



## ANNEX 2 - National IMBER Reports

(as collected in August 2014)

### Argentina

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#### A. IMBER research in the western South Atlantic

##### 1. Introduction

The western South Atlantic hosts one of the most productive marine ecosystems in the southern hemisphere. The productivity arises from a unique combination of forcings, including intense tidal mixing near shore, winds, nutrient input from the subantarctic zone via a strong western boundary current (the Malvinas Current), and mesoscale and sub-mesoscale processes. In addition, *aeolian* nutrient sources from South America may further promote the growth of phytoplankton (see Fig. 1). A number of studies carried out in the western South Atlantic are associated with IMBER goals and objectives and are briefly described below.

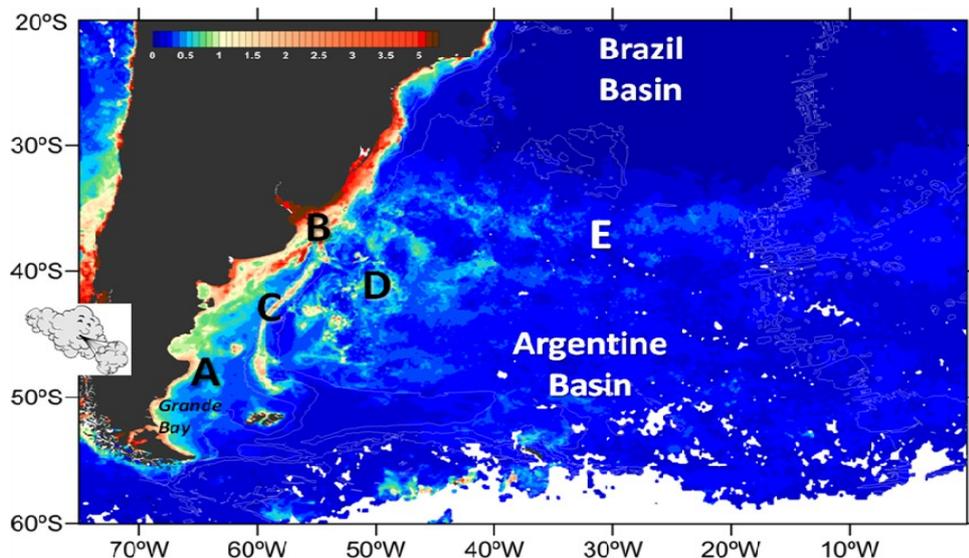


Figure 1: Mean sea surface chlorophyll-*a* concentration for September 2013 derived from MODIS Aqua radiometer and mapped on 9 km resolution. Note the high concentrations on the continental shelf (A) associated with tidal and wind mixing, and river discharge (B). In addition, shelf break upwelling (C), and mesoscale activity (D) are important to fertilize the open ocean domain. The productivity extends across the South Atlantic (E).

##### 2. Extending satellite based chlorophyll series

Monthly composites of chlorophyll concentration (Chl-*a*, mg m<sup>-3</sup>) were generated from SeaWiFS (SW) and MODIS Aqua (AQ) data. All level 2 data available were processed with the standard empirical algorithms OC4v4 for SeaWiFS and OC3M for MODIS, binned and mapped to a 2 km pixel<sup>-1</sup> spatial resolution. Monthly composites were generated for September 1997 - December 2006 for SW, and July 2002 - January 2014 for AQ. AQ was linearly fitted to SW for 2002-2006 and corrections applied to AQ. The resulting mean ratio AQ/SW = 1.003 mg m<sup>-3</sup>.

Figure 3 displays the mean Chl-*a* and Chl-*a* anomaly relative to the long term monthly means in the SUB region (indicated by the square in Fig. 2). The analysis reveals a clear seasonal pattern, with maximum concentrations in spring (October-November) and minima in winter (June-August) (Fig. 3). A secondary peak is often observed in fall (April-May). There are positive trends in both, chlorophyll concentrations and anomalies at SUB, suggesting overall increased phytoplankton abundances since 1997.

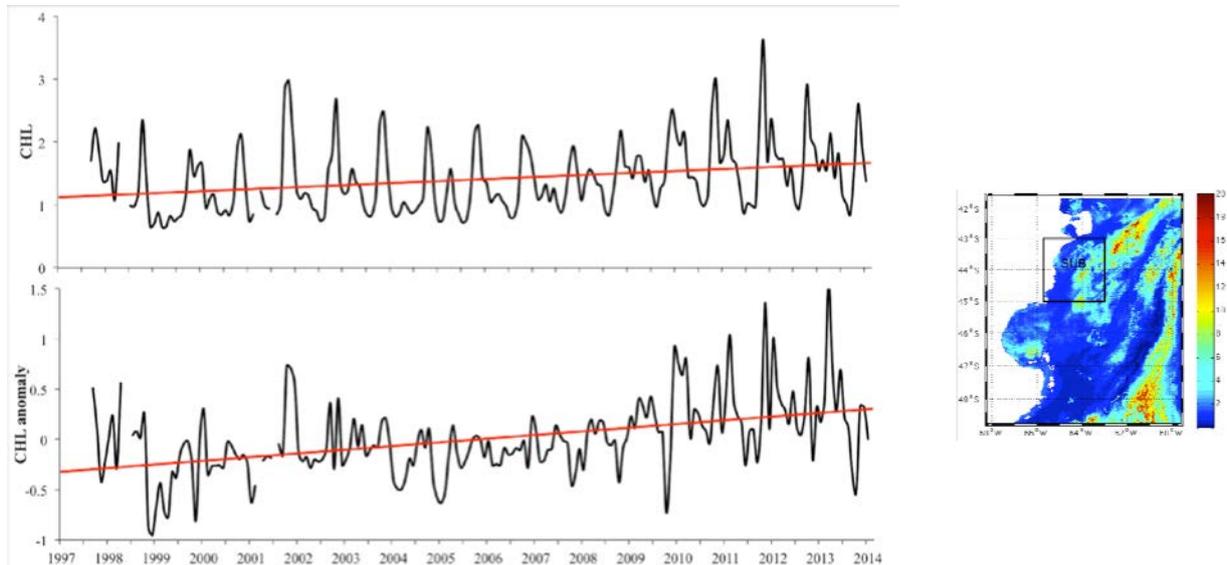


Figure 2: Time series of monthly mean chlorophyll concentration (Chl-*a*) (top) and anomalies ( $\text{mg m}^{-3}$ ) (bottom) at SUB for the period 1997-2014, constructed from the combination of SeaWiFS and MODIS-Aqua data.

### 3. The EPEA time series 38° 28'S - 57° 41'W

The EPEA time series is aimed at understanding the annual and inter-annual variability of all components of plankton and environmental variables, with emphasis on long term changes. Since 2000 EPEA collects monthly temperature, salinity, dissolved oxygen, nutrients, light penetration, absorption by particulate matter -phytoplankton and NAP- and chromophoric-dissolved-organic- matter, chlorophyll-*a*, pigment composition, bacterioplankton, phytoplankton (pico, nano and micro), zooplankton, and ichthyoplankton.

The zooplankton sampling with a 67  $\mu\text{m}$  mesh size revealed that small-size copepods (< 1 mm total length) strongly dominated the meso-zooplankton fraction throughout the year, representing > 80 % of its mean annual abundance (Figure 3a). On average, among adults, members of *Oithona* accounted for more than 60 % (Viñas *et al.*, 2013) (Figure 3b). Given that small zooplankton availability controls growth and mortality of early life stages of commercial fish species, worldwide use of finer meshes in zooplankton time-series should be considered.

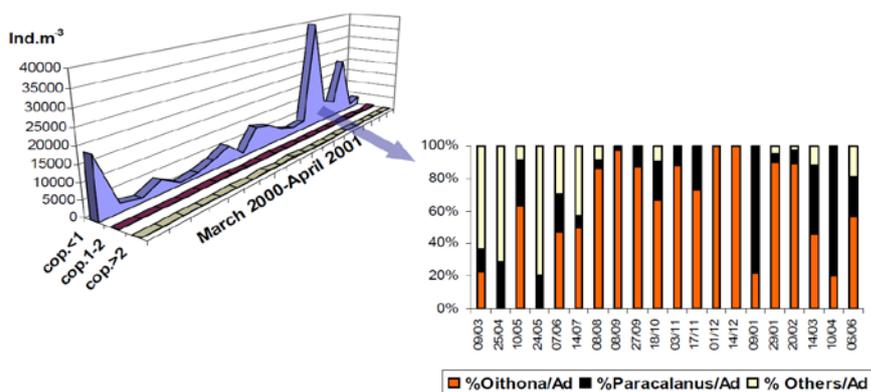


Figure 3. Annual variation of copepod size categories abundance (a) and percentage contribution of different copepod species in the < 1 mm size class (b) at EPEA station, from Viñas *et al.*, *Mar. Biol. Res.*, 2013.

#### 4. The northern shelf ecosystem

The area between 34°S and 41°S is a spawning and feeding ground of *Engraulis anchoita* (*Engraulidae*), the most abundant and commercially important species, which also plays a key role in the pelagic ecosystem. The analysis of a 13-yr time series (1997-2009) of hydrographic observations, chlorophyll, zooplankton composition and abundance, ichthyoplankton distribution, and recruitment of *E. anchoita* reveals that a massive spawning of one population takes place in the spring in coastal areas near the mid-shelf front (MSF), and in the two estuarine systems of the Plata River and El Rincón (40°S). North of 41°S larval survival (recruitment/spawning biomass) presents high interannual variability which is closely associated with spring-summer chlorophyll concentrations, as well as with the timing and duration of the spring bloom.

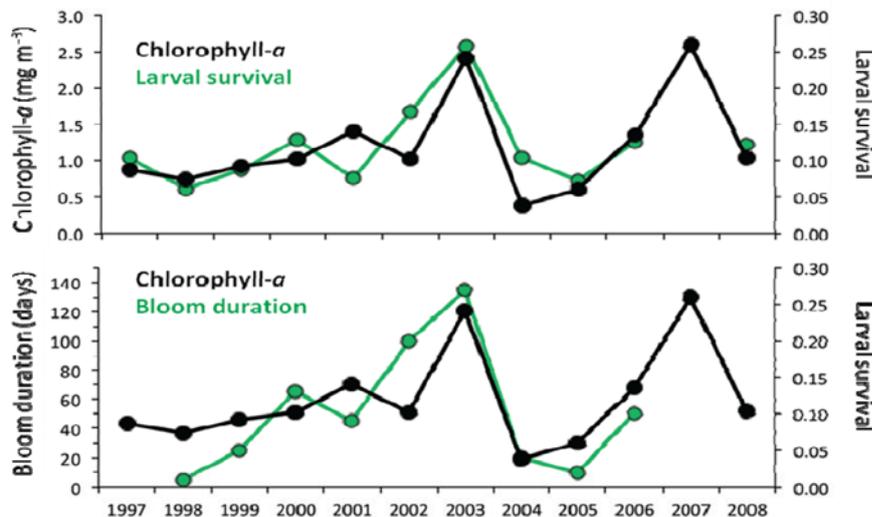


Figure 4: Larval Survival Index, R/SSB, for *Engraulis anchoita* north of 41°S (black circles) and median spring-summer (Sept.-Febr.) chlorophyll-a concentration ( $\text{mg m}^{-3}$ ) at MSF (green, top panel), and larval survival (black) and bloom duration (green, lower panel). From Marrari et al., Fish. Oceanogr., 2013

#### 5. Mesozooplankton and pelagic food webs

The southern shelf region is characterized by strong westerly winds and intense tidal mixing near shore. Biomass of primary producers are locally enhanced in spring-summer and a large mesozooplankton biomass increase is recurrently recorded by the end of the season. Respiration of zooplankton and the increase of  $\text{CO}_2$  by convection in these hotspots cause a large source of  $\text{CO}_2$  to the atmosphere (see section 6). Mesozooplankton and hydrographic data have been collected in late austral summer since 1994. Data collected in other seasons are being analyzed. Our aim is to carry out global comparisons to search for teleconnections amongst zooplankton communities and patterns of variability as a result of global climate forcing.

#### 6. Sea-air $\text{CO}_2$ flux: physics, biology or both?

We have estimated the biological (BE) and temperature (TE) effects on seawater  $p\text{CO}_2$  (Fig. 5) using seawater  $p\text{CO}_2$  and SST data collected from 2000 to 2006. The mean difference between ET and EB is  $-43\mu\text{atm}$ . The BE dominates ( $\text{BE} > \text{TE}$ ) in the mid and outer shelf. However,  $\text{TE} > \text{BE}$  in the inner shelf, particularly from 38 to 42°S. The mid and outer shelf regions are strong atmospheric  $\text{CO}_2$  sinks ( $-21 \text{ Tg C y}^{-1}$ ) while the near shore region is a source of  $\text{CO}_2$  ( $4 \text{ Tg C y}^{-1}$ ).

#### 7. Modelling the $\text{CO}_2$ fluxes

To study the coupled physical-biological processes which control primary productivity and carbon dynamics we implemented 1-D configurations of the Regional Ocean Modeling System (ROMS). The

biogeochemical component consists of an NPZD model using nitrogen as the master currency, along with an inorganic carbon component. In addition to radiative and wind forcing, we considered forcing by tides. Results indicate that in mid-shelf locations the annual variability of CO<sub>2</sub> fluxes is largely influenced by the cycle of biological productivity, while in near coastal areas the annual CO<sub>2</sub> variability is dominated by the thermal effect (Fig. 6).

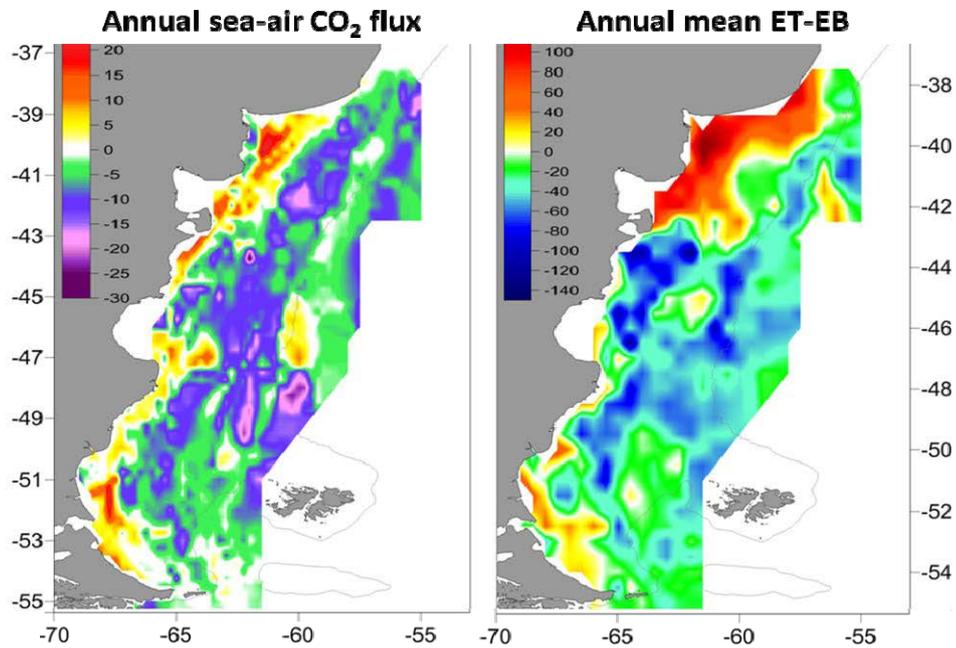


Figure 5: Distribution of annual sea-air CO<sub>2</sub> flux (left) and mean difference between the temperature effect (ET) and biological effect (EB) on the pCO<sub>2</sub> of seawater (right). Bianchi et al., in preparation.

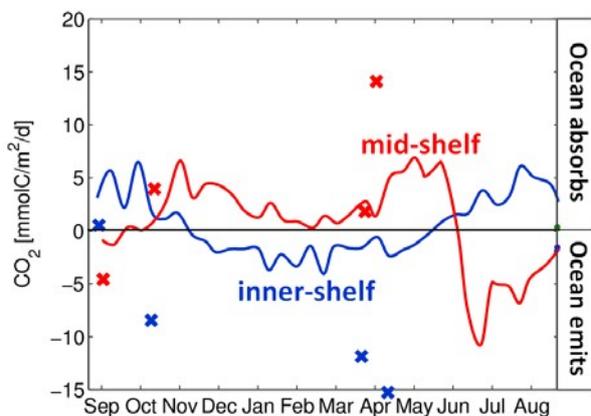


Figure 6: Seasonal variation of sea-air CO<sub>2</sub> fluxes simulated at a mid-shelf location (red) and a near coastal location (blue). Runs with tidal forcing present similar patterns (not shown). Also shown are CO<sub>2</sub> fluxes estimated from in situ data (crosses). Palastanga et al., in preparation.

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## B. Variability of Ocean Ecosystems around South-America (VOCES)

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**Key Words:** Marine Ecosystems, South America, Climate Change

**Funding:** Inter-American Institute for Global Change Research grant CRN3070, through US NSF grant GEO-1128040

**Participating Countries/PIs:** Argentina (Piola, Acha, Campagna, Mianzan), Brazil (Campos, Moller, Muelbert), Chile (Pizarro), Peru (Purca), Uruguay (Defeo), USA (Brink, Matano)

In October 2013 VOCES carried a multidisciplinary oceanographic cruise in the region of transition between the Patagonia and the South Brazil Large Marine Ecosystems. This transition is marked by the Subtropical Shelf Front (STSF), a strong thermohaline front separating Subantarctic Shelf Waters (SASW) and Subtropical Shelf Waters (STSW) (Piola et al., *J. Geophys. Res.*, 2000). Model experiments indicate the front develops by northward advection of southern shelf waters due to along-shelf pressure gradients imposed by an arrested topographic wave from the northernmost penetration of the Malvinas Current (Csanady, *J. Phys. Oceanogr.*, 1978; Palma et al., *J. Geophys. Res.*, 2008). Preliminary analyses of the cruise data confirm that SASW extend northward to  $\sim 32^{\circ}\text{S}$ , where they meet with STSF. The data further suggest that most shelf water masses are then fluxed southward along the front and off the shelf. Satellite and in-situ observations and very high resolution simulations suggest that the export of shelf waters along the STSF is an ubiquitous feature of the SW Atlantic Shelf (Guerrero et al., and Matano et al., submitted). The biogeochemical and biological data collected during the cruise are being analyzed.

Our analyses of the  $\text{CO}_2$  balance of the Patagonia LME indicate that the coastal band, characterized by well mixed waters is a region of strong emission of  $\text{CO}_2$  to the atmosphere ( $3.1 \times 10^{-3} \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ ), while the mid and outer shelf regions are characterized by strong  $\text{CO}_2$  uptake ( $-5.2 \times 10^{-3} \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ ) (Bianchi et al., in preparation). The transition between these distinct regimes is frequently associated with seasonal tidal fronts. The study further indicates that while the  $\text{CO}_2$  fluxes in the emission region is controlled by thermodynamic effects, biological effects clearly dominate the  $\text{CO}_2$  uptake regions. To understand the factors controlling the sharp biogeochemical changes across the tidal fronts we also implemented idealized configurations of the Regional Ocean Modeling System (ROMS). Results from idealized one-dimensional experiments confirm our conclusion that in mid-shelf locations the annual variability of  $\text{CO}_2$  fluxes are largely influenced by the cycle of biological productivity, while in near coastal areas the annual  $\text{CO}_2$  variability is dominated by the thermal effect (Palastanga, in preparation).

To overcome the scarcity of in-situ observations we are using satellite derived data to analyze the large interannual and longer term variability. To further extend the time scales we have implemented regional algorithms which effectively remove biases between SeaWiFS and MODIS radiometers, allowing to extend the time available data to 1997-2013. Preliminary analyses reveal that the northern Patagonia mid and inner shelves, are dominated by a clear seasonal pattern, with maximum concentrations in spring (October-November) and minima in winter (June-August) (Fig. 3). A secondary peak is often observed in fall (April-May). There are positive and significant trends in chlorophyll concentrations and anomalies, suggesting overall increased phytoplankton abundances since 1997 (Marrari, in preparation).

## Belgium

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### 1. Current projects contributing to the IMBER aims and activities:

- BELSPO BIGSOUTH (Biogeochemical Cycles in the Southern Ocean: Role within the Earth System; [www.co2.ulg.ac.be/bigsouth/index.htm](http://www.co2.ulg.ac.be/bigsouth/index.htm))

### 2. IMBER related activities in 2013-2014:

- University of Liège hosted the 45<sup>th</sup> International Liège Colloquium on Ocean Dynamics “Primary production in the ocean: from the synoptic to the global scale” (13-17 May 2013; [modb.oce.ulg.ac.be/colloquium/](http://modb.oce.ulg.ac.be/colloquium/)).
- University of Liège hosted the 46<sup>th</sup> International Liège Colloquium on Ocean Dynamics “Low oxygen environments in marine, estuarine and fresh waters” (5-9 May 2014; [modb.oce.ulg.ac.be/colloquium/](http://modb.oce.ulg.ac.be/colloquium/)).
- Alberto V. Borges is actively contributing as Associate Member to the Implementation Plan of the IMBER-LOICZ Continental Margin Task Team (CMTT).

### 3. IMBER related publications in 2013-2014:

Gypens N, A.V. Borges, G. Speeckaert & C. Lancelot (2014) The Dimethylsulfide Cycle in the Eutrophied Southern North Sea: A Model Study Integrating Phytoplankton and Bacterial Processes. PLoS ONE 9(1): e85862. doi:10.1371/journal.pone.0085862

Gypens N. & A.V. Borges (2014) Increase in dimethylsulfide (DMS) emissions due to eutrophication of coastal waters offsets their reduction due to ocean acidification, Frontiers in Marine Science - Marine Ecosystem Ecology, 1:4, doi: 10.3389/fmars.2014.00004

### 4. Future plans

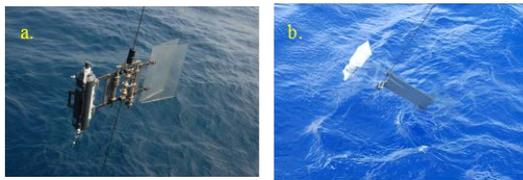
- University of Liège will host the 47<sup>th</sup> International Liège Colloquium on Ocean Dynamics “Data assimilation” (May 2015; [modb.oce.ulg.ac.be/colloquium/](http://modb.oce.ulg.ac.be/colloquium/)).

# China-PRC

## Project 973-III (MEcoPAM)

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The 2013 annual meeting of project 973-III “Sustainability of Marine Ecosystem Production under Multi-stressors and Adaptive Management” was held on March 6-8 in Qingdao, China, with over 70 participants. The project is of five sub-projects. In the meeting, progress report presentations of the five sub-projects were highlighted.



### 1. Sub-project “Biogeochemical Dynamics of Marine Ecosystems” developed new water sampler for trace element analysis and its measure precision is up to the international level:

Stations A3 and C3 were chosen in East China Sea, the result shows the data from our sampler “X-Vane” is consistent with world-wide used sampler “MITESS” under almost 1000 m water depth in measuring trace element concentration of iron and aluminium.

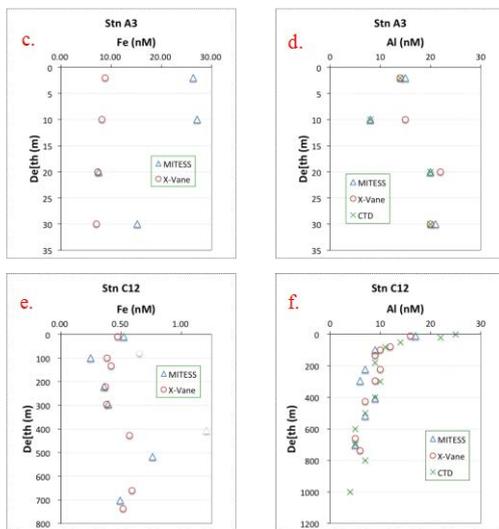
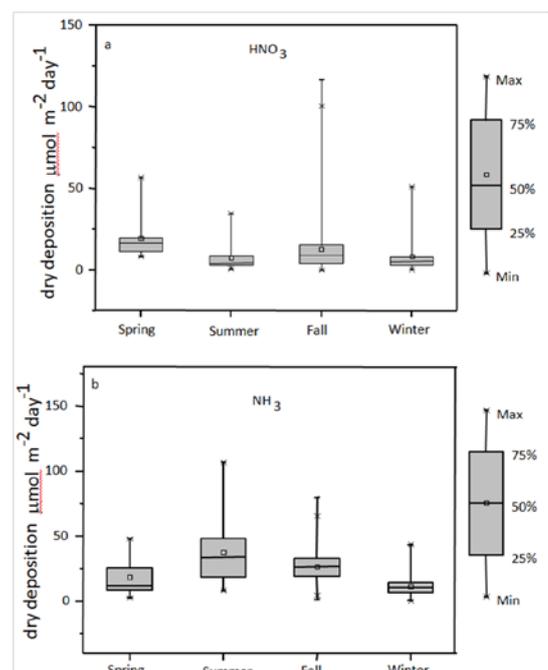


Fig.1. a: “X-vane” sampler; b: “MITESS” sampler); c & d: Fe and Al concentration in A3 station (122°58.468', 31°41.645'); e & f: Fe and Al concentrations in C12 station (27°4.382', 28°6.859')

### 2. Sub-project “Nutrient Cycles and Response to Multi-stressors” calculated the contribution of nitric acid (HNO<sub>3</sub>) and ammonia (NH<sub>3</sub>) to atmospheric nitrogen deposition:

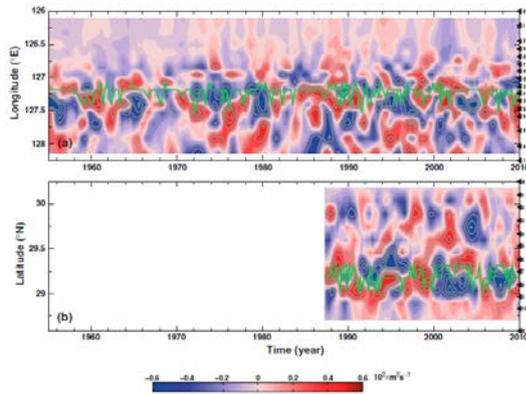
During May 2012 to January 2013, the average dry deposition flux of HNO<sub>3</sub> and NH<sub>3</sub> in Qingdao atmosphere were 11.0 μmol·m<sup>-2</sup>·day<sup>-1</sup> and 21.9 μmol·m<sup>-2</sup>·day<sup>-1</sup> which is 1.2 times of the total dry aerosol deposition flux of NO<sub>3</sub><sup>-</sup> + NH<sub>4</sub><sup>+</sup> in the of East China Sea atmosphere, about 30% atmospheric nitrogen flux ignored was re-calculated from nitric gas deposition.

Fig.2 a: deposition flux of HNO<sub>3</sub>; b: deposition flux of NH<sub>3</sub>



### 3. Sub-project “Response of the Hydrodynamics to Multi-stressors and Its impact on the Supply of Nutrients” using hydrographic data flow field in order to analyze the temporal and spatial variability of the Kuroshio Current

The temporal and spatial variability of the Kuroshio Current in the PN section was dominated by a transport mode, manifested by the high variability of current on the seaward side of current core with expansion or shrinkage of the core.

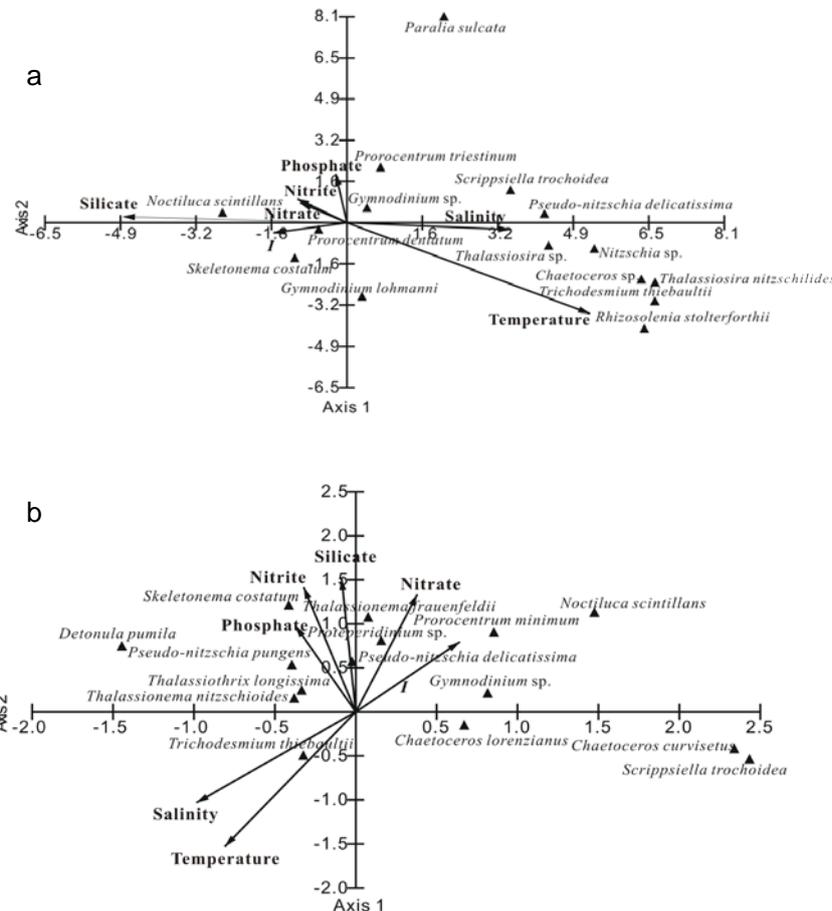


In contrast, the temporal and spatial variability of the Kuroshio Current in the TK section was dominated by a meandering mode, as indicated by the migration of the Kuroshio axis in the south gap of the Tokara Strait.

Fig.3. a: Anomalies in Kuroshio volume transport per unit width in the PN section smoothed by a 1-year moving average. b: Anomalies in Kuroshio volume transport per unit width in the TK section smoothed by a 1-year moving average. Heavy green lines indicate the Kuroshio axis in the PN and TK sections

### 4. Sub-project “Microbial Loop and Coupling with Biogeochemical Cycles”

It focuses on the characteristics of the plankton community structure in the East China Sea and found the correlation between the dominant species distribution and environmental factors such as salinity, nutrition concentration and temperature: In spring, *Prorocentrum dentatum* tend to survive in stable water areas with high nitrate concentration,



*Trichodesmium thiebaultii* and *Rhizosolenia stolterforthii* tend to survive in water area with high temperature. In summer, *Skeletonema costatum*, *Pseudo-nitzschia pungens* and *Pseudo-nitzschia delicatissima* tend to survive in areas with high phosphate and nitrate concentration, *Trichodesmium thiebaultii* tend to survive in water area with high temperature and high salinity

Fig.4. a quadrantal diagram of correlation between species distribution and environmental factors in spring. b quadrantal diagram of correlation between species distribution and environmental factors in summer. Upper left quadrant represents the low salinity, high nutrient concentrations of inshore water, the lower right quadrant represents water of high salinity and low nutrient concentration

## 5. Sub-project “Feedback Mechanisms of Ecosystem Structure and Function to Climate Change and Human Activities”

It focuses on the influence of carbonate in seawater on scallop growth, performed and evaluated the ecological function of three integrated cultivation systems including scallop-seaweed, nereid - *Paralichthys olivaceus* and scallop - *Apostichopus japonicus* integrated cultivation systems in Sanggou Bay: scallop can effectively reduce the partial pressure of carbon dioxide in water body and carbonate in seawater can promote calcification ability of scallop. Nereid and *Apostichopus japonicus* can effectively reducing sedimentary environment pollution in fish, shellfish cultivation.

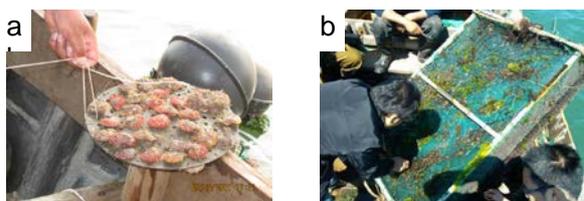


Fig.5 a scallop-seaweed system; b scallop- *Apostichopus japonicus* system

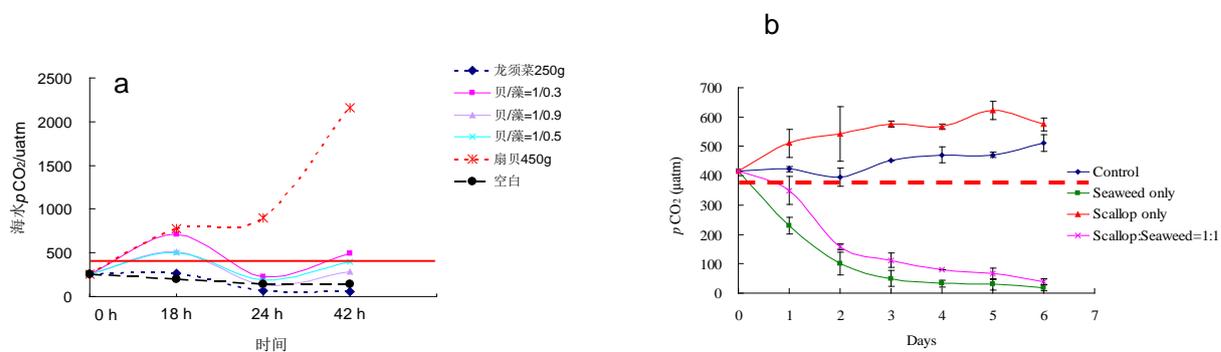


Fig.6 a: The curve of pCO<sub>2</sub> by day in different ratios of scallop-seaweed in August 2011 in Sanggou Bay; b: The curve of pCO<sub>2</sub> by day in different ratios of scallop-seaweed in July 2013 in Sanggou Bay

## China-Taiwan

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### Effects of Global Change on Ocean Biogeochemistry and Ecosystems in the Seas surrounding Taiwan in the Northwest Pacific (ECOBEST)

**Aim:** How external drivers (such as dust deposition, river discharges, increasing  $p\text{CO}_2$ ) and physical forcing (such as boundary currents, tides and internal waves, monsoons and typhoons) control the biogeochemistry and marine ecosystem of the western North Pacific Ocean near Taiwan

**Start date:** 1 August 2011 **End date:** 31 July 2014

**Major funding source:** Ministry of Science and Technology, Taiwan

#### 1. Synthesis of observed air-sea $\text{CO}_2$ exchange fluxes in the river-dominated East China Sea and improved estimates of annual and seasonal net mean fluxes from 1998 to 2011 (Tseng et al., 2014).

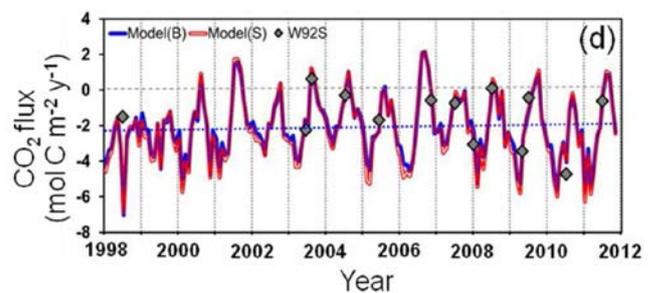
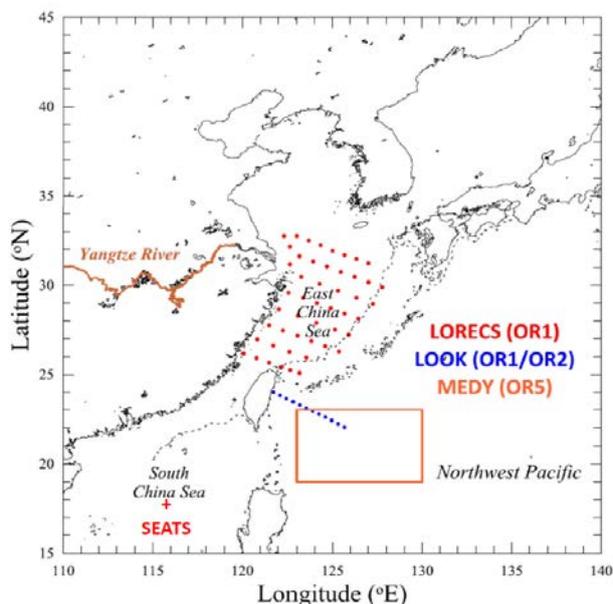


Fig. 1. (Right panel) Map showing the survey area of ECOBEST in the western North Pacific Ocean. (Left panel) Time-series of monthly mean sea-to-air  $\text{CO}_2$  flux in sea surface of the ECS shelf from 1998 to 2011 (Tseng et al., 2014). The symbols represent estimates of fluxes based on shipboard observations and the gas exchange coefficient of Wanninkhof (1992).

Limited observations exist for reliable assessment of annual  $\text{CO}_2$  uptake that takes into consideration the strong seasonal variation in the river-dominated East China Sea (ECS). Tseng et al. (2014) explored seasonally representative  $\text{CO}_2$  uptakes by the whole East China Sea derived from observations over a 14-year period. They first identified the biological sequestration of  $\text{CO}_2$  taking place in the highly productive, nutrient-enriched Changjiang river plume, dictated by the Changjiang river discharge in warm seasons. Then they established an empirical algorithm to predict sea surface  $p\text{CO}_2$  using Changjiang discharge and SST as the master variable. Thus they constrained the annually averaged  $\text{CO}_2$  uptake during 1998-2011 to  $1.9 \text{ mol C m}^{-2} \text{y}^{-1}$ . This assessment of annual  $\text{CO}_2$  uptake is more reliable and representative than previous estimates, in terms of temporal and spatial coverage. Additionally, the  $\text{CO}_2$  time-series, exhibiting distinct seasonal pattern, gives mean fluxes of  $-3.0$ ,  $-1.0$ ,  $-0.9$  and  $-2.5 \text{ mol C m}^{-2} \text{y}^{-1}$  in spring, summer, fall and winter, respectively, and also reveals apparent inter-annual variations. The weak sink status during warm seasons is sensitive to changes of  $p\text{CO}_2$  and may easily shift from a sink to a source due to environmental changes under climate change and anthropogenic forcing.

#### 2. Carbonate mineral saturation states in the East China Sea: present conditions and future scenarios (Chou et al., 2013b).

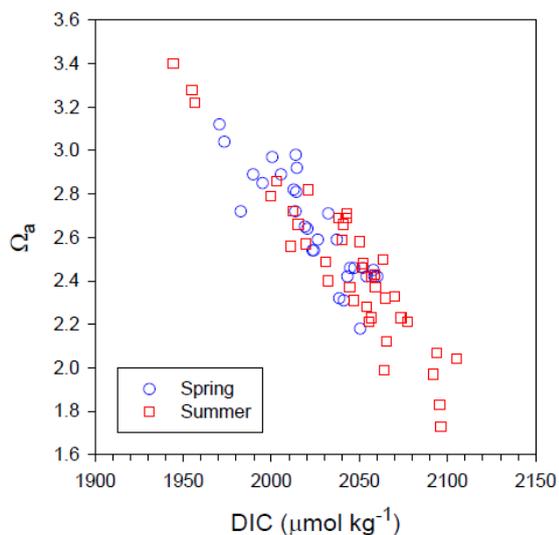


Fig. 2 Plots of  $\Omega_a$  vs. DIC for the bottom waters in the East China Sea during summer 2009, showing the strong control of DIC on carbonate saturation.

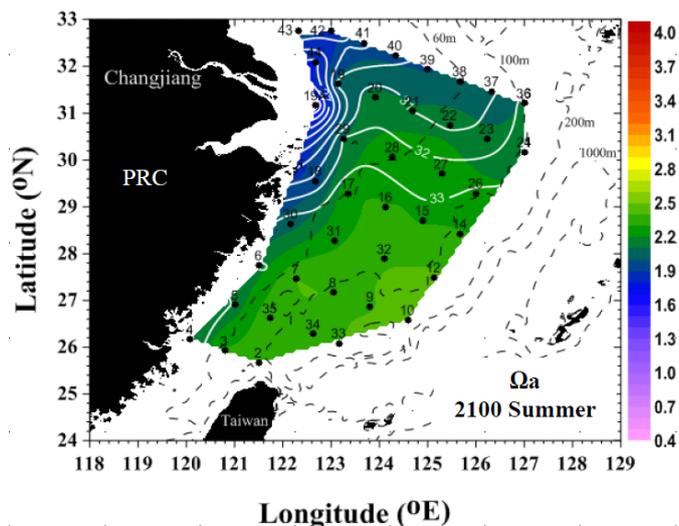


Fig. 3. Predicted surface water  $\Omega_a$  on the East China Sea shelf in summer by the year 2100. Superimposed white lines are isohalines showing the influence of the Changjiang runoff.

Chou et al. (2013b) assess the impact of rising atmospheric  $\text{CO}_2$  and eutrophication on the carbonate chemistry of the East China Sea shelf waters by estimating the saturation states ( $\Omega$ ) for two important biogenic minerals, calcite ( $\Omega_c$ ) and aragonite ( $\Omega_a$ ). Results show that the highest  $\Omega_c$  ( $\sim 9.0$ ) and  $\Omega_a$  ( $\sim 5.8$ ) values were found in surface water of the Changjiang plume area in summer, whereas the lowest values ( $\Omega_c \sim 2.7$  and  $\Omega_a \sim 1.7$ ) were concurrently observed in the bottom water of the same area. This divergent behavior of saturation states in surface and bottom waters was driven by intensive biological production and strong stratification of the water column. The high rate of phytoplankton production, stimulated by the enormous nutrient discharge from the Changjiang, acts to decrease the ratio of DIC to TA, and thereby increases  $\Omega$  values. In contrast, remineralization of organic matter in the bottom water acts to increase the DIC to TA ratio, and thus decreases  $\Omega$  values. The projected result shows that continued increases of atmospheric  $\text{CO}_2$  under the IS92a emission scenario will decrease  $\Omega$  values by 40-50% by the end of this century, but both the surface and bottom waters will remain supersaturated with respect to calcite and aragonite. Nevertheless, superimposed on such  $\Omega$  decrease is the increasing eutrophication, which would mitigate or enhance the  $\Omega$  decline caused by anthropogenic  $\text{CO}_2$  uptake in surface and bottom waters, respectively. Our simulation reveals that, under the combined impact of eutrophication and augmentation of atmospheric  $\text{CO}_2$ , the bottom water of the Changjiang plume area will become undersaturated with respect to aragonite ( $\Omega_a \sim 0.8$ ) by the end of this century, which would threaten the health of the benthic ecosystem.

#### **List of peer-reviewed publications:**

- Chang, F.H., Marquis, E.C., Chang, C.W., Gong, G.C., Hsieh, C.H. (2013). Scaling of growth rate and mortality with size and its consequence on size spectra of natural microphytoplankton assemblages in the East China Sea. *Biogeosciences*, 10(8), 5267-5280 10.5194/bg-10-5267-2013.
- Chen, C.C., Gong, G.C., Shiah, F.K., Chou, W.C., Hung, C.C. (2013). The large variation in organic carbon consumption in spring in the East China Sea. *Biogeosciences*, 10(5), 2931-2943 10.5194/bg-10-2931-2013.
- Chen, W.Y., Lee, M.A., Lan, K.W., Gong, G.C. (2014). Distributions and assemblages of larval fish in the East China Sea during the northeasterly and southwesterly monsoon seasons of 2008. *Biogeosciences*, 11(3), 547-561 10.5194/bg-11-547-2014.
- Chou, W.C., Gong, G.C., Cai, W.J., Tseng, C.M. (2013a). Seasonality of  $\text{CO}_2$  in coastal oceans altered by increasing anthropogenic nutrient delivery from large rivers: evidence from the Changjiang-East China Sea system. *Biogeosciences*, 10(6), 3889-3899 10.5194/bg-10-3889-2013.
- Chou, W.C., Gong, G.C., Hung, C.C., Wu, Y.H. (2013b). Carbonate mineral saturation states in the East China Sea: present conditions and future scenarios. *Biogeosciences*, 10(10), 6453-6467 10.5194/bg-10-6453-2013.
- Hsiao, S.S.Y., Hsu, T.C., Liu, J.w., Xie, X., Zhang, Y., Lin, J., Wang, H., Yang, J.Y.T., Hsu, S.C., Dai, M., Kao, S.J. (2014).

- Nitrification and its oxygen consumption along the turbid Chang Jiang River plume. *Biogeosciences*, 11(7), 2083-2098 10.5194/bg-11-2083-2014.
- Hung, C.C., Tseng, C.W., Gong, G.C., Chen, K.S., Chen, M.H., Hsu, S.C. (2013). Fluxes of particulate organic carbon in the East China Sea in summer. *Biogeosciences*, 10(10), 6469-6484 10.5194/bg-10-6469-2013.
- Lai, C.C., Fu, Y.W., Liu, H.B., Kuo, H.Y., Wang, K.W., Lin, C.H., Tai, J.H., Wong, G.T.F., Lee, K.Y., Chen, T.Y., Yamamoto, Y., Chow, M.F., Kobayashi, Y., Ko, C.Y., Shiah, F.K. (2014). Distinct bacterial-production-DOC-primary-production relationships and implications for biogenic C cycling in the South China Sea shelf. *Biogeosciences*, 11(1), 147-156 10.5194/bg-11-147-2014.
- Lin, K.Y., Sastri, A.R., Gong, G.C., Hsieh, C.H. (2013). Copepod community growth rates in relation to body size, temperature, and food availability in the East China Sea: a test of metabolic theory of ecology. *Biogeosciences*, 10(3), 1877-1892 10.5194/bg-10-1877-2013.
- Liu, K.K., Wang, L.W., Dai, M., Tseng, C.M., Yang, Y., Sui, C.H., Oey, L., Tseng, K.Y., Huang, S.M. (2013). Inter-annual variation of chlorophyll in the northern South China Sea observed at the SEATS Station and its asymmetric responses to climate oscillation. *Biogeosciences*, 10(11), 7449-7462 10.5194/bg-10-7449-2013.
- Tsai, A.Y., Gong, G.C., Hung, J. (2013). Seasonal variations of virus- and nanoflagellate-mediated mortality of heterotrophic bacteria in the coastal ecosystem of subtropical western Pacific. *Biogeosciences*, 10(5), 3055-3065 10.5194/bg-10-3055-2013.
- Tseng, C.-M., Shen, P.-Y., Liu, K.-K. (2014a). Synthesis of observed air-sea CO<sub>2</sub> exchange fluxes in the river-dominated East China Sea and improved estimates of annual and seasonal net mean fluxes. *Biogeosciences*, 11, (Accepted).
- Tseng, Y.F., Lin, J., Dai, M., Kao, S.J. (2014b). Joint effect of freshwater plume and coastal upwelling on phytoplankton growth off the Changjiang River. *Biogeosciences*, 11(2), 409-423 10.5194/bg-11-409-2014.

#### **Upcoming activities relevant to IMBER:**

The SEATS (South-East Asian Time-series Study) project will be re-launched by the Research Center for Environmental Changes, Academia Sinica located in Taipei, Taiwan. Regular cruises will be organized to survey the chemical hydrography surrounding the SEATS station (Fig. 1) and to maintain sediment trap deployments with assistance from the Taiwan Ocean Research Institute of the National Applied Laboratories.

A new integrated research project, eCOASTS (Environmental and Coastal Observation, Analysis and Simulation for Taiwanese Seas), will be launched in August 2014. The coastal zones along the 1139 km shoreline of Taiwan are exploited to meet various needs, causing the coastal zone to become an area of competing uses. Unrestrained use of coastal zones has resulted in rapid degradation of coastal environments and deterioration of coastal zone ecosystems. In order to balance environmental protection, public uses and socioeconomic development, there is an urgent need to develop innovative management strategy to resolve the conflicts between competing factions for the use of environmentally sensitive coastal resources. It has been proposed to develop a framework for integrative coastal research, which will lead to the provision of the knowledge, understanding and prediction needed to allow coastal communities to assess, anticipate and respond to the coastal changes.

#### **Any suggestions of new potential collaboration for IMBER:**

Inter-comparison of marine biogeochemistry and ecosystems in continental margins around the world, such as the East China Sea, South China Sea, Japan/East Sea, Andaman Sea, the Caribbean Sea, Gulf of Mexico, etc.

## Germany

### BIOACID Phase II

Contact person: **Arne Körtzinger**, [akoertzinger@geomar.de](mailto:akoertzinger@geomar.de)

The main objectives of BIOACID Phase II are to:

1. strengthen the integration within the BIOACID community to allow for more realistic community-level experimentation and field observation
2. focus more strongly on interacting affects through multiple stressors
3. expand evolutionary biology to assess the potential for adaptation of key taxa
4. integrate socio-economic assessments and stakeholder involvement

The overarching focus of BIOACID II is to address and better understand the chain from biological mechanisms, through individual organism responses, through food web and ecosystem effects, to economic impacts.

### Main scientific activities in 2013 / 2014

Regarding the strengthening of integration within the BIOACID community, especially the successful completions of the joint experiments and expeditions which involved the different consortia served this purpose.

Among these were mainly:

- The five-month lasting mesocosm - field experiment at Kristineberg in the Gullmarfjord / Sweden from January to June 2013 (see also [here](#)). There 69 participants studied the effects of ocean acidification on the whole planktic community.
- Combined effects of warming and ocean acidification (keyword: multiple stressors) on planktic communities were studied in two long-term - experiments with the Kiel Indoor mesocosms.
- Several long-term field experiments with the so-called Benthocosms in Kiel and on the island of Sylt were conducted to explore the benthic community. These mesocosms offer besides the control of pH and other parameters, the defined adjustment of the temperature (keyword: multiple stressors)
- The impacts of natural CO<sub>2</sub> - sources on the resident organisms (e.g. corals and macroalgae) were analyzed during a several weeks lasting ship expedition to Papua - New Guinea (see also [here](#)).

Studies on the adaptability of organisms to ocean acidification were carried out during the above-mentioned mesocosm experiment in Kristineberg.

Regarding the attempts to estimate the Socio-Economic Impact of ocean acidification the successful involvement of different stakeholders should be mentioned here (see also [here](#)).

### Future national research plans and priorities

- In September / October 2014, a next major mesocosm experiment is planned off the coast of Gran Canaria. There will be simulated upwelling events in addition to ocean acidification.
- At the moment the BIOACID community plans a third phase of BIOACID that will focus exclusively on the synthesis of the data obtained in the first six years of BIOACID.

## Greece

National contacts: **Alexandra Gogou**, [agogou@hcmr.gr](mailto:agogou@hcmr.gr) and **Constantin Frangoulis**, [cfrangoulis@hcmr.gr](mailto:cfrangoulis@hcmr.gr)

### IMBER-relevant projects

#### **Spatially resolved Ecosystem models and their Application to Marine MANagement (SEAMAN)**

**Start date:** 1/1/2013; **End date:** 31/12/2015

**Website:** [www.org.uib.no/seaman](http://www.org.uib.no/seaman)

**Major funding sources:** EU FP7 ERA-NET scheme

#### **Aim & Major achievements related to IMBER**

SEAMAN aims to 1) improve understanding of the marine ecosystem functioning and its spatio-temporal variations to address currently existing challenges in 3D ecosystem models, 2) Develop new and advanced spatially explicit modeling tools capable to resolve the combined influence of multiple ecosystem drivers, 3) advance the understanding of climatic induced variations in habitats and their implications for fisheries management, 4) Integrate state of the art understanding of bio-accumulation of pollutants and invasive species into coupled NPZD-fish models and advance the knowledge base on the risk of spatial variations in exposure to pollutants, 5) Provide a new and/or expanded database on observational based primary production estimates and phyto/zooplankton size-spectra data, and a compiled database from historic fish data and a construction of seasonally resolved habitat maps

#### **List of peer-reviewed publications:**

Politikos, D., Somarakis, S., Tsiaras, K., Giannoulaki, M., Petihakis, G., Machias, A., and G. Triantafyllou, 2014: Simulating anchovy's full life cycle in the eastern Mediterranean: a coupled hydro-biogeochemical-IBM model, **submitted** to Progress in Oceanography

#### **Technological and Oceanographic cooperation network for the study of mechanisms fertilizing the N.E. Aegean Sea (THALES-AegeanMarTech)**

**Start date:** 1/5/2012; **End date:** 30/9/2015

**Website:** [thales-aegeanmartech.hcmr.gr/en](http://thales-aegeanmartech.hcmr.gr/en)

**Major funding sources:** European Social Fund and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework Research Funding Program: THALES. Investing in knowledge society through the European Social Fund.

#### **Aim & Major achievements related to IMBER**

This project aims to investigate 1) the contribution of the water exchange between the Black Sea and the Mediterranean to the observed increased productivity of the N.E. Aegean and 2) the impact of wind-forced coastal upwelling observed each summer in the E. Aegean on the fertilization of surface waters with nutrients, the ocean-atmosphere CO<sub>2</sub> exchange rates and the functioning of the ecosystem. A mooring east of Lemnos and two coastal HF circulation radars (E. Lemnos) provide measurements of the horizontal buoyancy flux, that coupled to the *in situ* seasonal sampling will allow estimations of fluxes of nutrients, organic carbon, phosphorus and nitrogen entering the North Aegean through the Straits.

#### **Atmospheric Deposition And Mediterranean sea water Productivity (THALES-ADAMANT)**

**Start date:** 1/3/2012; **End date:** 30/9/2015

**Website:** [www.thales-adamant.hcmr.gr](http://www.thales-adamant.hcmr.gr)

**Major funding sources:** European Social Fund and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework Research Funding Program: THALES. Investing in knowledge society through the European Social Fund.

#### **Aim & Major achievements related to IMBER**

The ADAMANT project combines atmospheric and sea-water measurements and controlled mesocosm experiments, with a marine biogeochemical/ecosystem model forced by an atmospheric

chemistry/transport/deposition model. This study aims to assess the impact of atmospheric deposition of nutrients on Mediterranean Sea's primary production, population distribution and flows of carbon in the food chain over time; beginning from the preindustrial era up to future years (hind cast, present and forecast simulations).

**List of peer-reviewed publications:**

Im U., Christodoulaki S., Violaki K., Zampas P., Kocak M., Mihalopoulos N. and Kanakidou M., 2013. "Atmospheric deposition of nitrogen and sulfur over Europe with focus on the Mediterranean and Black Sea". Atmospheric Environment, doi: 10.1016/j.atmosenv.2013.09.048.

**Towards COast to COast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential (CoCoNet)**

**Start date:** 01/02/12; **End date:** 31/01/2016

**Website:** [www.coconet-fp7.eu](http://www.coconet-fp7.eu)

**Major funding sources:** EU FP7 for research, technological development and demonstration

**Aim & Major achievements related to IMBER**

The Project aims to identify groups of putatively interconnected Marine Protected Areas (MPAs) in the Mediterranean and the Black Seas, shifting from local (single MPA) to regional (Networks of MPAs) and basin scales. The identification of physical and biological connections with clear the processes that govern patterns of biodiversity distribution. This will enhance policies of effective environmental management, also to ascertain if the existing MPAs are sufficient for ecological networking and to suggest how to design further protection schemes based on effective exchanges between protected areas. The coastal focus will be widened to off shore and deep sea habitats, comprising them in MPAs Networks. These activities will also individuate areas where Offshore Wind Farms might become established, avoiding too sensitive habitats but acting as stepping stones through MPAs. Socioeconomic studies will integrate to knowledge-based environmental management aiming at both environmental protection (MPAs) and clean energy production (OFW). Current legislation is crucial to provide guidelines to find legal solutions to problems on the use of maritime space. Two pilot projects (one in the Mediterranean Sea and one in the Black Sea) will test in the field the assumptions of theoretical approaches. The project will produce the guidelines to design, manage and monitor network of MPAs, and an enriched wind atlas for both the Mediterranean and the Black Seas, creating a permanent network of excellent researchers (e.g. with summer schools) that will work together also in the future, making their expertise available to their countries and to the European Union.

**List of peer-reviewed publications:** see CoCoNet website for a full list of publications

**Policy-oriented marine Environmental Research in the Southern EUropean Seas (PERSEUS)**

**Start date:** 1/1/2012; **End date:** 31/12/2015

**Website:** [www.perseus-net.eu](http://www.perseus-net.eu)

**Major funding sources:** EU FP7 Theme "Oceans of Tomorrow"

**Aim & Major achievements related to IMBER**

PERSEUS (an IMBER endorsed project) aims to identify the interacting patterns of natural and human-derived pressures on the Mediterranean and Black Seas (SES), assess their impact on marine ecosystems and, using the objectives and principles of the Marine Strategy Framework Directive (MSFD) as a vehicle, to design an effective and innovative research governance framework based on sound scientific knowledge. Well-coordinated scientific research and socio-economic analysis will be applied at a wide-ranging scale, from basin to coastal. The new knowledge will advance our understanding on the selection and application of the appropriate descriptors and indicators of the MSFD. New tools will be developed in order to evaluate the current environmental status, by way of combining monitoring and modelling capabilities and existing observational systems will be upgraded and extended. In view of reaching Good Environmental Status (GES), a scenario-based framework of adaptive policies and management schemes will be developed. Scenarios of a suitable time frame and spatial scope will be used to explore interactions between projected anthropogenic and natural pressures. A feasible and realistic adaptation policy framework will be defined and ranked in relation to vulnerable marine

sectors/groups/regions in order to design management schemes for marine governance. Finally, the project will promote the principles and objectives outlined in the MSFD across the SES.

**List of peer-reviewed publications:** see PERSEUS website for a full list of publications

### **KRIPIS Greek National Project**

**Start date:** 1/1/2014; **End date:** 31/12/2015

**Website:** Under construction

**Major funding sources:** Greek General Secretary of Research and Technology

#### **Aim & Major achievements related to IMBER**

The overall aim related to IMBER activities is to determine the present state of the natural drivers (atmospheric forcing, physical properties and circulation and matter transfer processes) in order to develop a comprehensive description of carbon fluxes and associated mineral ballast fluxes throughout the water column in three deep sites at the north and south Aegean Sea and the eastern Ionian Sea. These dynamically active areas present unique physiographic and hydrodynamical characteristics and plays important role in the regime of the Mediterranean. To achieve this goal, we will measure simultaneously a suite of biogeochemical properties in the water column and sinking matter captured by sediment traps: (i) organic biogeochemistry for characterizing organic matter and determining its degradation state; (ii) stable isotope characterization ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) and radiochemistry ( $^{234}\text{Th}$ ) for assessing processes and time-scales involved in particle dynamics and transport; (iii) marine aggregates and zooplankton pellets/ carcasses etc for assessing organic matter alteration; and (iv) microbiology for its role in organic matter decomposition, and (v) modelling and statistical analyses to provide a process-based model of flux out of the euphotic zone to the sea floor.

### **Mediterranean Sea Acidification in a changing climate (MedSea)**

**Start date:** 1/2/2011; **End date:** 31/07/14

**Website:** [www.medsea-project.eu](http://www.medsea-project.eu)

**Major funding sources:** EU FP7

#### **Aim & Major achievements related to IMBER**

MedSea (an IMBER endorsed project) aims to 1) identify where the impacts of acidification on Mediterranean waters will be more significant, taking into account the sequence of causes and effects, from ocean chemistry through marine biology to socio- economic costs, 2) generate new observational and experimental data on Mediterranean organism and ecosystem responses to acidification and fed into existing fine-scale models of the Mediterranean Sea that are modified to better represent key processes, and then used to project future changes. The MedSea project focuses on a selected set of key ecosystem and socio-economic variables that are likely to be affected by both acidification and warming, studying the combination of both effects through ship-based observations, laboratory and mesocosm experiments, physical-biogeochemical-ecosystem modelling, and economical analyses, 3) provide best estimates and related uncertainties of future changes in Mediterranean Sea pH,  $\text{CaCO}_3$  saturation states, and other biogeochemical-ecosystem variables, assessing the changes in habitat suitability of relevant ecological and economically-important species.

**List of peer-reviewed publications:** see MEDSEA website for a full list of publications

### **European Multidisciplinary Seafloor & water column Observatory (EMSO)**

**Start date:** 2012; **End date:**

**Website:** [www.emso-eu.org](http://www.emso-eu.org); [www.emso-eu.org/infrastructure/emso-sites-description.html?id\\_site=11](http://www.emso-eu.org/infrastructure/emso-sites-description.html?id_site=11)

**Major funding sources for Greece:** The Greek Research Funding Agency (General Secretariat for Research/Ministry of Development)

#### **Aim & Major achievements related to IMBER**

EMSO is a European network of fixed point, deep sea observatories with the basic scientific objective of real-time, long-term monitoring of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere. It is a geographically distributed infrastructure composed of

several deep-seafloor and water-column observatories, which will be deployed at key sites in European waters, spanning from the Arctic, through the Atlantic and Mediterranean, to the Black Sea.

**List of peer-reviewed publications:**

**IMBER-relevant activities or events (conferences, workshops, meetings) that have taken place during the last year:**

- Joint PERSEUS-COCONET Scientific Workshop (27-30 January 2014, Athens, Greece).
- Workshop on Offshore Wind Farm development in the Mediterranean and Black Seas, HCMR, Anavyssos, 9-10 June 2014
- Plymouth, UK, 30 June-4 July 2014: AMEMR IV Advances in Marine Ecosystem Modelling Research (Oral: Sensitivity experiments of an anchovy full-life cycle model, two-way coupled with a biogeochemical model in the N. Aegean Sea)
- -EGU, Vienna, 27 April - 02 May 2014. Session: Atmospheric Deposition to the Ocean: Impacts on Marine Biogeochemistry - session arises from the work of GESAMP Working Group 38 on 'Atmospheric Deposition of Nitrogen and Its Impact on Marine Biogeochemistry.

**Upcoming activities relevant to IMBER:**

- PERSEUS Scientific Workshop (1-4 December 2014, Marrakesh, Morocco)
- AegeanMarTech Scientific workshop (20-22 October 2014, Mytilene, Lesvos, Greece,)
- 11<sup>th</sup> Panhellenic Symposium of Oceanography & Fisheries, 13-17/5/2015, Mytilene, Lesvos, Greece
- Workshop on Best Practice Guidelines for Managing and Monitoring MPA Networks (Mallorca, Spain on 6-7 October 2014)
- EurOCEAN 2014, 7-9 October 2014, Rome, Italy. Forum for the marine and maritime research community and wider stakeholders to interface with European and Member State policymakers and strategic planners, to consider, discuss and respond to new marine science and technology developments, challenges and opportunities.
- 2nd International Ocean Research Conference (17-21 November 2014, Barcelona, Spain). Plan the coming decade of international collaboration in marine science and technology, with a view to improving ocean governance. PERSEUS coordinator co-organises a session for young scientists.

**Any suggestions of new potential collaboration for IMBER:**

PERSEUS EU Project Endorsement to IMBER is offering a platform for future collaboration in both scientific and policy aspects.

## Japan

National contact: **Hiroshi Ogawa**, [hogawa@aori.u-tokyo.ac.jp](mailto:hogawa@aori.u-tokyo.ac.jp)

### 1. Research Cruise

The research cruise of R/V *Hakuho-maru* (KH-13-7, P.I. Drs. H. Ogawa, T. Atsushi, M. Sato) was conducted during December 11, 2013-February 12, 2014 in the central South Pacific. This cruise is entitled “3-D mapping of the Pacific Ocean according to integrated marine biogeochemistry and ecosystem research”, in which Japanese marine scientists related to IMBER projects participated. This cruise consisted of three legs, including Leg 1 (from Tokyo on December 11 to Pago-Pago on December 26, 2013), Leg 2 (from Pago-Pago on January 2 to Auckland on January 22, 2014) and Leg 3 (from Auckland on January 26 to Tokyo on February 12, 2014). The main focus of this cruise was a meridian full-depth survey of the central South Pacific along 170°W between equator and 40°S, which covered several geographical domains of the Pacific Ocean in the southern hemisphere with different biogeochemical and ecological properties, including equatorial upwelling system, oligotrophic subtropical gyre, and sub-Antarctic system. It is expected that the detailed distributions and the fluxes of a variety of chemical and biological parameters along the north-south transect in the central South Pacific could be integrated for deep understanding the biogeochemical cycles and ecological dynamics in the Pacific Ocean. Subsequently, we’ are now going on another research cruise of the meridian survey along 170°W in the central North Pacific, that is on KH-14-3 cruise of R/V *Hakuho-maru* (P.I. Dr. H. Ogawa) during June 23 - August 11, 2014. By connecting both cruise of KH-13-7 and KH-14-3, we could get comprehensive information of the biogeochemical cycles and ecological dynamics in the whole central Pacific Ocean.

### 2. Symposium

The meeting, the 6<sup>th</sup> China-Japan-Korea (CJK) - IMBER, was held in Japan at the University of Tokyo (3-4 October, 2013). At this international symposium on the marine systems of the Pacific region of East Asia, scientists concluded that changes in the ocean environment are having a significant effect on biogeochemical cycles and ecosystems and, consequently, on humans and the food supply (H. Ogawa *et al.*, in *EOS*, **95**, 66, 2014).

### 3. National research programme

The national research program entitled “New Ocean Paradigm on Its Biogeochemistry, Ecosystem and Sustainable Use” (NEOPS, chief scientist: Dr. K. Furuya, University of Tokyo) is now going on. This program is funded as a large-scale research fund “Scientific Research on Innovative Area” sponsored by Ministry of Education, Culture, Sports, Science and Technology-Japan (2012-2016). The core members are from IMBER-related group in Japan including both the natural sciences and the social sciences ([ocean.fs.a.u-tokyo.ac.jp/index-e.html](http://ocean.fs.a.u-tokyo.ac.jp/index-e.html)).

## Project “Study of Kuroshio Ecosystem Dynamics for Sustainable Fisheries” (SKED)

Contact person: **Hiroaki Saito**, [hsaito@aori.u-tokyo.ac.jp](mailto:hsaito@aori.u-tokyo.ac.jp)

Kuroshio is a western boundary current of the North Pacific Ocean, transporting oligotrophic subtropical water. In spite of the low nutrient concentration, various fish species use the region for spawning and nursery grounds, and the Kuroshio region is a good fishing ground. In order to understand the mechanisms of high fisheries productivity from oligotrophic condition, i.e., *Kuroshio Paradox*, and to find a way for sustainable use of the ecosystem services, we started an interdisciplinary research project SKED in October 2011, funded by the MEXT (Ministry of Education, Culture, Sports, Science and Technology, Japan). SKED is a 10-years project to 2021.

We carried out several cruises in the past 2-years and developed mathematical model to solve the issues. Because of year-round spawning by various fish species, it is expected various nutrient supply mechanisms support the primary productivity in different timing and locations. Kuroda et al. (2013) developed fine-scale ROMS ( $1/50^\circ$ ) and determined the control factor of winter mixing layer depth, which support early spring production of the Kuroshio ecosystem. Nagai et al. (2012) examined turbulent dissipation across the Kuroshio front, which is estimated to support late-spring to summer nutrient supply, and found quite high turbulent dissipation ( $10^{-7}$  to  $10^{-6}$  W kg<sup>-1</sup>) at the subsurface layer of the Kuroshio front. Zonal distribution of high back-rotated ageostrophic shear ( $uz+by/f$  s<sup>-1</sup>) indicates trapping/stalling near inertial waves under the Kuroshio which likely induce observed high turbulent. Umezawa et al. (2014) examined seasonal variation in the contributions of the Changjiang River and the Kuroshio Current to nitrate dynamics in the continental shelf of the northern East China Sea by means of nitrate dual isotopic composition approach.

For ecosystem structure, Endo and Suzuki (in prep.) found nanophytoplankton (haptophytes, green algae) were dominant in phytoplankton assemblage. Hirata et al (in prep.) developed new remote sensing algorithm to estimate phytoplankton category-specific primary production. Haptophytes are most important primary producer, and diatoms are minor contributor even in the spring bloom period. Key zooplankton transferring nanophytoplankton production to fishes is poechilostomatoid copepods, esp. for *Oncaea* spp. and *Sapphirina* spp. Nishibe et al. (in revision) found main prey of *Oncaea* is appendicularian house. Takahashi et al (2013) found *Sapphirina* spp. attached to doliolids by means of video plankton recorder and examined the feeding rate. Doliolids and appendicularians are dominant grazers of nanophytoplankton which are not fed by most calanoid copepods such as *Paracalanus* which have been thought the main transporter of the primary production to fish. The nanophytoplankton-poechilostomatoid-fish chain is an important process to consider the fish production in the Kuroshio region.

Key issues to resolve the Kuroshio Paradox are 1) nutrient supply mechanisms, and 2) ecosystem structure and dynamics. To solve the issues, SKED is planning several cruises in the years 2014-2015 with mathematical modelling.

Kuroda H., Y. Hirota, T. Setou, K. Aoki, D. Takahashi and T. Watanabe. 2014. Properties of winter mixed layer variability on the shelf-slope region facing The Kuroshio –study of Tosa Bay, southern Japan. *Ocean Dynamics* 64 (1), 47-60. 2014.

Nagai, T, A. Tandon, H. Yamazaki, M. J. Doubell, S. Gallager, 2012. Direct observations of microscale turbulence and thermohaline structure in the Kuroshio Front. *J. Geophys. Res. Oceans*, 117, C08013, doi:10.1029/2011JC007228.

Takahashi, K., Ichikawa, T., Saito, H., Takehi, S., Sugimoto, Y., Hidaka, K., Hamasaki, K. 2013. Sapphirinid copepods as predators of doliolids: Their role in doliolid mortality and sinking flux. *Limnology and Oceanography* 58, 1972-1984.

Umezawa, Y., Yamaguchi, A., Ishizaka, J., Hasegawa, T., Yoshimizu, C., Tayasu, I., Yoshimura, H., Morii, Y., Aoshima, T., and Yamawaki, N. 2014. Seasonal shifts in the contributions of the Changjiang River and the Kuroshio Current to nitrate dynamics in the continental shelf of the northern East China Sea based on a nitrate dual isotopic composition approach, *Biogeosciences*, 11, 1297-1317, doi:10.5194/bg-11-1297-2014.

## Korea

National contact: **Se-Jong Ju**, [sju@kiost.ac](mailto:sju@kiost.ac)

Korea IMBER-related research activities have been extended from coastal and marginal seas to open ocean. Most of these research activities are mainly focused on research theme 1 (Interactions between biogeochemical cycles & food webs) and 2 (Sensitivity to Global Change) of international IMBER project. Here is the list of on-going IMBER-related research projects with a funded period in Korea;

1. *Korea East Asian Seas Time-series (EAST) - 1 (2006-2015)*
2. *The study on the physical dynamics of the Yellow Sea bottom cold water and its impact on the ecosystem (2009-2014)*
3. *Long-term change of structure and function in marine ecosystems of Korea (LTMER-KOREA) (2011-2016)*
4. *Northwestern Pacific Ocean Study on Environment & Interactions between Deep Ocean & marginal seas (POSEIDON) (2006-2015)*

All these projects are being conducted to identify, quantify and model the physical and biogeochemical processes responding to the climate variability and their linkage to changes in marine ecosystem of Korean waters (Yellow Sea, East/Japan Sea, East China Sea, etc.). Real-time monitoring data of meteorological and oceanic parameters including pCO<sub>2</sub> have been provided from three surface monitoring buoys launched in East/Japan Seas and tropical Pacific through these projects. Also multidisciplinary research cruises were carried out in Korean waters and the northwestern Pacific by Korea Ocean Research and Development Institute (KIOST). Some of results from these projects were published in peer-reviewed journals (more than 100 articles) and presented at the various international and regional conferences such as 2014 Ocean Science Meeting and WESTPAC international symposium. Detail information on each on-going project is provided in next pages as an appendix.

### East Asian Seas Time series – I (EAST-I) Project

**Aim:** It has been approved that The East/Japan Sea may serve as a miniature test ocean for global changes in the future, since it has many oceanic features including its own conveyor belt system. In this regards, PICES approved a CREAMS/PICES program, named EAST (East Asian Sea Time-series)-I, promoting international cooperation over East/Japan Sea, especially among Japan, Korea and Russia. The long-term goal of Korea EAST-I program is to identify, quantify and model the dynamic processes governing the climate variability and their linkage to changes in marine ecosystem.

**Start date:** June 2011; **End date:** May 2016

**Website:** [east-1.snu.ac.kr](http://east-1.snu.ac.kr)

**Major funding sources:** Ministry of Oceans and Fisheries, Government of the Republic of Korea

**Major achievements:**

Through the Korea EAST-I project, integrated time-series monitoring of physical and biogeochemical properties (e.g. E-RAP, Figure1) was successfully performed on various spatiotemporal scales of the East/Japan Sea. Furthermore, Korea EAST-I program has promoted international cooperation on the joint cruises and international workshops successfully. Joint oceanographic surveys over the entire East/Japan Sea together with Russian and Japanese scientists is a pivotal part of the project, and most recent cruise took place between April 15 and 29, 2014 on board of the Russian *R/V Akademik M.A Lavertiev*. A team of 33 scientists from Pacific Oceanological Institute, Russia and five Korean institutions including Seoul National University participated in the cruise. At 31 stations, physical parameters (including temperature, salinity, and oxygen etc.), chemical parameters (including nutrients, pCO<sub>2</sub>, dissolved inorganic carbon, total alkalinity etc.), and biological parameters (including primary production, chlorophyll-*a* concentrations, and zooplankton biomass etc.) were measured (Figure 2).

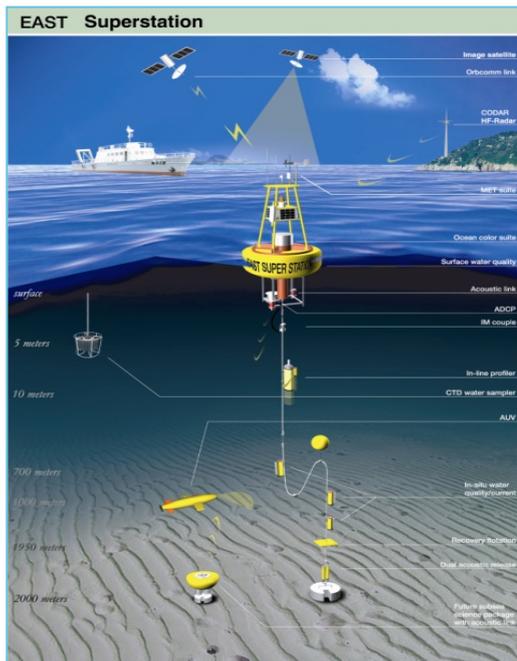


Figure 1. A schematic diagram of E-RAP, which is being operated by EAST-I.

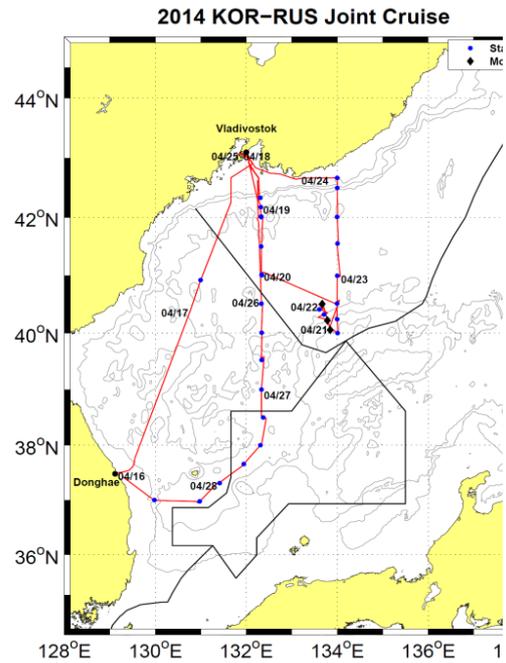


Figure 2. A map showing stations for physical, chemical, and biological parameters conducted by Korea-Russia joint cruise.

#### List of selected publications:

- Kwak, J. H. *et al.* (2013) Monthly measured primary and new productivities in the Ulleung Basin as a biological “hot spot” in the East/Japan Sea. *Biogeosciences* 10: 4405-4417
- Kwak, J. H. *et al.* (2013) High primary productivity and f-ratio in summer in the Ulleung basin of the East/Japan Sea. *Deep-Sea Res.* 79: 74-85
- Lee, Dong-Hun *et al.* (2013) Geochemical signature of lipid biomarkers related to the methane cycle in the gas hydrate-bearing sediments in the Ulleung Basin, East Sea (Sea of Japan). *Mar. & Petrol. Geol.* 47: 125-135
- Kim, Tae-Hoon & G. Kim (2013) Changes in seawater N:P ratios in the northwestern Pacific Ocean in response to increasing atmospheric N deposition: Results from the East (Japan) Sea. *Limnol. & Oceanogr.* 58(6): 1907-1914
- Lee, S. H. *et al.* (2013) Depositional features of co-genetic turbidite-debrite beds and possible mechanisms for their formation in distal lobated bodies beyond the base-of-slope, Ulleung Basin, East Sea (Japan Sea). *Mar. Geol.* 346:124-140
- Cho, C.-B. *et al.* (2014) Subtidal temperature variability in stratified shelf water off the mid-east coast of Korea. *Continental Shelf Res.* 75:41-53
- Son, Y.-T. *et al.* (2014) A newly observed physical cause of the onset of the subsurface spring phytoplankton bloom in the southwestern East Sea/Sea of Japan. *Biogeosciences* 11, 1319-1329.
- Kim, J.-Y. *et al.* (2014) Long-term trend of CO<sub>2</sub> and ocean acidification in the surface water of the Ulleung Basin, the East/Japan Sea inferred from the underway observational data. *Biogeosciences* 11: 2443-2454
- Khim, B.-K. *et al.* (2014) Different nature of glacial CaCO<sub>3</sub> constituents between MIS 2 and MIS 12 in the East Sea/Japan Sea and its paleoceanographic implication. *Quaternary International* 333: 130-138

**IMBER-relevant activities or events:** 2013 CREAMS/PICES International Workshop Commemorating the 20th Anniversary of the CREAMS expedition in the East/Japan Sea; August 22-23, 2013; Seoul National University, Korea; Organized by Research Institute of Oceanography, Seoul National University, and the Korean Society of Oceanography. The purpose of the workshop is to provide a forum to discuss the current status of time-series studies in the East Asian Marginal Seas and the new direction of the time-series studies in the ocean.

**Upcoming activities relevant to IMBER:** International Workshop on Marginal Seas in Change - Case for the East Sea and the Mediterranean Sea; September 23-26, 2014; Busan, Korea

**Any suggestions of new potential collaboration for IMBER:** Inviting IMBER scientist(s) to EAST-I program to discuss mutual interests and possible contribution of the regional program to IMBER

### ***The study on the impact of the Yellow Sea Bottom Cold Water Mass to the ecosystem.***

**Aim:** The project aimed to make food web trophic continuum which stands for temporal and spatial variation of planktonic ecosystem in the Yellow Sea Bottom Cold waters.

**Start date:** January 2012; **End date:** December 2014

**Website:** N/A

**Major funding sources:** In house project in KIOST

**Major achievements:**

To understand response of planktonic ecosystem in the Yellow Sea Bottom Cold Water Mass to temporal climatic changes, this project planned to form a trophic continuum which stands for characteristics of cold waters. Concurrently, this project focused on the understanding spatial-temporal physical traits of the cold waters itself and relationship between cold waters and climate index for comparative studies. In 2013, potential core species, standing for each trophic level, were selected based on ecological importance reflecting major spatio-temporal variation of cold waters. And interim food continuum was structured through three different methods which can explore direct and indirect predator-prey relationship. It was clarified that temporal physical variation of cold waters was closely related with the climate index such as Arctic Oscillation during 2009-2013. Furthermore, acoustic survey considering mesozooplankton gave us opportunity to understand more the temporal and spatial distributional features of zooplankton associated with the suspended materials. This year, the project focus on making up for a incomplete structuring of end-to-end trophic continuum in relation to the cold waters as well as understanding of temporal and spatial physical variation of cold waters.

#### **List of selected publications:**

- Lee, H.-J. et al (2013) Frontal Circulation and Westward Transversal Current at the Yellow Sea Entrance in Winter. J. of Geophysical Res. 118(8): 3851-3870
- Kang, J.-H. et al. (2013) Diel vertical migration of the copepod *Calanus sinicus* before and during formation of the Yellow Sea Cold Bottom Water in the Yellow Sea. Acta Oceanologica Sinica 32(9): 99-106
- Oh, K.-H. et al. (2013) The temporal and spatial variability of the Yellow Sea Cold Water Mass in the southeastern Yellow Sea, 2009-2011. Acta Oceanologica Sinica Vol 32(9): 1-10
- Lee, H. et al. (2013) The diel vertical migration of the sound-scattering layer in the Yellow Sea Bottom Cold Water of the southeastern Yellow sea: focus on its relationship with a temperature structure. Acta Oceanologica Sinica 32(9): 44-49
- Shin, H. H. et al. (2013) Distribution of dinoflagellate cysts in Yellow Sea sediments. Acta Oceanologica Sinica 32(9): 91-98
- Jang, P.-G. et al. (2013) The influence of thermohaline fronts on chlorophyll a concentrations during spring and summer in the southeastern Yellow Sea. Acta Oceanologica Sinica 32(9): 82-90
- Feinberg L. B. et al (2013) *Euphausia pacifica* brood sizes: a North Pacific synthesis. J. of Plankton Res. 36(6): 1192-1206

**IMBER-relevant activities or events:** The 5th Korea-China Joint Workshop on Yellow Sea Cold Water Mass; Venue: Qingdao, China (December 9-12, 2013)

**Upcoming activities relevant to IMBER:** The 6th China-Korea Joint Workshop on Yellow Sea Cold Water Mass will be held in Korea in 2014.

### ***Long-term change of structure and function in marine ecosystems of Korea***

**Aim:** 1) To better understand responses of organism, population, and ecosystem to global climate change, on time scales ranging from year to decades, 2) To predict future direction of marine ecosystems of Korea and thereby provide information to develop policy for conservation and sustainable use of marine ecosystems

**Start date:** June 2011; **End date:** February 2021

**Website:** N/A

**Major funding sources:** Ministry of Oceans and Fisheries, Government of the Republic of Korea

**Major achievements:**

1. Gwangyang bay, which is connected to the Sumjin River, is a semi-enclosed bay and has a salinity gradient from estuary to offshore during all season due to river discharge. High incorporation of riverine

organic matter to estuarine benthic food web and of in situ benthic producers to the within-bay and the offshore food web. Such a trophic importance of benthic producers to the within-bay and the offshore food web was confirmed by standing crops of phytoplankton, microphytobenthos, and seagrass accounting for 21, 17, and 25 ton, respectively, as a carbon equivalent in the whole area within the bay.

2. Hupo Bank in the East/Japan Sea ecosystem structure and increase/decrease pattern of biomass by using Ecopath model. The model contains 11 functional groups between primary producers and apex predators. Groups of apex predators and pelagic fish showed decreasing trend in number. Especially, pelagic fish group depends heavily on immigration. This model predicts some representative species such as *Sebastes schlegeli* and *Mytilus coruscus*, directly influenced by small change of catch. However, *Undaria pinnatifida* didn't be influenced by small change of current catch situation.

3. To investigate the trophic structure in an invasive seagrass *Halophila nipponica* bed were sampled at three different habitats: two seagrass beds (*H. nipponica* and *Zostera marina*) and a bare subtidal flat. The trophic importance of *H. nipponica* was studied using stable carbon and nitrogen isotope tracers. *H. nipponica* and *Z. marina* did not contribute significantly to this benthic trophic structure as indicated by the difference between their  $\delta^{13}\text{C}$  signatures and those of sampled animals. Most primary consumers fed mostly on suspended particulate organic matters, benthic diatoms and macroalgae. Accordingly, our results suggest that invasive species, *H. nipponica*, may not have a role in supporting food webs in our coastal system.

#### List of selected publications:

- Kim, J.-H. *et al.* (2013) Enhancement of photosynthetic carbon assimilation efficiency by phytoplankton in the future coastal ocean. *Biogeosciences* 10: 7525-7535.
- Hyun, J.-H. *et al.* (2013) Impacts of long-line aquaculture of Pacific oysters (*Crassostrea gigas*) on sulfate reduction and diffusive nutrient flux in the coastal sediments of Jinhae-Tongyeong, Korea. *Mar. Pollution Bull.* 74: 187-198
- Seong K. A. & H. J. Jeong (2013) Interactions between marine bacteria and red tide organisms in Korean waters. *Algae* 28(4): 297-305.
- Kim, T.-W. *et al.* (2013) Interannual nutrient dynamics in Korean coastal waters. *Harmful Algae* 30S: S15-S27
- Kim, C.-S. *et al.* (2014) Interannual variation of freshwater transport and its causes in the Korea Strait: A modeling study. *J. of Mar. Systems* 132: 66-74
- Park, M. G. *et al.* (2013) Parasitism of harmful dinoflagellates in Korean coastal waters *Harmful Algae* 30: S62-S74.
- Jeong, H. J. *et al.* (2013) Raphidophyte red tides in Korean waters. *Harmful Algae* 30S: S41-S52.
- Jeong, H.-J. *et al.* (2013) Red tides in Masan Bay, Korea in 2004-2005: I. Daily variations in the abundance of red-tide organisms and environmental factors. *Harmful Algae* 30S:S75-S88.
- Yoo, Y. D. *et al.* (2013) Red tides in Masan Bay, Korea in 2004-2005: II. Daily variations in the abundance of heterotrophic protists and their grazing impact on red-tide organisms. *Harmful Algae* 30S: S89-S101.
- Kim, J. S. *et al.* (2013) Red tides in Masan Bay, Korea, in 2004-2005: III. Daily variations in the abundance of mesozooplankton and their grazing impacts on red-tide organisms. *Harmful Algae* 30S:S102-S113.
- Park, K.-A. *et al.* (2014) Role of sea ice on satellite-observed chlorophyll-*a* concentration variations during spring bloom in the East/Japan sea. *Deep-Sea Res.* 83: 34-44.
- Lee C.-K. *et al.* (2013) Monitoring and trends in harmful algal blooms and red tides in Korean coastal waters, with emphasis on *Cochlodinium polykrikoides*. *Harmful Algae* 30S: S3-s14.

#### **Northwestern Pacific Ocean Study on Environment and Interactions between Deep Ocean and marginal seas (POSEIDON)**

**Aim:** To examine and to predict the influence of the oceanic variability in the northwestern Pacific Ocean upon the marginal seas around Korea in association with future climate change, and also to prepare a proper scenario in the near future (2030)

**Start date:** January 2014; **End date:** December 2014

**Website:** [tipex.kiost.ac](http://tipex.kiost.ac)

**Major funding sources:** In house project of Korea Institute of Ocean Science & Technology

**Major achievements:**

Oceanic currents at nine stations and suspended sediments at two selected stations have been measured by moored monitoring systems along a satellite altimeter track ( $\sim 135^\circ\text{E}$ ) in the subtropical-

to-tropical western Pacific Ocean. Using the data acquired from these mooring systems, long-term variabilities of the oceanic currents and climate indices, the driving mechanism of the Subtropical Countercurrent, interannual variabilities of the total suspended material fluxes, and the along-track sea-air CO<sub>2</sub> fluxes have been studied. The multidisciplinary annual cruise and monthly measurements were conducted to obtain the parameters for oceanic ecosystem modelling in the Korea Strait. Following subjects were studied: (1) ecosystem community structure and biodiversity in different oceanic regions of the northwestern Pacific; (2) interannual variation of meso-zooplankton due to spatio-temporal variations in the marine environment; and (3) the relationship between coastal and Kuroshio waters based on warm-water indicator species. The impacts and prospects of future trends of the North Pacific climate system, as well as the interannual variations in ocean circulation, were examined using an ocean-atmosphere circulation model: the relationship between the El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), coupled with a circulation-ecosystem model (POLCOMS-ERSEM) by the Plymouth Marine Laboratory.

#### **List of selected publications:**

- Kim, D. S. *et al.* (2013) Revisiting the seasonal variations of sea-air CO<sub>2</sub> fluxes in the Northern East China Sea. *Terr. Atmos. Ocean. Sci.* 24 (3): 409-419
- Kim, E. *et al.* (2013) Typhoon Rammasun-induced near-inertial oscillations observed in the tropical Northwestern Pacific Ocean. *Terr. Atmos. Ocean. Sci.* 24 (4): 761-772
- Sung, M. K. *et al.* (2013) An alternative effect by the tropical North Atlantic SST in intraseasonally varying El nino teleconnectin over the North Atlantic. *Tellus A* 65 (19863): 1-13
- Ham, Y. G. *et al.* (2013) Two distinct roles of Atlantic SSTs in ENSO variability: North Tropical Atlantic SST and Atlantic Nino. *Geophys. Res. Lett.* 40: 1-6
- Seo, I. A. *et al.* (2013) [A skeletal Sr/Ca record preserved in \*Dipsastraea \(Favia\) speciosa\* and implications for coral Sr/Ca thermometry in mid-latitude regions.](#) *Geochemistry Geophysics Geosystems* 14 (8): 2873-2885
- Hwang, S. W. *et al.* (2013) Collapse of the Crustacean Mesozooplankton in the Northern East China Sea: Effects of the Three Gorges Dam? *J. Coastal Res.* 29 (6): 1464-1469
- Jo, H. S. *et al.* (2013) A possible mechanism for the North Pacific regime shift. *Geophys. Res. Lett.* 49 (1): 4380-4385
- Choi, D. H. *et al.* (2013) Application of Pyrosequencing Method for Investigating the Diversity of *Synechococcus* Subcluster 5.1 in open ocean. *Microbes & Environments.* 29 (1): 17-22
- Park, J. H. & D. Farmer (2013) Effects of Kuroshio intrusions on nonlinear internal waves in the South China Sea during winter. *J. Geophys. Res.: Oceans* 118 (12): 7081-7094
- Na, H. A. *et al.* (2014) Observations of flow variability through the Kerama Gap between the East China and the Northwestern Pacific. *J. Geophys. Res.: Oceans* 119 (2): 689-703
- Kim, H. J. *et al.* (2014) Influence of Asian monsoon and ENSO events on particle fluxes in the western subtropical Pacific. *Deep-Sea Res. I* 90 (8): 139-151

#### **IMBER-relevant activities or events:**

International Workshop “Tropical Ocean Dynamics and Mid-latitude Phenomena in the Northwestern Pacific Ocean”; September 30-October 2, 2013; Seogwipo KAL Hotel, Jeju, Korea; Conveners: POSEIDON project Committee (KIOST); The main aims are to quantify the environmental impacts over the East China Sea and the Korea Strait with reliable predictability.

## New Zealand

National contacts: **Julie Hall**, [julie.hall@niwa.co.nz](mailto:julie.hall@niwa.co.nz) and **Matt Pinkerton**, [m.pinkerton@niwa.co.nz](mailto:m.pinkerton@niwa.co.nz)

Through 2013/14, the New Zealand fisheries oceanography project has continued to investigate the structure and function of key New Zealand ecosystems. Our three focus areas are (1) the Hauraki Gulf - a coastal system close to New Zealand's largest city, Auckland; (2) the Chatham Rise - New Zealand's best studied and most productive offshore area; (3) Ross Sea, Antarctica - where New Zealand is involved in fishing for toothfish under CCAMLR jurisdiction.

In the Hauraki Gulf, we have continued work on developing 5 food-web models representing the state of the system at 5 periods in history: (1) present day; (2) AD 1950, just prior to onset of industrial-scale fishing; (3) AD 1790, before European whaling and sealing; (4) AD 1500, early Maori settlement phase; (5) AD 1000, before human settlement in New Zealand. Five separate models were developed, one for each time period. Each model quantifies the flow of organic matter through the marine food-web over a typical one-year period. The groups in each model represent all the major biota of the Hauraki Gulf, from bacteria to whales. As part of this project, 10 teams of experts provided information to help estimate an initial set of over 700 parameters per model. The model parameters describe the annual-average abundance, energetics (growth, reproduction, consumption), and trophic linkages (diets) for all trophic groups. Preliminary results of the study show that some upper trophic level parts of the ecosystem have changed substantially since humans arrived in New Zealand, largely as a result of human harvesting. Fur seals and sea-lions were extirpated (locally absent) from the ecosystem before AD 1790 as a result of sealing. The abundance of cetaceans in the Hauraki Gulf is estimated to have declined by 97% since AD 1000 due to whaling. The abundance of seabirds is estimated to have declined by 69% since AD 1000, largely due to the introduction of rats and other predators of eggs and chicks. Reductions in the biomass of fish and lobster groups are estimated to be as high as 86% over the period of human occupation. In contrast, middle and lower trophic levels are estimated to have changed by much less (and often by very) little over the same period.

For the Chatham Rise region in 2013-14, we have focussed on developing methods to use multifrequency acoustic data together with mark type to estimate the distribution and biomass of myctophids, crustacean zooplankton and salps. Mesopelagic organisms link primary and tertiary production in the global marine food web. Estimating abundance of mesopelagic species with hydroacoustics is feasible but limited by difficulties in species identification. Research in this project in 2013-14 has shown that acoustic backscatter from a complex mesopelagic system can be partitioned into its individual species contingent using multi-frequency acoustics, mark morphology, and environmental data. A decision tree model correctly identified the species in 89.9% of a training dataset obtained from mark identification trawls. Applying the model to a validation dataset from areas of known species composition helped to verify the model, with model estimates of high acoustic backscatter by species correlated with high trawl catch rates of the same species. Running the Chatham Rise model on an application dataset from a random trawl survey provided information on the spatial distribution of mesopelagic species in this area. Although influenced by several assumptions, estimates of biomass for selected species categories gave insight into the contribution of each species to the complex mesopelagic ecosystem.

In 2013-14 we continued to investigate the potential ecosystem effects of fishing for Antarctic toothfish in the Ross Sea region of the Southern Ocean. Mixed trophic impact analysis was applied to a model of the Ross Sea food-web and used to calculate the relative trophic importances of species and trophic groups in the system. The trophic impact of toothfish on medium-sized demersal fishes was

identified as the strongest top-down interaction in the system based on multiple-step analysis. This suggests a potential for a strong predation-release effect on some piscine prey of toothfish (especially grenadiers and ice-fish on the Ross Sea slope). We have developed a minimum realistic model of the interactions between toothfish and its two major groups of demersal fish prey, grenadiers and icefish, which has been submitted to the CCAMLR working group on statistics and methods.

New Zealand also completed its first field season studying the potential dependence of Weddell seals and type-C (fish-eating) killer whales in the Ross Sea region. Weddell seals and type C killer whales (TCKW) have been identified as the top predators most likely to be directly affected by the removal of Antarctic toothfish in the Ross Sea region. However, extreme paucity of information about the diet of both predators, and uncertainty regarding the degree of reliance on toothfish as a critical prey item, have limited our ability to assess or manage the risk posed by the fishery to these marine mammals. During late January 2014, feeding by TCKW was recorded during 5 of 8 helicopter flights. For 3 of these observations, the prey was identifiable as toothfish parts; no consumption of non-fish prey by TCKW was detected. We also observed a large number of TCKW with small and presumably suckling calves. Given that lactation represents a significant energy cost, we calculated energy expenditures of adult TCKW during maintenance, late-stage gestation, and lactation. A comparison of energy expenditure with energy densities of fish prey indicates that available fish other than toothfish are insufficient to support the increased energetic costs of lactation. This conclusion holds even assuming unlimited access to prey and without considering the energy cost of foraging. Marine mammals and birds contain more energy than fish prey, but re-orientation of TCKW towards non-fish prey would represent a major behavioural modification of unknown probability. A dependence of lactating TCKW on toothfish to support the additional cost of milk production implies a strong trophic dependency even if limited to a relatively brief period of the year. We conclude that there is a probable risk to TCKW if there was a reduction in the availability of toothfish during the lactation period. Further information on this dependency, including to what extent it has clear spatial or seasonal demarcation, is urgently required.

## Spain

National contact: **X. Antón A. Salgado**, [xsalgado@iim.csic.es](mailto:xsalgado@iim.csic.es)

Five on-going national projects over the period May 2013 to July 2014 are endorsed by IMBER: (i) **Circumnavigation Expedition Malaspina 2010: Global change and biodiversity exploration of the global ocean (MALASPINA 2010)**, led by Carlos M. Duarte (endorsed in October 2009); (ii) **Coastal ocean microbial plankton and temperature (COMITE)**, led by Xosé Anxelu Gutiérrez Morán (endorsed in December 2011); (iii) **Mediterranean sea acidification in a changing climate (MedSeA)** led by Patrizia Ziveri (endorsed in February 2012); (iv) **Deep-water submarine canyons and slopes in the Mediterranean and Cantabrian seas: from synchrony of external forcings to living resources (DOS MARES)**, led by Miquel Canals (endorsed in March 2012); and (v) **Atmospheric deposition and ocean plankton dynamics (ADEPT)**, led by Franz Peters (endorsed in March 2012). Information about these projects may be found through links at the IMBER web site.

IMBER-Spain promoted the “Symposium on Integrating New Advances in Mediterranean Oceanography and Marine Biology” held in Barcelona from 25 to 29 November 2013.

Although Spain does not have a proper IMBER national programme, several projects funded in the 2013 call of the National Subprogram of Marine Science and Technology are closely related to the IMBER goals. Nine projects of this call that deal with IMBER scientific goals have been selected. They have received about 30% of the ca. 6 M€ distributed by the subprogram in 2013 (ship time not included), and obtained additional funds of about 0.7 M€ for training of 5 PhD students:

- **Biological and environmental risks of the culture of *Mytilus galloprovincialis* in the framework of global change**, executed by the Marine Research Institute (CSIC, Spanish Research Council)
- **Zooplankton response to climatic variability in Northeast Atlantic shelf waters in relation with latitude and eutrophy**, executed by the University of the Basque Country.
- **Comparative study of the physical-biological interactions and the ecophysiology of toxic dinoflagellates of the genus *dinophysis***, executed by the Coastal Laboratory of Vigo (IEO, Spanish Institute of Oceanography)
- **New challenges in the submarine canyons research: indicators of the environmental status and spatial-temporal variability —the role of storms**, executed by the University of Barcelona.
- **Planktonic food web of the Cantabrian Sea (Southern Bay of Biscay): structure and routes of biogenic carbon**, executed by the Coastal Laboratory of Xixón (IEO, Spanish Institute of Oceanography)
- **Impact of sub-mesoscale oceanic eddies in the distribution, abundance and growth of the European anchovy (*Engraulis encrasicolus*)**, executed by AZTI-Technalia.
- **Resilience of marine angiosperms to global warming: an analysis based on ecophysiology, population and ecosystem responses**, executed by the University of Barcelona, the Coastal Laboratory of Murcia (IEO, Spanish Institute of Oceanography) and the Centre for Aquatic Studies of Blanes (CSIC, Spanish Research Council).
- **Metabolism of the ocean: new biogeochemical approaches**, executed by the Institute of Earth Sciences of Andalucía (CSIC, Spanish Research Council).
- **Mesoscale and sub-mesoscale processes in the Strait of Gibraltar: the Trafalgar-Alboran connection**, executed by the University of Cadiz.

## Uruguay

National contact: **Omar Defeo**, [odefeo@dinara.gub.uy](mailto:odefeo@dinara.gub.uy)

### **IMBER-relevant projects**

#### **Bringing management and conservation in Latin American artisanal shellfisheries: the impact of climate, fisheries and governance and potential actions for adaptive and mitigation strategies.**

**Aim:** Assess the impact of impact of climate, fisheries and governance on Latin American artisanal shellfisheries

**Start date:** 2010; **End date:** 2014

**Website:** [www.pewenvironment.org/research-programs/marine-fellow/id/8589941401](http://www.pewenvironment.org/research-programs/marine-fellow/id/8589941401)

**Major funding sources:** The Pew Charitable Trusts

**Major achievements:** Evaluation of co-management as an institutional arrangement for managing fisheries, identification of the relative impact of fishing and climate in shellfisheries.

### **List of peer-reviewed publications:**

DEFEO O, CASTREJÓN M, ORTEGA L, KUHN A, GUTIÉRREZ NL, CASTILLA JC (2013) Impacts of climate variability on Latin American small-scale fisheries. *Ecology and Society* 18 (4): 30.

SCHOEMAN DS, SCHLACHER TA, DEFEO O (2014) Climate-change impacts on sandy-beach biota: crossing a line in the sand. *Global Change Biology* 20: 2383-2392.

SCHLACHER TA, SCHOEMAN DS, JONES AR, DUGAN JE, HUBBARD DM, DEFEO O, PETERSON CH, WESTON MA, MASLO B, OLDS AD, SCAPINI F, NEL R, HARRIS LR, LUCREZI S, LASTRA M, HUIJBERS CM, CONNOLLY RM (2014) Metrics to assess ecological condition, change, and impacts in sandy beach ecosystems. *Journal of Environmental Management*: doi: 10.1016/j.jenvman.2014.05.036

CASTREJÓN M, DEFEO O, RECK G, CHARLES AT (2014) Fishery science in Galapagos: From a resource-focused to a social-ecological systems approach. In: *The Galapagos Marine Reserve: A Dynamic Social-Ecological System*. Springer: 159-185.

DEFEO O, CASTREJÓN M, ORTEGA L, KUHN A, de ALAVA A (2014) Variabilidad climática y su impacto en pesquerías de pequeña escala de invertebrados en América Latina. *Desenvolvimento e Meio Ambiente (Brazil)*: in press.

CASTREJÓN M, DEFEO O (2014) Co-governance of small-scale shellfisheries in Latin America: Institutional capacity to cope with external drivers of change. In: Jentoft S, Chuenpagdee R (eds.) *Governing the Governance of Small-Scale Fisheries*. MARE Series, Springer, Berlin: submitted.

### **Abstracts presented in meetings and conferences:**

DEFEO O (2014) El co-manejo de recursos pesqueros en Uruguay: interrogantes, desafíos y perspectivas. Taller “La pesca en debate”, Núcleo Interdisciplinario para Estudios de la Pesca en Uruguay. June 2014. Invited speaker.

DEFEO O (2013) Global patterns in sandy beach macrofauna: species richness, abundance, biomass and body size. VI EUROLAG & VII LAGUNET Conference. Lecce, Italia, December 2013. Invited speaker.

DEFEO O (2013) Global patterns in sandy beach macrofauna: species richness, abundance, biomass and body size. COLACMAR 2013, Punta del Este, octubre 2013. Invited speaker.

DEFEO O (2013) Fisheries co-management: current trends and perspectives. COLACMAR 2013, Punta del Este, octubre 2013. Invited speaker.

### **Piloting of an Ecosystem-based Approach to Living Aquatic Resources Management**

**Aim:** To transform the utilization of Uruguay’s fisheries resources into sustainable production systems through the integration of ecosystem-related principles and concepts into national legal and planning frameworks that, in turn, would contribute to a reduction in the loss of biodiversity and an increase in social well-being.

**Start date:** 2009; **End date:** 2014

**Website:** [www.dinara.gub.uy](http://www.dinara.gub.uy) (specific web page under construction)

**Major funding sources:** Global Environmental Facility (GEF)

**Major achievements:** 1) Development and implementation of community-based Ecosystem Approach to Fisheries (EAF) plans; 2) Implementation of co-management and creation of fishing protected areas; 3) incorporation of EAF principles into the national policy framework; 4) integration of inter-alia climate

risks and climate proofing measures in a pilot site planning process to identify and promote adaptation measures among vulnerable fisher communities; 5) strengthening institutional capacity in the National Institute of Fisheries and other project institutional stakeholders, to better understand and promote the EAF principles as well as facilitate the implementation of supporting policies and regulations.

**List of peer-reviewed publications:**

GÓMEZ J, BARBOZA FR, DEFEO O (2013) Environmental drivers defining linkages among life history traits: mechanistic insights from a semi-terrestrial amphipod subjected to macroscale gradients. *Ecology & Evolution* 3: 3918-3924.

**Abstracts presented in meetings and conferences:**

DEFEO O (2014) Enfoque ecosistémico pesquero: marco teórico y factibilidad de aplicación. Workshop “Gestión y protección de la biodiversidad costero marina en áreas ecológicas clave y la aplicación del enfoque ecosistémico de la pesca”. Buenos Aires, Argentina, July 9-11 2014.

DEFEO O (2014) Enfoque ecosistémico pesquero en Uruguay. Taller “Gestión y protección de la biodiversidad costero marina en áreas ecológicas clave y la aplicación del enfoque ecosistémico de la pesca”. Buenos Aires, Argentina, July 9-11 2014. Invited speaker.

HORTA S, DEFEO O (2013) The spatial dynamics of the whitemouth croaker artisanal fishery in Uruguay and interdependencies with the industrial fleet. COLACMAR, Punta del Este, October 27-31.

CELENTANO E, GUTIÉRREZ NL, DEFEO O (2013) Efectos de la morfodinámica de playas y del gradiente estuarino en la metapoblación del tatucito *Emerita brasiliensis* en Uruguay. COLACMAR, Punta del Este, October 27-31.

LERCARI D, BERGAMINO L, DEFEO O (2013) Structure and functioning of trophic networks in temperate contrasting sandy beaches. COLACMAR, Punta del Este, October 27-31.

ORLANDO L, LERCARI D, BERGAMINO L, DEFEO O (2013) Surf zone fish assemblages in a dissipative sandy beach of Uruguay. COLACMAR, Punta del Este, October 27-31.

BARBOZA FR, GÓMEZ J, LERCARI D, DEFEO O (2013) Disentangling diversity patterns in sandy beaches along environmental gradients. COLACMAR, Punta del Este, October 27-31.

SAUCO S, GÓMEZ J, BARBOZA FR, LERCARI D, DEFEO O (2013) Modified whole effluent toxicity test to assess and decouple wastewater effects from environmental gradients. COLACMAR, Punta del Este, October 27-31.

CROSSA M, PUIG P, DEFEO O, HORTA S, MARTÍNEZ G, NUÑEZ D, ALBERTI V, BARRIENTOS C, OLIVA E (2013) Manejo ecosistémico en la pesca artesanal de Uruguay: implementación, avances y perspectivas. COLACMAR, Punta del Este, October 27-31.

**Variability of Ocean Ecosystems around South-America (VOCES) – see also above (Argentina)**

**Aim:** To assess the impact of climate variability—both natural and anthropogenic—on the Humboldt, Patagonia, and South Brazil Large Marine Ecosystems.

**Start date:** 2013; **End date:** 2015

**Website:** N/A

**Major funding sources:** Inter-American Institute for Global change Research

**Major achievements:** At the beginning phase. This is a multinational project where Argentina, Brazil, Uruguay, Peru, Chile and other countries will participate. The project is led by Alberto Piola (Argentina)

**Activities relevant to IMBER:**

XV Latin American Congress of Marine Sciences. Conrad Hotel, Punta del Este, Uruguay, October 27-31.

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