

## **Biogeochemical database in the north Pacific**

by

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The northwestern North Pacific is the terminal of the Great Conveyor Belt. Owing to the upwelling of aged and nutrients-rich deepwater, concentrations of surface nutrients are much higher than other oceans resulting high biological activity. It has been reported that the capability of biological activity to uptake atmospheric CO<sub>2</sub> and transport it vertically into the ocean interior (namely “the biological pump”) in this area works very efficiently to uptake atmospheric CO<sub>2</sub> based on large seasonal amplitude of nutrients and pCO<sub>2</sub>. However comprehensive study and seasonal study for the biological pump had not been conducted. MIO and MBCRT of RIGC have been conducting the time-series study for the biological pump with research vessels, mainly R/V MIRAI, and mooring systems with automatic sampler and sensors since the late 1990's. Using these data, characteristics of the biological pump in the northwestern North Pacific have been reported. However used data in previous reports is a handful of data collected. We compiled biogeochemical data relating the biological pump that have been collected by our group as much as possible.

This database consists of the following data sets associated deeply with biological pump:

1. Time-series moored Sediment Trap data set
2. Primary Productivity data set
3. Phytoplankton Pigments data set
4. Natural Radio Nuclides data set

On the other hand, we have also measured dissolved chemical species with high quality. These data are compiled in the K2 and KNOT hydrographic data sets (to see <http://www.godac.jamstec.go.jp/k2/index.html>).

We hope these data sets are helpful and / or useful for many scientists all over the world.

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### 3. Phytoplankton pigments

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Phytoplankton pigments were determined on board ship by both conventional fluorometry and high-performance liquid chromatography (HPLC). The fluorometric determination was made using a fluorometer (model 10-AU; Turner Designs Inc.) by the acidification method (Holm-Hansen et al., 1965) and the non-acidification method (Welschmeyer, 1994). Quantification of phytoplankton pigments by HPLC (Waters Corp.) was based on the C8 column method using pyridine in the mobile phase (Zapata et al., 2000).

For fluorometric determination, water samples (0.5 L) were filtered through a Whatman GF/F filter (25 mm diameter), and pigments were extracted immediately in N,N-dimethylformamide at  $-20^{\circ}\text{C}$  for 24 h (Suzuki and Ishimaru, 1990). Size-fractionated samples were obtained by sequential filtration from a 1-L water sample through 10  $\mu\text{m}$ , 3  $\mu\text{m}$ , 1  $\mu\text{m}$  and GF/F filters for fluorometric determination. For HPLC, 3 to 5 liter of water samples were filtered through a Whatman GF/F filter (47 mm diameter), then dehydrated by vacuum-drying treatment (Furuya et al., 1998) and extracted in N,N-dimethylformamide with the same way of fluorometric determination. Analytical conditions of fluorometric determination were listed in table 1. Size-fractionated samples were applied only “non-acidification” method.

The fluorometer is calibrated with a commercially available chlorophyll *a* standard (Anacystis nidulans, Sigma Chemical Co.). The HPLC system is calibrated with the following pigment standards obtained commercially (chlorophyll *a*, chlorophyll *b*, chlorophyll *c3*, divinyl Chlorophyll *a*, pheophytin *a*, pheophorbide *a*, peridinin, fucoxanthin, 19'-butanoyloxyfucoxanthin, 19'-hexanoyloxyfucoxanthin, prasinoxanthin, diadinoxanthin, alloxanthin from Sigma Chemical Co. and DHI Co.). The solvents of pigment standards were displaced to N,N-dimethylformamide. The concentrations were determined with spectrophotometer by using its extinction coefficient of N,N-dimethylformamide for chlorophyll *a* and chlorophyll *b*, but other chlorophylls were used the extinction coefficient of 90% acetone, and of 100% ethanol for carotenoides.

## References

- Holm-Hansen, O., Lorenzen, C.J., Holmes, R.W., strickland, J.D.H., 1965. Fluorometric determination of chlorophyll. J. Cons. Cons. Int. Explor. Mer. 30, 3-15.
- Welschmeyer, N.A., 1994. Fluorometric analysis of chlorophyll *a* in the presence of chlorophyll *b* and pheopigments. Limnol. Oceanogr. 39, 1985-1992.
- Zapata, M., Rodríguez, F., Garrido, J.L., 2000. Separation of chlorophylls and carotenoids from marine phytoplankton: a new HPLC method using a reversed phase C8 column and pyridine-containing mobile phases. Mar. Ecol. Prog. Ser. 195 : 29-45
- Suzuki, R., Ishimaru, T., 1990. An improved method for the determination of phytoplankton chlorophyll using N, N-dimethylformamide. J. Oceanogr. 46, 190-194.
- Furuya, K., Hayashi, M., Yabushita, Y., 1998. HPLC determination of phytoplankton pigments using N,N-dimethylformamide. J. Oceanogr. 54 (2), 199-203.

Table 1. Analytical conditions of “Non-acidification method” and “Acidification method” for chlorophyll *a* with Turner Designs fluorometer (10-AU-005).

	Non-acidification method	Acidification method
Excitation filter (nm)	436	340-500
Emission filter (nm)	680	>665
Lamp	Blue Mercury Vapor	Daylight White

Table 2. Explanation of data file

Column Heading Mnemonic	Units Mnemonic	Comments
CODE		Cruise code
STNNBR		Station number
CASTNO		Cast number
DATE		Cast date(UTC)
TIME	UTC	Cast time (UTC)
LATITUDE	DEG	LATITUDE
LONGITUDE	DEG	LONGITUDE
CTDPRS	DBAR	Pressure
CHLORA	mg m <sup>-3</sup>	Chlorophyll a (acidification method)
1CHLORA	mg m <sup>-3</sup>	Chlorophyll a (acidification method): replicate
CHLWELSH	mg m <sup>-3</sup>	Chlorophyll a (non-acidification method)
1CHLWEL	mg m <sup>-3</sup>	Chlorophyll a (non-acidification method): replicate
>10µm	mg m <sup>-3</sup>	Size-fractionated chlorophyll a (non-acidification method): >10µm
3-10µm	mg m <sup>-3</sup>	Size-fractionated chlorophyll a (non-acidification method): 3-10µm
1-3µm	mg m <sup>-3</sup>	Size-fractionated chlorophyll a (non-acidification method): 1-3µm
<1µm	mg m <sup>-3</sup>	Size-fractionated chlorophyll a (non-acidification method): <1µm
CHLAHPLC	mg m <sup>-3</sup>	Chlorophyll a (HPLC method)
CHLC3	mg m <sup>-3</sup>	Chlorophyll c3 (HPLC method)
PERID	mg m <sup>-3</sup>	Peridinin (HPLC method)
PHIDEA	mg m <sup>-3</sup>	Pheophorbide a (HPLC method)
BUTFUCO	mg m <sup>-3</sup>	19'-butanoyloxyfucoxanthin (HPLC method)
FUCO	mg m <sup>-3</sup>	Fucoxanthin (HPLC method)

PRAS	mg m <sup>-3</sup>	Prasinoxanthin (HPLC method)
HEXFUCO	mg m <sup>-3</sup>	19'-hexanoyloxyfucoxanthin (HPLC method)
DIADINO	mg m <sup>-3</sup>	Diadinoxanthin (HPLC method)
ALLO	mg m <sup>-3</sup>	Alloxanthin (HPLC method)
CHLB	mg m <sup>-3</sup>	Chlorophyll b (HPLC method)
DCHLA	mg m <sup>-3</sup>	Divinyl chlorophyll a (HPLC method)
PHYTINA	mg m <sup>-3</sup>	Pheophytin a (HPLC method)