Proceedings of conference:

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Content

NB: Poster abstracts and A4-posters are published in an annexed document.

Contact references

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Version: Thursday, December 27, 2012:

1. Purpose of the event

Time-series analysis is one of keys opening towards the future for marine sciences and industry to understand ocean processes and their dynamics. It not only helps identifying the phenomenon represented by sequences of observations, but also helps forecasting events by feeding models. Thanks to technological progress, marine scientists are benefiting from longer and longer data time-series with higher acquisition frequency, but they are also challenged by the need to optimize the analysis of these time-series in the face of the increasing amount of data. These considerations raised the idea that sharing time-series analysis methods across marine science topics would help scientists and engineers to improve their knowledge of existing methods, optimize the data analysis, and help scientists in improving scientific results. Consequently, **the purpose of this conference was to bring together the scientific community and research activities across fields in marine science (physical oceanography, marine chemistry, marine biology, ecology and geology) to foster interactions and collaborations focused on a common topic: time-series analysis methods.**

Starting by a 2-day training course and followed by a 3-day scientific conference, **this event promoted transfer of knowledge between researchers from several fields**. Both training courses and conference presentations were mainly based on application examples and case studies from field experiments.

The conference was based on the "Gordon conference format" (c.f. http://www.grc.org/), with all activities taking place on the conference site, including meals and accommodation, thus allowing ample time for informal discussions and brain-storming opportunities.

Each day discussions were held at the conclusion of the day's scientific conference talks, a synthesis of which is presented in the conclusion section of this document to communicate this issue to national and international funding agencies as well to the broader scientific community. With regard to scientific presentations their electronic version are available on Internet: http://www.europolemer.eu/time-series-analysis.php (after publication authorisation).

Scientific themes of the conference :

1) "Low" to "High" frequency signals in oceanography
2) Geosciences and seismic monitoring: HF and BF signal
3) Passive and active acoustical ecology
4) Marine ecology from coastal to deep-sea ecosystems
5) Applications for industry

2. Organisation, preparation of the event, budget management and acknowledgements

Lead Organiser: Ingrid Puillat (Ifremer)
With great support by Séverine Thomas (Europôle Mer) who I deeply thank for her involvement.

2.1 Organising Committee

I. Puillat (Ifremer)
M. Prevosto (Ifremer)
B. Ferré (University of Tromsø)
P. Morin (CNRS/INSU Roscoff)
S. Thomas (Europôle Mer)
N. Réniers (Europôle Mer)

2.2 Scientific committee

H. Mercier (CNRS/LPO) and B. Cornuelle (SCRIPPS)
P. Morin (CNRS/INSU Roscoff) and E. Frajka-Williams (NOCS)
J. Mienert (University of Tromsø) and L. Geli (Ifremer)
C. Gervaise (GIPSA)
J. Sarrazin (Ifremer) and M. Matabos (NEPTUNE Canada, University of Victoria)
M. Prevosto (Ifremer) and I. Rychlik (Chamers University)

2.3 Preparation

The preparation of the conference started one year before the event, by submitting a first successful proposal to the Europole Mer consortium that became our main supporting agency. Then followed important support of the Labex Mer consortium of marine research laboratories, and of the Office of Naval Research Global (ONRG, USA governmental organisation). Additional support came from CNRS/INSU in the frame of the National French research program LEFE (http://www.insu.cnrs.fr/lefe). Finally a few months before the event took place we also received support from the Conseil Régional de Bretagne, Conseil Général du Finistère and Brest Métropole Océane (BMO). Special thanks are addressed to those funding agencies in a dedicated section at the end of this document.

Thanks to the received support funding plus incomes from registration fees (18 % of the total budget) we could welcome about 100 participants and speakers, including accommodations for all participants, transfers to and from the venue location and meeting facilities. In addition the organisation funded the travel of 11 speakers and 19 students plus the accommodation of all speakers and of 30 students. Indeed, a grant was organised to help students and young PhD’s to attend this event.
In order to guarantee the success of the event, the organisation decided to welcome only participants whose work was reflected in the topic of the conference. To this aim an online application system was set up. We received about 95 applications (not including 33 speakers and chairpersons), about 80 were initially selected and 12 applications were on standby list. After cancellations of some selected participants, we finally welcomed 103 persons (including speakers and chairpersons). Only 3 persons were not accepted, as their research activities were not related to the conference topic.

The organisation favoured the attendance of students and young PhD's to foster exchanges with senior scientists. To this aim the on line application included the possibility to apply for a travel grant and accommodation grant (no registration fee) for students and young PhD's.
We received 24 travel grant requests and we funded 19 of them. We received 33 accommodation grant requests and we funded 31 of them (the 2 remaining ones were on the standby list, with no more grant available by the time they were selected).

Before the conference a booklet including programmes, logistical information, a list of talks, posters abstracts and an attendees list, was sent to all participants.

2.4 Budget Management

<u>Incomes</u> (in €, registrations and sponsors funding):

Europole Mer	30 000
Labex Mer	15 000
ONRG	10 000
Ifremer	5 000
CNRS/INSU (LEFE)	2 000
Brest Metropole Océane (BMO)	1000
Conseil Général du Finisterre	1000
Conseil Regional de Bretagne	300
registration fees	14 300
Total	78 600

<u>Outcomes:</u>

Accommodations and conference facilities	38 182
Travel for speakers	9 074
Travel for students	15 225
Local transportation	2 113
Social events	1 177
Communication material and medias (including participation fees for a special edition of Journal of Marine Systems and a webTV preparation)*	12 658
other	171
Total	78 600

* the communication expenses are only budgeted at this stage: the preparation of a special edition in Journal of Marine Systems will take approximately one year. The invoice is expected for late 2013.

2.5 Acknowledgements

This one-week event was successful from both scientific and human points of view. The success of this event was based on several pillars, but first and foremost the attendance of motivated speakers, teachers, and attendees. Consequently the organisation greatly thanks all speakers and professors for their interesting talks and courses, and attendees for listening, interacting and for what they brought: their knowledge, their science, their kindness and their positive energy.

The Organising committee thanks the Scientific Committee who helped a lot during the one-year preparation of the event and chaired the sessions, namely:

H. Mercier (CNRS/LPO) and B. Cornuelle (SCRIPPS)
P. Morin (CNRS/INSU Roscoff) and E. Frajka-Williams (NOCS)
J. Mienert (University of Tromsø) and L. Geli (Ifremer)
C. Gervaise (GIPSA), L. di Iorio (ESNTA Bretagne)
J. Sarrazin (Ifremer) and M. Matabos (NEPTUNE Canada, University of Victoria)
M. Prevosto (Ifremer) and I. Rychlik (Chamers University)

This event would not have been possible without our sponsorships. The organisation committee and participants are grateful to:

Europole Mer http://www.europolemer.eu/en
Consortium of research and higher education organisations in West Brittany focusing on marine science and technology and fostering interactions and collaborations between the regional research partners.

LabexMER : http://www.labexmer.eu/
Newly created consortium of Brittany universities and institutions that combine research capacities to improve understanding of ocean functioning in the context of climate change.

Office of Naval Research Global
http://www.onr.navy.mil/Science-technology/onr-global.aspx/
In building and fostering international connections, ONR Global propels the execution of long-range strategic efforts that address the future needs of the naval fleet and forces and international partners. *This work related to Department of the Navy Grant N62909-12-1-1115 issued by Office of Naval Research Global. The United Stated Government has a royalty-free license throughout the world in all copyrightable material contained herein*.
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Ifremer : http://wwz.ifremer.fr/institut_eng/
Through its research work and expert advice, Ifremer contributes to knowledge of the oceans and their resources, to monitoring of marine environments and to the sustainable development of marine activities.

WITH SUPPORT OF :

Conseil Général Finistère http://www.cg29.fr/
Local authority that funds selected research activities, in particular in marine sciences, including post-doctoral fellowships and scientific events and conferences.

Conseil Régional de la Région Bretagne http://www.bretagne.fr
Regional authority that actively supports marine science and technology research in Brittany, including research projects, a comprehensive PhD scholarships scheme, and networking activities. It also directly supports Europole Mer and UEB.

CNRS
National French research program LEFE (http://www.insu.cnrs.fr/lefe), directed by CNRS/INSU, supports research on oceanic and atmospheric sciences. In particular, subprogram LEFE-MANU (http://www-ljk.imag.fr/LEFE_MANU/) aims at developing the use of advanced mathematical and numerical methods for such applications.

Brest Métropole Océane http://www.brest.fr/
Brest city council supports initiatives by local institutions to develop activities in the marine and maritime economic sectors, including through research and development.

Finally as lead organisator I would like to personally thank members of the organising committee:

M. Prevosto (Ifremer)
B. Ferré (University of Tromsø)
P. Morin (CNRS/INSU Roscoff)
N. Réniers (Europôle Mer)
with special thanks for S. Thomas (Europôle Mer) for her deep engagement.

Disclaimer:

(1) Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the view of the Office of Naval Research global.

3. Debriefing of the event

3.1 Agenda of the Training part: 17-18 September 2012

Training sessions at a glance: Monday 17 & Tuesday 18 Sep

Time	Monday 17 Sep		Tuesday 18 Sep	
8:30-10:30	**Plenary Course 1:** Introductory course on Time-series analysis and applications J.M Boucher (Telecom Bretagne)		**AC3 group 1** Spectrogram analysis applied to marine mammal detection C. Gervaise & L. di Iorio (GIPSA and ENSTA Bretagne)	**AC4 group 2** Extreme Value theory in environmental sciences. Ph. Naveau (CNRS\LSCE)
10:45-12:45	**Plenary Course 2**: time-series in Marine biology P. Legendre (Univ. de Montréal)			
12:45-13:45	Lunch			
14:00-16:00	**AC1 group 1** Sound signal analysis C. Gervaise & L. di Ioro (GIPSA and ENSTA Bretagne)	**AC2 group 2** Case study on time series analysis in Marine Biolgy P. Legendre (Univ. de Montréal)	**AC4 group 1** Extreme Value theory in environmental sciences. Ph. Naveau (CNRS\LSCE)	**AC3 group 2** Spectrogram analysis applied to marine mammal detection C. Gervaise & L. di Iorio (GIPSA and ENSTA Bretagne)
16:30-18:30	**AC2 group 1** Case study on time series analysis in Marine Biolgy P. Legendre (Univ. de Montréal)	**AC1 group 2** Sound signal analysis C. Gervaise & L. di Iorio (GIPSA and ENSTA Bretagne)		
19:00-20:30	Pancakes Dinner!		19:00-20:30 Dinner and welcome of new participants	

AC: applied course

An active applied course © Ifremer/M/ Gouillou

Training sessions description:

Plenary Course 1

J.M Boucher and R. Fablet (Telecom Bretagne)
CNRS UMR 6285 LabSTICC
Brest, France
ronan.fablet@telecom-bretagne.eu
jm.boucher@enst-bretagne.fr

Course Title: " INTRODUCTORY COURSE ON TIME-SERIES ANALYSIS AND APPLICATIONS"

This lecture will provide an overview of the conventional methods used in the analysis of time series analysis. Beginning with a reminder of the key concepts regarding stochastic processes, it will then discuss the processing of stationary and non-stationary data and will outline the main properties, advantages and drawbacks of each method.

The program will focus on:
- Classic spectral analysis by periodogram, tradeoff between time and frequency resolution
- Parametric models for time series (AR, MA and ARMA models) and relationship to spectral analysis
- Empirical orthogonal functions (Principal Component Analysis)
- Short Time Fourier transform
- Time-Scale analysis (wavelet transform)
- Wigner-Ville transform
- Hidden Marrkov models

Plenary Course 2 + Applied Course AC2

P. Legendre (Université de Montréal, Canada)
Département de sciences biologiques,
Université de Montréal, Canada
Pierre.Legendre@umontreal.ca

Course Title: "TEMPORAL EIGENFUNCTION METHODS FOR MULTISCALE ANALYSIS OF COMMUNITY COMPOSITION AND OTHER MULTIVARIATE DATA"

The course will focus on temporal eigenfunction analysis, a new family of methods for multiscale analysis (i.e. analysis that addresses several scales of variation) of univariate or multivariate response data. For ecological communities, the analysis can be univariate and focus on synthetic descriptors such as species richness, or multivariate and analyse the entire community composition data table. The course will present distance-based Moran's eigenvector maps (dbMEM, formerly called PCNM), generalized Moran's eigenvector maps (MEM), and asymmetric eigenvector maps (AEM) developed to model directional process. Examples will show how this form of analysis can be combined with classical regression-type analysis (for univariate data) or canonical analysis (for multivariate data), in the framework of variation partitioning, to bring out the multiscale structure of the response data. R functions implementing the methods described in the course will be used by the participants in a practical session.

Applied Courses AC1 and AC3

C. Gervaise and L. Di Iorio (GIPSA, Grenoble and ENSTA Bretagne, France)
Department 'Signal and Image Processing'
GIPSA LAB
Saint Martin d'Heres, France

cedric.gervaise@gipsa-lab.grenoble-inp.fr, diiorio.lu@gmail.com

Two courses on signal processing applied to passive acoustic monitoring for the study and observation of coastal ecosystems will introduce basic concepts of acoustic signal processing and data analysis applied to real data and specific scientific questions. The two courses will rely upon 6 months of real data collected in 2011 in the Parc Naturel Marin d'Iroise, France.

Course AC1 (4h): spectral analysis, soundscape description, application to the observation of benthic, climatic and anthropogenic contributions in coastal ecosystems.
Content :

1) Introduction to the role of coastal ecosystems and their monitoring.
2) What is ambient noise and how can it contribute to study coastal ecosystems?
3) Which sound features do best describe a coastal habitat: Received level, Background noise Level, Power spectral density?
4) How to evaluate these features with Fourier transform
5) Practical application: Analysis of short-term (20s), mid-term (1 day) and long-term (6 months) sound measurements from data recoded within the Parc Naturel Marin d'Iroise, France.

Course AC3 (2h): detection, spectrogram analysis applied to marine mammal detection.
Content :

1) Introduction to sound production of cetaceans
2) Time-frequency representations
3) Introduction to detection theory
4) Whistle detection in a spectrogram (short-time Fourier transform)

Practical application: Analysis of short (20s) sound snapshots containing whistles and clicks from bottlenose dolphins, analysis of long-term (1 month) measurements to study the spatial and -temporal distribution of a resident bottlenose dolphin population (Iroise sea, Parc Naturel Marin d'Iroise).

Applied Course AC4

Ph. Naveau (LSCE, Saclay, France): AC2 course
Laboratoire des Sciences du Climat et l'Environnement (LSCE) CNRS
naveau@lsce.ipsl.fr

Course Title: "EXTREME VALUE THEORY IN ENVIRONMENTAL SCIENCES"
Extreme value theory is playing an increasingly important role in many areas of meteorology, hydrology, engineering and finance. This class on extreme value theory will develop the basic theoretical framework of extreme value models and the statistical inference techniques for using these models in practice. There will be an emphasis on practical applications (study of extreme winds on buildings, floods in hydrology, extreme weather and climate events). From a more theoretical point, the treatment of extreme value methodology for time series, spatial processes, and some of the standard models which occur in applications could be studied.

Depending on student backgrounds and interests, either a more exhaustive treatment of the probability theory of extremes or a more extensive presentation of applications and/or related fields will be emphasized.

3.2. Agenda of the Conference part: 19-21 September 2012

Poster sessions: Posters were made available from the first day until the last day. Poster discussions took place during coffee breaks and between lunch time and afternoon session (30 minutes), everyday.

Oral presentations were organised in several sessions distributed over three days. The corresponding agenda is given hereafter.

Wednesday 19 Sep: "Low" to "high" frequency signals in Oceanography"

Morning session chaired by:
Dr. H. Mercier, CNRS/LPO, Brest, France
Dr. B. Cornuelle, SCRIPPS, USA

This session dealt with physical and biogeochemical oceanography from observed data and numerical models outputs: modes of variability (EOF, CCA, SSA, MSSA) and statistical methods for detecting climate change

8:15-8:30	Dr. A. Dosdat, Europole mer Director and Ifremer Brest Centre Director "WELCOME WORDS AND INTRODUCTION"
8:30-8:45	Dr. I. Puillat, Ifremer, "PRESENTATION OF THE CONFERENCE: AGENDA AND ORGANISATION"
8:45-9:35	Dr. Bruce Cornuelle, SCRIPPS (USA), *"THE CALIFORNIA CURRENT IN THE CLIMATE SYSTEM: ANALYSIS OF OBSERVATIONS*".
9:35-10:15	Ingrid Puillat, Ifremer, on behalf of Dr. Bénédicte Ferré, University of Tromsø (Norway) *"TEMPERATURE, SALINITY AND CURRENT TIME SERIES FROM THE AOEM EXPERIMENT OFFSHORE SVALBARD"*
10:15-10:45	Coffee Break
10:45-11:25	Pr. P. Legendre University of Montreal (Canada), *" COMMUNITY SURVEYS THROUGH SPACE AND TIME: TESTING THE SPACE–TIME INTERACTION"*
11:25-12:05	Dr. Torbjørn Lorentzen, University of Bergen (Norway) " HYDROGRAPHICAL TIME SERIES FROM STATION M – NORWEGIAN SEA "

Lunch and after: special edition!

12:15-15:30	Pic nic and outdoor activities (trekking, kayak etc...)

Afternoon and evening session chaired by:
Dr. P. Morin, CNRS/UPMC, Station Biologique de Roscoff, France
Dr. Eleanor Frajka-Williams, NOCS, UK

This session dealt with seasonal signal, inertial and sub-inertial processes, tidal processes, analysis of regional time-series, etc, including spectral analysis and cross analysis, wavelets and other statistical approaches.

15:30-16:10	Dr. Nathalie Daniault, Bretagne University/UBO (France) *"ANALYSIS OF CURRENT AND TRANSPORT DATA FROM EULERIAN MOORINGS ON CONTINENTAL MARGIN"*
16:10-16:50	Dr. Eleanor Frajka-Williams, NOCS (UK) *"CHARACTERISTICS OF TRANSPORT ESTIMATES IN THE SUBTROPICAL NORTH ATLANTIC FROM THE RAPID ARRAY: GYRES, EDDIES AND THE MOC"*
16:50-17:10	Coffee break
17:10-17:50	Dr. Craig Jones, Marine Science and Engineering Institute, Santa Cruz, CA (USA) *" A DEEPER LOOK AT ESTUARINE PROCESSES - WAVELETS AND CIRCULATION "*
17:50-18:30	Pr. François Schmitt: CNRS/LOG, Wimereux (France) *"MULTISCALE TIME SERIES ANALYSIS: SCALING AND EXTREMES, STRUCTURE FUNCTIONS AND EMPIRICAL MODE DECOMPOSITION"*
18:30-19:15	**First round table and discussions**
19:00-19:30	Dinner

Thursday 20 Sep: "Geosciences and Seismic Monitoring" and "Applications for industry"

Morning session: " Geosciences and Seismic Monitoring", chaired by:
Pr. J. Mienert, University of Tromsoe, Norway
Pr. L. Geli, Ifremer, France

This session dealt with a series of topics including coral reef response to ocean temperature and chemistry changes over human time scales and beyond, cascading water masses and sediment transport in times of climate change, and seabed fluid flow release in response to seismic activity.

8:15-9:05	Dr. Thomas Feseker, University of Bremen (Germany) *"MULTI-PARAMETER TIME SERIES FROM AN UN-CABLED DEEP-SEA OBSERVATORY AT AN ACTIVE MUD VOLCANO".*
9:05-9:55	Dr. Stephen Monna, INGV (Italy) *"ANALYSIS AND INTERPRETATION OF GEOPHYSICAL TIME SERIES FROM SEAFLOOR OBSERVATORIES IN EMSO SITES"*
09:55-10:45	Coffee break
10:45-11:25	Dr. Gaye Barakci, Ifremer Brest (France) *"COMBINING COLLOCATED ACOUSTIC GAS BUBBLE RECORDERS AND OCEAN BOTTOM SEISMOMETERS TO DETECT GAS RELATED PROCESSES IN SHALLOW SEDIMENT LAYERS"*
11:25-12:15	Pr. Mathilde Cannat, IPGP, Paris (France) (cancelled) *"EMSO-AZORE . A NEAR-REAL TIME MULTIDISCIPLINARY OBSERVATORY OF HYDROTHERMAL PROCESSES AND ECOSYSTEMS AT THE MID-ATLANTIC RIDGE: GEOPHYSICAL MONITORING OF SUBSEAFLOOR PROCESSES"*

Lunch

12:15-13:15	Lunch

Afternoon session: "Applications for industry", chaired by:
Dr. Marc Prevosto, Ifremer Brest, France
Pr. Igor Rychlik, Chalmers University, Sweden

This session dealt with time-series analyses for ocean engineering: extremes / return values, joint extremes (wind, wave, current), fatigue, prediction / propagation statistical models (neural network, hidden Markov chains, etc).

13:45-14:25	Pr. Igor Rychlik, Chalmers University (Sweden) *"Reliability applications of spatio-temporal Hs model"*
14:25-15:05	Dr. Wengang Mao, Chalmers University (Sweden) *"Whipping / springing on the extreme prediction of ship responses "*
15:05-15:45	Michel Olagnon, Ifremer Brest (France) *"Statistical Processing of Wave Directional Spectral Time-Series Into A Climatology of Swell Events"*
15:45-16:15	Coffee break
16:15-16:55	Dr. Julie Bessac, Rennes University (France) " Gaussian state-space model for wind fields in the North-East Atlantic"
16:55-17:35	Dr. Kevin Ewans, Shell (Indonesia) *"Evaluating Environmental Joint Extremes for the Offshore Industry"*
17:35-18:15	Ståle Johnsen, Statoil (Norway) *"Evaluate the environmental effects of oil platform discharges in the Norwegian sector of the North Sea"*
18:20-19:00	**Second round table and discussions**
20:00-22:00	Dinner and Social event: Party time!

Friday 21 Sep: "Marine Ecology from Coastal to deep-sea ecosystems and acoustic monitoring"

chaired by:

Dr. J. Sarrazin, Ifremer Brest, France,
Dr. M. Matabos, University of Victoria, Canada
Dr L. Di Iorio, ENSTA Bretagne, France

This session dealt with sensing of marine ecosystem thanks to passive and active acoustics, growth, behaviour, community dynamics, succession patterns, natural versus anthropogenic changes, environmental variations, resilience, and links between abiotic and biotic conditions through time.

Morning session:

8:15-9:05	Dr. Lucia. Di Iorio, ENSTA Bretagne *"From ocean sounds to coastal ecosystem monitoring"*
9:05-9:55	Dr. Mike van der Schaar, UPC (Spain) *"Using deep-sea observatories to identify ocean noise trends"*
09:55-10:45	Coffee break
10:45-11:25	Pr. Philip C. Reid, SAHFOS, Plymouth (UK) (TBC) *"Ecological Times-series and climate change"*
11:25-12:15	Dr. Eric Thiebault, Station biologique de Roscoff (France) *" Long-term changes in a fine sand macrobenthic community from the Bay of Morlaix (western English Channel): thirty years of sampling*

12:15-13:15	Lunch

Afternoon session (continuation)

13:45-14:25	Dr. Jacques Grall, Brest University, UBO (France) (cancelled) *"Long term changes in benthic communities and coastal system functioning in relation to anthropogenic but also to climate forcing."*
14:25-15:05	Dr. Henry Ruhl, National Oceanography Centre, Southampton (UK) *" Ecology and dynamics in the deep-sea (PAP site)"*
15:05-15:45	Dr. Marjolaine Matabos, University of Victoria (Canada) *"Temporal Variability in Benthic Community Dynamics Using Seafloor Imagery"*
15:45-16:15	Coffee break
16:15-16:55	Dr. Jozée Sarrazin, Ifremer (France)" Short- and long-term ecological "variations at deep-sea hydrothermal vents – a multidisciplinary observatory approach "
17:00-18:20	**Final round table and closing discussions (next actions)**
19:00-21:00	BBQ

End of conference

3.3 Debriefing

3.3.1 On site and real time event organisation:

(1) On site accommodation

Attendees were hosted on site, in the Moulin Mer nautical centre, www.moulin-mer.fr/, on a shared-room basis. This place was selected by the organisation because as an isolated centre it offered to possibility to gather participants and to favour exchanges and brainstorming. It presented the advantage to offer a 120-place auditorium, numerous meeting rooms, a restaurant and outdoor facilities. The beauty of the place and its closeness to the seaside helped to organise the social activities needed to foster relationships between participants. Actually the organisation drew as much attention to human relationships as to scientific excellence of the conference. These were the 2 pillars of a successful event.

Conference facilities in the centre nautique Moulin Mer ©Ifremer/M. Gouillou

Restaurant facilities in the centre nautique Moulin Mer, ©Ifremer/M. Gouillou

(2) Training part:

This part was organised as a combination of plenary courses and group practical courses. For practical exercises (course with Ph. Naveau and P. Legendre), attendees were kindly asked to bring a laptop with R software installed. This software is free and available on the Internet : http://www.r-project.org/.

Courses on acoustics were more theoretical but were illustrated with a lot of examples and sounds to listen because of the topic could not be addressed with practical exercises in 8 hours. A part of this course was set up by Skype connexion to welcome C. Gervaise, with L. Di Iorio on site.

Practical tools and R-codes used in the training as well as presented slides have been made available to the attendees by a Dropbox directory as first stage and are on the conference website: http://www.europolemer.eu/time-series-analysis.php.

Plenary course during the training part: Course by P. Legendre, Université de Montréal, ©Ifremer/M. Gouillou

Applied course by L. Di Iorio, training session. ©Ifremer/M. Gouillou

(3) Conference part:

27 presentations were organised in 30-45 minutes time slots including at least 10 minutes for discussions. These long time slots helped speakers to express themselves in a free way without too

much time constraint. The objective was also to give the possibility to well develop and discuss the methods, as much as scientific conclusions. At the end of each day, a round table was organised to discuss the conference issues, the needs and next steps. A synthesis is presented in the next session.

(4) Poster sessions (training and Conference parts):
Posters were made available from the first day until the last day. Poster discussions took place during coffee breaks and between lunch time and afternoon session (30 minutes), everyday. The presented posters are listed below. Corresponding abstracts and posters allowed to be published are gathered in a dedicated report annexed to this one.

3.3.2 Synthesis of discussions and general conclusions

(1) Conclusions of training part
The attendees expressed the need to renew such a training session, but with more applications. It has been suggested to give the possibility to welcome participants with their own data sets to work them during several days. The main difficulty is this would convene only a small number of persons in order to be efficient. This can be organised as next steps.

(2) Synthesis of round-table discussions and conclusions from the conference part:
The community considered that developing the methodologies, data archiving, and analysis for optimized new observation programs is a subject of research per se, spanning the many disciplines where ocean time-series are invaluable. Consequently, the discussion has been oriented on bottlenecks in the field of time-series acquisition and analysis in ocean sciences:

- Data acquisition and measurements,
- Data management, data mining and service providers
- Data analysis and interpretation

The community involved in time-series analysis is focusing efforts on the 3rd step of data processing but is also concerned by the other steps. Bottlenecks identified in the 3 steps are listed below. In addition a special focus was added on links with industry.

i) **Bottlenecks for data acquisition and measurements**

- Maintaining long-term ("sustained") observations, including careful quality control and cross-calibration when measurement methods change, needs sustained funding:

In some countries, there is a dearth of funding mechanisms for sustained observations, either for projects longer than 3 or 5 years, or for supporting people to make long time-series observations. Agencies are interested in funding new projects, and once the project has been going for a little while it is no longer as exciting. Similarly, funding can be difficult to obtain to update old observations with **new processing** methodologies, to ensure consistent treatment of data.

- Maintaining long-term ("sustained") observations on the technology side:
There may be a lack of technology to make long-term observations. This includes the difficulties involved with working with time-series over the evolution time scale of sensors. As sensors evolve, or even just the frequency of observations changes, it can be difficult to maintain high quality, accurate and precise records of the metadata, so that the full length of the data record can be exploited in retrospect. As sensors change, there is also a need for cross-calibration, ideally with old and new sensors side by side in the water for a period of time.

In addition, there is a need to promote the development and availability of new sensors like chemical and biological sensors, including a diverse range of parameters ranging from pCO2 to species composition. **It was suggested that commercialization of technology may help.**

ii) **Bottlenecks for data management and data mining**

There is a need of funds for archiving/curating of observations, including complicated biological measurements that are not columns of numbers, and including samples. It was mentioned that valuable samples have been thrown away for lack of storage space or other resources.

iii) **Bottlenecks for data analysis**

These can be divided in 2 kinds of bottlenecks: those related to numerical analysis methods and those related to computing methods and support.

<u>With regards to analysis methods:</u>
- There are many methods but few handbooks are available. In this respect, the book of Pierre Legendre is welcome to many participants. Such initiatives are unanimously supported.

- Addressing the robustness of each method**.** How to deal with doubtful or lacking data as well as uncertainties

- Relating questions of ocean science to methods suitable for these questions could be valuable

-Packages of software libraries for each method are then expected. Interpretation will be important and will be part of the know-how.

- Regular basis for meetings is needed. Participants agreed that other « time-series » meeting should be held in the future during another large conference where several skill/knowledge levels will be taken into account according to the audience

-Another approach to analyses may be actually the meta-analysis of published results, by analogy to medical studies. This depends on the quality of the metadata.

- Interest in organizing summer schools or intense short courses applying numerical methods to actual data (both on site and group enlarged with remotely internet connected people) in order to train next generation of data analysts.

<u>With regards to computing methods and support:</u>
- Benchmark: a reference/example database where problems have been solved, starting with a series of data sets would be helpful
- Accessible open-source code and how-to information for the analysis methods that are most useful, including those discussed at the Conference should be available.

iv) **Improve links to industries**:

Two main questions arose from attendees:

-Transition of sensors from academic labs to non-expert users is really difficult: can industry help with this?

-Industry has lots of data and expertise, but does not have a strong mandate or ressources to put the work into sharing it, even if it's not proprietary, how to encourage this?

It was underlined that with marine resource development, both energy and mining should be increasing in the future and this problem/opportunity will grow in importance.

Industrial companies are not sure of what they will find once the data is analysed. We definitely need **meeting platforms**, involving industry, small companies (some of them issued from research labs), and research institutes.

A recommendation is to organize a conference of similar type (hopefully improved thanks to the suggestions of participants) to perform scientific analysis of data made accessible by the industry by several methods and disciplinary approaches. It could be the next ESONET-Vi workshop. Norway was mentioned as a potential hosting country. This point led to conclude the conference and discussions about possible upcoming ESONET –Vi activities and events.

(3) General conclusions

This conference and the evening discussions confirmed the topic of the conference as original and meeting needs in term of knowledge sharing related to time-series analysis.

Several important points have been acknowledged in addition to those mentioned above:

- **Need to promote mobility for training** of (young) scientists and technical staff between marine research infrastructures (in addition to Marie Curie "people" funds of the EC). This is needed as soon as possible.
- **Need to open to more countries** access to marine science time-series and their analysis. The number of countries represented in this conference is a good start.
- The community in this conference wishes to let the **public** understand the importance of long time-series. Using dissemination tools is a request.
- Finally, the ESONET-Vi project, co-organizer of this conference, will keep the following **targets** to keep the momentum acquired during the Logonna-Daoulas 2012 conference:
  - Pursue interest in organizing summer schools or intense short courses applying numerical methods on actual data (both on site and group enlarged with remotely internet connected people).
  - Promote new manuals/books….
  - Use ESONET-Vi website and marine research infrastructure program portals to send news (either « ESONEWS » continuity or e-mail news)
  - Keeping the « virtual community » active, working on new (and sustained) observation campaigns or infrastructure through a time-series linking group.

This was a short review of the discussions of participants and direct input from E. Frajka-Williams, B. Cornuelle, and M. Best. Reporting by Jean-François Rolin and Ingrid Puillat.

3.3.4 Outcomes of the conference

The outcomes of the conference are of various types.

- pdf of the oral presentations (training and conference parts) allowed to be published, available at http://www.europolemer.eu/time-series-analysis.php
- this proceeding includes A4 format posters in an annexed document
- a special edition is in process in Journal of Marine Systems. 14 publications are expected to be submitted, 13 are already in review process.

In addition this conference helped to reach a consensus on the needs and next steps as explained in the previous section. We can say that a consortium focused on time series analysis methods is on the way, and will hopefully meet again for such events.

Photo recorded in front of the auditorium of the conference facilities, Centre nautique Moulin Mer, © Ifremer/M. Gouillou

3.4 Posters list

During the event, 36 posters were shown. Corresponding abstracts and A4 format are available in an annexed document.

AGUIRRE Arturo	Growth of Peruvian scallops Argopecten purpuratus (Lamarck, 1819): importance of the availability and quality of seston.
AMORIM Fabiola	Estudo dos Processos Físicos subjacentes à dinâmica de blooms de algas tóxicas na região adjacente à costa central de Portugal.
ARUNIMA Sen	Community succession via time-series analysis in hydrothermal vent habitats of the Eastern Lau Spreading Center, Tonga
BENSI Manuel	Thermohaline variability and mesoscale dynamics observed at the E2M3A deep-site in the Southern Adriatic (Mediterranean Sea)
CANNAT Mathilde	EMSO-AZORES. A near-real time multidisciplinary observatory of hydrothermal processes and ecosystems at the mid-atlantic ridge : geophysical monitoring of subseafloor processes
CHRYSANTHI Tsimitri	The characteristics of Lake Baikal's internal wave spectrum.
CIAVATTA Stefano	Climate-driven changes in plankton trophic dynamics
CROS Estelle	Learning from the seismicity in the Marmara Sea
CUVELIER D.	A glimpse of the day to day of a hydrothermal faunal assemblage in the Atlantic
DARGACZ Aneta	Times-series analysis in addition to novel techniques of passive acoustic detection and wave buoy measurements of wave breaking process.
DE VLEESCHOUWER David	The Late-Devonian (~370 Ma) climate response to astronomical forcing
DEROT Jonathan	Analysis of high frequency monitoring biogeochemical time series in the coastal waters of the eastern english channel
DRAGON Anne-Cécile	Mertz polynya sea-ice variability over 1979-2009 and its links to the surface atmosphere
FONTAN Almudena	Air-sea interaction patterns and time scales within the southeastern Bay of Biscay
GAYATRI Dudeja	Detection of global warming using satellite records of ocean productivity
GERTMAN Isaac	Anthropogenic effects on the Dead Sea atmospheric boundary layer and water body

HAMMERSCHMIDT Sebastian	Analysing long-term fluid pressure data: an example from the SmartPlug borehole observatory
IRISSON Jean-Olivier	Detecting hydrologic seasons in a long term monitoring time series
JACKSON Chu	Soft-bottom communities along a low oxygen gradient in Saanich Inlet
KALYUZHNAYA Anna	Data assimilation in the flood forecasting model for Saint-Petersburg
KHARITONOVA Lyudmila	Numerical modeling of wind waves in the Western Crimea coastal zone, Black Sea.
KLIMCHUK Evgeniya	Sverdrup transport temporal and spatial variability in North Atlantic based on NOC1.1 dataset.
KPOGO-NUWOKLO K. Agbéko	Construction of a realistic wave climate from swell systems statistics
LEITAO Francisco	Times-series analysis for study ecological trends in Portuguese fisheries over the last 60th years.
LOPEZ-CASTEJON Francisco	Time series analysis for tide-surge overlapping. A critical analysis to understand the water exchange of a non-tidal coastal lagoon in the SW Mediterranean Sea.
MARREC Pierre	Time-series analysis of the CO2 system in the English Channel/North Atlantic continental shelf using pCO2 sensors on fixed buoys and Voluntary Observing Ships (VOS)
MARTINI Séverine	How to analyse bioluminescence time series from the ANTARES in situ observatory ?
OGUGUAH Ngozi	Variations in Air and Sea Surface Temperature at the Commodore channel and Victoria Beach, Lagos Nigeria.
PETER Franek	Analysis of Håkon Mosby Mud Volcano seismic data
PRISTA Nuno	Using SARIMA models to assess data-poor fisheries
RAZVAN Mateescu	Multi-annual Analysis of the Waves Time-series for Marine Regime Characterization in the Danube Delta Area
REDA Anna	Analysis of freak wave measurements in the Baltic Sea
RENOSH P.R.	Analysis of a high frequency time series of bio-optical properties in complex coastal waters: couplings with turbulence
RIGOBERTO Rosas-Luis	Environment variation related to jumbo squid Dosidicus gigas and short-finned squid Illex argentinus
SOLABARRIETA	HF radar observations of surface currents in the SE Bay of Biscay

Lohitzune

STAUFFER Beth	Tidally-mediated bloom initiation in a nearshore embayment resolved from a high resolution time-series.
URANGA Jon	Automated analysis in tuna long-range sonar signals for fishing vessels.

4. ANNEXES

Oral Presentations abstracts

Abstracts are listed in order of appearance according to program.
Presenting author is underlined, and only affiliation of presenting authors is indicated.

Session "Low and high frequency signals in Oceanography"

Chaired by :
H. Mercier (CNRS/LPO) and B. Cornuelle (SCRIPPS)
P. Morin (INSU/Station biologique de Roscoff and E. Frajka-Williams (NOCS)

THE CALIFORNIA CURRENT IN THE CLIMATE SYSTEM: ANALYSIS OF OBSERVATIONS

CORNUELLE Bruce, Sung Yong Kim, Ganesh Gopalakrishnan, Matthew Mazloff
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The California Current system (CCS) is an important example of a productive eastern-boundary current system. Locally wind-driven upwelling combines with influences from the circulation of the entire Pacific Basin. The California Cooperative Fisheries Investigations (CalCOFI) has been collecting observations in the CCS for more than 60 years. This rich dataset can be mined statistically for long-term trends and climate linkages, but it also can be used for synoptic (re)analysis. I will present some recent work on the CCS using both statistical analysis and state estimation with a dynamical ocean model. The scientific questions motivating the study include understanding of local and non-local influences on the current system. Technical details of different analysis tools will also be discussed.

Keywords: Eastern Boundary currents, Time Series analysis, State Estimation, climate, upwelling, statistics

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TEMPERATURE, SALINITY AND CURRENT TIME SERIES FROM THE AOEM EXPERIMENT OFFSHORE SVALBARD

FERRÉ Bénédicte, Ian Wright, Rachael James, Douglas Connelly and Veit Huhnerbach
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Understanding the effects of climate change on the Arctic region is a major scientific challenge of high societal relevance as it is uniquely sensitive to climate change. The MASOX (Monitoring Arctic Seafloor – Ocean Exchange) observatory has been deployed from October 2010 to August 2011 offshore Svalbard, in a ~400m depth site where methane hydrate is actively dissociating from sub-seafloor methane (Westbrook et al. 2009. Escape of methane gas from the seabed along the West Spitsbergen continental margin, *Geophysical Research Letters*, 36). The main objective of this observatory is to determine the potential causative effect of warming shallow Arctic seas on methane hydrate stability, increasing free and methane gas release in the water column. Current, temperature, salinity and oxygen measurements show a strong seasonal variability, highlighting the water masses transport from southern and eastern Svalbard.

Keywords: Arctic; Monitoring; climate change; gas hydrates; water masses; seasonality

HOW TO DETECT AND ANTICIPATE CHANGES IN SPECIES AND ECOSYSTEMS IN THE CONTEXT OF GLOBAL CHANGE?

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The biodiversity of marine ecosystems is being altered by many human-induced factors including overexploitation of marine resources, chemical pollution and physical alterations, eutrophication, invasion of exotic species and global warming. With this multitude of direct or indirect anthropogenic influences, in addition to the confounding effects of the natural variability of the marine environment related to hydro-climatic forcing, managing marine ecosystems and achieving sustainable exploitation represents a real challenge. Many statistical analyses from multivariate to time series analyses can be applied to detect, understand and anticipate changes in both biological and ecological systems. However, conventional techniques can rarely be applied directly to ecological data. For example, some time series analyses are so sensitive to missing data that they cannot be applied when they occur. Correlation analysis and more generally inferential testing cannot be performed when time series are temporally autocorrelated. These issues will be discussed and recently developed techniques or analyses rarely applied in oceanography techniques will be presented to rapidly detect biological and ecological changes and anticipates major ecosystem shifts.

Keywords: Biodiversity, marine ecosystems, variance, mean state

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HYDROGRAPHICAL TIME SERIES FROM STATION M – NORWEGIAN SEA

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Having performed daily oceanographic measurements in the deep Norwegian Sea since 1 October 1948 until the end of November 2009, Ocean Weather Ship Station (OWS) M, at 66°N, 2°E, can present the longest existing homogeneous time-series from the deep ocean.

With the expansion of civil aviation and growing understanding of the impact of aerological observations on weather forecasts after World War II, ICAO (The International Civil Aviation Organization) demanded a greater network of aerological stations, primarily in the North Atlantic.

At station M routine programme was implemented within physical oceanography, including serial observations of temperature, salinity, and (since 1953) oxygen weekly at standard depths to 2000 meters, and serial observations of temperature and salinity at standard depths down to 1000 meters 3 or 4 times a week. This programme has been running continuously since 1 October 1948 until the end of November 2009 when the weather ship service on the station was terminated. The method of obtaining temperature and salinity observations (Nansen bottles with reversing thermometers) has not changed significantly either so the time series are indeed homogeneous.

We will give a brief overview over the hydrographical time series data and present an example how the time series can be applied in a statistical analysis.

Keywords: long-term dynamics of temperature series, stationarity and climate change

ANALYSIS OF CURRENT AND TRANSPORT DATA FROM EULERIAN MOORINGS ON CONTINENTAL MARGIN

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The circulation and related transports at the south-east tip of Greenland were determined from direct current observations of a moored current meter array. The measurements covered a time span from June 2004 to June 2006. I will show all the steps needed to construct a time series of transport from eulerian current measurements and then comment on the statistical tools used to analyze this time series.

The East Greenland - Irminger Current transport west of the 2000 m isobath was then weekly estimated, between 1992 and 2009 by combining surface geostrophic velocities derived from altimetry with an estimate, via EOF decomposition, of the vertical structure of the transport variability statistically determined from the previous moored array measurements. The reconstructed 17 ‐ year time series of the EGIC transport was afterwards validated against independent estimates.

Keywords: current meter measurements, time series, spectral analysis, coherence spectrum , Empirical Orthogonal Function.

CHARACTERISTICS OF TRANSPORT ESTIMATES IN THE SUBTROPICAL NORTH ATLANTIC FROM THE RAPID ARRAY: GYRES, EDDIES AND THE MOC

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The RAPID/MOCHA project has been making estimates of the transbasin Atlantic Meridional Overturning Circulation (MOC) since April 2004. The MOC is a key player in the global climate system, responsible for transport 1.5 PW of heat northwards in the Atlantic. Understanding sources of variability are critical to determining how the MOC may change due to climate change. The MOC is estimated from individual components being the Gulf Stream transport through Florida Straits, Ekman transport from winds, and a mid-ocean transport from moorings at the eastern and western boundaries of the Atlantic. The time-series of transport show variability on a range of timescales from subseasonal to interannual, with spectral analysis identifying peaks at monthly and annual periods. The covariability between transport estimates that contribute to the MOC calculation have nonstationary variability; in early years of measurement, the individual components were unrelated, each contributing variability independently to the MOC. In recent past, correlation and coherence analysis identifies a change in behavior at the western boundary: where the Gulf Stream and western boundary transports covary at periods longer than 50 days. I will discuss the characteristics of these timeseries, as determined from a range of time series analysis methods, and their physical interpretation.
Keywords: Meridional overturning circulation, eddy variability, correlation, coherence, spectra, nonstationarity.

A DEEPER LOOK AT ESTUARINE PROCESSES - WAVELETS AND CIRCULATION

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Understanding sediment transport is key for environmental management of the Lower Passaic River (LPR), New Jersey, USA. The LPR is contaminated with numerous hydrophobic contaminants, which strongly sorb to sediments in the system. Deposition of cleaner sediment can reduce biologically available contaminant concentrations, while erosion of contaminated sediments can result in a redistribution of contaminants to other parts of the system. Therefore, the sediment transport processes are important in determining the magnitude and rate of recovery of LPR sediments.
LPR is a partially mixed estuary, with its main source of sediments from flow over Dundee Dam at river mile 17. Under daily low flow conditions, the LPR experiences tidal delivery and deposition of sediment from Newark Bay due to estuarine circulation. During occasional high flow events, river flow in the LPR dominates and there is a net flux of sediments out of the river to Newark Bay. Large storm events provide energy for erosion of sediments in higher shear regions of the river, with subsequent deposition of resuspended sediment in lower shear regions. The net flux of solids during high flow events is orders of magnitude larger than upstream tidal delivery of sediment from the bay during low flow events. Long term transport has resulted in net deposition in the river coupled with a net efflux of sediment from the river.
Wavelet analysis was used on hydrodynamic and geophysical measurements collected at several locations along the 17-mile stretch of the LPR to decompose time series of measured data into time-frequency space in order to determine dominant modes of variability and how these modes vary in time. The advantage of wavelets over traditional fast Fourier transforsm (FFTs) is that wavelet analysis identifies dominant frequencies in a temporal context. Cross wavelet transforms reveal high common power between two variables in time-frequency space and wavelet coherence exposes strong coherence and relative phase between two variables in time-frequency space. This presentation will explore the analysis of data at locations along the LPR and examine how the wavelet analysis reveals the underlying physical relationships governing sediment transport in the system.
Keywords: Wavelet, sediment transport, estuary, environmental, sediment flux

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MULTISCALE TIME SERIES ANALYSIS: SCALING AND EXTREMES, STRUCTURE FUNCTIONS AND EMPIRICAL MODE DECOMPOSITION

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Marine ecosystems are complex systems and their variability is characterized, in time and space, by possible huge fluctuations on a wide range of scales. New methods are needed to analyse and characterize these fluctuations. We focus here on methods inspired by the fields of turbulence and signal processing. We consider extremes of increments of time series (characterized using probability density functions studies), and scaling properties using in particular Fourier power spectral analysis.
We particularly focus on intermittency, considered using structure functions approach, as well as using the newly introduced Empirical Mode Decomposition. The latter method, complemented by Hilbert Huang Spectral Analysis, has been introduced in 1998 and now there are several thousands studies using the method. We will present the method and show how it can be used to consider multiscale intermittency properties of time series.
We will show the theories and illustrate the results using high frequency marine turbulence time series as well as MAREL biogeochemical monitoring time series.
Keywords: multi-scale; extremes; scaling; empirical mode decomposition; power laws

Session "Geosciences and seismic monitoring"

Chaired by J. Mienert (Tromsoe University) and L. Geli (Ifremer)

MULTI-PARAMETER TIME SERIES FROM AN UN-CABLED DEEP-SEA OBSERVATORY AT AN ACTIVE MUD VOLCANO

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The Håkon Mosby mud volcano (HMMV) is located at around 1250 m water depth on the Barents Sea slope. In the past decades, numerous scientific expeditions provided evidence of persistent high seepage rates and abundant gas hydrates at shallow sediment depths. However, the temporal variability of activity and the corresponding dynamics of the gas hydrate reservoir associated with this mud volcano remained poorly understood. An in situ sediment temperature observation conducted between 2005 and 2006 provided the first indications of rapid changes in activity on time scales of weeks and months and suggested complex and dynamic flow patterns of mud or pore fluids. These observations led to the installation of an un-cabled observatory within the framework of the ESONET Demonstration Mission "LOOME", which recorded physical and chemical parameters in the sediment, at the seabed, and in the water column between 2008 and 2010. The data revealed alternating periods of high activity and quiescence that lasted from a few days to several weeks and point to a complex interplay of pore fluid flow, gas hydrate dynamics, seafloor deformation and sediment movement.

Keywords: deep-sea observatory, mud volcano, gas hydrates, fluid flow, methane seepage, episodic activity

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ANALYSIS AND INTERPRETATION OF GEOPHYSICAL TIME SERIES FROM SEAFLOOR OBSERVATORIES IN EMSO SITES

MONNA Stephen, Laura Beranzoli, Angelo De Santis, Paolo Favali and the EMSO Team of INGV [1]
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EMSO is a large-scale distributed European Research Infrastructure (RI) of the ESFRI roadmap. It is made up by fixed-point, seafloor and water column observatories with the basic scientific objective of long-term and, where possible, real-time monitoring of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere. It encompasses key sites of European waters, from the Arctic, through the north-western Atlantic and Mediterranean Sea to the Black Sea.
Scientific experiments and sustained observations have been developed regularly in many of the EMSO sites. This presentation will show geophysical time series acquired in some of these sites by GEOSTAR-class observatories with the aim to address the potentiality of the scientific observations for the investigation of remote tectonic and volcanic areas and the importance of a multidisciplinary approach to unravel the complex interactions among different natural phenomena traditionally studied apart such as seismic and volcanic activity, gas seepage, deep water-circulation regime. In particular, analyses of some geophysical time-series from the Western Ionian, Iberian Margin and Sea of Marmara will be presented in the frame of a trans-disciplinary approach.

[1] G. Cianchini, De Caro Maria Grazia, D. Embriaco, G. Etiope, F. Frugoni, G. Giovanetti, V. Iafolla, F. Italiano, N. Lo Bue, S. Monna, G. Marinaro, C. Montuori, T. Sgroi.

Keywords: marine geophysics, multi-parameter analysis, trans-disciplinary approach

COMBINING COLLOCATED ACOUSTIC GAS BUBBLE RECORDERS AND OCEAN BOTTOM SEISMOMETERS TO DETECT GAS RELATED PROCESSES IN SHALLOW SEDIMENT LAYERS

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Submarine degassing processes may be either natural (continuous exploration efforts and progress in multi-beam sonar techniques in the recent years have shown that natural seafloor degassing is a wide spread phenomenon), either artificial resulting from human activities (e. g. sediment destabilization related to oil exploration, pipe leaking, etc). Whether natural or artificial, degassing processes require a number of generic tools for their detection and monitoring.

We here present different multiparameter datasets from the submerged section of the North Anatolian Fault, within the Sea of Marmara, showing that the combination of collocated acoustic gas bubble recorders and Ocean Bottom Seismometers (OBSs) provide the means to detect gas accumulation and release processes in shallow sediment layers. Understanding the physical processes is a prerequisite, before we can propose methods for combining all different datasets and detecting anomalous signals that could eventually be identified as indicators that a potentially dangerous situation is under way.

Keywords: degassing processes, geohazards, seafloor monitoring

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EMSO-AZORES. A NEAR-REAL TIME MULTIDISCIPLINARY OBSERVATORY OF HYDROTHERMAL PROCESSES AND ECOSYSTEMS AT THE MID-ATLANTIC RIDGE : GEOPHYSICAL MONITORING OF SUBSEAFLOOR PROCESSES

CANNAT Mathilde, J Escartin, T Barreyre, W Crawford, A Jourdain, V Ballu, V Chavagnac, C Boulart, F Fontaine, R Daniel, C Courrier, J Legrand, J Blandin, M Miranda, C Corela, A Blin & PM Sarradin.
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The EMSO-Azores project focuses on the Lucky Strike hydrothermal vent field, on the ridge south of the Azores. It addresses two main questions : What are the feedbacks between volcanism, deformation, seismicity, and hydrothermalism at a slow spreading mid-ocean ridge? and How does the hydrothermal ecosystem couple with these sub-seabed processes?

With partial support from ESONET we successfully deployed (in 2010), and maintained (in 2011) a near-realtime buoyed multidisciplinary observatory system. Sensors are connected to two junction boxes, acoustically linked to a surface buoy with satellite communication to shore. The connected instruments (seismometer, pressure probes, GPS, ecological sensors) are nested in arrays of autonomous sensors (OBSs, pressure probes, temperature probes in selected vents, currentmeters and temperature probes in the water column). The interpretation of time series data also relies on repeated observations and sampling of fluids and faunas.

In this presentation we will outline the latest results of this prototype observatory system, focusing on the geophysically-oriented components of the experiment (seismicity, geodesy, fluid temperature and chemistry). We will outline our approaches to time-series analyses and discuss perspectives for future studies and modelling.

Keywords: multidisciplinary seafloor observatory, hydrothermal circulation, seismicity, ground deformation, mid-ocean ridge

Session "Applications for industry"

Chaired by M. Prevosto (Ifremer) and I. Rychlik (Chalmers university)

RELIABILITY APPLICATIONS OF SPATIO-TEMPORAL HS MODEL

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In the talk we shall first present a spatio-temporal random non-homogenous field used to describe variability of the significant wave height. Some aspects of statistical estimation of the model will be mentioned. Then following applications will be discussed

1) *Long-term variability :* Estimation of safety indexes for fatigue of a container ship sailing in North Atlantic. Estimation of 100 years Hs .
2) *Medium term variability:* Validation of radar measurements (confidence intervals) during a voyage .
3) Extrapolation of hindcast data to denser grid, time span of few hours and distance of 100 km.

Keywords: Spatio-temporal models, non-separable covariances, significant wave highs, fatigue damage

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WHIPPING/SPRINGING ON THE EXTREME PREDICTION OF SHIP RESPONSES

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Wave-induced vibrations, also known as whipping and springing, are defined as the high frequency response of ship structures. Whipping is usually referred to the ship response caused by transient impact loading, such as slamming, green water or underwater explosion. Springing is associated with a stationary resonant response phenomenon of the ship beam. In this study, the full-scale measurements of a 2800 TEU container ship that operates in the North Atlantic Ocean, will used for the investigation of extreme prediction of ship responses. The measurement campaign includes 7 voyages from Europe to North America and 7 voyages back to Europe, lasting for continuous 6 months. The record frequency of time series of stress (strain) is 25 Hz, which is able to capture the response of whipping/springing of this ship.

The whipping/springing-induced contribution to the extreme response is investigated by means of the level crossing approach. It shows that the level crossing model for Gaussian load cannot be used for the prediction of extreme responses, such as the 100-year stress, based on the full-scale measurement. A more complicated non-Gaussian model is required to consider the contribution from whipping/springing. In this study, a simple formulation is derived to compute the necessary parameters in compute the upcrossing intensities. One parameter is called the significant response range hs , 4 standard deviation of stress signals in one stationary sea state. The other is the mean stress up-crossing frequency fz. It is found that the first parameter could be approximated by only considering ship response (stress) without whipping/springing. The other parameter is approximated by taking the expected value of encountered wave frequency. The capability and accuracy of this method is demonstrated by stress signal from both measurements and numerical analysis.

Finally, the difference of extreme prediction using the full-scale measurements (with and without whipping/springing) and classical principles is also presented, and deserves more investigation in the future research.

Keywords: Extreme prediction, Whipping/springing, upcrossing intensity

Statistical Processing of Wave Directional Spectral Time-Series Into A Climatology of Swell Events

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Accurate estimation of the nature and occurrence probabilities of long-term sea conditions is a major issue for the design of coastal and offshore structures, for the preparation of marine operations, and for other applications such as marine energy, coastal erosion, etc. When those conditions are complex, it is necessary on one hand to extract a condensed meaningful structure from the available time-history of measured directional spectra, yet on the other hand the commonplace simple joint probabilities of, say, global wave height, period and direction are far from sufficient to fully describe the climate complexity, for instance in West African regions.
We present here some preliminary results of a method that identifies time-consistent events in the history, models them, and investigates their occurrence process, thus allowing to reconstruct synthetic histories of a larger number of sea-state parameters with acceptable statistical properties. The method consists in the following steps:

- Extraction of wave systems from each directional spectrum
- Gathering over time of systems corresponding to the same storms into events
- Identification of parametric models for the time-evolution of wave characteristics within each event.
- Model of the occurrence process of the discrete events.

Keywords: Joint probabilities, array time-series, spectral parameters, wave climate

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Gaussian state-space model for wind fields in the North-East Atlantic

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We propose a stochastic space-time model for wind fields at regional scale in the North-East Atlantic. This work aims at developing stochastic models which can generate realistic wind conditions and be used to estimate various related risks (renewable energy, coastal erosion,...).
We use a gaussian linear state-space model in which the hidden state represent the mean circulation at the regional scale and the observationn equation relates the regional conditions to the local ones. One of the goal of the model is to reproduce space-time motions of the meteorological systems as, for example, the propagation of a storm in the channel. The observation equation of the state-space model describes the spatial structure of the variables and time structure is contained in model equation: the hidden variable is an auto-regressive process.
The estimation strategy is based on maximum likelihood (Kalman filter and EM algorithm). Estimation is done on 6-hourly reanalysis data from ECMWF. The model is validated by comparing statistics of the data with those computed from artificial realizations of the model.
This model does not allow to correctly reproduce the weather regimes existing in this area. The next step could be to add an extra layer of hidden variables. These variables with values in a finite state space will describe the various regional weather types and will provide a more flexible model.

Keywords: stochastic weather generators, wind time series, markov-switching autoregressive model, multiscale model, overdispersion

EVALUATING ENVIRONMENTAL JOINT EXTREMES FOR THE OFFSHORE INDUSTRY

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Understanding extreme ocean environments and their interaction with fixed and floating structures is critical for offshore and coastal design. The joint effect of various ocean parameters on extreme responses of offshore structures is important. For example, it is known that mean values of wave periods tend to increase with increasing storm intensity, and a floating system responds in a complex way to both parameters. Joint extreme estimation for the offshore industry fall mainly into two camps - response-based and response-independent. Both are discussed, but the emphasis is on new methods associated with response-independent methods.
Many methods of multivariate extreme value analysis are based on models which assume implicitly that in some joint tail region each parameter is either independent of or asymptotically dependent on other parameters; yet in reality the dependence structure in general is neither of these. The underpinning assumption of multivariate regular variation restricts these methods to estimation of joint regions in which all parameters are extreme; but regions where only a subset of parameters are extreme can be equally important for design.
Design contours are useful to describe the joint behaviour of environmental, structural loading and response variables. Different forms of design contours are discussed and a new method for joint estimation of contours of constant exceedence probability for a general set of variables is described, including those based on the First Order Reliability Method. The methods are discussed in terms of contours of constant exceedence probability using measured and hindcast data from the Northern North Sea, the Gulf of Mexico and the North West Shelf of Australia.

Keywords: environmental time series, Joint extremes, offshore structure design

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EVALUATE THE ENVIRONMENTAL EFFECTS OF OIL PLATFORM DISCHARGES IN THE NORWEGIAN SECTOR OF THE NORTH SEA

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In 2011 Statoil initiated a program to develop real time based integrated environmental monitoring of discharges from oil and gas exploration and production to the marine environment. The goal is to develop technology and methodology for real time recording of vital environmental parameters in the influence area of oil and gas E&P activities offshore to improve environmental management and performance. The development is building on Statoil.s experience in collecting time series of marine environmental data from sensor systems and sensor platforms, and the company's risk based approach to environmental management.
Statoil is presently operating several systems for time series data collection related to different offshore E&P operations in the offshore sector, varying from monitoring discharges from drilling operations to data collection in virgin areas with no petroleum infrastructure. It is the company's ambition to share relevant data with the scientific community, by giving relevant institutions access to these data.
Our latest initiative is the establishment of a cabled ocean observatory outside Vesterålen in Northern Norway, focusing on oceanographic parameters and biomass fluxes in the water column. The presentation will address this and other ongoing projects, technology development, ambitions and plans for the development of integrated environmental monitoring.
Keywords: environmental monitoring, real time data, sensor technology, sensor platforms, marine environment, oil and gas industry

Session "Marine Ecology: from coastal to deep-sea ecosystems and Acoustical ecology"

Chaired by
J. Sarrazin (Ifremer) and M. Matabos (University of Victoria), L. Di Iorio (ENSTA Bretagne)

FROM OCEAN SOUNDS TO COASTAL ECOSYSTEM MONITORING

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Coastal ecosystems are crucial in terms of their ecological and socio-economical importance. Benthic organisms have a paramount impact on these ecosystems since they influence the regulation of primary production and play a major role in transforming and exporting organic matter and in influencing biogeochemical processes. Monitoring their activity and responses to environmental fluctuations therefore is a key element for understanding ecosystem dynamics. However, acquiring high-resolution time series to characterize biological rhythms, spatio-temporal variability, and environmental quality at different ecological levels is arduous. Here we demonstrate how listening to the sounds emitted involuntarily by a variety of benthic organisms (e.g. crustaceans, molluscs, echinoderms) contributes to fill this gap. We introduce the term "micro acoustics" describing the behaviour at the individual/species level; the term "meso acoustics" referring to the population or community and enabling the characterisation of a habitat; and the term "macro acoustics" used to describe and compare ecosystems or habitats also at different spatial scales. We show how the analysis of species-specific sounds or ambient noise of data acquired over several months helps monitoring the activity of an ecosystem sentinels used as quality indicator, to describe the natural variability, the biomass and species richness of a habitat and to assess responses to environmental changes.

Keywords: passive acoustic monitoring, ambient noise, benthic ecology, environmental description, ecosystem sentinels of biological origin.

USING DEEP-SEA OBSERVATORIES TO IDENTIFY OCEAN NOISE TRENDS

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The growing scientific and societal concern about the effects of underwater sound on marine ecosystems has been recently recognized through the introduction of several international initiatives, like the International Quiet Ocean Experiment, aiming at measuring the environmental impact of ocean noise on large spatial and temporal scales. From a regulatory perspective, the European Marine Strategy Framework Directive includes noise (and other forms of energy) as one of eleven descriptors to determine Good Environmental Status of the oceans. The Directive specifically requires Member States to provide a measure of annually averaged noise. The Laboratory of Applied Bioacoustics has developed a software package that measures sound levels and monitors acoustic sources in real-time; this software was used for the LIDO project (www.listentothedeep.com), which originated from the European Sea-floor Observatory Network of Excellence (ESONET). The system is currently operating worldwide from several wired and radio-

linked observatories. Recently, through a zero-cost contract with the CTBTO (Preparatory Commission for the Comprehensive nuclear-test ban treaty organization), years of data from hydroacoustic stations were analysed to look for background noise trends and to detect cetacean presence. Here, we present the analysis of four CTBTO platforms, each covering 42 months of data, focussing especially on the estimation of background noise levels and the measurement of noise contributions from anthropogenic sources. Continuous monitoring of background noise will help to understand whether long-term exposures, in areas with intense shipping or seismic campaigns, for instance, might alter animal natural behaviour and may be used in the future to assess the effects of ocean noise on marine life.

Keywords: ocean observatories, noise, acoustic events, acoustic long-term time series

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ECOLOGICAL TIME-SERIES AND CLIMATE CHANGE

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On a global scale there are only a small number of marine ecological time series that have been maintained using a consistent methodology over a long period of time. This is in contrast to time series of physical and to some extent chemical data, which are easier to measure in a consistent manner and often have strategic value e.g for weather forecasting. Spatially gridded and satellite based time series will also be mentioned. Few ecological time series studies survive beyond three years (thesis projects) and very few beyond a decade, and this situation is ongoing as funding for marine science stalls due to the global economic crisis. Monitoring is often the first programme to be cut in the research portfolio of laboratories and funding agencies and is rarely ring-fenced. Maintaining such programmes is expensive and time consuming, and the proponents often lose sight of the importance or become tired of the repetitiveness of their work fighting against funding, publication and other priorities. In the past monitoring to produce time series was considered as poor science, on a par with stamp collecting. The survival of many surveys has been fortuitous due to the foresight of a few scientists and funders who saw the intrinsic value of the work against criticism from process orientated and laboratory based experimental researchers. The true value of historical datasets is now well recognised due to an increasing awareness of the need to assess the impacts and rates of environmental change from for example, climate, eutrophication and overfishing. Increasingly policy makers are becoming aware of the value of time series data for policy development and marine management and as a means of assessing rates and impacts of climate change. An attempt will be made to summarise other time series datasets used in climate change research. It is now clear from long programmes such as the Continuous Plankton Recorder and the Helgoland dataset that the value of a time series increases progressively as new previously un-thought of applications are applied to the data and samples. In a global context there are large gaps in coverage of time series by region, ecosystem and water depth, especially in the open ocean. For plankton especially this is a huge gap in knowledge, given their importance in the carbon cycle. I will examine the past record of ecological time series and comment on the statistical analyses used prior to 2000 to interpret Continuous Plankton Recorder (CPR) data. The presentation will also highlight and analyse the reasons why a few long-term programmes have been successful and others not. Their importance in climate change research will be emphasised. An urgent need to develop and implement an appropriately funded ecological observation programme, integrated with research and modelling, that complements the present physical and chemical monitoring of the Global Ocean Observing System (GOOS) will be stressed.

Keywords: , Ecological time series, climate change, Global Ocean Observing System, Continuous Plankton Recorder, long-term, monitoring,

LONG-TERM CHANGES IN A FINE SAND MACROBENTHIC COMMUNITY FROM THE BAY OF MORLAIX (WESTERN ENGLISH CHANNEL): THIRTY YEARS OF SAMPLING

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In the Bay of Morlaix, benthic samples were collected at 2-3 month intervals (i.e. 5 observations per year) from one station in a fine sand community over a thirty-year period (1977-2006). In parallel, different environmental variables measured at different frequencies are available to describe climate variability (i.e. sea surface temperature, wind speed and direction, and freshwater inputs) as well as large-scale hydroclimatic indices (NAO, AMO, NHT). The site was also strongly affected by the Amoco Cadiz oil spill during which 220,000 tons of hydrocarbons were discharged in April 1978.
Data were analysed to identify inter-annual variability and long-term trends in the densities of the dominant species and the community structure in response to both anthropogenic disturbances and climate change. A typology was proposed to classify the species according to their temporal variations corresponding to different types of ecological responses to environmental changes (e.g. erratic proliferations of opportunistic species, multi-year cycles, and positive trends).
Our results highlight the importance of long-term observations for the understanding of temporal dynamics of coastal benthic communities and disentangle the relative role of natural and human-induced changes. For managers, they raise the question of a reference status of a habitat and the shifting of baselines.

Keywords: macrofauna, coastal environment, climate change, oil spill, reference status, English Channel

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"LONG TERM CHANGES IN BENTHIC COMMUNITIES AND COASTAL SYSTEM FUNCTIONING IN RELATION TO ANTHROPOGENIC BUT ALSO TO CLIMATE FORCING."

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Western Brittany coastal ecosystems have been subjected to disturbance due to anthropogenic activities for centuries. However, recent improvement in fishing techniques or in agricultural activities has meant that impacts to coastal benthic communities have drastically increased.
In parallel, seawater temperature has been regularly increasing along the last century in response to global warming, which may also influence benthic communities.
In order to measure the consequences of these impacts to the benthic communities and the coastal ecosystem functioning, we use multiple long-term series (hydrological parameters, chlorophyll concentration, phytoplankton, benthic communities, and benthic indicator species) from the bay of Brest and the adjacent Iroise.
We will give several detailed examples of such impact including:
- how clams and scallop dredging has profound, long term impacts on the biodiversity and nursery role of a fished maerl bed, while in comparison, adjacent unfished areas do not show similar damages.
- regarding eutrophication, how the use a novel approach coupling quantitative long term data to trophic web structure (obtained through stable isotopes analysis) allowed to delineate strong eutrophication events and benthic communities recovery through time.
- how the survey of species at their northern limits of distribution may help to better understand and predicts changes to coastal systems under global warming
Keywords: benthic community, fishing impact, eutrophication, climate change, biodiversity, ecosystem functionning

BIOGEOCHEMICAL AND ECOLOGICAL RESEARCH AT THE PORCUPINE ABYSSAL PLAIN

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Research at the Porcupine Abyssal Plain (PAP) has included time-series studies of biogeochemical and ecological variation since 1989. The site is located in the sub-polar northeast Atlantic and is subject to seasonality, as well as longer term variations. Since 2002, the infrastructure has also included long-term mooring deployed sensors for temperature, salinity, chlorophyll-a fluorescence, nitrate and pCO_2 all from the upper mixed layer. Currently, in collaboration with the UK MetOffice, atmospheric data are also collected at PAP. Data from the atmospheric and upper ocean sensors are made available in near real time via MyOcean and the Global Telecommunications System (GTS). Data and samples from PAP have been used to understand the efficiency of carbon uptake in the surface ocean, its transfer to deeper depths, and ultimately the impact on benthic ecology of the abyssal plain. Order of magnitude variations have been found at interannual scales in several key variables including the flux of particulate organic carbon and the abundance of specific megafauna species on the seafloor. Current time-series research at the site is focused on understanding the degree to which climate, mixed layer depth, primary productivity, and pCO_2 variations are related and influence carbon transfer in the ocean. We will discuss approaches used to disentangle potential links between variables including multivariate community analysis, spectral analysis and phenology.

Keywords: Porcupine Abyssal Plain, ecology, carbon, biogeochemistry, particulate organic carbon, ocean observatory

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TEMPORAL VARIABILITY IN BENTHIC COMMUNITY DYNAMICS USING SEAFLOOR IMAGERY

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Deep-sea ecosystems are subjected to a variety of environmental forces that act at temporal scales that range from diurnal to millennial. Our understanding of how these environmental factors shape benthic communities is very incomplete, and most of what we know is the result of brief ship-based expeditions. Cabled ocean observatories offer a new approach for studying the dynamics in deep-sea benthic communities and their relationship with habitat variables. The power and bandwidth available through cabled connections permits high-resolution, time-series observations for months and even years.

VENUS and NEPTUNE Canada are the coastal and regional components of the Ocean Network Canada observatory. We used the VENUS digital still camera, located at 104 m depth in Saanich Inlet, to acquire a high-resolution photographic time-series to determine animal abundances and bacterial mat coverage in relation to changes in environmental variables. A 890 m depth NEPTUNE Canada camera in Barkley Canyon was used to examine qualitative changes in benthic macrofauna in relation to seasonal environmental changes, over a one-year period. We applied multivariate ordination methods and a principal coordinate analysis of neighbour matrices to decompose the variance in the data and determine temporal structures in our dataset. We will use results from both studies to discuss the power and limitations of the cabled observatory approach to documenting and explaining benthic community dynamics in the deep ocean.

Keywords: cabled observatories, activity rhythms, imagery, Saanich Inlet, submarine canyon, benthic community

SHORT- AND LONG-TERM ECOLOGICAL VARIATIONS AT DEEP-SEA HYDROTHERMAL VENTS – A MULTIDISCIPLINARY OBSERVATORY APPROACH

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Located on oceanic ridges, hydrothermal ecosystems are characterized by strong physicochemical gradients and a unique fauna, sustained by chemosynthesis. Because of their remoteness in the deep-sea, it remains difficult to evaluate sub-annual variations and to understand the variability of the local environment. Long-term monitoring is thus indispensable to gain fundamental knowledge about the response of faunal assemblages to changes in their habitats, growth, succession and biotic interactions.

An autonomous deep-sea observatory is currently deployed in the Atlantic Ocean of which the ecological module focuses on a hydrothermal mussel assemblage. Its first deployment (2006) gathered video imagery, iron-concentrations and temperature. Video imagery is an effective and important tool to monitor long-term natural changes in remote ecosystems, though the data-analysis is very time-consuming. For this purpose, an automated video processing platform was developed. A selection of different image analyses techniques was implemented in this platform. During this presentation, the interface will be presented.

In addition, results on temporal variations from 2006 for both fauna and environment will be discussed. Periodicities and rhythms in environmental variables were unravelled using PCNM/MEM analyses, which decompose the time-series in sinusoidal waves. Significant scales and periods are thus revealed for all variables and tested within ecological models.

Keywords: Hydrothermal vents, time-series, faunal assemblages, image analyses, numerical ecology, automation

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Annex (Posters presentation)
Proceedings of conference

Report made by I. Puillat (Ifremer) version 1.0: 27 Nov. 2012

CONTENT

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1. Forewords and Acknowledgements

Forewords

This document gathers posters presented in the framework of the conference and training days "Time-series analysis in marine science and applications for industry" organised in Logonna-Daoulas, Centre Nautique Moulin Mer, (Brittany, France) the 17-21 September 2012.

This event convened about 100 scientists and students. The purpose was to bring together the scientific community and research activities across fields in marine science (physical oceanography, marine chemistry, marine biology, ecology and geology) to foster interactions and collaborations focused on a common topic: time-series analysis methods.

The conference, started with a 2-day training course followed by a 3-day scientific conference. In addition to the courses and oral presentations, 36 posters were presented. Most of them are published in this report. Slides presented during oral presentations and allowed to be published are available on Internet: http://www.europolemer.eu/time-series-analysis.php.

Acknowledgements:

This one-week event was successful: on scientific and human points of view. The success of this event was based on several pillars: the venue of motivated speakers, teachers, and attendees firstly. Consequently the organisation greatly thanks all speakers and professors for their interesting talks and courses, and attendees for listening, interacting, for what they brought: their knowledge, their science, their kindness and their positive energy.

The Organising committee thanks the Scientific Committee who helped a lot during the one-year preparation of the event and chaired the sessions, namely:

H. Mercier (CNRS/LPO) and B. Cornuelle (SCRIPPS)
P. Morin (CNRS/INSU Roscoff) and E. Frajka-Williams (NOCS)
J. Mienert (University of Tromsø) and L. Géli (Ifremer)
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Finally as lead organiser I would like to personally thank members of the organising committee:

M. Prevosto (Ifremer)
B. Ferré (University of Tromsø)
P. Morin (CNRS/INSU Roscoff)
S. Thomas (Europôle Mer)
N. Réniers (Europôle Mer)

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2. Posters list

AGUIRRE Arturo	Growth of Peruvian scallops Argopecten purpuratus (Lamarck, 1819): importance of the availability and quality of seston (**unpublished poster**)
AMORIM Fabiola	Estudo dos Processos Físicos subjacentes à dinâmica de blooms de algas tóxicas na região adjacente à costa central de Portugal.
BENSI Manuel	Thermohaline variability and mesoscale dynamics observed at the E2M3A deep-site in the Southern Adriatic (Mediterranean Sea)
CHU Jackson	Soft-bottom communities along a low oxygen gradient in Saanich Inlet
CIAVATTA Stefano	Climate-driven changes in plankton trophic dynamics
CROS Estelle	Learning from the seismicity in the Marmara Sea
CUVELIER Daphné	A glimpse of the day to day of a hydrothermal faunal assemblage in the Atlantic
DARGACZ Aneta	Times-series analysis in addition to novel techniques of passive acoustic detection and wave buoy measurements of wave breaking process.
DE VLEESCHOUWER David	The Late-Devonian (~370 Ma) climate response to astronomical forcing (**unpublished poster**)
DEROT Jonathan	Analysis of high frequency monitoring biogeochemical time series in the coastal waters of the eastern english channel (**unpublished poster**)
DRAGON Anne-Cécile	Mertz polynya sea-ice variability over 1979-2009 and its links to the surface atmosphere
DUDEJA Gayatri	Detection of global warming using satellite records of ocean productivity
FONTAN Amudena	Air-Sea Interaction patterns and times scales within the southeastern Bay of Biscay
FRANEK Peter	Analysis of Håkon Mosby Mud Volcano seismic data
GERTMAN Isaac	Anthropogenic effects on the Dead Sea atmospheric boundary layer and water body (**unpublished poster**)
HAMMERSCHMIDT Sebastian	Analysing long-term fluid pressure data: an example from the SmartPlug borehole observatory (**unpublished poster**)
IRISSON Jean-Olivier	Detecting hydrologic seasons in a long term monitoring time series

KALYUZHNAYA Anna	Data assimilation in the flood forecasting model for Saint-Petersburg (**unpublished poster**)
KHARITONOVA Lyudmila	Numerical modeling of wind waves in the Western Crimea coastal zone, Black Sea (**unpublished poster**)
KLIMCHUK Evgeniya	Sverdrup transport temporal and spatial variability in North Atlantic based on NOC1.1 dataset.
KPOGO-NUWOKLO K. Agbéko	Construction of a realistic wave climate from swell systems statistics
LEITAO Francisco	Times-series analysis for study ecological trends in Portuguese fisheries over the last 60th years.
LOPEZ-CASTEJON Francisco	Time series analysis for tide-surge overlapping. A critical analysis to understand the water exchange of a non-tidal coastal lagoon in the SW Mediterranean Sea.
MARREC Pierre	Time-series analysis of the CO2 system in the English Channel/North Atlantic continental shelf using pCO2 sensors on fixed buoys and Voluntary Observing Ships (VOS)
MARTINI Séverine	How to analyse bioluminescence time series from the ANTARES in situ observatory ?
RAZVAN Mateescu	Multi-annual Analysis of the Waves Time-series for Marine Regime Characterization in the Danube Delta Area
OGUGUAH Ngozi	Variations in Air and Sea Surface Temperature at the Commodore channel and Victoria Beach, Lagos Nigeria.
PRISTA Nuno	Using SARIMA models to assess data-poor fisheries
REDA Anna	Analysis of freak wave measurements in the Baltic Sea
RENOSH P.R.	Analysis of a high frequency time series of bio-optical properties in complex coastal waters: couplings with turbulence
RIGOBERTO Rosas-Luis	Environment variation related to jumbo squid Dosidicus gigas and short-finned squid Illex argentinus
SEN Arunima	Community succession via time-series analysis in hydrothermal vent habitats of the Eastern Lau Spreading Center, Tonga
SOLABARRIETA Lohitzune	HF radar observations of surface currents in the SE Bay of Biscay

STAUFFER Beth Tidally-mediated bloom initiation in a nearshore embayment resolved from a high resolution time-series.

TSIMITRI Chrysanthi The characteristics of Lake Baikal's internal wave spectrum.

URANGA Jon Automated analysis in tuna long-range sonar signals for fishing vessels.

3. POSTERS ABSTRACTS

Poster abstracts are alphabetically ordered according to the first author name.

Growth of Peruvian scallops Argopecten purpuratus (Lamarck, 1819): importance of the availability and quality of seston.

AGUIRRE Arturo, Jonathan Flye-Sainte Marie, Frédéric Jean
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Argopecten purpuratus growth (height and ash-free dry weight) and environmental parameters (availability and quality of seston and some physico-chemical) monitoring was conducted for 98 days between April and July 2007 in Paracas bay, Peru. Two treatments were used: bottom and suspended (2 m above bottom) culture. In a first moment the periodicity of striae formation on the valves has been validated: a deposition rhythm of one day striae was found independently of treatment. In a second part, growth rates deviations to theoretical curves, resulting of the Von Bertalanffy growth function fitting, were calculated. The canonical analysis of correlation, made between the growth rate deviations and the environmental parameters, shows that the concentration in phaeopigments is correlated inversely with the deviations and that this one is related to the bottom treatment. The time series cross-correlation analysis of bottom treatment shows that the deviations in height growth rates are correlated with parameters of seston availability, especially the concentration of particulate organic carbon and nitrogen, whereas the growth differences in weight somatic tissues are correlated with the availability and the quality parameters of seston and temperature. The multivariate predictive model suggested shows that the temperature, chlorophyll-a and residual particulate organic nitrogen explain rather well the somatic dry weight variation into the both treatments.

Keywords: seston quality, aquaculture, Peru.

Study of Physical Processes underlying the dynamics of blooms of toxic algae in the region adjacent to the central coast of Portugal.

AMORIM Fabiola, Dubert Jesus and Nolasco Rita and Oliveira Paulo and Moita Teresa.
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The physical processes of transport and retention of harmful algal bloom dynamics offshore Aveiro (40oN-41oN) are investigated based on in situ observational data. The data consist of hydrographic (temperature, salinity, chlorophyll) and currents (depth time-series and bottom-tracking) measurements during the 2010 and 2011 summer seasons. The results points to a intense upwelling system along the coast mainly due to the wind forcing. Also, a cyclonic eddy formed by the interaction of the alongshore flow with the Aveiro Canyon topography can enhance the upwelling system leading to a strong surface chlorophyll concentration.

Keywords: algal bloom, coastal upwelling system, observational data.

Thermohaline variability and mesoscale dynamics observed at the E2M3A deep-site in the Southern Adriatic (Mediterranean Sea)

BENSI Manuel, Cardin Vanessa, Rubino Angelo and Gacic Miroslav
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Continuous sampling measurements are strictly essential to better understand the deep convection. The Southern Adriatic Sea, recognized as a dense water formation site able to oxygenate the deep layers of the Eastern Mediterranean, has been constantly monitored at the E2M3A deep-site (Latitude 41° 50' N, Longitude 17° 45' E, maximum depth 1250m) since 2006. Temperature, salinity and currents time-series were merged with air-sea heat fluxes data and analyzed for the period 2006-2010. Here we report on the abrupt temperature and salinity decrease down to 700m depth from March 2008 on (maximum temperature and salinity decrease of ~0.3°C and ~0.06 respectively) and on the continuous temperature and salinity increase (linear trend: ~0.05 °C y-1 and ~0.004 psu y-1) observed at the bottom. A strong relationship with the recently discovered variability of the Ionian surface circulation, responsible for the heat and salt content changes in the Adriatic, emerges. The data also reveal that the passage of mesoscale eddies produces a twofold effect: the contribution to the restratification of the water during the post convection phase by exchanging the buoyancy between the mixed path and the surroundings water and the transfer of heat and salt between the deep and the intermediate layers.

Keywords: Deep Convection, Eastern Mediterranean, Mesoscale Dynamic

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Soft-bottom communities along a low oxygen gradient in Saanich Inlet

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In situ observations of seafloor communities living at their minimum dissolved oxygen (dO2) limits are urgently needed to determine how ecosystems can respond to hypoxia.

Biological patterns often occur at small spatial and temporal scales, thus fine scale field observations are important in determining organism level responses to hypoxic events.

To determine how animals distribute themselves along changing gradients of low dO2, we repeated a benthic transect line over 4 years using a remotely operated vehicle fitted with high-definition camera systems and a CTD with oxygen probe.

Our preliminary results reveal the lower limits of dO2 tolerance for several species in Saanich Inlet and show how animal populations will migrate into shallower depths when a shifting floor of severe hypoxia compresses the area of available habitat.

Keywords: hypoxia, benthos, epifauna

Climate-driven changes in plankton trophic dynamics

CIAVATTA Stefano, Claudia Halsband, Claire Widdicombe, Tim Smyth, Elaine Fileman, Angus Atkinson
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Climate impact on the ocean can induce changes in the plankton community, with effects on the ecosystem functioning and services, e.g. fishery. Data from long-term plankton surveys can provide important insights in the above changes, if adequate analytical tools are applied.

In this work, we investigated the changes of the plankton trophic dynamics induced by fluctuations of essential climate variables (ECVs, e.g. wind velocity and sea surface temperature) in the western English Channel. Decadal time series of phytoplankton and upper trophic taxa, sampled weekly by the Western Channel Observatory, were decomposed in their long-term and seasonal components, by using Dynamic Harmonic Regression (DHR) models and a Kalman filtering algorithm.

The results show that the interannual fluctuations of the ECVs impacted the whole planktonic structure in the last decade, inducing significative changes in the biomass of phytoplankton taxa, microzooplankton and macrozooplankton abundance and production, with effects up to the level of fish larvae.

Crucially, the correlation analysis among the long-term components of the time series indicated that the changes in the ECVs impacted also the trophic relationships between the primary and secondary producers.

This work points out the relevance of plankton survey and sound modelling to investigate the functioning and trends of planktonic ecosystems in the context of global changes.

Keywords: essential climate variables, plankton trophic dynamics, Western Channel Observatory.

Improving the accuracy of earthquake locations using Ocean Bottom Seismometers in the immediate vicinity of the North Anatolian Fault in the western and central parts of the Sea of Marmara

CROS Estelle, Géli Louis, Gaye Bayrakci, Namik çagatay, Cemil Gürbüz
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The Marmara Sea is located between the Aegean Sea and the Black Sea, along the North Anatolian strike-slip fault, which experienced a sixty year sequence of earthquakes since 1940, propagating to the west towards Istanbul. Prior to this sequence, which ended with the Izmit and Duzce earthquakes in 1999, at the eastern end of the SoM, the fault ruptured to the west in 1912 in Ganos, with an estimated moment magnitude of 7.4. Therefore, a major earthquake is expected within the Sea of Marmara seismic gap.

In order to better understand the seismicity and to reduce the threshold of detection, a network of ten OBS with four components was deployed by Ifremer with R/V Yunuz of Istanbul Technical University, in the western and central parts of the Marmara Sea to record the micro-seismicity from the immediate vicinity of the Main Marmara Fault, between april and august, 2011. The network was specifically designed to survey the segments crossing the Western High, where gas hydrates where recently found, the Central Basin and the Kumburgaz Basin. During this period more than one hundred earthquakes were detected by the CSEM (European-Mediterranean Seismological Centre) in the Sea of Marmara.

Because the basins of the Sea of Marmara are filled with more than 5 km of Plio- Quaternary soft ("slow") sediments, it is of critical importance to take into account the velocity structure of the offshore domain, which is drastically different from the one onshore. To improve the localization of seismic events, a 3D velocity model was thus considered and implemented in the Sytmis® software developed by INERIS. This model is based on the tomographic data collected in 2001 using a controlled source experiment and on the numerous multichannel seismic profiles that provide information on, respectively, the deeper structures and the upper, sedimentary layers.

Preliminary results are presented. Special focus will be given on : i) the depth of the events below the Western High, where the NAF is known to intersect a gas reservoir ; ii) on the clustering of the micro-seismicity at both extremities of the Central Basin. As a perspective to future work, an attempt will be made to improve earthquake locations using the dataset from the permanent, cabled, Ocean Bottom Broad-Band Seismometers network operated by KOERI.

Keywords: Seismicity, OBS, Marmara Sea

A glimpse of the day to day of a hydrothermal faunal assemblage in the Atlantic

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Since the discovery of hydrothermal vents in 1976, our understanding of the hydrothermal faunal assemblages is growing, however, their functional ecology and temporal dynamics remain less clear. Many critical features of these rapidly evolving systems can only be discovered and understood through time-series observations. Several ecological time-series studies in the Pacific and Atlantic Oceans have already been carried out but they are - at best - based on yearly visits.

While the use of time-lapse cameras at hydrothermal vents has already demonstrated that sub-annual processes, such as diurnal or semi-diurnal periodicities, also play a role in shaping hydrothermal vent communities and influencing their dynamics. Since a couple of years, the scientific community has been rooting for the development of novel techniques and approaches for studying the temporal aspects of biotic and abiotic variables in deep-sea ecosystems both in real-time and over longer time-scales.

An autonomous deep-sea observatory is currently up and running in the Atlantic Ocean (MoMAR at the Lucky Strike on the Mid-Atlantic Ridge (MAR) at 1700m depth) of which the ecological module (TEMPO) focuses on a Bathymodiolus azoricus hydrothermal vent faunal assemblage. Its first deployment took place in 2006 for which the data available comprises 45 days of video imagery (recording ca. 4 minutes/day), along with 4.5 months of total dissolved iron (Fe) data and 18 months of temperature. First results and ecological interpretations are revealed, while periodicities and rhythms in environmental variables are unraveled.

Keywords: autonomous deep-sea observatory, faunal dynamics, hydrothermal vents, numerical ecology

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Times-series analysis in addition to novel techniques of passive acoustic detection and wave buoy measurements of wave breaking process.

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Wave breaking is one of the main processes taken into account in the modelling of wind waves. In the present study an insight into the process of wave breaking was achieved by applying acoustic techniques. The studies are based on the analysis of the noise generated by acoustically - active bubbles produced by breaking waves. The noise was recorded by a system of hydrophones located under the sea surface. Simultaneously, the free surface elevation was measured by wave buoys. The combination of the recorded signals was applied to analyze the wave breaking processes in the time domain for different storm wave parameters. The analysis enabled us to identify wave breaking events for individual waves as well as the intensity of wave breaking processes. Moreover, the applied analysis enabled us to determine the direction and speed of breaking waves as well as the duration of wave breaking events.

Keywords: time-series, wave breaking, acoustics

The Late-Devonian (~370 Ma) climate response to astronomical forcing

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Only few general circulation models have been used to simulate the extreme greenhouse climate of the Late-Devonian, and knowledge on its dynamics comes almost exclusively from geological proxy-data. Given that these data sources are fragmentary, the understanding of Devonian climates is limited. Nonetheless, the Late-Devonian is a key-period in the evolution of life: land plants invaded the continents, fish evolved to amphibians, extinction events, etc. To better understand the functioning of the climate system during this key-period, we applied the HadSM3 climate-model.

We simulated Late-Devonian climates by prescribing palaeogeography, vegetation

distribution and pCO2-concentration. Different experiments were carried out under 27 combinations of eccentricity, obliquity and precession. First results suggest that the climate at the palaeogeographical position of western and central Europe (~10°S) is highly susceptible for changes in precession. Precession maxima climates are wetter and colder (up to 300 mm/month and 9°C) compared to precession minima climates. Obliquity does not influence strongly this (sub)tropical climate. The imprint of obliquity on polar climates is extensive (up to 6°C).

This work can be considered the first quantitative understanding of palaeoclimatic response to astronomical forcing during the Devonian. Therefore, it offers a crucial framework to correctly interpret time-series analyses on geological palaeoclimatic proxy-records.

Keywords: Late-Devonian, astronomical forcing, climate simulation

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Analysis of high frequency monitoring biogeochemical time series in the coastal waters of the eastern english channel

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We considerate here automatic high frequency measurements of biogeochemical properties of sea water in the Eastern English Channel (Boulogne-sur-mer). This system, operated by Ifremer and belonging to the MAREL network of automatic measurements in littoral waters, records every 20 minutes about 15 parameters (including temperature, salinity, pH, dissolved oxygen, nutrients, and in vivo fluorescence) since 2004.

Such time series possess tens of thousands of data; for the analysis we use several methods coming from the fields of statistical physics and turbulence: probability density function analysis, structure functions analysis, Fourier power spectra. We also consider the dynamics of stochiometric ratio such as N/P. We particularly focus on extreme dynamics.

The objective here is to better understand the high frequency and also multi-scale dynamics of biogeochemical parameters and especially phytoplankton communities.

Keywords: high frequency; coastal waters; multi-scale; multi-scale; extremes

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Mertz polynya sea-ice variability over 1979-2009 and its links to the surface atmosphere

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Antarctic sea ice concentration based on passive microwave observations for the period 1979-2009 were analysed to examine the effects of atmospheric forcing. We were especially interested in the study of the Antarctic sea-ice dynamic in coastal polynyas, areas of open water within pack ice. Local sea-ice thickness has been estimated in the Mertz polynya, one of the main sea-ice formation areas in east Antarctica and, as such, an important "biological hotspot" of the Antarctic and Southern Ocean ecosystem. This study of the polynya sensitivity to atmospheric forcing (air temperature, air pressure, wind speed, wind direction etc.) has helped us to determine, with a very fine spatial resolution, the rate of ice growth in winter and the processes occurring as the ice forms. This information will help us track how rapidly climate is changing and help us improve our understanding of the importance of sea-ice for the Southern ecosystem.

Keywords: long-term time series, sea-ice formation, atmospheric forcing

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Detection of global warming using satellite records of ocean productivity

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Detecting the climate change signal in satellite records of productivity would imply that ocean primary production has been affected by anthropogenic influences. An approach using optimal fingerprints to detect anthropogenic climate change in ocean colour measurements is demonstrated. The methodology has been applied to detect and attribute greenhouse gas induced climate change in sea-surface temperature records, ocean heat content, atmospheric air temperature etc., but this is the first attempt to apply it to ocean productivity records. Monthly chlorophyll concentration (Chl) from Control (1959-2059) and Historical (1959-2005) forced runs of the Geophysical Fluid Dynamics Laboratory (GFDL) CM 2.1 model were used to derive the pattern of the warming signal. Chl data (1997-2006) from NASA's Ocean Biogeochemical Model were projected onto the warming signal. Here, we test the hypothesis that the observed trends are due to anthropogenic climate change. Our results indicate that the global warming signal is not yet detectable. However, introducing adaptations to the methodology, may allow the fingerprint of global warming to be detected in the satellite ocean colour record.

Keywords: ocean productivity, detection-attribution, climate change

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Air-sea interaction patterns and time scales within the southeastern Bay of Biscay

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The understanding of air-sea interaction patterns and time-scales is of prime importance for forecasting changes in the climate, oceanic circulation and ecosystems in general. The air-sea interaction patterns are complex: they have a variety of time-scales and amplitudes and occur simultaneously. Further, the degree to which the Atmosphere and Ocean are coupled varies spatially, from coastal to oceanic environments. In the present investigation, the wind forced

currents on the sea surface are investigated with special attention. The contribution of the wind to the current fluctuations occurs over a wide range of frequencies (inertial, diurnal, synoptic, seasonal, etc.). Additionally, the wind-current interaction patterns together with the time-scales involved vary from coastal areas to deep sea. In this context, the purpose of the present study is to describe and determine quantitatively the wind-current interaction patterns and time scales within the southeastern Bay of Biscay.

Keywords: wind-induced currents, land-sea breezes, Bay of Biscay

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Analysis of long-term ocean-bottom seismic data from the Håkon Mosby Mud Volcano

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Håkon Mosby Mud Volcano, located at around 1250 m deep on the SW Barents Sea slope between Norway and Svalbard, has been the object of intensive study since its discovery in 1990's. It has a diameter of about one kilometer and rises a few meters above the seafloor. Methane seeps, mud flows and high temperature creates suitable conditions for extensive microbial communities. Within the LOOME project a variety of sensors monitoring hydrological, geochemical and biological parameters were deployed in the area. Institute of Geology, University of Tromsø, using long term ocean-bottom seismic station has acquired continuous two years seismic records of vertical and both horizontal components of motion which enabled to record P and S seismic waves. Considerable activity of mud volcano is the source of seismic waves propagating to surroundings. Analysis of seismic records showed that there are two types of events. Irregular occurrences of local tremors are probably caused by sudden stress release in the area. Regularly occurring events with distinct frequency peaks at 4 and 8 Hz presumable correspond to the mud flows. Based on the analysis of time record envelopes we determined the increase of activity of these events with period of about 12-14 hours.

Keywords: Håkon Mosby Mud Volcano, ocean-bottom seismic data, mud flow

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Anthropogenic effects on the Dead Sea atmospheric boundary layer and water body

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Intensive utilization of fresh water from the Dead Sea's water shed has led to decline in the sea level since the middle of XX century with rate about 100 cm/year. Long term Dead Sea monitoring, during this period, has been resulting in unique time series of water body parameters as well as meteorological parameters of atmospheric boundary layer. The time series consist from non-equidistant oceanographic casts in the deepest part of the sea and from regular meteorological observations from an open sea station. All data accumulated in MS ACCESS database allowing effective quality control and statistical analysis. The analysis reviled wealth of knowledge regarding non-stationary variability of the Dead Sea meteorological forcing and hydrological regime.

Significant problems in estimation of interannual variability arise due to changing of sensors. For example accuracy of the relative humidity sensor during 1992-2000 was not satisfied for measurements in arid regions. The problem was discovered only in 2002 when a next generation of humidity sensor was introduced. Some statistical processing and correction were implemented to diminish the non-stationarity in time series generated by technically different sensors.

Keywords: Long term monitoring, interannual variability, thermohaline overturn, Dead Sea.

Analysing long-term fluid pressure data: an example from the SmartPlug borehole observatory

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During the last two decades, borehole observatories or CORKs (Circulating Obviation Retrofit Kits) proved to be reliable systems for monitoring in situ properties like fluid pressure, temperature and/or geochemistry. The scientific outcome is vital, not only for understanding the hydrogeology of the oceanic crust, including the global transport of solutes and heat flow budgets, but also in shedding light on seismogenic processes at convergent margins.

The SmartPlug, which is very simple CORK system, was installed in the Nankai Trough accretionary prism, SE Japan, where it crosscuts a shallow branch of a giant splay fault system that showed co-seismic activity during past earthquakes. The 15-months lasting record was heavily influenced by tidal noise, which was dealt with by two ways: (1) By conducting a Fast Fourier Transformation and by calculating the power spectral density, the so-called "tidal loading efficiency" was obtained, i.e. the total fraction of a pressure change caused by tidal signals which is elastically taken up by the fluid. The tidal loading efficiency was used to infer hydrogeologic and poroelastic properties of the splay fault system, which shed light on its mechanical properties and the possibility of fluid migration. (2) The tidal noise was removed, and after the pressure data was filtered using a Butterworth filter, a proper analysis of the time series was possible. By using fluid pressure transients as proxy for strain and combining that with data from local Japanese earthquake catalogues, it was possible to relate pressure anomalies to the occurrence of regional and distant earthquakes, tsunamis and low-pressure weather systems.

The results indicate that no seismo-tectonic event occurred during the monitoring period, and that fluid migration is, based on the present hydrogeologic properties, unlikely. Consequently, previous assumptions that the splay fault might be episodically active only can be supported.

Keywords: in-situ, fluid pressure, tidal loading

Detecting hydrologic seasons in a long term monitoring time series

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Long-term monitoring time-series are the key to understanding climate and other anthropogenic changes. The hydrology of Point B in Villefranche's Bay (Southern France) has been monitored weekly since 1952. In 1992, more intense sampling started, a with CTD and fluorometer associated with water samples for oxygen, chlorophyll and nutrients measurement. Here we try to decompose these long series to extract large-scale trends, detect seasonal patterns and study the dynamics of these seasons through time. We focus in particular on the blooming and mixing events. Finally, we start to relate those patterns to the zooplankton series, which are collected with the same frequency at this location.

Keywords: monitoring, season, decomposition

Data assimilation in the flood forecasting model for Saint-Petersburg

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For several centuries, floods were a threat for many European centers such as London, Amsterdam, Saint-Petersburg. Nowadays, special complexes are developed and continuously improved to protect high population cities from economic and cultural damage, which could cause by flood. To protect Saint-Petersburg from destruction a dike, which separates Neva Bay from the Gulf of Finland, was built.

High water level are almost always meteorologically induced water level disturbances that originate in the western and central Baltic Sea, which then propagate and intensify going eastward, leading to increased level in Saint-Petersburg.

To predict extremely level rising a mathematical model based on shallow water equations is taken. This model performs only synoptic component of oscillation (long-term oscillations are not produced at all). To account for so-called background level additional procedure is need to be applied in a couple with hydrodynamic model. For this aim and for enhance the forecasting accuracy applied the assimilation of measured water level in the model. The difference between the modeled and observed water level at a station in the model is used to adjust model results in the neighborhood of that station. Optimal interpolation and Kalman filtering are the relevant approaches to data assimilation and used before operating the barrier's gates.

Keywords: flood forecasting, data assimilation, dike

Numerical modeling of wind waves in the Western Crimea coastal zone, Black Sea.

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A paper presents results of numerical modeling for waves near the Western Crimea coast, Black Sea. By using a well-developed wave transformation routine (SWAN) the wave heights, periods and directions were estimated over a low resolution (4,5 km), coarse grid that includes the Sea of Azov and Black Sea regions and high resolution (600 m), nested grid that covers the Western Crimea shelf. Moreover these numerical calculations were fulfilled with the results of re-analysis data from JRA project, Japan Meteorological Agency. As a result the Regional Wave Climate were obtained for 32-year period (1978-2010). For four test locations near the shore statistical characteristics of waves were examined and compared with the in situ data from on shore hydrometeorological stations. Notably, our results show good correlation. Furthermore method of annual maxima, based on the Gumbel integral distribution function was used to analyze extreme wave heights. It was revealed that extremely height waves occurring once in a 100 years near the Western Crimea coast can reach up to eight meters.

Keywords: Regional Wave Climate, numerical modeling, coastal zone.

Sverdrup transport temporal and spatial variability in North Atlantic based on NOC1.1 dataset.

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The North Atlantic Ocean is the most completely observed and extensively studied among other oceans, but as a dynamic system interacting with atmosphere and affecting surrounding territories it remains significant for scientists to analyze. In order to understand multi-decadal variability of the Sverdrup transport (meridional transport estimated from the wind stress curl) a continuous time-series need to be examined. NOC1.1 flux climatology (Southampton, UK) is the most realistic and freely available meteorological dataset existing nowadays. It contains monthly components of zonal and meridional wind stress for World Ocean with 1×1° spatial resolution from 1980 to 2005 year. Curl of wind stress and then integrated Sverdrup transport were estimated for every month in the area of Atlantic Ocean within 35S-70N based on the dataset. Revealed that maximum average yearly Sverdrup transport in North Atlantic is 24.3 Sv (1Sv=106m3/s) at 33N, this value is consistent with other authors estimates for different time-series. Moreover a comparison analysis between integrated Sverdrup transport and Florida Current transport (AOML NOAA project) in vicinity of 27N indicated that average annual barotropic mass transport can determine average annual Florida Current transport by almost 70%. Presumably rest is determined by thermohaline component.

Keywords: NOC1.1dataset, Sverdrup transport, North Atlantic.

Construction of a realistic wave climate from swell systems statistics

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Design of a marine structure requires to characterize all sea states that will occur during its service life, whatever complex they may be when they are represented by their decomposition into wave systems. The objective of this study is to propose a methodology that can be used to construct accurately realistic wave climate histories for any desired duration, in typical West Africa conditions. We based our method on the modeling of wave systems in correspondence with the storms that are at their source and that can be identified from the history of environmental parameters of the sea states. A parametric definition of a storm event was first built by modeling the temporal variation of the parameters of swell systems, then statistical study of the model parameters was carried out. Sea states are simulated by combining swell systems, the parameters of which are generated randomly according to their empirical distributions. Swell events could be assembled into realistic simulated sea states, yet it will require additional assumptions on how the events occur in order to build reliable combined sea states for practical use in fatigue design.

Keywords: wave climate, sea states, fatigue design.

Times-series analysis for study ecological trends in Portuguese fisheries over the last 60th years.

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To date, few studies have addressed the aggregate effects of oceanographic and hydrological factors on trends in Portuguese fishery resources. Climate changes affect marine ecosystems and the survival, growth, reproduction and distribution of species, and consequently also fisheries of commercial species. The combined analysis of long-term trends in fisheries and environmental variables may shed light on factors influencing particular species or functional groups and provide a basis for improved assessment and management. In pursuit of this, we compile and review information regarding Portuguese time-series landings over last 60 years. Dynamic factorial analysis were used both as exploratory techniques and analysis techniques to understand the role of climate changes impact (NAO, SSt etc) on landings time series. The results are herein discussed.

Keywords: time-series, multivariate exploratory techniques; dynamic factorial analysis; fishing trends

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Time series analysis for tide-surge overlapping. A critical analysis to understand the water exchange of a non-tidal coastal lagoon in the SW Mediterranean Sea.

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Tide analysis is a widely used technique to identify amplitude and phase of tide components in order to understand sea level elevation processes in the coastal ocean. However, in areas in which surge episodes or meteorological phenomena show same or similar frequencies to the tide, it can be quite difficult to perform a tide analysis properly. The aim of this poster is to show different techniques applied to tide analysis of a yearly sea level record of the Mar Menor coastal lagoon (South-Western Mediterranean Sea, Spain). In this area surge episodes and meteorological phenomenon with frequencies close to the S2 and K1 tide component have been found. Some of the techniques applied to discriminate tide and surge signals comprise : 1) different atmospheric data correction, 2) low-pass data filter, 3) spectral analysis and 4) modeling simulations forced by astronomical tide components only, atmospheric forcing only and both together. The Mar Menor is one of the largest European coastal lagoons and is connected to the Mediterranean Sea by three shallow channels. The water exchange between the lagoon and Mediterranean Sea is affected by centimeters changes in the Mediterranean Sea level due to overlapping of surge and tide phase, therefore it is critical to identify those signals by proper use of time series analysis.

Keywords: time-series, tide phase, surge, Mar Menor

Time-series analysis of the CO2 system in the English Channel/North Atlantic continental shelf using pCO2 sensors on fixed buoys and Voluntary Observing Ships (VOS)

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The raise of atmospheric CO2 due to anthropogenic activities is a major driver of the climate change and the ocean plays a key role in the uptake of this CO2. The contribution of open ocean to this uptake is presently rather well quantified. The role of coastal ocean to this process remains ambiguous due to the diversity and the high spatio-temporal variability of air-sea CO2 fluxes in these ecosystems. Time-series analysis of the carbonate system at fixed stations or using Voluntary Observing Ship (VOS) is a novel way to investigate the variability of these fluxes. In particular, the high frequency allows quantifying the partial pressure of CO2 (pCO2) from diurnal to inter-annual time scales.

In the CHANNEL project, we investigate the air-sea CO2 fluxes variability based on high-frequency signals from 2 fixed stations (MAREL in the bay of Brest and ASTAN off Roscoff) and 1 VOS line, which crosses daily the English Channel. These datasets allow us to get a large spatio-temporal coverage of the pCO2 variability in these systems. We will present the first results obtained with these sensors and discuss the benefits of high-frequency measurements to better understand the CO2 system dynamic in coastal ecosystems under climate change.

Keywords: Time-series, High-frequency, CO2

How to analyse bioluminescence time series from the ANTARES in situ observatory ?

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Sampling, quantifying and observing marine bioluminescence in the natural environment is currently done using manned submersibles or autonomous underwater vehicles. The recent use of in situ sensor technology such as undersea observatories provides new insights. We use data from the ANTARES neutrino telescope, located 40 km off the French Mediterranean coast at 2475 m depth. This structure is mainly dedicated to the search of

the Cherenkov light emission indirectly produced by neutrinos interactions. However, this deep observatory also provides a huge amount of real-time data at high frequency, of in situ bioluminescence, coupled with oceanographic data. Only two mathematical methods are existing to explore these particular data defined as non-stationary and non-linear. The wavelet and the Hilbert-Huang methods are dedicated to analyse fluctuations at various scales of time and frequencies. Both methods decompose time series into bases of functions dedicated to specific frequencies. In this study, several long time series between the end of 2007 and the middle of 2010 have been analysed providing informations on links between the biological variable bioluminescence and oceanographic ones. These relations are characterized using common frequencies excited in the signals and time where they are excited. These analyses are the first innovative step to propose the use of bioluminescence activity records by Eulerian observatories as a proxy of biological activity in the deep sea. In a final aim bioluminescence sensors would be a new way to provide informations of ecological global changes taking place in the deep ecosystems.

Keywords: observatories, non-stationarity, time-frequency

Variations in Air and Sea Surface Temperature at the Commodore channel and Victoria Beach, Lagos Nigeria.

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Variations in Air and Sea Surface Temperature at the Commodore Channel and Victoria Beach, Lagos Nigeria was carried out between January 2004 and December 2010. Sampling was carried out twice daily at 9am and 2pm. Air temperature was measured with the aid of mercury in glass thermometer; sea surface temperature was measured with the aid of mercury in glass thermometer placed in a temperature bottle. Results show that the highest and lowest air temperature recorded at the Victoria Beach over the sampling period was 31.42°C ± 0.86 and 24.83°C in January2004 and August 2009 respectively. Sea surface temperature recorded at the Victoria Beach showed that the highest reading was 32.51°C± 1.09 in January 2006 and the lowest temperature was 25.39°C in August 2009. Temperature readings at the Commodore channel varied over the sampling period. The highest air temperature readings recorded was 32.06°C± 1.68in August 2006 and the lowest temperature was recorded in August 2005 with a value of 25.93°C± 1.94. Sea surface temperature at the Commodore

channel showed that August 2006 had the highest temperature with a value of 33.14°C± 1.66, while the lowest temperature was 26.01°C, recorded in August 2009.

Keywords: Air Temperature, Sea surface Temperature, Victoria Beach

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Using SARIMA models to assess data-poor fisheries

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Research on assessment and monitoring methods has primarily focused on fisheries with long multivariate data sets. Less research exists on methods applicable to data-poor fisheries with univariate data sets with a small sample size. We examine the capabilities of (seasonal) autoregressive integrated moving average ((S)ARIMA) models to fit, forecast, and monitor the landings of such data-poor fisheries. We use several Portuguese fisheries where analytical assessments are not carried out and where only short time series of landings are available to model as our case-studies. We show that despite the limited sample size, (S)ARIMA models can be found that adequately fit and forecast the time series of landings. We show how (S)ARIMA models can be integrated in a statistical process control framework and generate model-based prediction intervals that can be used as alarm thresholds in detecting problematic situations in data-poor fisheries. We discuss the information that (S)ARIMA model structure conveys on the species life-cycles, the methodological requirements of (S)ARIMA forecasting of data-poor fisheries landings, and the capabilities (S)ARIMA models present within current efforts to monitor the world's data-poorest resources.

Keywords: time-series, autoregressive integrated moving average models, fisheries

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Multi-annual Analysis of the Waves Time-series for Marine Regime Characterization in the Danube Delta Area

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Experimental researches, multi and inter-disciplinary, related to the marine and coastal hydrodynamics, as well as to the shore response and development in the fronts of big river mouths, were become more and more important in the last decades.

The present work emphasize the results of the coastal hydrodynamics processes induced in front of Danube River Delta, mainly affecting the safe navigation, but also human activities, in relation with sediment unbalanced situations and management at regional scale. The work is extended based on the analysis of multiannual wave data recorded within the hydrological monitoring of several coastal hydro-metric stations, in parallel with several hydro-graphic and geomorphological survey.

It is described, on short and medium term, the evolutions of the main hydrodynamic parameters in the adjacent areas of the Danube River mouths and its influence of the navigation accidents. The measured hydrodynamics parameters, where studied on its seasonal/annual and multi-annual variability, but also for certain violent hydrological events in the Romanian coastal zone.

Keywords: marine hydrological times-series, waves/currents analysis, coastal hydrodynamics processes

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Analysis of freak wave measurements in the Baltic Sea

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Within past years numerous cases of large vessels accidents and offshore structures failures have been reported. In many of them the cause of the accident is believed to be individual waves of exceptional wave height or of abnormal shape. These unique and rare phenomena are called freak waves. They pose serious threats to large vessels as well as smaller ships. Such waves deviate strongly in shape or in height from the average sea state, described by the usual integral parameters of significant wave height and peak period. The analysis of a unique set of wave data comprising 20000 wave records from the Baltic Sea disclosed a large number of freak-type waves. In this work a statistical analysis of time series of free-surface elevation recorded by Waverider buoys in the southern Baltic Sea is performed. The analysis focuses on individual extreme waves and wave events. It includes a wide range of aspects related with individual extreme waves to collect as much information as possible on their occurrence and features of extreme waves, and eventually to provide a contribution to a future warning system. The conducted analysis revealed novel and often surprising results of significant importance for scientists and engineers.

Keywords: freak waves, time-series, buoy measurements

Analysis of a high frequency time series of bio-optical properties in complex coastal waters: couplings with turbulence

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This poster describes physical processes (mainly the turbulence and re-suspension of particles due to turbulence) which control the micro scale variability of the bio-optical properties in highly turbid coastal waters. We analyse the variability of the bio-optical properties and their dynamics according to the re-suspension of particles. For this, time series analyses of different bio-optical and physical properties (like current velocity) have been performed from moored stations in coastal waters in the Eastern English Channel. The data bases considered are high frequency (1 Hz) simultaneous measurements during several days in a fixed point in the

highly turbid coastal waters of the English Channel. We consider optical, dynamical and biogeochemical properties recorded using different instruments. We mainly focus on the absorption, back scattering, attenuation, turbidity, particle concentration in different size classes, velocity series. For each parameter we consider the statistics (mean values, probability density functions) and the dynamics (Fourier power spectra, structure function analysis) and we also consider cross-correlations between attenuation and turbidity signals, and between particle concentration and turbulence.

Keywords: Bio-Optical Properties, Turbulence, Intermittency

Environment variation related to jumbo squid Dosidicus gigas and short-finned squid Illex argentinus

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Environment variation has been the main factor related to natural populations in the ocean and its influence has modified the availability of fishery resources like sardine and mackerel fish in the Pacific Ocean. The effects of this variation can be measured using time series analysis and the corresponding correlation factor with biomass estimates of the natural resources. This is the principal method applied to understand the dynamic of jumbo squid and the short-finned squid populations in the Pacific Ocean and the Southern Atlantic Ocean. An apparently correlation was observed between the biomass estimates and the chlorophyll and zooplankton anomalies that can explain the changes in abundance and distribution of these squids.

Keywords: Dosidicus gigas and Illex argentinus abundance, climate variation

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Community succession via time-series analysis in hydrothermal vent habitats of the Eastern Lau Spreading Center, Tonga

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Deep-sea hydrothermal vent communities of the Western Pacific are dominated by mobile mollusks that harbor chemoautotrophic symbionts. These communities are targeted for mining of polymetallic sulfide deposits, and understanding how these communities change naturally over time will be critical to formulating environmental impact assessment policies and interpretation of post impact studies. We analyzed high-resolution photo-mosaics and spatially explicit in-situ physico-chemical measurements within a Geographic Information System (GIS) to characterize changes in community composition and localized environmental conditions for 7 lava sites and 8 chimney sites in the Eastern Lau Spreading Center (ELSC) over 3 years or 4 years. This has enabled us to test our hypotheses addressing the roles of various groups as pioneering, intermediate or climax species, and their interactions with each

other and changing vent conditions. We have discovered that the ELSC fauna responds to changes in subsurface fluid patterns and move to maintain fidelity to a defined range of environmental conditions. The responses of ELSC megafauna to changing local conditions may help explain the rarity of sessile symbiont containing groups on the ELSC, such as those that can dominate at Eastern Pacific hydrothermal vents.

Keywords: time-series, succession, hydrothermal vents

HF radar observations of surface currents in the SE Bay of Biscay

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A CODAR Seasonde High Frequency (HF) radar system is operational since the beginning of 2009 for the oceanic region of the Basque Country (southeastern Bay of Biscay). It forms part of the Basque operational data acquisition system, established by the Directorate of Emergency Attention and Meteorology of the Basque Government. It is made up of two antennas, at the capes Higer and Matxitxako. This system provides hourly surface currents within a 6 km spatial resolution regular grid, covering 10,000 km2. The HF radar technology offers many benefits in several fields as: scientific research on surface currents and oceanic physical processes, security at navigation and maritime rescue, validation and calibration of hydrodynamic and pollutant drift models, etc.

This data, together with those obtained with similar systems developed by other institutions, will permit in the near future to improve the current knowledge about the surface circulation patterns both in the study area.

In this context, the aim of this work is to show the HF radar system of the Basque Country main characteristics and its ability to describe accurately surface circulation at different time scales in the southeastern Bay of Biscay. Monthly and seasonal surface circulation patterns are analysed and described for the period 2009-2011.

Keywords: High Frecuency Radar, surface currents, Bay of Biscay.

Tidally-mediated bloom initiation in a nearshore embayment resolved from a high resolution time-series.

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Blooms of microalgae are a common occurrence in many coastal ecosystems, with a range of effects on marine food webs. Documentation of blooms and their causative environmental factors has typically relied on low temporally-resolved datasets and linear statistical

techniques, focusing mainly on climatological trends over long time-series. In the present study, microalgal bloom dynamics within a nearshore, semi-enclosed embayment in southern California, USA, were found to be significantly correlated with the tidal cycle. Wavelet coherence revealed significant decoupling of the semi-diurnal tidal harmonic from chlorophyll fluorescence during periods of bloom initiation, and regression analyses confirmed that up to 24% of variation in algal biomass was explained by tidal amplitude. The tide-biomass relationship was largely explained by initiation of bloom events during or immediately following neap tide and was stronger in the more hydrodynamically-constrained area of the harbor. Neap tides provided « windows of opportunity » for increased phytoplankton growth and retention, and 2- and 7-day histories of dissolved nitrate and salinity were significant predictors of biomass. The current study underscores the role for the tidal cycle in initiation of microalgal blooms and emphasizes the need for high temporal resolution and analyses of local processes to understand episodic bloom dynamics in coastal environments.

Keywords: Algal blooms, wavelet coherence, tidal forcing.

The characteristics of Lake Baikal's internal wave spectrum.

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Lake Baikal is the deepest (over 1.6 Km) lake on earth holding 80% of world's fresh water supplies. The lake supports a remarkable biodiversity with a major deep-water fauna composed almost entirely of endemic species. A unique dataset of temperature and current was collected between 2000 and 2012 with moorings installed in the South basin of the lake. Due to its great depth only the top 200 m are experiencing the direct effects of the wind. However, a strong signal in the temperature data is observed around the inertial frequency most of the time and throughout the depth. Here we investigate the particularities of the internal wave spectrum and we focus on the inertial frequency band. Our goal is to evaluate the importance of the internal oscillations to the mixing and to correlate them to external forcing.

Keywords: time-series, internal-waves, wavelet

Automated analysis in tuna long-range sonar signals for fishing vessels.

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This study presents a new methodology for automated analysis in tuna long-range sonar signals. This approach attempts to solve the problem of sonar image processing. The study is focused at Albacore (Thunnus alalunga) and Buelfin (Tunnus thynnus) Tuna of the Bay of Biscay. With this process, for each sonar image we obtain measurable regions to analyze, each region is described by a set of characteristics. By the help of expert judgment each region is identified into a class attribute and a database is created for supervised learning. Thus, a classification model is performed. The final aim of this process is to maximize the estimation of tuna in regard to the real values, and to propose a new index of abundance, based on the automatic estimation of sonar images.

Keywords: Sonar image analysis, Supervised classification, Tuna stock estimation

4. POSTERS ALLOWED TO BE PUBLISHED

STUDY OF PHYSICAL PROCESSES UNDERLYING THE DYNAMICS OF BLOOMS OF TOXIC ALGAE IN THE REGION ADJACENT TO THE CENTRAL COAST OF PORTUGAL

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Introduction

The region of study (Fig. 1) extends from the coast to ~9°45'W longitude, between 40°N-41°N latitudes, on the western coast of the Iberian Peninsula, which represents the northernmost limit of the eastern North Atlantic upwelling system *(Peliz et al., 2002)*. The circulation within this region undergoes strong seasonal cycle, with upwelling favorable winds typically in late spring and summer, while during winter, weak northerly winds, interspersed occasionally by strong south-southwest winds, favor coastal convergence.

In the absence of coastal upwelling, the surface circulation is predominantly northward, partially driven by meridional alongshore density gradients. This circulation assumes a character of a poleward jet transporting higher salinity and warmer (subtropical) waters over the upper slope and shelf-break *(Peliz et al., 2002)*.

The continental shelf is relatively wide (~60 km), with the edge defined by the 200 m isobath. The region hosts an important topographic feature, the Aveiro Canyon (AC), where the slope gets very steep in just few kilometers, which may add more complexity to the local circulation and associated thermohaline structure. The AC is long (~43 km) and narrow (L/2~12 km), relatively symmetrical in shape and aligned perpendicular to the local isobaths, that is to say that the alongshore geostrophic currents intersect the canyon axis at right angles which may breaks the geostrophic constraint inducing upwelling/downwelling. According to *Haynes et al. (1993)*, the northern and southern edges of the canyon are known to be places of recurrent filament activities.

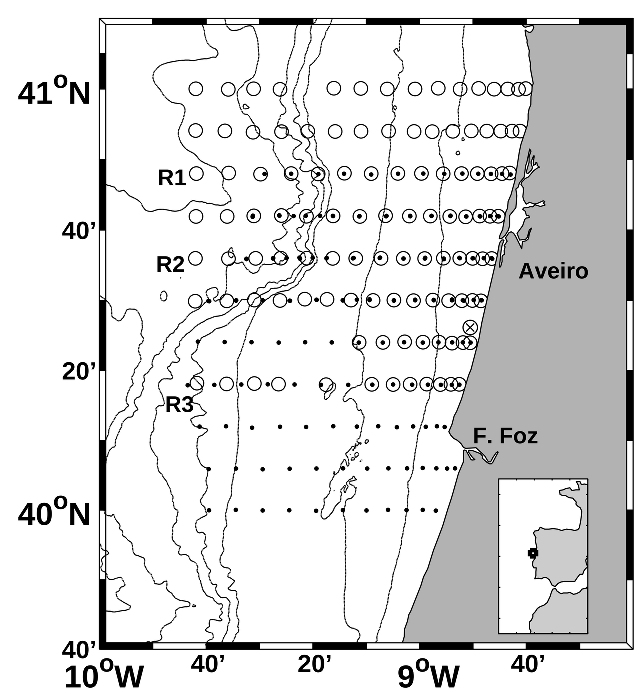

FIGURA 1: Location map of the region of study where the symbol • (○) represents the CTD stations and delimits the ADCP *bottom-tracking* transects during the 2010 (2011) campaign. R1 (40.8°N), R2 (40.6°N) and R3 (40.3°N) are the radials selected for investigating the dynamics of algae bloom. The time-series of the ADCP profile were obtained at ⊗ station (31 m local depth).

The objective of this work is to investigate the physical processes associated to the algae bloom dynamics at the region of study based on data collected in two campaigns during the 2010 and 2011 summer season.

Methodology

Hydrographic data (temperature and chlorophyll) was taken at 163 (111) stations distributed in nine (eight) radials perpendicular to the coastline (Fig. 1), during the 2010 (2011) campaign. Also, vertical current profiles was registered in each radial and current time-series along the water column was taken at the 31 m local depth (Fig. 1).

The hydrographic data was registered with a *SBE 9 SEACAT Profiler Seabird* CTD and the currents was recorded with a *Workhorse RD* ADCP *Profiler/Bottom-tracking*. The wind data was taken at the Universidade de Aveiro meteorological station. Wind and current time-series was low-pass filtered *(Walters & Heston,1982)* with a cut-off period of 33 h.

Results

2010 Campaign

The results for the 2010 campaign are presented in Figure 2.

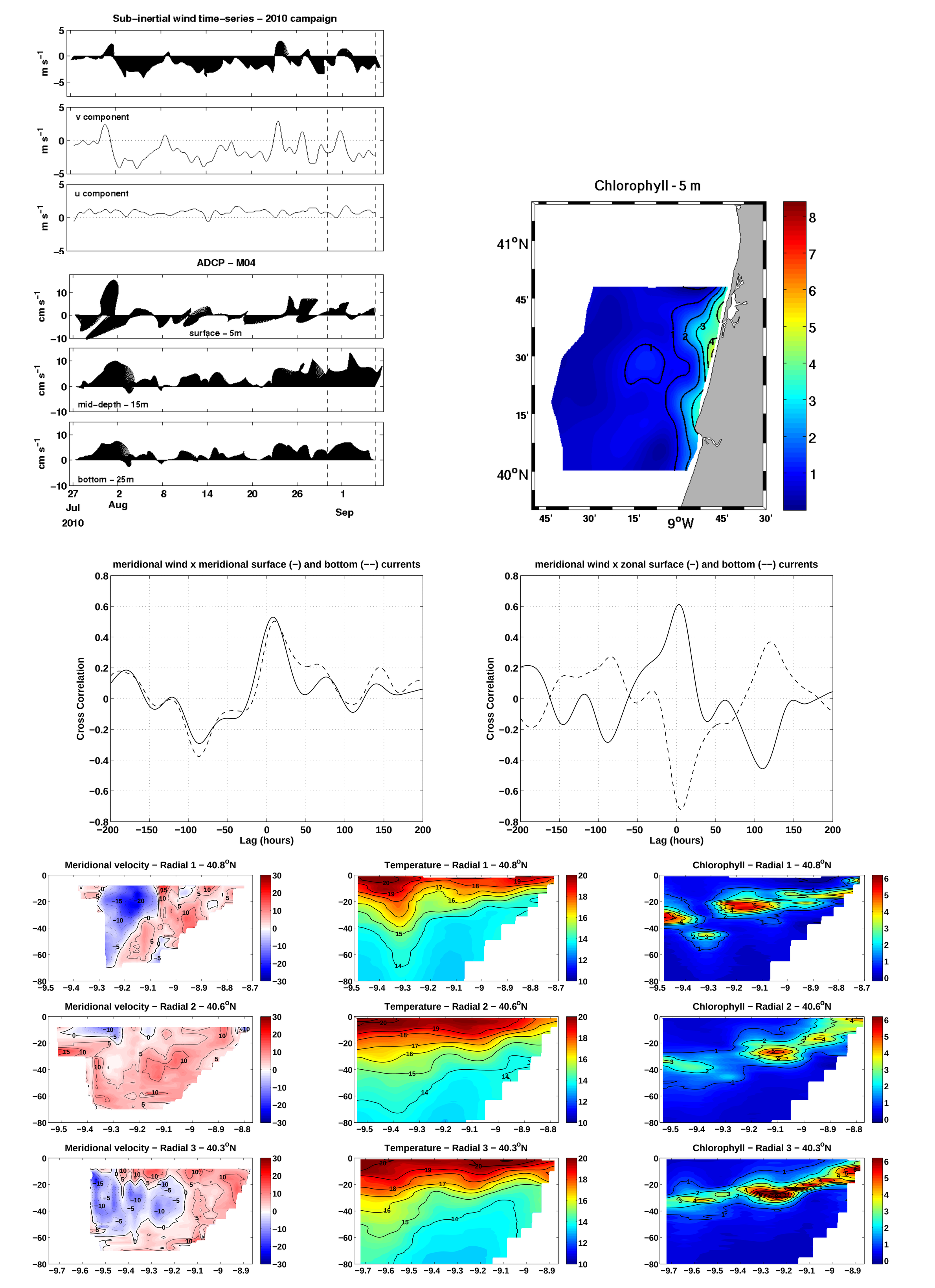

FIGURA 2: Campaign 2010: Sub-inertial time-series of the wind (obtained at Aveiro University meteorological station) and currents (31 m local depth); Surface (5 m depth) chlorophyll field concentration (mg m^{-3}); Lagged cross-correlation functions between sub-inertial wind and currents; Vertical sections of meridional velocity (cm s^{-1}), positive (red) northwards, temperature (°C) and chlorophyll (mg m^{-3}) for the radials R1, R2 and R3 (see Fig. 1 for location). The vertical dashed lines at the sub-inertial time-series indicate the period where the CTD casts and ADCP transects were performed.

During the summer 2010 the wind was mainly southwards, with a relaxation time during the campaign period. The surface currents (5 m) followed the local wind pattern, with a reversal of the preferential flow after the relaxation period. Currents along depth presented preferentially a northward flow. However, the surface and bottom current components presented a high correlation with the alongshore wind. Also, the pattern of the cross-shore current correlation reflects the opposing surface and bottom Ekman layers and the phase relationship is an indicative of an upwelling system.

The chlorophyll concentration was higher at the thermocline, with a maximum value of 8 mg m^{-3} at radial 3. At surface (5 m), the highest concentration was observed south of Aveiro, with a maximum value of 4 mg m^{-3}, associated with an intense upwelling system and a rise of the isotherms near the coast.

An intense cyclonic eddy was observed at radial 1, which can be associated with the AC dynamics. However, the local dynamics associated with the AC at this radial do not seems to affect the coastal region.

Also, a cyclonic structure could be observed at radial 3. However, the high sub-surface (~10 m) chlorophyll concentration (6 mg m^{-3}) may be associated with an upwelling system generated by a southward coastal jet.

2011 Campaign

The results for the 2010 campaign are presented in Figure 3.

During the observed period the wind was preferentially southward, with some reversal episodes. For this summer (2011), the currents along depth followed the local wind pattern during most of the time monitored, presenting a strong vertical shear. However, as observed during the 2010 summer, the surface and bottom current components presented a high correlation with the alongshore wind and the pattern of the cross-shore current correlation reflects the opposing surface and bottom Ekman layers. Also, the phase relationship between alongshore winds and cross-shore currents indicates the presence of an upwelling system.

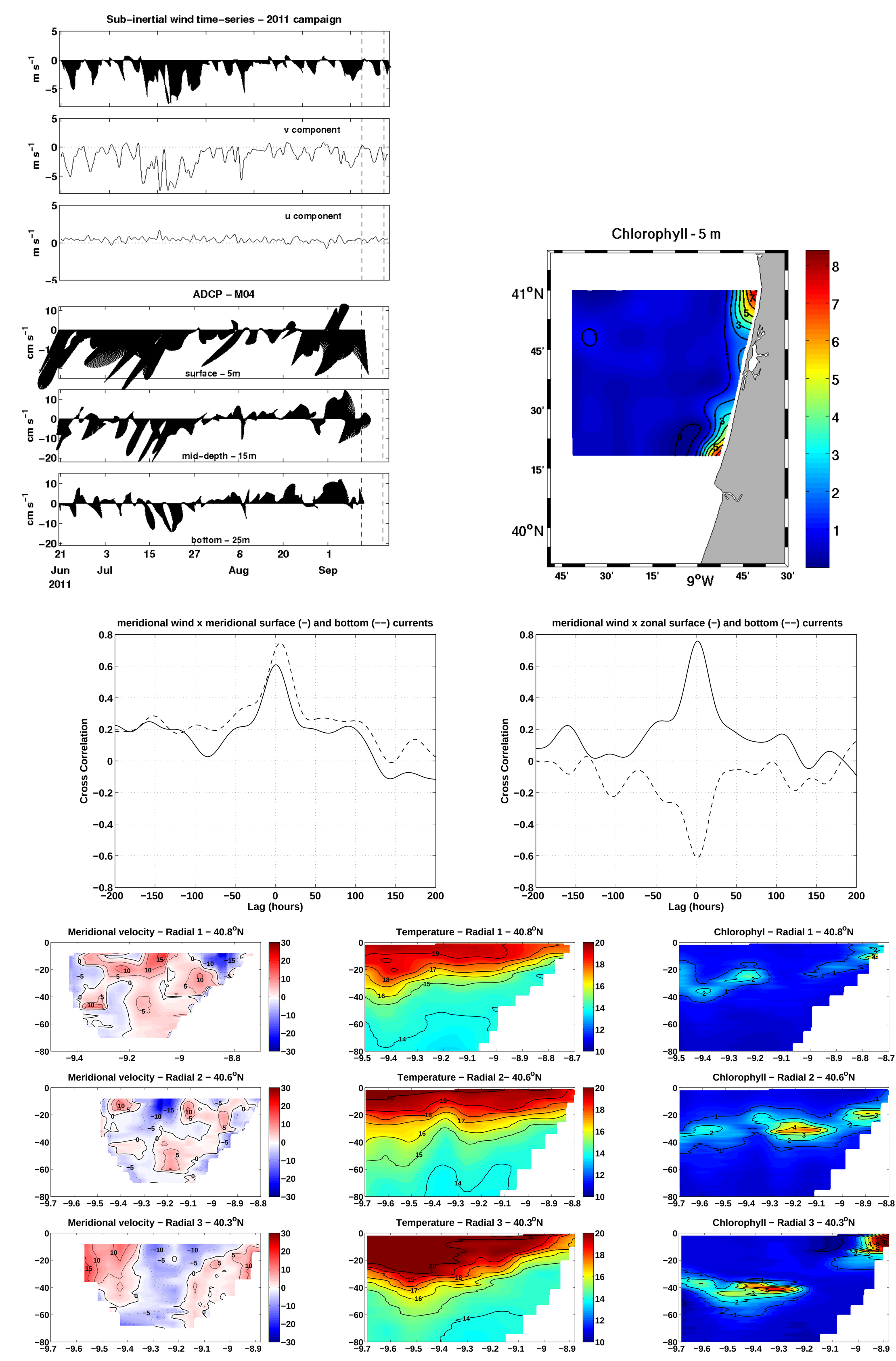

FIGURA 3: Same as Figure 2, but for the 2011 campaign.

The highest surface (5 m) chlorophyll concentrations were observed north of Aveiro and north of Figueira da Foz, with values as high as 8 mg m^{-3}. The high chlorophyll concentration north of Figueira da Foz (radial 3) could be associated with a southward coastal jet, which contributed to the isotherms rise and consequent generation of an upwelling system. Also, at this radial could be observed a sequence of eddies and high chlorophyll concentrations (>5 mg m^{-3}) at ~45 m depth as a response to the dynamics of an anticyclone eddy.

For radial 1 could also be observed an intense southward coastal jet. However, despite the presence of an coastal upwelling system, the subsurface chlorophyll concentration of 5 mg m^{-3} is lower than those observed for the other radials.

At radial 2 a cyclonic structure could be associated to the AC dynamics. However, as observed at radial 1 during the 2010 campaign, this dynamics do not seems to influence the coastal upwelling system.

Conclusions

The results presented points to an intense upwelling system at the regions adjacent to Aveiro and Figueira da Foz.

Despite the presence of an important topographic feature, represented by the Aveiro Canyon, the dynamics associated do not seems to affect the coastal upwelling system.

The surface algae bloom seems to be associated to the upwelling system, characteristic of the summer season, and intense southward coastal jets.

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Acknowledgments

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THERMOHALINE VARIABILITY AND MESOSCALE DYNAMICS OBSERVED AT THE E2M3A DEEP-SITE IN THE SOUTHERN ADRIATIC (MEDITERRANEAN SEA)

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Figure 1 – EuroSITES oceanographic buoys network (a) and the Italian E2M3A location (Latitude 41° 50' N, Longitude 17° 45' E) in the Southern Adriatic Sea (maximum depth 1250m). The panel *c* shows the basic circulation in the Adriatic Sea [NAdDW =North Adriatic Deep Water; AdDW = Adriatic Dense Water; LIW = Levantine Intermediate Water].

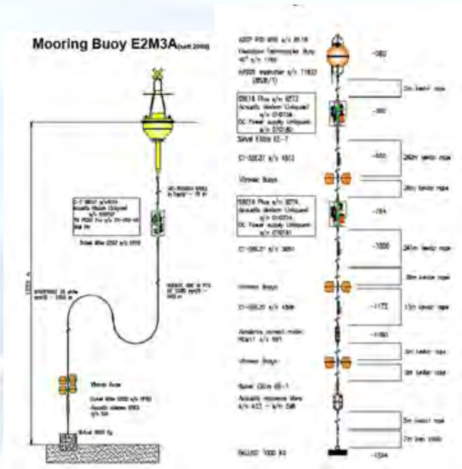

Figure 2 – E2M3A configuration: surface buoy on the left (meteorological sensors + CT at 15m depth) and deep mooring scheme (CT, CTD and current-meters) on the right. The data presented in this work refer only to those collected by means of the deep mooring.

The Southern Adriatic (E2M3A Site, see Fig. 1): *why this site ??*

- It is considered a major site of deep water formation and the origin of the deep thermohaline cell in the Eastern Mediterranean.
- The dynamic of the area is dominated by the presence of a quasi-permanent cyclonic gyre which favours the surfacing of high salinity water (LIW = Levantine Intermediate Water). Strong north easterly winds (Bora) are responsible for large surface heat loss during winter. These factors give birth to convective events with typical temporal scale of several days and spatial scale of O (20km).
- The newly produced dense water, called Adriatic Dense Water (AdDW), becomes the main component of the Eastern Mediterranean Deep Water (EMDW).

Datasets and methods:

The Southern Adriatic Sea has been constantly monitored by means of a deep- ocean observatory (E2M3A site) located in its central part (**Fig. 1**). The dataset used in this study comprises temperature (T), salinity (S) and current timeseries (Fig. 2) between 16 November 2006 and 16 September 2010. Different Conductivity-Temperature-Depth (CTD) profiles collected in the Southern Adriatic during several oceanographic campaigns were also used for the validation or the E2M3A data. Air–sea heat fluxes were calculated using meteorological data coming from the ECMWF (Centre for Medium-Range Weather Forecasts) Operational Data set.

OCEANOGRAPHIC RESULTS

Important features observed at the E2M3A

1. To define the role of the atmospheric forcing in **convective events,** heat fluxes were estimated at the E2M3A for the whole study period (**Fig. 3a**). Winter 2007 was mild, while the following winters were much harsher. This variability is consistent with that observed in T and S timeseries (**Fig. 3b,c**). However, the relationship between maximum convection depth and surface heat flux is not always straightforward (Lilly et al., 2003). Thermohaline and current data show complete absence of mixing during winter 2006/2007, contrary to what occurred during the following winters when intermediate-deep convection occurred (**Fig. 3b,c**).

2. **An abrupt T and S decrease in the layer 300m-1000m depth occurred after winter 2008 (Fig. 3b,c).** It was due to a combination of Deep Water Formation (DWF) processes, which act on the water column transferring colder/fresher surface waters towards deeper horizons, and lateral advection. In particular, the switch of the surface circulation in the northern Ionian from cyclonic to anticyclonic, occurred between 2006 and 2007 (Gačić et al., 2010), reduced the LIW volume entering the Adriatic Sea (Cardin et al., 2011), with a consequent reduction of the total heat and salt content.

3. **A progressive increase of temperature (linear trend of ~0.05 °C y^{-1}) and salinity (linear trend of ~0.004 psu y^{-1}) in the layer 1000m-1200m depth (Fig. 3b,c).** It is very likely associated with the increase of temperature and salinity observed in the north Adriatic till 2007. Indeed, the North Adriatic Dense Water (NAdDW) produced on the northern shelf flows and sinks into the deep layers of the Southern Adriatic after 3-4 months (**Fig.1c**).

4. **Current measurements collected in the upper layer (100m-300m) showed very large values** mainly during winter periods and in conjunction with convective events (the strongest horizontal currents reached 33-43 cm s^{-1}).

5. **The vertical currents associated with the convective events reached values up to 3-4 cm s^{-1}** during February 2008, when the major DWF event was observed at the E2M3A.

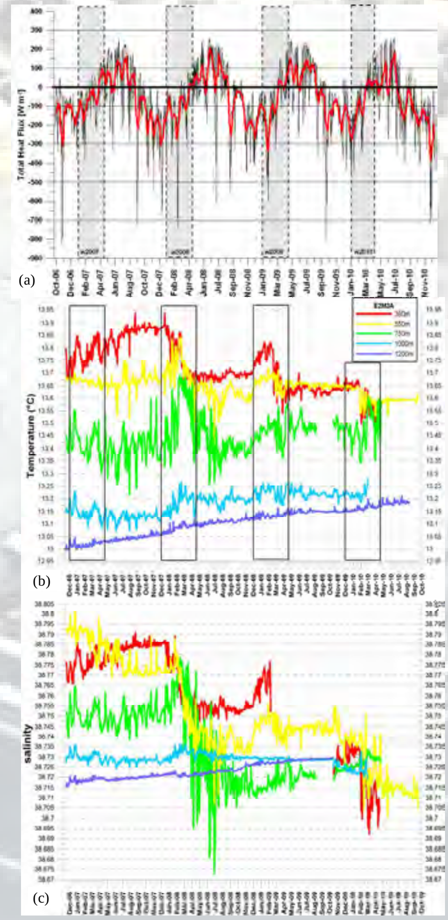

Figure 3 – Time series of heat fluxes (a), temperature (b) and salinity (c) at the E2M3A. Data are cleaned by spikes and filtered with a 33h Hamming filter. Winter periods are indicated in panels a and b.

Mesoscale activity

Mesoscale eddies can be important in influencing deep convection: cyclonic eddies can contribute to destabilize the upper water column, exerting thus a preconditioning for DWF; anticyclonic eddies can push water towards deeper layers, thus simulating the effect of a convection phase.

Currents data collected in the upper layer (100-300m) and close to the bottom (1180m) of the Southern Adriatic revealed a great number of rotational events, some of which seem to be associated to the passage of mesoscale eddies in the proximity of E2M3A (**Fig. 4**). Eddy polarity was determined from the current velocity fields together with the density structure along the water column. Indeed, isopycnal fluctuations and T/S variability typically accompany the passage of eddies. We hypothesize that vortices in the Southern Adriatic could contribute to transport anomalies both along the water column and from the periphery to the centre of the Southern Adriatic basin.

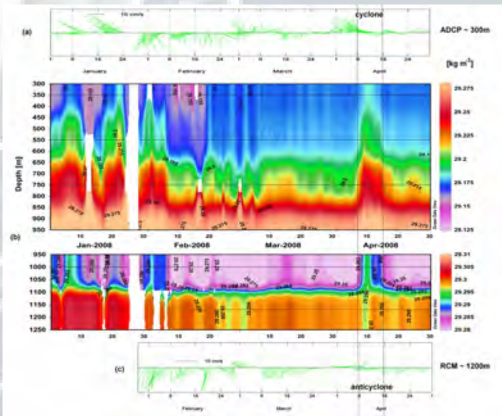

Figure 4 - Stick diagram of horizontal currents at 300m (a) and at 1180m (c). Temporal evolution of potential density along the water column (b). The passage of a cyclonic eddy in the intermediate layer and the concurrent passage of an anticyclonic one close to the bottom are marked between the black lines. This figure shows data recorded between 1 January 2008 and 30 April 2008.

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Soft-bottom communities along a low oxygen gradient in Saanich Inlet

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VENUS Victoria Experimental Network Under the Sea

NSERC CRSNG

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In situ observations of seafloor communities living at their minimum dissolved oxygen (dO_2) limits are urgently needed to determine how ecosystems can respond to hypoxia. Biological patterns often occur at small spatial and temporal scales, thus fine scale field observations are required to determine organism level responses to hypoxic events.

To determine how animals distribute themselves along changing gradients of low dO_2, we repeated a benthic transect line over 4 years using an ROV fitted with high-definition camera systems and a CTD with oxygen probe. Our results reveal the lower field limits of dO_2 tolerance for several species found througout the Eastern Pacific continental shelf and how their distributions can shift when severely hypoxic deep waters compresses the area of available habitat into shallower waters.

Field work

Saanich Inlet is a bathtub-shaped basin with a maximum depth of 230 m. Our site overlaps with VENUS instrumentation in Patricia Bay. The ROV ROPOS was equipped with a CTD (Seabird SBE 19plus) and O2 probe (SBE 43) sampling at 5 Hz. Camera systems recorded high-definition video with 10 cm laser dots for scale. Transects were done at ~0.6 m s^{-1} while flying < 2 m above the bottom. VENUS data was downlloaded from http://venus.uvic.ca

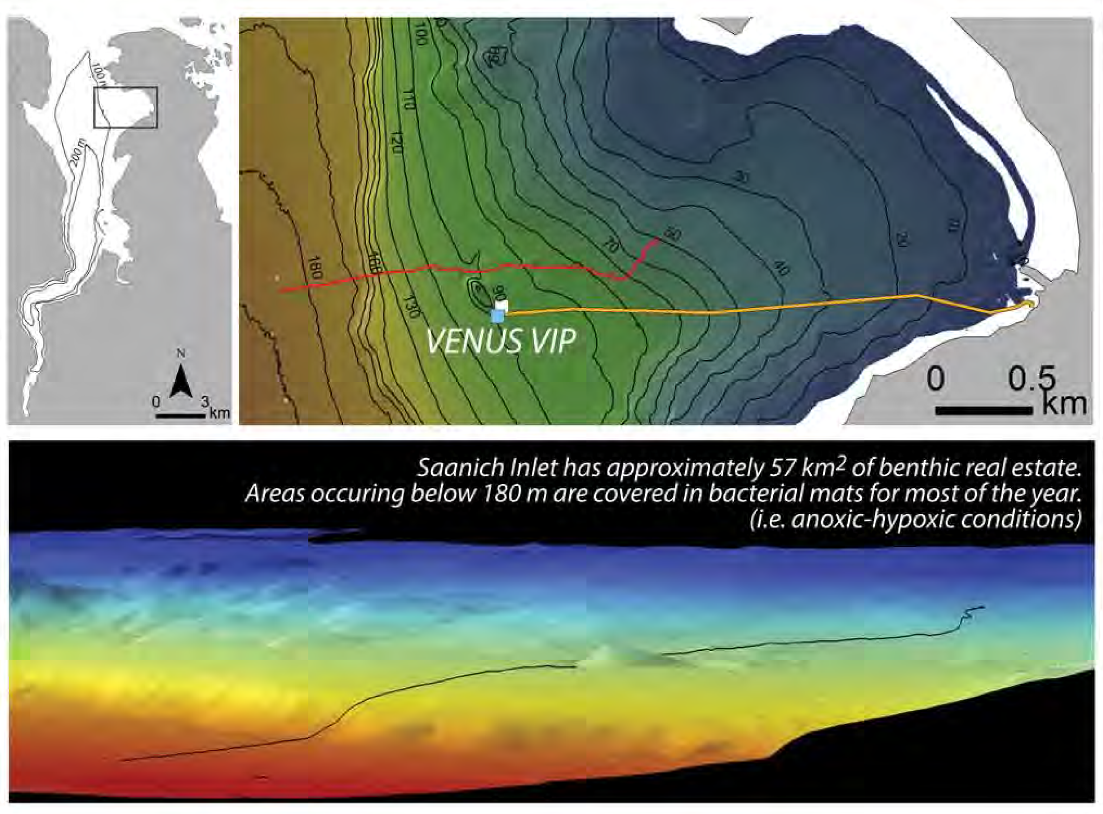


Table 1. Transect details.

Transect	Date	Depth Range: Deepest (m)	Depth Range: Shallowest (m)	Dissolved oxygen range: Lowest (ml l^{-1})	Dissolved oxygen range: Highest (ml l^{-1})
R1176	Sep 28, 2008	188.3	55.7	0.34	2.44
R1197	Feb 15, 2009	187.7	104.7	0.02	2.49
R1396	Dec 13, 2010	119.2	77.3	0.04	3.16
R1491	Oct 02, 2011	187.1	75.7	0.35	1.05

Transects were 1-2 km long and repeated over the same bathymetric slope which starts at 180 m depth and reaches 60 m. The VENUS array is at a fixed depth of 96 m.

A standardized workflow was developed to log, process, and manage our large data sets. For each 1 s of HD-video, animals were identified, counted, and georeferenced to 1 Hz ROV navigation (LOKI) data. All 1 Hz data (LOKI, CTD, HD-video) were combined into a personal ArcGIS (ESRI) relational geodatabase. ArcMAP attribute tables were then exported and manipulated in MATLAB.

Dissolved oxygen units:

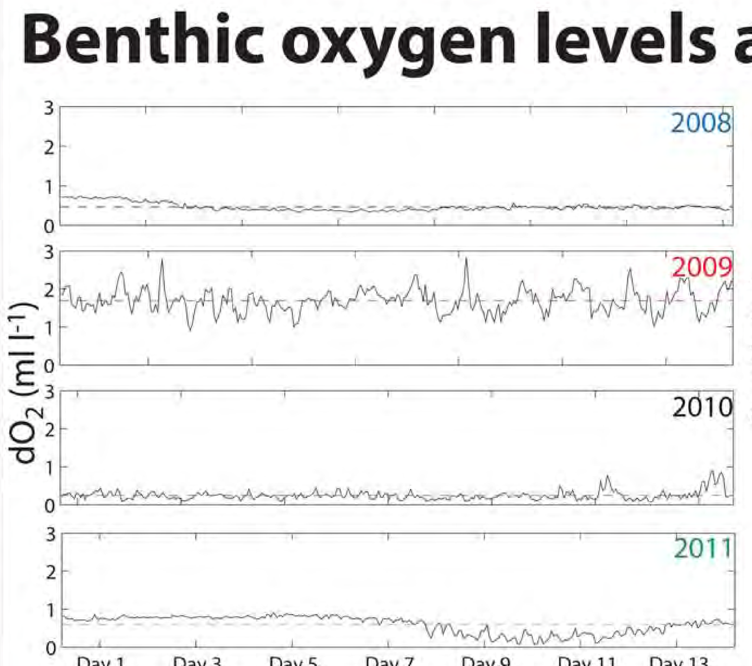
Oxygen units vary in their use in the literature. dO_2, temperature, salinity, and density change in relation to depth. Also, pO_2 better assesses hypoxia stress in animals with gills. Therefore, we converted our CTD & dO_2 data to units of partial pressure:

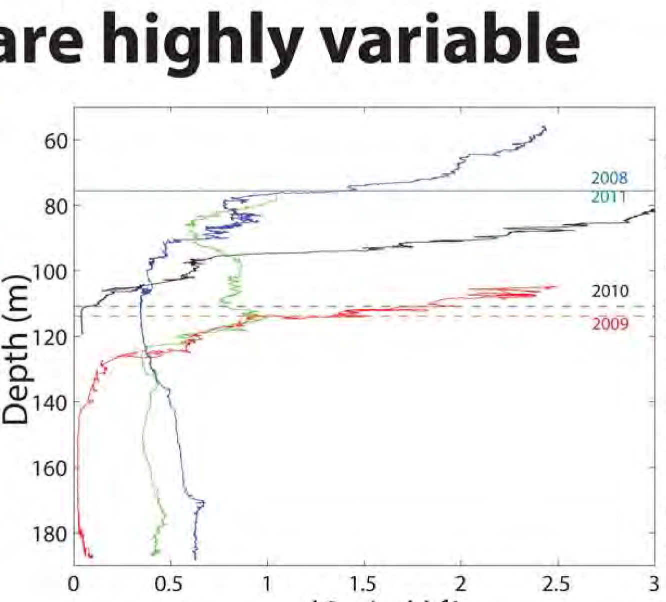
$$PO2 = (dO2\ measured / \quad dO2\ at\ equilibrium) * 1 - \quad vpress) * O2atm * 101.325$$

Where:
- dO_2 measured = values from *in situ* CTD
- dO_2 equilibrium = expected values at equilibrium (depends on salinity and temperature)*
- vpress = vapor pressure of seawater (depends on salinity and temperature)*
- O2ATM = 0.21 atm & and 101.325 atm per kPa

* calculated using Matlab functions O2sol.m & vpress.m (courtesy of Roberta Hamme)

Benthic oxygen levels are highly variable



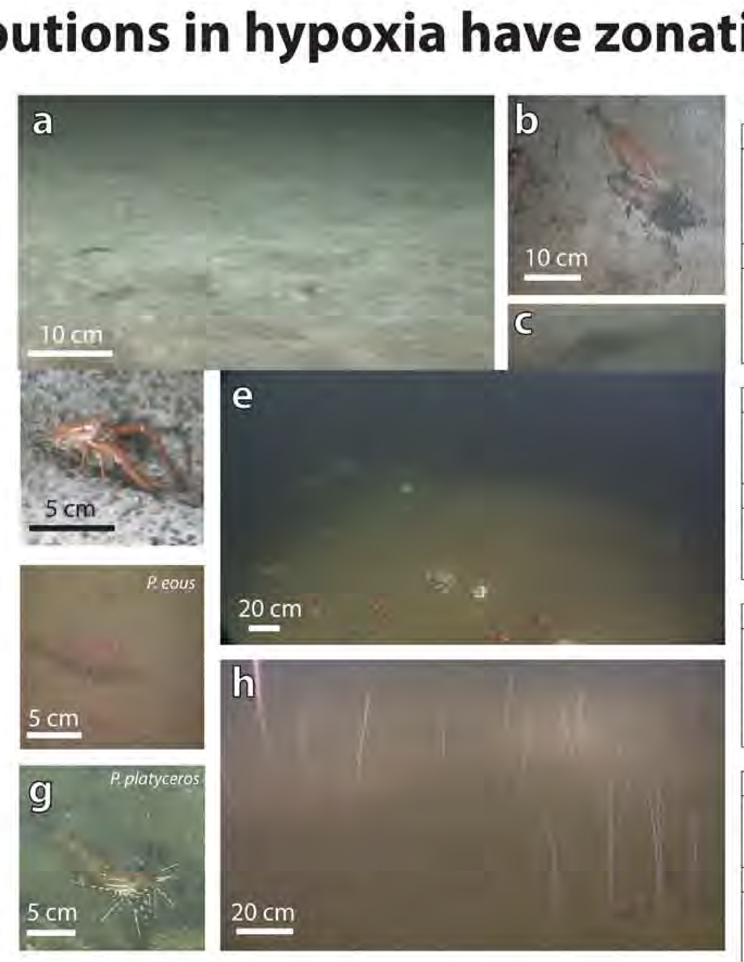


(*Far left*) Measurements at the VENUS VIP for 2 weeks prior to each transect line show benthic animals can experience periods of stable low dO_2 and periods of rapid dO_2 fluctuations (dashed lines = 2 wk avg).

(*Left*) Transects were done on day 15 and show the shifting hypoxia zone. (dashed lines show 1.4 ml l^{-1} depth limit).

Animal distributions in hypoxia have zonation patterns

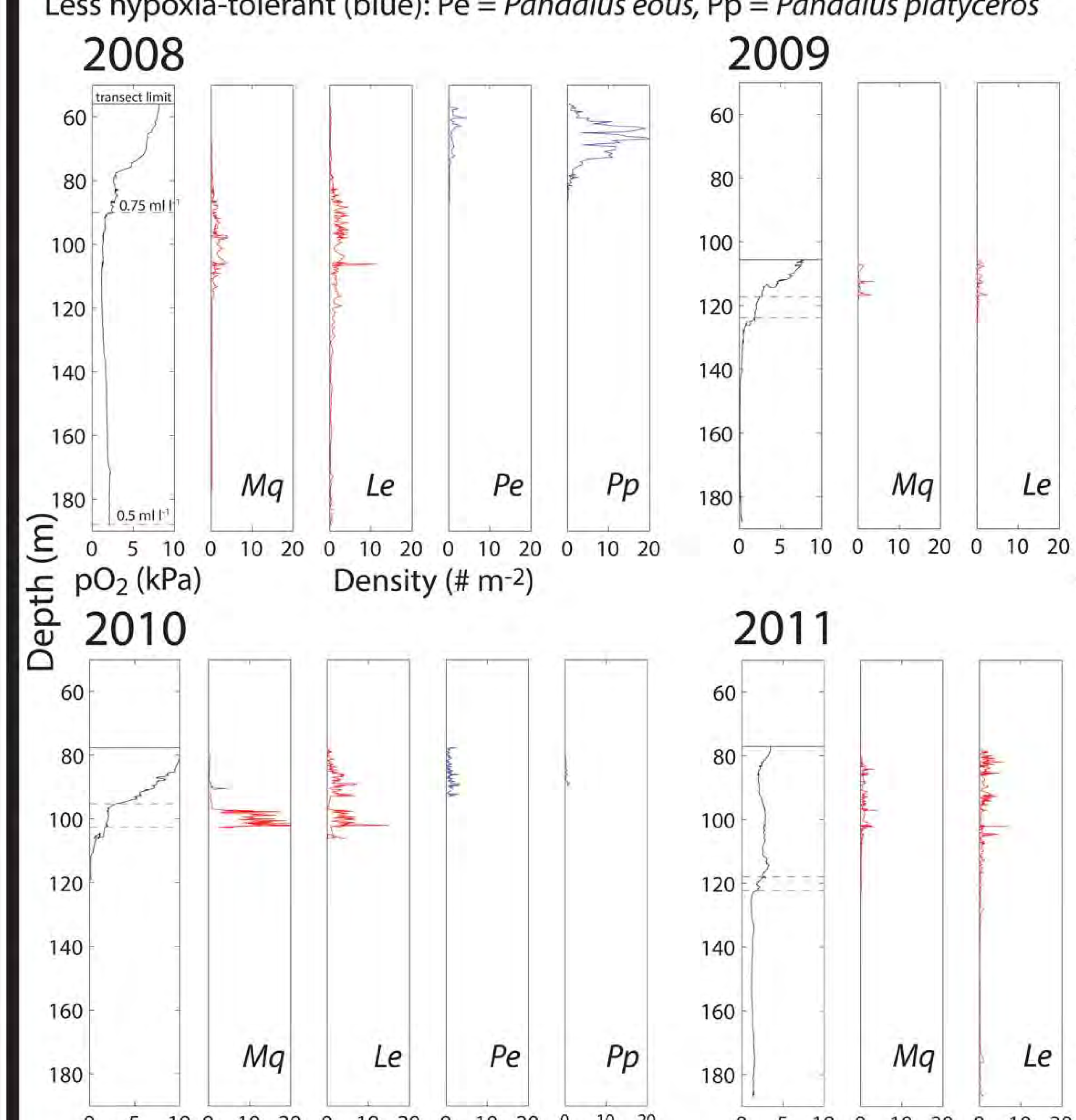
(*Right*) - (a) Only chemosynthetic H_2S bacterial mats (*Beggiatoa* spp.) are found in the deepest, most hypoxic waters. (b) Slender sole (*Lyopsetta exilis*) are found in extremely hypoxic waters (dO_2 > 0.10 ml l^{-1}) and (c) buriesin bacterial mat. (d) Squat lobsters (*Munida quadrispina*) are also highly abundant and tolerant to extreme hypoxia. Both species are the most abundant in the "extreme hypoxia community" (dO_2 < 0.5 ml l^{-1}). (e) When bacterial mats disappear (dO_2 > 0.75 ml l^{-1}), species richness increases with (f,g) shrimp (*Pandalus* spp.) and other fish. In shallower waters, the soft-bottom community is dominated by (h) cnidarians (seawhips, anemones), and sponges.



ANIMAL	n	% of Transect	Zone
Slender sole (*Lyopsetta exilis*)			Deep
2008	2565	19.8	
2009	123	44.4	
2010	1100	31.3	
2011	1485	40.7	
Squat lobster (*Munida quadrispina*)			
2008	1240	9.6	
2009	62	22.4	
2010	887	25.2	
2011	955	26.2	
Pink Shrimp (*Pandalus eous*)			Mid
2008	2252	17.4	
2010	42	1.2	
2011	303	8.3	
Spot prawn (*Pandalus platyceros*)			
2008	292	2.3	
2010	423	12.0	
2011	88	2.4	
Other Fish			Shallow
2009 - POLLOCK	78	28.2	
2010 - POLLOCK	86	2.4	
2010 - PRICKLEBACKS	83	2.4	
2011 - PRICKLEBACKS	112	3.1	
2011 - EELPOUTS	84	2.3	
***Metridium farcimen* (Giant Anemone)**			
2008	262	2.0	
2010	63	1.8	
2011	85	2.3	
Seawhip (*Halipteris* sp.)			
2008	6065	46.9	
2010	707	20.1	
2011	370	10.1	

Animals move according to their lower limits of hypoxia tolerance. In 6 months, 14 km^2 of livable habitat can disappear (a 35% habitat loss) as dO_2 becomes depleted in deeper waters. Up to 20 km^2 (49 %) is lost during the most severe hypoxia. Populations are compressed into shallower waters.

More hypoxia-tolerant (red): Mq = *Munida quadrispina*, Le = *Lyopsetta exilis*
Less hypoxia-tolerant (blue): Pe = *Pandalus eous*, Pp = *Pandalus platyceros*



Steep dO_2 gradient from anoxia to normoxia: more zonation among species.

Low dO_2, small gradient: more overlap between species distributions.

Oxygen Limits

*Values are given in **ml l^{-1}** with **kPa in parentheses***

Beggiatoa spp. **upper** dO_2 range limit

Date	UPPER Limit	Mean	SD
2008	0.68 (2.27)	0.50 (1.67)	0.12 (0.42)
2009	1.83 (5.54)	0.27 (0.87)	0.40 (1.31)
2010	0.36 (1.21)	0.15 (0.49)	0.07 (0.36)
2011	1.00 (3.32)	0.56 (1.84)	0.20 (0.65)

Lyopsetta exilis **lower** dO_2 range limit

Date	LOWER Limit	Mean	SD
2008	0.34 (1.14)	0.54 (1.85)	0.26 (0.99)
2009	0.12 (0.38)	1.04 (3.34)	0.54 (1.86)
2010	0.15 (0.50)	1.91 (6.43)	0.91 (3.13)
2011	0.35 (1.15)	0.73 (2.43)	0.14 (0.48)

Munida quadrispina **lower** dO_2 range limit

Date	LOWER Limit	Mean	SD
2008	0.34 (1.14)	0.50 (1.72)	0.19 (0.67)
2009	0.73 (2.37)	1.24 (4.05)	0.44 (1.51)
2010	0.47 (1.55)	0.65 (2.34)	0.29 (1.32)
2011	0.46 (1.51)	0.76 (2.48)	0.09 (0.31)

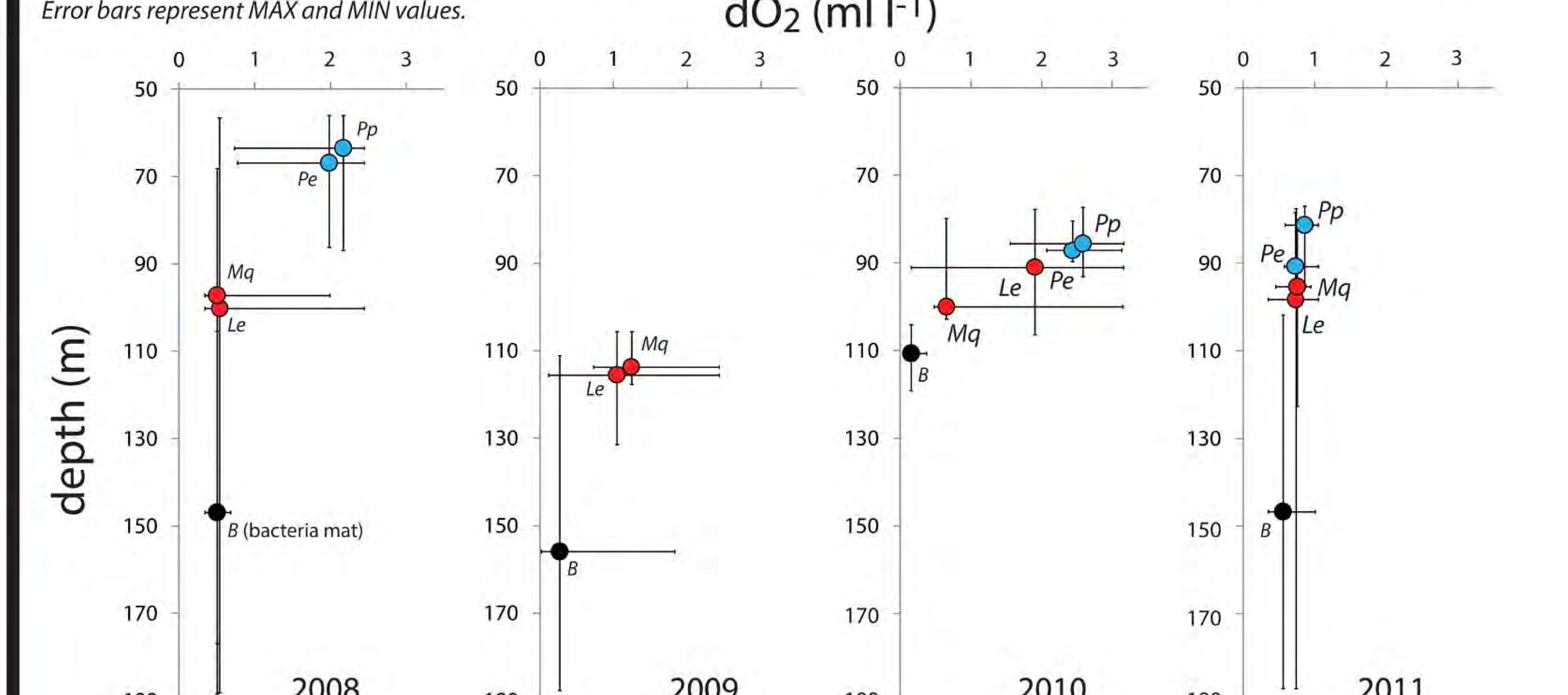
Pandalus eous **lower** dO_2 range limit

Date	LOWER Limit	Mean	SD
2008	0.77 (2.57)	1.98 (6.10)	0.38 (1.81)
2009	-	-	-
2010	2.07 (6.85)	2.44 (8.13)	0.28 (0.97)
2011	0.58 (1.91)	0.73 (2.40)	0.09 (0.31)

Pandalus platyceros **lower** dO_2 range limit

Date	LOWER Limit	Mean	SD
2008	0.73 (2.44)	2.17 (7.10)	0.34 (1.25)
2009	-	-	-
2010	1.55 (5.13)	2.58 (8.59)	0.43 (1.43)
2011	0.58 (1.92)	0.86 (2.83)	0.14 (0.47)

Circles are MEAN values.
Error bars represent MAX and MIN values.



Hypoxia-tolerant animals (red) can live close to their lower limits of low dO_2. Less hypoxia-tolerant species (blue) appear to live within a wider safety margin. Hypoxia-tolerant species migrate into shallower depths and overlap with less tolerant species when dO_2 supply is diminished.

Potential consequences of oxygen loss & habitat compression

Habitat compression may increase resuspension of sediments by *Lyopsetta exilis*[1,2] activity in shallow waters which enhances dO_2 loss from increased redox reactions.

Habitat overlap and the resulting increased competition for shared resources may reduce fitness of commercially exploited species (e.g. *Pandalus* spp.)

(*Left Pandalus platyceros* outnumbered by *Munida quadrispina*, 30:1)

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Acknowledgements:
This research was funded by an NSERC PGS-D to JWFC and CRC, Discovery, shiptime, and CHONe grants to VT. We thank VENUS, the Captains and crew of the CCGS JP Tully, RV Thompson, the entire ROPOS team, J Rose, R Hamme, A Spicer, K Gale.

Improving the accuracy of earthquake locations using Ocean Bottom Seismometers in the immediate vicinity of the North Anatolian Fault in the western and central parts of the Sea of Marmara

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Abstract :

The Marmara Sea is located between the Agean Sea and the Black Sea, along the North Anatolian strike-slip fault, which experienced a sixty year sequence of earthquakes since 1940, propagating to the west towards Istanbul. Prior to this sequence, which ended with the Izmit and Duzce earthquakes in 1999, at the eastern end of the SoM, the fault ruptured to the west in 1912 in Ganos, with an estimated moment magnitude of 7.4. Therefore, a major earthquake is expected within the Sea of Marmara seismic gap.

In order to better understand the seismicity and to reduce the threshold of detection, a network of ten OBS with four components was deployed by Ifremer with R/V Yunuz of Istanbul Technical University, in the western and central parts of the Marmara Sea to record the micro-seismicity from the immediate vicinity of the Main Marmara Fault, between april and august, 2011. The network was specifically designed to survey the segments crossing the Western High, where gas hydrates where recently found, the Central Basin and the Kumburgaz Basin. During this period more than one hundred earthquakes were detected by the CSEM (European-Mediterranean Seismological Centre) in the Sea of Marmara. Because the basins of the Sea of Marmara are filled with more than 5 km of Plio- Quaternary soft ("slow") sediments, it is of critical importance to take into account the velocity structure of the offshore domain, which is drastically different from the one onshore.

Preliminary results are presented. Special focus will be given on : i) the depth of the events below the Western High, where the NAF is known to intersect a gas reservoir ; ii) on the clustering of the micro-seismicity at both extremities of the Central Basin. As a perspective to future work, an attempt will be made to improve earthquake locations using the dataset from the permanent, cabled, Ocean Bottom Broad-Band Seismometers network operated by KOERI.

I- The mission

The Marmara sea is situated in Turkey, along the North Anatolian fault. Due to the high probability than an earthquake of M_w >7 strikes in few decades along the fault, several missions are conducted in this region in order to detect precursor of earthquakes.
In 2011, a campaign of 4 months was achieved in the Sea of Marmara with this aim.

A seismic network of 10 OBS installed during the experiment was concentrated around the Western High and the Central Basin (Figure 1).

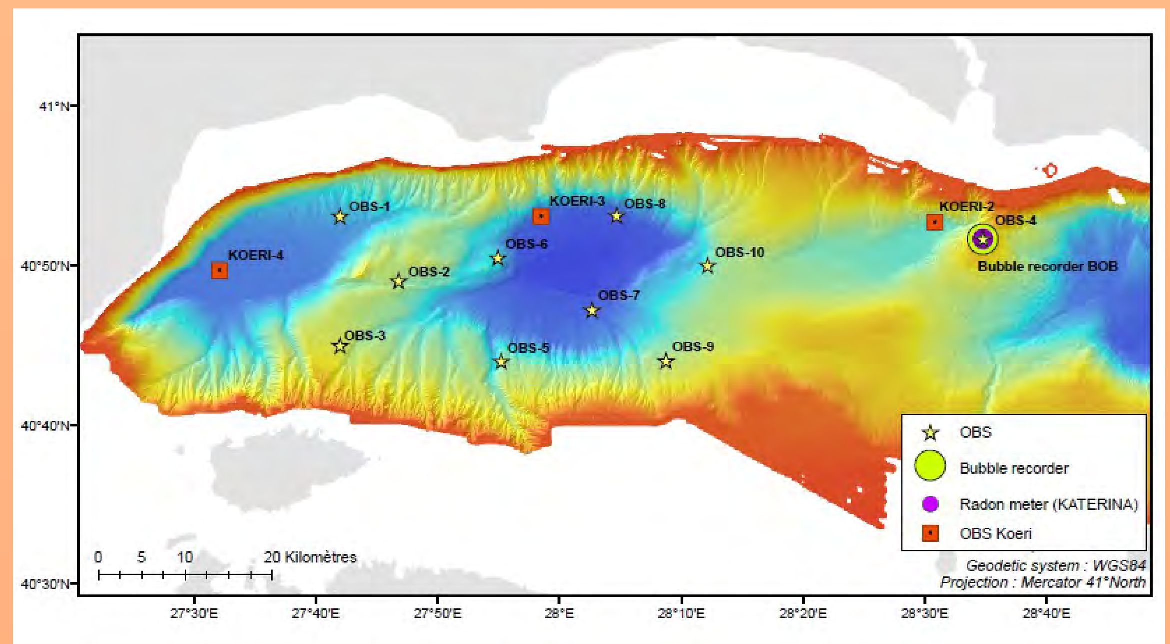

Figure 1 : Map of the instruments installed during the campaign and of the OBS from KOERI

The seismic network of the KOERI counts 5 OBS in the Marmara sea. This allows them to detect and localize146 earthquakes with magnitude from 1.8 to 5 during the period of our study (Figure 2).
Using the 10 OBS available from the deployement of the campaign, 506 earthquakes were localized, with the same order of magnitude between April and July 2011.

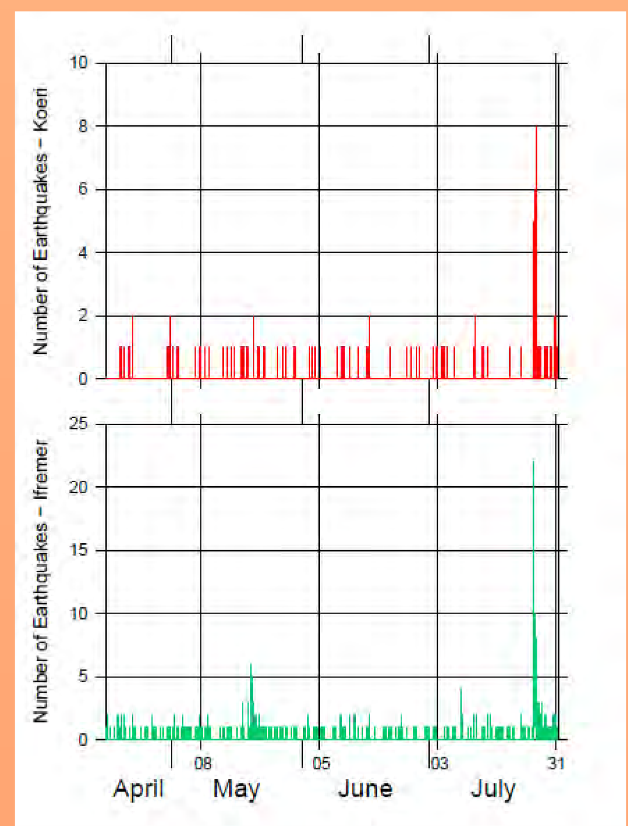

Figure 2 : Histogram of the earthquakes located by the Koeri and our group for the period of Zpril to July 2011

The magnitude of completeness with our network is of Mw=2.8 and we obtain for the Gutenberg-Richter law a b value of ~0.9 (Figure 3).

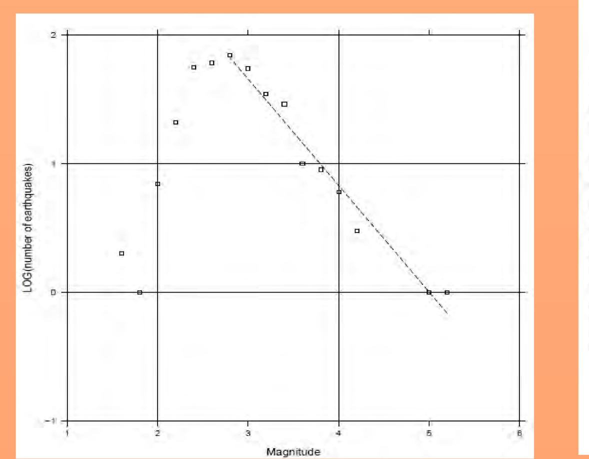
Figure 3 : Gutemberg-Richter law fit with the magnitude of the earthquakes detected

A cluster of events with 148 earthquakes is identified in the last part of the period of study, between the 25th and 28th July (Figure 2).

II- Location and results

To localize the seismic events we first apply a STA/LTA algorithm in order to detect events on the seismic signal, with detection on more than 4 channels of the network. Once the events were detected, we used the Software SYTMIS developped at the INERIS to locate all the earthquakes.

The velocity model used to locate the events is a one-dimensional velocity model. It is the velocity model proposed by Tary [2011][1]. This model conceives a lower velocity model at the surface due to the presence of shallow basins filled with soft sediments (Figure 4). This model was constructed using wide-angle profiles recorded in the Tekidarg Basin. Below 4 km deep, the velocity model is based on the velocity models inversed by Bécel [2006][2].

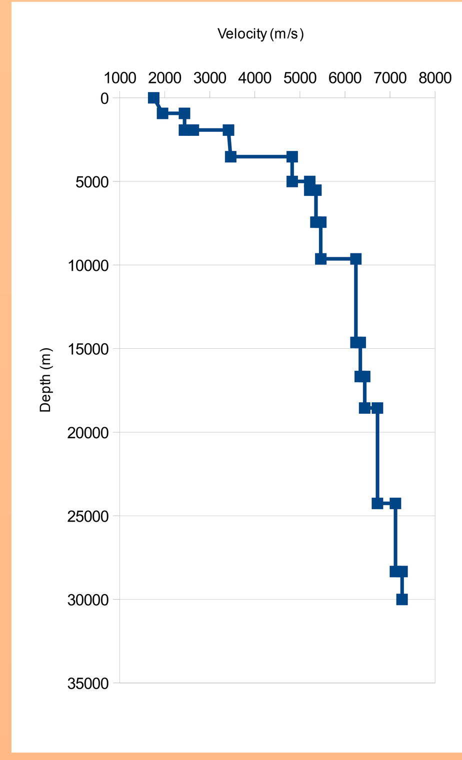

Figure 4 : One-D velocity model of Tary [2011]

Most of the seismicity during this period is located in the South of the Western High (Figure 5). This area is also known to encounter an high activity of gas emission (Géli et al. [2008][3], Tary [2011][1]).

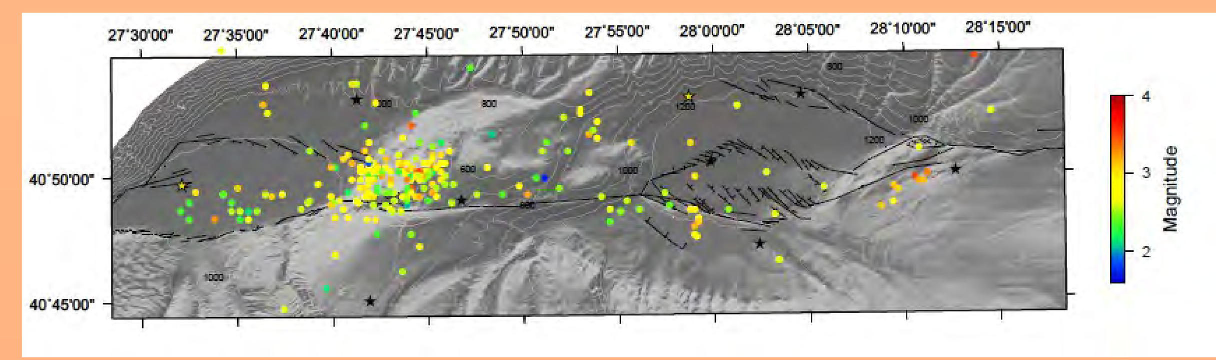

Figure 5 : Location of the earthquakes during the period of April to July 2011 from a network of 10 OBS

The cluster of events between the 25th to 28th July presents a big event of magnitude 5 at 17h57 the 25th July, following by the other events, with the first one at 18h03 (Figure 6).

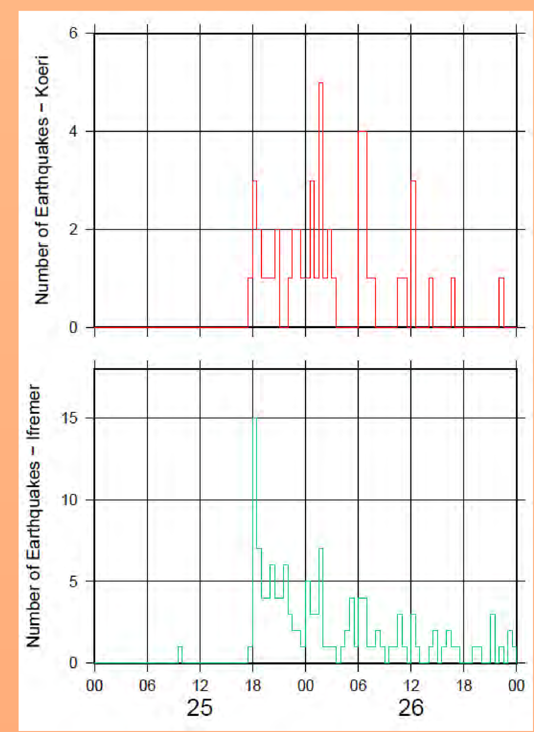

Figure 6 : Zoom of the histogram of the earthquakes detected between the 25th to 28th July 2011

All the major part of the events are localized in the Western High (Figure 7).

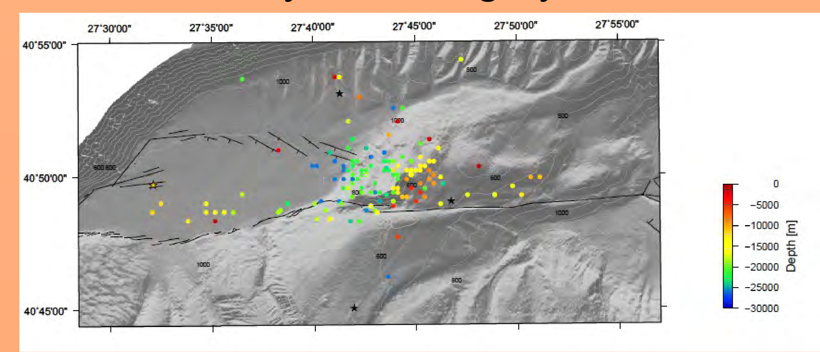
Figure 7 : Location of the earthquakes of the cluster of July 2011

III- Conclusion

1- The increase of the number of OBS recording the seismic activity in this region allows us to improve the number of small earthquakes that can be detected. This is of major importance in this region frequently strikes by big earthquakes.

2- The amount of seismic events located during the campaign shows an important seismic cluster that need to be more detailed in the future. A particular attention has to be considered in the depth of the events to constrain information about potential gas revervoirs detected in the part the sea. To do that, several options are available (doublets study, 3D velocity model).

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A glimpse of the day to day of a hydrothermal faunal assemblage in the Atlantic

by Daphne Cuvelier

and

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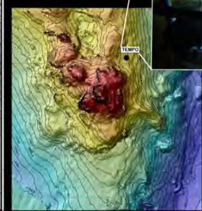
Introduction

Since the discovery of hydrothermal vents in 1976, our understanding of the hydrothermal faunal assemblages is growing, however, their functional ecology and temporal dynamics remain less clear. Many critical features of these rapidly evolving systems can only be discovered and understood through time-series observations. Several ecological time-series studies in the Pacific and Atlantic Oceans have already been carried out but they are - at best - based on yearly visits. While the use of time-lapse cameras at hydrothermal vents has already demonstrated that sub-annual processes, such as diurnal or semi-diurnal periodicities, also play a role in shaping hydrothermal vent communities and influencing their dynamics. Since a couple of years, the scientific community has been rooting for the development of novel techniques and approaches for studying the temporal aspects of biotic and abiotic variables in deep-sea ecosystems both in real-time and over longer time-scales. An autonomous deep-sea observatory is currently up and running in the Atlantic Ocean (MoMAR at the Lucky Strike on the Mid-Atlantic Ridge (MAR) at 1700m depth) of which the ecological module (TEMPO) focuses on a *Bathymodiolus azoricus* hydrothermal vent faunal assemblage. Its first deployment took place in 2006 for which the first results are presented

Where and How - Deployment and Data



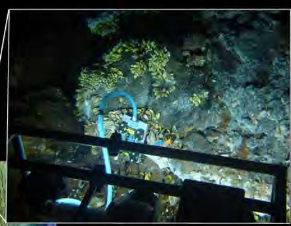


Fig. 1.
TEMPO deployment site at the base of Eiffel Tower

Details on TEMPO:
TEMPO is a wireless observatory, first deployed in 2006 and recovered in 2008.The module was composed of an autonomous video camera and two LED-projectors, both treated with a microchloration anti-biofouling protection. It was also equipped with a CHEMINI Fe in situ analyser along with three temperature probes.

Data
- 45 days of video imagery, recording 4 minutes/day up to twice a day (AM and PM)
- 4.5 months of Fe, recorded every 12 hours
- >12 months of T°C data, recorded every 30 minutes

Results ecology

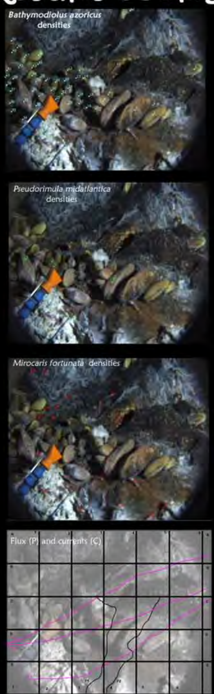
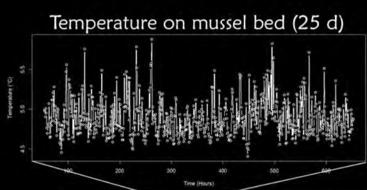


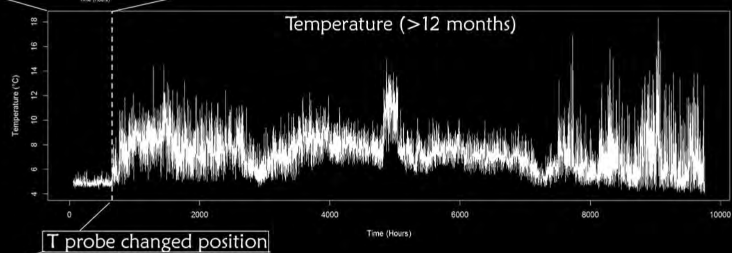
Fig.2 Examples of image analyses

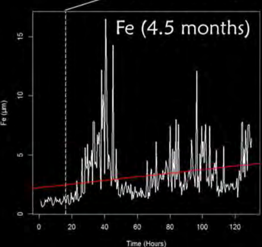
- **Mussel** densities remained rather **constant**, but individuals repositioned constantly
- There was an **increase** in *Pseudorimula* **limpet** abundance noticeable with time, though **no significant links** with the environmental variables could be established.
- Several **limpets** were seen **moving** around on the mussel shells during the video sequences, hence their differences in abundances between the sequences
- **Significant** differences in **shrimp** densities between **morning (8 AM) and evening (8 PM)**
- **No influence of the lights** on the shrimps densities
- **Significant** correlation of **shrimp** densities with fluid **flux**
- *Segonzacia mesatlantica* **crabs** showed what appeared to be **random** appearances, i.e. no links with other fauna or environmental variables
- **Microbial** cover **significantly** correlated with T°C

Results environment (T°C & Fe)



- Mussel bed: Significant temporal variability for T°C for 57 periods ranging from 4hrs 7min 53sec to 17 days 11hrs, including semi-diurnal and diurnal patterns.
- For the rest: statistical analyses are proven difficult due to huge amount of data. Temperatures were averaged per 6 hrs and 100 significant periods were revealed ranging from 24 hrs to 254 days 6 hrs.





- Significant temporal variability for Fe for periods ranging from 52hrs 43min 5sec to 130 days.

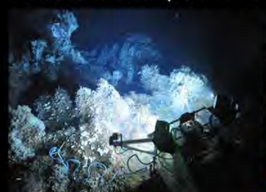
Patterns observed:
- semi-diurnal frequencies (~12 hrs) + harmonics ~6hrs
- coriolis ~ 20 hrs
- diurnal ~24 hrs

Patterns to be explained:
- investigate multiple-day periodicities - possible causes?
- test 3 months time-spans of T°C against one another

What's up next:

Data analyses of the TEMPO deployments in 2010 and 2011 and of the TEMPO-mini module hosted by the cabled NEPTUNE observatory, off the coast of British Columbia, Canada

TEMPO 2010 and 2011 on the MAR AND TEMPO-mini on NEPTUNE (North East Pacific) since 2011



The novel technique of the detection of wave breaking processes

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INTRODUCTION

Wave breaking process is responsible for local and sudden loss of wave energy accumulated on a certain fetch length.The knowledge of this process is of substencial importance for understanding mechanisms of the exchange of masses and energy between the atmosphere and the sea, and for the assessment of intensity of hit exchange in the ocean upper layer. Moreover, an understanding of this process is of signifficant importance for the numerical modelling of wind waves.

In this studies an insight into the process of wave breaking is achieved by applying a novel technique. The technique is based on the analysis of the noise generated by acoustically active bubbles produced by breaking waves and the measurements of free-surface elevation conducted by a wave buoy. The combination of the recorded signals is applied to analyze wave breaking processes in the time domain for different storm wave parameters. The analysis is expected to provide information on wave breaking events for individual waves as well as it provides insight into the intensity of wave breaking processes.

MEASUREMENTS

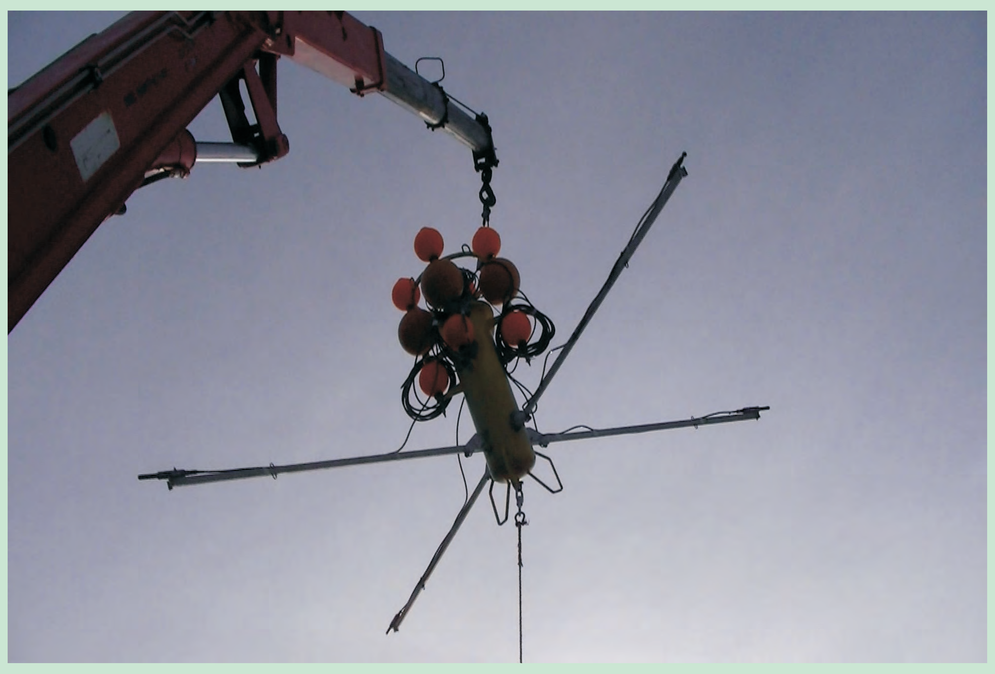

Fig. 1. The acoustic buoy with four hydrophones.

Detection of noise from breaking waves is possible by the use of just one hydrophone but if we use two pairs, it is possible to assess time delay of acoustic signals reaching each hydrophone. Information about delay and hydrophone system allows to localize and track the acoustic source. In order to find the delay between two hydrophone measurements we have to determine correlation function between recorded signals

$$R_{ij}(x_1;x_2)=E\{z_i(t_1)z_j(t_2)\}$$

Maximum value of this function gives the information about time delay between pair of hydrophones. Assuming that the sound speed is constant and the acoustic signal source is located on the sea surface, its location can be found from equations

$$x=\frac{c\tau_1}{2}\left[\left(1-\frac{c^2\tau_2}{d^2}\right)\cdot\frac{d^2-c^2\tau_1^2+c^2\tau_2^2}{\Delta^2}\right]^{\frac{1}{2}}$$

$$y=\frac{c\tau_2}{2}\left[\left(1-\frac{c^2\tau_1}{d^2}\right)\cdot\frac{d^2-c^2\tau_2^2+c^2\tau_1^2}{\Delta^2}\right]^{\frac{1}{2}}$$

Where c is the acoustic wave velocity, τ_1 is the time delay between first pair of hydrophones, τ_2 is the time delay between second pair of hydrophones, d is the distance between hydrophones, $\Delta=d^2-c^2\tau_1^2+c^2\tau_2^2$

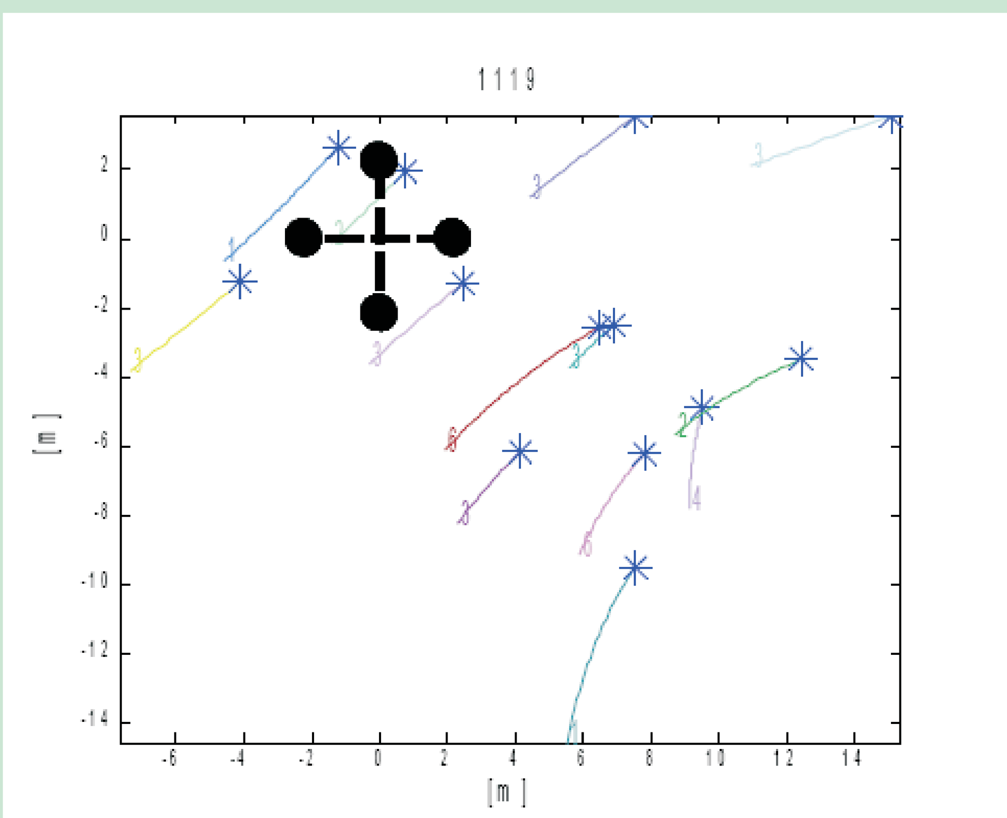

Fig. 2. Trajectories of sound signal sources with hydrophones position.

By make an assumption that acoustic noise source represent a dipole, the total emitted acoustic energy can be assessed by integrating the sound intensity over a half sphere. Acoustic energy radiated during wave breaking event can be determined from

$$E_{ak}=\frac{2\pi R^2}{3\rho_w c}\cdot\int p_s^2\,dt$$

Where R is the distance from hydrophone to acoustic sound source, ρ_w is the water density, c is the sound velocity, p_s is the sound pressure recorded by hydrophone, τ is the time of sound source emission.

Velocity and propagation direction of breaking waves were determined by the analysis of sound source position in time.

Fig. 3. Directional Waverider.

Measurements of wind waves were conducted by using directional waverider buoy. The range of a sampling rate of recorded data was 0.033 - 0.6 Hz.

The direction wave spectrum $S(f,\Theta)$ is assumed in the following widely recognized form

$$S(f,\Theta)=S(f)G(\Theta,f)$$

provided that $\int_0^{2\pi}S(f,\Theta)d\Theta=S(f)$

In which $G(\Theta,f)$ is the dimensionless function of wave frequency and angle Θ.

DATA ANALYSIS

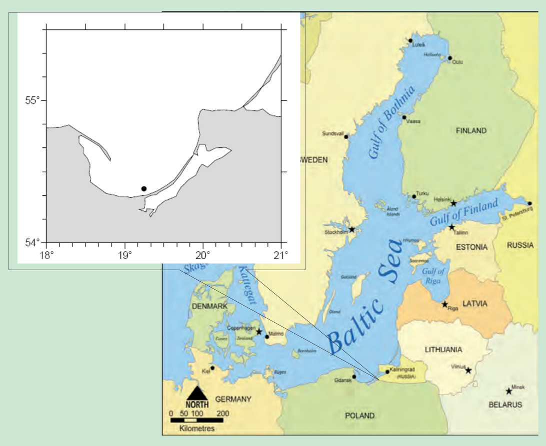

Fig. 4. Wave buoys localization during experiment, 8-14 November 2009.

The results of the measurements conducted by hydrophones can be combained with the coressponding results of wave buoy measurements. By assuming that velocity of wave breaking propagation, c_b, is equal to the wave phase velocity, it is possible to asses the frequency of breaking wave

$$f_b=\frac{g}{2\pi\cdot c_b}$$

The frequency and the angle of breaking waves provide an opportunity to locate information on breaking waves on the directional wave spectra. This is illustrated by dots in Figs.5-6.

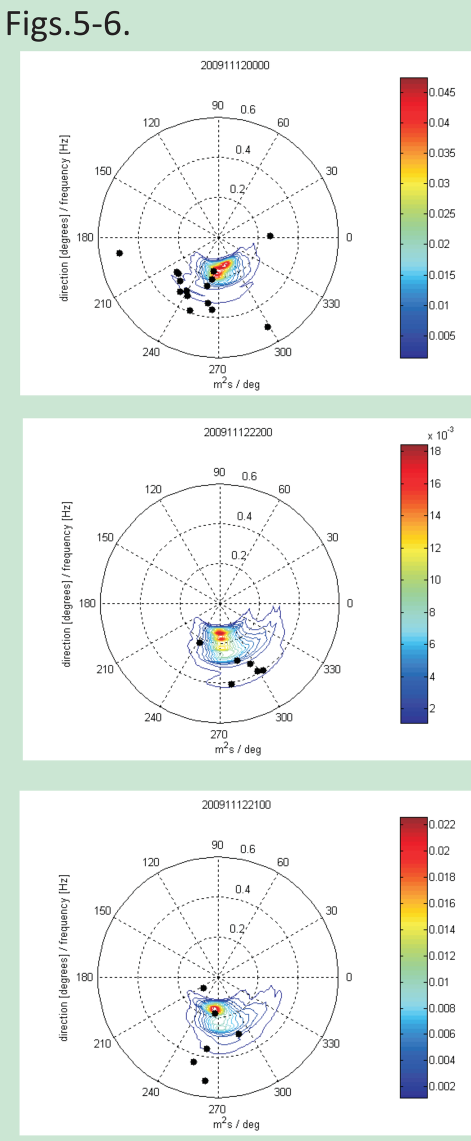

Fig. 5. The directional wave spectra.

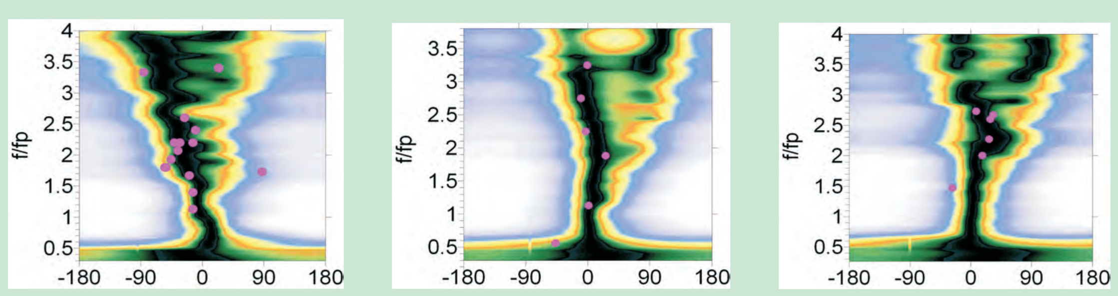

Fig. 6. The normalized directional distribution.

The measurements conducted by hydrophones as well as the wave buoy records can be applied to asses the probability of wave breaking events. This was achieved by applying a wavelet method.

The time-frequency wavelet spectrum ,$W_X(\omega,t)$ can be obtained from the time series of the free surface elevations X(t)

$$W_X(\omega,t)=\frac{1}{C_\Psi}\left|\int_{-\infty}^{+\infty}X(\tau)|\omega|^{1/2}\Psi^*[\omega(\tau-t)]d\tau\right|^2$$

where $C_\Psi<\infty$ is the admissibility condition and the function Ψ is the mother wavelet. Here we use the Morlet wavelet given by

$$\Psi(t)=\frac{1}{\pi^{1/4}}\left(e^{-imt}-e^{-m^2/2}\right)e^{-t^2/2}$$

where $m=\pi\sqrt{2/\ln 2}$

The time-frequency wavelet spectrum is be applied to calculate amplitudes for each time moment t_i

$$a_i=A_i\cos(\Theta_i)$$

where $A_i=\left|Hilbert(X_i)\right|$

$$\Theta(\omega,t)=\tan^{-1}\left\{\frac{\mathrm{Im}[W_X(\omega,t)]}{\mathrm{Re}[W_X(\omega,t)]}\right\}$$

Moreover the time-frequency wavelet spectrum is applied to determine a localize frequency spectrum at each time moment

$$\Phi_i(\omega)=[W_X(\omega,t)]_{t=t_i}$$

This quantity is applied to calculate the characteristic frequency σ

$$\sigma_i=\left[\frac{\int_{\lambda\omega_p}^{\omega_n}\omega^2\Phi_i(\omega)d\omega}{\int_{\lambda\omega_p}^{\omega_n}\Phi_i(\omega)d\omega}\right]^{1/2}$$

which is used to asses a coressponding wave number k_i

The approach was applied to the same measurements as in the cases used in the analysies of the directional wave spectra. The results are shown in Fig.7.

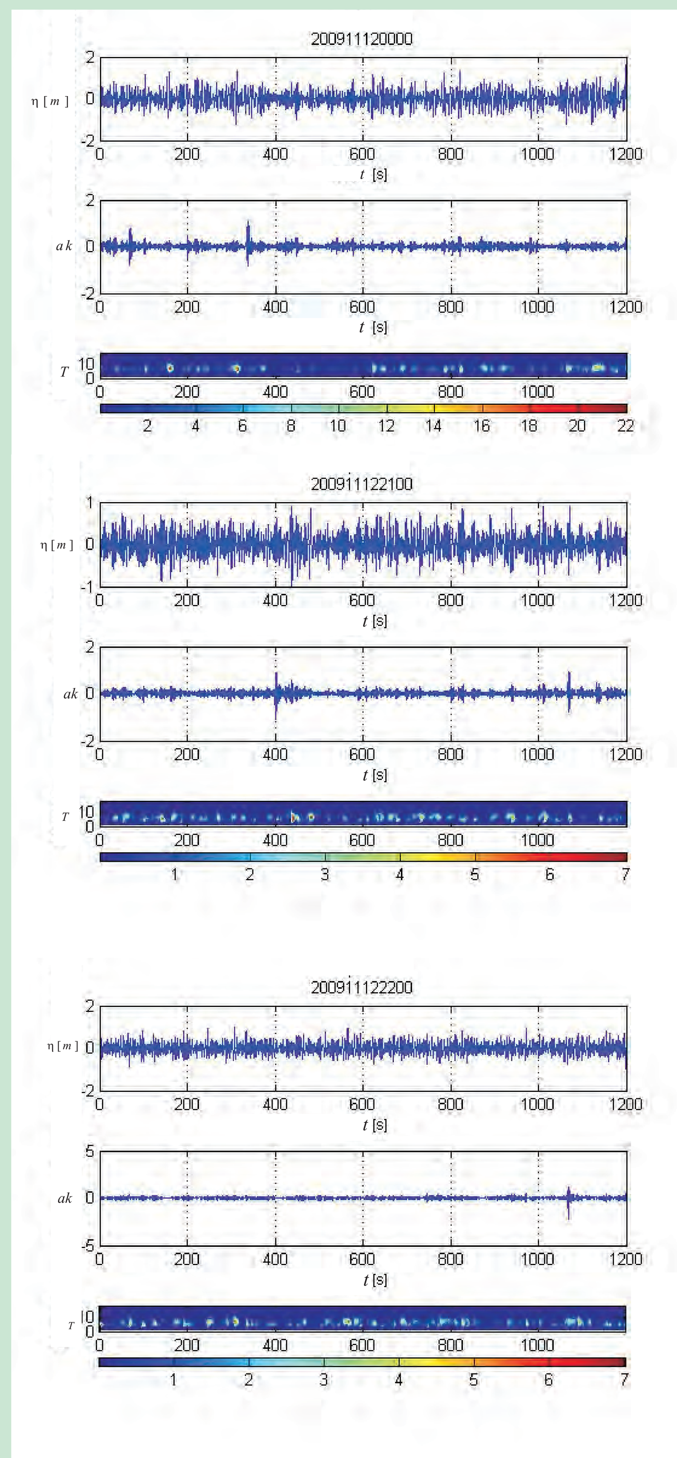

Fig. 7. The wavelet spectra analysis.

CONCLUSIONS

In this study an insight into the process of wave breaking was achieved by applyinga novel technique. The approach is based on the analysis of the noise generated by acoustically active bubbles produced by breaking waves. The noise was recorded by a system of hydrophones located under the sea surface. Simultaneously, the free surface elevation was measured by a wave buoy. The recorded data were applied to analyze wave breaking processes in the time domain for different storm wave parameters. The analysis enabled us to identify wave breaking events for individual waves as well as the intensity of wave breaking processes. Moreover, the applied analysis enabled us to determine the direction and speed of breaking waves as well as the duration of wave breaking events.

ACKNOWLEDGEMENT

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Polynia sea-ice variability and its links to surface atmosphere prior and after the Mertz Calving

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During winter, thin sea-ice is formed in coastal polynias, areas of open-water within pack ice, that supply favorable habitat conditions to many marine species. In the Mertz glacier polynia, an important sea-ice and biological "hotspot" of Adélie/George V Land continental shelf (138E-147E, East Antarctica), we examined the effects of atmospheric forcing (air temperature, air pressure, wind speed, wind direction etc.) on sea-ice formation. The dynamics of sea-ice concentration was studied from passive microwave observations with fine spatial and temporal resolutions. The calving of the Mertz glacier tongue in February 2010 greatly modified the shape and the extent of the polynia, with potential impact on sea-ice formation in its vicinity. Our study documents these substantial changes using statistical analyses. These changes reveal to be significant with regards to the interannual variability observed prior to the Mertz calving.

Introduction

Importance of Mertz glacier polynia as a sea-ice formation "hotspot" in East Antarctica (Barber & Massom 2007)

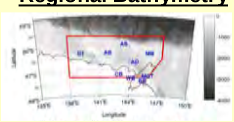
The formation of sea-ice is linked to the atmospheric forcing at large spatial scale (Yuan & Li 2008)

Calving of the Mertz Tongue on February 2010

What are the effects of the Mertz calving on the fine-scale distribution of sea-ice ?

Physical environment of the shelf off Adélie Land Coast

- **Regional Bathymetry**

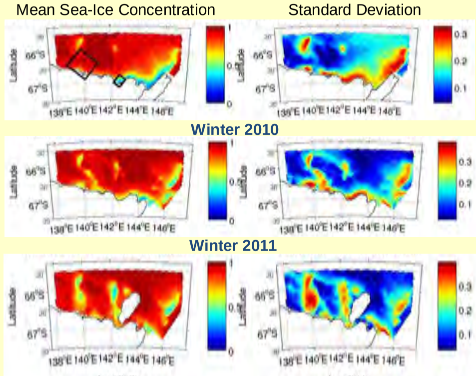


- Mertz Glacier Tongue (**MGT**)
- Three coastal Bays: Commonwealth Bay (**CB**), Watt Bay (**WB**) and Buchanan Bay (**BB**)
- Two banks: Mertz Bank (**MB**), Adélie Bank (**AB**)
- Two deep hydrographic structures: Adélie Depression (**AD**), D'Urville Trough (**DT**)

- **Sea-ice conditions**

- **AMSRE data** (6.25km) + ASI algorithm
- **Prior to Mertz calving**: large year-to-year contrast in extent, shape more or less preserved (coastal + glacier polynias)
- **After Mertz calving**: redistribution of the low concentration areas

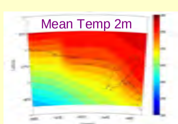
-February 2010: Mertz calving
-May 2010: Mertz Tongue drifting out of the study area (north-west drift)
-May 2011: B9B grounded in Commonwealth Bay

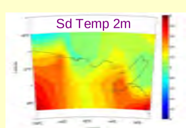


- **Atmospheric conditions**

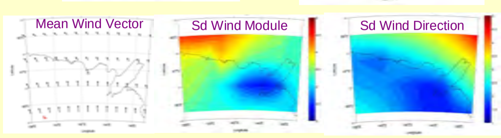
- **ERA-Interim data** (0.75°)

2-metre Temperature (K)





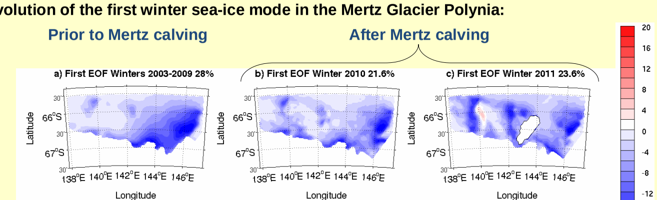
Wind (m/s)



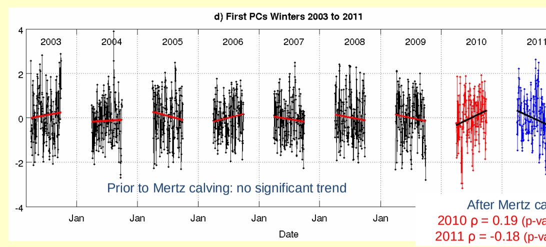
Results: 1/ Variations in winter sea-ice modes

- **Evolution of the first winter sea-ice mode in the Mertz Glacier Polynia:**

Prior to Mertz calving — After Mertz calving

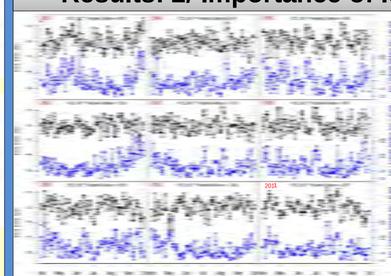


- **Significant trend differences prior and after Mertz calving:**

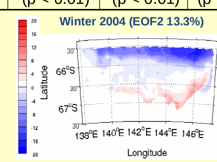


After Mertz calving
2010 ρ = 0.19 (p-value < 0.01)
2011 ρ = -0.18 (p-value < 0.01)

Results: 2/ Importance of local sea-ice dynamics



	CB	DT	polynia
PC1	**0.57** (p < 0.01)	**0.23** (p < 0.01)	**0.79** (p< 0.01)
PC2	0.01 (p < 0.02)	0.09 (p < 0.03)	**0.16** (p < 0.05)
PC3	**- 0.37** (p < 0.01)	**- 0.30** (p < 0.01)	0.03 (p < 0.02)



- **1st PC reproduces the polynia sea-ice extent**

2003-2009 ρ = 0.78 (p < 0.0001)
2010 ρ = -0.84 (p < 0.0001)
2011 ρ = 0.87 (p < 0.0001)

Winter 2004:
most southerly position of ice-edge

September 2006:
additional open-water area in the north of the study zone

- **2nd PC driven by the ice edge dynamics**

2004: Ice-edge dynamic orthogonal to coastal polynia dynamic

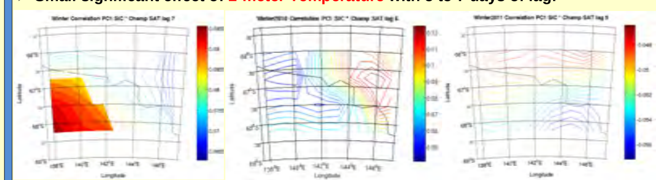
- **3rd PC driven by local sea-ice extent (CB & DT)**

3rd PC correcting 1st PC:
the smaller the coastal polynia, the more ice formation in Commonwealth Bay

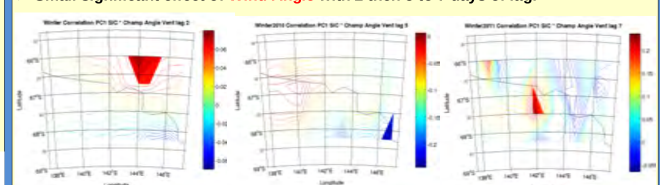
Results: 3/ Atmospheric impact on Sea-Ice

Prior to Mertz calving — After Mertz calving

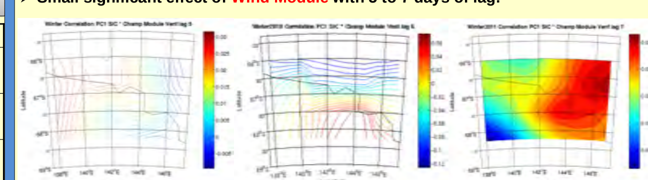
- **Small significant effect of 2-meter Temperature with 5 to 7 days of lag:**



- **Small significant effect of Wind Angle with 2 then 5 to 7 days of lag:**



- **Small significant effect of Wind Module with 5 to 7 days of lag:**



Conclusions & Perspectives

- Impact of Mertz calving on regional sea-ice conditions
- Importance of local sea-ice features to explain regional polynia variations
- Small **linear** effect of atmospheric conditions on sea-ice formation
  ⇨in future work, study of non-linear relations
  ⇨influence of specific atmospheric modes (SAO, SAM, PSA …) on sea-ice formation
- Contrast in polynia dynamic between prior and after Mertz calving
  ⇨hydrographic study on winter formation of Antarctic bottom waters

Is this contrast likely to increase or stabilise in future years ?

Will this evolution in sea-ice conditions positively impact local marine species ?

Detection and Attribution of Climate Change in Satellite Records of Ocean Productivity

Gayatri Dudeja, Stephanie Henson, Peter Challenor*, Claudie Beaulieu**
National Oceanography Centre, University of Southampton, *University of Exeter, **Princeton University

Introduction

Climate change is defined as the change in the statistical properties of the climate system over long periods of time. The near-surface temperature of the Earth's atmosphere has been increasing over the last several decades. The effect of the increase in surface temperature on marine production has been predicted as shown in Figure 1.

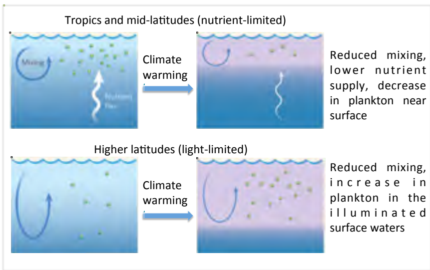


Figure 1: Doney et al. 2006 [1] – Increased surface temperature increases stratification which has varied effects on marine production in different regions of the global ocean.

Efforts have been made to study this effect, e.g. Boyce et al. 2010 studied decadal variability of chlorophyll (chl) by merging ocean transparency measurements since 1899 and satellite ocean color data since 1979 [2]. He observed a global decline of chl by 1% per year (see Figure 2).

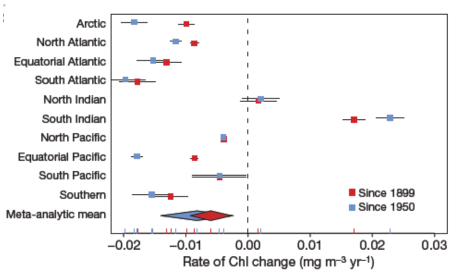


Figure 2: Boyce et al. 2010 – Regional and global trends in chl.

How do we know if the observed increase or decrease in chlorophyll is due to natural variability or anthropogenic variability? Previous studies have analyzed a linear trend but the climate system variability is much more complex than just a linear response. To get a clear identification of the anthropogenic signal in climate observations, improved techniques of detection and attribution have been developed. **The Optimal fingerprint method** is one such technique.

Method

Detection – Identifying Variability.
Attribution – Attributing the variability to specific causative factors (natural or anthropogenic).
Developed by Hasselman in 1979 [3], Optimal fingerprint is a regression-based approach to climate detection and attribution.
It can be simply explained by a schematic diagram.

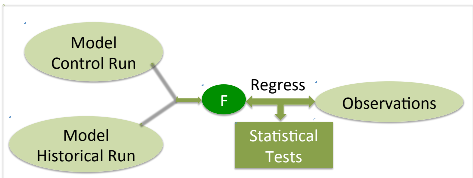


Figure 3: Simple schematic of the steps followed in the Optimal fingerprint method. F represents the climate change fingerprint.

The model control run represents natural variability and the historical run represents the response to anthropogenic forcing. Using statistical tools like Empirical Orthogonal Function analysis (EOF) we extract the climate change fingerprint (F in Figure 3). Next, we project the observations with this fingerprint and test the significance of the regression coefficient. Results of the test determine whether we detected climate change signal or not.

Data

Model – Geophysical Fluid Dynamics Laboratory (GFDL) ESM2G RCP8.5 (the latest IPCC global warming scenario).
Observations - NASA Ocean Biogeochemical Model (NOBM); which assimilates SeaWiFS data and fills gaps in the satellite data time series.
Time Period – Jan 1999 to Dec 2005

Result

We applied the above method to the North Atlantic region of the global ocean. Examples of the first EOF pattern from model control run and model historical run are shown in Figure 4.

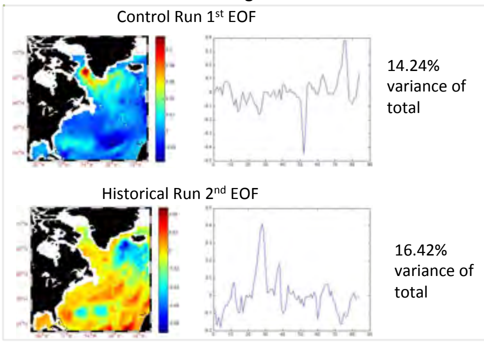


Figure 4: Pattern and time series of the first EOFs from model control run and model historical run.

Control run EOF represents natural variability of chl in North Atlantic.
Historical run EOF represents anthropogenic response of chl in North Atlantic.
Climate change fingerprint is the residual of the regression of the historical run response and control run EOFs.
We projected NOBM data with this fingerprint and did t-test on the coefficients.
Result of the test indicates that -

NO CLIMATE CHANGE SIGNAL DETECTED!
yet in SeaWiFS chlorophyll dataset

Conclusion

Application of a simple form of Optimal fingerprint method of detection and attribution to NOBM data using GFDL model run outputs in the time period of 1999 to 2005 in North Atlantic region of global ocean results in 'No' climate change signal detected yet in ocean chlorophyll.

Future Research

- Introducing statistical complexities in the basic method of optimal fingerprinting.
- Applying the method to different ocean regions of the global ocean.
- Utilizing output from different models with different climate forcings.
- Investigating other methods of detection and attribution.

References:
[1] Doney *et al.* (2006) Nature Vol 444; [2] Boyce *et al.* (2010) Nature Vol 466; [3] Hasselmann et al. (1979) Meteorology of Tropical Oceans

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Email: G.Dudeja@noc.soton.ac.uk

Air-sea interaction patterns and time-scales within the southeastern Bay of Biscay

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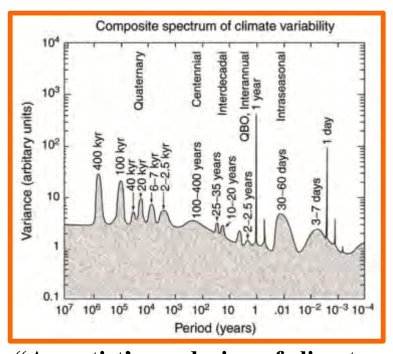
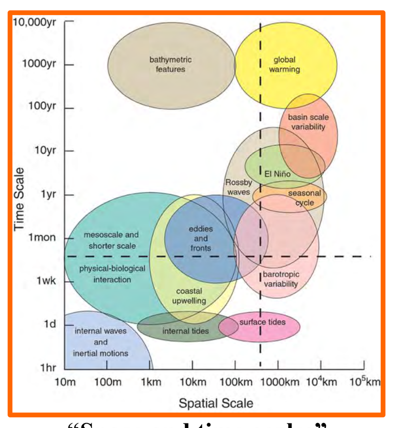
ABSTRACT

The understanding of air-sea interaction patterns and time-scales is of prime importance for forecasting changes in the climate, oceanic circulation and ecosystems in general. The air-sea interaction patterns are complex: they have a variety of time-scales and amplitudes and occur simultaneously. Further, the degree to which the Atmosphere and the Ocean are coupled varies spatially, from coastal to oceanic environments. In the present investigation, the surface wind-induced currents at the coastal and oceanic locations are investigated with special attention. The contribution of the wind to the current fluctuations occurs over a wide range of frequencies (inertial, diurnal, synoptic, seasonal, etc.). Additionally, the wind-current interaction patterns together with the time-scales involved vary from coastal areas to deep sea. In this context, the purpose of the present study is to describe and determine quantitatively the wind-current interaction patterns and time-scales within the southeastern Bay of Biscay.

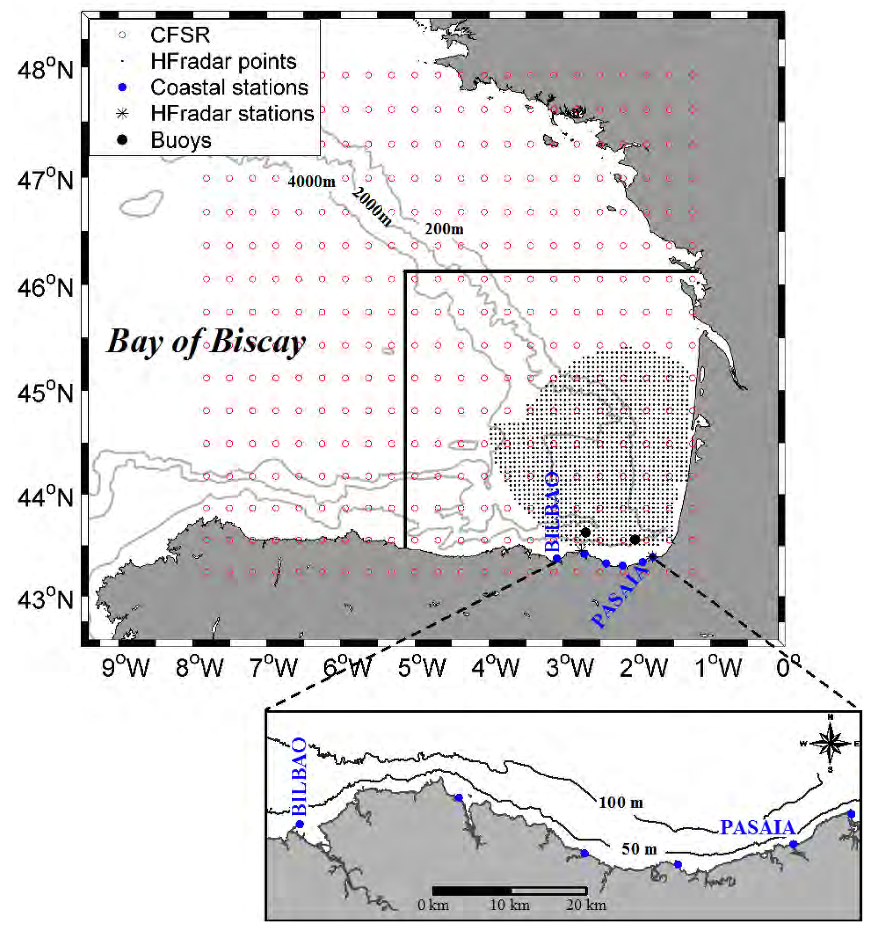


"An artist's rendering of climate variability" (Ghil, 2002).



"Space and time-scales" (Chelton, 2001).

STUDY AREA and FIELD DATA



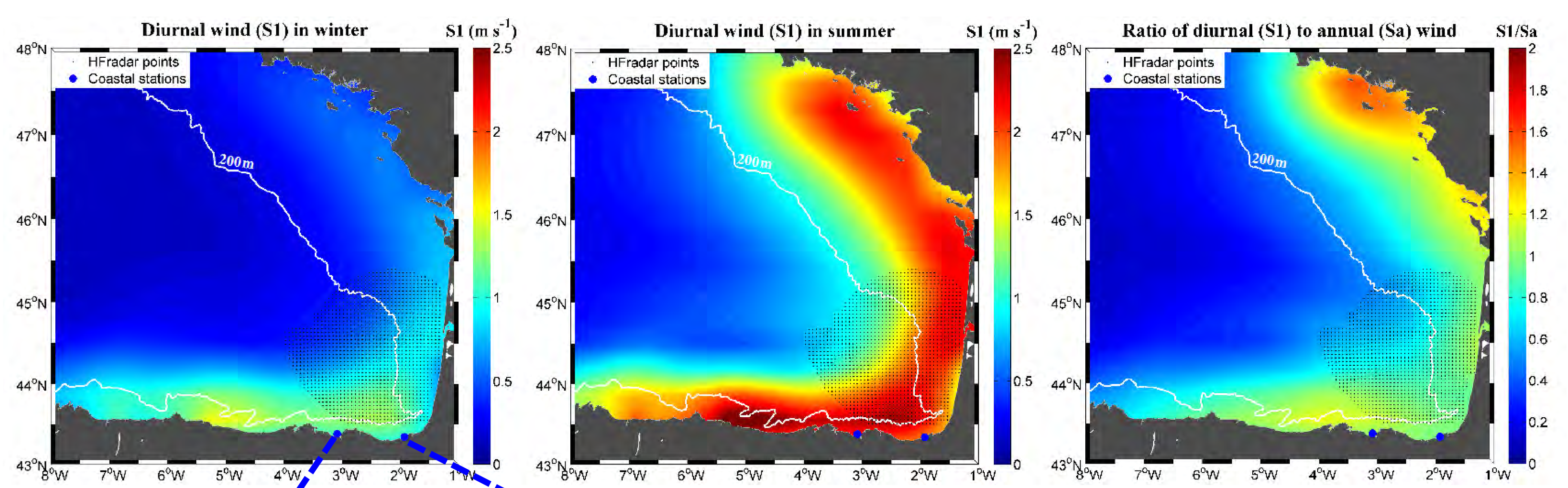
The Directorate of Emergency Attention and Meteorology (Basque Government) established an Operational Oceanography system in the SE Bay of Biscay:

- 2004: the data acquisition system was formed by 6 coastal stations, including Bilbao and Pasaia.
- 2007: 2 deep sea buoys were moored in the continental slope.
- 2009: the system was complemented with a HF radar array.

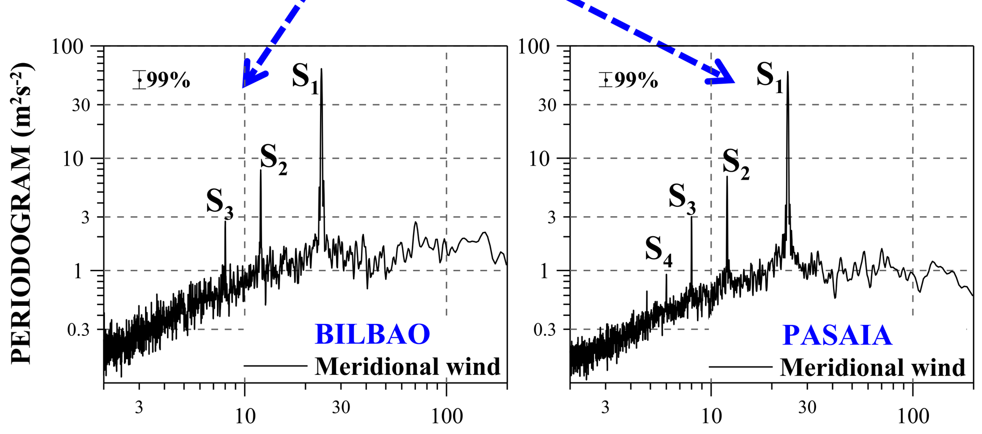
Wind components at 10 m above sea level of the Climate Forecast System Reanalysis (CFSR) were also used.

WIND VARIABILITY: diurnal to annual

Reanalysis winds (CFSR)



Coastal winds



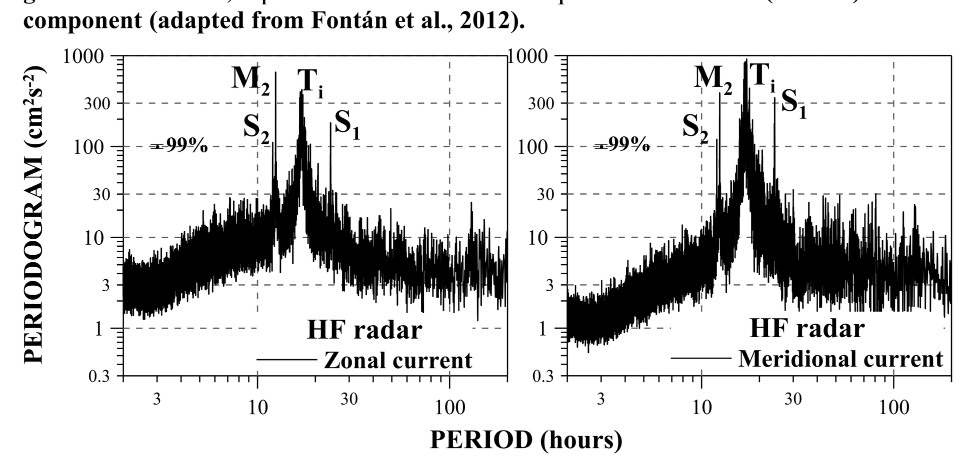
Periodograms of the meridional wind at the Pasaia and Bilbao stations. S_1 is diurnal wind (breezes) and S_2, S_3 and S_4 are higher harmonics of the diurnal wind (adapted from Fontán et al., 2011).

- Breezes are well-developed not only at coastal stations but also at the continental shelf (depth < 200m) and slope (depth > 200m).
- Amplitude of breezes exceeds amplitude of annual component at the shelf and partially at the slope.
- The breezes are intensified in summer and these may generate stronger surface-enhanced diurnal currents.

VARIABILITY in CURRENTS

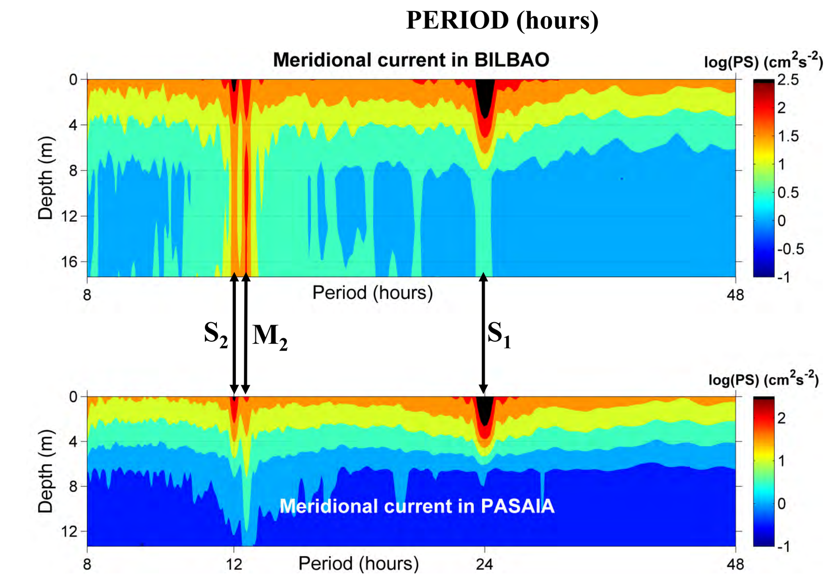
HF radar

Averaged periodograms for the HF radar surface currents. S_2 and M_2 are semidiurnal gravitational tides, T_i is inertial motion and S_1 is wind-induced (breezes) diurnal component (adapted from Fontán et al., 2012).



- Tidal, inertial and diurnal motions dominate the high-frequency variability of surface currents at the continental shelf and slope.
- Actually, breezes induce diurnal water motions at sea surface.

Coastal currents

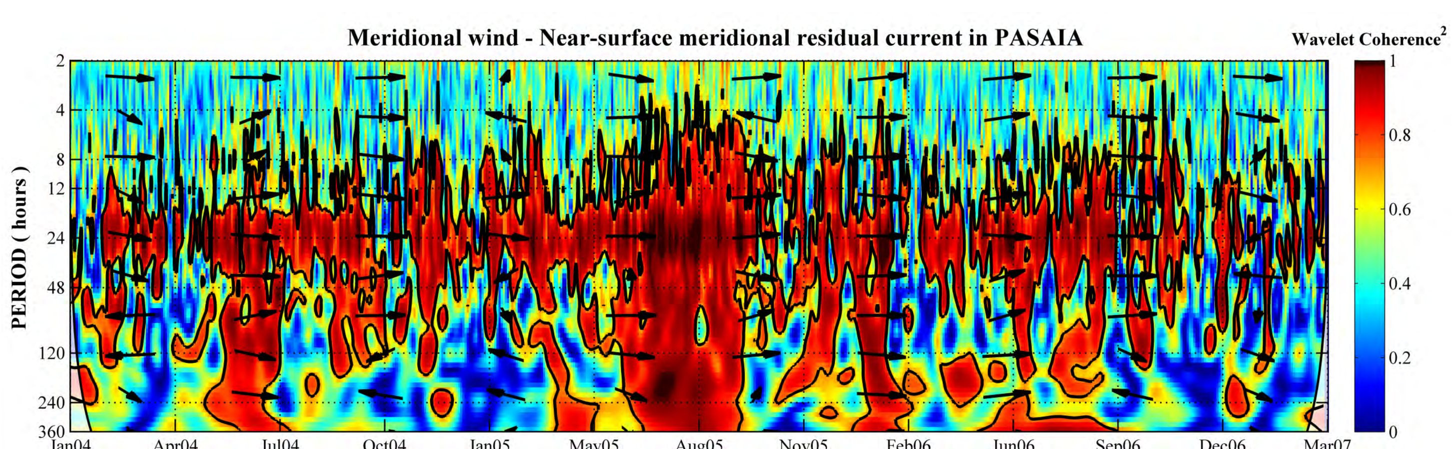


Distribution of spectral power throughout the water column in the Bilbao and the Pasaia coastal stations.

- Tidal and diurnal motions dominate the high-frequency variability of currents at coastal areas.
- Once again, breezes induce surface-intensified diurnal water motions.

WIND-CURRENT INTERACTION: patterns and time-scales

Coastal areas

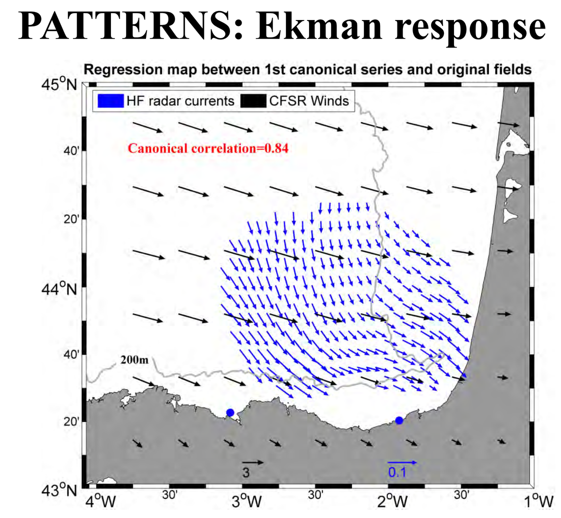


Squared wavelet coherence for the meridional wind and near-surface residual northward current components at the Pasaia station. The thick black contour is the 5% significance level against red noise from a Monte Carlo simulation of wavelet coherence. The relative phase relationship is shown as arrows (with in-phase pointing right, anti-phase pointing left and wind leading current by 90° pointing upwards) (adapted from Fontán et al., 2011).

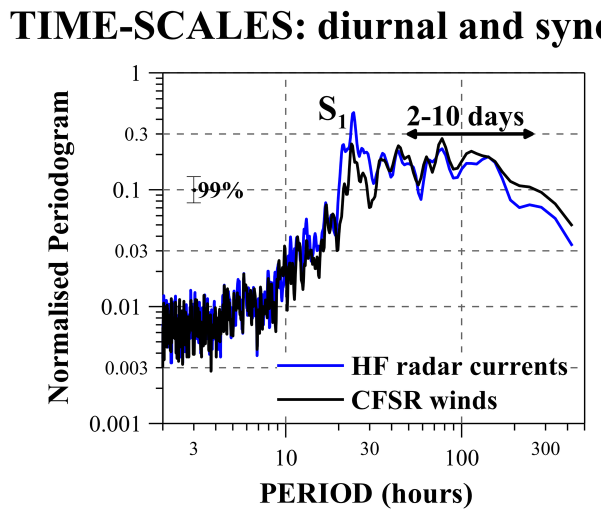
- The wavelet coherence measures the intensity of covariance between two time-series in the time-frequency domain.
- At coastal locations, near-surface currents respond almost instantaneously to wind forcing with stronger correlation at synoptic (2-10 days) and at diurnal time-scales.

Continental shelf and slope

PATTERNS: Ekman response ⟷ **TIME-SCALES: diurnal and synoptic**



Homogeneous regression map between the first canonical series and the HF radar currents and CFSR winds (adapted from Fontán et al., 2012).



Normalised periodograms for the first canonical variables of the wind and currents (adapted from Fontán et al., 2012).

- Canonical correlation analysis identifies new basis vectors for two sets of variables such that the correlation between the projections of the variables onto these basis vectors are mutually maximised.
- At the continental shelf and slope, near-surface currents respond almost instantaneously to local wind forcing at synoptic (2-10 days) and at diurnal time-scales.
- The wind-current interaction pattern corresponds to the classical Ekman drift.
- The canonical correlation between the first canonical series corresponding to the wind and currents is 0.84.

CONCLUSIONS

- Tidal and diurnal motions dominate the high-frequency variability of surface currents at coastal and oceanic areas (continental shelf and slope). The inertial motion also dominates high-frequency surface currents at open sea.
- The upper circulation is mainly driven by local winds at coastal and oceanic areas of the SE Bay of Biscay.
- The currents respond almost instantaneously to local winds at coastal and oceanic areas.
- The wind-current interaction occurs at diurnal (breezes) and synoptic time-scales (apart from the well-known seasonal variability) at both coastal and oceanic regions.
- The wind-current interaction pattern corresponds to the classical Ekman drift at oceanic areas.
- Finally, "The answer, my friend, is blowing in the wind" (Bob Dylan).

Acknowledgments

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The CFSR winds are from the Research Data Archive (RDA) (http://dss.ucar.edu), maintained by the CISL at the National Center for Atmospheric Research (NCAR). NCAR is sponsored by the National Science Foundation (NSF).

Wavelet coherence software was provided by A. Grinsted and is available at URL: http://www.pol.ac.uk/home/research/waveletcoherence/.

References

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UNIVERSITY OF TROMSØ UiT

Analysis of long-term ocean-bottom seismic data from the Håkon Mosby Mud Volcano

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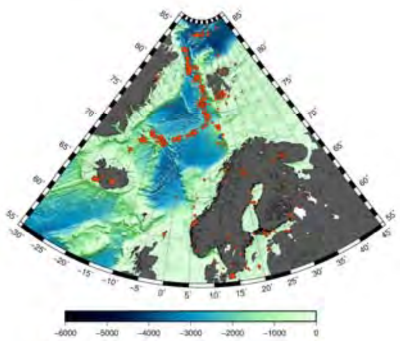
Introduction

Håkon Mosby Mud Volcano (HMMV) is located at around 1250 m deep on the SW Barents Sea slope between Norway and Svalbard. It has been the object of intensive study since its discovery in 1990's. It has a diameter of about one kilometer and rises a few meters above the seafloor. Methane seeps, mud flows and high temperature creates suitable conditions for extensive microbial communities.

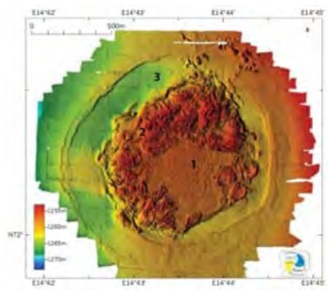
Within the LOOME project (Long-term Observatory On Mud-volcano Eruptions, an ESONET-NoE demonstration mission) a variety of sensors monitoring hydrological, geochemical and biological parameters were deployed in the area. Institute of Geology, University of Tromsø, using long term ocean-bottom seismic station has acquired continuous two years seismic records of vertical and two horizontal components of motion which enabled to record seismic events. The seismic records can help in understanding and constraining geophysical processes of the HMMV.

Considerable activity of mud volcano is the source of seismic waves propagating to surroundings. The analysis of seismic records was performed. The results of the analysis performed on data, that were recorded during first 8 months of deployment, are presented.

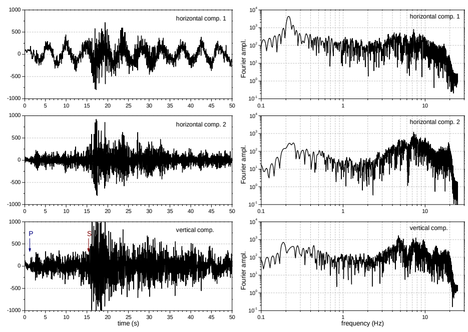
position of the HMMV and earthquake epicenters
in time period
Nov 01, 2008 – June 30, 2009



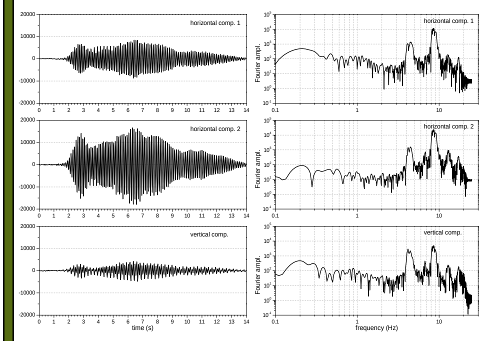
microbathymetry of the HMMV
(Foucher et al. 2009)



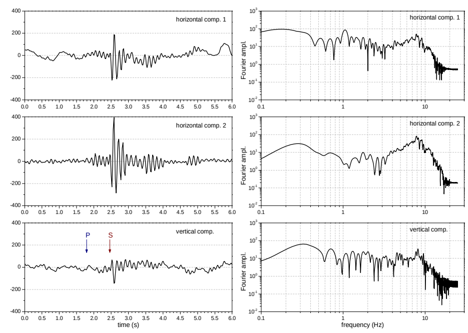
earthquake from catalogue
(November 04, 2008, 02:13:25)



probable mud flow
(November 03, 2008, 10:43:21)



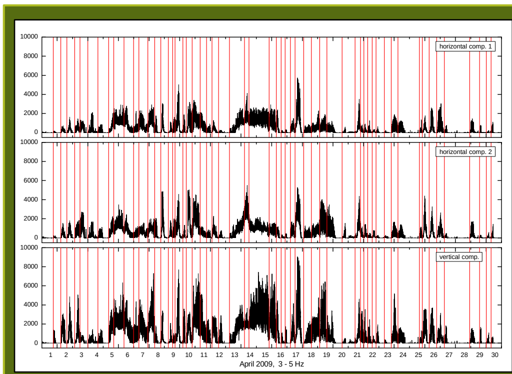
local earthquake
(March 06, 2009, 00:32:11)

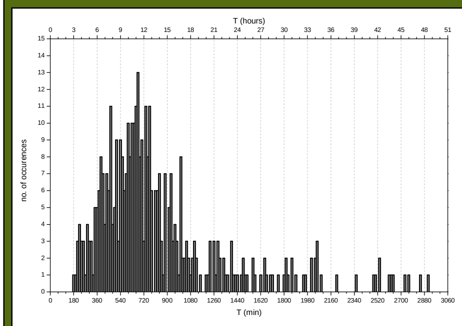


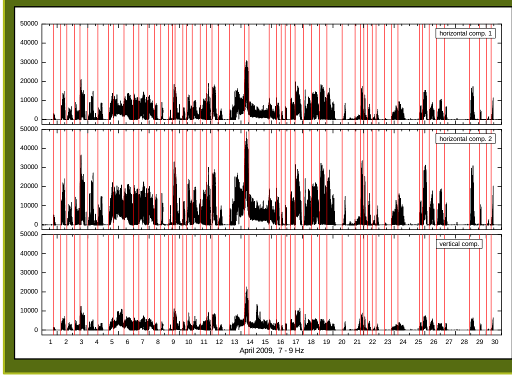
Catalogue of earthquakes was compiled from catalogues of several seismological agencies (ISC, EMSC, NORSAR, NEIC). The earthquakes in the records were identified based on the compiled catalogue and the estimation of travel times between the HMMV and the earthquake epicenters.

Example of the records of earthquake listed in the catalogue with local magnitude ML=3.0, that occurred 157 km northward of study area, is shown in the upper left corner. The local earthquakes, that occurred in the vicinity of study area, were also identified besides the earthquakes from the catalogue (example is shown in the bottom left corner). Records in the upper right corner corresponds to regularly occurring tremors probably caused by mud flows.

The arrivals of P and S wave can be distinguished in the records of earthquakes in time domain. The records of probable mud flows exhibit distinct frequency peaks at 4 and 8 Hz in frequency domain.







Butterworth band-pass filter was applied on the records for frequency intervals 3-5 Hz and 7-9 Hz. The envelopes of filtered records were calculated and smoothed by running average (example of filtered one-month 3 component records is shown on the left side).

In acquired time series of filtered and smoothed envelopes the onset times of increased activity were determined. The activity of mud volcano in the frequency band around 4 Hz is in quite accordance with the activity in the frequency band around 8 Hz.

Histogram of differences between the onset times (upper right corner) represents distribution of period of occurrences of increased activity. Average value is 14 h 17 min, median value is 11 h 32 min.

Summary

The analysis of seismic records showed there are two types of recorded events – the earthquakes and the tremors probably induced by mud flows.

Mud flows exhibit distinct frequency peaks at 4 and 8 Hz.

The activity of mud flows is relatively regular with average period of around 14 hours. This periodicity is possibly correlated with regular release of stress in the volcano caused by upward migration of pore fluids/gas.

The analysis of the relationship between earthquakes and mud volcano activity will be performed in the future.

Acknowledgement

We thank the crews and scientific parties of all LOOME-related cruises (*RV Jan Mayen* 2008, *RV Polarstern* 2009, *RV Heincke* 2010), the result of which have contributed to produce this poster. We are also grateful to T. Feseker (MARUM, Brehmen, Germany) for fruitful comments and discussions.

Reference

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DETECTING HYDROLOGIC VARIATIONS IN A LONG TERM MONITORING TIME SERIES

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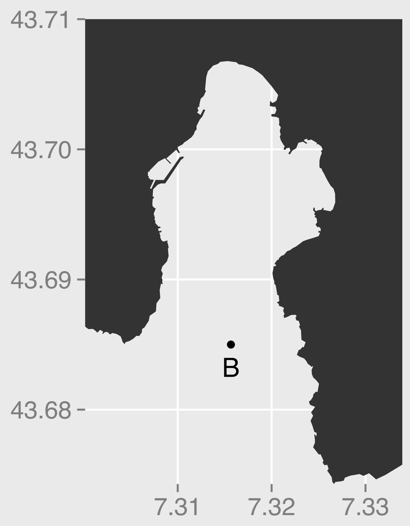
INTRODUCTION



Long term time series are the most promising source of information to detect climate-induced changes and understand the modification of ecosystem processes.

Processes at the interface between hydrology and biology in the pelagic ecosystem are of particular interest in the time series collected at point B, in Villefranche's bay. Temperature and salinity are monitored weekly since 1957. More variables are recorded since 1995, using a CTD and water samples. Zooplankton is sampled daily since 1966 using nets.

Sampling this bay allows to capture both continental influences due to the proximity of the shore and pelagic processes because of the absence of continental shelf in this region of the Mediterranean. Furthermore, the Mediterranean itself is particularly sensitive to climate change.

DATA PREPARATION

Focus is put here on the richest data record, collected since 1995, at six depths, from surface to bottom. Of course, the record is not complete: missing values are present either sporadically or over long periods (years 2007 and 2008 for nutrients – Fig. 2).

We take advantage of the correlations between variables (chlorophyll and fluorescence, NO_3 and NO_2, temperature at 10 and 20 m depth, etc.) to reconstruct missing values in one record from existing values in others. Correlations between variables are captured through a Principal Component Analysis (Fig. 1).

The first 11 components of the PCA (80% of variance) are used to recompute the missing values. The PCA is then repeated on this new, complete, record until the predicted values converge. This technique allows to recreate credible seasonal cycles over two years of missing nutrients data, using depths 0 and 50 m where the data record is almost complete as well as correlations with salinity or chlorophyll.

Data is then regularised with a 7 days time step and the few completely missing weeks are linearly interpolated. This results in 883 data points per series.

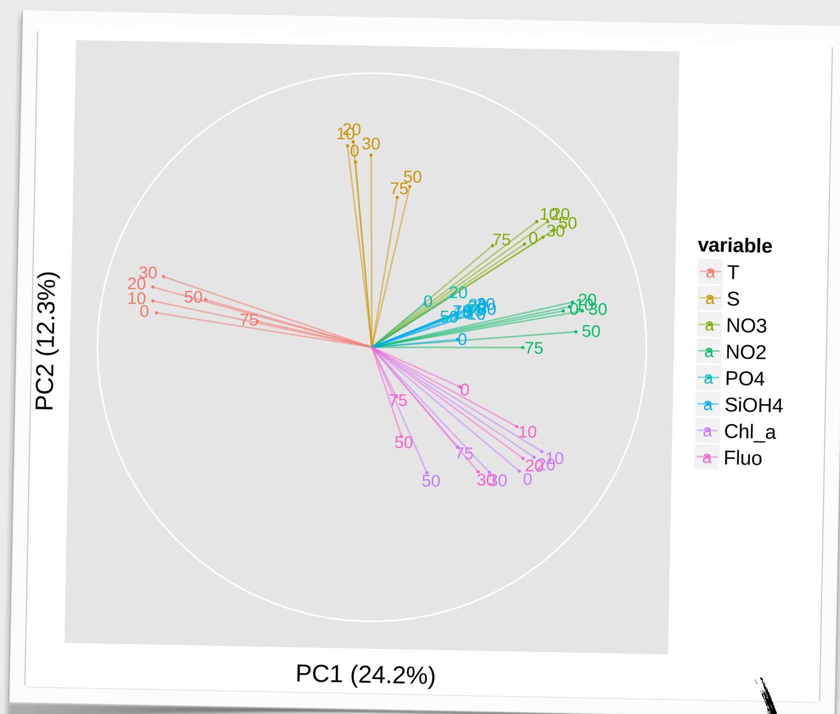


Figure 1: PCA factor space showing the correlations between hydrologic variables at six depths used to fill missing values.

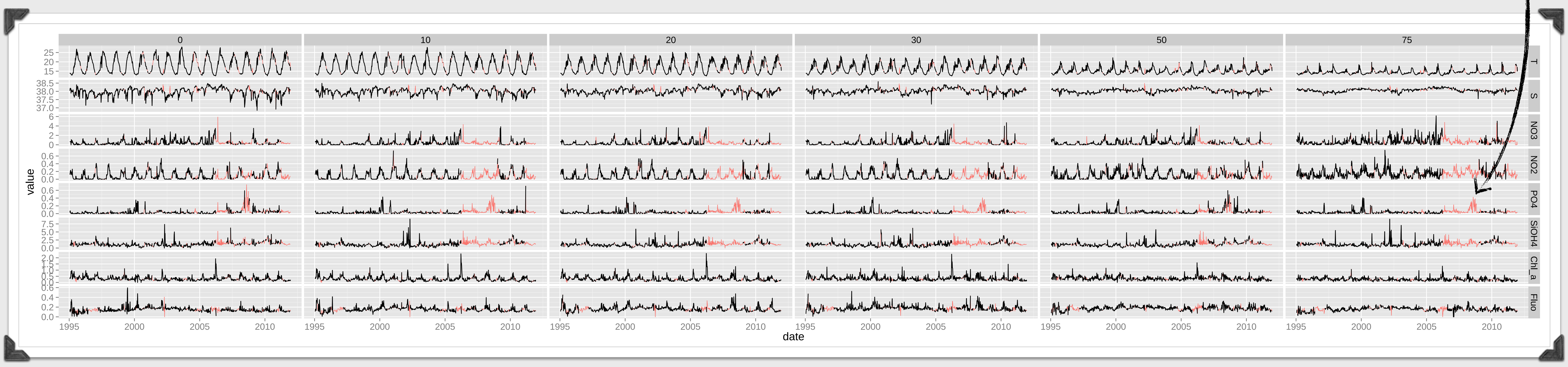


Figure 2: Complete data record in raw form (black) and after missing data imputation and regularisation (red). When data is present, the time step is already very regular, hence the almost perfect match even after regularisation.

DECOMPOSITION OF VARIANCE

The filled and regularised data series is influenced by a collection of processes acting on different scales. To tear them apart, we first use Eigen Vector Filtering (EVF). It decomposes each series into components representing orthogonal portions of the variance and sorted in decreasing order of importance (through a modified PCA procedure). The first EVF component captures seasonality in most series (Fig. 3), combined with larger-scale trends for salinity. Such a strong seasonality is expected in temperate systems and this result is therefore reassuring.

Because seasonality is the first source of variance in most series, it needs to be removed to see other processes. We locally fit two polynomials over short (3 months) and long (5 years) scales to extract the seasonal component and the larger scale trend (Fig. 4), through a process called STL (Seasonal-Trend decomposition based on Loess). Residuals sometime still have a seasonal component (Fig. 4) but removing it require to reduce the short scale to less than three months (i.e., a season) which introduces too much noise in the seasonal signal.

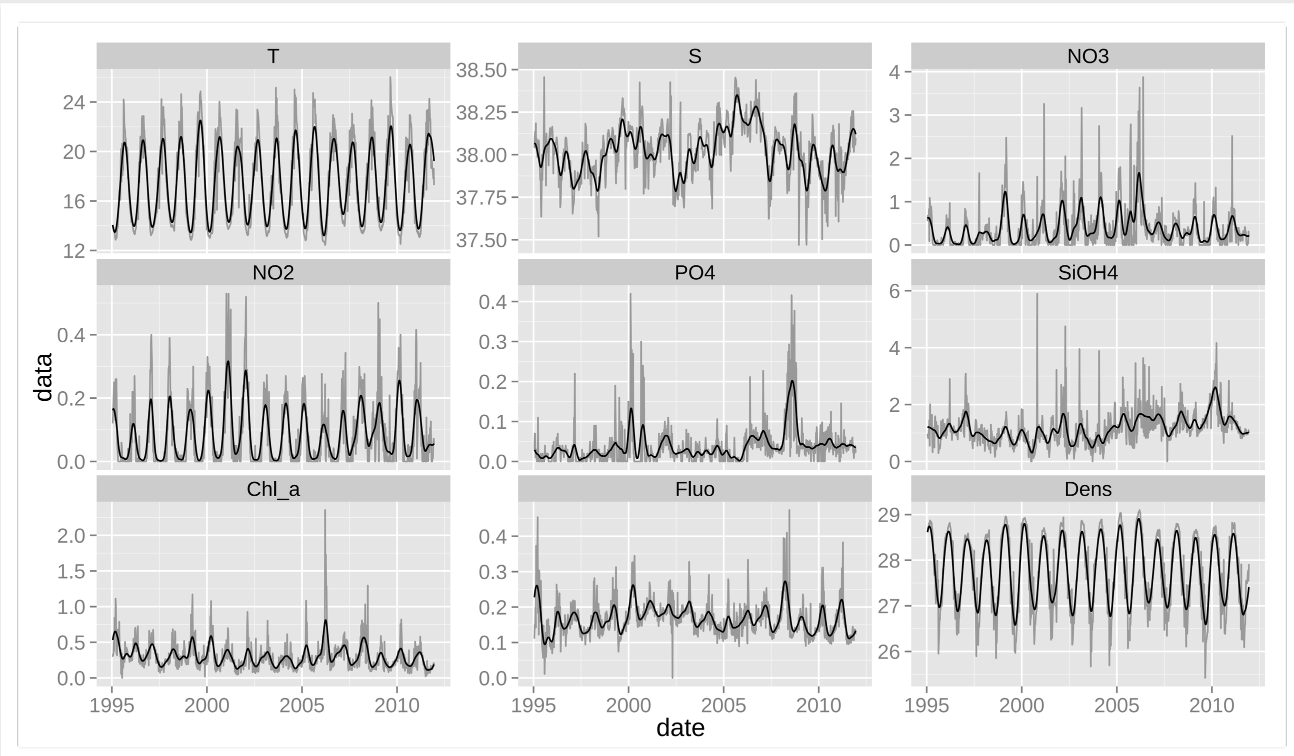


Figure 3: Data series at 20 m (grey) and first EVF component (black), which captures the process of highest variance (often seasonality here).

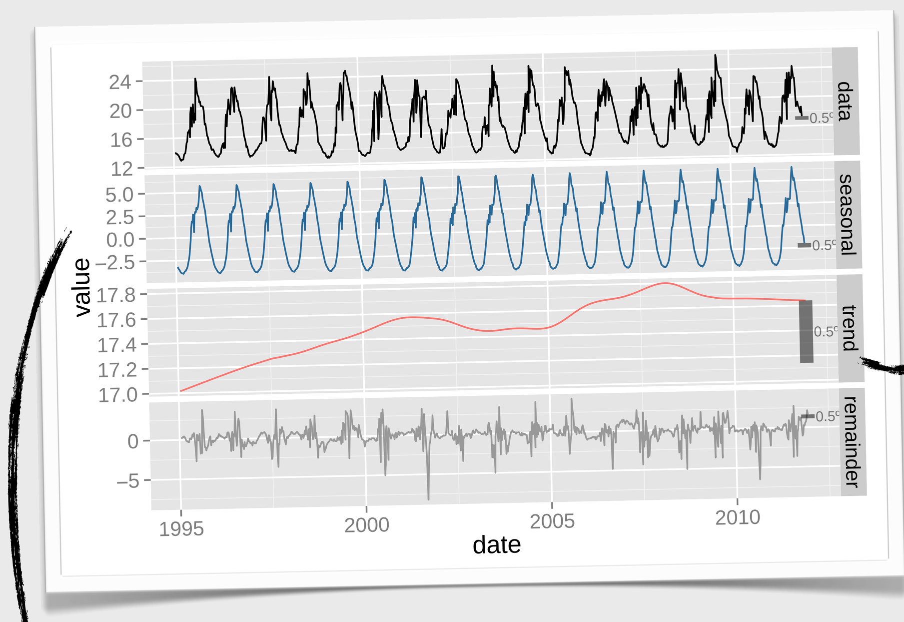


Figure 4: Seasonal-trend decomposition of temperature at 20 m.

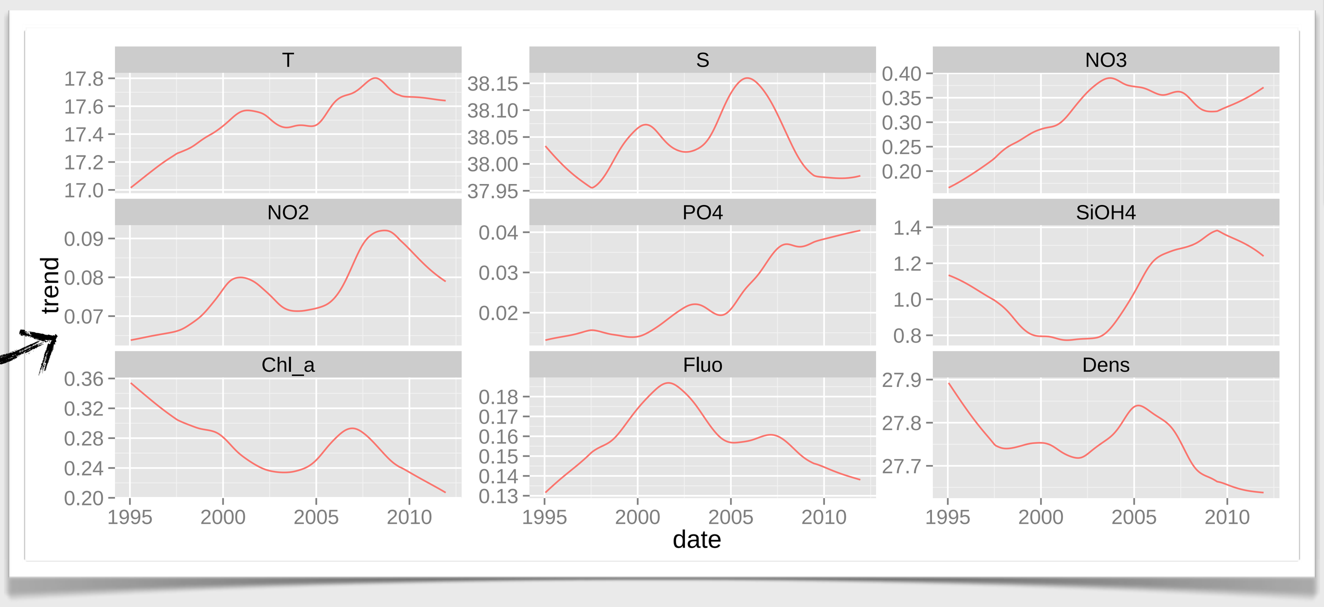


Figure 5: Trend component of the STL decomposition of data series at 20 m.

TRENDS

The trend for water temperature at 20 m shows an increase of 0.8°C over 17 years (Fig. 5). This fits with a larger scale trend in the whole data record (since 1957, not shown), although the increase accelerates. 0.8°C is already well above the global IPCC estimate of 0.74°C over the next 100 years. This increase is associated with a corresponding decrease in water density.

In the meantime, chlorophyll concentration, a proxy for primary production, decreases overall, while the concentrations of nutrients increases. This could suggest a top-down control of primary production by grazers rather than a bottom-up control by nutrients.

Yet, the chlorophyll trend peaked around 2007. This peak is associated with high salinity in the previous years, particularly 2006 (Fig. 5 and 2). During those years, dry and cold winters drove the increase in salinity. As a result, density also increased, winter convection was stronger and provided a more intense pulse of nutrients at the beginning of spring, hence feeding primary production. This pulse can be reliably be seen in 2006 (Fig. 2) but unfortunately not in the following years in which the nutrient series is mostly reconstructed.

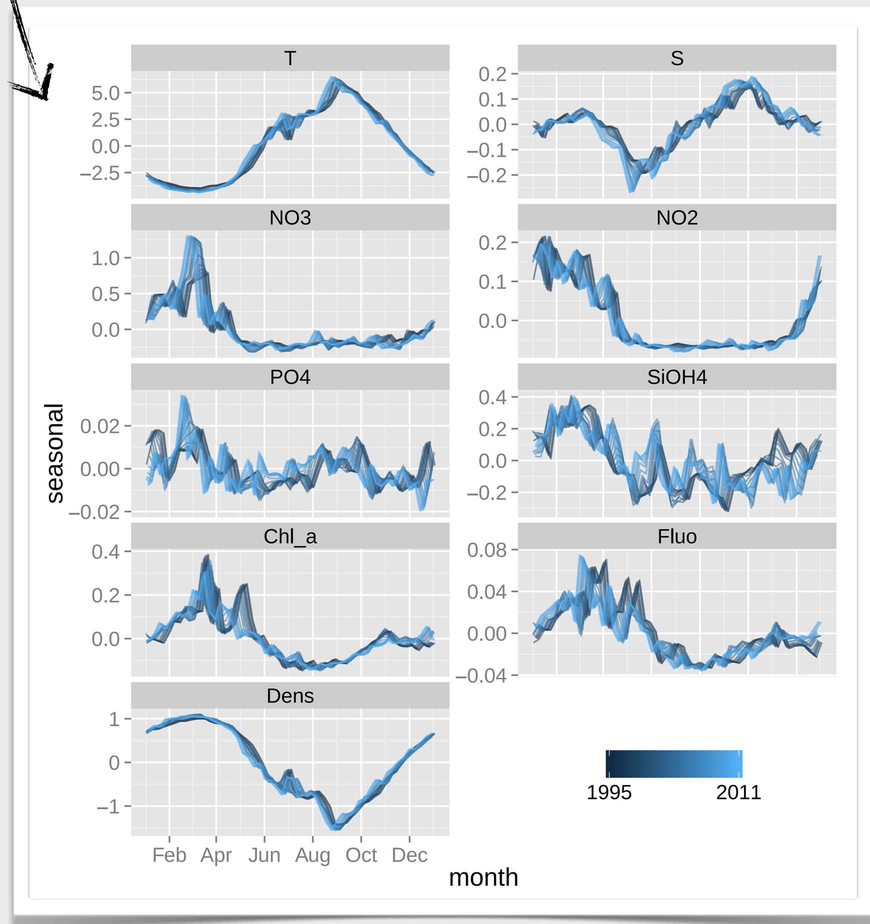


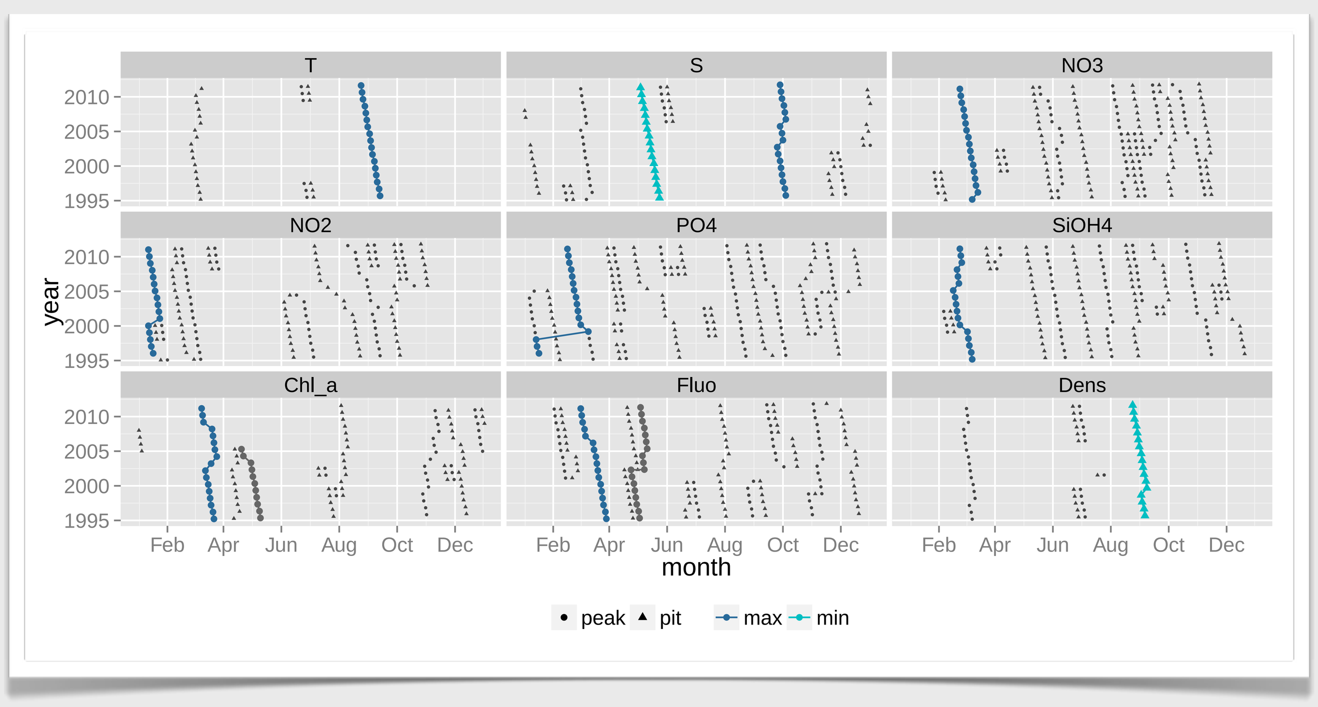
Figure 6: Seasonal component of the STL decomposition of data series at 20 m.

SEASONALITY

Looking at the superposition of seasonal components over a few years (Fig. 6), it seems that events are occurring earlier in the year. This is supported by the trajectory of remarkable peaks and pits through time which reveals the same shift towards earlier dates (Fig. 7). This trend is hardly visible in the raw data because of small scale inter-annual variability. While the steadiness of the shift might be exaggerated by the method, which smoothes out small-scale variability, the shift is quite clear.

The chlorophyll series also reveals a regime change, from two blooms, the main one in early spring and a weaker one in May, to just one in early spring (Fig. 7).

Figure 7: Dates of the peaks and pits in the seasonal components at 20 m. Maxima and minima are highlighted when relevant. The two main blooming events are shown for chlorophyll and fluorescence.



CONCLUSIONS

- Iterative PCA can help fill large gaps in time series
- As expected, series are dominated by the seasonal component
- Temperature increased strongly in surface waters
- Primary production decreased, overall
- Dry years may cause an increase in salinity, mixing and primary production in the following year
- Remarkable events, such as blooms, seem to have shifted towards earlier dates in the year

Data provided by "Service Observation en MIlieu LITtoral-SORade, INSU-CNRS-UPMC, OOV". All analyses made in R 2.15.1, with packages stats and pastecs for time series decomposition, plyr and reshape2 for data management and ggplot2 for graphics.

Sverdrup transport temporal and spatial variability in North Atlantic based on NOC1.1 dataset

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The North Atlantic Ocean is the most completely observed and extensively studied among other Oceans, but as a dynamic system interacting with atmosphere and affecting surrounding territories it remains significant for scientists to analyze. To understand multi-decadal and spatial variability of the Sverdrup transport (meridional transport estimated from the wind stress curl) a continuous time-series need to be examined.

DATASET

NOC v 1.1 flux climatology (National Oceanographic Center, UK) is the most realistic and freely available meteorological dataset existing nowadays. It contains monthly components of zonal (τ_x) and meridional (τ_y) wind stress for World Ocean with 1° x 1° spatial resolution from 1980 to 2005 year. NOC v 1.1 time series includes also basic meteorological parameters like sea and air temperature, wind speed, evaporation, humidity, cloudiness and heat fluxes - all of them are montly or yearly averages. NOC v 1.1 dateset nowadays is expected to be the most accurate, available from ship observations.

Florida Current transport (montly avarages, 1982-2005yr.) dataset was taken from an AOML NOAA project which includes everyday data of water transport on a transect in Florida passage in the vicinity of 26.75N - between Bahamas and Florida peninsula.

METHOD

The general circulation of the upper ocean is mainly driven by wind stress through the Sverdrup balance. The Sverdrup transport (ψ_s) is the net meridional transport diagnosed in both the subtropical and subpolar gyres, resulting from planetary vorticity changes that balance Ekman pumping (Fig.1)

Mathematically, the Sverdrup balance is derived from the geostrophic equations of motion with variable Coriolis parameter. H.Sverdrup (1947) modified them in order to be able to get the upper ocean layer circulation.

Monthly averages of wind stress curl (Fig.2) and integrated Sverdrup transport (Fig.3) were estimated in the area of Atlantic Ocean within 35S-70N based on the NOC v 1.1 dataset and Sverdrup equation.

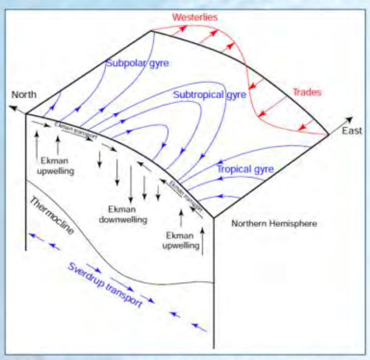

Fig.1 Sverdrup balance circulation (Northern Hemisphere). Westerly and trade winds force Ekman transport creating Ekman pumping and hence Sverdrup transport [1].

$$curl_z\tau = \frac{\partial\tau_x}{\partial y} - \frac{\partial\tau_y}{\partial x} \qquad \psi_s = \beta\rho^{-1}\int_{X_E}^{X_W} curl_z\tau dx$$

*β - beta effect (Coriolis force dependance over latitude).

[1] Talley L.D. et al.(2011) Descriptive Physical Oceanography p.212.

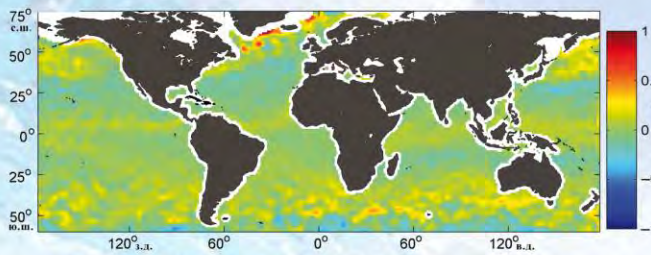

Fig.2 Example of monthly mean distribution of wind stress curl(1×10^{-7} N/m³) over the World Ocean

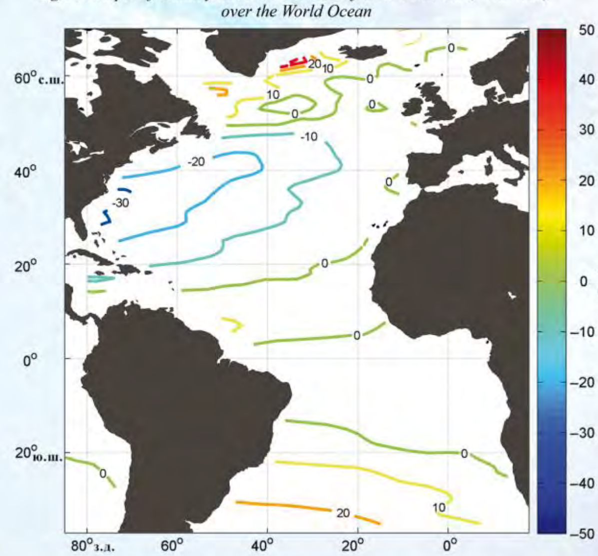

Fig.3 Example of monthly mean Sverdrup transport (1×10^6 m³/s = 1Sv.) distribution the North Atlantic

DISCUSSION

Maximum multi-anual mean of Sverdrup transport computed within the boundaries of subtropical gyre in the North Atlantic from 1980 to 2005 is 25.2 Sv (1Sv = 1*10⁶m³/s) at 33N, which is consistent with other estimates made by different authors. Correlation analysis between Sverdrup transport values for different latitudes and Florida Current transport showed significant correlation (r~0.5) on 27N.

Comparison analysis between inttegrated Sverdrup transport and Florida Current transport in vicinity of 27N indicated that average annual barotropic mass transport can determine average annual Florida Current transport by almost 70%. Presumably rest is determined by thermohaline component.

Moreover correlation analysis between NAO index and Sverdrup transport showed close to significant correlation coefficient (r~0.45) on 49N.

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Construction of a realistic wave climate from swell systems statistics.

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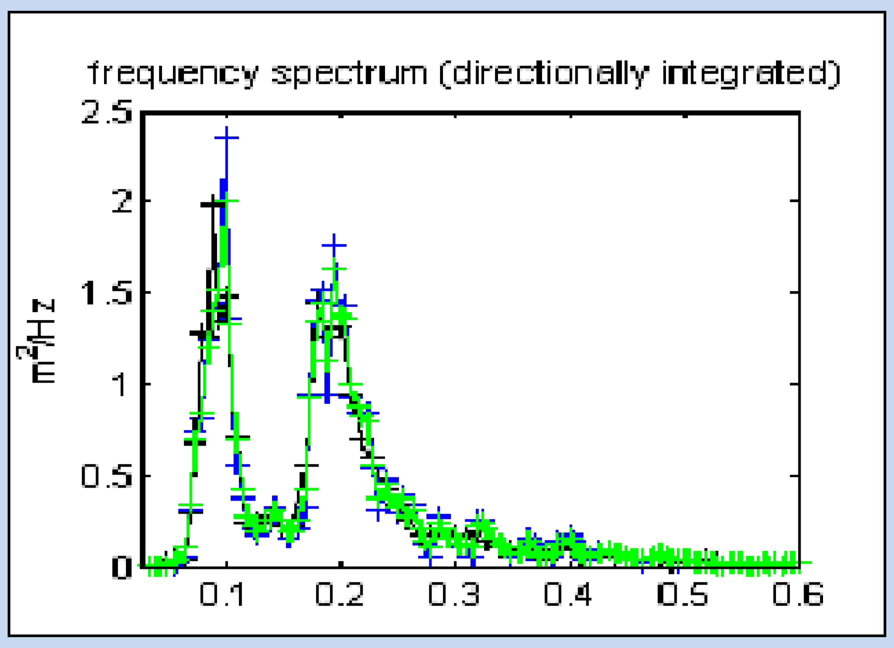
Context and objectives

- The issue is to characterize the longterm statistics of sea states, in particular for the design of marines structures.

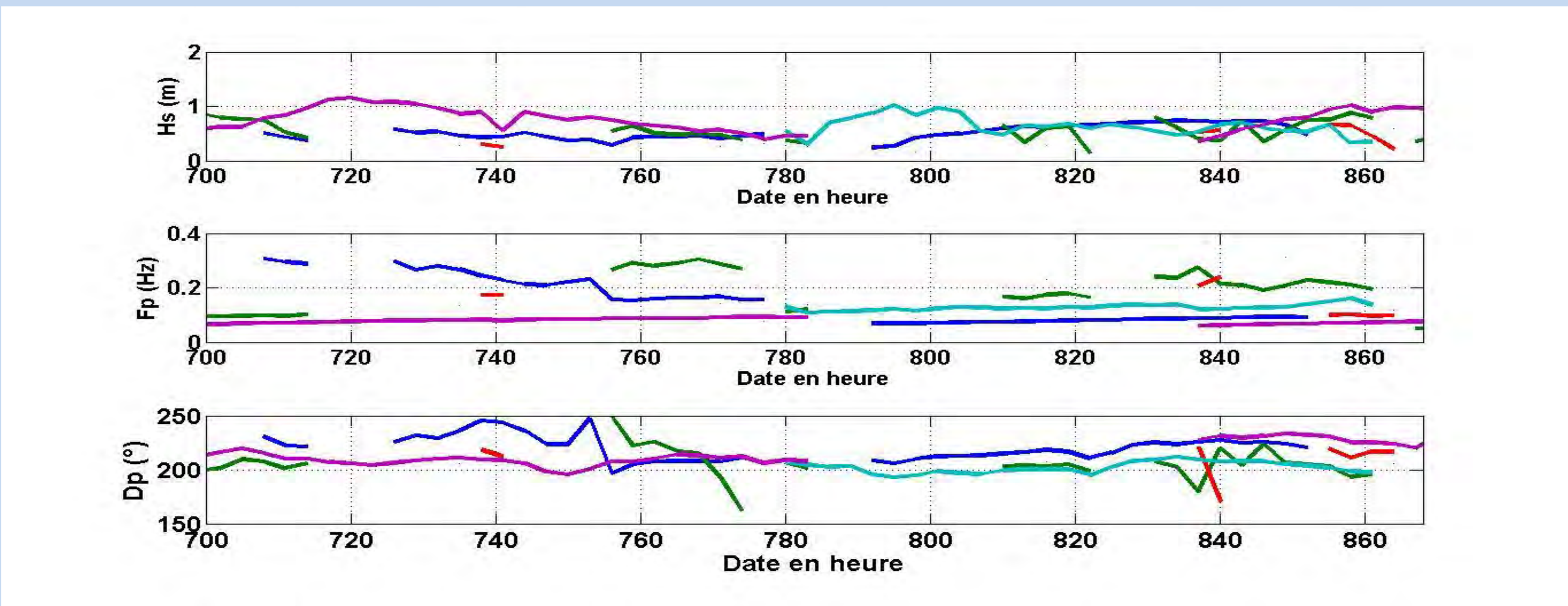


- Waves efforts are the main causes of fatigue damage (*AKPO platform, Nigeria*).
- typical west Africa wave spectrum may be present at the same time: a main swell, a secondary swell and possibly some other swells and wind sea.

- The objective of this study is to propose a methodology that can be used to construct accurately realistic wave climate histories for any desired duration, in typical West Africa conditions.

Methods

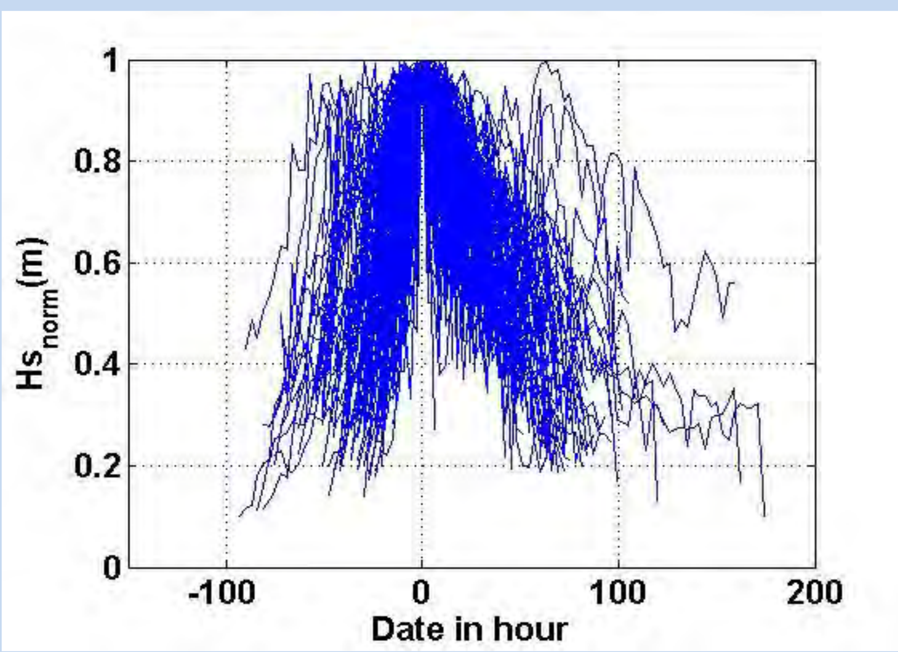
- We based our method on the modeling of wave systems in correspondence with the storms that are at their source and that can be identified from the history of environmental parameters(*significant wave height Hs, wave frequency Fp* and *wave main direction Dp*) of the sea states.

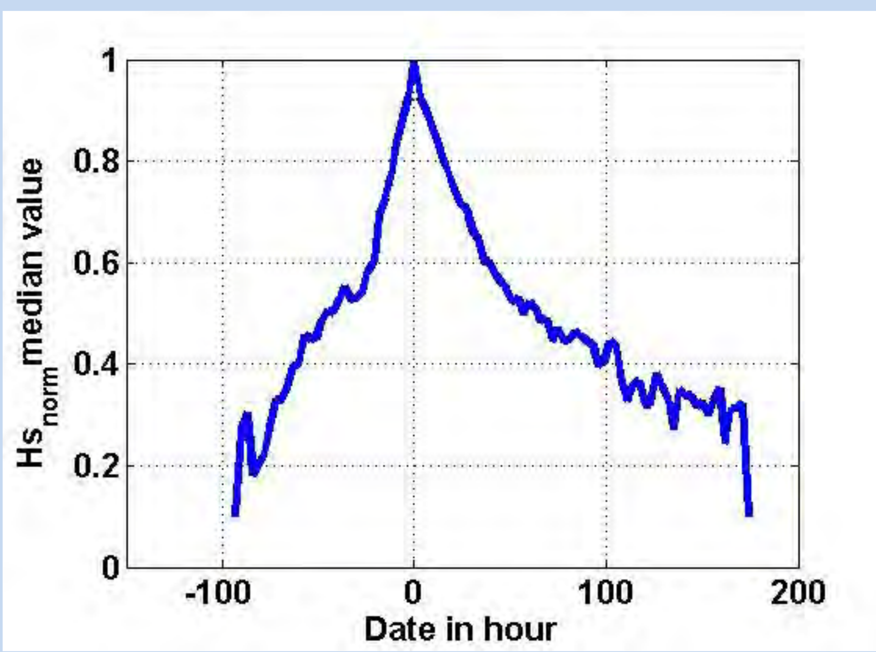


A week environmental parameters history; each different colour corresponding to a particular swell event (*Girassol data, Angola*)

- The method is made of three steps:
  - parameterization of wave events
  - statistical analysis of the parameters
  - reconstruction of synthetic histories

- Intelligent method needed for parametric models
- Significant wave heights' illustration

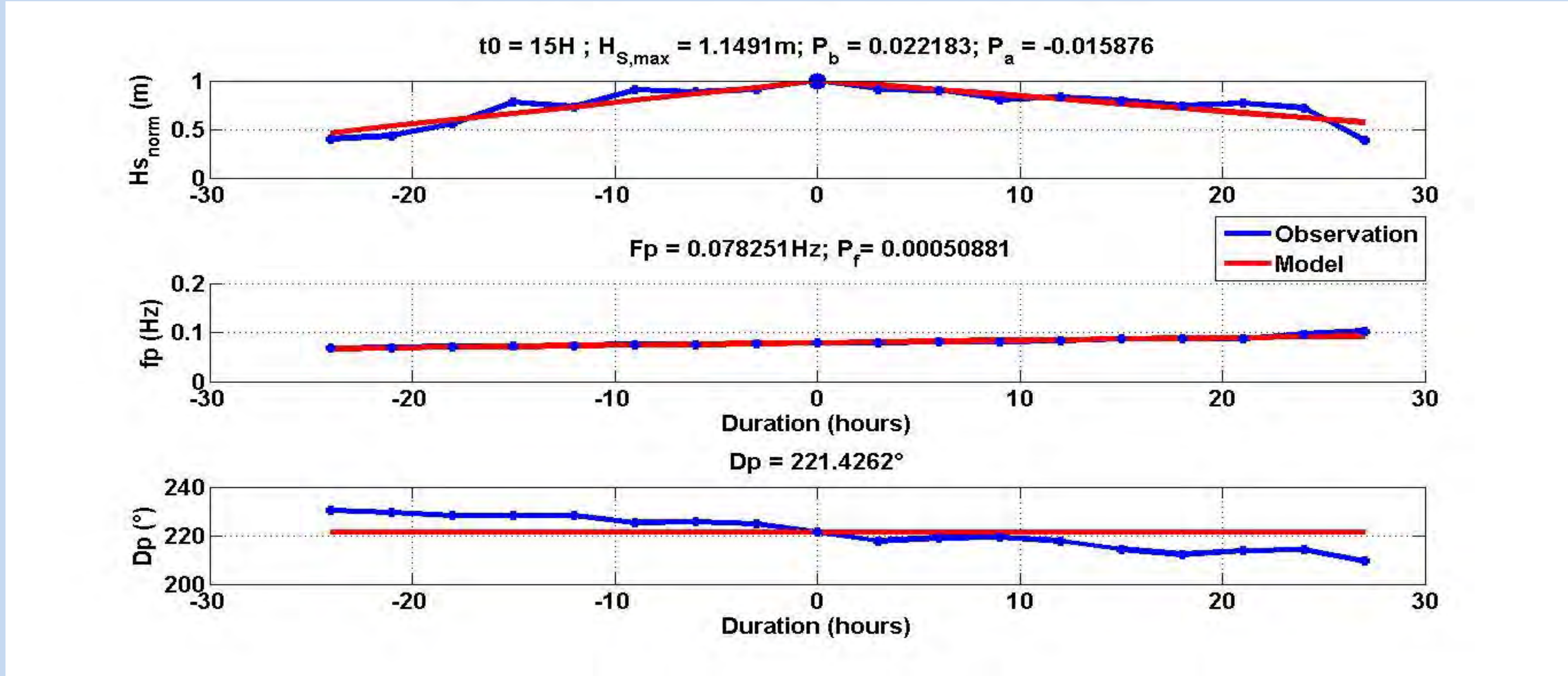




- After normalizing all Hs by their maximum value Hsmax, all swell events are superposed on the same graph.
- For each measure date, the median value is found and the median values graph is ploted. So, it was decided for a swell event to choose triangular form as model of temporal variation of significant wave heights .

Results

- Work on swell data only

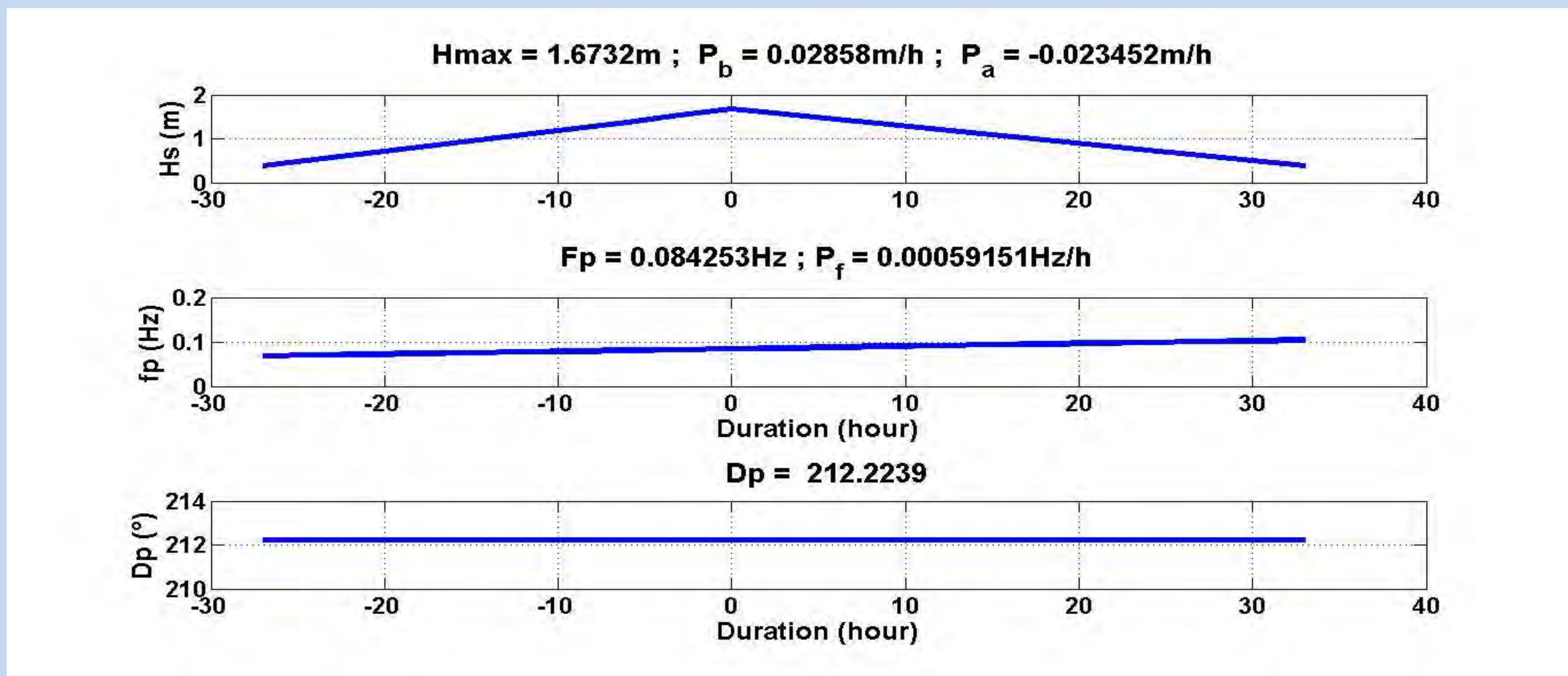


Fitting of swell event model to met-ocean data

- A swell event is modeled by seven parameters whose distributions are:

Parameters	Parameters descriptions	Distributions
Hsmax	Maximum value of Hs	Log-normal
P_b	Slope obtained on Hs values before Hsmax	Log-normal
P_a	Slope obtained on Hs values after Hsmax	Sum of 2 log-normal
Fp	Swell frequency at Hsmax date	Log-normal
P_f	Slope obtained on swell frequency values	Log-normal
Dp	Main swell direction	Normal
to	Duration between an Hsmax event occurrence and its previous	Sum of 2 log-normal

Conclusion



Sample of reconstructed Swell event

- A parametric definition of a storm event is built by modeling the temporal variation of the parameters of swell systems.
- Theorical distributions of swell event model parameters were found.
- Swell events are reconstructed.
- Swell events could be assembled into realistic simulated sea states, yet it will require additional assumptions on how the events occur in order to build reliable combined sea states for practical use in fatigue design.

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Ecological trends in Portuguese fisheries over the last 60th years

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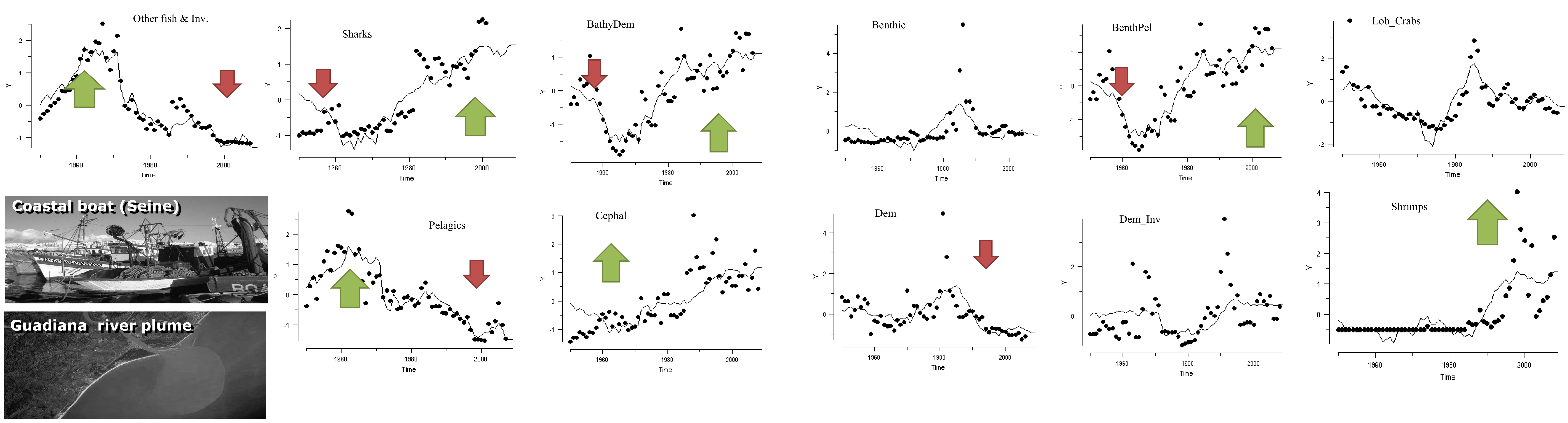
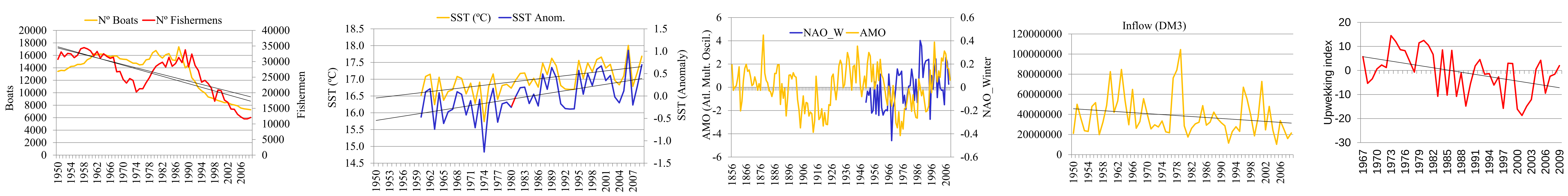
Background information:
Portugal has an historical tradition in fisheries, relying on fishing as a major mean of subsistence, particularly for coastal communities. It is also one of the largest (3rd) Exclusive Economic Zones (EEZ) in the European Union (EU). Even though great scientific effort has been dedicated to the sustainable development and management of fisheries, few studies have considered climatic effects in fishing resources together with fishing impacts, an approach that is very useful to support fisheries science. The evidence that environmental factors (hydrological and oceanographic) cause long-term, large-scale (sometimes synchronous) variability in fish stocks is growing, but it is a mistake to conclude that the effects of fishing are, therefore, less important. Accordingly, fisheries managers need to consider aspects of the climate (oceanographic and hydrologic), fish stocks and fisheries in coastal Portuguese waters. In order to understand how this information can be used to describe the ocean environment, fish stocks and fisheries, we have compiled series of data from the last decades, regarding: Hydrology (river discharges), Oceanography (e.g. temperature, phytoplankton, upwelling, North Atlantic oscillation;), and fisheries (e.g. fishing effort and landing catch data, mainly small and median pelagic fishes which comprise one third of the world's marine fish catch - sardines, anchovies, mackerel and other small pelagic fishes). The analysis of recent decadal trends in fisheries landings and environmental variables, with historical data series ("before situation") will reveal factors influencing particular groups (e.g: Functional groups), providing a basis for improved Ecological based assessment and management.

Challenges/Goals: Our approach, based on different areas, should allow an improved understanding of how environmental processes force large-scale changes in marine resources. The integrated knowledge (oceanographic, hydrology and fisheries data) of this project, instead of a fragmented approach, will contribute to show how climatic and fisheries affect marine resources, providing a sound basis for assessing the vulnerability of coastal fisheries and marine ecosystems to climatic changes

Fishing Trends (autocorrelation time lag 1 year)

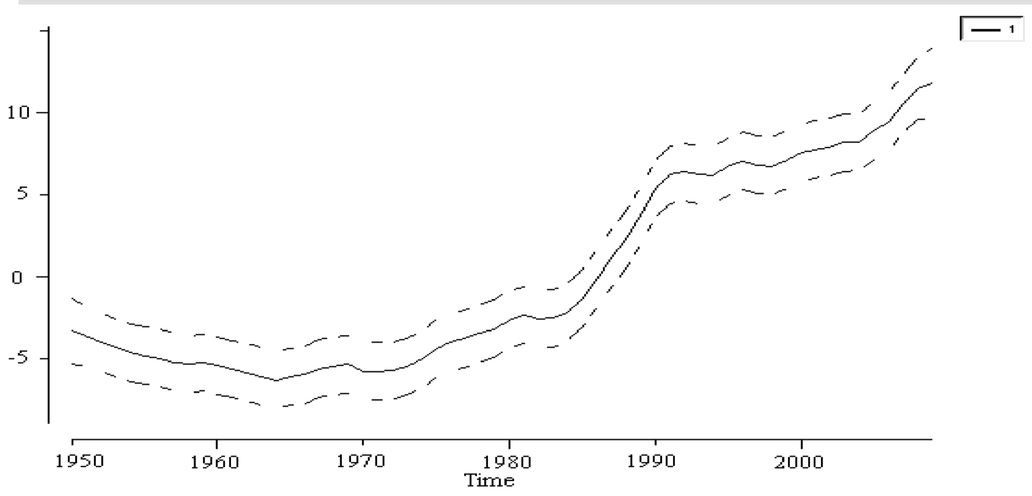


Explanatory variables (Environmental and Fisheries variables):

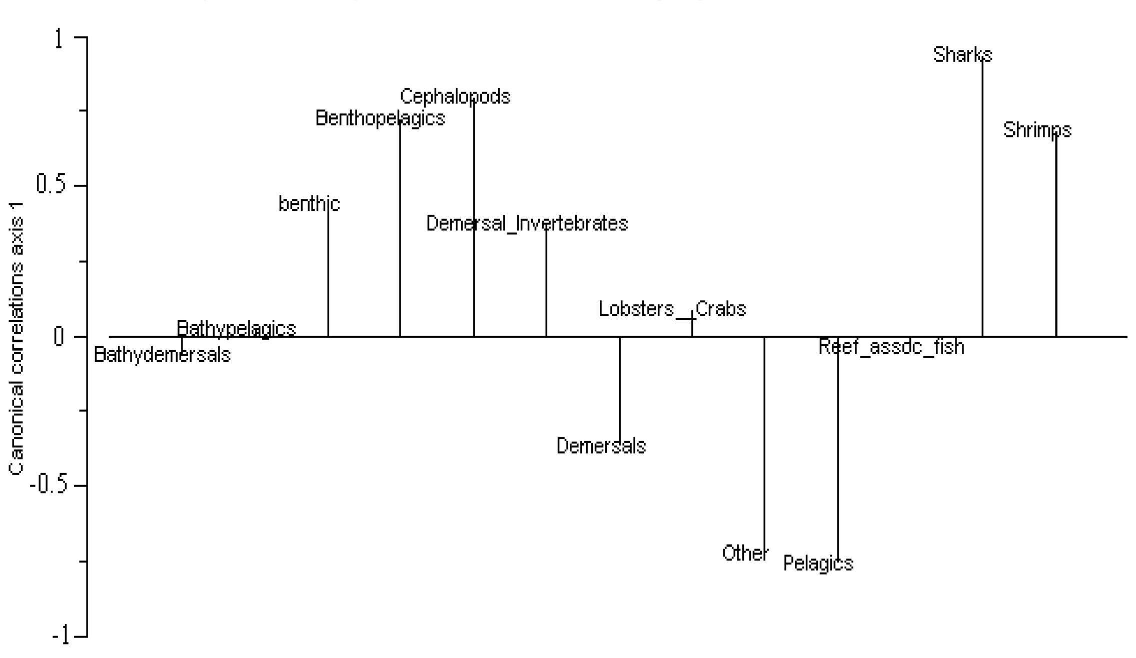


Methodology:

Statistical analysis: To date, few studies have addressed the aggregate effects of oceanographic and hydrological factors on trends in Portuguese fishery resources. Climate changes affect marine ecosystems and the survival, growth, reproduction and distribution of species, and consequently also fisheries of commercial species. The combined analysis of long-term trends in fisheries and environmental variables may shed light on factors influencing particular species or functional groups and provide a basis for improved assessment and management. In pursuit of this, we compile and review information regarding Portuguese time-series landings over last 60 years. Dynamic factorial analysis were used both as exploratory techniques (identify the fishing trends most contribute to overall trends shifts, showed in graphs below: M - Common trend + noise model) and analysis techniques to understand the role of climate changes impact (NAO, SSt etc) on landings time series (Table 1). Fisheries data were collected from FAO world fish data base and grouped into FG (Functional Groups) according SAU (SeaAroundUs project).



Response variables Canonical correlation with overall landing trend (Functional Groups):



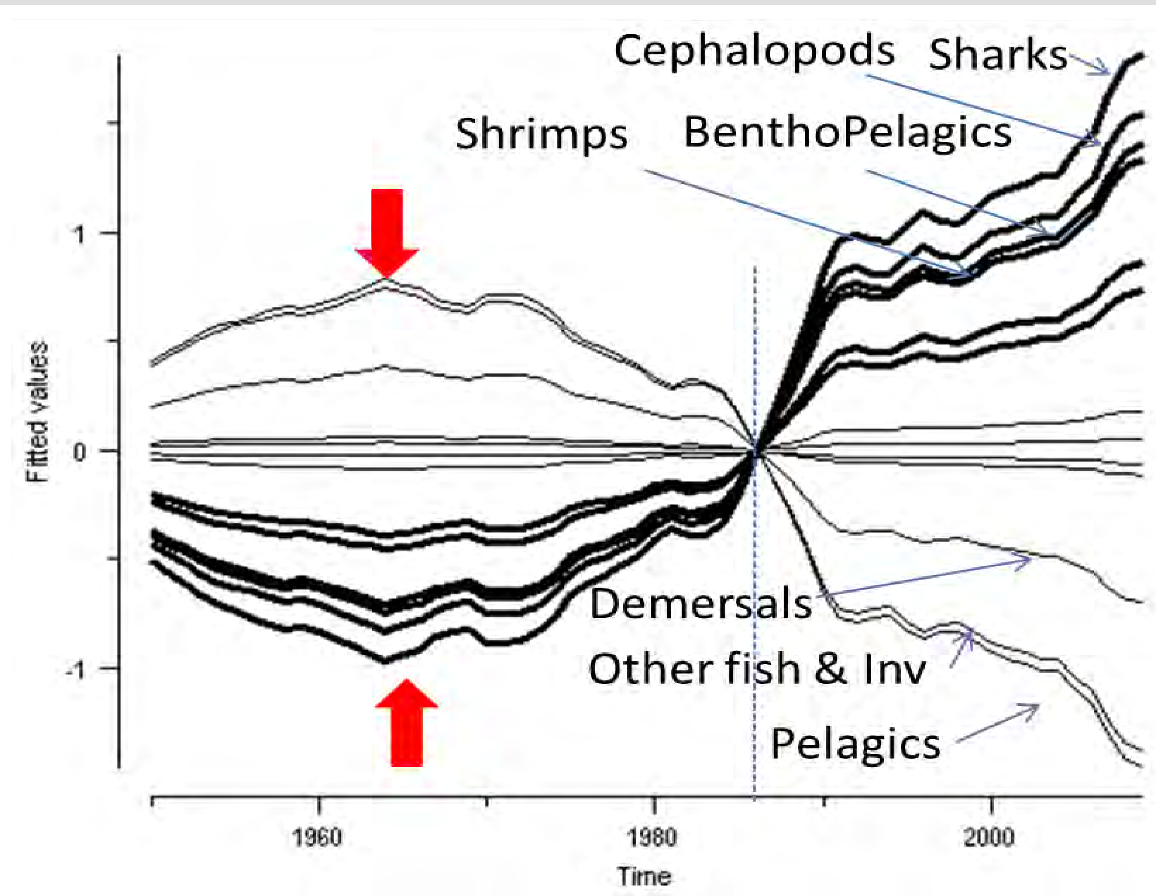


Table 1. FG Sensibility table to Environmental & fisheries effects (DFA - Dynamic factor analysis) (-) correlated with trend (+) correlated with trend

Expl. Variables	BenthoPel	Pelagics	Cephalopods	Shrimps	BathyDem	Demersals	Dem. Inv.	Lobst. & Crabs
1TS =Tr. + noise	76.487	68.747	89.535	60.359	56.066	114.022	88.648	72.847
NAOI	78.468	**64.132**	90.976	61.649	57.472	**112.085**	90.713	74.299
NAO_W	78.445	67.029	89.756	62.351	57.96	115.517	**86.401**	74.806
N_Boats	77.966	69.587	90.905	62.313	**54.079**	115.442	90.409	72.682
Fishermens	**74.377**	70.736	91.135	61.334	57.504	115.716	90.691	74.984
INFLOW	75.639	70.639	91.535	57.129	55.658	115.341	88.629	73.893
INFLOW1	76.803	70.774	91.308	57.601	55.552	115.418	90.616	73.001
INFLOW2	**72.96**	69.761	91.535	62.35	56.704	115.865	90.616	74.273
INFLOW3	76.651	70.711	87.064	62.202	56.437	115.963	88.931	72.063
INFLOW4	78.284	70.388	89.08	62.051	57.999	115.883	87.654	72.839
X	*77.766*	70.68	91.504	61.638	57.999	115.981	89.267	72.137
Y	*78.017*	70.602	90.649	62.342	57.816	115.836	89.996	73.603
UPW	78.369	67.51	88.768	60.601	57.345	116	90.25	73.16
SST	*78.463*	70.734	89.824	61.936	57.812	115.633	90.671	69.859
SST1	*77.794*	70.566	87.78	**49.804**	57.093	114.738	90.096	68.941
SST2	76.817	69.85	**85.41**	59.969	57.988	115.87	87.657	72.336
SST3	*78.488*	70.763	86.25	62.269	57.957	115.592	88.227	72.336
SST4	*78.382*	70.239	91.524	62.182	57.911	115.902	90.708	74.105
AMO	78.234	70.753	90.855	61.142	56	113.186	90.806	**64.961**
Effort & Inflow 2	**71.24**	-	-	-	-	-	-	-

Effort & Inflow2 | NAOI | SST | SST | Effort | NAOI | NAOI_W | AMO

Notes (Results)

- Decrease trends in landings is due to Pelagic Fish decrease (Small and Medium Pelagic; Other fish and Invertebrates fishes since middles 60ths and also L_BathyDemersal and L_BathyPelagics since middles 80ths)
- Markedly increase in the number of landed species in the last 30 years: allow redistribution of fishing effort over more species avoiding overexploitation of most commercial ones (making use of marine biodiversity)
- fishing down the deep "effect" ? : *Medium_bathyDemersal, Small_Large_BenthPelagic, L_BathyPelagics* fisheries and also Shrimp fisheries have been exploited heavy over the last 30 years) and consequently exploitation over long-life bottom Fucntional Groups species (more vulnerable species)
- Increase of the Biomass of higher top predator trophic levels (sharks & Large_Rays and Cephalopods) in the last 20-30ths - *"New" large scale Fisheries*

Acknowledgments: F. Leitão (SFRH / BPD / 63935 / 2009) is supported by a Post-Doc grant from the Fundacão para a Ciência e Tecnologia.

Time series analysis for tide-surge overlapping.

A critical analysis to understand the water exchange of a non-tidal coastal lagoon

The Mar Menor (SW Mediterranean Sea)

Time-series analysis in marine science and applications for industry. 2012

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Universidad Politécnica de Cartagena

Department of Chemical & Environmental Engineering

Introduction

The Mar Menor, **one of the largest (135 km2) Mediterranean coastal lagoons**, is located on the southeastern coast of Spain (37 38′ N, 0 42′ W) in a semi-arid region. It has a mean depth of about 4 m with a maximum of 6 m. It is separated from the Mediterranean Sea by a sand bar of 100 to 1500 m width with several narrow channels to the Mediterranean Sea.

Period 1	January-May
Period 2	May-September
Period 3	October-February

Table 1. Station 1 deployment periods

Fig 1. Ubication of the Mar Menor on the southeastern coast of Spain.

Five sea level sensor (RBR DR-1050) were deployed at 5 meter depth along Mar Menor and the Mediterranean sea between 2010 and 2012. For this study we have used the data measured in Station 1 (Fig. 1) in 2011.

The small sea level variations between the Mediterranean Sea and the lagoon is one of the main forcing factors of the water exchange and hydrodynamics of the lagoon. The Mediterranean tide have an amplitude of 11 cm and the lagoon about 4 cm (Fig.2), with a delay of 3 hours.

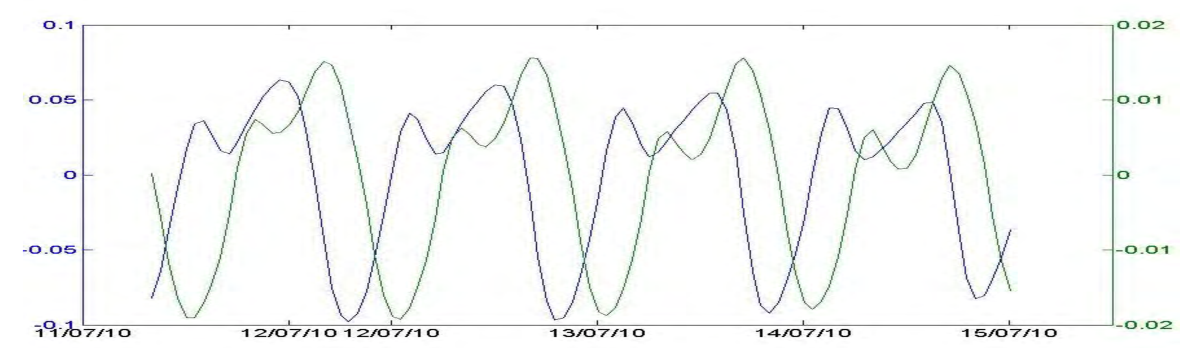

Fig 2. Tide obtained for Station 1 (blue) and Mar Menor lagoon (green)

Temporal tide phase shift

Table 2 show the main tide component calculated by the classic harmonic method, for each sampling period (Table 1). The **phase value change** *(Brown, 2012)* in each period due to :

- Changes in the sea level in shelf-sea could influence on the tide phase.
- The tidal interaction with other physical processes (i.e: Storm surge (Fig. 4)) can leave a strong tidal signal in the residual.
- In short records, might over-estimating the tidal content and under-estimating tide-surge interactions.

Every 15 days, the phase tide component and mean sea level was calculate for a 4 month time serie. The relation betwen sea level change and phase variation is show in Figure 3.

Wind events measured in El Mar Menor, ranging from hourly to one or two days, overlap with diurnal, semidiurnal periodicities. In the wind spectral density (Fig. 4) we can see two peak energy at diurnal and semidiurnal periodicities.

Phase Station1 (Degree)

	Period 1	*Period 2*	*Period 3*
O1	123.040	120.090	122.470
k1	163.330	151.780	156.100
N2	40.480	38.400	36.830
M2	51.250	50.910	51.460
S2	77.470	75.560	69.950

Table 2. Tide phase calculate by harmonic analysis for each period analysed.

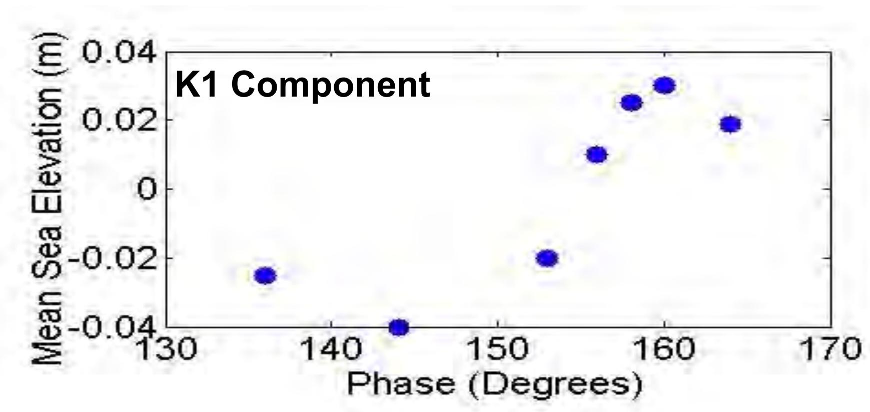

Fig 3. K1 Component and mean sea level calculated between 05/2011 and 9/2011 every 15 days.

Methodologies

Spectral analysis

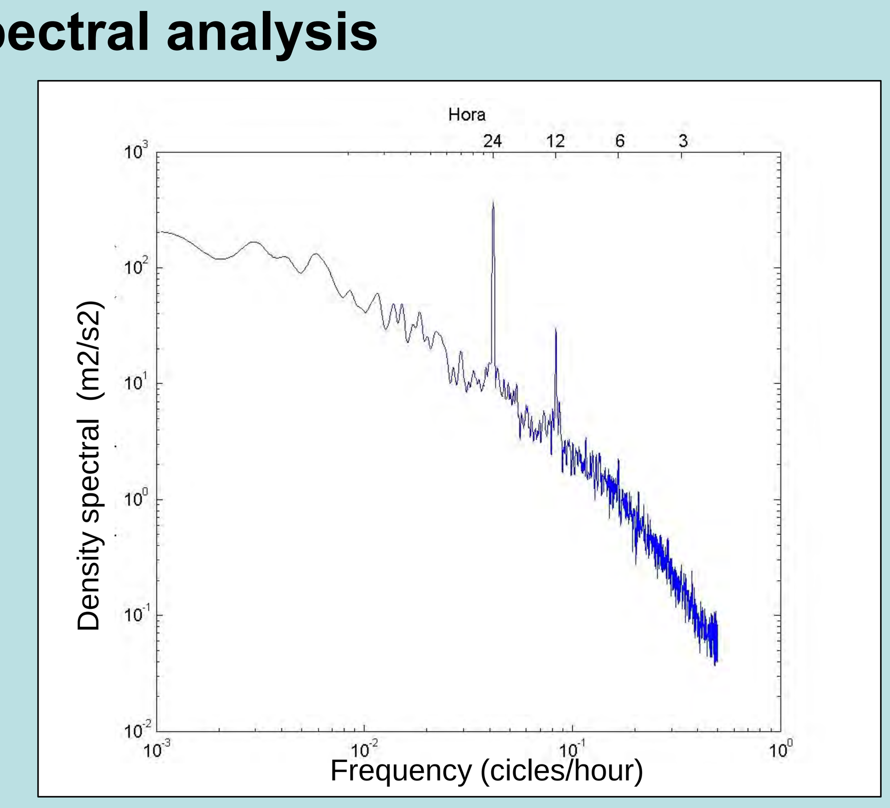

Fig. 4 Wind Spectral analysis.

Problem: The energy peak is continuos so it is dificult to identify only tide energy.

Filter techniques

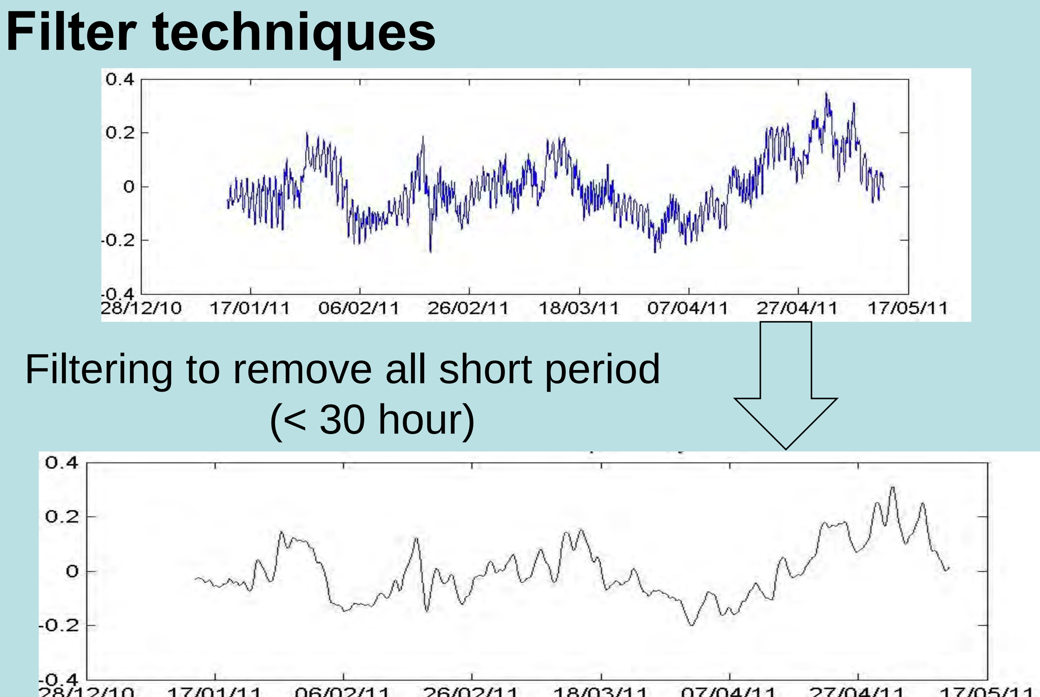

Fig. 5 Up, hourly sea level data for Station 1. Down, low pass filtered data.

Problem: Dificult to diference the tide and residual component with close frequency (Fig.4), overstimating the tide influence on the sea level.

Modeling simulations

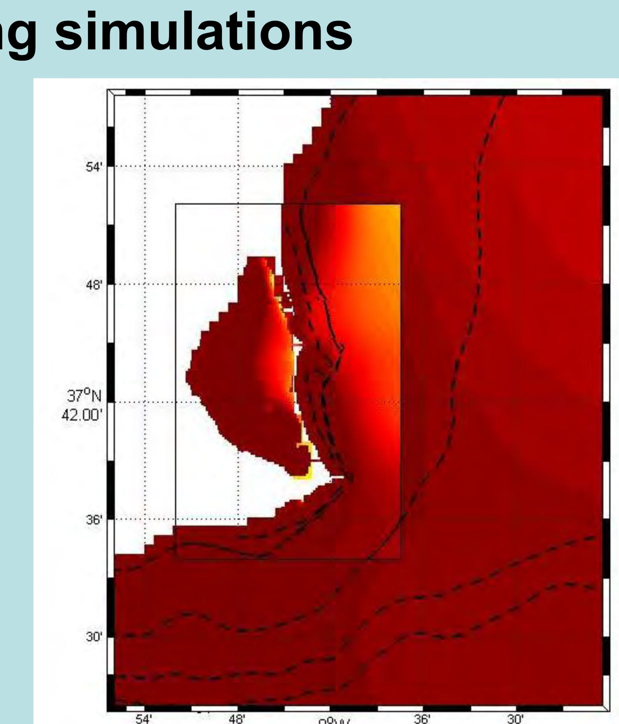

Fig. 6 Nested grid for the studied area.

Problem: Need a long term tide station near the study area and the capabilty to work with ocean models.

Conclusions

- **It is not easy to separate the tide and residual In the Mar Menor and adjacent Mediterranean sea due to overlapping phenomena.**
- **The classic harmonic analysis is not fully valid for short –term records in shallow-seas.**
- **The spectral analysed and filter technique do not remove completly the tide effect.**
- **Tide modeling allow us to remove near all the tide effect but it's a difficult technique and need a sea level long-term time series near our study area *(Brown et al. 2012).***

References

Extracting sea level residual in tidally dominated estuarine environments. Jennifer M. Brown, Rodolfo Bolaños, Michael J. Howarth and Alejandro J. Souza. Ocean Dynamics, Volume 62, Number 7 (2012), 969-982

Región de Murcia

Comunidad Autónoma de la Región de Murcia

Consejería de Universidades, Empresa e Investigación

Plan de Ciencia y Tecnología 2007-2010

Proyecto: "Sistema de Monitorización Costera para el Mar Menor"

Time-series analysis of the CO_2 dynamics in the Western English Channel using Voluntary Observing Ships (VOS)

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Introduction

The increase of atmospheric CO_2 due to anthropogenic activities is a major driver of climate change. Oceans absorb a large fraction of atmospheric CO_2 and act as a buffer by storing about a third of anthropogenic CO_2 emissions. Despite the relatively moderate size of continental shelves (7%) compared to the global ocean, these ecosystems play a significant role in the biogeochemical cycle of carbon and in oceanic uptake of atmospheric CO_2. The high biological activity occurring in the marginal seas, ranging from 15% to 30% of oceanic primary production, causes enhanced air-sea CO_2 fluxes. Because of the large diversity and heterogeneity of coastal ecosystems, a robust estimation of air-sea CO_2 fluxes in the coastal ocean at the global scale remains a challenge. High-frequency measurements using VOS lines or fixed stations become essential tools to unravel the CO_2 system dynamic in coastal ecosystems.

Study site

- The Western English Channel (WEC) is part of one of the world's most expanded margin, the North-West European continental shelf.
- Characterized by relatively shallow depth and by intense tidal streams.
- Hosts three different hydrographical structures:
  - All year well-mixed (southern WEC)
  - Seasonally stratified (northern WEC)
  - Thermal fronts structures.

Data acquisition

- The VOS is the *Armorique* ferry (BAI).
- A Ferrybox system records pCO_2 and ancillary data on the *Armorique* since 2011.
- The ferry can cross the WEC up to 3 times a day between Roscoff and Plymouth (Fig. 1).
- VOS allows a high spatio-temporal coverage.
- ASTAN is a complementary mooring for high-frequency times-series (Fig.1) of similar parameters as the VOS.

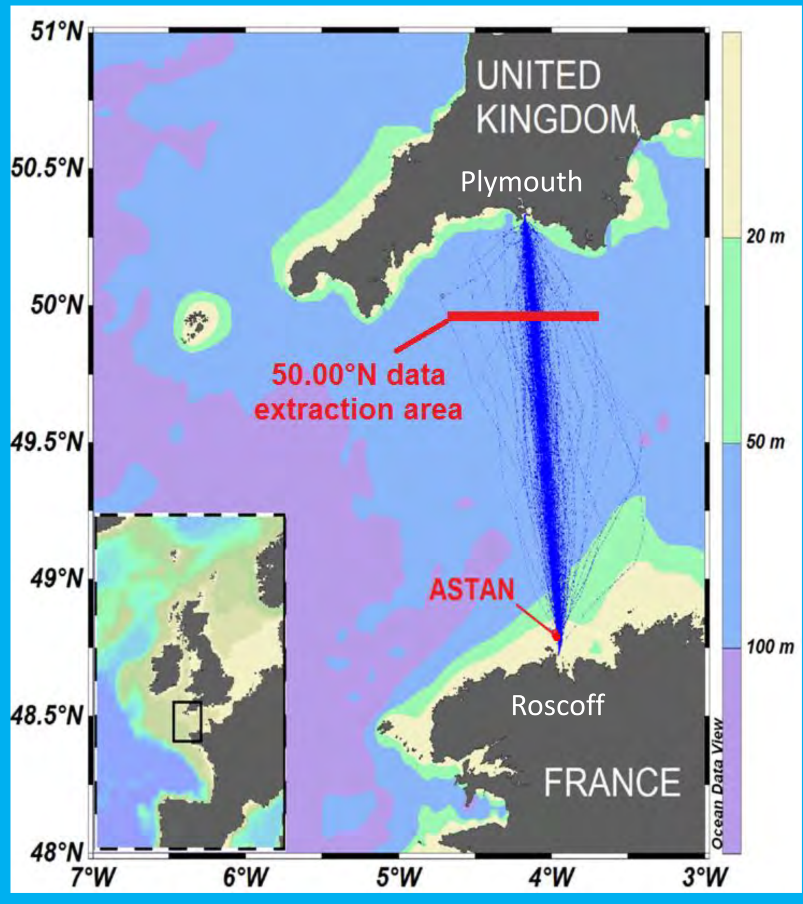

Figure 1. Map and bathymetry of the study area with the tracks of all crossings made between the 25/04/2012 and the 10/08/12 with locations of the ASTAN buoy and the 50.00°N fixed point data extraction.

Sensors calibration

- The FerryBox system is engineered by -4H- JENA, runs on a Labiew environment and is equipped with the following sensors :
  - Sea Bird SBE 38 (*in-situ* seawater temperature).
  - Sea Bird SBE45 thermosalinograph (inside the seawater circuit)
  - ANDERAA Optode 3835 (dissolved oxygen concentration)
  - Turner C3 (fluorescence, turbidity, CDOM)
  - CONTROS HydroC™/ CO_2 FT (seawater partial pressure of CO_2 (pCO_2).
- Sensors are calibrated bimonthly with discrete measurements during return crossings on the ferry (Fig. 2).
- Similar calibration are performed at ASTAN for the Sea Bird SBE43 (dissolved oxygen concentration).

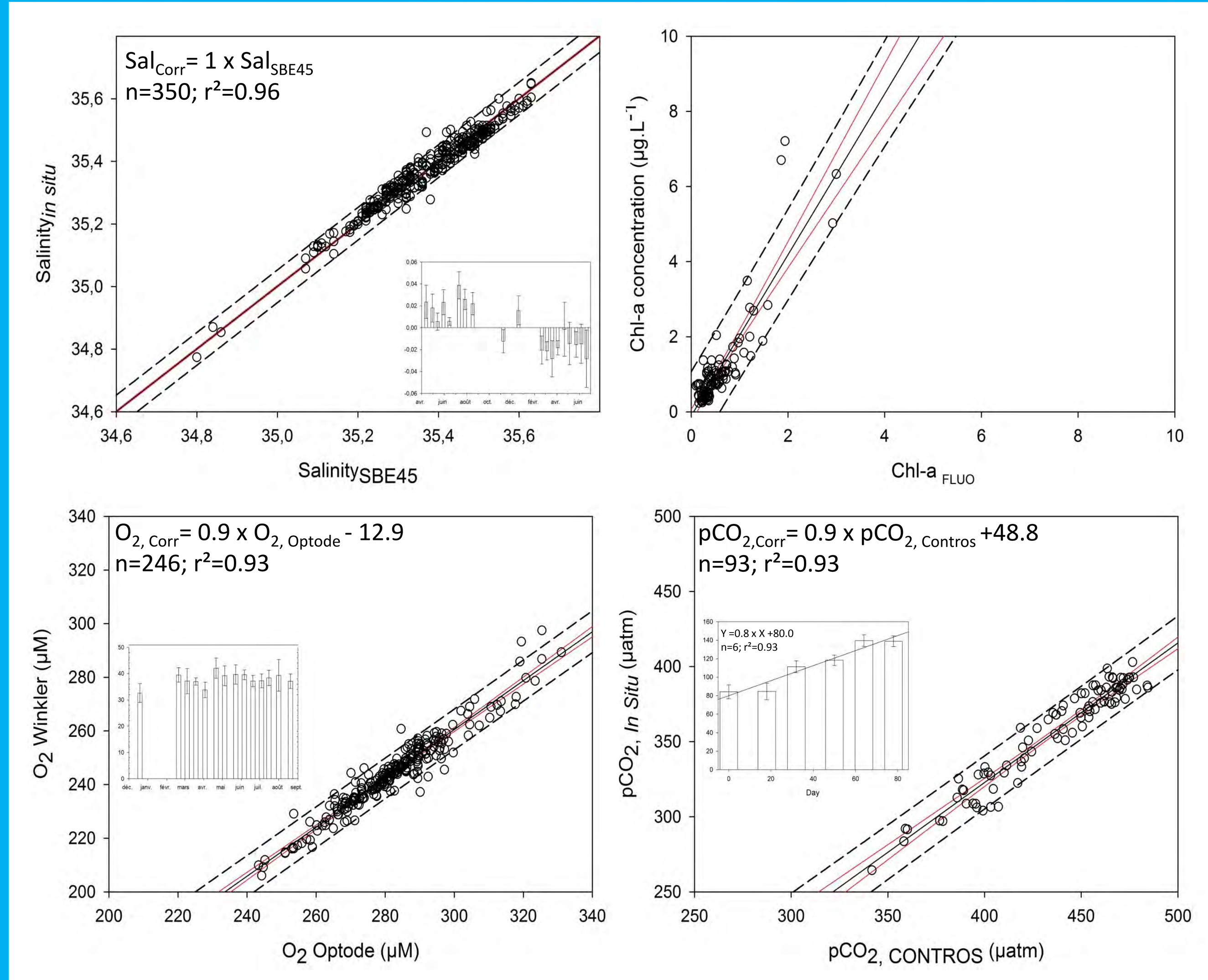

Figure 2. Calibration of the sensors installed on the FerryBox with discrete measurements. The inserts show the absolute difference between discrete measurements and sensor values during the period of study. Red lines : Confidence interval at 95 % Dash lines : Prediction interval at 95%. Discrete measurements were obtained with the following methods : portasal salinometer (salinity, ± 0.002), Winkler titration (oxygen, ± 0.5 µmol L^{-1}), fluorimetry (chlorophyll-a, ± 0.05 µg L^{-1}). The pCO_2 was calculated from TA/DIC analysis (± 5.8 µatm). $pCO_{2,\ CONTROS}$ was corrected from the temporal drift of the sensor based on this discrete measurements.

Surface Measurements of pCO_2 and ancillary data

- Northern WEC : Warmer than southern WEC (stratification). Higher biological activity. Lowest pCO_2 (Fig. 3).
- Southern WEC : Colder than northern WEC (mostly homogenous). Biological activity relatively low and homogeneous pCO_2.
- Strong relationship between DO%, Chl-*a* and pCO_2.
- pCO_2 mainly driven by the biology in the northern WEC and by the thermodynamic in the southern WEC during the period.

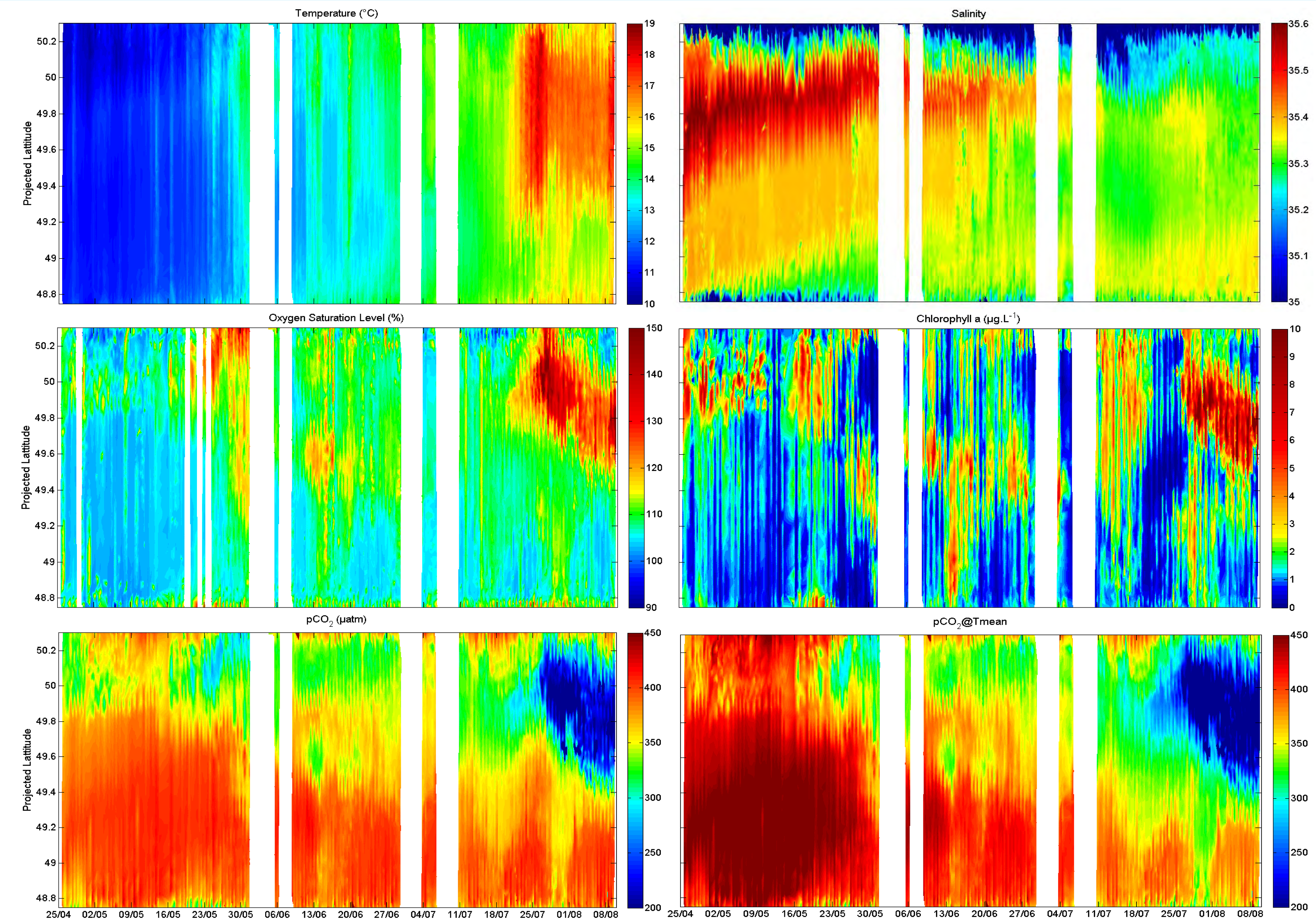

Figure 3. Surface distribution of temperature (°C), salinity, oxygen saturation level (DO%), Chl-*a* (µg L^{-1}), pCO_2 (µatm) and pCO_2 normalized (µatm) at the mean temperature of 13°C (pCO_2@Tmean) between Roscoff (48.7°N) and Plymouth (50.3°N) after sensors calibration.

Air-Sea CO_2 fluxes

- Northern WEC : net sink for atmospheric CO_2 (Fig. 4)
- Southern WEC : weak source of atmospheric CO_2
- Related to the higher biological activities observed in the northern WEC and to the thermodynamic control of pCO_2 in the southern WEC.

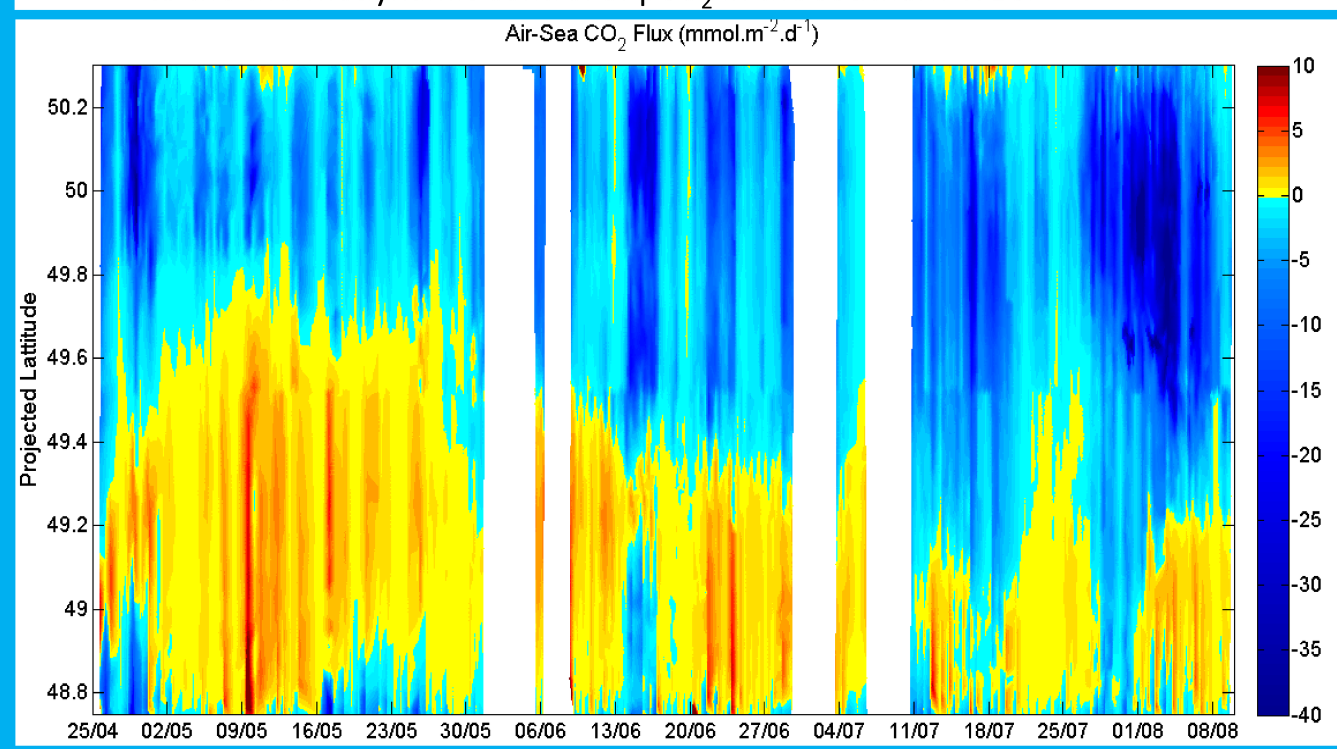

Figure 4. Air-sea CO_2 fluxes (in mmolC m^{-2} d^{-1}) between Roscoff (48.7°N) and Plymouth (50.3°N) computed from pCO_2 air-sea gradient using gas transfer velocity coefficient from Nightingale et al. (2000).

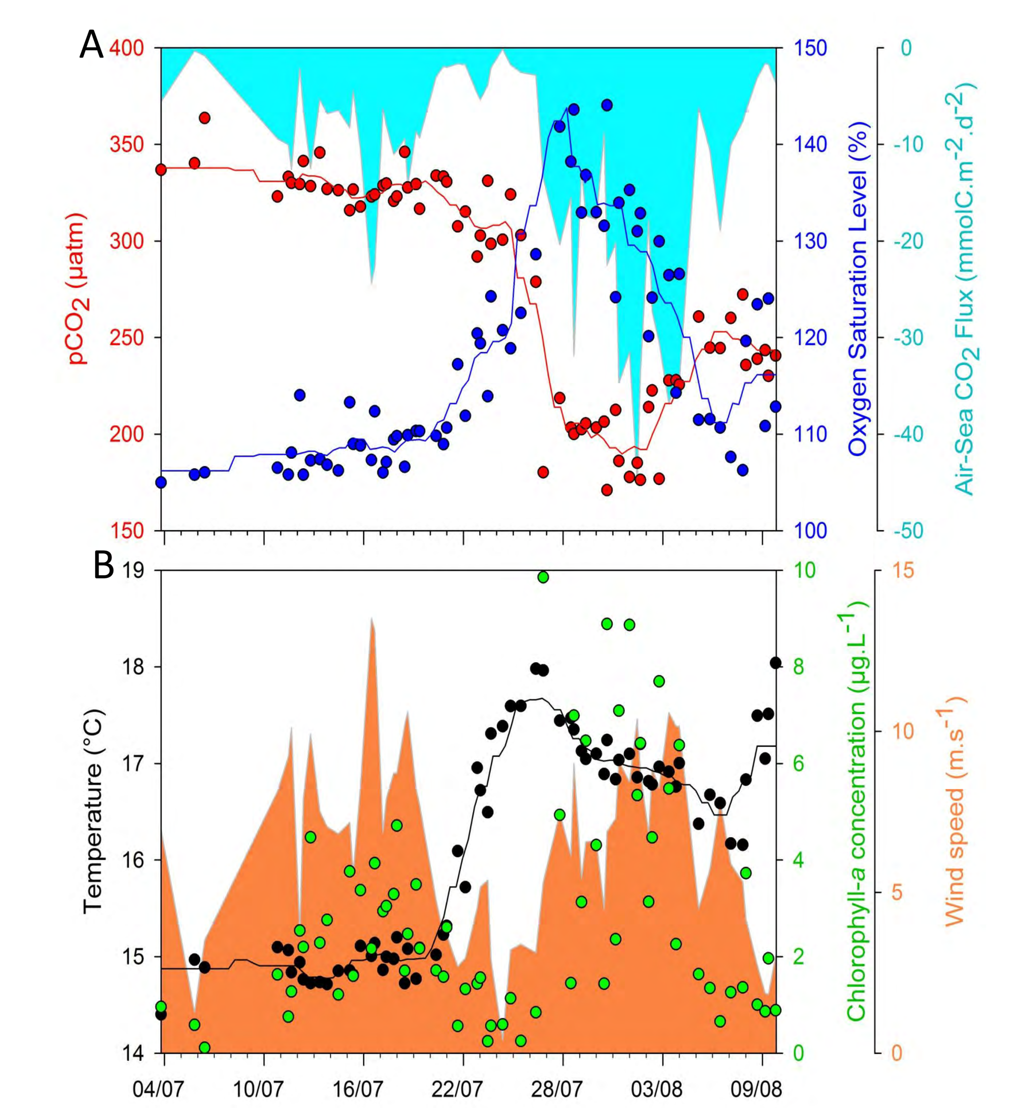

Figure 5. A) Variation of DO% (blue), pCO_2 (µatm, red) and air-sea CO_2 flux (mmolC m^{-2} d^{-1}, cyan area) and **B)** variation of temperature (°C, black), wind speed (m s^{-1}, yellow area) and Chl-a (µg L^{-1}, green). Red, blue and black lines are running average. Data were extracted at 50.00 °N (Fig. 1) from the 3/07/12 to the 9/08/12.

Fixed station approach

• At 50.00°N : Effect of a short scale phytoplancton bloom (Fig. 5)

- Before 22/07 : SST, Chl-*a* and DO% were relatively low for this period and pCO_2 was relatively high. From 10/07 to 22/07, the CO_2 sink (10-20 mmolC m^{-2} d^{-1}) was related to higher Chl-*a* and wind speeds.
- On 22/07 : Brutal increase of SST (+ 2.5 °C) was associated with drops in wind speed and Chl-*a*. DO% started to increase and pCO_2 to decrease. CO_2 uptake was low.
- After 22/07 : SST and wind speed were relatively high. We observed peaks of DO% (up to 140 %) and of Chl-a (up to 10 µg L^{-1}) and a drop of pCO_2 (down to 200 µatm). CO_2 uptake was high (close to -40 mmolC m^{-2} d^{-1}) due to low pCO_2 values and the high wind speeds.

• At the fixed buoy ASTAN : Effect of the tidal cycle (Fig. 6)

- The fixed buoy ASTAN allows to observe continuously the DO% variation.
- The strong daily DO% variations were related to the tidal cycles (low tide – max DO% / high tide – min DO%).
- As seen previously, pCO_2 is strongly related to DO%, therefore pCO_2 and air-sea CO_2 fluxes might be highly influenced by the tide on a daily scale.
- The diel biological cycle was not the dominant process controlling the diurnal cycle as previously recorded in the adjacent Bay of Brest (Bozec et al., Mar. Chem., 126 (**2011**) 13-26).

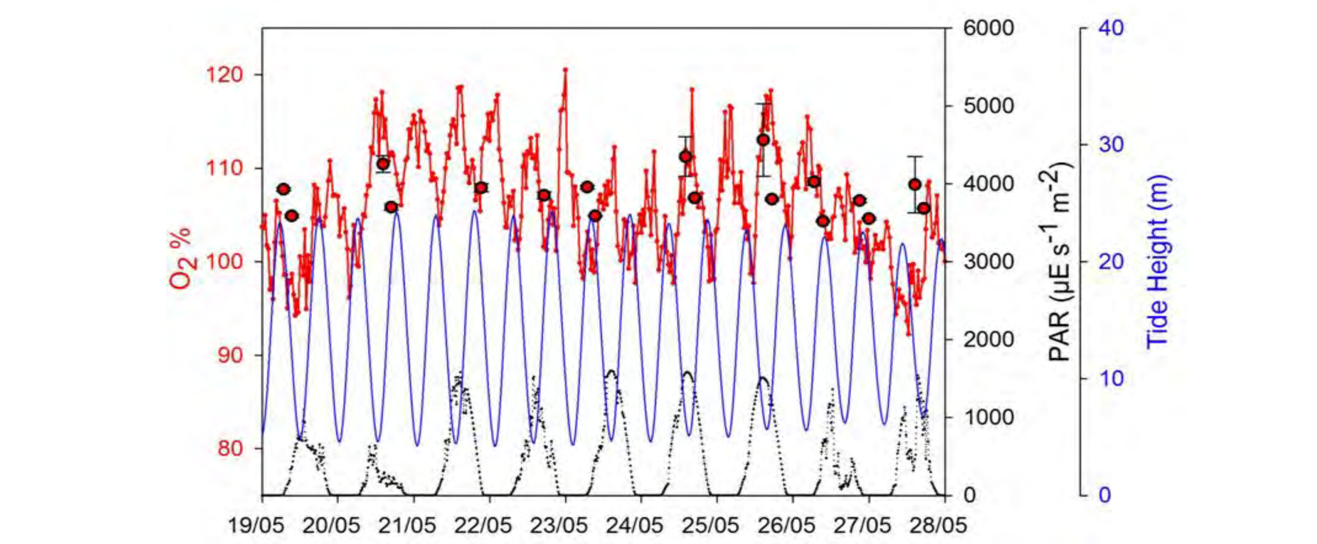

Figure 6. Variation of DO% (red line), tide height (in m, blue line) and PAR (in µE s^{-1} m^{-2}, black dotted line) at the buoy ASTAN and DO% (red points) for the FerryBox data extracted in the vicinity.

Conclusion

- Discrete sampling is essential to calibrate automated sensors.
- Continuous field deployment of high-frequency sensors necessitate careful and frequent maintenance.
- The VOS line allows an excellent survey of biogeochemical parameters variations throughout the year and identifying the different processes controlling the dynamics of the CO_2 system.
- VOS line data shows that short scale variability of air-sea CO_2 fluxes in the WEC is strongly influenced by sudden phytoplankton blooms.
- Time-series at ASTAN shows that the tidal cycle might dominate the CO_2 dynamic in coastal zones of the WEC.
- Combined approach, based on VOS line and time-series, is a valuable tool to unravel the variability of air-sea CO_2 fluxes from daily to inter-annual time scale in coastal ecosystems.

How to analyze time-series from *in situ* observatories ?
Example from the ANTARES telescope

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1- SCIENTIFIC CONTEXT

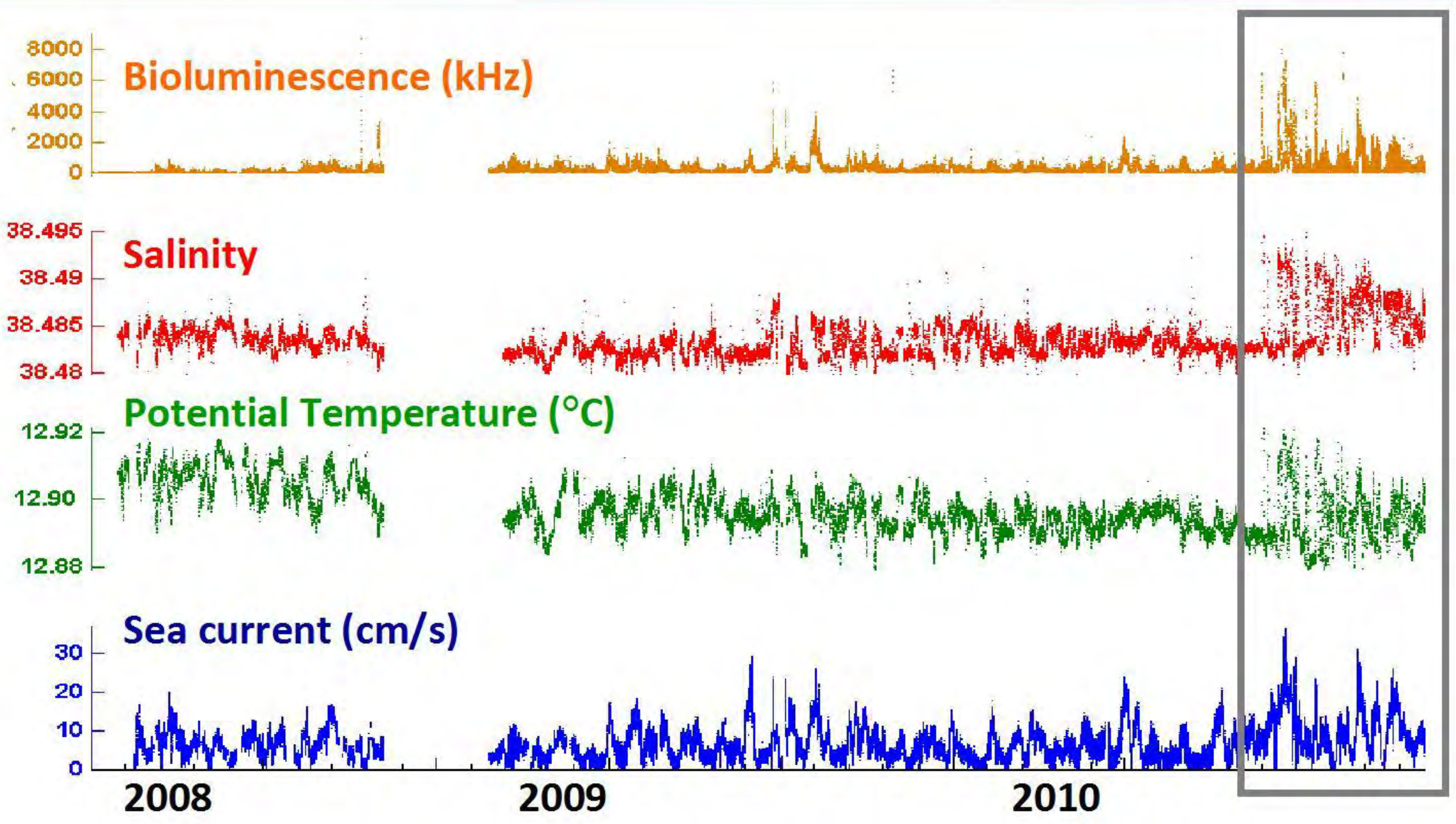


Fig. 1 : *In situ* dataset sampled at the ANTARES station showing a high intensity event in 2010.

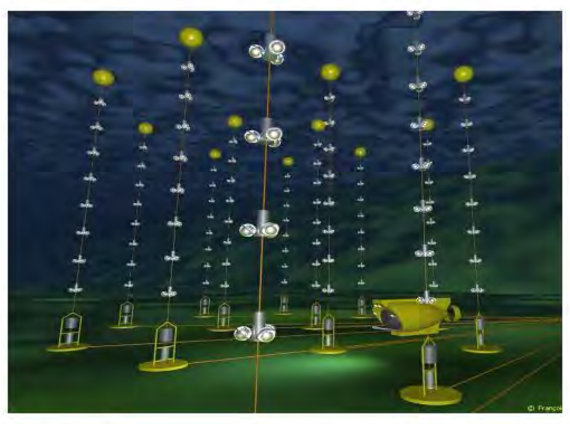


Fig. 2 : Representation of the ANTARES telescope.

Situated in the north-occidental Mediterranean sea, the ANTARES* neutrino telescope is also a deep cabled observatory. An unanticipated application is to provide a direct method of examinate *in situ* bioluminescence from deep marine organisms, between 2200m and 2500m depth.

High bioluminescence intensity periods have been detected mainly in 2010 and seems to be attributed to major water-mass changes due to winter convection.

* Astronomy with a Neutrino telescop and Abyss Environnemental RESearch

How is the bioluminescence linked to environmental variables ?
How to correlate oceanographic data and bioluminescence ?

2- TIME-FREQUENCY ANALYSIS

Environmental datasets are commonly defined as non-linear and non-stationary, meaning that statistical properties depend on time. Two time-frequencies methods are more efficient to understand these particular dataset.

Hilbert-Huang decomposition

Analytic signal

With X(t) time series

$$Z(t) = X(t) + iY(t) = a(t)e^{i\theta(t)}$$

Hilbert transform

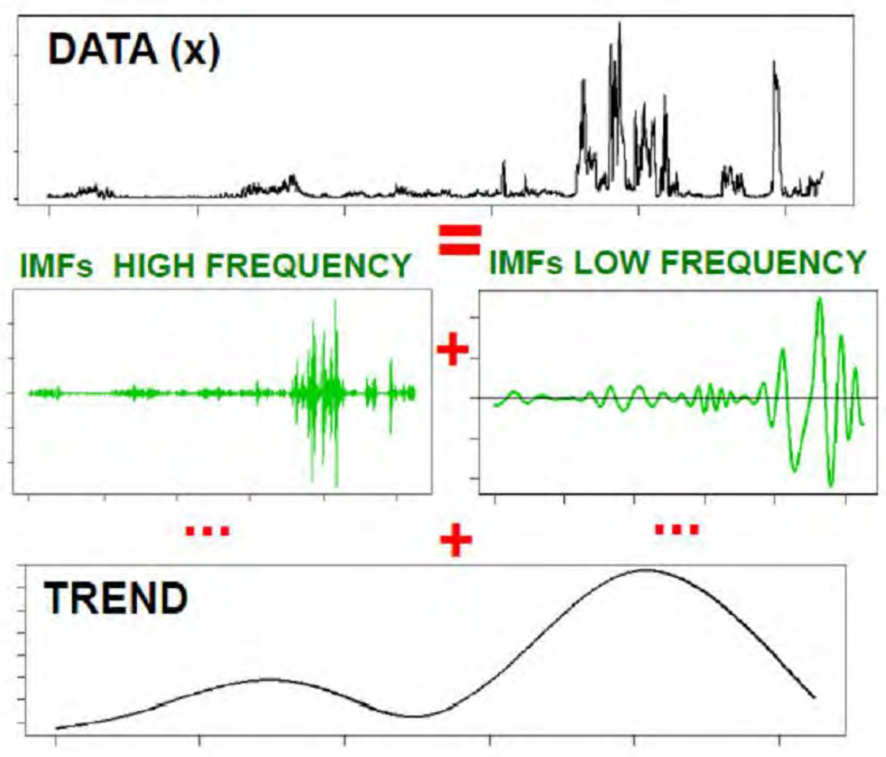
$$Y(t) = \frac{1}{\pi} P \int_{-\infty}^{\infty} \frac{X(t')}{t - t'} dt'$$

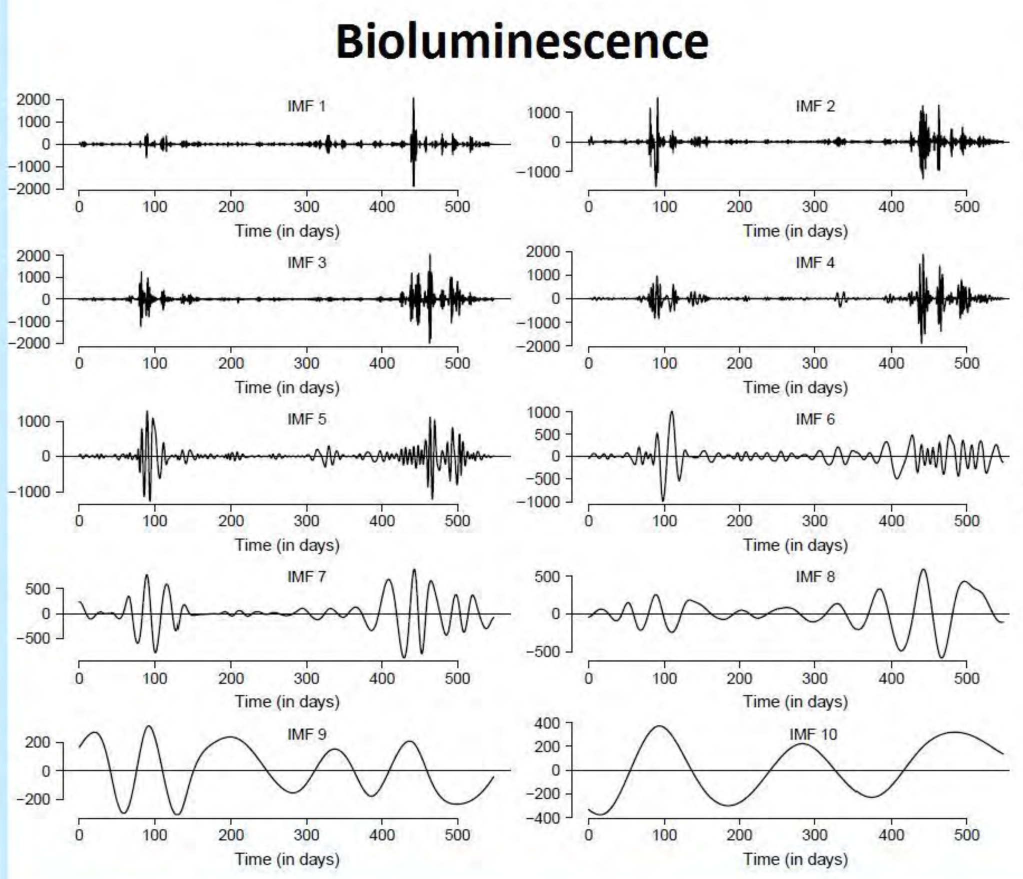
Instantaneous amplitude

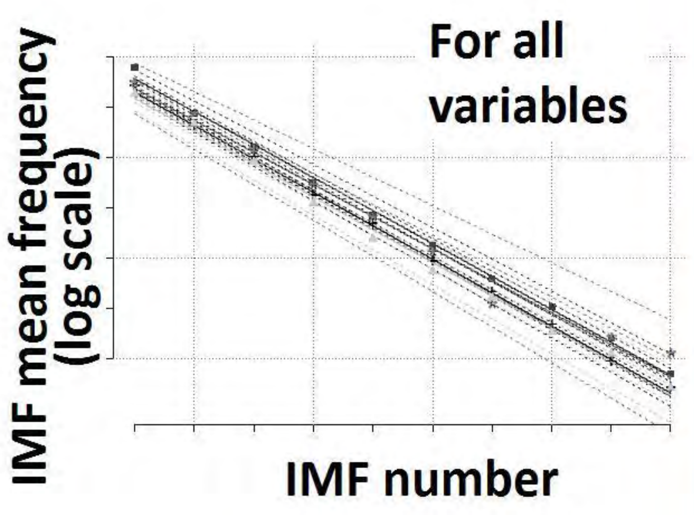
$$a(t) = [X^2(t) + Y^2(t)]^{1/2}$$

Instantaneous frequency

$$w(t) = \frac{d\theta(t)}{dt}$$







Hilbert-Huang decomposition into functions (IMFs) as a dyadic filter

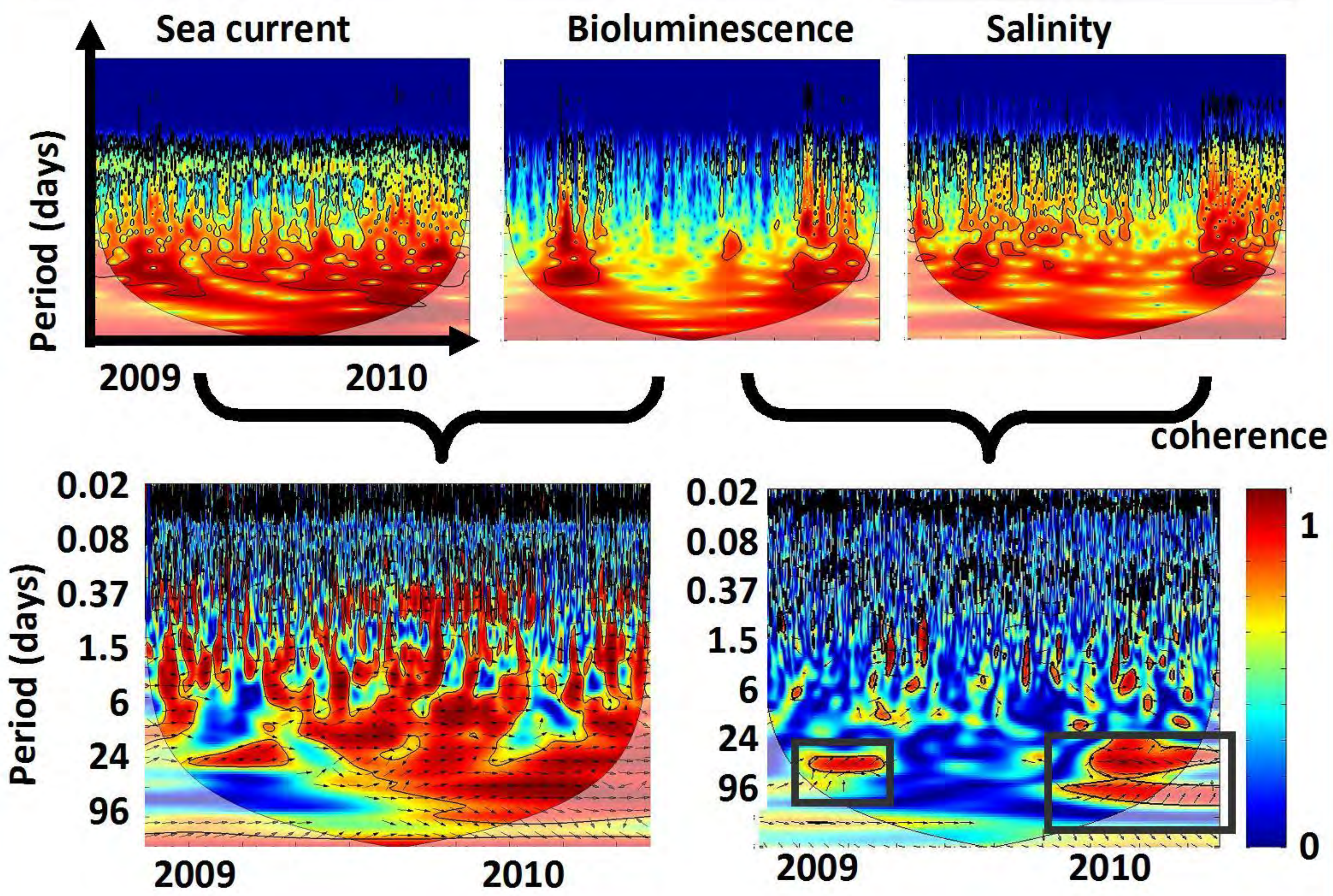
Wavelet decomposition

Continuous wavelet transform (CWT)

$$CWT(a,b) = \langle \psi_{a,b}; x \rangle = \int_{-\infty}^{+\infty} x(t)\psi^*_{a,b}(t; a, b)dt$$

$$\psi_{a,b}(t) = \frac{1}{\sqrt{a}}\psi(\frac{t-b}{a})$$

ψ : decomposition base
$\langle .,. \rangle$: inner product
$\psi(t)$: mother wavelet
a : dilatation coeficient
b : localisation parameter
$*$: complex conjugate form
$c = \frac{2\pi}{b}$: frequency
b : period.



High current velocity
=> bioluminescence

Mechanical stimulation of bioluminescence

New water masses (θ, S)
=> bioluminescence
→ Transport of organisms
→ Enrichment of the deep-sea (C, O_2 ...)

3- RESULTS and CONCLUSIONS

- **Wavelet :** (+) same bases decomposition, coherence coefficient possible; (−) choice for bases decomposition
- **Hilbert-Huang :** (+) adaptative bases on data; (−) no correlation between data

Time-frequency analysis give new insights for non-stationary datasets

Multi-annual Analysis of the Waves Time-series for Marine Regime Characterization in the Danube Delta Area

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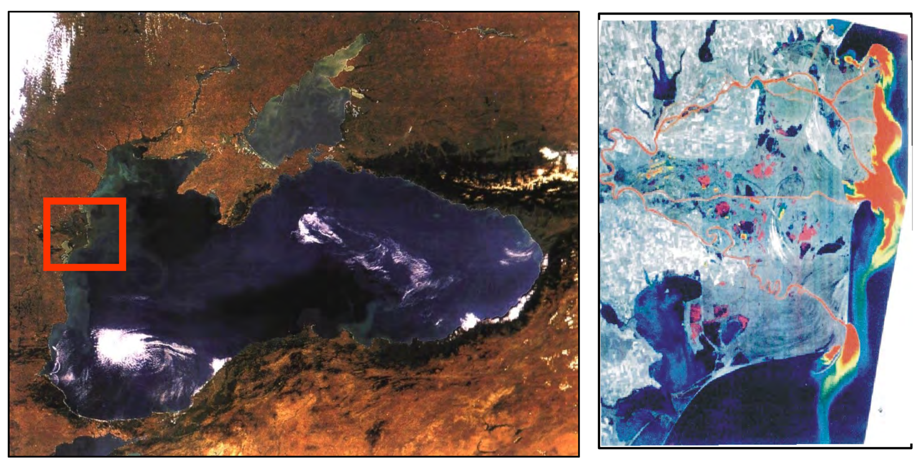
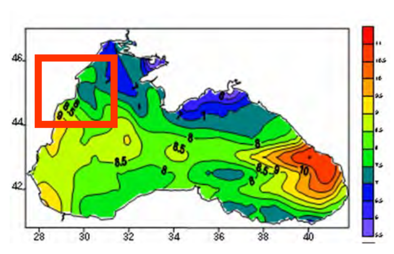
Introduction

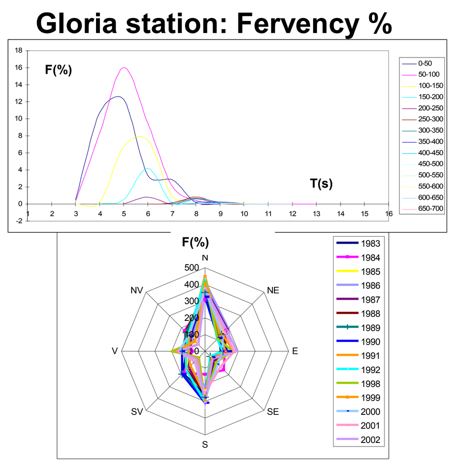
Coastal hydrodynamics processes induced in front of Danube River Delta, mainly affecting the safe navigation, but also human activities, in relation with the ecological impact of the sediment transport processes at regional scale. The analysis of multi-annual wave data recorded in an offshore and a series of coastal marine hydroelectric monitoring stations, as well as the data recorded in field expedition for hydro-geo-morphologic survey, show on short and medium term, the rapid evolutions of the main hydrodynamic parameters in of the wave regime in the adjacent areas of the Danube River mouths, and its impact on the coastal processes.

Black Sea - Danube Delta Area



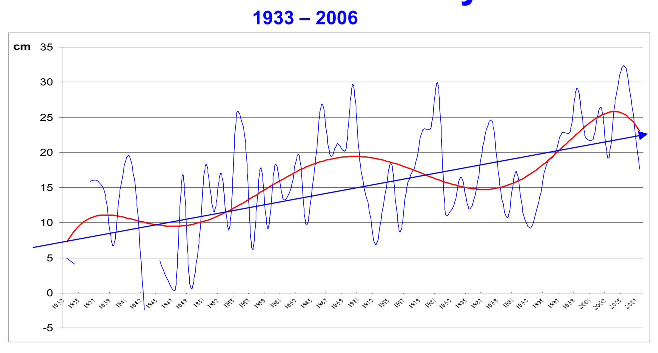
Waves regime



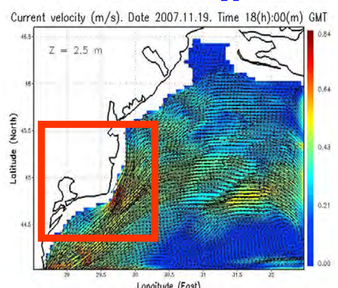


Sea-level variability

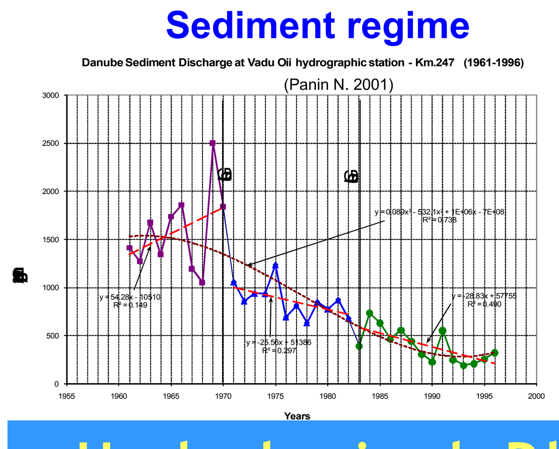
1933 – 2006



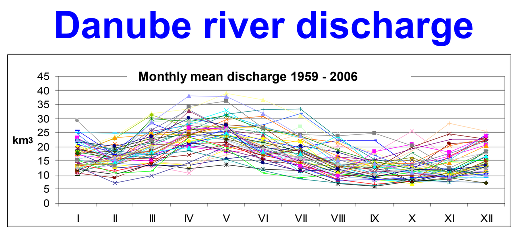
Currents regime



Sediment regime



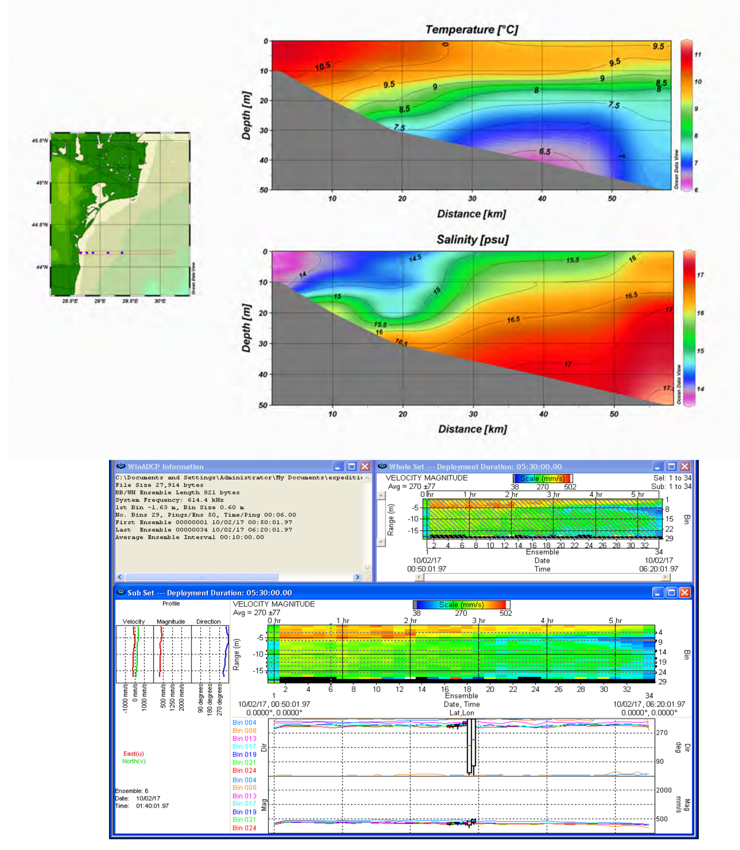
Danube river discharge

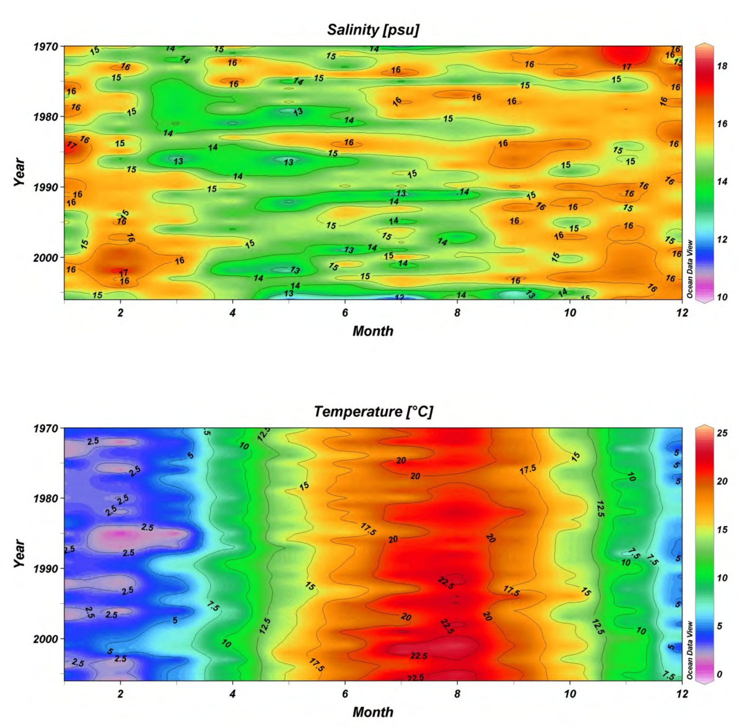


Hydrological, Physical, Chemical and Biological Monitoring Network

Romanian Monitoring grid - 44 stations
21 in coastal waters, 12 in transitional waters, 11 in marine waters
4 hydrometric stations - ADCP

Expeditionary vs. continuous monitoring data in Constanta Station





ODV - plots

Romanian National Oceanographic and Environmental Data Center - NOEDC

It is designated as a NODC in the context of IOC-IODE system. It was established in 2007 as a Department of National Institute of Marine Research and Development "Grigore Antipa"/NIMRD. The centre is officially recognized by UNESCO/IOC as Romanian Oceanographic Data Centre, replacing former Designated National Agency and is included in the list of world oceanographic data centers of IOC/IODE.

NIMRD DATA BASE is in developing stage under PostgreSQL system together with extension of a QC dynamic process for historical/all available data

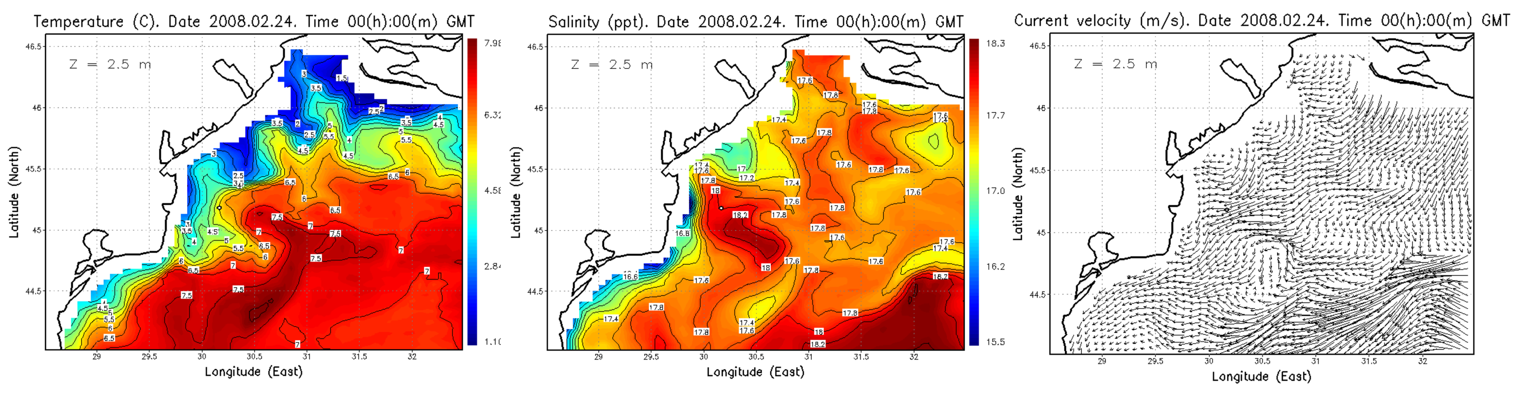
On-line access
At present, on-line data access is provided for the sea-level data: from Constanta MedGLOSS station no 28

BS Forecast System

North-Western Shelf zone regional model (NoWesReM)

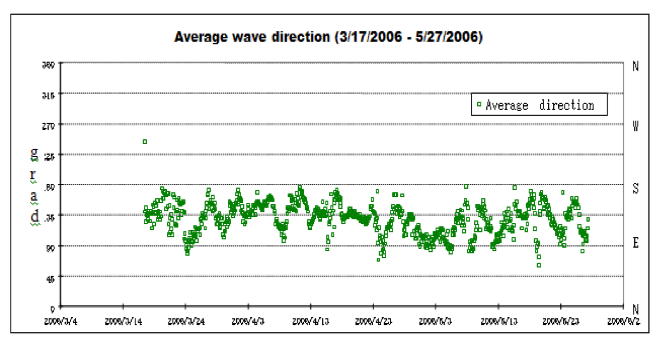
The Black Sea Regional Forecasting System (*Black Sea RNFS*) is developed in MHI. It consists of a set of high resolution regional models and is represented as the subsystem of Black Sea NFS. The *Black Sea RNFS* permits to monitor and to forecast continuously the state of the 5 coastal zones of the Black Sea.

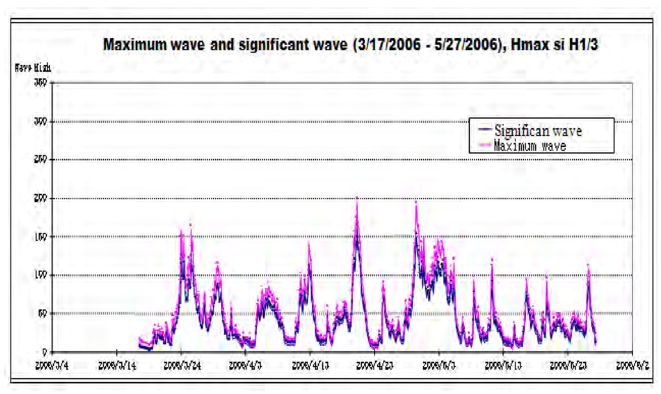
Regional Atmospheric Model (ALADIN Family) → Basin-Scale Circulation Model → Nearshore Regions Forecasting System



(NoWesReM) Numerical Model validation

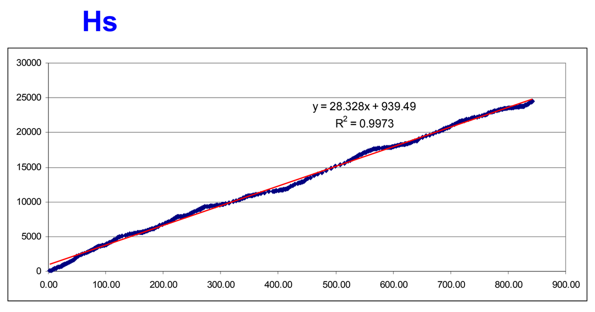
For sea current and waves monitoring, it uses four Acoustic Doppler Current Profilers: 3 ADCP Workhorse Sentinel 600 Hz used in fixed, underwater measurements locations or in oceanographic cruises.



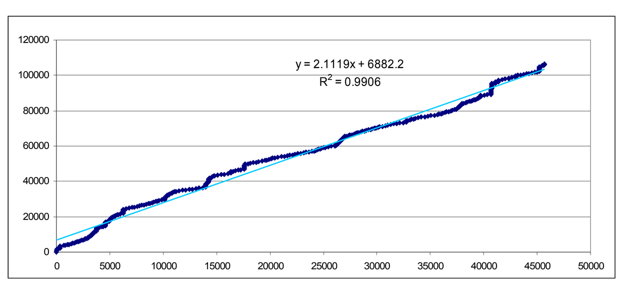


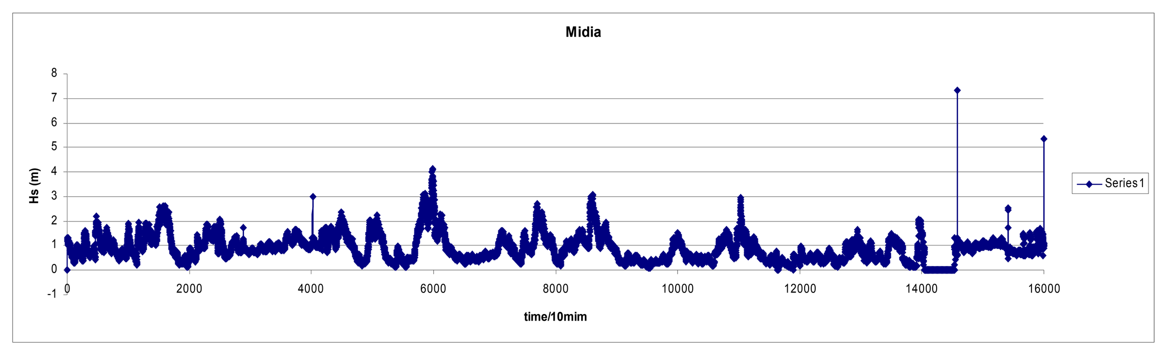
Data correlation between offshore and coastal stations

Hs



Wave Directions

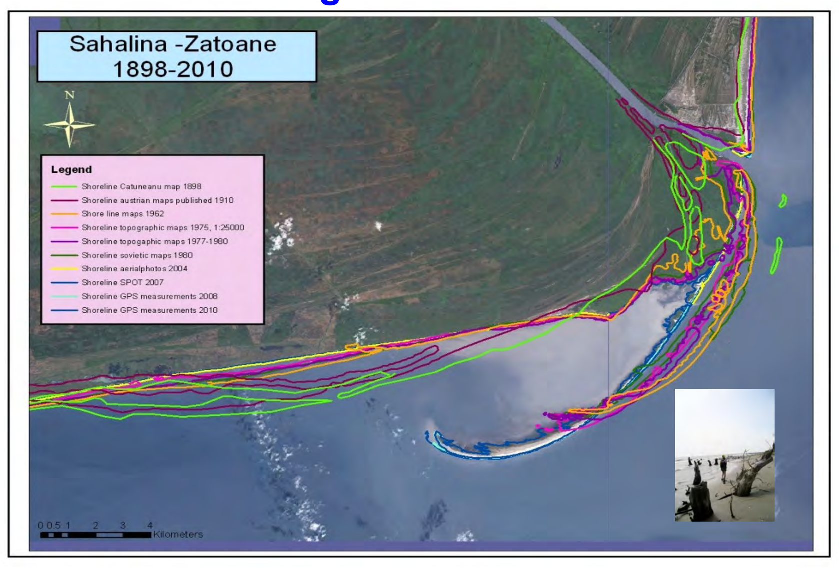




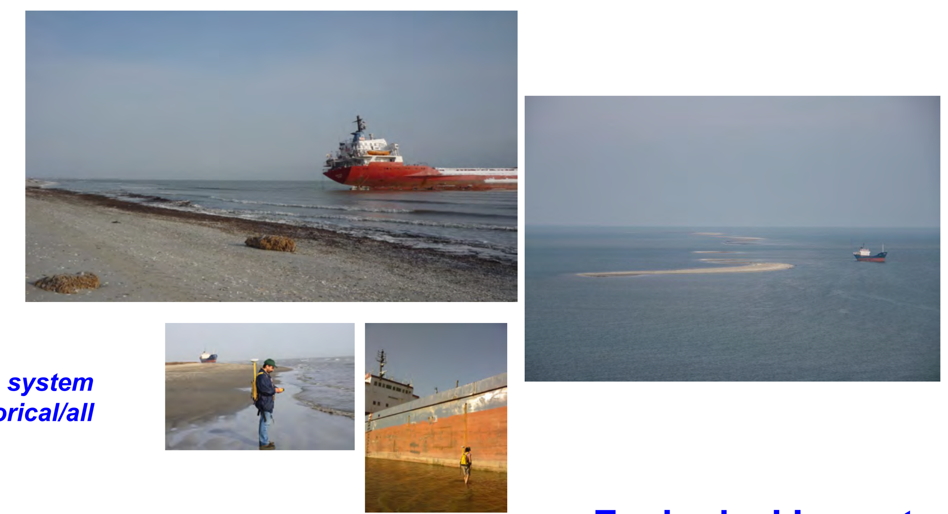
Analysis of model-data misfits reveals differences between the water mass properties/3D, permitting/resolving general circulation models against marine hydrological observations

Impacts on the coastal processes

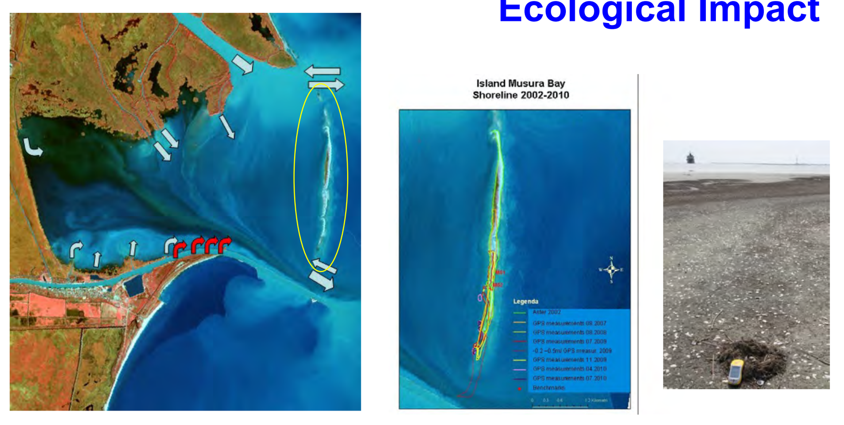
Shoreline change



Threatening Navigation on Danube Channel

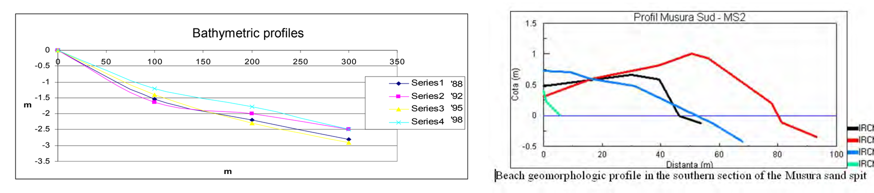


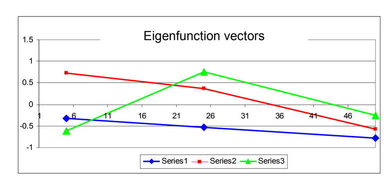
Ecological Impact



Ecological recovering techniques selections in Musura Bay

Coastal erosion - Cross-shore profiles variability

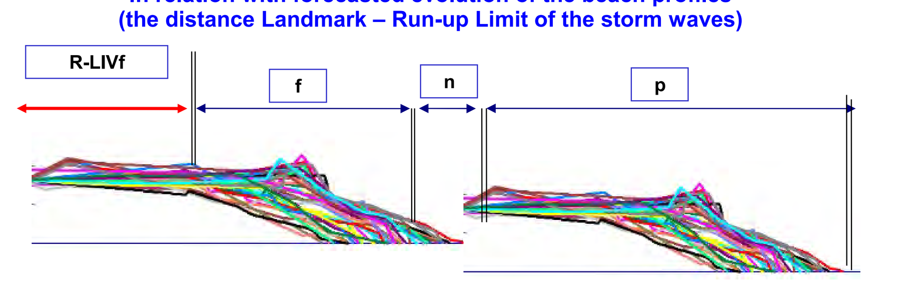




The Eigenfunction vectors shows the maximum variance of 4.537 (99.7%) in the small depth of the certain bathymetric profiles series in nearshore area

Setback delimitations at the sea-land interface

In relation with forecasted evolution of the beach profiles (the distance Landmark – Run-up Limit of the storm waves)



Historical shoreline changes (p), Dune line changes at storms event (f) and shoreline forecasted changes due to sealevel rise in the next 10 years (n).

Conclusions

- The Wind/wave regime in the Danube Delta Area, the main driving factor of hydrodynamical processes in the western BS Basin, is under the dominance of certain fast changes in the last decades; the extreme event occurrence is increasing gradually
- Danube Delta coast is a wave dominated, but the adjacent areas of the branches are strong influenced by sediments and river discharges (Danube hydrological regime).
- The variability of the wave regime is reflected by the shoreline variability and variance of the cross-shore profile at small depths; sand spits dynamics are extremely fast .
- The ICZM Implementation Process need to be improved consider the extreme events hydro-geomorphological studies:
  - Extension of the Masteplan for coastal protection (2011), Danube Delta Master Plan– spatial planning,Law projects dispute: Musura Bay Dredging vs. natural development (2012)

Acknowledgments: This work was supported by the strategic grant POSDRU/89/1.5/S/58852, Project "Postdoctoral program for researcher formation in the field of sciences", co-financed by the European Social Found within the Sectoral Operational Program Human Resources Development 2007 – 2013.

Variations in Air and Sea Surface Temperature at the Commodore Channel and Victoria Beach, Lagos Nigeria.

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Introduction

Nigeria, with a total area of 923,769sq km (land 910,768 and water 13,000sq km) is located between 4 and 14 latitude north and 2.30 and 14.30 degrees longitude east. The Nigerian Coastal environment consists of rich and diverse ecosystems, natural resources, and large human populations. The Nigerian coastal and marine area is a narrow strip of land bordered by the gulf of Guinea of the Central Eastern Atlantic in the South (CEDA 1997). The Nigerian coast and marine areas are under the influence of moderate oceanographic dynamics consisting of semi diurnal tides with tidal ranges varying from 1meter in the west to 3 meters in the east. The surface water off the Nigerian coast is basically warm with temperature generally greater than 24°c. The sea surface temperature show double peaked cycles which match quantitatively the cycle of solar heights. Between October and May, sea surface temperature range from 27°c – 28°c while during the peak rainy season of June-September the range is between 24°c-25°c. This decline has been attributed to an expression of the overall cooling of the South Atlantic and the Gulf of Guinea during this period of the year. (Longhurst, 1964).

The Commodore channel and the Victoria beach are important water bodies in the Lagos Coastal zone. The former being a major entry point of vessels into the Lagos port and the latter a part of the Atlantic Ocean and is a popular resort in the Lagos coastal zone.

Materials & Methods

Measurements of Air and Sea Surface Temperature at the Commodore Channel and Victoria Beach, Lagos Nigeria were carried out between January 2004 and December 2010. Sampling was carried out twice daily at 9 am and 2 pm. Air temperature was measured with the aid of mercury in glass thermometer; sea surface temperature was measured with the aid of mercury in glass thermometer placed in a temperature bottle.

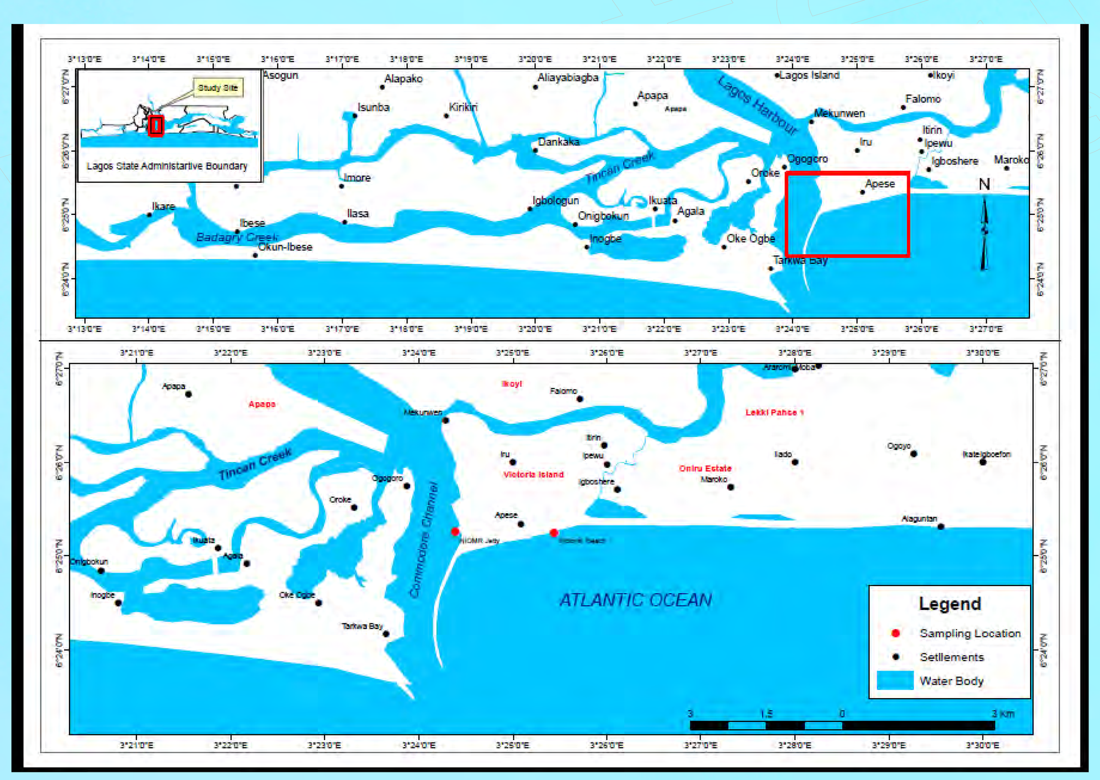

Fig 1. Map of Lagos State showing sampling sites.

Results

Results show that the highest and lowest air temperature recorded at the Victoria Beach over the sampling period was 31.42°C ± 0.86 and 24.83°C in January 2004 and August 2009 respectively. Sea surface temperature recorded at the Victoria Beach showed that the highest reading was 32.51°C± 1.09 in January 2006 and the lowest temperature was 25.39°C in August 2009. Temperature readings at the Commodore channel varied over the sampling period. The highest air temperature readings recorded was 32.06°C± 1.68in August 2006 and the lowest temperature was recorded in August 2005 with a value of 25.93°C± 1.94. Sea surface temperature at the Commodore channel showed that August 2006 had the highest temperature with a value of 33.14°C± 1.66, while the lowest temperature was 26.01°C, recorded in August 2009.

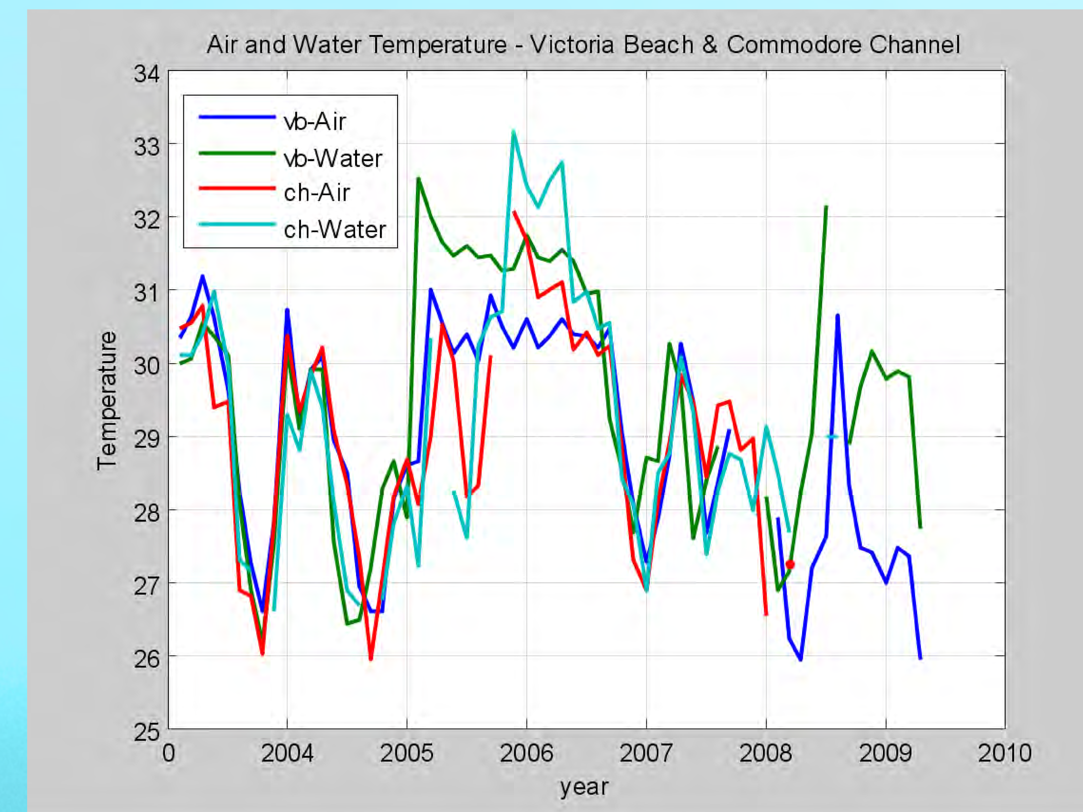

Fig. 2: Air & Water Temperature in Victoria beach & Commodore channel.

Temperature variability for both Air and Water in the vicinity of Victoria Beach and Commodore Channel. The temperatures are defined by the legend. vb=Victoria beach; cc=commodore channel.

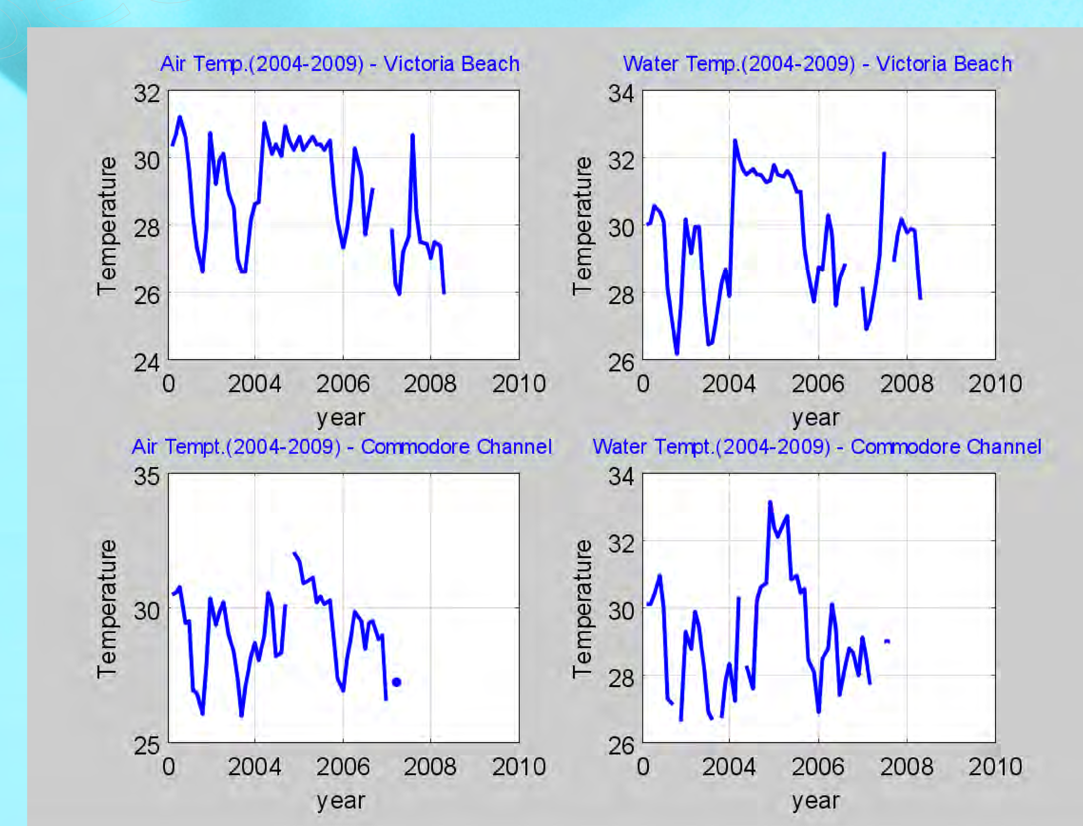

Fig 3: . Air & Water Temperature readings for Victoria Beach & Commodore Channel.

The air and water temperature for the different locations are plotted on the same figure (Fig. 3) for a quick overview picture of the temperature behaviour in these locations.

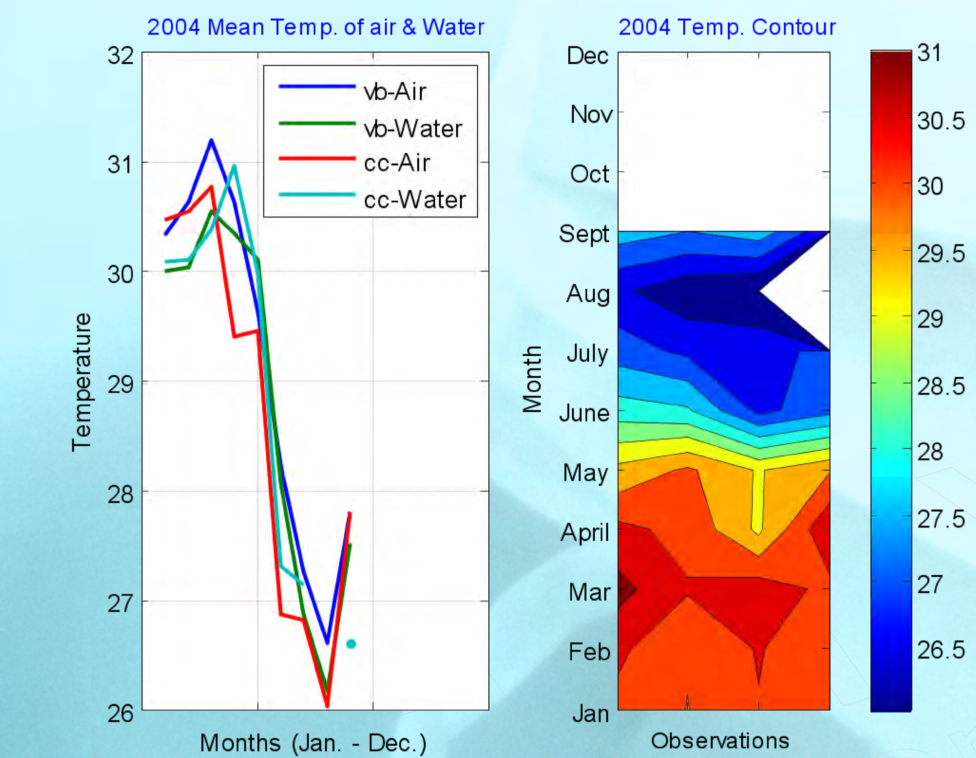

Fig. 4. Air & Water Temperature readings for Victoria Beach & Commodore Channel in 2004.

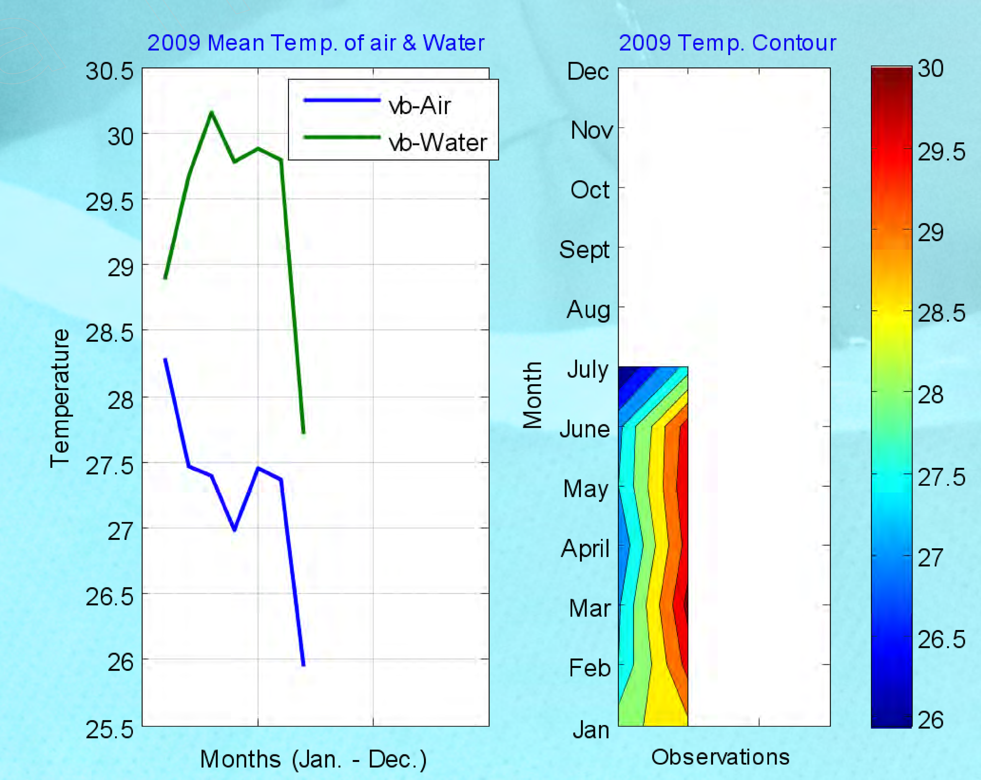

Fig. 5. Air & Water Temperature readings for Victoria Beach & Commodore Channel in 2009.

Conclusions

Aquatic ecosystems are critical components of the global environment. In addition to being essential contributors to biodiversity and ecological productivity, they also provide a variety of services for human populations, including water for drinking and irrigation, recreational opportunities, and habitat for economically important fisheries. However, aquatic systems have been increasingly threatened, directly and indirectly, by human activities. In addition to the challenges posed by land-use change, environmental pollution, and water diversion, aquatic systems are expected to soon begin experiencing the added stress of global climate change (Poff et al., 2002); Parameters that can be used to assess some of these impacts, particularly global climate change are temperature measurements.Temperature measurements are important parameters in Oceanography today, especially as it relates to climate change and species distribution in the aquatic environment. Temperature time series data gives an insight into the trend of temperature variations over a period of time. This information is useful in determining boundary conditions for atmospheric and oceanic models, as well as verifications of model outputs (Hosoda et al., 2006). Data on sea surface and atmospheric temperature from these sampling points will form an invaluable source of information in predicting trends in oceanography and its effects on the biodiversity in the Lagos coastal zone.

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Acknoledgements

The Nigerian Institute for Oceanography and Marine Research for providing the data used

EUROPÔLE MER for the travel grant

Using (S)ARIMA models to assess data-poor fisheries

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Data Poor Fisheries

- Present low diversity and/or quantity and/or quality of data (frequently only landings data)
- Present reduced information on the species biology and exploitation patterns
- Experience significant budget and staff constraints in research and management
- Can hardly be monitored with complex multivariate deterministic models

(S)ARIMA Models

- Univariate, simple and flexible
- Large statistical background (1978 -)
- >100 primary literature applications

SARIMA $(p,d,q)\times(P,D,Q)_S$

$$\phi(B)\Phi(B^S)(1-B)^d(1-B^S)^D X_t = \theta(B)\Theta(B^S)Z_t$$

where

$$\phi(B)=1-\phi_1B-\phi_2B^2-\dots-\phi_pB^p \qquad \Phi(B^s)=1-\Phi_1B^s-\Phi_2B^{2s}-\dots-\Phi_PB^{Ps}$$
$$\theta(B)=1+\theta_1B+\theta_2B^2+\dots+\theta_qB^q \qquad \Theta(B^s)=1+\Theta_1B^s+\Theta_2B^{2s}+\dots+\Theta_QB^{Qs}$$

and

$(1-B)^d(1-B^S)^DX_t$ is stationary

Statistical Process Control (SPC) framework for fisheries monitoring

- 1. Model available univariate data (e.g., fisheries landings) with (S)ARIMA.
- 2. Obtain monthly/annual predictions and determine their prediction intervals
- 3. Use prediction intervals as alarm thresholds in detecting changes in the data generating process

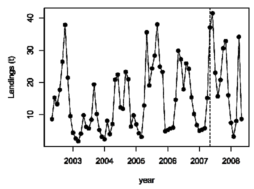
Multi-step Prediction Intervals

$PI_{ms,h} = \hat{x}_h \pm t_{df,\frac{\alpha}{2h}}\sqrt{PMSE_h}$ where $PMSE_h$ is the prediction MSE at step h

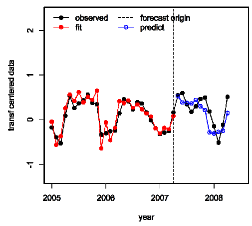
Case-study 1

Spp: Meagre
Area: Lisboa, Central Portugal
Fishery Type: Artisanal
Gear: Longlines and nets
Assessment/Monitoring: No
Data: 60+12 monthly landings
Model: SARIMA(0,0,5) x $(1,1,0)_{12}$

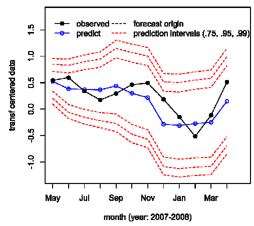
1.Data



2. Prediction



3. Monitoring

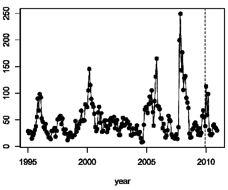


Conclusion:
Landings are in-control

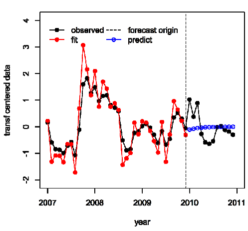
Case-study 2

Spp: Common octopus
Area: Santa Luzia, SE Portugal
Fishery Type: Artisanal
Gear: pots and traps
Assessment/Monitoring: No
Data: 180 +12 monthly landings
Model: ARMA (1,1)

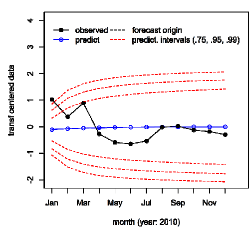
1. Data



2. Prediction



3. Monitoring

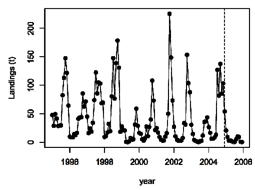


Conclusion: landings in-control!

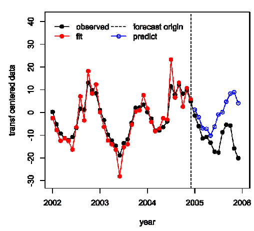
Case-study 3

Spp: Common squid
Area: NW Portugal
Fishery Type: Industrial
Gear: trawl
Assessment/Monitoring: No
Data: 108 +12 monthly landings
Model: SARIMA(4,0,2) x $(0,1,1)_{12}$

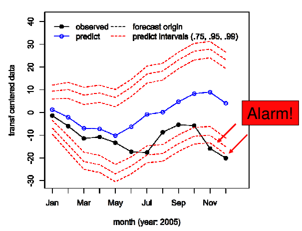
1. Data



2. Prediction



3. Monitoring



Conclusion: landings out-of-control!

Funding for this research was provided by FCT grant BD/12550/2003 to N. Prista, research project CORV (DGPA-Mare: FEDER-22-05-01-FDR-00036) and PNAB-DCF national Biological Sampling Programme.

Analysis of freak wave measurements in the Baltic Sea

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Introduction

Studies of sea waves in the Baltic Sea have a long history in Poland. The results of numerous projects have found applications in many fields, such as shore protection, design of maritime construction, etc. However, within past years numerous cases of large vessels accidents and offshore structures failures have been reported. In many of them the cause of the accident is believed to be individual waves of exceptional wave height or of abnormal shape. These unique and rare phenomena are called freak waves. They pose serious threats to large vessels as well as smaller ships. Such extremely large or freak-type waves deviate strongly in shape or in height from the average sea state, described by the usual integral parameters of significant wave height and peak period. Knowledge of freak waves is particularly significant and it requires much better understanding of extreme sea conditions. Some progress in that field can be achieved by the analysis of data sets containing reliable measurements. A unique set of time series of free-surface elevation records is available in the Institute of Hydroengineering of Polish Academy of Sciences, Gdańsk (IBW). It consists of measurements obtained by Waverider and Directional Waverider buoys located at several points placed along the Polish coastline of the Baltic Sea. The analysis of wave database comprising 20000 wind-wave records from the Southern Baltic revealed a large number of freak-type waves.

Input data

The measurements of free-surface elevation were conducted in the southern part of the Baltic Sea at three buoy stations located in the vicinity of Niechorze (Pomeranian Bay), Lubiatowo and in the Puck Bay. The measurements were performed using both Waverider (WR) and Directional (DWR) Waverider buoys. The locations of all measuring points are shown in Fig. 1.

Fig. 1. Chart of the coast of Baltic Sea and locations of buoy stations.

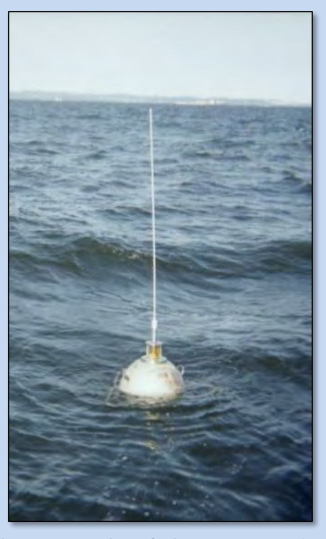
1. Niechorze - the buoy station was located in the eastern part of the Pomeranian Bay in the vicinity of the Niechorze village. It was about 6km offshore at the water depth 18m. Waves are generated there on the fetch limited by Bornholm Island and the West Baltic coastline.

2. Lubiatowo - the buoy stations at Lubiatowo were located in the middle part of the Polish coastline near Lubiatowo village. The coastline is straight there on a long section. A sea bottom is characterized by the presence of well-formed set of four longshore sand bars. Measurements were performed using the buoy located 1km offshore (water depth approximately 7m). There were also measurements conducted in another point located 7km from the coastline at the water depth approximately 20m.

3. Puck Bay - the buoy station in the Puck Bay was located about 6-7km offshore, where the water depth was approximately 15-16m. This Bay is a part of the Bay of Gdańsk which is separated from the Baltic Sea by the Hel Peninsula. Taking into account this specific geographical location, it can be assumed, that a wave field in the Puck Bay consists of waves coming from two different sources namely, waves generated on the short fetches in the Bay of Gdańsk and the waves generated on the long fetches in the Baltic Sea (Paplińska, 1995).

Measurements

Wave measurements were performed using initially the WR and next the DWR buoys made by Datawell (Fot. 1).



Fot. 1. A photograph of the Waverider buoy.

The Waverider buoy determines sea surface displacements by integrating acceleration measurements. The measurements are stored in a form of three files, including raw data, statistical and spectral parameters. The raw data file contains 20-minutes records of free-surface elevations measured with frequency 1.28 Hz. Each record consists of 1536 samples. The data are usually collected every 1-hour, and are normally assumed to represent a stationary sea state between measurements.

The statistical file comprises maximum, average or significant wave heights, maximum, average, significant wave periods, heights of crest and trough of successive waves and theirs period, etc. A "wave" is defined by applying zero up-crossings procedure. The wave height is the difference between the crest and the trough. The H_{max} is the highest wave in the record and the H_s is a significant wave height being an average of the highest 1/3 waves in a record. The wave direction is defined as the angle of the vector measured from geographical north clockwise – the direction where the waves are coming from. Measurements were taken every hour, and during storms, as often as it was possible. The analyzed results were treated using standard Datawell software and software developed in the IBW.

Data analysis

From the described foregoing measurement data sets, there were selected individual waves coming up the assumed criterion, on the basis of which the freak waves can be determined. Such waves in a case of the Baltic Sea were defined as:

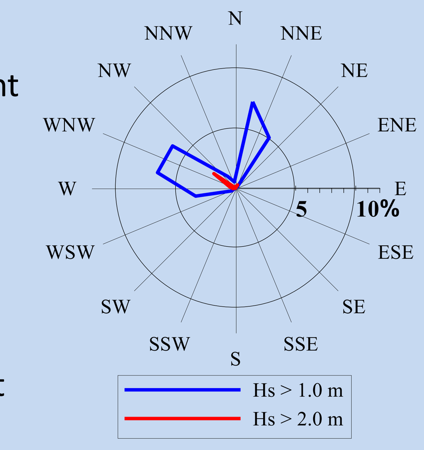
- waves exceeding twice the significant wave height $H_{max}/H_s>2$,
- significant wave height is larger than $H_s>1$m.

The application of this definition resulted in 414 extreme wave records, which is sufficient to perform a short-term statistical analysis. Most of records (330) come from Lubiatowo, 63 from Niechorze, and 21 from the Puck Bay. Extreme waves can be categorized into steep elevated waves occurring in a storm and episodic waves (Chien *et al*, 2002). It is obvious, that the above definition takes into account only the former one. However, no significant, episodic waves for the considered measurements periods and buoy locations have been observed. Some records of *in situ* measurements intrinsically involve biased data and "spikes". Thus, in order to remove data errors, it was necessary to perform a visual quality control of records. It was assumed that all points deviating more than four times the standard deviation of the free-surface displacement from the mean water level were rejected.

Freak waves formation and propagation depend on many factors as storm variation and duration or wave direction, for example. Most useful parameter describing a sea-state is the significant wave height. This parameter indicates the possibility of occurrence of the extreme wave and requires a special attention.

Niechorze

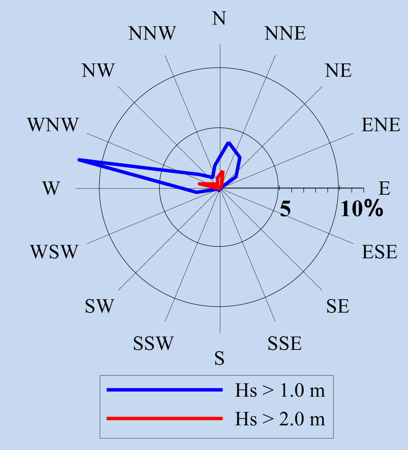
The wave rose for the area of Niechorze is presented in Fig. 2. (Wave rose of significant wave height exceeding 1m and 2m for measurements at buoy station. The mean direction is considered). The plot shows that waves with H_s greater then 1m come mainly from W-NW and N-NE direction. The maximum measured height of an individual wave was 6.5m and the highest significant wave height was 3.3m.



The significant wave height exceeding 1m occurred 37% of time and greater than 2m - 5%, respectively. The largest waves come from the NW direction.

Lubiatowo

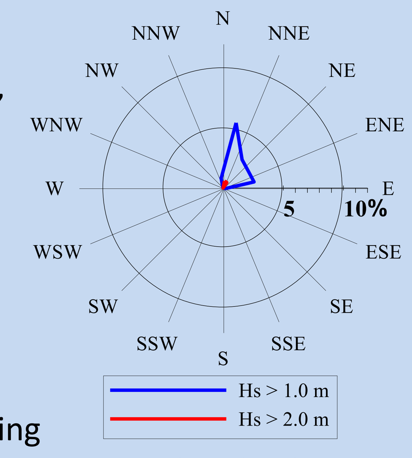
The wave rose for the area of Lubiatowo is presented in Fig. 3. It is seen that waves with H_s greater then 1m are coming mainly from W-WNW and N-NNE directions. The biggest measured height of an individual wave was 7.6m, the highest significant wave height was 4m. The significant wave height exceeding 1m occurred 29% and greater than 2m - 6%,



Respectively. It has been found that the majority of the largest observed waves came from the northern direction although some of them came also from the western direction.

Puck Bay

The wave rose for the area of the Puck Bay obtained on the basis of DWR measurements, is shown in Fig. 4. The plot shows the exceedence probability of wave height in different direction. It is seen in Fig. 4. that the waves with H_s greater then 1m are coming mainly from NNE-N directions. The maximum measured height of an individual wave was 6.1m and the highest significant wave height was 3.5m. The significant wave height exceeding



1m occurred 15% of time and over 2m 1%, respectively. The largest waves come from the N direction.

Some efforts have been taken to assess the effect of wave direction on the formation of individual freak waves and group of extreme waves. The analysis was conducted on the basis of data sets recorded at Lubiatowo buoy station in 2001. The time series of a sea wave mean direction and significant wave height are shown in Fig. 5. Extreme waves are pointed out by vertical lines.

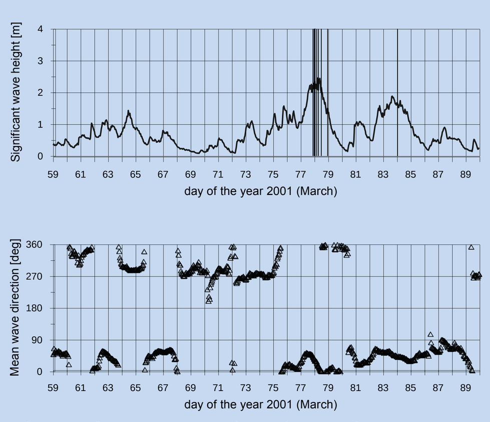


Fig. 5. Time series of significant wave height and sea wave mean direction.

Some typical extreme wave shapes and the spectrums corresponding to each record of extreme wave are shown in Fig. 6. In each case where the freak wave occurs, the wave spectrum is multipeaked.

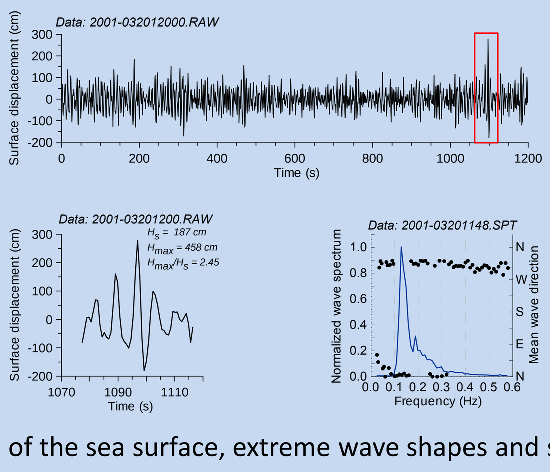


Fig. 6. Time series of the sea surface, extreme wave shapes and spectrum.

It should be emphasized that the above analysis was performed on the basis of limited data set. Thus, the deduced conclusions are of limited use, and cannot be generalized at this stage.

Statistical analysis

Statistical methods have been proven to be very useful in the analysis of wind wave records. In the present studies the statistical analysis was carried out for the entire set of data records. Then, more detailed analysis was performed for the Lubiatowo 3-year data sets and next for several selected extreme wave records.

Global statistics

An important statistical parameter characterizing random waves is the skewness. The skewness is closely related with wave steepness and is a measure of second-order wave nonlinearities (Stansberg, 1992). The relationship between the statistical skewness and the significant wave steepness for the wave records from Lubiatowo (2000-2002) is shown in Fig. 7. A positive and fairly strong mutual correlation is visible. It is also seen in Fig. 7 that the significant wave steepness of the largest waves exceeds 0.055, which is a typical value for severe strong storms. It should be noted, that although the significant wave steepness has no precise physical meaning, it provides useful information about sea state.

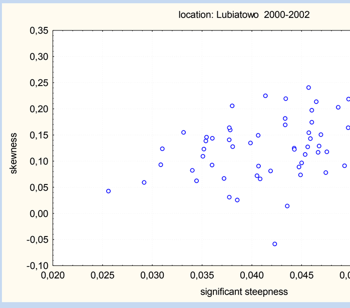


Fig. 7. Statistical skewness vs. significant wave steepness for records from Lubiatowo.

The significant wave steepness S_s and the coefficient of skewness γ_1 assumed in above considerations were defined as follows:

$$S_s = \frac{2\pi H_s}{g T_z^2}, \qquad \gamma_1 = \frac{1}{n}\frac{\sum_{i=1}^{n}(H_i - H_m)^3}{\sigma^3}$$

where:

T_z – mean wave period for a particular record, g – acceleration of gravity, H_m, σ – mean value and standard deviation of free surface elevation.

A useful parameter describing wave shape is the wave steepness. It was of some interest to analyze differences between the shape of ordinary and extreme waves. An adequate analysis was performed for the one-year set of data from Lubiatowo (2001). This set was chosen because of the greatest number of records. The change of the steepness in relation to the significant and the maximum wave heights is shown in Fig. 8. The plot shows that wave steepness tends to a constant value for severe storms disregarding whether extreme wave was present in the record.

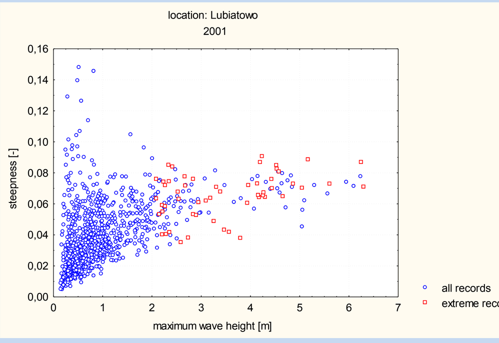


Fig. 8. Steepness vs. maximum wave height for records, Lubiatowo.

Statistics of selected records

More detailed statistical analyses were performed for several selected records. For Lubiatowo buoy localisation the record containing largest value of the maximum wave height and fulfilling extreme wave criteria was chosen. Selected time series for the highest ratio of the maximum and significant wave heights for Lubiatowo buoy location are plotted in Fig. 9 in the form of wave crest, trough and height envelopes. The time series of the record from Lubiatowo, characterised by the largest value of the H_{max}/H_s ratio, is shown in Fig. 10.

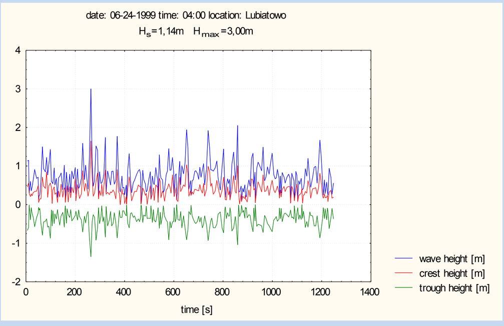


Fig. 9. Envelopes of the highest H_{max}/H_s ratio of record from Lubiatowo.

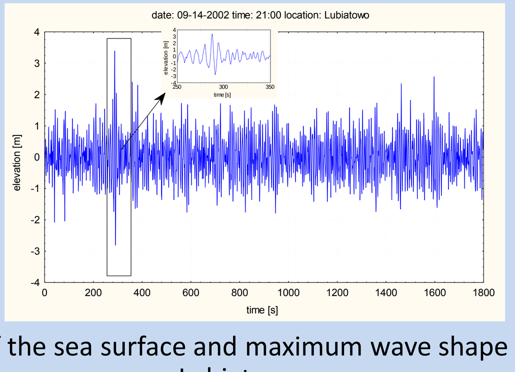


Fig. 10. Time series of the sea surface and maximum wave shape for the record from Lubiatowo.

Conclusions

The analysis of a unique set of wave data comprising 20000 wave records from the Baltic Sea disclosed a large number of freak-type waves. In this work a statistical analysis of time series of free-surface elevation recorded by Waverider buoys in the southern Baltic Sea is performed. The analysis focuses on individual extreme waves and wave events. It includes a wide range of aspects related with individual extreme waves to collect as much information as possible on their occurrence and features of extreme waves, and eventually to provide a contribution to a future warning system. The conducted analysis revealed novel and often surprising results of significant importance for scientists and engineers.

Acknowledgments

The authors are indebted to dr B. Paplinska for her valuable contribution to this study.

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Analysis of a high frequency time series of bio-optical properties in complex coastal waters: couplings with turbulence

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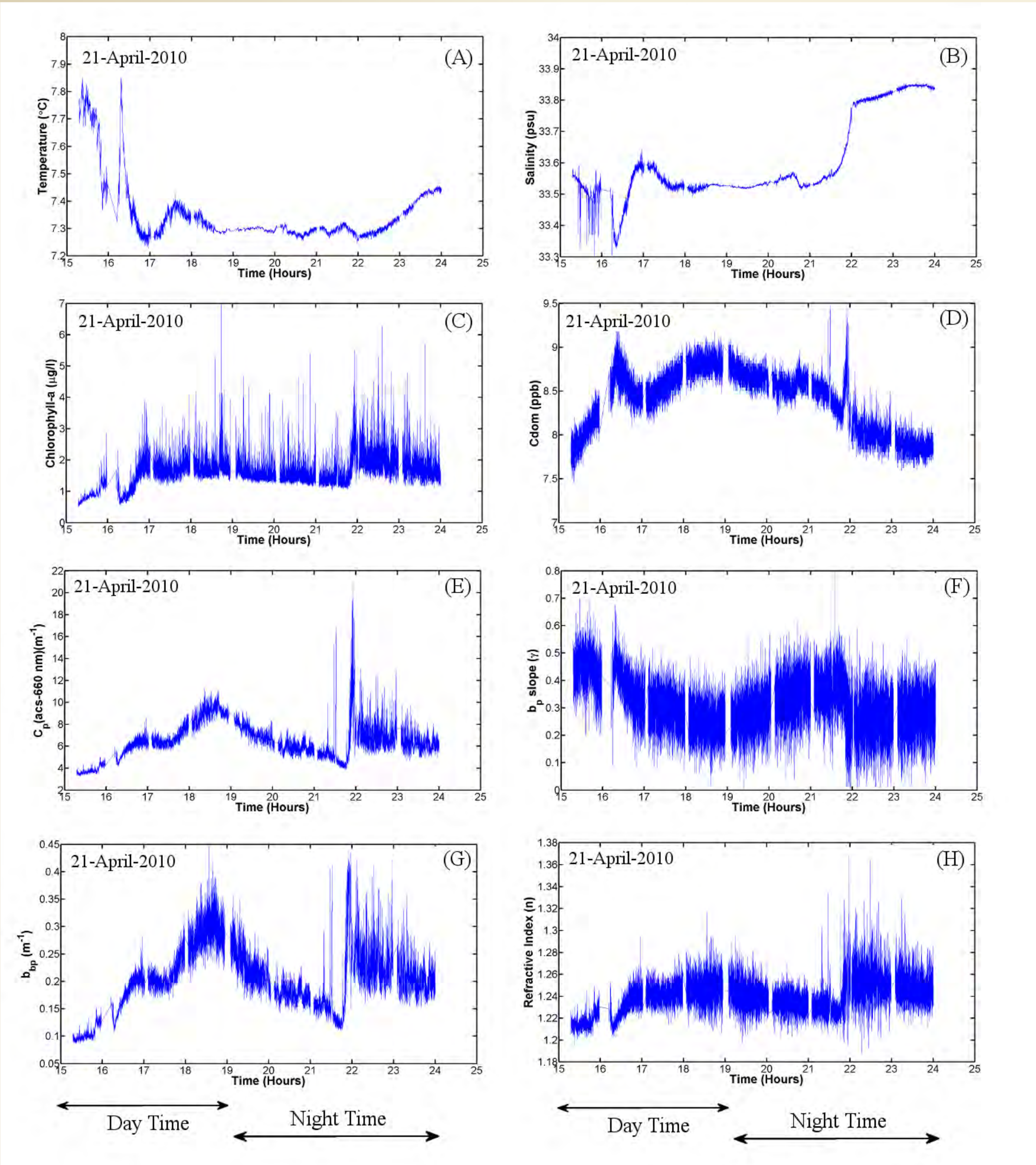
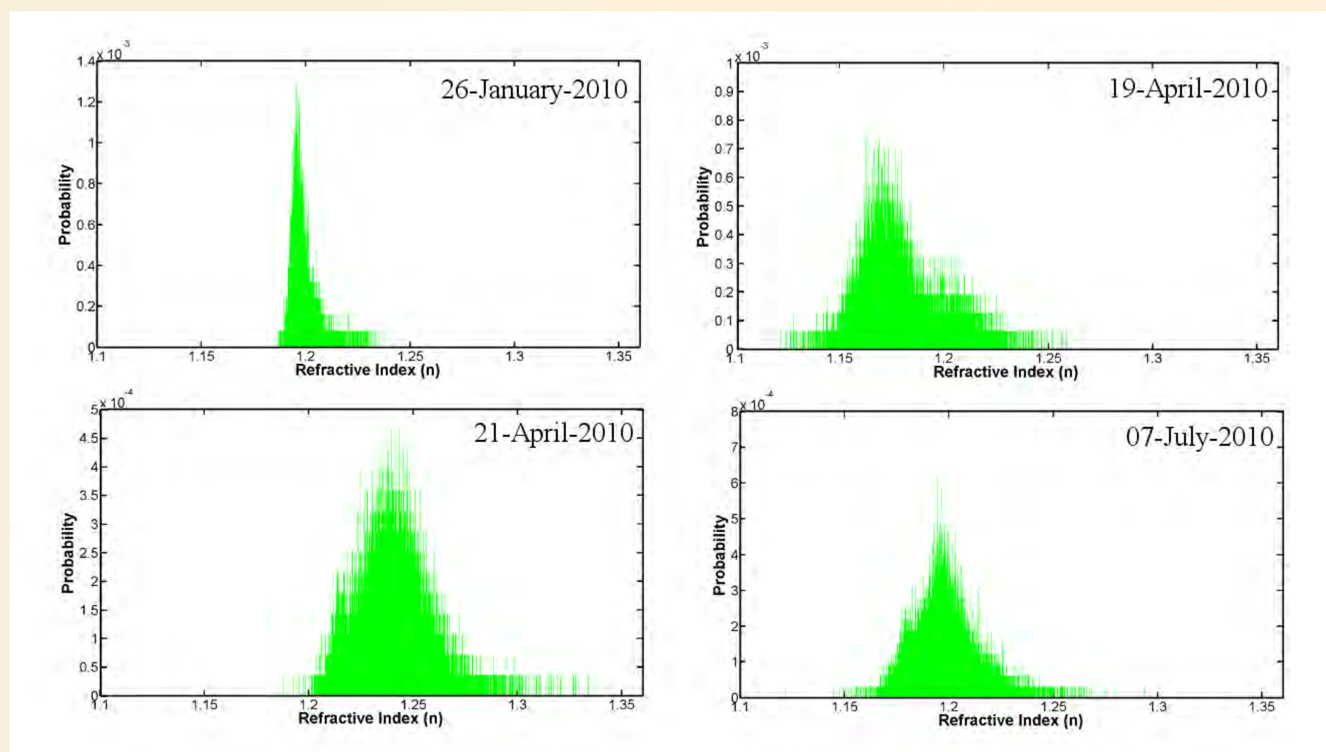


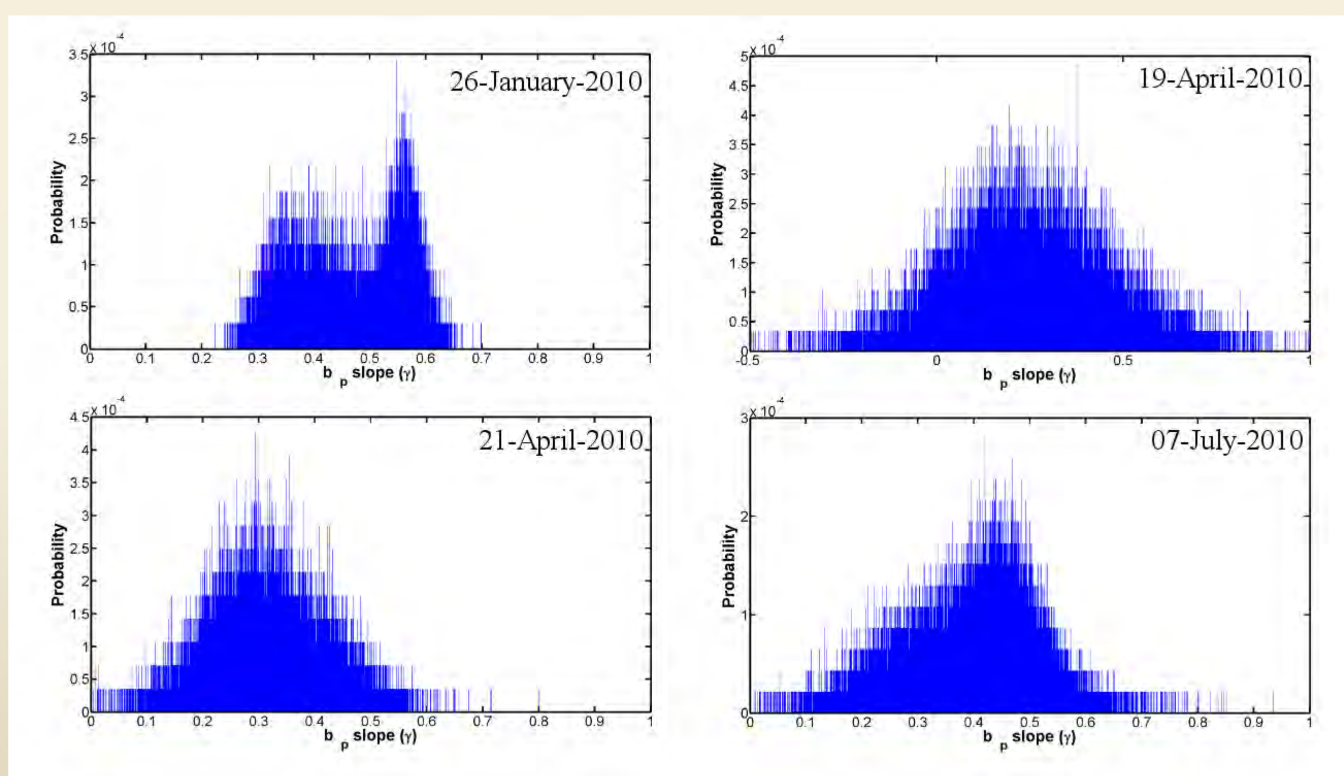
Time series observation of different parameters: T, S, Chlorophyll-a, CDOM, C_p-660 nm, b_p slope(ɣ), b_{bp}-532 nm and Refractive Index(n) of day 21-April.

ABSTRACT

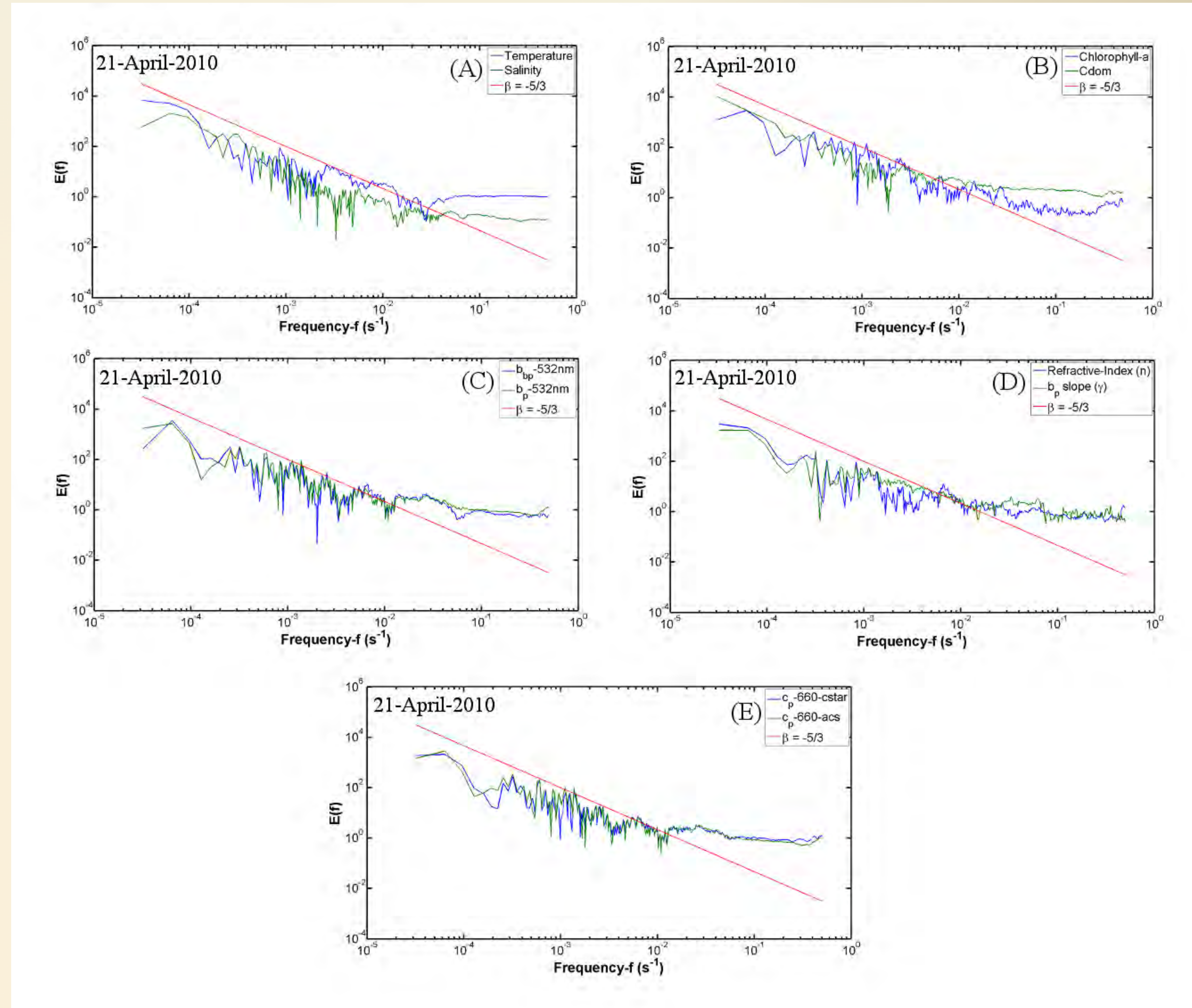
This poster describes physical processes (mainly the turbulence and re-suspension of particles due to turbulence) which control the micro scale variability of the bio-optical properties in highly turbid coastal waters. We analyse the variability of the bio-optical properties and their dynamics according to the re-suspension of particles. For this, time series analyses of different bio-optical and physical properties (like temperature and salinity) have been performed from stations in the coastal waters of Southern North Sea. The data bases considered are high frequency (1 Hz) simultaneous measurements during several hours in a fixed point in the highly turbid coastal waters of the Southern North Sea. We consider optical and physical properties recorded using different instruments. We mainly focus on the back scattering, attenuation, For each parameter we consider the statistics (probability density functions) and the dynamics (Fourier power spectra).



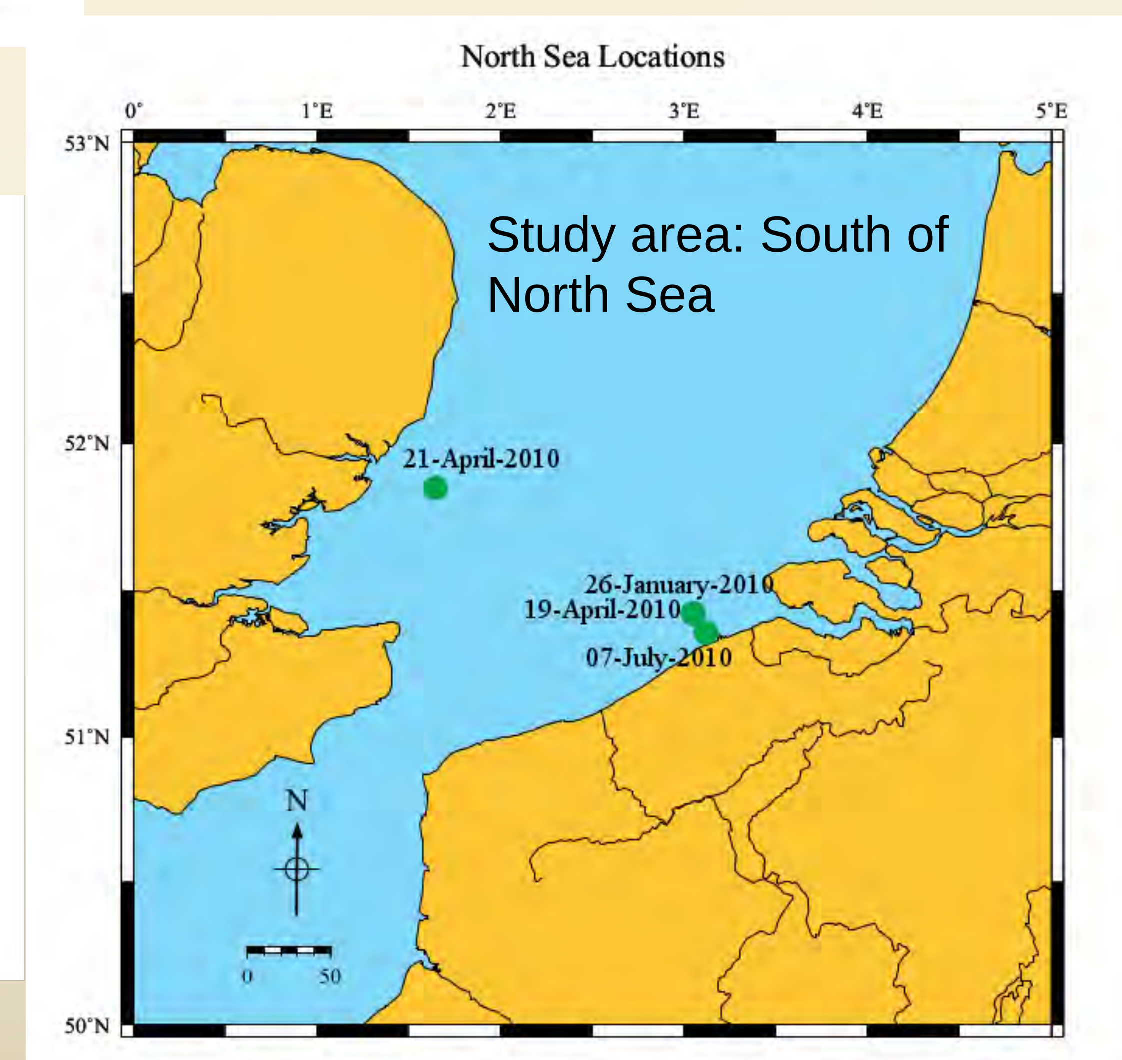
pdf of Refractive Index (n) for all the 4 days



pdf of b_p-slope (ɣ) for all the 4 days



Power spectra of different parameters observed on 21-April



Framework

The fluctuations in the density field and refractive index of an oceanic fluid are controlled by the turbulent fluctuations, which are well observed through passive scalars such as Temperature, T, and Salinity, S. Almost all oceanic flows are turbulent and are characterised by a wide range of coexisting scales of motion. The turbulence field also affects the spatial and temporal variability of the particulate and dissolved matter.

Main results

For the first time we estimated simultaneous turbulence (S, T) and optical parameters at high frequency and considered their stabilities (mean, coefficient of variance and pdf) and their dynamics using power spectra. We found that these optical parameters (b_{bp}, b_p-slope (ɣ), Refractive index-n and c_p) are influenced by turbulence and inherit some of turbulence characteristics; high frequency noise, scales of variability at lower frequencies.

The response of the jumbo squid *Dosidicus gigas* and the short-finned squid *Illex argentinus* to ecosystem variability in the Oceanic Biological Activity Centers

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SUMMARY:

The population development of *Dosidicus gigas* and *Illex argentinus* in the Pacific Ocean off Mexico-Peru and in the South Atlantic Ocean off Argentina was related to the sea surface temperature SST, chlorophyll and zooplankton biomass estimates in order to know their effect and function on the ecosystem. The chlorophyll series defined areas with a characteristic high biological production, where both squid species were present. Chlorophyll series were influenced by warm and cold events and a relation with the zooplankton was observed. BACs were the main factors to describe the development of catches and biomass of squid populations and a relation between chlorophyll and zooplankton values with biomass estimates of *D.gigas* and *I. argentinus is reported*. These trophic relations in BACs have promoted the abundance and presence of squid species in the ocean.

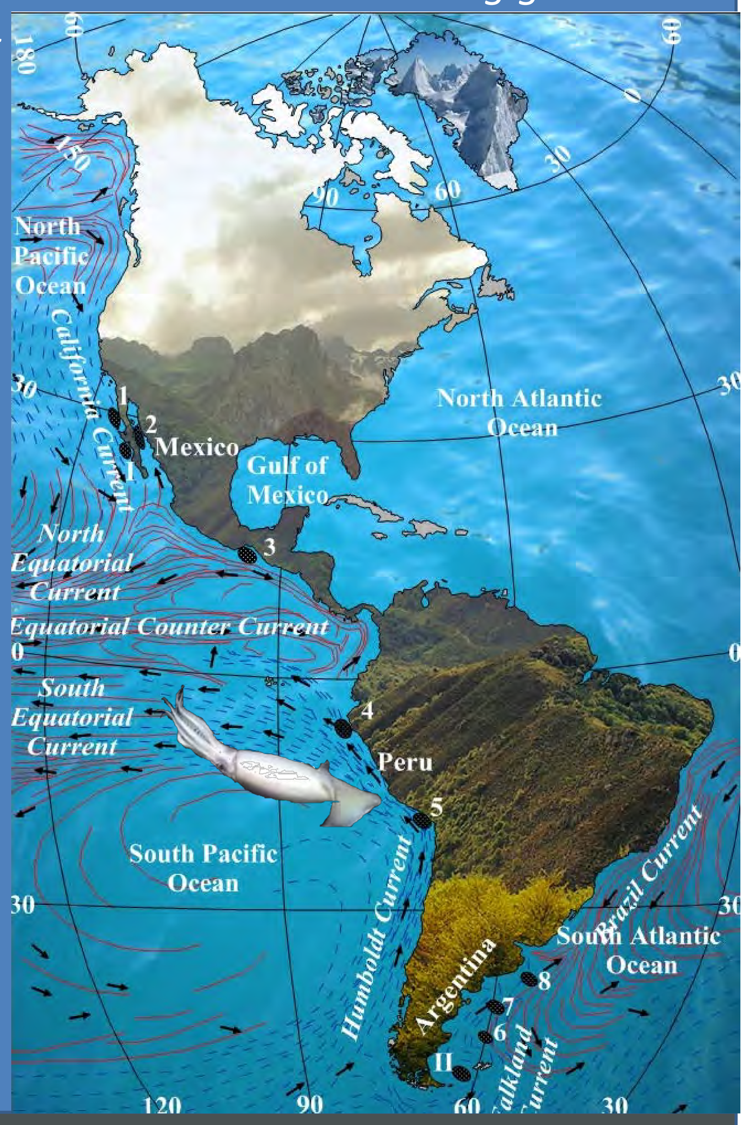

Figure 1.- 1- San Quintin and Cedros Island complex, I- Pacific coast of Baja California Sur, 2- Gulf of California, 3- Gulf of Tehuantepec, 4- Paita, 5- Ilo, II- Tierra del Fuego, 6-Santa Cruz, 7- San Antonio Rio Negro and 8-Mar del Plata.

INTRODUCTION

Variation in abundance and distribution of marine organisms and their possible relation to changes in physical parameters have been relevant in recent decades. Research has focused on species which are common to marine currents, such as those in California, Mexico, Peru and southwest Africa where high productivity is associated with upwelling events. This production is maintained in the area and exported to other ecosystems, these areas are referred to as Biological Activity Centers BACs.

In the selected regions for this study BACs were considered key to the development of jumbo squid *Dosidicus gigas* fisheries in the Pacific Ocean (Mexico and Peru) and *Illex argentinus* in the South Atlantic Ocean (Argentina). These areas are considered the support for the increase of plankton, fish, marine mammal and bird biomass. However, changes in the intensity, location or periodicity of BACs can modify the ecosystem structure that is related to variability in squid populations.

Using the sea surface temperature SST as a factor to determine the periodicity and intensity of enrichment in BACs, we can characterize the ecosystem but we have to integrate into the analysis the values of primary production (chlorophyll) and the impact on primary consumers (zooplankton Zoo). These were the three factors that we used to describe changes in population of the jumbo squid *D. gigas* and the short-finned squid *I. argentinus* in the Pacific Ocean and the South Atlantic Ocean, considering trophic relationships from primary production to primary consumers and higher trophic levels of the ecosystem.

OBJECTIVE

D. gigas and *I. Argentinus* are species of importance in marine ecology and fisheries. Due to the abundance of both squid species and wide distribution in the ocean waters we decided to characterize and make a comparison with environmental factors in order to find key areas and years which help us to understand the dynamic, increase in biomass and distribution of these species.

METHODS:

Mean values of SST were obtained from data set of CALCOFI, IMECOCAL, IMARPE, and the CIBNC program, chlorophyll data Chl to 10 m deep and zooplankton estimates were obtained from the .45 stations of the IMECOCAL program, IMARPE and published data. Series of biomass estimates and catches of squid were obtained from the CIBNOR and the Annual Fisheries Report in Mexico, Production Agency and IMARPE in Peru, Bruneti (1988) and the Subagency of Fisheries and Aquaculture MAGyP in Argentina. Biomass estimates of squid were taken from the IMARPE and published data.

The annual cycle was calculated (Fig, 2a, b and c) using the monthly average by the time period of SST, Chl and Zoo. Anomalies were calculated as deviations of this cycle, after that a spectral analysis was applied to eliminate the tendency of the time series, according to:

$$X_1 = x_1 - (a + bt_1) \;......\; X_n = x_n - (a + bt_n)$$

the lineal tendency equation : *x* is the anomaly, *a* and *b* constants of the linear equation and *t* time.

We identified the main frequencies of the periodogram which modeled the SST behavior using the Fast Fourier Transform. Time series were smoothing with a 12 term spectral window and processed with the Time Series Analysis routine in STATISTICA 8.0. We compared the time series with one and two years delay and without delay to determine the function of SST, Chl and Zoo anomaly series with catches and biomass series of squid and a correlations analysis was applied.

RESULTS:

Anomalies and tendency in the SST, Chl and Zoo cycles

Environmental changes which are present in the study areas reflected the high variability to these ecosystems are exposed trough the time. Environmental changes detected in the SST series were seasonal (Summer-Winter), interannual (El Niño-La Niña), interdecadal (Warm and Cold periods) and seculars (high and low variability).

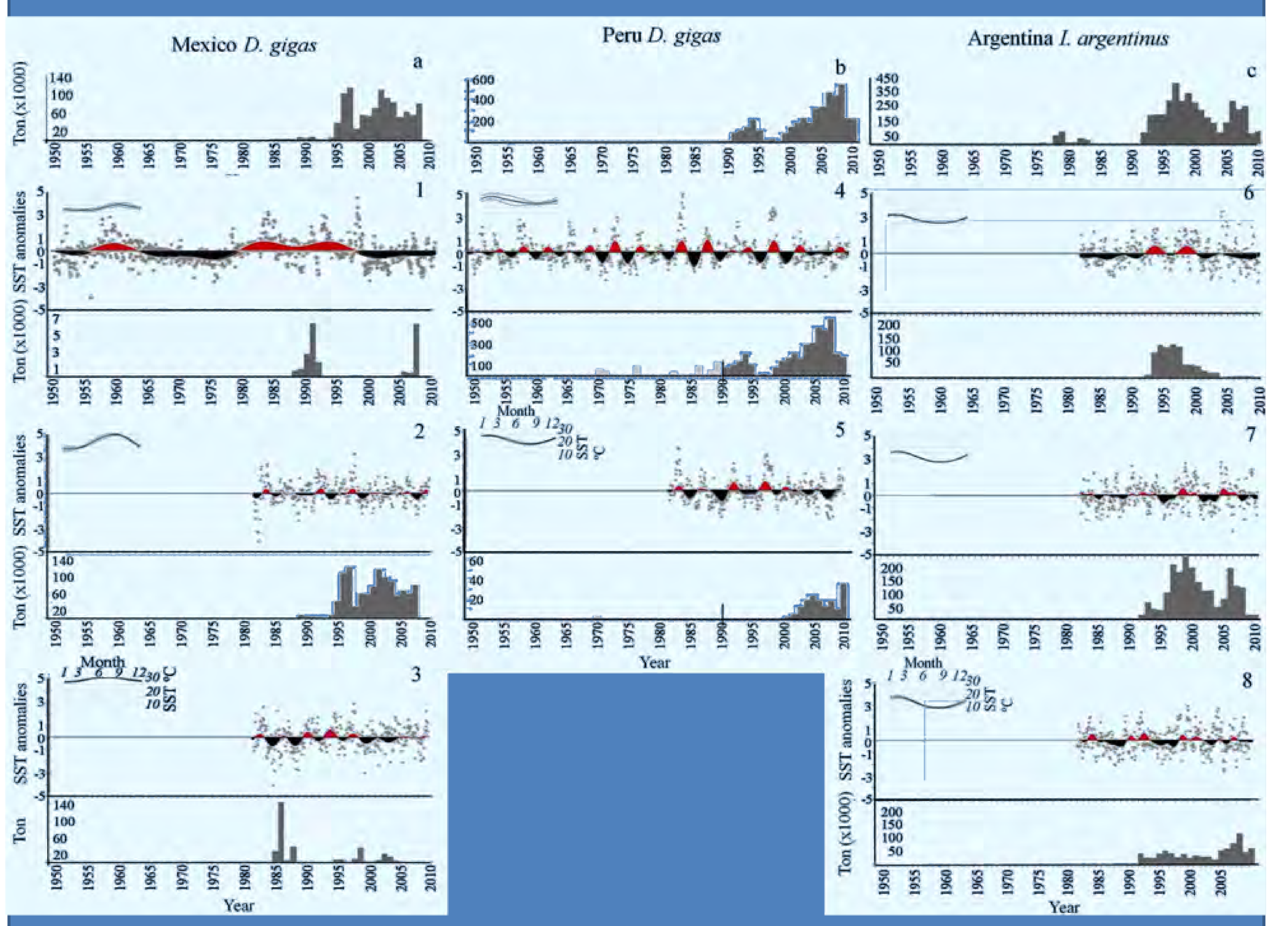

Figure 2. Historical catches, SST anomalies modeled and the annual variation of SST related to figure 1.

Chlorophyll values in BACs promoted the ecosystem development because their increase or diminish is important to define the outbreak dynamic in the trophic levels in the future. Based in the Chlorophyll we observed that negative anomalies were directly related with the presence of high temperature during El Niño events (warm periods) and the opposite was observed in cold periods. The gradual warming of water masses and lower nutrients availability promoted a diminish in the primary production but contrary in the zooplankton populations which under high temperature increased their biomass (Fig. 3).

Catches and biomass of squid species

The dynamic of *D. gigas* catches and biomass in the Pacific Ocean and *I. argentinus* in the South Atlantic Ocean was similar. They are important species for the worldwide fisheries due to a wide distribution and high abundance. They showed a variation that may define abundance cycles and a latitudinal movement in both hemispheres.

RESULTS:

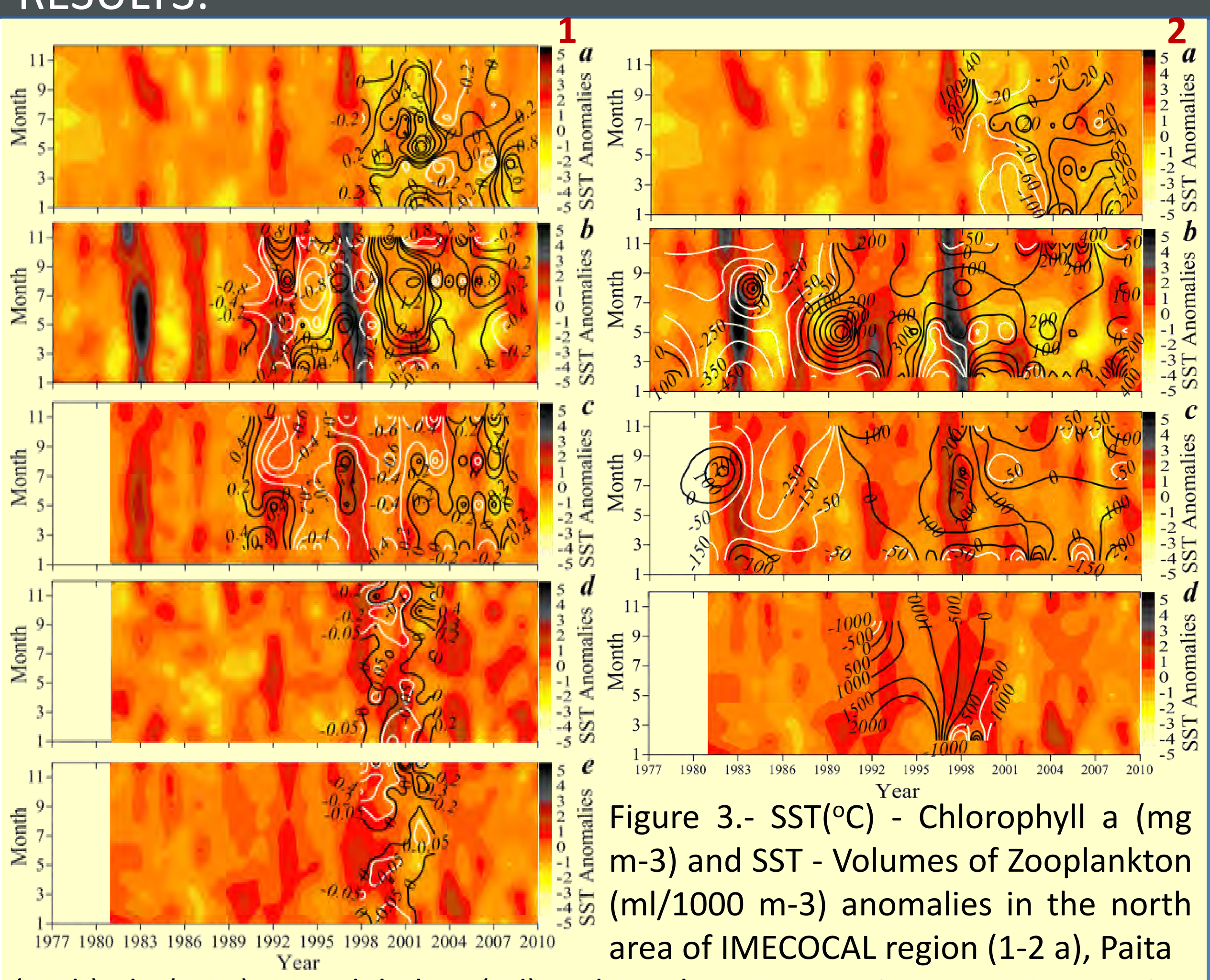

Figure 3.- SST(ºC) - Chlorophyll a (mg m-3) and SST - Volumes of Zooplankton (ml/1000 m-3) anomalies in the north area of IMECOCAL region (1-2 a), Paita (1-2b), Ilo (1-2c), Mar del Plata (1d) and Southern Patagonia Area 6-7 Argentina (1-2e). Black line positive and white line negative.

In the graphics 4 *D. gigas* showed high abundances in both hemispheres and a constant increase in biomass reflected in their catches, even in the biomass estimate series high and low abundances were detected for both species promoting the same in catches, and sometimes the decrease was so strong that in the fishery activity it is considered like a fishery collapse "periodic collapses"

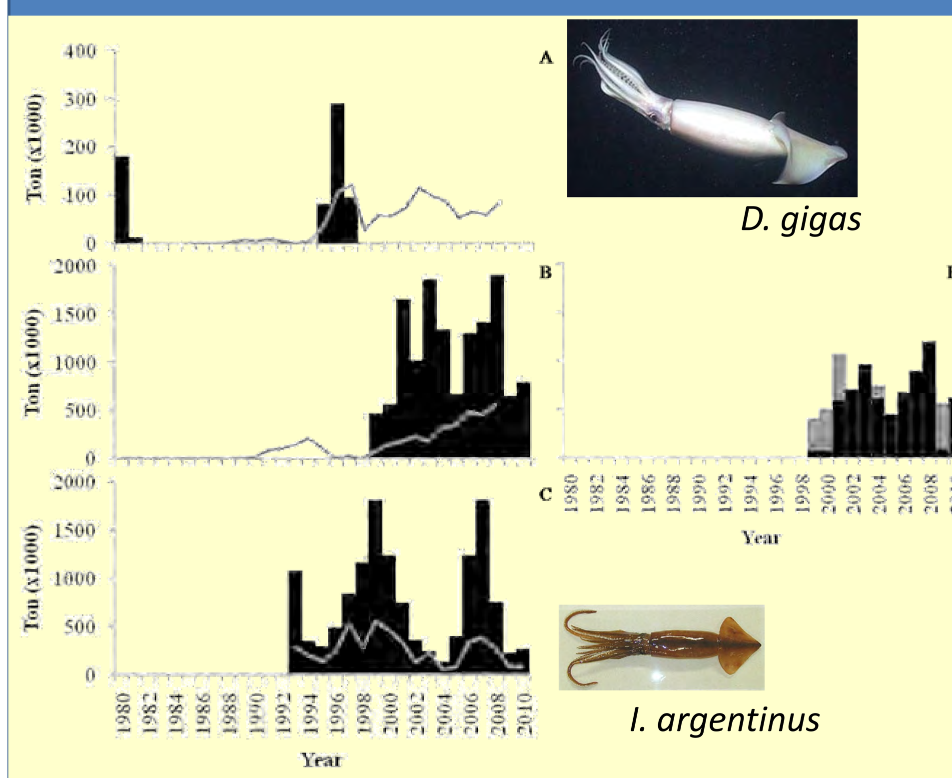

Figure 4. Squid biomass estimates (black bars) and fishery captures (gray line). A).- Mexico, B).- Peru and C).- Argentina. B1 biomass estimates from the north (Paita gray bars) and south part (Ilo black bars) of Peru.

Associations between catches and biomass of *D. gigas* and *I. argentinus* with SST, Chl and Zoo

There was no relation between the biomass estimates and catches with the SST in BACs when the analysis did not consider a delay in time, but when a delay of a year was applied the correlation showed negative values for *D. gigas* in the Pacific Ocean and positive for *I. argentinus* in the South Atlantic Ocean. But the negative relation between Chl and Zoo, explained by the natural grazing, favored the abundance of these squid species that use the high abundance of zooplankton.

CONCLUSION

.- Globally we observed that the SST variability has changed from 1999 expressed in the decrease of maximum values in the time series and promoting the restructuring of the trophic relationships in the ecosystem community of these BACs. Espino, (2003) and Espino & Yamashiro, (2012) commented that in high variability periods the effects of the El Niño-La Niña events are stronger and the seasonality is marked. So that, a decrease in this variability promoted the system homogenization, and considering the dynamic and adaptability of squid species the result observed was a population restructure that started in the 90s and after 1998 El Niño event when the *D. gigas* and *I. argentinus* populations were conformed as main components in the ecosystem of the Pacific and South Atlantic Oceans.

ACKNOWLEDGEMENT

The authors thank the IMECOCAL program (Investigaciones Mexicanas de la Corriente de California http://imecocal.cicese.mx) and IMARPE (Instituto del Mar del Peru) for the databases. Thanks to Danna Staaf and Jeremy Hand for their support and observations on the English version, this article is based on the PhD thesis in Marine Science of Rigoberto Rosas Luis, his doctoral degree is supported by CONACyT (Consejo Nacional de Ciencia y Tecnología, México).

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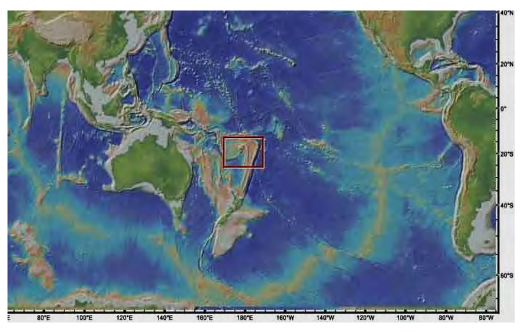
Community succession via time-series analysis in hydrothermal vents of the Eastern Lau Spreading Center, Tonga



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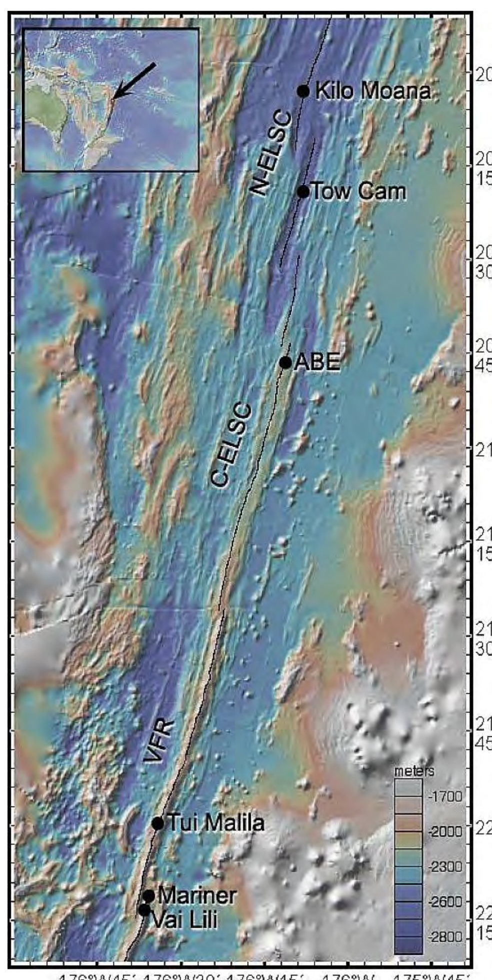
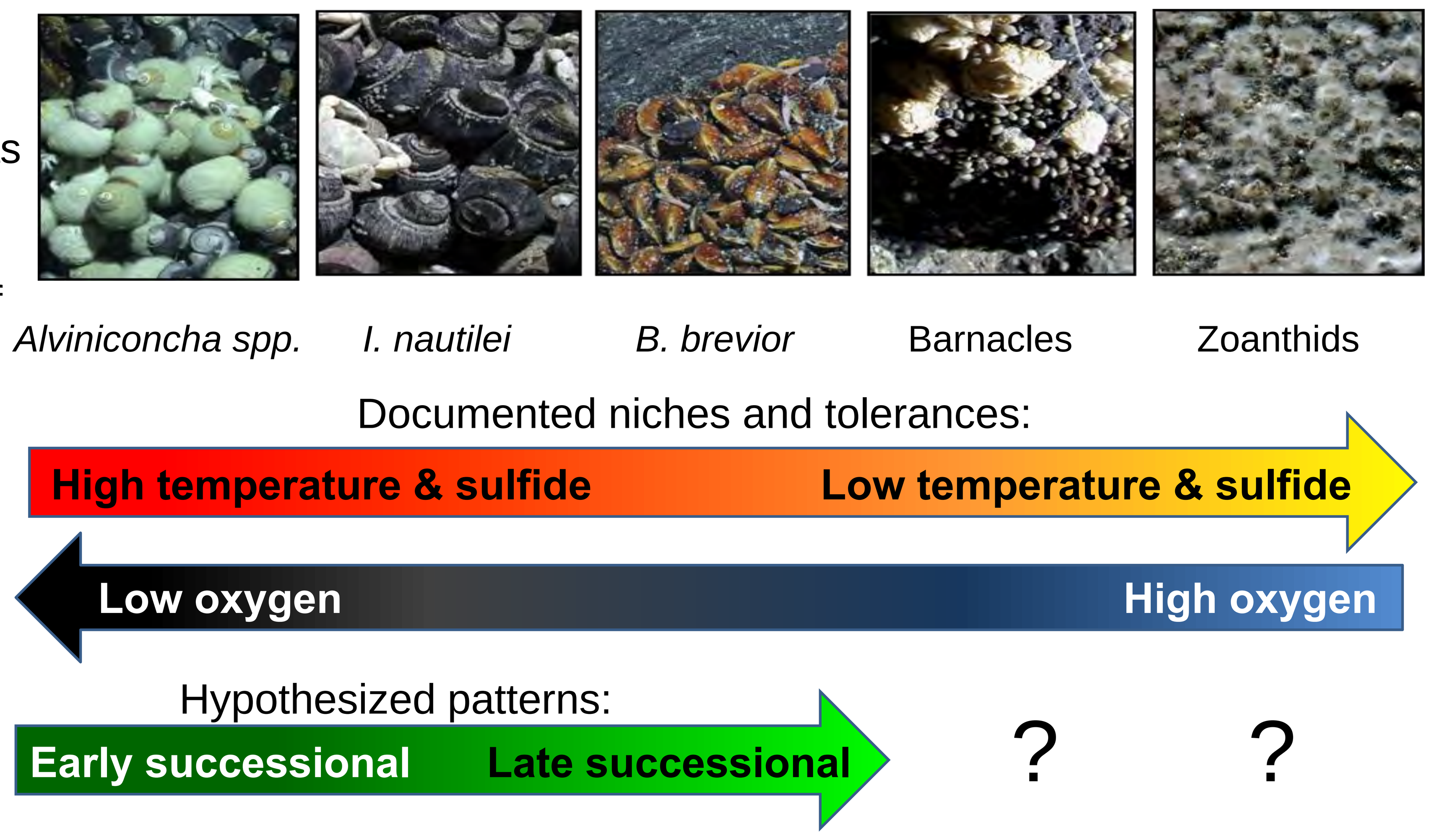
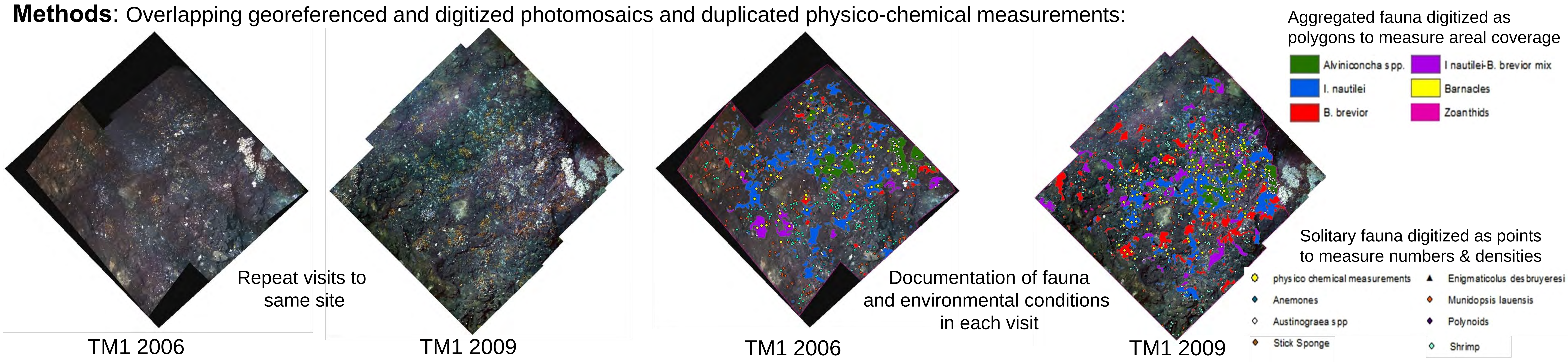


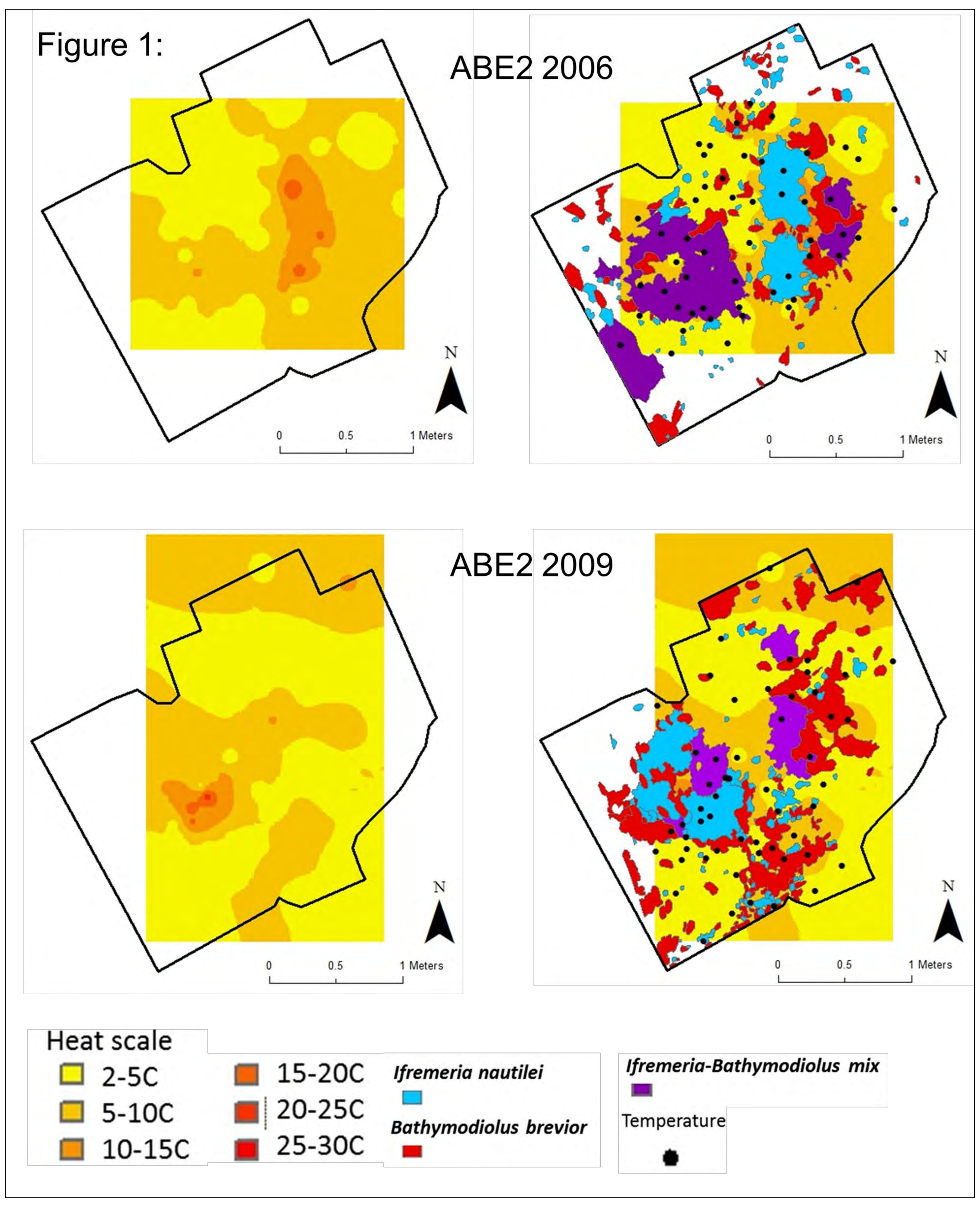
Introduction:

Though succession has been studied at Eastern Pacific and Mid-Atlantic Ridge hydrothermal vents[1, 2, 7, 8, 9], no such work has yet been conducted at the vents of the Western Pacific which host entirely different communities. Impending deep sea mining makes the study of natural temporal change in these habitats of topical importance. Five groups of aggregated fauna, each with their own distinct thermochemical niches and tolerances dominate macrofaunal communities at the ELSC: *Alviniconcha spp., Ifremeria nautilei*, *Bathymodiolus brevior,* barnacles and zoanthids[3, 5, 4, 6]. Based on the niches and the patterns of distribution documented in 2005 and 2006, we postulated a model of succession in which we hypothesized that newly formed sites would be dominated by *Alviniconcha spp.,* and successively by *I. nautilei* and *B. brevior* as the site ages and eventually cools[6].



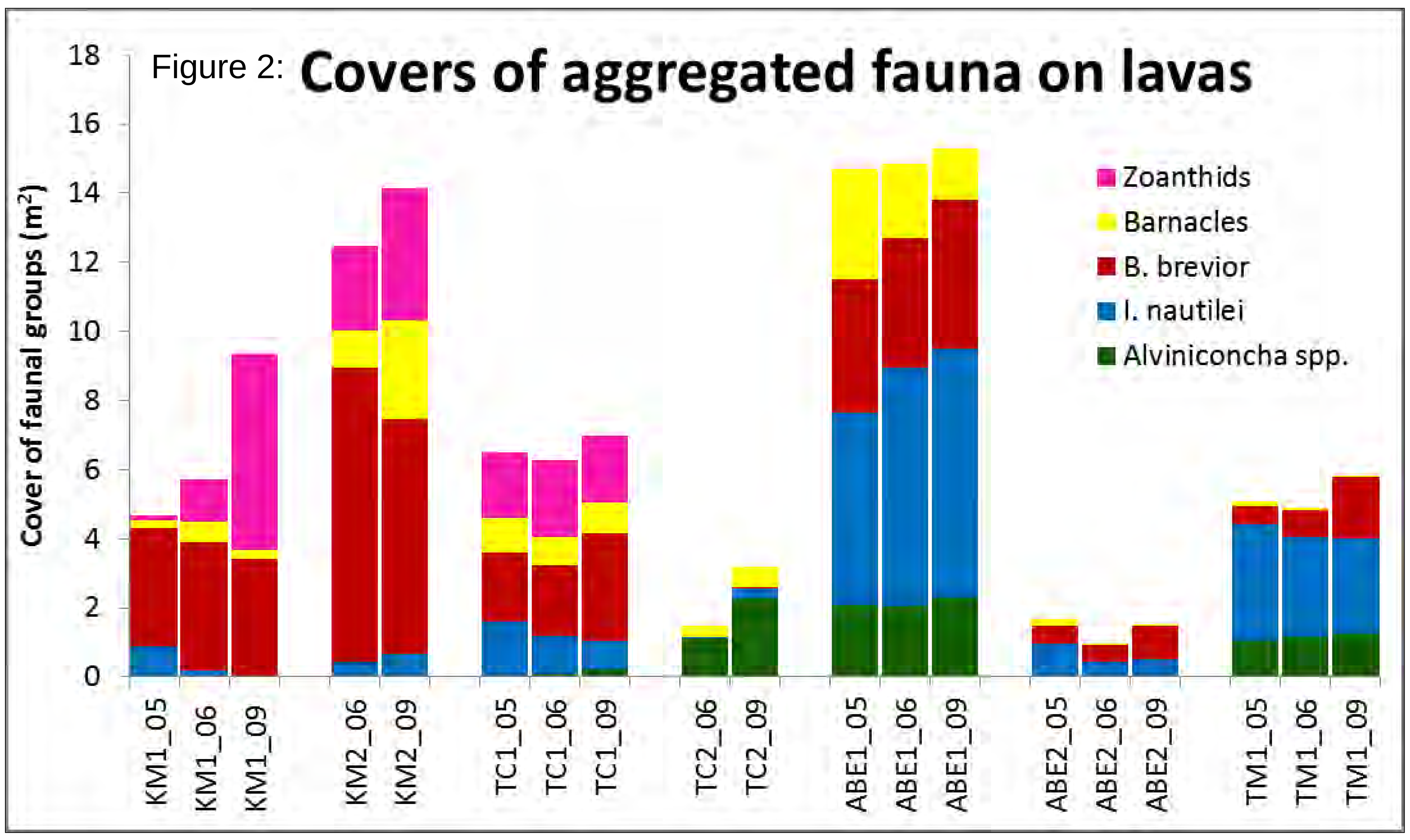
Methods: Overlapping georeferenced and digitized photomosaics and duplicated physico-chemical measurements:





Results and Discussion: The aggregated fauna overall were associated with similar physico-chemical conditions in the different years of sampling. However, small scale spatial changes in environmental conditions occurred at various sites and the faunal aggregations tracked these changes. This is shown in Figure 1. Note the location of the hot spots in each year at the site ABE2. No *Alviniconcha spp.* was present at this site in either year, however, the aggregation of *I. nautilei* shifted from 2006 to 2009 and was stationed directly above the hot spot in each year.

Overall composition of the communities also tracked physico-chemical changes in the communities. The areal coverage of the aggregated fauna during each visit is shown in Figure 2, providing evidence that sites change as hypothesized over time. At KM1, average sulfide concentration and temperature dropped which was accompanied by the disappearance of snails and an increase in zoanthids. Most sites remained very similar both in terms of the environmental conditions measured as well as in terms of the composition of the faunal community, indicating an unexpected stability in the communities. TC2 was hypothesized in 2006 to be a site in an early successional stage. Although the environmental conditions in 2009 were quite similar at this site, the increasing numbers of *Alviniconcha spp.*, increase in *I. nautilei* and appearance of *B. brevior* follow the hypothesized successional pattern for this region.



Though species richness and diversity indices are similar in different successional stages, the species present differ. Bythograied crabs and shrimp are abundant in early successional stages. Galatheid crabs increase in abundance and non-vent endemic fauna such as sea stars and sponges appear in late successional stages.

Acknowledgements and References: Many thanks to the crews of the R/V Melville and Thomas G. Thompson as well as the crew of the ROV Jason II without whom none of this work would have been possible. I also thank Liz Podowski for all the training and Steve Schaeffer, Katriona Shea, Alex Klippel, Pen-Yuan Hsing, Betsy Larcom and Miles Saunders for discussions and suggestions, as well as Marlena Brown, Max Zelenevich and Sarah Cobb for assistance with digitizing.

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Surface circulation patterns at the southeastern part of the Bay of Biscay from HF Radar data

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1.- INTRODUCTION

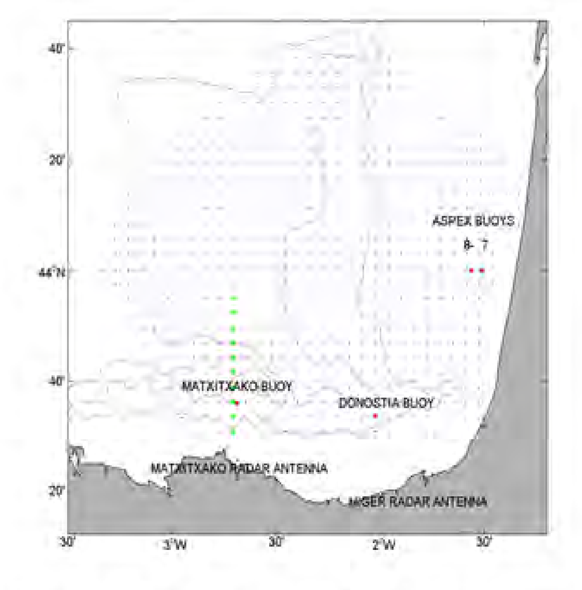

Figure 1: Study area. Radar nodes, Basque Country Buoys (Matxitxako and Donostia) and ASPEX buoys. Green dots are the nodes used at figure 6 to draw currents in front of cape Matxitxako

The installation in January 2009 of a HF radar system over-looking the southeastern part of the Bay of Biscay (Figure 1) has permitted to build a large data base of high frequency (hourly) and high spatial resolution (~ 6 km) surface current maps.

known features of the circulation in this area:

- **seasonal slope current (IPC)** (Pingree and Le Cann, 1990, González et al, 2006, 2008, Castanedo et al, 2006)
- **At shorter time scales, the variability over the slope is dominated by tidal and inertial oscillations** (Rubio et al., in press)
- **Over the shelf the circulation is governed principally by the wind,** (OSPAR, 2000).

2.- DATA AND METHODS

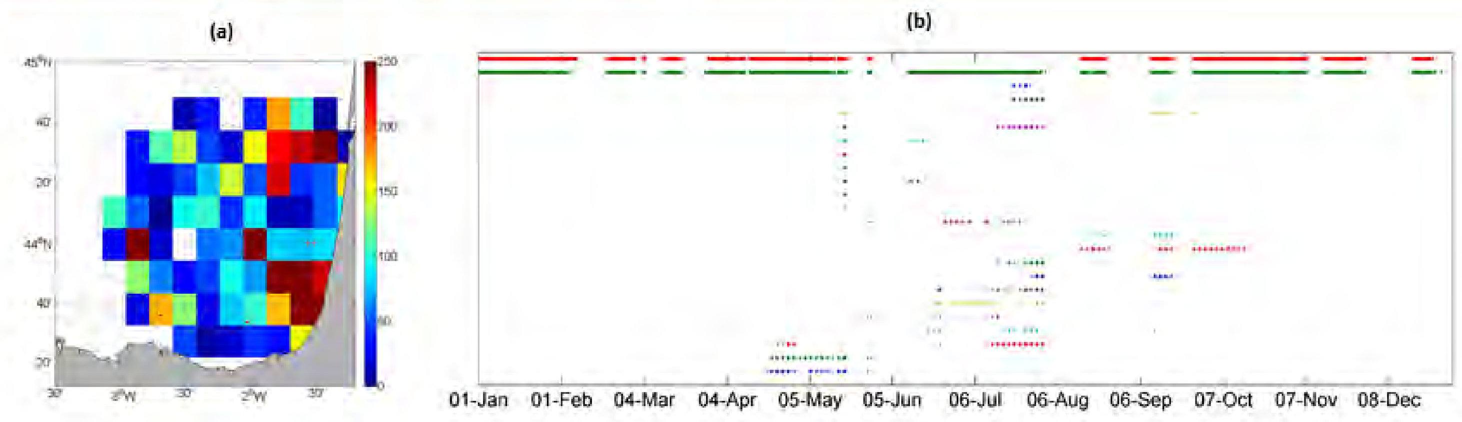

Figure 2: (a) Density of points of comparison in each grid. (b): Hours with radar and drifter/buoy jointly information for each of the 20 drifters and 4 moored buoys. The order for the top is: Matx, Don., Aspex 8, Aspex 7 and 20 Drifters

(a)

*(boya-radar); ** Rubio et al. 2011.

BUOY NAME	Measurement depth (m)	Corr (U)	Corr (V)	RMS_U (cm·s-1])	RMS_V (cm·s-1])	BIAS* U	BIAS* V
Matxitxako**	1.5	0.86	0.64	8.09	8.12	-	-
Donostia**	1.5	0.53	0.34	10.38	12.88	-	-
ASPEX 7	12.8	0.35	0.51	14.07	16.82	-1.10	-12.73
ASPEX 8	17.8	0.40	0.43	13.91	15.81	0.58	-7.07

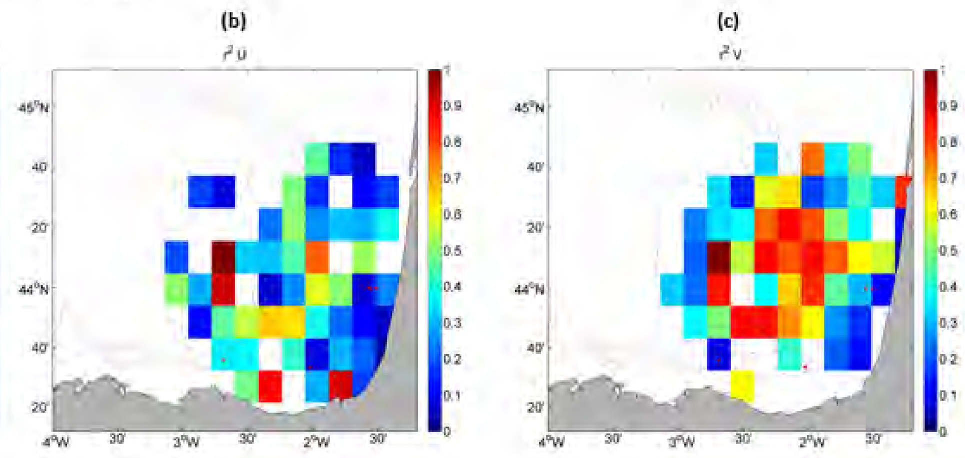

Figure 3: (a) Correlation, RMS and BIAS values for radar and drifter comparison data. (b, c) Spatial distribution of correlation, r2,

3.- RESULTS & DISCUSSION

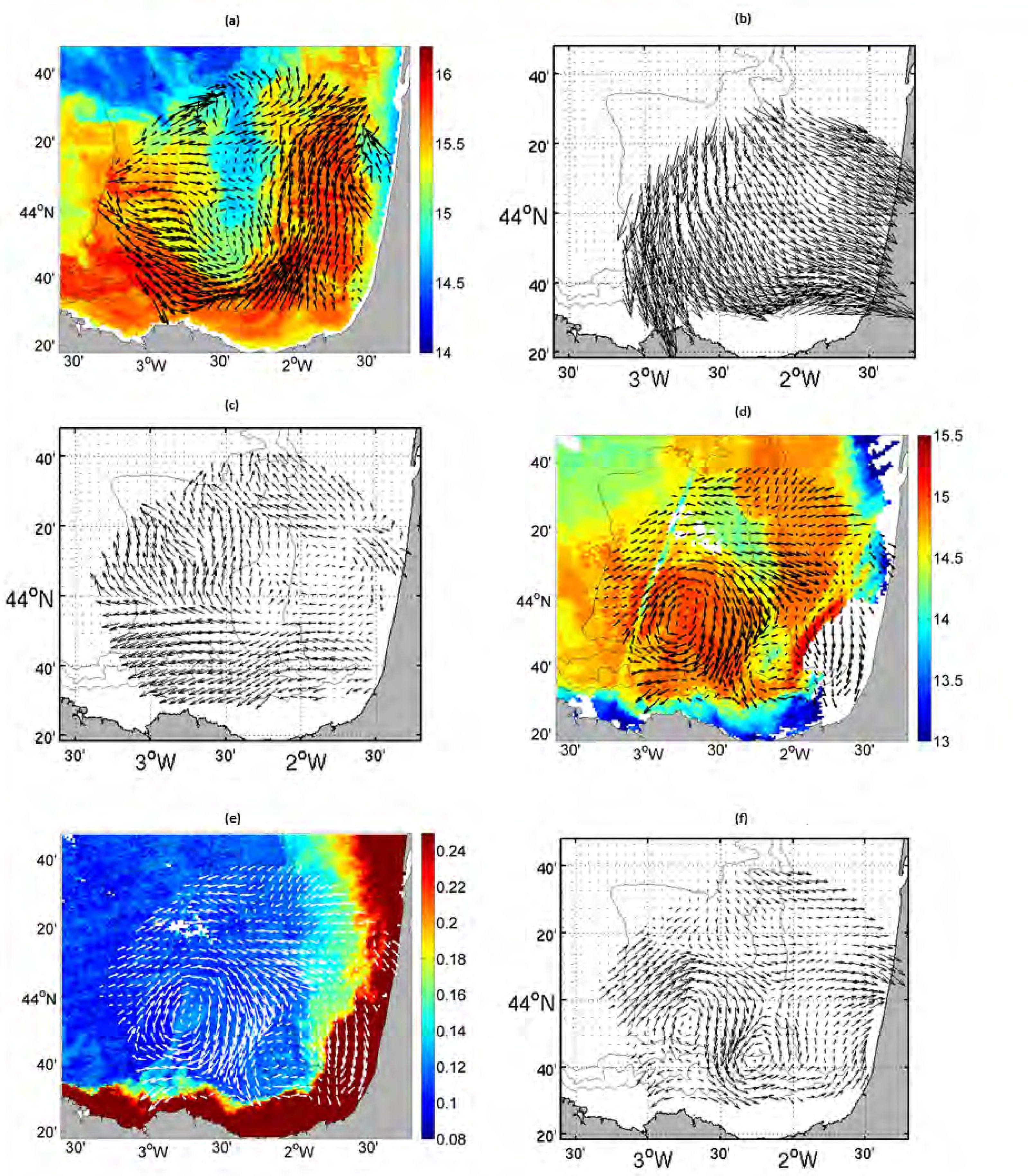

Figure 4: Snapshots of hourly radar-derived sea surface current fields for the study area.

Illustration of some of the most commonly observed patterns through the study period, are shown at figure 4: (a) winter-time circulation with the surface signal of the along slope poleward current (IPC) and the associated warm surface flow, (b) intense southeastward currents in response to intense northwest winds associated to the passage of Klaus explosive cyclogenesis storm in winter 2009, (c) summer-time circulation with intensified westward currents over the slope, and (d,e,f) surface patterns associated to a well-defined anticyclonic mesoscale eddy. Its signal on SST and Chl-a satellite data is shown in (d) and (e), respectively; the interaction of this anticyclone with a smaller cyclone in the area some days later is shown in (f). Dates used are: (a) 24/11/2009 13:59 for SST satellite data and 24/11/2009 00:00 HF radar data, (b)24/01/2009 09:00, (c) 22/09/2010 09:00, (d, e) 27/12/2011 12:36 and 27/12/2011 12:50 for SST and Chl-a concentration, respectively, and 29/12/2011 19:00 for HF radar data and (f) 31/12/2011. Isobaths: 200, 1000, 2000m.

EOF analysis

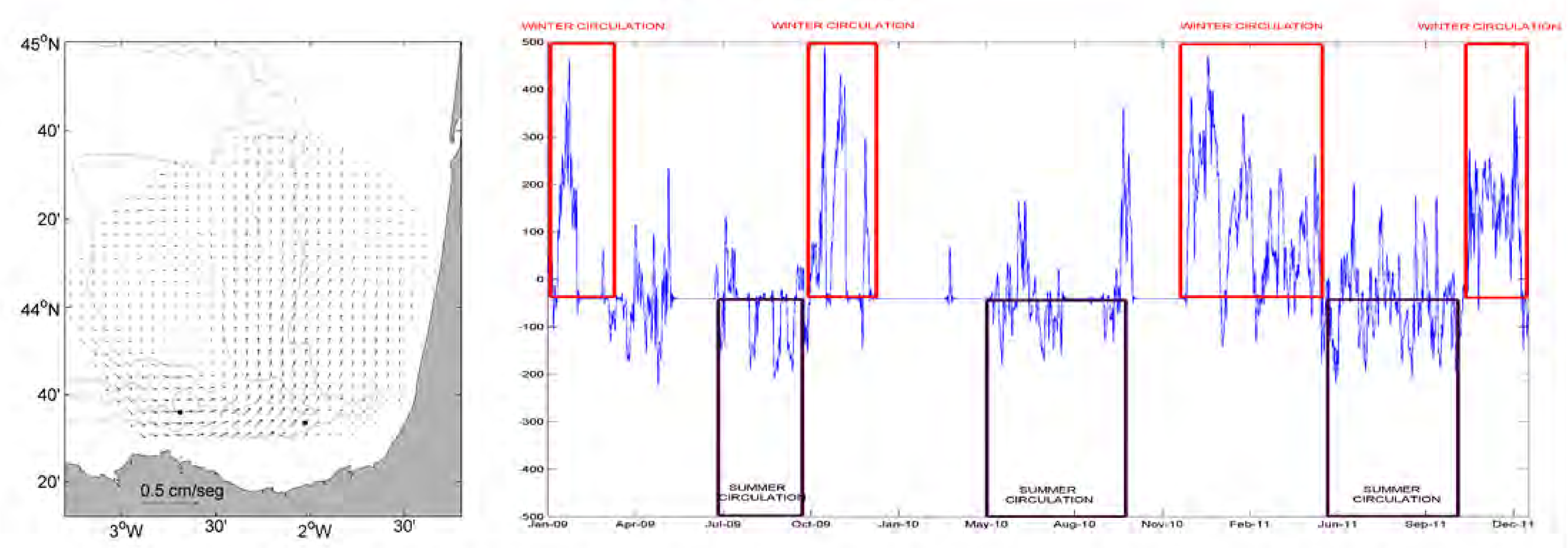

Figure 5: Results of the EOF analysis to lowpass filtered data: Pattern 1 and its temporal variation. This pattern contribute with 28 % to the total variance

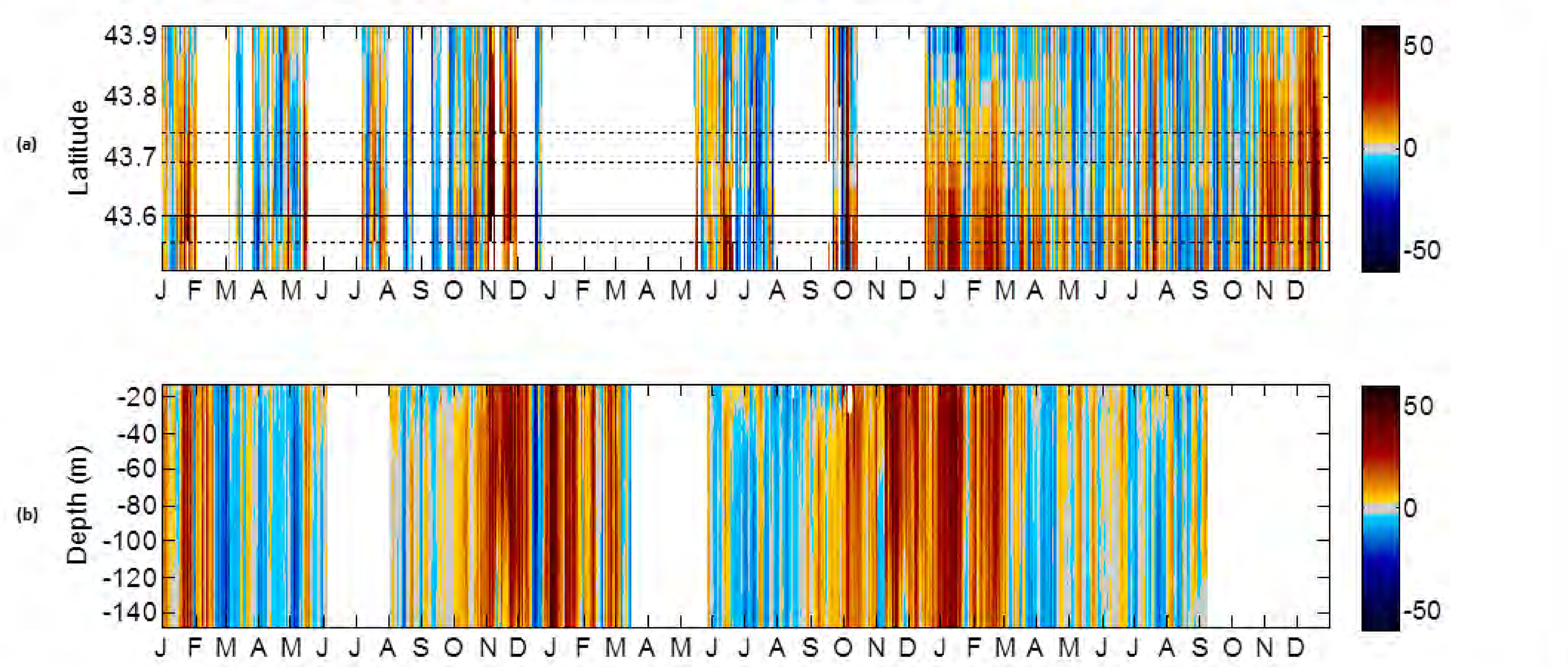

Figure 6: (a) East (positive) – west (negative) along slope currents at the HF radar nodes within the transect shown in Figure 1, 2009-2011. Dashed lines indicate the position in latitude at the longitude of the transect of the 200m, 1000m and 2000m isobaths (dashed lines) and Matxtixako buoy (solid line). (b) East (positive) – west (negative) along slope currents at Matxitxako buoy with depth. White spaces correspond to data gaps.

The results of an EOF analysis and the currents at the transect in front of cape Matxitxako (Figure 1), show a seasonality in agreement with previous works (Pingree and Le Cann, 1990, González et al, 2006, 2008, Castanedo et al, 2006).

4.- CONCLUSIONS

According to the results, it has been observed the summer-winter current variability, described previously by other authors in the study area.

Taking into account the EOF analysis results, there is an anticyclonic and cyclonic circulation associated to that seasonality.

Several mesoscale eddies have been observed during 2009-2011.

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Acknowledgements:

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Tidally-mediated bloom Initiation in a near-shore embayment resolved from a high resolution time-series

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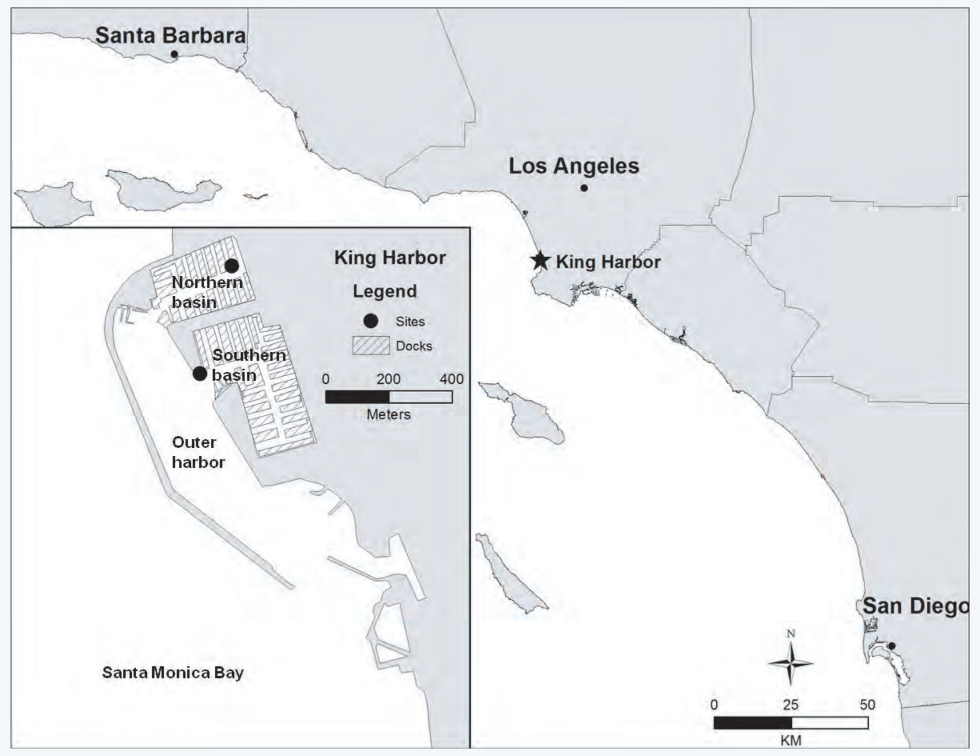
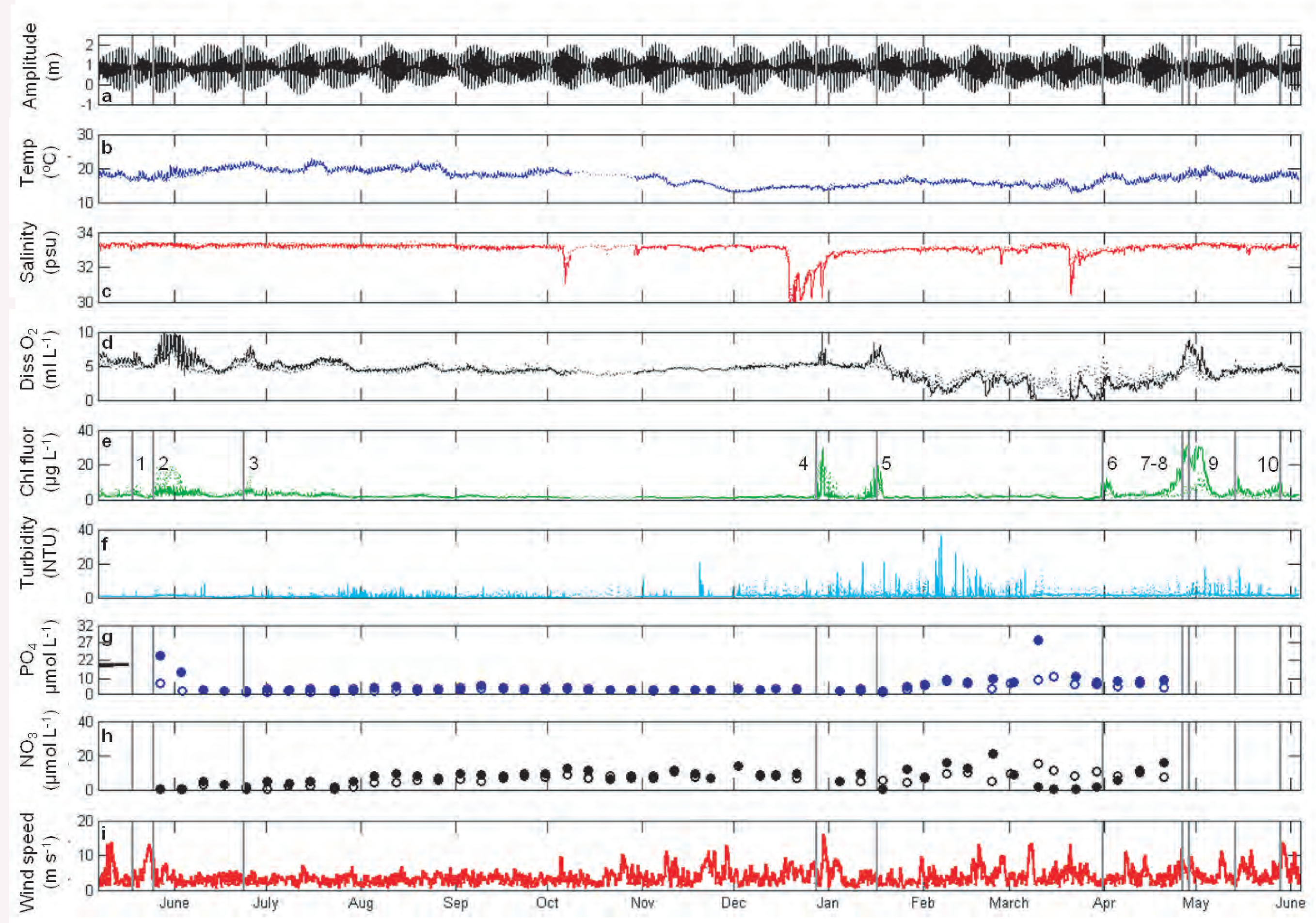
Introduction: Coastal marine environments are important links between the open ocean and land-based processes and are often characterized by enhanced primary productivity compared to their offshore counterparts. Blooms of microalgae are a common occurence in many coastal ecosystems, with a range of possible advantageous and deleterious effects on marine food webs and ecosystem health. Near-shore environments may act as incubators for microalgal blooms and retain seed populations[8,9] and are also often characterized as "hot spots" for harmful algal blooms[10]. Physical processes within near-shore coastal environments and embayments are highly complex, but the tidal cycle often plays a signficant role in structuring such environments[4]. Water movement resulting from tidal cycling may affect phytoplankton populations in several ways including advective transfer of biomass and nutrients, fundamental changes in water column depth, and periodic mixing and turbulence[1]. Many studies examining phytoplankton dynamics in coastal ecosystems have relied on temporally coarse sampling (weekly to monthly) and classical linear regression techniques to establish relationships between environmental parameters and biological conditions. Time-series approaches provide a non-linear alternative, allowing for decomposition of datasets into periodic constituents, and represent excellent alternatives and additions to linear approaches. Wavelet analysis, and coherence, specifically, is capable of resolving oscillations and correlations that vary in their periodicities and strength over time. The current study addressed the role of physical processes, specifically the tidal cycle, on phytoplankton biomass in a nearshore harbor environment over the course of a year.

Study Site: King Harbor is a semi-enclosed, recreational harbor in the City of Redondo Beach on the Pacific coast of Southern California, USA (33.847° N 118.397° W). The harbor is protected by a rubble breakwater with an opening towards the south and consists of northern and southern basins adjoined by an outer harbor region. The two basins are hydrographically distinct, and exchange of water between the harbor and adjacent bay is provided primarily via the south-facing harbor channel. There are no known freshwater inputs into the northern basin; there are, however, 5 small-volume storm drains discharging into the southern basin. The harbor has been the site of significant dinoflagellate blooms in 2005-2006 as well as fish mortality events during those years and since[11].

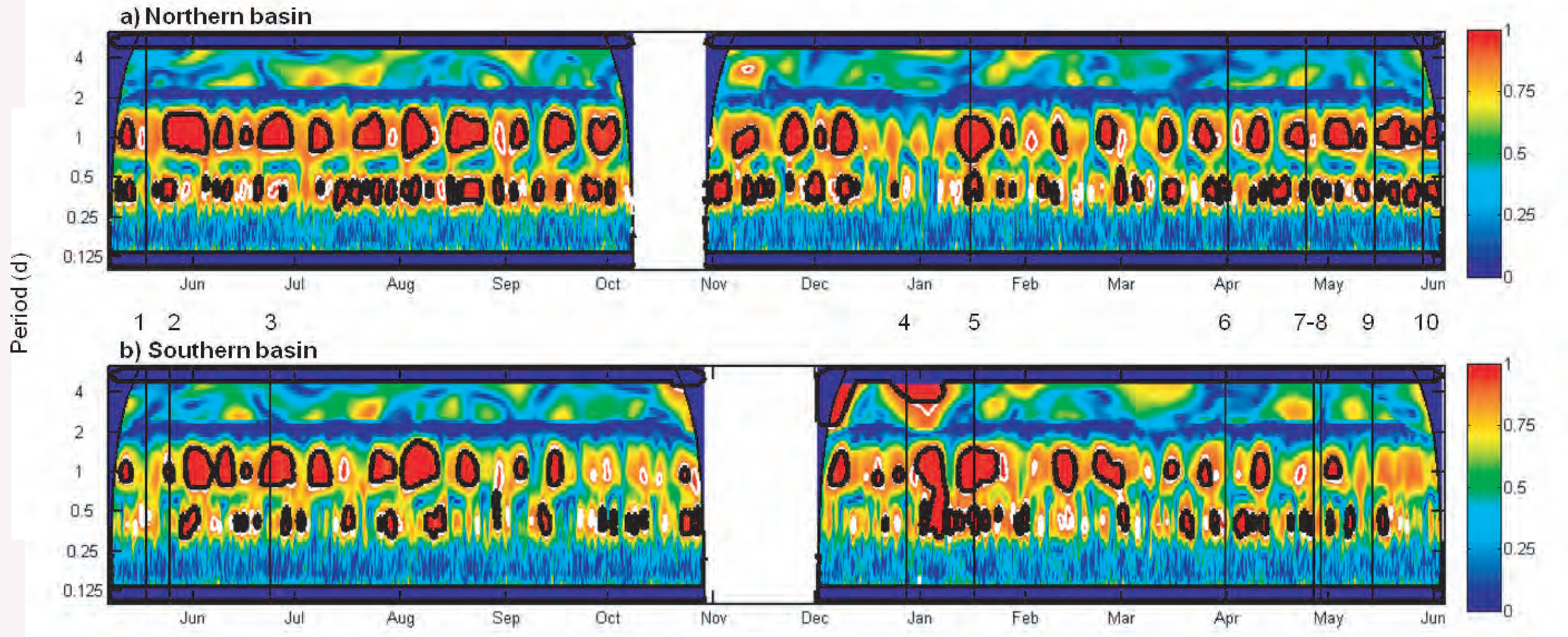


The Dataset: Time-series data from King Harbor shows a high degree of variability on a wide range of timescales. **Microalgal blooms were defined using a constant threshold approach**[3], namely > 2 x standard deviation, and are denoted by vertical gray lines and numbers in the plot of chlorophyll fluorescence (green). This definition produced **9 and 6 documented blooms** in the northern and southern basins, respectively.

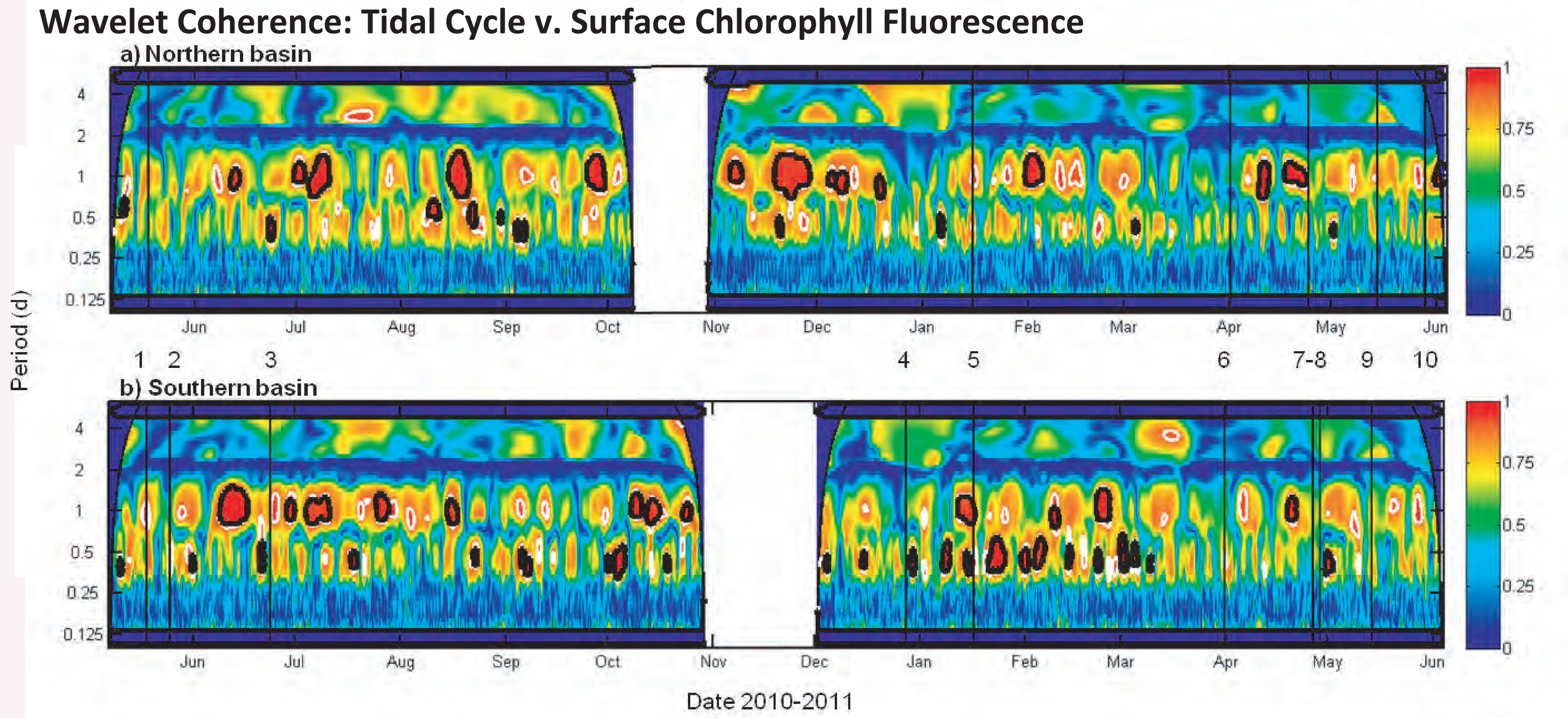
Data Methods: Multi-parameter Water Quality Monitors (WQMS; WetLabs) were deployed at ~ 1 m depth from floating docks in the northern and southern basins. These sensors were programmed to record for 10 sec at 30 min intervals temperature, salinity, dissolved oxygen, chlorophyll *a* fluorescence (at 695 nm), and turbidity (at 700 nm). The WQM sensors were cross-calibrated following field deployment over 7 days in a 500-gallon tank and the chlorophyll sensors were cross-calibrated using *in vitro* chlorophyll fluorescence of whole seawater (WSW) samples collected weekly at each monitoring site. Futher data processing included removal of outliers, binning to hourly means, minimal interpolation (piecewise cubic Hermite polynomial) over periods < 2 hours, and correction of chlorophyll data for non-photochemical quenching[7] using light irradiance measured by a co-deployed datalogger (Onset, HOBO). Phosphate and nitrate were measured from filtered WSW samples, and wind speed and tidal cycle were obtained from NOAA's Tides and Currents and National Data Buoy Center websites, respectively.



Wavelet Coherence: Tidal Cycle v. Surface Temperature



Wavelet Coherence: Tidal Cycle v. Surface Chlorophyll Fluorescence



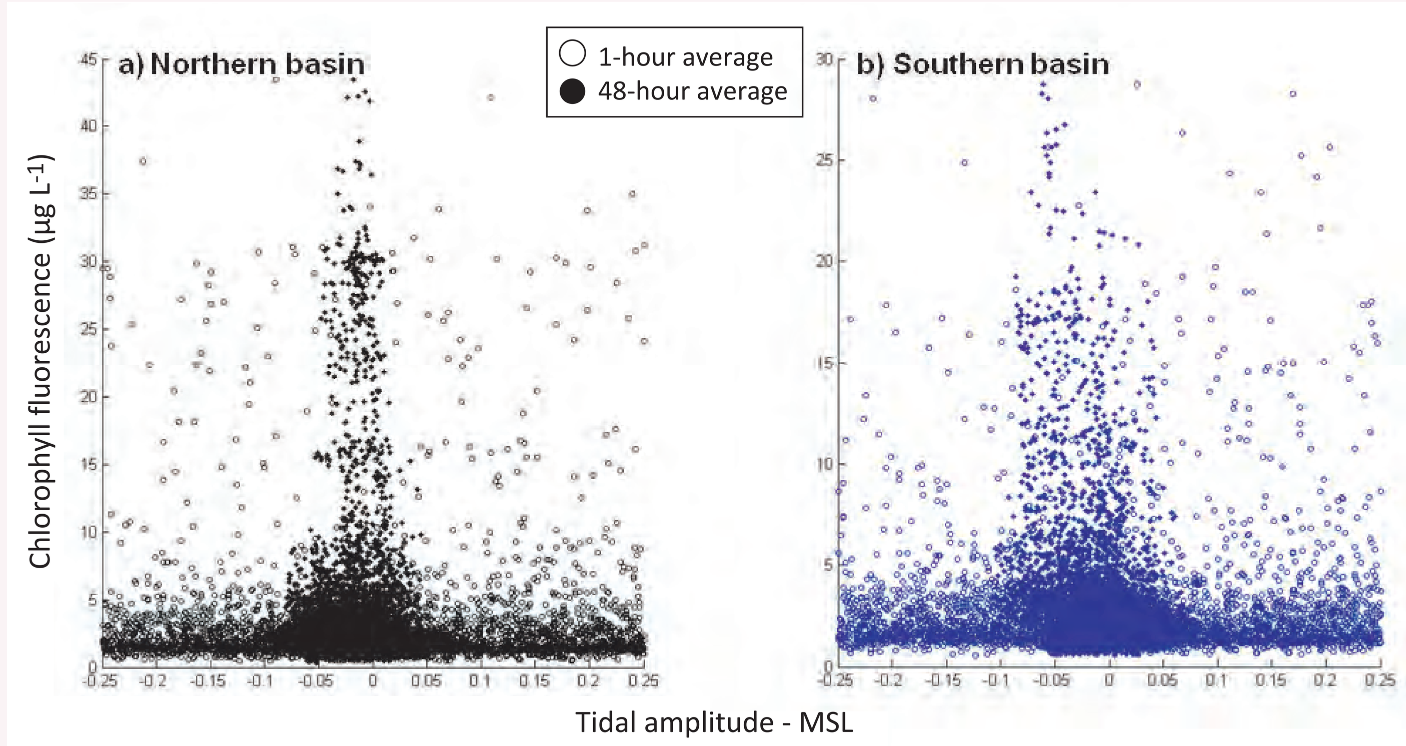
Wavelet Coherence Analyses: Sea surface **temperature** in the northern basin was **strongly correlated with tidal amplitude at both the diurnal and semi-diurnal periods** and less consistently correlated in the southern basin, particularly in the fall and winter months. The latter finding perhaps signifies a decoupling of the tidal cycle from thermal regulation during months when solar warming of the surface layer is minimal and storm events more significantly affect water column structure.

Significant, though more sporadic, correlations between tidal amplitude and chlorophyll fluorescence were also apparent throughout the year at both sites at both the **diurnal and semi-diurnal periods.**

Overall, wavelet coherence analysis indicated a **de-coupling of tidal cycle from temperature and chlorophyll fluorescence oscillations during periods of bloom initiation.** With the exception of the onset of bloom #5 in mid-January (which was strongly tied to the storm event in late December), **all blooms (numbered) occurred in periods during which both diurnal and semi-diurnal coherence were markedly absent.** This finding implies a general decrease in tidal forcing of the physical and biological water column at both the diurnal and semi-diurnal periods.

Wavelet Methods: All analyzed parameters were normalized to the mean and standard deviation for each dataset. All wavelet transforms were run in MATLAB using the SOWAS package[5,6], which utilizes more conservative area-wise significance testing (at the 95% level) to minimize false positives associated with point-wise testing of Torrence & Compo[12]. The Morlet continuous wavelet function, offering a good balance of resolution in both time and frequency[2], was used. An initial scale of 0.1 day (2 x the sampling scale) was used and scaled up six octaves consisting of 12 voices (sub-octaves) each. For coherence analyses, the time-series were smoothed 1 octave (sw = 0.5 in each direction) in scale and 3 periods in time (tw = 1.5 in each direction).

Environmental History and Biomass: Scatter plots of corrected surface chlorophyll fluorescence and tidal amplitude in the northern (a) and southern (b) basins of King Harbor revealed **increased chlorophyll fluorescence centered around low absolute values of tidal amplitude.** The relationship between tidal amplitude **averaged over the previous 48 h (filled symbols) and surface chlorophyll fluorescence was much more distinct** than comparisons using amplitudes occurring simultaneously, especially in the northern basin, suggesting a significant lag on the order of days between tidal forcing and algal biomass. Analysis of a distance-based regression model (DistLM, Permanova) revealed **19 %, 7.1 %, and 12 % of the variability** of chlorophyll in the **northern basin** was attributable to **1 h, 48 h, and 7 d** histories of tidal amplitude, respectively. In the southern basin, tidal amplitude contributed only 1.3 - 7.8 % of the variability explained by the model and was not a significant predictor variable.



Northern Basin

	0d lag	2d lag	7d lag
AICc	193.15	191.74	193.12
R^2	0.47449	0.4915	0.44251
Tide p	**0.006**	0.076	**0.013**
Tide % SS	**19.223**	7.0983	**11.968**
Other best variables	Temp, DO, Turb	Temp, Sal, DO	Temp, DO

Southern Basin

	0d lag	2d lag	7d lag
AICc	178.84	173.3	174.37
R^2	0.57615	0.67272	0.66422
Tide p	0.061	0.492	0.373
Tide % SS	7.78	1.3273	2.1622
Other best variables	Sal, NO_3, DO	Sal, PO_4, NO_3, Turb	Temp, Sal, PO_4, DO

Conclusions:

1) Tidal cycle was **de-coupled** from temperature and chlorophyll fluorescence during periods of bloom initiation (Exception: bloom 5 in mid-Jan composed of Euglenids and strongly tied to the storm event in late Dec).
2) Nine of the ten defined blooms began either during **neap tide** or a few days following neap tide, a period during which the semi-diurnal constituent is minimized, tidal amplitude is at a minimum, and tidally-induced mixing is theoretically low.
3) The tide-chlorophyll relationship was most apparent in the more **hydrodynamically constrained northern basin**, while chlorophyll in the southern basin was more skewed towards negative amplitude (e.g. low tide) time periods.
4) Incorporated into distance-based multiple regression models of chlorophyll, instantaneous and lagged averages for tidal amplitude accounted for 8-19 % and 1-8 % of total **variance explained** by those models in the northern and southern basins, respectively. Tidal amplitude was a significant contributor to the best models only in the northern basin.

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The characteristics of Lake Baikal's internal wave spectrum

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Abstract

Lake Baikal is the most voluminous and deepest (over 1.6 Km) fresh water body on earth holding 80% of the world's fresh water supplies. The lake supports a remarkable biodiversity with a major deep-water fauna composed almost entirely of endemic species. Due to the lake's great depth only the top 250 m are experiencing the direct effects of the wind. However, a strong signal is observed in the temperature around the inertial frequency most of the time and at all depths. Here we investigate the particularities of the IW spectrum and we focus on the inertial frequency band. Our goal is to evaluate the importance of the internal oscillations to the mixing and to correlate them to external forcing.

The site and the data

The temperature of the lake's South Basin has been systematically monitored for over a decade (since 2000) with moored stations placed close to the north-western coast. We are in possession of a time series with a temporal resolution between 10 s and 1 h and a vertical resolution varying between 25m at the top and the bottom and 150m in the mid depths. Additionally sparse velocity measurements are available, taken with a mechanical current meter placed either on the top of the mooring string or at the very bottom.

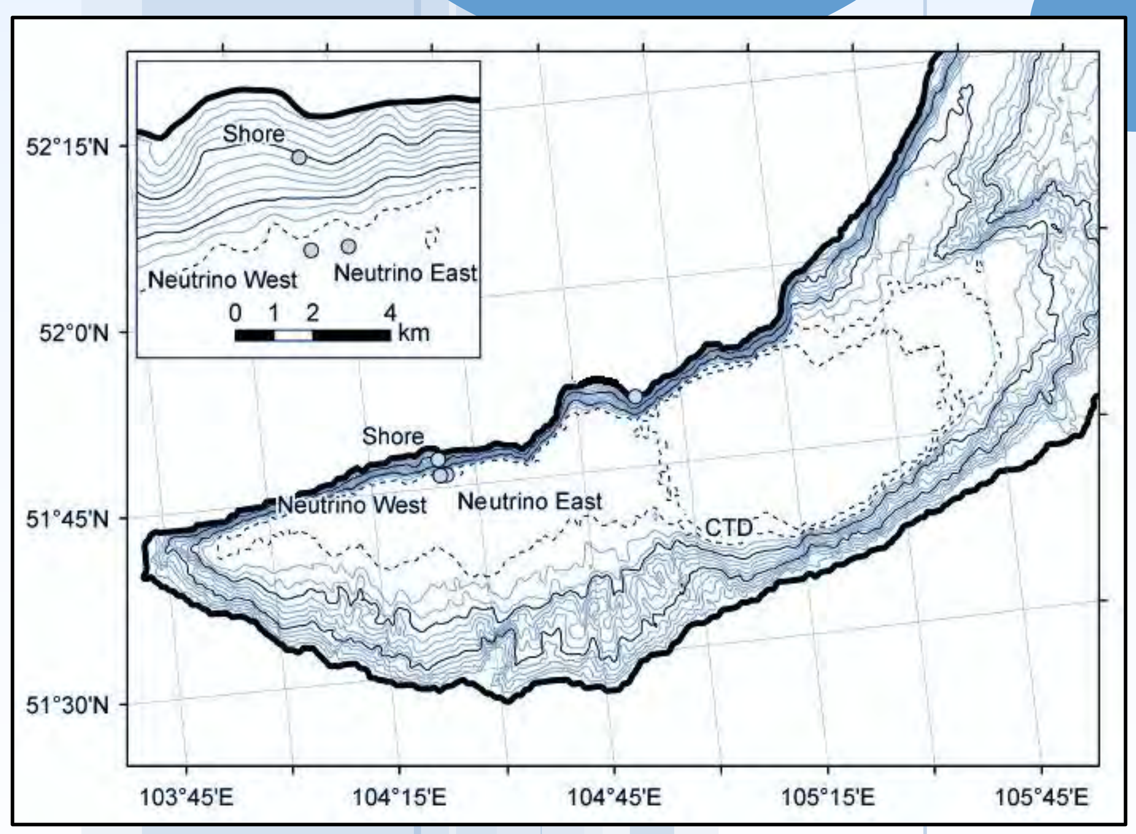

Figure 1. Locations of moorings and the South Basin bathymetry. The isobaths show depth intervals of 100 m. The darker lines mark intervals of 500 m, the dashed lines mark 1300 and 1400 m depth (Schmid et al., 2008).

Annual Temperature Regime

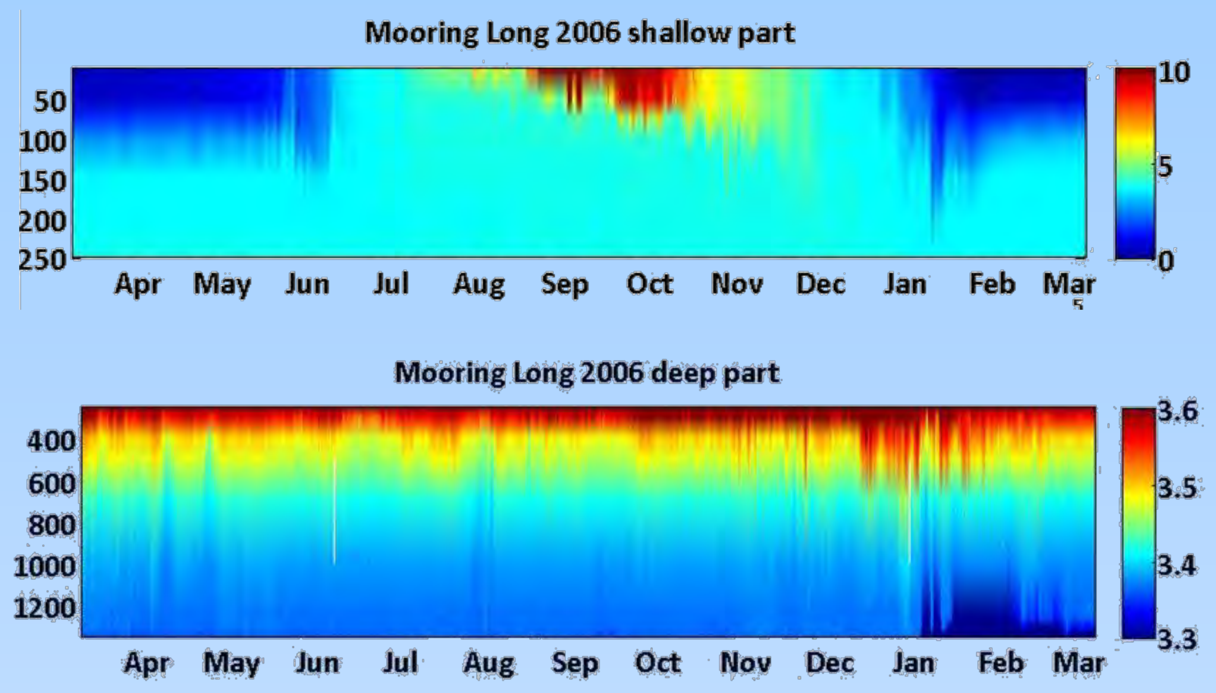

Figure 2. Annual temperature in the South Basin of Lake Baikal. Any significant change of the temperature is confined to the top 250 m. The surface temperature varies between 0 °C and 18 °C. The South Basin is completely ice-covered from January until May. A reverse thermobaric stratification exists (cold water overlying warm water) slightly before and during the ice cover facilitating deep convective processes. Below 250 m the temperature structure is very stable throughout the year with a very weak stratification ($N^2 = 10^{-7}$ -10^{-8} s^{-2}).

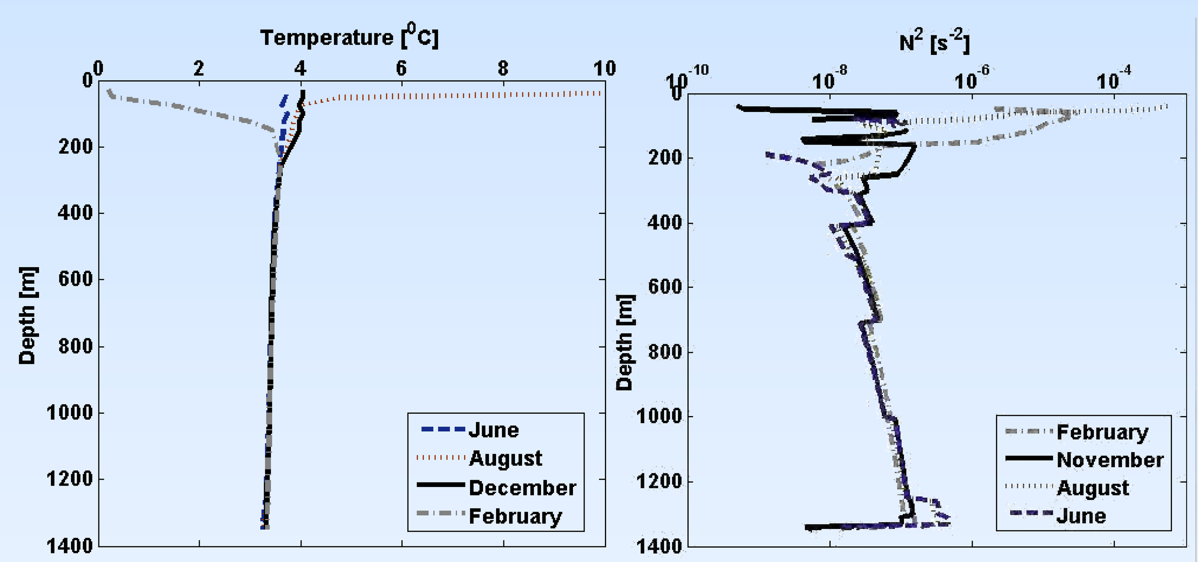

Figure 3. Annual temperature and stratification profiles. The salinity is almost constant and very low throughout the depth and thus the density gradient only depends on the temperature and pressure. The weak stratification below 250m depth, can only support inertial internal waves. At the top 250 m we also expect to find internal Kelvin waves.

Annual Temperature Spectra

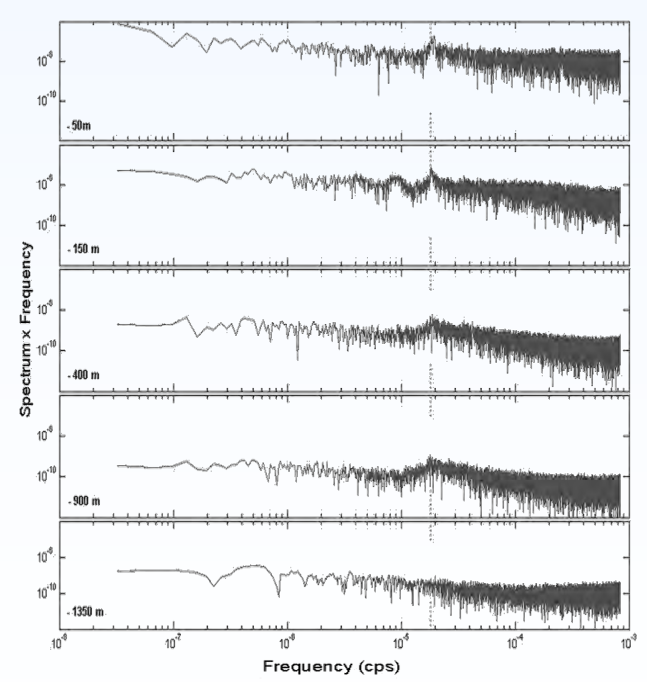

Figure 4. Typical annual spectrum at different depths of the lake at position Neutrino West. (fft of the temperature measurements). The dominant peak at shallow depths is very close to the inertial frequency, f=1.145 10^{-4} cycles per second, denoted by the dotted line. f corresponds to a period of 15 hrs 14 min.

Wavelet analysis

By adapting the wavelet code developed by Torrence C. and Compo G (1998) we analyze the available temperature data. To have an overview of the internal waves around the inertial frequency we apply a low-pass filter to exclude the seasonal and weekly oscillations.

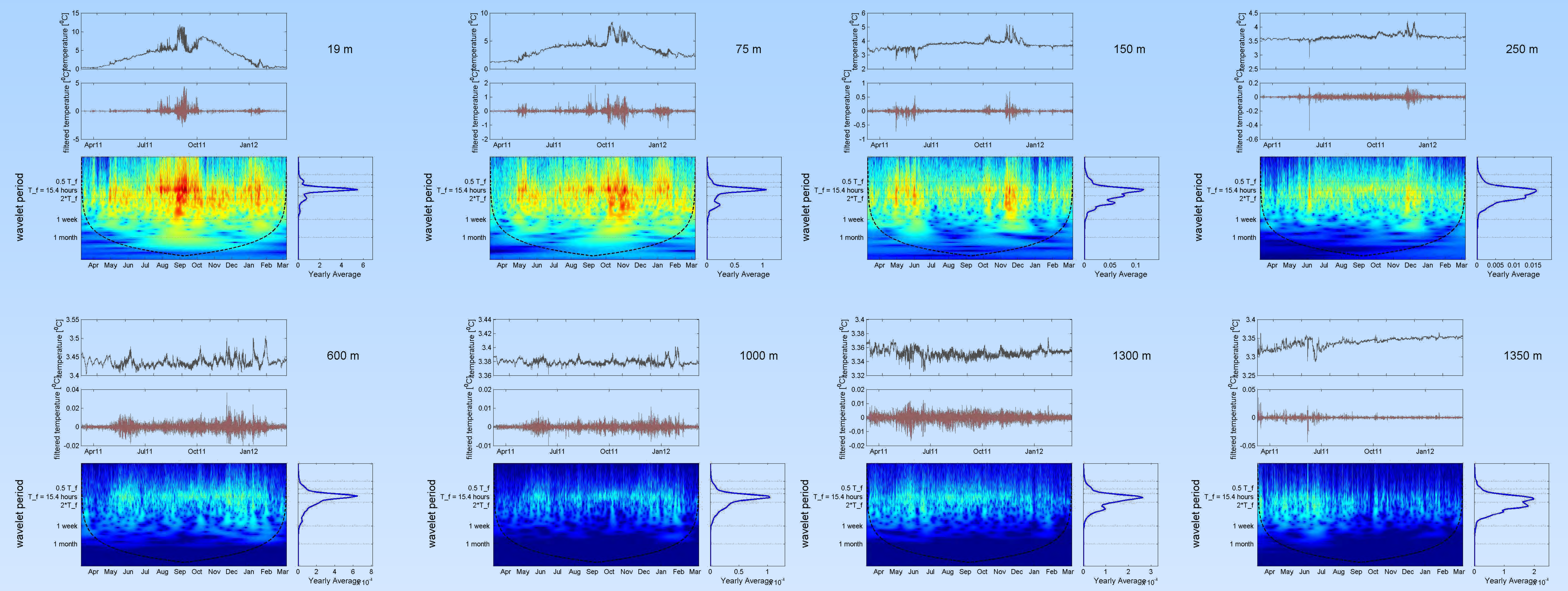

Figure 5. Wavelet analysis of the temperature from March 2011 to March 2012 at various depths at the Neutrino West mooring. Each subfigure includes, the actual temperature measurement (top), the detrended, with a 3-day moving average filter, signal (middle), the wavelet power spectrum [T^2] (bottom) and the annual cumulative power for each frequency (left). The colobar used indicates the wavelet power spectrum [T^2] and it is the same in all subfigures

As we are interested in the inertial frequency band, we integrate the spectra calculated above around f at each depth. In this way we can visualize the temporal and spatial distribution of the inertial oscillations

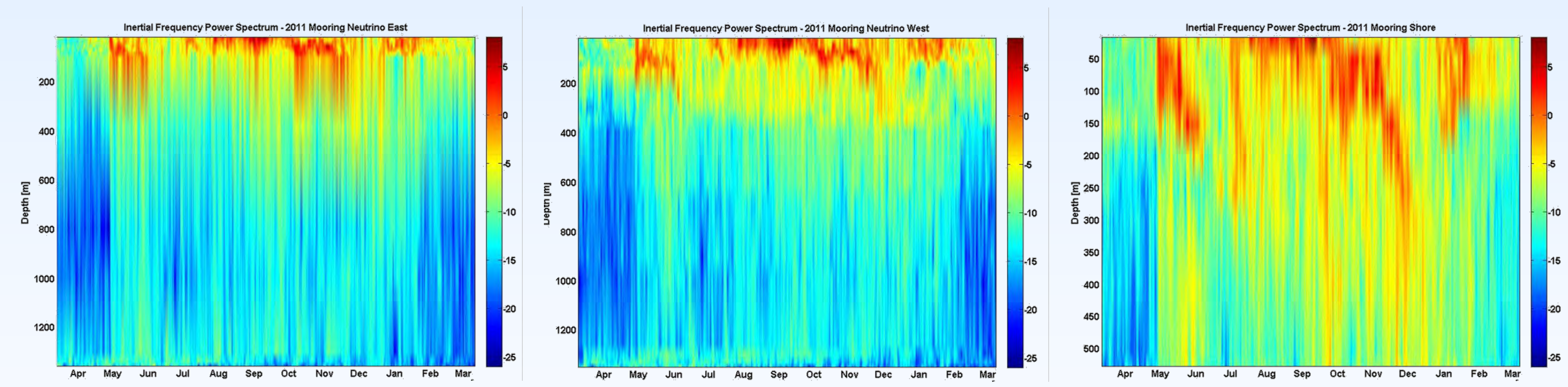

Figure 6. Integrated wavelet power spectrum around the inertial frequency for a whole year, at the three mooring stations of the South basin.

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Automated analysis in tuna long-range sonar signals for fishing vessels

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INTRODUCTION

PROBLEM DESCRIPTION

BINARY PROBLEM ->TUNA/NO TUNA

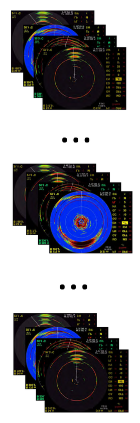
- Solve the problem of sonar image processing.
- A new methodology for automated analysis in tuna long-range sonar signals is presented.

DATABASE DESCRIPTION

Positive examples (tuna):832
Negative examples (no-tuna): 14506
ratio: 1/17.43

Slightly unbalanced DB.

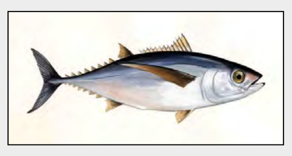
20 attributes per example



STUDY AREA & TECHNIQUES

- The artisanal fleet targets juvenile tuna every summer using live bait fishing techniques.

Albacore
(Thunnus alalunga)



Bluefin (Tunnus thynnus)

MATERIALS. SONAR EQUIPMENT

MAQ Sonar for the commercial fishing industry

+

Azti Tecnalia Black box for the Basque fishing fleet

- Port 400Mhz Video Splitter.
- External VGA Capture Device.
- Labtop. Pre-programmed with auto power on script, for continuous data acquisition.
- Power cord & Powerstrip.
- Discarded PCU cover, as protection.

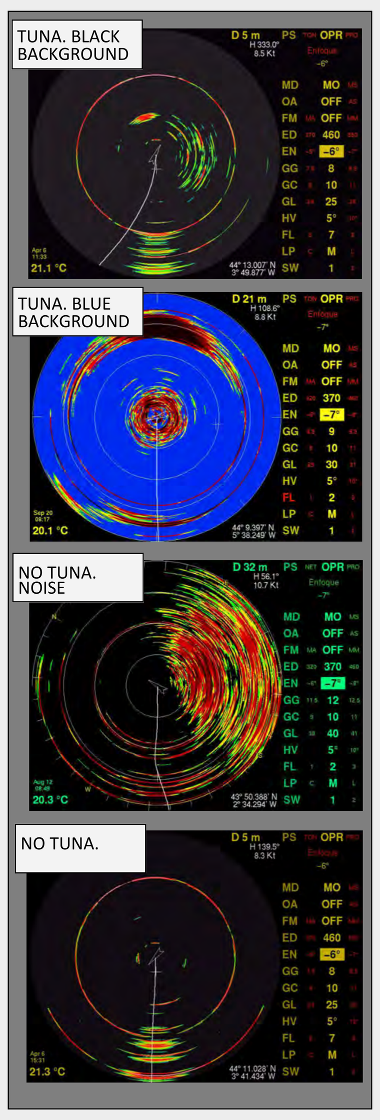
OBJECTIVE

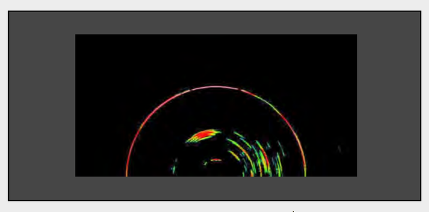
- To assess the possibility of getting acoustic-based abundance indices for bluefin tunas.
- Several uncertainties regarding the abundance of Atlantic bluefin tuna raised the need to develop fishery-independent abundance estimates.
- Comparative study of the data mining techniques over the sonar signal data.

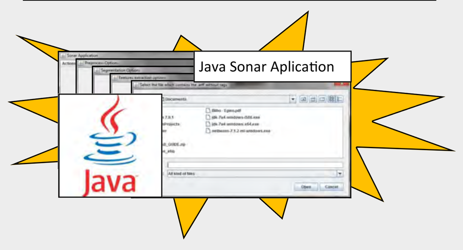
METHODS

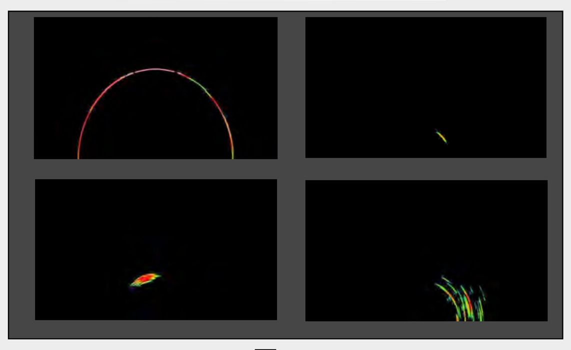
1. Pre-processing

1.IMAGE CAPTURE ⇨ 2. IMAGE PRE-PROCESSING ⇨ 3. SEGMENTATION









4. CHARACTERISTICS EXTRACTION ⇨ 5. EXPERTS ON LABELING

Generation of a complete DB. (*.arff format)

```
@relation sonar
 @attribute Area numeric
...
@attribute Solidity numeric
@attribute class {artefactos,atun}
@data
HEGALABUR_1321_11,...Attribute Values...,0.296,artefactos
                    ...
HEGALABUR_1321_125,... All Characteristic Values...,0.417,atun
```

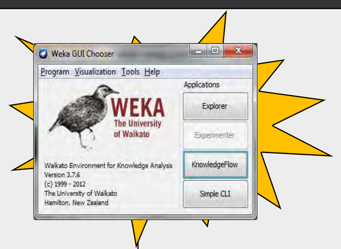
Generation of an incomplete DB. (*.arff format)

```
@relation sonar
 @attribute Area numeric
...
@attribute Solidity numeric
@attribute class {}
@data
HEGALABUR_1321_11,...Attribute Values...,0.296,?
                    ...
HEGALABUR_1321_125,... All Characteristic Values...,0.417,?
```

BD with 20 Attributes

Area, X, Y, Perimeter, BX, BY, Width, Height, Major, Minor, Angle, Circularity, Feret, FeretX, FeretY, FeretAngle, MinFeret, AR, Round, Solidity.

2. Attribute selection



Complete Database (Complete DB)

↓

ATTRIBUTE SELECTION METHODS (ASM)
InfoGain, GainRatio, Chi Squared, Principal Components Analysis.

Generation of Databases with different number of attributes: 5-20 attributes

↓

Reduced databases

↓

Random Forest

↓

Selection of NUMBER of attributes based on:
Kappa, Sensitivity, Specificity, AUC, CPU Time

↓

Best Reduced Database (BR-DB): InfoGain (10 attributes)

Selected attributes (10): MinFeret, Width, Area, Major, Minor, Perimeter, Feret, Height, BY, Angle.

3. Classification

BR-DB

⇩

SMOTE filter for unbalanced DB

⇩

Complete DB | **BR-DB+SMOTE** | **BR-DB**

⇩

CLASSIFICATION METHODS (CM)
Naive Bayes, IBK, J48, MultiLayer Perceptron, Random Forest

⇩

RESULTS EVALUATION based on:
Kappa, Sensitivity, Specificity, AUC, CPU Time

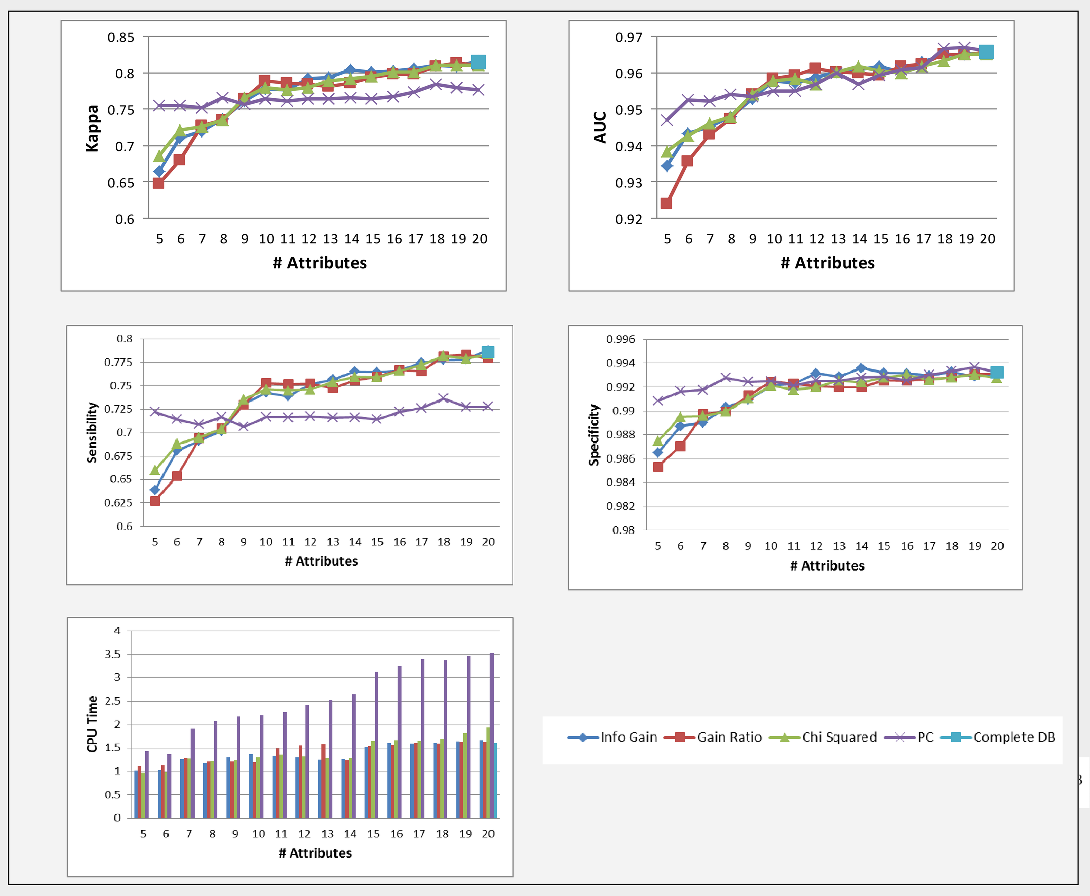
⇩

COMPARISON

RESULTS & DISCUSSION

Attribute selection

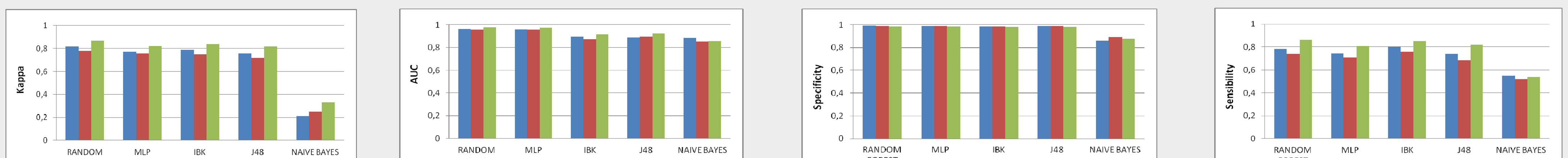
- Mean values of Kappa index, AUC (Area under ROC), sensibility, specificity, and CPU time have been computed for 10 runs of cross-validation with 10 folds.



- **Info Gain (10 attributes)** has been chosen. It has a good performance for all indices and it has reduced significantly the CPU time.

Classification

- Mean values of Kappa index, AUC (Area under ROC), sensibility, specificity, and CPU time have been computed for 30 runs of cross-validation with 10 folds to avoid overfitting and to found stable results.



Complete DB

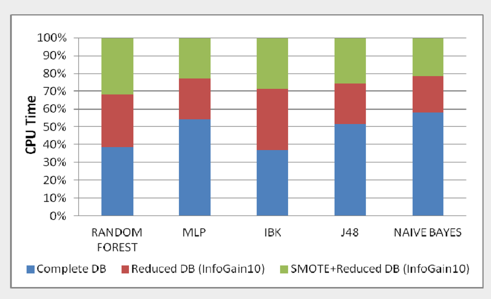
	Kappa Mean	Kappa Min	Kappa Max	Kappa SD	AUC Mean	AUC Min	AUC Max	AUC SD	Sensibility Mean	Sensibility Min	Sensibility Max	Sensibility SD	Specificity Mean	Specificity Min	Specificity Max	Specificity SD	CPU Time Mean	CPU Time Min	CPU Time Max	CPU Time SD
RANDOM FOREST	0.816	0.806	0.825	5.10E-03	0.966	0.961	0.973	2.79E-03	0.786	0.769	0.805	7.40E-03	0.993	0.993	0.994	3.51E-04	1.606	1.537	1.830	5.86E-02
MLP	0.772	0.755	0.789	7.05E-03	0.962	0.957	0.968	2.91E-03	0.745	0.722	0.772	9.88E-03	0.991	0.989	0.993	7.49E-04	55.720	54.636	57.099	6.01E-01
IBK	0.789	0.778	0.797	4.60E-03	0.894	0.888	0.897	2.25E-03	0.799	0.787	0.805	4.38E-03	0.989	0.988	0.989	4.00E-04	2.60E-03	1.00E-06	7.80E-03	1.80E-03
J48	0.756	0.744	0.767	7.07E-03	0.890	0.872	0.905	9.45E-03	0.740	0.719	0.764	9.63E-03	0.989	0.988	0.991	5.95E-04	1.034	0.899	1.376	1.64E-01
NAIVE BAYES	0.212	0.211	0.213	5.38E-04	0.885	0.884	0.885	2.17E-04	0.551	0.550	0.552	5.98E-04	0.860	0.860	0.860	1.70E-04	0.135	0.131	0.148	3.44E-03

Best Reduced DB (Info Gain 10 attributes)

	Kappa Mean	Kappa Min	Kappa Max	Kappa SD	AUC Mean	AUC Min	AUC Max	AUC SD	Sensibility Mean	Sensibility Min	Sensibility Max	Sensibility SD	Specificity Mean	Specificity Min	Specificity Max	Specificity SD	CPU Time Mean	CPU Time Min	CPU Time Max	CPU Time SD
RANDOM FOREST	0.778	0.766	0.788	5.79E-03	0.956	0.950	0.959	2.15E-03	0.742	0.725	0.752	6.61E-03	0.992	0.991	0.993	5.43E-04	1.241	1.181	1.326	4.08E-02
MLP	0.756	0.736	0.770	8.23E-03	0.957	0.951	0.964	3.24E-03	0.711	0.672	0.737	1.60E-02	0.992	0.990	0.993	8.23E-04	23.455	22.264	26.358	1.33E+00
IBK	0.750	0.736	0.764	5.95E-03	0.873	0.867	0.879	2.86E-03	0.759	0.746	0.770	5.53E-03	0.987	0.986	0.988	5.00E-04	0.002	0.000	0.006	1.82E-03
J48	0.720	0.702	0.752	9.53E-03	0.894	0.871	0.915	9.07E-03	0.683	0.662	0.721	1.25E-02	0.990	0.988	0.991	7.44E-04	0.451	0.424	0.505	2.16E-02
NAIVE BAYES	0.250	0.248	0.251	7.65E-04	0.852	0.852	0.852	2.07E-04	0.522	0.521	0.524	8.93E-04	0.892	0.892	0.893	1.21E-04	0.048	0.044	0.051	1.89E-03

Best Reduced DB (Info Gain 10 attributes) with SMOTE filter

	Kappa Mean	Kappa Min	Kappa Max	Kappa SD	AUC Mean	AUC Min	AUC Max	AUC SD	Sensibility Mean	Sensibility Min	Sensibility Max	Sensibility SD	Specificity Mean	Specificity Min	Specificity Max	Specificity SD	CPU Time Mean	CPU Time Min	CPU Time Max	CPU Time SD
RANDOM FOREST	0.865	0.857	0.872	4.10E-03	0.981	0.978	0.984	1.24E-03	0.864	0.856	0.874	4.51E-03	0.988	0.987	0.989	6.11E-04	1.320	1.293	1.367	1.79E-02
MLP	0.821	0.812	0.831	4.90E-03	0.974	0.971	0.978	1.65E-03	0.808	0.786	0.826	9.54E-03	0.986	0.982	0.988	1.49E-03	23.438	23.294	23.934	1.62E-01
IBK	0.841	0.837	0.847	2.71E-03	0.918	0.915	0.921	1.59E-03	0.852	0.846	0.856	3.15E-03	0.985	0.984	0.985	4.41E-04	0.002	0.000	0.006	1.79E-03
J48	0.819	0.809	0.827	5.58E-03	0.926	0.917	0.938	4.59E-03	0.820	0.809	0.834	6.51E-03	0.984	0.983	0.985	6.91E-04	0.515	0.490	0.641	2.94E-02
NAIVE BAYES	0.334	0.332	0.335	4.92E-04	0.857	0.857	0.857	1.27E-04	0.539	0.538	0.540	3.78E-04	0.880	0.880	0.881	1.16E-04	0.050	0.044	0.062	4.20E-03



- Mean, min, max values and standard deviation for all experiments have been computed, to compare the quality of results.
- As shown in the previous table, the method yields a good performance both as the quality of classification as CPU time.

CONCLUSIONS

Main ideas to take home

A new supervised classification methodology for automated analysis in tuna long-range sonar signals is presented.

The method yields a good performance both as the quality of classification as CPU time.

High specificity and lower sensibility than expected is observed in the performance of the algorithms. This is due to the morphological similarity of the tuna and no-tuna images.

For future efforts, to solve the problem of morphological similarities among tuna and no-tuna images, should be considered a study of temporality.

References

- Ian H. Witten; Eibe Frank, Mark A. Hall (2011). *Data Mining: Practical machine learning tools and techniques, 3rd Edition.* Morgan Kaufmann, San Francisco.
- R.C. Gonzalez and R.E. Woods (2008). *Digital Image Processing, 3rd Edition.* Prentice Hall, New Jersey.

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