



# **An International Time-Series Methods Workshop: Improving Communication and Building Consensus**

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## Value of Marine Biogeochemical Time-Series

- Established **multidisciplinary observational platforms** with ongoing field and process studies, modeling efforts, etc.
- Provide **ship-based** and **moored** observations
- Provide opportunities for **calibration and validation** of autonomous measurements
- Provide **long, temporally resolved datasets** needed to monitor ocean biogeochemistry and ecosystem change
- Comparison of data across time-series also provides opportunity to **obtain a broader spatial perspective of ocean change**



Contents lists available at SciVerse ScienceDirect

## Deep-Sea Research II

journal homepage: [www.elsevier.com/locate/dsr2](http://www.elsevier.com/locate/dsr2)

“Developing confidence that measurements conducted at different sites are intercomparable demands that these programs continue to regularly participate in community-wide efforts directed toward standardizing methodologies and analyses.”

### WORKSHOP OBJECTIVES

- Obtain community input on HOT, BATS, and CARIACO time-series sites
- Synthesize highlights of ongoing research at these sites and discuss future research directions



## Workshop Details

**Timing and Venue:** November 28-30, 2012, Bermuda Institute of Ocean Sciences

**Objective:** To review current shipboard biogeochemical time-series sampling and analytical protocols

**Participants:** Technical and scientific staff from 33 shipboard ocean time-series sites (17 countries represented)

### **Format:**

**Plenary talks** on scientific value of and logistical challenges facing ocean time-series

**Working groups** focused on sampling order and sampling and analytical protocols for 9 sets of biogeochemical parameters

**Group discussions** on potential activities and experiments to improve internal consistency and data comparability across time-series



## Biogeochemical Parameters

**Pigments** - Chlorophyll *a* and others

**In line (bow intake) measurements** – T, S,  $p\text{CO}_2$ , pH, DIC, fluorescence, oxygen, etc.

**CTD parameters and discrete calibrations** – T, S, fluorescence, oxygen, beam attenuation

**Inorganic macro- and micronutrients** –  $\text{NO}_3$ ,  $\text{NO}_2^-$ ,  $\text{NH}_4$ ,  $\text{PO}_4$ ,  $\text{SiO}_4$ , Fe (including low level methods for N and P species)

**Biomass** – Bacteria, viruses, phytoplankton (micro-/nano-/pico-), zooplankton

**Inorganic carbon parameters** – DIC, TA, pH, discrete  $p\text{CO}_2$ , computations

**Biological rates** – Primary and bacterial production

**Trap fluxes** – Collection methods, sample processing, data reporting, etc.

**Organic matter** – C, N, P (dissolved and particulate fractions)



## Workshop Outcomes

- Global compilation of measurements and methods used at shipboard biogeochemical time-series sites
- *Eos* meeting report and full workshop report
- Permanent website and email list to support a global shipboard biogeochemical time-series network

# Global Time-Series Compilation

	REPRESENTATIVE	LOCATION	DURATION	FREQUENCY	METHODS INFORMATION	DATA ACCESS
<b>SOUTH PACIFIC</b>						
<b>Munida</b>	Kim Currie	Surface transect from 45.77° - 45.84° S, 170.22° - 171.54° E	1998-	6 cruises/yr		
<b>IMARPE (Callao)</b>	Jesús Ledesma	12.1° S - 77.2° W (Peru Shelf) and Transect 12.1 - 12.2 ° S - 77.1 - 78.0 °W	20 years	4cruises/yr	<a href="http://www.imarpe.pe/imarpe/index.php?id_seccion=101080201000000000000000">http://www.imarpe.pe/imarpe/index.php?id_seccion=101080201000000000000000</a>	<a href="http://www.imarpe.pe/imarpe/index.php?id_seccion=101380000000000000000000">http://www.imarpe.pe/imarpe/index.php?id_seccion=101380000000000000000000</a>
<b>COPAS</b>	Fabian Tapia	36.5° S; 73.1° W (Chile)	2002-	monthly-seasonal cruises		
<b>Eastern Australia</b>	Tom Trull	IMOS National Reference Station Network	variable, see pdf Long term sites: Maria: 1944-2005, Hacking: 1941-2004, Rottneest: 1951-2001	quarterly-monthly (varies by station)	<a href="http://imos.org.au/fileadmin/user_upload/shared/ANMN/IMOS_NRS_BIOGEOCHEMICAL_SAMPLIN/IMOS_NRS_BIOGEOCHEMICAL_OPERATIONS_PRACTICAL_HANDBOOK.v2.pdf">http://imos.org.au/fileadmin/user_upload/shared/ANMN/IMOS_NRS_BIOGEOCHEMICAL_SAMPLIN/IMOS_NRS_BIOGEOCHEMICAL_OPERATIONS_PRACTICAL_HANDBOOK.v2.pdf</a>	
<b>NORTH PACIFIC</b>						
<b>Japan (JMA)</b>	Masao Ishii, Yusuke Takatani	Transects along 137°E from 5-34°N and 165°E from 10-50°N	137°E transect: 1994- (1994-2002: irregular, 2003- : regular) 165°E transect: 2003-	137°E transect: 4 cruises/yr, 165°E transect: 2 cruises/yr		<a href="http://www.data.kishou.go.jp/kaiyou/db/vessel_obs/data-report/html/ship/ship_e.php">http://www.data.kishou.go.jp/kaiyou/db/vessel_obs/data-report/html/ship/ship_e.php</a>
<b>Japan (JAMSTEC)</b>	Makio Honda	NW Pacific S1 (30°N, 145°E); K2 (47°N, 160°E), KNOT (44°N, 155°E)	S1: 2010-present; K2: 2001-present with some hiatuses; KNOT: 1997-present with hiatuses;	1-3 cruises/yr	<a href="http://www.jamstec.go.jp/rigc/e/ebcrp/mbcrt/index.html">http://www.jamstec.go.jp/rigc/e/ebcrp/mbcrt/index.html</a>	
<b>Ensenada</b>	Eduardo Santamaria-del-Angel	31.2° N, 116.0° W (Mexico)	2007-	6 cruises/yr		
<b>CalCOFI and CCE-LTER</b>	Ralf Goericke	southern and central California	1949-	4 cruises/yr	<a href="http://calcofi.org/reference/ccmethods">http://calcofi.org/reference/ccmethods</a> , <a href="http://cce.lternet.edu/data/methods/">http://cce.lternet.edu/data/methods/</a>	
<b>MBARI</b>	Marguerite Blum	Monterey Bay, CA	1989-	cruises ev. 2-3 weeks		
<b>SPOT</b>	Diane Kim	San Pedro Basin, CA	1998-	monthly cruises		
<b>HOT</b>	Karin Bjorkman, Matt Church	22.8° N, 158.0° W	1987-	10 cruises/yr	<a href="http://hahana.soest.hawaii.edu/hot/protocols/protocols.html">http://hahana.soest.hawaii.edu/hot/protocols/protocols.html</a>	

# Global Time-Series Compilation

	INORGANIC MACRO- AND MICRONUTRIENTS									
	Nitrate + Nitrite	Nitrite	Low Level Nitrate + Nitrite	Ammonium	Soluble Reactive Phosphorus (SRP)	Low Level SRP	Silicate	Biogenic (particulate) Si	Fe	NOTES
<b>SOUTH PACIFIC</b>										
Munida	AA <sup>2</sup>				AA <sup>2</sup>		AA <sup>2</sup>			
IMARPE (Callao)	M	M			M		M			
COPAS	AA*			F	AA*		AA*			
Eastern Australia	x	x			x		x			
<b>NORTH PACIFIC</b>										
Japan (JMA)	AA	AA			AA		AA			
Japan (JAMSTEC)	AA*			AA*	AA*		AA*			
Ensenada	AA*			AA*	AA*		AA*			
CalCOFI and CCE-LTER	AA*			AA*	AA*		AA*			
MBARI	AA▼	AA▼		F	AA▼		AA▼			
SPOT	AA*			F	AA*		AA*	AA*		
HOT	AA*		Chemiluminescence		AA*	MAGIC	AA*	AA*	x	
Line P	x			x	x		x			
Station Papa	x			x	x		x			
NEPTUNE Canada	x			x			x			
Santa Barbara Channel - Plumes and Blooms	x				x		x	x		

# METADATA = POWER

## METHODS USED

### Biomass/pigments

M = microscopy

FC = flow cytometry

F(T) = Fluorescence (Turner)

F = Fluorescence

DW = dry weight

A = Acoustic determination

B = Backscatter

NT = Net Tows

EF = Epifluorescence

### Dissolved Organic Methods

HTC = High temperature combustion

MAGIC = MAGIC DOP method

### Particulate Organic

#### Methods

EA = Elemental Analyzer

HTC = High temperature combustion

### CTD/discrete

W = Winkler titration

GP = Guildline Portasal

GA = Guildline Autosol

M = Minisal

### DIC

C = Coulometer

P = Potentiometric

S = Spectrophotometric

### Nutrients

AA = Autoanalyzer

F = Fluorescence

M = manual spectrophotometry

### Traps

MCI = Mclane Traps

DT = Drifting trap

### In Line

IR =  $p$  CO<sub>2</sub> Infrared analysis

### Rates

<sup>14</sup>C = Radiocarbon

<sup>13</sup>C = Carbon 13

O<sub>2</sub> = Oxygen uptake

H3L = Leucine Incorporation

## NOTES

♣ Filters are NOT acid-fumed prior to running for POC/PN

♠ Dry weight is size-fractionated

### Chl *a* Fluorescence

⌘ Acetone Extraction

⌘ Methanol Extraction

⌘ Ethanol Extraction

### Autoanalyzers

\*continuous segmented flow (e.g., Technicon, Seal, Skalar, Quattro, etc.)

\*\*flow injection analysis (e.g., Lachat)

▼ rapid flow analyzer (e.g., Alpkem)

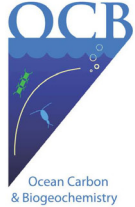

◇ micro-segmented flow (e.g., Astoria)

# Workshop Report

Global Intercomparability  
in a  
**CHANGING OCEAN**

**Global Intercomparability in a Changing Ocean: An International Time-Series Methods Workshop**






November 28-30, 2012  
(Bermuda Institute of Ocean Sciences, St. George's, Bermuda)  
<http://www.whoi.edu/website/TS-workshop>

**Recommended citation:**  
Lorenzoni, L., Benway, H. M. (Editors), 2013. Report of *Global intercomparability in a changing ocean: An international time-series methods workshop*, November 28-30, 2012, Bermuda Institute of Ocean Sciences (OCB) Program and International Ocean Carbon Coordination Project (IOCCP), 60 pp.

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- Tiered (best/good/acceptable) method recommendations
- Detailed sampling and analytical guidelines (standardization, QA/QC protocols, data reporting, nomenclature, emerging technology, etc.)
- Experiments and intercomparison activities
- Funding and capacity building considerations
- Prioritized measurement recommendations for global change questions (ocean acidification, marine ecosystem shifts)

# Global Time-Series Network: Coordination and Communication

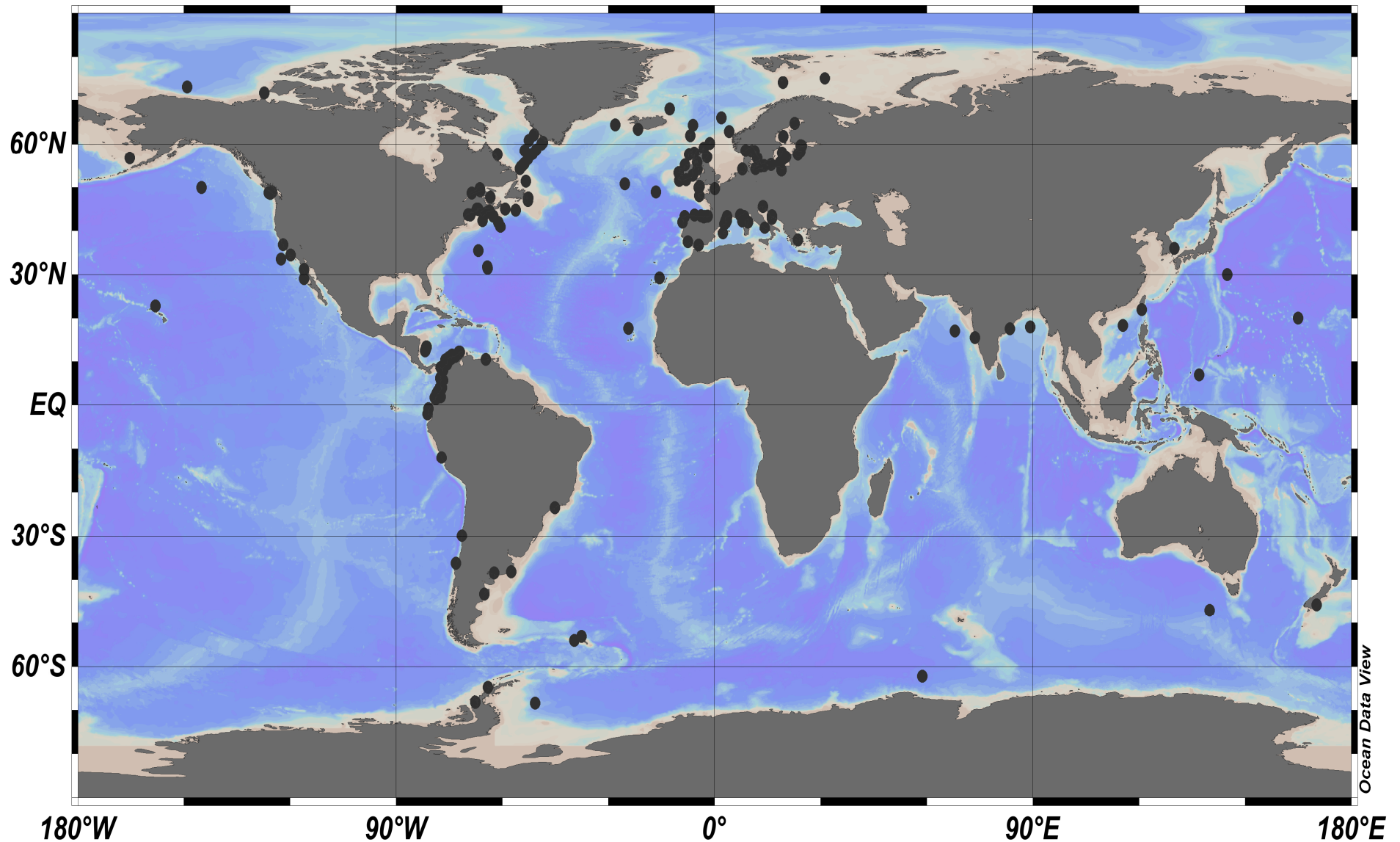
**Website - <http://www.whoi.edu/website/TS-network/>**

- Regularly updated time-series information (parameters measured, methods used, data access, etc.)
- Scientific highlights from time-series
- Relevant publications and reports, including time-series bibliographies
- Methods manuals

**Email list - [TS\\_network@whoi.edu](mailto:TS_network@whoi.edu)**

- Relevant meetings and workshops
- Employment, funding, and cruise opportunities
- Scientific publications and outcomes
- Experiments and intercomparison activities
- Instrument calibration opportunities

# Global Time-Series Network: *A work in progress...*



# Supporting a Global Ocean Acidification Observing Network

