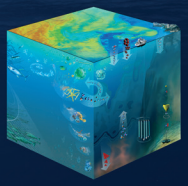
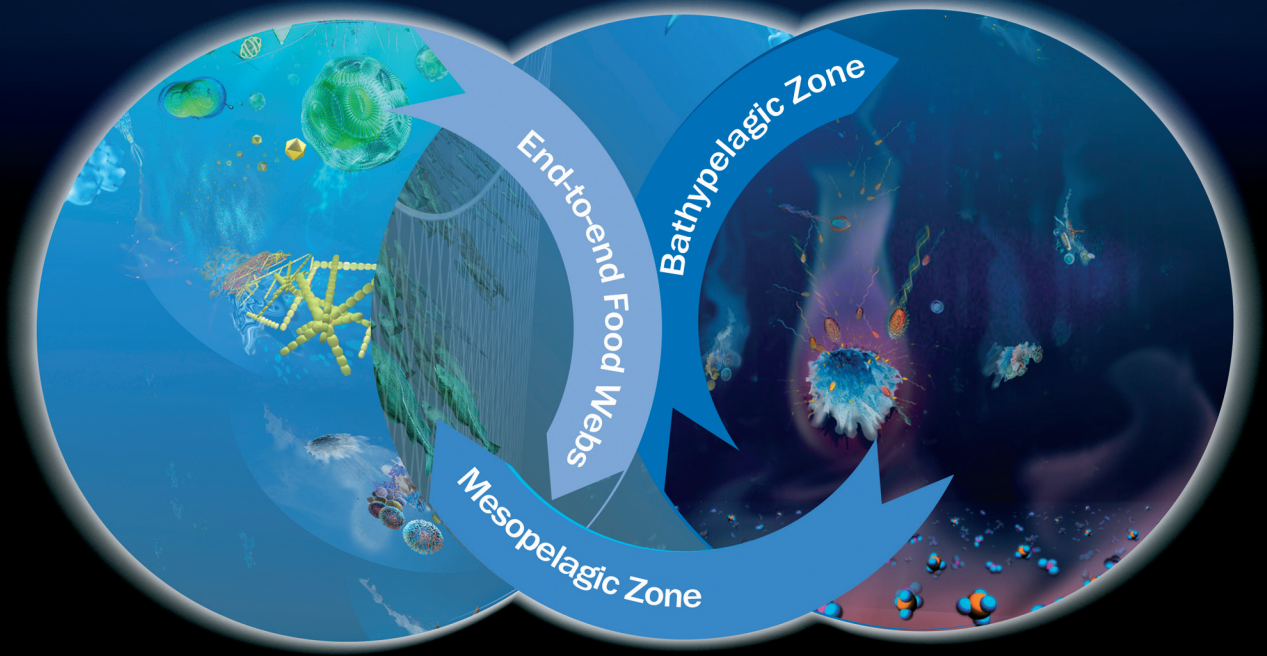
IMBER IMBIZO

Integrating biogeochemistry and ecosystems in a changing ocean



9-13 Nov 08 — Miami (FL.USA)



Conveners: Julie Hall - Dennis Hansell - Gerhard Herndl
Coleen Moloney - Wajih Naqvi - Mike Roman - Hiroaki Saito
Sharon Smith - Debbie Steinberg - Jing Zhang

IMBER IMBiZO

Integrating biogeochemistry and ecosystems in a changing ocean

9-13 November 2008
Miami, FL, United States

Produced by: IMBER International Project Office

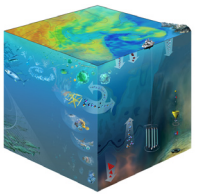
Printed by: Doug Tyrrell at International Assets / www.iadigitalprint.com

Front cover illustration by: Sébastien Hervé / www.sebastien-herve.com/

The beaded lanyards are supplied through AfriSkills (http://www.afriskills.co.za/), based in Durban, S. Africa. They are made by groups of women living in rural communities in KwaZulu Natal (one of the provinces of S. Africa), and provide a very important source of income for them.

http://www.imber.info

Contents



AM

	Sunday 9	Monday 10	Tuesday 11	Wednesday 12	Thursday 13
7:30 - 8:30		**Registration** Crystal Ballroom			
8:30 - 08:45		**Welcome plenary session** (Crystall Ballroom)	**Workshop break out session**	**Workshop break out session**	**Plenary session: final presentations, discussions and writing** Crystal Ballroom
8:45 - 9:00		**Hiroaki Saito** *End to end foodwebs*			
9:00 - 9:15					
9:15 - 9:30					
9:30 - 9:45		**Richard Lampitt** *Mesopelagic*			
9:45 - 10:00					
10:00 - 10:15				**Plenary on data integraton** **Raymond Pollard** Crystal Ballroom	
10:15 - 10:30		Coffee break - Palm terrace			
10:30 - 10:45			Coffee break - Palm terrace	Coffee break - Palm terrace	Coffee break - Palm terrace
10:45 - 11:00		**Dave Karl** *Bathypelagic*			
11:00 - 11:15					
11:15 - 11:30					
11:30 - 11:45		**Workshop break out session**	**Workshop break out session**	**Plenary reports from each workshop** Crystal Ballroom	**Plenary session: final presentations, discussions and writing** Crystal Ballroom
11:45 - 12:00					
12:00 - 12:15	**Registration** Crystal Ballroom				
12:15 - 12:30					
12:30 - 13:00		Lunch - Palm terrace	Lunch - Palm terrace	Lunch - Palm terrace	Lunch - Palm terrace

PM

	Sunday 9	Monday 10	Tuesday 11	Wednesday 12	Thursday 13
13:00 - 13:30	**BEER workshop** Kentia 3	Lunch	Lunch	Lunch	Lunch
13:30 - 14:00		**Workshop break out session**	**Workshop break out session**	**Workshop break out session**	**Writing session for chairs, rapporteurs, etc...** Breakout rooms: Kentia 1, 2 & 3, Alexander 1 & 2, Boardroom 2
14:00 - 14:30					
14:30 - 15:00					
15:00 - 15:30	Coffee break				***Break out session rooms*** **E2E**: Kentia 3 & Alexander 2 **Meso**: Kentia 1 & 2 **Bathy**: Alexander 1 & Boardroom 2
15:30 - 16:00	**BEER workshop** Kentia 3	Coffee break			
16:00 - 16:30					
16:30 - 17:00		**Workshop break out session**			
17:00 - 17:30	**Registration** Crystal Ballroom		**Joint poster session and refreshments** Palm terrace	**Joint poster session and refreshments** Palm terrace	
17:30 - 18:00					
18:00 - 18:30		**Ice breaker** Palm terrace			
18:30 - 19:00					
19:00 - 19:30				*BANQUET Rusty Pelican*	
19:30 - 20:00					
20:00 - 22:30					

Buses will leave hotel at 19:30 and restaurant at 23:00

Welcome to Miami

The University of Miami's Rosenstiel School is pleased to welcome you to Miami to participate in the first IGBP/SCOR IMBER (Integrated Marine Biogeochemistry and Ecosystem Research) IMBIZO (gathering) on November 9-14, 2008. The focus of this meeting is "Integrating biogeochemistry and ecosystems in a changing ocean". Understanding the role of the ocean in climate change and the impact of climate change on the marine environment is critically important to the future of the Earth.

As we have seen from the most recent IPCC reports, we are committed to an experiment of increasing CO_2 on our planet Earth. The projected increases in upper ocean temperatures and pH will affect oceanic biogeochemical processes and food webs in complex and not well-understood ways. Understanding these impacts and changes will be critical to sustaining oceanic ecosystems in this period of change and providing options for policy makers.

South Florida, with its large urban population, low elevation, and fragile ecosystems could be the example for climate change in this hemisphere. So, we are very interested in results of this meeting from both intellectual and personal perspectives. Miami, the portal for immigrants, trade and services from Central and South America is a prototype for the next generation of cities in North America, and, an opportunity for meeting participants to engage in this century's "melting pot" experience. Miami is a new city age-wise (it is barely a century old), a new city due to rapid immigration, and, a new city due to rapid development. We invite you to enjoy the energy of South Florida, be your interest in the environment, South Beach, or the arts. Its future is inextricably linked to the quality of its subtropical ecosystems, which are increasingly impacted by natural and anthropogenic stressors.

IMBER IMBIZO is an opportunity to improve our knowledge of how marine ecosystems are and might respond to climate change. We look forward to meeting with many of you as you participate in this very important meeting. Miami invites you all to contribute to this dialogue.

Otis Brown
Dean, The Rosenstiel School of Marine and Atmospheric Science, University of Miami

Scientific organizing committee:

Julie Hall (NIWA, New-Zealand)
Dennis Hansell (RSMAS, United States of America)
Gerhard Herndl (Royal Netherlands Institute for Sea Research, The Netherlands)
Coleen Moloney (University of Cape Town, South Africa)
Wajih Naqvi (National Institute of Oceanography, India)
Mike Roman (University of Maryland, Center for Environmental Science, United States of America)
Hiroaki Saito (Fisheries Research Agency, Japan)
Sharon Smith (RSMAS, United States of America)
Debbie Steinberg (Virginia Institute of Marine Science, United States of America)
Jing Zhang (East China Normal University, Shanghai, China)

Local organizing Committee:
RSMAS, University of Miami, United States of America

Sandrine Apelbaum
Sidney Hartley
Julie Hollenbeck
Sharon Smith

IMBER International Project Office:
European Institute for Marine Research, University of Western Brittany, France

Sophie Beauvais
Elena Fily
Sylvie Roy

Aim & format of the conference

IMBER is an IGBP-SCOR project focussing on ocean biogeochemical cycles and ecosystems research. The goal of IMBER is “to investigate the sensitivity of marine biogeochemical cycles and ecosystems to global change, on time scales ranging from years to decades”.

To achieve this goal we need to identify key interactions between marine biogeochemical cycles and ecosystems, and assess how these interactions respond to complex natural and anthropogenic forcings.

The first IMBER IMBIZO* will contribute to this goal by reviewing current knowledge and identifying key questions for future research on, End to end marine food webs, and the biogeochemistry, ecosystems and their interactions in both the mesopelagic and bathypelagic ocean.

The IMBIZO’s innovative format of three concurrent and interacting workshops with joint plenary and posters sessions will provide a forum for stimulating discussion between interdisciplinary experts and encourage the linkage between biogeochemistry and ecosystem research.

The IMBER IMBIZO will also provide an opportunity for junior and senior scientists to participate in a half-day interactive workshop entitled «BEER: The secret to a successful project».

Each of the workshops will prepare a special journal issue containing synthesis and primary research papers resulting from the workshop contributions and discussions.

The first IMBER IMBIZO interdisciplinary workshops will be held in parallel in order to facilitate interactions between scientists from a range of disciplines to discuss current knowledge and future research directions in specific topics of interest.

Ecological and Biogeochemical Interactions in End to End Food Webs

(co-chaired by Coleen Moloney and Michael Roman)

The consequences of global change for plant and animal communities can be direct and/or indirect. Indirect effects are likely to be complex, with many possible responses and different degrees of response to different combinations of factors. Perturbations can propagate both up and down a food web hierarchy, affecting living organisms and feeding back to biogeochemical cycles. Marine food webs should be considered from end to end (from viruses to top predators) as integrated systems within changing physical and chemical environments. Food web research has tended to be fragmented among different research communities, focusing on either the low trophic levels (phytoplankton and the microbial food web), intermediate trophic levels (zooplankton and fish), or high trophic levels (top predators).

**IMBIZO is a Zulu word for meeting or gathering*

The aims of this workshop are to bring together scientists studying these disparate communities to make progress in linking biogeochemistry and food web dynamics from end to end. This will be addressed primarily through presentations of ongoing work (oral and poster), and through a series of small, parallel workshop discussion sessions.

Deep Ocean Realms – the Mesopelagic and the Bathypelagic

The deep sea, comprising the meso- and bathypelagic zones, is the least explored system on Earth. Considerably less is known about biological and biogeochemical processes and their rates in this dark realm than in the euphotic zone–the prior focus of several major interdisciplinary studies. The biological pump connects surface processes to the deepest ocean layers, where biological processes occur at low rates and with unique metabolisms. The deep ocean is characterized by significant decomposition, recycling, and repackaging of particulate and dissolved organic matter. Thus the interplay between biological and geochemical processes in this zone can have significant effects on the magnitude of the biological pump, which regulates in part atmospheric CO_2 and, hence, climate.

The central aim of the workshops on the mesopelagic and bathypelagic zones is to gather the interdisciplinary expertise required to identify what is known about the systems in aggregate, and to identify and pursue outstanding uncertainties. Through a combination of presentations and discussion groups, we seek to identify the current state of our knowledge about deep-ocean food-web processes, particle flux and dynamics, and biogeochemical cycling, and to identify gaps in our knowledge to be pursued in future research programs. The cross section of disciplines required to advance our understanding in the deep ocean includes biogeochemistry, organic geochemistry, microbial and plankton ecology, trace element and isotope geochemistry, genomics, technology, and modeling. The knowledge advanced at the workshops will be reported as publications in a peer reviewed journal. Those publications will highlight to the science community our knowledge, our uncertainties, and directions required for advanced study.

Ecological and Biogeochemical Interactions in the Mesopelagic Zone

(co-chaired by Debbie Steinberg and Hiroaki Saito)

Most of the biogenic material exported from the euphotic zone is remineralized within the mesopelagic zone. The structure of the planktonic food web exerts control on vertical transport, cycling, and composition of this particulate and dissolved organic matter, but there are still many questions concerning how microbial and metazoan diversity is linked to function in this zone. In addition, ecological and biogeochemical approaches to estimating remineralization rates need to be reconciled. While important processes regulating organic matter transformations and remineralization in the mesopelagic can be tightly coupled with the euphotic zone, the time and space scales of these processes are different in the mesopelagic, which is critical to predicting the ability of the biological pump to sequester C in the deep ocean. Also explored will be regional comparisons in food-web structure and biogeochemistry, and potential responses of the system to environmental change.

Biogeochemistry and Microbial Dynamics in the Bathypelagic Zone

(co-chaired by Dennis Hansell and Gerhard Herndl)

With residence times in the bathypelagic (taken here to be inclusive of all ocean depths >1000 m) ranging from centennial to millennial scales temporally, and global scales spatially, this deep zone is only slowly ventilated and circulated. Biogeochemical signals in the bathypelagic are thus integrative of unique ecosystem and metabolic processes occurring slowly over very long periods. Biological processes in the deepest ocean layers are intimately tied to particle dynamics and microbial food webs, much of which remain to be characterized. These processes, while occurring at low rates, can play important roles in global marine elemental cycling, with feedbacks to the climate system. Changes in ocean stratification, for example, will elicit changes in the ecosystem functioning of the deepest layers. Slowly occurring processes, which may occur throughout the ocean depths, are hidden from view by the strong impacts of more dynamic processes in the upper ocean. Signals for these same processes will emerge in the deepest layers where vertical and horizontal inputs are greatly reduced, thus exposing more cryptic metabolic and biophysical processes.

IMBER: Integrated Marine Biogeochemistry and Ecosystem Research
IMBER project's goal is to investigate the sensitivity of marine biogeochemical cycles and ecosystems to global change, on time scales ranging from years to decade. IMBER is co-sponsored by IGBP (International Geosphere-Biosphere Programme and SCOR (see below)

SCOR: Scientific Committee on Oceanic Research
SCOR activities focus on promoting international cooperation in planning and conducting oceanographic research, and solving methodological and conceptual problems that hinder research. Scientists from 35 nations participate in SCOR working groups and steering committees.

RSMAS: Rosenstiel School of Marine & Atmospheric Science
The Rosenstiel School of Marine and Atmospheric Science at the University of Miami is one of the premier oceanographic research and education institutions in the world. As the only subtropical institute of its kind in the continental United States, its more than 100 Ph.D. faculty members, 190 graduate students, and more than 250 research support staff comprise the academic community. Through excellence in applied and basic marine and atmospheric research, the Rosenstiel School sheds light on today's most pressing environmental issues, including fisheries, oceans and human health, hurricane warnings, climate change, and coral reefs.

Sponsors

EUR-OCEANS is a Network of Excellence co-funded under the European Commission's 6th Framework Programme for Research and Technological Development (FP6).
The overall networking objective of EUR-OCEANS is to achieve lasting integration of European research organisations on global change and pelagic marine ecosystems and the relevant scientific disciplines.

The **OCB** (Ocean Carbon Biogeohemistry) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners.

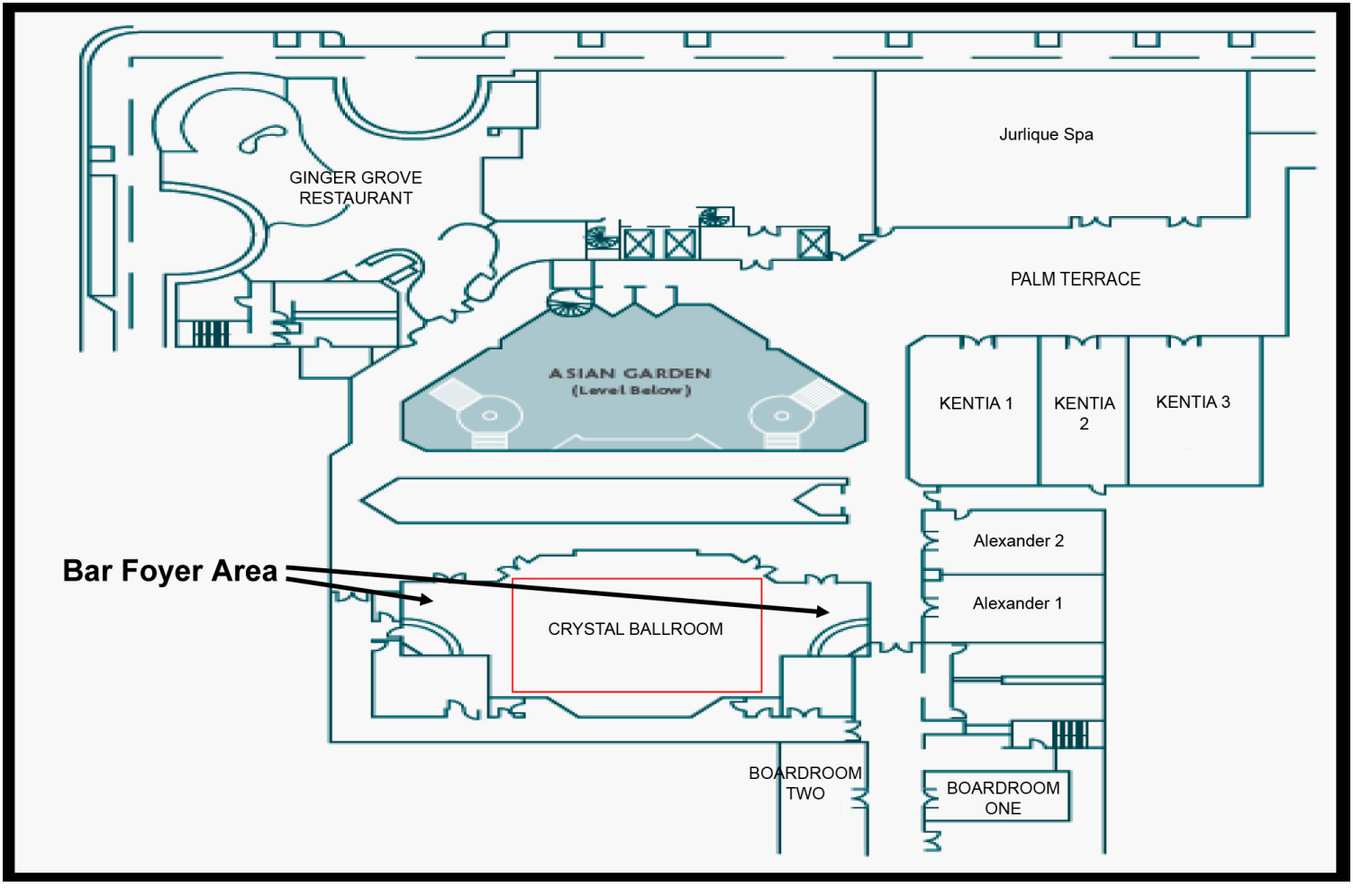
GLOBEC (Global Ocean Ecosystem Dynamics) was initiated by SCOR and the IOC of UNESCO in 1991, to understand how global change will affect the abundance, diversity and productivity of marine populations comprising a major component of oceanic ecosystems. The aim of GLOBEC is to advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the responses of the marine ecosystem to global change.

The **Oceans and Human Health Center** at the University of Miami Rosenstiel School brings together medical and ocean researchers to investigate how humans affect oceans and how oceans affect humans in tropical and subtropical environments.

The **Centre National de la Recherche Scientifique** (National Center for Scientific Research) is a government-funded research organization, under the administrative authority of France's Ministry of Research. As the largest fundamental research organization in Europe, CNRS carries out research in all fields of knowledge, through its six research departments: 1) Mathematics, Physics, Earth Sciences and Astronomy, 2) Chemistry, 3) Life Sciences, 4) Humanities and Social Sciences, 5) Environmental Sciences and Sustainable Development, 6) Information and Engineering Sciences and Technologies.

The University of Western Brittany (Université de Bretagne Occidentale) is a French University educating more than 20 000 students in multidisciplinary fields such as sciences, economy, law, medecine, litterature etc... The UBO cooperates with european and international educational institutes and hosts the IMBER International Project Office. Marine Sciences are a central activity of UBO bringing together research and teaching in marine biology, chemistry, physics and gesosicences in an institute, the European Institute for Marine Studies (IUEM).

Mayfair hotel map



Social events

Ice breaker **Monday 10th, 17:00 - 20:00**

There will be an Ice Breaker at the Palm Terrace of the May Fair Hotel and Spa from 17:00 to 19:00 on Monday 10th. Finger food and refreshments will be served. All participants are invited to join.

IMBIZO Dinner **Wednesday 12th, 19:30 - 22:30**

The IMBIZO banquet will be held at the Rusty Pelican Restaurant on Wednesday 12th from 20:30 to 22:30. Buses will be leaving the May Fair Hotel at 19:30 sharp to take participants to the restaurant. A cash bar will be available at the Rusty Pelican for participants one hour before the banquet. Buses will be departing from the Rusty Pelican for the return to the hotel at 23:00.

Prizes and Awards
A financial support of 500 USD will be awarded to the best young scientist poster presentation.

Miami city guide

Time zone
GMT/UTC -5 (Eastern Standard Time)

Currency
Name: US Dollar
Symbol: US$
Universal Currency Converter:
http://www.xe.com/ucc/

Miami International Airport (MIA)
http://www.miami-airport.com/

Changing your money
Major credit and debit cards, including the Visa Cash Passport Card, are widely accepted. You can also access your bank account using US ATMs which are ubiquitous. Travellers cheques are easily converted to cash at any bank. You will probably need to take your passport along to prove your identity.

Bank of America: http://www.coconutgrove.com/affiliatedetail.cfm?ID=335
Biscayne Bank: http://www.coconutgrove.com/affiliatedetail.cfm?ID=336
Coconut Grove Bank: http://www.coconutgrove.com/affiliatedetail.cfm?ID=571

Transport
Ground transportation: http://www.miami-airport.com/html/ground_transportation.html
Bus and Train services: http://www.miami-airport.com/html/bus_and_train_service.html
Car rental service: http://www.miami-airport.com/html/car_rentals.html
Taxi and shuttle service: http://www.miami-airport.com/html/taxi_and_shuttle_service.html

Taxicabs and SuperShuttle (305) 871 2000) vans are available only on the ARRIVAL (ground) level at Miami International Airport, outside of the baggage claim areas. In the daytime, the price from the airport to Coconut Grove is around $25 USD.

Useful numbers
Country dialing code: +1
Telephone area code: 305
Police emergency number: 911
Police in Coconut Grove: (305) 579 6111
Non-emergency call center: 311
Coconut Grove Pharmacy 3206 Grand Avenue: (305) 444 0640
MayFair Hotel & Spa: (305) 441 0000

Weather
Average temperatures in November:
Average High: °C 25/27 (°F 81/84)
Average low: °C 18/20 (°F 64/68)
Because of the humidity, Miami heat can often feel a lot hotter than the temperature reading suggests, but ocean breezes help clear the sultry air.

Attractions in Coconut Grove and nearby, within walking distance from the Hotel

The Barnacle Historic State Park & Museum (http://www.floridastateparks.org/theBarnacle/ParkSummary.cfm). 8 minute walk from hotel. The oldest home in Miami Dade County at its original location on Biscayne Bay. Built by Commodore Munroe, it gives a glimpse of Miami's rich past. The grounds can be rented for private parties.

Peacock & Kennedy Parks – both parks face Biscayne Bay and are 1 block away from the hotel. Boat rentals are available for fishing trips in marinas at Kennedy Park.

CocoWalk Shopping Mall – An open air retail and entertainment complex with shops,
outdoor cafes, trendy nightclubs, a 16 screen theatre and 'street entertainment."
Shopping options are not limited to this mall – there are dozens of shops a few steps away from the hotel.

Attractions located near Coconut Grove

Villa Viscaya http://www.vizcayamuseum.com, Tel. (305) 579 2708 - 2 miles from the hotel, in Coconut Grove. This 70 room Italian Renaissance mansion with 10 acres of formal gardens on Biscayne Bay is a must see attraction in Miami.

Venetian Pool http://www.venetianpool.com, Tel. (305) 460 5306 - 4 miles from the hotel - historic pool formed from a coral rock quarry in 1923. This 820,000 gallon pool is fed with cool spring water daily and features two waterfalls, coral caves and grottos.

Village of Merrick Park http://www.villageofmerrickpark.com/html/index19.asp , Tel. (305) 529 0200 - 2 miles from the hotel - the new high-end shopping center in Miami including a Nordstrom and a Neiman Marcus as anchor stores

Fairchild Tropical Gardens http://www.fairchildgarden.org/index.cfm , Tel. (305) 667 1651 – 6 miles from the hotel. 83-acre garden paradise of tropical plants from around the world and featuring the largest collection of palm trees in America.

Restaurants and bars / nights clubs in Miami

Within walking distance of the hotel:

Restaurant	Type	website / tel.
Ginger Grove Restaurant	Asian Fusion cuisine	Tel. (305) 441 0000
Jaguar	Peruvian/ Mexican / Latin Grill	www.jaguarspot.com Tel. (305) 444-0216
Cristabelle's Quarter Restaurant	Cajun & Creole food	http://www.christabellesquarter.com/ Tel. (786) 517-5299
Le Bouchon du Grove	French bistro	Tel. (305) 448-6060
Casa Nostra	Northern Italian	Tel. (305) 447-9222
Chart house	Continental	http://www.chart-house.com/ Tel. (305) 856-9741
Greenstreet café	Mediterranean	http://www.chart-house.com/ Tel. (305) 444 0244
Monty's	Seafood / raw bar - very casual	Tel. (305) 854 5316
Bice Bistro	Steak house	http://www.bice.ws/ Tel. (305) 443 1770
Bar	**Type**	**website / tel.**
Cefalo's	Italian w/ wine bar	www.cefaloswine.com Tel. (305) 971-2400
Ginger Grove Lounge		Tel. (305) 441-0000
Mr. Moe's		Tel. (305) 442-1114
Firkin & Friar		Tel. (305) 443-2774
Improv Comedy Club & Café		http://www.miamiimprov.com/v2/ Tel. (305) 441 8200
Nightclub – Oxygen Lounge		http://www.oxygenlounge.biz/ Tel. (305) 476 0202

Further links
http://miami.citysearch.com/
http://www.coconutgrove.com/index.cfm
Coconut Grove Interactive map: http://www.miamimaps.com/grovemap.html

Meeting logistics

Registration/information desk
The registration/information desk is located at the entrance of the Crystall Ballroom. Your conference booklet and name badge will be available at the registration desk as of Sunday afternoon. There will be three dedicated registration sessions on Sunday Noon, Sunday night from 17:00 - 19:00 and Monday morning from 7:30 - 8:30. The registration/information desk will be staffed at all time if you require further assistance during the meeting.

Catering
Please note that breakfasts are not provided by the conference.
Coffee breaks and buffet lunches will be provided by the conference in the Palm Terrace area.

Rooms
Plenary sessions will be held in the Crystall Ballroom.
Workshop breakout sessions will be located as follows:
BEER workshop: Kentia 3
End to end workshop: Room Kentia 3 & Alexander 2
Mesopelagic workshop: Room Kentia 1 & 2
Bathypelagic workshop: Alexander 1 & Boardroom 2

Internet access and business facility
WiFi (wireless) connection is available at different areas of the hotel including the lobby & lobby bar areas, the upcoming restaurant, Palm Terrace, Asian Garden and sleeping rooms on a complimentary basis. It is not available in the pool area.

Delegate assistance
The local organizers are setting up a business office in the Boardroom 1 where printing facility will be available for participants.

Poster instructions

Posters will be setup on November 10th, starting at lunch time and available for viewing until November 13th. However, participants will be asked to stand by their poster during one of the two poster sessions.
The following group of participants will be presenting their posters on **Tuesday 11th**:

Aguilera Victor
Aluwihare Lihini
Anderson Thomas
Beaupre Steven
Bollens Steve
Carlson Craig
Currie Bronwen
Dam H.G.
Dehairs Frank
Dutkiewicz Stephanie
Fonda Serena
Gogou Alexandra
Hofmann Eileen
Jarre Astrid
Leinen Margaret
Liu Min
Llopiz Joel
Malisana elisa
Miquel Juan Carlos
Nieto-Cid Mar
Niiranen Susa
Nishioka Jun
Prakash Satya
Pu Xinming
Ragueneau Olivier
Robison Bruce
Shannon Lynne J
Tamburini Christian
Toennesson Kajsa
Wishner Karen
Yamashita Youhei
Zhang Wuchang

Group of participants presenting their posters on **Wednesday 12th**:

Alonso Ivan
Baltar Federico
Bochandsky Alexander
Buesseler Ken
Carlotti Francois
Chen Jianfang
Condon Robert
DeMaster David
Dunne John
Fukuda Hideki
Hansman Roberta
Harris Lora
Hernández-León Santiago
Hood Raleigh
Koslow Tony
Libralato Simone
Ma Hongguang
Meador Travis Meador
Moloney Coleen
Nagata Toshi
Naqvi Wajih
Oka Akira
PAN Jin-Fen
QUEGUINER Bernard
Reinthaler Thomas
Salihoglu Baris
Sohrin Rumi
Solidoro Cosimo
Wilson Stephanie
XIAO Tian
Yamada Namiha
Zhang Jing
Zuo Tao

Posters should not exceed 36 inches x 36 inches (91 cm x 91 cm).
Size requirements must be strictly adhered to, so they fit within the space assigned to them. If your poster exceeds these specifications, it may be subject to removal by the organizing committee.

Posters will be set up in three different areas of the venue and organized by workshops as follow:
End to end workshop: Kentia 3 walls
Mesopelagic workshop: Kentia 1 & 2 walls
Bathypelagic workshop: Palm Terrace Poster boards

The organizers will be available to help you locate your poster area and provide supplies needed to place your poster on the poster boards. You will be expected to stand by your poster during the poster session.

BEER: The secret to a successful project

Chairs: Raymond Pollard and Todd O'Brien

Organising committee

Raymond Pollard (raymond.pollard@gmail.com)
Chair, IMBER Data Management Committee
Physical and multi-disciplinary oceanographer, observationalist (retired)
National Oceanography Centre Southampton, UK

Todd O'Brien (Todd.OBrien@noaa.gov)
Project manager for COPEPOD (Coastal & Oceanic Plankton Ecology, Production & Observation Database)
National Marine Fisheries Service, NOAA , USA

Sophie Beauvais (sophie.beauvais@univ-brest.fr)
IMBER Deputy Executive Officer – Data Liaison Officer
European Institute for Marine Studies, IUEM/UBO, France

Aim of the workshop

How can we tell that climate is changing? Answer: because we have data going back a century and more - and because someone made the effort to record, calibrate and then preserve these data long after the project (and funding) were gone. Nobody questions that scientists must publish, so why is organizing data the poor relation? IMBER seeks to change this ethos and recommends that all projects appoint a Data Integration Scientist, emphasising the benefits to both the project investigators and the appointee. This short workshop addresses those benefits, and we seek your input to the discussion.
BEER - "Being Efficient and Environmentally Responsible"

Meeting room: the BEER workshop will take place in room **Kentia 3**

Sunday 9 November
13:00 - 17:00

Workshop and discussion

Kentia 3 (Theater)

12:00 - 13:00	Registration
13:00 - 13:45	**Being a data scientist is fun!**
	Raymond Pollard
13:45 - 14:30	**Has data management gone mainstream?**
	Robert Groman Biological and Chemical Oceanography Data Management Office, Woods Hole Oceanographic Institution, USA
14:30 - 15:15	**Data integration made easier**
	Gwen Moncoiffé Biological Oceanographer and Data Scientist, British Oceanographic Data Center, UK
15:15 - 15:30	Coffee break
15:30 - 16:00	**Better data, better science!**
	Todd O'Brien
16:00 - 17:00	**Discussion session**
	Are you convinced? How can we help?

Hotel Bar

17:00 - 18:30	Beer after BEER

HAS DATA MANAGEMENT GONE MAINSTREAM?
Groman R.C.

In order to make use of data, information about how the data were collected and processed (part of what some people call metadata) must be collected and made available. Properly dealing with metadata during the data's collection, processing, and archiving phases will enable more people to effectively use the data for other purposes. The "old practice" of keeping one's data in one's desk drawer (or now on a personal computer) for exclusive use is giving way to the recognition that data are a valuable resource, and their subsequent use by others increases their quality and value, especially when combined with other data sets. In addition, agencies funding research projects with public funds are now mandating that the data are made publicly available. This presentation reviews some basic concepts of data management, and introduces the Biological and Chemical Oceanography Data Management Office (BCO-DMO), funded by the National Science Foundation to provide researchers from NSF's Ocean Biology and Ocean Chemistry programs with a no cost option to make their data publicly available.

Oral Presentation

DATA INTEGRATION MADE EASIER
Moncoiffé G.

As most environmental scientists will know collating data sets can be time-consuming, cumbersome and prone to errors. Even when working with your own data, how often did you wish you had taken time to label your data files and columns more clearly? How often have you had to re-check essential QC or processing steps to ensure that the data were fit for purpose simply because you could not remember what had been done to them? These issues become even more important when sharing data. Even if data are well managed and organised, integration could still be made easier by following a number of basic rules.
Focusing on data from oceanographic cruises and data types relevant to IMBER, this presentation will review basic data management steps that can be carried out at the individual level, at the cruise level, and at the project level to ensure the data collected are quickly and easily shared and integrated. The aim is to focus on practical issues and to offer a non-technical overview of existing resources and recommended best practices. The content should be useful to principal investigators, data collectors and anybody interested in taking on a role as a data integration scientist. Reference will be made to the IMBER Data Integration Cookbook. In the ensuing discussion, workshop participants will be invited to comment and complete the overview by providing additional tips or recommendations, particularly in areas not generally covered by conventional guidelines including incubation/manipulation experiments, molecular techniques, and other novel or developing technologies.

Oral Presentation

BETTER DATA, BETTER SCIENCE!
O'Brien T.D.

Whether you are a data provider or a data user, the quality and usability of your data are crucial in determining the extent to which these data can be readily applied and trusted by yourself and others. The quality of a data set goes beyond the state of its numeric values, relying also on the comprehensiveness of the descriptive data that summarizes exactly how these data were sampled and processed (i.e. the "metadata"). These metadata are especially important when compiling data from multiple sources and methodologies (e.g. to build a database of an ocean or region), where the most common cause of error is due more to mistranslation or misunderstanding of the data type than from bad data values.
This talk presents an overview of common data translation and data value errors to "look out for", then presents an array of simple to advanced methods for quickly detecting these errors in a variety of parameter types ranging from temperature to zooplankton. In addition to quickly catching human or equipment errors, these types of checks may also help with the early detection of changes in the hydrographic or biological environment, an instance in which diligent data stewardship can lead to new discoveries.
Ultimately, ensuring the quality of the data being contributed or compiled improves the quality of the science and studies that will rely on these data.

Oral Presentation

BEING A DATA SCIENTIST IS FUN!
Pollard R.

Data management and writing papers are both essential parts of a researcher's job. So why do we do one to the best of our ability and skimp the other? We seek to show the benefits, for both senior and junior researchers, of spending time and money on data tasks. SCOR is considering how recognition might be obtained for Data Publication, using (say) digital object identifiers (DOIs) that can be referenced and incorporated in your CV. This talk discusses the value of being/having a Data Scientist on a cruise or project to help document and manage the data being collected. Being a Data Scientist will take time, sure, but you will learn a huge amount by working closely with other researchers, and you might even be paid. Why is it FUN? Because the inquiring mind you have as a researcher makes you interested and excited to learn what other researchers are doing. You learn interpersonal skills too if you are to support the Project Leader as well as helping and encouraging other PIs to document and back up their data. And the final project data set will be in good shape to be reinterpreted in the light of subsequent experiments.

Oral Presentation

Ecological and Biogeochemical Interactions in End to End Food Webs

Chairs: Coleen Moloney and Mike Roman

Organizing Committee

Coleen Moloney (South Africa)
Mike Roman (USA)
Bob Cowen (USA)
Roger Harris (United Kingdom)
Michio Kishi (Japan)
Olivier Maury (France)
Eugene Murphy (United Kingdom)
Mike St John (Germany)
Qisheng Tang (China)

Invited speaker

Dr Hiroaki Saito, Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan (see abstract list).

Guidelines

Speakers will give a 12-minutes review/ talk on the topic to inform participants and stimulate discussion. Each participant is encouraged to present one poster on their relevant science. Participants should bring reduced/electronic version of their poster for distribution and discussion.

Participants are asked to prepare for the workshop by considering the following questions:
1) Why is it important to develop e2e food web approaches?
2) What are the key issues to consider in e2e food web analyses?
3) What do we know about e2e food web operation of regional systems?
4) What modelling approaches can we adopt to develop e2e food web analyses and what are the difficulties?
5) What other issues should be considered?

Outcomes

The workshop product will be a special issue of a journal/ collection of papers with a focus on end to end marine food webs. Details of the journal and instructions for submission of manuscripts will be posted on the web page as soon as they are available.

A synthesis paper, highlighting the findings of the workshop, will be developed by a subset of participants.

Workshop room: All End to end food web meetings will take place in room **Kentia 3** and **Alexander 2.**

	Monday 10 Nov.	Tuesday 11 Nov.	Wednesday 12 Nov.	Thursday 13 Nov.
7:30 - 8:30	Registration	**Session: End to end operation of regional ecosystems** Chair: Michio Kishi Rapporteur: Mike St John		
8:30 - 8:45	**Welcome plenary session**	**Eleen Hofmann** (USA) Synthesis of Southern Ocean Food webs	**Workshop synthesis** Preparation for plenary reports	**Workshop synthesis** Preparation for plenary reports
8:45 - 9:00	**Hiroaki Saito** End to end foodwebs	**Simone Libralato** (Italy) Effects of climate-driven changes on north-central Adriatic food web: an end to end approach		
9:00 - 9:15		**Stephanie Dutkiewicz** (USA) Ecological control of subtropical nutrient concentrations		
9:15 - 9:30		**Fei Chai** (USA) Modeling and forecasting Peru upwelling ecosystem dynamics: from physical to anchovy		
9:30 - 9:45	**Richard Lampitt** Mesopelagic	**Baris Salihoglu** (Turkey) A coupled plankton anchovy population dynamics model assessing non-linear controls of anchovy and gelatinous biomass in the Black Sea		
9:45 - 10:00		**E2E workshop Plenary discussion** Common features and major differences in regional food webs		
10:00 - 10:15			**Raymond Pollard** Plenary on data integration	
10:15 - 10:30	*Coffee break*			
10:30 - 10:45		*Coffee break*	*Coffee break*	*Coffee break*
10:45 - 11:00	**Dave Karl** Bathypelagic	**Session: Modeling approaches to develop end to end food web analysis** Chair: Jing Zhang Rapporteur: Eugene Murphy	**IMBIZO Plenary session** Reports from 3 workshops	**IMBIZO Plenary session** Final reports from each workshop and concluding presentations
11:00 - 11:15		**Olivier Maury** (France) NEMO-PISCES-APECOSM (NPA), a coupled numerical model for studying two ways coupling between circulation, biogeochemistry and ecosystem		

11:15 - 11:30	.... **Dave Karl**	**Michio Kishi** (Japan) Applications of the NeMURO.FISH model	**IMBIZO Plenary session** Reports from 3 workshops	**IMBIZO Plenary session** Final reports from each workshop and concluding presentations
	Session: End to end marine food webs: background, concepts and issues Chair: Mike Roman Rapporteur: Bob Cowen			
11:30 - 11:45	**Mike Roman** (USA) Welcome and introduction	**Cosimo Solidoro** (Italy) Integration of physical, biogeochemical and ecological processes in food web ent to end models		
11:45 - 12:00	**Coleen Moloney** (S. Africa) Bridging gaps by weaving marine food webs from end to end	**Astrid Jarre** (S. Africa) Qualitative ways to approach complex problems in marine ecosystems		
12:00 -12:15	**Mike St John** (Germany) Complexity, food web theory and marine ecosystem models: understanding and embracing complexity	**E2E workshop plenary discussion** Modeling approaches for end to end food webs: difficulties and ways forward		
12:15 -12:30				
12:30 -13:00 13:00 -13:30	*Lunch*	*Lunch*	*Lunch*	*Lunch*
		Field programmes, observations and experimentation for end to end food web analyses Chair: Olivier Maury Rpporteur: Roger Harris	**E2E workshop plenary discussion** Report-backs and discussion from the breakaway groups	**Writing sessions for chairs, rapporteurs, etc**
13:30 -13:45	**Eugene Murphy** (UK) The spatial and temporal operation of ecosystems: scales of interaction in oceanic food webs	**Hans Dam** (USA) Cascading trophic effects, omnivory & ecological stoichiometry		
13:45 -14:00	**Dian Gifford** (USA) Reconciling concepts in biological oceanography	**François Carlotti** (France) Some issues concerning zooplankton modeling, experimentation and observation in the context of the IMBER objectives		
14:00 -14:15	**E2E workshop plenary discussion** What is an end to end food web?	**Irina Marinov** (USA) Responses of ocean plankton ecology to climate change over the 21st century		

	Session: Key issues in end to end food web analyses Chair: Coleen Moloney Rapporteur: Astrid Jarre	**E2E workshop Plenary discussion** How might end to end food web approaches be incorporated into field programmes, observations and experiments?	.... **E2E workshop plenary discussion**	**Writing sessions for chairs, rapporteurs, etc**
14:15 -14:30	**Breakaway sessions** (groups of 3-5 people to prepare one slide) What are the key issues to consider in E2E food web analyses?			
14:30 -14:45			**E2E workshop plenary discussion** Linking biogeochemistry and food webs: the way forward in models, experiments and field programs	
14:45 -15:00		**Breakaway sessions** Recommendations for linking biogeochemistry and food webs: the way forward in models, experiments and field programmes		
15:00 -15:15				
15:15 -15:30				
15:30 -16:00				
16:00 -16:15	*Coffee break*			
16:15 -16:30				
16:30 -16:45	**E2E workshop plenary discussion** 5 min presentations and discussions from the 10-12 breakaway groups		**E2E workshop break out sessions for synthesis/ writing**	
16:45 -17:00				
17:00 -17:15		**Joint poster session and refreshments**	**Joint poster session and refreshments**	
17:15 -17:30				
17:30 -17:45	**E2E workshop plenary discussion & summary of day's activities**			
17:45 -18:00				
18:00 -18:30				
18:30 -19:00				

PLENARY TALK

Hiroaki Saito, Tohoku Natl. Fish. Res. Inst., Fisheries Research Agency, Shiogama 985-0001, Japan, hsaito@affrc.go.jp

ONTOGENETIC VERTICAL MIGRATING COPEPOD *NEOCALANUS*: PIVOTAL ROLE LINKING THE END-TO-END FOOD WEB IN THE SUBARCTIC NORTH PACIFIC

Copepod *Neocalanus* is the most dominant mesozooplankton in the subarctic North Pacific playing a pivotal role linking the end-to-end food web components. *Neocalanus* feeds on not only phytoplankton but also microzooplankton and detritus and is preyed by higher trophic levels, such as fish, sea bird, baleen whales, etc. The size range of the prey and predator of *Neocalanus* reaches 7-order in length, from $5x10^{-5}$ to 2x10 m. The other important role of *Neocalanus* is transporting organic matter from epipelagic to mesopelagic ecosystem. *Neocalanus* grows in the epipelagic layer, accumulates lipids and migrates down to 400-2000 m for mating and spawning. During the mesopelagic inhabiting period, *Neocalanus* respires, excretes and is preyed by mesopelagic predators, and a large amount of carbon is transferred to the mesopelagic ecosystem. Ecological and biogeochemical interactions through the window of *Neocalanus* will be presented.

POSTER & ORAL ABSTRACTS

UPWARD BIOLOGICAL PUMP, NUTRIENT DYNAMICS, AND TROPHIC INTERACTIONS MEDIATED BY THE VERTICALLY MIGRATING, THIN-LAYER FORMING DINOFLAGELLATE *AKASHIWO SANGUINEA*

Bollens S., Bochdansky A., Rollwagen-Bollens G. and Quenette J.

Phytoplankton “thin layers” represent patches of high prey concentrations for micro- and mesozooplankton, and are thus excellent models for the study of how food web structure can influence carbon and nutrient fluxes. We tested the hypothesis that microzooplankton and mesozooplankton contribute differently to the export of carbon from thin layers. We introduced carbon-14 labeled phytoplankton (Isochrysis galbana) to laboratory tower tanks and exposed them to predation by a heterotrophic dinoflagellate (Oxyrrhis marina) and a copepod (Acartia tonsa). Differences in the behavior and physiology between dinoflagellates and copepods changed the quality of carbon flux markedly. In both cases, DIC flux increased over DOC release when compared to ungrazed controls. Most strikingly, and in contrast to dinoflagellates, copepods increased the release of CO_2 into the atmosphere by moving between the thin layer and the surface. In a second set of experiments we used the dinoflagellate Akashiwo sanguinea, which forms dense thin layers at the surface during the day and at nutrient-rich depths during the night. We examined the extent to which this

vertical migration contributed to the redistribution of phosphorus in the water column. We found A. sanguinea contributed to the movement of phosphorus upwards by recharging with phosphorus at depth, and then excreting organic and inorganic phosphorus in shallower waters. It also formed a vector of phosphorus flux downwards due to sinking cells. The net balance of phosphorus (especially the gains and losses of particulate phosphorus) is a function of a complex interplay between light, vertical nutrient distribution, and dinoflagellate behavior.

Poster presentation

SOME ISSUES CONCERNING ZOOPLANKTON MODELLING, EXPERIMENTATION AND OBSERVATION IN THE CONTEXT OF THE IMBER OBJECTIVES.
Carlotti. F.

The pivotal role of zooplankton in the marine pelagic ecosystem at the interface of the so-called “lower” and “upper” trophic levels has been clearly identified, but most of observations and process studies on zooplankton are of little use for present biogeochemical models and food web models. One reason is that zooplanktonologists have preferentially studied zooplankton biology and processes at the species level (exceptions are the respiration and excretion rates measurable at the community level) whereas biogeochemical models require processes functioning at the level of community and functional groups. Thus, there are several challenges to be addressed to zooplankton researchers and ecosystem modellers to develop observation and processes studies which could adequately be exploited for biogeochemical models and trophic models.
Whereas new observation tools open large perspective to validate zooplankton outputs in IMBER models, allowing better quantification (from species levels to highly resolved size spectrum) and better spatio-temporal resolution, converting zooplankton vital rates, from species level to community level, in units appropriate for biogeochemical and trophic food web models is still a gruelling task. Mesozooplankton in biogeochemical models are not satisfyingly validated and the parametrisations linked to zooplankton are known to be very sensitive. Development of food web models beyond the zooplankton component (usually the closure term in ecosystem models) require to bridge laboratory and field processes studies with model requirements. Clearly, the required information for these models is not the one presently delivered by zooplanktonologists, and it is key issue to guide closer interactions between modellers and observers /experimentalists.

Oral and poster presentation

MODELING PERU UPWELLING ECOSYSTEM DYNAMICS: FROM PHYSICS TO ANCHOVY
Chai F., Chavez F., Chao Y. and Barber R.

The coastal waters of Peru are among the richest and most productive of ocean ecosystems with the world’s largest single-species fishery, the Peruvian anchovy. The Peru coastal upwelling

ecosystem varies dramatically in responding to El Nino and Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). In order to link climate variability with nutrients and plankton dynamics to Peruvian anchovy growth, distribution, and abundance, an end-to-end ecosystem model has been developed, which consists three components. First, a Pacific basin-wide circulation model based on the Regional Ocean Model Systems (ROMS), with 12.5 km resolution, is forced with daily air-sea fluxes derived from the NCEP reanalysis between 1990 and 2008. Second, biogeochemical processes are simulated with Carbon, $Si(OH)_4$, Nitrogen Ecosystem (CoSiNE) model containing multiple plankton groups. The Pacific ROMS-CoSiNE model is integrated synchronously, and produces monthly outputs of three-dimensional temperature, current, nutrient and plankton distributions from January 1990 to December 2008. The third component of this upwelling ecosystem model is an anchovy dynamical model using an individual based model (IBM) approach. The IBM anchovy model takes the ROMS-CoSiNE model outputs for the Peruvian coast, and links each life-stage of the anchovy growth and reproduction with environmental conditions, such as temperature and food availability. Our analyses will focus on each sub-model system performance, their connections, and how these processes along the coast of Peru respond to ENSO and PDO climatic variability. The ROMS-CoSiNE-IBM has been also forced with the ENSO forecasts, which produces 3, 6 and 9 month forecasts for the Peru coast.

Oral presentation

THE 'JELLY C PUMP': JELLYFISH BLOOMS RESULT IN A MAJOR MICROBIAL RESPIRATORY SINK OF C IN MARINE SYSTEMS

Condon R.H., Steinberg D.K., Del Giorgio P.A., Bouvier T.C. and Bronk D.A.

Large jellyfish blooms of lobate ctenophores (Mnemiopsis leidyi) and scyphomedusae (Chrysaora quinquecirrha) occur in many coastal areas, including large summer blooms in Chesapeake Bay. High jellyfish biomass coincides with peaks in microbial activity and biomass, but few studies have investigated the potential link between jellyfish blooms and microbial functioning in coastal ecosystems. We measured dissolved organic matter (DOM) production by jellyfish, and the response of free-living bacterioplankton to this C input, in terms of bacterial cell growth, metabolism, and phylogenetic community composition. Both species of jellyfish released large amounts of carbon (C)-rich dissolved organic matter (J-DOM), and bacterioplankton quickly responded with large increases in metabolic activity. Enumeration of prokaryotic phylogenetic groups using fluorescence in situ hybridization (FISH) showed specific bacterial groups were responsible for increased metabolism resulting from jellyfish-generated DOM. Furthermore, decreases in bacterial growth efficiency suggest a shunt of C consumed towards bacterial respiration. In the context of worldwide increases in jellyfish, our results suggest the possibility of major shifts in marine microbial structure

and function, and a potential for a large bacterial C sink away from higher trophic levels, including commercially important fish species.

Poster presentation

IMPLICATIONS OF HYDROGEN SULPHIDE TO THE PELAGIC FOOD WEB OFF NAMIBIA
Currie B., Utne Palm A.C.,. Salvanes A.G.V., Peard K.R., Emeis K-C. and Brüchert V.

The occurrence of hydrogen sulphide and intense hypoxia is characteristic of the inner shelf coastal upwelling system off central Namibia. This area is critical to recruitment of important commercial fish stocks and includes nursery areas of pilchard *Sardinops sagax* and hake *Merluccius capensis*.
High primary production downstream of the Lüderitz upwelling cell is largely underutilized and sinks to form diatomaceous muddy sediment where intense decay processes form hydrogen sulphide and methane close to the sediment surface. Resulting hypoxia and episodic bouts of hydrogen sulphide in the water column pose challenges to the survival of the pelagic fauna. Whilst fish species such as horse mackerel *Trachurus trachurus* and hake *Merluccius capensis* show remarkable tolerance to hypoxic stress, experimental work has shown that the bearded goby *Sufflogobius barbatus* survives extended periods of anoxia and hydrogen sulphide. We believe that the exceptional behavioural and physiological adaptations by the bearded goby have enabled this species to both exploit and find refuge from predators in the potentially unliveable conditions associated with the sediment. Gobies are presently key players in the pelagic food web off Namibia, comprising a major part of the diet of predatory fish, seabirds and marine mammals.

Poster presentation

USING MEASUREMENTS OF NATURALLY OCCURRING C-14 TO ASSESS BENTHIC FEEDING STRATEGIES AND THE FATE OF LABILE ORGANIC MATTER IN ANTARCTIC BENTHIC FOOD WEBS
DeMaster D., Thomas C. and Smith C.

Our research examines bentho-pelagic coupling on the West Antarctic continental shelf. Measurements of naturally occurring C-14 in deposit feeder body tissue, deposit feeder gut contents, surface plankton, and surface sediments are being used to assess the fate of labile organic matter in Antarctic benthic food webs. The radiochemical data indicate that certain deposit feeders (such as the holothurian, *Peniagone vignoni,* as well as an echiuran worm) primarily obtain their labile organic material by ingesting organic material almost exclusively from the surface floc layer. In contrast, other deposit feeders (such as the holothuria *Protelpidia murrayi, Bathyplotes fusciviculum* and the head-down conveyor belt feeder, *Molpadia musculus)* primarily rely on selective digestion/

assimilation in their gut. The body tissues of the benthos utilizing both of these feeding strategies are identical in C-14 content to that in surface plankton. In contrast, the organic matter in the upper 0.5 cm of the seabed is considerably depleted in C-14 relative to the C-14 content of surface plankton (or the body tissues of local benthos). These feeding strategies appear to remain constant for a particular species throughout the year, despite large seasonal changes in the primary production occurring in the euphotic zone. Th-234 measurements (24-day half life) in shelf sediments near Palmer station (64 degrees S) reveal that deposit feeders in this area ingest recently deposited sediment year round. This is in contrast to reports in the literature of deposit feeders further south on the Antarctic Peninsula (68 degrees S) that become dormant during the austral winter.

Poster presentation

COUPLING BETWEEN THE C, N, P, FE, SI, CA AND LITHOGENIC CYCLES IN A GLOBAL OCEAN BIOGEOCHEMICAL AND ECOLOGICAL MODEL

Dunne J. P., Gnanadesikan A. . and Sarmiento J. L.

We present comparisons of a broad suite of observational constrains from satellites to sediments with a multiple element (C, N, P, Fe, Si, Ca) biogeochemical model of small, large and diazotrophic phytoplankton and cycling of organic matter. The model includes such processes as gas exchange, atmospheric deposition, river inputs, ligand-based iron scavenging, N_2 fixation, water column denitrification and sediment processes of lithogenic and iron removal, $CaCO_3$ cycling and denitrification. Phytoplankton physiology is based on colimitation by light, nitrogen, phosphorus and iron with flexible N, P, Fe, chlorophyll, Ca and Si stoichiometry. Loss of phytoplankton to the microbial loop and to mesozooplankton is parameterized through a size-based relationship. This model is imbedded in a 1-degree; global ice/ocean general circulation model (MOM4) forced by atmospheric reanalysis forcing to quantify the relationship between food web structure, biogeochemical cycles and atmospheric CO_2 signature. Our analysis focuses on controls on the decoupling between the various elemental cycles represented in the model and on the dynamical roles played by variability linked to the annual cycle, El Nino, and other modes.

Poster presentation

ECOLOGICAL CONTROL OF SUBTROPICAL NUTRIENT CONCENTRATIONS

Dutkiewicz S., Follows M. and Bragg J.

Resource competition theory is used by ecologists to predict the outcomes of competition between species for common limiting resources. Here we apply resource competition theory in a global three-dimensional physical/biogeochemical/ecosystem model where phytoplankton communities are assembled based on competitive interactions. We use the theory to help us understand where

and why different types of phytoplankton species dominate in the global ocean. We find that in stable, low latitude environments, physiological properties of phytoplankton and their loss rates control the nutrient distribution. In these regions, the dominant phytoplankton species are able to grow at low levels of nutrient availability, and draw nutrients down to levels where other phytoplankton cannot be supported. In this way, the biogeochemistry of these regions is largely regulated by the phytoplankton assemblage. We investigate how this control on nutrients changes in the model ocean on interannual timescales, and postulate how this might impact future ocean biogeochemistry.

Oral and poster presentation

RECONCILING CONCEPTS IN BIOLOGICAL OCEANOGRAPHY
Gifford D.J., Steele J. H. and Collie J. S.

The inherent complexity in the structure and dynamics of marine food webs has led to two major simplifying concepts –species-centric, focusing on physical processes affecting particular pelagic species, including the early life history stages of fish—and trophic-centric, emphasizing energy flow through broad functional groups from nutrient input to fish production. The two concepts are complementary. Together they embrace most food web processes and answer different questions. They can describe features of spatial distribution of individual species, and of food web structure, especially those relevant to fish communities. But they cannot provide general explanations for the factors determining changes in the abundance of individual marine species. Nor can they resolve the practical problems of managing fish stocks in an ecosystem-based context. These issues remain central theoretical and practical challenges for biological oceanography.

Oral presentation

USING THERMODYNAMIC FIRST PRINCIPLES TO CONSTRAIN END TO END FOOD WEB MODELING
Harris L.

The challenge of linking bottom-up and top-down processes in holistic models of food webs may be considered a “Gordian Knot” of ecology. While we are well poised to develop heuristic models that will improve our mechanistic understanding of marine ecosystems from end to end, empirically derived formulations are limited to the time and space scales of the data used for model parameterization. The goal of prediction in these models may not be achievable when projected climate change or unforeseen fishing effects occur outside of a given model’s empirical constraints. Here I provide some examples of thermodynamic first principles that may be used to support food web modeling using the metabolic theory of ecology and the principle of maximum entropy production.

Application of these principles may be useful in developing indices of energy transfer through food webs under dynamic temperature conditions due to the dependency of metabolic rates on differential autotrophic versus heterotrophic activation energies, or by providing a goal function to constrain optimal energy transfer among different trophic levels.

Poster presentation

SYNTHESIS OF SOUTHERN OCEAN FOOD WEBS
Hofmann E. E., Murphy E. J., Cavanagh R. D. and Johnston N. M.

Some of the strongest regional expressions of global climate change have occurred in the Southern Ocean. Changes to the environment, including modifications in sea ice extent and concentration, have been associated with variations in ecosystems and biogeochemical processes. The region is characterized by unique food webs, is an important component of the global carbon cycle, and supports commercially harvested species. Understanding climate-induced changes and their consequences for food webs and biogeochemical cycling is integral to predicting the impacts and feedbacks of the Southern Ocean as part of the Earth System, and to developing sustainable management for the region. Fundamental to predicting how ecosystems respond to change is an understanding of food web structure and function. This requires synthesis of current knowledge of Southern Ocean food webs and modeling approaches. This presentation will review the status of Southern Ocean food web models and explore issues associated with developing these to the circumpolar scale. The gaps in knowledge that limit current food web models will be highlighted with particular emphasis on the importance of considering regional and trophic complexities. Multidisciplinary modeling approaches that bring together different scales and processes will be discussed with a particular focus on the development of end-to-end food web models for the Southern Ocean.

Oral and poster presentation

SIBER: SUSTAINED INDIAN OCEAN BIOGEOCHEMICAL AND ECOSYSTEM RESEARCH
Hood R.R., Naqvi S. W. A. and Wiggert J. D.

There are many outstanding research questions in the Indian Ocean because it is a dynamically complex and highly variable system, yet it is substantially under-sampled compared to the Atlantic and Pacific.
Due to this complexity we still do not have a complete characterization and understanding of the primary production variability and dynamics in the Indian Ocean. Nor have the impacts of major physical perturbations, associated with phenomena like the Madden-Julian Oscillation and the Indian Ocean Dipole, been characterized. Questions also persist about the role of the Indian Ocean

in the global carbon and nitrogen cycles, and about the role of grazing versus nutrient limitation in mediating primary production and bloom dynamics in the Arabian Sea. Furthermore, there is exciting emerging evidence which suggests that Fe limitation may be important in the Indian Ocean and even in the Arabian Sea during the southwest monsoon. However, direct measurements and experiments are limited. Global warming impacts are also becoming apparent in the Indian Ocean, such as the emerging evidence that climate change is influencing the strength of the monsoon winds, and also the rapid warming of the Indian Ocean surface waters, both of which could have profound impacts on biogeochemical and ecosystem dynamics.
The goal of this poster presentation is to raise awareness about the need for a new international research program in the Indian Ocean and promote research there in general.

Poster presentation

QUALITATIVE WAYS TO APPROACH COMPLEX PROBLEMS IN MARINE ECOSYSTEMS
Jarre A., Moloney C., Howard J., Kean E. and Smith M.

End-to-end foodwebs are highly complex, and traditional top-down (multispecies) or bottom-up (biogeochemical) food web models do not yet allow us to grasp their complexity in a fully quantitative way. We show how qualitative, rule-based modelling can be used to analyse long-term ecosystem change, and how small expert systems can be used to synthesize quantitative and qualitative information into scientific advice for management of human activies in a changing ocean. Our examples are taken from the southern Benguela upwelling ecosystem, an exploited eastern boundary current system bordered by a developing society. Many predators in the southern Benguela depend on anchovy and sardine for food; these species are also being fished. Alternating dominance regimes of the two small pelagic fishes have been linked to composition of their plankton prey, the long-term dynamics of which has in turn been linked to changes in the oceanography of the system. We have used multivariate statistical methods and developed a small expert system to determine long-term ecosystem change. Using rule based models, we explore the impact of fisheries management strategies on the abundance and dominance of the small pelagics under realistic environmental regimes. We discuss the value of these simple approaches in addressing the problems of spatial and temporal scales that need to be overcome in numerical modelling.

Oral and poster presentation

APPLICATIONS OF THE *NEMURO.FISH* MODEL
Kishi M. J.

Relative roles of top down vs. bottom up regulation of marine ecosystems is a common topic of scientific discussion but the resolution of the question remains elusive. Idea of my presentation

is to examine the NEMURO related modeling tools that describe mainly bottom up control and evaluate modeling capabilities on food-web. The advantages of NEMURO families are they have ability to address top-down and bottom-up control through detailed process description, they have ecological realism - includes important species interactions and biological processes and that parameters can be estimated with laboratory experiments. The disadvantages are that large amounts of data are required for parameterization (NEMURO.FISH – 191 parameters), somewhat restricted to well studies species and functional groups, number of species that can be modeled is low due to parameter needs, uncertainty about functional relationships between species and various factors important during different life stages on multiple trophic levels. However, we need the model to understand the E2E food web anyway.

Oral presentation

ADDING ACOUSTICS TO CALCOFI AND CCE-LTER: A SOLUTION TO THE END-TO-END RESEARCH CHALLENGE IN THE SOUTHERN CALIFORNIA CURRENT?

Koslow J. A.

The NSF/NOAA-funded California Current Ecosystem-Long Term Ecological Ressearch (CCE-LTER) program has significantly augmented the 60-year California Cooperative Oceanic Fisheries Investigations (CalCOFI) ocean observation program with its interdisciplinary, long-term study of biogeochemical processes at lower trophic levels. Research based on the use of multi-frequency acoustics (18, 38, 70, 120, and 200 kHz) and pelagic trawl sampling has now been added to address key questions linking physics and lower trophic level processes to the ecology of mid- to higher trophic levels:

- the distribution, biomass, and ecology of krill, small pelagics, and juvenile fishes in relation to oceanographic features (e.g. eddies, fronts, and upwelling features) ;
- the feeding, condition, growth, and relative survival of the late larval and juvenile stages of key fish species in relation to oceanographic features to assess the factors driving recruitment success;
- the role of the mesopelagic micronekton in the flux of carbon to deep water.

These field studies, combined with retrospective analyses and spatially-explicit modelling approaches (e.g. NEMURO FISH) that cover the system from physics to the fish, are seen as a strategic approach to developing ecosystem-based fishery management in the region and to understanding the impacts of climate change.

Poster presentation

PLANNING A MODERATE-SCALE OCEAN IRON FERTILIZATION EXPERIMENT
Leinen M.

Planning is underway for a moderate-scale (>100 x 100 km) ocean iron fertilization experiment to be carried out by the international ocean science community with private funding. Previous experiments were designed primarily to answer questions about the role of iron as a limiting nutrient for phytoplankton growth in high nutrient-low chlorophyll (HNLC) regions. Less than half of the previous experiments measured export of carbon from the surface and the small size of the experiments (generally ~10 x 10 km) resulted in substantial dilution of the export signal and difficulty in relating measurements at depths of 200-500m with surface production in those cases where export was measured. Larger experiments designed for carbon export measurement have been called for by the science community. Such experiments also offer the opportunity to observe the impact of the export on the biological community, including the mesopelagic and bathypelagic communities.

Poster presentation

EFFECTS OF CLIMATE-DRIVEN CHANGES ON NORTH-CENTRAL ADRIATIC FOOD WEB: AN END-TO-END APPROACH
Libralato S., Arneri E., Bahamon N., Coll M., Cossarini G., Giorgi F., Morello B., Palomera I., Santojanni A. And Solidoro C.

Climatic changes are expected to produce variations that might substantially modify the structure and functioning of marine food webs with important consequences for exploited species. Important factors to be considered include modification of river run-off and water column stratification, which in turn cause modification in nutrient concentration within the euphotic layer with cascading effects on the upper part of the food web. Integration of biogeochemical processes and food web dynamics in an end to end approach is a possible way to tackle this issue.
In this work, we analyse the potential cascading effects of climate-driven changes on the food web of the Adriatic Sea ecosystem (Italy, Slovenia and Croatia) by using a hierarchy of linked models. An Ecopath with Ecosim model representing the food web of the North-Central Adriatic Sea is forced by a biogeochemical model of the system which, in turn, is forced with highly resolved meteorological outputs obtained from a Regional Climate model (RegCM). A scenario analysis is presented by comparing results for a reference situation (RF, 1961-1990) and two future IPCC scenarios (2071-2100), representing market oriented (A2) and local sustainability policies (B2), respectively. The effects of climate-driven changes on higher trophic levels are analyzed by comparing the mean seasonal evolution of biomass for different trophic groups simulated under the different scenarios, with particular attention to species target of fishing activities (e.g. small pelagic species and demersal predators).

Oral and poster presentation

IGNORED NO MORE: THE ROLE OF LARVAL FISHES IN THE PLANKTONIC FOOD WEB OF THE LOW-LATITUDE OCEAN

Llopiz J. K. and Cowen R. K.

Ecosystem-level descriptions of the specific trophic pathways to a community of co-occurring larval fishes are largely absent from studies focused on the planktonic food webs of the open ocean. From monthly collections over two years in the Straits of Florida (SOF), we report on the feeding ecologies of 21 taxa of fish larvae to elucidate the levels of larval fish community reliance upon specific zooplankton prey. Larval taxa examined included billfishes, tunas, mackerels, and several coral reef fishes. A linkage web of the 21 taxa and their dominant prey showed the highly variable and selective feeding strategies of the co-occurring larvae. Copepod nauplii had the most links (18), followed by calanoids (14), the cyclopoids *Farranula* (14) and *Oncaea* (11), and appendicularians (12). A novel quantitative web of larval taxa and prey, incorporating the taxon-specific diets with the abundances of the larvae in the plankton, more accurately indicated the degree to which the larval fish community as a whole consumed each prey type. Appendicularians were most important to the larval community, followed by calanoid copepodites, nauplii, and *Farranula* copepodites. Contrary to the presumed constraints of the oligotrophic and warm low-latitude ocean, larval fishes in the SOF, in addition to feeding selectively, feed rather successfully. A possible explanation for this paradox is the high reliance upon zooplankton prey that provide a direct link to the microbial food web, notably appendicularians. As such, future work should focus on increasing our limited understanding of these important zooplankton prey, especially in the oligotrophic open ocean of lower latitudes.

Poster presentation

FISHERIES ECOSYSTEM MODEL IN CHESAPEAKE BAY AND ITS COUPLING WITH HYDROGRAPHIC AND WATER QUALITY MODELS

Ma H. and Townsend H.

To assess the influence of water quality and fisheries management scenarios on multiple fisheries species, we coupled a fisheries ecosystem model for Chesapeake Bay (developed using Ecopath with Ecosim) with a hydrographic model and a water quality/eutrophication model. The hydrographic model takes wind, rainfall, river inflow, and relative loading as major inputs and it solves for equilibrium velocity fields and calculates mass-balanced chemical concentrations. The model simulates the long-term pattern (~ 50 years) in primary production and it can provide historical perspectives on changes in primary production if nutrient input was reduced according to management strategies. In addition, the eutrophication model projected significant increase in submerged aquatic vegetation (SAV) when nutrient loading was reduced. We used the outputs from these models as inputs or forcing functions for the fisheries ecosystem model. Modelled blue crab

biomass was clearly enhanced through habitat mediation in the fisheries ecosystem model when SAV was adjusted by the projection from the eutrophication model. The impacts of different nutrient loading and fishing management scenarios are currently being studied for some major fishery species in the Bay. Such model coupling can provide valuable tools for exploring ecosystem-based fisheries management options.

Poster presentation

RESPONSE OF OCEAN PLANKTON ECOLOGY TO CLIMATE CHANGE OVER THE 21ST CENTURY

Marinov I., Doney S., Lima I, Lindsey K. and Moore K.

Here we analyze the impact of climate change on ocean plankton ecology over the 21st century using a multi-decadal (1880-2100) experiment conducted with the latest version of the Community Climate System Model (CCSM-3.1) coupled ocean-atmosphere-land-ice model. The oceanic ecosystem model component includes three classes of phytoplankton (diatoms, pico/nano plankton, diazotrophs) and one class of zooplankton which grazes differentially on the phytoplankton groups. The competition between phytoplankton groups is altered by climate induced changes in nutrients, light and zooplankton.

Increasing stratification in the northern hemisphere oceans decreases the nutrient supply to the ocean surface and decreases the relative and absolute diatom abundance. The northern hemisphere shift from diatoms to small phytoplankton results in a decreases total primary production, export production and export ratio, and a shift to a more efficiently recycled, lower biomass euphotic layer.

By contrast, an increase in Southern Ocean westerlies acts against increasing temperature and freshwater flux to destratify the water-column. Additionally, the wind-driven poleward shift in the Southern Ocean subpolar-subtropical front results in a southward shift and increase in the largest oceanic diatom bloom. In the Southern Ocean diatoms are favored over small phytoplankton on average, acting to increase total chlorophyll, primary production and export production.

The impact of these ecological shifts on the global oceanic carbon sink is complex, with northern and southern hemisphere effects partially compensating each other. In the net, total chlorophyll, primary and export production decrease, but less than previous modeling studies have suggested, suggesting a small positive feedback on atmospheric pCO_2.

Poster presentation

BRIDGING GAPS BY WEAVING MARINE FOOD WEBS FROM END TO END

Moloney C. L., St John M. A., Denman K. L., Karl D. M., Köster F. W., Sundby S. and Wilson R. P.

Marine food web dynamics are determined by interactions within and between species and between species and their environment. Global change directly affects abiotic conditions and living organisms. Different groups of marine researchers traditionally study different aspects of these changes. However, over medium to long time scales perturbations affecting food webs need to be considered from nutrients to top predators. Studies of end to end food webs should help align multidisciplinary research to common goals and perspectives. Topics are described that could help bridge disciplinary gaps and develop new understanding of the reciprocal impacts of global change on marine food webs and ocean biogeochemistry. These include the effects of varying element ratios on community structure at low trophic levels and food quality at mid and high trophic levels, the role of behaviour in linking different food webs and allowing organisms to adapt to changing conditions, the effect of predator prey interactions on trophic controls and food web dynamics, and the factors affecting transfer efficiencies in food webs. These issues need to be tackled through a combination of field and experimental studies, comparative studies across different food webs, and a variety of modelling approaches.

Oral and poster presentation, End to end workshop co-chair

THE SPATIAL AND TEMPORAL OPERATION OF ECOSYSTEMS: SCALES OF INTERACTION IN OCEANIC FOOD WEBS

Murphy E. J, Watkins J. L., Trathan P. N. and Johnston N.

Oceanic ecosystems show marked temporal and spatial variability in structure and operation. This variability is a fundamental aspect of oceanic food webs. Physical and biological interactions at different scales determine the ecological structures observed and understanding these interactions will be important in developing end-to-end analyses of food webs. In this presentation we will use examples from the Southern Ocean to illustrate how physical and biological interactions at different scales influence food webs. These examples, which have relevance in other oceanic systems, include the importance of: horizontal flows of energy associated with advection and movement, effects of patchiness in production systems, the interactive effects of life-history and population dynamics and the frequency dependence of responses to disturbance. These examples highlight the underlying scale-based nature of ecosystem structure, which generates complexity that in turn affects ecosystem properties and overall food web structure. Understanding how to quantify these scale based effects will be important in developing end-to-end analyses of food webs.

Oral presentation

MODELLED IMPACT OF DECREASED NUTRIENT CONCENTRATIONS ON THE BALTIC SEA FOOD WEB

Niiranen S., Tapani S., Pääkkönen J-P., Norkko A. and Kaitala S.

Eutrophication is a severe threat to the Baltic Sea ecosystem. Hence, reducing nutrient loading is the most serious challenge facing the Baltic Sea environmental policy. The resulting impacts on the Baltic food web are, however, not fully understood. Here, we studied the ecosystem effects of decreased nitrogen and phosphorus concentrations with an Ecopath with Ecosim food web model of 30 functional groups. The model is based on Baltic Sea data from year 1996 and includes the most important commercial fish species, cod (Gadus morhua), Baltic herring (Clupea harengus membras) and sprat (Sprattus sprattus). Unlike in previous studies, the entire Baltic Sea is now covered with spatial resolution (2D) and the impacts of advection, regional fishing effort, marine protected areas and bottom hypoxia are specified.
The fish biomasses modelled correspond well with ICES multispecies virtual population analysis estimates (MSVPA) for Baltic fish stocks (1997-2006). Fishing pressure was detected as the most significant factor influencing the mortality of commercial fish and this top-down control was mediated to biomasses of fish prey. Furthermore, nutrient reductions impacted the entire food web. When nitrogen and phosphorus concentrations were both reduced by 5 and 10 percent, the relative reduction in phytoplankton biomass was approximately half, and in zooplankton one fourth, of the initial nutrient reduction percentage. Eventually, also fish suffered reductions in biomass, the exception being cod that experienced a slight biomass increase. A more detailed analysis reveals area-specific responses to nutrient changes and sensitivity to the proportion of nutrients recycled within the euphotic water layer.

Poster presentation

A COUPLED PLANKTON ANCHOVY POPULATION DYNAMICS MODEL ASSESSING NONLINEAR CONTROLS OF ANCHOVY AND GELATINOUS BIOMASS IN THE BLACK SEA

Oguz T., Salihoglu B. and Fach B.

A one-dimensional bi-directionally coupled model of lower trophic level and anchovy population dynamics was developed to analyse the mechanisms controlling sharp anchovy and gelatinous zooplankton biomass transitions during the critical period of radical ecosystem transformation from the late 1960s to the late 1980s in the Black Sea. A two-fold increase in anchovy stock from its low (~ 300 kt) to moderate (~ 700 kt) regime at the end of the 1960s was related to weakening piscivore predation pressure, slight nutrient enrichment of the basin during early eutrophication phase and competitive exclusion of gelatinous carnivores. After maintaining the moderate stock regime during the 1970s, the next transition to the high anchovy stock regime (~ 1500 kt) during 1979–1980 was caused by additional nutrient enrichment of the water column due to growing influence of

eutrophication. As the enrichment was building up, jellies started to coexist with anchovy at low biomass levels (< 1.0 gC m^{-2}) but they did not yet exert a strong control on anchovy because of their competitive disadvantage of consuming prey at low carrying capacity conditions. The high stock regime (> 1000 kt) persisted until the third transition (1989-1990) that brought anchovy stock back to the low regime (~ 300 kt) and proliferated the biomass of the alien gelatinous species Mnemiopsis up to 3.0 gC m^{-2}. The anchovy-Mnemiopsis shift was pre-conditioned by eutrophication-induced nutrient accumulation in the subsurface layer and triggered by their more effective transport into the productive surface layer following the switch of regional climate into a severe winter phase during 1985-1987. The resulting enhanced resource carrying capacity together with decreasing adult anchovy stocks due to overfishing led to competitive advantage of Mnemiopsis in food exploitation relative to anchovy, growth and reproduction advantages relative to the native gelatinous species Aurelia aurita, and stronger predation on anchovy eggs and larvae. Approximately 50% of the anchovy stock depletion was caused by increasing fishing pressure beyond its threshold 1.5 y^{-1} and the rest by competition with and predation by Mnemiopsis. Nonlinear coupling of these two independent processes amplified the anchovy collapse; neither of them however would be able to impose individually such a severe anchovy stock change under the observed environmental conditions of the Black Sea.

Oral and poster presentation

HEAVY METAL SPECIATION AND BIOAVAILABILITY IN MARINE ENVIRONMENTS
PAN J-F.

Different speciation of heavy metals has different bioavailability. The influences of organic matters (e.g., dissolved organic carbon, colloidal organic carbon, humic substances) on the bioavailability of dissolved and sedimentary heavy metals were reviewed. Though there were some contradictions in the effects of organic carbon on metal bioavailability, it was strongly approved that organic carbon influenced the bioavailability of metals to marine organisms. The significant roles of organic carbon in the biogeochemical cycling of trace metals and thus the interaction between organic matter and trace metals in aquatic environments have been demonstrated. The influences of organic carbon on metal bioavailability were metal-specific and dependent on the geochemical properties of organic carbon -metal complexation. For the uptake mechanism of metal-organic complexes, metal dissociation may be an important step for the uptake of complexed metals, other mechanisms such as pinocytosis and co-transport may also be involved, which need to be further studied.

Poster presentation

DEGRADATION OF MARINE ECOSYSTEM AND CHANGES OF FOOD WEB STRUCTURES: A REVIEW AND AN EXAMPLE IN THE LAIZHOU BAY

Pu X., Pan J. and Ding D.

Marine ecosystems, especially those in coastal and estuarine oceans, are in a process of degradation. Pressures responsible for the degradation come mainly from two directions: over-exploitation from the top of the marine food chain and eutrophication from the basis. Phenomena of the degradation include occurrences of harmful algal blooms, loss of SAV and benthic algae, hypoxia or anoxia, loss of biodiversity, and so on. The linkages between the pressures and degradation of marine ecosystem lie in the biological community structures, or food chain structures. In healthy marine ecosystems, energy and organic matters produced by photosynthesis of primary producers are transferred to top predators through effective cascading interval organisms. However, energy and materials in degraded marine ecosystems cannot be effectively conveyed in the food chains or food webs, which results in the accumulation of algal biomass and nutritional deficiency of animals. The effects of changing environmental factors on species compositon in the Laizhou Bay were studied, and the routes and efficiencies of nutritional transfer through food webs were analysed using fatty acids as indicator.

Poster presentation

COMPARING INTERNAL AND EXTERNAL DRIVERS IN THE SOUTHERN BENGUELA, AND THE SOUTHERN AND NORTTHERN HUMBOLDT UPWELLING ECOSYSTEMS

Shannon L., Neira S. and Taylor M.

Trophic models of two upwelling ecosystems, namely the southern Benguela (South African), southern Humboldt (Chilean) and northern Humboldt (Peruvian) systems, have been fitted to catch, abundance and fishing mortality time series. Three drivers were considered during the model fitting: internal forcing by means of the trophic flow controls between the various interacting species groups, and two kinds of external forcing, namely fishing and the environment. The southern Benguela model was fitted to time series data from 1978-2003, the southern Humboldt model to data from 1970-2004, and the northern Humboldt to data for a shorter period, 1995-2004. Fishing has been relatively carefully managed in the southern Benguela during the period modelled and previous studies found that most of the resource variability was attributed to internal trophodynamic forcing and to environmental forcing rather than to fishing. By comparison, fishing has been shown to have played a relatively major role in driving ecosystem changes observed in the southern and northern Humboldt models. Bearing in mind the different roles played by each of the drivers in these ecosystems, flow controls between interacting species groups, which improved the fits of the models, were compared across the three ecosystems to determine to what extent the three models supported the hypothesis that upwelling ecosystems function as wasp-waist systems. Secondly,

environmental forcing was examined by searching for hypothetical forcing functions, affecting different levels of the food web, which improved the model fits. This was an attempt to start to uncover the processes that may be involved in linking the environment to observed ecosystem dynamics and changes in these upwelling ecosystems. Model results confirmed the important ecological role played by small pelagic fish in the studied upwelling ecosystems. For example, the fit of the Southern Benguela model to time series data of catch and abundance was similarly improved when anchovy/sardine-prey and anchovy/sardine-predator interactions were externally forced, supporting the wasp-waist hypothesis. In addition, although physical drivers and conditions may differ in their nature or merely their frequency and intensity between systems, and different fishing strategies operate in each of the three ecosystems, model results suggest that these effects are transferred through the ecosystems and manifest themselves as ecosystem changes and observed resource dynamics largely via interactions with small pelagic fish.

Poster presentation

CASCADING TROPHIC EFFECTS, OMNIVORY AND ECOLOGICAL STOICHIOMETRY
Siuda A.N.S. and Dam H.G.

Trophic interactions are a cornerstone of pelagic ecology. These interactions determine both the structure and function of pelagic communities, and strongly influence biogeochemical cycles. Zooplankton play a key role in linking the microbial loop to higher trophic levels in the oceans, and in the functioning of the biological pump. However, to date it has been difficult to document strong cascading effects of zooplankton in the ocean. Cascading effects are influenced by the complexity of the food web, by the degree of omnivory in the zooplankton, and by the stoichiometric imbalance between consumers and producers. The more complex the food web, the more difficult it is to discern cascading effects. Omnivory weakens cascading effects, but stoichiometric imbalance should strengthen cascading effects. We have studied copepod-induced studied trophic cascading effects in contrasting ecosystems (Estuarine, Coastal, Open Ocean and Orinoco River Plume) in the North Atlantic Ocean. Using path analysis, we document pervasive cascading effects (both direct and indirect) throughout the food web. These effects are not always obvious when analyzed with simple or multivariate regression techniques.Direct effects predominated in estuarine and coastal environments, and indirect effects in open ocean environments. In other laboratory and field studies, we also tested the competing effects of omnivory versus stoichiometric imbalance in food web interactions. Omnivory effects were stronger than stoichiometric imbalance effects.

Oral and poster presentation

INTEGRATION OF PHYSICAL, BIOGEOCHEMICAL AND ECOLOGICAL PROCESSES IN FOOD-WEB END-TO-END MODELS

Solidoro C. and Libralato S.

In the integration of physical, biogeochemical and ecological processes spanning over different trophic levels, a common attitude is to focus only on the 'vertical' dimension, i.e. the flows of energy and matter among trophic levels, and to neglect the 'horizontal' dimension, i.e. the accounting for ecological and functional roles of ecosystem components within a trophic level. This implies to privilege transfer efficiency versus biodiversity, and to neglect both the importance of alternative pathways for energy transfer and stabilizing effects.
The integration of biogeochemical models and mass balance food web model –such as ecopath with ecosim- help in solving this criticality, and entail a more proper representation of detritus and related feedbacks. It poses, however, other questions, some still to be solved, including identification of appropriate scales for integration, up(down)scaling of models parameterization, and careful definition of links among models.
As an example, the choice of space and time scales to be simulated and of the associated resolutions/aggregation could suggest to couple physical models to food web models properly modified so to explicitly include biogeochemical processes, rather than to biogeochemical models in turn coupled to food web one, or to couple integrated physical-biogeochemical model to food web ones.
Similarly, the level of biological complexity might change with the choice of the scales of interest.
Here we present a critical review of theoretical and technical difficulties in linking biogeochemical and food web models, and a discussion of more relevant applications presented so far in literature and in specific workshops.

Oral and poster presentation

COMPLEXITY, FOOD WEB THEORY AND MARINE ECOSYSTEM MODELS: UNDERSTANDING AND EMBRACING COMPLEXITY

St. John M.

Marine ecosystems are typified by a myriad of interactions between species and individuals as constrained by the abiotic environment. These complex non equilibrium systems are in a constant state of change with the overall system dynamics determined by the interaction of individuals with their abiotic and biotic environment. As such marine ecosystems are a classic example of complex adaptive systems (CAS) in which the aggregate of parts exhibit properties, which wouldn't be expected from the parts alone. As a result, a reductionist approach to their study will not lead to the prediction of their emergent properties e.g. biodiversity, sequestration of green house gas materials and exploited resources. However, the integration of quantitative and qualitative process

knowledge will allow us to better understand the lever points - points at which a small perturbation can produce a directed effect of which a regime shifts are a classic example. Recognizing the constraints imposed on prediction of CAS dynamics, a pragmatic approach to the development of a predictive understanding of the emergent properties of marine ecosystems is presented.

Oral presentation

FEEDING OF CARNIVOROUS ZOOPLANKTON IN WEST GREENLAND WATERS
Tönnesson K. and Nielsen T.G.

Today, the West Greenland marine ecosystem sustains fisheries which contribute 95% of Greenland's total export value. Knowledge about the marine food webs that supports these rich resources is essential to manage the economical important fisheries resources in a sustainable manner. Important and common predatory groups, such as the chaetognaths and carnivorous copepods are particularly understudied in the Arctic. The aim of the present presentation is to contribute to a better knowledge about carnivorous zooplankton and their trophic role in the artic pelagic ecosystem.
The vertical and horizontal distribution of carnivorous zooplankton and their potential prey were analysed in West Greenlandic waters. Feeding by *Pareuchaeta norvegica* was assessed by measuring egestion of faecal pellets. The chaetognaths, *Eukrohnia hamata* and *Sagitta elegans*, were investigated for gut contents.
P. norvegica was at all times restricted to the deeper parts of the water column while *Sagitta elegans* was found at all depths. *Calanus* spp., *Pseudocalanus* sp.and *Fritillaria* sp. where the main prey item for *Eukrohnia hamata* and *Sagitta elegans.* Comparing prey abundance and gut content for *E. hamata* shows that *Pseudocalanus* sp. and appendicularians where selectively preyed. Selective feeding was also observed in *S. elegans*. Number of prey per chaetognath (NPC) ranged from 0.2 to 0.4 prey ind^{-1} and the feeding rate from 0.5 to 1.0 prey d^{-1} with digestion time = 10 h. We show that the predators in this study are important predators of copepods, appendicularians and, in the case *of Sagitta elagans*, of conspecifics.

Poster presentation

DISTRIBUTION OF PLANKTONIC CILIATE IN RELATION TO FRONTS AND THERMOCLINE IN SOUTHERN YELLOW SEA
Zhang W., Zhao N. and Xiao T.

Planktonic ciliates are one of the major components of microzooplankton (<200 μm). They are ubiquitous in marine environment and play an important role in the connection between traditional food chain and microbial food webs. In the Chinese GLOBEC-IMBER program, planktonic ciliates

were studied mainly as food item of upper trophic levels, especially the dominant copepod *Calanus sinicus*. *C. sinicus* distributed mainly near the tidal front in winter and early spring and in the centre of YSCBW (Yellow Sea Cold Bottom Water) in summer, which occurred repeatedly in southern Yellow Sea. In order to evaluate the potential role of planktonic ciliates as prey of *C. sinicus*, vertical distributions of planktonic ciliates along two transects in central part of southern Yellow Sea were studied in 8 months during April 2006 to December 2007.
Ciliate abundance was in the range of 0- 14822 ind./L. Most of the ciliate were aloricate ciliates. The year round cycle of average planktonic ciliate in the water column (1.1×10^7-1.26×10^8 ind./m^2) showed that peak abundances appeared in May and August. In December, March and April, planktonic ciliates mainly distributed near tidal front. In May and June when YSCBW was forming, there was a tintinnid in abundance in YSCBW. In August, September and October, most of the ciliate distributed above the thermocline. Ciliate abundance in the YSCBW was very low. Therefore, in this period, ciliate could not be the food item of *C. sinicus*.

Poster presentation

ECOREGIONS OF BACTERIOPLANKTON IN THE EAST CHINA SEA AND THE YELLOW SEA
Zhao Y., Xiao T., Huang L., Huang B. and Lu R.H.

Oceanographer classified the world's coast and shelf to a nested system of 12 realms, 62 provinces, and 232 ecoregions (Marine Ecoregions of the World, MEOW). In the map of MEOW , the china sea was divided into five ecoregions (Yellow Sea, East China Sea, Gulf of Tonkin, Southern China and South China Sea Oceanic Islands). According to the characteristics of spatial patterns of bacterioplankton (heterotrophic bacteria, *Synechococcus*) and flagellate in spring and autumn, we divided the East China Sea and the Yellow Sea into four small ecoregions (Yellow Sea I, Yellow Sea II, East China Sea I and East China Sea II). We believe that this classification will be critically important in supporting analysis of patterns in marine microbiology, and in understanding the function of microbial loop.

Poster presentation

BIOMASS SIZE SPECTRUM OF NET PLANKTON IN THE YELLOW SEA
Zuo T., Tang Q., Wang J. and Jin X.

Biomass size spectra (BSS) of net plankton were analyzed based on the samples collected seasonally in the southern part of the Yellow Sea. The individual size (carbon content) compositions and functional groups of plankton were compared among the different waters in the neritic, central part and transition area of the Yellow Sea. Results showed a constant size distribution of

plankton individuals including phytoplankton (100pg C.ind^{-1}~70ng C.ind^{-1}) and zooplankton (70ng C ind^{-1}~62mg C ind^{-1}). The seasonal normalized biomass spectra (NBSS) were linear on a double log plot with the slopes which strongly deviated from the ideal value (slope = -1.22) of a steady pelagic ecosystem. The slope was less negative in autumn and winter than in spring and summer. According to the statistical analysis, plankton functional diversity had more influences on characters of normalized biomass size spectra. Based on the BSS, the trophic pagoda trees of plankton in the Yellow Sea were depicted showing seasonal functional groups compositions with individual size class.

Poster presentation

Useful Approaches for Detection and Interpretation of Cascading Trophic Interactions

Amy N.S. Siuda[1,2] & Hans G. Dam[1]
1. Department of Marine Sciences, University of Connecticut, Groton, CT 06340, USA
2. Current Address: Sea Education Association, Woods Hole, MA, USA

Our presentation will focus on addressing one of the key questions of the e2e food web workshop: **What modelling approaches can we adopt to develop e2e analyses and what are the difficulties?** It has been difficult to document strong cascading effects in the ocean. Cascading effects are influenced by the complexity of the food web, by the degree of omnivory in the zooplankton, and by the stoichiometric imbalance between consumers and producers. Omnivory weakens cascading effects, but stoichiometric imbalance should strengthen them. These effects are not always obvious when analyzed with simple or multivariate regression techniques, but can be properly discerned with path analysis (Fig. 1). Manipulative experiments (varying additions of predators to natural food webs, and laboratory manipulation of the elemental composition of prey) are useful approaches to elucidating food web complexity.

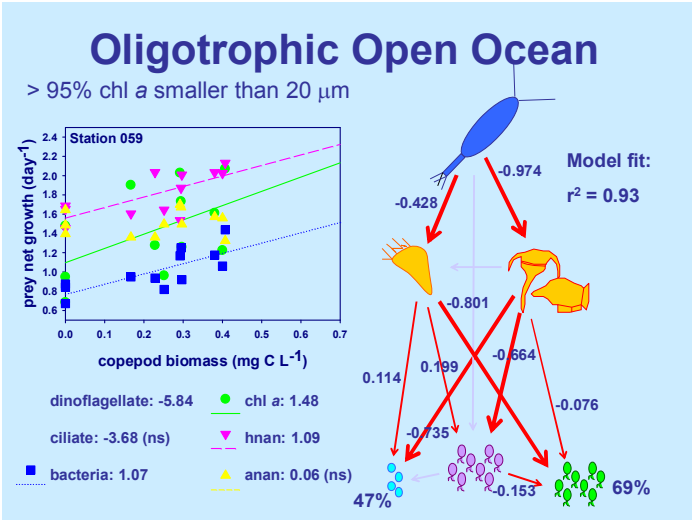
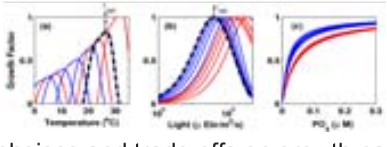


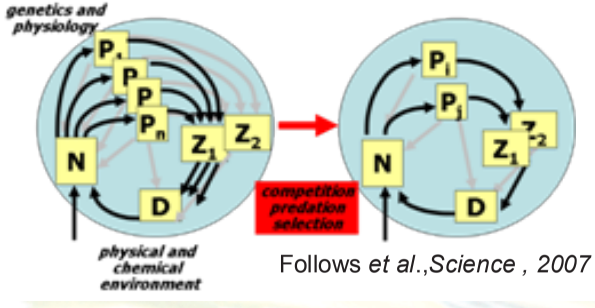
Fig. 1. Illustration of indirect cascading effects of copepods on a food web. Left panel: Net growth rate of prey type versus copepod biomass. Not all prey are plotted. Numbers under the panel for each of the prey types are regression coefficients. NS = non-significant regression coefficient. Right panel: Best fit food web model derived from path analysis. Direction of arrow indicates consumption of prey. Numbers next to arrows are path coefficients, which indicate the strength of the interaction. Width of the arrow is proportional to path coefficient. Percentages next to prey type indicate % explained variance of the prey growth rate associated with all paths leading to that prey.

The MIT Self-Assembling Ocean Ecosystem Model:

- The model is initialized with a large number of potentially viable phytoplankton, with physiological traits chosen stochastically from a plausible range.
- Competition within the ecosystem is the key organizing principle, and allows community structure to self-assemble rather than be imposed.
- This is a unique tool to investigate applicability of ecological theories and ideas in a 3-D ocean circulation and biogeochemistry simulation.
- We are working to encompass multiple trophic with this same approach.



choices and trade-offs on growth parameters



Follows *et al.*,*Science , 2007*

Stephanie Dutkiewicz, Mick Follows and Jason Bragg

The Darwin Project

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Applications of the NEMURO.FISH model

Michio J. Kishi[1,2)]

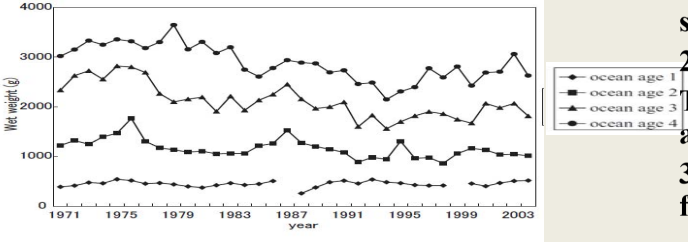
Hokkaido University, 2)FRSGC JAMSTEC, Japan

d(Biomass)/dt=d(Weight*Number)/dt
=N(dW/dt)+W(dN/dt)

Bio-energetic model NEMURO.FISH

Population dynamics/ Lagrangean model

Simulated Interannual variability of wet weight of chum salmon in Bering Sea by NEMURO.FISH



1) NEMURO.FISH can succeeds to simulate time dependent wet weight for saury, squid, salmon.

2) Criteria of migration is VERY important. To migrate toward best growth may bring about no difference of growth.

3) Multi species modelling must be included for W(dN/dt)

ADDING ACOUSTICS TO CALCOFI AND CCE-LTER: A SOLUTION TO THE END-TO-END RESEARCH CHALLENGE IN THE SOUTHERN CALIFORNIA CURRENT?

Tony Koslow
Scripps Institution of Oceanography, University of California, SD
La Jolla, CA 92093 USA (tkoslow@ucsd.edu)

Multifrequency acoustic and pelagic trawl sampling are proposed to augment the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program, which has monitored the California Current since 1949, and the California Current Ecosystem Long-Term Ecological Research (CCE-LTER) project in order to address the following questions:

the distribution and biomass of krill, micronekton, small pelagics, and juvenile fishes in relation to oceanographic features (e.g. eddies, fronts, and upwelling features);

-the spatially explicit role of these mid-trophic level elements to the ecology and biogeochemistry of the California Current (i.e. their top-down influence on the ecosystem);

-the influence of oceanography on the feeding, condition, growth, and relative survival of the late larvae and juveniles of key species (i.e. the bottom-up influence of the ecosystem on recruitment);

-the role of the mesopelagic micronekton in the flux of carbon to deep water.

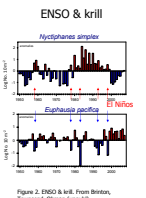


Figure 2. ENSO & krill. From Brinton, Townsend, Ohman (unpubl)

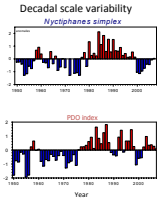


Figure 3. Decadal-scale forcing (Pacific Decadal Oscillation (PDO)) and krill species anomalies. From Ohman, Brinton and Townsend.

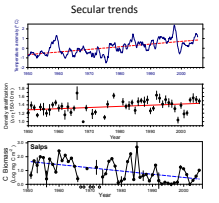


Figure 4. Secular trends: Scripps pier temperature (upper panel), density stratification (middle), and carbon biomass of salps (lower). (From Lavaniegos and Ohman 2007 *Progr. Ocean.* 75:42)

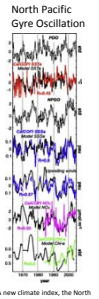


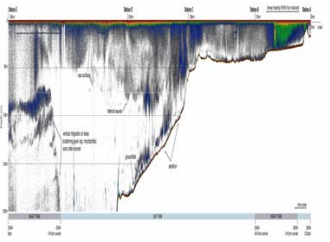
Figure 5. A new climate index, the North Pacific Gyre Oscillation (NPGO), related to basin-scale wind driven upwelling and transport, explains salinity, nutrient and chl a variability in the California Current. (From di Lorenzo et al. 2008 GRL)

In 2008, hull-mounted and portable, pole-mounted Simrad multi-frequency (18, 38, 70, 120, and 200 kHz) EK-60 echo sounders and a midwater trawl were obtained.* Funds were requested from the NOAA/NSF program, Comparative Analysis of Marine Ecosystem Organization (CAMEO), to use the system on CalCOFI, CCE-LTER and other cruises in the northern and southern California Current. The aim of the CAMEO proposal is to address key questions linking physics and lower trophic level processes to the ecology of mid- to higher trophic levels:

- the distribution, biomass, and ecology of krill, small pelagics, and juvenile fishes in relation to oceanographic features (e.g. eddies, fronts, and upwelling features) ;
- the feeding, condition, growth, and relative survival of the late larval and juvenile stages of key fish species in relation to oceanographic features to assess the factors driving recruitment success;
- the role of the mesopelagic micronekton in the flux of carbon to deep water.

These field studies, combined with retrospective analyses and spatially-explicit modelling approaches (e.g. NEMURO FISH) that cover the system from physics to the fish, are seen as a strategic approach to developing ecosystem-based fishery management in the region and to understanding the impacts of climate change.

*Funding from the Gordon and Betty Moore Foundation is gratefully acknowledged for the purchase of the acoustic and net sampling system.



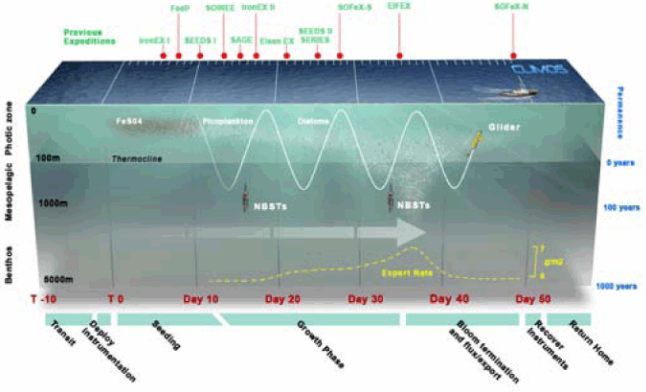
Echogram showing micronekton features in relation to topography and hydrography.

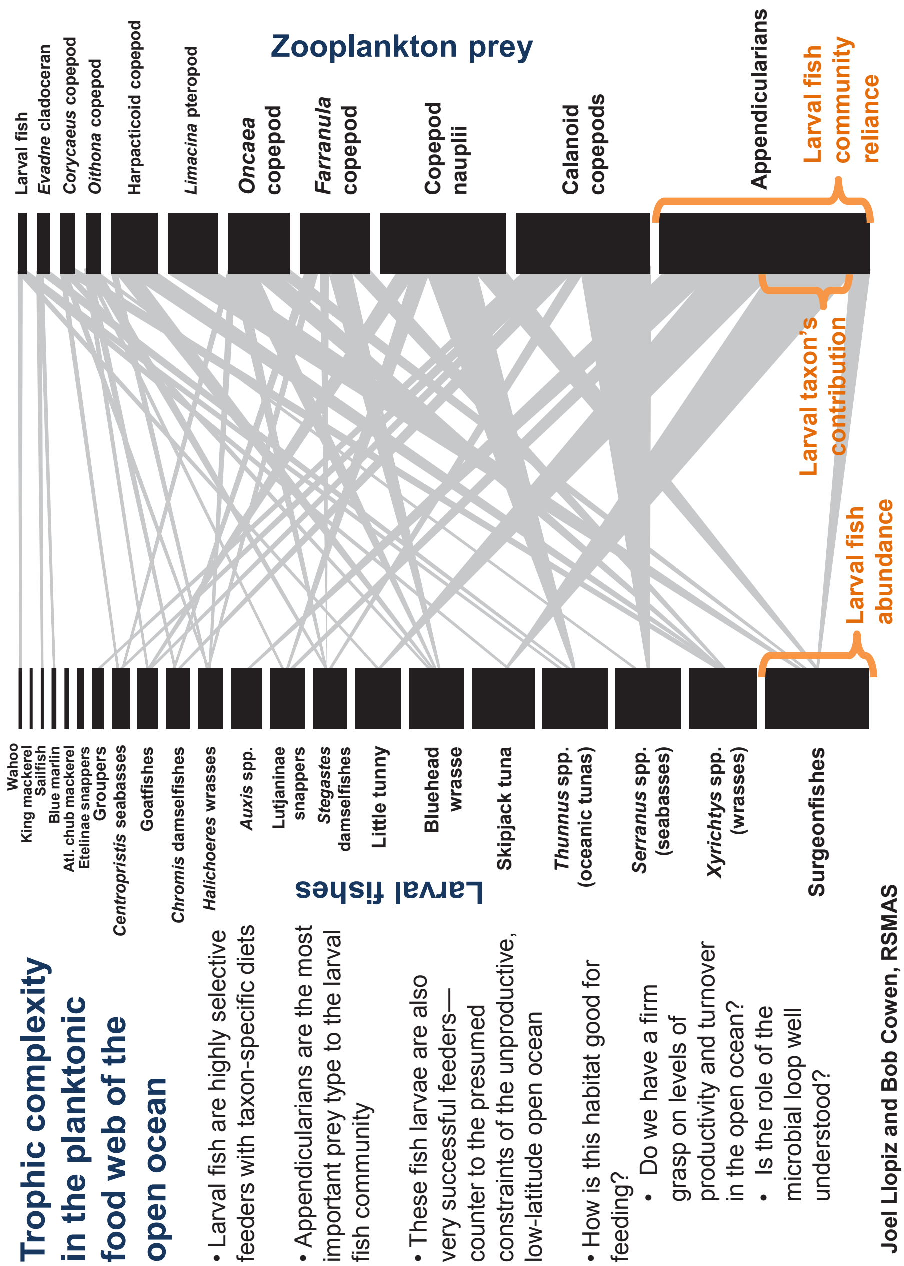
Japanese-designed midwater research trawl designed for towing at 4 – 5 kt for efficient capture of juvenile fishes and other micronekton.

MODERATE-SCALE OCEAN IRON FERTILIZATION EXPERIMENTS AND THEIR USE IN END-TO-END FOOD WEB STUDIES

MARGARET LEINEN
CLIMOS, INC.
119 S. Columbus Street
Alexandria, VA 22314

The scientific community has called for moderate-scale ocean iron fertilization (OIF) experiments (up to 200 x 200 km) in order to understand the potential of OIF for carbon mitigation and its impact on the ocean environment. This will certainly require study of end-to-end food webs. However, studies of the impact of OIF on ocean biology have the potential to also be extremely valuable experiments for understanding end-to-end marine food webs. For example, such experiments allow the unique opportunity to look at perturbation of open ocean food webs. This will probably require sampling strategies and, perhaps, instrumentation that can be deployed in the mid-waters, bottom waters, and benthic environment and/or that can travel with water masses. The experiments might be appropriate as model systems for study of climate change impacts on end-to-end marine food webs. Although they experiments would not involve changes in most physical properties of water masses or in water masses themselves, the chemical and biological changes may mimic some climate change impacts.




Trophic complexity in the planktonic food web of the open ocean
• Larval fish are highly selective feeders with taxon-specific diets
• Appendicularians are the most important prey type to the larval fish community
• These fish larvae are also very successful feeders—counter to the presumed constraints of the unproductive, low-latitude open ocean
• How is this habitat good for feeding?
• Do we have a firm grasp on levels of productivity and turnover in the open ocean?
• Is the role of the microbial loop well understood?
Joel Llopiz and Bob Cowen, RSMAS
Zooplankton prey
Larval fish
Evadne cladoceran
Corycaeus copepod
Oithona copepod
Harpacticoid copepod
Limacina pteropod
Oncaea copepod
Farranula copepod
Copepod nauplii
Calanoid copepods
Appendicularians
Larval fish community reliance
Larval taxon's contribution
Larval fish abundance
Larval fishes
Wahoo
King mackerel
Sailfish
Blue marlin
Atl. chub mackerel
Etelinae snappers
Groupers
Centropristis seabasses
Goatfishes
Chromis damselfishes
Halichoeres wrasses
Auxis spp.
Lutjaninae snappers
Stegastes damselfishes
Little tunny
Bluehead wrasse
Skipjack tuna
Thunnus spp. (oceanic tunas)
Serranus spp. (seabasses)
Xyrichtys spp. (wrasses)
Surgeonfishes

By Hongguang Ma

In the Chesapeake Bay, there is a need to adopt ecosystem-based approaches to fisheries management as suggested by the Fisheries Ecosystem Planning (FEP). In response to the FEP, the NOAA Chesapeake Bay Office initiated a project to develop an Ecopath with Ecosim (EwE) model for the fisheries ecosystem. To address the needs in the Chesapeake 2000 agreement (C2K), we are trying to link the fisheries ecosystem model with a water quality model (WQM) developed by the US EPA Chesapeake Bay Program to assess the impacts of different water quality management scenarios (Figure 1). In addition, we used a hydrographic model to simulate the long-term pattern (~ 50 yr) in primary production driven by nutrient loading.

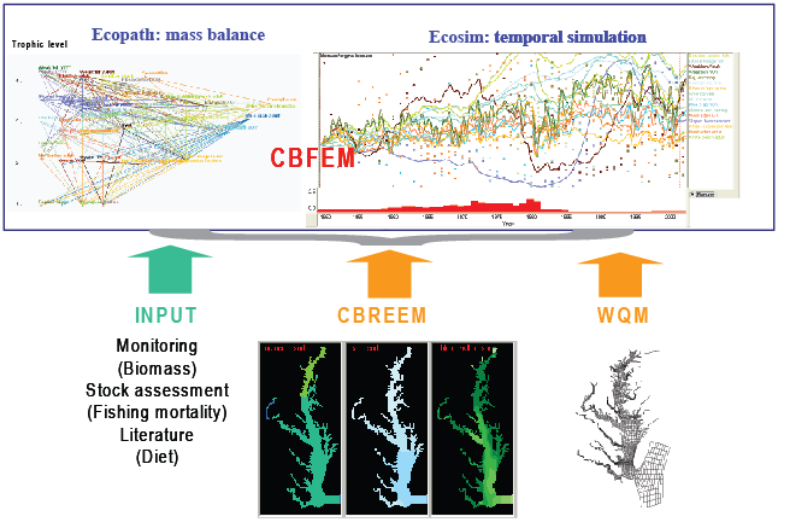
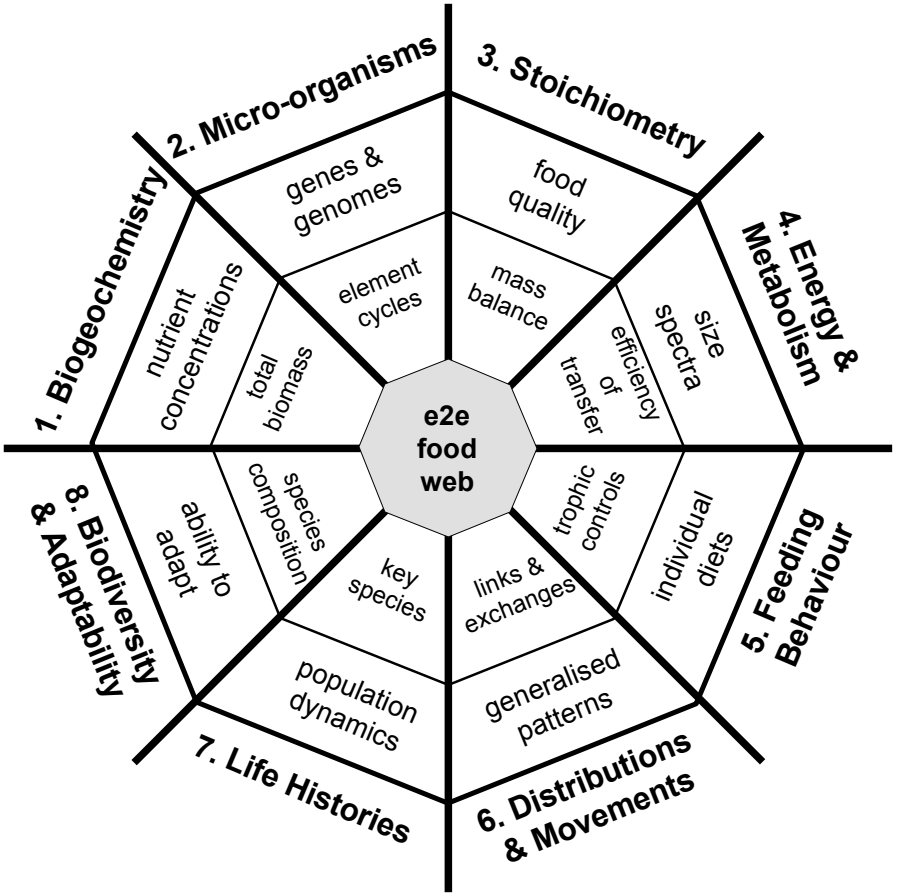


Figure 1. Inputs and links to the Chesapeake Fisheries Ecosystem Model (CBFEM) developed with Ecopath and Ecosim. CBREEM is a hydrographic model and WQM is a water quality model developed by EPA.

To effectively manage natural resources in the Bay, it is desirable to consider the effects of eutrophication/water quality (bottom-up) and fishing (top-down), i.e. the End to End Food Web approaches. How to link low trophic level species in the water quality model with high trophic level species in EwE model is one of the key issues. There is no direct interactive coupling between these two models due to different temporal and spatial scales used. Currently, non-coupled model comparisons and indirect (one-way) coupling have been used. The first approach does not really involve quantitative exchange of information between models, but rather it involves comparative analysis of the structures and behaviors of the two models from which information can be derived to improve interpretation of each model. In the second approach, the output from WQM and other models are used as input or used to construct forcing or mediation functions for EwE ecosystem model. Ideally, we can combine two model codes into a single executable program with information exchanged between the two models at each time step. It would require a substantial investment of time and resources to modify respective model codes to accommodate required spatial/temporal scales and currencies of exchange. As an alternative, we are developing a spatially explicit fisheries ecosystem model with Atlantis which can accommodate submodels for primary production, invertebrates, vertebrates, nutrients, and oceanography.

Weaving marine food webs from end to end

Coleen Moloney, Mike St John, Ken Denman, Dave Karl,
Fritz Köster, Svein Sundby and Rory Wilson

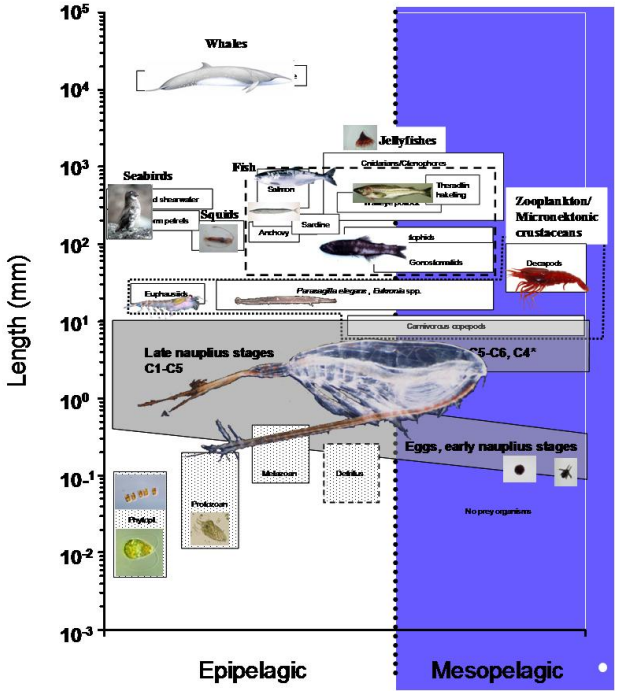


A framework for end-to-end food web research. Eight major thematic areas are shown. Each theme spans small to large time and space scales. All themes are required for predictions of marine ecosystems under global change. The challenge is to isolate the relevant elements or processes from each theme at appropriate times and combine them sensibly to predict ecosystem dynamics

Pivotal role of *Neocalanus* linking E2E food-web

Hiroaki Saito: Fisheries Research Agency, Japan hsaito@affrc.go.jp

Prey-predator interactions of *Neocalanus*



Neocalanus directly liked to food-web components in the size range between 5×10^{-6} and 2x10 m (i.e., 10^{7} order in length)

Feeding on 14% of 1er prod. year^{-1} (Oyashio).

Transporting 1.06×10^{14} gC y^{-1} to the mesopelagic layer in the subarctic North Pacific.

Predation rates on *Neocalanus*

Myctophids:	21.3	x 10^{12} gC y^{-1}
Baleen whales:	1.5	x 10^{12} gC y^{-1}
Sea birds:	0.010	x 10^{12} gC y^{-1}
Japanese sardine: (at peak biomass)	6.4	x 10^{12} gC y^{-1}

Neocalanus biomass varies year-to-year by a factor of 10 (Oyashio).

What are drivers of the annual variation in *Neocalanus* biomass and what impacts does the variation induce on E2E food-web?

End-to-end modelling approaches in the Black Sea

Baris Salihoglu, Temel Oguz, Bettina Fach

Institute of Marine Sciences, Middle East Technical University, Erdemli, Mersin, Turkey

We have developed a a coupled lower trophic level (Fig. 1) and anchovy Engraulis encrasicolus ponticus population dynamics model (Fig. 2) to analyze the mechanisms controlling sharp anchovy and gelatinous zooplankton biomass transitions from the 1960s to the 2000s in the Black Sea (cf. Oguz et al., 2008a).

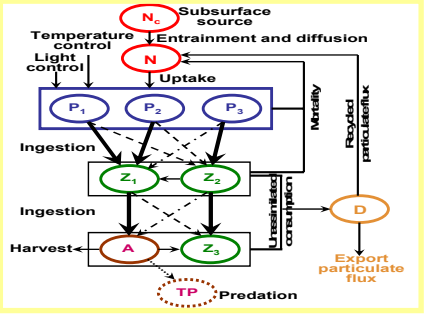


Fig. 1 NP3Z3 MODEL: Nitrate +3 phytoplanton functional groups + 3 zooplankton

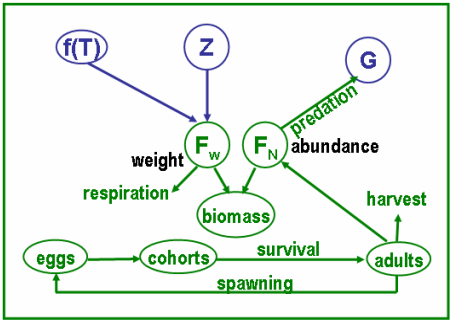


Fig. 2 ANCHOVY life cycle model: Bioenergetic based model with 90 cohorts: spawning June to August: (90 days)

Simulations showed that a combination of direct and density-dependent effects of overfishing, eutrophication-induced nutrient enrichment, climate-induced over-enrichment, and temperature-controlled opportunistic carnivore (i.e. Mnemiopsis) spring production were the controlling mechanisms of the ecosystem during 1960s to 2000. For example, the model is used to analyze the Anchovy-Mnemiopsis regime shift that took place during 1989-1990. Simulations suggest that eutrophication made the system vulnerable to further enrichment by the change of regional climate to a severe winter regime during 1985-1987. As Mnemiopsis acclimated to its new environment, this increased nitrate flux into the euphotic layer enhanced the carrying capacity of the system but a disproportionate Mnemiopsis biomass increase was delayed until spring temperature conditions returned to normal in 1989-1990. Enhanced carrying capacity provided competitive advantage in food consumption to Mnemiopsis, and warm spring temperature conditions promoted increased spring-summer productions. Relative to the high stock regime of the early- 1980s, two-thirds of the total anchovy stock loss was realized by increasing fishing pressure prior to the Mnemiopsis population outbreak. The rest occurred during the Mnemiopsis outbreak period due to the sum of prevailing high fishery and increased impact of Mnemiopsis on the food web.

This work is a good example that shows the importance and usefulness of developing end-to-end approaches, also it indicates the key issues to consider in end-to-end analyses. A schematic showing the end-to-end operation of the Black Sea ecosystem is given in Fig. 3 (After Oguz et al., 2008b).

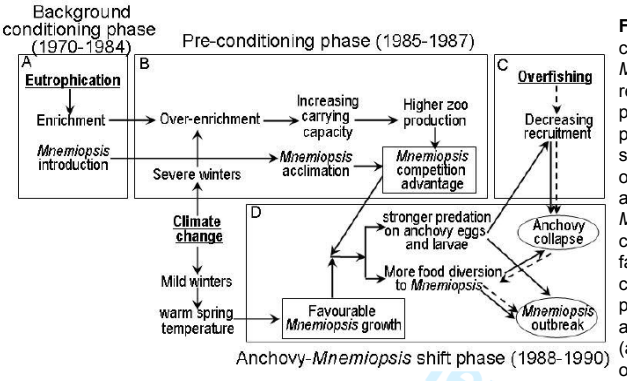


Fig. 3 Main features of the new conceptual description of the anchovy-*Mnemiopsis* shift. The boxes A and B represent the background- and preconditioning phases of *Mnemiopsis* population, respectively. The box C shows the additional contribution of overfishing and recruitment failure to the anchovy collapse. The box D relates the *Mnemiopsis* population outbreak and concurrent anchovy stock collapse to favourable spring temperature conditions, stronger *Mnemiopsis* predation on anchovy eggs and larvae and more food diversion to *Mnemiopsis* (arrows with continuous line) as well as overfishing (arrows with broken line).

Comparing internal and external drivers in the southern Benguela, and the southern and northern Humboldt upwelling ecosystems

L.J. Shannon, S. Neira and M. Taylor

- Trophic models of three upwelling ecosystems were fitted to catch, abundance and fishing mortality time series. Three drivers were considered during the model fitting: internal forcing by means of the trophic flow controls between the various interacting species groups, and two types of external forcing; fishing and the environment.
- Fishing has been relatively carefully managed in the southern Benguela during the period modelled (1978-2003) and previous studies found that most of the resource variability was attributed to internal trophodynamic forcing and to environmental forcing rather than to fishing. By comparison, fishing has been shown to have played a relatively major role in driving ecosystem changes observed in the southern and northern Humboldt models.
- In an attempt to start to uncover the processes that may be involved in linking the environment to observed ecosystem dynamics and changes in these upwelling ecosystems, environmental forcing was examined by searching for hypothetical forcing functions, affecting different levels of the food web, which improved the model fits.
- Model results confirmed the important ecological role played by small pelagic fish in the studied upwelling ecosystems. For example, the fit of the Southern Benguela model to time series data of catch and abundance was similarly improved when anchovy/sardine-prey and anchovy/sardine-predator interactions were externally forced (Fig. 1), supporting the wasp-waist hypothesis.
- Although physical drivers and conditions may differ in their nature or merely their frequency and intensity between systems, and different fishing strategies operate in the three ecosystems, model results suggest that these effects are transferred through the ecosystems and manifest themselves as ecosystem changes and observed resource dynamics largely via interactions with small pelagic fish.

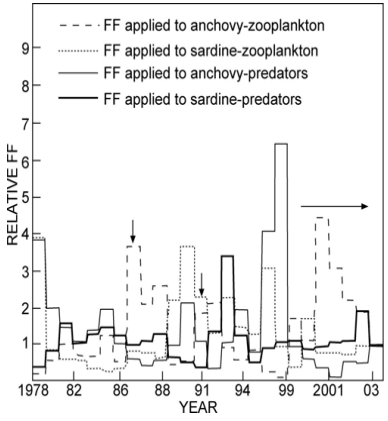


Fig. 1 Southern Benguela monthly forcing functions applied to i) anchovy and sardine as predators (i.e. anchovy-meso/macrozooplankton interactions and sardine-meso/macrozooplankton interactions) and ii) anchovy and sardine as prey (i.e. anchovy-all predators and sardine-all predators interactions), after fishing was included and vulnerability parameter values (*vs*) had been estimated for the 25 most sensitive interactions. Anchovy biomass was high in the years marked on the graph.

Shannon, L.J., Neira, S., Taylor. 2008. Comparing internal and extemal drivers in the southem Benguela
•and the southern and northern Humboldt upwelling
•ecosystems. African Journal of Marine Science 30(1): 63-84.

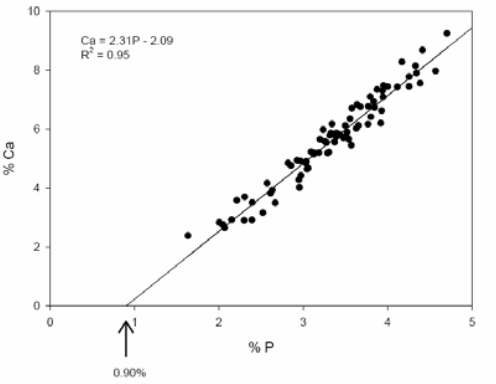
ECOLOGICAL STOICHIOMETRY AS A TOOL FOR END TO END APPROACHES

ROBERT W. STERNER

A set of tools designed to link biogeochemistry to food web dynamics have been developed within the field of Ecological Stoichiometry (ES). ES has been applied most often to freshwater systems but has also been extended to terrestrial and marine systems as well. ES considers species in higher trophic levels to be abstract molecules with defined elemental content. It considers autotrophs and some microbes to be more flexible in their elemental content.

Because different species have different chemical content, community shifts in dominance patterns have biogeochemical imprint. Further, system-level biogeochemical patterns in nutrient availability exert influence on community structure due to different needs for elements by different species.

Fish are among the most stoichiometrically variable species that have yet been studied with ES approaches. It seems as though there has not yet been a systematic study of elemental content of marine fish, but for freshwater fish, phosphorus and calcium are tightly correlated with a coefficient similar to the Ca:P ratio of apatite mineral found in bones and scales (Fig.) (Hendrixson et al. 2007). This result points to a wide range of biogeochemical functions possible with fish.

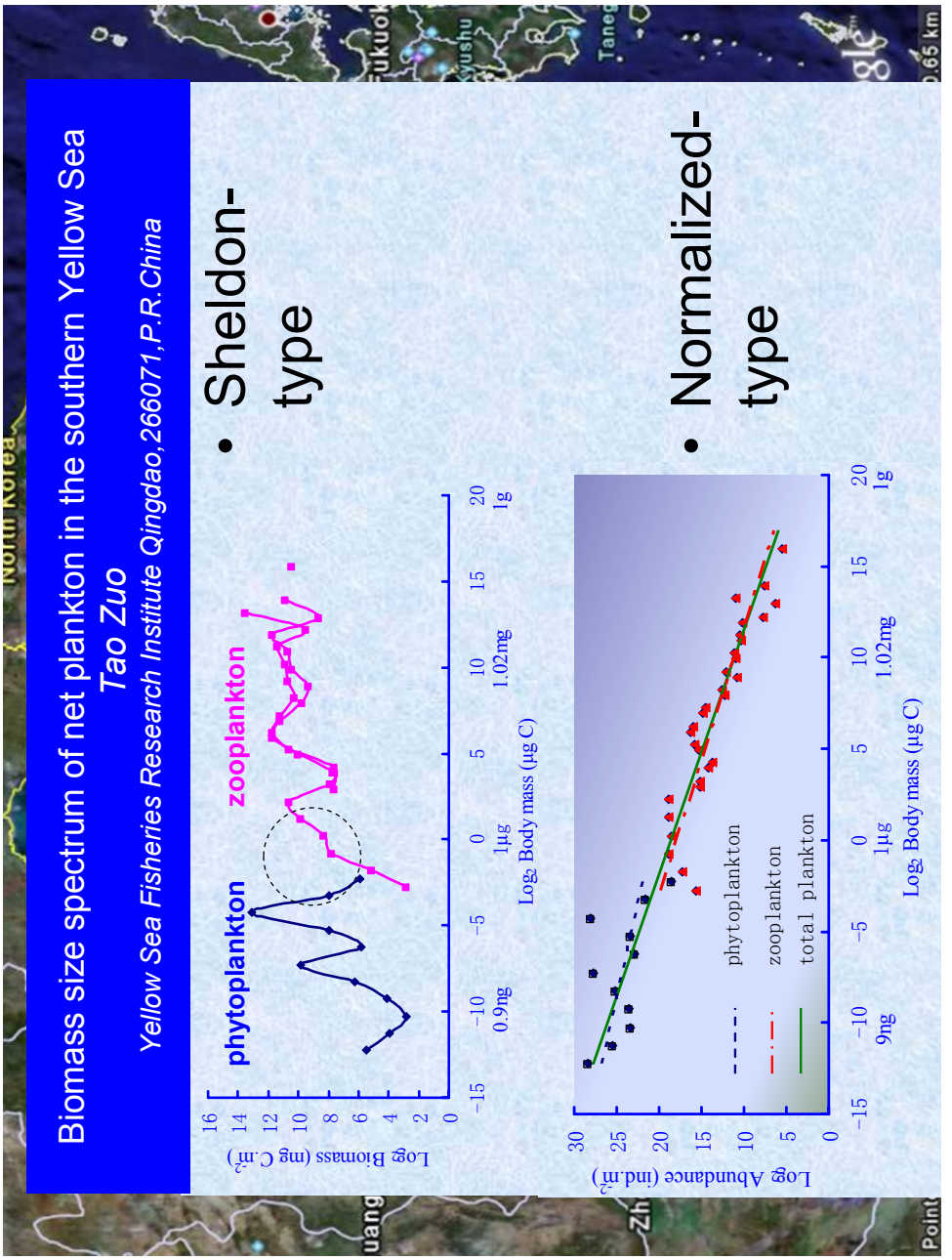


At the other end of the food web, marine and freshwater seston have patterns in C:N:P ratio that reflect a strong scale dependence (Sterner et al. 2008). Regionally (within single ocean basins, for instance), C is related to N and P via a power law function, not a constant ratio as has often been assumed in the past. A constant ratio approach is appropriate, however, for the largest scales of observation.

Ecological Stoichiometry will continue to provide a means of linking food webs and biogeochemical functioning from end to end.

Hendrixson, H. A., R. W. Sterner, and A. D. Kay. 2007. Elemental stoichiometry of freshwater fish in relation to phylogeny, allometry and ecology. Journal of Fish Biology 70:121-140.

Sterner, R. W., T. Andersen, J. J. Elser, D. O. Hessen, J. M. Hood, E. McCauley, and J. Urabe. 2008. Scale-dependent carbon:nitrogen:phosphorus seston stoichiometry in marine and freshwaters. Limnology and Oceanography 53:1169-1180.


Biomass size spectrum of net plankton in the southern Yellow Sea
Tao Zuo
Yellow Sea Fisheries Research Institute Qingdao,266071,P.R.China
• Sheldon-type
phytoplankton
zooplankton
Log Biomass (mg C.m⁻³)
Log2 Body mass (μg C)
• Normalized-type
Log Abundance (ind.m⁻³)
phytoplankton
zooplankton
total plankton
Log2 Body mass (μg C)

Ecological and Biogeochemical Interactions in the Mesopelagic Zone

Chairs: Debbie Steinberg and Hiroaki Saito

Organizing Committee

Debbie Steinberg (co-chair, USA)
Hiroaki Saito (co-chair, Japan)
Javier Arístegui (Spain)
George Jackson (USA)
Carol Robinson (UK)
Richard Sempéré (France)

Invited speaker: Dr Richard Lampitt, a biogeochemist with a main focus on the factors that control the downward flux of material from the surface ocean to the deep seabed, will give a plenary talk on the mesopelagic during the opening session of the IMBIZO. Dr. Lampitt is a senior scientist at the National Oceanography Centre, University of Southampton, UK.

Guidelines

Seven 1.5-2 hour focused sessions will be held during the workshop. Speakers will provide a 15-minute overview/ provocative talk for each session on the topic to initiate discussion.

Topics planned for discussion include:

• Mesopelagic particulate and dissolved organic matter distribution, source material, characterization, and flux
• planktonic food web controls on vertical transport, cycling, and composition of particulate and dissolved organic matter
• linking microbial and metazoan diversity to function
• regional comparisons in food-web structure and biogeochemistry, and potential responses of the system to environmental change
• ecological and biogeochemical approaches to estimating remineralization rates
• models
• methods and new technologies
• What should future mesopelagic zone research programs look like?

Each participant is encouraged to present one poster on their relevant science. Participants should bring reduced/electronic version of their poster for distribution and discussion.

Outcomes

A special issue of a journal will be developed through the contributions of the workshop participants.

A synthesis paper, highlighting the findings of the workshop, will be developed by a subset of participants.

Meeting room: all Mesopelagic sessions will take place in room **Kentia 1 & 2**

	Monday 10	Tuesday 11	Wednesday 12	Thursday 13
7:30 - 8:30	Registration			
8:30 - 8:45	**Welcome plenary session**	**Regional comparisons of mesopelagic food web structure and biogeochemistry, response to environmental change** Chair: Hiroaki Saito Speakers: Ken Buesseler, Bernard Quéguiner **Key issues for discussion:** 1) What regions do we know about already, where do we need to concentrate on in future research? 2) Potential responses of the mesopelagic system to climate change or other anghropogenic disturbances 3) Potential feedbacks between changing surfaces ocean productivity and community structure to mesopelagic	**Workshop synthesis** Preparation for plenary reports	**IMBIZO plenary session** Final presentations, discussions and writing
8:45 - 9:00	**Hiroaki Saito** End to end foodwebs			
9:00 - 9:15				
9:15- 9:30				
9:30 - 10:00	**Richard Lampitt** Mesopelagic			
10:00 - 10:15			**Raymond Pollard** Plenary on data integration	
10:15 - 10:30	*Coffee break*			
10:30 -10:45		*Coffee break*	*Coffee break*	*Coffee break*
10:45 - 11:00	**Dave Karl** Bathypelagic			
11:00 - 11:15		**Mesopelagic workshop break out session** **Ecological and biogeochemical approaches to estimating remineralization rates** Chair: Javier Aristegui Speakers: J. Aristegui, Wajih Naqvi **Key issues for discussion:** 1) Time and space scales of organic matter remineralization int the mesopelagic zone 2) Pros, cons and mismatches in using different approaches 3) Consideration of suspended POM and of DOC in addition to sinking POC 4) Comparing AOU with respiration estimates from heterotrophs-	**IMBIZO Plenary session** Reports from 3 workshops	**IMBIZO Plenary session** Final presentations, discussions and writing
11:15 - 11:30				
11:30 - 11:45	**Welcome, Introductions, plans for the mesopelagic workshop** Debbie Steinberg and Hiroaki Saito			
11:45 - 12:00				
12:00 - 12:15	**Mesopelagic POM/DOM distribution, source material, characterization, flux** Chair: Richard Sempéré Speakers: R. Sempéré, Juan Carlos Miquel ...			
12:15 - 12:30				
12:30 - 13:30	*Lunch*	*Lunch*	*Lunch*	*Lunch*

Time				
13:30 - 13:45	**..Meso POM/DOM distribution..** **Key issues for discussion**	**Models** Chair: George Jackson Speakers: G. Jackson, Tom Anderson **Key issues for discussion** 1) Status of models: TEP, ballast, aggregation, zooplankton, global biogeochemical, assimilation 2) Are current models suitable to cover processes discussed? 3) How should we model the complex processes in this zone?	**What should future mesopelagic zone research programmes look like?** Chairs: Debbie Steinberg, Hiroaki Saito	**Writing sessions for chairs, rapporteurs, etc**
13:45 - 14:00	1) Vertical and horizontal distributions 2) Variations and controls on 'Martin Curve'			
14:00 - 14:15	3) Characterization of semi-labile and refractory DOM 4) Importance of episodic, seasonal forcing			
14:15 - 14:30	5) Links between particle size/type distributions, sinking rates			
14:30 - 14:45	**Planktonic food web controls on vertical export, cycling, and composition of POC and DOC**			
14:45 - 15:00	Chair: Debbie Steinberg			
15:00 - 15:15	Speakers: D. Steinberg, Santiago Hernandez-Leon	*Coffee break*	*Coffee break*	
15:15 - 15:30	**Key issues for discussion**	**Methods, new technologies** Chair: Paul Wassmann Speakers: Bruce Robison, Thomas Reinthaler **Key issues for discussion** 1) Measures of respiration, new promising techniques? 2) Experiments at in situ pressure, temperature 3) Detection and sampling of microbes and metazoans- (genomics, video profiling, etc.) 4) Different approaches encompass different time and space scales? 5) Required process studies and sustained, or new, observational programes?	**Meso workshop break out session Synthesis**	
15:30 - 15:45	1) What is the role of the mesopelagic food web in determining quality, quantity and export of organic matter? 2) Transformations by microbes vs. zooplankton			
15:45 - 16:00	3) Daily cycles of organic matter & prokaryotic activity in the mesopelagic, incl. the role of migrators			
16:00 - 16:30	*Coffee break*			
16:30 - 16:45	**Linking microbial and metazoan diversity to function**			
16:45 - 17:00	Chair: Carol Robinson Speakers: Craig Carlson, Karen Wishner **Key issues for discussion**			
17:00 - 17:15	1) Mesopelagic diversity - current knowledge of microbial/ melazoan communities	**Joint poster session and refreshments**	**Joint poster session and refreshments**	
17:15 - 17:30	2) Role in POM-DOM transformations			
17:30 - 17:45	3) Significance of 'hot spots' of biological activity			
17:45 -18:00	4) Controls of prokaryotic mesopelagic production: grazing vs. virus infection			
18:00 - 19:00				

PLENARY TALK

A ZONE OF TRANSITION: THE MYSTERIES OF THE MESOPELAGIC
Lampitt R.S.

The twilight zone or mesopelagic (100-1000m depth) has been a focus of study for many years as a result of its rich diversity of species some of which periodically venture into the surface zone. It is, however only in the last decade that the processes taking place there are seen to have a fundamental effect on those in the euphotic zone and hence a direct bearing on the global climate. It is therefore no longer acceptable to ignore those processes which happen to take place below the 1% light level and the requirement is for a deeper understanding of these processes and how they might change in the future.
This presentation is an overview of the progress that has taken place over the last decades, some impressions of our current understanding and an assessment of the outstanding questions. The community has recently lost some particular skills mainly from the biological sciences and although these have the potential to be replaced by others, some remedial action can be taken now. Techniques presently at our disposal include novel means of sampling and observing this environment. Developments of autonomous sensors are already giving us great insights into the changes that occur in the mesopelagic and sensors now under development will further enhance our ability to make observations whether from ships, eulerian observatories or drifting floats. Finally new approaches to modelling have taken place which will enable us to tease apart the complex spatial and temporal variations in the physical, biological and biogeochemical processes.

POSTER ABSTRACTS

INTER DAILY VARIABILITY OF NANOPLANKTON AND MICROPLANKTON ASSEMBLAGES IN THE COASTAL UPWELLING ZONE OFF NORTHERN CHILE
Aguilera V., Escribano R. and Herrera L.

Autotrophic and heterotrophic components of nanoplankton and microplankton play a key role in producing and channelling organic carbon through the food web in the marine ecosystem of upwelling zones. These components may vary widely in quantity and composition over a variety of spatial and temporal scales, creating a highly heterogeneous food resource for subsequent trophic levels. In this work, we assessed daily changes in sized-fractioned biomass, species richness and diversity and community structure of nanoplankton and microplankton from two upwelling sites, Mejillones (23° S) and Chipana (21° S), at northern Chile, during the summer 2006, winter 2006 and summer 2007, in association with changes in oceanographic conditions driven by upwelling variation. We found highly-significant daily changes in quantity and quality of both nanoplankton

and microplankton components coupled to a permanent, but intermittent upwelling. Over a few days the whole community may be drastically changed in terms of species and size structure. During the winter 2006 there was also a strong perturbation of remote origin that substantially impacted temperature, oxygenation and stratification of the water column overriding the upwelling process. Abundance and composition of the nanoplankton and microplankton were also drastically affected by this perturbation. Our findings suggest that despite the high biological productivity of this upwelling region, high frequency variation may be a major cause of changes in food quality for zooplankton, fish larvae and benthic organisms in the near-shore area.

Poster presentation

MESOSCALE AND REGIONAL VARIABILITY IN ORGANIC MATTER COMPOSITION: SOURCES VS DEGRADATION

Alonso-González I.J., Arístegui J., Calafat A. and Lee C.

We studied the regional and mesoscale variability in chloropigment and total hydrolyzed amino acid (THAA) compositions and fluxes in the subtropical Northeast Atlantic Ocean during two oceanographic cruises carried out in August 2006 and February 2007. Amino acid and chloropigment compositions were determined in three mesoscale eddies, two far-field stations (outside the influence of mesoscale structures), and seven stations along two transects extending from the Canary Islands to Cape Verde. Principal Components Analysis (PCA) was used to assess changes in particulate organic composition between eddy and far-field stations and over a range of latitudes (20º-27º N). Both composition and flux were influenced by the presence of eddies. An increase in chloropigment (84%) and particulate amino acid (40%) fluxes was observed in the eddy cores in comparison with the far-field stations. Compositional changes in pigments and THAA suggested that organic matter within eddies was more labile than that in far-field stations. At the eddy stations, higher chlorophyll enrichment reflected “fresher” material, while at the far-field stations a higher proportion of pheophytin illustrated the more important role of microbes and microzooplankton in degradation. With respect to regional variability, fluxes increased from 0.9 to 2.46 µmol chloropigment m^{-2} d^{-1} and from 1.45 to 2 mmol amino acid m^{-2} d^{-1} when moving from south of the Canary Islands to north of the Cape Verde Islands. Compositional changes in pigments and THAA demonstrate how the source of sinking particles varies with latitude and suggests that sinking particles were most degraded south of the Canary Islands, which is in agreement with the higher remineralization rates reported for this area. Knowledge of the quality of the organic matter entering the mesopelagic zone aids our understanding of the carbon cycle in the deep ocean.

Poster presentation

CARBON CYCLING IN THE MESOPELAGIC ZONE OF THE ARABIAN SEA: RESULTS FROM A SIMPLE MODEL

Anderson T.

Using a 3D hydrodynamic-ecosystem model, Anderson et al. (2007: Deep-Sea Research I 54, 2082-2119) investigated the carbon budget of the mesopelagic zone of the central Arabian Sea and concluded that the vertical supply of sinking particles from the euphotic zone is sufficient to meet the carbon demand of the mesopelagic biota. Justifying this conclusion, they argued that the predicted rates of bacterial production (BP) and particle export, 1.92 and 6.97 mmol C m^{-2} d^{-1} respectively, were consistent with field estimates. Bacteria were however assumed to be the sole agents of detritus turnover (D_T) in the mesopelagic, their production being calculated from the product of a fixed bacterial growth efficiency (BGE) of 0.27 and D_T.
A new model of the mesopelagic food web in the central Arabian Sea is presented in which both bacteria and zooplankton act as consumers of detritus, and in which BGE is ≤ 0.135. The predicted ratio of BP:D_T in the mesopelagic zone was 0.10, with bacteria accounting for 82% of total respiration (zooplankton were responsible for the remainder). If the carbon budget of Anderson et al. (2007) is recalculated assuming BP:D_T of 0.10 (rather than 0.27), the resulting BP is then only 1.07 mmol C m^{-2} d^{-1}, less than half the observational estimate of 2.38 mmol C m^{-2} d^{-1}. The results presented herein therefore reopen the debate as to whether BP in the central Arabian Sea is, at least in part, fuelled by external sources of organic matter such as lateral advection from the western basin.

Poster presentation

SHEDDING LIGHT ON PROCESSES THAT CONTROL PARTICLE FLUX AND ATTENUATION IN THE TWILIGHT ZONE

Buesseler K. and Boyd P.

This paper builds upon key aspects of VERTIGO (VERtical Transport In the Global Ocean) data sets to reinterpret prior process studies, especially from the JGOFS process studies and ocean station Papa. Due to the paucity of combined geochemical data on fluxes with biological data on processes, we have limited our discussion to sites where data could be re-evaluated for flux vs. depth patterns in the upper 200-500m. To obtain such a standardized dataset we used a common metric – the naturally occurring tracer thorium-234 as a POC flux proxy. We can thus compare Th derived estimates of export out of the euphotic zone and patterns of flux vs. depth below on a standardized basis. In parallel, we develop a 1-D biological model that parameterizes export from the euphotic zone and attenuation below. Both the POC flux data and models are used to set bounds on particle transformations and attenuation length scales. What results from this exercise is thus not a comprehensive synthesis, but a conceptual model of a layered ocean with particle

formation and consumption in the euphotic zone and biologically driven processes of bacterial remineralization, zooplankton feeding, and active transport and repackaging below. Taken together, this allows us to compare the importance of surface and subsurface processes in controlling the magnitude and efficiency of flux at contrasting sites. What comes out of this is also recommendations for an improved framework for sampling the twilight zone in future experiments.

Poster presentation

BACTERIAL DYNAMICS AND LINEAGE SPECIFIC RESPONSES TO MIXING AND DOM DYNAMICS IN THE MESOPELAGIC ZONE AT THE BERMUDA ATLANTIC TIME-SERIES STUDY SITE

Carlson C.A., Morris R.M., Giovannoni S.J., Hansell D.A., Goldberg S.J. and Parsons R.

The Bermuda Atlantic Time-series Study (BATS) site experiences regular annual patterns of nutrient and DOM variability, DOM diagenetic quality, and biological production, all of which are influenced by seasonal convective overturn. DOC dynamics at BATS demonstrate an annual pattern where DOC stocks accumulate rapidly within the surface 100 m, are redistributed within the upper 250 m during convective overturn, and are removed in the upper mesopelagic zone after restratification. Regular annual patterns of prokaryote cell dynamics can also be observed in the upper mesopelagic between 140 –250 m, with cell concentrations increasing during or shortly following convective overturn and persisting at elevated concentrations for several weeks. Here we use DOM characterization data in combinations with Terminal Restriction Fragment Length Polymorphism (T-RFLP), clone library and fluorescent in situ hybridization (FISH) to characterize spatial and temporal patterns in bacterioplankton lineages that respond to these mixing and DOM export events. Non-metric multidimensional scaling of monthly 200 m bacterial 16S rDNA T-RFLP fragments from 1992 to 2002 revealed temporal trends in bacterial community structure in response to mixing and introduction of diagenetically fresh DOM to the mesopelagic. T-RFLP fragments matching cloned OCS116, SAR11, and marine Actinobacteria fragments exhibited the strongest increases in the mesopelagic following convective overturn. The combination of T-RFLP data and FISH probe data allowed us to model temporal variability of the SAR11 type II ecotype in the mesopelagic zone. Together these data suggest the importance of specific bacterial lineages of bacterioplankton to the remineralization and diagenetic alteration of DOM in the upper mesopelagic zone.

Poster presentation

THE RAIN RATIOS IN THE SOUTH CHINA SEA RECORDED BY TIME SERIES SEDIMENT TRAPS

Chen J. and Wiesner M.G.

In this paper, the particle flux and ratio between the export of organic carbon and the export of calcium carbonate carbon (the “rain ratio”) was discussed based on results from time-series sediment trap experiments in the northern South China Sea (SCS-N,1987-1988) and central South China Sea (SCS-C,1991-1999, about ars break during this period).
The annual total flux was about 100 mg m^{-2} d^{-1} in the deep SCS. Higher fluxes appeared in winter or summer, suggesting the particle flux in the SCS is controlled by monsoons, while the E1 Niño event could reduce flux to about 20%. There was decoupling of particle flux between upper and deep traps, and further more, some times deep trap collected more flux than shallower traps during the same periods suggesting that advection was the main reason for this phenomenon. Biogenic material occupied the main part of bulk particles collected, up to 80%, and the ratio of biogenic matter/lithogenic matter shows the order of SCS-C>SCS-N. Carbonate particles was equivalent to opal in the biogenic matter which means that “carbonate pump” and “silica pump” are equally important in the total “biological pump” in the SCS. Rain ratio varied from 0.42-1.14 (average 0.67) in the northern South China Sea and 0.57-1.79 (average 1.10) in the central South China Sea. There is no significant seasonal variation of rain ratio in the South China Sea according to 6 year monthly average. The equivalent silica pump and carbonate pump suggested that CO_2 uptake by biological pump would be very weak.

Poster presentation

MICRO-CRYSTALLINE BARITE ACCUMULATION IN SUSPENDED MATTER AS A PROXY OF MESOPELAGIC REMINERALIZATION

Dehairs F., Jacquet s. and Cardinal D.

While the relationship between barite accumulation in oceanic sediments and primary production has been widely studied and used for reconstruction of paleoproductivities, less effort has gone into the study of the non- or slowly sinking suspended matter reservoir. Nevertheless seasonal accumulation of micro-crystalline barite in mesopelagic waters has been documented and shown to represent an ubiquitous process in the World Ocean. These crystals are formed inside degrading aggregates and pellets and reflect the process of mid water column organic matter breakdown. We have tried to calibrate excess-Ba (Baxs, mainly consisting of barite) in suspended matter against oxygen consumption rates (as obtained form advection diffusion models) and bacterial activity rates and compared these with export production (from ^{234}Th deficit) and new production. The overall aim being to constrain mesopelagic remineralization and understand spatiotemporal variability in mineralization length scales. Overall results highlight a strong relationship with bacterial

activity, and especially its vertical distribution in the upper 1000m appears important in controlling mesopelagic Baxs. Indeed, in order for larger Baxs accumulation to occur, bacterial activity needs to extend deeper in the water column well below the upper mixed layer. A further point of interest is the sensitivity of the mesopelagic Baxs proxy to (i) the type of phytoplankton dominance, with diatoms dominated systems leading to shallower remineralization, confirming observations done by others and (ii) biomass and grazing, suggesting there is relatively less mesopelagic remineralization under conditions of high biomass and high grazing pressure.

Poster presentation

CARBON SEQUESTRATION AND ZOOPLANKTON LUNAR CYCLES: COULD WE MISSING A MAJOR COMPONENT OF THE BIOLOGICAL PUMP?

Hernández-León S., Moyano M., Menéndez I., Schmoker C. and Putzeys S.

Massive iron fertilization of the oceans has been suggested as a method to remove carbon dioxide from the atmosphere. However, iron fertilization seems at present an inefficient method of carbon sequestration. Other nutrients, bacterial remineralization, grazing and environmental factors would be limiting factors. However, the role of large diel vertical migrants (DVMs) in the ocean carbon sequestration has been almost neglected. DVMs transport carbon to the mesopelagic zone due to their feeding at the shallower layers and their defecation, respiration, excretion and mortality at depth. Here, we infer that DVMs drives a rather large flux of carbon to the mesopelagic zone. We studied the plankton outburst during the so-called late winter bloom in subtropical waters in relation to lunar illumination and dust deposition in the Canary Island waters. Nutrient enrichment by mixing and dust deposition promoted a bloom of phyto-and zooplankton as observed in a previous work in the area. Mesozooplankton biomass increased as the winter mixing progressed, but peaking in every full moon and decreasing thereafter due to the effect of predation by DVMs. The pattern was similar to the one described in lakes due to predation by fishes and confirms this phenomenon as a non-negligible process in the sea. The predated zooplankton after every full moon (average of 1.9-7.8 mmolC$\bullet m^{-2}\bullet d^{-1}$) promotes an important and unaccounted flux of carbon to the mesopelagic zone. The results suggest a pivotal role of zooplankton and DVMs in the biological pump and gives insight on the fate of an iron-induced bloom in subtropical waters.

Poster presentation

MAJOR DEVELOPMENT OF BACTERIAL COMMUNITY DURING A PHYTOPLANKTON BLOOM IN THE YELLOW SEA

Liu M. and Xiao T.

To understand the bacteria-phytoplankton relationship and the influence of specific bacteria on the rate and extend of organic matter transition, major successional development and comparison of

bacterial community composition were investigated firstly during a phytoplankton bloom in the Yellow Sea. The concentrations of chla reach as high as 10mg/m^3. Vertical distribution of the chla concentrations changed dramaticly in 24 hours. The predominant bacteria community dynamics were examined during a 24 hours period encompassing the bloom by PCR-DGGE. The results indicate that the predominant bacterial communities were gamma-proteobacteria, alpha-proteobacteria, and CFB group, which were also the most dominant in the other researches about phytoplankton bloom, such as in the southern ocean, mesocosm diatom bloom. However the predominant bacterial communities during non-bloom period, which were gamma-proteobacteria, delta-Proteobacteria and Bacteroides, were different from the bloom period. These results suggested that alpha-proteobacteria might represent functional groups that play an important role in the cycling of carbon. Seven 16S rDNA clone libraries, four libraries have been finished, will provide more information in details, and further study will be undertaken.

Poster presentation

CORRELATIONS BETWEEN DISSOLVED ORGANIC MATTER (DOM) CHEMICAL COMPOSITION AND ENVIRONMENTAL PROCESSES

Meador T. and Aluwihare L.

Recent investigations have revealed spatial and seasonal variability in the oceanic concentrations and elemental ratios of dissolved organic carbon (DOC) and dissolved organic nitrogen (DON). These important global reservoirs of carbon and nitrogen thus appear to be coupled to production and remineralization processes that result in locally unique turnover of DOC and DON. DOC is also an important substrate for heterotrophic microbial communities in the subsurface ocean; therefore, factors that control the bioavailability of DOM that is exported to the mesopelagic ocean need to be elucidated. Chemical characterization analyses of ultrafiltered dissolved organic matter (UDOM) indicate both local and basin-scale variability in UDOM composition, with apparent relationships to additional biogeochemical parameters. In particular, we note strong correlations between DOM monosaccharide composition and abundances of Trichodesmium, a colonial diazotroph, and equally strong, but opposite correlations with the diatom-diazotroph symbiont Richelia. These relationships indicate distinct controls for DOM processing by autotrophic and heterotrophic communities and have begun to identify a link between plankton species composition and the flux of carbon and nitrogen through oceanic DOM.

Poster presentation

DOWNWARD POC FLUX THROUGH THE MESOPELAGIC ZONE; A HIGH-RESOLUTION STUDY IN THE NW MEDITERRANEAN SEA

Miquel J-C., Toubal T., Rodriguez-y-Baena A., Daudey D. and Andersen V.

POC production in the ocean surface and subsequent transport to depth represents one of the critical processes governing the carbon cycle. During their downward motion, sinking particles are modified through a number of processes including zooplankton grazing and repackaging, decomposition, and physical aggregation and disaggregation. Such interactions result in significant depth-dependant changes affecting the particle flux both quantitatively and qualitatively. During DYNAPROC 2, a Proof-France project aiming to better characterize the NW Mediterranean pelagic ecosystem during the summer-fall transition, particle fluxes were studied at 5 depths in the mesopelagic zone using moored sediment traps. Fluxes were measured during one month in autumn between 100 and 1000 m with a time resolution of 3 days. Carbon (TC, POC), nitrogen, pigments and ^{234}Th fluxes were assessed. Elemental and radionuclide fluxes were generally low and decreased with time and depth, except at 400 m where an input of fresh organic material likely related to the influence of zooplankton dial migrators was observed. High C/N ratios suggest an important degradation of the settling material except at 100 m and at 400 m. POC and ^{234}Th fluxes were also derived from a 0-1000 m ^{234}Th water column profile carried out short after the end of the trap sampling. Disequilibrium-based flux estimates matched (within uncertainty) those directly measured with traps at the base of the euphotic layer, and showed a clear increase of flux at the 400 m horizon. The high resolution of this study enabled biologically- and physically-mediated changes in particle fluxes to be identified.

Poster presentation

ENHANCED RESPIRATION IN PELAGIC SUBOXIC ZONES

Naqvi W., Gauns M., Naik H., Pratihary A., Roy R., Narvenkar G., Machomadkar S., Kurian S., Reshma K., and Narvekar P.

Oceanic suboxic (denitrifying) zones are characterized by a turbidity maximum, the exact cause of which remains unknown. An increase in total bacterial counts (TBC) in denitrifying waters is believed to produce the high “particle” load, but whether this is due to elevated bacterial growth or suppressed grazing-related mortality is not known. We present here data on TBC and heterotrophic nanoflagellates (HNF) from the Arabian Sea suboxic zone that show co-abundance of HNFs and bacteria within the turbid layer, thereby discounting the grazing hypothesis. We propose that bacterial abundance is controlled by a threshold response of dissimilatory nitrate reduction to decrease in ambient oxygen levels: As the oxygen concentrations approach but do not reach suboxia, respiration may be limited by low oxidant levels rather than organic matter supply, producing the “clear zone”, also distinguished by a TBC minimum, just above the suboxic zone. However,

once the nitrate reduction threshold is crossed (at oxygen < 1 μM), and bacteria are able to utilize nitrate as an electron acceptor, their rapid growth produces the turbid layer. Results of laboratory incubations of natural, initially-oxygenated samples support this hypothesis. Enhanced respiration in suboxic environments, which is consistent with previously-published data on ETS activity, has important implications for organic carbon cycling, particularly in view of projected changes in dissolved oxygen distribution in the oceans due to global warming. It also explains why maximal accumulation of organic carbon in continental margin sediments occurs not within the core of the OMZs, but close to their lower boundaries.

Poster presentation

IMPORTANCE OF LATERAL IRON TRANSPORTATION FROM THE SEA OF OKHOTSK TO THE WESTERN SUBARCTIC PACIFIC

Nishioka J., Nakatsuka T., Saito H., Ono T. and Shiraiwa T.

Iron is an essential nutrient and plays an important role in the control of phytoplankton growth. Atmospheric dust has been thought to be the most important source of iron, supporting annual biological production in the Western Subarctic Pacific (WSP). Additionally, our study clearly indicated that the intermediate waters in the WSP (North Pacific Intermediate Water: NPIW) receive their primary source of iron through ventilation processes originating in the Sea of Okhotsk, a marginal sea. We conducted direct observation of the source water in the area of the Sea of Okhotsk, and find that the large amounts of iron in the intermediate waters would be introduced by the Amur river input and the re-suspension of the sediments from the north-western continental shelf area. This source of iron is transported through NPIW formation processes and distributed to wide area in the WSP. Furthermore, there is a clear seasonality in dissolved iron concentrations in the surface waters of the WSP region. The waters are significantly influenced by high iron concentrations in the intermediate waters through diffusion and winter mixing. Therefore, in addition to the traditional view of dust input, the iron transported into mesopelagic zone by intermediate waters should be consider as an important source of iron for phytoplankton blooms in the WSP region. Our findings contribute to a better understanding of the mechanisms influencing biological production and iron biogeochemical cycles in the subarctic Pacific as well as defining the role of its marginal sea, the Sea of Okhotsk.

Poster presentation

EVALUATING EFFECT OF BALLAST MINERAL ON DEEP-OCEAN NUTRIENT CONCENTRATION BY USING AN OCEAN GENERAL CIRCULATION MODEL

Oka A.

The ballast parameterization separates sinking organic flux into two parts: the flux associated with ballast minerals and the flux independent of minerals. The ballast parameterization begins to be incorporated into global ocean biogeochemical models. However, parameters used in this parameterization such as those of calcium carbonate flux are not constrained enough and it has been difficult to evaluate quantitatively how much the ballast-induced flux affects nutrient concentration in deep ocean. In this study, we obtain optimized parameters of calcium carbonate flux by conducting 64 sensitivity simulations using export production estimated from satellite observation and an ocean circulation field simulated by a state-of-the-art ocean general circulation model. By comparing simulations with and without the ballast-induced flux with the optimized parameters, 6% of nutrient of the deep Pacific is estimated to be transported by the ballast-induced flux. Because this accounts for 30% of effects of the total biological pump, it indicates that the ability of the biological pump to carry nutrients to deep ocean significantly depends on the ballast-induced flux. Results of additional sensitivity simulations suggest that choice of model parameters associated with calcium carbonate flux strongly affects its estimation. Although the implementation of the ballast parameterization has potential ability to improve simulation of nutrient concentration, it is possible only when the model parameters of calcium carbonate flux are set appropriately.

Poster presentation

'NEW' NITROGEN ADDED BY TRICHODESMIUM IN THE ARABIAN SEA DURING THE SPRING 2006

Prakash S., Gandhi N. and Ramesh R.

The marine biological productivity of the large expanses of the oceans has traditionally been recognised as nitrogen limited. Trichodesmium, N_2-fixer, provides 'new' nitrogen to the ocean waters and plays an important role in regulating marine productivity of the oceans. Trichodesmium bloom occurs every year in the north-eastern Arabian Sea during spring inter-monsoon. During the spring, winds are predominantly from the Arabian Peninsula and other parts of the Middle East and the wind-blown dust supplies bioavialble Fe. The Arabian Sea is also known for intense denitrification, contributing ~60 TgN to the atmosphere annually. Therefore the addition of 'new' nitrogen by Trichodesmium plays a dominant role in the regulating the combined nitrogen contents in the Arabian Sea. Here we present the nitrogen contribution, in the form of nitrate, from Trichodesmium during the spring-2006 in the Arabian Sea.
A cruise was undertaken in the north-eastern Arabian Sea during April-2006 onboard FORV Sagar Sampada, (cruise# SS-244) where Trichodesmium presence was observed along the west coast

of India. A bloom of Trichodesmium was ascertained at 20°31'N, 70°36'E. We detected significantly higher concentration of nitrate (~35 mmolNm^{-2}) in the top 20m surface water at the bloom station. Nitrification of NH_4 released from the remineralization of Trichodesmium could be the source of this nitrate, as the Trichodesmium was observed at the same location. Our preliminary results show that the 'new' nitrogen input into the Arabian Sea in the form of nitrate (Trichodesmium-derived) appears to be comparable in magnitude to the estimated loss of nitrogen through denitrification.

Poster presentation

VERTICAL DISCONTINUITIES OF BIOGEOCHEMICAL PROPERTIES: THE NATURE AND LOCATION OF DEEP BIOGENIC SILICA MAXIMA IN THE SOUTHERN OCEAN

Quéguiner B., Leblanc K., Armand L., Cornet-Barthaux V. and Mosseri J.

The rapid sinking of diatom blooms out of the surface layer, as a result of nutrient limitation and/or zooplankton grazing, is often considered as a general rule in oceanic ecosystems. However, whereas several observations of fast diatom bloom sinking have been reported for coastal waters, the occurrence of deep biogenic silica maxima (DSM), principally but not exclusively, in the Southern Ocean, calls for the existence of other mechanisms coupling sinking, grazing, nutrient limitation, light adaptation, and physical processes. Here we use data obtained from recent cruises (KEOPS, SAZ-SENSE) in the Southern Ocean and revisit previous data acquired in the framework of S.O.JGOFS to derive a tentative explanation of the DSM build-up dynamics. DSM is shown to be composed of detrital material as well as living cells. DSM formation is the result of complex interactions between iron-nutrients co-limitation, iron-light co-limitation, grazing resistance of heavily silicified diatoms (not only linked to iron deficiency but to species-specific properties), low rates of silica regeneration as compared to carbon and nitrogen, and vertical position and extension of a so-called "barrier layer" controlled by wind-induced vertical mixing. There are strong differences in the intensities of the controlling factors among the different Southern Ocean subsystems although DSM is a common result at the end of the growing season. We suggest that more attention be given to the "barrier layer" DSM which has hitherto received little attention partly because of sampling difficulties. DSM could be an important component of deep HNLC and oligotrophic environments.

Poster presentation

DIATOMS AND THE BIOLOGICAL PUMP: A NOVEL VIEW FROM INSIDE SINKING PARTICLES AND INDIVIDUAL MESOPELAGIC GRAZERS

Ragueneau O., Schultes S., Moriceau B., Parenthoën M., Pondaven P. and Mémery L.

Diatoms play a major role in oceanic productivity and export of carbon but what is their exact role in the biological pump and what are the mechanisms controlling its spatial and temporal variability?

We have used recently Si as a tracer to estimate the efficiency of the biological pump, showing that in the form of POC, it must be lower than previously thought and that its efficiency increases with seasonality, not with primary production. Studying the downward evolution of Si:C ratios in different biogeochemical provinces also shows that sinking particles are profoundly modified before they reach 1000 m. To further understand the fate of the carbon exported with diatoms requires that we explore the biogeochemical processes taking place inside sinking particles (aggregates, faecal pellets) and that we better account for the complexity of biological processes taking place throughout the mesopelagic. Here, we first demonstrate that diatom-carbon degradation is clearly dependent upon diatom-silica dissolution so both Si and C can not be modelled separately anymore in ocean models. We then propose a new way of addressing the role of the mesopelagic grazers by developing a virtual mesopelagic plankton model to account for their individual behaviour within a multi-scale environment for interactions. By combining this autonomy-based approach of consumer behaviour and the biogeochemistry of the food, we hope to test hypotheses concerning the structure of the mesopelagic food web as a function of the production regime and to evaluate the feedback of this structure on the fate of carbon throughout the mesopelagic.

Poster presentation

CONTRIBUTION OF AUTOTROPHY TO PROKARYOTIC CARBON CYCLING IN THE NORTH ATLANTIC'S INTERIOR

Reinthaler T. and Herndl G.J.

The dark ocean accounts for 75% of the global ocean's volume, however, little is known about the biological activity below the euphotic zone. In the absence of light, heterotrophic processes are assumed to dominate despite the various known energy sources making autotrophy a potential alternative trophic pathway for microbes in the dark. Along an 11000 km long transect in the North Atlantic from 65°N to 5°S, we measured prokaryotic heterotrophic production via radiolabeled leucine incorporation and chemoautotrophy via 14C bicarbonate uptake at depths between 100 m and 4000 m. Heterotrophic prokaryotic production generally decreased exponentially with depth and was more variable in the northern part of the Atlantic where the meso- and bathypelagic water masses are relatively young. Chemoautotrophy decreased significantly from the subsurface to the oxygen minimum zone (~200-500 m) while rates of chemoautotrophic production in the bathypelagic were similar to that in the oxygen minimum zone. In the top 500 m, chemoautotrophy was on average twice as high as heterotrophic prokaryotic production. In the deeper water layers, however, heterotrophic prokaryotic production was 4 times higher than chemoautotrophic production. Depending on the extent of primary productivity in the surface ocean, depth integrated chemoautrophy in the meso- and bathypelagic realm is in the range of 1% to 10%. Thus, on a basin-scale,

chemoautotrophy might be an important and hitherto unrecognized sink of CO_2 in the dark ocean and a substantial source of primary production for the dark ocean's microbial food web.

Poster presentation

THE BATHYPELAGIC COMMUNITY OF THE MONTEREY CANYON
Robison B., Sherlock R. and Reisenbichle K.

We used the ROV Tiburon to conduct quantitative video transects at depths between 1000 and 3500 m over the axis of the Monterey Canyon. During 15 dives over three years, we measured the vertical distribution and abundance of the bathypelagic fauna as taxonomic groups, as trophic groups, and by species. Analyses of the data show a repeating pattern of four distinct depth regions in the vertical plane. The upper bathypelagic (1 – 1.8 km depth) had the greatest diversity and overall abundance; species diversity and abundance declined in the middle region (1.9 – 2.6 km); then increased again in the lower bathypelagic (2.7 – 3.1 km); and rose substantially in the benthopelagic layer (3.1 – 3.5 km). The principal detritivores in the upper region were copepods, doliolids, larvaceans and the aberrant polychaete Poeobius. In the middle range this trophic category was dominated numerically by Poeobius. In the lower bathypelagic and benthopelagic layers, larvaceans were the primary detritus feeders. Discarded larvacean houses ("sinkers") occurred consistently through the entire water column. Chaetognaths were most abundant in the two upper strata and declined along with their copepod prey at depths below 2.7 km. Diphyid siphonophores occurred throughout the depth range examined, while other siphonophores were discontinuous. Medusae also appeared throughout the water column but there was considerable variability of species with depth. During these dives we discovered a number of "new" animals that differ significantly from their shallower-living relatives.

Poster presentation

MESOPELAGIC MICROBIAL LOOP: ITS DIVERSITY AND FUNCTION
Tanaka T. and Rassoulzadegan F.

To better understand biogenic material cycling in the ocean, it is important to understand the diversity of both structure and function of microplankton food web in both euphotic and aphotic layers. However very little is known for distribution and activity of microbial heterotrophs in the aphotic layer. The Mediterranean is one of the interesting sites because of intense winter overturn despite relatively low latitude, P limited pelagic system during the stratified period, and a longitudinal trophic gradient. We review recent studies of the mesopelagic microbial loop in the northwestern Mediterranean: (1) Bacteria, heterotrophic nanoflagellates (HNF), and ciliates were always detected throughout the water column down to 2000 m, with one, two, and three orders of

magnitude of depth-dependent decrease, respectively. This suggests that the balance between growth and loss processes is less variable for bacteria than for protozoa over the depth and that the density-dependent predator-prey relationship becomes less coupled between the three groups with increase of depth. (2) In the mesopelagic layer, bacterial abundance was controlled by both bottom-up (substrate) and top-down (predation) controls, and the availability of dissolved organic matter was seasonally variable. (3) A food chain model analysis for the mesoepelagic layer suggested that bacterial mortality is similarly caused by viruses and HNF, and that HNF are potentially important remineralizers of the mesopelagic bacterial production. Future challenges to link the microbial loop, mesozooplankton and biogeochemical cycling will also be discussed.

Poster presentation

VERTICAL ZONATION AND DISTRIBUTIONS OF CALANOID COPEPODS THROUGH THE LOWER OXYCLINE OF THE ARABIAN SEA OXYGEN MINIMUM ZONE (OMZ)

Wishner K., Gelfman C., Gowing M., Outram D., Rapien M., and Williams R.

Oxygen minimum zones (OMZs) are thought to be expanding in the world's oceans. This phenomenon would have substantial consequences for mesopelagic zooplankton and communities. This report summarizes recent progress in understanding copepod distributions, vertical zonation, and community ecology at midwater depths (300 – 1200 m) through OMZs, especially at the lower oxycline (sharp oxygen gradient at the lower OMZ "edge"). We worked in the Arabian Sea and collected zooplankton in day and night vertically-stratified MOCNESS tows. Copepod species and species groups differed in their horizontal and vertical distributions relative to environmental and ecological characteristics. Major distributional changes were associated with surprisingly small oxygen gradients at very low oxygen concentrations (0.02 to ~0.3 ml/L) through the lower OMZ. The OMZ also affected diel vertical migration. Although some micronektonic taxa migrated into the OMZ, no apparent diel vertical migration of calanoid copepods was observed at midwater depths in the strongest OMZs. Some prominent species were omnivorous, feeding at multiple trophic levels. OMZ Subzones (Upper Oxycline, OMZ Core, Lower Oxycline, Sub-Oxycline) differed in copepod community structure and ecological interactions. Vertical zonation through the OMZ probably involves complex interactions between physiological limitation by low oxygen, potential predator control, and potential food resources. If OMZs expand in the future as a consequence of climate change, pelagic OMZ and oxycline communities, and their ecological interactions in the water column and with the benthos (where OMZs intersect the seafloor), may become more widespread and important.

Poster presentation

MESOPELAGIC ZOOPLANKTON FEEDING ECOLOGY AND EFFECTS ON PARTICLE REPACKAGING AND CARBON TRANSPORT IN THE SUBTROPICAL AND SUBARCTIC NORTH PACIFIC OCEAN

Wilson, S.E. and Steinberg, D.K.

Variations in zooplankton community structure and diet within the mesopelagic zone can differentially alter the transfer efficiency of sinking POC. How these factors change with depth or location, especially within the mesopelagic zone, is poorly known. We compared how mesopelagic zooplankton affect particle export in an oligotrophic (Hawaii Ocean Time-series site ALOHA) compared to a mesotrophic (Japanese time series site K2) open-ocean system. Specifically, we 1) investigated how fecal pellet characteristics change in sediment traps with depth in order to quantify the extent of particle repackaging by mesopelagic zooplankton, 2) analyzed fatty acid (FA) profiles to characterize zooplankton diet and large particle composition in the mesopelagic zone of these two contrasting regions, and 3) quantified cyanobacteria and small eukaryotic phytoplankton in the guts of mesopelagic zooplankton using light and epifluorescence microscopy to determine if mesopelgic zooplankton mediate the export of small phytoplankton to the deep-sea. We found significant evidence of mesozooplankton repackaging of sinking particles in the mesopelgic zone, that mesozooplankton grazing on aggregates is a pathway by which flux of carbon and picoplankton can be enhanced, and that carnivory becomes an increasingly important component of mesopelagic zooplankton diet with depth. Changes in zooplankton feeding ecology from the surface through the mesopelagic zone, and between contrasting environments, have important consequences for the quality and quantity of organic material transported to the deep sea.

Poster presentation

CROSS-LINK BETWEEN BIOGEOCHEMISTRY AND FOOD-WEB DYNAMICS USING STABLE ISOTOPES AND BIOMARKERS

Wu Y., Huang L., Wang N. and Zhang J.

Concentration of carbon and nitrogen and their isotopes are used to examine the food-web structure and the relationship between different nutrition levels from the Yellow Sea and East China Sea. GC/C-IRMS analysis was applied to fish, zooplankton and demersal species. The results showed that δ13C varied from -19.8 to -32.2‰ of which the minimum one was 22:6n3 for phytoplankton and the maximum 22:1n11 for Trachurus japonicus. Generally, 13C/12C ratio was less negative in saturated fatty acids. With an increase in de-saturation, δ13C-FA values decline. It is further demonstrated that 13C/12C ratios of individual fatty acids in potential prey (i.e. diet) and consumers allow identifying carbon fluxes and trophic links. Highly un-saturated fatty acids (PUFAs) are often used as dietary indicators since they cannot be created de novo, are seldom modified by marine organisms due to biochemical limitations, and are typically the most common fatty acids in marine

ecosystems. Combined fatty acid content analysis with Cluster and ADS analyses, fish species were identified into two groups. Fish feeding on plankton were most pelagic species and larva with specific prey preference, respectively. Benthos feeders were bottom-dwelling or demersal species. Thrissakarnrnalensis was the basal pelagic phytoplankton feeder, while Trachurus japonicus was commonly feed in seagrass circumstance.

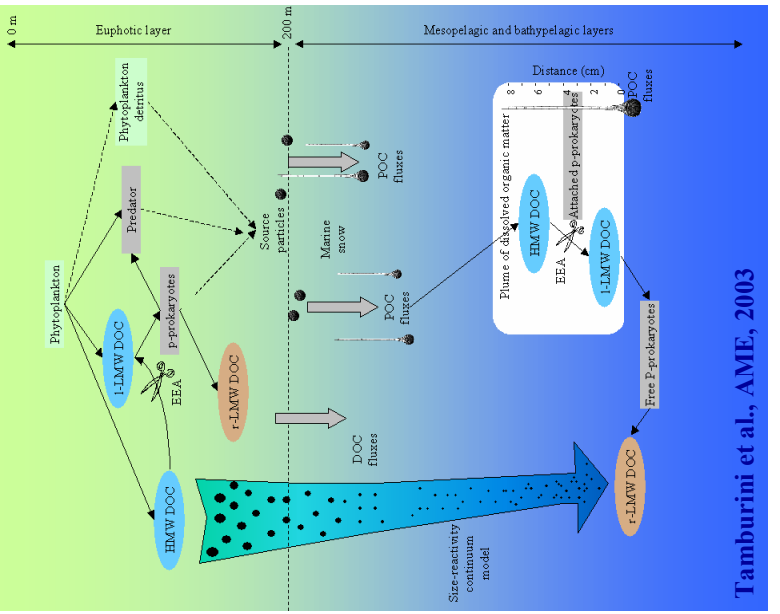
Poster presentation

S1. Mesopelagic POM/DOM distribution, source material, characterization, flux

DOM reactivity, and composition in the mesopelagic zone of the Ocean

R. Sempéré[1], C. Panagiotopoulos[1], C.Tamburini[1], D. Repeta[2] and B. Charrière[1]

[1]LMGEM/COM, UMR CNRS 6117, Marseille France; [2] Woods Hole Oceanographic Institution USA



CORRELATIONS BETWEEN DISSOLVED ORGANIC MATTER (DOM) CHEMICAL COMPOSITION AND ENVIRONMENTAL PROCESSES

Meador, Travis[1] and Aluwihare, Lihini[2]

Recent investigations have revealed spatial and seasonal variability in the oceanic concentrations and elemental ratios of dissolved organic carbon (DOC) and dissolved organic nitrogen (DON). These important global reservoirs of carbon and nitrogen thus appear to be coupled to production and remineralization processes that result in locally unique turnover of DOC and DON. DOC is also an important substrate for heterotrophic microbial communities in the subsurface ocean; therefore, factors that control the bioavailability of DOM that is exported to the mesopelagic ocean need to be elucidated. Chemical characterization analyses of ultrafiltered dissolved organic matter (UDOM) indicate both local and basin-scale variability in UDOM composition, with apparent relationships to additional biogeochemical parameters. In particular, we note strong correlations between DOM monosaccharide composition and abundances of *Trichodesmium*, a colonial diazotroph, and equally strong, but opposite correlations with the diatom-diazotroph symbiont *Richelia*. These relationships indicate distinct controls for DOM processing by autotrophic and heterotrophic communities and have begun to identify a link between plankton species composition and the flux of carbon and nitrogen through oceanic DOM.

[1] Woods Hole Oceanographic Institution, Department of Marine Chemistry and Geochemistry, MS#51, Woods Hole, MA 02543. (tmeador@whoi.edu)
[2] University of California San Diego - Scripps Institution of Oceanography, La Jolla, CA 92093-0244.

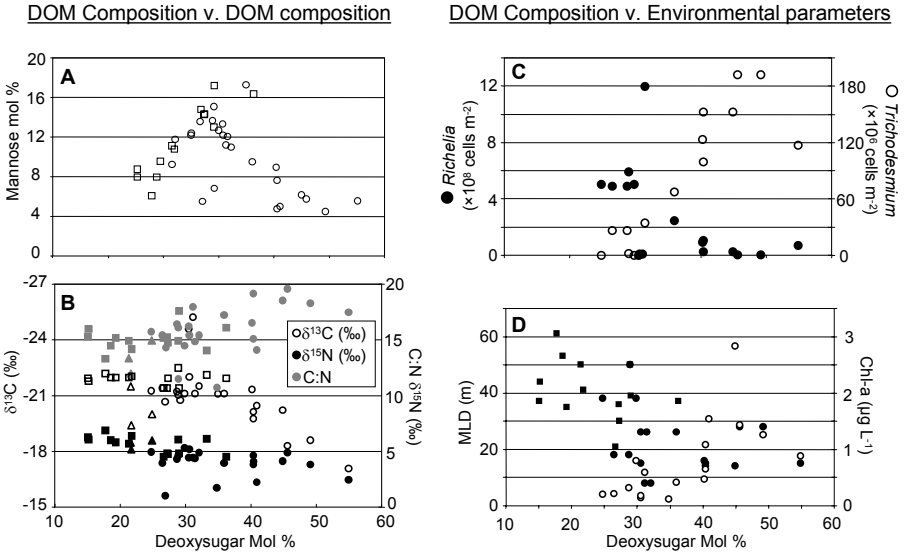


Figure 1. Regressions of combined rhamnose and fucose mole percentages in UDOM isolated in the surface subtropical N. Atlantic (circles), subtropical N. Pacific (squares), and Angola upwelling region (triangles) are plotted versus (A) mannose mole percentage in UDOM (B) δ13C, δ15N, and C:N composition of UDOM, (C) mixed layer depth, and (D) depth integrated abundances of *Richelia* and *Trichodesmium* (R. Foster *pers. comm*.).

S2. Planktonic food web controls on vertical export, cycling, and composition of POC and DOC

Vertical discontinuities of biogeochemical properties: the nature and location of deep biogenic silica maxima in the Southern Ocean

B. Quéguiner [1], K. Leblanc [1], L. Armand [2], V. Cornet-Barthaux [1], J. Mosseri [1]

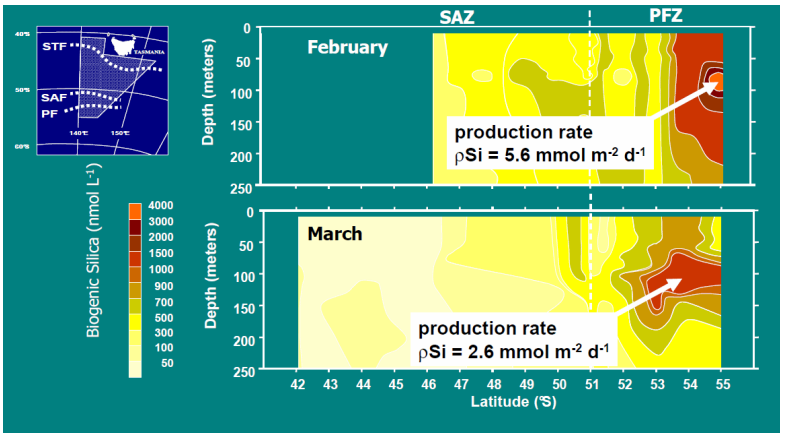
[1] Laboratoire d'Océanographie Physique et Biogéochimique, CNRS/INSU – Aix-Marseille Université, Centre d'Océanologie de Marseille, France, bernard.queguiner@univmed.fr
[2] Antarctic Climate and Ecosystems Cooperative Research Centre, Private Bag 80, Hobart Tasmania 7001, Australia

The rapid sinking of diatom blooms out of the surface layer, as a result of nutrient limitation and/or zooplankton grazing, is often considered as a general rule in oceanic ecosystems. However, whereas several observations of fast diatom bloom sinking have been reported for coastal waters, the occurrence of deep biogenic silica maxima (DSM), principally but not exclusively, in the Southern Ocean, calls for the existence of other mechanisms coupling sinking, grazing, nutrient limitation, light adaptation, and physical processes.

From data obtained from recent cruises (KEOPS, SAZ-SENSE) in the Southern Ocean and revisiting previous data acquired during the S.O. JGOFS era, DSM appear to be composed of detritus as well as living cells. DSM formation is the result of complex interactions between iron-nutrients co-limitation, iron-light co-limitation, grazing resistance of heavily silicified diatoms (not only linked to iron deficiency but also to species-specific properties), low rates of silica regeneration as compared to carbon and nitrogen, and vertical position and extension of a so-called "barrier layer" controlled by wind-induced vertical mixing. There are strong differences in the intensities of the controlling factors among the different Southern Ocean subsystems although DSM is a common result at the end of the growing season.

We propose a concept of the Deep Glass Forest, which relies on several hypotheses that await further demonstration. We stress the possibility that delayed vertical export of biogenic matter could arise from such structures which could play a role in the delivery of organic compounds to the mesopelagic layers.

We suggest that more attention be given to the "barrier layer" DSM which has hitherto received little attention partly because of sampling difficulties. DSM could be an important component of deep HNLC and oligotrophic environments. The study of discontinuity layer is particularly difficult due to the vertical scales of these structures which probably do not exceed several meters and are prone to be perturbed by traditional sampling devices. The emergence of new automated tools like AUVs should bring new opportunities to sample these small scale structures more with accuracy and less perturbation.



Jessica Frost, Uni. Hamburg

GELATINOUS ZOOPLANKTON – UNDERESTIMATED FUNCTIONAL GROUPS IN MARINE ECOSYSTEMS

- Are recent increased sightings a bona fide problem or merely passing the blame?
- Paucity of long-term series data.
- Lack of sufficient and appropriate sampling techniques for gelatinous zooplankton.
- Exploring the role gelatinous zooplankton play in the downward transfer of carbon.

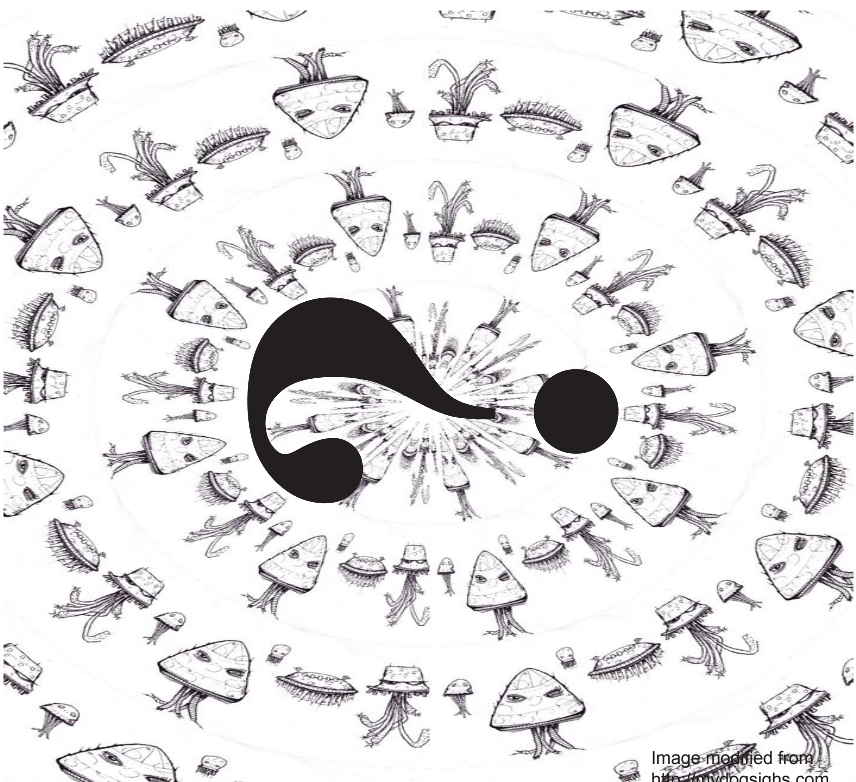


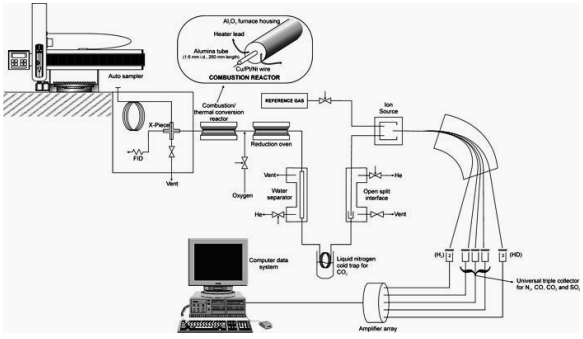
Image modified from http://mydogsighs.com

Cross-link between Biogeochemistry and Food-web Dynamics using Stable Isotopes and Biomarkers

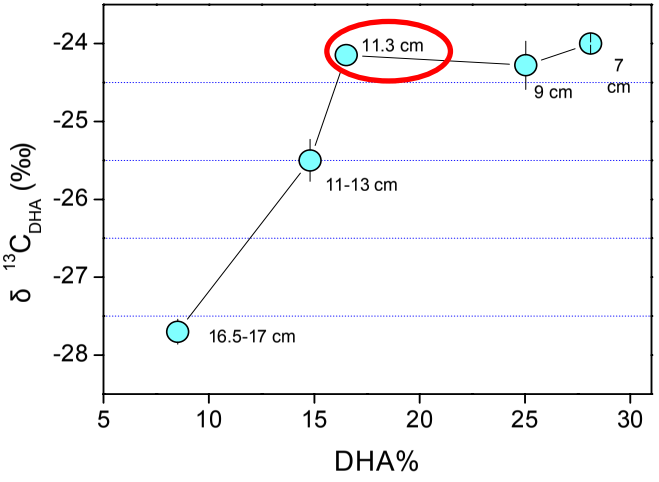
Y. Wu, L. Huang, N. Wang and J. Zhang

East China Normal University

Shanghai, China



In this study, we use GCC-IRMS (left) to determine the isotopic composition of individual fatty acids compounds to understand the food-web dynamics in the Yellow Sea and East China Sea

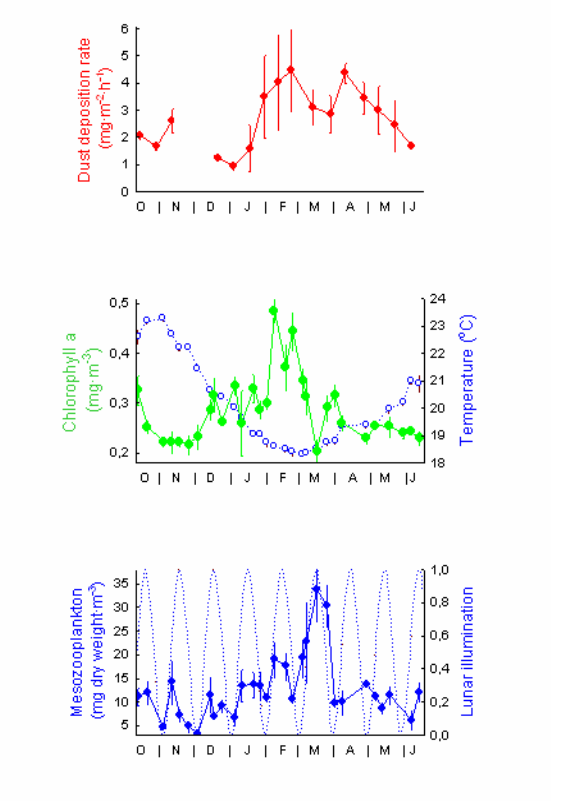


Concentration of DHA and its isotopic composition indicate the change in food stuff of Yellow Croakers in the Yellow Sea and East China Sea (right)

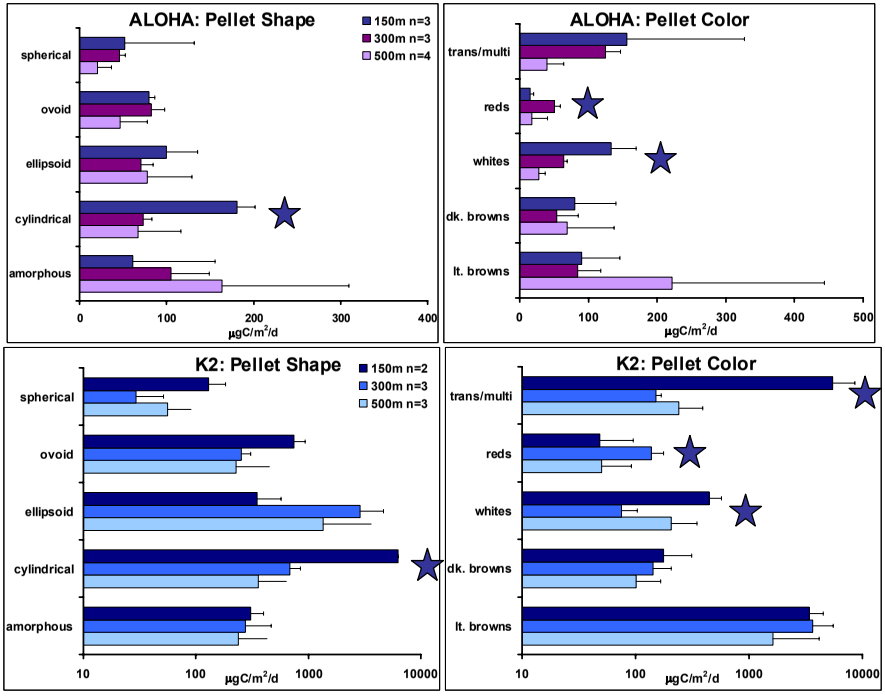
Carbon sequestration and zooplankton lunar cycles:
Could we be missing a major component of the biological pump?

Santiago Hernández-León

The export of organic matter to the deep ocean is a key process in carbon sequestration. This export consists both of a gravitational sinking component and an active transport component carried out by diel vertical migrants (DVMs). Here, we show an important consumption of carbon by the lunar-driven migrant biota, which represents an important and unaccounted flux of carbon to the mesopelagic zone. We studied the plankton outburst during the late winter bloom in subtropical waters. Nutrient enrichment by mixing and dust deposition promoted a bloom of phytoplankton. Mesozooplankton biomass increased as the winter mixing progressed, but peaked in every full moon and decreased thereafter due to the effect of predation by DVMs. The transport of epipelagic zooplankton biomass by DVMs after every full moon exceed the mean gravitational export, and suggests that we could be missing a major component of the biological pump if active flux is not considered.



Time series of dust deposition rates (A), temperature and chlorophyll in the mixed layer (B), and mesozooplankton biomass and lunar illumination (dashed line, C) from October 2005 to June 2006. Vertical bars represent standard error. Lunar illumination is scaled relative to maximum brightness. Observe the increase in chlorophyll coinciding with the increase in dust deposition rates, and the lunar cycle in mesozooplankton biomass as the mixing develops through winter (from December to March).



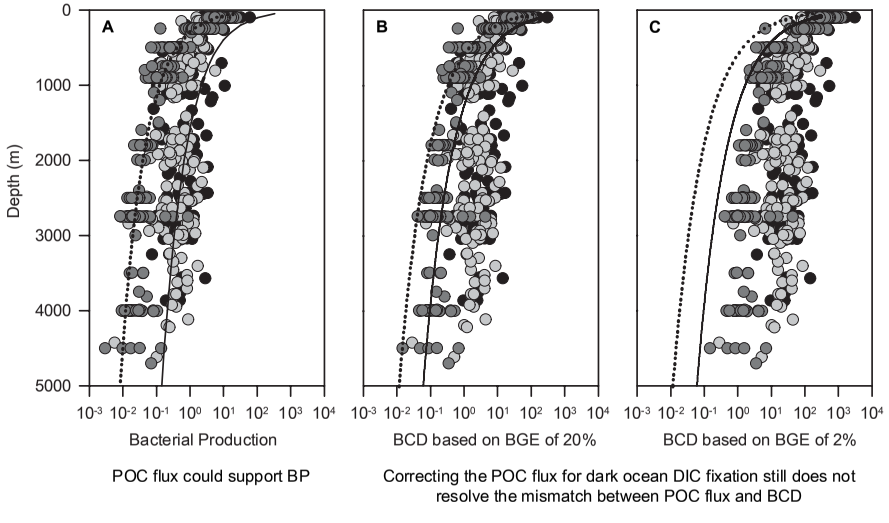
Changes with depth in flux of fecal pellets, categorized by shape and color, at an oligotrophic subtropical sampling station ALOHA and a mesotrophic subarctic station K2 (North Pacific Ocean). Dark brown and spherical pellets may be attributed to small copepods and herbivores. Red pellets are attributed to carnivores. Ellipsoid pellets were produced by filter feeding larvaceans. Cylindrical pellets (predominately light brown) are attributed to omnivorous large copepods. White or transparent (trans/multi) pellets are attributed to particle feeders (e.g. large copepods and euphausiids). A ★ indicates significant differences between depths.

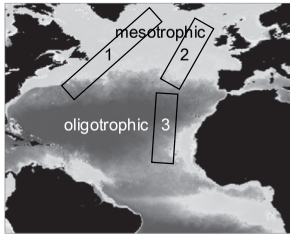
Stephanie Wilson

Wilson, S.E., Steinberg, D.K., Buesseler, K.O., 2008. Changes in fecal pellet characteristics with depth as indicators of zooplankton repackaging of particles in the mesopelagic zone of the subtropical and subarctic North Pacific Ocean. Deep-Sea Research II 55 (14-15), 1636-1647

Matching the POC flux into the dark ocean with the bacterial carbon demand: What are we missing?

Thomas Reinthaler & Gerhard J. Herndl





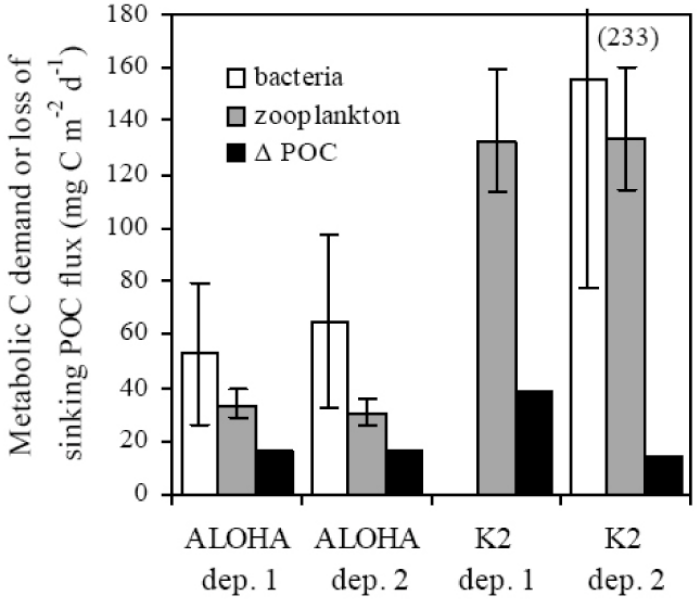
(A) Bacterial production, **(B)** bacterial carbon demand based on BGE of 20%, and **(C)** bacterial carbon demand based on more typical BGE for the dark ocean of 2% versus depth. In **(B)** and **(C)** DIC fixation by prokaryotes is added to the POC flux. DIC fixation represents a fresh source of non-sinking organic carbon in the dark ocean.
All rates in µmol C m^{-3} d^{-1}; BP = Bacterial production measured via ^{3}H-Leucine uptake; Bacterial growth efficiency (BGE) = BP/BP+BR; Bacterial carbon demand (BCD) = BP/BGE; DIC fixation was measured via ^{14}C-bicarbonate uptake.

Lines represent the POC flux model of Antia *et al.*, GBC, 2001. Depending on the oceanographic region we assumed different net primary productivity (NPP) in the euphotic zone as input for the model:

—— NPP of 100 mmol C m^{-2} d^{-1}, mesotrophic region (Antoine *et al.*, GBC, 1996)

------ NPP of 20 mmol C m^{-2} d^{-1}, oligotrophic region (Behrenfeld *et al.*, Nature, 2006)

Debbie Steinberg

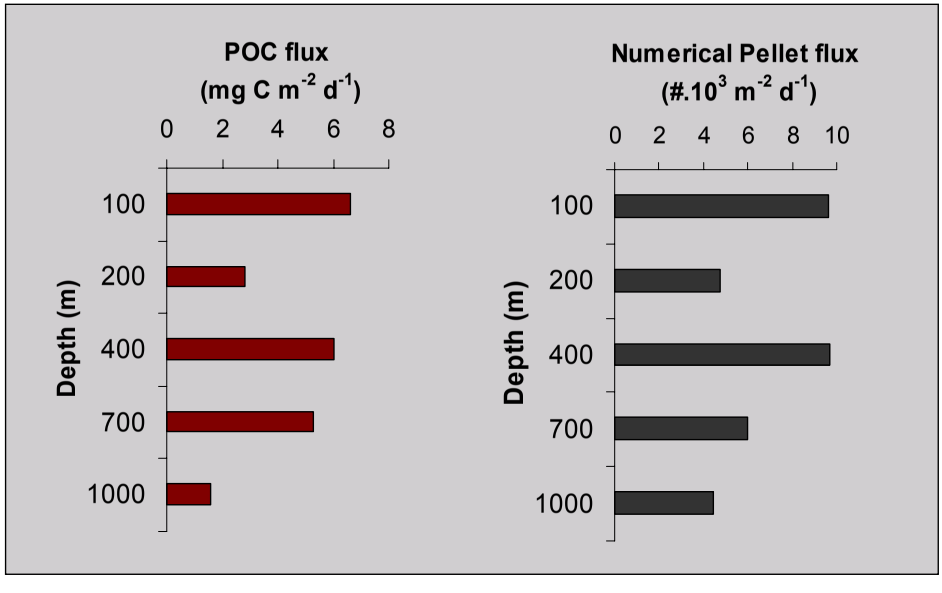


Integrated (150-1000 m) bacteria and zooplankton metabolic carbon demand compared to loss of sinking particulate organic carbon flux (ΔPOC) in the same depth interval. Study was conducted in the North Pacific Ocean at the Hawaii Ocean Time-series site ALOHA, and the Japanese times-series site K2. dep.= sediment trap deployments 1 and 2 at each site. Bars represent bacteria and zooplankton carbon demand using middle estimate conversion factors, with the range shown as error bars (with low and high range values determined using lower and upper estimate conversion factors, respectively, from a sensitivity analysis, *see* reference below for details). Note that bacteria and zooplankton C demand both exceed POC available in sinking particles.

Steinberg, D. K., B. A. S. Van Mooy, K. O. Buesseler, P. P. Boyd, T. Kobari, and D. M. Karl (2008) Bacterial vs. zooplankton control of sinking particle flux in the ocean's twilight zone. Limnology and Oceanography. 53(4): 1327-1338.

Downward POC flux in the mesopelagic and zooplankton contribution -Mediterranean Sea-

Enhanced POC flux and numerical fecal pellet flux in midwaters (400, 700 m depth)



Juan Carlos Miquel et al.

S3. Linking microbial and metazoan diversity to function

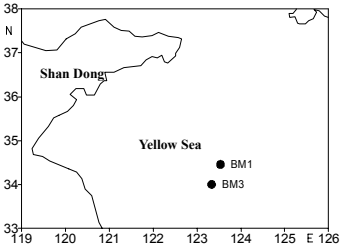


Fig.1. Map of sampling stations (April-2007)
(BM1: the 1st diatom bloom, Sampled at 05-04-2007; BM3: the 2nd diatom bloom, at 16-04-2007)
The concentration of chl*a* reached as high as **10 mg/m^3**. Vertical distribution of the chl*a* concentration changed dramatically in 24 h.

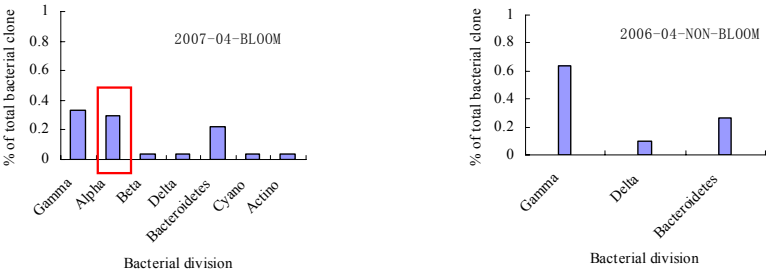


Fig.2. Predominant bacterial community composition of bloom and non-bloom (Liu Min *et al.*, 2008) studied by PCR-Denaturing Gradient Gel Electrophoresis (DGGE) analysis

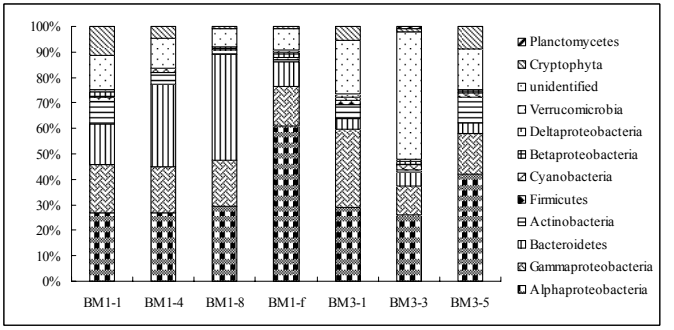


Fig.3. Distribution of clones from seven clone libraries
(BM1-1: Sampled at 12:00 05-04; BM1-4: At 00:00 06-04; BM1-8: At 12:00 06-04; BM1-f: At 21:00 15-04; BM3-1: At 00:00 16-04; BM3-3: At 06:00; BM3-5: At 12:00)

Four libraries of BM1 were dominated by A*lphaproteobacteria*, *Gammaproteobacteria*, and the *Cytophaga-Flavobacteria-Bacteroides* group, while three libraries of BM3 were dominated by A*lphaproteobacteria*, *Gammaproteobacteria*, and unidentified bacteria. However, the dominant operational taxonomic unites (OTUs) was the *Roseobacter* group in the two diatom blooms. The results implied that the *Roseobacter* group was responsible for a major part in the cycling of carbon.

By Liu Min, Institute of Oceanology Chinese Academy of Sciences

MESOPELAGIC MICROBIAL LOOP: ITS DIVERSITY AND FUNCTION

Tsuneo Tanaka[1] and Fereidoun Rassoulzadegan[2]

1: LOPB-UMR6535 CNRS, Université de la Méditerranée, Campus de Luminy Case901, 13288 Marseille France, tsuneo.tanaka@univmed.fr

2: LOV-UMR7093 CNRS, Université de Paris 6, Station Zoologique, BP 28, 06234 Villefranche-sur-Mer, France, rassoul@obs-vlfr.fr

It is considered that most of sinking POC is consumed by detritivorous zooplankton and particle-attached heterotrophic prokaryotes (*Bacteria* and *Archaea*, hereafter bacteria) in the mesopelagic layer and that DOC exported to the mesopelagic layer by lateral advection or winter mixing is likely consumed by free-living bacteria. While several studies report that not only bacteria and zooplankton but also viruses, flagellates, ciliates, dinoflagellates, foraminiferans, and radiolarians exist in the mesoepelagic layer, the ecological role of the latter components has not yet been well understood.

In the NW Mediterranean, bacteria, heterotrophic nanoflagellates (HNF), and ciliates were always detected throughout the water column during an annual study, with one, two, and three orders of magnitude of depth-dependent decrease (5-2000 m), respectively (Fig. 1). Under the assumption that the food web was close to steady state, this suggests that rate processes (i.e. growth and loss rates) are less variable for bacteria than for protozoa over the depth, and that the density-dependent predator-prey relationship becomes less coupled between the three microbial heterotrophs with increasing depth down to 2000 m. Increase in number of trophic levels generally results in less efficient material transfer from lower to higher trophic levels or more efficient remineralization in the food web, which has been emphasized as a function of the “microbial loop” in the euphotic layer (cf. Azam et al. 1983). This concept may be applied in the mesopelagic layer (here, 110-1000 m), where all microbial heterotrophs and zooplankton exist and constitute the mesopelagic food web. Our simple steady-state food chain model analysis suggests that the mesopelagic bacterial production is similarly allocated to “DOC-bacteria-viruses” circuit and “DOC-microbial loop” circuit, or 1.5 times greater to the former than the latter, and that HNF are potentially important remineralizers of the mesopelagic bacterial production. But note that direct evidence of trophic interaction (predator-prey and virus-host relationships) is very few in the microbial part of the mesopelagic plankton food web. We wish to exchange the information of the structure and function of the mesopelagic plankton food web.

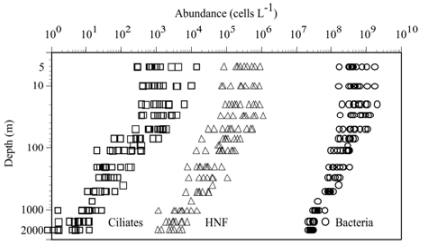


Figure 1. Distributions of bacteria, HNF and ciliates (cells L^{-1}). Measurements were monthly done at 13 depths between 5 and 2000 m from May 1999 to March 2000 at the DYFAMED time-series station (43°25.2’N, 07°51.8’E; 2350 m max depth) in the NW Mediterranean as a part of the French-JGOFS program. Circles, triangles and squares denote bacteria, HNF and ciliates, respectively.

S4. Regional comparisons of mesopelagic food-web structure and biogeochemistry, response to environmental change

Impact of eddies on sinking particulate organic matter: mesoscale and regional variability in NE Atlantic Ocean

Ivan Alonso Gonzalez, ULPGC
Javier Arístegui Ruiz, ULPGC
Cindy Lee, SoMAS, Stony Brook
Antoni Calafat, UB

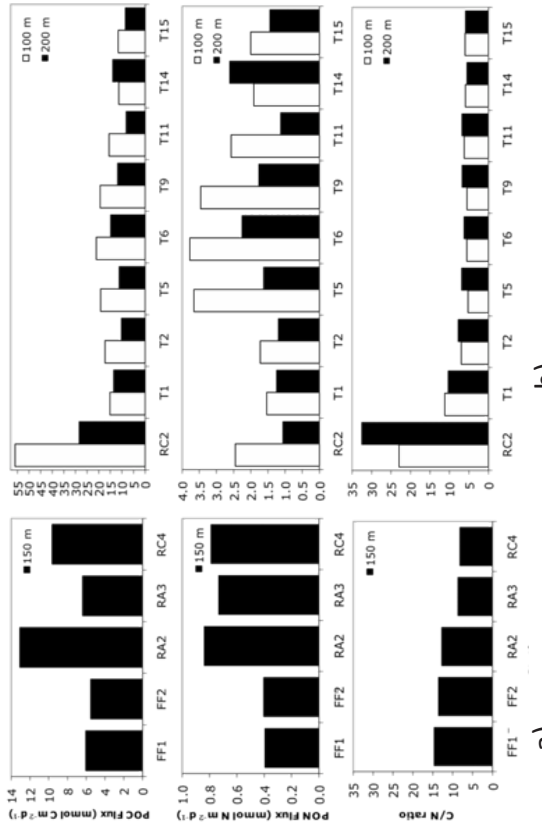


Figure 1. (a) POM fluxes and C/N ratios at eddy and far-field stations (August); (b) POM fluxes and C/N ratios across the transect stations (February).

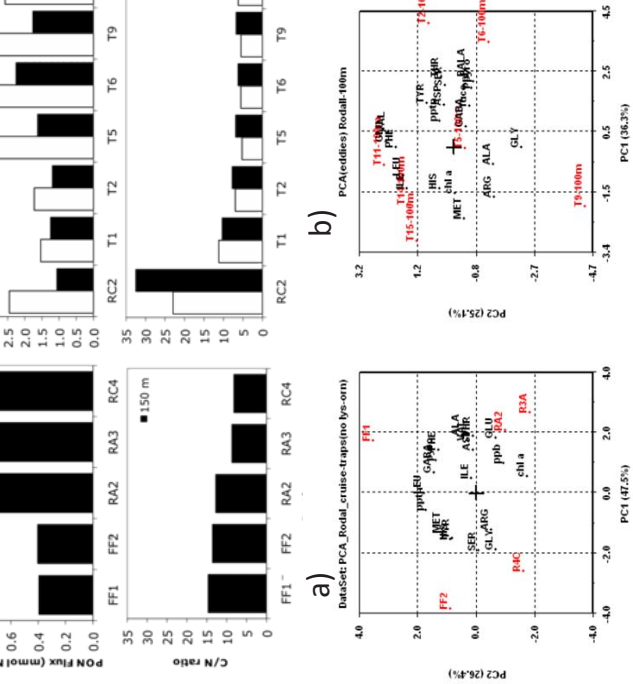
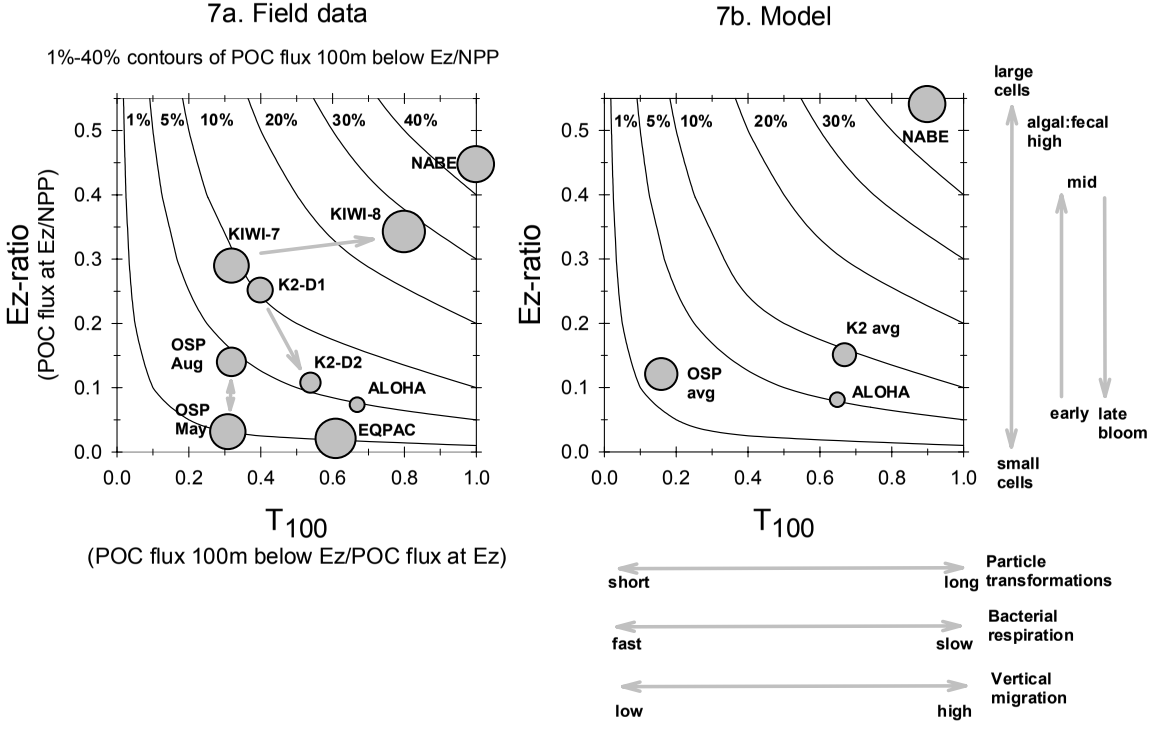


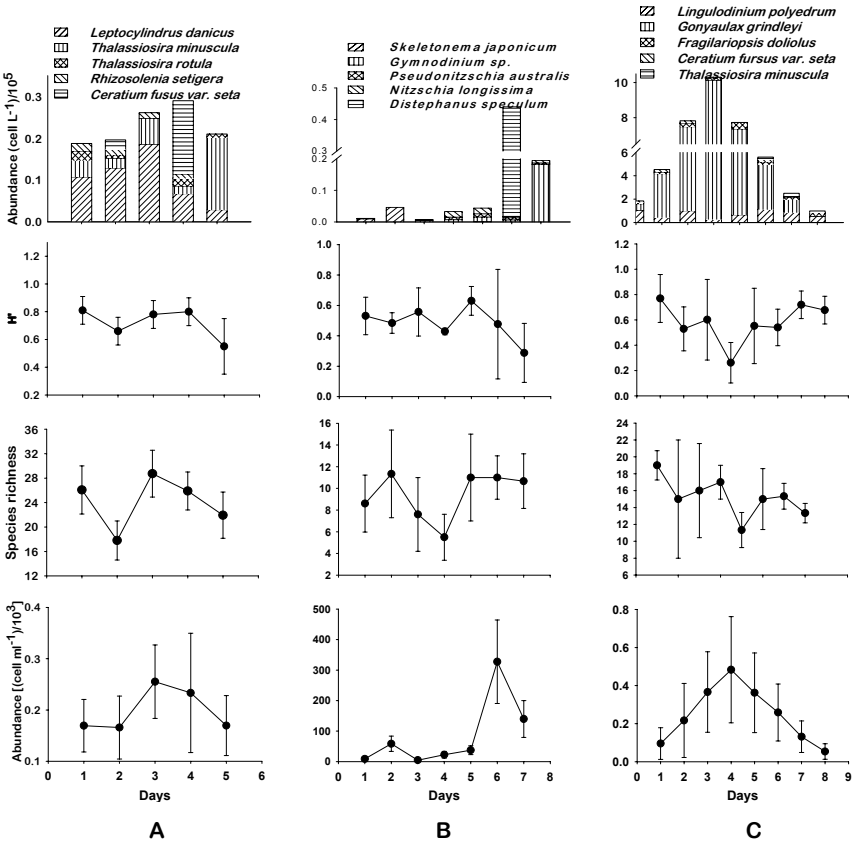
Figure 2. Principal components analysis (PCA) comparing: (a) eddies and far-field stations and (b) transect station samples. The data set used included mol % of individual amino acids and chloropigments. The first two principal components (PC1 and PC2) explain most of the variance in the data set.

Ken Buesseler and Phil Boyd- Key synthesis figure from "Shedding light on processes that control particle export and flux attenuation in the twilight zone. Submitted Sept. 2008 to Limnology and Oceanography as "Review Article"



Plot of Ez-ratio vs. T_{100} where the area of the circle for each site is proportional to NPP (Ez = depth of euphotic zone). The left panel (Figure 7a) shows these data from the study sites, with arrows between those sites indicating temporal changes when there was repeated sampling during one field season (KIWI, OSP, K2) as discussed in the text. The right panel (Figure 7b) shows a prediction of these same parameters using our biological model. The contour lines from 1% to 40% show the relationships between the POC flux 100 m below Ez and NPP. Also on this right panel are arrows along the Y and X axis which indicate the processes that would move a particular system higher/lower on these scales.

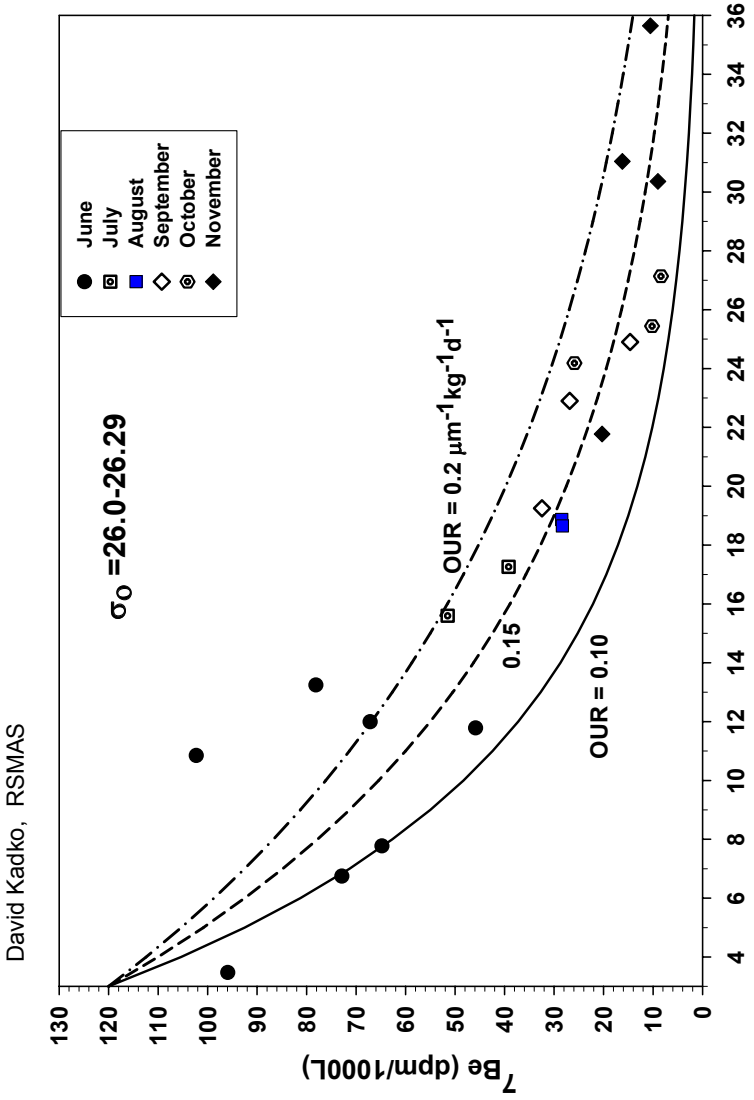
Ecological and Biogeochemical Interactions in the Mesopelagic Zone
Participant: Victor Aguilera R.
Topic related: Regional comparisons in food-web structure and biogeochemistry, and potential responses of the system to environmental change.



Daily time series of dominant species of nano- and microplankton and community structure descriptors (biodiversity=H', species richness and abundance = n) at the upwelling area of Chipana, off northern Chile during 3 surveys. **A**) Chipana in summer 2006, **B**) Chipana in winter 2006, **C**) Chipana in summer 2007. Values are integrated over the photic layer from 3-4 depths estimates of cellular abundances. Diversity and species richness were estimated from the total number of species found.

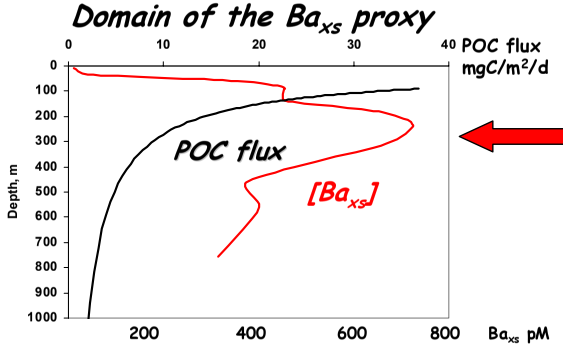
Similarly to total abundances, substantial changes in Diversity (H') and species richness (s) took place after 3-4 days. After that time variation in H' and s became significant, even though when changes in cell abundance were not significant. Therefore this short-term variation (3-4 days) occurred after changes in dominance or co-dominance among different algae classes. For example, after a dominance of Bacillarophyceae towards Dinophyceae has taken place. These short-term variations in the coastal upwelling zone were mainly associated with the daily accumulated alongshore wind.

S5. Ecological and biogeochemical approaches to estimating remineralization rates

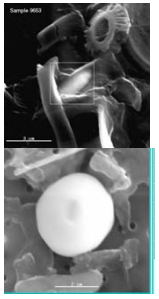


Be-7 (53.3 d half-life) technique demonstrates high OUR *implied* by POC observations in shallow sediment traps – but not "captured" by longer timescale tracers. Illustrates the importance of the shallow "Twilight Zone" in remineralization of organic matter— limiting sequestration of carbon in the deep sea.

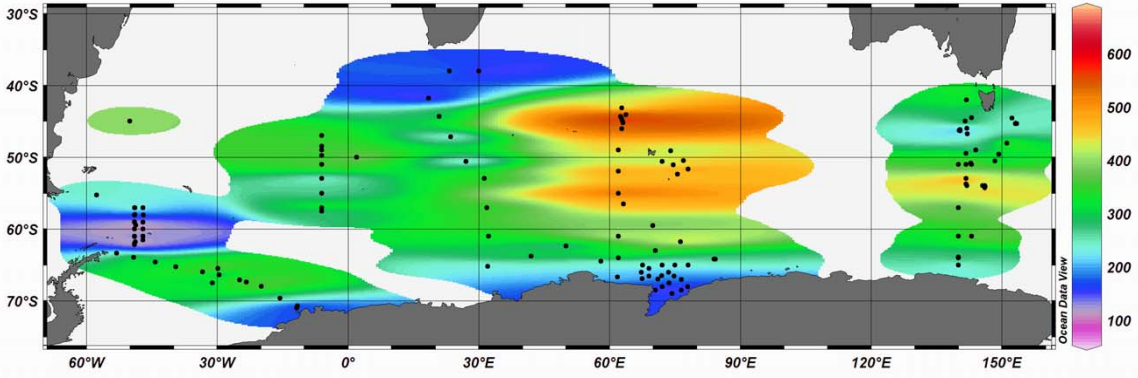
Mesopelagic particulate biogenic Ba stocks relate with mesopelagic remineralization of organic carbon



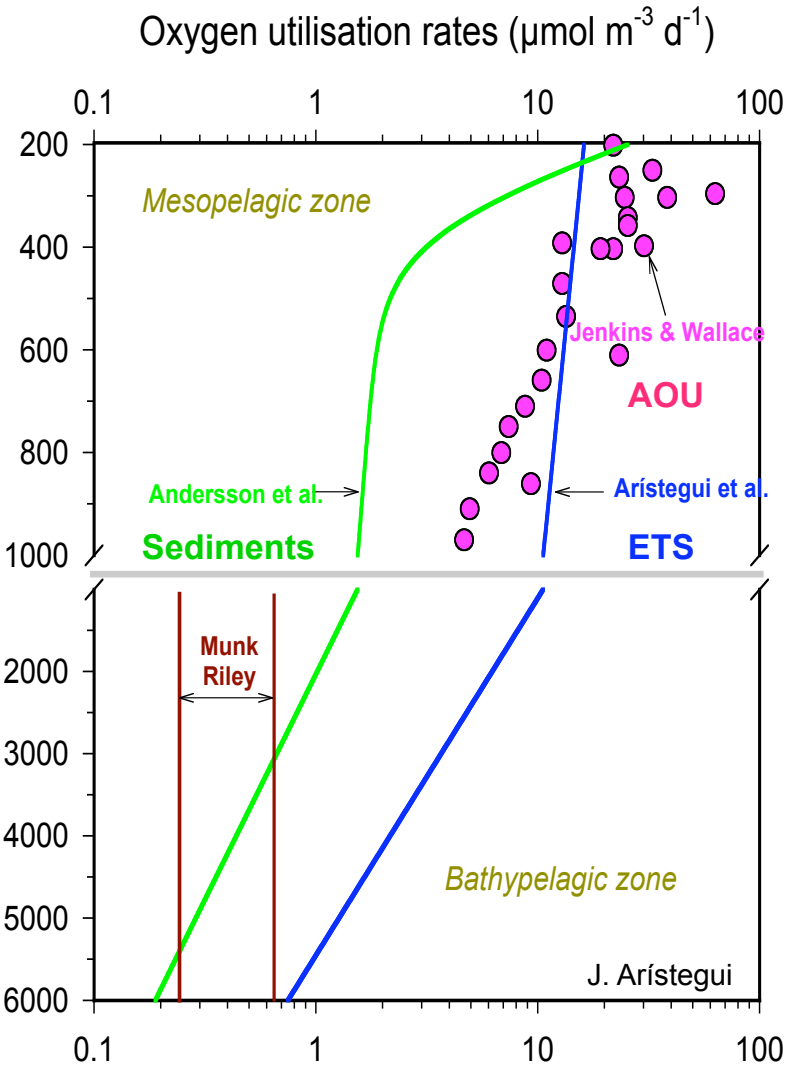
Particulate biogenic Ba profile showing the characteristic max. in the upper mesopelagic. This Ba_{xs} mainly consist of micro-crystalline barite ($BaSO_4$).



Southern Ocean distribution of mesopelagic (100-600m) Ba_{xs} stocks (pM): a proxy for the spatial variability of POM remineralization ?



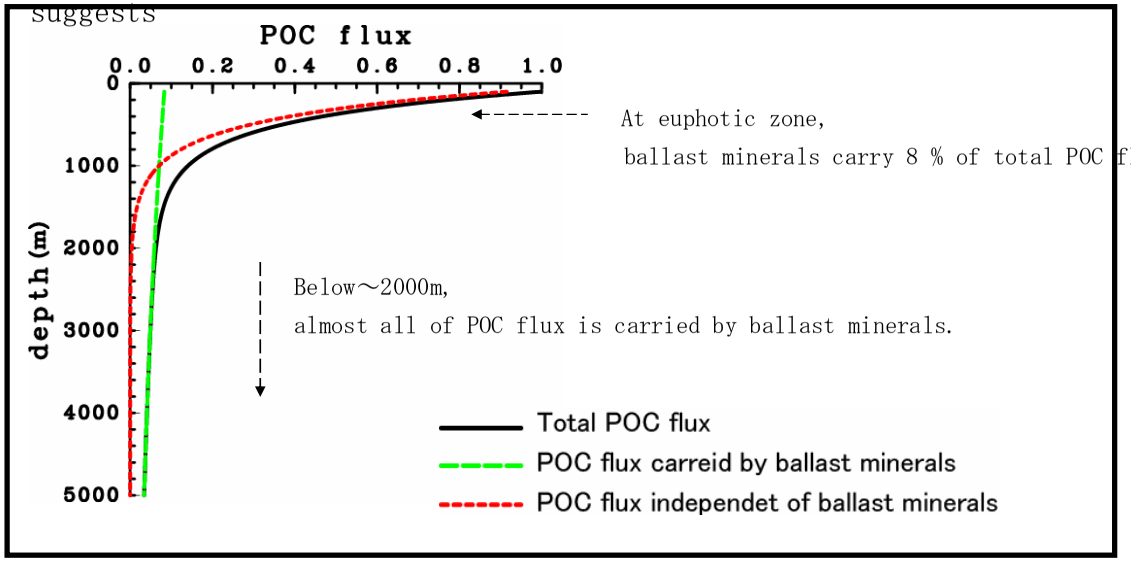
F. Dehairs, S. Jacquet, D. Cardinal



Global estimates of OUR versus depth, derived from ETS measurements and oxygen consumption in sediments. Rates are compared with OUR in the North Atlantic mesopelagic zone (<1000 m), estimated from AOU and large-scale tracers, and with oxygen consumption in the bathypelagic zone (>1000 m) derived from oxygen fields in the North Atlantic and Pacific Ocean

Global OGCM simulations using "ballast model parameterization"
digest of poster by Akira Oka (akira@ccsr.u-tokyo.ac.jp).

Our best-fit simulation for reproducing global nutrient distribution suggests

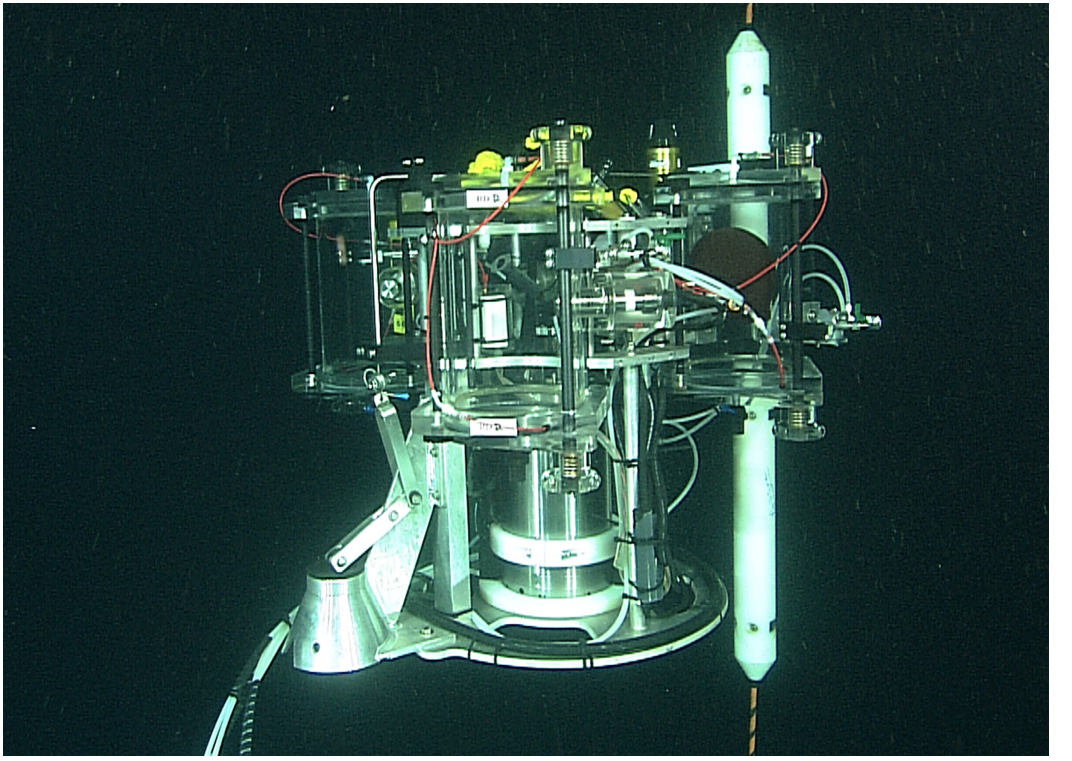


- Best-fit total POC flux is almost identical to "Martin Curve".
- When we separately evaluate role of two parts of POC flux, it is shown that ballast-induced POC flux accounts for 30 % of the total biological pump.

More info:
Oka, A., S. Kato and H. Hasumi (2008, GBC)
Evaluating effect of ballast mineral on deep-ocean nutrient concentration by an ocean general circulation model.

S7. Methods, new technologies

MBARI
MIDWATER RESPIROMETRY SYSTEM



MBARI's Midwater Respirometry System (MRS). This in situ respirometer has three chambers for animals and a fourth that serves as a control. Each chamber has an optode to measure oxygen levels over time and a pump to gently mix the water inside. The MRS is first mounted on the front of an ROV, while specimens are being collected in the chambers. Then the MRS is attached to a mooring line at the same depth where the animals were collected; to depths as great as 4,000 meters. The ROV then disconnects its hydraulic and electrical links and the system is left to incubate for 48 hours, operating on battery power. The ROV returns, lifts the system off the mooring line and carries it back up to the support ship, where the specimens are removed, measured, and weighed. The MRS allows us to measure the oxygen consumption rates (as proxies for metabolism) of deep-living animals that have not been subjected to the physiological stresses of decompression. As of 10/23/08, there have been twelve successful deployments – Bruce Robison & Kim Reisenbichler.

Biogeochemistry and Microbial Dynamics of the Bathypelagic Zone

Chairs: Dennis Hansell and Gerhard Herndl

Organizing Committee:

Dennis Hansell (USA; co-chair)
Gerhard Herndl (Netherlands; co-chair)
Doug Bartlett (USA)
Roger Francois (Canada)
Gabriel Gorsky (France)
Toshi Nagata (Japan)
Dan Repeta (USA)
Monika Rhein (Germany)
Ken Smith (USA)

Invited speaker: Dr. David M. Karl, a member of the USA National Academy of Sciences, will give a plenary talk on the bathypelagic during the opening session of the IMBIZO (Monday morning session, see schedule for details). Dr. Karl is a professor with the Department of Oceanography at the University of Hawaii (USA).

Aim and format

The central aim of the bathypelagic workshop is to gather the interdisciplinary expertise required to identify what is known about this realm and to identify and pursue outstanding uncertainties. The workshop will focus on two sectors of scientific interest: biogeochemistry and microbial dynamics. Each topic will be the focus of a breakout session. Each participant will be given time to present their most compelling science within one of those sectors. Through a combination of presentations and discussion groups, we will identify the current state of our knowledge about geochemical, biogeochemical, and biological processes in this deep system, particularly as these processes interact with one another and may change with evolving physical forcings. Each participant is also encouraged to present one poster on their relevant science.

Outcomes

A special issue of a journal will be developed through the contributions of the workshop participants. The due date of the paper will be approximately 2 months after completion of the workshop.

A synthesis paper, highlighting the findings of the workshop, will be developed by a subset of participants.

Meeting room: all Bathypelagic break out sessions will take place in room **Alexander 1 & Boardroom 2.**

	Monday 10	Tuesday 11	Wednesday 12	Thursday 13
7:30 - 8:30	Registration			
8:30 - 8:45	**Welcome plenary session**	**Bathy workshop break out session** Microbial dynamics	**Workshop synthesis** Preparation for plenary reports	**IMBIZO plenary session** Final presentations, discussions and writing
8:45 - 9:00	**Hiroaki Saito** End to end foodwebs			
9:00 - 9:15				
9:15 - 9:30				
9:30 - 9:45	**Richard Lampitt** Mesopelagic			
9:45 - 10:00				
10:00 - 10:15			**Raymond Pollard** Plenary on data integration	
10:15 - 10:30	*Coffee break*			
10:30 - 10:45		*Coffee break*	*Coffee break*	*Coffee break*
10:45 - 11:00	**Dave Karl** Bathypelagic			
11:00 - 11:15		**Bathy workshop break out session** Microbial dynamics	**IMBIZO Plenary session** Reports from 3 workshops	**IMBIZO Plenary session** Final presentations, discussions and writing
11:15 - 11:30				
11:30 - 11:45	**Bathy workshop break out session** Biogeochemistry			
11:45 - 12:00				
12:00 - 12:30				
12:30 - 13:30	*Lunch*	*Lunch*	*Lunch*	*Lunch*
13:30 - 14:00	**Bathy workshop break out session** Biogeochemistry	**Bathy workshop break out session** Food webs	**Bathy workshop break out session** Synthesis	Writing sessions for chairs, rapporteurs, etc
14:00 - 14:30				
14:30 - 15:00				
15:00 - 15:30				
15:30 - 16:00				
16:00 - 16:30	*Coffee break*			
16:00 - 16:30	**Bathy workshop break out session** Biogeochemistry	Joint Poster session and refreshments	Joint Poster session and refreshments	
16:30 - 17:00				
17:00 -17:30				
17:30 - 18:00				
18:00 - 18:30				
18:30 - 19:00				

PLENARY TALK

LINKING THE SURFACE OCEAN TO THE DEEP SEA: LESSONS FROM STATION ALOHA
Karl D.M.

Primary production of organic matter coupled to the downward flux of particulate carbon, mostly via gravitational settling, links atmospheric carbon dioxide (CO_2) to the much larger deep-sea reservoirs of dissolved inorganic and organic carbon. This deep water carbon sequestration mechanism, termed the "biological carbon pump (BCP)," is a time- and space-variable process that is controlled by habitat structure (e.g., mixed-layer depth, temperature), primary production resources (e.g., light and nutrients) and the diversity of microbial and grazer communities. My presentation will be based on a 13-year data set from an ongoing sediment trap experiment at the Station ALOHA in the North Pacific Subtropical Gyre (NPSG) that documents a large, rapid and very predictable summertime (15 Jul – 15 Aug) pulse in particulate matter export to the deep sea (4000 m). The summer export pulse has a faster sinking rate and a lower particulate matter attenuation with increasing depth, leading to a higher efficiency of carbon sequestration. The results indicate that nitrogen (N_2) fixation via symbiotic associations between diatoms and N_2-fixing cyanobacteria fuels the summer export pulse, leading to a decoupling of new production from deep water NO_3^- supply and imposing a summertime phosphorus stress on the ecosystem as a whole. The summer export pulse is enigmatic, in part, because they are sharply focused in time despite the absence of any obvious stimulus.
I hypothesize that changes in daylength (photoperiodism) may be an important environmental cue to initiate the aggregation of diatoms and subsequent export of organic matter into the deep sea.

POSTER ABSTRACTS

THE RADIOCARBON DISTRIBUTION IN MARINE DISSOLVED ORGANIC CARBON (DOC)
Aluwihare L.I.

Much of what is known about the cycling of dissolved organic carbon (DOC) in the ocean has been learned through bulk radiocarbon measurements. Surface to deep ocean gradients in the radiocarbon content of DOC (Δ^{14}C-DOC) and inter-ocean gradients in both Δ^{14}C and concentration have been interpreted as passive aging and slow removal of a fraction of photosynthetic DOC during deep ocean circulation. Building on earlier studies, the current re-analysis of available Δ^{14}C-DOC data concludes that observed gradients in the deep ocean could result entirely from basin-scale inputs and turnover (on timescales <50 years) of DOC synthesized in surface waters. In addition, this work favors the existence of a background, refractory DOC component that has a similar Δ^{14}C signature throughout the deep ocean. This interpretation is consistent with recent high resolution measurements of DOC concentration, made as part of the WOCE/CLIVAR Repeat Hydrography

program, which show no significant DOC gradients within water masses that have been isolated from the surface ocean on >100 year timescales. The demonstration that Δ^{14}C-DOC profiles can be effectively modeled as the mixing between a "young" and refractory DOC reservoir places constraints on the possible concentration of a radiocarbon-dead DOC reservoir (≤ 21 µM C). Several future research directions are offered to help establish the Δ^{14}C signature of refractory DOC and test the hypothesis that deep ocean gradients in Δ^{14}C-DOC result from the relatively-rapid (decadal-scale) addition and removal of photosynthetic DOC.

Poster presentation

DEPENDENCE OF PROKARYOTIC METABOLISM ON SUSPENDED PARTICULATE ORGANIC MATTER IN THE DARK WATERS OF THE (SUB)TROPICAL NORTH ATLANTIC

Baltar F., Arístegui J., Gasol J.M., Sintes E. and Herndl G.J.

The distribution of prokaryotic abundance (PA), respiration (R), heterotrophic production (PHP), and suspended particulate (POM) and dissolved (DOM) organic matter was determined in the meso- and bathypelagic waters of the (sub)tropical North Atlantic. PA decreased by one order of magnitude from the lower euphotic zone to the bathypelagic waters, while R decreased by two and PHP by three orders of magnitude. On a transect following the Mid-Atlantic Ridge from 35°N to 5ºN, R below 1000 m depth increased southwards up to three-fold. This latitudinal gradient in the deep-waters was paralleled by a six-fold increase in POC (Particulate Organic Carbon), whereas no trend was apparent in the DOM distribution. Significant correlations between POM and respiratory activity were obtained in the water masses between 1000 m and 3000 m depth, the Antarctic Intermediate Water and the North East Atlantic Deep Water. A strong imbalance in the dark ocean was found between prokaryotic carbon demand and the carbon sinking flux derived from sediment trap records, suggesting that the suspended carbon pool must account for this metabolic imbalance. Our results, together with other recent findings discussed in this work, indicate that microbial life in the dark ocean is more dependent on slowly sinking or buoyant, laterally advected suspended particles than hitherto assumed.

Poster presentation

MARINE DISSOLVED ORGANIC CARBON (DOC) SERIAL-OXIDATIONS, RADIOCARBON, AND BIOGEOCHEMICAL IMPLICATIONS

Beaupré S.R. and Druffel E.R.M.

Dissolved organic carbon (DOC) from the NE Pacific (Station M, 34° 50' N, 123° 00' W) was serially-oxidized to CO_2 via a 1200 W medium-pressure Hg lamp to examine photochemical lability and radiocarbon content (Δ^{14}C). Percent DOC oxidized and Δ^{14}C were inversely related, with approximately 50 % of the DOC significantly enriched relative to corresponding bulk samples from both 20

m and 2000 m depth. In 20 m DOC, the initial 1 % oxidized was significantly depleted relative to DIC $\Delta^{14}C$, indicating concurrent photo-mineralization of $\Delta^{14}C$-depleted material. These results are consistent with molecular and isotopic heterogeneity throughout the water column, as well as preliminary evidence for a photochemical sink of $\Delta^{14}C$-depleted DOC. Modified procedures and a well-constrained DOC isotopic composition are needed to improve estimates of natural photochemical degradation of $\Delta^{14}C$-depleted DOC by sunlight.

Poster presentation

VIDEO PARTICLE PROFILES ACROSS THE TROPICAL ATLANTIC AND INSIDE A PROMINENT FRACTURE ZONE IN THE MIDATLANTIC RIDGE

Bochdansky A.B., Herndl G.J. and van Aken H.M.

Sinking particles are primary vehicles for carbon fixed in surface waters to reach the deep sea where residence times are long and biological processes are slow. These particles consist of plankton carcasses, marine snow and fecal pellets of larger zooplankton. While much information exist on sinking fluxes determined by sediment traps, there are relatively few data on visual analysis of these sinking particles, particularly in meso- and bathypelagic environments. During a recent research cruise as part of the Archimedes project, we determined particle distributions in the water column between 100 and 6000 m in a transect across the tropical Atlantic from Brazil, through the Romanche Fracture Zone (one of the deepest locations in the Atlantic), to the Cape Verde islands using a simple video camera and newly designed image analysis software. Most of the imaged particles were larger than 50 um and smaller than a few millimeters which is representative of particles that comprise the bulk of sinking particles. Distinct particle abundance peaks were found in the oxygen minimum zone in the equatorial upwelling region, and inside the Romanche Fracture Zone between 3000 and 6000 m. Water masses located inside the fracture zone were part of different layers of the North Atlantic Deep Water and of the Antarctic Bottom Water. The origins of the high particle loads inside the the valley are unknown, but may derive from resuspension from the canyon walls due to strong currents inside the valley.

Poster presentation

ADVECTING AGGREGATES AS A POTENTIAL SOURCE OF MICROBES, HYDROLYTIC ENZYMES, EXOPOLYMERS AND VIRUSES IN THE BATHYPELAGIC ZONE

Deming J.W.

Particles and aggregates that descend into the bathypelagic realm of the ocean deliver the organic material that fuels bathypelagic and benthic communities. They also deliver microbes, sometimes in surprisingly high densities, into environmental conditions typically suboptimal for their reproduc-

tion. The biochemical and physiological responses of bacteria to their new deeper surroundings, from extracellular enzyme and exopolymer production to viral production and cell lysis, are expected to influence the selection and behavior of surrounding, free-living heterotrophic microbes whether also allochthonous or indigenous (adapted to ambient conditions of temperature and pressure) to the deep sea. Comparative observations and simple models from work done in the deep Gulf of Mexico and on Arctic shelves and slopes, as well as earlier work in the deep Atlantic, are merged to suggest the potential importance of advecting material in nepheloid layers and of particle aggregates in general to the structure and behavior of bathypelagic microbial communities.

Oral presentation

GRAZING IMPACT ON BACTERIA EXERTED BY HETEROTROPHIC NANOPLANKTON ASSESSED BY DILUTION EXPERIMENTS IN SUMMER 2007 IN THE MEDITERRANEAN BATHYPELAGIC ZONE

Fonda Umani S., Malisana E. and Focaracci F.

Bathypelagic ecosystems strictly depend on the production of “new” biomass by bacteria, which fuels the whole trophic web. Very few researches were devoted to estimate their role, which can be supposed to be pivotal as in the photic layers. To assess the grazing impact of nanoflagellates (HNF) on bacterial biomass and production we performed a series of dilution experiments, using natural water collected at 1500 m depth at 10 sites during a cruise (summer 2007) from the Atlantic Ocean to the Eastern Mediterranean. Incubations over 24h were performed at in situ simulated conditions (in the dark and at the same temperature of the sampling depth). Water was pre-screened through a 10 µm mesh size nylon sieve to eliminate all possible HNF predators, and diluted with water filtered on 0.22 µm pore size filter. Heterotrophic bacteria (HB) biomass varied from < 0.5 to 2.4 μgCl^{-1} showing an increasing eastward gradient. HNF ingestion ranged 0.4 - 11.9 $\mu gCl^{-1}d^{-1}$ and was as average higher in the eastern part, where, nevertheless, the top control exerted by HNF on HB production was less efficient being most of the times the HB growth rate higher than the mortality one, resulting in estimated production up to 1.25 $\mu gCl^{-1}d^{-1}$. Microzooplankton (10 – 200 µm) in the same samples was rather scarce (1.5 - 78 specimens l^{-1}). Thus we can consider potential growth rate of HNF (ranging 1 - 2.5 $\mu gCl^{-1}d^{-1}$) close to the real one.

Poster presentation

RELATIONSHIPS IN CELL ABUNDANCE BETWEEN MICROBIAL PRODUCER AND PREDATOR IN OCEAN’S INTERIOR

Fukuda H., Sohrin R., Nagata T. and Koike I.

Despite increasing recognition that heterotrophic prokaryote in meso- and bathypelagic water columns play an important role in oceanic carbon cycles, the fate of bacteria and microbial trophic

dynamics in deep oceanic waters are still largely unknown. We examined the full depth profile of the abundance of nanoflagellates (FA) and prokaryote (PA), and prokaryote production (^{3}H-Leucine incorporation: PP) throughout the water column (maximum depth, 3,800 - 6,000 m) of the subarctic Pacific and the Bering Sea. The lowest PP in deep waters was 8.6 x 10^{-5} µg C L^{-1} day^{-1}, yielding a unique dataset that covers an enormous range (5-ordersof magnitude) of the productivity gradient. Our data on the abundance relationship between PA and FA along the productivity gradient was well fitted by a power function (R^2 = 0.624) with an exponent of 0.717 (95% CI: 0.636 to 0.807), which is significantly lower than 1. Although previous studies have concluded that PA:FA ratios tend to scatter around a constant ratio of 1000:1 in aquatic systems, our re-analysis of the published data on the relationship between BA and FA over a broad environmental scale revealed a remarkable consistency in the allometric relation between BA and FA, with an average exponent of 0.741 ± 0.067. Although the structure of microbial food webs in deep ocean is still unclear, our results suggests that mechanisms determining abundances of microbes in deep water is extended continuously from those in more productive upper oceans.

Poster presentation

COMPARATIVE ANALYSES OF UDOM CHEMICAL COMPOSITION AND HETEROTROPHIC DIVERSITY IN THE MESOPELAGIC & BATHYPELAGIC ZONES

Meador T.B., Gogou A., Jones V., Migon C. and Repeta D.J.

Heterotrophic organisms in the subsurface ocean respire a significant portion of oceanic organic carbon and represent an important role in the global carbon cycle; however, the abundances and diversity of mesopelagic and bathypelagic Bacteria and Archaea are highly variable and controls on the composition of the heterotrophic community are not well understood. Oceanic profiles of the concentration of dissolved organic carbon (DOC) and dissolved organic nitrogen (DON) indicate that these reservoirs serve as substrates for subsurface, heterotrophic organisms. To investigate the potential for variability in DOM chemical composition to drive diversity in subsurface microbial communities, ultrafiltered dissolved organic matter (UDOM) was collected at various depths and basins of the Eastern and Western Mediterranean Sea (5 - 4500 m). Our approach was to study DOM composition at the monomeric level, by amino acid enantiomer and monosaccharide analysis, at the macromolecular level, by considering intact proteins and finally at the structural level by NMR. This study complements collaborative investigations of prokaryotic genetic diversity in the same water column depths. Chemical characterization of the UDOM substrate could provide valuable information on the biogeochemical processes that occur in the mesopelagic and bathypelagic ocean and shape heterotrophic oceanic communities.

Poster presentation

EXPORT OF DISSOLVED ORGANIC CARBON TO DEEP OCEAN SINKS
Hansell D.A., Carlson C.A., Repeta D.J. and Schlitzer R.

Dissolved organic matter in seawater is the largest ocean reservoir of reduced carbon, comparable to the inventory of atmospheric carbon dioxide, and serves as substrate to vast microbial populations, a source of nutrients to autotrophs, and exchange capacity for bioactive trace metals and other solutes. Dissolved organic matter is produced in the surface ocean, but overturn of the ocean water column results in export of this material to depth, thus contributing to the biological pump whereby biogenic carbon is sequestered in the deep ocean. Until now, our knowledge of dissolved organic carbon biogeochemistry on the global scale had been limited to few high precision measurements scattered widely across ocean basins. Here we employ a new, vastly enlarged global ocean data set to produce unprecedented insights on the distribution of dissolved organic carbon. From the observed distribution, as well as from model results, we quantify deep ocean biotic and abiotic sinks for this carbon. One hypothesized abiotic sink of particular interest is the conversion of DOC to particulate matter in the deep ocean. If the process is occurring, and if these particles sink to the seafloor, the carbon may be sequestered over geological time scales.

Oral presentation

THE RADIOCARBON SIGNATURE OF MICROBIAL ORGANISMS IN THE MESOPELAGIC
Hansman R.L., Griffin S., Watson J.T, Druffel E.R.M., Pearson A. and Aluwihare L.I.

Natural abundances of radiocarbon in various organic and inorganic carbon pools in the environment have provided invaluable insights into the pathways of carbon flow and carbon residence time in various reservoirs. Radiocarbon has been particularly valuable in delineating the carbon cycle of the deep ocean; for example, without radiocarbon measurements the extremely long residence time of dissolved organic carbon (DOC) in the deep ocean (~6000 radiocarbon years) would never have been approximated. In this study we capitalize on the measured distinctions of the various carbon pools in the meso- and bathypelagic to add a new dimension to carbon cycling in these environments – identifying the carbon sources fueling microbial production. We hypothesized that fresh DOC, released from sinking particles, provides the major source of carbon for microorganisms in the mesopelagic. Here we present a depth profile (21m, 670m, and 915m) of the radiocarbon content of nucleic acids from size-fractionated particles (0.2-0.5μm and >0.5μm), which indicate vertical heterogeneity in the carbon sources supporting the microbial community, and explore possible metabolic processes responsible for the observed differences using quantitative PCR.

Poster presentation

LARGE-SCALE VARIATIONS IN FULL DEPTH DISTRIBUTION OF PROKARYOTIC PRODUCTION IN THE CENTRAL PACIFIC (FROM 67.5° S TO 53° N)

Nagata T. and Yokokawa T.

Oceanic biogeochemical models rely on equations that describe the magnitude and the length scale of the remineralization of organic matter (OM) in the ocean's interior. Although studies have suggested variations in time and space of fitting parameters such as the exponent of the Martin equation, modelers have generally used the composite value partly because of the inadequacy in validation data on vertical distribution of OM remineralization across different basins and hemispheres. Because prokaryotes are the major consumer/remineralizer of OM in aphotic layers, measurement of prokaryote production (PP) throughout the whole water column is potentially useful to examine the extent and spatial patterns of OM remineralization. Here we report our data on PP collected during two meridional transect cruises conducted in the central Pacific. We occupied 31 stations located in oceanic regions from 67.5° S to 53° N. In the mesopelagic layer, there was a remarkable consistency between prokaryotic production and the sinking flux of POC at a depth of 100 m (F100). In contrast, PP in the bathypelagic layer was only weakly correlated with F100 and was high in subtropical (oligotrophic) regions of both hemispheres. Our data support the hypothesis that distributions of bacterial production largely reflect sinking fluxes of POM, but they also suggest that a significant fraction of variation in OM mineralization in bathypelagic waters might be accounted for by either lateral transport of OM, the flux of OM from sediments, or both.

Poster presentation

EFFECT OF DISSOLVED ORGANIC MATTER FRACTIONATION ON MICROBIAL UTILIZATION IN THE DEEP OCEAN

Nieto-Cid M. and Repeta D.J.

Microbial utilization of dissolved organic carbon (DOC) in the Atlantic and Pacific deep oceans was studied using ultrafiltration (nominal 500 Da membrane) to separate high (<0.2µm; >500 Da) and low (<500 Da) molecular weight DOC. Samples were inoculated 1:100 with <0.7 µm surface seawater and incubated in the dark. DOC, oxygen and cell counts analysis were performed to monitor the progress of the incubations. Our results show that neither DOC degradation nor oxygen consumption occurs during the incubation of whole seawater (control) samples. On the other hand, the low molecular weight fraction of Atlantic deep waters showed a loss in carbon up to ~4 µmoles C (~11%) in five days, while oxygen consumption for the same samples was 10 µmoles O_2. The low C/O_2 ratio (0.4) hints that half of the oxygen consumed may be directed to incomplete oxidation of the DOC to carbolixic acids and other more highly oxidized functional groups of carbon. The bacterial growth associated with these incubations was very low, pointing to low cell efficiencies and high respiration rates. Globally, these results suggest that the refractory DOC in the deep ocean can be

degraded over short time scales. Further research is needed to assess why filtration stimulates the degradation of the low molecular weight DOC compared to the non-fractionated seawater.

Poster presentation

FULL-DEPTH PROFILES OF MICROZOOPLANKTON ALONG THE CENTRAL PACIFIC OCEAN

Sohrin R., Imazawa M. and Fukuda H.

Full-depth profiles of ciliates, heterotrophic nanoflagellates (HNF) and bacteria were obtained in the central Pacific between 10°S and 53°N along 160°W in summer, 2005. In the surface layer, their abundance was generally high in the subarctic region and ciliates were also abundant at the equator, which relates to high chlorophyll a concentration in these regions. Ciliates were also abundant in the equatorial and subarctic regions through 200-4000m and were not detected (<0.1cells/l) at 5000m. Equivalent spherical diameter (ESD) of ciliate's cells was relatively constant with depth and it successively increased from the equator (17-21μm) to the subarctic (20-25 μm). Although we should take it into account the possible ESD changes during the sampling, constant ESD through the water column suggests downward export of ciliates from the surface to the deep ocean.
In the bathypelagic zone, abundance of bacteria and ciliates was about three times higher in the subarctic region than the tropical and subtropical regions, whereas HNF varied less (<1.8 times) among the regions. Bathypelagic zone accounted for 15-29%, 22-44%, 21-38% of the total biomass in the water column of ciliates, HNF and bacteria, respectively. These values were highest in the subarctic for bacteria (33-38%), whereas it was lowest for ciliates (15-18%) and HNF (22-29%). The result suggests lower grazing pressure of microzooplankton in the subarctic bathypelagic compared to the other regions. In the equatorial and tropical regions, the values were low for bacteria and high for ciliates and HNF, suggesting the importance of microbial food-web in the tropical bathypelagic.

Poster presentation

ARE DEEP-SEA PROKARYOTES CAPABLE OF DEGRADING HIGH MOLECULAR WEIGHT DISSOLVED ORGANIC MATTER (HMW DOM)?

Tamburini C., Boutrif M., Garel M., Panagiotopoulos C., Kirchman D.L., Matthew T., Cottrell M.T. and Repeta D.J.

Recent studies (using molecular biology and/or study on piezophilic strain) might suggest the ability of deep-sea prokaryotes to degrade refractory organic matter under high-pressure conditions. We know that HMWDOM (>1KDa) is essentially composed by sugars (> 60% of HMWDOM-C). Elifantz et al. (2005) proposed to use 3H-EPS (Extra Polymeric Substances) and 3H-glucose to fol-

low the contribution of major bacterial groups according the salinity gradient in Delaware estuary.
We hypothesize that natural deep-sea prokaryotic communities are able to degrade HMW DOM when they are maintained under in situ pressure condition. To verify this hypothesis, two types of experiment will be done:
(i) one using 3H-EPS (and 3H-glucose) incubated with deep-sea samples to check the deep-sea prokaryotic community capacity to use macromolecule (vs labile organic matter) at 3 different depths (10, 500 and 2000m). Deep-sea samples were retrieved using our High Pressure Serial Sampler (HPSS, to avoid any decompression): 3H-EPS and 3H-Glucose assimilation showed a higher rate when the samples were maintained at the in situ pressure conditions comparatively to decompressed one. Micro-CARD-FISH data are still in analyses to determined who do what and will be presented during the IMBIZO meeting.
(ii) a second to estimate the capacity of deep-sea prokaryotes to degrade natural HMW DOM. Ultrafiltrated and concentrated DOC (HMW DOM>1KDa) will be incubated under in situ pressure condition with a deep-sea prokaryotic community. Several chemical and biological parameters will be measured (DOC, carbohydrates, CARD-FISH, prokaryotic activity) over time. The preliminary results will be presented during the IMBIZO meeting.

Poster presentation

INFLUENCE OF CO2 SEQUESTRATION INTO BATHYPELAGIC LAYER ON BACTERIAL ACTIVITIES

Yamada N., Suzumura M. and Tsurushima N.

Bacteria are very important organisms for marine biogeochemical cycling through decomposition of organic matter and release of nutrients. In bathypelagic layer, they are most abundant. "CO_2 sequestration into bathypelagic layer" is one of the mitigation technologies against global warming. It is essential to assess the potential influence of this technology on bacterial activities, i.e., biogeochemical cycling. We have investigated the influence in laboratory simulations of this technology.
Seawater samples collected from 2000 m depth off Kuroshio were acidified by bubbling with air containing various concentrations of CO_2. CO_2 altered the sample pH from 7.6 (original) to 7.4, 7.1 and 6.8, respectively. In addition, a chemical buffer reagent (Tris-maleic acid mixture) was utilized to adjust the sample pH ranging from 5.7 to 7.9. In above condition, bacterial abundance, production rate, and the contribution of viable cells were investigated.
In the CO_2 treatments, no significant difference was observed in bacterial abundance, production rate and the proportion of viable cells. In the buffer treatments, these parameters were decreased with pH decrease. It suggested that high CO_2 conditions exhibited negligible effects on the bacterial activities, however, in some organic–rich "microbial hot-spots" simulated by buffer treatment bacteria would show high sensitivity to acidification. Classification of viable cells indicated that more than 50 % in CO_2 treatments were classified into Archaea, while more than 60% in original

and buffer treatments were Eubacteria. The injection of CO^2 likely increased active Archaea and unknown-mechanism related to their activities may work in marine biogeochemical cycling.

Poster presentation

DISTRIBUTION OF FLUORESCENT DISSOLVED ORGANIC MATTER IN THE PACIFIC
Yamashita Y. and Tanoue E.

Dissolved organic matter (DOM) in the ocean constitutes one of the largest reduced carbon pools on the earth's surface, but its role in global carbon cycles is poorly understood. Almost all oceanic DOM is originated from marine organisms. A majority of the DOM pool has been considered to comprise constituents refractory to biological degradation. An unanswered question is how such refractory DOM is produced in the ocean. In the present study, we conducted two transect observations from Southern Ocean to subarctic region of the North Pacific and clarified the basin scale distribution of fluorescent DOM (FDOM), determined by fluorescence intensity at 320-nm excitation and 420-nm emission wavelengths. The FDOM distribution is similar to that of apparent oxygen utilization (AOU), the amount of the oxygen consumed by respiration in the ocean interior, and levels of FDOM were positively correlated with the AOU in the mesopelagic and bathypelagic layers. Such correlation suggesting that FDOM are produced in situ in the ocean interior along with biological oxidation of organic matter and that in situ produced FDOM is resistant to biological degradation with centennial to millennium time scale. The production rate of bio-refractory FDOM in the ocean interior is larger than the riverine input of terrestrial humic substances when determined by means of fluorescence intensity, indicating that in situ production of FDOM is one of the key processes in maintaining the DOM pool in the global carbon cycle.

Poster presentation

Bollens, Stephen
Washington State University
School of Earth and Environmental Sciences
14204 NE Salmon Creek Ave.
Vancouver 98686, WA
USA
+1 360 546 9620
bollens@vancouver.wsu.edu

Carlotti, Francois
CNRS
Station Marine d'Endoume
Rue de la Batterie des Lions
13007 Marseille
France
+33 4 91 04 16 44
francois.carlotti@univmed.fr

Chai, Fei
University of Maine
5706 Aubert Hall
Orono 04469-5706, ME
USA
+1 207 581 4317
fchai@maine.edu

Cowen, Robert
RSMAS/UM
4600 Rickenbacker Causeway
Miami 33149, FL
USA
+1 305 421 4023
rcowen@rsmas.miami.edu

Currie, Bronwen
Ministry of Fisheries and Marine Resources
P.O. Box 912, Strand Street
Swakopmund, Erongo 9000
Namibia
+00264 64 4101139
bcurrie@mfmr.gov.na

Dam, Hans
University of Connecticut
1080 Shenecossett Rd
Groton 06340-6048, CT
USA
+1 860 405 9098
hans.dam@uconn.edu

DeMaster, David
North Carolina State University
Dept. of MEAS, Box 8208
North Carolina State University
Raleigh 27695-8208, North Carolina
USA
+1 919 515 7026
demaster@ncsu.edu

Denman, Kenneth
Fisheries and Oceans Canada
c/o University of Victoria
Box 1700, STN CSC
Victoria V8W 2Y2, BC
Canada
+1 250 3638230
ken.denman@ec.gc.ca

Dunne, John
NOAA Geophysical Fluid Dynamics Laboratory
201 Forrestal Rd
Princeton 08540-6649, NJ
USA
+1 609 452 6596
john.dunne@noaa.gov

Dutkiewicz, Stephanie
MIT
77 Massachusetts Ave
Cambridge 02139, MA
USA
+1 617 253 2454
stephd@ocean.mit.edu

Gifford, Dian
University of Rhode Island
South Ferry Road
Narragansett 02882-1197, RI
USA
+1 401 874 6690
dgifford@gso.uri.edu

Green, David
NOAA National Weather Service
1325 East West Hwy
Silver Spring 20910, MD
USA
+1 301 713 1858 x105
david.green@noaa.gov

Hall, Julie
Assistant Regional Manager
NIWA Greta Point
301 Evans Bay Parade
Private Bag 14901
Kilbirnie Wellington, 6241
New Zealand
+64 7 856 1709
j.hall@niwa.co.nz

Harris, Lora
University of Maryland Center for Environmental Science
1 Williams Street
Solomons 20688, MD
USA
+410 326 7391
harris@cbl.umces.edu

Harris, Roger
Plymouth Marine Laboratory
Prospect Place
PLYMOUTH PL1 3DH
United Kingdom
+44 (0)1752 633481
r.harris@pml.ac.uk

Hofmann, Eileen
Old Dominion University

4111 Monarch Way
Norfolk 23528, VA
USA
+1 757 683 5334
hofmann@ccpo.odu.edu

Hood, Raleigh
University of Maryland Center for Environmental Science
HPL/UMCES
P.O. Box 775
Cambridge21613, Maryland
USA
+1 410 221 8434
rhood@hpl.umces.edu

Jarre, Astrid
Marine Research Institute and Zoology Dept.
University of Cape Town
Private Bag X3
Rondebosch 7700, Cape Town
South Africa
+27 21 6505453
ajarre@gmail.com

Kishi, Michio
Hokkaido University
N10, W5, Kitaku
Sapporo 060-0810, Hokkaido
Japan
+81 11 706 2323
mjkishi@nifty.com

Koslow, Tony
Scripps Institution of Oceanography, UCSD
9500 Gilman Drive
La Jolla 92093-0218, California
USA
+1 858 534 7284
tkoslow@ucsd.edu

Landry, Michael
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive
La Jolla 92093-0227, California
USA
+1 858 534 4702
mlandry@ucsd.edu

Leinen, Margaret
Climos, Inc.
119 S Columbus Street
Alexandria 22314, VA
USA
+1 202 415 6545
mleinen@climos.com

Libralato, Simone
OGS
Borgo Grotta Gigante 42/c
Sgonico 34010 Trieste
Italy
+39 040 2140376
slibralato@ogs.trieste.it

Lipschultz, Fred
NASA Headquarters
300 E St. SW
Washington D.C. 20546
USA
+1 202 341 7580
fredric.lipschultz@nasa.gov

Llopiz, Joel
RSMAS/University of Miami
4600 Rickenbacker Cswy
Miami 33149, FL
USA
+1 305 421 4025
jllopiz@rsmas.miami.edu

Ma, Hongguang
NOAA Chesapeake Bay Office - Oxford Lab / Versar Inc.
904 South Morris Street
Oxford 21654, Maryland
USA
+1 410 226 5193
Hongguang.Ma@noaa.gov

Marinov, Irina
Woods Hole Oceanographic Institution
WHOI, MS 25
360 Woods Hole Rd
Woods Hole 02543, MA
USA
+1 617 230 9923
imarinov@whoi.edu

Maury, Olivier
IRD, CRH
av. Jean Monnet, B.P. 171
Sète 34000
France
+33 499-57-32-28
maury@ird.fr

Moloney, Coleen
University of Cape Town
Private Bag X3
Rondebosch 7701Cape Town
South Africa
+27 21 650 2681
Coleen.Moloney@uct.ac.za

Murphy, Eugene
British Antarctic Survey
High Cross
Madingley Road
Cambridge, Cambs CB3 0ET
United Kingdom
+1223 221614
e.murphy@bas.ac.uk

Niiranen, Susa
Finnish Institute of Marine Research
Erik Palménin aukio 1, PO Box 2
Helsinki 00561

Finland
+358 50 595 6616
susa.niiranen@fimr.fi

Pan, Jin-Fen
Ocean University of China
College of Environmental Science and Engineering
No.238 Songling Road, Laoshan District
Qingdao 266100, Shandong
China (Peoples Republic of)
+86 13625328491
jfpan@ouc.edu.cn

Perry, Ian
Fisheries & Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo V9T 6N7, BC
Canada
+1 250 756 7137
Ian.Perry@dfo-mpo.gc.ca

Pu, Xinming
First Institute of Oceanography, SOA
6 Xianxialing Road,
Qingdao 266061, Shandong
China (Peoples Republic of)
+86 532 88961625
xmpu@fio.org.cn

Richardson, Tammi
University of South Carolina
Coker Life Sciences Bldg
Columbia 29208, SC
USA
+1 803 777 2269
richardson@biol.sc.edu

Roman, Mike
University of Maryland
Horn Point Laboratory
2020 Horn Point Road
Cambridge 21613, MD
USA
+1 410 221 8425
roman@hpl.umces.edu

Saito, Hiroaki
Fisheries Research Agency
3-27-5 Shinhama-cho
Shiogama 985-0001, Miyagi
Japan
+81 22 365 9929
hsaito@affrc.go.jp

Salihoglu, Baris
METU Institute of Marine Sciences
Institute of Marine Sciences METU
PK 28 Erdemli
Mersin 33731
Turkey
+903245212150
baris@ims.metu.edu.tr

Shannon, Lynne
University of Cape Town
36 Field Close
Pinelands 7405, Cape Town
South Africa
+27 825346351
lshannon4@yahoo.co.uk

Solidoro, Cosimo
ist naz ocean. & exp geophysics
borgo grotta giante 42/c
sgonico 34010, Trieste
Italy
+040 2140315
csolidoro@inogs.it

Sterner, Robert
National Science Foundation
4201 Wilson Blvd. Suite 635
Arlington 22230, VA
USA
+1 703 292 8480
sedaniel@nsf.gov

St. John, Michael
University of Hamburg
Grosse Elbstrasse 133
Hamburg 22676
Germany
+49 40428386600
michael.st.john@uni-hamburg.de

Toennesson, Kajsa
Natrional Environmental Research Institute
Frederiksborgvej 399, PO Box 358
Roskilde 4000
Denmark
+45 46301896
kt@dmu.dk

Xiao, Tian
Institute of Oceanology, Chinese Academy of Science
7 Nanhai Road
Qingdao 266071, Shandong
China (Peoples Republic of)
+86 532 82898586
txiao@ms.qdio.ac.cn

Zhang, Wuchang
Institute of Oceanology, Chinese Academy of Sciences
7 Nanhai Road
Qingdao 266071, Shandong Province
China (Peoples Republic of)
+86 532 82898937
Wuchangzhang@ms.qdio.ac.cn

Zuo, Tao
Yellow Sea Fisheries Research Institute,CAFS

106 Nanjing Road, Qingdao
Qingdao 266071, Shandong Province
China (Peoples Republic of)
+86 532 85836344
zuotaolinch@yahoo.com.cn

Aguilera, Victor
University of Concepcion
Barrio Universitario S/N, Cabina#9
Concepcion 160 C
Chile
+56 41 2205157
vaguiler@udec.cl

Alonso, Ivan
University of Las Palmas
Tafira Baja, sn
35017 Las Palmas de Gran Canaria
Spain
+34 928454547
ialonso@becarios.ulpgc.es

Anderson, Thomas
University of Southampton
National Oceanography Centre
Waterfront Campus
Southampton SO14 3ZH
United Kingdom
+44 (0)23 80596337
tra@noc.soton.ac.uk

Arístegui, Javier
Universidad de Las Palmas de Gran Canaria
Campus Universitario de Tafira
35017 Las Palmas de Gran Canaria
Spain
+34 928 452906
jaristegui@dbio.ulpgc.es

Buesseler, Ken
Woods Hole Oceanographic Institution
Mail Stop #25, Clark 447
Woods Hole 02543, Massachusetts
USA
+1 508 289 2309
kbuesseler@whoi.edu

Carlson, Craig
University of California Santa Barbara
Marine Science Institute
Goleta 93106, CA
USA
+1 805 893 2541
carlson@lifesci.ucsb.edu

Chen, Jianfang
Second Institute of Oceanography, SOA
36 North Baochu Road
Hangzhou 310012, Zhejiang
China (Peoples Republic of)
+0086 571 88076924, ext. 2454 or 2483
biogeo_chen@hotmail.com

Dehairs, Frank
Vrije Universiteit Brussel
Pleinlaan 2
Brussels B-1050
Belgium
+32 2 629 32 60
fdehairs@vub.ac.be

Frost, Jessica
University of Hamburg
Grosse Elbstrasse 133
Hamburg 22767
Germany
+49 40 17622784359
jessica.frost@uni-hamburg.de

Hernández-León, Santiago
Facultad de Ciencias del Mar
Campus Universitario de Tafira
Las Palmas de Gran Canaria, 35017 Canary Islands
Spain
+34 928 45 29 07
shernandez@dbio.ulpgc.es

Jackson, George
Texas A&M University
Dept. Oceanography
3146 TAMU
College Station 77843, TX
USA
+1 979 845 0405
gjackson@tamu.edu

Kadko, David
University of Miami
4600 Rickenbacker Causeway
Miami 33149, FL
USA
+1 305 421 4721
dkadko@rsmas.miami.edu

Lampitt, Richard
National Oceanography Centre, Southampton
University of Southampton Waterfront Campus
European Way
Southampton SO14 3ZH
United Kingdom
+44 (0) 23 80596347
R.Lampitt@noc.soton.ac.uk

Liu, Min
Institute of Oceanology, Chinese Academy of Sciences
7 Nanhai Road
Qingdao 266071
China (Peoples Republic of)
+86 532 82898584

liuminxm@126.com

Meador, Travis
WHOI & Hellenic Center for Marine Research
11121 Royal Ln.
Providence Forge 23140, Virginia
USA
+1 858 752 8180
travis.meador@gmail.com

Miquel, Juan-Carlos
IAEA
4 Quai Antoine 1er
Monaco MC98000
Monaco
+377 97977259
j.c.miquel@iaea.org

Naqvi, Wajih
National Institute of Oceanography
Dona Paula 403004, Goa
India
+91 832 2450294
naqvi@nio.org

Nishioka, Jun
Hokkaido University
19N, W8 Kita-ku
Sapporo 060-0819, Hokkaido
Japan
+81 11 706 7655
nishioka@lowtem.hokudai.ac.jp

Oka, Akira
Center for Climate System Research, University of Tokyo
5-1-5, Kashiwanoha, Kashiwa-shi, Chiba, 277-8568
Kashiwa 277-8568, Chiba
Japan
+81 4 7136 4371
akira@ccsr.u-tokyo.ac.jp

Pollard, Raymond
National Oceanography Centre, Southampton
Empire Way
Southampton SO14 3ZH
United Kingdom
+44 1590 682118
rtp@noc.soton.ac.uk

Prakash, Satya
Physical Research Laboratory, Navrangpura
Planetary and Geosciences Division
Ahmedabad 380 009, Gujarat
India
+91 79 26314267
satyap@prl.res.in

Queguiner, Bernard
Centre d'Oceanologie de Marseille
Campus de Luminy / Case 901
13288 Marseille Cedex 09
France
+33 491 829 111
bernard.queguiner@univmed.fr

Ragueneau, Olivier
CNRS
Institut Universitaire Européen de la Mer (IUEM)
Technopole Brest-Iroise
29280 Plouzané
France
+33 298 498 656
Olivier.Ragueneau@univ-brest.fr

Rassoulzadegan, Fereidoun
Paris VI University
OOV, Station Zoologique
Quai de la Darse, BP 28
06234 Villefranche-sur-Mer
France
+33 493763821
rassoul@obs-vlfr.fr

Reinthaler, Thomas
Netherlands Institute for Sea Research
PO Box 59
Den Burg, 1790 AB
Netherlands
+31(0)222 369493
treinthaler@thomas-reinthaler.eu

Robinson, Carol
University of East Anglia
School of Environmental Sciences
University of East Anglia
Norwich NR4 7TJ
United Kingdom
+ 44 1603 593174
carol.robinson@uea.ac.uk

Robison, Bruce
Monterey Bay Aquarium Research Institute
7700 Sandholdt Rd.
Moss Landing 95039, California
USA
+1 831 775 1721
robr@mbari.org

Sempéré, Richard
CNRS
LMGEM, Center of Oceanology of Marseille, Case 901
Campus de Luminy
13 288 Marseille
France
+33 4 91 82 92 12
richard.sempere@com.univmed.fr

Steinberg, Deborah

Participants list

Mesopelagic workshop

Virginia Institute of Marine Science
P.O. Box 1346
Rt. 1208 Greate Rd.
Gloucester Point 23062, Virginia
United States of America
+1 804 684 7838
debbies@vims.edu

Tanaka, Tsuneo
LOPB UMR6535-CNRS
Campus de Luminiy - Case 901
163 Av. de Luminy
13288 Marseille Cedex 09
France
+33 (0)4 91 82 91 07
tsuneo.tanaka@univmed.fr

Wassmann, Paul
University of Tromsø
Breivika
N-9037 Tromsø
Norway
+47 776 44459
paulw@nfh.uit.no

Wilson, Stephanie E.
Virginia Institute of Marine Science
P.O. Box 1346, Gloucester Point, VA 23062
+1 804-684-7481
sewilson@vims.edu

Wishner, Karen
University of Rhode Island
URI / GSO
South Ferry Rd
Narragansett 02882, RI
USA
+1 401 874 6402
kwishner@gso.uri.edu

Zhang, Jing
East China Normal University
3663 Zhongshan Road North
Putuo 200062, Shanghai
China
+86 21 62233009
jzhang@sklec.ecnu.edu.cn

Bathypelagic workshop

Aluwihare, Lihini
Scripps Institution of Oceanography/UCSD
9500 Gilman Drive, MS 0244
La Jolla 92037, CA
USA
+1 858 822 4886
laluwihare@ucsd.edu

Baltar, Federico
University of Las Palmas de Gran Canaria
Urb. Garoé, 1. Los Lentiscos
Santa Brígida, 35310 Las Palmas
Spain
+34 928454547
federico.baltar102@doctorandos.ulpgc.es

Bartlett, Douglas
UCSD
8750 Biological grade, 4405 Hubbs Hall
MBRD/SIO/UCSD
La Jolla 92037, CA
USA
+1 858 534 5233
dbartlett@ucsd.edu

Beaupré, Steven
University of California, Irvine
Dept. Earth System Science, 2212 Croul Hall
Irvine 92697-3100, CA
USA
+1 949 379 0589
sbeaupre@uci.edu

Bochdansky, Alexander
Old Dominion University
4600 Elkhorn Ave
Norfolk 23529, VA

USA
+1 757 683 4933
abochdan@odu.edu

Burd, Adrian
University of Georgia
Department of Marine Sciences
University of Georgia
Athens, 30602-3636 Georgia
USA
+1 706 542 1604
adrianb@uga.edu

Deming, Jody
University of Washington
Box 357940
Seattle 98195, WA
USA
+1 206 543 0845
jdeming@u.washington.edu

Fonda, Serena
University of Trieste
v. Valerio 28/1
Trieste 34127, TS
Italy
+ 39 040 5582007
s.fonda@units.it

Fukuda, Hideki
The University of Tokyo
Ocean Research Institute
2-106-1, Akahama
Otsuchi town
Kamihei county, 0281102 Iwate
Japan
+81 193 42 5611
hfukuda@ori.u-tokyo.ac.jp

Gogou, Alexandra
Hellenic Centre for Marine Research
46,7 km Athens-Sounion Avenue
19013 Anavyssos
Greece
+30 22910 76365
agogou@ath.hcmr.gr

Hansell, Dennis
University of Miami
4600 Rickenbacker Causeway
Miami 33156, FL
USA
+1 305 421 4078
dhansell@rsmas.miami.edu

Hansman, Roberta
Scripps Institution of Oceanography / UCSD
9118-C Regents Rd
La Jolla 92037, CA
USA
+1 858 692 3421
rhansman@ucsd.edu

Herndl, Gerhard
Royal Netherlands Institute for Sea Research
PO Box 59
Den Burg, 1790AB
Netherlands
+31 222 369 507
herndl@nioz.nl

Karl, Dave
Department of Oceanography
1000 Pope Rd. MSB 629
University of Hawaii
Honolulu, HI 96822
USA
+1 808 956 8964
dkarl@hawaii.edu

Malisana, Elisa
University of Trieste
Santa Croce 174
Trieste 34014, Ts
Italy
+39 0405584008
elirolling@yahoo.it

Nagata, Toshi
Ocean Research Institute, The University of Tokyo
1-15-1 Minami-dai
Nakano-ku 164-8639, Tokyo
Japan
+81 3 5351 6460
nagata@ori.u-tokyo.ac.jp

Nieto-Cid, Mar
Woods Hole Oceanographic Institution
WHOI MS#51
266 Woods Hole Road
Woods Hole 02540, Massachusetts
USA
+1 508 289 2835
mnietocid@whoi.edu

Panagiotopoulos, Christos
Lab. Microb. Geoch. Ecol. Marines
LMGEM, CNRS UMR 6117, COM
Campus de Luminy, Case 901
13009 Marseille
France
+ 33 4 91 82 90 52
panagiotopoulos@univmed.fr

Repeta, Daniel
Woods Hole Oceanographic Institution
MS 51, Watson Laboratory
WHOI, 360 Woods Hole Road
Woods Hole 02543, MA
USA
+1 508 289 2635
drepeta@whoi.edu

Participants list

Bathypelagic workshop

Sohrin, Rumi
Shizuoka University
836 Oya, Suruga-ku
Shizuoka 422-8529
Japan
+81 54 238 4934
srsohri@ipc.shizuoka.ac.jp

Tamburini, Christian
CNRS - Université de la Méditerranée
63 Avenue de Luminy
Marseille 13288 Cedex 09
France
+33 4 91 82 90 53
tamburini@univmed.fr

Verdugo, Pedro
University of Washington
Friday Harbor Laboratories
620 University Rd
Friday Harbor 98250, WA
USA
+1 206 543 5994
verdugo@u.washington.edu

Yamada, Namiha
National Institute of AIST
16-1 Onogawa
Tsukuba 305-8569
Japan
+81 29 861 8035
namiha-yamada@aist.go.jp

Yamashita, Youhei
Florida International University
University Park Campus, OE-148
Miami 33199, Florida
USA
+1 305 348 6085
yamashiy@fiu.edu

Organising committee

Apelbaum, Sandrine
University of Miami
Rosenstiel School of Marine and Atmospheric Science
NSF-NIEHS Oceans & Human Health Center
4600 Rickenbacker Cswy, E. Grosvenor Building, #E211
Miami, 33149 FL
USA
305-421-4192
sapelbaum@rsmas.miami.edu

Beauvais, Sophie
IMBER IPO
Institut Universitaire Européen de la Mer (IUEM)
Technopole Brest-Iroise
29280 Plouzané
France
+33 298 498 693
sophie.beauvais@univ-brest.fr

Fily, Elena
IMBER IPO
Institut Universitaire Européen de la Mer (IUEM)
Technopole Brest-Iroise
29280 Plouzané
France
+33 298 498 672
elena.fily@univ-brest.fr

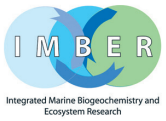
Hartley, Sidney
University of Miami
Rosenstiel School of Marine and Atmospheric Science
NSF-NIEHS Oceans & Human Health Center
4600 Rickenbacker Cswy, E. Grosvenor Building, #E211
Miami, 33149 FL
USA
+1 305-421-4176
shartley@rsmas.miami.edu

Hollenbeck, Julie
University of Miami
Rosenstiel School of Marine and Atmospheric Science
NSF-NIEHS Oceans & Human Health Center
4600 Rickenbacker Cswy, E. Grosvenor Building, #E211
Miami, 33149 FL
USA
+1 305 421 4609
jhollenbeck@rsmas.miami.edu

Roy, Sylvie
IMBER IPO
Institut Universitaire Européen de la Mer (IUEM)
Technopole Brest-Iroise
29280 Plouzané
France
+33 298 498 706
sylvie.roy@univ-brest.fr

Smith, Sharon
University of Miami
RSMAS - MBF
4600 Rickenbacker Causeway
Key Biscayne 33149, Florida
USA
+1 305 421 4819
sharon.smith@rsmas.miami.edu

Contact: imbizo@univ-brest.fr
Web site: http://www.imber.info/imbizo.html



Scientific images by Glynn Gorick - glynn@gorick.co.uk / Background illustration & graphic design by Sebastien Herve - contact@sebastien-herve.com