± 0.07	2.37	0.31	2.6	—
25	25.97	33.66	0.10 ± 0.01	1.52 ± 0.05	2.37	0.32	2.5	—
50	24.74	33.85	0.07 ± 0.01	1.26 ± 0.05	2.38	0.40	2.5	—
75	24.64	33.96	0.26 ± 0.01	1.20 ± 0.05	2.39	0.34	2.3	—
100	22.93	34.07	0.37 ± 0.02	1.12 ± 0.04	2.40	0.12	2.3	—
A1, 20°09′N, 115°45′E, 850 m								
5	23.89	33.87	0.24 ± 0.01	1.65 ± 0.05	2.38	0.70	4.9	—
25	23.25	34.04	0.19 ± 0.01	1.74 ± 0.05	2.39	0.42	2.4	—
50	22.55	34.10	0.22 ± 0.02	1.81 ± 0.06	2.40	0.38	2.4	—
75	20.80	34.24	0.22 ± 0.01	2.10 ± 0.06	2.41	0.23	1.9	—
100	18.53	34.42	0.27± 0.01	2.24 ± 0.06	2.42	0.08	1.7	—
125	17.23	34.59	0.27± 0.01	2.94 ± 0.59	2.43	0.02	1.6	—
150	15.74	34.54	0.25± 0.01	2.40 ± 0.07	2.43	—	1.1	—
200	14.13	34.43	0.25± 0.02	2.29 ± 0.06	2.42	—	1.6	—
300	11.02	34.40	0.23± 0.01	2.28 ± 0.06	2.42	—	1.8	—
500	8.16	34.40	0.32± 0.01	2.21 ± 0.06	2.42	—	1.4	—
E605, 19°18′N, 113°42′E, 544 m								
5	24.53	33.82	0.20 ± 0.01	1.51 ± 0.05	2.38	0.58	4.3	—
25	24.53	33.75	0.24 ± 0.02	1.59 ± 0.05	2.37	0.63	5.6	—
50	24.36	33.91	0.17 ± 0.01	1.70 ± 0.05	2.38	0.63	2.6	—
75	23.58	34.12	0.20 ± 0.01	1.72 ± 0.05	2.40	0.25	1.6	—
100	20.04	34.56	0.22 ± 0.02	2.24 ± 0.07	2.43	0.03	1.8	—
125	18.00	34.57	0.28 ± 0.01	2.11 ± 0.09	2.43	0.01	1.6	—
150	17.19	34.55	0.33 ± 0.02	2.05 ± 0.06	2.43	0.01	1.4	—
SEATS,18°00′N, 116°00′E, 3846 m								
5	25.94	33.62	0.20 ± 0.01	1.54 ± 0.05	2.36	0.34	3.2	—
25	26.09	33.59	0.25 ± 0.01	1.60 ± 0.05	2.36	0.38	2.8	—
50	24.04	33.97	0.21 ± 0.02	1.97 ± 0.06	2.39	0.51	2.2	—
75	20.22	34.42	0.14 ± 0.01	2.43 ± 0.07	2.42	0.23	1.9	—
100	18.47	34.51	0.26 ± 0.01	2.45 ± 0.07	2.43	0.06	1.7	—
125	16.64	34.54	0.28 ± 0.01	2.34 ± 0.07	2.43	0.02	2.2	—

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
150	15.25	34.53	0.23 ± 0.01	2.40 ± 0.07	2.43	0.01	1.8	—
200	13.90	34.50	0.23 ± 0.02	2.06 ± 0.06	2.43	—	1.2	—
300	11.16	34.43	0.25 ± 0.01	2.36 ± 0.07	2.42	—	1.3	—
500	8.05	34.40	0.23 ± 0.01	2.32 ± 0.06	2.42	—	1.3	—
A0, 19°53′N, 116°00′E, 1479 m								
5	26.92	33.53	0.16 ± 0.01	2.03 ± 0.07	2.36	0.19	2.4	—
25	26.67	33.70	0.17 ± 0.01	1.73 ± 0.05	2.37	0.29	2.7	—
50	26.58	33.78	0.13 ± 0.02	1.63 ± 0.05	2.38	0.48	2.9	—
75	22.49	34.21	0.16 ± 0.01	2.08 ± 0.06	2.41	0.31	2.3	—
100	18.56	34.51	0.20 ± 0.01	2.54 ± 0.07	2.43	0.11	1.6	—
125	17.43	34.53	0.31 ± 0.01	2.53 ± 0.07	2.43	0.03	1.5	—
150	15.97	34.53	0.23 ± 0.01	2.29 ± 0.06	2.43	0.00	1.2	—
200	13.77	34.49	0.25 ± 0.02	2.34 ± 0.07	2.43	—	1.2	—
300	12.00	34.43	0.24 ± 0.01	2.43 ± 0.10	2.42	—	1.5	—
500	8.77	34.40	0.28 ± 0.01	2.37 ± 0.07	2.42	—	1.7	—
A10, 19°16′N, 116°40′E, 2850 m								
5	26.91	33.69	0.17 ± 0.01	1.88 ± 0.07	2.37	0.20	3.1	—
25	26.92	33.70	0.20 ± 0.01	1.65 ± 0.05	2.37	0.20	2.1	—
50	26.67	34.07	0.25 ± 0.02	1.97 ± 0.06	2.40	0.45	2.1	—
75	26.30	34.52	0.25 ± 0.01	2.27 ± 0.07	2.43	0.22	1.7	—
100	23.15	34.29	0.27 ± 0.01	2.16 ± 0.07	2.41	0.10	1.9	—
125	20.14	34.49	0.24 ± 0.01	2.48 ± 0.08	2.43	0.03	1.2	—
150	17.87	34.57	0.22 ± 0.01	2.25 ± 0.07	2.43	0.02	1.2	—
200	15.05	34.52	0.19 ± 0.02	2.37 ± 0.07	2.43	—	1.6	—
300	11.91	34.44	0.24 ± 0.02	2.30 ± 0.12	2.42	—	1.9	—
500	8.63	34.40	0.27 ± 0.01	2.37 ± 0.08	2.42	—	1.9	—
700	6.85	34.43	0.27 ± 0.01	2.49 ± 0.07	2.42	—	1.9	—
S504, 19°44′N, 117°36′E, 3096 m								
5	26.36	33.99	0.14 ± 0.01	1.87 ± 0.06	2.39	0.52	2.7	—
25	26.36	33.99	0.14 ± 0.02	1.73 ± 0.07	2.39	0.58	2.4	—
50	26.37	33.99	0.12 ± 0.01	2.15 ± 0.06	2.39	0.55	2.3	—
75	26.38	33.99	0.15 ± 0.01	2.02 ± 0.06	2.39	0.57	2.2	—
100	26.38	33.99	0.15 ± 0.01	2.21 ± 0.06	2.39	0.48	1.9	—
125	26.12	34.02	0.28 ± 0.01	2.19 ± 0.06	2.39	0.03	1.3	—
150	23.13	34.55	0.30 ± 0.02	2.35 ± 0.07	2.43	0.02	1.2	—
200	17.44	34.52	0.22 ± 0.02	2.69 ± 0.07	2.43	—	1.1	—
S503, 20°15′N, 117°00′E, 746 m								
5	26.57	33.76	0.14 ± 0.01	1.68 ± 0.06	2.37	0.41	2.7	—
25	26.58	33.76	0.15 ± 0.01	1.79 ± 0.06	2.37	0.50	3.0	—
50	26.52	33.90	0.16 ± 0.01	1.87 ± 0.06	2.38	0.47	2.3	—
75	26.64	34.09	0.27 ± 0.02	2.04 ± 0.06	2.40	0.18	1.3	—
100	24.08	34.28	0.23 ± 0.02	2.15 ± 0.06	2.41	0.05	1.1	—
125	21.75	34.52	0.28 ± 0.01	2.68 ± 0.08	2.43	0.03	1.0	—
150	19.07	34.49	0.27 ± 0.02	2.54 ± 0.07	2.42	0.02	1.7	—
S501, 20°57′N, 116°12′E, 324 m								
5	25.62	33.59	0.25 ± 0.01	1.97 ± 0.06	2.36	0.29	2.6	—
25	25.63	33.59	0.20 ± 0.02	1.97 ± 0.06	2.36	0.42	2.1	—
50	25.48	33.65	0.22 ± 0.01	2.24 ± 0.07	2.37	0.10	1.7	—
75	22.61	34.17	0.19 ± 0.01	2.33 ± 0.07	2.40	0.07	1.0	—
100	21.24	34.32	0.23 ± 0.01	2.36 ± 0.07	2.41	0.04	1.3	—
125	18.53	34.49	0.21 ± 0.01	2.39 ± 0.07	2.42	0.02	1.0	—
150	16.88	34.56	0.27 ± 0.02	2.42 ± 0.07	2.43	0.01	1.2	—
Winter (6 Jan to 30 Jan 2010)								
E603, 20°06′N, 112°54′E, 95 m								
5	24.05	33.92	0.24 ± 0.03	1.68 ± 0.06	2.38	0.57	4.2	0.20
25	24.05	33.92	0.26 ± 0.03	1.52 ± 0.06	2.38	0.54	3.5	0.22
50	23.87	33.91	0.30 ± 0.03	1.72 ± 0.06	2.38	0.39	3.0	0.15
75	22.90	34.02	0.24 ± 0.03	1.68 ± 0.06	2.39	0.11	1.5	0.21
E602, 20°30′N, 112°30′E, 78 m								
5	22.91	33.74	0.32 ± 0.03	1.29 ± 0.05	2.37	0.50	4.4	0.25
25	22.93	33.74	0.31 ± 0.03	1.31 ± 0.05	2.37	0.13	3.4	0.31
50	22.92	33.73	0.26 ± 0.03	0.88 ± 0.04	2.37	0.41	3.4	0.60
70	22.25	33.74	0.30 ± 0.03	0.88 ± 0.04	2.37	0.41	2.9	0.59
E601, 20°55′N, 112°06′E, 53 m								
5	21.41	33.72	0.33 ± 0.03	0.87 ± 0.05	2.37	1.16	4.6	0.41
15	21.41	33.72	0.31 ± 0.03	0.65 ± 0.04	2.37	0.74	3.7	0.50
25	21.35	33.73	0.22 ± 0.03	0.52 ± 0.04	2.37	0.42	3.0	0.67
45	21.93	33.75	0.21 ± 0.03	0.43 ± 0.04	2.37	0.34	2.9	0.93

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
QD02, 20°43′N, 111°00′E, 36 m								
5	20.51	33.64	0.18 ± 0.03	0.20 ± 0.04	2.37	0.37	6.3	1.2
15	20.52	33.64	0.19 ± 0.03	0.20 ± 0.04	2.37	0.95	—	1.6
25	20.51	33.64	0.10 ± 0.03	0.25 ± 0.04	2.37	—	—	1.6
E500a, 20°12′N, 111°27′E, 70 m								
5	22.68	33.79	0.29 ± 0.03	1.19 ± 0.05	2.38	0.73	3.3	0.19
25	22.68	33.79	0.24 ± 0.03	1.11 ± 0.05	2.38	0.50	3.9	0.23
30	22.67	33.75	0.19 ± 0.03	1.14 ± 0.05	2.37	0.81	5.1	0.27
60	21.60	33.76	0.20 ± 0.03	0.36 ± 0.04	2.37	0.28	3.8	1.7
E501a, 19°42′N, 111°54′E, 105 m								
5	24.10	33.87	0.26 ± 0.03	1.82 ± 0.06	2.38	0.46	2.4	0.06
25	24.10	33.87	0.25 ± 0.03	1.75 ± 0.06	2.38	0.49	2.4	0.09
50	24.11	33.87	0.24 ± 0.03	1.90 ± 0.06	2.38	0.37	2.2	0.23
75	24.07	33.86	0.30 ± 0.03	1.75 ± 0.06	2.38	0.31	1.9	0.15
90	22.77	33.77	0.43 ± 0.03	0.85 ± 0.05	2.37	—	2.7	0.34
E502a, 19°12′N, 112°21′E, 191 m								
5	24.07	33.92	0.46 ± 0.02	1.62 ± 0.06	2.39	0.46	2.8	0.16
25	24.08	33.92	0.36 ± 0.02	1.70 ± 0.06	2.39	0.58	2.7	0.13
50	24.08	33.91	0.41 ± 0.02	1.69 ± 0.06	2.38	0.58	2.7	0.15
75	23.23	34.06	0.28 ± 0.02	1.97 ± 0.06	2.39	0.10	1.3	0.09
100	22.20	34.37	0.34 ± 0.02	2.06 ± 0.07	2.42	0.05	0.9	0.13
125	20.47	34.42	0.34 ± 0.02	2.48 ± 0.07	2.42	0.02	0.8	0.07
150	18.65	24.52	0.40 ± 0.02	2.25 ± 0.07	2.43	0.01	0.8	0.11
E604, 19°45′N, 113°18′E, 186 m								
5	23.94	33.94	0.24 ± 0.02	1.70 ± 0.06	2.39	0.37	2.8	0.11
25	23.83	33.93	0.26 ± 0.02	1.67 ± 0.06	2.39	0.49	3.2	0.15
50	23.18	33.91	0.29 ± 0.02	1.67 ± 0.06	2.38	—	3.1	0.09
75	22.59	33.91	0.27 ± 0.02	1.70 ± 0.06	2.38	0.28	1.8	0.09
100	21.27	34.11	0.42 ± 0.02	1.63 ± 0.06	2.40	—	1.2	0.18
125	20.11	34.33	0.43 ± 0.02	1.81 ± 0.08	2.41	0.02	1.2	0.13
150	19.03	34.42	0.43 ± 0.03	2.14 ± 0.09	2.42	0.01	1.0	0.13
E605, 19°18′N, 113°42′E, 544 m								
5	24.60	33.79	0.15 ± 0.02	1.62 ± 0.06	2.38	0.20	2.2	0.08
25	24.57	33.80	0.34 ± 0.02	1.93 ± 0.07	2.38	0.17	2.1	0.09
50	24.52	33.91	0.29 ± 0.02	1.74 ± 0.07	2.38	0.35	2.3	0.07
75	24.26	34.14	0.31 ± 0.02	1.61 ± 0.06	2.40	0.11	2.0	0.12
100	21.44	34.16	0.27 ± 0.02	2.31 ± 0.07	2.40	0.05	0.9	0.05
125	19.44	34.56	0.26 ± 0.02	2.33 ± 0.09	2.43	0.02	0.9	0.05
150	17.25	34.57	0.28 ± 0.02	2.44 ± 0.09	2.43	0.00	0.8	0.05
E607, 18°30′N, 114°30′E, 3581 m								
5	24.51	33.87	0.43 ± 0.02	1.69 ± 0.06	2.38	0.50	3.1	0.09
25	24.53	33.87	0.42 ± 0.02	1.65 ± 0.06	2.38	0.50	2.6	0.18
50	24.47	33.86	0.45 ± 0.02	1.83 ± 0.06	2.38	0.47	2.4	0.17
75	22.33	34.16	0.28 ± 0.02	2.21 ± 0.07	2.40	0.31	1.2	0.09
100	20.11	34.41	0.28 ± 0.02	2.42 ± 0.07	2.42	0.05	0.8	0.04
125	17.90	34.56	0.30 ± 0.02	2.31 ± 0.09	2.43	0.01	0.8	0.06
150	16.01	34.60	0.35 ± 0.03	2.52 ± 0.09	2.43	0.00	0.8	0.07
SEATS, 18°00′N, 116°00′E, 3846 m								
5	24.82	33.72	0.35 ± 0.02	1.87 ± 0.07	2.37	—	2.5	0.07
25	24.62	33.74	0.36 ± 0.02	1.94 ± 0.07	2.37	—	1.9	0.09
50	24.49	33.86	0.45 ± 0.02	1.50 ± 0.07	2.38	—	2.0	0.10
75	22.75	34.28	0.36 ± 0.02	2.12 ± 0.07	2.41	—	1.7	0.07
100	20.24	34.52	0.38 ± 0.02	2.41 ± 0.08	2.43	—	1.0	0.06
125	18.27	34.54	0.37 ± 0.02	2.43 ± 0.08	2.43	—	0.6	0.05
150	17.07	34.59	0.31 ± 0.02	1.95 ± 0.07	2.43	—	0.8	0.05
200	14.80	34.52	0.23 ± 0.02	2.59 ± 0.09	2.43	—	0.5	0.06
300	11.27	34.41	0.27 ± 0.02	2.42 ± 0.08	2.42	—	1.1	0.08
500	8.04	34.42	0.25 ± 0.02	2.52 ± 0.08	2.42	—	1.2	0.09
A10, 19°16′N, 116°40′E, 2814 m								
5	24.12	33.80	0.41 ± 0.02	1.60 ± 0.07	2.38	0.72	2.9	0.10
25	24.12	33.80	0.37 ± 0.02	2.01 ± 0.07	2.38	0.76	3.3	0.11
50	24.12	33.82	0.39 ± 0.02	1.80 ± 0.07	2.38	0.66	3.0	0.10
75	22.85	34.29	0.38 ± 0.02	2.09 ± 0.08	2.41	0.17	2.6	0.11
100	21.00	34.41	0.33 ± 0.02	2.29 ± 0.08	2.42	0.18	0.9	0.06
125	20.44	34.49	0.32 ± 0.02	2.40 ± 0.08	2.43	0.03	1.3	0.07
150	18.26	34.65	0.35 ± 0.02	2.34 ± 0.08	2.44	0.01	0.7	0.07
200	14.92	34.40	0.34 ± 0.02	2.57 ± 0.09	2.42	0.01	1.5	0.10

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_P$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
300	11.60	34.44	0.28 ± 0.02	2.35 ± 0.08	2.42	—	0.9	0.07
500	8.76	34.41	0.31 ± 0.02	2.09 ± 0.08	2.42	—	0.7	0.07
A0, 19°54′N, 116°01′E, 1445 m								
5	23.40	34.04	0.24 ± 0.02	1.72 ± 0.08	2.39	—	2.6	0.08
25	23.40	34.04	0.26 ± 0.02	1.69 ± 0.07	2.39	—	2.5	0.10
50	23.41	34.04	0.26 ± 0.02	1.96 ± 0.07	2.39	—	2.3	0.09
75	22.85	34.24	0.24 ± 0.02	1.85 ± 0.08	2.41	—	2.0	0.08
100	22.21	34.55	0.27 ± 0.02	2.10 ± 0.08	2.43	—	1.6	0.06
125	20.65	34.65	0.31 ± 0.02	2.47 ± 0.08	2.44	—	1.2	0.05
150	18.79	34.56	0.31 ± 0.02	2.17 ± 0.09	2.43	—	1.4	0.09
A1, 20°10′N, 115°46′E, 812 m								
5	23.23	34.07	0.30 ± 0.02	1.71 ± 0.08	2.40	0.59	3.0	0.11
25	23.24	34.07	0.37 ± 0.02	1.90 ± 0.07	2.40	0.58	3.2	0.13
50	23.25	34.07	0.35 ± 0.02	1.83 ± 0.07	2.40	0.23	3.6	0.16
75	22.66	34.42	0.32 ± 0.02	2.08 ± 0.08	2.42	0.21	3.1	0.09
100	21.89	34.49	0.30 ± 0.02	2.40 ± 0.08	2.42	0.06	1.6	0.10
125	17.99	34.59	0.34 ± 0.02	2.37 ± 0.08	2.43	0.04	1.8	0.17
150	18.83	34.56	0.31 ± 0.02	2.35 ± 0.08	2.43	0.02	2.1	0.06
200	14.03	34.62	0.31 ± 0.02	2.43 ± 0.08	2.43	0.00	2.3	0.09
300	11.05	34.43	0.26 ± 0.02	2.11 ± 0.07	2.42	—	1.6	0.07
500	7.87	34.43	0.34 ± 0.02	2.35 ± 0.08	2.42	—	1.6	0.07
A2, 20°30′N, 115°29′E, 400 m								
5	22.67	34.17	0.31 ± 0.02	1.67 ± 0.07	2.40	0.61	3.0	0.14
25	22.67	34.16	0.40 ± 0.02	1.75 ± 0.08	2.40	0.59	3.8	0.15
50	22.59	34.26	0.38 ± 0.03	1.84 ± 0.07	2.41	0.76	3.4	0.15
75	22.55	34.30	0.41 ± 0.02	1.66 ± 0.07	2.41	0.71	3.3	0.24
100	20.41	34.56	0.39 ± 0.03	2.09 ± 0.08	2.43	0.03	1.2	0.09
125	19.19	34.66	0.30 ± 0.02	2.32 ± 0.09	2.44	0.02	0.9	0.10
150	17.96	34.67	0.26 ± 0.02	2.21 ± 0.08	2.44	0.01	0.9	0.11
A4, 20°45′N, 115°15′E, 190 m								
5	22.77	34.49	0.25 ± 0.02	1.71 ± 0.08	2.43	0.59	2.4	0.13
25	22.76	34.49	0.22 ± 0.02	1.86 ± 0.08	2.43	0.54	2.2	0.08
50	22.38	34.51	0.31 ± 0.02	1.94 ± 0.08	2.43	0.66	2.6	0.17
75	22.14	34.48	0.30 ± 0.02	1.82 ± 0.08	2.42	0.55	2.6	0.15
100	22.22	34.50	0.37 ± 0.03	1.87 ± 0.08	2.43	0.25	1.9	0.32
125	18.79	34.55	0.56 ± 0.03	1.99 ± 0.09	2.43	0.07	1.4	0.21
150	17.18	34.61	0.46 ± 0.03	2.28 ± 0.10	2.43	0.01	1.2	0.18
A5, 21°00′N, 115°00′E, 104 m								
5	22.60	34.41	0.19 ± 0.05	2.02 ± 0.09	2.42	0.56	4.3	0.13
25	22.52	34.41	0.20 ± 0.05	1.74 ± 0.08	2.42	0.75	3.6	0.14
50	22.48	34.45	0.19 ± 0.04	1.87 ± 0.09	2.42	0.70	3.0	0.15
75	22.39	34.42	0.42 ± 0.04	1.76 ± 0.08	2.42	0.59	3.3	0.15
95	22.38	34.41	0.28 ± 0.05	1.62 ± 0.08	2.42	0.51	2.6	0.25
A6, 21°16′N, 114°44′E, 87 m								
5	21.26	34.16	0.27 ± 0.05	1.22 ± 0.07	2.40	0.37	3.6	0.17
25	21.26	34.15	0.28 ± 0.04	1.09 ± 0.07	2.40	0.24	4.3	0.23
50	21.22	34.15	0.22 ± 0.04	1.01 ± 0.07	2.40	0.41	3.4	0.17
75	21.26	34.17	0.21 ± 0.04	0.87 ± 0.07	2.40	0.30	2.2	0.24
85	34.23	34.23	0.39 ± 0.06	0.74 ± 0.07	2.41	0.16	2.8	0.51
A7, 21°30′N, 114°30′E, 74 m								
5	20.99	34.28	0.21 ± 0.04	0.88 ± 0.07	2.41	0.32	3.1	0.21
25	21.00	34.28	0.10 ± 0.04	0.83 ± 0.07	2.41	0.46	2.3	0.28
50	20.15	34.14	0.24 ± 0.04	0.70 ± 0.07	2.40	0.56	3.5	1.2
68	20.14	34.10	0.33 ± 0.06	0.65 ± 0.07	2.40	1.06	14.5	0.89
S103, 21°39′N, 115°24′E, 106 m								
5	22.11	34.38	0.23 ± 0.04	1.95 ± 0.09	2.42	0.48	4.0	0.13
25	21.89	34.36	0.34 ± 0.04	1.57 ± 0.08	2.42	0.44	2.6	0.16
50	21.83	34.35	0.26 ± 0.04	1.61 ± 0.08	2.42	0.58	2.7	0.19
75	21.72	34.35	0.34 ± 0.04	1.38 ± 0.08	2.42	0.27	2.9	0.22
100	20.78	34.34	0.41 ± 0.06	0.72 ± 0.07	2.41	0.16	3.1	0.71
S501a, 21°00′N, 116°10′E, 314 m								
5	23.28	34.10	0.43 ± 0.03	1.88 ± 0.09	2.40	0.74	3.9	0.15
25	23.11	34.13	0.49 ± 0.03	1.73 ± 0.09	2.40	0.68	2.7	0.13
50	22.83	34.24	0.49 ± 0.03	1.81 ± 0.09	2.41	0.33	2.0	0.14
75	22.31	34.55	0.44 ± 0.03	2.25 ± 0.09	2.43	0.07	1.5	0.11
100	19.25	34.57	0.35 ± 0.03	2.35 ± 0.10	2.43	0.03	1.1	0.10

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_p$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
125	18.27	34.59	0.40 ± 0.03	2.49 ± 0.10	2.43	0.03	1.4	0.06
150	17.84	34.62	0.34 ± 0.03	2.23 ± 0.19	2.43	0.01	1.1	0.08
S503, 20°15′N, 117°00′E, 739 m								
5	24.12	33.74	0.35 ± 0.03	1.92 ± 0.10	2.37	0.71	3.2	0.15
25	24.01	33.74	0.39 ± 0.03	1.94 ± 0.09	2.37	0.79	3.1	0.11
50	24.00	33.74	0.40 ± 0.03	2.03 ± 0.09	2.37	0.80	2.4	0.09
75	23.95	33.75	0.33 ± 0.03	1.82 ± 0.11	2.37	0.39	1.7	0.07
100	22.31	34.39	0.29 ± 0.03	2.12 ± 0.12	2.42	0.10	1.3	0.07
125	19.64	34.68	0.30 ± 0.03	2.32 ± 0.11	2.44	0.03	1.6	0.06
150	18.67	34.69	0.39 ± 0.03	2.54 ± 0.11	2.44	0.02	1.1	0.07
S504, 19°44′N, 117°36′E, 3098 m								
5	24.23	33.77	0.48 ± 0.03	1.76 ± 0.09	2.37	0.62	3.6	0.14
25	24.24	33.77	0.41 ± 0.03	1.82 ± 0.09	2.37	0.42	5.3	0.13
50	24.22	33.77	0.53 ± 0.03	1.91 ± 0.09	2.37	0.43	3.5	0.13
75	24.26	33.77	0.42 ± 0.03	1.61 ± 0.09	2.37	0.29	2.2	0.10
100	19.93	33.46	0.40 ± 0.03	2.16 ± 0.09	2.42	0.14	1.1	0.06
125	18.14	34.56	0.34 ± 0.03	2.52 ± 0.10	2.43	0.03	1.0	0.07
150	17.42	34.58	0.35 ± 0.03	2.43 ± 0.10	2.43	0.01	1.1	0.06
E406, 18°45′N, 120°00′E, 2746 m								
5	25.79	33.57	0.25 ± 0.02	1.61 ± 0.09	2.36	0.32	2.7	0.11
25	25.54	33.58	0.27 ± 0.03	1.84 ± 0.10	2.43	0.37	2.8	0.11
50	20.05	34.54	0.42 ± 0.02	2.50 ± 0.10	2.43	0.55	3.2	0.15
75	18.30	34.48	0.35 ± 0.02	2.31 ± 0.09	2.42	0.18	1.5	0.07
100	17.32	34.51	0.38 ± 0.03	2.44 ± 0.10	2.43	0.06	1.4	0.04
125	16.62	34.53	0.36 ± 0.02	2.71 ± 0.10	2.43	0.03	1.2	0.05
150	15.67	34.54	0.30 ± 0.03	2.73 ± 0.10	2.43	0.02	1.2	0.08
E405, 19°30′N, 120°00′E, 4265 m								
5	24.53	33.82	0.47 ± 0.03	1.74 ± 0.08	2.38	0.95	5.3	0.22
25	24.54	33.80	0.47 ± 0.03	1.76 ± 0.09	2.38	0.81	5.3	0.26
50	21.95	34.35	0.37 ± 0.03	1.80 ± 0.08	2.41	0.63	4.1	0.24
75	18.16	34.47	0.39 ± 0.03	2.75 ± 0.10	2.42	0.22	1.8	0.11
100	16.41	34.57	0.30 ± 0.03	2.50 ± 0.10	2.43	0.06	1.0	0.08
125	15.39	34.56	0.32 ± 0.02	2.33 ± 0.10	2.43	0.03	1.4	0.07
150	13.97	34.55	0.23 ± 0.03	2.26 ± 0.09	2.43	0.02	1.1	0.08
E404, 20°00′N, 120°00′E, 3608 m								
5	24.94	33.57	0.53 ± 0.03	1.68 ± 0.11	2.36	0.74	4.2	0.18
25	24.94	33.58	0.61 ± 0.03	1.75 ± 0.10	2.36	0.79	3.7	0.17
50	19.18	33.67	0.43 ± 0.03	2.63 ± 0.10	2.37	0.31	1.8	0.11
75	17.81	34.26	0.53 ± 0.03	2.71 ± 0.10	2.41	0.12	1.3	0.08
100	16.77	34.43	0.49 ± 0.03	2.37 ± 0.10	2.42	0.04	1.3	0.08
125	15.29	34.50	0.47 ± 0.03	2.31 ± 0.10	2.43	0.02	1.4	0.10
150	14.54	34.52	0.44 ± 0.03	2.26 ± 0.09	2.43	0.01	1.3	0.09
E403, 20°30′N, 120°00′E, 3378 m								
5	24.87	33.77	0.36 ± 0.03	1.60 ± 0.09	2.37	0.94	5.0	0.18
25	24.58	33.77	0.34 ± 0.03	2.53 ± 0.10	2.37	0.79	4.4	0.20
50	23.32	34.11	0.27 ± 0.02	1.66 ± 0.08	2.40	0.34	2.1	0.11
75	22.47	34.44	0.30± 0.03	1.56 ± 0.08	2.42	0.14	1.6	0.10
100	20.71	34.51	0.37 ± 0.03	2.37 ± 0.10	2.43	0.07	1.5	0.12
125	18.64	34.52	0.30 ± 0.03	2.37 ± 0.10	2.43	0.03	1.4	0.07
150	17.43	34.52	0.35 ± 0.03	2.62 ± 0.11	2.43	0.02	1.2	0.11
E402, 21°00′N, 120°00′E, 3635 m								
5	23.88	34.43	0.32 ± 0.03	1.75 ± 0.09	2.42	0.62	3.6	0.14
25	23.93	34.43	0.36 ± 0.03	2.06 ± 0.10	2.42	0.59	2.9	0.14
50	24.00	34.48	0.38 ± 0.03	2.36 ± 0.11	2.42	0.54	2.7	0.20
75	22.71	34.45	0.49 ± 0.03	2.26 ± 0.10	2.42	0.06	1.9	0.14
100	20.84	34.43	0.34 ± 0.03	2.50 ± 0.12	2.42	0.03	1.4	0.09
125	19.05	34.54	0.33 ± 0.03	2.45 ± 0.11	2.43	0.03	1.6	0.08
150	18.52	34.53	0.38 ± 0.03	2.18 ± 0.09	2.43	0.02	1.3	0.14
E401, 21°30′N, 120°00′E, 2957 m								
5	24.72	34.47	0.33 ± 0.03	2.03 ± 0.10	2.42	0.53	3.1	0.13
25	24.75	34.47	0.29 ± 0.02	1.99 ± 0.10	2.42	0.52	6.3	0.11
50	24.55	34.64	0.39 ± 0.03	2.14 ± 0.09	2.44	0.15	2.4	0.11
75	19.99	34.47	0.34 ± 0.02	2.39 ± 0.10	2.42	0.09	1.1	0.08
100	18.57	34.56	0.36 ± 0.03	2.47 ± 0.11	2.43	0.04	1.2	0.09
125	17.03	34.67	0.33 ± 0.03	2.41 ± 0.09	2.44	0.03	1.0	0.06
150	16.06	34.60	0.30 ± 0.02	2.59 ± 0.10	2.43	0.01	0.9	0.06

Table A1. (continued)

Depth (m)	T (°C)	S (PSU)	$^{234}Th_P$ (dpm L^{-1})	$^{234}Th_T$ (dpm L^{-1})	^{238}U (dpm L^{-1})	Chl-a (mg m^{-3})	POC (μmol L^{-1})	TSM (mg L^{-1})
E400, 22°12′N, 119°52′E, 1249 m								
5	25.32	34.67	0.27 ± 0.03	2.31 ± 0.11	2.44	0.19	3.0	0.13
25	25.24	34.67	0.33 ± 0.02	2.08 ± 0.10	2.44	0.20	1.3	0.10
50	25.23	34.67	0.31 ± 0.02	2.28 ± 0.11	2.44	0.26	1.8	0.06
75	25.22	34.67	0.36 ± 0.02	2.13 ± 0.10	2.44	0.35	1.4	0.08
100	23.80	34.64	0.21 ± 0.02	2.86 ± 0.11	2.44	0.31	1.6	0.06
125	20.44	34.68	0.35 ± 0.03	2.33 ± 0.10	2.44	0.07	1.1	0.07
150	18.52	34.70	0.34 ± 0.03	2.51 ± 0.11	2.44	0.02	0.9	0.07

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