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Libro de resúmenes

Symposium
GLOBEC–IMBER
España

Valencia

(Ciudad de las Artes y las Ciencias)

28 a 30 de Marzo de 2007

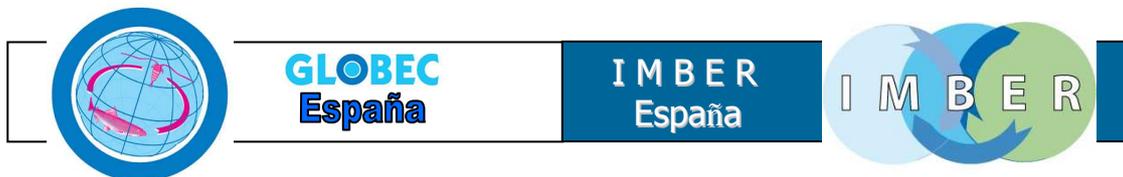


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Imagen obtenida de "Google Earth" en la que se indica la ubicación de los dos edificios de la Ciudad de las Artes y las Ciencias de Valencia en los que se celebrará el symposium.



EL SYMPOSIUM GLOBEC-IMBER ESPAÑA

En Noviembre de 2001 se celebró en el Puerto de Santa María (Cádiz) el Primer *Symposium* GLOBEC-España. Aquella reunión congregó a una parte importante de la comunidad oceanográfica española y, en palabras del director de la Oficina Internacional GLOBEC, significó el punto de partida para considerar oficialmente la existencia de un programa GLOBEC-España.

Han pasado algo más de 5 años y GLOBEC Internacional se encuentra ya en la fase de discusión y síntesis, previa a la finalización de este programa prevista para el año 2009. A partir de ese momento, los contenidos de GLOBEC serán absorbidos por el nuevo programa de investigación marina IMBER, cuyo Plan de implementación se ha publicado recientemente (2005). En este *symposium* tenemos la oportunidad de revisar algunos de los logros del programa GLOBEC-España a la vez que impulsar la actividad entorno al programa IMBER-España. Además estamos ante una buena ocasión para reunir a los investigadores vinculados a ambos programas, que son de hecho la mayor parte de quienes hacen investigación oceanográfica en España.

Este *symposium* va a ser simultáneo a otro más general que han organizado las 5 Facultades de Ciencias del Mar españolas, y que ha sido bautizado como ISMS07 (Internacional *Symposium* on Marine Science). En realidad fué la “Conferencia de Decanos de Ciencias del Mar” la verdadera impulsora de esta doble convocatoria, ya que desde ese foro se contactó con las Comisiones GLOBEC e IMBER para invitarnos a participar en esta iniciativa. El papel de Santiago Hernández León, en su doble condición de decano de la Facultad de Ciencias del Mar en la ULPGC y miembro de la Comisión GLOBEC-España ha sido clave en la génesis de este doble congreso. La Universidad Católica de Valencia, que incluye la más joven de las 5 Facultades de Ciencias del Mar españolas, asumió el difícil reto de liderar la iniciativa y encargarse de la organización local.

La ciudad de Valencia y en particular el emblemático y singular espacio de la “Ciudad de las Artes y las Ciencias” va a ser durante 3 días un lugar de encuentro sin precedentes de la comunidad oceanográfica española. Los dos *symposia* compartirán las sesiones plenarias iniciales de cada día, así como las sesiones de inauguración y clausura en el edificio de *L’ Oceanogràfic*. El *Museo de la Ciencia “Príncipe Felipe”*, a muy poca distancia de *L’oceanogràfic*, será el lugar en que se desarrollará el grueso del *symposium* GLOBEC-IMBER, incluyendo las sesiones orales y de poster.

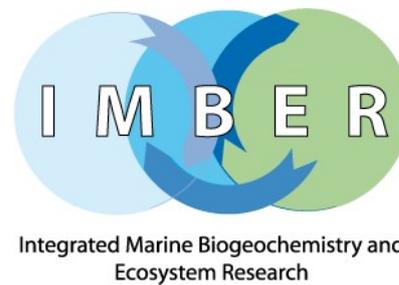
Durante estos días tendremos la ocasión de discutir tanto aspectos científicos como de organización y gestión de estos programas. Para este segundo objetivo va a ser importante poder contar con personas que ocupan puestos relevantes en la coordinación internacional de ambos programas como Manuel Barangé (director de la Oficina Internacional de GLOBEC), Julie Hall (*chairman* de IMBER), o los coordinadores GLOBEC en Alemania (Jurgen Alheit) y Portugal (Miguel Santos). A todos ellos estamos muy agradecidos, y su presencia añadirá dimensión internacional a esta reunión.

El *symposium* GLOBEC-IMBER España es el resultado de un esfuerzo colectivo en el que han tenido un papel relevante las comisiones nacionales de GLOBEC e IMBER, que han nutrido los Comités Científico y Organizador. También queremos agradecer la labor de personas que han participado activamente en fases anteriores de estas comisiones, y en especial a Celia Marrasé, Luis Valdés y Miquel Alcaraz. En aspectos concretos de organización ha sido clave la disposición y ayuda recibida del Comité Organizador Local en Valencia y en particular de Carolina Padrón. También ha sido importante la ayuda ofrecida por Maria del Mar Montes y Rosa Rodríguez, del Centro Andaluz de Ciencias y Tecnologías Marinas de la Universidad de Cádiz.

Desde el comité organizador del *symposium* GLOBEC-IMBER os damos la bienvenida y os deseamos una provechosa estancia en Valencia.

Fidel Echevarría, Javier Arístegui, Aida F. Ríos, Beatriz Morales. Marzo de 2007

Organizadores



Patrocinadores



Entidades colaboradoras



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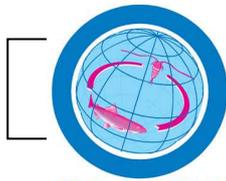
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SYMPOSIUM GLOBEC-IMBER ESPAÑA

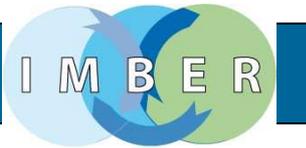
Valencia, 28 a 30 de Marzo de 2007

	Miércoles 28	Jueves 29	Viernes 30	
9.00	INSCRIPCIÓN DOCUMENTACIÓN	CONF. PLENARIA Manuel Barangé	CONF. PLENARIA Julie Hall	L'oceano- gràfic
10.00	INAUGURACIÓN	SESIÓN 3 Moderan: Bode, Borja Conferencia: Alheit Ponencias: 4	SESIÓN 7 Moderan: Marañón, F. Ríos Conferencia: Cacho Ponencias: 4	
11.00	CONF. INAUGURAL Carlos Duarte			
12.00	CAFÉ	CAFÉ	CAFÉ	
13.00	SESIÓN 1 Moderan: Gasol, Agustí Conferencia: Pedrós-Alió Ponencias: 8	SESIÓN 4 Moderan: Marrasé, Sangrà Conferencia: Santos Ponencias: 6	SESIÓN 6 Moderan: Aristegui, Alvarez Conferencia: Barton Ponencias: 6	Museo de la Ciencia "Príncipe Felipe"
14.00	ALMUERZO	ALMUERZO	ALMUERZO	
16.00	SESIÓN 2 Moderan: Saiz, Acuña Conferencia: Calbet Ponencias: 6	SESIÓN 5 Moderan: Irigoien, Echevarría Conferencia: López Urrutia Ponencias: 6	SESIÓN 8 Moderan: Calafat, Peters Conferencia: Ruiz Ponencias: 6	
17.00	PRIMERA SESIÓN POSTERS	SEGUNDA SESIÓN POSTERS	C. FINAL: B. Morales	
18.00			MESA REDONDA	L'oceano- gràfic
19.00			CLAUSURA	
20.00	CONCIERTO + COCKTAIL BIENVENIDA			
21.00			CENA CLAUSURA	



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SYMPOSIUM GLOBEC-IMBER ESPAÑA

28-30 Marzo 2007. Valencia.

Programa

Miércoles 28 de Marzo

L'Oceanogràfic

09.00 a 10.00: Inscripción y recogida de documentación

10.00 a 10.30: Acto de inauguración.

10.30 a 11.15: Conferencia plenaria inaugural: **Carlos Duarte** (IMEDEA, Mallorca)
"Our evolving view of the carbon budget of the ocean"

11.15 a 11.45: Pausa Café

Museo Príncipe Felipe

11.45 a 12.00: **Aida Fernández Ríos** (IIM-CSIC Vigo. Presidenta IGBP-España):
"Los Programas Marinos de IGBP: GLOBEC-IMBER-SOLAS-LOICZ"

12.00 a 14.00 Sesión 1: Biodiversidad, función y metabolismo en el océano.

Responsables: *Josep M. Gasol* (ICM-CSIC Barcelona), *S. Agustí* (IMEDEA-CSIC Mallorca)

12.00: Conferencia invitada: **Carles Pedrós-Alió** (ICM-CSIC Barcelona):
"Genomics, light, and marine bacteria"

12.30: Moira Llabrés, S. Agustí, P. Alonso-Laita, G. Herndl. *Diel cycles of cell death in picophytoplankton and coupling with cell division.*

12.42: Marta Alvarez, X.A. Alvarez Salgado. *Biogeochemical budgets in the Eastern boundary current system of the North Atlantic: Evidences of net heterotrophy and nitrogen fixation.*

12.53: Laura Alonso-Sáez, O. Sánchez, C. Pedrós-Alió, J.M. Gasol. *Active marine prokaryotic groups in two contrasting coastal systems: Blanes (NW Mediterranean) and Franklin bay (western arctic).*

13.04: Eva Teira et al. *Linkage between bacterial community structure, environmental factors and microbial carbon processing in a highly dynamic coastal ecosystem*

13.16: Sebastien Putzeys, L. Yebra, C. Almeida, P. Becognee, S. Hernández León. *Carbon fluxes due to migrant zooplankton movements during the late winter bloom in the Canary Island waters.*

13.27: Montserrat Sala, C. Pedrós-Alió. *Bacterioplankton metabolic diversity under the ice.*

13.38: Federico Baltar, J. Arístegui, G.J. Herndl, J.M. Gasol, S. Hernández-León. *Surface-depth and coastal ocean gradients in diversity and activity of prokaryotes in the Canary CTZ region.*

13.49: Emilio García-Robledo, A. Corzo. *Microbenthic metabolism and nutrient dynamics under drifting green macroalgae canopies.*

14.00 a 15.30: Almuerzo

15.30 a 17.30 Sesión 2: Interacciones tróficas

Responsables: *Enric Saiz (ICM-CSIC Barcelona), José Luís Acuña (U. Oviedo)*

15.30: Conferencia invitada: **Albert Calbet (ICM-CSIC Barcelona):**

“Microzooplankton, key organisms in marine food webs”

16.00: Andrés Gutierrez, Mikel Latasa. *Carbon fluxes through main phytoplankton groups in an oligotrophic coastal system.*

16.15: Claire Schmoker, Santiago Hernández-León. *Latitudinal variability of microzooplankton growth and mortality.*

16.30: Miquel Alcaraz, Rodrigo Almeda, MariLuz Fernández Puelles, Renate Scharek. *Zooplankton and carbon flow in the Northwestern Mediterranean: respiratory requirements and fecal pellet production during a spring phytoplankton bloom.*

16.45: Lucía Zarauz, Xabier Irigoien. *Trophic control in the generation of phytoplankton blooms in the Central Cantabrian sea.*

17.00: Elvira Morote, M.P. Olivar, F. Villate, I. Uriarte. *Trophic ecology of bullet tuna larvae (*Auxis rochei*) in the Northwestern Mediterranean.*

17.15: Antonio Bode, M.T. Alvarez Osorio, N. González, C. Porteiro, M. Varela. *Coastal nutrient inputs and litoral food webs of Galicia.*

17.30 a 19.00 Sesión de posters I

20.00 *Concierto ofrecido por el quinteto “Cuesta” en el Palacio de la Exposición de Valencia y cocktail de bienvenida*

Jueves 29 de Marzo

L’Oceanografic

09.00 a 9.50: Conferencia plenaria: **Manuel Barangé (Director IPO GLOBEC, Plymouth):**

“From description to prediction: a decade of GLOBEC’s research”.

Museo Príncipe Felipe

10.00 a 11.30 Sesión 3: Análisis retrospectivo y estudio de series temporales

Responsables: *Antonio Bode (IEO Coruña), Angel Borja (AZTI, Pasaia)*

10.00: Conferencia invitada: **Juergen Alheit (coordinador GLOBEC Alemania):**

“Teleconnection patterns of impact of climate variability on pelagic ecosystems across Europe”

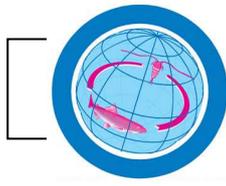
10.30: Mariona Segura, A. Cruzado, M. Emelianov, E. Vázquez-Domínguez, D. Blasco. *Physico-chemical trends since 1970 at the catalan sea (NW Mediterranean sea)*

10.45: Agueda Vázquez, M Bruno, A Izquierdo, D Macías, CM García, F Echevarría, R Mañanes. *Relaciones de la NAO con procesos ondulatorios y de mezcla en el Estrecho de Gibraltar: Análisis de potenciales efectos biogeoquímicos.*

11.00: Magdalena Santana-Casiano, M. González-Dávila. *Interannual variability of CO2 parameters at the ESTOC site.*

11.15: G. González Nuevo, E. Nogueira, J. Cabal, X.A.G. Morán. *Influence of the Iberian poleward current (IPC) in the southern bay of Biscay during the winter-spring transition from 1987 to 2006.*

11.30 a 12.00 Pausa café



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12.00 a 14.00 Sesión 4: Interacción física-biología en el océano

Responsables: *Celia Marrasé (ICM Barcelona), Pablo Sangrá (U. Las Palmas)*

12.00: Conferencia invitada: **Miguel Santos** (*coordinador GLOBEC Portugal*):
“*Physical-biological interactions in the Western Iberia Upwelling Ecosystem*”

12.30: Marta Moyano, JM Rodríguez, S Hernández-León. *Ichtioplankton composition and distribution during the late winter bloom in the Canary island waters.*

12.45: Manuel Vargas, Ana Sabatés. *The influence of high frequency mesoscale processes on fish larvae distributions in the Alboran sea.*

13.00: Jaime Otero, X.A. Alvarez-Salgado, AF González, A Guerra. *Does short time scale upwelling variability determine cephalopoda paralarvae abundance?*

13.15: Jesús Mercado, T Ramirez, D Cortés. *Cambios en la concentración de nutrientes inducidos por la variabilidad hidrológica y su efecto sobre la absorción de luz por el fitoplancton en el sector NO del mar de Alborán.*

13.30: Gabriel Navarro, L Prieto, J Gómez-Enri, J Ruiz. *Effect of oceanographic conditions on seasonal and interannual variability in timing of spring bloom in the gulf of Cádiz.*

13.45: Beatriz Mouriño, A Cianca, S Neuer. *Regional differences in the role of eddy pumping in the North Atlantic subtropical gyre.*

14.00 a 15.30 Almuerzo

15.30 a 17.30 Sesión 5: Efectos del cambio global sobre las especies, ecosistemas y ciclos biogeoquímicos

Responsables: *Xabier Irigoien (AZTI Pasaia), Fidel Echevarría (U. Cádiz)*

15.30: Conferencia invitada: **Angel López Urrutia** (*IEO Gijón*):
“*A metabolic theory of the oceans: simple rules for complex systems*”

16.00: Antonio Tovar, S Sañudo-Wilhelmy. *Biochemical characterization of Trichodesmium spp along tropical North Atlantic ocean.*

16.15: César Meiners, L Fernández, F Salmerón, A Ramos. *First approach about climate variability and fisheries dynamics of black hakes (Merluccius polli and Merluccius senegalensis) in NW Africa.*

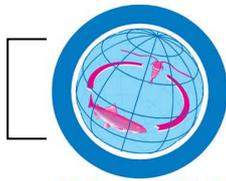
16.30: Marta Ribes, R Coma, E Serrano, E Jiménez. *Global change effect on mediterranean coraligenous community: mass mortality events and their consequences on hydrodynamics and nutrient transfer at ecosystem level.*

16.45: Lidia Yebra, D Bonet, R Harris, K Peijnenburg, P Lindeque. *Intra-specific genetic structuring in Calanus helgolandicus european populations associated with latitudinal differences.*

17.00: Mikel Latasa, Miquel Alcaraz, Rodrigo Almeda, Elisa Berdalet, Clara Cardelús, Mikhail Emelianov, Marta Estrada, Josep-Maria Gasol, Andrés Gutiérrez, Celia Marrasé, Jordi Salat, M^a Luz Fernández de Puellas, Eva Alou, Javier Jansà, José Luís López-Jurado, Montse Vidal, Gemma Vila and Renate Scharek. *An overview of EFLUBIO: Structures and biogeochemical fluxes in the NW Mediterranean*

17.15: Rosa Martínez. *Effect of temperature and ultraviolet radiation on the activity of the antioxidant enzyme superoxide dismutase in antarctic plankton.*

17.30 a 19.00 Sesión de pósters II



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Viernes 30 de Marzo

L'Oceanografic

09.00 a 9.50: Conferencia plenaria: **Julie Hall** (Chairman IMBER):
“IMBER, Integrated Marine Biogeochemistry and Ecosystem Research”

Museo Príncipe Felipe

10.00 a 11.30 Sesión 7: Papel de los ecosistemas y el océano en la regulación del clima

Responsables: *Emilio Marañón (U. Vigo), Aida Fernández Ríos (IIM-CSIC Vigo)*

10.00: Conferencia invitada: **Isabel Cacho** (U. Barcelona):
“Role of the Eastern Equatorial Upwelling System in Past Rapid Climatic Variability”

10.30: **Miquel Canals**, A.M. Calafat, J. Frigola, I. Cacho, P. Puig, A. Palanqués, X. Durrieu de Marón, S. Heusner, J.O. Grimalt, A. Moreno, J.A. Flores, F.J. Sierro. *Dense shelf water cascading in the gulf of Lion and its implication for the western Mediterranean Paleoceanographic record.*

10.45: **Eva Calvo**, Carles Pelejero. *Ocean acidification: a view from reconstructions of past seawater pH.*

11.00: **Rafel Simó**, Sergio Vallina. *Ups and downs in the plankton/sulphur/clouds/sunlight feedback.*

11.15: **Emma Huertas**, Susana Rodríguez-Gálvez, A. Makaoui, J. García Lafuente, A. Sánchez, A.F. Ríos, S. Zizah, A. Orbi, J. Ruiz. *Carbon exchange through the strait of Gibraltar.*

11.30 a 12.00 Pausa café

12.00 a 14.00 Sesión 6: Transferencia de materia y energía entre interfases oceánicas.

Responsables: *Javier Arístegui (U. Las Palmas GC), Xosé Alvarez Salgado (IIM-CSIC Vigo)*

12.00: Conferencia invitada: **Eric D. Barton** (IIM-CSIC Vigo):
“Upwelling, Ekman transport and horizontal exchanges: changing perspectives”

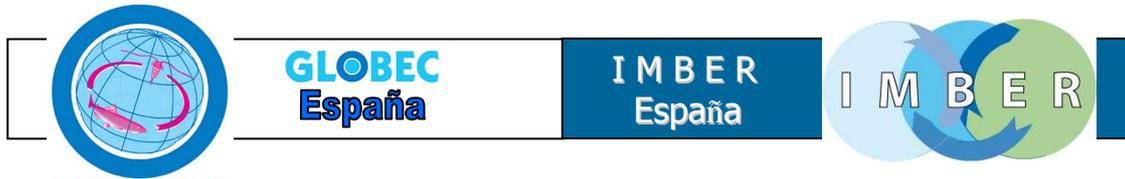
12.30: **Iván Alonso**, J Arístegui, A Hernández-Guerra, J.C. Vilas, I. Polo. *Suspended POC transport and consumption in surface and deep waters of Canary current: a box model study.*

12.45: **M Gómez Gesteira**, M. de Castro, I. Alvarez, AJC Crespo, JM Cabanas, R Prego. *Winter upwelling recurrence along the Galician western coast.*

13.00: **Ricardo Prego**, D Guzmán, M Varela, M deCastro, M Gómez Gesteira. *Water and nutrient transfer in the ría-ocean interface and phytoplanktonic patterns of two winter upwelling events in a Galician ría.*

13.15: **S. Piedracoba**, M. Nieto-Cid, C. Souto, I.G. Teixeira, M. Gilcoto, J. L. Garrido, X. A. Álvarez-Salgado, G. Rosón, R. Varela, C.G. Castro, F. G. Figueiras, F.F. Pérez. *Geochemical microbial approach to the new production of the coastal upwelling system of the ría de Vigo (NW Spain).*

13.30: **Montserrat Vidal**, G. Vila, M. Emelianov, J. L. López-Jurado, M. Latasa, J. Salat. *Hydrographical structure and nutrient distribution during the 2005 spring phytoplankton bloom in the NW Mediterranean: a tool for estimating export production.*



13.45: Jesús M. Arrieta, A Tovar-Sánchez, S Agustí, Carlos M Duarte. *Utilization of atmospheric materials by marine prokariotic communities.*

14.00 a 15.30 Almuerzo

15.30 a 17.30 Sesión 8: Capacidad predictiva y modelado

Responsables: *Antoni Calafat (U. Barcelona), Francesc Peters (ICM-CSIC Barcelona)*

15.30: Conferencia invitada: **Javier Ruiz** (ICMAN-CSIC Cádiz):
“From nitrate to tunna: a model of models”

16.00: César González Pola, Julio Fernández Díaz, Alicia Lavín. *Evolution of the vertical structure of the upper ocean from a time series of profiles fitted to physically-consistent functional forms.*

16.15: Pablo Otero, Manuel Ruiz Villareal. *Present uncertainties on ocean modelling of north and northwest Iberia.*

16.30: Marcos Cobas, Manuel Ruiz Villarreal, Pablo Otero, Paula Conde, Laura Escalera, Pedro Montero, José Manuel Cabanas. *Oceanographic conditions affecting red tides in NW Iberia during October 2005.*

16.45: Luis Ferrer, Manuel González, Adolfo Uriarte, Víctor Valencia, Julien Mader, Almudena Fontán. *Marine forecast capacity and modelling in the bay of Biscay.*

17.00: Ch. Troupin, P. Sangrá, J. Arístegui. *Simulation and annual cycles of phytoplankton, zooplankton and nutrients to the south of the Gran Canaria island using a mixed layer model coupled with a biological model.*

17.15: Francesc Peters. *Aproximaciones a la modelización y la predicción de ecosistemas marinos.*

L’Oceanografic

17.40 a 18.00 **Beatriz Morales** (IMEDEA, CSIC, Baleares. Gestora del Subprograma CYTMAR):
“Las Ciencias Marinas en España”

18.00 a 19.00 Mesa redonda: “Presente y futuro de las Ciencias del Mar: Investigación y Docencia”

19.00 a 19.30 Sesión de clausura

21.30 *Cena de clausura*

Conferencia plenaria inaugural

Miércoles 28, 10:30

OUR EVOLVING VIEW OF THE CARBON BUDGET OF THE OCEANCarlos M. Duarte

IMEDEA (CSIC-UIB), Mallorca.

The ocean carbon budget has been identified as a test of our understanding of the fundamental processes controlling carbon cycling in the ocean. A deconstruction of widely-used carbon budgets will show that present depictions imply processes and assertions that are controversial and present major omissions. I shall discuss these processes and omissions to identify the need to expand our present view to include additional processes and will also address apparent paradoxes resulting from focus on various processes to resolve the ocean carbon budget. I shall then test the merit of these ideas at a regional scale by showing how the carbon budget at the NE Subtropical Atlantic Ocean can be balanced and apparent paradoxes explained by considering all processes in concert.

Conferencia inaugural symposium GLOBEC-IMBER

Miércoles 28, 11:45

LOS PROGRAMAS MARINOS DE IGBP: GLOBEC-IMBER-SOLAS-LOICZ.Aida F. Ríos¹, Fidel Echevarría², Javier Arístegui³, Rafel Simó⁴, Jose Lucas Pérez Lloréns⁵.

IIM-CSIC Vigo. Presidenta IGBP-España
 Universidad de Cádiz. Coordinador GLOBEC-España
 Universidad de Las Palmas GC. Coordinador IMBER-España
 ICM-CSIC-Barcelona. Coordinador SOLAS-España
 Universidad de Cádiz. Coordinador LOICZ-España

El programa IGBP (International Geosphere-Biosphere Program, <http://www.igbp.kva.se/>) tiene como objetivo el estudio de los procesos físicos, químicos y biológicos que regulan a escala planetaria el “Sistema Tierra”, de los cambios que ocurren en el sistema y de la influencia humana en dichos cambios, aportando un marco internacional a la investigación relacionada con el Cambio Global. El papel de los Comités Nacionales es asistir en la coordinación nacional de investigaciones relacionadas con los objetivos de IGBP para incentivar la integración de estas actividades con los programas internacionales. Desde 2004 IGBP ha entrado en una segunda fase en la que los programas se articulan en torno a los principales compartimentos del Sistema Tierra (océano, litosfera, atmósfera) y sus interfases. El Comité Español opera dentro del marco institucional de la Comisión Interministerial de Ciencia y Tecnología (CICYT). En esta ponencia se revisan las actividades más importantes desarrolladas en España en el marco de los programas IGBP relacionados con el océano: GLOBEC (Global Ocean Ecosystem Dynamics) e IMBER (Integrated Marine Biogeochemistry and Ecosystem Research) son los dos programas activos de investigación del compartimento “océano”, mientras que SOLAS (Surface Ocean Lower Atmosphere Study) y LOICZ (Land Ocean Interactions in the Coastal Zone) se ocupan de las interfases océano-atmósfera y océano-tierra, respectivamente.

*Conferencia invitada**Miércoles 28, 12:00***GENOMICS, LIGHT, AND MARINE BACTERIA***Carles Pedrós-Alió*

Instituto de Ciencias del Mar- CSIC, Barcelona

Before the development of microbial ecology in the 1970s, microbes were not even considered in marine ecological studies. Today we know that half of the total primary production of the planet must be credited to microorganisms. This and other discoveries have changed dramatically the perspective and the focus of marine microbial ecology. In the last few years genomics has brought about a revolution in all fields of biology. The application of genomics-based approaches has provided new challenges and has allowed the discovery of novel functions, an appreciation of the great diversity of microorganisms, and the introduction of controversial ideas regarding the concepts of species, genome, and niche. Nevertheless, thorough knowledge of the traditional disciplines of biology is necessary to explore the possibilities arising from these new insights. This work reviews the different genomic techniques that can be applied to marine microbial ecology, including both sequencing of the complete genomes of microorganisms and metagenomics, which, in turn, can be complemented with the study of mRNAs (transcriptomics) and proteins (proteomics). The example of proteorhodopsin illustrates the type of information that can be gained from these approaches. A genomics perspective constitutes a map that will allow microbiologists to focus their research on potentially more productive aspects.

Miércoles 28, 12:30

DIEL CYCLES OF CELL DEATH IN PICOPHYTOPLANKTON AND COUPLING WITH CELL DIVISIONMoira Llabrés¹, Susana Agustí¹, Patricia Alonso-Laita¹ & Gerhard Herndl²¹ IMEDEA CSIC–UIB, Mallorca² Royal Netherlands Institute for Sea Research (NIOZ), Texel, The Netherlands

The diel variability in the proportion of dead cells of picocyanobacterial populations was monitored in the Mediterranean Sea. Increasing percentages of dead cells of *Prochlorococcus* and *Synechococcus* were observed during the course of the day reaching highest percentages around dusk and decreasing as the night progressed. The highest percentage of dead cells coincided with the time when cell division took place. Thus, our results indicate a close coupling between cell death and cell division. The maximum percentage of dead cells and the G₂+M phase of the cell division occurred within a period of two hours, at 8.30 and 10.30 PM (local time) for *Synechococcus* and at 6.30 and 8.30 PM for *Prochlorococcus*. The lowest fraction of dead cells was found when the abundance of daughter cells was highest (maximum number of cells in G₁ phase), at 10 AM for *Synechococcus* and at 7- 8.30 AM for *Prochlorococcus*. Cell death rates exceeded growth rate values during daytime hours indicating pronounced diel variations in death and growth of picocyanobacterial populations in surface waters. The diel patterns in cell death observed may influence the bacterial activity and dynamics through the release of DOC by dead and lysed picocyanobacterial cells.

Miércoles 28, 12:42

BIOGEOCHEMICAL BUDGETS IN THE EASTERN BOUNDARY CURRENT SYSTEM OF THE NORTH ATLANTIC: EVIDENCES OF NET HETEROTROPHY AND NITROGEN FIXATIONMarta Álvarez¹ and Xosé Antón Álvarez-Salgado²¹ IMEDEA CSIC–UIB, Mallorca² Instituto de Investigaciones Marinas CSIC , Vigo

Thermohaline and chemical data from three WOCE cruises conducted in 1997/98 define the MedBox region, bounded by the Strait of Gibraltar, 24°N, 41°N and 22°W. The carbon budget indicates that the MedBox is a heterotrophic region, where carbon is mineralised at a net rate of $17 \pm 11 \text{ g C m}^{-2} \text{ yr}^{-1}$, supported by the input of allochthonous organic matter, mainly in the dissolved form, from the adjacent ocean. Dissolved organic carbon accounts for 90% of the organic carbon demand. In vitro measurements to estimate the net community production of the study area differ largely from our geochemical budget estimation, likely reflecting different spatial and temporal scales and/or terms or processes not taken into account by both methods. The nitrogen budget of the MedBox pointed to a significant atmospheric input via N₂ fixation ($3.4 \pm 3.1 \text{ g N m}^{-2} \text{ yr}^{-1}$).

Miércoles 28, 12:53

ACTIVE MARINE PROKARYOTIC GROUPS IN TWO CONTRASTING COASTAL SYSTEMS: BLANES (NW MEDITERRANEAN) AND FRANKLIN BAY (WESTERN ARCTIC).Laura Alonso-Sáez, Olga Sánchez, Carles Pedrós-Alió and Josep M. Gasol

Institut de Ciències del Mar-CSIC, Barcelona

The identification of the phylogenetic groups of marine prokaryotes that are actively recycling the dissolved organic matter *pool* in the sea can greatly improve our understanding of the oceanic carbon cycle. However, for many years, the study of the activity of prokaryotic groups has been restricted to those bacteria that were easily cultured from seawater. The development of methodologies such as microautoradiography combined

with fluorescence in situ hybridization (MARFISH) has been crucial to analyse the *in situ* activity of different groups. With this main objective, we applied this technique in two contrasting marine coastal systems: the NW Mediterranean and the coastal Western Arctic. We found some similarities in the prokaryotic assemblage structure, such as the dominance of Alphaproteobacteria (from 20% to over 50% of total cell counts), and more specifically the SAR11 group in both systems. However, Bacteroidetes reached high abundances in some periods in the Arctic (25% of cell counts during the phytoplankton *bloom*), while this group never exceeded 15% of cell counts in the Mediterranean. Betaproteobacteria were also more abundant in the Arctic (up to 6% of total cell counts), a system more affected by freshwater inputs, compared to Mediterranean waters, where this group was absent. Similarly, Archaea were quantitatively important during winter in the Arctic (15% of total cell counts), while in NW Mediterranean this group rarely exceeded 5% of cell counts. Surprisingly, the percentages of active cells in the uptake of three labile substrates (glucose, amino acids, and ATP) analysed by microautoradiography were similar in these two contrasting systems (generally within a range of 10-30% of active Eubacteria). The similarities of *in situ* activities of specific bacterial groups were also more striking than the differences. Despite the low contributions of Roseobacter to assemblage composition (range 1 to 8%), this group showed high activity in both systems, reaching values of over 70% of active cells in the uptake of all substrates. Betaproteobacteria was another low-abundance group but with high percentage of active cells in Arctic waters. On the contrary, SAR11 was more abundant year-round, but showed lower uptake activities in both systems (generally under 20% of active cells). Although more research is needed, the appearance of low-abundance but highly active groups, such as Roseobacter or Betaproteobacteria, seems to be a common feature in some coastal marine systems, and indicates a highly dynamic marine bacterioplankton assemblage with respect to the processing of organic matter.

Miércoles 28, 13:04

LINKAGE BETWEEN BACTERIAL ASSEMBLAGE STRUCTURE, ENVIRONMENTAL FACTORS AND MICROBIAL CARBON PROCESSING IN A HIGHLY DYNAMIC COASTAL ECOSYSTEM.

*Eva Teira*¹, X.A. *Álvarez-Salgado*², M. *Aranguren*¹, A. *Fernández*¹, F.G. *Figueiras*², J.M. *Gasol*³, J. *González*¹, I. *Lekunberri*³, E. *Marañón*¹, P. *Serret*¹.

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Bacterioplankton communities play an important role in the flow of energy and nutrients through plankton food webs, as a consequence of their high abundance, efficient nutrient uptake and large growth potential. A number of studies have shown changes in bulk bacterial properties, as a response to biological or environmental factors. However, much less is known about how such factors may influence bacterial composition, and how potential shifts in bacterial assemblage structure may in turn influence microbial carbon processing. Even the distribution of the major phylogenetic groups of bacteria is still not well understood. We used mesocosm experiments to study the dynamics of the bacterioplankton assemblage in an extraordinarily hydrodynamic system during the four contrasting periods of the seasonal cycle: winter period, spring phytoplankton bloom, summer stratification and upwelling. We used a correlation approach in order to investigate the degree of coupling between bacterial diversity, carbon cycling and environmental factors. As a proxy for bacterial diversity we used the relative abundance of the most abundant phylogenetic groups of bacteria (*Alphaproteobacteria*, *Gammaproteobacteria*, and *Bacteroidetes*) as determined with CARD-FISH. Carbon flux-related variables included, primary production, extracellular release, bacterial production and microbial community respiration. The environmental set of factors and variables included temperature, concentrations of inorganic and organic nutrients, and chlorophyll-a concentration. Contrary to previous studies, we found out that even at this broad phylogenetic level, rapid shifts in bacterial assemblage structure occur associated to biotic and abiotic changes, and a significant correlation exists between bacterial diversity and

both carbon flux and environmental factors. Microbial carbon processing also significantly correlated to environmental factors.

Miércoles 28, 13:16

CARBON FLUXES DUE TO MIGRANT ZOOPLANKTON MOVEMENTS DURING THE LATE WINTER BLOOM IN THE CANARY ISLANDS WATERS.

Putzeys, S.¹, Yebra L.², Almeida C.³, Bécognée P.¹ and S. Hernández-León¹

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Temporal variability of zooplankton vertical distribution (0-800 m) was studied at dawn, noon and night in a station located at 100 km to the North of Gran Canaria Island (Canary Islands) during March 2000. Zooplankton biomass (protein content), indices of feeding (gut fluorescence, GF) and indices of metabolism (electron transfer system activity, ETS) were measured at the end of a late winter bloom period. Two dense layers of organisms were clearly observed during the day, one above 200m and the other at about 500 m, coincident with the deep scattering layer (DSL). A typical pattern of higher biomass in the shallower layers was displayed at night. Biomass in the 0-200 m layer remained high during the study period due to the combination of the influence of the late winter bloom, a dust storm. Average ETS activity was almost two-fold higher above 200 m than at 200-800 m depth. The gut flux estimated ($1.262 \text{ mg C}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$) was similar to the values previously found in the Canary Island waters. This value represent 2.5% of the calculated passive particulate export production resulting from primary production. The active respiratory flux mediated by diel vertical migrants ($1.23\text{-}2.70 \text{ mg C}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$) was in the lower range of values reported for this area. This value represented only 5% of the calculated total passive particulate export production. These results agree with previous estimates and suggest that diel-migrants play a moderate role in the downward flux of carbon.

Keywords: Canary Islands, carbon flux, metabolism, respiration flux, vertical migration, zooplankton, late winter bloom.

Miércoles 28, 13:27

BACTERIOPLANKTON METABOLIC DIVERSITY UNDER THE ICE

Maria Montserrat Sala & Carlos Pedrós-Alió

Institut de Ciències del Mar (CSIC), Barcelona

The metabolic diversity of bacterioplankton under the ice covered arctic shelf in Franklin Bay, Canadian Arctic, was studied using Biolog plates. Samples were taken weekly during the period December 2003-May 2004 at the surface, bottom and temperature inversion depths.

Bacterioplankton in the Arctic used preferentially polymers and carbohydrates over carboxylic and amino acids. Surface chlorophyll a and bacterial concentration were low between December and March and started increasing in April, with the melting of the ice. Bacterial metabolic richness in spring, when chlorophyll a and bacterial concentrations were high, was markedly lower than in winter.

Both at the temperature inversion depth and at the bottom samples chlorophyll a was lower than at the surface and bacterial metabolic richness did not show a clear difference between winter and spring. At both layers, a period of high metabolic richness was found during February and March that may correspond to sedimentation or resuspension events of organic matter.

The results show that, despite the oligotrophic conditions in winter, metabolic richness of surface bacterioplankton was higher than in spring, suggesting that bacteria might use preformed organic matter under the sea ice coverage. Metabolic diversity of bacterioplankton in the Arctic will be compared with that found in other oceans.

Miércoles 28, 13:38

SURFACE-DEPTH AND COASTAL-OCEAN GRADIENTS IN DIVERSITY AND ACTIVITY OF PROKARYOTES IN THE CANARY CTZ REGION*Federico Baltar¹, Javier Arístegui¹, Gerhard J. Herndl², Josep M. Gasol³, Santiago Hernández-León¹*¹ Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria² Royal Netherlands Institute for Sea Research (NIOZ), Texel, The Netherlands³ Institut de Ciències del Mar – (CSIC), Barcelona

Prokaryotes are an important component of the marine plankton playing a key role in mediating a range of biogeochemical cycles in the ocean. However, very few studies have addressed their patterns of distribution, or the relative importance of bulk and group-specific prokaryotic activity in the dark ocean. Here we report results of the differential distribution in the water column of the major prokaryotic groups, including Archaea and Bacteria (Crenarchaeota, Euryarchaeota, SAR 11, Roseobacter, Gammaproteobacteria and Cytophaga-Flavobacterium), along a transect stretching from the eutrophic waters of the NW Africa upwelling to the oligotrophic waters of the Canary Coastal Transition Zone (CTZ) region. We used the catalyzed reported deposition FISH (CARD-FISH) technique, together with measurements of leucine incorporation, to look at coastal-ocean and surface-depth patterns of distribution in the abundance and metabolism of Bacteria and Archaea, related to the hydrography and presence of distinct water masses in this heterogeneous region. From surface to depth a marked substitution between SAR11 (ranging from 42% to 4% in the Deep Chlorophyll Maximum (DCM) and 2000 m depth respectively) and Crenarchaeota (ranging from 1% to 39% in the DCM and Oxygen Minimum (OM) respectively) was observed. A clear influence of the different intermediate water masses was also observed in the prokaryotic bulk heterotrophic activity, with lower values at the stations where Antarctic Intermediate Water was detected. Crenarchaeota and gammaproteobacteria increased in abundance in the OM, presumably due to nitrification processes. Along the coastal-ocean gradient we found -at the DCM level- a substitution in all the community assemblage, together with decreasing rates in the bulk prokaryotic heterotrophic activity. The slow-growing groups (Crenarchaeota, Euryarchaeota, SAR11), better adapted to oligotrophic environments, were substituted by the fast-growing groups (Cytophaga-Flavobacterium, Roseobacter, Gammaproteobacteria) better adapted to eutrophic conditions. To our knowledge this is the first detailed report showing a clear substitution of Archaea and different groups of Bacteria along a coastal-ocean gradient.

Miércoles 28, 13:49

MICROBENTHIC METABOLISM AND NUTRIENT DYNAMICS UNDER DRIFTING GREEN MACROALGAE CANOPIES*Emilio García -Robledo, Alfonso Corzo*

Departamento Biología. Universidad de Cádiz.

Development of green macroalgae blooms in shallow water areas is a phenomenon commonly observed worldwide. Under dense canopies, light cannot be enough to support photosynthetic activity changing net benthic metabolism. Benthic metabolism controls nutrient fluxes and then those canopies can alter nutrient dynamics of shallow areas. Three aquaria were set-up with sieved sediment in an open seawater system. In two of them, macroalgae was added reaching a density of 80 and 250 g DW m⁻², leaving other one as Control. After initial measurements, macroalgae was added and aquaria were followed for 20 days. Oxygen microprofiles were measured inside aquaria (step resolution 100 µm) and used to calculate Net Production in light (Pn) and Respiration in dark (Rd). NH₄⁺, NO₃⁻, NO₂⁻ and PO₄³⁻ profiles were measured in the pore water (step resolution 1 mm) and used to calculate sediment-water fluxes. Nitrogen nutrient profiles were modelled using the numerical method described by Berg et al. (1998, L&O 43:1500). This procedure allowed the estimation of the rates of ammonification, nitrification and anaerobic NO_x⁻ reduction. Macroalgae addition produced a quick change in benthic metabolism, from net autotrophic system to net heterotrophic. Nutrient concentration in the sediment pore water increased as a results of the decline of nutrient uptake by benthic microalgae and consequently

increasing the net efflux of nutrient to the water column. Particularly as a result of the increases in NH_4^+ we also detected an enhancement of another microbial process like nitrification and denitrification.

*Conferencia invitada**Miércoles 28, 15:30***MICROZOOPLANKTON, KEY ORGANISMS IN MARINE FOOD WEBS***Albert Calbet*

Institut de Ciències del Mar, CSIC. Barcelona.

Microzooplankton are important structural and functional components of planktonic ecosystems, acting as top predators within microbial food webs and as nexus between the microbial loop and the classical food chain. They are also important contributors to the diet of mesozooplankton (e.g. in oligotrophic ecosystems microzooplankton-associated carbon supply for copepods surpasses that of phytoplankton), and they have key roles as nutrient recyclers and CO₂ producers. This talk will summarize the present knowledge on the role of microzooplankton in the oceans, comparing their relevance on the trophodynamics of different ecosystems with that of mesozooplankton. Furthermore, the contribution of microzooplankton to the diet of mesozooplankton will also be analyzed based on previously published values. The data discussed along the talk will correspond to different oceans, although special stress will be posed on those examples from the GLOBEC-Spain umbrella. Finally, I will try to identify the main deficits and needs of the actual investigation on the subject, and suggests future lines of research to be stressed.

Miércoles 28, 16:00

CARBON FLUXES THROUGH MAIN PHYTOPLANKTON GROUPS IN AN OLIGOTROPHIC COASTAL SYSTEM

Andrés Gutiérrez Rodríguez, Mikel Latasa Arcalis

Instituto de Ciencias del Mar, CSIC, Barcelona

Microzooplankton is now recognized as the main consumer of daily primary production in the ocean (Landry et al. 1997; Calbet and Landry 2004). This status confers microzooplankton a key role in the carbon fluxes through planktonic food webs. However different phytoplankton groups may differ in their growth and grazing-caused mortality rates (Latasa et al 1997, 2005). Within this background this work aims to 1) Characterize growth and mortality dynamics of main phytoplankton groups determined by marker pigments, 2) Quantify the carbon fluxes derived from these dynamics, 3) Analyze links between initial composition of phytoplankton community and relative contribution of different phytoplankton groups to carbon fluxes.

In order to answer these questions we monthly sampled an oligotrophic coastal system of the northwestern Mediterranean. This sampling included dilution experiments and primary production measurements.

Preliminary results show a clear seasonality. Phytoplankton community present during spring-summer period was more dynamic, with higher growth and mortality rates than the community observed during autumn-winter period. On average microzooplankton consumed daily 76 % of the primary production (66% and 90% during spring-summer and autumn-winter respectively) and 77 % of the chlorophyll a standing stock (110 % and 34 % for spring-summer and autumn-winter period respectively). Carbon cycling through microzooplankton grazing was much faster during the spring-summer than autumn-winter period.

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Landry, M.R., R.T Barber, R.R Bidigare, F. Chai, K.H. Coale, H.G. Dam, M.R. Lewis, S.T. Lindley, J.J. McCarthy, M.R. Roman, D.K. Stoecker, P.G. Verity, J.R. White (1997) Iron and grazing constraints on primary production in the central equatorial Pacific: an Eqpac synthesis. *Limnol. Oceanogr.* 42: 405-418.

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Miércoles 28, 16:15

LATITUDINAL VARIABILITY OF MICROZOOPLANKTON GROWTH AND MORTALITY

Claire Schmoker and Santiago Hernández-Léon

Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria

Latitudinal variation of phytoplankton growth rates and mortality by microzooplankton grazing estimated from dilution experiments was reviewed from published data. Preliminary results show a slight and similar influence of temperature on phytoplankton growth ($Q_{10}=1.6$) and mortality rates ($Q_{10}=1.5$). Smaller rates were observed at higher latitudes. However, there was no clear variation of phytoplankton growth and mortality rates by microzooplankton grazing in tropical, sub-tropical and temperate regions. Microzooplankton ingestion and growth were also assessed from respiration rates using data from the literature. The results obtained from the latitudinal variation of growth using the data reviewed from the dilution method and those of respiration are compared.

Miércoles 28, 16:30

ZOOPLANKTON AND CARBON FLOW IN THE NW MEDITERRANEAN: RESPIRATORY REQUIREMENTS AND FAECAL PELLET PRODUCTION DURING A SPRING PHYTOPLANKTON BLOOM

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The role traditionally attributed to zooplankton in the cycle of marine biogenic carbon has been somewhat disregarded since the recognition of the importance of matter and energy transfer through microbial food webs. However, in recent re-evaluations zooplankton metabolic activity appears by no means negligible, depending very much on the trophic status of the system. In the NW Mediterranean, most of the data about zooplankton biomass and function refer to summer and winter conditions, while the quantitative role of zooplankton during the most important production event in the area, the spring phytoplankton bloom, is almost unknown.

In order to improve our understanding of the contribution of zooplankton to the pelagic carbon balance in the NW Mediterranean, the basic structural and functional properties of zooplankton communities were studied in phytoplankton-bloom and post-bloom conditions. The cruise took place in the vicinity of the Balearic frontal system, in March-April 2005, in two trophically contrasting stations (N and S of the Balearic front, bloom and post-bloom situations, respectively). Zooplankton biomass was highly variable, although during the repeated experiments on metabolism and faecal pellet production it was slightly higher in the N stations. Specific C requirements were higher in the S (post-bloom) stations, as were the faecal production rates. As average, daily zooplankton metabolic expenses required between 30 and 60 % of C primary production (N and S stations respectively). The global production of faecal pellets by zooplankton was similar for N and S stations. According to the faecal pellet collected in sediment traps, from 80 to 90 % of the faecal pellets produced were recycled in the first 100 m depth. The relationships between the time-evolution of the trophic characteristics of the system and the relative contribution of zooplankton to the biogenic C cycling are discussed.

Miércoles 28, 16:45

TROPHIC CONTROL IN THE GENERATION OF PHYTOPLANKTON BLOOMS IN THE CENTRAL CANTABRIAN SEA

Zarauz, L, Irigoien, X

AZTI, Pasaia (Gipuzcoa)

Phytoplankton blooms are one of the most exceptional manifestations of biological oceanographic dynamics, where photoautotrophic biomass may increase by orders of magnitude in the course of a few days. Marine phytoplankton blooms are dominated by a single, generally large species, but the mechanisms underlying that dominance are not well understood. Our study area was located in the central Cantabrian Sea. Six stations situated in a transect perpendicular to the coast were sampled eight consecutive times during February-March of 2005. The transition from mixing conditions to a shallow thermal stratification, together with an improvement of meteorological conditions settled the conditions for the bloom to occur. It was observed that the increase of biomass during the bloom occurred through addition of "new" size classes of larger cells. In coastal waters, changes in the community size structure, with increasing contribution of larger cells, were found before the outburst of biomass. The increase of biomass in these waters was dominated by large diatoms. In oceanic waters, changes in size structure of the community were simultaneous with the bloom of biomass. These results suggest a higher initial trophic pressure on small phytoplankton in the coastal waters whereas in oceanic ones the protists density responded to the increase in phytoplankton biomass.

Miércoles 28, 17:00

TROPHIC ECOLOGY OF BULLET TUNA LARVAE (*AUXIS ROCHEI*) IN THE NORTHWESTERN MEDITERRANEAN

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Bullet tuna (*Auxis rochei*) is a small tuna of tropical and temperate distribution that performs a reproductive migration from the Atlantic to the Mediterranean Sea. Studies on the trophic ecology of tuna larvae, and particularly on *Auxis* spp. are very scarce. This constitutes the first attempt to jointly study the diet and selectivity in larvae of this species. Specimens were collected in the Catalan Sea in June 2005 by means of oblique Bongo hauls (fish larvae) and vertical Calvet tows (microplankton and mesozooplankton).

Larvae appeared all along the study area, with main concentrations in the southwestern sector, where sea surface temperature was higher than 23°C. Maximum values of sea surface fluorescence were recorded also in this sector, where lower salinities were also found. Larval size ranged from 2 to 7 mm SL.

Larval feeding incidence was high during daylight hours (87%) and low during the night (19%). Prey number ranged from 0 to 13 (mean 5±3). Diet was based on phytoplankton, copepods (eggs, nauplii and postnauplii), cladocerans, appendicularians, tintinnids, gastropoda larvae, equinodermata larvae, invertebrate eggs and fish larvae. Prey diversity was higher in preflexion larvae. Piscivory was only observed in larvae larger than 5 mm. Although an increasing prey size with larval development was observed, no increase in the trophic niche breadth was found.

Chesson Selectivity index indicated that small larvae (2-3 mm) selected phytoplankton, copepods eggs and nauplii, and gastropoda larvae. From 3-5 mm copepod nauplii, cladocerans and appendicularians were selected. Larvae ≥5 mm preferred copepod postnauplii, cladocerans and appendicularians.

Miércoles 28, 17:15

COASTAL NUTRIENT INPUTS AND LITTORAL FOOD WEBS OF GALICIA

Antonio Bode¹, María Teresa Alvarez-Ossorio¹, Nicolás González¹, Carmela Porteiro² and Manuel Varela¹

¹Instituto Español de Oceanografía, Centro Oceanográfico de A Coruña,

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Littoral food webs receive nutrient and organic matter inputs from both the ocean and the coast. In Galicia, the effects of the seasonal upwelling on the rias are the main natural cause of nutrient enrichment and productivity of the marine ecosystem. Besides, growing urban and industrial pressure on the coast produce increasing inputs of anthropogenic materials which add to natural inputs. This study summarizes recently published and new measurements of the natural abundance of stable carbon and nitrogen isotopes in compartments representative of the main trophic levels to analyze the influence of natural and anthropogenic inputs on littoral food webs. Case studies include food webs from benthic intertidal (rocky and sedimentary substrates) and pelagic domains. The results indicate a dominance of upwelling-derived over anthropogenic nutrients in all food webs, being the phytoplankton the main vector. Seasonal variations in the isotopic signatures in zooplankton and sinking particles reflect variations in the source of nutrients related to upwelling dynamics. In contrast with other ecosystems, there is a small transfer of nutrients and organic matter from benthic to pelagic food webs. Anthropogenic inputs, however, are detected in benthic food webs inside the rias, where sewage nitrogen is assimilated by macroalgae causing a large isotopic enrichment that is transmitted through the food web. There are evidences of a progressive reduction of the effects of sewage nitrogen as residual water treatment improves near large urban areas.

Conferencia plenaria

Jueves 29, 9:00

FROM DESCRIPTION TO PREDICTION: A DECADE OF GLOBEC'S RESEARCH

*Manuel Barange*¹ and *Francisco Werner*²

¹GLOBEC IPO, Plymouth Marine Laboratory, Plymouth (UK)

²Department of Marine Science, University of North Carolina, USA

GLOBEC International was initiated by the International Geosphere-Biosphere Programme, The Intergovernmental Oceanographic Commission and the Scientific Committee on Oceanic Research in 1995. Its formation was preceded by several major nationally-funded GLOBEC programmes (e.g., US GLOBEC, Canada GLOBEC, Benguela Ecology Programme) and other GLOBEC-inspired global initiatives (e.g., IOC-FAO Sardine and Anchovy Recruitment Project, SARP). GLOBEC was built on the promise offered by dramatic, yet poorly understood, correlations between climate indices, sea water properties, zooplankton parameters and fish dynamics. The ultimate intention was to develop diagnostic and prognostic models to elucidate ecosystem responses to diverse natural and anthropogenic forces on a range of space and time scales. With this vision in mind GLOBEC activities were structured to,

- Understand how multiple physical environmental processes force large-scale changes in marine ecosystems
- Determine the relationship between structure, function and dynamics in a variety of oceanic systems
- Determine the impacts of global change on stock dynamics using coupled physical, biological and chemical models
- Determine how changing marine ecosystems will affect the global earth system by identifying and quantifying feedback mechanisms.

Soon GLOBEC became the most significant international initiative investigating the impacts of climate variability and change on the structure and dynamics of the world's marine ecosystems, with major activities in the North Atlantic, North Pacific, Southern Ocean, Eastern Boundary Currents and more recently in the equatorial and sub-Arctic regions. GLOBEC preceded the development of the concept of the Ecosystem Approach to the Management of marine Resources (EAMR), by promoting field programmes characterised by a holistic ecosystem research agenda that paid particular attention to the linkages between elements of the marine food web. In December 2009 GLOBEC will complete its work, although part of its mandate will continue through a merger with the IMBER programme. GLOBEC is currently in its synthesis phase, when the expectations and hopes set up at the onset face the reality of integrating the enormity of the work undertaken. How close are we to develop marine ecosystem predictive capabilities? What are the surprises and the successes? This presentation will use examples from GLOBEC projects worldwide and will provide a critical assessment of the programme's achievements and conceptual developments

Conferencia invitada

Jueves 29, 10:00

TELECONNECTION PATTERNS OF IMPACT OF CLIMATE VARIABILITY ON PELAGIC ECOSYSTEMS ACROSS EUROPE

Juergen Alheit

Baltic Sea Research Institute, Warnemunde, Germany.

The North Atlantic Oscillation (NAO) is the dominant mode of climate variability over Europe. NAO variability impacts directly on aquatic ecosystems across Europe as described recently for marine systems, such as the North Sea, the Baltic Sea or the Mediterranean, as well as for lakes in central Europe. The shift to a mainly positive NAO index after the late 1980s was clearly mirrored in the dynamics of zooplankton populations in marine and freshwater environments which exhibited synchronous dramatic changes in abundance, biomass, phenology and trophic relationships. For some systems such as the central Baltic Sea ecological regime shifts in the late 1980s have been described which have re-organized marine communities and trophodynamic relationships and induced changes in the mix of dominating species. Crustacean zooplankton played a pivotal role in these climatically induced processes, however, mechanisms linking the NAO signal to the dynamics of zooplankton are very different in the different ecosystems. The impact of decadal-scale climate variability on contrasting marine and freshwater ecosystems will be interpreted by a comparative approach and ecological teleconnection patterns will be described.

Jueves 29, 10:30

PHYSICO-CHEMICAL TRENDS SINCE 1970 AT THE CATALAN SEA (NW MEDITERRANEAN SEA)*Mariona Segura – Noguera¹, Antonio Cruzado², Mikhail Emelianov¹, Evaristo Vazquez – Domínguez¹, Dolors Blasco¹*¹Institut de Ciències del Mar, CSIC, Barcelona²Centre d'Estudis Avançats de Blanes, CSIC

Temperature and salinity in Western Mediterranean Deep Water (WMDW) and Levantine Intermediate Water (LIW) are increasing, specially since 1955 (Béthoux *et al.*, 1990; Rohling and Bryden, 1992; Béthoux and Gentili, 1996; Painter and Tsimplis, 2003). This has been related to global warming, positive NAO index and to damming of the rivers that discharge into the Black and Eastern Mediterranean Sea. Those increases in salinity and temperature have been observed on several parts of the Mediterranean Sea. Parallel to the increases in temperature and salinity, Béthoux *et al.*, (1998) detected in deep waters of the Algerian and Provençal sub-basins, positive trends on the concentration of nitrate and phosphate, from 1970 to 1994.

Here we study the trends in the Catalan Sea (0 – 4,5 W; 38,7 – 42,4 N) of temperature, salinity, density, inorganic nutrients and dissolved oxygen. The study is based on the oceanographic data of 30 cruises, between 1970 and 2003. Our results confirm previous findings, since we observe also an increase of temperature and salinity and of nitrate and phosphate in the WMDW and in the LIW.

In addition we also have observed an increase in silicate and in apparent oxygen utilization, associated with a decrease in dissolved oxygen. These findings confirm Bethoux's prediction (1989) of an increase in oxygen consumption. We explore possible sources of this increase, which leads to the augment of inorganic nutrients in deep waters which will be in addition to the increases due to anthropogenic input as suggested by Béthoux *et al.* (1998).

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Jueves 29, 10:45

RELACIONES DE LA NAO CON PROCESOS ONDULATORIOS Y DE MEZCLA EN EL ESTRECHO DE GIBRALTAR: ANÁLISIS DE POTENCIALES EFECTOS BIOGEOQUÍMICOS.*Vázquez, A.¹, M. Bruno¹, A. Izquierdo¹, D. Macías², C. M. García^{2,3}, F. Echevarría^{2,3} y R. Mañanes¹.*Universidad de Cádiz: ¹Departamento de Física Aplicada, ²Departamento de Biología.³Centro Andaluz de Ciencia y Tecnología Marina (CACYTMAR)

El Estrecho de Gibraltar es conocido por la generación de ondas internas de gran amplitud (~ 100 m) debido a la interacción de los flujos de marea con su umbral principal (Camarinal). La formación y propagación de estas ondas internas hacia el mar Mediterráneo lleva asociados procesos de mezcla que implican un aporte de nutrientes desde la capa mediterránea a la atlántica donde, con adecuadas condiciones de iluminación, puede

activarse la producción primaria haciéndose más o menos intensa la recirculación de nutrientes hacia el Mediterráneo, siendo modulada de acuerdo con la intensidad de las mezclas inducidas. Por ello, el análisis de los factores mareales o de mayor periodo que puedan modificar estos patrones de mezcla lleva a conclusiones de alto interés desde el punto de vista biológico.

La generación de estas ondas internas, con subsecuente mezcla, suele estar ligada a mareas vivas. Sin embargo, los flujos esperados a través del Estrecho pueden alterarse por factores meteorológicos haciendo posible observar la generación de ondas internas también durante mareas muertas cuando éstas coinciden con altas presiones sobre el Mediterráneo Occidental, dándose el caso inverso (inhibición de generación) durante mareas vivas coincidentes con bajas presiones sobre el Mediterráneo Occidental. De esta forma la exploración de factores asociados con la posición de estos centros de presión lleva aparejadas consecuencias muy relevantes sobre la biogeoquímica de la región y de ambas cuencas. Este trabajo analiza la respuesta de los procesos ondulatorios internos a la variabilidad climática, examinando la relación entre las variaciones de presión atmosférica sobre el Mediterráneo Occidental y las variaciones del índice NAO.

Jueves 29, 11:00

INTERANNUAL VARIABILITY OF CO₂ PARAMETERS AT THE ESTOC SITE

J. Magdalena Santana-Casiano and Melchor González-Dávila

Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria.

Time-series approach is the best procedure to detect long term trends and changes against the background of the interannual variability of biogeochemical processes and hydrodynamics. Since 1995, hydrography properties, $f\text{CO}_2$, pH_T and A_T have been measured in surface waters on monthly cruises at the European Station for Time Series in the Ocean at the Canary Islands, ESTOC, located in the Northeast Atlantic subtropical gyre (González-Dávila et al., 2003). With over ten years of oceanographic data, seasonal and interannual trends of pCO_2 and pH have been evaluated. This area is acting as a minor sink of CO_2 , with an average ingassing value of $51 \pm 36 \text{ mmol CO}_2 \text{ m}^{-2} \text{ yr}^{-1}$ (Santana-Casiano et al., 2007) controlled by the dominant Trade Winds blowing from May to August.

After removing seasonality variability, $f\text{CO}_{2\text{sw}}$ increases at a rate of $1.57 \pm 0.3 \text{ uatm yr}^{-1}$ and total inorganic carbon (NC_T) increases at a rate of $0.9 \pm 0.2 \text{ umol kg}^{-1} \text{ yr}^{-1}$, while pH_{T25} decreases at a rate of 0.0017 ± 0.0003 and total alkalinity decreases at a rate of $0.79 \pm 0.14 \text{ umol kg}^{-1} \text{ yr}^{-1}$ following the same trend presented by the salinity.

Hydrographic and biogeochemical anomalies induce a significant variability in the inorganic carbon fluxes at ESTOC produced by variations in the winter mixed-layer depth that have been linked to large-scale climate variability indexes. This variability reflects fluctuations relating to NAO showing a closer correlation with a 3-year NAO delay.

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Jueves 29, 11:15

INFLUENCE OF THE IBERIAN POLEWARD CURRENT (IPC) IN THE SOUTHERN BAY OF BISCAY DURING THE WINTER-SPRING TRANSITION FROM 1987 TO 2006*G. González-Nuevo, E. Nogueira, J. Cabal, X. A. G. Morán*

Instituto Español de Oceanografía. C.O. Gijón

The influence of the Iberian Poleward Current (IPC) in the southern Bay of Biscay was studied using data from 19 oceanographic cruises carried out between 1987 and 2006 in the NW and N Iberian shelf during the winter-spring transition, the decaying phase of the IPC. To assess this influence, an iterative algorithm was developed to determine the position of the frontal area (IPC_f) which defines the limit of influence of warm and salty waters, thus spicing (Flament, 2002), characteristic of the IPC. The IPC_f varies along the shelf from the Rías Bajas (42.5° N 9.0° W) up to the Cape Breton Canyon area (44.0° N 2.0° W), with a mean position situated in 44.0° N 6.5° W (around Aviles Canyon). According to the time series of the IPC_f , the influence of this current into the southern Bay of Biscay presented a significant increasing trend of 8.8 nautical miles per year in the analysed period ($n=19$, $r=0.71$, $\alpha<0.001$). It is assumed that the main driving process of the IPC was the latitudinal density gradient, principally induced by the temperature gradient (Peliz et al. 2005), through the joint effect of baroclinicity and relief (JEBAR; Huthnance, 1984). According to this assumption, we found a statically significant lagged correlation between the depth-averaged value of the IPC_f of each year and the temperature gradient calculated between 40° N and 50° N from July to October of the previous year ($n=19$, $r=0.73$, $\alpha=0.001$).

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Conferencia invitada

Jueves 29, 12:00

PHYSICAL-BIOLOGICAL INTERACTIONS IN THE WESTERN IBERIA UPWELLING ECOSYSTEMA. Miguel P. Santos

INIAP-IPIMAR, Lisboa, Portugal

Populations of small pelagic fishes (e.g., sardine and anchovy) show evidence of important long-term natural fluctuations in their abundance. These fluctuations seem to be related, among other factors, to environmental variability, raising important scientific and economic concerns. In the last decades, a decline has been observed in sardine recruitment in the Western Iberia Upwelling Ecosystem, which was accompanied also by environmental changes, mainly in upwelling patterns and intensity. Several studies concluded that environmental variability could explain, at least partially, the observed fluctuations in the productivity of sardine. One of the main (potential) mechanism described is that northerlies in winter increase upwelling (offshore transport) during the spawning season with strong and frequent events being unfavourable for sardine recruitment, and the explanation hypothesis could be related with the dispersal of the eggs and larvae from the shelf to unfavourable areas, either from a hydrodynamic point of view, as well as from a trophic one. However, the variability of local features, such as buoyant plumes from river discharge (the Western Iberia Buoyant Plume-WIBP) and the Iberian Poleward Current (IPC) introduce important fluctuations in the transport patterns of the region, and modulate the impact of winter upwelling events in the survival of larvae. Furthermore, the presence of the WIBP allows a growth of phytoplankton biomass and is a suitable environment for larval fish retention and survival.

Based on observations of these features, complemented with ichthyoplankton sampling, a mechanism for retention and concentration of fish eggs and larvae in the NW Iberia is proposed. The retention in the shelf of the ichthyoplankton in general and, of larval sardine in particular, along convergence areas formed by the interaction of these local structures, plays an important role in their survival. Finally, it is clear that simplified Ekman transport models could not explain the transport/retention of larvae in this region and more realistic biophysical models should be used to simulate the local oceanographic conditions to understand larval dynamics in the region.

Jueves 29, 12:30

ICHTHYOPLANKTON COMPOSITION AND DISTRIBUTION DURING THE LATE WINTER BLOOM IN THE CANARY ISLAND WATERS.*M. Moyano*¹, *J.M. Rodríguez*², *S. Hernández-León*¹¹ Biological Oceanography Laboratory, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria.² Instituto Español de Oceanografía, C.O. Gijón.

The species composition, distribution and concentration of ichthyoplankton off Gran Canaria, an oceanic island in the NE Atlantic, were studied from January to August 2005. Weekly oblique bongo hauls were carried out at six stations in the eastern and southern flanks of the island, at the edge of the island shelf. The highest values for chlorophyll were observed in March followed by a maximum of zooplankton biomass during the so-called late winter bloom. Zooplankton biomass and neritic larvae abundance showed higher values in two stagnation points, one upstream of the island and another in the warm lee region downstream. The average fish larvae abundance was higher than expected (411.0 ± 324.6 SD ind per 10m^{-2}). Zooplankton biomass, however, was typical of the area (13.5 ± 10.9 SD mg dry weight. m^{-3}). Fish larvae were sorted and a total of 128 taxa were identified. Neritic and oceanic larvae appear almost in a similar percentage. Only three families represented half of the total fish larvae captured: *Myctophidae* (24.92%), *Sparidae* (12.75%) and *Clupeidae* (11.91%). *Sardinella aurita* (8% of total larvae) was the most abundant larvae, appearing during the whole period of study at the six stations sampled. *S. aurita* eggs were also frequently observed. Few individuals of *Sardina pilchardus* were captured suggesting a replacement of *S. pilchardus* by *S. aurita* in these waters.

Jueves 29, 12:45

THE INFLUENCE OF HIGH FREQUENCY MESOSCALE PROCESSES ON FISH LARVAE DISTRIBUTIONS IN THE ALBORAN SEA.*Manuel Vargas Yáñez*¹, *Ana Sabatés*²¹Instituto Español de Oceanografía. C.O. Málaga²Institut de Ciències del Mar, CSIC, Barcelona

This work analyses results from a multidisciplinary high frequency experiment, including hydrological and meteorological data, satellite images, and fish larvae abundance along a north-south transect across the Western Alboran Sea anticyclonic gyre. Four consecutive occupations of the transect, crossing the frontal area, evidenced the high frequency variability of hydrological structures and its influence on the latitudinal and vertical distribution of fish larvae in very few days period. The analyses of the time evolution of the whole data set, allow us to propose a conceptual model for the average distribution of fish larvae, its time variability and the influence of hydrological processes on it. The influence of dynamical processes on fish larvae depends on the location of the spawning as well as on the larval fish position in the water column. Wind induced upwelling and/or the southward drift of the Atlantic current transport larvae of neritic species, such as *Sardina pilchardus* and *Engraulis encrasicolus* to open sea areas. At the same time, these events bring about alterations in the latitudinal and vertical distributions of mesopelagic fish larvae. The species with a relatively surface distribution, as *Ceratospilus maderensis*, were transported and accumulated to the south of the Atlantic Jet (AJ), while those with a deeper distribution in the water column, as *Maurolicus muelleri* or *Benthosema glaciale*, would be upwelled and concentrated to the north. This work shows that it is difficult to extract conclusions about the mean or preferential distributions of fish larvae when one single/synoptic survey is considered and that time evolution of hydrological structures has to be considered in order to conclude.

Jueves 29, 13:00

DOES SHORT-TIME SCALE UPWELLING VARIABILITY DETERMINE CEPHALOPODA PARALARVAE ABUNDANCE?

Jaime Otero, X. Antón Álvarez-Salgado, Ángel F. González & Ángel Guerra

Instituto de Investigaciones marinas-CSIC, Vigo.

Many fish and coastal invertebrates have complex life cycles with variations in the supply of settling larvae affecting the structure of their communities. The dynamics of coastal upwelling areas can favour larval “washout” by means of cross-shelf transport that may move larvae away from the settlement sites. Earlier studies provided evidences of sweeping offshore during upwelling and shoreward movement during downwelling. However, this picture has revealed more complex. Galicia constitutes the northern boundary of the Iberian-Canary current upwelling system where seasonal winds promote upwelling from April to September and downwelling the rest of the year. The upwelling season appears as a succession of wind stress/relaxation cycles of period 10-20 days. Here, we study the short-timescale variability of upwelling episodes and their influence on the abundance of *Octopus vulgaris* paralarvae. We sampled a cross-shore transect in the Ría de Vigo and the adjacent shelf during three years under contrasting oceanographic periods. Paralarvae abundance and biomass increased when nitrate, ammonium and chlorophyll decreased. These conditions occur during the relaxation of upwelling events when nutrient salts are consumed to produce biogenic matter, which is retained in the system and transferred through the food web. A multiple linear relationship with these hydrographic variables explains up to 85% VAR of paralarvae abundance. Therefore, octopus paralarvae are affected by the high frequency variability of the upwelling characteristics increasing its abundance/biomass during the relaxation phase of upwelling events.

Jueves 29, 13:15

CAMBIOS EN LA CONCENTRACIÓN DE NUTRIENTES INDUCIDOS POR LA VARIABILIDAD HIDROLÓGICA Y SU EFECTO SOBRE LA ABSORCIÓN DE LUZ POR EL FITOPLANCTON EN EL SECTOR NO DEL MAR DE ALBORÁN

Jesús M. Mercado, Teodoro Ramírez, Dolores Cortés

Instituto Español de Oceanografía. C.O. Málaga

El efecto de la variabilidad hidrológica sobre el coeficiente de absorción específico de la clorofila a [$a^*(\lambda)$] fue investigado durante una campaña llevada a cabo en primavera. La columna de agua estuvo fuertemente estratificada. La capa eufótica, cuyo límite inferior coincidió con el límite inferior de la capa de mezcla, se caracterizó por presentar muy bajas concentraciones de nitrato y fosfato. Concordantemente, la concentración de clorofila a fue baja, lo que indica que el crecimiento del fitoplancton estuvo limitado por nutrientes. En contraste, la concentración de nitrato aumentó casi un orden de magnitud por debajo de la capa eufótica, donde estuvo localizado el máximo vertical de clorofila. Las propiedades ópticas del fitoplancton variaron con la profundidad óptica. Así, $a^*(440)$, $a^*(490)$ y $a^*(675)$ disminuyeron un 40% bajo la capa eufótica. La disminución de $a^*(675)$ estuvo correlacionada con un aumento de la razón de los picos de absorción 440:675, lo que sugiere que el grado de empaquetamiento y la absorción relativa de pigmentos accesorios fueron menores en la capa eufótica. El grosor de la capa de mezcla fue mayor en las estaciones situadas hacia el oeste, donde la salinidad en superficie (SS) y la concentración de nutrientes fue también mayor. Este aumento coincidió con una disminución de $a^*(675)$ y de la razón de los picos de absorción 440:675 en la capa eufótica, lo cual indica que la respuesta de aclimatación del fitoplancton al aumento en la disponibilidad de nutrientes consistió en un incremento del grado de empaquetamiento de la clorofila.

Jueves 29, 13:30

EFFECT OF OCEANOGRAPHIC CONDITIONS ON SEASONAL AND INTERANNUAL VARIABILITY IN TIMMING OF SPRING BLOOM IN THE GULF OF CADIZ*Gabriel Navarro*¹, *Laura Prieto*¹, *Jesús Gómez-Enri*² and *Javier Ruiz*¹.¹Instituto de Ciencias Marinas de Andalucía (CSIC), Puerto Real (Cádiz)²Dpt. Física Aplicada, Universidad de Cádiz, 11510, Puerto Real, Cádiz, Spain

Seasonal and interannual variability of chlorophyll-*a* concentration in the Gulf of Cadiz was detected by ocean colour satellite remote sensing between 1997 and 2006. Smoothed by 4-week running, means of chlorophyll-*a* concentration were fitted to a Gaussian curve in order to obtain several parameters such as peak concentration, peak timing and duration of the bloom, beginning and end timing. Variability in these parameters of the spring bloom in the basin has been evaluated according to physical properties in the water column such as mixed layer depth (MLD), sea surface temperature (SST), sea level anomaly (SLA), eddy kinetic energy (EKE), wind forcing and in situ data. The analysis indicated that the timing, size and duration of the phytoplankton bloom in this zone were influenced by meteorological and oceanographic conditions, which mean that they can vary widely from one year to another. Peak intensity varied between 0.12 and 0.24 mg m⁻³ and shifted between years and peak timing showed a larger difference between earliest and latest years. The timing of the start of the bloom was an indicator of interannual variability in phytoplankton bloom characteristics. The main physical factor that forced the bloom timing was found to be the position of the MLD in the water column, being maxima when the depth of the MLD was deepest during winter time. Other factors also contributed to modulate the duration and magnitude of the spring bloom.

Jueves 29, 13:45

REGIONAL DIFFERENCES IN THE ROLE OF EDDY PUMPING IN THE NORTH ATLANTIC SUBTROPICAL GYRE*Beatriz Mouriño Carballido*¹, *Andrés Cianca*², *Susanne Neuer*³¹ Dpt Ecología e Biología Animal, Universidade de Vigo.² Instituto Canario de Ciencias Marinas, Gran Canaria³.School of Life Sciences, Arizona State University, Tempe, USA.

The subtropical North Atlantic (NAST) constitutes a test-bed for paradigms on nutrient supply and metabolic balance. In the western subtropical North Atlantic (NASW), results from direct measurements of nutrient supply have been considerably lower than those from indirect estimates. In the eastern part of the subtropical North Atlantic (NASE), instantaneous oxygen production rates by bottle incubations indicate net heterotrophy prevailing throughout large areas. Episodic pulses of nutrient inputs into the photic layer and net oxygen production associated with mesoscale activity have been proposed to reconcile both discrepancies. However, enhanced biological activity associated with mesoscale dynamics is not persistent in time, and recent modelling experiments disagree on the relevance of eddy-pumping in surface nitrate-depleted waters. This disagreement could derive from the different temporal and spatial variability scales involved in the biological response associated with mesoscale dynamics, scales that modelling studies have not been able to completely reproduce so far. In this presentation we will compare findings obtained at time-series station BATS (NASW), and in a region between ca. 25-44°N and 13-35°W (NASE), including time-series station ESTOC north of the Canary Islands. The comparison confirms the greater importance of mesoscale activity as nutrient supply mechanism in NASW compared to NASE. Mesoscale eddies, responsible for <10% of the organic carbon imbalance postulated for NASE, were found to contribute significantly to the metabolic balance at BATS.

*Conferencia invitada**Jueves 29, 15:30***A METABOLIC THEORY OF THE OCEANS: SIMPLE RULES FOR COMPLEX SYSTEMS***Angel Lopez-Urrutia*

Instituto Español de Oceanografía, Centro Oceanográfico de Gijón.

Global climate change has profound effects on marine ecosystems at all levels of organization. A change in climate is irrevocably linked to a change in the physiology of species, to a modification of community composition and ecosystem metabolism and to a modulation of biogeochemical cycles. Ultimately, all these biological changes will trigger a change in climate, generating a feedback loop. The complexity of these climate-ecosystem interactions is in stark contrast with the oversimplistic representation of biological processes in current global climate models. We are faced with the need for a theoretical framework that not only provides a synthetic view of the effects of climate on marine communities but that can also be easily integrated in coupled climate/carbon-cycle models. Here, I advocate that the emerging field of marine macroecology can serve that purpose. I show how an extension of the Metabolic Theory of Ecology (MTE) to marine communities can help understand the possible effects of global warming on planktonic organisms; and that MTE can be used to scale these effects from organisms to ecosystems and to biogeochemical cycles in a manner that can be easily incorporated into global climate models. I validate the predictions of MTE using global databases of planktonic metabolism, community composition and structure to show that the theory fits the data and that it challenges current understanding of how warming and shifts in ecosystem trophic state will modify oceanic carbon cycle feedbacks to climate change.

Jueves 29, 16:00

BIOCHEMICAL CHARACTERIZATION OF *Trichodesmium* Spp. ALONG TROPICAL NORTH ATLANTIC OCEANAntonio Tovar-Sanchez¹, Sergio A. Sañudo-Wilhelmy²¹IMEDEA (CSIC-UIB), Mallorca.²University of Southern California, Marine and Environmental Biology, Los Angeles (USA)

Despite of the importance of *Trichodesmium* in the global ocean new nitrogen budget, there is a limited information on its trace metal physiology. We report here the total (Ag, Al, Cd, Co, Cu, Fe, Mn, Mo, Ni, P, Pb, V) and intracellular (Cd, Co, Cu, Fe, Mn, Mo, Ni, P, V) element composition of *Trichodesmium* populations collected at the West Tropical North Atlantic Ocean (April-May 2003) along the influence of the Amazon River. Intracellular Cd, Co, Cu, Fe, Mo and Ni contents were from a 31% for Cd to 88 % for Ni higher than the surface adsorbed pools. For the majority of the studied elements the intracellular pools was good correlated with the total content along a different salinity and dissolved metals concentration gradients, suggesting that uptake of these metals in *Trichodesmium* cells may occurs by two-step kinetic process, adsorption to the surface cells followed by internalization. While total and intracellular Cu and Fe composition of *Trichodesmium* are clearly influenced by the dissolved concentrations in the studied area, Co, Mo and V did not reflect the water environment.

Jueves 29, 16:15

FIRST APPROACH ABOUT CLIMATE VARIABILITY AND FISHERIES DYNAMICS OF BLACK HAKES (*Merluccius polli* AND *Merluccius senegalensis*) IN NW AFRICACésar Meiners, Lourdes Fernández, Francisca Salmerón and Ana Ramos

Instituto Español de Oceanografía. Centro Oceanográfico de Malaga

Fish population and fisheries fluctuations are closely linked to climate dynamics through environmental variability that determines the distribution, migration, and abundance of fish. Fishery science were largely focused on the great northern hemisphere fisheries, which some of them fluctuate at decadal time scales and show patterns of synchrony with low frequency signals, as reflected by climatic indices such as the North Atlantic Oscillation (NAO). However, there is scarce information about these patterns at lower latitudes like NW African coast, in spite of this area supports a large international fisheries. The aim of this work was to analyse the impact of climate variability described by NAO on black hakes dynamics, and to determine the processes that links them in NW Africa. Catch-based abundance indices from fisheries carried out off Mauritania and Senegal were used as the dependent variables in simple correlation analysis with NAO index. It was tested the mechanistic dependence between NAO index and wind stress v component (τ_v) as a proxy of upwelling variability. The black hakes abundance was highly negatively correlated with NAO index with a time lag of 3 years. The NAO explained around 40 - 50% of abundance variability between 1960-2003. The wind stress fields were positively correlated with NAO, which was responsible of 53% of their variability. In opposite sense that could be expected, these results suggest that black hakes abundance is inversely related with intensified and extended upwelling processes off Mauritania and Senegal, which caused the prevailing southwardly of the cold oceanographic season.

Jueves 29, 16:30

GLOBAL CHANGE EFFECT ON MEDITERRANEAN CORALIGENOUS COMMUNITY: MASS MORTALITY EVENTS AND THEIR CONSEQUENCES ON HYDRODYNAMICS AND NUTRIENT TRANSFER AT ECOSYSTEM LEVEL

Marta Ribes¹, Rafel Coma², Eduard Serrano^{1,2} and Eroteida Jiménez^{1,2}

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Diseases and mass mortalities are affecting an increasing number of marine species worldwide including many ecosystem engineers (Harvell et al., 2004, Coma et al., 2006). The increase of these strong disturbances has been linked with the serious decline in the conservation status of many species in marine ecosystems in response to global climate change (Hughes et al., 2003). Although, this is especially evident in bleaching events affecting coral reefs, temperate benthic communities are also being strongly affected by mass mortality events (Coma and Ribes 2003). Ecosystem engineer species such as gorgonian and sponges were among the most affected taxa, however, the main causes and consequences of these events are still unknown. Hypotheses about the main cause of these events focus on the occurrence of climatic anomalies. In relation to this, previous studies hypothesized that energetic constraints related to temperature and food availability may be the underlying mechanism. A combination of in situ observations and laboratory experiments allowed us to examine the role of these two factors on causing mass mortality events. The linkage between mass mortality and global warming supports current trend on frequency increase of these events which would induce profound changes in the present benthic community composition in littoral areas. We determined that the disappearance of gorgonians have strong consequences on hydrodynamic characteristics of the boundary layer as well as on nutrient transfer between the water mass and benthic communities dominated by suspension feeders.

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Jueves 29, 16:45

INTRA-SPECIFIC GENETIC STRUCTURING IN *CALANUS HELGOLANDICUS* EUROPEAN POPULATIONS ASSOCIATED WITH LATITUDINAL DIFFERENCES

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The marine copepod *Calanus helgolandicus* is of considerable importance in the marine food web. It plays a critical role in marine ecosystems as a grazer of microplankton and as a major food source for commercially important fish. The distribution of *C. helgolandicus* in European waters covers a wide range of habitats, from open ocean to coastal environments. Recent studies [Reid et al., 2003; Bonnet et al., 2005] have shown that *C. helgolandicus* is

sensitive to changes in climate, particularly along the European shelf of the northeast Atlantic. On the fringes of its distribution the range and abundance of *C. helgolandicus* has increased as water in the North Atlantic has warmed over recent decades. Building on the network of laboratories created by *Bonnet et al.* for their review on *C. helgolandicus* (2005), we collected samples in 95% ethanol from 19 European sites. From several individuals at each site a region of the mitochondrial large subunit (16S) ribosomal RNA (rRNA) gene was amplified and sequenced. Significant genetic differences have been identified for the first time between and within basins (Northern Fjords, Northeast Atlantic, West and East Mediterranean, and Black Sea) as well as a decrease of prosome length with the latitude. Our study provides a molecular evaluation of the intra-specific structuring in this key species in relation to variation in morphological characters.

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Jueves 29, 17:00

AN OVERVIEW OF EFLUBIO: STRUCTURES AND BIOGEOCHEMICAL FLUXES IN THE NW MEDITERRANEAN.

Mikel Latasa¹, Miquel Alcaraz¹, Rodrigo Almeda¹, Elisa Berdalet¹, Clara Cardelús¹, Mikhail Emelianov¹, Marta Estrada¹, Josep-Maria Gasol¹, Andrés Gutiérrez¹, Celia Marrasé¹, Jordi Salat¹, M^a Luz Fernández de Puellas², Eva Alou², Javier Jansà², José Luís López-Jurado², Montse Vidal³, Gemma Vila³ and Renate Scharek⁴.

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The main objective of the project EFLUBIO (2002-2006) was to establish relationships between the physical, chemical and biological structures and the biogeochemical fluxes in the NW Mediterranean. Bloom, post-bloom and late summer stratification situations were found during two oceanographic cruises in September 2004 and March-April 2005. The conditions of water column stability, nutrient concentrations and plankton community type responded to the classical canons of the three situations, although with some exceptions. Trophic flux patterns were also more or less as expected in each situation. Bacterial production was much higher during the bloom than during the other 2 situations, when it was similar. Primary production was highest during the bloom, second highest during the post-bloom and lowest during the late stratification. Herbivory grazing rates, measured only during bloom and post-bloom, matched phytoplankton growth rates, which were higher during the bloom. Mesozooplankton specific metabolism was similar during the bloom and post-bloom. The daily vertical particulate flux at 100-200 m represented <1% of the water column particulate stock. The relative composition of the sedimented material indicated a more autotrophic material falling during the bloom. The vertical flux at 2100 m depth was continuously recorded during 17 months. Surprisingly, it did not reflect the important surface phytoplankton bloom. However, it recorded 2 important events of lateral input of material originating on the shelf.

Jueves 29, 17:15

EFFECT OF TEMPERATURE AND ULTRAVIOLET RADIATION ON THE ACTIVITY OF THE ANTIOXIDANT ENZYME SUPEROXIDE DISMUTASE IN ANTARCTIC PLANKTONRosa Martinez

Departamento de Ciencias y técnicas del Agua. Universidad de Cantabria.

Environmental conditions affect cellular metabolism. Growing attention is being paid to cell damage induced by reactive oxygen radicals (ROS). Superoxide radicals, $O_2^{\cdot-}$ are formed as by-products of cell metabolism, specially photosynthesis and respiration. Several environmental stresses cause an increase in these and other ROS. Among other, extreme temperatures and UV radiation. The cell antioxidant system acts through several compounds and processes to eliminate the excess oxidant. It includes some protective compounds and radical scavenging by specialized enzymes. The activity of the scavenging enzyme, superoxide dismutase (SOD), has been determined in Antarctic plankton, under two types of stress: a) temperature and b) ultraviolet radiation.

Antarctic plankton are subject to low temperatures that, in spite of constituting their usual environment, are suboptimal for growth and metabolism and that generate ROS. The effect of temperature (1 to 25°C) on *in vitro* SOD was studied. SOD was shown to increase with decreasing temperature within this range. This behaviour of an enzyme is counterintuitive in terms of our experience when studying enzyme activity or any other chemical reaction. The advantage of such behaviour is that the same amount of antioxidant will act better under low temperatures when the ROS increase, as shown by reaction kinetics (Perelman et al., 2006).

The effects of ultraviolet radiation A and B (UVAR and UVBR) on SOD activity in Antarctic plankton was studied on samples exposed for 3 h to Photosynthetically Active Radiation (PAR), PAR+UVAR and PAR+UVAR+UVBR, under fixed experimental irradiances. Initial activities were inversely related to the solar radiation received *in situ* during the previous 24 h-period, suggesting acclimation processes. Experimental UVBR enhanced SOD activity in a dose-dependent manner. UVAR inhibited SOD activity. This can be due to the lack of antioxidant enzyme induction under UVAR, since protection towards UVAR is due to radiation absorption more than ROS scavenging. ROS produced under UVAR did not stimulate a significant activity increase. SOD activity under PAR was higher than under PAR+UVAR, suggesting repair mechanisms triggered by UVAR that counteract UVBR effects. All this suggests that: 1) the targets for UVAR and UVBR damage are different, 2) the exposure to joint PAR+UVAR might have an alleviating effect on oxidative UVBR damage, and 3) acclimation to UVR plays an important role on the magnitude of effects caused by subsequent experimental radiation. The significance of these findings for Antarctic plankton ecology and response to environmental changes is discussed (Martinez, 2007).

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Conferencia plenaria

Viernes 30, 9:00

IMBER: INTEGRATED MARINE BIOGEOCHEMISTRY AND ECOSYSTEM RESEARCH

Julie Hall¹, Sylvie Roy²

¹National Institute of Water and Atmospheric Research Ltd., New Zealand.

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Human activities are rapidly altering Earth System processes that directly and indirectly influence society. Informed decisions require an understanding of which parts of the Earth System are most sensitive to change, and the nature and extent of anticipated impacts of global change. In response to this need, the new IGBP-SCOR Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project has been formed, to focusing on ocean biogeochemical cycles, ecosystems and there interactions. The IMBER goal 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, the IMBER Science Plan and Implementation Strategy are structured around four major research themes. Theme 1 focuses on identifying and characterising interactions of the key biogeochemical and ecosystem processes that will be impacted by global change. Central to IMBER goal, Theme 2 will develop a predictive understanding of how marine biogeochemical cycles and ecosystems respond to complex forcings, such as large-scale climatic variations, changing physical dynamics, carbon cycle chemistry and nutrient fluxes, and the impacts of harvesting. Theme 3 investigates the roles of ocean biogeochemistry and ecosystems in impacting the larger Earth System through direct and indirect feedbacks. Finally, Theme 4 integrates natural and social sciences, drawing on information from the previous three themes to investigate key interactions with the human system and the options for mitigating or adapting to the impacts of global change on marine biogeochemical cycles and ecosystems. An update on IMBER activities and working groups will be presented.

Conferencia invitada

Viernes 30, 10:00

ROLE OF THE EASTERN EQUATORIAL UPWELLING SYSTEM IN PAST RAPID CLIMATIC VARIABILITY*Isabel Cacho*

Universidad de Barcelona

Southwesterly trade winds in the Eastern Equatorial Pacific (EEP) induce the upwelling of nutrient rich waters from the Eastern Equatorial Undercurrent which feeds primary producers but it is also a source of carbon dioxide to the atmosphere. From the climatic point of view the EEP is the most sensitive region to the largest inter-annual to decadal climatic mode of variability known as El Niño-Southern Oscillation (ENSO). Some models indicate that ENSO also occurred in the past times and potentially had an active role in past orbital-millennial scale climate changes. ODP Site 1240 is located midway between mainland Ecuador and the Galapagos at the northern edge of the upwelling cell. A new approach consisting in paired measurements of stable isotopes (O and C) and Mg/Ca ratios in carbonate tests from two foraminiferal species with different dwelling preferential depths allows the reconstruction of water properties from both surface and deep thermocline layer. This approach has been applied to reconstruct EEP conditions along the last 300,000 yr BP covering the last three major glacial-interglacial cycles and with a 100-200 yr resolution which allow the identification of centennial-millennial changes. Results highlight the coupling between oscillations in the EEP surface temperatures and global atmospheric carbon dioxide as recorded in Antarctic ice sheet and suggest that the re-structuration EEP thermocline triggered major changes in the global carbon dioxide inventory and consequently in global climate.

Viernes 30, 10:30

DENSE SHELF WATER CASCADING IN THE GULF OF LION AND ITS IMPLICATIONS FOR THE WESTERN MEDITERRANEAN PALEOCEANOGRAPHIC RECORD

*Miquel Canals*¹, *A.M. Calafat*¹, *J. Frigola*¹, *I. Cacho*¹, *P. Puig*², *A. Palanques*², *X. Durrieu de Madron*³, *S. Heussner*³, *J.O. Grimalt*⁴, *A. Moreno*⁵, *J.A. Flores*⁶, *F.J. Sierro*⁶

¹GRC Geociències Marines, Fac. Geologia, Universitat de Barcelona, ²Instituto de Ciencias del Mar, CSIC, Barcelona, ³CEFREM, CNRS-Université de Persignan, ⁴Instituto de Investigaciones Químicas y Ambientales, CSIC, Barcelona, ⁵University of Minnesota, Minneapolis (USA), ⁶Facultad de Ciencias, Universidad de Salamanca

Some recent papers (Canals et al., 2006; Gaudin et al., 2006; Heussner et al., 2006; and Palanques et al., 2006) have illustrated the consequences of Dense Shelf Water Cascading (DSWC) in the western Gulf of Lion. Winter and early spring DSWC may last for more than one month (i.e. 40 days during the 2005 severe DSWC event). During such events large amounts of dense water sink down along the seafloor while carrying sedimentary particles from the continental shelf and organic matter from the shallowest reservoirs. Submarine canyons, and specially the Cap the Creus Canyon (CCC), play a principal role in funnelling dense water downslope. While DSWC-carried coarse sediment is able to reshape canyon floors, DSWC also is a significant natural carbon sequestration and deep ecosystem fuelling mechanism.

It is reasonable to assume that during the different phases of the Pleistocene climatic oscillations DSWC had variable frequencies and intensities. It is also reasonable to assume that DSWC left their imprint on the sediment record. Marked variations on bottom circulation have been identified by paleoceanographers (e.g. Frigola et al., 2007) directly off the Gulf of Lions. As cascaded waters move down till they reach their density equilibrium level it seems possible that past intensification and weakening of the near-bottom circulation was, at least partly, related to DSWC fluctuations. However, this still is a matter of debate on which both modern ocean biogeochemists and paleoceanographers may learn one from each other.

Canals, M. et al., 2006. Flushing submarine canyons; *Nature*, 444: 354-357.

Frigola, J. et al., 2007. A deep water sediment record of Holocene climate variability in the Western Mediterranean region; *Paleoceanography* (in press).

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Heussner, S. et al., 2006; Spatial and temporal variability of downward particle fluxes on a continental slope: lessons from an 8-yr experiment in the Gulf of Lions (NW Mediterranean); *Marine Geology*, 234: 63-92.

Palanques, A. et al., 2006. Suspended sediment fluxes and transport processes in the Gulf of Lions submarine canyons. The role of storms and dense water cascading; *Marine Geology*, 234: 43-61.

Viernes 30, 10:45

OCEAN ACIDIFICATION: A VIEW FROM RECONSTRUCTIONS OF PAST SEAWATER pH

*Eva Calvo*¹ and *Carles Pelejero*^{1,2}

¹Institut de Ciències del Mar (ICM), CSIC, Barcelona,

²Institució Catalana de Recerca i Estudis Avançats (ICREA).

It is now well recognised that levels of carbon dioxide (CO₂) in the atmosphere have been increasing since the Industrial Revolution due to burning of fossil fuels, leading to global warming. It is not that well known, however, that ~50% of this CO₂ is actually being absorbed by the oceans, and that seawater is becoming more acidic because of this. Such pH reduction could have major effects on marine biota, especially on calcareous plankton

and coral reef communities, which will be unable to calcify effectively under these new conditions. However, the fate of individual species will depend on their past acclimatisation and ability to adapt, and will remain unknown until the preindustrial range of surface ocean pH is quantified. Using the boron isotope composition of a *Porites* coral from a reef offshore north-eastern Australia, we have obtained the first record of seawater pH variability, which shows large amplitude pH changes over the last 300 years (Pelejero et al, 2005). The ranges and patterns of temporal and spatial pH variation, however, are still largely unknown and other reefs and oceanic areas need to be studied in order to obtain a more global picture. We now intend to perform further pH reconstructions in corals from the northern Red Sea, one of the northernmost latitudes where *Porites* corals develop. The feasibility of boron isotopes is also being assessed in other coral species from the Mediterranean Sea, where *Porites* corals cannot be found.

References:

Pelejero, C., E. Calvo, M.T. McCulloch, J. Marshall, M.K. Gagan, J.M. Lough, B.N. Opdyke, 2005. Preindustrial to modern interdecadal variability in coral reef pH. *Science* 309, 2204-2207.

Viernes 30, 11:00

UPS AND DOWNS IN THE PLANKTON/SULFUR/CLOUDS/SUNLIGHT FEEDBACK

Rafel Simó, Sergio M. Vallina

Institut de Ciències del Mar (ICM), CSIC, Barcelona

Over two decades, the hypothesis that oceanic plankton influence climate through the production and emission of the cloud precursor dimethylsulfide (DMS) has fostered intensive research on the cycle of biogenic sulfur in the ocean. Because of the cross-scale nature of the hypothesis, DMS research has to be conducted at multiple temporal and spatial scales and with a big load or multidisciplinary (Simó 2001). In recent years, field and process-based studies have been complemented with modelling activities the use of new-generation satellite sensors for global observation. This is yielding important advances in the knowledge of the DMS cycle, its dynamics, its atmospheric effects and its responses to climate forces. Here we present very recent work conducted in our group on global observation and modelling of the bidirectional links between oceanic DMS, cloud-forming aerosols and solar radiation (Vallina and Simó 2007, Vallina et al. 2006, 2007).

References:

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Viernes 30, 11:15

CARBON EXCHANGE THROUGH THE STRAIT OF GIBRALTAR

*I. E. Huertas*¹, *S. Rodríguez-Gálvez*¹, *A. Makaoui*², *J. García Lafuente*³, *A. Sánchez*³, *A. F. Rios*⁴, *S. Zizah*², *A. Orbi*², *J. Ruiz*¹

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Although the role of the ocean in global climate is not fully understood, there is general agreement that it is significant, particularly through its involvement in the exchange of CO₂

with the atmosphere. It is well established that the atmospheric CO₂ concentration has been increasing for many decades due to anthropogenic activities and although the ocean is believed to be removing much of it, the actual extent of CO₂ uptake by the marine environment remains a question. Therefore, many efforts are being directed towards investigating the participation of the ocean in the carbon sequestration, the consequences of the CO₂ rise on the marine ecosystems and the associated feedbacks with the terrestrial systems. In this sense, the European Integrated Project CARBOOCEAN is aimed at determining the ocean's quantitative role for uptake of CO₂ since the correct estimation of this sink is a fundamental necessary condition for all realistic prognostic climate simulations. As part of the project, the exchange of carbon through the Strait of Gibraltar is being studied since it is through this channel where both the Mediterranean Sea and the Atlantic Ocean mix and interact, transferring substances and energy that must be considered in the assessment of matter inventories in the North Atlantic. Therefore, the variables involved in the CO₂ system in the Strait of Gibraltar are currently being examined extensively in order to monitor their temporal variability and determine the mechanisms controlling the carbon fluxes between the Atlantic and the Mediterranean basin. This work presents the results obtained in five campaigns performed in the area that have allowed to estimate the fluxes of total inorganic carbon through the Strait

*Conferencia invitada**Viernes 30, 12:00***UPWELLING, EKMAN TRANSPORT AND HORIZONTAL EXCHANGES:
CHANGING PERSPECTIVES***Eric D. Barton*

Instituto de Investigaciones Marinas-CSIC, Vigo

Advances in the understanding of the horizontal and vertical exchanges in coastal upwelling regions are reviewed. The evolution of understanding from early two-dimensional time-invariant ideas of the system to present-day concepts of a three-dimensional, constantly changing system is traced. These advances have followed in the wake of increasingly sophisticated observational and computational techniques that have provided unprecedented views of the ocean. Our present understanding is explored through the examples of processes near shore, upwelling and relaxation in the upper layers, cold filaments and long term trends. On the basis of these examples, the biogeochemical implications are explored and possible priorities for future research are suggested.

Viernes 30, 12:30

SUSPENDED POC TRANSPORT AND CONSUMPTION IN SURFACE AND DEEP WATERS OF CANARY CURRENT: A BOX MODEL STUDY*Iván J. Alonso, Javier Arístegui, Alonso Hernández-Guerra, Juan C. Vilas, Iraida Polo*

Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria

The eastern boundaries of oceanic basins connect the eutrophic waters of coastal upwelling areas with the oligotrophic open ocean waters. As a consequence, boundary currents have been postulated as potential key regions for organic matter production and export to the interior ocean. Nevertheless, there are almost no studies available on the role of boundary regions as sinks or links of coastally-produced organic matter to the open ocean waters of the subtropical Gyres. Here, we have evaluated the horizontal transport and consumption, from surface to 3000 m, of suspended particulate organic carbon (POC) through a box-model approach (20-29° N, 20-26° W) in the Canary Current region (subtropical Northeast Atlantic Ocean). Our results show that a close balance exists if considering the whole water column, although sharp differences may be observed at different water masses. The upper Surface Waters (<100 m) show a westward transport of $3.5 \times 10^8 \text{ mol C d}^{-1}$ between 21° N and 24° N. However, the Central Waters (100-700 m) show a negative balance of $-4.2 \times 10^8 \text{ mol C d}^{-1}$, with the highest POC entering through the more coastal section. Intermediate Waters (Mediterranean and Antarctic waters; 700-1000 m) present lower transports, except in the north transect, where $5.8 \times 10^8 \text{ mol C d}^{-1}$ are transported northward at the easternmost sector of the section. In the Deep Waters (>1000 m) the transport is almost negligible. Our results indicate that, during the time of our study, the upper Surface Waters accumulated and transported POC to the open ocean, perhaps due to the large mesoscale activity of the region. However, the Central Waters behaved as net sinks of coastally produced organic carbon, in agreement with the high remineralization rates reported for the mesopelagic zone of this region. Our results contradict previous studies from other boundary regions, which suggest that ocean margins act as links for coastal organic carbon sedimented on the continental shelf before being transported to the deep waters of the interior ocean.

Viernes 30, 12:45

WINTER UPWELLING RECURRENCE ALONG THE GALICIAN WESTERN COAST*M. Gómez-Gesteira¹, M. deCastro¹, I. Alvarez¹, A.J.C. Crespo¹, J. M. Cabanas² and R. Prego³*¹ Grupo de Física de la Atmósfera y del Océano, Universidad de Vigo, ²Instituto Español de Oceanografía. C.O. Vigo, ³Instituto de Investigaciones Marinas, CSIC, Vigo

Upwelling events driving ENACW (Eastern North Atlantic Coastal Water) into the Galician western coast rias had been considered typical spring-summer processes, according to the research developed in this area. However, they can also be observed in fall or winter under northerly winds blowing at shelf. Six different upwelling events were analyzed in the Ria of Pontevedra during the wet season (NDJF) from 2000 to 2005. These events were characterized by means of the zonal Ekman transport (Q_x) at four control points in front of the Western Rias (locally known as *Rias Baixas*) and the thermohaline variables measured at a fixed station in the main mouth of the Ria of Pontevedra. The duration of the upwelling events ranges from 27 days (during February and March 2002) to 69 days (during November, December 2004 and January 2005). Upwelling events studied in the Ria of Pontevedra from 2000 to 2005 show the similarity in upwelling features during both seasons (similar wind forcing and upwelled water). Finally, Q_x was correlated with the most representative atmospheric patterns in the Northern Hemisphere (EA, NAO, EA/WR, POL and SCAND) from 1966 to 2005. The winter EA pattern has the most influence on Q_x .

showing an annual evolution with a prevalence of the positive phase from 1976 on. This positive phase is directly correlated with a prevalence of positive values of Q_x which are upwelling unfavorable in the *Rias Baixas*.

Viernes 30, 13:00

WATER AND NUTRIENTS TRANSFER IN THE RIA-OCEAN INTERFACE AND PHYTOPLANKTONIC PATTERNS OF TWO WINTER UPWELLING EVENTS IN A GALICIAN RIA

*Ricardo Prego*¹, *Dafne Guzmán*^{1,2}, *Manuel Varela*³, *Maitte DeCastro*⁴ and *Moncho Gómez-Gesteira*⁴

¹ Instituto de Investigaciones Marinas (CSIC), Vigo,

² Universidad del Mar, Viña del Mar, Chile,

³ Instituto Español de Oceanografía, C.O. Coruña ⁴ Universidad de Vigo

The consequences of two upwelling events in mid (MW) and late (LW) winter on the oceanographic patterns were studied in the Pontevedra Ria and compared with patterns measured under typical winter conditions and under a summer upwelling event. Thermohaline properties measured during MW revealed the intrusion of saltier seawater into the ria associated to the Iberian Poleward Current, however in LW the upwelled seawater showed characteristics of Eastern North Atlantic Central Water mass. In both cases, the water residence time measured, 4 days and 10 days respectively, was related to both meteorological and fluvial forcing.

During MW-up, the ria becomes poor in nutrients (exported $3.4 \text{ mol}_{\text{DIN}} \cdot \text{s}^{-1}$ in comparison with $6.9 \text{ mol}_{\text{DIN}} \cdot \text{s}^{-1}$ of non-upwelling) and phytoplankton showed a uniform distribution throughout the ria, as during unfavorable upwelling conditions. The phytoplankton distribution was characterized by the dominance of diatoms, mainly *Nitzschia longissima* and *Skeletonema costatum*.

During LW-up, a nutrient depletion in the photic layer also occurred but as a result of a phytoplankton spring bloom developing at this time. The ria was a nutrient trap where $4.1 \text{ mol}_{\text{DIN}} \cdot \text{s}^{-1}$ were processed by photosynthesis. The ria became more productive (three times higher than under non-upwelling conditions) although not as productive as during a summer upwelling event ($9.9 \text{ mol}_{\text{DIN}} \cdot \text{s}^{-1}$). The taxonomic composition of phytoplankton community did not change, varying only the relative proportions. Diatoms were always the dominating microphytoplankton community with *Pseudo-nitzschia pungens*, *Thalassionema nitzschioides* and several species of *Chaetoceros* as characteristic taxa.

Acknowledgements. We thank Dr. José M. Cabanas (IEO) for the upwelling index data and Dr. Manuel Alvarez Eijo (USC) for the calibration of the river gauging station. This work is a contribution to the Spanish LOICZ program and it was supported by CICYT under the project PONTRIA (ref. MAR96-1782).

Viernes 30, 13:15

GEOCHEMICAL VS MICROBIAL APPROACH TO THE NEW PRODUCTION OF THE COASTAL UPWELLING SYSTEM OF THE RÍA DE VIGO (NW SPAIN)

S. Piedracoba^{1, 2}, *M. Nieto-Cid*^{2, 3}, *C. Souto*², *I.G. Teixeira*¹, *M. Gilcoto*⁴, *J. L. Garrido*¹, *X. A. Álvarez-Salgado*¹, *G. Rosón*², *R. Varela*², *C.G. Castro*¹, *F. G. Figueiras*¹, *F.F. Pérez*¹

¹ Instituto de Investigaciones Mariñas CSIC, Vigo, ² Facultad de Ciencias del Mar, Universidade de Vigo, ³ Woods Hole Oceanographic Institution, USA, ⁴ Flinders University, School of Chemistry, Physics & Earth Sciences, Adelaide, Australia

The fate of the inorganic and organic N trapped in the coastal upwelling system of Ría de Vigo (NW Spain), accumulation/export versus production/ consumption, was studied at the short time-scale (2–4 d) during July 2002. A transient geochemical box model was applied to the measured residual currents and concentrations of inorganic (N_T), dissolved (DON)

and particulate (PON) organic N to obtain the i) net balance of inputs minus outputs ($i - o$); ii) the net accumulation ($V \cdot dN/dt$); and iii) the net ecosystem production (NEP) of N_T , DON and PON. The average NEP during July ($107 \text{ mg N m}^{-2} \text{ d}^{-1}$) indicates an autotrophic metabolism of the ría. About 25% of this material was exported to the shelf and the remaining 75% was transferred to the sediments or promoted to higher trophic levels. Measurements of oxygen production (P_g) and respiration (R) were performed in a single site twice a week at five depths. In addition, microzooplankton grazing and sedimentation rates were measured for first time in the Ría de Vigo. The high grazing rates observed reduce the efficiency of the ría to transfer organic matter directly from phytoplankton to the metazoans. Comparison of the metabolic state of the Ría de Vigo derived from these *in vitro* measurements (P_g , R , grazing and sedimentation) and the *in situ* geochemical budget shows that they agree in 2 of the 3 study cases. Both methods are complementary and their simultaneous application allows obtaining a better knowledge of coastal upwelling ecosystems functioning.

Viernes 30, 13:30

HYDROGRAPHICAL STRUCTURE AND NUTRIENT DISTRIBUTION DURING THE 2005 SPRING PHYTOPLANKTON BLOOM IN NW MEDITERRANEAN: A TOOL FOR ESTIMATING THE EXPORT PRODUCTION.

M. Vidal¹, G. Vila¹, M. Emelianov², J. L. López-Jurado³, M. Latasa² and J. Salat²

¹Departament d'Ecologia, Universitat de Barcelona, ²Institut de Ciències del Mar (CSIC), Barcelona, ³Instituto Español de Oceanografía, C.O. Baleares

Knowing the export production is a primary goal of ocean sciences. This has been limited by the complex physical and biological controls and the high spatial and temporal variability (Fasham 2003). Many estimates are based on changes in nutrient concentrations. Consequently, awareness of nutrient distribution and fate during phytoplankton blooms is essential. Here we report on the dissolved inorganic, organic and particulate nutrient and carbon distribution in NW Mediterranean during the EFLUBIO-2 cruise (between March 25 and April 5 2005). The studied area in the Gulf of Lions is a major site of carbon export, since strong deep mixing provides nutrients for phytoplankton growth. The study included an area south of the Nor-Balearic Front outside the bloom area. We found equivalent vertical profiles of nitrate, phosphate and silicate in the north stations. In contrast, there was high variability in water T-S characteristics. Nutrient concentrations were low in surface waters, increasing to a maximum of $10.2 \pm 0.25 \mu\text{M}$ nitrate, $0.39 \pm 0.01 \mu\text{M}$ phosphate and $9.50 \pm 0.11 \mu\text{M}$ silicate at depth. Particulate organic carbon, nitrogen and phosphorus concentrations were around 30, 4 and $0.2 \mu\text{M}$, respectively, at the beginning, decreasing subsequently to values below 5, 1 and $0.05 \mu\text{M}$. In addition, there was a deepening of the peak concentrations and an increase in the contribution of dissolved organic nutrients in the total pool. These results are discussed in the frame of the export production of the region.

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Viernes 30, 13:45

UTILIZATION OF ATMOSPHERIC MATERIALS BY MARINE PROKARYOTIC COMMUNITIES

Jesús M. Arrieta, Antonio Tovar-Sanchez, Susana Agustí and Carlos M. Duarte

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Large atmospheric inputs of both particulate (aerosols) and gaseous volatile organic carbon (VOC) to the surface ocean in have been measured recently . However, the fate these atmospheric materials deposited in surface waters is still uncertain. Deposition of atmospheric aerosols can enhance phytoplankton growth, probably due to the large amounts

of nutrients and trace-metals contained in aerosol particles .There are indications that aerosol depositions may have an effect also on heterotrophic prokaryotes (Bacteria and Archaea). Utilization of VOC by marine biota is likely linked to prokaryotic activity, since these organisms are the only significant consumers of dissolved organic carbon in the ocean. The effect of atmospheric deposition on marine prokaryotic communities was evaluated by monitoring dilution cultures amended with in-situ-collected aerosols and VOC as compared to appropriate controls. Our results show that atmospheric VOC can be readily consumed by marine prokaryotes. Moreover, prokaryotic growth efficiencies indicate that VOC is composed of rather labile compounds as compared to the bulk of the dissolved organic carbon pool, while aerosols contain more refractory compounds. Nevertheless, a large enhancement of prokaryotic growth was also observed in aerosol-enriched cultures, indicating a significant prokaryotic utilization of aerosol-derived materials.

*Conferencia invitada**Viernes 30,15:30***FROM NITRATE TO TUNNA: A MODEL OF MODELS**Javier Ruiz

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The high diversity of processes and scales affecting the trophic axis of the pelagic ecosystem hinders views that integrate together biogeochemical cycles and trophic transfers. This is particularly the case for oligotrophic systems like the Mediterranean where taxonomic diversity of primary and secondary producers makes inefficient those approaches based on key species, which eventually dominate at higher latitudes. However, this integrated view is at the core of the progress foreseen by programmes like IMBER or Euro-Oceans. The Mediterranean community involved in the later has reached a consensus to generate a conceptual structure that incorporates a wide range of processes, from nutrient remineralization to interannual fluctuations of top predators. The structure is based on the success achieved by functional types at the lower trophic levels as well as on the consensus between experimentalists and modellers about the necessary parsimony for trophic resolution at the meso-zooplankton level. This group is the vector towards species like small pelagic fish with economic interest and whose modelling might demand Lagrangian approaches. Modelling the transfer from small pelagics to top predators requires a connection between Lagrangian and/or Eulerian frames with the mass-balance view usually implemented in the ecosystem approach to fisheries management. More than a model, the overall consensus of the Mediterranean community is a road map, a model of models to go from nitrate to tuna in the Mediterranean. The trophic and habitat diversity sustaining this consensus is wide enough to think of it as a scheme feasible to be extended to other regions beyond the Mediterranean.

Viernes 30, 16:00

EVOLUTION OF THE VERTICAL STRUCTURE OF THE UPPER OCEAN FROM A TIMESERIES OF PROFILES FITTED TO PHYSICALLY-CONSISTENT FUNCTIONAL FORMS*César González-Pola¹, Julio M. Fernández-Díaz²*¹Instituto Español de Oceanografía, C.O. Gijón²Universidad de Oviedo

A method for characterising the upper ocean structure and its seasonal evolution is developed. Each temperature (density) profile is fitted to an ideal function which is constructed on the basis of two premises: the permanent and seasonal thermoclines can be approximated respectively by steady-state and transients of turbulent-diffusive processes and the mixed layer can advance sharply under external forcing. The ideal profile is composed of two pieces joined at the Mixed Layer Depth (MLD). The upper part is a constant and the part below the MLD is a composition of an exponential decay and a Gaussian, representing the seasonal thermocline and decaying asymptotically to a straight line that describes the permanent thermocline. The composition of exponential decay and Gaussian fits accurately a wide family of solutions of the diffusion equation and includes the case of a shift of the boundary (the MLD). The ideal fit for each profile relies on six adjustable parameters including the MLD and the fitting is achieved through a Differential Evolution optimisation algorithm. The solution gives a nice estimate of the MLD based on the topology of the profile and it also gives an objective measure of the gradient and the shape of each profile, thus yielding a tool for upper ocean structure characterisation. The method is applied to a series of profiles at a fixed location in the southern Bay of Biscay for constructing a climatology of the vertical structure evolution.

Viernes 30, 16:15

PRESENT UNCERTAINTIES ON OCEAN MODELLING OF NORTH AND NORTHWEST IBERIA*Pablo Otero and Manuel Ruiz-Villarreal*

Instituto Español de Oceanografía, C.O. Coruña

Ecological ocean models are of vital importance to create scenario simulations, evaluate anthropogenic effects like river nutrient inputs, increase the understanding on phytoplankton blooms, larvae dispersion or describe the impacts of climate change. Previous studies have demonstrated that ecosystem modelling should be 3D and should be coupled with or forced by state-of-the-art circulation models. Therefore, a previous step requires the proper validation and adaptation of a physical model to reproduce realistic conditions. Present circulation models have weaknesses and strengths and sources of uncertainties including external forcing are numerous. In this contribution, we focus on uncertainties affecting the performance of the model in describing shelf circulation. We will report on the advances of the setting-up of a high resolution physical model in North and North-West Iberian shelf and slope, which Instituto Español de Oceanografía is currently performing. We will focus on the description of river plumes and report how the model is sensitive to variations in river runoff or atmospheric forcing. To illustrate the sensitivity of the modelled circulation patterns to the source of atmospheric forcing, results of forcing the model with the widely used NCEP reanalysis wind fields and winds from INM/HIRLAM and MeteoGalicia/MM5 high-resolution forecast models will be compared. The use of different wind products results in differences larger than 20 cm s^{-1} in the surface speed of the river plume.

Viernes 30, 16:30

OCEANOGRAPHIC CONDITIONS AFFECTING RED TIDES IN NW IBERIA DURING OCTOBER 2005

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Red tides are typical phenomena of the end of the summer that can cause large economical losses to the seafood industry in the Galician Rías, one of the most important seafood producers in the world. Oceanographic conditions play an important role in the development of the blooms, either transporting the algae to the photic layer and creating favorable conditions for its reproduction, or advecting the algae along-shore by means of a shelf counter-current. In this contribution, we will analyze oceanographic conditions in autumn 2005, when several episodes of algae blooms took place. The toxin found in these occasions was PSP (Paralytic Shellfish Poison), not found in the area since 1990. It was detected off the coast of Aveiro (Portugal), on October 20th, and in the following days the toxin bloomed in Vigo, Pontevedra, O Grove, and Sada (Spain) located further North. Using the Regional Ocean Modeling System (ROMS) we will simulate the ocean circulation in the area, focusing on the oceanographic conditions during that period, and how they could have affected the bloom.

Viernes 30, 16:45

MARINE FORECAST CAPACITY AND MODELLING IN THE BAY OF BISCAY

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AZTI-Pasaia (Gipuzcoa)

The Bay of Biscay is an arm of the Atlantic Ocean located in the sea region limited by the northern and western coasts of Spain and France, respectively, with a large economical importance of the fisheries sector. The oceanographic regimes that characterise the near-shore, shelf, slope and offshore areas have a fundamental role in the selection of the spawning areas by the different species, in the fish dispersion, retention and growth, especially during the early life stages (eggs and larvae), and in the future recruitment. Although numerous studies have been undertaken in the last years, the complexity of the system showed by the drifting buoys at sea surface during the *Prestige* event was such that numerous questions are still open. Nowadays, high order and resolution hydrodynamic models are the direction chosen to explore the physical processes affecting fish recruitment. From a regional point of view, the near-surface circulation in this area is directly related to the wind fields. Close to the shore, the orientation of the coastline (east-west and north-south along the Spanish and French coasts, respectively), together with the seasonal distribution of the prevailing winds explain (to a large extent) the general drift of the surface water masses. Hence, the winds blow predominantly from the southwest in autumn and winter, generating marine currents that, on an average, cause predominant eastward and northward drift. The wind regime changes towards the north-northwest during spring, causing currents to move in a southerly direction and towards the west-southwest along the French and Spanish coasts, respectively. The summer situation is similar to that of the spring, although the presence of weak winds of high variability results in a more indeterminate general drift direction of the currents. Results derived from numerical modelling, both in hindcast and forecast modes, confirm the importance of the wind on the sea surface circulation. As well, the frequent presence of eddies in the Bay of Biscay are predicted, shaping the large-scale circulation and, therefore, having a large impact on the climate and biology of the oceans.

Viernes 30, 17:00

SIMULATION OF ANNUAL CYCLES OF PHYTOPLANKTON, ZOOPLANKTON AND NUTRIENTS TO THE SOUTH OF THE GRAN CANARIA ISLAND USING A MIXED LAYER MODEL COUPLED WITH A BIOLOGICAL MODEL

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In oceanography, the *mixed layer* refers to the near surface part of the water column where physical and biological variables are distributed quasi homogeneously. Its depth depends on the conditions at the air-sea interface and on the characteristics of the flow, and has a strong influence on biological dynamics.

The aim of this work is to model the behaviour of the mixed layer in waters situated to the south of Gran Canaria Island, as well as the annual biological cycles (nutrients, planktons, detritus) which depend on it. To this end the one dimensional version of the ROMS (Shchepetkin and McWilliams, 2005) model is applied. The model consists of a physical model coupled with a biological one, with a mixed layer sub-model *K-Profile Parameterization* (Large et al., 1994).

Initialization is done using mean profiles established from *in situ* data (Barton et al., 2004), forcing is from monthly means of heat fluxes, surface temperature, wind stress and heat flux sensitivity to sea surface temperature. These physical parameters are extracted from climatic databases and averaged over a 10-year period.

Simulations underlines a strong stratification and a shallow mixed layer under the effect of the important heat fluxes in summer and a deep mixed layer due to convective mixing in late winter, causing an injection of nutrients into the *euphotic layer* and a phytoplankton bloom in February. *Sverdrup critical depth theory* (Sverdrup, 1953) is applied in the interpretation of these observations.

Finally the model validation is achieved either through *in situ* or climatic data, bringing to light a qualitative and quantitative agreement between model results and reality.

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Viernes 30,17:15

APROXIMACIONES A LA MODELIZACIÓN Y LA PREDICCIÓN DE ECOSISTEMAS MARINOS

Francesc Peters

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Los ecosistemas marinos son complejos por definición, tanto por la cantidad de variables de estado, como el número de relaciones entre estas variables de estado y el gran número de variables ambientales que afectan las funciones de estas relaciones. Finalmente, los ecosistemas marinos comprenden procesos en un rango muy grande de escalas espaciales y temporales. La modelización es una abstracción simplificada de esta complejidad a un grado tratable y comprensible que ha servido sobretodo en retrospectiva para entender la dinámica de algunos procesos y dirigir esfuerzos de observación y experimentación. Con la creciente certeza de los cambios globales, se suma ahora un esfuerzo de predicción. A mi

modo de ver, hay dos escalas de temporales de predicción. Por un lado está la escala de tiempo larga, entiéndase de variabilidad anual hasta multianual. Esta escala puede dar lugar a predicciones de la dinámica de los ecosistemas marinos a "grosso modo" sobretudo para planificación a largo término de políticas ambientales y sociales. La segunda escala es la de la variabilidad subdiaria hasta semanal. Aunque en principio pueda parecer menos interesante, a semejanza de la meteorología, estas predicciones del estado del ecosistema a corto plazo serán las más relevantes para la sociedad con aplicaciones de salud ambiental y seguridad marítima, entre muchas otras. Ambas escalas requieren indudablemente de un esfuerzo similar a la meteorología con la cuál llevamos un retraso de 50 a 100 años. Se necesitan extensas redes de observación en tiempo real de una amplio abanico de variables, potentes bases de datos que vayan estructurando la adquisición de estos datos con metaanálisis automatizados y modelos numéricos con asimilación de datos en tiempo real. La tarea a realizar es compleja y costosa, pero no por ello podemos permitirnos la demora de su puesta en marcha.

Conferencia plenaria

Viernes 30, 17:40

LAS CIENCIAS MARINAS EN ESPAÑA

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Los Océanos continúan siendo un misterio del que solo se conoce un 5% a pesar de su importancia capital para el planeta. Aunque la conciencia de su relevancia ha aumentado progresivamente, todavía se los considera como una fuente de servicios (p.e.: vertedero, suministrador de alimentos, medio de transporte). La sociedad, y los gestores y responsables políticos, no son conscientes de su importancia frente a los cambios actuales ni frente a sus posibles consecuencias. En España la falta de conciencia sobre la importancia que el océano tiene para la sociedad es patente, aunque casos como el del Prestige han actuado como revulsivo y han tenido consecuencias a corto y medio plazo.

A nivel de la I+D+I las ciencias marinas han perdido relevancia y visibilidad en los últimos años, motivando que en 2005 el subprograma MAR organizara una reunión con expertos en Ciencias del Mar. El debate generado sobre la problemática y acciones de futuro permitió diagnosticar la necesidad un aumento de visibilidad y de la creación de un observatorio de las ciencias marinas. Algunas de las acciones realizadas para aumentar la citada visibilidad han sido en 2006 la creación de la Escuela Sobre Ciencias Marinas “Augusto González De Linares”, Aula Del Mar y la publicación del estudio sobre las Ciencias y Tecnologías Marinas en España. Si bien los científicos marinos españoles forman parte de diversas redes internacionales, no existía una estructura corporativa propia. En 2007 se ha lanzado una red con los objetivos:

- ✓ Organizar la comunidad científica que trabaja en ciencias relacionadas con el mar potenciando la interdisciplinariedad necesaria para abordar los complejos problemas que la naturaleza del mar conlleva. Se constituirá una red de intercambio de información y conocimientos cuyo antecedente es el Boletín CYTMAR, distribuido durante 9 años. Para ello se cuenta con una página web (http://otvm.uvigo.es/red_mar).
- ✓ Construir un directorio de científicos relacionados con este campo que permita identificar fácilmente las personas relevantes, en caso de necesidad, por las administraciones, empresas y otros científicos.
- ✓ Realizar análisis y estudios prospectivos para identificar líneas prioritarias de investigación en función del cambiante escenario medioambiental y en respuesta a las demandas de la sociedad.

ON THE EFECTS OF UVR FOR THE METABOLIC BALANCE OF PLANKTONIC COMMUNITIES

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Net community metabolism, is an important descriptor of the role of biological processes in the carbon flow of the ecosystem. Data reporting the metabolic balance of marine planktonic systems is still limited, despite its relevance. Moreover, most measurements of net planktonic metabolism have been performed by incubating the samples in glass bottles, which filter-out most UVB (ultraviolet B) radiation. Recent studies indicated, however, that stratospheric ozone did not yet recover the concentration values reported before CFC's emissions, with subsequent increased UVB reaching the ocean surface at the present time. The recovery of ozone values in mid latitude areas is not expected until 2050-65, and the impact of increased UVB over present oceanic systems should be, however, quantified. The goal of this study was to provide present values of net planktonic metabolism measured by exposing communities to total (UVR+PAR) solar radiation underwater. Also, to analyze the effects of UVR on planktonic net metabolism, and, to evaluate the possible deviation of the published values reported where UVB was removed. We did so along a temporal study where the planktonic net metabolism of pristine coastal waters of Majorca Island (Mediterranean Sea) was measured.

EKMAN TRANSPORT ALONG THE GALICIAN COAST CALCULATED FROM QUIKSCAT WINDS

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Grupo de Física de la Atmósfera y del Océano. Universidad de Vigo.

Ekman transport is studied close to the Galician coast by means of wind data provided by the QuikSCAT satellite from November 1999 to October 2005. Three different coastal zones are identified, western coast from Miño River to Cape Finisterre, middle coast from Cape Finisterre to Cape Ortegal and northern coast, from Cape Ortegal to Cape Peñas. In addition to existence of long- term variations, the periodicity of the transport signal is characterized by an annual component (365 days), a seasonal fluctuation (50-80 days) and a time scale related to passing storms (15-20 days). Although the periodicity of the signal is similar at the three zones due to external meteorological forcing, the Ekman transport is modulated by the presence of the coast, in such a way that seasonal patterns vary in intensity and direction along the coast. Thus, the spring- summer pattern is characterized by high transport at the western coast, pointing seaward perpendicular to the shore- line. The same orientation is observed at the middle coast although with a lower magnitude. Finally, Ekman transport at the northern coast points landward and oblique to the shore-line. The different transport orientations are shown to be responsible for the upwelling probability variation along the coast. On the other hand, the autumn-winter pattern does not show a clear trend with important inter-annual differences showing the high variability of Ekman transport for this period.

ANALYSIS OF PHOTO-PHYSIOLOGICAL STATE AND VERTICAL DISTRIBUTION OF PHYTOPLANKTON IN CAMARINAL SILL (STRAIT OF GIBRALTAR)

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Hydraulic control of Mediterranean flow to the Atlantic in the Strait of Gibraltar occurs at the shallower Camarinal Sill in the western side of the channel. The sharp topography of Camarinal Sill and tidal forcing lead to generate intense undulatory processes as internal waves (Bruno et al., 2002) that induce vertical mixing, that can presumably lead in turn to enhance biological production. In order to study the influence of tidal induced mixing on photosynthetic performance of plankton in the zone, a register of hourly profiles both of physical variables (T, S) and physiological parameters (F₀, F_v/F_m, σ PSII) were obtained

during 8 hours. These registers were taken in November 2005 aboard the “B.C. Malaspina” using a CTD (SAIV SD204) plus a FRRF (Fast Repetition fluence Rate Fluorometer) package on a fixed station located near to Camarinal Sill (35° 56'N /5° 40' W). Vertical profiles of F_0 showed a significant positive correlation with Chl *a* concentration and revealed two different chlorophyll maxima that had been previously described in the neighbourhood of the Strait (Macías, 2006) and named as Atlantic maxima (AM; 26.3 isopycnal, 15 m) and Deep Maxima (DM; 27.6 isopycnal, 40 m). AM occurred in the upper water column before the arrival of the internal waves with F_v/F_m decreasing from a maximum value of 0.429 ± 0.03 in the dark to 0.152 ± 0.027 at midday. DM only appeared after high water at an intermediate depth of 40.8 m with lower values of F_v/F_m (< 0.2). σ_{PSII} values associated to both maxima showed a small variation during the sample period. At high water + 1.5 internal waves arrived to the sampled site, mixing the water column and producing an unique and broad joint chlorophyll maximum that ascended drastically to the surface in the order of a few minutes (10'). Phytoplankton associated to DM was then, consequently, transported to surface waters in a short time scale being introduced in the Alboran Sea with the incoming Atlantic water.

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THE PHYSIOLOGICAL STATE OF MICROPLANKTON COMMUNITIES DURING CONTRASTING SITUATIONS IN THE NW MEDITERRANEAN

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Two multidisciplinary cruises were performed in open sea waters of the NW Mediterranean, in the area of influence of the Nor-Balearic Front (NBF) and the two water masses bordering it. The objectives of the field work were to identify, quantify and establish relationships between the physical and chemical conditions, the structure of the planktonic communities and the biogeochemical fluxes in that area over different seasonal periods. Two cruises were conducted in two contrasting situations: during the summer stratification (September 2004) and during the spring bloom (March-April 2005) periods. In this last cruise, the physico-chemical and biological properties corresponding to the spring bloom were found at the North of the NBF while at the South of it corresponded to a post-bloom situation. In this communication, we discuss the distribution of the biochemical indicators of biomass (chlorophyll, protein and DNA) and of physiological state of the microbial communities, the RNA/DNA ratio, in relationship with other physico-chemical (temperature, salinity, inorganic nutrients) and biological (phytoplankton pigment composition, bacterial numbers, primary and bacterial productions) variables.

Overall, the highest levels of protein and DNA concentrations were found during the bloom situation along with the highest values of the RNA/DNA ration, indicative of high metabolic activity and good physiological state. The lowest values were found during the stratification and intermediate ones in the post-bloom. Protein and DNA concentrations correlated well with phytoplankton biomass and bacterial abundances, respectively. The Protein/DNA ratio reflected the different proportion of autotrophic vs heterotrophic groups.

BIOGEOCHEMICAL MODELLING OF THE NORTH-WESTERN MEDITERRANEAN SEA

Raffaele Bernardello, M.A. Ahumada, A. Cruzado, G. Cardoso

Centre d'Estudis Avançats de Blanes (CSIC)

It has been widely recognized that primary production in the Sea is strongly dependent on physical conditions of the water column. This is true at the space-scale of plankton organisms because, for instance, of the direct effect of turbulence on nutrient availability

and at larger scales because the conditions of the water column contribute to determine the flux of nutrient into the euphotic layer.

As a consequence, modelling biogeochemical cycles at a sub-basin scale requires a fine resolution and accurate description of the physical conditions in the Sea. Complexity in biology needs to be matched with an appropriate complexity in the representation of the physical and chemical environment (Anderson, 2005).

As a base of this work the Princeton Ocean Model (POM) has been used. POM is a primitive equations ocean circulation model (Blumberg and Mellor, 1987) that was adapted to the conditions prevailing in the Northwestern Mediterranean Sea (Ahumada and Cruzado, 2006). This physical model (hereafter regional model) successfully simulates the general circulation patterns known in the considered domain.

The coupling of a biogeochemical model to the regional model was implemented in order to simulate the biogeochemical processes at a sub-basin scale. An NPZD-type model (Bahamón and Cruzado, 2003) was used and successfully simulated all the biogeochemical known patterns on a climatological basis. The model outputs were validated against ENVISAT-MERIS remote sensing data for chlorophyll-a.

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LEAD EXCHANGE BETWEEN THE INNER AND MIDDLE ZONES OF VIGO RIA

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Two sampling cruises (dry and wet season) were carried out at the Rande Strait during a tidal cycle on board the R/V *Mytilus*. Water velocity at different depths was measured using a ship-mounted ADCP (surface waters: Valeport-808 currentmeter). During the entire tidal cycle (tidal range: 1.4-1.5 m) samples were taken at five depths every two hours (5-L Go-Flo bottles), stored at 4 °C and vacuum filtered (0.45 µm polycarbonate) upon arrival to the onshore ultra-clean lab. Filtrate was acidified to pH 2 whereas filters were stored in petri dishes and frozen pending analysis. Dissolved Pb (DPb) was analysed by means of DPASV after UV-digestion; Particulate Pb (PPb) by GCAAS after microwave-assisted filter digestion. The analytical procedure accuracy was assessed by CRM analysis, CASS-4 (near-shore seawater), SLRS-4 (riverine water) and PACS-2 (sediment).

In the wet season cruise (river flow: 67 m³·s⁻¹) DPb ranged 0.8-1.9 nM, PPb 0.1-4.6 nM, and the current speed did not exceed of 18 cm·s⁻¹. In the dry season cruise (river flow: 4 m³·s⁻¹) DPb ranged 0.1-0.4 nM, PPb 0.1-0.6 nM and the current speed did not exceed of 20 cm·s⁻¹. Average Pb values were higher in winter conditions, possibly as a consequence of sediment resuspension resulting of higher fluvial caudal in this season. In both periods, outgoing water at the San Simon Inlet was richer in total Pb than the incoming waters from the outer ria part. Accordingly, the resulting Pb budget in both seasons indicate a net outflux from the inner part of the ria (1-8 kgPb per tidal cycle). The well-documented contamination of Pb in San Simón is suggested to explain these observations.

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CAMBIOS ESTACIONALES E INTERANUALES EN LAS COMUNIDADES PLANTÓNICAS DEL SECTOR NO DEL MAR DE ALBORÁN

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En el presente trabajo se analiza, durante el período de tiempo 1992-2002, la respuesta del ecosistema pelágico a cambios temporales en las condiciones hidrológicas. Los datos empleados en este estudio fueron obtenidos trimestralmente en el marco del proyecto ECOMALAGA. El área de estudio se caracteriza por la presencia de un afloramiento casi permanente que se intensifica en primavera. Debido a estos afloramientos, un máximo anual de nutrientes es observado habitualmente en esa época del año. De igual forma, la concentración de clorofila *a* y la abundancia de micro- y nano-plancton aumentan en primavera. A pesar de este ciclo estacional, no hubo un patrón anual de sucesión claro en la composición taxonómica del fitoplancton. Por el contrario, los máximos anuales de zooplancton se registraron habitualmente en verano, debido fundamentalmente al incremento de braquiópodos con respecto a copépodos (que dominaron de otoño a primavera). Con independencia del ciclo estacional, se registraron notables cambios interanuales en la composición del fito- y zooplancton. En particular, la abundancia de dinoflagelados y cocolitofóridos respecto a diatomeas aumentó desde 1997 a 2002. Esta tendencia coincidió con una progresiva disminución en la intensidad del afloramiento. Los cambios interanuales afectaron al crecimiento y estado nutricional de las larvas de *Sardina pilchardus*, observándose las mayores tasas de crecimiento somático (expresadas tanto en talla larvaria como en contenido de ADN) en 2001, coincidiendo con los cambios observados en la composición de la comunidad de fitoplancton.

BIOGEOCHEMICAL CONSEQUENCES OF MACROALGAL BLOOMS ON INTERTIDAL SEDIMENTS: NET METABOLISM, NUTRIENT FLUXES AND COMMUNITY STRUCTURE

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Eutrophication in coastal areas promotes macroalgal blooms affecting the mass exchange at the water-sediment interface. Net metabolism, species composition of the biological community and nutrient fluxes are likely to change as a consequence. Here we report the results of a seasonal study in intertidal sediment flats of Natural Park Bay of Cádiz. Two sediment enclosures (with and without macroalgae) of 1.5 x 1.5 m were installed and maintained 2-3 weeks during every season. Sediment cores, with and without macroalgae, were collected from each enclosure in which vertical profiles of oxygen, pH and sulfide were measured with microelectrodes at the water-sediment interface. Photosynthetic pigments, microphytobenthos taxonomic composition, inorganic nutrients, abundance and taxonomic composition of meiofauna, and total C and N were analysed for every season. Our results show a strong impact of macroalgae in the net metabolism of microbenthos, inorganic nutrient concentration in the interstitial water and abundance of microphytobenthos and meiofauna in the sediment. Parallel in situ incubations with macroalgae (¹⁴C, O₂, inorganic nutrients changes) were performed to analyse the seasonal changes of their contribution to the carbon, oxygen and inorganic nutrient balances. Gross photosynthesis, respiration and inorganic nutrient fluxes were positively correlated with light intensity and temperature.

HALIBUT CPUE SHORT-TERM FORECASTING

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Two univariate forecasting techniques were tested to evaluate the short-term CPUE capacity forecast for Pacific halibut, *Hippoglossus stenolepis* (Pleuronectidae). The Pacific halibut catches data are from the data base of the IPHC (International Pacific Halibut Commission). The data show daily catches during the fishing period (May to September) from 1998 to 2003 in the IPHC regulation area (Bering Sea and Gulf of Alaska).

In spite of the economic importance of this fishery, prediction models for long term biomass or CPUE are scarce, except for some studies such as Quinn (1985), Zhang *et al.* (1991), Tanaka, (2000), Clark *et al.* (2004). Changes in abundance can be forecast if quantitative data are available on the past catch, and if the “assumption of continuity” is accepted: that is to say, if we assume that some features of the past pattern will continue into the future (Makridakis *et al.*, 1983; Stergiou *et al.*, 1997).

The first methodology, based on the Box-Jenkins (1976) approach (seasonal ARIMA models), assumes a linear relationship between the time series data. The second methodology, using Artificial Neural Network models (ANNs), enables highly non-linear processes to be modelled.

The best results from an ARIMA model (ARIMA) with an explained variance level of 32.6% in the validation phase, provide statistically acceptable but insufficiently satisfactory estimations. The best result from the ANN model (3:5s:11) in the external validation phase, with 91% of the variation explained, was significantly better than seasonal ARIMA models, indicating a clear non-linear relationship between variables.

Modelling of the abundance indices is a useful tool for understanding the dynamics of populations and may enable short-term quantitative recommendations for fisheries management to be made. The principal aim is evaluate and compare the ARIMA and ANN models for Pacific halibut CPUE forecasting; for this we analyse the general characteristics of fishing time series and identify the possible sources of error in the models.

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ATMOPHERIC MODES INFLUENCE ON COASTAL UPWELLING IN THE WEST COAST OF THE IBERIAN PENINSULA BY MEANS OF SST SATELLITE DATA (1985 TO 2005).

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Night-time weekly sea surface temperature (SST) was used to analyze the influence of the most representative patterns of atmospheric variation in the Northern Hemisphere on coastal upwelling at the west coast of the Iberian Peninsula (IP) from 1985 to 2005. The annual and seasonal variability of coastal upwelling was also analyzed from 1985 to 2005. The upwelling index (UI) was calculated as the difference between coastal SST (20km) and oceanic SST (500km). The entire west Iberian coast is affected by upwelling with an upwelling season coinciding with summer time (JAS). Stronger values of UI were detected in August and September at latitudes close to 42°N. At latitudes between 37°N and 39°N some persistence in upwelling events was detected during autumn. The main variability of the upwelling index averaged meridionally (UIM) is explained by means of EA atmospheric pattern when any lag in UIM is considered. This may be due to the locations of the action centres of the north-south EA dipoles. EA is observed to be the most prominent atmospheric pattern affecting coastal upwelling with a correlation coefficient of 0.52 during winter (DJFM) and -0.65 during summer-autumn (JASON). In both cases, a significance level of 99% was obtained. When some lag is considered the variability of UIM is explained by more than one atmospheric mode. In fact, the main variability of spring-summer UIM is explained by means of the winter NAO, EA, SCA and AO atmospheric patterns with correlation coefficients of 0.53, -0.42, -0.42 and 0.39 respectively. All these correlations have a significance level greater than 95%. The main variability of autumn-winter UIM is explained by means of the summer-autumn EA, POL and SCA atmospheric patterns with correlation coefficients of -0.57, -0.58 and 0.48, respectively. All these correlations have a significance level greater than 97.5%. The correlation between winter EA and UI is stronger at latitudes between 39°N and 41°N. The correlation between summer-autumn EA and UI is stronger at latitudes between 37°N and 39°N. The correlation coefficients between the winter atmospheric indices: NAO, EA, SCA and AO and the spring-summer UI are practically constant along the west coast of the IP. Only at latitudes close to 43° N the correlation coefficients drop drastically to zero. Finally, the correlation coefficient between the summer-autumn atmospheric indices: EA and POL and the autumn-winter UI are practically constant along the west coast of the IP.

A NESTED MODEL OF WESTERN IBERIA SHELF: VALIDATION AND APPLICATION TO CRAB LARVAE DISPERSAL

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A high resolution (< 2km) nested realistic model of the Western Iberia shelf is presented together with a set of WOCE observations in Spring 1991 which are used to validate the model and to describe the shelf response to a spring upwelling event. The most relevant dynamical features are present in the model. The shelf response to upwelling winds in model results is similar to the one described in the observations. An application to Crab larvae dispersal was developed through a particle submodel that includes advection, diffusion and diel migrations. Major larvae dispersal patterns are reproduced by the lagrangean submodel. The larvae disperse in elongated patches parallel to the coast usually inshore of 100 m isobath.

This distributions are associated with the nature of the local wind-driven circulation, of the coastline orientation, and of the vertical movements of larvae. River plumes are critical factors in the retention patterns as far as they influence near surface stratification, surface

Ekman layer speed and vertical diffusion. A large part of larvae (~70%) are retained in the shelf zone of the emission points. The remaining is preferentially transported northward. Dispersion distances (L_d) of about 60 km were estimated and depend essentially on the meridional component of dispersion.

Some consequences of the results to the local population dynamics are discussed. It is hypothesized that estuaries of the Northwest Iberian coast are communicating populations sharing similar conditions of dispersion (winds, coastline orientation, and river plumes) which change in a significant way to the north and south of that region.

Key words: Western Iberia, Nested modeling, Larvae Dispersal, dispersal distance, Crab larvae, *Carcinus maenas*

METHANE AND NITROUS OXIDE EMISSIONS IN THE GULF OF CÁDIZ

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Dissolved methane and nitrous oxide concentrations were measured in surface nearshore waters of the Gulf of Cádiz (SW of the Iberian Peninsula) during June 2006. The concentrations were determined with a gas chromatograph equipped with a flame ionization detector (FID) for methane, and an electron capture detector (ECD) for nitrous oxide. Net air-sea fluxes were also estimated, using the parameterization of Wanninkhof (1992) to calculate the gas transfer coefficients.

Both gases were found to be supersaturated with respect to the atmosphere, with averaged saturations of $246 \pm 31\%$ and $274 \pm 54\%$ for nitrous oxide and methane, respectively. Nitrous oxide concentrations were homogeneously distributed along the coast, showing a decrease with the distance offshore, its saturation values ranging from 172% to 303%. Methane saturations were in the range of 180-505%, also showing a decrease with distance to coast. Waters closer to the bay of Cadiz showed higher methane concentrations. Averaged air-sea fluxes of nitrous oxide and methane were estimated to be $20.36 \mu\text{mol m}^{-2} \text{d}^{-1}$ and $7.34 \mu\text{mol m}^{-2} \text{d}^{-1}$, respectively. Therefore, coastal waters of the Gulf of Cádiz were found to be a source of atmospheric methane and nitrous oxide during the study period.

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DECOMPOSITION OF MACROALGAE BLOOM ON INTERTIDAL MICROBENTHOS: A MICROCOSM EXPERIMENT

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The decomposition of macroalgal detritus on the sediment surface was studied in a microcosm. Inorganic nutrients (NO_3^- , NO_2^- , NH_4^+ , PO_4^{3-} and SiO_3^{2-}), dissolved organic carbon (DOC) and inorganic carbon (DIC) were measured in the inflowing and outflowing seawater. Vertical microprofiles of O_2 , pH and H_2S at the sediment-water interface, sediment contents of organic matter (OM), inorganic and organic carbon (C_{org}), total nitrogen (N) and inorganic nutrients were measured before and after addition of macroalgal detritus. The changes in the taxonomic composition were studied by optical microscopy and by the analysis of photosynthetic pigments. Macroalgal detritus vanished from the sediment surface in 6 days. Decomposition shifted the microcosm net balance for DOC, DIC and inorganic nutrients to more positive values, suggesting a quick release from macroalgal biomass. Besides being released to the water column, a fraction of macroalgal carbon and nitrogen were incorporated into the sediment since we observed a transient increase in C_{org} and N. Aerobic mineralization of macroalgal detritus reduced O_2 in the microcosm water column and in the sediment, favouring sulfate reducing activity. Microbenthos photosynthetic activity was initially inhibited but recovered from the third day in parallel to the decomposition of macroalgal detritus. Photosynthetic O_2 production by microbenthos largely determined the fraction of macroalgal detritus being aerobically or anaerobically

mineralised. Decomposition of macroalgal detritus favoured cyanobacteria dominance respect to diatoms in the microbenthos.

ENERGY LIMITATION OF OCEANIC BACTERIA REFLECTED IN CONSISTENT PATTERNS IN BACTERIAL GROWTH EFFICIENCY, LEUCINE PROCESSING AND THE CONVERSION FACTOR

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Oceanographers and ocean modelers require estimates of the amount of carbon that heterotrophic bacterial assemblages process. These estimates are commonly obtained from measures of bacterial production based on the incorporation of either leucine or thymidine. The accuracy of these estimates depends on empirical carbon-to-leucine conversion factors (LCF). On the other hand, bacterial respiration, another key aspect of microbial metabolism, is linked to bacterial production through bacterial growth efficiency (BGE), which has been shown to relate to bacterial physiological condition. Here we will first present a review of published and unpublished values of LCF. More than 200 individual measurements in all types of systems that suggests that this parameter varies systematically from coastal to open ocean communities, and that this pattern is similar to that observed for BGE. We also show data collected on a series of cruises in the Pacific and the Atlantic Ocean, and in the mediterranean Blanes Bay Microbial Observatory in which we empirically explored the connections between LCF and BGE and the consequences of their variability. In general terms we found that the LCFs were positively correlated to BGE, and negatively to the proportion of leucine respired and to the ratio leucine-thymidine, suggesting that even though some of the general variability might be methodological, the patterns in bacterial growth, BGE and LCF all reflect the basic physiological response of bacteria to energy limitation.

MAIN BENTHIC ECOSYSTEM FEATURES SURROUNDING THE “LABERINTO” (GULF OF CADIZ, SW IBERIAN PENINSULA): GEOENVIRONMENTAL AND FAUNISTIC COMPOUNDS IN RELATION TO HABITATS

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The case and study presented in this communication is based on the *ecosystem approach* concept applied in a particular area, so called the “Laberinto”. This area was geological extensively surveyed, and most particularly in a small sector named “Ver Mudas Triangle” where three mud volcanoes frame in a triangle shape the fishing ground. Subsea-floor hydrate distribution shows the extensive coverage that methane has in the uppermost sedimentary units along the Triangle.

Several benthic ecosystems occur on active and inactive gas seepages zones existing in the Gulf of Cádiz. Geoenvironmental contexts favour biodiversity and communities supported by chemosynthesis related to methane seeps. Sandy sediments dominate along the littoral and inner shelf becoming finer-grained increasing depth and distance to the shore. Upper slope is strongly dominated by contourite deposits composed by fine and very fine sands, occasionally muddy sands, related to longitudinal transport along the margin forced by strong contour currents (Mediterranean outflow) running parallel to the isobaths down to 400 m. A certain number of pock-marks, mud volcanoes, carbonate crust and chimneys have revealed the intensive of hydrocarbon-rich fluid venting (mainly methane) existence along the South Atlantic Iberian Margin.

Since 1992 a serie of annual cruises have been carried out in order to increase the knowledge on the benthic and demersal biodiversity in the Gulf of Cádiz. The traditional fisheries monitoring in these grounds, targeting Norway lobster, *Nephrops norvegicus*, let us know the megafauna biodiversity of the area. Fauna collected in the six trawling

samplings performed in the Triangle shows the following figures: 41 fish, 31 crustaceans, 15 molluscs and 8 echinoderms. The frequency and abundance of each species is variable depending of the sampling. The fish assemblage is mainly dominated by chondrichthyan with 4 species (*Chimaera monstrosa*, *Etmopterus spinax*, *Galeus melastomus*, *Galeus atlanticus*, *Scyliorhinus canicula*) always present in the sampling. In relation to osteichthyan fish the most frequent species are *Nezumia aequalis*, *Micromesistius poutassou*, *Phycis blennoides*, *Argyroteleus hemigymnus*, *Myctophum punctatum*, although the last four are scarce. Except for the euphasiacean *Meganyctiphanes norvegica*, all the crustaceans collected belong to the order Decapoda, with species of all the suborders, although *Pasiphaea sivado*, *Plesionika martia* y *Solenocera membranacea*, among the Natantia and the Reptantia *Nephrops norvegicus* are the most frequent and abundant. Molluscs species are infrequent and scarce, except for *Galeodea rugosa* which is relatively frequent. Echinoderms are fully scarce but only the sea urchin, *Cidaris cidaris*, is frequent. However is remarkable the presence of *Leptometra* sp. in many samples, due to its significance as indicator of high productivity areas.

ON THE JOINTLY USE OF IN-SITU AND REMOTE SENSING DATA FOR THE TRACKING AND CHARACTERIZATION OF EDDIES IN THE DRAKE PASSAGE

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High resolution XBT sections directed across the Drake Passage, have been used to analyze depth structure and position of eddies relative to the main fronts in the area (the South Antarctic Front (SAF), the Polar Front (PF) and the South Atlantic Circumpolar Current Front (SACCF)). Eddies found at these sections have been then tracked moving eastward using different sources of information. The main objective of this work is to analyze eddies eastward advections in the surrounding area of Drake Passage, analyzing their evolving surface temperature, chlorophyll concentration and sea surface height signatures. To do this, weekly maps of sea surface temperature images, colour images and sea surface height (mean dynamic topography put back in) have been used in the study area. A semi-automatically method has been applied to the XBT sections to record frontal positions. This information was then applied in the sea surface temperature images, colour images and dynamic height data to trace and characterize possible eddies moving eastward along the Drake Passage area. Preliminary results show that the semi-automatically method applied to the XBT data detects the position of the main fronts flowing eastward in the area along the sections. The position of the SAF in the XBT sections acts as a southern boundary on the high chlorophyll waters. Features produced by SAF to south should be warm and anticyclonic, whereas those produced by PF to north should be cold and cyclonic. We present the possibilities that the jointly use of in-situ measurements and data from three different platforms (sea surface temperature images, colour images and maps of sea surface height) may offer to the detection, tracking and characterization of eddies advection moving eastward in the Drake Passage.

THE STRENGTH OF COUPLING BETWEEN PHYTOPLANKTON AND BACTERIOPLANKTON IN COASTAL OLIGOTROPHIC SYSTEMS

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This study analyses the dependence of heterotrophic bacteria on dissolved primary production in two coastal oligotrophic sites of the Northwest Mediterranean Sea. Primary production and bacterial metabolism have been estimated using *in situ* incubations. Picoplankton formed the bulk of phytoplankton (75 ± 6 % SE). The contribution of heterotrophic bacteria to total phytoplankton biomass indicated an inverse relationship with

chlorophyll ($r^2 = 0.70$, $p < 0.001$). The mean values of dissolved ($0.35 \text{ mg C m}^{-3} \text{ h}^{-1}$) and particulate ($0.44 \text{ mg C m}^{-3} \text{ h}^{-1}$) organic carbon production (DOC and POC, respectively) were within the ranges previously reported for oligotrophic regions. On average, bacterial activity estimated by ^3H -leucine incorporation amounted to 22 % ($\pm 7\%$ SE) of total primary production. Bacterial activity (BA) was not correlated with DOC production, however, 66 % of its variance accounted by DOC stock ($p < 0.001$). Heterotrophic bacteria were the main contributor to the bulk community respiration, accounting for 73 % (± 8 SE) of the total respiration. We used empirical leucine-to-carbon conversion factor (mean value $1.16 \text{ Kg C mol Leu}^{-1}$) to estimate the bacterial growth efficiency (BGE). The mean value of BGE (mean value $8 \pm 0.02\%$ SE) was between the values estimated with models given by del Giorgio and Cole (1998; $4 \pm 0.01\%$ SE) and Rivkin and Legendre (2001; $16.4 \pm 0.01\%$ SE). The tendency of DOC production to exceed bacterial carbon demand ($\text{DOC/BCD} > 1$) was statistically significant (ANOVA, $p < 0.01$) at more productive areas. These results suggest coupling between the two planktonic groups at more productive systems. Whereas, bacteria does not depend on phytoplankton DOC release in poor waters but need other sources of carbon for maintenance and growth.

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A FIRST APPROACH AT MACROSCALE LEVEL TO BIODIVERSITY AND DISTRIBUTION OF DEEP MEGABENTHIC COMMUNITIES FROM ATLANTIC MOROCCAN COAST

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Data collected at 288 trawling stations carried out during the Maroc' surveys (2004, 2005 and 2006) on board O/V *Vizconde de Eza*, have allowed to obtain a global overview, at a macroscale level, on distribution and biodiversity of deep benthic communities from the Atlantic coast of Morocco, as well as the location of vulnerable ecosystems to trawl fishing. During the three surveys, the zone shared from the Gibraltar Strait to Cape Blanco (Mauritania) was prospected in order to evaluate the demersal resources between 500 and 2,000 m depth; hauls, of one hour length, were carried out with a commercial Lofoten trawl gear, using the swept-area method and following a stratified random sampling procedure; in each station total invertebrates catch were separated to specific level, counted and weighted (180,155 individuals, 13,4 tons and 500-600 species).

Although the individual values shows large geographical fluctuations, mean numerical abundances and biomass, as well as the total specific richness, seems highest in the south zone, varying significantly the last ones with both, latitude and depth.

As in other deep north Atlantic zones occur (Gage & Tyler, 1991, Levin & Gooday, 2003) sponges and holothurids were the dominant taxa (30%-45% of benthic biomass); both faunistic groups reflects, however, the presence of benthic communities with opposite ecological strategies conditioned by very different environmental factors.

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OXYGEN PRODUCTION AND CARBON FIXATION IN OLIGOTROPHIC COASTAL BAYS AND RELATIONS WITH GROSS AND NET PRIMARY PRODUCTION.

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This study evaluates planktonic primary production and respiration in two coastal oligotrophic sites of the Northwest Mediterranean Sea. Primary production has been quantified using three *in situ* methods (light and dark changes in dissolved O₂, ¹⁸O-labelling and ¹⁴C uptake technique) and we compare rates of ¹⁴C fixation with rates of net and gross primary production and community respiration in the light and dark. Respiration in the light is similar to dark respiration. Gross primary production based on the O₂ light-dark technique is not significantly different from that estimated using the ¹⁸O-labelling technique, indicating that the former technique provides accurate estimates of gross primary production in these environments. A significant fraction (54% ± 4) of the fixed ¹⁴C was released in dissolved form. Total ¹⁴C uptake (including the DOC and POC fractions) during the whole duration of the light period approached gross primary production and consequently overestimated net primary production

HYDROLYTIC ACTIVITY AND PROKARYOTIC PRODUCTION IN DIFFERENT COASTAL AND OCEANIC SEAWATERS: CANTABRIAN SEA, MEDITERRANEAN SEA AND SOUTHERN OCEAN

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In marine systems low molecular weight compounds are not abundant and therefore prokaryotes need hydrolytic activities to obtain substrates for growth. The hydrolysis of large molecules provides utilizable dissolved organic matter, which once taken up and processed with the subsequent growth efficiency will lead to new prokaryotic biomass. Measurements of hydrolytic activity using fluorescent analogous and saturate concentrations indicate enzymatic potential whereas the measurements of production using tritiated leucine and thymidine incorporation are closer to the actual figures. The objective of this study was to analyse how the hydrolytic potential and the production of prokaryotic biomass are related in different marine waters. Coastal waters of the Bay of Biscay (Cantabrian Sea), seawaters offshore Marseille (Mediterranean Sea), seawaters offshore Nice (Mediterranean Sea), and Southern oceanic waters were analysed. In these ecosystems different levels of hydrolytic activity and prokaryotic production were found, which could be explained using basic variables such as seawater temperature and chlorophyll *a* as indicative of organic matter content. However, when comparing seawaters offshore Nice with Southern waters, both hydrolytic activity and production showed similar levels being the behaviour of temperature and chlorophyll *a* just the opposite. A covariation analysis with depth in several stations showed that the hydrolytic activity was exponentially related to the prokaryotic production. Moreover, mathematical equations were different for these two ecosystems and allowed to distinguish the influence of both temperature and chlorophyll *a* levels in the exponential relationship between hydrolysis and production.

SIMULACIÓN DEL INTERCAMBIO BAROCLINO A TRAVÉS DEL ESTRECHO DE GIBRALTAR. INTERCAMBIO MÁXIMO Y SIMULACIÓN DE MAREAS.

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En este trabajo examinamos la dinámica baroclina del Estrecho de Gibraltar mediante un modelo bidimensional en el que se considera un flujo estratificado constituido por dos

capas inmiscibles de aguas someras de densidad constante por capa (ver [1] para más detalles). Por otra parte el modelo considera la abrupta geometría de este estrecho, esencial a la hora de determinar los flujos intercambiados y responsable último de diversos procesos de generación de ondas que en él tienen lugar. El sistema de ecuaciones resultante puede escribirse bajo la forma de un sistema de leyes de conservación con productos no conservativos y términos fuente.

La discretización de las ecuaciones se lleva a cabo mediante técnicas de tipo volúmenes finitos. Este tipo de esquemas, implementados de forma conveniente, son capaces de capturar de forma adecuada soluciones donde se presentan discontinuidades en alguna de las variables (por ejemplo, el salto hidráulico que se produce al oeste de Camarinal). Tampoco necesitan de la inclusión en las ecuaciones del modelo de términos difusivos para conseguir estabilidad, y este tipo de esquemas están bien adaptados para el tratamiento de geometrías irregulares y topografías complejas como es el caso del Estrecho de Gibraltar. También permiten representar frentes seco/mojado que pueden aparecer, por ejemplo, en las simulaciones de marea tanto en la superficie libre como en la interfaz, con aguas mediterráneas que inundan la plataforma continental y que la abandonan con la periodicidad inducida por la marea ([2]).

Los resultados numéricos obtenidos se comparan con diversas observaciones provenientes de campañas oceanográficas en diversos puntos y secciones del dominio. El modelo es extremadamente robusto y representa de forma adecuada la posición de la interfaz, la elevación de la superficie libre y las velocidades promedio en cada una de las capas. Parece por tanto que este modelo numérico puede ser una herramienta muy útil en el estudio y comprensión de la dinámica en el Estrecho de Gibraltar.

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SCALING OF PHYTOPLANKTON PHOTOSYNTHESIS AND CELL SIZE IN THE OCEAN

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The size structure of marine phytoplankton largely determines the efficiency of the biological pump in transporting atmospheric CO₂ towards the deep ocean. Although there is evidence suggesting that plant biomass production scales as the $\frac{3}{4}$ -power of body size, the scaling exponent in the relationship between phytoplankton photosynthesis and cell size has never been determined in natural ecosystems, and the factors that control phytoplankton size structure in the ocean remain unclear. We report that phytoplankton photosynthesis does not follow the $\frac{3}{4}$ -power rule, but scales approximately isometrically with cell size, indicating that a single model cannot predict the metabolism-size relationship in all photosynthetic organisms. The scaling relationship between cellular chlorophyll a content and cell volume is also isometric. We suggest that taxonomical changes along the size spectrum may explain the deviation of phytoplankton photosynthesis from the general allometric rule. We also show that the size scaling exponent is significantly higher in coastal productive waters than in the oligotrophic open ocean. Our results support a purely physiological mechanism to explain the dominance of larger cells and the enhanced potential for carbon export in nutrient-rich environments. The observed size scaling relationships for photosynthesis and abundance imply that carbon fixation per unit volume decreases with cell size in oligotrophic waters, whereas the opposite occurs in productive ones. By controlling the metabolism-size scaling relationship, nutrient supply plays a major role in determining community size structure and the energy flow through the pelagic ecosystem.

RELATIONSHIP BETWEEN BIOMASS, GROWTH RATE, RESPIRATION AND ETS ACTIVITY IN THE BRINE SHRIMP *ARTEMIA SALINA*

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Zooplankton respiratory metabolism and biomass are keys to understanding energy flow, population abundance, community structure, as well as other variables of marine plankton communities. Zooplankton respiratory electron transport activity (ETS) measures potential respiration (Φ) and is a proxy for both respiratory oxygen consumption and biomass. Interpreting ETS measurements is not well understood and requires experimental research into the effects of age, physiological states, temperature, pressure, etc. Here, using controlled cultures of the crustacean *Artemia salina*, we investigate the relationships between biomass (as protein or as carbon), ETS activity, respiration and growth rate and their sensitivity to culture age.

Observed growth rates ($\mu = 0.21 \pm 0.27 \text{ day}^{-1}$) and potential respiration rates ($\Phi = 11.76 \pm 18.49 \mu\text{L O}_2 \text{ h}^{-1} \text{ animal}^{-1}$) were in the range found in the literature for similar experiments. They were unrelated to each other. Specific ETS activity, as metabolism, was regressed against biomass, as protein, in the logarithmic form of Kleiber's allometric equation (Kleiber, 1961). The slope was 0.75 as one would expect for a metabolism proxy, from zooplankton metabolism studies of King and Packard, 1975, and from Whitfield's (2006) recent book. The respiration measurements defined a rate of $R = 0.331 \pm 0.076 \mu\text{L O}_2 \text{ h}^{-1} \text{ animal}^{-1}$, but the measurement range was too limited to define a relationship with either ETS activity or biomass. Investigations of the ratios, R/biomass, Φ /biomass, and R/ Φ showed that all three declined with the culture age. Here we discuss the role food-limitation plays in the decline of these ratios.

METABOLISMO DE LA COMUNIDAD PLANCTÓNICA EN EL OCÉANO ANTÁRTICO

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El objetivo de este trabajo ha sido evaluar el metabolismo de las comunidades planctónicas del Océano Antártico, es decir, cuantificar la producción bruta (GPP), la producción neta (NCP) y la respiración (R) del plancton mediante incubaciones de 24 horas a distintas profundidades de la capa fótica. La importancia de este estudio radica en la necesidad de saber como se comporta el Océano Antártico dentro del balance del carbono global. Un predominio de la respiración (comunidad planctónica heterotrófica) se traduciría en un flujo de CO₂ hacia la atmósfera, que será hacia el océano cuando dominen los procesos autotróficos. Se han realizado estas medidas en 9 estaciones. En cada una de estas estaciones se estudiaron 4 profundidades en la zona fótica, siendo 2 de ellas el máximo de clorofila y superficie (5 m).

Todas las estaciones estudiadas son autotróficas, es decir la producción primaria es mayor que la respiración, lo que se traduce en el flujo de CO₂ desde la atmósfera al océano, es decir el océano actúa como un sumidero de CO₂. El valor medio obtenido en esta campaña de NCP fue de $3.88 \pm 0.82 \text{ mmol O}_2 \text{ m}^{-3} \text{ d}^{-1}$. Las estaciones mas autotróficas fueron la estación 9 en el mar de Weddell (con valores de GPP de $16.75 \mu\text{mol O}_2 \text{ dm}^{-3} \text{ d}^{-1}$ a 26 m), la estación 15 dentro de la isla de Decepción (valores de GPP de $16.36 \mu\text{mol O}_2 \text{ dm}^{-3} \text{ d}^{-1}$ a 5 m), la estación 13 en la isla Rey Jorge (valores de GPP de $8.07 \mu\text{mol O}_2 \text{ dm}^{-3} \text{ d}^{-1}$ a 5 m), la estación 14 en la isla Livingston (valores de GPP de $7.65 \mu\text{mol O}_2 \text{ dm}^{-3} \text{ d}^{-1}$ a 5 m), y la estación 11 en el estrecho Antarctic (valores de GPP de $5.43 \mu\text{mol O}_2 \text{ dm}^{-3} \text{ d}^{-1}$ a 5 m). En el resto de las estaciones los valores máximos de GPP oscilaron entre 2.05 y $3.42 \mu\text{mol O}_2 \text{ dm}^{-3} \text{ d}^{-1}$.

Los valores de metabolismo integrados para la zona fótica (1 % de la irradiancia de superficie) nos indican que hay una baja variabilidad en los datos de R mientras que la variabilidad es alta en los datos de GPP y NCP.

Analizando los factores que determinan el estado metabólico de este ecosistema planctónico se observa que la Chl *a* y GPP son responsables de la variabilidad de NCP. Así mismo se observa una relación positiva entre el metabolismo neto de la comunidad y la concentración de formas reducidas de N.

MOLECULAR AND PIGMENT ANALYSES OF SIZE-FRACTIONATED PHYTOPLANKTON IN THE RÍA OF PONTEVEDRA (NW SPAIN)

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The dynamics and diversity of phytoplankton were assessed in the Ría of Pontevedra (P2 station) from May-December 2004 using pigment analyses, light microscopy and fluorescent *in situ* hybridization coupled with tyramide signal amplification (FISH-TSA). Phytoplankton was dominated by nano-microplankton (>3 µm organisms), which contributed ~85% total Chl *a* (range 55-99%). Most abundant algal categories in this size class were diatoms and unidentified nanoflagellates from microscopic counts. Marker pigments characterized diatoms, cryptophytes and haptophytes as the major pigmentary groups in terms of Chl *a*. Picoplankton (<3 µm) Chl *a* never reached 50% total Chl *a*, and maxima (~250 ng Chl *a* l⁻¹) corresponded with summer downwelling and autumn mixed conditions. Chlorophytes represented an identical proportion (50%) of both picoplankton Chl *a* and cell numbers targeted by FISH-TSA. Most photosynthetic picoeukaryotes were explained by FISH-TSA: ~30% picoeukaryotic cells remained unidentified but these included also the heterotrophic organisms. ~75% of chlorophytes belonged to the prasinophyte genus *Mamiellales* and *Micromonas pusilla* was its main component (~75% of *Mamiellales*, ~25% total picoeukaryotes). By contrast, using marker pigments *Mamiellales* only represented ~11% of chlorophytes. With respect to chromophytes, the prymnesiophyte probe targeted ~25% of the non-chlorophytes cells, other abundant group being the pelagophytes (~12%; screened from May-August). Based on pigment signatures the main chromophytes were diatoms II (chl *c*₃-containing), pelagophytes and prymnesiophytes (20%, 13% and 8% picoplankton Chl *a*, respectively). In conclusion, despite the different estimates for some groups, both HPLC and molecular procedures provided a comprehensive and complementary overview of phytoplankton groups, especially in the case of picoplankton.

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ADVANCES IN MEASURING RESPIRATORY ETS ACTIVITY AS A MEASURE OF POTENTIAL RESPIRATION IN PLANKTON.*T.T. Packard¹, M. Alcaraz¹ y M. Gómez²*¹Instituto de Ciencias del Mar, CSIC, Barcelona.²Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria

Measuring the activity of the respiratory electron transport system (ETS) requires the application of analytical chemistry, biochemistry, enzymology, and physiology. In addition, the interpretation and application of ETS measurements to oceanography and ecology requires knowledge of these two fields plus microbiology, invertebrate zoology and algology. Understanding the reactions involved and their relation to the respiratory process, determining the dependence of ETS activity on biomass, time, temperature, pH, enzyme stabilizers, extinction coefficients, and substrate concentration; and developing reliable biological standards are all critical to good ETS activity measurements. Here we discuss the concept behind ETS measurements and interpretation, explain advances in its measurement, recommend changes in terminology, and propose future experiments.

Specifically, we will demonstrate the following. (1) How a kinetic ETS assay guarantees evidence of reaction-rate linearity with time, cuts reaction time in half, and eliminates the need for turbidity blanks. (2) Why one can eliminate substrate blanks and why it is necessary to measure the Michaelis-Menten V_{max} when measuring ETS activity. (3) The biochemical meaning of the respiration-ETS ratio in seawater. (4) New measurements of the molar specific absorption coefficient for the tetrazoliums, INT and CTC, yielding 17.8 and 22.9 absorbance units (mM formazan)⁻¹ (1 cm cuvette)⁻¹, respectively. Finally we propose using baker's yeast (*Saccharomyces cerevisiae*), with an ETS activity (20°C) of $25.1 \pm 5.1 \mu\text{mol e}^- \text{min}^{-1} (\text{mg dry weight})^{-1}$ as a biological standard.

f*CO₂ IN THE EQUATORIAL AND NORTH SUBTROPICAL ATLANTICPadín, X. A., Vázquez-Rodríguez, M., Ríos, A. F. and Pérez, F. F.*

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The FICARAM project aims to evaluate the air-sea CO₂ fluxes along meridional transects in the Atlantic Ocean. Underway measurements of seawater CO₂ fugacity (*f*CO₂), sea surface temperature and salinity were performed during 9 cruises spanning from 2000 through 2006. The transects were divided into 4 zones according to the spatial *f*CO₂ distribution and mean physical structures, namely: Subtropical Gyre (SG; from 35°N to 17°N), North Equatorial Current (NEC; from 17°N to 5°N), Equatorial Region (ER; from 5°N to 5°S) and Brazil Current (BC; 5°S to 10°S). In order to normalize the *f*CO₂ observations, the measurements were recalculated to a common constant temperature (25°C), and the interannual increase of atmospheric CO₂ was also corrected. Empirical algorithms of normalized CO₂ were estimated for every region by cubic regression fits using SST, SSS and geographical position. Subsequently the estimations of normalized *f*CO₂ for each observation were converted to in situ temperature and the respective atmosphere conditions. A high percentage of the *f*CO₂ variability was explained with these expressions. The RMS errors are 8, 12, 5 and 12 μatm for SG, NEC, ER and BC, respectively. The predicted *f*CO₂ distribution along FICARAM V yielded a slightly overestimation of $2 \pm 8 \mu\text{atm}$. The air-sea CO₂ flux differences associated with the use of the estimated empirical algorithms were also studied. Discrepancies of -0.2 ± 0.2 , 0.3 ± 0.2 , 0.1 ± 0.2 and $-0.1 \pm 0.1 \text{ mol} \cdot \text{m}^{-2} \cdot \text{yr}^{-1}$ were found for the SG, NEC, ER and BC, respectively. The seasonal variability and the source/sink behaviour of the region are adequately predicted for any of the considered regions.

RESEARCH GROUP ON MARINE BIOGEOCHEMISTRY AND GLOBAL CHANGE: SOME HIGHLIGHTS AND FUTURE PROSPECTS

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Marine biogeochemistry, the science which studies the cycling of elements in the sea and their transformation by biological, chemical, and physical processes, is becoming a major focus of scientific research, in particular for its close relationship with global change. In 2005, a research group on marine biogeochemistry and global change was constituted at the ICM-CSIC to study the biogeochemical interactions between ocean and atmosphere and to assess their importance in controlling climate and global change. Since then, several key topics have been addressed, leading to exciting findings, some of which we will review in this presentation. We have focused, for instance, on the progressive acidification of the oceans, and have been able to produce the first reconstruction of marine pH since preindustrial times by means of the isotopic composition of boron in a massive *Porites* coral from the Coral Sea (Pelejero et al., 2005). We have also advanced significantly in the understanding of the dynamics of the emission of climate-active, volatile sulphur from the global ocean (Vallina and Simó, 2007; Vila-Costa et al., 2006). Finally, we have been studying the role of benthic communities in biogeochemical nutrient cycles (Jiménez and Ribes 2007). Regarding future prospects, we are now focusing on the effect of environmental changes on benthos dynamics and also studying the imprint of these changes on their isotopic composition (Ribes et al in Session 5 and Calvo and Pelejero in Session 7), and are developing and coupling atmospheric and oceanic models to further constrain ocean-atmosphere exchange fluxes of key compounds (Simó and Vallina in Session 7).

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SPATIAL AND TEMPORAL DISTRIBUTION OF TEP IN RELATION TO CO₂ CONCENTRATION AND PHYTOPLANKTON BIOMASS IN THE CONTINENTAL SHELF OF THE GULF OF CADIZ (SW SPAIN)

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The export of organic carbon to the deep ocean is mediated by sinking of large particles, such as marine snow, the formation of which is enhanced in the presence of transparent exopolymer particles (TEP). TEP form from dissolved and colloidal polysaccharides by aggregation processes, particularly when phytoplankton experience nutrient limitation in the pelagic ecosystem. Since CO₂ concentration influences carbon assimilation rates and growth, polysaccharide exudation and aggregation into TEP is expected to be related to the CO₂ levels in the water column. Therefore, in order to investigate the relationships between the availability of CO₂ and the generation of TEP in the pelagic environment, the spatial and temporal distribution of both variables have been measured over the period of one year comprised from September 2005 to August 2006 in the continental shelf of the Gulf of Cadiz. Previous studies performed in the area have shown that TEP play indeed a relevant role in the export of matter from the euphotic zone to deeper waters, with high TEP accumulation being observed during the development of a spring phytoplankton bloom, providing an enhanced sink for carbon (Huertas et al 2005; Prieto et al 2006). This works

presents an extensive analysis of the generation of TEP in this productive coastal shelf in relation to CO₂ and phytoplankton biomass that was determined through chlorophyll concentration estimated by ocean colour satellite images. Results indicate that the annual cycle of TEP production seems to be mainly regulated by the phytoplankton succession and the associated fluctuations of CO₂ concentration.

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THE BELLINGSHAUSEN SEA EPIBENTHOS: A DESERT IN THE HIGH ANTARCTIC?

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In contrast to the Weddell and Ross seas, where a lot of surveys have been carried out, the marine benthic fauna of the third large Antarctic sea, the Bellingshausen sea, have remained virtually unknown until nowadays.

Thanks to two Spanish research programmes named ‘Bentart-2003’ and ‘Bentart-2006’, it has been finally observed that the epibenthos along the Bellingshausen sea is scarce and its composition different to those of other High Antarctic marine areas.

Only 64 kg wet weight and 14,500 individuals per station of benthic invertebrates were collected on the Bellingshausen sea and also on the seafloor around Peter I island by using 34 Agassiz trawls at depths between 86 and 3,310 m. The results showed low biomasses around 5–6 kg by station.

Vagile megabenthos, mainly demersal fishes (35,1%), asteroids (27,2%) and holothuroids (10,3%), dominate the biomass, while the sea urchin *Sterechinus* spp. (21%) and other in crustant bryozoans, *Aspericreta crassatina* and *Exochella hymanae* (40%) (López-Fé, 2005), are numerically dominant.

Nevertheless, the macrobenthos seems constituted by more than 600 species and Shannon (1,48–3,88) and Pielou (>0,5) indexes are quite high, indicating an equitable abundances distribution.

The environmental conditions in the West Antarctic sea, are characterized by soft bottoms, high sedimentation rates and low primary production (excepting in coastal zones <100 m, Sáiz-Salinas *et al.*, 1997; Arnaud *et al.*, 1998). This benthic situation is different to those reported from the Weddell and Ross seas, where dense tridimensional communities of long-lived filter-feeders have been described.

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PRODUCCIÓN NUEVA EN EL SECTOR NO DEL MAR DE ALBORÁN

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Se acepta habitualmente que la elevada concentración de clorofila-a encontrada en el sector NO del Mar de Alborán está soportada por la inyección de nitrato en la capa eufótica. Este aporte de nutrientes está causado por el afloramiento de aguas mediterráneas, más ricas en nutrientes que las aguas atlánticas superficiales que penetran por el Estrecho de Gibraltar. Con el fin de contrastar esta hipótesis, se realizaron estimaciones de producción nueva (en

términos de f-ratio) durante un ciclo estacional. La f-ratio fue muy variable, oscilando entre 0.02 y 0.61. En verano, otoño y primavera, los menores valores de la f-ratio fueron encontrados en superficie, aumentando éstos a la profundidad del máximo de fluorescencia. En otoño e invierno, aproximadamente el 80% de la variabilidad espacial de la f-ratio fue explicada por los cambios de la salinidad en superficie. En verano, la correlación entre la concentración de nitrato en la capa eufótica y f-ratio fue también estadísticamente significativa. En primavera, la f-ratio varió independientemente de la concentración de nitrato, siendo los valores de f-ratio muy bajos (< 0.3) incluso en estaciones en las que la concentración de nitrato fue relativamente alta ($> 4 \mu\text{M}$). Los resultados obtenidos indican que, durante gran parte del ciclo estacional, hubo un fuerte acoplamiento entre el flujo vertical de nitrato y la producción nueva en la capa eufótica. No obstante, en primavera las formas reducidas de nitrógeno fueron preferentemente utilizadas por el fitoplancton.

THE COASTAL ZONE OF THE GULF OF CÁDIZ: SINK OR SOURCE OF CO_2 ?

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The variations of the partial pressure of CO_2 ($p\text{CO}_2$) in surface seawaters of the Gulf of Cadiz (southwestern Spain) were examined and air-sea CO_2 fluxes also were calculated during two seasons: summer and autumn. The studied area covers down to 15 nautical miles and could be divided in two zones: Bay of Cadiz, where the main input is anthropogenic carbon and Estuary of Guadalquivir, where continental inputs are predominant.

Data were obtained from 17th to 29th June and 19th to 30th November 2006 on board R/V *Mytilus* (CSIC, Vigo). Underway partial pressure of CO_2 was measured using an autonomous home-made equipment, following the design of Kortzinger et al. (1996). The equipment was calibrated at the beginning and at the end of each day using two gas standards of CO_2 . The carbon flux between the atmosphere and the ocean was calculated using the k-wind parameterization given by Wanninkhof, 1992 and Ho et al., 2006. The wind speed was obtained from the meteorological station on board.

The highest values of $p\text{CO}_2$ have been observed in the Estuary of Guadalquivir and they are up to 1000 μatm in summer and in autumn. In contrast, in the Bay of Cadiz values were roughly 500 μatm in summer and even lower in autumn. $p\text{CO}_2$ decreases while distance to the coast increases. The equilibrium atmospheric value is reached in the Bay of Cadiz closer to the coast than in Estuary of Guadalquivir. Calculations of average CO_2 fluxes indicated that the sampled coastal sector of the Gulf of Cadiz behaved as a net source for atmospheric CO_2 during the period studied.

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FLUORESCENT DISSOLVED ORGANIC MATTER (FDOM) DURING A DOWNWELLING PERIOD IN THE RIA DE VIGO USING EXCITATION-EMISION MATRIX SPECTROSCOPY.

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Two types of dissolved organic matter fluorophores (FDOM) have been observed in seawater, humic-like and protein-like, which may serve as tracers of major dissolved

organic carbon (DOC) pools in the ocean. Terrestrial and marine humic substances contribute to the humic-like fluorescence. The former have been used as indicators of total organic carbon to study river mixing processes in coastal waters and estuaries, and also as a water mass tracer. Marine humic substances provide information about photochemical and microbial degradation processes in the surface ocean. The protein like fluorescence is related to the presence of aromatic amino acids in the medium and, therefore, it can be used to trace the synthesis and early degradation of biogenic labile DOM. A useful tool to study these fluorescent substances are the excitation-emission matrices (EEMs) that give a detailed description of the position and intensity of the fluorophores in each sample. We have used this tool to study the FDOM distribution in Ria de Vigo during a downwelling period in September, when the ría is progressively occupied by warm and salty shelf surface water. We collected full-depth profiles over the whole ría during two days and in three different transects for others three days to examine the effect of the tides. This study provides new information about the origin and fate of FDOM in the Ria de Vigo, which will be discussed in relation to other relevant environmental variables.

ATMOSPHERIC DRY DEPOSITION IN COASTAL WATERS: A NEGLECTED KEY INPUT?

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Nutrient availability is a major constraint for phytoplankton growth and dynamics in the NW Mediterranean. The poorly understood nutrient concentration dynamics in coastal waters raises the question whether atmospheric inputs may be more important than often presumed. Despite wet deposition being the main source of atmospheric nutrient supply in the NW Mediterranean Sea, dry fluxes may also play a key role in several marine locations. Barcelona is a densely populated area with multiple anthropogenic emissions, particularly severe for N and P species (e.g. NO_x from industrial combustion and vehicle traffic, HNO₃ from vehicle traffic, P compounds from incinerators and domestic and industrial substances). A series of experiments were conducted to assess the short-term impact of atmospheric dry deposition on the concentration of nutrients in Barcelona's inshore waters. Acid-washed polyethylene tubes, containing 20 to 25ml of seawater, were exposed to the open air for 24 h. The results show a high temporal variability with mean dry fluxes of about 40-60 μmol NO₃ m⁻² d⁻¹. Consequently, estimated daily median increases in dissolved available inorganic nitrogen in the water column were 1-10%.

The estimated atmospheric nutrient inputs could not fully explain nutrient concentration increases observed in Barcelona's coastal waters, and further experiments may be carried out to determine long-term values for dry deposition. This may help clarify the dynamics of nutrients whenever increases in concentration are not matched by either changes in the water masses or freshwater inflows.

DISSOLVED COPPER SPECIATION BETWEEN THE MARINE AND FRESHWATER ENDMEMBERS IN THE VIGO RIA (NW SPAIN)

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This study investigates the dissolved speciation of copper during the winter estuarine mixing in a major coastal system which is the Vigo Ria. Riverine end member dissolved copper concentrations were around 4 nM (Oitavén River). This concentrations increased towards the saline end member (Rande Strait), reaching a concentration of 15 nM. A conservative pattern was observed. Copper speciation in the dissolved phase was mainly controlled by two types of ligands:

L₁: log K'₁ ranged from 12.9 to 13.9

L₂: log K'₂ ranged from 10.8 to 12.1

In all samples the concentration of L₁ (C_{L1} varied between 11 and 34 nM) was greater than that of copper, causing copper speciation to be dominated by this strong organic ligand. If

copper concentration increases, L_2 (C_{L2} varied between 10 and 96 nM) would play an important role complexing the excess of copper. Both types of ligands showed a decrease in their concentrations towards the marine end member.

Acknowledgements. Juan Santos-Echeandía thanks to the Basque Government for the predoctoral fellowship. This work is a contribution to the Spanish LOICZ program and it was funded by the CICYT research project “Balance biogeoquímico y modelado de los flujos de metales en una ría gallega (METRIA)”, ref. REN2003-04106-C03.

THE ROLE OF CYSTS IN HARMFUL ALGAL BLOOMS. A MODELLING STUDY

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This contribution presents the application of modelling approaches at two different time scales, to explore the effects of the size of the cyst inoculum and of some life-cycle parameters on the resulting number of new cysts and the evolution of a microalgal bloom population. We used a stage-classified matrix model to analyse the short-term evolution of a microalgal population comprising four different stages: vegetative cells, gametes, planozygotes and cysts. A new module representing the cyst stage of a flagellate population was implemented in a multi-species model (ERSEM) in order to investigate the seasonal evolution of an ecosystem under some selected scenarios typical of a Mediterranean harbour (Arenys de Mar). This study shows how important aspects of algal bloom evolution are affected by the initial cyst inoculum and by population parameters related to different life-cycle stages.

DYNAMICS AND CHARACTERIZATION OF DISSOLVED AND CHROMOPHORIC ORGANIC MATTER ON THE CATALAN COAST

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Dissolved organic matter (DOM) is a key component of oceanic carbon fluxes. Besides, in coastal ecosystems DOM provides a source of nutrients and energy. Moreover, the chromophoric (or colored) DOM (CDOM) can influence the aquatic light field and the penetration depth of radiation potentially harmful to organisms. In this study we report on the absorption spectra, the fluorescence excitation and emission spectra and the concentrations of dissolved organic carbon, nitrogen and phosphorus (DOC, DON and DOP, respectively) in filtered samples taken from the Catalan coast in 2006. Samples were taken monthly at a fixed station and seasonally, through a vertical land-offshore section of the coast of Blanes (Girona) and at different stations all over the Catalan coast. In addition, DOM decomposition experiments were performed to study changes in optical properties and elemental composition due to microbial alteration.

The absorption coefficients ranged from 0.01 m^{-1} to 0.36 m^{-1} , and were modelled with an exponentially decreasing function. The spectral dependence of the CDOM absorption coefficients yields a slope from 0.004 to 0.02 nm^{-1} . The fluorescence of marine and terrestrial dissolved humics was of 0.1 - 6.6 ppb equivalent quinine sulphate (ppb eq Q) and 0.4 - 5.8 ppb eq Q, respectively, while that of dissolved aromatic amino acids was 0.1 - 16 ppb equivalent tryptophan. DOC, DON and DOP concentrations were 60 - $200 \text{ }\mu\text{M}$, 5 - $9 \text{ }\mu\text{M}$ and 0.03 - $0.07 \text{ }\mu\text{M}$, respectively. These data are discussed in relation to the factors controlling the temporal and spatial variability of DOM and CDOM.

ESTIMATING COPEPOD NAUPLII GROWTH WITH BIOCHEMICAL TOOLS

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Marine copepod nauplii are the most abundant multicellular organisms in the planet. They are important in the marine food web as a major food source for larvae and juveniles of commercially important fish. However, field studies are mainly focused on copepodites and adults. Due to their small size, little is known about nauplii ecology and metabolism. We present two biochemical methods, already in use for adults, adapted as indexes of *in situ* nauplii growth: i) the aminoacyl-tRNA synthetases (AARS) activity (Yebra & Hernández-León, 2004) and ii) the RNA/DNA ratio (Berdalet *et al.*, 2005). Once calibrated, these methods will be applied to our ongoing research, which focuses on the differential response of nauplii to physiological stress induced by temperature and contaminants (eutrophication and hydrocarbons). On the long term, we aim to simplify the study of copepod nauplii ecology, and to improve zooplankton description at oceanic scale, optimising cruises and costs.

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FINE SCALE ZOOPLANKTON DISTRIBUTION IN THE BAY OF BISCAY IN SPRING

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AZTI, Pasaia, Gipuzcoa

A fine scale spatial resolution survey (3•15 nautical miles) was conducted on May 2004 in the Bay of Biscay (43.32° N to 46.12° N and 1.29° W to 4.31° W), to study the zooplankton community during the onset of spring stratification. Cluster analysis classified the 45 most abundant species into 7 major groups. In the southern part of the surveyed area a front separating neritic waters from eddies off the shelf delimited distinct zooplankton communities. On the northern side of the surveyed area river plumes and the generation of internal waves over the shelf-break were the main mesoscale structures determining the composition and abundance of the zooplankton assemblages. Canonical Correspondence Analysis (CCA) and Generalized Additive Models (GAMs) were used to investigate the relationship between zooplankton species distribution and selected environmental variables (sea surface temperature and salinity along with water column stratification and fluorescence pattern). The high spatial and taxonomic resolution enabled to successfully relate zooplankton communities to environment.

EFFECTS OF TURBULENCE ON CLEARANCE AND INGESTION RATES OF METAZOAN MICROZOOPLANKTON FEEDING ON A NATURAL MICROPLANKTONIC COMMUNITY.

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The changes induced by small-scale turbulence on the grazing rates of metazoan microzooplankton on the different components of a natural microplankton community were studied by laboratory experiments.

Eight, 15 L Perspex cylindrical microcosms containing coastal water were incubated during three days under controlled temperature, light and turbulence conditions. In four of the microcosms the metazoans had been excluded by reverse-flow filtration through 50 µm mesh (m- microcosms). In the remaining four microcosms the “in situ” community of metazoan microzooplankton 50-150 µm size organisms) had been concentrated three times, also by reverse-flow filtration (M- microcosms). Four microcosms, two duplicates from each trophic manipulation, were maintained in still conditions (S- microcosms), whereas the remaining four microcosms were subjected to the turbulence generated by vertically oscillating grids ($\epsilon = 0.055 \text{ cm}^2 \text{ s}^{-3}$, T- microcosms).

The grazing rates were estimated by comparing the changes occurred along the incubation in the microplankton community of SM, Sm, TM and Tm microcosms.

Turbulence enhanced clearance and ingestion rates of metazoan microzooplankton. This community, dominated by meroplanktonic invertebrate larvae, exerted a strong trophic impact on ciliates, flagellates and especially on dinoflagellates. Similarly, the microcosms under turbulence illustrate clear examples of trophic cascade effects.

PROKARYOTIC BIOMASS AND PRODUCTION IN THE EASTERN NORTH ATLANTIC: AN OBJECTIVE SEPARATION OF PHYSICAL AND BIOLOGICAL COMPONENTS

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Within the framework of the TRANSAT project, several studies have been recently published on the role of prokaryotes in relation to the distribution of major deep-water masses in the North Atlantic. Here, we revisit the TRANSAT-1 cruise data, collected in the Eastern North Atlantic by applying an optimum multiparameter (OMP) approach to objectively solve the mixing problem of water masses. The OMP analysis is commonly used to separate the distribution of any non-conservative chemical compound into its variability due to water mass mixing and that associated with biogeochemical activity. In this work, we apply the OMP analysis for the first time to bacterial biomass and production. Water mass mixing explains 83% of the variability of total bacterial biomass, 75% of the high DNA bacterial abundance and 58% of the bacterial production. The OMP analysis reveals that the proportion of high DNA-content bacteria is significantly lower in the physical (52±4%) than in the biological component (62±1%). Furthermore, this proportion increases from the central (57±2%), to the intermediate (62±3%) and deep-water (74±2%) masses. The specific bacterial production is also higher in the biological (0.034±0.002 fmol C d⁻¹ cell⁻¹) than in the physical component (0.017±0.003 fmol C d⁻¹ cell⁻¹) suggesting that bacterial activity is enhanced during water masses mixing. The OMP analysis discriminates the bacterial biomass and activity due to physical and biological processes within the water masses that contribute to the oxygen minimum zone in the transition from the central to the intermediate waters of the Eastern North Atlantic (Eastern North Atlantic Central Water, Subpolar Mode Water, Subarctic Intermediate Water and Mediterranean Water).

DISTRIBUCION DE CLOROFILA Y PICOPLANCTON EN EL GOLFO DE CADIZ

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Se han realizado dos campañas oceanográficas (BIO Mytilus) en la zona más costera del Golfo de Cádiz (15 millas de costa) correspondientes a situaciones típicas de verano y otoño de 2006. Su objetivo es verificar la importancia de los aportes costeros, tanto de la bahía de Cádiz como del estuario del Guadalquivir, sobre la distribución de fitoplancton en la zona. Para ello se han fijado un total de 63 estaciones y se han tomado muestras, a diferentes profundidades, destinadas al análisis de la cantidad de clorofila total y de la distribución de nano/picoplancton mediante citometría de flujo. La roseta de toma de muestras, provista de CTD, suministra información complementaria de salinidad, temperatura, oxígeno y fluorescencia.

En la campaña realizada en verano se han encontrado un amplio intervalo de la concentración de clorofila-a (0,006 - 2,594 µg/L), donde los valores máximos se sitúan en las proximidades de la desembocadura del Guadalquivir. En la misma zona se aprecian también la mayor densidad de poblaciones obtenidas por citometría de flujo (33874 cel/mL), poniendo de manifiesto la importancia de los aportes continentales de nutrientes sobre la dinámica del plancton en esta zona.

En la campaña realizada durante el otoño, las concentraciones de clorofila y densidades de nano/picoplancton son, en términos generales, más bajas. También se observan los valores máximos en la zona de influencia del estuario del Guadalquivir, pero en este caso, existen diferencias espaciales importantes entre las zonas de máxima clorofila y de máxima densidad de nano/picoplancton.

VARIABILITY OF MESOZOOPLANKTON AND ICHTHYOPLANKTON IN “EL HIERRO” ISLAND, CANARY ISLANDS.

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Temporal and spatial variation in mesozooplankton biomass and ichthyoplankton and egg abundance was studied on three neritic stations in a marine reserve leeward of El Hierro Island (Canary Islands). Monthly oblique bongo hauls were carried out during spring and autumn 2006 in a station inside the integral reserve and two others on its border. Surface temperature fluctuated from 20.0°C in April to 24.5°C in October showing a well marked thermocline from June to October. Average dry weight obtained for mesozooplankton biomass ($7.8 \text{ mg}\cdot\text{m}^{-3} \pm 4.2 \text{ SD}$) was a normal value for the Canary Islands waters. Average fish egg abundances ($1307.8 \text{ eggs}\cdot 10\text{m}^{-2} \pm 1648.6 \text{ SD}$) was higher than those observed before around the islands. However, the average fish larvae abundance ($348.3 \text{ ind}\cdot 10\text{m}^{-2} \pm 333.8 \text{ SD}$) matched other estimates in the Canary Current. No significant differences were observed between stations for eggs abundance. The lowest values for total fish larvae densities were observed in the station located over the protected area, while the largest values appeared in windshear area of the island as observed for mesozooplankton in the other islands of the archipelago.

Key words: fish larvae, mesozooplankton, marine reserves, Canary Islands.

15-YEARS OF SAMPLING IN THE BAY OF BISCAY: WHAT ARE OCEANOGRAPHIC TIME SERIES TELLING US?

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The project “Studies on time series of oceanographic data” (Radiales) was established as a pilot project by the Instituto Español de Oceanografía (IEO- MEC) in 1991. After more than 15-years, the project has grown to encompass a network of 20 sampling stations in 5 different transects at the N and NW coast of Spain: Vigo, Coruña, Cudillero, Gijón and Santander beginning in 1987, 1988, 1993, 2001, 1991, respectively. At each location a coastal-ocean gradient is sampled monthly for physical, biological and chemical measurements. The project has substantially contributed to get a deeper knowledge on the variability of plankton communities and its biodiversity and to calculate baselines, climatologies and reference levels for the north coast of Spain. These data have been used to set with statistical significance the range of variability of several environmental and biological variables and to determine the rates and trends of warming due to climate change and its consequences on planktonic communities. Here we summarize the main results deriving from this sampling programme at different levels of knowledge: taxonomy, seasonal variability and trends, in the marine environment in the north coast of Spain. Despite the difficulties in maintaining oceanographic time series programmes, the Radiales project has been a successful Spanish initiative. It represents a significant contribution to the understanding of an important regional marine environment and an essential tool for a responsible management of natural resources.

MICRO AND MESOZOOPLANKTON AS INDICATORS OF THE BALEARIC FRONTAL SYSTEM: SPRING, 2005

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During early spring 2005, the spatial distribution of zooplankton (collected by 53 and 200 μm meshes) was studied and correlated with an intense frontal system, which appeared in the northern area of the Balearic islands. The Balearic Front (BF) was characterized and analyzed its implications in the zooplanktonic communities by the EFLUBIO 0305 survey (REN 2002-10718E/MAR), carried out during 25 days from 1.5 °E; 6.0°E to 38°N; 42°N. The hydrography conditions registered a particular cool winter and a pronounced thermohaline front separating the recent Atlantic Water from cooler Mediterranean Water (> 38 PSU), just in the northern part of the Mallorca and Menorca islands. Nutrient salts and chlorophyll “in situ” data revealed a higher concentrations in the front northern side and a coupling among them and the hydrological features in the upper water (0-100m) of the Balearic sea. In advance, zooplankton spatial distribution exhibited clear differences according to the water masses found. Gelatinous, siphonophores, chaetognaths and several copepod species described the boundary effect acting on the larger organisms, highlighting the role of the microzooplankton fraction as main indicators of the frontal system impact on the Western Mediterranean pelagic ecosystem.

EXPLORING PHYSICAL-BIOLOGICAL COUPLING IN THE STRAIT OF GIBRALTAR AT SEVERAL SCALES.

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The Strait of Gibraltar has attracted the attention of physical oceanographers for half a century due to the water exchange between the Atlantic Ocean and the Mediterranean Sea, and it has been a fertile framework to promote the knowledge of processes relevant to the hydrodynamic of straits. Nevertheless, the investigation of coupling between the observed hydrodynamic and biological processes, trying to explain the organisms' distribution and patterns is more recent.

We present a synthesis of results both from hydrodynamics and biological points of view, including integration and coupling efforts, derived from the collaboration of our physics and biological oceanography teams with recent reviews in Macías (2006) and Vázquez (2006). These results include observations, interpretations and model proposal at several scales, presenting the state of the art of investigation on undulatory, mixing circulation and exchange processes together with some implications on biogeochemistry and pelagic life.

These processes involve several scales including (a) the observation, interpretation and modelling of the wave generation process itself on Camarinal Sill in a tidal cycle scale; (b) observation and modelling in a 1D perspective of wave propagation and seston pulsating fluxes towards the Mediterranean sector through the main channel of the Strait; (c) description of mesoscale structures and fortnightly variations in a larger scale on the NW Alborán sector, examining the role of both tidal amplitude and wind driven episodes and, finally (d) the analysis of larger scale variability (seasonal and interannual) by means of remote sensing imagery and theoretical approaches to explore the relationship with climatic indexes as NAO.

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EFECTO DEL REGIMEN DE VIENTOS COSTEROS SOBRE EL CRECIMIENTO Y LA COMPOSICIÓN BIOQUÍMICA LARVARIA EN LA SARDINA DEL MAR DE ALBORAN

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Se analiza el crecimiento diario y la composición bioquímica de series larvianas de sardina (*Sardina pilchardus*) muestreadas entre los años 1995-2003 en el período invernal y primaveral con el régimen de vientos que inciden en su zona de alevinaje de la Bahía de Málaga (sector NO Mar de Alborán). En el área de estudio, los procesos de afloramiento están inducidos por vientos de componente nor-oeste, siendo estos los de mayor frecuencia en la zona.

En relación con el crecimiento somático, se observa una relación lineal positiva del crecimiento somático expresado en la talla y peso larvario de cada población con el régimen de vientos que ocurren a lo largo del período de vida larvaria, expresado por el índice de estrés, y en particular con una ventana óptima, definida por los valores entre ≥ 5 y ≤ 30 m^2/seg^2 . Asimismo, la misma relación se observa con el índice de afloramientos, y particularmente en una ventana óptima de afloramientos expresada en el porcentaje de días con intensidades ≤ 20 m^2/seg^2 . La variabilidad del crecimiento somático se refleja en el crecimiento de los otolitos, en el que se establece una relación lineal positiva de la tasa de crecimiento del otolito con el número total de días de afloramiento que se observaron durante el período de vida larvaria.

La condición nutricional de las poblaciones larvianas expresada por el contenido de RNA y el índice RNA/DNA mostraron una significativa y positiva relación con el porcentaje de días con un régimen de viento favorable a los procesos de afloramiento y con una intensidad igual o menor de 20 m^2/seg^2 .

SEA SURFACE AND CHLOROPHYLL VARIABILITY MEASURED BY REMOTED SENSORS IN ALBORAN SEA (SOUTHWESTERN MEDITERRANEAN SEA)

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From March 1993 to December 2005, a total of 145 monthly mean sea surface temperature (SST) (<http://wdc.dlr.de/>) satellite data have been analysed, as well as 100 monthly mean chlorophyll concentration derived from satellite measures (SeaWifs, <http://oceancolor.gsfc.nasa.gov/>) from September 1997 to December 2005, to examine the spatial and temporal variability patterns in the Alborán Sea. An Empirical Orthogonal Function (EOF) (Preisendorfer, 1988) analysis has been performed for both kind of images, using the residual ones, obtained subtracting to each monthly image its climatological image (the monthly mean one).

The first SST (fig. 1) autovector is positive for all the study region, and its mode amplitude is decreasing, indicating a diminishing surface temperature for the 1993-2005 period. On the other hand, the second SST autovector presents changes in its sign, while the mode amplitude trend is positive, revealing a heating in the surface waters to the north of the Atlantic Jet (AJ), and a negative trend for the waters south the AJ, where the Atlantic waters are accumulated.

In the case of surface chlorophyll concentration (SCC) the negative second mode evolution, represents a SCC diminution to the north of the front, coinciding with the heating in these waters, which could be linked to a decreasing upwelling intensity.

There are two different temporal patterns in this region. The first one, a decreasing sea surface temperature in all the region, as a general rule for the basin, and a superimposed pattern, related to the inflow of Atlantic Waters through the Strait of Gibraltar, where a cooling for Atlantic waters is detected, as well as an increasing SST trend for Mediterranean waters.

The SST trend determined for is $-0.0626^\circ\text{C}/\text{year}$ (first autovector) and $-0.0195^\circ\text{C}/\text{year}$ (Atlantic water) and $-0.02^\circ\text{C}/\text{year}$ (Mediterranean water).

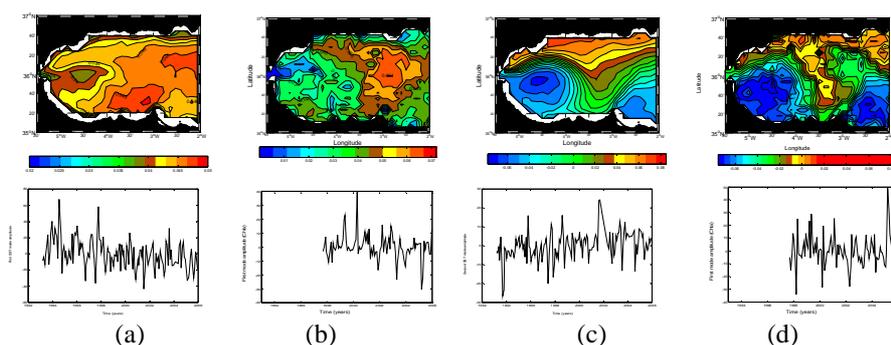


Fig.1. First autovector, and first mode amplitude for SST (a) and chlorophyll (b). Second autovector, and second mode amplitude for SST (c) and chlorophyll (d)

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POLYCHLORINATED BIPHENYLS AND HEAVY METALS IN WILD MUSSEL (*MYTILUS GALLOPROVINCIALIS*) FROM N-NW OF SPAIN. PERIOD 2000-2005

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Concentrations of polychlorinated biphenyls (PCBs) and heavy metals were determined in wild mussel from four areas of the N-NW Spanish coast: Bilbao, Santander, A Coruña and Arosa. These contaminants pose an important environmental pollution problem, and their control is mandatory in the marine pollution surveillance studies.

Temporal trend information of contaminant concentrations is crucial for understanding the effect and spreading of emissions to the environment, and to evaluate the effectiveness of regulations on the production and use of chemicals of concern. Besides, they can also help the authorities to make decisions to prevent or remove the existing pollution in a specific area.

PCBs were determined by gas chromatography with electron capture detector and heavy metals by atomic absorption spectrophotometry. In order to validate the analytical procedure, certified reference materials were used, as well as participation in international intercomparison exercises, on a regular basis.

Comparing the sampling sites, the highest concentrations of PCBs correspond to Santander and Bilbao, with values that ranged between 18 and 38 $\mu\text{g}/\text{kg}$ w.w. and the lower values to Arosa ranged 1.7-2.9 $\mu\text{g}/\text{kg}$ w.w. Also in heavy metals Bilbao showed high levels and Arosa had lower concentrations. Concentrations in all these areas were: Cd ranged 0.426 and 1.50 mg/kg d.w.; Hg varied from 0.067 and 0.272 mg/kg d.w. and Pb concentrations varied largely from 0.742 and 7.40 mg/kg d.w.

A statistical study was carried out to find if there is any significant trend in this period 2000-2005.

EPISODIC METEOROLOGICAL AND NUTRIENT LOAD EVENTS AS DRIVERS OF COASTAL ECOSYSTEM DYNAMICS: A TIME SERIES ANALYSIS

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In temperate coastal zones, episodic meteorological forcing can have a strong impact in the classical seasonal phytoplankton succession. The episodes of river discharges and wind

storms involve nutrient enrichment and turbulence, two factors that can promote primary production along with changes in the planktonic community composition and structure. The aim of this study was to determine the influence of these variables in the changing osmotrophic planktonic community of Blanes Bay (NW Mediterranean Sea). To do so we performed a 13 months sampling of several parameters of the water column, and we seek for correlations between these and several meteorological and physical high-frequency time series. Influence of river discharge in this particular location was found to be dominant, triggering phytoplankton growth. Occasional resuspension events caused by waves had also an impact in phytoplankton composition and size structure. Crosscorrelations allow to define a sequence of responses to meteorological forcings, from turbidity, to nutrient concentration, phytoplankton and bacteria. The system was generally limited by phosphorus. Diatoms were found to be strongly related both with phosphate concentration and with Si:N ratio. Peak ecosystem response in terms of chlorophyll concentration lagged nutrient enrichment for about 1 week. Easily available high frequency time series of meteorological and physical data are shown to be potentially good predictors of the state of the coastal ecosystem.

HIGH-CHLOROPHYLL NEAR BOTTOM LAYERS: CLASSIFICATION OF CTD CASTS OBTAINED IN COASTAL CATALAN WATERS (NW MEDITERRANEAN).

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The vertical distribution of fluorescence obtained with CTD casts in Western Mediterranean coastal waters often shows a peak near the bottom (several meters in thickness). On the Catalan coast, these high-chlorophyll near-bottom layers (HCNBL) are usually found between 20 and 50 m depths, from spring to late summer. Their origin is probably diverse: sedimentation of the spring phytoplankton bloom, resuspension of sediments and nutrients, or new nutrient supply from submarine sewage outfalls, among others. At present, these chlorophyll maxima do not seem to represent an important eutrophication problem, but they may indicate future undesirable situations if chronic marine sewage disposal produced by an increasing population goes unchecked.

We present the results of a preliminary general analysis of more than 300 CTD profiles sampled seasonally all along the Catalan coast since 2004 (monitoring program of the Agència Catalana de l'Aigua). The variables used are: temperature, salinity, density, oxygen, fluorescence (chlorophyll-a), turbidity and photosynthetic active radiation. Profiles and individual sampled depths are alternatively considered as objects. We show heuristically obtained classifications of the HCNBL profiles compared to automatically produced classifications, using different algorithms.

One point of interest is the heterogeneity found in HCNBL profiles in relation to the different sign of the correlation between chlorophyll-a fluorescence and turbidity.

ANNUAL CYCLE OF SMALL PELAGIC FISHES IN THE CANARY ISLAND WATERS

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The annual cycle of pelagic fishes *Scomber colias*, *Trachurus picturatus*, *Sardinella aurita* and *Sardina pilchardus* around the island of Gran Canaria (Canary Islands) was studied from February 2005 to January 2006. We analyzed 1952 specimens of Atlantic chub mackerel (*Scomber colias*) ranging from 8-40.2 cm in total length (TL). Its reproductive period was short and extended from January to February. A total of 398 specimens of *T. picturatus* (blue jack mackerel) in the size range of 8-30 cm TL were also studied. Its reproductive period extended through the winter months with a peak in March. *S. aurita* (round sardinella) showed a size range of 6-31 cm TL (401 specimens). This species showed a small variability in the gonadosomatic index (IGS), which was constant from

December to July, decreasing from August to November. *S. pilchardus* (European pilchard) appeared in a very low number (only 33 individuals captured) in the size range of 8.5-20.5 cm TL. It is remarkable that *Sardina pilchardus* did not show clear evidences of being reproducing in the Canary Archipelago, since during the annual cycle studied low numbers of specimens were caught and those always showed the gonads not developed. The other species seemed to be positively reproducing around the islands. Compared to previous studies during the 80s and 90s our results suggest a replacement of *S. pilchardus* by *S. aurita*.

PICOPLANKTON AND NANOPLANKTON DISTRIBUTION ACROSS HYDROGRAPHICS FRONTS IN THE DRAKE PASSAGE (ANTARCTIC REGION)

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The analysis of coupling between hydrodynamics and phytoplankton distribution is a major task in Antarctic research. In this study, we analysed the spatial distribution of picoplankton and nanoplankton abundance in relation to the hydrography in a transect from the ice edge in the Weddell Sea (63°S), across the Drake Passage, to the South American continental platform (55°S). In this survey, carried out in December 1998 (late spring) in the framework of the DHARMA project, we had the opportunity to analyze the changes of phytoplankton populations in the strongest gradient of temperature and nutrients of the circumpolar current.

The results showed the low abundance of *Synechococcus* spp., with no more than 300 cells/ml, and the progressive drop of this group as we were coming closer to the polar front. On the other hand, it is remarkable the absent of the most abundant photosynthetic prokaryotic of template oceans, that is *Prochlorococcus* spp.

Eukaryotic picoplankton showed a similar pattern to those of *Synechococcus* but being much more abundant, reaching 6000 cells/ml. Nanoplankton presented the highest densities at surface waters of the Antarctic zone, a region that could be described as HNLC type, with values up to 2000 cells/ml near the Southern Boundary of the Antarctic Circumpolar current. Matching this pattern, heterotrophic bacteria presented the highest abundance at the Antarctic zone (aprox. 1.4×10^5 bact/ml) being almost constant (1.0×10^5 bact/ml) at others surface areas of this transect. In summary, we can underline the strong gradient of phytoplankton populations according to hydrographic characteristics of water masses in this region.

MESOOPLANKTON BIOMASS ESTIMATION FROM DIGITIZED IMAGES

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The measurement of mesozooplankton biomass in the ocean requires the use of analytical procedures which needs the destruction of samples or, by contrast, the development of methods to estimate biomass from optical systems and appropriate conversion factors (Postel *et al.*, 2000). The conversion of the area recorded by an optical counter or a camera has been suggested as a suitable method to estimate total biomass by converting the digitized area of an organism into individual biomass and summing up the individual biomass. In this study, crustacean mesozooplankton from subtropical waters were analyzed and direct individual dry weight of the most common groups and body area by digitized image analysis were obtained. Relationships between individual dry weight and body area agreed with other measurements of biomass obtained in a previous study in Antarctic waters (Hernández-León and Montero, 2006), suggesting a universal regression for these organisms. Gelatinous mesozooplankton from subtropical and Antarctic waters were also sampled and processed for body area and biomass. As expected, differences between these two planktonic groups (crustacean and gelatinous) were highly significant. Transparent

gelatinous organisms have a lower dry weight per unit area. Therefore, to estimate biomass from digitized images, pattern recognition discerning, at least, between crustaceans and gelatinous forms are required.

Keywords

Canary Islands, Antarctic Waters, body area, digitized images, mesozooplankton, biomass

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DIRECT EFFECTS OF SMALL-SCALE TURBULENCE ON THE PHYSIOLOGY OF RED-TIDE INVOLVED DINOFLAGELLATES

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Laboratory experiments have shown that many dinoflagellate species display some degree of sensitivity to certain levels of small-scale turbulence (last review by Berdalet and Estrada 2005). The response is species-specific and highly dependent on the intensity and the experimental design and setup used. The reported effects (including alterations of morphology, population development -biomass yield and net growth rate-, mortality, migration pattern), point to a particular interference of turbulence with cell division and life cycle processes, although the involved mechanisms are still not known. In the field, dinoflagellate proliferations appear to be favoured by calm weather and water column stability (Margalef et al., 1979). Given the ecological and economic importance of such harmful events, our line of research is trying to unveil the effects of small-scale turbulence on the physiology of dinoflagellates, specially focussing on cyst production, toxin content, swimming and cell division patterns (Berdalet et al., in press).

Here we will illustrate the main striking results of our experiments performed on widespread bloom forming species, such as, *Alexandrium catenella* and *A. minutum*, *Prorocentrum micans* and *Akashiwo sanguinea*. Turbulence has been generated with an orbital shaker and the corresponding range of turbulent kinetic dissipation rates has been estimated by an acoustic Doppler velocimeter. Aware that any laboratory setup cannot mimic nature, we aim to set our physiological studies into an ecologic framework.

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PHOTO ACCLIMATION AT THE VERGE OF A SPRING PHYTOPLANKTON BLOOM

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The Spring Phytoplankton Bloom (SPB) represents the single most important seasonal pulse of primary production in temperate and polar oceans. Competing theories explain the SPB either as a consequence of a seasonal thinning of the upper mixed layer below some critical depth or of a decay of wind mixing below some critical turbulence. These mechanisms would confine the phytoplankton cells to the illuminated portion of the water

column thus releasing them from light limitation. A key element of these models is the photosynthetic response to light, which is assumed to be vertically homogeneous and constant. The 2005 SPB in the Bay of Biscay was preceded by a dramatic change in phytoplankton photophysiology. This change was triggered by a sudden increase in irradiance, and led to photoacclimation to high irradiance levels in surface phytoplankton. The change occurred without a noticeable decrease in wind velocity or Mixed Layer depth, thus neither a critical depth or critical turbulence mechanisms were at play. After a time lapse of 4 days, a marked decay in wind velocity triggered the simultaneous onset of the SPB and of an incipient, shallow seasonal thermocline. Our results reveal a more complex picture of the SPB, with an initial, physiological activation phase driven by light, and a second, growth phase driven by turbulence.

PHYTOPLANKTON BIOMASS IN THE BRANDSFIELD STRAIT (ANTARCTICA): COUPLING WITH MESOSCALE STRUCTURES

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During the Antarctic summer, the phytoplankton distribution in the central area of Bransfield Strait is not affected by the major nutrients but it is associated with hydrographical conditions. In the deep chlorophyll maximum (DCM), the microplankton constitutes a small fraction of phytoplanktonic biomass, being the most representative species, *Corethron criophylum*, *Thalassiosira* spp y *Proboscia* sp, with maxima contributions to the total biomass of 9, 7 and 4 %, respectively. Most of the biomass corresponds to cryptophycean population (22-90 %), followed of ultraplankton (7-47 %), the rest of nanoplankton (0.7-18 %) and picoplankton (0.4-15 %). There is a very good correlation between the biomass and the chlorophyll fluorescence signal in the flow cytometer (FL3) ($r^2 = 0.96$), whereas there is a greater dispersion in the correlation biomass-CTD fluorescence ($r^2 = 0.67$).

The hydrographic front established by the isohaline of 34.4 defines the limit of the distribution of most of the species. Thus, the cryptophycean population and *Corethron criophylum* are concentrated in the Transitional Zonal Water with Bellingshausen influence (TBW), relatively warm, low salinities and stratified waters. The rest of the species are shut away in the Transitional Zonal Water with Weddel Sea influence (TWW), relatively cold, salty and mixed waters that flow towards the southwest by the southern margin of the Straits of Bransfield.

TIDAL INDUCED DYNAMICS OF WATER MASSES INTERFACES AND PHYTOPLANKTON CHLOROPHYLL MAXIMA IN THE STRAIT OF GIBRALTAR

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A conceptual model proposing the distribution and dynamics of water-masses and chlorophyll maxima according to tidal cycle is presented for the Strait of Gibraltar. This conceptual model has been based on the analysis of data registered in an along-strait section for different stages of the tidal cycle. Basic water characteristics were registered from CTD casts combined with oceanographic bottles. Composition and nature of the phytoplankton assemblage was studied by analysis of chlorophyll, pulse amplitude modulated fluorometry, flow cytometry and light microscopy analyses.

The apparition of deep chlorophyll maximum (DCM) linked to pycnoclines and/or water masses interfaces is usually found in the ocean. In the Gibraltar region, where three water masses meet (Gascard & Richez, 1985), the apparition of fluorescence maxima in the water column should be more complicated and linked to the dynamics of water masses circulation

The results indicate that (1) the flow of water masses through the Strait of Gibraltar is not continuous but highly dependent on tidal cycles, (2) the chlorophyll maxima present in the channel of the Strait are not homogeneous and could be classified at least into three types (Atlantic maxima, Suction maxima and Deep maxima), (3) these chlorophyll maxima are strongly related to the different water masses interfaces and to a specific water density. Furthermore, this work adds new elements supporting the hypothesis that some of the pulsating chlorophyll patches observed in the Strait could have a coastal origin being clearly different to other chlorophyll maxima detected in the channel coming from open sea regions.

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DOES SMALL SCALE TURBULENCE INTERFERE COMPETITION FOR NUTRIENTS BETWEEN DIATOMS AND BACTERIA?

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In aquatic systems phytoplankton and bacteria compete for inorganic nitrogen and phosphorus. It has been shown that the outcome of this competition will be in favour of diatoms when silicate (Si) is in excess and in favour of bacteria when Si is depleted [Havskum et al, 2003; Thingstad et al 2007]. We postulate that turbulence could change this competition interaction. Shear derived from turbulence increases nutrient flux to large cells, thus it should increase the phytoplankton competition capability for nutrients and reduce the organic matter utilisation by bacteria. Then, when Si is in excess diatom growth should be further enhanced by turbulence.

We evaluated the effect of turbulence on the competition between bacteria and diatoms in experiments with natural plankton communities enclosed in microcosms. The response of plankton to turbulence versus still conditions was evaluated in four different nutrient conditions: C (glucose addition), Si (silicate addition), CSi (glucose and silicate addition), and B (no addition). In general, turbulence increased both heterotrophic and autotrophic biomass under all nutrient addition conditions, and enhanced the diatom competition for nutrients when Si was available. However turbulence did not change the ratio between autotrophic and heterotrophic biomass. We discuss the discrepancy between these results and previous data in terms of the level and frequency of nutrient additions, trophic interactions and initial conditions.

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INTERANNUAL VARIABILITY OF ZOOPLANKTON IN THE RÍA DE VIGO, NORTHEAST ATLANTIC.

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From 1997 to 2005, a mesozooplankton monthly study was carried out in a station located in the Ría de Vigo (42° 13, 3' N, 8° 47, 7' W) at a depth of 29 m. Its biomass was estimated and a range of 0.23-208.47 mg dry weight free of ash per m³ was found.

Total abundance was counted and interannual range was between 252 and 52 474 ind. per m³. Zooplankton abundance showed an increasing trend during the last years.

In the community structure it was observed that the dominant zooplanktonic group was copepods, with an interannual range of 45.4-56.0 % and 1 591-8 499 ind. per m³. For the rest of holoplankton, predominant groups were appendicularia (7 -14%) and cladocera (2 -15%). In meroplankton the cirripedia nauplii and echinodermata larvae are dominant. The first do not reach 15% and record abundances minor than 9 000 ind. per m³, and the latter do not exceed 6% and a maximum of 22 433 ind. per m³ in the year 2003.

Presence of species from warm waters must be highlighted, such as the copepods *Temora stylifera* and *Oncaea mediterranea*, with respective maximum values of 840 and 141 ind. per m³ as well as the cladocera *Penilia avirostris*, showing an occasional important presence in october 1997, reaching a 11.2 % and abundance of 81 ind. per m³.

SEASONALITY AND TRENDS OF AUTOTROPHIC AND HETEROTROPHIC PICOPLANKTON IN THE SOUTHERN BAY OF BISCAY CONTINENTAL SHELF

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Picoplanktonic organisms, comprising *Synechococcus* and *Prochlorococcus* cyanobacteria, eukaryotic phytoflagellates <2 µm and heterotrophic bacteria, are key components of the ocean carbon cycle. In April 2002 we started a picoplankton time-series in the central Cantabrian Sea (S Bay of Biscay) continental shelf, in which abundance, cellular characteristics and biomass are determined monthly by flow cytometry at three stations ranging from 30 to 160 m depth. We found strong seasonal patterns for autotrophic groups, with consistently higher total abundances (up to 2 x 10⁵ cells mL⁻¹, water column averages) in September and lower (10³ cells mL⁻¹) in April. Bacteria showed less variability in total numbers (0.2-2 x 10⁶ cells mL⁻¹) but a highly predictable annual cycle of the percentage of high nucleic acid content cells, with minima (~40%) in summer and maxima (~80%) in April. Temperature alone explained 40% of the variance in picophytoplankton abundance but only 13% of that of bacteria (p<0.001, n=162). The persistent temporal window of *Prochlorococcus* (present only from September to February) suggests a close association with regional hydrodynamics. Although cyanobacteria generally outnumbered picoeukaryotes, the latter were the greatest contributors to total picophytoplankton biomass (0.04-1.0 g C m⁻²) year round, except in late summer and early autumn. Picophytoplankton prokaryote:eukaryote ratios of abundance and biomass were remarkably consistent, with minima in April and maxima generally found in September. Biomass of heterotrophic bacteria (0.2-1.5 g C m⁻²) generally exceeded that of autotrophs except at the most coastal station. Significant trends were apparent over the 5-year period for some groups. For instance, summer bacterial biomass has consistently increased at the three stations, illustrating the potential of microbial monitoring to readily detect ecosystem long-term changes.

A CONCEPTUAL FRAMEWORK FOR THE APPLICATION OF BIOTECHNOLOGY TO DETECT SIGNALS OF GLOBAL WARMING IN FISH

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The marine ecosystems in general and the coastal aquatic systems in particular are experiencing, as a result of the climate change, a warming of the surface and deep waters. An increase in the average temperature and in the number of "heat waves" is predicted, in which the temperature of the surface waters may reach considerable levels, not ruling out changes in the levels of salinity in some areas. In fish, the acclimatization to changes in temperature and salinity is associated with changes in the composition of lipids and

proteins. In addition to the concomitant increase in biomass due to an accelerated growth, the greater demand for oxygen produced by the increase of the metabolism together with the temperature, and the lower availability of oxygen of the warmest waters may lead to situations of hypoxia which are known to produce oxidative stress and alterations in the synthesis of proteins and lipids. The previously described effects, potentially slight and rapid, can be hard to detect by conventional analytical methodologies based on the monitoring of single parameters, and may require a holistic approach half way-through the genomics and the classical phenotypic approaches. We propose here a conceptual framework based on the hypothesis that combining analyses of protein and lipid profiles, of enzymatic activities, oxidation levels of the molecules etc., a global vision of the changes produced in fish when the different environmental factors (water composition, temperature, radiation etc...) act on the animal in an individual or combined way can be obtained. Definitively, an integrated study of these characteristics will allow finding biomarkers useful for the evaluation and prediction of the impact of the climate change in fish. These biomarkers could be used in pilot programmes aiming at tracking the impact of the climate change on fish (wild and farmed) and for predicting the response of these animals in the scenarios foreseen by the climatic models.

Keywords: Climate change, marine fish, protein expression, lipid metabolism, biomarkers

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SPATIAL AND TEMPORAL VARIATION IN *OCTOPUS VULGARIS* PARALARVAL SUPPLY ON A WIND-DRIVEN UPWELLING AREA (RÍA DE VIGO, NE ATLANTIC)

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The dynamics of coastal upwelling areas, which are characterized by a surface layer under the direct influence of the wind, and a compensation counterflow in the deep layer, may have important consequences for the cross-shelf transport of larval stages of many species. Earlier studies provided evidences of the importance of advection in these systems; however, larvae distribution results from a combination of water mass circulation, species-specific larval behaviour, and larval sources. Galicia constitutes the northern boundary of the Iberian-Canary current upwelling system where seasonal winds promote upwelling from April to September and downwelling the rest of the year. The upwelling season appears as a succession of wind stress/relaxation cycles of period 10-20 days. Here, we study the short-timescale variability of the wind cycles and associated water circulation to examine their influence on the distribution of *Octopus vulgaris* paralarvae. We sampled a cross-shore transect in the Ría de Vigo and the adjacent shelf during three years under contrasting oceanographic conditions. Paralarvae performed vertical migrations between the surface layer during the night and the deeper layer during the day. The highest concentrations during upwelling conditions occurs nearshore in the surface layer and offshore in the deeper layer; while, when upwelling relaxes paralarvae are more numerous and appear more evenly distributed enhancing its coastal retention. Therefore, the general pattern of octopus paralarvae distribution appears to be influenced by the coupling of their diel vertical migration pattern and the residual circulation induced by the wind forcing.

MODELLING THE ECOLOGICAL ROLE OF SMALL PELAGIC FISH IN THE NW MEDITERRANEAN

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Small pelagic fish are important elements of marine ecosystems due to their relevant biomasses at intermediate levels in the food web, contributing to canalize the energy connecting the lower and upper trophic levels. Fluctuations in small pelagic populations can

contribute to modify the structure and functioning of marine ecosystems (Cury et al., 2000). Environmental factors and fishing activity are essential to explain the dynamics of small pelagic which are subjected to fluctuations due to their relatively short life cycle (2-3 years). Anchovy and sardine are the main small pelagic fish inhabiting the NW Mediterranean Sea. These species represent almost 50% of the total landings and support important biomasses. However, both landings statistics and biomass estimates of sardine and anchovy have shown a steadily decline in the NW Mediterranean Sea during the last decades. In order to put available ecological data from small pelagic fish into an ecosystem context, a food web model that describes the exploited continental shelf and upper slope in the South Catalan Sea (Coll et al., 2006) was used in this contribution. In addition, the ecological model fitted with time series of data from 1978 to 2003 was able to satisfactorily reproduce the dynamics of several target species considering fishing, trophic interactions and the environment (Coll et al., 2005).

Small pelagic fish in the NW Mediterranean Sea are highlighted to be essential mid trophic levels of the food web. They are involved in main trophic flows and constitute important elements controlling prey and predator populations, related with bottom-up and wasp-waist flow control situations. Fishing activity shows a high impact on these groups with high exploitation rates and high primary production required to sustain their catches. When fitting the ecological model to available time series results show how trophic interactions account for half of the observed data variability. The function affecting primary production (PP) calculated by the model is significant, and negatively correlated with sea surface temperature. This result could be underlying the impact of an increase of sea surface temperature on sardine populations. The high exploitation of small pelagic fish can produce important impacts of the structure and functioning of the exploited ecosystem. Thus, a large removal of biomass in terms of catches from the food web could likely imply the impairment of the canalization of energy flows in the NW Mediterranean food web.

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SIMULACIÓN EXPERIMENTAL DE LA CARGA DE NUTRIENTES Y LA TURBULENCIA EN SISTEMAS COSTEROS

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La carga de nutrientes es un factor importante en la dinámica de los ecosistemas costeros. Asimismo, la turbulencia de escala pequeña también se tiene que tener en cuenta más allá del forzamiento hidrodinámico que llevará agua rica en nutrientes a la zona fótica. En los últimos años se ha visto que la turbulencia afecta una serie de procesos en la columna de agua, incluyendo el encuentro de presas con depredadores, el flujo de nutrientes hacia células algales y la sedimentación de partículas.

Para estudiar la interacción de ambas variables, se hicieron una serie de simulaciones experimentales en contenedores con agua sometida a gradientes de carga de nutrientes (0 to 24 μM nitrato) y turbulencia ($2 \cdot 10^{-9}$ to 10^{-4} $\text{cm}^2 \text{s}^{-3}$). Los experimentos se hicieron con agua costera de un fiordo noruego y del mediterráneo noroccidental. La clorofila mostró picos después de 2 a 5 días. Estos picos claramente incrementaron con la carga de nutrientes. Niveles crecientes de turbulencia también afectaron la clorofila. Un efecto sinérgico entre la adición de nutrientes y la turbulencia era aparente: a altos niveles de ambas variables la respuesta era mayor. También se observó sedimentación de material orgánico en los contenedores. La cantidad de material sedimentado se calculó con balances de fósforo total.

Un modelo de regresión muestra que tanto la carga de nutrientes como la turbulencia afectan la cantidad de material sedimentado. Estos resultados manifiestan la importancia de considerar ambas variables para determinar la dinámica de los ecosistemas costeros.

PRODUCTIVITY IN THE NORTHEASTERN SHELF OF THE GULF OF CADIZ

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The productivity of a marine ecosystem is based on the first steps of the trophic food web, which are themselves dependent of the environmental physic-chemical characteristics. In this sense, the productivity of the Gulf of Cadiz is mirrored in its important and diverse fishery activity. In order to study the mechanisms responsible for variations in the productivity of the area, monthly cruises were carried out during almost three annual cycles in the coastal fringe located at the northeastern shelf of the Gulf of Cadiz, between the mouths of the Gadiana and Guadalquivir rivers. Based on a total of 31 oceanographic cruises performed from March 2002 to September 2004, temporal and spatial patterns of diverse biogeochemical variables in surface seawaters have been examined, with the aim to study their seasonal and interannual variability. The analysis conducted conforms the largest (in terms of spatial coverage and sample frequency) oceanographic data base in the whole Andalusia coast. Besides the concentration of total chlorophyll-*a* and that associated to larger cells, inorganic nutrients (nitrate, nitrite, silicate and phosphate), total particulate matter and the percentage of inorganic particulate matter, remote sensing images have been also used to support the characterization of the Gulf. The mouth of the Guadalquivir River protrudes as the sector with usually highest particulate and dissolved matter concentration, and consequently, highest phytoplankton pigment abundance. The temporal variability of these biogeochemical descriptors in the Gulf of Cadiz has been also analyzed within a meteorological frame.

THE BENTHIC COMMUNITIES OF THE SCOTIA ARC AFTER 20 YEARS OF CLIMATIC CHANGE

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During 1986-87 a total of 345 stations at depths between 26 and 643 m were sampled by using bottom trawl catches along the Scotia Arc archipelago (Shag Rocks, South Georgia, South Sandwich, South Orkney, Elephant and South Shetland Islands) (Balguerías *et al.*, 1989).

Some interesting zones with rich communities of sessile filter-feeders, long-lived sponges, reef formations of calcareous bryozoans or serpulids were discovered during the survey on the shelf zones of Georgia, Orkneys and King George islands (Ramos, 1999).

After 20 years, and having concluded the benthic studies carried out at West Antarctica (Bellingshausen Sea and Antarctic Peninsula areas), the Bentart projects will try to extend its benthic research to the Scotia Arc. The aims of the new projected surveys will be, at one hand, to investigate the biodiversity pattern along the eastern Antarctic Peninsula; and on the other hand, to verify if the last 20 years of global warming have affected the state and amplitude of those dense filter-feeder assemblages located around King George island (South Shetlands) and Coronation island (South Orkneys) during the 'Antartida-8611' survey.

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SPATIO-TEMPORAL VARIABILITY OF THE NW-ALBORAN UPWELLING AREA AND PHYTOPLANKTON DISTRIBUTION AS DERIVED FROM SATELLITE IMAGES AND IN SITU MEASUREMENTS.

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The NW-Alboran Sea is one of the most productive areas in the western Mediterranean.

In order to assess the spatio-temporal variability of the NW-Alboran upwelling area, its surface extension is estimated on a daily scale through Sea Surface Temperature (SST) satellite images during several summer periods.

In addition, the water column is characterized by *in situ* measurements of temperature, salinity, and light field, as well as water analysis of nutrient concentration, chlorophyll and phytoplankton abundance, on both short term (3 days) and seasonal (winter, spring, summer, autumn) scale sampling along a transect. Furthermore, grid samplings were carried out in winter (February) and summer (July).

High spatial variability in the surface extension of the upwelling region was observed even at a daily scale. Phytoplankton abundance followed the short term drift of the front, being prokaryotic picoplankton (*Synechococcus* and *Prochlorococcus*) characteristic for oligotrophic stratified water and greater sized nano-microplankton for the upwelling area.

The vertical position of the thermocline, photic layer depth and nutrient concentration below the thermocline were used to estimate the nutrient input into the photic layer during the expansion of the upwelling area. On the contrary, the decrease of the upwelling area implied downwelling of surface water at the front, as observed during short-term displacements of the front during the sampling period.

Due to the time lag of phytoplankton response to fertilizing processes, the frequency of upwelling and downwelling events might strongly affect phytoplankton production and transport of biomass along isopycnals to deeper waters in the NW-Alboran Sea.

CHLOROPHYLL_a AND SEA SURFACE TEMPERATURE SPATIO-TEMPORAL VARIABILITY IN THE MEDITERRANEAN SEA (2003-2005)

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The Mediterranean Sea is a semi-enclosed basin with oligotrophic characteristics and shows, at local scales, marked seasonal variations in phytoplankton concentrations. The study of algae biomass and primary production on a long-term basis will contribute to the detection of possible modifications in the biochemical balance of the basin. The objective here is to improve the spatio-temporal knowledge of two different but related variables like the sea surface temperature (SST) and the chlorophyll_a (CHL) concentrations in the Mediterranean Basin by means of satellite imagery, the AVHRR for the SST and the MODIS/SeaWiFS merged product for CHL. Through performing the analysis, several homogeneous areas in the basin are marked out from each other in terms of their oceanographic dynamics. In addition, it determines the reaction of the variables mentioned to other meteorological elements such as wind speed.

The study is based on the processing and analysis of a set of data taken over the course of three years, from January 2003 to December 2005. The methodology consists firstly of processing the satellite data set to obtain a long-term series of SST and CHL images and its accurate observation on a monthly basis. Then, a visual inspection of the monthly climatology is performed. Lastly, an Empirical Orthogonal Function (EOF) analysis was applied to the monthly averages in order to characterize the spatio-temporal variability of both the SST and surface chlorophyll in the whole basin.

SEA WARMING AND FISH DISTRIBUTION: THE CASE OF THE SMALL PELAGIC FISH, *Sardinella aurita*, IN THE WESTERN MEDITERRANEAN

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Fish populations display a broad range of distribution patterns and their characteristic preference for a certain range of temperatures implies that the thermal structure of the water mass determines the habitat extension of species. A warming trend in Mediterranean waters has been reported during the last decades, both at surface as well as deep waters (Salat and Pascual, 2002, Bethoux and Gentili, 1996). Round sardinella is a thermophilic small pelagic species that extends in tropical and subtropical waters of the Atlantic and Pacific. In the Mediterranean, the species is particularly frequent in the warm waters of the eastern part, as well as in the south western basin. This study analyses the temporal and spatial changes in abundance and distribution of round sardinella (*Sardinella aurita*) in the western Mediterranean over the last decades in relation to sea water temperature. At the basin scale (1950-2003), a significant positive relationship was found between round sardinella landings and temperature anomalies. Along a latitudinal gradient off the Mediterranean Iberian coast (1989-2004), a gradual increase in species abundance was observed from south to north, with a certain time lag going northwards, associated with the increase in sea water temperature. The comparison between round sardinella larvae distribution in summers of 2003 and 2004 with the situation reported twenty years before, summer 1983, (Palomera and Sabatés, 1990) showed a marked increase in larval abundance and the presence of larvae in the northernmost study areas, where they did not occur twenty years ago. This indicates the successful reproduction of round sardinella in the northern part of the Mediterranean, where the species has expanded, confirming its establishment in the area.

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PHYSICAL- BIOLOGICAL COUPLING AT THE CENTRAL PART OF THE BRANSFIELD STRAIT (ANTARCTICA)

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We present data from two interdisciplinary cruises conducted in the central part of the Bransfield Strait during 1999/2000 (CIEMAR project) and 2002/2003 (project BREDDIES project) austral summers. The physical support of the marine system is characterized by a quite rich mesoscale activity. We observed two fronts, a narrow slope front along the South Shetland Island Slope (The Bransfield Front) and a shallow, meandering hydrographic front close to the Antarctic Peninsula. The Bransfield Front has associated a baroclinic jet flowing North-Eastward (the Bransfield Current). Below the Bransfield Front we observed a narrow tongue of Circumpolar Deep Water (CDW). The hydrographic front separates a warm and relatively fresh water entering from the west (Transitional Zonal water with Bellinghousen influence, TBW) from a cold and salty water coming from the Weddell Sea (Transitional Zonal water with Weddell Sea influence, TWW). Between both fronts we observed an intense field of mesoscale anticyclonic eddies (radius 20-30 km, depth=150-

300 m). Phytoplankton groups distribution is related to those mesoscale structure. Criptofycean tends to accumulate at the well stratified TBW whereas Picoplankton concentration increases in mixing regions associated to both fronts. We also notice that phytoplankton accumulates in the anticyclonic eddies. Meroplankton distribution is also related with water masses and mesoscale structures. We mainly found that meroplankton concentration is greater at the slope front and TBW. Finally zooplankton distribution show greater densities at the hydrographic front.

TRACE METAL COMPOSITION OF *Posidonia oceanica* FROM THE WESTERN MEDITERRANEAN SEA (BALEARIC ISLANDS)

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Metal concentrations (Ag, Al, Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn, As, V, Cr, and Mo) were measured in rhizomes of *Posidonia oceanica*, the longest living seagrass, collected in 53 sites along the Balearic Islands.

Seagrass metal concentrations were used as a proxy of metal concentrations in the environment.

Metal concentrations were measured in seagrass rhizomes dated and dissected by lepidochronology procedures. Hence, time series of seagrass metal composition were obtained, allowing examination of present and past ambient metal availability. Iron in seagrass rhizomes from Balearic Islands showed lower concentrations (25%) than in other Mediterranean sites. Highest concentrations of Al (321.4 +/- 265.7 µg/g), Cd (3.9 +/- 1.1 µg/g), Co (1.4 +/- 2 µg/g), Fe (968 +/- 841 µg/g), Mn (39.7 +/- 28.2 µg/g), Pb (12.4 +/- 10.2 µg/g) and Zn (76.7 +/- 55.4 µg/g) were observed in the north of Mallorca island. Interannual changes in seagrass metal concentrations were also detected in some examined sites, suggesting increased inputs of some metals for particular years. The spatial scale of temporal fluctuations in metal concentrations will be examined.

DIET, FEEDING INTENSITY AND STRESS MARKERS IN THE HENSLOW'S SWIMMING CRAB *POLYBIUS HENSLOWI* (LEACH, 1820) FROM THE GALICIAN AND CANTABRIAN COASTS (NW SPAIN).

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The diet and the feeding intensity of the portunid swimming crab, *Polybius henslowi* were studied during the spring of 2004, in an area comprising the Galician and the W Cantabrian Sea (NW Iberian Peninsula) at depths ranging from 78 to 327 m in the continental shelf. The entire area had been affected by the "Prestige" oil spill in November 2002, though the different sectors studied displayed different level of pollution/oil impact. A total of 342 specimens were collected in 25 bottom hauls and analyzed for diet composition. Stomach fullness was compared between three impacted sectors: (1) Miño River and Finisterre Cape (MF), (2) Finisterre and Estaca de Bares Cape (FE), and (3) Estaca and Peñas Cape (EP). Stomach fullness was lower in FE, although significant differences (Mann Withney test) between sectors were not reached. Diet (wet weight) consisted of a mixture of pelagic and benthic prey. Cephalopods (*Ilex* sp.), brachyurans (*Polybius henslowi*) and polychetes (e.g. *Glycera* spp.) were the main prey items found. Other important prey were Beloniform eggs and fish remains. Polychetes were especially abundant in MF, and *Polybius henslowi* in EP. Two stress markers were studied in twelve *P. henslowi* specimens from each of the 3 affected sectors. Neither acetylcholinesterase (a neurotoxic marker) nor lipid peroxidation (a marker of oxidative stress) were seen affected by the sampling area. Variations in the studied variables will be analysed in relation to changes in environmental factors (T, S, sediment nature), surface productivity (Chl *a* by satellite imagery) and tar aggregates concentration in the sediments.

SEASONAL CHANGES IN PLANKTONIC BACTERIVORY RATES UNDER THE ICE IN FRANKLIN BAY (ARCTIC-CANADA)

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The dynamics of bacterivory rates were determined in surface samples in Franklin Bay, western Arctic, over a seasonal period (October 2003 - July 2004) comprising ice-covered and ice-free conditions. The main objectives were, first, to obtain information of the functioning of microbial food web under the ice, from the dark winter (December- mid March) to spring (mid March –May) and second, to test whether grazing losses of bacteria would be driven by the phytoplankton bloom, that would stimulate bacterial production. Chlorophyll a during the ice-covered period (December 2003- May 2004) ranged from 0.04 to 0.36 $\mu\text{g L}^{-1}$, starting to increase in early March and achieving this maximal value in April (spring bloom), whereas after ice melting it reached values between 0.22 and 1.46 $\mu\text{g L}^{-1}$. Average monthly bacterivory rates during the ice-covered period ranged between 0.17 \pm 0.015 and 0.22 \pm 0.00 $\mu\text{g C L}^{-1} \text{d}^{-1}$ between December and February, and between 0.16 \pm 0.15 and 0.42 \pm 0.21 $\mu\text{g C L}^{-1} \text{d}^{-1}$ between March and May. Bacterial production was lower than or similar to bacterivory rates during the winter, from 0.011 \pm 0.01 to 0.33 \pm 0.47 $\mu\text{g C L}^{-1} \text{d}^{-1}$ (from December to February), and higher than bacterivory from March to May (0.90 \pm 0.15 to 1.17 \pm 0.16 $\mu\text{g C L}^{-1} \text{d}^{-1}$). In consequence the dynamics of bacterivory rates during the ice-covered period did not show remarkable changes. However bacterial production increased immediately after chlorophyll a concentration augmented. Hence, we conclude that bacteria were substrate limited, and protists were likely feeding more on growing phytoplankton than on bacteria.

TRENDS AND SEASONALITY OF PHYTOPLANKTON BIOMASS AND SPECIES COMPOSITION IN THE PERIOD 1989-2003 OFF A CORUÑA (NW SPAIN)

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Chlorophyll and phytoplankton species composition from A Coruña shelf (NW Spain) were studied for the period 1989-2003, to analyse seasonality and trends in relation to regional climate and oceanographic variability. Seasonal variability of chlorophyll was closely related to variations of upwelling, with high chlorophyll concentrations in the period between March-October. Diatom seasonality followed that of chlorophyll, and this group formed the bulk of phytoplankton biomass. Dinoflagellates did not dominate during summer as upwelling prevents strong stratification. However high densities of dinoflagellates were observed in autumn coinciding with the beginning of downwelling period. Chlorophyll declined from 1989 to 2003, and diatom abundance decreased, especially since 1995, while dinoflagellates slightly increased. Microflagellates (<10 μm), decreased since 1995, and Cryptophyceans showed two peaks in 1994 and 1996 decreasing thereafter. The decrease of diatoms and chlorophyll matched the negative trend for climatic NAO and upwelling indices. The decrease of diatoms coincided with an increase of the water stratification. However, the comparison of normalized data showed that variability in biological variables appeared weakly related to the selected climatic and oceanographic properties. Spring bloom development can occur between February and May and no clear trend was observed for the period of study. Characteristic dinoflagellate species increased their abundances during the study. Decrease in diatoms coincided with a steadily decrease in the abundances of those species characteristics of blooms, while other species indicative of upwelling relaxation or stratification remained and even increased. Chrysophyceae or Prymnesiophyceae did not show any clear variation through the period of study. These variations are consistent with a reduction in the intensity of upwelling and an enhancement of stratification.

Keywords: phytoplankton, chlorophyll, trends, seasonality, climate, NAO, upwelling, continental shelf, NW Spain.

TIME SERIES ANALYSIS OF SEA LEVEL AND HEAT CONTENT IN THE WESTERN MEDITERRANEAN

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The Group on Climate Change of the Instituto Español de Oceanografía (IEO) has analyzed monthly sea level time series from three tide-gauges in Algeciras, Ceuta (close to the Strait of Gibraltar) and Málaga in the Alboran Sea, extending from the beginning of the 1940s to 2005, to detect and quantify long-term changes in the sea level of the western Mediterranean; we have also analyzed time series in L'Estartit (Northwestern Mediterranean) and Mallorca Island (Balearic Sea), but in these latter cases time series only extend from 1990 and 1997 to 2005. We have used both pressured-corrected sea level time series, and thermosteric sea level in order to assess the origin of the observed variability. We have detected a continuous positive trend in Malaga (fig. 1a), Ceuta and Algeciras, ranging between 0.4 and 1.3 mm/yr. The time series length, allow us to speak about long-term changes. And it sticks out the large acceleration of these trends during the 1990s decade. Although the L'Estartit (fig. 1a) time series only expand 15 years, it shows a large trend around 3.4 mm/yr, but in this case, the influence of decadal variability is obviously important.

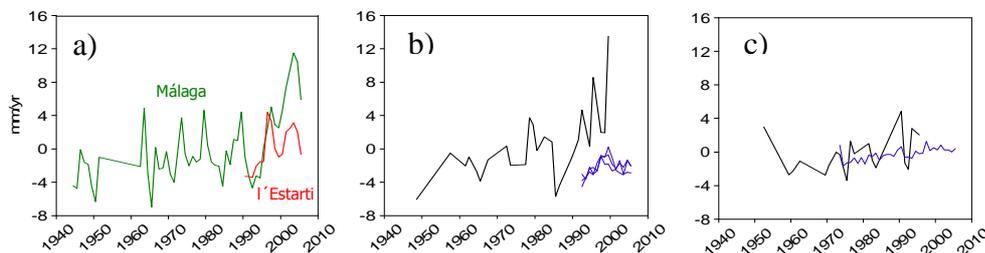


Figure 1. a) Trend in sea level (mm/year) time series (1940-2005) from three tide-gauges in Málaga (Alboran Sea) and L'Estartit (Northwestern Mediterranean). b) Thermosteric level (mm/year) in Alboran Sea and c) in the Northwestern Mediterranean, calculated with the hydrological time series from the MEDATLAS data base (in black) and with hydrological time series collected in the Alboran Sea and L'Estartit respectively by IEO and Institut de Ciències del Mar (ICM, CSIC) (in blue).

We have used MEDAR data base to estimate changes in the heat content in both the Alboran Sea (fig. 1b) and in the Northwestern Mediterranean (fig. 1c). The last part of these time series has been completed with the hydrological time series collected from the beginning of the 1990s and 1970s by IEO and ICM respectively. There is a significant agreement between direct sea level trends and heat content trends in both areas, suggesting that this could be the leading factor. Another evidence of the importance of this factor is the abrupt decrease of sea level in Mallorca from 1997 to 2005, where a loss of heat on the water column has been observed from hydrological local time series corresponding to the same period. This reversal, mainly during the beginning of the XXI century has also been detected in Málaga and L'Estartit.

INFLUENCE OF SMALL INCREASES OF TEMPERATURE ON THE MICROPLANKTON COMMUNITY STRUCTURE OF THE BAY OF BLANES (NW MEDITERRANEAN).

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Some climatic scenarios predict that the concentration of CO₂ in the atmosphere could be doubled during this century (Houghton et al. 2001). Under such circumstances, the average temperature of large regions of the ocean could increase near 2.5 °C (Timmermann et al. 1999). Temperature is an extremely important factor influencing biological processes; particularly those related with the microbial components of marine systems. Due to their shallowness, the increases of temperature predicted in the ocean should have a deep impact on the transfer of energy and materials channeled through the microbial community of coastal marine systems.

In a previous study in the Bay of Blanes, a well characterized NW-Mediterranean coastal oligotrophic site, we described important changes associated to small increments of temperature on: planktonic respiration, bacterial production and bacterial carbon demand (Vázquez-Domínguez et al.). Here we show that the same positive effect was observed for bacterial net growth rates, while was not evident on flagellate and ciliate net growth rates. Thus, suggesting a differential effect of temperature on such microorganisms or a high predator-prey coupling. We neither observe a clear effect of temperature on the diversity of the community of microplankton (ciliates and flagellates) thriving in the Bay. Our results, therefore, suggest complex interactions within the microbial food web under warmer oceanic conditions

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TROPHIC RELATIONSHIPS OF THE INTER-TIDAL FISH SPECIES OF A ROCKY SHELF OF THE GULF OF CADIZ (NORTH EASTERN ATLANTIC)

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Many species of blennid, goby, gobiesocid, clinid, tripterygiid and labrid fish are syntopic, that is, they share the same coastal portion, showing similar feeding behaviour, and utilising small hollows as places to hide and to spawn (Nieder, 1997). In numerous studies the selection of habitat has been resolved in a distribution of the species at different depths (Gibson, 1982; Illich & Kotschal, 1990; Macpherson, 1994); however, in the study zone, the characteristics of the rocky shelf itself, which presents a very gradual slope and is somewhat raised with respect to the sub-tidal zone, do not allow any spatial segregation. Therefore in order to understand how the assemblage functions, it is necessary to study the trophic relationships of the species.

But the question arises of how to resolve the potential trophic competition (expressed as diet overlap). In the assemblage studied here are 2 herbivorous species (*L. caneavae* and *P. sanguinolentus*), 8 carnivorous species, with a percentage of occurrence of algae in the diet below 10% (*Gobius paganellus*, *G. cobitis* and *G. bucchichi*; *Clinitrachus argentatus*; *Tripterygion delaisi*; *Lepadogaster lepadogaster*, *L. purpurea* and *L. candolii*) and 6 carnivorous species in the earlier phases of their life cycle, which gradually increase the proportion of algae in their diet (by grazing), reaching significant proportions in the diet of larger size classes (*L. pholis*, *P. trigloides*, *P. incognitus*, *S. pavo*, *C. galerita* and *S.*

roissali). The overlapping of diet between the different species does not explain the different patterns of abundance found between co-occurring species, nor the coincidence in their reproductive cycles or in the period of recruitment. The common utilisation of abundant resources, and the particularised utilisation of other types of resource, allow the different species to minimise the effects of possible trophic competition between them. In this scenario, the physiography is possibly the element that determines the composition of the assemblage of fishes in this zone.

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