I MARIE CURIE ACTIONS INDIVIDUAL FELLOWSHIPS

SEVENTH FRAMEWORK PROGRAMME

Project n°: 221059

Project Acronym: MESOMED

Project Full Name:

Climate Change; Marine Sciences; Zooplankton; Fish Larvae; Fisheries; Sustainability; Observations; Models

Marie Curie Actions

IEF-IOF-IIF- IIFR -Final Report

Period covered: from 11/01/2009 to 10/01/2010

Period number: 1

Start date of project: 11/01/2009

Project beneficiary name: CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

Project beneficiary organisation name: CNRS – Laboratory of Physical and Biological Oceanography

Date of preparation: 15/08/2010

1. FINAL PUBLISHABLE SUMMARY REPORT

The MESOMED, funded to Professor Meng Zhou hosted at the CNRS–Marseille Oceanographic Center (COM)–Laboratory of Physical and Biological Oceanography (LOPB), focused on 2 objectives associated with marine ecosystem structure, function and modeling under human impacts and climate change:

1) Developing sensor package configurations in studying small–mesoscale distributions and transport of zooplankton and fish larvae associated with currents and eddies in coastal and shelf areas
2) Developing and verifying mathematical models for zooplankton and fish larvae based on measurements from sensor packages

To address the first objective, we developed three sensor packages:

1) An integrated Laser Optical Plankton Counter (LOPC) – Conductivity, Temperature and Depth sensors (CTD) –fluormeter–Data logger on a CTD frame for measuring mesozooplankton and fish larvae within the size range in equivalent spherical diameter (ESD) between 100 μm and 30 mm deployable on a small ship (Fig. 1)
2) An integrated towed Acrobat platform–LOPC–CTD–fluorometer for measuring mesozooplankton and fish larvae within the size range in equivalent spherical diameter (ESD) between 100 μm and 30 mm deployable on a medium ship (Fig. 2)
3) An integrated Laser In-Situ Scattering and Transmissometery (LISST) (ESD between 1 and 250 μm) – LOPC (ESD between 100 μm and 30 mm)–CTD–fluorometer–water sampler on a rosette frame deployable on a medium–large ship (Fig. 3)

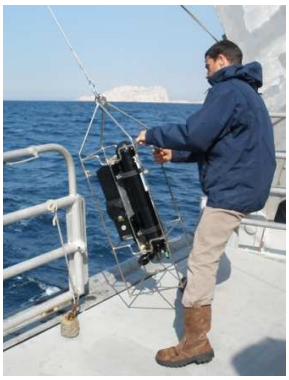

Fig. 1. LOPC–CTD–fluorometer on the RV Antedon in the Marseille Bay (Mar 29, 2009)

Fig. 2. Acrobat–LOPC–CTD–fluorometer, rosette–LISST–CTD, and Bongo net on the RV Tethys in the Gulf of Lion, northwestern Mediterranean Sea (Oct 03, 2009).

Fig. 3. Deploying the rosette–LISST–LOPC–CTD–water samplers on the RV Gould in the Gerlache Strait, Antarctica (May 01, 2009).

These sensor packages were deployed on

(1) the RV Antedon at the SOFCOM Station (Service d'Observation du Frioul du Centre d'Océanologie de Marseille) in the Bay of Marseille for developing and testing methods in monitoring seasonal variability of hydrographic, biogeochemical and zooplankton (during several one day cruises), and to validate size structure from captors and from samples. Several researchers of LOPB were involved together with Meng Zhou).

(2) the RV Tethys for 2 weeks cruise (from October 2 to October 17, 2009) in the Gulf of Lions to map physical and biological fields spatial, to quantify stock distributions of nutrients, phytoplankton and zooplankton, and to study advection and dispersion processes, and to identify linkages between size

structure and community structure for phyto- and zooplankton. Several researchers, technicians and students of LOPB were involved together with Meng Zhou, as well as one researcher and one engineer from University of Massachusetts Boston.

(3) RV Gould in the Gerlache Strait, Antarctica for 6 weeks cruise (from April 21 to June 11, 2009) to map distributions of zooplankton, krill and whales, and to study whale feeding behavior and krill overwintering strategies. One PhD student of LOPB was involved together with Meng Zhou.

To address the second objective, we have developed:

1) Mesozooplankton size relationships between their length and ESD (Fig. 4)
2) Ecosystem size spectrum models between 1 and 250 µm for LISST, between 250 µm and 35 mm for Optical Plankton Counter (OPC), and between 100 µm and 30 mm for LOPC
3) A growth rate model for zooplankton based on literature data and theoretical approaches
4) Plankton trophic dynamics model based on sizes for carbon flux, recycling and export (Figs. 5 and 6).

Fig. 4 Zooplankton shape analysis using ZooScan images from zooplankton net samples.

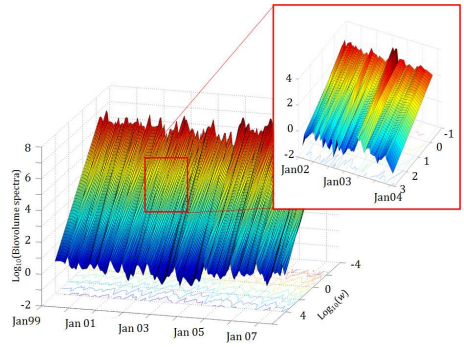

Fig. 5. Modeled zooplankton biomass spectra between 60 mm and 10 mm in mg C and m^{-3}, respectively, applied to the SOFCOM zooplankton time series (inserted panel shows the zooplankton size spectra).

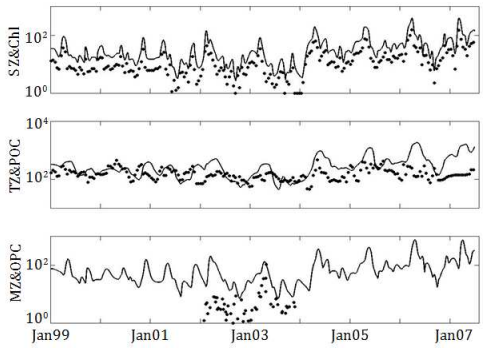

Fig. 6. Solid lines: modeled zooplankton (SZ: 60–100 µm, MZ: 0.3–1.5 mm, TZ: 0.06–10 mm), and black dots: observed chl-a (Chl), particular organic carbon (POC), net-OPC derived biomass (OP) in mg C m^{-3}.

Specific research activities include:

- Analyzing hydrographic, biogeochemical and zooplankton data collected at the SOFCOM time series station in last 10 years for developing zooplankton growth and trophic dynamics models.
- Developing and testing an instrument package (LOPC–CTD–fluorometer) for potential expansion of the SOFCOM monitoring program
- Developing a 2-week COSTEAU ("Contaminants dans le système trophique phytoplankton-zooplankton-anchois dans le Golfe du Lion") cruise including the installation of a winch and towed Acrobat–LOPC–CTD–fluorometer system and a rosette–LISST system on the RV Tethys, participation in the cruise, operating the instrument package and data–processing
- Participating in a 6 week US Antarctic cruise using an integrated rosette–LOPC–CTD system and a ship–mounted acoustic Doppler current profiler (ADCP) for studying krill aggregation and feeding behavior in a US funded krill-whale interaction project (a PhD student at the LOPB participated in the cruise and is using the data and samples for his PhD thesis)

During the project, several scientists, technicians and students of LOPB were involved in sensor integration, training and cruises. Boris Espinasse, a PhD student (2009-2011) funded by CNRS, has been using the data collected in this project for his thesis.

The project has produced a peer reviewed journal article, three manuscripts in preparation, two meeting abstracts and presentations, one workshop, three sensor integration configurations and one funded French national project.

The significant impacts of this project on the CNRS–COM–LOPB include:

- New capability and capacity to conduct mesoscale physical and biological surveys for studying freshwater plumes, coastal currents and cross–shelf exchange;
- New sensor packages to integrate physical and biological measurements addressing ecosystem structure and bio–carbon fluxes between trophic levels
- Mathematical theories and models based on sensor packages developed to study seasonal variations of plankton communities and bio–carbon fluxes and burials applicable to end–to–end modeling for fisheries and carbon export flux for climate studies.

2. USE AND DISSEMINATION OF FOREGROUND

Section A (public) – DISSEMINATION MEASURES

1) A peer reviewed journal article

   Zhou, M., Carlotti, F., Zhu, Y., 2010. A size-spectrum zooplankton closure for ecosystem models, Journal of Plankton Research, 32(8), 1147-1165.

LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES								
NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages
1	A size-spectrum zooplankton closure for ecosystem models	Zhou	J. Plankt. Res	32(8)	Oxford Univ. Press		2010	1147-1165

2) Three manuscripts in preparation
   - Espinasse, B., Zhou, M., Carlotti, F., Zhu, Y., Mesozooplankton distributions and species composition in the embayment of the Gerlache Strait, Antarctica. In preparation.
   - Espinasse, B., Zhou, M., Carlotti, F., Zhu, Y., Krill carnivorous feeding behavior inferred from mesozooplankton distributions, sizes and compositions in the embayment of the Gerlache Strait, Antarctica. In preparation.
   - Carlotti, F., Zhu, Y. , Espinasse, B., Zhou, M., Distribution and composition of zooplankton related to the Rhone River freshwater plume and North Current in the Gulf of Lions. In preparation.
3) Two meeting abstracts and presentations
   - Zhou, M., Carlotti, F. and Zhu, Y., Modeling the time series of plankton size spectra in the Bay of Marseille, Advancing the Science of Limnology and Oceanography-Aquatic Science Meeting, Nice, France, January, 2009.
   - Zhou, M., Carlotti, F., Tande, K.S. and Zhu, Y., Biomass fluxes and biomass spectra in an ecosystem model, Global Ecosystem Dynamics Program (GLOBEC) Open Science Symposium, June, 2009.
4) One workshop
   - AMEMR workshop on coupling models of different trophic levels, Plymouth, February 2009.

Section B (confidential) - EXPLOITABLE FOREGROUND AND PLANS FOR EXPLOITATION:

The Marie Curie project has allowed us to organize a team of researchers, engineers and one student working together with Meng Zhou in the way to take experiences of the observing and modeling tools:

- With the accepted **Marie Curie-IIF MESOMED** project, the CNRS gave a grant for a PhD student (2009-2011), Boris Espinasse, to be involved in the project. The PhD student was involved in all cruises as well as the data analysis. The 3 year duration PhD allows to maintain a continuity in the activities after the **Marie Curie-IIF MESOMED**. Both Meng Zhou and F. Carlotti are supervisors of the PhD. The data of the various cruises made in 2009 have been processed and analyzed, and we are still writing publications to present these results.
- The sensor packages allowing to integrate physical and biological measurements addressing ecosystem structure and bio–carbon fluxes between trophic levels have been (/will be) used in several cruise in 2010
    i. COSTEAU4 cruise (Contaminants dans le système trophique phytoplancton , zooplancton anchois dans du Golfe du Lion) from April 26 to Mai 8, 2010, in the Gulf of Lions (PI. F. Carlotti & B. Quéguiner, LOPB)
    ii. LATEX cruise (LAgrangian Transport EXperiment) from August 30 to September 25, 2010. PI Anne Petrenko (LOPB)
- A proposal to buy a larger towed instrument (the Moving Vessel Profiler; ODIM Brooke Ocean Compnay) with the sensor packages has been submitted by LOPB and IFREMER La Seyne and accepted by the region PACA (including European funds). The proposal benefited from Meng Zhou' s deep knowledge about this instrument. The implementation of the tool is planned for the second half of 2010 and beginning of 2011.

Moreover, the Marie Curie project has allowed us to develop further our capacity for receiving a French

project which will maintain the cooperation on a 4-year duration:

- Agency of National Research: Chair of Excellence - Excellence **F**or **O**bservation–model **C**oupling and **E**cological **A**ssessment in the Sea (**FOCEA**), 2010-2014 (€1 million), Principle Investigator: Meng Zhou, CoPI: Francois Carlotti. Project period: 01/01/2010 – 31/12/2013.

As a conclusion, the project **Marie Curie-IIF MESOMED allowing one –year research for Meng ZHou** in LOPB Marseille, has been extremely beneficial to the LOPB for:

- Increasing our capability and capacity to use new biological captors and to conduct mesoscale physical and biological surveys for studying oceanic structures,

- Educating students, engineers and researchers to the use of these new tools.

- For producing valuable data during all cruises made in 2009 as well as processing data and contributing to several publications.

Finally, the project **Marie Curie-IIF MESOMED served as starter for a longer term international cooperation between Meng Zhou, and his team** from University of Massachusetts Boston, **the LOPB** and a **few other regional laboratories** (LOV-Villefranche, IFREMER-La Seyne, and IFREMER-IRD Sète).

3. SCIENTIST IN CHARGE QUESTIONNAIRE
TRANSFER OF KNOWLEDGE ASSESSMENT

QUESTION	Answer
What is the size of the hosting research group	45 scientists + 20 PhD –Post-doc students

How many researchers have you supervised (collaborated), within the past 10 years	
EC/Marie Curie Actions	0
EC other funding	1
If yes please specify contract number, programme and directorate general in charge	#: 036949, Integrated Project SESAME Research Directorat-General
University fellowships	5
National public bodies	30
Industry	0
Others	0

How many researchers supervised within this project	10
Corresponding how many person months	10 months

Number of publications resulting directly from the research project	
Recruited researchers and yourself	1 in press and 3 in preparation
Recruited researchers alone	0
Recruited researchers with authors other than yourself	4

Participation of the fellow researcher at conferences (number)	
Passive	0

Active	3
How do you rate the overall success of the research training (IEF,IOF) /transfer of knowledge (IIF)	Excellent

RESEARCHERS ASSESSMENT

Rate the overall level of the follow researcher integration in the research team and the host organization with regards to	
Participation in meetings/seminars	Excellent
Discussions of results and project-related topics	Excellent
Cooperation with other team members	Excellent
Cooperation with other researchers of the host institution	Excellent

Rate the overall performance of the fellow researcher with regard to:	
Originality of fellow approach towards research	Excellent
Capacity to develop new skills and to benefit from training	N/A
Productivity	Excellent
Communication skills	Excellent
Training and teaching skills	Excellent
Please comments	Both for his outstanding scientific competencies, and his convivial attitude.

TRANSFER OF KNOWLEDGE (IIF)

Has this project provided additional links with other research groups or institutions?	
If yes, indicate the number of contacts in each case	Yes
Universities	3 UMass (USA) SIO (USA) Ui Tromsoe (NORWAY)
Research centres	5 WHOI (USA) PML (UK) LOV-Villefranche (FRANCE) IFREMER La Seyne (FRANCE) IFREMER –IRD Sète (FRANCE)
Industry/private companies	2 Brooke Ocean (USA) Sequia (USA)
Others	

Rate the importance of the following outcomes of the research training/transfer of knowledge	
Results of the research	Excellent
Number of publications	4-6
Development of research	1 medium and 1 large projects
Establishment of international collaborations	Great opportunity
Transfer of knowledge/technology	Excellent
Training of researcher	Excellent

Further academic qualification for fellows	N/A
Comments	Outcomes of research training and transfer of knowledge are excellent (see description in the report) and represent a high added value for the LOPB.

YOUR OPINION ABOUT THE MARIE CURIE ACTIONS

Do you have any other comments or suggestions of how to improve the concerned Marie Curie actions? No.

Did you have previous knowledge of the Marie Curie actions	Yes, another fellowship in LOPB (Eliane Armand)
If yes, what sort of image do you think that the Marie Curie actions have among the scientific community in your research area	Marie Curie fellowships are considered as a funding for excellent candidates, and are tools to initiate strong cooperation.

Attachments:	1 : Published paper Zhou et al. 2010

Date: 16/08/2010 Signature Scientist in Charge:  Francois Carlotti	Date: 28/04/2010 Signature Researcher:  Meng Zhou