Proceedings after

JERICO Science Day
28th – 29th April 2015

Grant Agreement n° 262584
Project Acronym: JERICO

Project Title: Towards a Joint European Research Infrastructure network for Coastal Observatories

Coordination: P. Farcy, IFREMER

jerico@ifremer.fr, www.jerico-fp7.eu:

Authors: I. Puillat, N. Beaume, S. Pichereau
Involved Institution: Ifremer
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SEVENTH FRAMEWORK PROGRAMME

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I] Introduction

The JERICO Science Day presented researches and developments supported by the JERICO infrastructure, including scientific results after TNA experiments, Observing Simulation Experiments and Observing SS, and technologies updated or developed. Each talk was divided into a 15-minute presentation and a 5-minute discussion.
Poster sessions were planned during coffee breaks and after lunch.

Hereafter, abstracts of presentations are given, as well as the presented slides when authorised by the authors.

Agenda

Time slot	Topic	Speaker

	Tuesday, 28th of April – Science Day	
16:00–17:45	**Topic 1: Harmonisation, Technology, sensors & platforms** **Chairpersons: Wilhelm Petersen (HZG) & Georges Petihakis (HCMR)**	
16:00-16:20	1. *Comparison of 3 ferrybox ferry observations in the Baltic Sea*	S.Kaitala (SYKE)
16:20-16:40	2. *Unmanned Surface Vehicles and Voluntary Observing Ship for oceanographic in situ measurements*	L. Delauney (Ifremer)
16:40-17:00	3. *Evaluation of different typology of commercial sensors to be used on fishing gears*	S. Sparnocchia (CNR)
17:00-17:20	4. *JERICO - Biofouling Monitoring Program (BMP): biofouling diversity on different materials, exposure conditions and locations.*	G. Pavanello (CNR)
17:20-17:45	5. *Results from 3 TNA calibration experiments (CIEBIO, RTC and TOFU) and Toward a networking approach for metrology in oceanography*	M. Ntoumas (HCMR) and F. Salvetat (Ifremer)
	End of first day – Science Day [18:00: Bus to Railway station & Ibis Styles]	
19:30	*Dinner at the Yacht Club*	

Wednesday, 29th of April – Science Day (con't)		
08:00-08:45	**Bus to Ifremer (Stop at Ibis Styles & Railway station)**	
08:45-10:45	**Topic 2: Integrated monitoring, Modelling & in situ observation, network assessment** **<u>Chairpersons:</u> Stefania Sparnocchia (CNR) & Julien Mader (AZTI)**	
08:45-09:05	6. *Optimizing observation networks in the Bay of Biscay and English Channel*	G. Charria (Ifremer)
09:05-09:25	7. *Evaluation of numerical models by FerryBox and Fixed Platform in-situ data in the southern North Sea*	M. Haller (HZG)
09:25-09:45	8. *Observation system experiments and observation system simulation experiments in the Baltic Sea*	Z. Wan (DMI)
09:45-10:05	9. *Hydrography and fluorescence variability induced by 3 eddies, observed during the GESEBB mission*	J. Mader (AZTI)
10:05-10:25	10. *Multiscale monitoring in Mediterranean with gliders: the Jerico TNA experience (ABACUS, FRIPP, GABS, MUSICS)*	A. Ribotti (CNR)
10:25-10:45	11. *Particle fluxes in the Sicily Channel - Preliminary results from the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment*	S. Sparnocchia (CNR)
10:45-11:15	*Coffee break and poster session*	
11:15-12:15	**Topic 3: Monitoring of biological compartment** **<u>Chairpersons:</u> Antoine Grémare (CNRS) & Jukka Seppälä (SYKE)**	
11:15-11:35	12. *Monitoring phytoplankton taxonomy and productivity using fluorometry*	J. Seppälä (SYKE)
11:35-11:55	13. *Algal bloom observations using the JERICO infrastructure*	M. Mohlin (SMHI)
11:55-12:15	14. *Surveying the whole plankton community with imaging systems*	J.B. Romagnan (CNRS)
12:15-12:45	*Poster session*	
12:45-14:00	*Lunch (Ifremer)*	

14:00-15:00	**Topic 3: Monitoring of biological compartment** **<u>Chairpersons:</u> Antoine Grémare (CNRS) & Jukka Seppälä (SYKE)**	
14:00-14:20	15. *Image analysis developments within JERICO*	A. Gremare (CNRS)
14:20-14:40	16. *Dissolved oxygen variability of the LIW in the Ligurian Sea (OXY-COR TNA results)*	L. Coppola (CNRS)
14:40-15:00	17. *Field test of microLFA modules for on-line measurement of NH_3 and PO_4 in Ferrybox (FITO MicroLFA)*	L. Sanfilippo (Systea)
15:00-18:00	**Topic 4: Monitoring of Chemicals and contaminants, pH & carbonate systems** **<u>Chairpersons:</u> Kai Sorensen (NIVA) & Laurent Delauney (Ifremer)**	
15:00-15:20	18. *Physicochemical characterization of aerosols in the Adriatic Sea (MAPOM)*	C. Quentin (CNRS)
15:20-15:40	19. *Unmanned tools for monitoring chemical pollution in coastal waters study (MEDACID)*	L. Nizzetto (NIVA)
15:40-16:10	*Coffee break and poster session*	
16:10-16:30	20. *Legacy and Emerging Chemical Contaminants in European Coastal waters (ECCECs)*	M. Brumovsky (RECETOX)
16:30-16:50	21. *Sensor developments for continuous measurements of pH and alkalinity on FerryBox systems*	W. Petersen (HZG)
16:50-17:10	22. *Combined pCO_2-pH in situ metrology: assessing acidification in Norwegian coastal waters*	E. Reggiani (NIVA)
17:10-17:30	23. *Seasonal pH variability in the Saronikos Gulf: a year study (MEDACID)*	A. González (ULPG)
17:30-18:00	*Poster session*	
End of the Science Day [18:00: Bus to Railway station & Ibis Styles]		

Participant List

Family name	Surname	Institution	Email @
Almeida	Sara	IH	sara.almeida@hidrografico.pt
Bastianini	Mauro	CNR	mauro.bastianini@ismar.cnr.it
Beaume	Nolwenn	IFREMER	nolwenn.beaume@ifremer.fr
Blauw	Anouk	Deltares	anouk.blauw@deltares.nl
Boukerma	Kada	IFREMER	kada.boukerma@ifremer.fr
Brumovsky	Miroslav	RECETOX	brumovsky@recetox.muni.cz
Buch	Erik	EuroGOOS	erik.buch@eurogoos.eu
Chapalain	Georges	Cerema/LGCE	Georges.Chapalain@cerema.fr
Charria	Guillaume	IFREMER	guillaume.charria@ifremer.fr
Colijn	Franciscus	HZG	franciscus.colijn@hzg.de
Coppola	Laurent	CNRS	coppola@obs-vlfr.fr
Delauney	Laurent	IFREMER	Laurent.delauney@ifremer.fr
Delory	Eric	PLOCAN	eric.delory@plocan.eu
Durand	Dominique	NIVA/IRIS	dodu@iris.no
Farcy	Patrick	IFREMER	patrick.farcy@ifremer.fr
Galea	Anthony	UoM	anthony.j.galea@um.edu.mt
Gaughan	Paul	MI	paul.gaughan@marine.ie
Gonzalez	Aridane	ULPGC	aridaneglez@gmail.com
Gorringe	Patrick	EuroGOOS	patrick.gorringe@eurogoos.eu
Grémare	Antoine	CNRS/UB	antoine.gremare@u-bordeaux
Haller	Michael	HZG	michael.haller@hzg.de
Kaitala	Seppo	SYKE	seppo.kaitala@ymparisto.fi
Keeble	Simon	BLIT	simon@bluelobster.co.uk
Krieger	Magali	IFREMER	magali.krieger@ifremer.fr
Laakso	Lauri	FMI	Lauri.Laakso@fmi.fi
Lamouroux	Julien	Noveltis	julien.lamouroux@noveltis.fr
Lefebvre	Alain	IFREMER	alain.lefebvre@ifremer.fr
Loubrieu	Thomas	IFREMER	Thomas.Loubrieu@ifremer.fr

Mader	Julien	AZTI	jmader@azti.es
Mills	David	CEFAS	david.mills@cefas.co.uk
Mohlin	Malin	SMHI	Malin.Mohlin@smhi.se
Morin	Pascal	CNRS	pmorin@ipev.fr
Nair	Rajesh	OGS	rnair@ogs.trieste.it
Newton	Janet	Univ Washington	newton@apl.washington.edu
Nizzetto	Luca	NIVA	luca.nizzetto@niva.no
Nolan	Glenn	MI	glenn.nolan@marine.ie
Norli	Marit	NIVA	marit.norli@niva.no
Ntoumas	Manolis	HCMR	mntou@hcmr.gr
Pavanello	Giovanni	CNR	giovanni.pavanello@ge.ismar.cnr.it
Perivoliotis	Leonidas	HCMR	lperiv@hcmr.gr
Petersen	Wilhelm	HZG	wilhelm.petersen@hzg.de
Petihakis	George	HCMR	gpetihakis@hcmr.gr
Petit de la Villéon	Loic	IFREMER	Loic.Petit.De.La.Villeon@ifremer.fr
Pichereau	Sylvie	IFREMER	sylvie.pichereau@ifremer.fr
Puillat	Ingrid	IFREMER	ingrid.puillat@ifremer.fr
Quentin	Céline	CNRS	celine.quentin@mio.osupytheas.fr
Reggiani	Emanuele	NIVA	ere@niva.no
Ribotti	Alberto	CNR	alberto.ribotti@cnr.it
Riminucci	Francesco	CNR	francesco.riminucci@bo.ismar.cnr.it
Riou	Philippe	IFREMER	philippe.riou@ifremer.fr
Robakiewicz	Małgorzata	IBW PAN	marob@ibwpan.gda.pl
Robin	Agnès	EC	agnes.robin@ec.europa.eu
Romagnan	Jean-Baptiste	UPMC	romagnan@obs-vlfr.fr
Salvetat	Florence	IFREMER	florence.salvetat@ifremer.fr
Sanfilippo	Luca	SYSTEA SpA	luca.sanfilippo@systea.it
Seppälä	Jukka	SYKE	jukka.seppala@ymparisto.fi
Slabakova	Violeta	IO-BAS	v.slabakova@io-bas.bg
Sørensen	Kai	NIVA	kai.sorensen@niva.no
Sparnocchia	Stefania	CNR	stefania.sparnocchia@ts.ismar.cnr.it
Taupier-Letage	Isabelle	CNRS	isabelle.taupier-letage@ifremer.fr

Testor	Pierre	CNRS	testor@locean-ipsl.upmc.fr
Tintore	Joaquin	IMEDEA	jtintore@uib.es
Turpin	Victor	CNRS	vtlod@locean-ipsl.upmc.fr
Vukicevic	Tomislava	CMCC	tomislava.vukicevic@cmcc.it
Wan	Zhenwen	DMI	zw@dmi.dk
Wehde	Henning	IMR	henning.wehde@imr.no

II] Topic 1: Harmonization, Technology, sensors & platforms

01- Comparison of 3 ferrybox observations in the Baltic Sea

Seppo Kaitala, Petri Maunula, Mikko Jalo, Jukka Seppälä, Pasi Ylöstalo, (all SYKE)

- 4 key words: Ferrybox, chlorophyll fluorescence, salinity, temperature, instrument calibration
- 2 Regional key words: Baltic Sea

The annual Alg@line ferrybox instrument calibration is carried out in February in Finnish Environment institute (SYKE). In the calibration workshop also SMHI, EMI and MSI participate with their own instruments. The CDOM fluorimeters are calibrated with solid standards, turbidity with formazin standard and chlorophyll with algae culture. All equipment are compared also with each other. The ferries with these instruments operate in the Central Baltic and occasionally occur in the same area within the 24 hours. This gives the opportunity to compare the ferrybox observations in the same area by different ferries. Spatiotemporal comparisons of chlorophyll fluorescence, temperature and salinity observations are demonstrated.

Slides are presented in the next pages

SYKE

Comparison of 3 ferrybox ferry observations in the Baltic Sea

Seppo Kaitala I Finnish Enviroment Institute SYKE I Email seppo.kaitala@environment.fi

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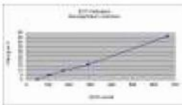
Annual calibration of fluotometers (in February)



Factory calibration

Chlorophyll	Counts	CHL ug/l=	(Counts - 49)	*0.0182
Factory set	**ECO**	CHL ug/l=	-0,8918 +0,0182*Counts	

2015			
ECO SN1287		Counts	
no	**Chla ug/l**	**ECO**	CHL ug/l
1	0	50	0,0182
2	4,77	108	1,0738
3	9,33	174	2,275
4	16,21	291	4,4044
5	46,43	665	11,2112
"Monoraphidium Standard" µg/l			

Factory Set values

NEW REGRESSION

y's=CHL (values) x's=FLUOR (values)			
const=True stats=TRUE			
0,074986	-3,96837	X Coefficie	Constant, y-intercept
0,002207	0,746213	Std Err of Co	Std Err of Y Est
0,997407	1,080445	R squared	residual sum of squares
1153,888	3	F	Degrees of freedom

Chlorophyll CHL ug/l= -3,96837 +0,075*Counts

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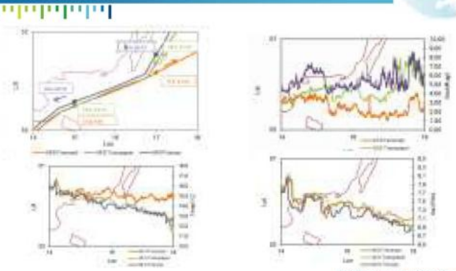
Three Alg@line ferrybox ferries comparison 27-29.6.2014 by Swedish coast



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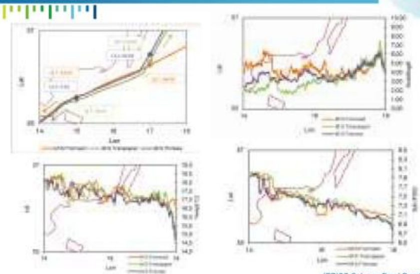
Three Alg@line ferrybox ferries comparison 12-13.7.2014 by Swedish coast



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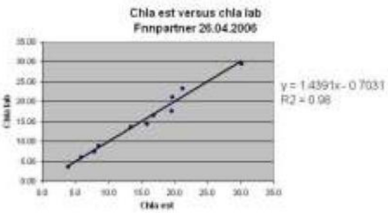
Weekly validation of chlorophyll fluorometer Spring bloom case



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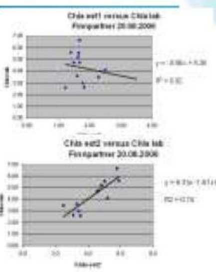
Weekly validation of chlorophyll fluorometer Summer with cyanobacteria blooming

Chlorophyll-a validation of chlorophyll-a fluorescence against chlorophyll-a analysis with extraction



Validation of same records with phycocyanin as auxiliary parameter

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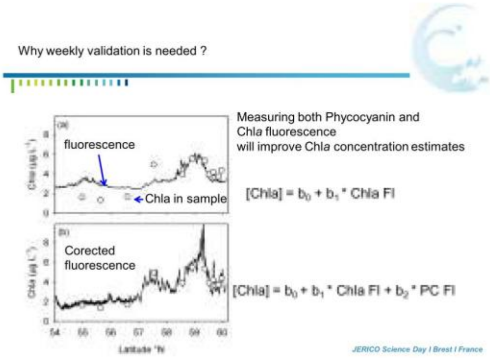
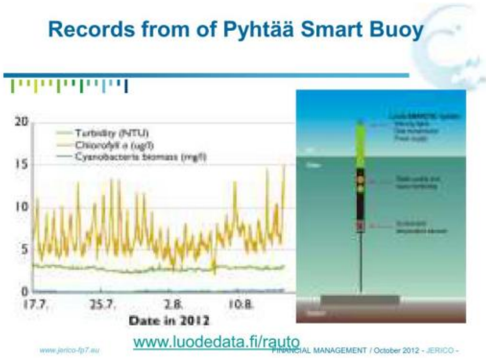
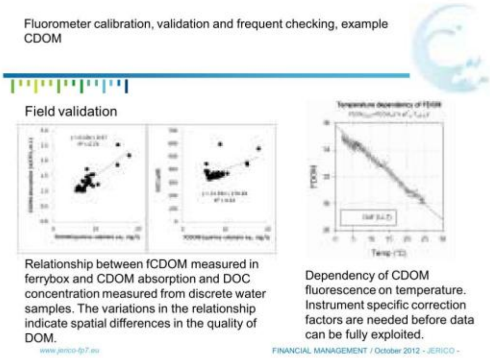
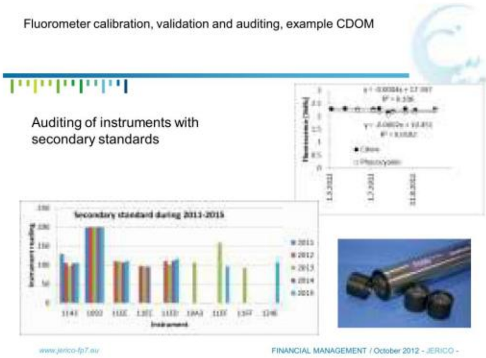
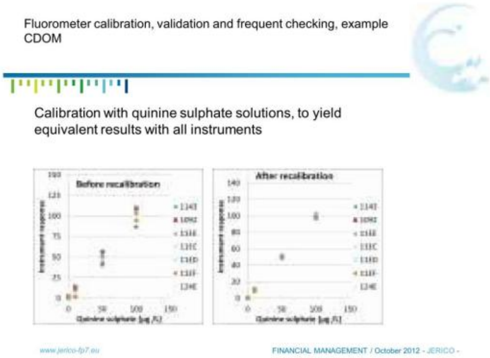
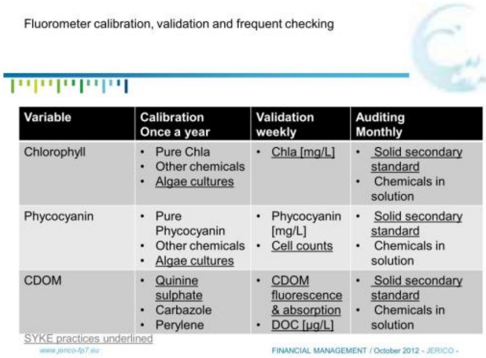




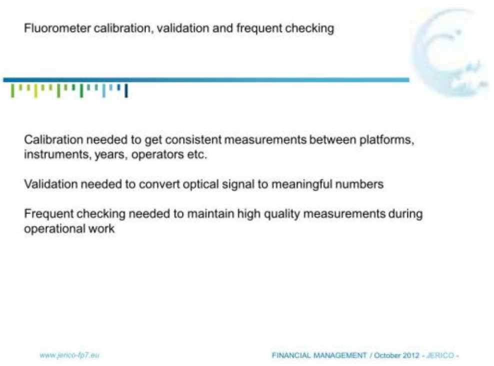








Variable	Calibration Once a year	Validation weekly	Auditing Monthly
Chlorophyll	• Pure Chla • Other chemicals • Algae cultures	• Chla [mg/L]	• Solid secondary standard • Chemicals in solution
Phycocyanin	• Pure Phycocyanin • Other chemicals • Algae cultures	• Phycocyanin [mg/L] • Cell counts	• Solid secondary standard • Chemicals in solution
CDOM	• Quinine sulphate • Carbazole • Perylene	• CDOM fluorescence & absorption • DOC [µg/L]	• Solid secondary standard • Chemicals in solution


Fluorometer calibration, validation and frequent checking
Calibration needed to get consistent measurements between platforms, instruments, years, operators etc.
Validation needed to convert optical signal to meaningful numbers
Frequent checking needed to maintain high quality measurements during operational work
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Thank you
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02- Unmanned Surface Vehicles and Voluntary Observing Ship for oceanographic in situ measurements

Laurent Delauney (Ifremer), Loic Dussud, Patrick Rousseau, Thierry Terre & Olivier Menage (Ifremer)
Laurent.delauney@ifremer.fr

- 4 key words: USV, in situ, measurement, oceanography
- 2 Regional key words: every regions

Unmanned Surface Vehicle (USV) and Voluntary Observing Ship (VOS) are a growing trend for ocean *in situ* monitoring. However, the use of such medium for *in situ* automated measurement is not without problems and questions. In addition, the diversity of possibilities from ferry boat to drone through racing or pleasure yachts requires to well adapt its choices based on precise specifications.
This presentation proposes to review existing and futuristic systems and to give feedbacks of already running usage.
Actual market and commercial catalogue is mainly orientated to lake application and gas/petroleum offshore services. Scientific surface vehicle is growing little by little and few systems are available for deployment. Actual medium can be categorized in function of their purpose and capability in term of autonomy, navigability, payload capacity, energy availability, adaptability to *in situ* measurement; real time data transfer possibility, maintenance frequency for the embedded instrumentation, and, in some extent, global operation cost.
These new vehicles (USV) and VOS will be as well compared to actual well known oceanographic *in situ* measurement methodologies like drifters, profiling floats, gliders and Ferrybox.

Slides are presented in the next pages


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JERICO
JOINT EUROPEAN RESEARCH INFRASTRUCTURE NETWORK FOR COASTAL OBSERVATORIES
USV Novel platforms
Delauney Laurent - Dussud Loic
Ifremer REM/RDT/DCM - REM/RDT/I2M
laurent.delauney@ifremer.fr
loic.dussud@ifremer.fr
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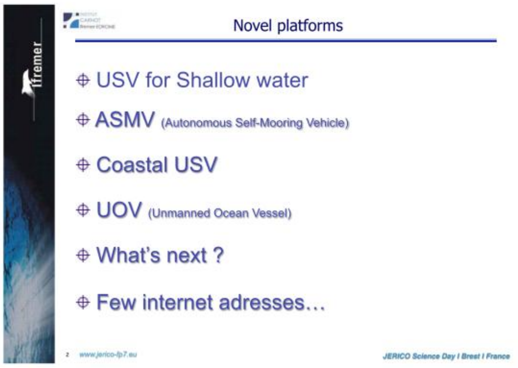
Novel platforms
USV for Shallow water
ASMV (Autonomous Self-Mooring Vehicle)
Coastal USV
UOV (Unmanned Ocean Vessel)
What's next ?
Few internet adresses…
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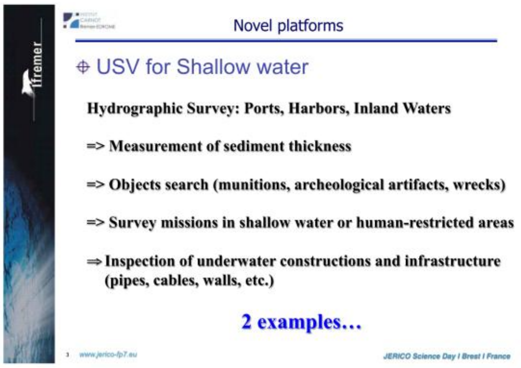
Novel platforms
USV for Shallow water
Hydrographic Survey: Ports, Harbors, Inland Waters
=> Measurement of sediment thickness
=> Objects search (munitions, archeological artifacts, wrecks)
=> Survey missions in shallow water or human-restricted areas
⇒ Inspection of underwater constructions and infrastructure (pipes, cables, walls, etc.)
2 examples…
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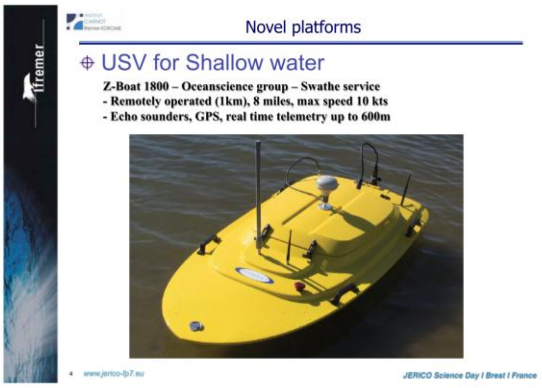
Novel platforms
USV for Shallow water
Z-Boat 1800 – Oceanscience group – Swathe service
- Remotely operated (1km), 8 miles, max speed 10 kts
- Echo sounders, GPS, real time telemetry up to 600m
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Novel platforms
USV for Shallow water
Evo logics, sonoboat
- 10 hours operation, auto or radio controlled, 35 kg
- Echo sounders, GPS, camera
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Novel platforms
ASMV (Autonomous Self-Mooring Vehicle)
ASV Limited (UK) – C Enduro platform
Applications and Sensors
Metocean & Oceanographic data collection.
Environmental surveys e.g. CO2 monitoring.
Seismic support e.g. Passive Acoustic Monitoring
Data gateway e.g. AUV/ROV/Glider to satellite.
Operation caracteristics
3 months endurance, 4 knots speed for over 4000 miles range. 2 brushless motors, 350 to 500 kg, M2M operability (Iridium).
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Novel platforms
Coastal USV
Deployed with continuous human supervision
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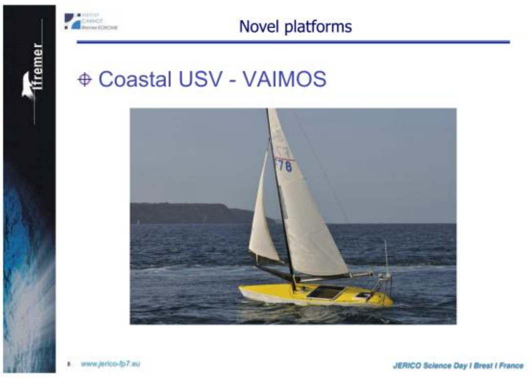
Novel platforms
Coastal USV - VAIMOS
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Novel platforms

Coastal USV - VAIMOS

Collaboration between :
- **Ifremer LPO (scientific need)**
- **Ifremer RDT (Sailing boat technological realisation)**
- **ENSTA (sailing automation algorithm)**

Objectives :
- **Autonomous waypoint operation**
- **Salinity and fluo measurement on the ocean surface layer**
- **Surface layer perturbation at the minimum**

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Novel platforms

Coastal USV - VAIMOS

- **Solar panels**
- **Vertical wind energy mill**
- **Specific ringing adapted for automation**
- **Water inlet under hull and at the base of keel for multiparameter probe measurement.**
- **Adapted for trailer operation for easy transport**
- **Specific device for launching and recovery from large support ship (oceanografic vessel)**

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Novel platforms

Coastal USV - VAIMOS

VAIMOS in automated operation

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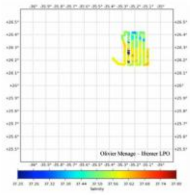
Novel platforms

Coastal USV - VAIMOS

VAIMOS on STRASSE Oceanographic campaign for salinity surface measurement



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Novel platforms

Coastal USV - VAIMOS

VAIMOS on STRASSE Oceanographic campaign

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Novel platforms

Coastal USV - Mobesens

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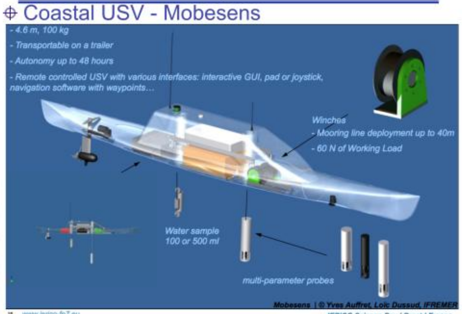
Novel platforms

Coastal USV - Mobesens



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Novel platforms

Coastal USV - Mobesens

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ifremer
Novel platforms
Coastal USV - Mobesens
Probe and water winching sampling in operation
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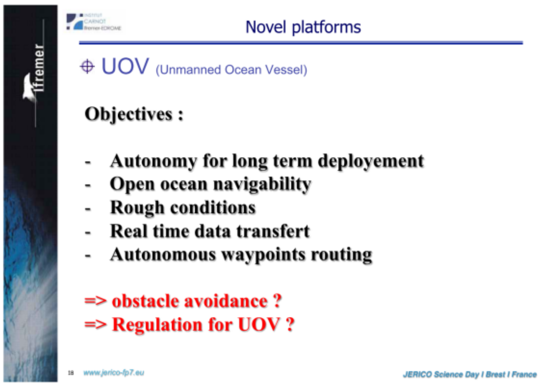
ifremer
Novel platforms
UOV (Unmanned Ocean Vessel)
Objectives :
- Autonomy for long term deployement
- Open ocean navigability
- Rough conditions
- Real time data transfert
- Autonomous waypoints routing
=> obstacle avoidance ?
=> Regulation for UOV ?
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ifremer
Novel platforms
UOV (Unmanned Ocean Vessel)
The Wave-Glider from Liquid robotic
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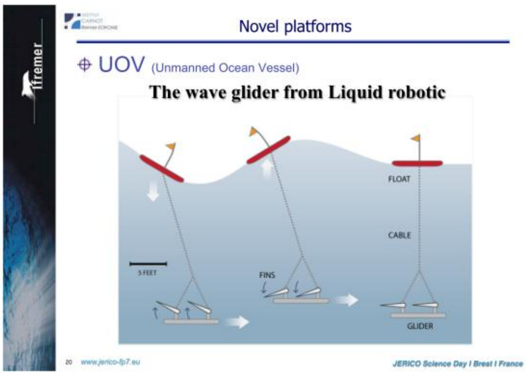
ifremer
Novel platforms
UOV (Unmanned Ocean Vessel)
The wave glider from Liquid robotic
FLOAT
CABLE
5 FEET
FINS
GLIDER
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Novel platforms
UOV (Unmanned Ocean Vessel)
The wave glider from Liquid robotic
The Wave Glider®
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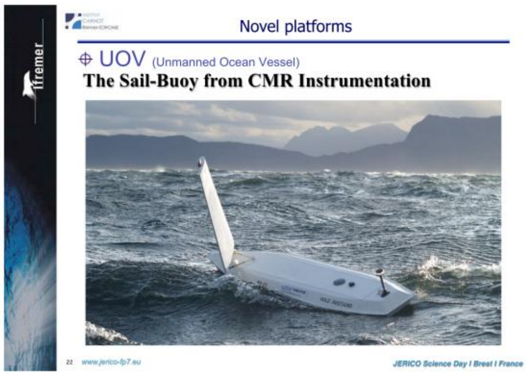
ifremer
Novel platforms
UOV (Unmanned Ocean Vessel)
The Sail-Buoy from CMR Instrumentation
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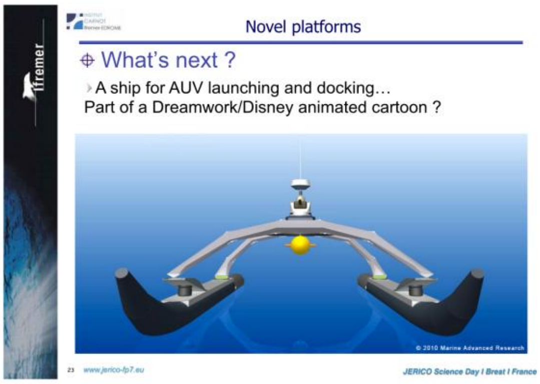
ifremer
Novel platforms
What's next ?
A ship for AUV launching and docking…
Part of a Dreamwork/Disney animated cartoon ?
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Novel platforms
What's next ?
Surely not ;)
Marine Advanced Research introduces the WAM-V™
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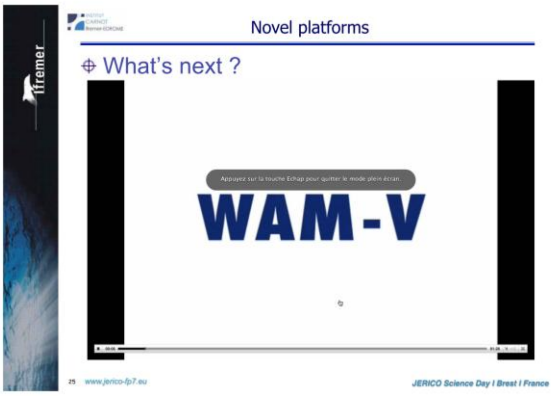
ifremer
Novel platforms
What's next ?
WAM-V
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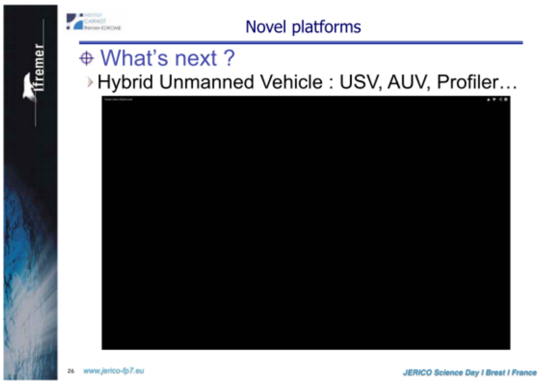
ifremer
Novel platforms
What's next ?
Hybrid Unmanned Vehicle : USV, AUV, Profiler…
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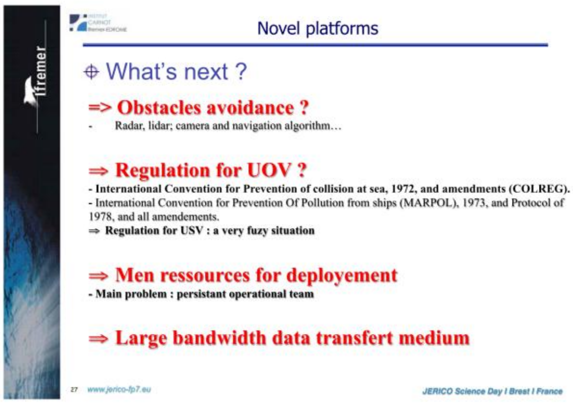
ifremer
Novel platforms
What's next ?
=> Obstacles avoidance ?
- Radar, lidar; camera and navigation algorithm…
⇒ Regulation for UOV ?
- International Convention for Prevention of collision at sea, 1972, and amendments (COLREG).
- International Convention for Prevention Of Pollution from ships (MARPOL), 1973, and Protocol of 1978, and all amendements.
⇒ Regulation for USV : a very fuzy situation
⇒ Men ressources for deployement
- Main problem : persistant operational team
⇒ Large bandwidth data transfert medium
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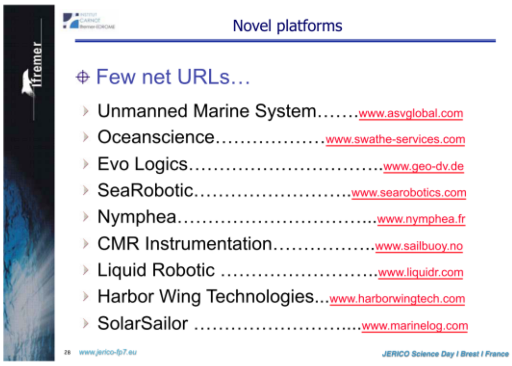
ifremer
Novel platforms
Few net URLs…
Unmanned Marine System…….www.asvglobal.com
Oceanscience………………www.swathe-services.com
Evo Logics…………………………..www.geo-dv.de
SeaRobotic……………………….www.searobotics.com
Nymphea…………………………..www.nymphea.fr
CMR Instrumentation……………..www.sailbuoy.no
Liquid Robotic ………………………www.liquidr.com
Harbor Wing Technologies…www.harborwingtech.com
SolarSailor ……………………...www.marinelog.com
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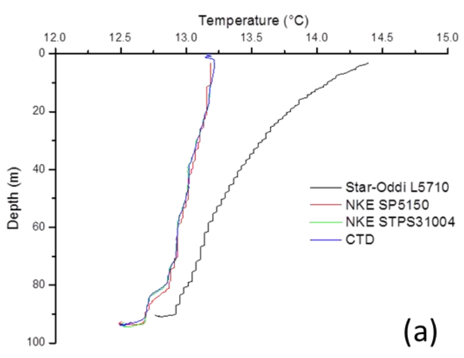
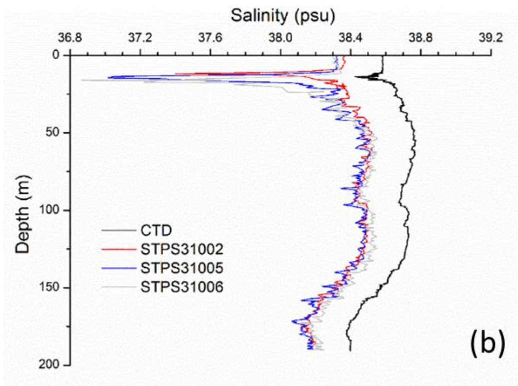
03- Evaluation of the measurement accuracy of different typologies of commercial sensors to be used on fishing gears

Michela Martinelli, Stefano Guicciardi, Pierluigi Penna, Andrea Belardinelli, Camilla Croci, Filippo Domenichetti, Alberto Santojanni, Elio Paschini, Stefania Sparnocchia (all CNR-ISMAR)

- 4 key words: vessels of opportunity, fishing vessel, next generation probes, measurement accuracy
- 2 Regional key words: Adriatic Sea, Mediterranean Sea

In order to assess the accuracy of probes already in use by monitoring systems installed on fishing vessels (Star-Oddi and NKE probes), comparison tests were performed in the Adriatic Sea with a calibrated CTD instrument. The results showed that the temperature data collected by Star-Oddi sensors are reliable only considering the data portion where a dwell time at fixed depth permanence is longer than 50 s, which happens usually when the net/gear is actively fishing and not during the deployment of the gear. The data collected by NKE sensors are definitely much more accurate for both depth and temperature measurements and could be usefully considered for broader oceanographic purposes since their temperature accuracy is half that of XBTs. The weak point of the NKE sensors is the salinity measurement whose accuracy is out of the nominal accuracy range in most cases. The above evaluation underlined the optimal conditions for the usage of the considered sensors and produced a series of offsets that might be used to enhance the accuracy of the already recorded datasets.





(a) Temperature-depth profile of four different sensors deployed together with the SeaBird CTD. Only the descent part of the cast is shown.
(b) Salinity-depth profile for three NKE sensors and SeaBird CTD. Only the descent part of the cast is shown.

Slides are presented in the next pages


JERICO
Evaluation of different typologies of commercial sensors to be used on fishing gears (WP10 – task 10.4)
Martinelli M., Guicciardi S., Penna P., Belardinelli A., Croci C., Domenichetti F., Santojanni A., Paschini E., Sparnocchia S.
CNR - ISMAR michela.martinelli@an.ismar.cnr.it
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Fishing vessels as Voluntary Vessels of Opportunity
The Fishery & Oceanography Observing System in the Adriatic Sea
Evaluation of the commercial probes used in monitoring systems participating in JERICO
Calculation of sensors offsets
Example of Data correction
Conclusions
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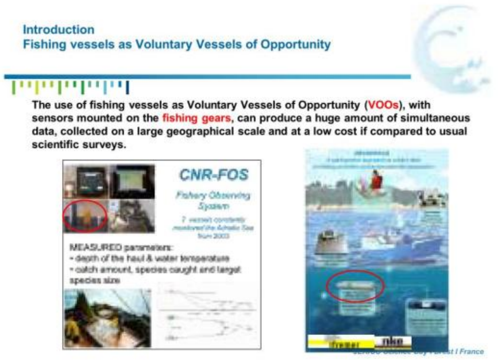
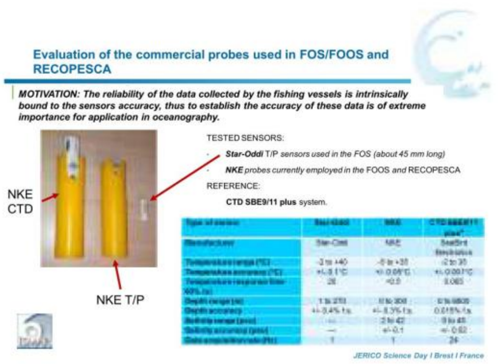

Introduction
Fishing vessels as Voluntary Vessels of Opportunity
The use of fishing vessels as Voluntary Vessels of Opportunity (VOOs), with sensors mounted on the fishing gears, can produce a huge amount of simultaneous data, collected on a large geographical scale and at a low cost if compared to usual scientific surveys.
CNR-FOS
Fishery Observing System
MEASURED parameters:
• depth of the haul & water temperature
• catch amount, species caught and target species size


SSD-Pesca Project
From FOS to FOOS
Data Center
OR


Evaluation of the commercial probes used in FOS/FOOS and RECOPESCA
MOTIVATION: The reliability of the data collected by the fishing vessels is intrinsically bound to the sensors accuracy, thus to establish the accuracy of these data is of extreme importance for application in oceanography.
NKE CTD
NKE T/P
TESTED SENSORS:
Star-Oddi T/P sensors used in the FOS (about 45 mm long)
NKE probes currently employed in the FOOS and RECOPESCA
REFERENCE:
CTD SBE9/11 plus system.
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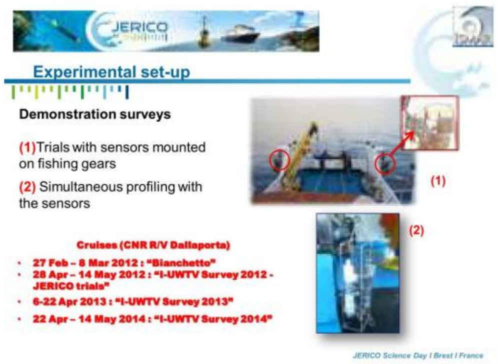
JERICO
Experimental set-up
Demonstration surveys
(1) Trials with sensors mounted on fishing gears
(2) Simultaneous profiling with the sensors
(1)
(2)
Cruises (CNR R/V Dallaporta)
27 Feb – 8 Mar 2012 : "Bianchetto"
28 Apr – 14 May 2012 : "I-UWTV Survey 2012 - JERICO trials"
6-22 Apr 2013 : "I-UWTV Survey 2013"
22 Apr – 14 May 2014 : "I-UWTV Survey 2014"
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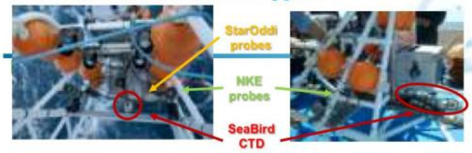
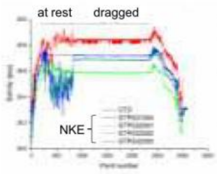
1

Trials with sensors mounted on fishing gears





- Sensors and CTD are fixed to a sledge
- The sledge is deployed at the sea bottom
- The sledge is left at the sea bottom for about 15 min (**sledge at rest**) and then horizontally pulled (**sledge drag**).
- When the sledge is dragged, water regularly flows through the sensors.

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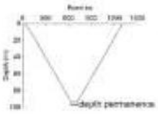
Simultaneous profiling

Simulations of data collection during fishing activity:

Two types of profiling vs. depth



Staircase profile

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Data and Methods

Data

- 26 **Star-Oddi** sensors (T/P) and 18 **NKE** sensors (9 T/P and 9 CTD) were evaluated to determine **offsets in depth, temperature and salinity readings**.
- 1260 different casts were analyzed for depth and temperature and 213 for salinity.
- To avoid effects due to the different response time of the sensors and their response in presence of vertical gradient of the water properties, **only data collected during a depth permanence were used** in the calculation.

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Data and Methods

Methods

- Calculation of differences with respect to the reference for each sensor tested:
  StarOddi/NKE sensors (D/T/S) - SBE911plus (D/T/S)
- Median statistics per sensor using
  - ✓ the whole data set
  - ✓ sub-groups depending on
    - permanence at a given depth
    - dwell time at permanence depth

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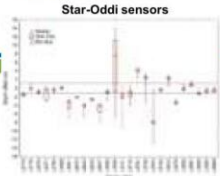
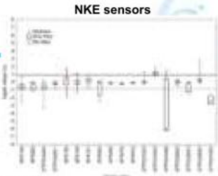
Results: Depth offsets

Star-Oddi sensors



NKE sensors



whole datasets

- Each sensor has its own behaviour
- Several cases are outside the nominal sensor accuracy (offs>7m).
- No influence of depth or dwell time.

- Depth offset in most cases<1 m.
- No influence of depth or dwell time.

Note: nominal sensor accuracy is indicated by the horizontal lines in the plots

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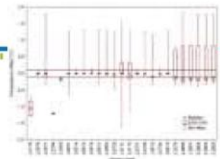
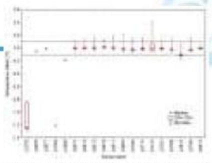
Results: Star-Oddi Temperature offsets



whole datasets



dwell time at the depth permanence > 50s (nominal time response = 20 s).

Temperature Data collected by Star-Oddi sensors should be considered **reliable only when the dwell time at a fixed permanence is longer than 50s** (that usually occurs during fishing operations). In this condition, the temperature offset is inside the nominal accuracy range of the sensor (±0.1°C).
Hence, due to their very large time response, nor the descendant or ascendant part of a cast (e.g. drop and sail of fishing net) can be corrected in any reliable way and thus confidently used.

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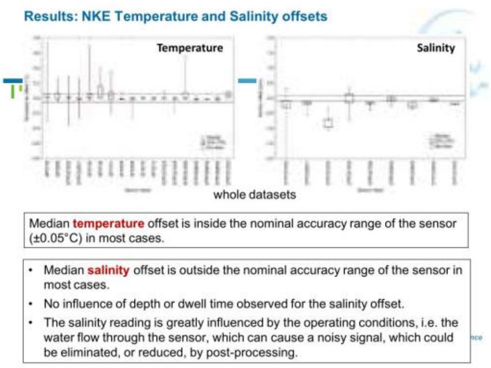
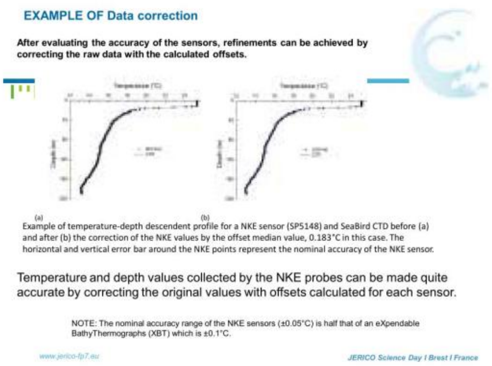
2


Results: NKE Temperature and Salinity offsets
Temperature
Salinity
whole datasets
Median temperature offset is inside the nominal accuracy range of the sensor (±0.05°C) in most cases.
• Median salinity offset is outside the nominal accuracy range of the sensor in most cases.
• No influence of depth or dwell time observed for the salinity offset.
• The salinity reading is greatly influenced by the operating conditions, i.e. the water flow through the sensor, which can cause a noisy signal, which could be eliminated, or reduced, by post-processing.


EXAMPLE OF Data correction
After evaluating the accuracy of the sensors, refinements can be achieved by correcting the raw data with the calculated offsets.
(a)
(b)
Example of temperature-depth descendent profile for a NKE sensor (SP5148) and SeaBird CTD before (a) and after (b) the correction of the NKE values by the offset median value, 0.183°C in this case. The horizontal and vertical error bar around the NKE points represent the nominal accuracy of the NKE sensor.
Temperature and depth values collected by the NKE probes can be made quite accurate by correcting the original values with offsets calculated for each sensor.
NOTE: The nominal accuracy range of the NKE sensors (±0.05°C) is half that of an eXpendable BathyThermographs (XBT) which is ±0.1°C.
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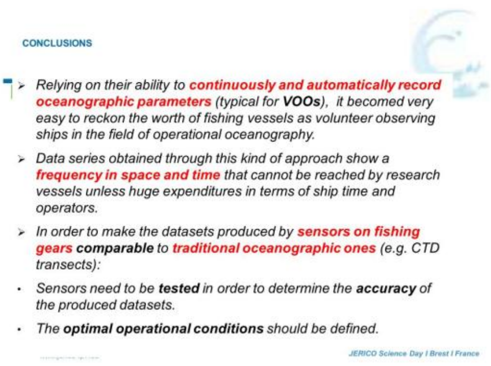
CONCLUSIONS
Relying on their ability to continuously and automatically record oceanographic parameters (typical for VOOs), it becomed very easy to reckon the worth of fishing vessels as volunteer observing ships in the field of operational oceanography.
Data series obtained through this kind of approach show a frequency in space and time that cannot be reached by research vessels unless huge expenditures in terms of ship time and operators.
In order to make the datasets produced by sensors on fishing gears comparable to traditional oceanographic ones (e.g. CTD transects):
• Sensors need to be tested in order to determine the accuracy of the produced datasets.
• The optimal operational conditions should be defined.
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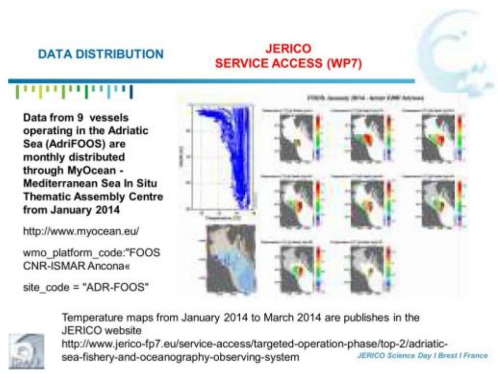
DATA DISTRIBUTION
JERICO
SERVICE ACCESS (WP7)
Data from 9 vessels operating in the Adriatic Sea (AdriFOOS) are monthly distributed through MyOcean - Mediterranean Sea In Situ Thematic Assembly Centre from January 2014
http://www.myocean.eu/
wmo_platform_code:"FOOS CNR-ISMAR Ancona«
site_code = "ADR-FOOS"
Temperature maps from January 2014 to March 2014 are publishes in the JERICO website
http://www.jerico-fp7.eu/service-access/targeted-operation-phase/top-2/adriatic-sea-fishery-and-oceanography-observing-system
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3

04- Biofouling Monitoring Program (BMP): biofouling diversity on different materials, exposure conditions and locations

Marco Faimali (CNR-ISMAR), Giovanni Pavanello, Giuliano Greco, Silvia Morgana, Mauro Bastianini, Kada Boukerma (Ifremer), Manolis Ntoumas (HCMR), Laurent Delauney (Ifremer)

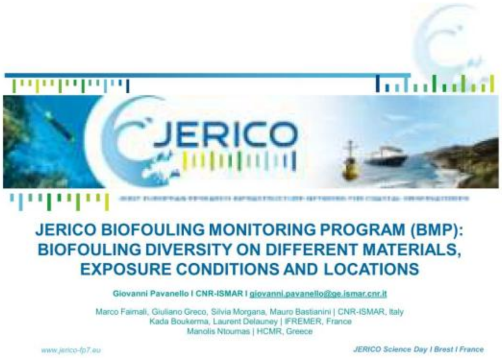
- 4 key words: Biofouling, antifouling, materials, oceanographic sensors

Biological growth on man-made structures immersed in the water (biofouling) is a major problem for nearly all the activities related to the marine environment, including oceanographic monitoring. In order to study the differences in biofouling development related to materials, exposure conditions and locations, ISMAR-CNR developed a special sampling system (Biofouling Monitoring Box - BMB). The BMB provides substrates made of different materials, with spatial and structural heterogeneity that can simulate the complexity of oceanographic sensors and of their housing/container.

BMBs have been sent to JERICO partners interested in the biofouling monitoring activity, for a total of 11 different monitoring sites (open water and coastal water) along a European geographical gradient. Each partner immersed the BMB close to an oceanographic sensor, selected as the reference sensor, for this long-term study.

Aim of this study is to highlight any differences and / or similarities of biofouling settlement process at different spatial scales (local and geographic) in order to characterize in more detail the types of potential organisms that make up the biofouling of the sensors at different latitudes of some of the major European Marine Regions.

Slides are presented in the next pages


JERICO
JERICO BIOFOULING MONITORING PROGRAM (BMP):
BIOFOULING DIVERSITY ON DIFFERENT MATERIALS, EXPOSURE CONDITIONS AND LOCATIONS
Giovanni Pavanello I CNR-ISMAR I giovanni.pavanello@ge.ismar.cnr.it
Marco Faimali, Giuliano Greco, Silvia Morgana, Mauro Bastianini | CNR-ISMAR, Italy
Kada Boukerma, Laurent Delauney | IFREMER, France
Manolis Ntoumas | HCMR, Greece
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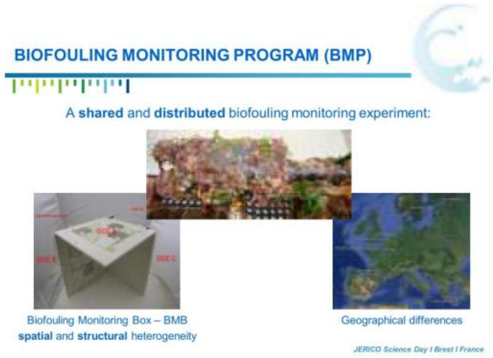
BIOFOULING MONITORING PROGRAM (BMP)
A shared and distributed biofouling monitoring experiment:
Biofouling Monitoring Box – BMB
spatial and structural heterogeneity
Geographical differences
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BIOFOULING MONITORING BOX (BMB)
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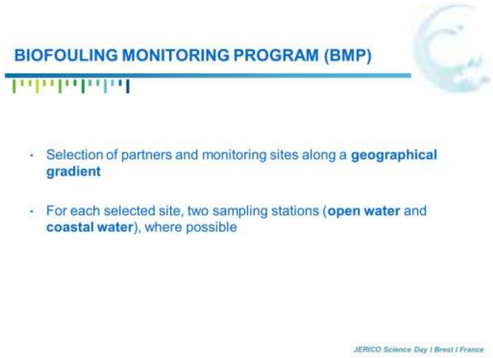
BIOFOULING MONITORING PROGRAM (BMP)
Selection of partners and monitoring sites along a geographical gradient
For each selected site, two sampling stations (open water and coastal water), where possible
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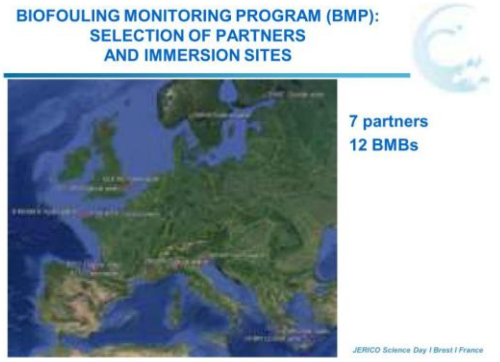
BIOFOULING MONITORING PROGRAM (BMP):
SELECTION OF PARTNERS
AND IMMERSION SITES
7 partners
12 BMBs
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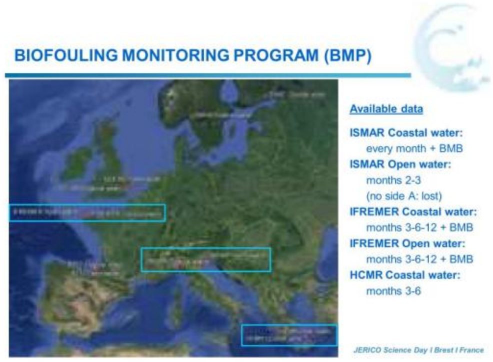
BIOFOULING MONITORING PROGRAM (BMP)
Available data
ISMAR Coastal water:
every month + BMB
ISMAR Open water:
months 2-3
(no side A: lost)
IFREMER Coastal water:
months 3-6-12 + BMB
IFREMER Open water:
months 3-6-12 + BMB
HCMR Coastal water:
months 3-6
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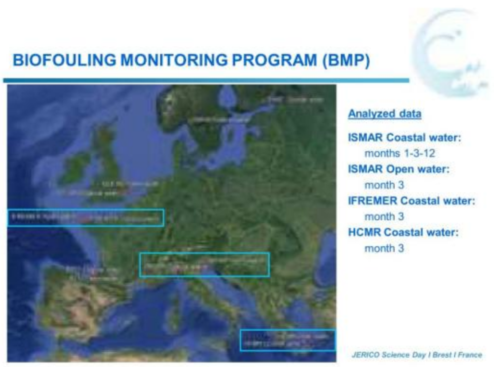
BIOFOULING MONITORING PROGRAM (BMP)
Analyzed data
ISMAR Coastal water: months 1-3-12
ISMAR Open water: month 3
IFREMER Coastal water: month 3
HCMR Coastal water: month 3
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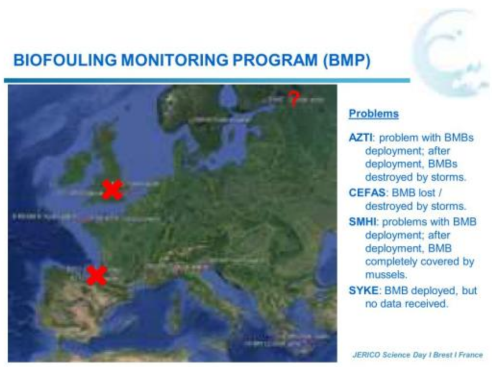
BIOFOULING MONITORING PROGRAM (BMP)
Problems
AZTI: problem with BMBs deployment; after deployment, BMBs destroyed by storms.
CEFAS: BMB lost / destroyed by storms.
SMHI: problems with BMB deployment; after deployment, BMB completely covered by mussels.
SYKE: BMB deployed, but no data received.
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BIOFOULING MONITORING PROGRAM (BMP)


BIOFOULING MONITORING PROGRAM (BMP)
Each selected partner immersed the system (BMB) close to a reference sensor
Every 2 months (at least): each partner was expected to carry out photographic sampling of the BMB and of the reference sensor, following the protocol prepared by CNR-ISMAR
After 12 months each partner was expected to ship the two BMBs to CNR-ISMAR, after appropriate conservation treatment
At CNR-ISMAR, analysis of collected images and BMBs
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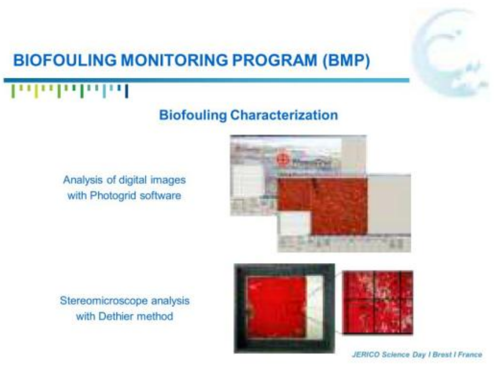
BIOFOULING MONITORING PROGRAM (BMP)
Biofouling Characterization
Analysis of digital images with Photogrid software
Stereomicroscope analysis with Dethier method
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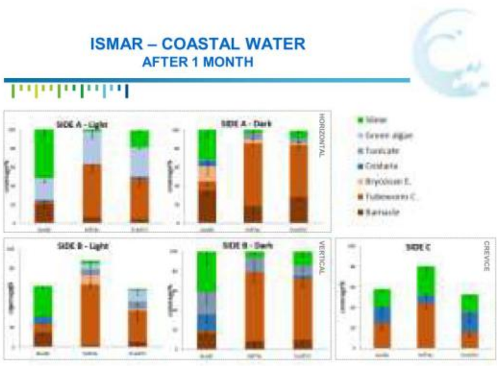
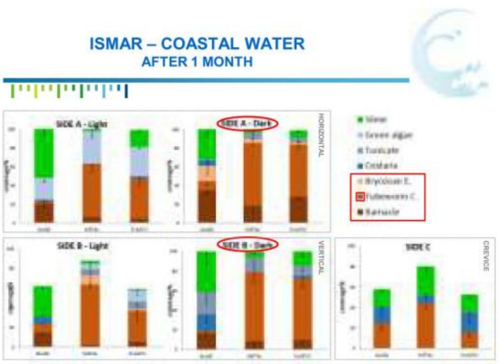
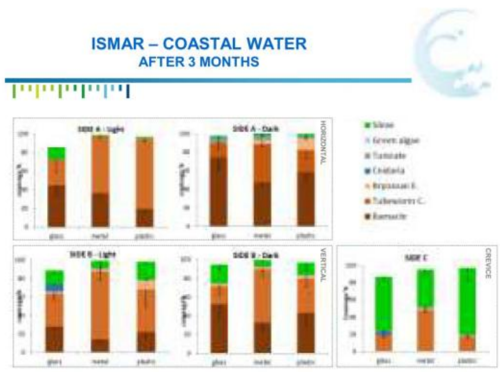
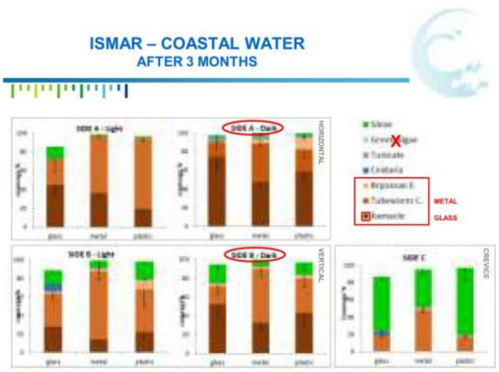
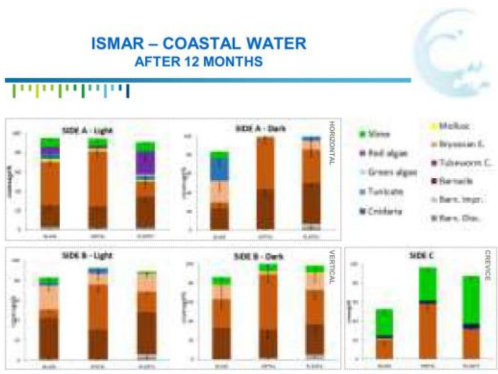
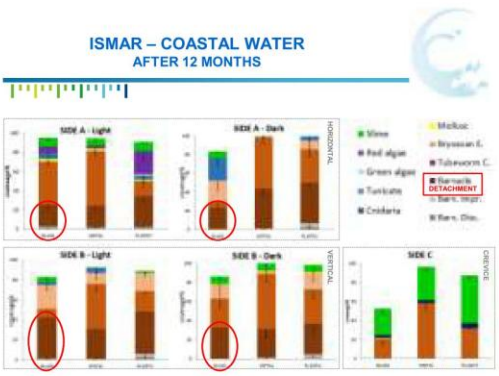

ISMAR – COASTAL WATER
AFTER 1 MONTH
SIDE A - Light
SIDE A - Dark
HORIZONTAL
SIDE B - Light
SIDE B - Dark
VERTICAL
SIDE C
CREVICE

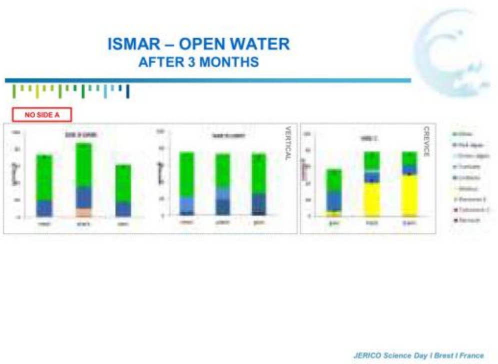

ISMAR – COASTAL WATER
AFTER 1 MONTH
SIDE A - Light
SIDE A - Dark
SIDE B - Light
SIDE B - Dark
SIDE C
HORIZONTAL
VERTICAL
CREVICE


ISMAR – COASTAL WATER
AFTER 3 MONTHS
HORIZONTAL
VERTICAL
CREVICE


ISMAR – COASTAL WATER
AFTER 3 MONTHS
SIDE A - Dark
SIDE B - Dark
METAL
GLASS
HORIZONTAL
VERTICAL
CREVICE


ISMAR – COASTAL WATER
AFTER 12 MONTHS
HORIZONTAL
VERTICAL
CREVICE


ISMAR – COASTAL WATER
AFTER 12 MONTHS
DETACHMENT
HORIZONTAL
VERTICAL
CREVICE


ISMAR – OPEN WATER
AFTER 3 MONTHS
NO SIDE A
VERTICAL
CREVICE
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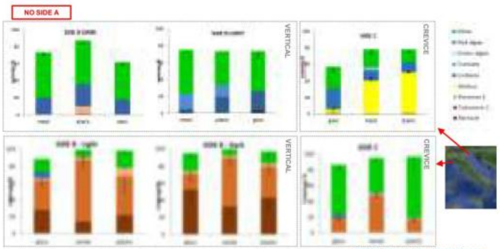
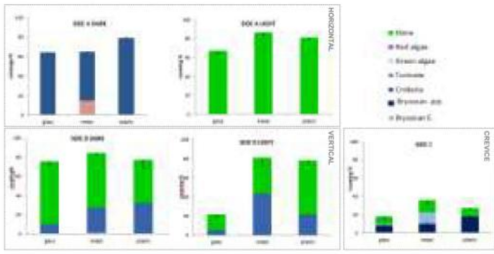
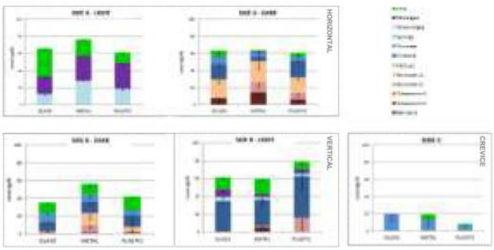
ISMAR – OPEN WATER
AFTER 3 MONTHS



HCMR – COASTAL WATER
AFTER 3 MONTHS



IFREMER – COASTAL WATER
AFTER 3 MONTHS



BMP CONCLUSIONS

- When deploying an oceanographic instrument, in particular (but NON ONLY) for long-term studies, it is essential to keep into account biofouling-related issues!
- High variability in biofouling dynamics, linked to:
  - Materials
  - Light/dark exposure
  - Sensor structure (geometry)
  - Deployment site
  - Season
  - Deployment duration
  - *Many many others factors*
- **It is only possible to foresee a general trend, but only field tests / monitoring will *tell us the truth!***
- **There is no universal antifouling approach**

BMB NEXT: FUTURE IMPROVEMENTS

ACKNOWLEDGEMENTS

MANY THANKS TO ALL THE PEOPLE WHO SUPPORTED JERICO BMP!

CNR-ISMAR: Stefania Sparnocchia, Francesca Garaventa, Elisa Cervetto
HCMR: George Petihakis
IFREMER: Michel Peleau, Michel Repecaud
AZTI: Carlos Hernandez
CEFAS: Dave Sivyer
SMHI: Bengt Karlson
SYKE: Jukka Seppälä


…AND THANK YOU FOR YOUR ATTENTION!
ANY QUESTION?
giovanni.pavanello@ge.ismar.cnr.it
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05.1– Results from 3 TNA experiments

Manolis Ntoumas (HCMR), Rajesh Nair (OGS), Nevio Medeot (OGS), Roberto Bozzano (CNR), Sara Pensieri (CNR), Tatiana Tsagkaraki, Manolis Potiris, Costas Frangoulis, Dimitirs Podaras, Fotis Pantazoglou, George Petihakis (All HCMR)

- 4 key words: Calibration, Harmonization, In-situ observations, M3A network
- 2 Regional key words: Adriatic, Aegean

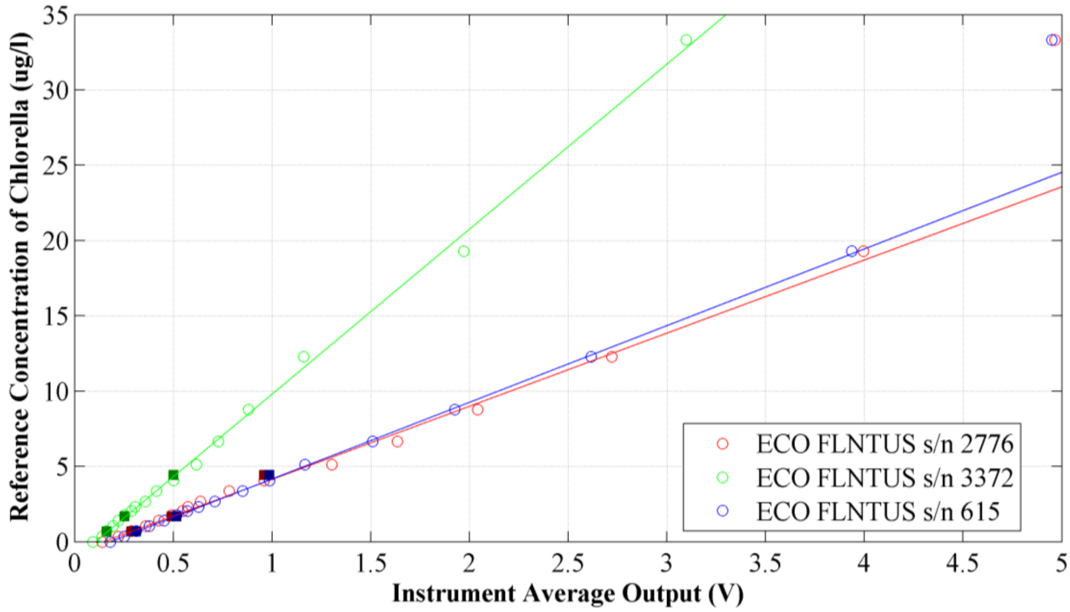
Reference Temperature Calibration (OGS-HCMR)

The Triple Point of Water

The experiment was conducted at the OGS-Oceanographic Calibration Centre (OGS-CTO), the facility for oceanographic testing and calibration of the Department of Oceanography of the OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), located in Trieste, Italy. The purpose of the experiment was to acquire expertise, receive guidance, and gain "hands-on" experience in applying the procedures and Best Practice conventions for the calibration of oceanographic temperature sensors using primary reference standards. The long-term goal is for HCMR to be able to perform such calibrations on its own premises. This is essential in order to ensure the quality of the data collected by the POSEIDON network (http://poseidon.hcmr.gr) and field surveys performed by HCMR.

Calibration and inter-calibration exercise of bio-geochemical sensors, Tools for Oxygen, Fluorescence and Turbidity sensors testing and intercomparison (HCMR-CNR)

The experiments address the main scope of performing a calibration and inter-calibration exercise of bio-geochemical sensors to be operationally and routinely deployed on off-shore marine observatories making part on a continuous basis of the marine monitoring network of the Mediterranean Sea. The W1-M3A observatory, together with the E1-M3A buoy moored in the south Aegean Sea and the E2-M3A buoy positioned in the South Adriatic, is part of the M3A network, developed within the framework of the MFSTEP project in order to answer to the needs of the Mediterranean Forecasting System of real-time physical and biogeochemical observations of the upper thermocline. Indeed, the possibility to use sensors calibrated with the same procedures installed on the different sites belonging to the M3A network makes feasible a comparison between the involved sites thanks to a homogenous database in order to verify at a quantitative level the observed differences and to enhance the quality of the in-situ observations.



Slides are presented in the next pages

Results from 3 TNA experiments

Manolis Ntoumas I HCMR I mntou@hcmr.gr

Reference Temperature Calibration (OGS-HCMR)

OGS - Oceanographic Calibration Centre (**OGS-CTO**), the facility for oceanographic testing and calibration of the Department of Oceanography of the OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), located in Trieste, Italy. **(28th of February and the 1st of March 2013).**

- The experiment proposal was submitted by HCMR at the First TNA call of JERICO.

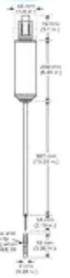
Rajesh Nair, Nevio Medeot, Manolis Ntoumas, Fotis Pantazoglou, George Petihakis

RTC objectives

- The purpose of the experiment was to acquire expertise, receive guidance, and gain "hands-on" experience in applying the procedures and Best Practice conventions for the calibration of oceanographic temperature sensors using primary reference standards.
- The long-term goal is for HCMR to be able to perform such calibrations on its own premises.

Sensors:

- two SBE 35 Deep Ocean Standards Thermometers (serial numbers 58 and 59) manufactured by Seabird Electronics, Inc. that were purchased by HCMR in 2007.
- The one bearing serial number (s/n) 59, had never been used in the field while the other (s/n) 58 has been employed in HCMR's evaluation/calibration experiments.

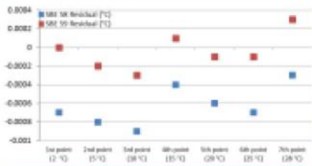


RTC: OGS - Oceanographic Calibration Centre equipment

- Precision Digital Thermometer Fluke/Hart 1590 with metal-sheath SPRT Rosemount 162CE e Fluke/Hart 5699, with reference resistors L&N 4030B and Guildline 9930.
- Triple Point of Water Maintenance Bath (TPW) Fluke/Hart 7312 with triple point of water cells Jarrett B13 e Fluke/Hart 5901.
- Gallium Cell Maintenance Apparatus Fluke/Hart 9230, with Gallium melting point (MpGa) cell Fluke/Hart 5943.

RTC: Linearization at seven calibration set - points

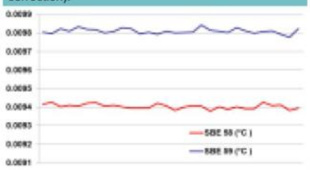
Seven calibration set-points (28 °C to 2 °C) were chosen, and at each set-point, the bath temperature was logged for 10 minutes.



The averaged data of the sensors at the different set-points and the corresponding temperature residuals with respect to the relevant reference temperatures.

RTC: Slope and offset terms were evaluated one at a time at the Triple Point of Water (TPW) and the Melting Point of Gallium (MPGa)

SBE thermometers logging at the Triple Point of Water (0.0098 °C, after the hydrostatic head effect correction).



SBE sn:59 was never used
SBE sn:58 was used only at the lab (≈ 120 hours)

RTC: Results

Both SBE 35 are used as the reference temperature sensors for HCMR.

4 Fixed stations +1 FerryBox System

- 30 *SBE 37 Microcat* CTs
- 20 *SBE 16 plus* CTDs
- 5 *Aanderaa* CTs

The bath set-point residuals of the SBE 35,s/n 58 before and after the Slope and Offset adjustments.

CIEBIO and TOFU

Calibration and **i**nter-calibration exercise of **bio**-geochemical sensors – **CIEBIO** (26-30 November 2012). 1st TNA call

Tools for **O**xygen, **F**luorescence and t**U**rbidity sensors testing and intercomparison –**TOFU** (19 July - 2 August 2014). 3rd TNA call

The HCMR Thalassocosmos complex in Crete

- CNR: Roberto Bozzano, Sara Pensieri
- HCMR: Manolis Ntoumas, Tatiana Tsagkaraki, Manolis Potiris, Costas Frangoulis , Dimitirs Podaras and George Petihakis.

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CIEBIO and TOFU

JERICO calibration workshops

Date	Title	Coordinator
9th February 2012	1st Calibration and biofouling prevention of optical sensors & sharing of calibration facilities	SYKE, Helsinki
10th October 2012	2nd Calibration exercise (T,S,O2), sharing of calibration facilities	IFREMER, Brest

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CIEBIO and TOFU

CIEBIO- TOFU objectives

- perform a calibration and inter-calibration exercise of bio-geochemical sensors
- develop common procedures and techniques

CIEBIO scientific issues:

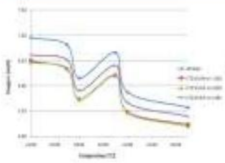
- **Enhance the accuracy** on a long term perspective of in-situ measurements of dissolved oxygen, chlorophyll-a and turbidity in the Ligurian basin.
- **Improve the knowledge** about the biogeochemical processes in the upper thermocline.
- **Support the developing of bio-geochemical forecast models** with real-time quality controlled observations for both the of assimilation and calibration/validation phases.

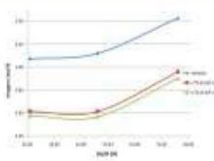
CIEBIO achievements: Laboratory and at sea inter-comparison/calibration of dissolved oxygen and fluorescence sensors.

- **Laboratory dissolved oxygen calibration:**
  - tank (800x500x500 mm) furnished by an Haake N2 immersion circulator and two aerators.
  - 2 SBE43 tested together and Winkler chemical titration served as the reference.
  - 5 calibration points
  - 3 samples for each point used for Winkler.
- **Laboratory chl-a calibration:**
  - 2 reference of chlorella cultures.
  - 8 concentration points of uranine solution.
- **Field test :**
  - 1 day cruise onboard the R/V Philia.
  - 3 water samples acquired for the determination of dissolved oxygen and chl-a content.

CIEBIO results: Dissolved Oxygen sensors.

- **Laboratory dissolved oxygen calibration:** overestimation of Winkler titration method with respect to laboratory tests and in-situ samples.





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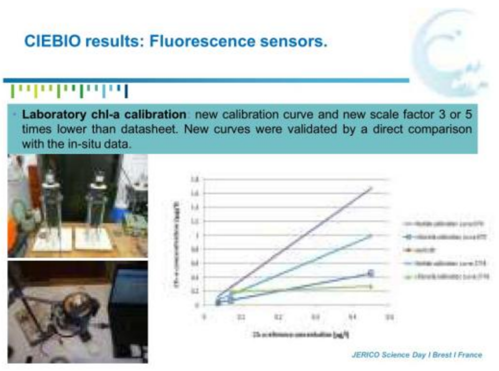
JERICO


CIEBIO results: Fluorescence sensors.
Laboratory chl-a calibration: new calibration curve and new scale factor 3 or 5 times lower than datasheet. New curves were validated by a direct comparison with the in-situ data.
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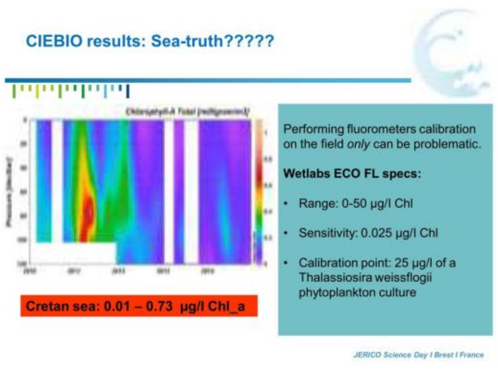
CIEBIO results: Sea-truth?????
Cretan sea: 0.01 – 0.73 µg/l Chl_a
Performing fluorometers calibration on the field only can be problematic.
Wetlabs ECO FL specs:
Range: 0-50 µg/l Chl
Sensitivity: 0.025 µg/l Chl
Calibration point: 25 µg/l of a Thalassiosira weissflogii phytoplankton culture
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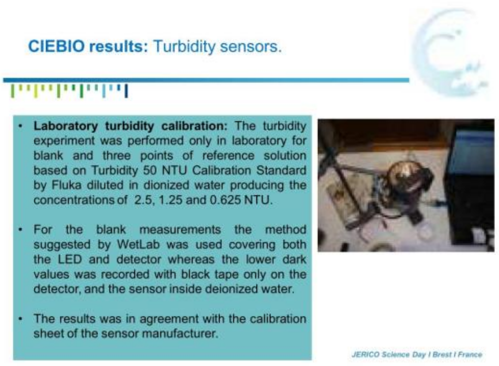
CIEBIO results: Turbidity sensors.
Laboratory turbidity calibration: The turbidity experiment was performed only in laboratory for blank and three points of reference solution based on Turbidity 50 NTU Calibration Standard by Fluka diluted in dionized water producing the concentrations of 2.5, 1.25 and 0.625 NTU.
For the blank measurements the method suggested by WetLab was used covering both the LED and detector whereas the lower dark values was recorded with black tape only on the detector, and the sensor inside deionized water.
The results was in agreement with the calibration sheet of the sensor manufacturer.
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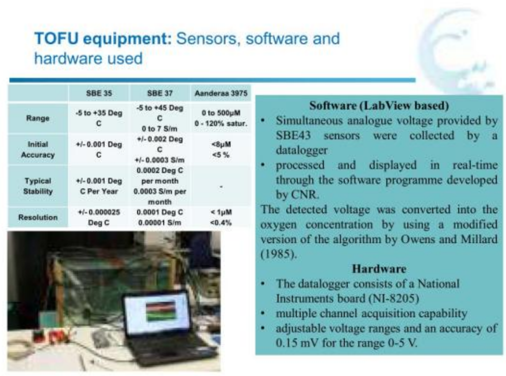
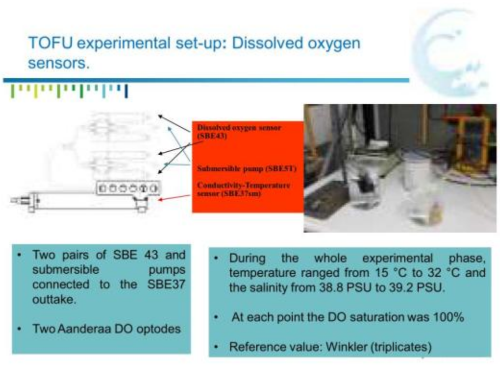
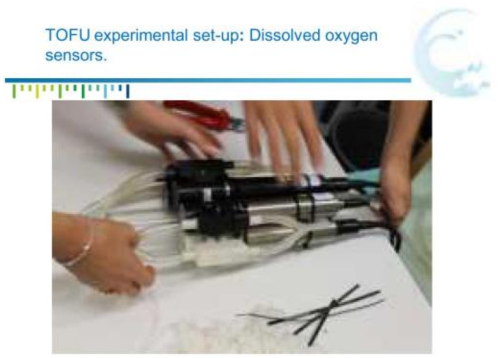
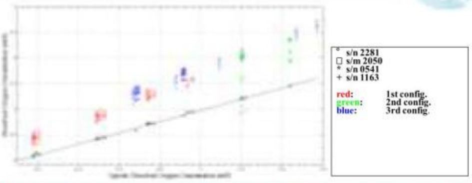

TOFU equipment: Sensors, software and hardware used
SBE 35
SBE 37
Aanderaa 3975
Range
-5 to +35 Deg C
-5 to +45 Deg C 0 to 7 S/m
0 to 500µM 0 - 120% satur.
Initial Accuracy
+/- 0.001 Deg C
+/- 0.002 Deg C +/- 0.0003 S/m
<8µM <5 %
Typical Stability
+/- 0.001 Deg C Per Year
0.0002 Deg C per month 0.0003 S/m per month
-
Resolution
+/- 0.000025 Deg C
0.0001 Deg C 0.00001 S/m
< 1µM <0.4%
Software (LabView based)
Simultaneous analogue voltage provided by SBE43 sensors were collected by a datalogger
processed and displayed in real-time through the software programme developed by CNR.
The detected voltage was converted into the oxygen concentration by using a modified version of the algorithm by Owens and Millard (1985).
Hardware
The datalogger consists of a National Instruments board (NI-8205)
multiple channel acquisition capability
adjustable voltage ranges and an accuracy of 0.15 mV for the range 0-5 V.


TOFU experimental set-up: Dissolved oxygen sensors.
Dissolved oxygen sensor (SBE43)
Submersible pump (SBE5T)
Conductivity-Temperature sensor (SBE37sm)
Two pairs of SBE 43 and submersible pumps connected to the SBE37 outtake.
Two Aanderaa DO optodes
During the whole experimental phase, temperature ranged from 15 °C to 32 °C and the salinity from 38.8 PSU to 39.2 PSU.
At each point the DO saturation was 100%
Reference value: Winkler (triplicates)


TOFU experimental set-up: Dissolved oxygen sensors.

TOFU results: Dissolved oxygen sensors.



Dissolved oxygen concentration measured by four SBE43 sensors (circle s/n 2281, square s/n 2050, star s/n 0541, plus s/n 1163) vs. Optode 3975 (s/n 1647) concentration in the three configurations (red, green, blue). Grey dots correspond to the concentrations obtained through Winkler tritation.

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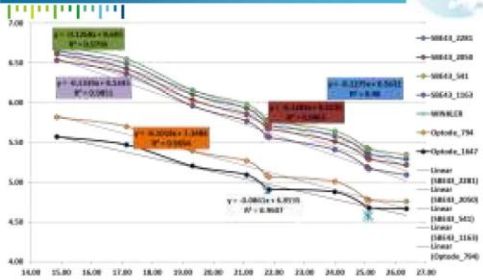
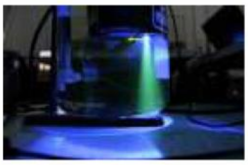
TOFU results: Dissolved oxygen sensors.



TOFU experimental set-up: Fluorometers Eco FLNTU

A chamber developed by CNR was used ,it is composed by a box with an inlet and outlet from which a pipe pass through a magnetically coupled centrifugal pump having a flow rate of 50 liters/minute.

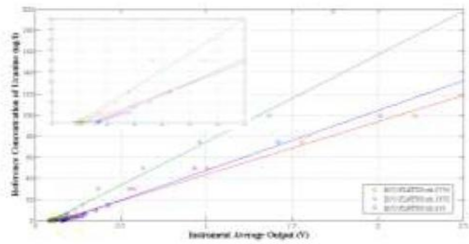
Sensors: 3 WetLabs ECO FLNTU



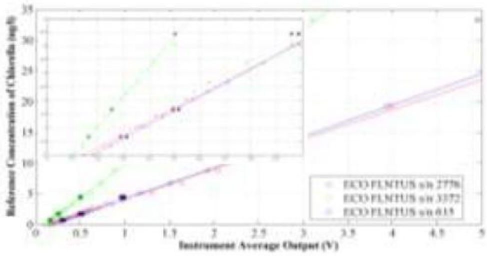
Reference solutions: Chlorella

Three samples of water were collected for laboratory analysis through chemical analysis and high-performance liquid chromatography (HPLC) in order to identify and quantify each component of the mixture.

TOFU results: Eco FL-NTU Uranine experiment

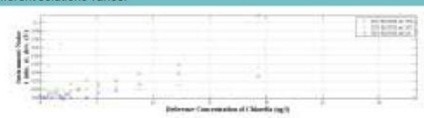


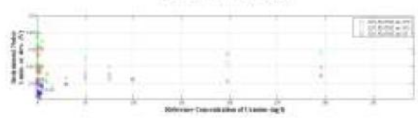
TOFU results: Eco FL-NTU Chlorella experiment



TOFU results: Eco FL-NTU Chlorella and Uranine experiment

Instrument noise considered as 1 minute standard deviation of the raw output voltage for (top) chlorella and (bottom) uranine tests as concentration of the two different solutions varies.



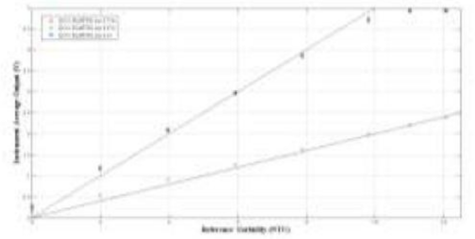


TOFU results: Eco FL-NTU Turbidity experiment set-up

Step	Added Volume (ml)	Turbidity (NTU)
1	80	1.992
2	80	3.968
3	80	5.929
4	80	7.874
5	80	9.804
6	50	11.002
7	45	12.076

Snapshot of the user interface of the software managing the acquisition of analogue and serial data from a ECO FLNTUS sensor. The plot shows the increase of the voltage signal of the s/n 2776 sensor corresponding to the addition of 80 ml of Formazine at 500 NTU into the chamber.

TOFU: Eco FL-NTU Turbidity experiment results



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JERICO Calibration TNA experiments

RTC: OGS and HCMR shared and developed procedures for Temperature sensors calibration.

CIEBIO and TOFU: CNR and HCMR developed common procedures, tools and techniques for calibrating DO, FL and Turbidity sensors.

JERICO TNA

"Harmonization" between two instrumentation/calibration labs. OGS and HCMR have a common reference for temperature measurements.

"Harmonization" between two FP operators. E1-M3A (Cretan Sea) and W1-M3A (Ligurian Sea) observatories are NOW hosting sensors that have been tested with the same procedures

JERICO Calibration TNA experiments

Thank you

5

05.2- Toward a networking approach for metrology in oceanography

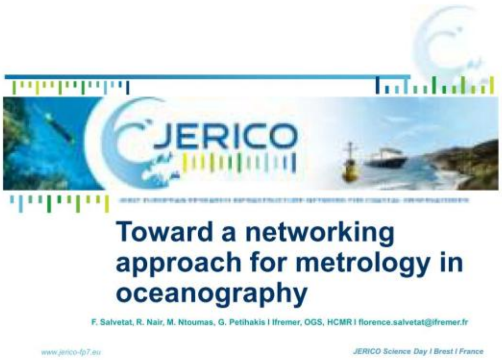
Florence Salvetat, (Ifremer)

- 4 key words: Metrology, Harmonization, Quality, COST project
- 2 Regional key words:

In a few slides, we will present a proposal currently in progress that Ifremer intends to submit to the COST programme in order to improve metrology in the oceanographic field.
At first, we will present the current status of metrology in oceanography: we will focus on the benefits provided by metrology but also on the remaining traceability issues for oceanographic data.
Then we will explain the main objectives of the COST proposal in terms of traceability, harmonization and collaboration. We will emphasize how the networking structure of COST projects could contribute significantly to the success of this metrology project especially in terms of harmonization, efficiency and reliability of data collected.
We will finally present a draft structure that has been discussed between several partners (PTB, LNE, InRim, SYKE, MIKES, University of Plymouth): we will have a look at the oceanographic parameters that may be investigated, the issues addressed, the possible working groups and tasks, the collaborative opportunities and the proposed deliverables.

Slides are presented in the next pages


JERICO


JERICO
Toward a networking approach for metrology in oceanography
F. Salvetat, R. Nair, M. Ntoumas, G. Petihakis I Ifremer, OGS, HCMR I florence.salvetat@ifremer.fr
www.jerico-fp7.eu
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What is COST
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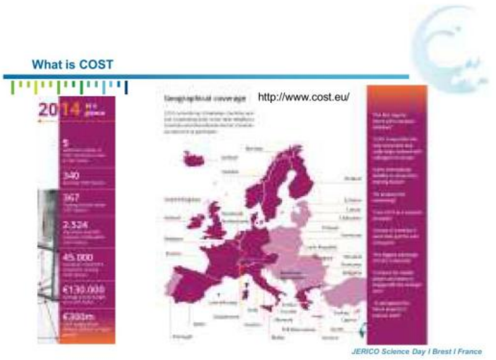
What is COST
http://www.cost.eu/
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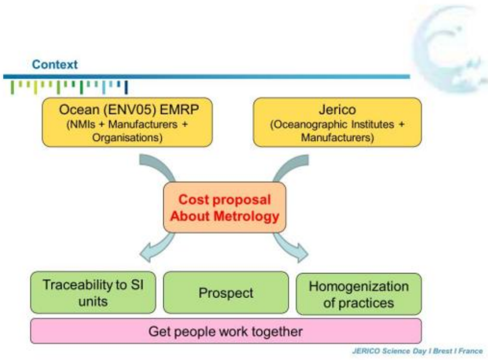
Context
Ocean (ENV05) EMRP
(NMIs + Manufacturers + Organisations)
Jerico
(Oceanographic Institutes + Manufacturers)
Cost proposal
About Metrology
Traceability to SI units
Prospect
Homogenization of practices
Get people work together
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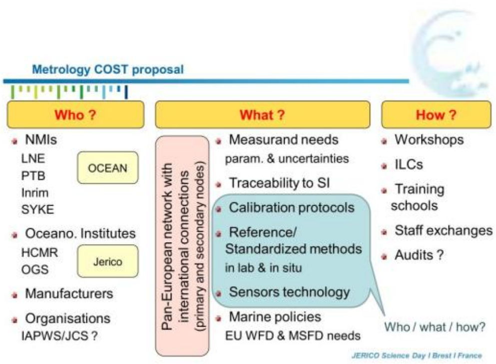
Metrology COST proposal
Who ?
What ?
How ?
NMIs
LNE
PTB
Inrim
SYKE
OCEAN
Oceano. Institutes
HCMR
OGS
Jerico
Manufacturers
Organisations
IAPWS/JCS ?
Pan-European network with international connections (primary and secondary nodes)
Measurand needs
param. & uncertainties
Traceability to SI
Calibration protocols
Reference/ Standardized methods in lab & in situ
Sensors technology
Marine policies
EU WFD & MSFD needs
Workshops
ILCs
Training schools
Staff exchanges
Audits ?
Who / what / how?
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Metrology COST proposal
Possible structure
WG1: Salinity
WG2: pH
WG3: O2 (+CO2?)
WGx: ...
Primary methods & standards
Secondary methods & standards
Sensors & Technologies
Workshops Trainings Technical Schools ILCs
WG6 : Management and Coordination
Create a unique community in metrology for oceanography
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1

Why this proposal?

NMIs do not, by themselves, have the very particular expertise and skill-set necessary to resolve real-world marine metrological issues: there is an urgent need to put in place this necessary «interface» for the future.

The reasons:
The changing view on Data – from single use to multi-use, local to global, (science) need to utility to (priced) commodity – this transition means assigning value, therefore, metrology (whether you like it or not!).

The European policy climate – Integrated Maritime Policy, Blue Growth, MFSD, regulatory measures for environmental sensors and instrumentation.

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Don't hesitate to contact me: florence.salvetat@ifremer.fr

Thanks for your attention.

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III] Topic 2: Integrated monitoring, in situ observation & modeling, network assessment

06- Optimizing observation networks in the Bay of Biscay and English Channel

Guillaume Charria, (IFREMER), Julien Lamouroux (Noveltis), Pierre De Mey (LEGOS), Stéphane Raynaud, Catherine Heyraud, Philippe Craneguy (Actimar), Franck Dumas (Ifremer), Matthieu Le Hénaff (NOAA, USA, Miami)

- 4 key words: Design of observation network, ensemble model simulations, glider, FerryBox
- 2 Regional key words: Bay of Biscay, English Channel

In the Bay of Biscay and the English Channel, existing in situ observation networks aim to sustain research activities and to monitor the coastal environment over the continental shelf. Diverse platforms (fixed stations, coastal profilers, FerryBox) are combined to optimally describe this region. However, an efficient network, considering the technical and financial constraints, needs to be regularly improved.
In this context, we used the ArM method, based on an ensemble model approach to assess extensions of existing networks:
- a network of coastal profiles from fishing vessels (RECOPESCA programme),
- a glider section in the Loire river plume in the Bay of Biscay,
- a glider section in the vicinity of the FerryBox line in the western English Channel.
These three experiments allowed quantifying the efficiency of the different network in different configurations (e.g. number of profiles, direction of glider section). Major orientations have been drawn on the importance of coastal profile locations (instead of the large number of profiles), the potential efficiency of a glider line close to Loire river, and the capacity of the FerryBox line to describe the dynamics in a tidally-mixed coastal region.

Slides are presented in the next pages

Optimizing observation networks in the Bay of Biscay and English Channel

Charria Guillaume I IFREMER I guillaume.charria@ifremer.fr
J. Lamouroux (Noveltis), P. De Mey (LEGOS), S. Raynaud, C. Heyraud, P. Craneguy (Actimar), F. Dumas (IFREMER), M. Le Henaff (UM/NOAA)

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How to proceed ?

Efficient observation network
=
Network able to detect (and constrain) model errors

Principle: form and study the properties of the Ensemble-based Representer Matrix (model ECM* in data space)

Method: study the eigenspectrum of the RM to identify which error modes the network can detect

**ECM: Error Covariance Matrix*

Le Hénaff et al., 2009; De Mey, 2010, 2014; Kourafalou et al., 2014

Diagnostics: eigenvalues of the scaled representer matrix

HP^fH^T « Representer Matrix » : projection of model ECM in observation space

R Observation ECM

→ If $R < HP^fH^T$: (H, R) efficient
If $R > HP^fH^T$: (H, R) limited efficiency

→ **Number of eigenvalues larger than 1**

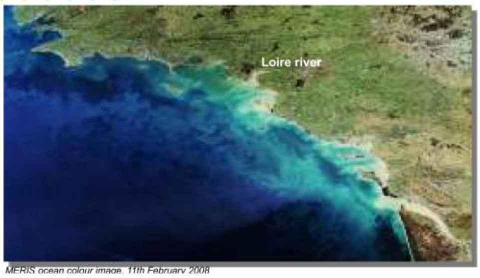
(of the scaled representer matrix $\chi = R^{1/2}HP^fH^TR^{1/2}$)

1

Study framework

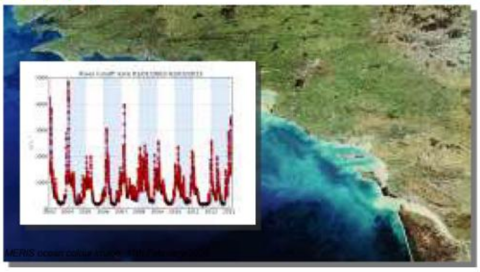
- Model: MARS3D, MANGA configuration (English Channel + Bay of Biscay)
- Ensemble of 50 model simulations. Modified parameters or forcings:
  - Atmospheric forcings (U10, V10, T2m,Pmsl,Tcc)
  - Bottom friction coeff. Z_0
  - Extinction coeff. (river plume influence) *coext*
  - Parameterization coeff. of the turbulent closure scheme C_k
- 4 seasonal periods, year 2006 :
  - 15/01 → 02/02
  - 02/05 → 24/05
  - 02/07 → 18/07
  - 22/10 → 11/11

Observing Loire river plume variability

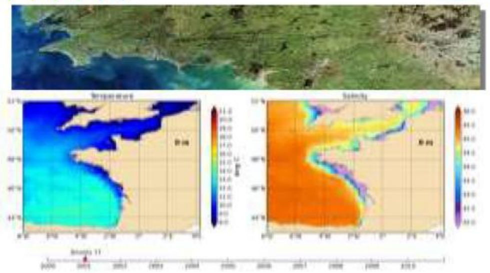


MERIS ocean colour image, 11th February 2008

Observing Loire river plume variability

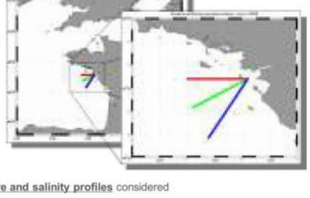


Observing Loire river plume variability



Using moored buoy and gliders

Aim - identifying the optimal glider line to observe Loire river plume variability

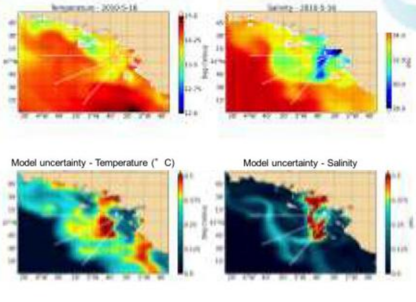


Temperature and salinity profiles considered

Observation error:

- $e^o(T)$=0.3° C
- $e^o(S)$=0.25 psu

Example of model uncertainty



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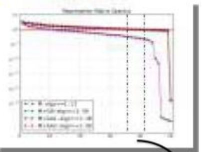
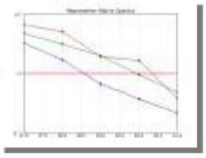
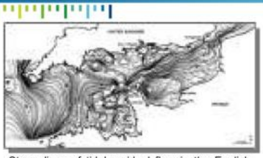
Representer Matrix Spectra





Period : 03/05/2006 – 25/05/2006

Western English Channel

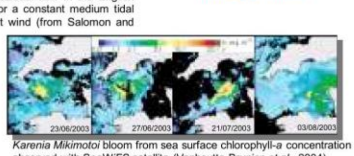


Streamlines of tidal residual flow in the English Channel, computed for a constant medium tidal amplitude and without wind (from Salomon and Breton, 1991).

Macro-tidal region

+

Toxic algal blooms

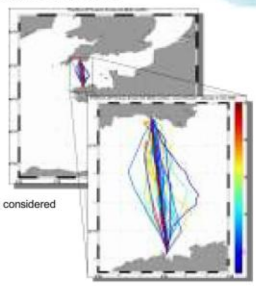


Karenia Mikimotoi bloom from sea surface chlorophyll-*a* concentration observed with SeaWiFS satellite (Vanhoutte-Brunier *et al.*, 2004)

A tandem monitoring between FerryBox and glider

<u>**Aim**</u> - identifying the added value of a glider line sampling the water column under a FerryBox line in a <u>macro-tidal regime</u>.

- *Study configuration*
  - *Ferrybox + glider section Roscoff-Plymouth*
- *Network features*
  - *Ferrybox*
    - *2-3 transects per day*
    - *5h by transect*
    - *Sampling = 1 min*
    - *surface*
  - *Glider*
    - *1 transect / 4 days*
    - *Sampling = 7 min*
    - *3D*

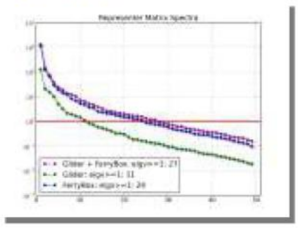


<u>**Temperature and salinity profiles**</u> considered

Observation error:

- $e^o(T)=0.3^\circ$ C
- $e^o(S)=0.25$ psu

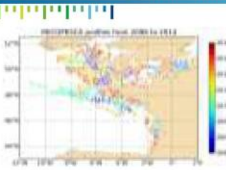
Representer matrix spectra

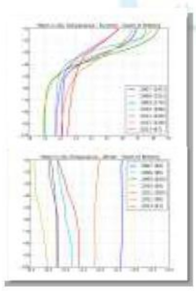


In the western English Channel surface high frequency sampling of the hydrology allows following most of hydrological patterns.

Period : 03/05/2006 – 25/05/2006

RECOPESCA – *in situ* profiles from fishing vessels





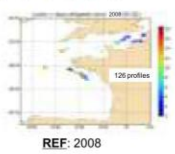
<u>In 2014</u>:
- 49 ships
- 4328 profiles

<u>End of 2014</u>:
- 33276 profiles collected

Charria et al., 2014; Lamouroux et al., in prep., 2015

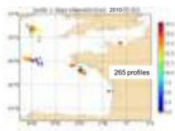
Network scenarii

Spring 02/05/2006 – 24/05/2006



- <u>**Temperature profiles**</u> only considered
- Observation error: **0.3° C**
  - Sensor accuracy: 0.05° C (NKE-SP2T probe)
  - 0.3° C : sensor accuracy & representativity error

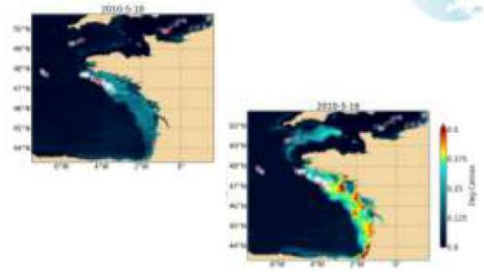
<u>**REF**</u>: 2008



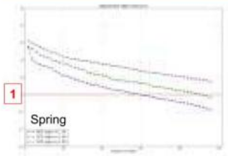
<u>**SC1**</u>: base 2010

<u>**SC2**</u>: collection 2006-2011

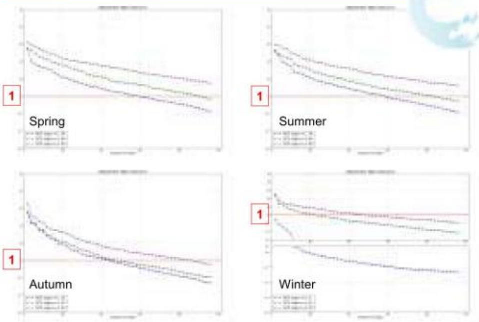
Model uncertainty in spring (⇔ Ensemble Variance)



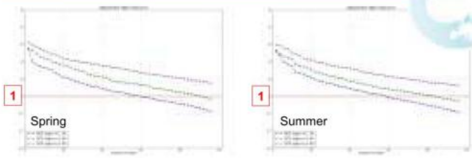
Representer Matrix Spectra

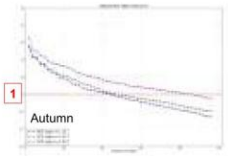


Representer Matrix Spectra



Representer Matrix Spectra





Based on Representer Matrix Spectra (RMS):

SC2 > SC1 > REF

But …

Limits due to the ensemble size (50 members)

Suggesting …

- *To increase the ensemble (not straightforward)*
- *To propose other indicators (following step)*
- *To consider more local systems (1rst part)*

Modal profiles for spring

Quantitative indicators

- *« Modal profiles » (MP) associated to the first modal representer*
  - *REF: 27 MP over 126 available profiles*
  - *SC1: 39 MP over 265*
  - *SC2 : 303 MP over 843*
- *« efficiency » = number of MP / number of available profiles*
  - *REF : 0.21*
  - *SC1 : 0.14*
  - *SC2 : 0.36*

➔ *Following this diagnostics:*

SC2 > REF > SC1

➔ MP $\mathbf{\mu}_k^{MP}$ as $\exists j\,;\mathbf{\mu}_k^{MP}(j) \geq \left(\bar{\mathbf{\mu}} + \sqrt{\langle \mathbf{\mu}_i \rangle}\right)(j)$

μ : network modes (model error modes detected by the network, projected on observation space)

Modal profiles for spring

Quantitative indicators

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μ : network modes (model error modes detected by the network, projected on observation space)


Conclusions & Perspectives
In the Bay of Biscay and English Channel
Strong added value to use **gliders** to monitor Loire
FerryBox measurements are very efficient to monitor western English Channel dynamics,
Voluntay Vessels of Opportunity (VOOs), here fishing
efficient observing system for the Bay of Bis


Conclusions & Perspectives
RMS method - a promising approach ...
To design or improve observing network,
At low computational cost,
Adapted for multi-parameter systems and limited geographical domains (*e.g.* coastal applications)
In the near future ...
Extent to HF Radar observations (JERICO-
Application to regional bio-physical network
Improving methods to
ensembles (*e.g.* AMICO project)


Thanks for your attention ...

07- Evaluation of numerical models by FerryBox & Fixed Platform in-situ data in the southern North Sea

Michael Haller (HZG), Frank Janssen (BSH), John Siddorn (Met Office), Wilhelm Petersen (HZG), Stephan Dick (BSH).

- 4 key words: FerryBox, hydrodynamic model, model data evaluation, salinity
- 2 Regional key words: North Sea, German Bight

FerryBoxes installed on ships of opportunity (SoO) provide high-frequency surface biogeochemical measurements along selected tracks on a regular basis. Within the European FerryBox Community, several FerryBoxes are operated by different institutions. Here we present a comparison of model simulations applied to the North Sea with FerryBox temperature and salinity data from a transect along the Southern North Sea and a more detailed analysis at three different positions located off the English East coast, at the Oyster Ground and in the German Bight. In addition to the FerryBox data, data from a Fixed Platform of the MARNET network are applied. Two operational hydrodynamic models have been evaluated for different time periods: results of BSHcmod v4 are analysed for 2009-2012, while simulations of FOAM AMM7 NEMO have been available from MyOcean data base for 2011 and 2012. The simulation of water temperatures is satisfying; however, limitations of the models exist, especially near the coast in the southern North Sea, where both models are underestimating salinity. Statistical errors differ between the models and the measured parameters, as the root mean square error (rmse) accounts for BSHcmod v4 to 0.92 K, for AMM7 only to 0.44 K. For salinity, BSHcmod is slightly better than AMM7 (0.98 psu and 1.1 psu, respectively).

The study results reveal weaknesses of both models, in terms of variability, absolute levels and limited spatial resolution. In coastal areas, where the simulation of the transition zone between the coasts and the open ocean is still a demanding task for operational modelling, FerryBox data, combined with other observations with differing temporal and spatial scales serve as an invaluable tool for model evaluation and optimization. The optimization of hydrodynamical models with high frequency regional datasets, like the FerryBox data, is beneficial for their subsequent integration in ecosystem modelling.

Slides are presented in the next pages

Evaluation of numerical models by FerryBox and Fixed Platform in-situ data in the southern North Sea

Michael Haller[1], Frank Janssen[2], John Siddorn[3], Wilhelm Petersen[1] and Stephan Dick[2]
1 Institute of Coastal Research, Helmholtz-Zentrum Geesthacht (HZG)
2 Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg
3 Met Office, Exeter, UK
michael.haller@hzg.de

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Why Evaluation of hydrodynamical model parameters salinity and water temperature?

- *High interest for reliable modeling of coastal seas*
- *Applied models are used operationally*
- *The parameters water temperature and salinity are the basis for hydrodynamics as well as ecosystem modeling*
- *The North Sea is a complex system (currents, tides, bathymetry, coastal exchange processes (Wadden Sea, freshwater input)*
- *FerryBox transects cross different regions*

HZG FerryBox routes

- *Operation of currently four operational FerryBoxes:*
  - *„Funny Girl“ on Helgoland-Büsum / Helgoland-Cuxhaven (since 2008)*
  - *„LysBris“ on England-Norway-Belgium (since 2007)*
  - *„Hafnia Seaways“ on Zeebrugge-Gothenburg (since 2015)*
  - *Former FerryBox: „TorDania“ (2006 - 04/2012) on route Cuxhaven-Immingham*

HZG FerryBox routes

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  - *„Hafnia Seaways“ on Zeebrugge-Gothenburg (since 2015)*
  - *Former FerryBox: „TorDania“ (2006 - 04/2012) on route Cuxhaven-Immingham*
  - *Cruise Ship „Mein Schiff 3“ in Mediterranean Sea / Canary Islands (since 2014)*

HZG FerryBoxes are part of Coastal Observation network COSYNA
⇨ Poster!

Observation data sets

FerryBox	Marnet
Cargo RoRo ship „TorDania“ CuxImm route	Light-vessel „Deutsche Bucht“ 7.45°E 54.1667°N
Avg. cruising speed 12 kn, transect every 2-3 days, time resolution 10s	Time resolution 1 hour
Lat, Lon, Water temperature, Salinity at 5m depth	Water temperature, Salinity at 6m depth
Data available 2006-04/2012	Data available 01/2010-10/2011

TorDania

Model descriptions

Model names	BSHcmod v4	FOAM AMM7 NEMO
Model type	Operational 3D- hydrodynamical ocean circulation model	Coupled 3D hydrodynamic-ecosystem model, nested in Met Office global ocean model
Grid resolution, time resolution, vertical levels	5km (900 m in German Bight), 0.25 h, 36 levels	7km (1/9° x 1/15°), 1h, 32 levels (hybrid s-sigma terrain following coordinate system)
Boundary conditions	Meteorological and wave forecasts by German Weather Service (DWD)	One-way nested with FOAM 1/12° Met Office deep ocean model, meteorological forcing by Met Office weather model, satellite SST
Freshwater input	Daily averages from German rivers, climatological runoff from other rivers	Climatological inputs from 300 rivers, updated river scheme
Time period	01/2009 – 01/2012	04/2011 – 04/2012

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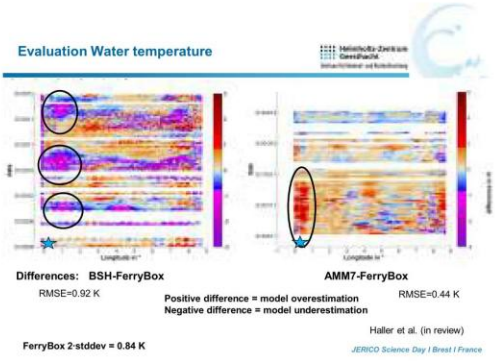
Evaluation Water temperature
Differences: BSH-FerryBox
AMM7-FerryBox
RMSE=0.92 K
Positive difference = model overestimation
Negative difference = model underestimation
RMSE=0.44 K
Haller et al. (in review)
FerryBox 2·stddev = 0.84 K
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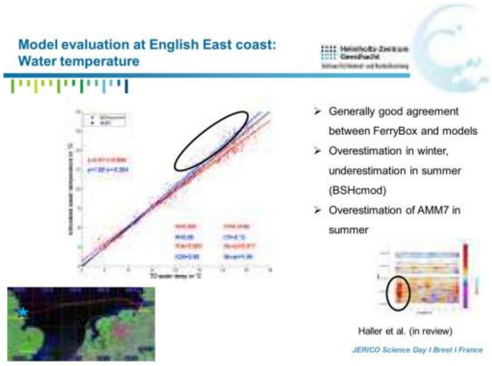
Model evaluation at English East coast: Water temperature
Generally good agreement between FerryBox and models
Overestimation in winter, underestimation in summer (BSHcmod)
Overestimation of AMM7 in summer
Haller et al. (in review)
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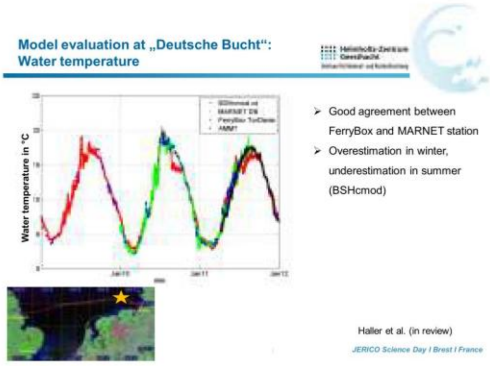
Model evaluation at „Deutsche Bucht“: Water temperature
Water temperature in °C
Good agreement between FerryBox and MARNET station
Overestimation in winter, underestimation in summer (BSHcmod)
Haller et al. (in review)
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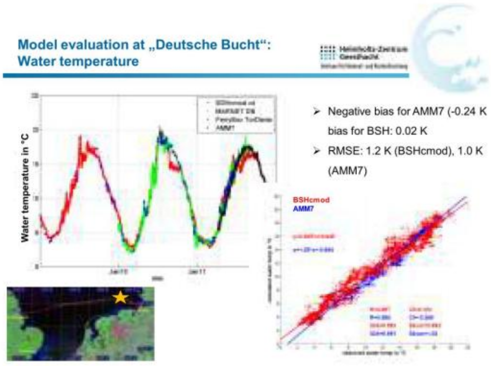
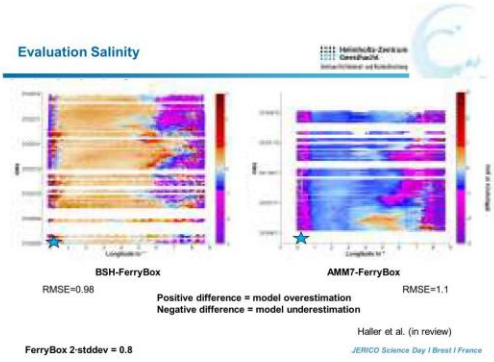

Model evaluation at „Deutsche Bucht“: Water temperature
Water temperature in °C
Negative bias for AMM7 (-0.24 K bias for BSH: 0.02 K
RMSE: 1.2 K (BSHcmod), 1.0 K (AMM7)
BSHcmod
AMM7


Evaluation Salinity
BSH-FerryBox
AMM7-FerryBox
RMSE=0.98
Positive difference = model overestimation
Negative difference = model underestimation
RMSE=1.1
Haller et al. (in review)
FerryBox 2·stddev = 0.8
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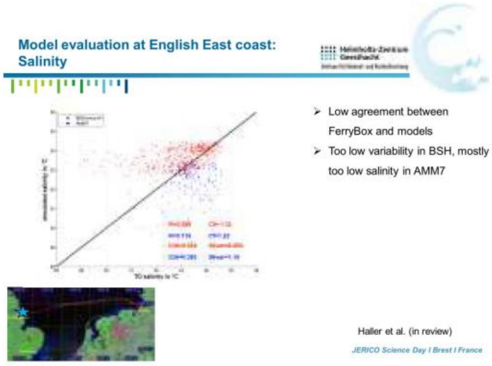
Model evaluation at English East coast: Salinity
Low agreement between FerryBox and models
Too low variability in BSH, mostly too low salinity in AMM7
Haller et al. (in review)
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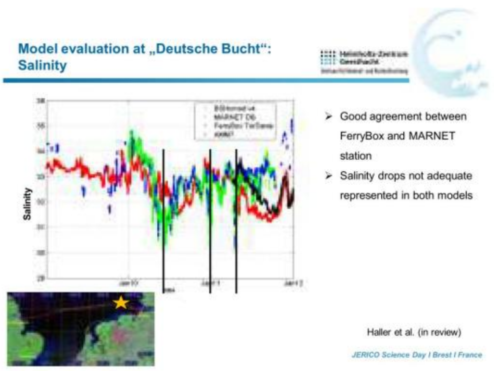
Model evaluation at „Deutsche Bucht“: Salinity
Salinity
Good agreement between FerryBox and MARNET station
Salinity drops not adequate represented in both models
Haller et al. (in review)
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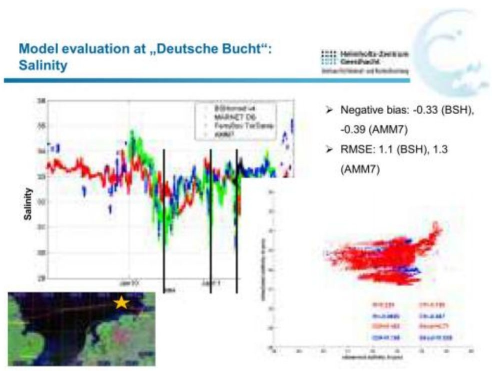
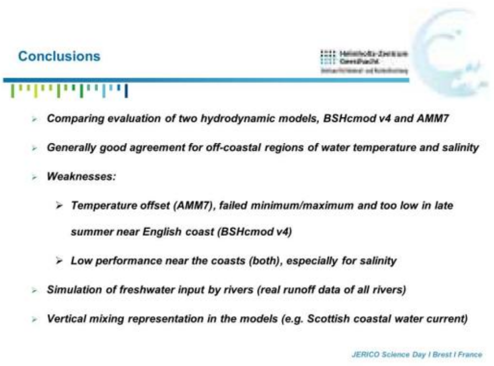

Model evaluation at „Deutsche Bucht“: Salinity
Salinity
Negative bias: -0.33 (BSH), -0.39 (AMM7)
RMSE: 1.1 (BSH), 1.3 (AMM7)


Conclusions
Comparing evaluation of two hydrodynamic models, BSHcmod v4 and AMM7
Generally good agreement for off-coastal regions of water temperature and salinity
Weaknesses:
Temperature offset (AMM7), failed minimum/maximum and too low in late summer near English coast (BSHcmod v4)
Low performance near the coasts (both), especially for salinity
Simulation of freshwater input by rivers (real runoff data of all rivers)
Vertical mixing representation in the models (e.g. Scottish coastal water current)
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08- Observation system experiments and observation system simulation experiments in the Baltic Sea

Zhenwen Wan, Jun She, Weiwei Fun (all DMI)

Buoy observation system and satellite remote sensing system are two fundamental data resources for correcting and improving operational oceanographic predictions in the Baltic Sea. A three-dimensional variation data assimilation scheme and the Danish operational circulation model HBM are employed to experiment the effects from operating individual observation systems and combining two of them. The effects are examined throughout spatio-temporal dimensions. The results indicate that the buoy observation system can improve operational predictions better than satellite remote sensing system for both temperature and salinity, and the combination of two systems can be better than each of individuals.

Model simulation in the year 2009 with data assimilation from both observation systems is assumed as a 'real' ocean. Two routes to operate gliders in the 'real' ocean are designed to examine the effects of glider observation system. Observation system simulation experiments include Scenario 1 – running model HBM with perturbation of initial fields but without data assimilation, Scenario 2 – running the same model with same perturbation and assimilating data from glider operating along Route 1, Scenario 3 – same as Scenario 2 but along Route 2, Scenario 4 -- same as Scenario 2 but operating two gliders along Route 1 and Route 2 respectively. Comparison between the results from four scenarios and the 'real' ocean is made to analyze the effects in seasonal pattern, vertical profiles and regional difference. The scheme of observation system simulation experiments can serve to optimize the design of operating glider observation system.

Slides are presented in the next pages

JOINT EUROPEAN RESEARCH INFRASTRUCTURE NETWORK FOR COASTAL OBSERVATORIES

Baltic OSE and OSSE

Zhenwen Wan I Danish Meteorological Institute I zw@dmi.dk

Tables of content

Baltic monitoring systems and their assessments

- real time monitoring systems ran by SMHI, posted at MyOcean website
- ensembled observation systems, HELCOM
- New technology -- gliders by FMI
- Ferry Box
- DMI has a long history involving in observation system assessment by ODON, ECOOP, MyOcean, OPEC, Jerico.

Circulation Model and Data Assimilation Scheme

Circulation Model -- HBM, is providing operational oceanography service for the Baltic Sea during MyOcean and its following-on Copernicus. A two-way nested model grid covers four domains with different resolution.

Data Assimilation Scheme -- 3DVar

Details:
http://ocean.dmi.dk/models/hbm.uk.php

Data Sources

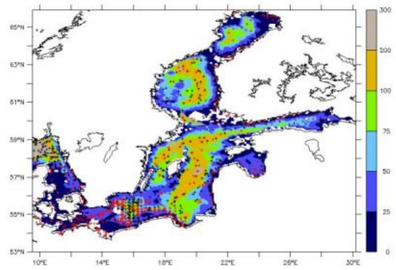
- SST -- Satellite remote sensing L3 data

Detailed in
http://catalogue.myocean.eu.org/static/resources/myocean/pum/MYO2-OSI-PUM-010-018-V1.0.pdf

- TS profiles -- from In Situ Thematic Assembly Centre

Detailed in
http://www.myocean.eu/web/69-myocean-interactive-catalogue.php?option=com_csw&view=details&product_id=INSITU_BAL_NRT_OBSERVATIONS_013_032

Data Sources



Model domain and sampling locations in 2009: black crosses for T/S profiles and red crosses for others

OSE -- Observation System Experiments

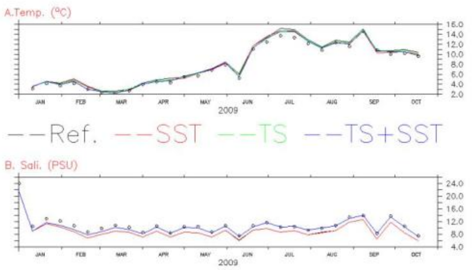
Exp. 0: reference run, without data assimilation

Exp. 1: identical to reference run, but assimilating data SST from satellite remote sensing

Exp. 2: identical to reference run, but assimilating data T/S profiles from moorings

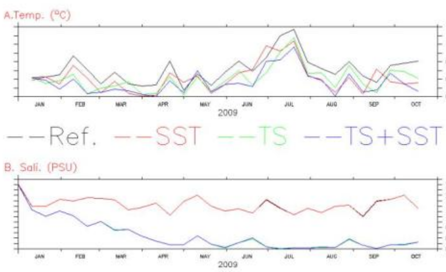
Exp. 3: identical to reference run, but assimilating both data SST and T/S profiles.

OSE -- Results -- mean values



Model results of four experiments (colored curves: black, red, green, blue for Exp.s 0-3, respectively) integrated over basin in comparison with observations (black cycles) for temperature (a) and salinity (b).

OSE -- Results -- mean values



Mean deviations of model results from observations for four experiments (colored curves: black, red, green, blue for Exp.s 0-3, respectively) for temperature (a) and salinity (b).

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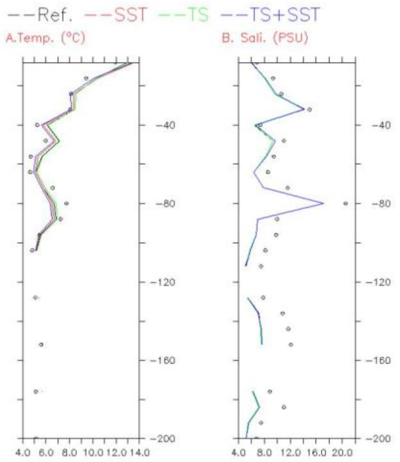
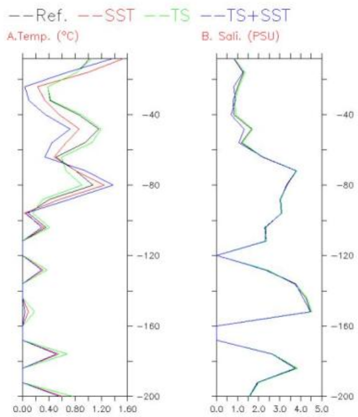


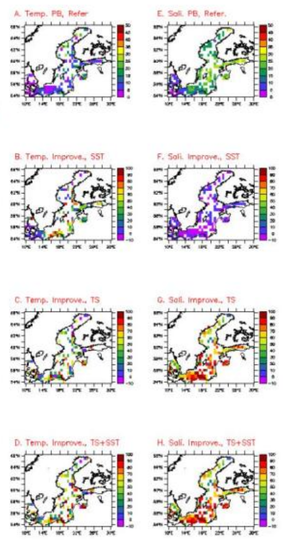
Observed mean (cycles) and model means of four experiments (colored curves)



Deviations of three DA Exp.s (red, green, blue) comparing to reference Exp. (black)

In the right panel, no much difference among four Exp.s

OSE -- Results -- regional distribution



Regional distribution of percentage deviations between prediction products and validation data. Panels in left (right) for temperature (salinity), panels in first row for absolute percentage deviations in reference run (a & e), panels in other rows for percentage improvements relative to reference run as to assimilating data SST (b & f), T/S profiles (c & g) and SST + T/S (d & h).

OSE -- Results -- Statistical metrics for temperature

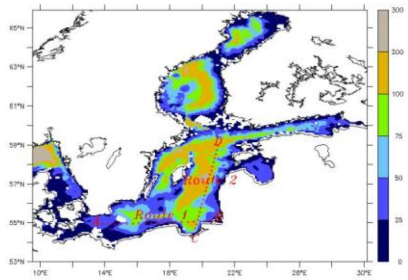
Temperat.	R^2	CF	ME	PB
Refer.	0.91	0.10	0.89	7.1
SST	+0.2%	+7.9%	+1.2%	+45%
TS	+1.9%	+22%	+2.8%	+32%
TS+SST	+2.1%	+25%	+3.4%	+49%

Salinity	R^2	CF	ME	PB
Refer.	0.95	0.11	0.90	-16.
SST	+0.00%	+0.00%	+0.00%	-0.03%
TS	+1.6%	+61%	+6.9%	+73%
TS+SST	+1.6%	+61%	+6.9%	+73%

OSSE -- Observation System Simulation Experiments

Observation system -- gliders

gliders operating along Route 1 & 2 at speed 1 km/h and to release data once per day



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OSSE -- Observation System Simulation Experiments

Exp. 0: reference run, without data assimilation

Exp. 1: identical to reference run, but assimilating data T/S from glider operating along Route 1

Exp. 2: identical to reference run, but assimilating data T/S from glider operating along Route 2

Exp. 3: identical to reference run, but assimilating data T/S from both gliders operating along Route 1 & 2.

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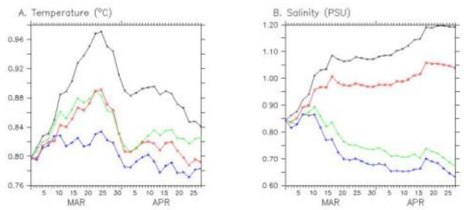
OSSE -- Results -- mean value



Comparison of mean deviations among four experiments (Exp. 0 – black, Exp. 1 – red, Exp. 2 – green, Exp. 3 – blue). Panel a – temperature, panel b – salinity.

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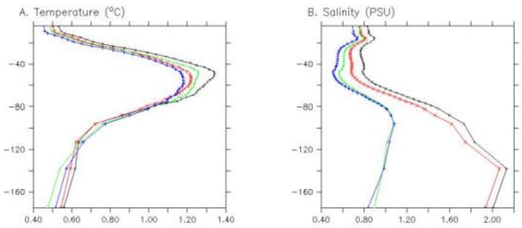
OSSE -- Results -- profiles



Comparison of profiles of mean deviations among four experiments (Exp. 0 – black, Exp. 1 – red, Exp. 2 – green, Exp. 3 – blue). Panel a – temperature, panel b – salinity.

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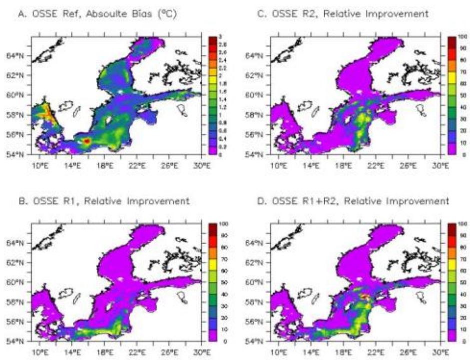
OSSE -- Results -- regional distribution

Mean deviations of temperature from the reference state Exp. 0 to 'true' state (a) and percentage improvements of Exp. 1 (b), 2 (c) and 3 (d) relative to Exp. 0.



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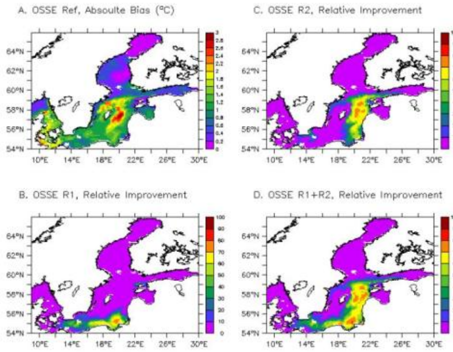
OSSE -- Results -- regional distribution

Mean deviations of salinity from the reference state Exp. 0 to 'true' state (a) and percentage improvements of Exp. 1 (b), 2 (c) and 3 (d) relative to Exp. 0.



OSSE -- Results -- statistics

Statistics based on daily means of temperature at all model grids show that mean deviation from the reference state to the 'true' state is 2.8% due to the introduced perturbation in initial fields. The glider observation system can reduce mean deviations for the entire Baltic Sea up to 6.6%, 2.3%, 13% in circumstance with one glider operating along Route 1, Route 2 and two gliders along Route 1 and Route 2 respectively, comparing to the reference run (without DA). For salinity, mean deviation from the reference state to the 'true' state is 1.2%. The glider observation system can reduce mean deviations for the entire Baltic Sea up to 3.8%, 27%, 30%.

OSE -- Lessons we learnt

Gains:
OSE displays how the Baltic data assimilation system improves model results in seasonal features, profiles and regional distributions.

To do:
impacts on specific features, e.g. salty water intrusion, variability of vertical mixing and bottom flows, should be exploited, given in-situ observations.

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The end

Thank you!

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09- Hydrography & fluorescence variability induced by 3 eddies observed during the GESEBB mission

Ainhoa Caballero (AZTI), Julien Mader (AZTI), Anna Rubio (AZTI), Simón Ruiz (IMEDEA), Bernard Le Cann (LPO), Pierre Testor (LOCEAN), Carlos Hernández (AZTI)

- 4 key words: Eddies, SWODDIES, mode-water eddies, Ekman pumping
- 2 Regional key words: Bay of Biscay, Southeastern Bay of Biscay

The analysis of deep-water glider hydrographic and fluorescence data, together with satellite measurements provide a new insight into eddy-induced anomalies within the South-Eastern Bay of Biscay, during summer. Two cyclonic eddies (C13E and C13W) and a SWODDY (X13) have been observed in different glider transects and by means of different source satellite images/data. Vertical profiles reveal complex structures (characteristic of the second baroclinic mode): upward/downward displacement of the seasonal/permanent thermocline in the case of X13 and the opposite thermocline displacements in the case of the cyclones. This is a typical behaviour of mode-water (X13) and "cyclonic thinny" (C13E and C13W) eddies. A qualitative analysis of the vertical velocities in X13 indicates that though geostrophic currents dominate the main water column, depressing the isopycnals, near the sea surface the eddy-wind interaction affects the vertical currents, favouring Ekman pumping. These two types of intrathermocline lenses appear to deeply impact the fluorescence profiles, since the maximum fluorescence is located just below the seasonal thermocline. The mean fluorescence was higher in the anticyclone than within the cyclones and the mean for the entire study period; the highest values were observed in the centre of X13. The analysis of the Θ-S properties corroborate that inside cyclones and between the 26 and 27 isopynals, net downwelling occurs. Significant differences in the Θ-S properties of the two cyclonic mesoscale structures have been observed: higher temperatures and lower salinity in C13E, in comparison to C13W. Finally, time variation of the salinity content of the shallowest water masses of X13 (salinity decreasing over time), probably indicates advective mixing processes occurred during the mission.

Slides are presented in the next pages

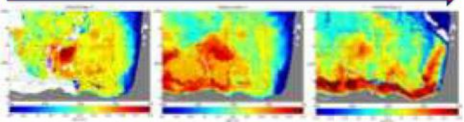
Hydrography and fluorescence variability induced by 3 eddies, observed during the GESEBB mission

Authors: **Caballero A.**, Mader J., Rubio A., Hernandez C. Ruiz S., Le Cann B. and Testor P.
Institutes: AZTI, IMEDEA, LPO, LOCEAN
Email: acaballero@azti.es

The Bay of Biscay & mesoscale eddies

Slope Water Oceanic eDDIES (SWODDIES) are **generated** from a winter warm slope current instabilities, as a consequence of topographic irregularities (Pingree and Le cann, 1992a, Pingree and Le Cann, 1992b…).

February → **April**

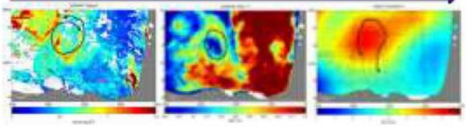


SWODDIES have been **observed** afterwards by different authors and different methods: Satellite data, drifters, numerical models, XBT… (Garcia-Soto et al., 2002, Sánchez et al.,2004; Caballero et al., 2008, 2013…).

The Bay of Biscay & mesoscale eddies

They migrate **westward**, excluding the so-called **4ºW** anticyclonic that remains near the same position during weeks and months (Pingree and Le Cann, 1992a; Pingree and Le Cann, 1992b; Garcia-Soto et al., 2002). This kind of eddy appeared during years of strong winter slope current (Garcia-Soto et al., 2002…).

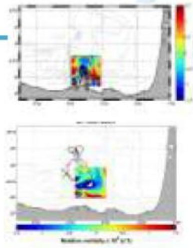
May → **August**



Mesoscale eddies modify the physical dynamics and affect the **biology** of the area (e.g. Irigoien et al., 2008): retention of plankton (e.g. ichthyoplankton), advection of particles, upwelling…

Objectives of the GESEBB campaign

- Analyzing **3D** characteristics of the **4ºW** SWODDY.
- To know in detail the **vertical structure** of the eddy and its **evolution** during the two months of the campaign.
- To sample in detail the vertical structures of the **water column** (stratification, thermocline…) over the shelf-slope area in a period which is especially interesting regarding the biological cycle of some of the key species for the fishery activity.



Glider mission funded by the First call of the JERICO TNA (7th Framework Programme).

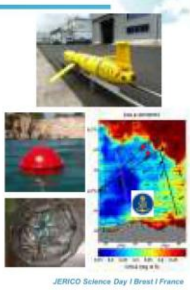
Equipments and tools

Glider
- ✓ Campe: Slocum-1000 type glider; from the INSU-CNRS; CTD, dissolved oxygen, and fluorescence-turbidity sensors.
- ✓ Real time data transmission every surfacing event (~4h)
- ✓ Deployment position: Around 43.64ºN 2.69ºW (Matxitxako B.)
- ✓ Mission period: 23 July-24 September

Drifters
- ✓ 2 Ocean drifter Iridium (Albatros) drifters with a holey sock drogue centred at 50 m depth.
- ✓ Deployment position: 44º42'N 3º30'W and 44º36'N 3º27'W
- ✓ Mission period: 5 August -27 August and 2 September

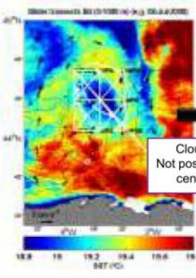
Satellite data/images (NRT)
- ✓ SST (AVHRR 1 km)
- ✓ Chlorophyll-a concentration (MODIS 1 km)
- ✓ AVISO-NRT altimetry (geostrophic currents, merged)

Center Of Eddy Finder (COE)
- ✓ Applied to the vertical integrated currents
- ✓ Developed by **Nencioli et al. (2008)**



First mission design

4 Rotating butterflies over the center of the 4ºW SWODDY



FINAL MISSION
Adapted transects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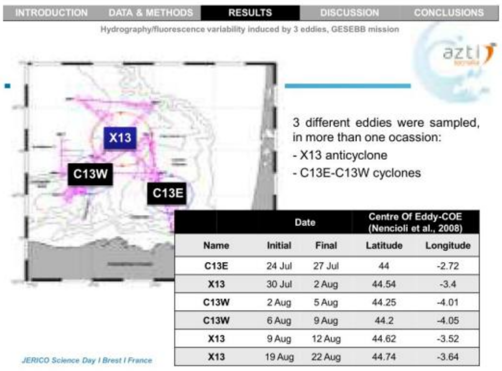
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X13
C13W
C13E
3 different eddies were sampled, in more than one ocassion:
- X13 anticyclone
- C13E-C13W cyclones
Date
Centre Of Eddy-COE (Nencioli et al., 2008)
Name | Initial | Final | Latitude | Longitude
C13E | 24 Jul | 27 Jul | 44 | -2.72
X13 | 30 Jul | 2 Aug | 44.54 | -3.4
C13W | 2 Aug | 5 Aug | 44.25 | -4.01
C13W | 6 Aug | 9 Aug | 44.2 | -4.05
X13 | 9 Aug | 12 Aug | 44.62 | -3.52
X13 | 19 Aug | 22 Aug | 44.74 | -3.64
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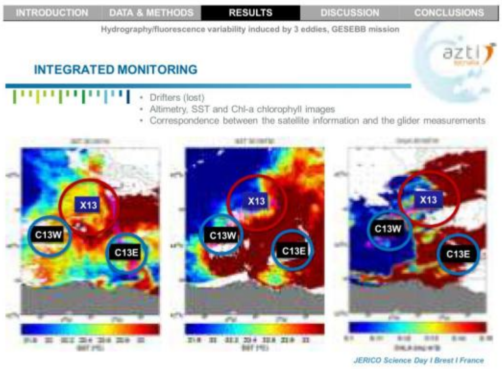
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INTEGRATED MONITORING
• Drifters (lost)
• Altimetry, SST and Chl-a chlorophyll images
• Correspondence between the satellite information and the glider measurements
X13
C13W
C13E
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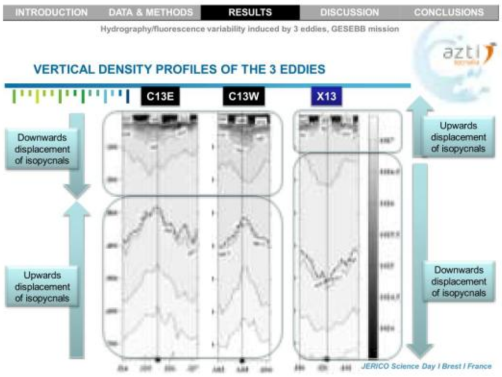
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VERTICAL DENSITY PROFILES OF THE 3 EDDIES
C13E
C13W
X13
Downwards displacement of isopycnals
Upwards displacement of isopycnals
Upwards displacement of isopycnals
Downwards displacement of isopycnals
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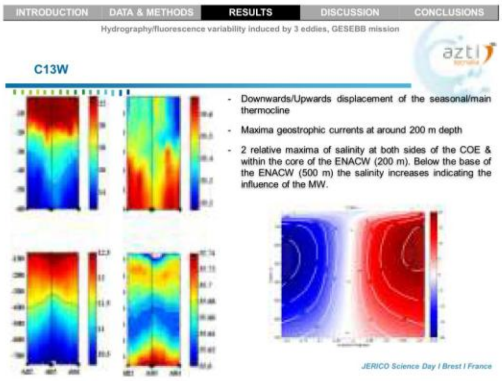
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C13W
- Downwards/Upwards displacement of the seasonal/main thermocline
- Maxima geostrophic currents at around 200 m depth
- 2 relative maxima of salinity at both sides of the COE & within the core of the ENACW (200 m). Below the base of the ENACW (500 m) the salinity increases indicating the influence of the MW.
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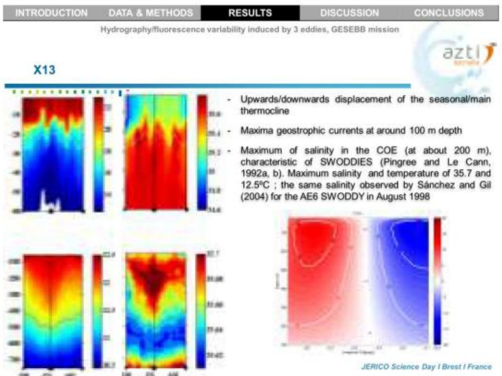
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X13
- Upwards/downwards displacement of the seasonal/main thermocline
- Maxima geostrophic currents at around 100 m depth
- Maximum of salinity in the COE (at about 200 m), characteristic of SWODDIES (Pingree and Le Cann, 1992a, b). Maximum salinity and temperature of 35.7 and 12.5ºC ; the same salinity observed by Sánchez and Gil (2004) for the AE6 SWODDY in August 1998
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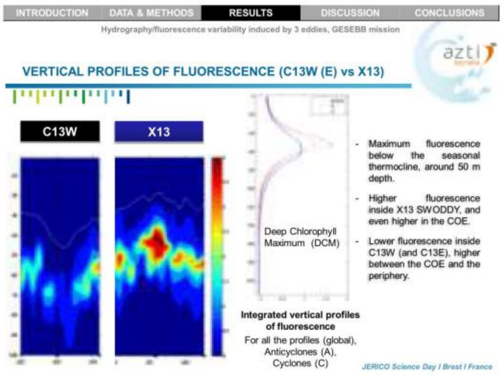
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VERTICAL PROFILES OF FLUORESCENCE (C13W (E) vs X13)
C13W
X13
Deep Chlorophyll Maximum (DCM)
Integrated vertical profiles of fluorescence
For all the profiles (global), Anticyclones (A), Cyclones (C)
- Maximum fluorescence below the seasonal thermocline, around 50 m depth.
- Higher fluorescence inside X13 SWODDY, and even higher in the COE.
- Lower fluorescence inside C13W (and C13E), higher between the COE and the periphery.
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WHY THESE STRUCTURES DON'T SHOW A TYPICAL BEHAVIOUR OF CYCLONES AND ANTICYCLONES?
WHY THERE IS A HIGHER FLUORESCENCE INSIDE ANTICYCLONES?
WHY DO THEY HAVE HIGHEST FLUORESCENCE BELOW THE SEASONAL THERMOCLINE?
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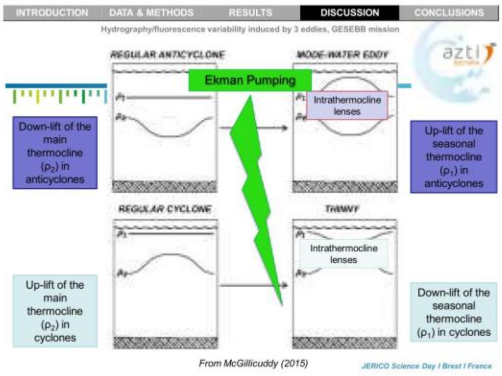
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REGULAR ANTICYCLONE
MODE-WATER EDDY
Ekman Pumping
Intrathermocline lenses
Down-lift of the main thermocline (ρ2) in anticyclones
Up-lift of the seasonal thermocline (ρ1) in anticyclones
REGULAR CYCLONE
THINNY
Intrathermocline lenses
Up-lift of the main thermocline (ρ2) in cyclones
Down-lift of the seasonal thermocline (ρ1) in cyclones
From McGillicuddy (2015)
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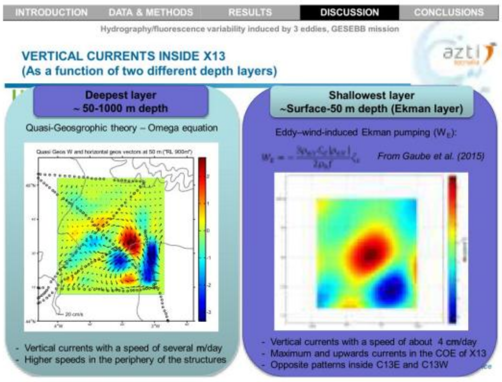
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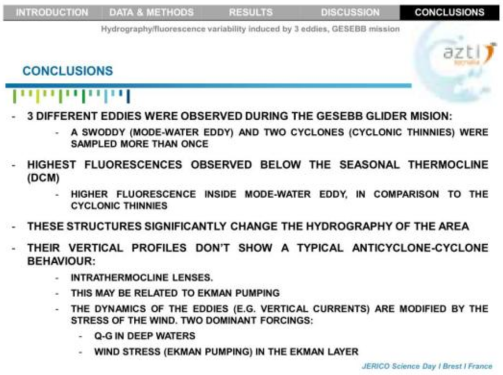
VERTICAL CURRENTS INSIDE X13
(As a function of two different depth layers)
Deepest layer
~ 50-1000 m depth
Quasi-Geosgrophic theory – Omega equation
- Vertical currents with a speed of several m/day
- Higher speeds in the periphery of the structures
Shallowest layer
~Surface-50 m depth (Ekman layer)
Eddy–wind-induced Ekman pumping (W_E):
From Gaube et al. (2015)
- Vertical currents with a speed of about 4 cm/day
- Maximum and upwards currents in the COE of X13
- Opposite patterns inside C13E and C13W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CONCLUSIONS
- 3 DIFFERENT EDDIES WERE OBSERVED DURING THE GESEBB GLIDER MISION:
- A SWODDY (MODE-WATER EDDY) AND TWO CYCLONES (CYCLONIC THINNIES) WERE SAMPLED MORE THAN ONCE
- HIGHEST FLUORESCENCES OBSERVED BELOW THE SEASONAL THERMOCLINE (DCM)
- HIGHER FLUORESCENCE INSIDE MODE-WATER EDDY, IN COMPARISON TO THE CYCLONIC THINNIES
- THESE STRUCTURES SIGNIFICANTLY CHANGE THE HYDROGRAPHY OF THE AREA
- THEIR VERTICAL PROFILES DON'T SHOW A TYPICAL ANTICYCLONE-CYCLONE BEHAVIOUR:
- INTRATHERMOCLINE LENSES.
- THIS MAY BE RELATED TO EKMAN PUMPING
- THE DYNAMICS OF THE EDDIES (E.G. VERTICAL CURRENTS) ARE MODIFIED BY THE STRESS OF THE WIND. TWO DOMINANT FORCINGS:
- Q-G IN DEEP WATERS
- WIND STRESS (EKMAN PUMPING) IN THE EKMAN LAYER
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THANKS FOR YOUR ATTENTION!
Acknowledgements:
JERICO project, in particular the TNA Team: Stefania Sparnoccia (CNR)
Laurent Beguery (INSU), Francesco Nencioli (MIO-LPO), Ana Rietz (Sasemar)… And all the people that made possible this campaign!
Complementary information: Ainhoa Caballero acaballero@azti.es
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10- Multiscale monitoring in Mediterranean with gliders: the Jerico TNA experience (ABACUS, FRIPP, GABS, MUSICS)

Alberto Ribotti (CNR), Giuseppe Aulicino, Giorgio Budillon, Yuri Cotroneo (Pathenope University), Antonio Olita, Bruno Buongiorno Nardelli (CNR), Slim Gana (SAROST S.a.), Daniele Ludicone (SZN), Pierre Testor, Laurent Mortier (LOCEAN), Joaquin Tintoré, Ananda Pascual, Simon Ruiz (IMEDEA)

- 4 key words: hydrodynamics, Western Mediterranean, glider, general circulation
- 2 Regional key words: Western Mediterranean

Between the 2012 and 2014 experiments with deep gliders have been conducted in the Western Mediterranean in four JERICO TNA projects. Their data may substantially help to new insights on the dynamics of the area, encompassing physical biological relationships, at scales ranging from the sub-regional to the sub-mesoscale.

The investigated regions include the Sardinia Channel, between Sardinia and Balears, the Algerian basin (Balears – Algeria) and the Alboran Sea. Almost all experiments have been planned contemporary with oceanographic cruises, making possible both an integration and an intercomparison of the different datasets collected from different platforms. Altimetric and SST satellite data have been also used for comparison and to provide a synoptic view of the situation during the experiments.

A paper has been published on results from the first experiment of the GABS TNA project, when the bloom initiation was detected through gliders data in a frontal area. Then preliminary results from FRIPP suggest possible interesting topics as the relation between oxygen and chlorophyll distribution in a frontal region during DCM period. In other projects (ABACUS, MUSICS) data are very promising and still in elaboration.

In a future TNA program, a larger coordination among various PI would be desirable in order to fully exploit the capabilities of this platform and partly bypass the problem to resolve spatial and temporal scales through the planning of synchronous glider experiments.

Slides are presented in the next pages

Multiscale monitoring in the Mediterranean with gliders: the Jerico TNA experience (ABACUS, FRIPP, GABS, MUSICS)

Ribotti A., Olita A., Buongiorno Nardelli B., CNR, Italy
Aulicino G., Budillon G., Cotroneo Y., Pathenope University, Italy
Gana S., SAROST S.a., Tunisia
Iudicone D., SZN, Italy
Testor P., Mortier L., LOCEAN-IPSL, France
Fuda J.-L., INSU CNRS, France
Tintoré J., Pascual A., Ruiz S., Cusi S., CISC-IMEDEA/SOCIB, Spain

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Premises

Between the 2012 and 2014 several experiments/missions with deep gliders have been conducted in the Western Mediterranean in four JERICO TNA projects. Their data may substantially help to new insights on the dynamics of the area, encompassing physical biological relationships, at scales ranging from the sub-regional to the sub-mesoscale.

GABS - Deep Glider Acquisitions between Balears and Sardinia, Oct. 12 – Nov. 13

FRIPP - FRontal dynamics Influencing Phytoplankton Production and distribution during DCM period, May 14

MUSICS - Multi-Sensor Investigations in the Channel of Sardinia, Aug. – Sept. 14

ABACUS - Algerian BAsin Circulation Unmanned Survey, Sept. – Dec. 14

The investigated regions include the Sardinia Channel, between Sardinia and Balears, the Algerian basin (Balears – Algeria) and the Alboran Sea.

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Deep Glider Acquisitions between Balears and Sardinia

GABS

OBJECTIVES

i) seasonal variability of the physical properties of intermediate waters

ii) assess the transport of water, salt and heat between Balears and Sardinia

iii) validate the operational hydrodynamic numerical model of the western Mediterranean (http://www.seaforecast.cnr.it)

iv) investigate mechanisms of spring bloom triggering over a frontal area

A. Ribotti, A. Olita
CNR Oristano (Italy)

J. Tintorè, S. Cusi, M.C. Torner, E. Heslop
CSIC-IMEDEA/SOCIB (Spain)

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ACCESSED INFRASTRUCTURE
- a Seaglider, able to reach 1000 m depth
- two runs of about 45 days each

Two missions planned and accomplished.

EXPERIMENTS
- Glider pre-mission: 23/10/2012 - 30/10/2012
- 1st mission: 31/01/2013 – 16/03/2013
- 2nd mission: 15/10/2013 - 29/11/2013


OCEAN SCIENCE, 10, 2014, 657-666

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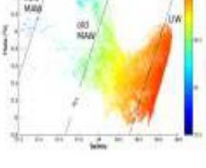
GABS

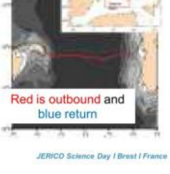
1st mission: 31/01/2013 – 16/03/2013

The glider measured water temperature, conductivity and pressure up to 1000 m, then fluorescence, turbidity and dissolved oxygen up to 300 m in the transect Menorca - Oristano and return along the latitude 39° 49.457' N in about 49 days



Outbound leg:
31/01 – 19/02

Return leg:
20/02-09/03



Red is outbound and blue return

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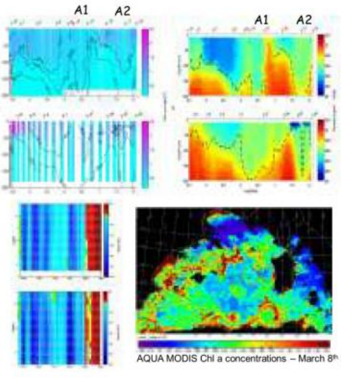

AQUA MODIS Chl a concentrations – March 8th 2013

Observed:
- two **anticyclonic eddies** A1 and A2 along the two paths
- a deep and **well-mixed upper layer** between 100 and 150m between 5-6 °E
- **rise of the mixed layer** of over 40 m measured during the return path between 4,5-5 °E coincident with a frontal meander of the North Balearic Front
- **phytoplankton bloom** is strongly related to heat fluxes inversion and the mesoscale activity associated with NBF and the margins of the largest anticlyclonic eddies

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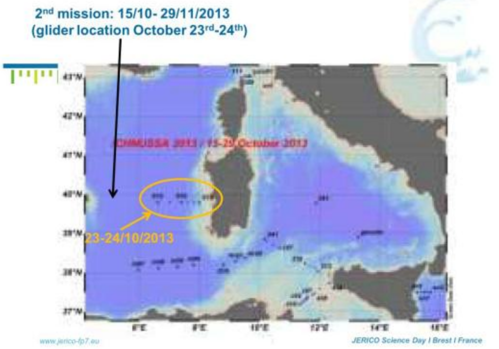
JERICO


2nd mission: 15/10- 29/11/2013
(glider location October 23rd-24th)
CHMUSSA 2013 / 15-25 October 2013
23-24/10/2013
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FRontal dynamics Influencing Phytoplankton Production and distribution during DCM period
FRIPP
A. Olita
CNR Oristano (Italy)
J. Tintorè, A. Pascual, S. Ruiz
CSIC-IMEDEA/SOCIB (Spain)
OBJECTIVE
The project aimed to study, through a multisensor sea-glider mission supported by modelled and remotely-sensed data, the impact of frontal dynamics on the phytoplankton production and distribution as inferred from fluorometric measurements.
On May 25 2014, two SLOCUM gliders (a_coast and a_deep) were launched in the framework of the multiplatform and multidisciplinary experiment in the Alboran sea named ALBOREX (a PERSEUS project sampling) and of the JERICO TNA FRIPP project.
The two instruments glided for 6 days, during which ADCP, ship based CTD, ARGO floats and surface drifters also sampled surface to deep waters allowing, together with bottle water samples, to collect a comprehensive dataset of oceanographic multidisciplinary quasi-synoptic data at (sub-)mesoscale.
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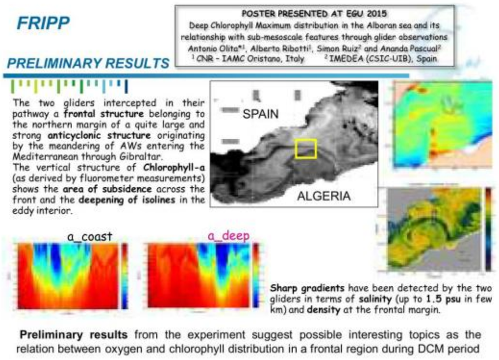
FRIPP
POSTER PRESENTED AT EGU 2015
Deep Chlorophyll Maximum distribution in the Alboran sea and its relationship with sub-mesoscale features through glider observations
Antonio Olita*1, Alberto Ribotti1, Simon Ruiz2 and Ananda Pascual2
1 CNR - IAMC Oristano, Italy 2 IMEDEA (CSIC-UIB), Spain
PRELIMINARY RESULTS
The two gliders intercepted in their pathway a frontal structure belonging to the northern margin of a quite large and strong anticyclonic structure originating by the meandering of AWs entering the Mediterranean through Gibraltar.
The vertical structure of Chlorophyll-a (as derived by fluorometer measurements) shows the area of subsidence across the front and the deepening of isolines in the eddy interior.
SPAIN
ALGERIA
a_coast
a_deep
Sharp gradients have been detected by the two gliders in terms of salinity (up to 1.5 psu in few km) and density at the frontal margin.
Preliminary results from the experiment suggest possible interesting topics as the relation between oxygen and chlorophyll distribution in a frontal region during DCM period


MuSICS
JERICO
EGO
Multi-Sensor Investigations in the Channel of Sardinia
« MuSICS »
S. Gana
SAROST Marine Engineering and Geosciences Division, Tunisia
P. Testor, L. Mortier
LOCEAN-IPSL, France
Fuda J.-L.
INSU CNRS, France
Other contributors:
Iudicone D., Ghenim L., Olita A., Buongiorno-Nardelli B., Tintoré J.
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The missions
SCIENTIFIC GOALS
• Identify the physical properties of surface and intermediate water masses between Northern Tunisian Coast and Sardinia and their short term variability
• Assess water quality status based on optical sensors
• Understand and quantify exchanges through sub-basins and the complex interactions through eddies
16 August – 19 September 2014
• Mission 1: (16 – 28 August): Sardinia - Northern Tunisian coasts and return
• Mission 2: (28 August – 08 September): Sardinia - Northern Tunisian coasts and return
• Mission 3: (08 – 19 September): Sardinia - Northern Tunisian coasts and return
The glider followed SARAL/Altika Ground Track #887
The glider was equipped with the following sensors:
CTD, d.Oxy, CDOM, Turbidity, Chl-a
600 profiles realized in 33 days
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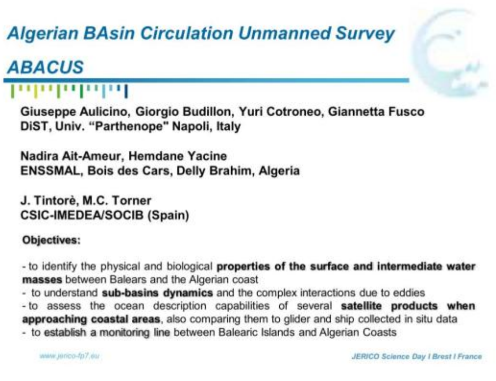
Algerian BAsin Circulation Unmanned Survey
ABACUS
Giuseppe Aulicino, Giorgio Budillon, Yuri Cotroneo, Giannetta Fusco
DiST, Univ. "Parthenope" Napoli, Italy
Nadira Ait-Ameur, Hemdane Yacine
ENSSMAL, Bois des Cars, Delly Brahim, Algeria
J. Tintorè, M.C. Torner
CSIC-IMEDEA/SOCIB (Spain)
Objectives:
- to identify the physical and biological properties of the surface and intermediate water masses between Balears and the Algerian coast
- to understand sub-basins dynamics and the complex interactions due to eddies
- to assess the ocean description capabilities of several satellite products when approaching coastal areas, also comparing them to glider and ship collected in situ data
- to establish a monitoring line between Balearic Islands and Algerian Coasts
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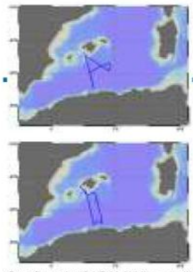


First Deployment : Sept 1st 2014
Emergency Recovery: Sept 3rd
Second Deployment: Sept 15th
End Run Recovery: Oct 20th
Days at sea : 36

First Mission

First Deployment : Nov 3rd
Emergency Recovery: Nov 5th
Second Deployment: Nov 18th
End Run Recovery: Dec 19th 2014
Days at sea : 32

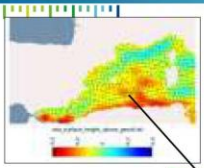
Second Mission

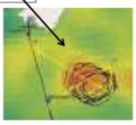
Overflown by SARAL/Altika satellite twice in two neighbour ground tracks:
- Nov 26th 2014 (track #773)
- Dec 12th 2014 (track #229)

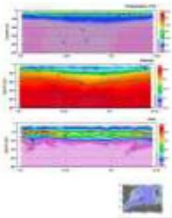
- Gathered Scientific Profiles: **875**
- Distance Coverage: **898 nm (1661 Km)**

I experiment – very preliminary results

Glider and satellite monitoring of a Mediterranean mesoscale eddy







SVP surface drifters

SARAL/Altika data are under elaboration

Final general considerations

In a future TNA program, a larger coordination among various PIs would be desirable in order to fully exploit the capabilities of a platform like gliders and partly bypass the problem to resolve spatial and temporal scales. This can be done through the planning of synchronous glider experiments (2-stage TNA proposals)

This can be extended also between PIs using different platforms in same or neighboring areas (at sub-basin scale)

COMMON SENSE

Cost-effective sensors, interoperable with international existing ocean observing systems, to meet EU policies requirements

- **DURATION:** 40 Months (Nov. 13 – Feb. 17)
- **COORDINATOR:** LEITAT Technological Center (LEITAT), Barcelona, Spain
- **CONSORTIUM:** 15 partners from 7 countries (6 SMEs, 5 research institutes, 3 universities and 1 foundation)

- The **COMMON SENSE project has been designed to develop innovative, cost-effective sensors** that will increase the availability of standardized data on:
  - eutrophication;
  - concentrations of heavy metals;
  - microplastic fraction within marine litter;
  - underwater noise;
  - nanosensors for autonomous pH and pCO2 measurements
  - innovative piro and piezo resistive polymeric temperature and pressure sensors.

www.commonsenseproject.eu

11- Particle fluxes in the Sicily Channel: Preliminary results from the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment

Anna Sanchez-Vidal (Universitat de Barcelona), Aitor Rumin-Caparrós (Universitat de Barcelona), Mireno Borghini, Katrin Schroeder, Stefania Sparnocchia. (ISMAR-CNR)

- 4 key words: sediment trap, particle flux, carbon
- 2 Regional key words: Sicily Channel

The main objective of the METRO (MEditerranean sediment TRap Observatory) project is to characterize the environmental factors that drive the particulate carbon pump (which includes photosynthesis, particle settling and advection, and organic matter remineralization) at three key locations in the Western Mediterranean. The carbon pump cause sequestration of carbon dioxide in the deep sea due to the sinking of particles, thus an accurate quantification of the export flux of particulate organic carbon, and knowledge on physical processes affecting it during its descent to the seafloor (i.e. advection by strong currents), is fundamental for the understanding its magnitude and efficiency. This study has been achieved through the installation of 3 sediment traps at 25-30 meters above the seafloor over 1 year (October 2013 to October 2014) at the three key locations in the Western Mediterranean which are the Gulf of Lion, the Algero-Balearic basin and the Sicily Channel. Sinking particles collected by the sediment traps are being processed in the laboratory to obtain several geochemical parameters including organic carbon, calcium carbonate, opal and lithogenics, the stable isotopes of organic carbon and grain size. Geochemical results will be integrated with physical variables (current speed, temperature, salinity) to determinate which are the physical forcings affecting particle and specially carbon export to the deep sea.

Slides are presented in the next pages

Particle fluxes in the Sicily Channel

Preliminary results from the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment

A. Sanchez-Vidal, A. Rumín-Caparrós, M. Borghini, K. Schroeder, S. Sparnocchia

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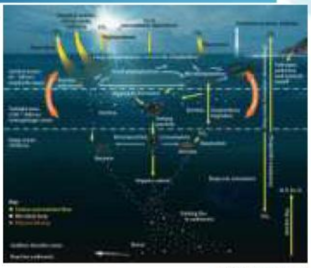
Why monitoring particle (and carbon) fluxes?



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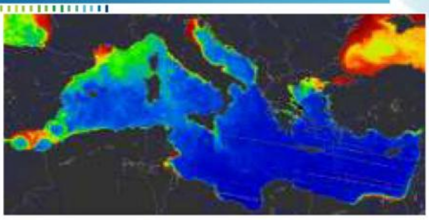
Why monitoring particle (and carbon) fluxes in the Mediterranean Sea?



Importance of monitoring environmental drivers (defined as environmental shifts that cause increase carbon sequestration) -> diverse in the Mediterranean Sea

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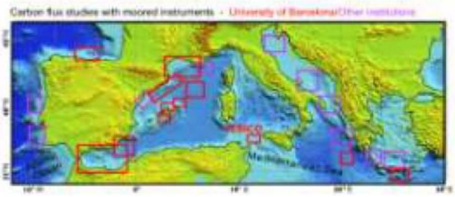
Where particle (and carbon) fluxes have been monitored so far?



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Objectives of the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment

1. Monitoring environmental drivers of particle (and carbon) fluxes in an unexplored area (the Sicily Channel) over 1 year, and at the same time than in the Cap de Creus submarine canyon and in the Algero-Balearic basin
2. Determine the environmental drivers of carbon fluxes in these 3 key areas of the Mediterranean Sea, and have an estimation of the magnitude of the export of carbon (and the functioning of the carbon pump) to the deep sea

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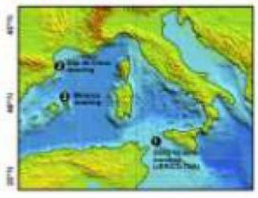
Objectives of the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment



3 mooring lines with sediment traps and currentmeters near the bottom deployed from October 2013 to November 2014 in three key areas of the (western) Mediterranean Sea: the Cap de Creus canyon, the Algero-Balearic basin north of Minorca (both framed within the FP7-PERSEUS project) and the Sicily Channel (JERICO action).

PERSEUS ↔ JERICO

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Methods of the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment
Field work – Sicily Channel

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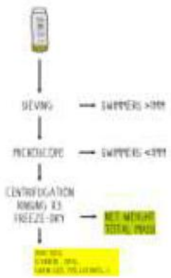
Methods of the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment
Field work – Cap de Creus and Minorca

Methods of the JERICO TNA METRO (MEditerranean sediment TRap Observatory) experiment
Laboratory work

Curiosity: young specimen of *Galeus melastomus* found inside a cup (is any biologist interested on that?)



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First results obtained
Total mass fluxes in the Sicily Channel

- Total mass fluxes show minimum values (179 mg m^{-2} d^{-1}) in November 2013 and maximum values (up to 1737 mg m^{-2} d^{-1}) in May 2014.
- There are signals of seasonal variability in total mass fluxes with higher fluxes in spring and lower fluxes in summer and autumn

What are the environmental drivers of this seasonal variability?

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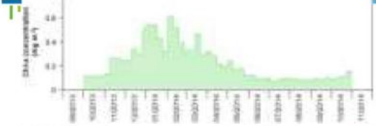
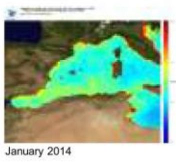
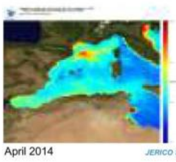
First results obtained
Environmental drivers: Chl-a concentration



High chl-a values in January and February 2014: higher primary production triggered by nutrient mixing in the Algero-Balearic current, as seen by MODIS imagery



January 2014



April 2014

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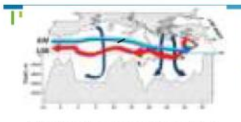
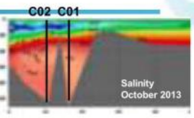
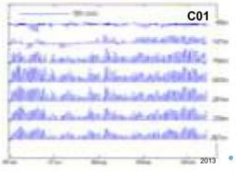
First results obtained
Environmental drivers: circulation



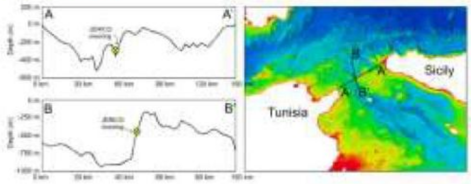


- Atlantic water flows at the surface West to East
- LIW and EMDW flow at intermediate and deep levels East to West:
- Long time series of currents in C01 and C02 (since 1993), regular six months oceanographic cruises
- Coherent current pattern below 150 m in C01 site
- Energetic currents (maximum values > 50 cm/sec)



2

First results obtained
Environmental drivers: bathymetric features



High probability that current speeds and bathymetric features (complex bathymetry with continental shelf and hills nearby) have an effect on the advection of particles

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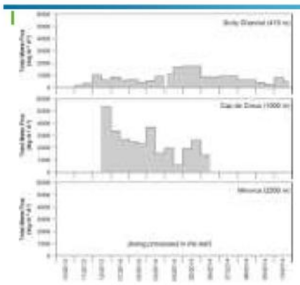
First results obtained
Total mass fluxes at the three sites



- Despite total mass fluxes in the Cap de Creus show were unusually low, fluxes were significantly higher than in the Sicily Channel
- Year 2013-14 was relatively "monotonous" in the context of the extreme physical forcings (such as dense water formation) impacting sites in the Western Mediterranean. As an example, cascading or storms can trigger fluxes of up to 120000 mg $m^{-2}d^{-1}$!!

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Our results in the context of (some) other Mediterranean environments

Area	Depth (m)	Annual mean flux ($mg\ m^{-2}d^{-1}$)	Reference
Western Mediterranean			
DYFAMED site	200 m 1000 m	**95** **87**	*Miquel et al.*
Catalan Sea & Gulf of Lions	300-400 m 1000-1900 m	**700-28000** **300-22000**	*Lopez-Fernandez et al., Martin et al., Heussner, Pasqual*
Mallorca slope	900 m	**200-300**	*Pasqual et al.*
Algero-Balearic Basin	250 m 800-3000 m	**85-112** **52-390**	*Zúñiga et al., Gogou et al.*
Alboran Sea	400 m 600-2000 m	**320-802** **170-860**	*Fabrés et al., Sanchez-Vidal et al.*
Sicily Channel	**400 m**	805	***This study***
Central Mediterranean			
Adriatic Sea	500-600 m	**400-14000**	*Boldrin et al., Tesi et al.*
Eastern Mediterranean			
NESTOR site	700 m 700-4300 m	**100** **50-150**	*Stravakakis et al*
Ionian Sea	1400-2800 m	**50**	*Gogou et al*
Ierapetra basin	4300 m	**10**	*Pedrosa-Pàmies et al.*

To be done / future work

- Finalize chemical analyses of content of major components of particle fluxes (organic carbon and its stable isotope, opal, calcium carbonate, lithogenics) as well as grain size of settling particles
- Analyse pollutants (trace metals and/or some organic pollutants such as PAHs, etc.) and compare with other Mediterranean sites
- Relate results obtained to environmental (physical, biological and chemical) forcings and estimate the drivers and the magnitude of the biological pump (export of carbon) in this key area of the Mediterranean sea
- **Put the Sicily Channel in the map of particle flux studies in the Mediterranean Sea**

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IV] Topic 3: Monitoring of biological compartment

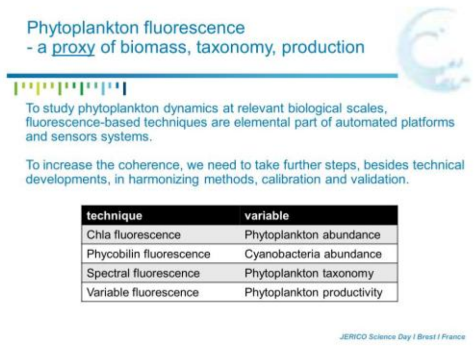
12- Monitoring phytoplankton taxonomy and productivity using fluorometry

Jukka Seppälä, (SYKE), Pasi Ylöstalo (SYKE), Stefan Simis (Plymouth Marine Laboratory), Seppo Kaitala, Emilie Houliez (SYKE)

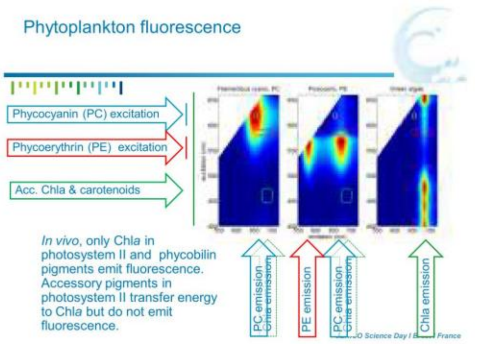
- 4 key words: Fluorescence, phytoplankton, taxonomy, productivity
- 2 Regional key words: Baltic Sea

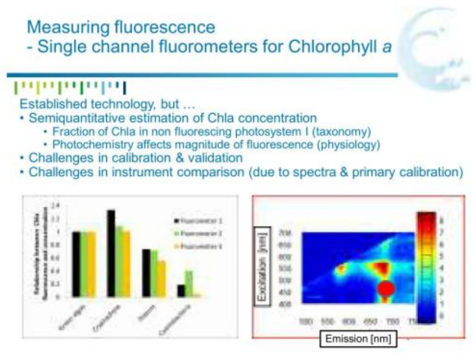
In vivo fluorescence methods are increasingly used in estimating phytoplankton biomass, taxonomy and primary production. We review phytoplankton pigmentation, principles of phytoplankton fluorescence, fluorescence measuring techniques and their recent developments. We discuss the challenges in the instrument calibration, field validation and data-analysis.
Spectral fluorometry can be used to resolve main taxonomic phytoplankton classes, based on their differences in pigmentation. Discrimination of spectral phytoplankton classes is typically done with spectral libraries of reference species. In ideal species mixtures of phytoplankton cultures this turns out well but the performance in natural waters may be less satisfactory. Alternative analytical and statistical multivariate methods to analyze spectral fluorescence data are demonstrated.
Variable fluorescence techniques allow determination of the electron transport rate in photosystems, which is correlated with the rate of photosynthesis. Variability in the conversion factor between the electron transport and carbon fixation rates is illustrated with field data from the Baltic Sea. We also demonstrate recent developments including automated measurements of fluorescence-light curves with several excitation channels improving the sensitivity under varying community composition, and instruments designed for flow-through systems.

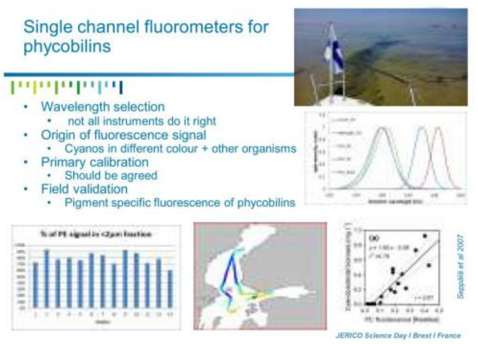
Slides are presented in the next pages

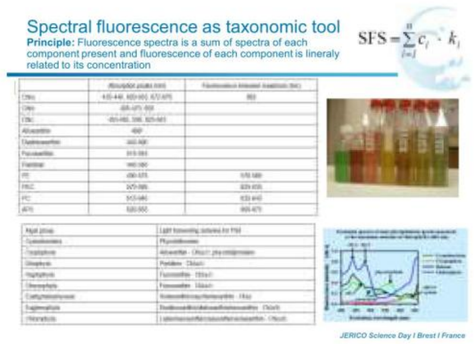


technique	variable
Chla fluorescence	Phytoplankton abundance
Phycobilin fluorescence	Cyanobacteria abundance
Spectral fluorescence	Phytoplankton taxonomy
Variable fluorescence	Phytoplankton productivity









1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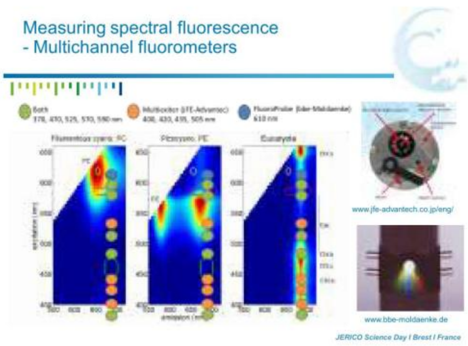
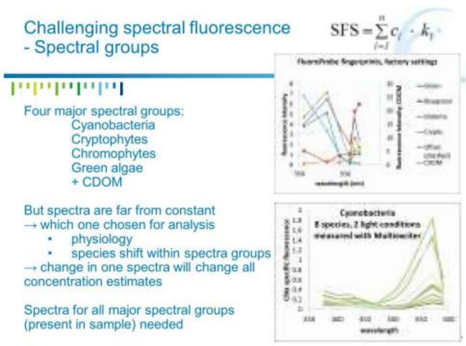
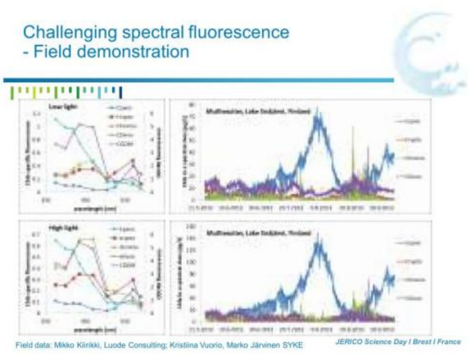

Measuring spectral fluorescence
- Multichannel fluorometers
www.jfe-advantech.co.jp/eng/
www.bbe-moldaenke.de
JERICO Science Day I Brest I France


Challenging spectral fluorescence
- Spectral groups
Four major spectral groups:
Cyanobacteria
Cryptophytes
Chromophytes
Green algae
+ CDOM
But spectra are far from constant
→ which one chosen for analysis
physiology
species shift within spectra groups
→ change in one spectra will change all concentration estimates
Spectra for all major spectral groups (present in sample) needed


Challenging spectral fluorescence
- Field demonstration
Field data: Mikko Kiirikki, Luode Consulting; Kristiina Vuorio, Marko Järvinen SYKE
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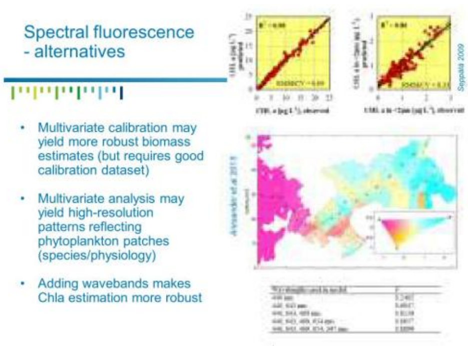
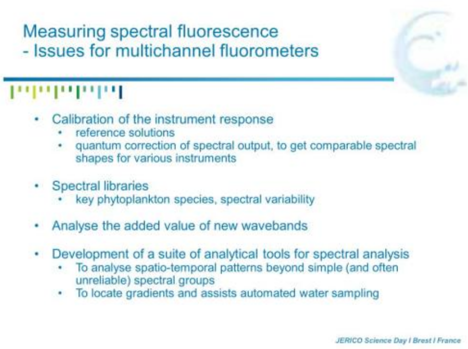

Spectral fluorescence
- alternatives
Multivariate calibration may yield more robust biomass estimates (but requires good calibration dataset)
Multivariate analysis may yield high-resolution patterns reflecting phytoplankton patches (species/physiology)
Adding wavebands makes Chla estimation more robust


Measuring spectral fluorescence
- Issues for multichannel fluorometers
Calibration of the instrument response
reference solutions
quantum correction of spectral output, to get comparable spectral shapes for various instruments
Spectral libraries
key phytoplankton species, spectral variability
Analyse the added value of new wavebands
Development of a suite of analytical tools for spectral analysis
To analyse spatio-temporal patterns beyond simple (and often unreliable) spectral groups
To locate gradients and assists automated water sampling
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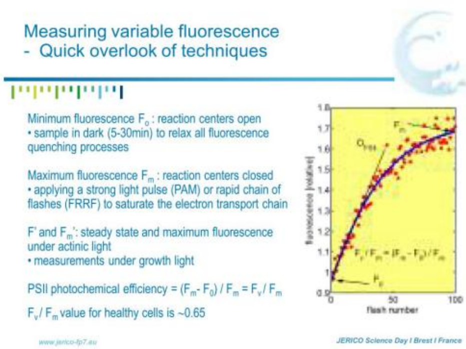
Measuring variable fluorescence
- Quick overlook of techniques
Minimum fluorescence F0 : reaction centers open
• sample in dark (5-30min) to relax all fluorescence quenching processes
Maximum fluorescence Fm : reaction centers closed
• applying a strong light pulse (PAM) or rapid chain of flashes (FRRF) to saturate the electron transport chain
F' and Fm': steady state and maximum fluorescence under actinic light
• measurements under growth light
PSII photochemical efficiency = (Fm- F0) / Fm = Fv / Fm
Fv / Fm value for healthy cells is ~0.65
flash number
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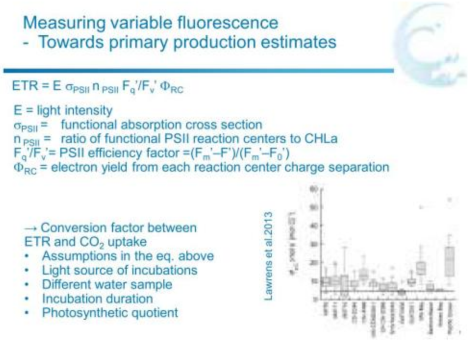
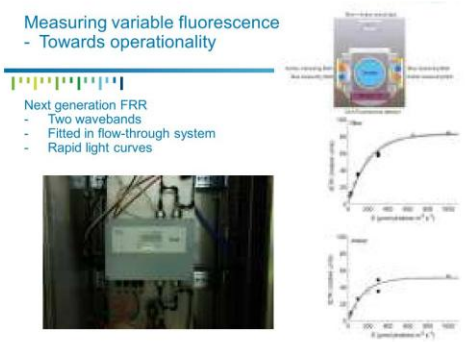
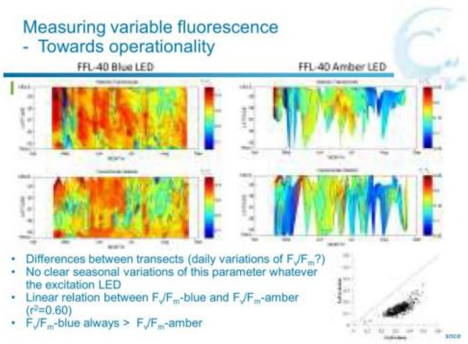
2



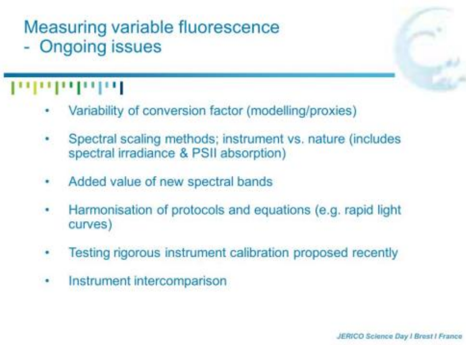
Measuring variable fluorescence
- Towards primary production estimates
ETR = E σPSII n PSII Fq'/Fv' ΦRC
E = light intensity
σPSII = functional absorption cross section
n PSII = ratio of functional PSII reaction centers to CHLa
Fq'/Fv'= PSII efficiency factor =(Fm'–F')/(Fm'–F0')
ΦRC = electron yield from each reaction center charge separation
→ Conversion factor between ETR and CO2 uptake
• Assumptions in the eq. above
• Light source of incubations
• Different water sample
• Incubation duration
• Photosynthetic quotient
Lawrens et al.2013



Measuring variable fluorescence
- Towards operationality
Next generation FRR
- Two wavebands
- Fitted in flow-through system
- Rapid light curves



Measuring variable fluorescence
- Towards operationality
FFL-40 Blue LED
FFL-40 Amber LED
• Differences between transects (daily variations of Fv/Fm?)
• No clear seasonal variations of this parameter whatever the excitation LED
• Linear relation between Fv/Fm-blue and Fv/Fm-amber (r²=0.60)
• Fv/Fm-blue always > Fv/Fm-amber



Measuring variable fluorescence
- Ongoing issues
• Variability of conversion factor (modelling/proxies)
• Spectral scaling methods; instrument vs. nature (includes spectral irradiance & PSII absorption)
• Added value of new spectral bands
• Harmonisation of protocols and equations (e.g. rapid light curves)
• Testing rigorous instrument calibration proposed recently
• Instrument intercomparison
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3

13- Algal bloom observations using the JERICO infrastructure

Bengt Karlson (SMHI), Malin Mohlin (SMHI), Ye Liu, Anders Andersson (KTH Royal Institute of Technology)

- 4 key words: Phytoplankton algal bloom, harmful algae, barcoding
- 2 Regional key words: Baltic Sea, the Kattegat-Skagerrak

Phytoplankton growth supports most of the life in the seas. The phytoplankton community usually consists of a large number of different species. Sometimes the phytoplankton grow to high cell densities often termed algal blooms, some of these may be harmful. The biodiversity and biomass of phytoplankton and the frequency of algal blooms are used to describe the ecological state of the seas in EU Water Framework Directive and the Marine Strategy Framework Directive which includes also invasive species and harmful algal blooms. A general problem with algal bloom observations is to resolve the natural variability. Standard monitoring programs often have sampling frequencies that are too low. In JERICO a number of different approaches were used to observe algal blooms with a focus on harmful species. Measurements of chlorophyll fluorescence using FerryBox-systems and oceanographic buoys in the Baltic Sea and the Kattegat-Skagerrak made it possible to follow the development of the spring bloom in detail. Using phycocyanin fluorescence as a proxy for cyanobacteria biomass it was possible to investigate the development of summer cyanobacteria blooms in the Baltic Sea. Using FerryBox systems as platforms for automated water sampling for later microscope analysis of samples has provided a cost efficient way to investigate the biodiversity of the phytoplankton, also a study comparing microscope and gene-barcoding-based results was made.

Slides are presented in the next pages

JERICO science day 28-29 April 2015, Bres, France

SMHI

Algal bloom observations using the JERICO infrastructure

Bengt Karlson, Malin Mohlin[1], Ye Liu[1] and Anders Anderson[2]
[1]Swedish Meteorological and Hydrological Institute, Gothemburg, Sweden
[2]KTH Royal Institute of Technology, Stockholm, Sweden

*Corresponding author:
bengt.karlson@smhi.se

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Very brief background

- Phytoplankton are the dominant primary producers in the seas
- Most algal blooms are natural phenomena
- Some algal blooms are harmful
  - High biomass blooms, e.g. cyanobacteria blooms in the Baltic Sea and blooms of some fish killing species
  - Low biomass blooms, e.g. bloom of algae that produce biotoxins that accumulate in shellfish

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EU directives related to phytoplankton

- Water Framework Directive
  - Biodiversity of phytoplankton
  - Biomass of phytoplankton
  - Frequency of algal blooms
- Marine Strategy Framework Directive
  - Biodiversity
  - Invasive species
  - Food webs
  - Eutrophication including harmful algal blooms
- Directives related to health and hygiene
  - Biotoxin producing algae causing shellfish toxicity

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Sampling platforms used in JERICO

- Oceanographic buoys
  - Fluorescence of chlorophyll – proxy for phytoplankton biomass
  - Fluorescence of phycocyanin – proxy for biomass of certain cyanobacteria
  - Oxygen – related to primary production
  - Automated water sampling (e.g Cefas Smartbuoys)
- Ships of opportunity, i.e. FerryBox systems
  - Fluorescence of chlorophyll – proxy for phytoplankton biomass
  - Fluorescence of phycocyanin – proxy for biomass of certain cyanobacteria
  - Oxygen and pCO_2– related to primary production
  - Automated water sampling
- Research vessels
  - FerryBox plus:
  - CTD with sensors for fluorescence of of chlorophyll and phycocyanin –Oxygen – related to primary production
  - Water sampling

Väderö buoy, SMHI

TransPaper – ship with FerryBox system

FerryBox-system with sensors and water samplers

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Some problems to solve

- What is the spatial and temporal distrubution of phytoplankton?
- How do blooms develop?
- Are the blooms harmful?

1


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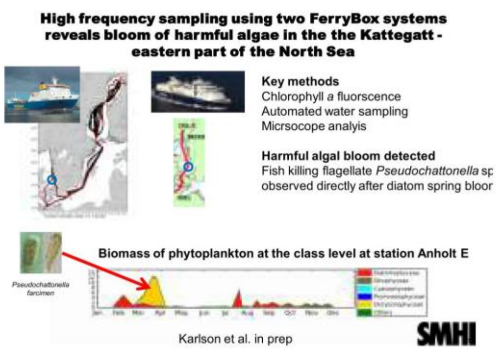
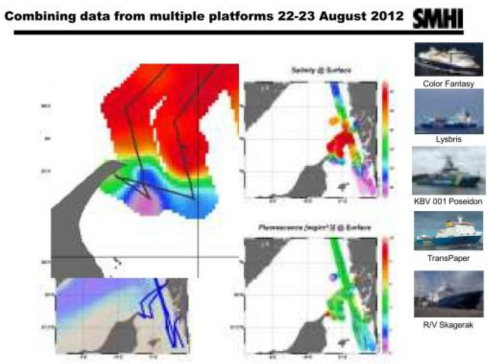
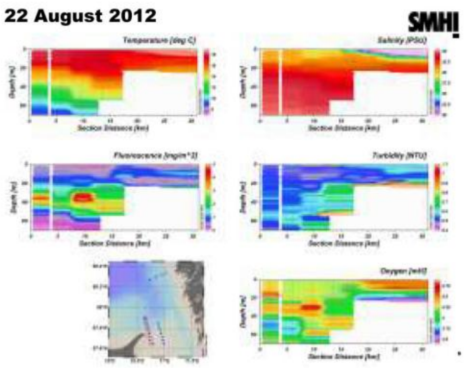
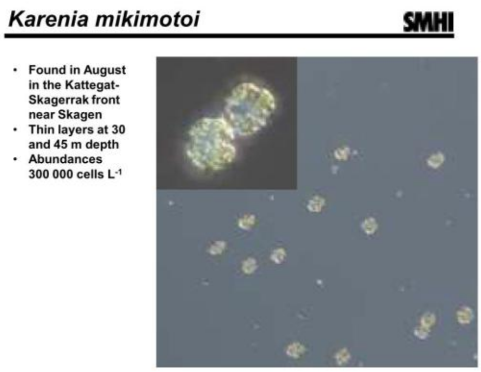
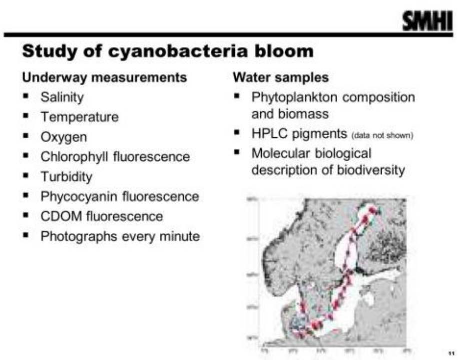

High frequency sampling using two FerryBox systems reveals bloom of harmful algae in the the Kattegatt - eastern part of the North Sea
Key methods
Chlorophyll a fluorscence
Automated water sampling
Micrsocope analyis
Harmful algal bloom detected
Fish killing flagellate Pseudochattonella sp
observed directly after diatom spring bloom
Pseudochattonella farcimen
Biomass of phytoplankton at the class level at station Anholt E
Karlson et al. in prep
SMHI


Combining data from multiple platforms 22-23 August 2012
SMHI
Color Fantasy
Lysbris
KBV 001 Poseidon
TransPaper
R/V Skagerak


22 August 2012
SMHI


Karenia mikimotoi
SMHI
Found in August in the Kattegat-Skagerrak front near Skagen
Thin layers at 30 and 45 m depth
Abundances 300 000 cells L-1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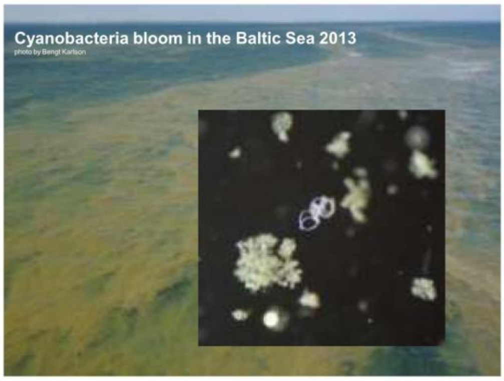
Study of cyanobacteria bloom
Underway measurements
Salinity
Temperature
Oxygen
Chlorophyll fluorescence
Turbidity
Phycocyanin fluorescence
CDOM fluorescence
Photographs every minute
Water samples
Phytoplankton composition and biomass
HPLC pigments (data not shown)
Molecular biological description of biodiversity


Cyanobacteria bloom in the Baltic Sea 2013

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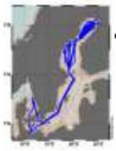
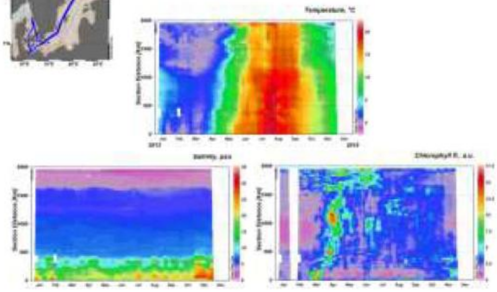
Overview of conditions in 2013





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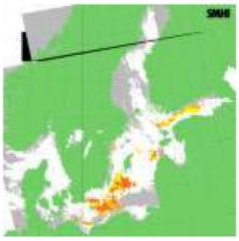
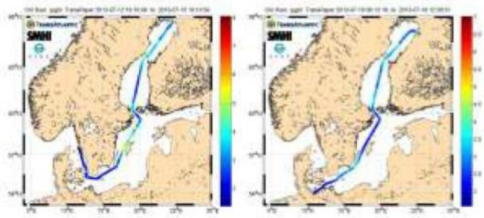
Satellite remote sensing of surface accumulations of cyanobacteria



17 July 2013, MODIS, Baltic Algae Watch System

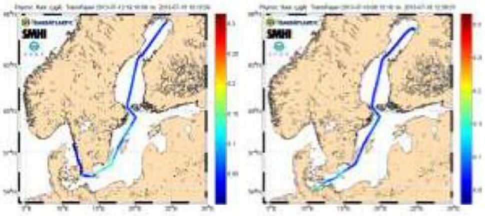
Conditions during study in July 2013 SMHI

Chlorophyll fluorescence – proxy for phytoplankton biomass



Conditions during study in July 2013 SMHI

Phycocyanin fluorescence - proxy for cyanobacteria



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Methods: comparison microscopy vs 16S and 18S rDNA sequencing 19 samples

Microscopy
- Samples preserved using Lugols iodine on the ship
- Analysed using inverted microscope – Utermöhl method
- Sedimented volume ~ 20 ml
- Magnification 40-400 x

rDNA
- 200-500 ml filtered on the ship
- Frozen using liquid nitrogen
- Sequenced using Illumina MiSeq
- Approximately100 000 sequences/sample
- Eukaryotic organisms:
  - 18S rDNA OTUs
  - Clustered at 97% sequence similarity
- Prokaryotic organisms
  - 16S rDNA OTUs

OTU = Operational Taxonomic Unit

Overview of data from microscopy

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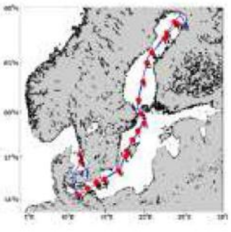
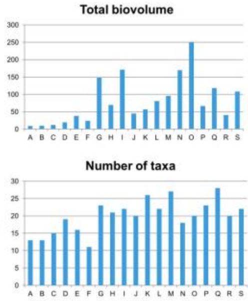
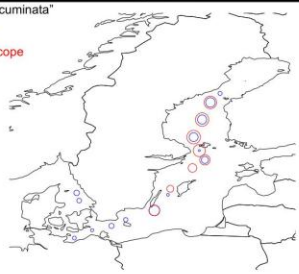




Comparison of rDNA relative counts and microscope counts

SMHI

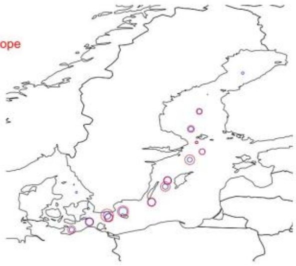
"Dinophysis.acuminata"
Log scale
Blue = DNA
Red = microscope



Comparison of rDNA relative counts and microscope counts

SMHI

"Nodularia"
Log scale
Blue = DNA
Red = microscope



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Comparison Utermöhl vs rDNA

Microscopy – Utermöhl
+ organisms with morphological features detected
+ cell numbers
+ cell volumes – biomass

- Low sample throughput
- Small organisms (< 5 µm) not well identified
- Autotrophic picoplankton not included

rDNA 16S and 18S
+ high sample troughput
+ skilled taxonomist not needed
+ also the very small organisms are included

- Sequence must be available in database
- Limited information related to cell abundance or biomass

22

Summary and conclusions

SMHI

- Microscopy analysis and rDNA sequencing was compared as methods for detecting HAB-organisms in the Baltic Sea area
- The methods show similar results for some species
- For other species large differences are found
- Possible explanations:
  - Different sample volumes analysed
  - Variable rDNA content in organisms
  - Cell counts and molecular results are not directly comparable
- A more extensive study is underway

23

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The JERICO NEXT STEPS

Algal bloom studies in several European seas

Combining data from different sources
- FerryBox
- Fixed platforms
- Remote sensing

Novel methods
- Imaging Flow Cytometry
- Molecular methods

24

14- Development of new tools and strategies for the monitoring of bottle and net collected plankton. A system based on image acquisition and semi-automatic analysis.

Jean-Baptiste Romagnan, Claire Desnos, Amanda Elineau, Gaby Gorsky, Natalia Llopis-Monferrer, Marc Picheral, Lars Stemmann (all UPMC, CNRS UMR 7093 LOV),

- 4 key words: Zooprocess, imaging, whole-plankton, integrated monitoring
- 2 Regional key words: Western Mediterranean

Marine communities are essential in the context of sustainable services provided by coastal ecosystems. Their monitoring is still largely based on time consuming and expensive procedures, which are not suitable for high frequency monitoring or for extensive spatial coverage. In the planktonic realm, difficulties result from analyzing plankton on a size range which encompasses tiny phytoplankton to large zooplankton. Recently developed imaging instruments and image analysis techniques now enable the fast and reliable enumeration and measurement of both phytoplankton and zooplankton. The Zooscan and its associated open source software, the Zooprocess, offer a solution for analyzing the zooplankton which is open, efficient and now widely used. Open platforms allow users to develop specific applications which can be shared in the community. In the framework of the JERICO WP10, we upgraded and used the Zooprocess which now has specific modules and dedicated toolboxes for analyzing Zooscan, FlowCAM, Underwater Vision Profiler, HD camera and ISIIS images, manage metadata associated with samples, and perform some quality check operations. We will present challenges in collecting times series of plankton, methodological and practical improvement of the Zooprocess and the whole analysis procedure in the framework of the Villefranche Imaging Platform for Plankton and Particles (VIP3), and recent achievements, in particular the results of a coastal, whole-plankton integrated study.

Slides are presented in the next pages

JERICO
Development of new imaging tools for the monitoring of plankton
Romagnan JB I Observatoire Oceanologique de Villefranche UMR 7093 I romagnan@obs-vlfr.fr
Desnos C, Elineau A, Llopis-Monferrer N, Picheral M & Stemmann, L
www.jerico-fp7.eu
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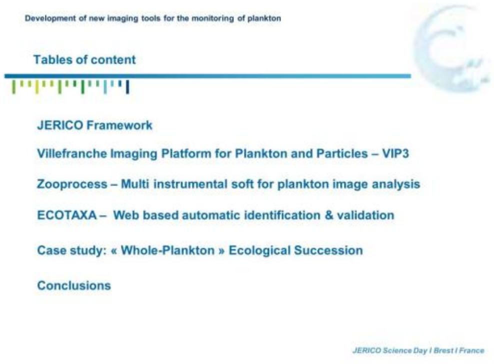

Development of new imaging tools for the monitoring of plankton
Tables of content
JERICO Framework
Villefranche Imaging Platform for Plankton and Particles – VIP3
Zooprocess – Multi instrumental soft for plankton image analysis
ECOTAXA – Web based automatic identification & validation
Case study: « Whole-Plankton » Ecological Succession
Conclusions
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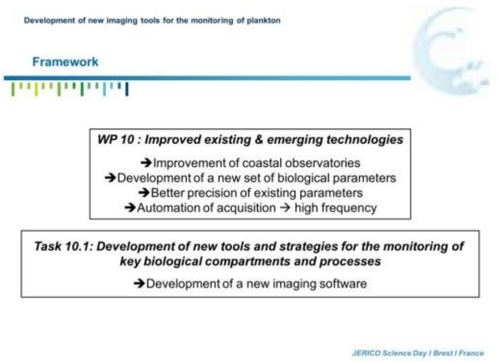

Development of new imaging tools for the monitoring of plankton
Framework
WP 10 : Improved existing & emerging technologies
➔Improvement of coastal observatories
➔Development of a new set of biological parameters
➔Better precision of existing parameters
➔Automation of acquisition ➔ high frequency
Task 10.1: Development of new tools and strategies for the monitoring of key biological compartments and processes
➔Development of a new imaging software
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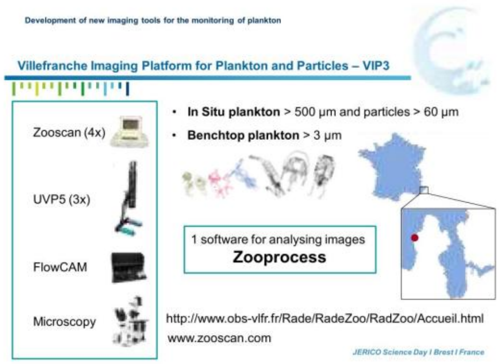

Development of new imaging tools for the monitoring of plankton
Villefranche Imaging Platform for Plankton and Particles – VIP3
Zooscan (4x)
UVP5 (3x)
FlowCAM
Microscopy
• In Situ plankton > 500 µm and particles > 60 µm
• Benchtop plankton > 3 µm
1 software for analysing images
Zooprocess
http://www.obs-vlfr.fr/Rade/RadeZoo/RadZoo/Accueil.html
www.zooscan.com
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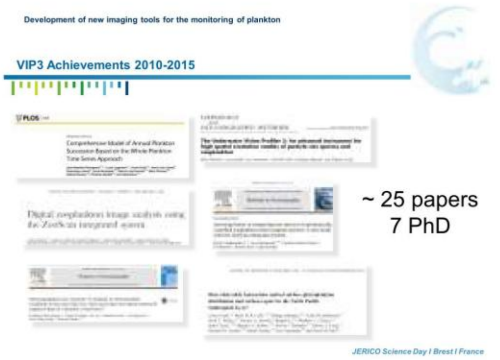

Development of new imaging tools for the monitoring of plankton
VIP3 Achievements 2010-2015
~ 25 papers
7 PhD
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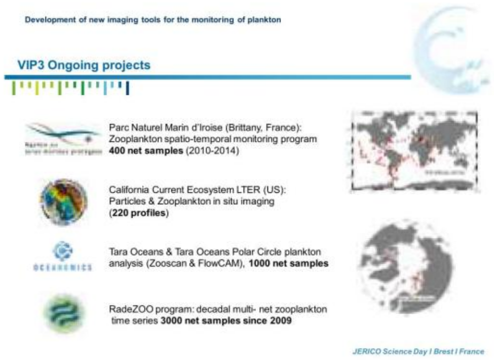

Development of new imaging tools for the monitoring of plankton
VIP3 Ongoing projects
Parc Naturel Marin d'Iroise (Brittany, France): Zooplankton spatio-temporal monitoring program 400 net samples (2010-2014)
California Current Ecosystem LTER (US): Particles & Zooplankton in situ imaging (220 profiles)
Tara Oceans & Tara Oceans Polar Circle plankton analysis (Zooscan & FlowCAM), 1000 net samples
RadeZOO program: decadal multi- net zooplankton time series 3000 net samples since 2009
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1


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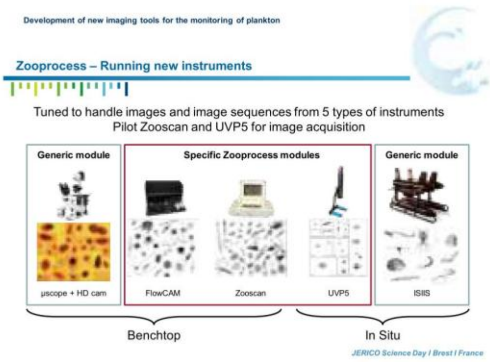
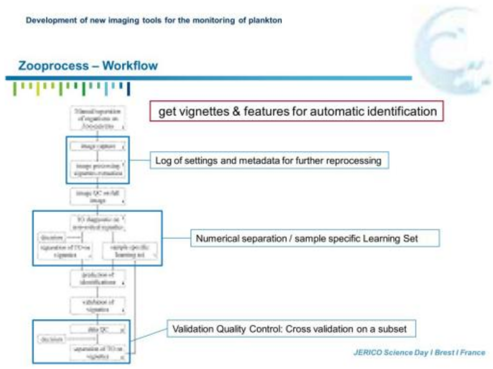

Development of new imaging tools for the monitoring of plankton
Zooprocess – Running new instruments
Tuned to handle images and image sequences from 5 types of instruments
Pilot Zooscan and UVP5 for image acquisition
Generic module
Specific Zooprocess modules
Generic module
µscope + HD cam
FlowCAM
Zooscan
UVP5
ISIIS
Benchtop
In Situ
JERICO Science Day / Brest / France


Development of new imaging tools for the monitoring of plankton
Zooprocess – Workflow
get vignettes & features for automatic identification
Log of settings and metadata for further reprocessing
Numerical separation / sample specific Learning Set
Validation Quality Control: Cross validation on a subset
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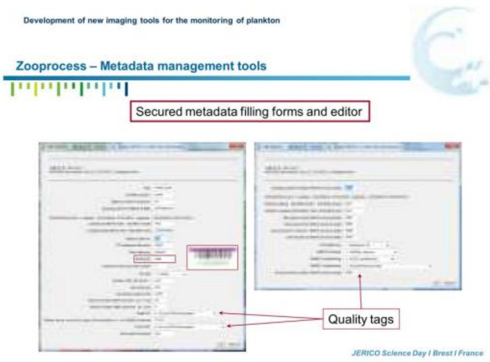
Development of new imaging tools for the monitoring of plankton
Zooprocess – Metadata management tools
Secured metadata filling forms and editor
Quality tags
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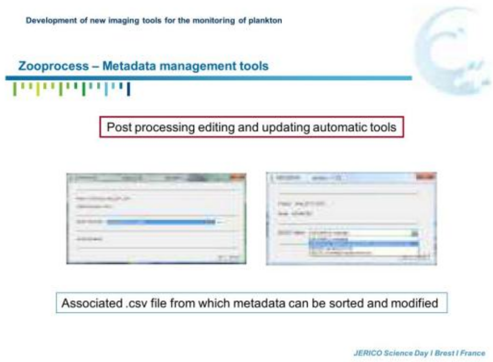
Development of new imaging tools for the monitoring of plankton
Zooprocess – Metadata management tools
Post processing editing and updating automatic tools
Associated .csv file from which metadata can be sorted and modified
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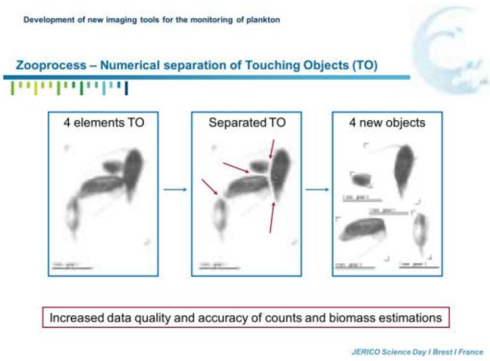
Development of new imaging tools for the monitoring of plankton
Zooprocess – Numerical separation of Touching Objects (TO)
4 elements TO
Separated TO
4 new objects
Increased data quality and accuracy of counts and biomass estimations
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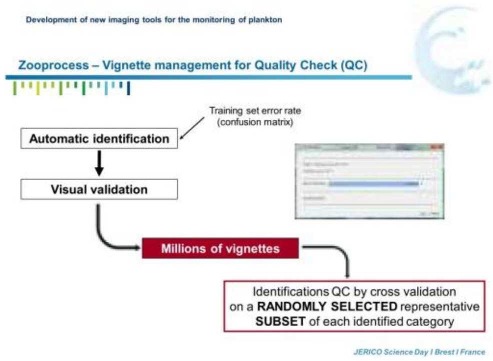
Development of new imaging tools for the monitoring of plankton
Zooprocess – Vignette management for Quality Check (QC)
Training set error rate
(confusion matrix)
Automatic identification
Visual validation
Millions of vignettes
Identifications QC by cross validation
on a RANDOMLY SELECTED representative
SUBSET of each identified category
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2

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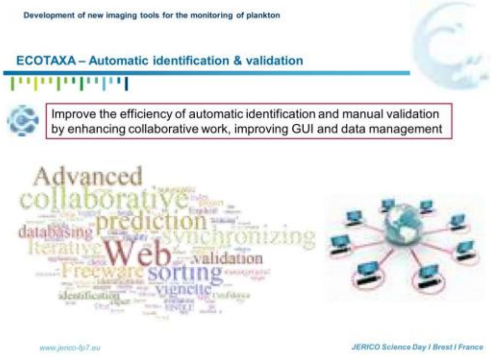

Development of new imaging tools for the monitoring of plankton
ECOTAXA – Automatic identification & validation
Improve the efficiency of automatic identification and manual validation by enhancing collaborative work, improving GUI and data management
Advanced
collaborative
databasing
prediction
synchronizing
iterative
Web
validation
Freeware
sorting
vignette
identification
www.jerico-fp7.eu
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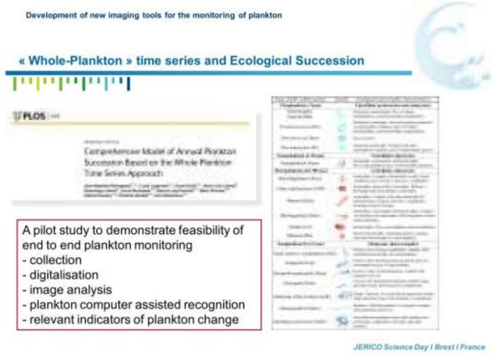

Development of new imaging tools for the monitoring of plankton
« Whole-Plankton » time series and Ecological Succession
PLOS
Comprehensive Model of Annual Plankton Succession Based on the Whole-Plankton Time Series Approach
A pilot study to demonstrate feasibility of end to end plankton monitoring
- collection
- digitalisation
- image analysis
- plankton computer assisted recognition
- relevant indicators of plankton change
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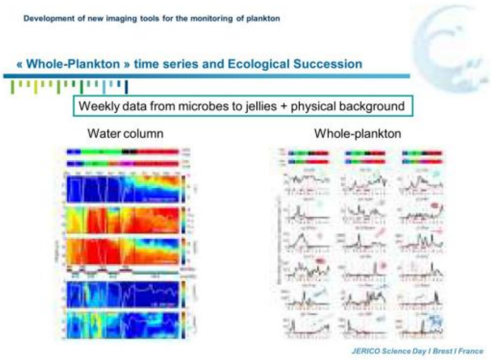

Development of new imaging tools for the monitoring of plankton
« Whole-Plankton » time series and Ecological Succession
Weekly data from microbes to jellies + physical background
Water column
Whole-plankton
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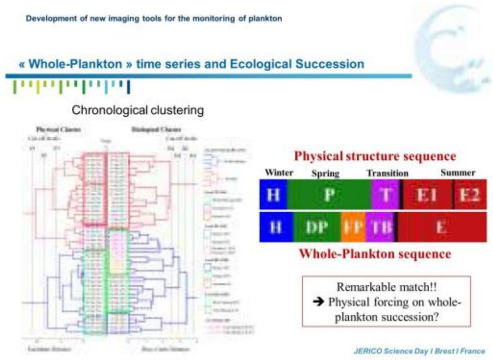

Development of new imaging tools for the monitoring of plankton
« Whole-Plankton » time series and Ecological Succession
Chronological clustering
Physical Cluster
Biological Cluster
Physical structure sequence
Winter
Spring
Transition
Summer
H
P
T
E1
E2
H
DP
FP
TB
E
Whole-Plankton sequence
Remarkable match!!
➔ Physical forcing on whole-plankton succession?
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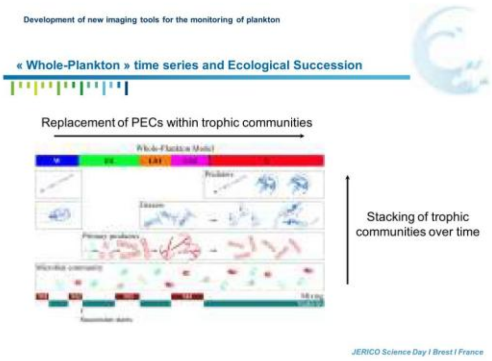
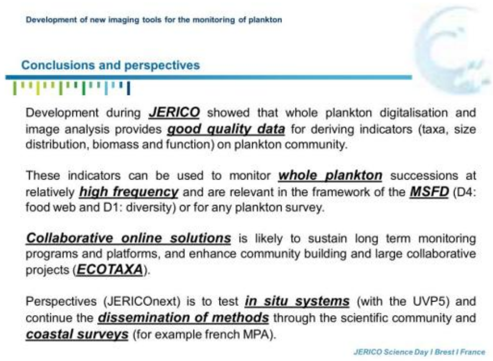


Development of new imaging tools for the monitoring of plankton
« Whole-Plankton » time series and Ecological Succession
Replacement of PECs within trophic communities
Whole-Plankton Model
Predators
Grazers
Primary producers
Microbial community
Stacking of trophic communities over time
JERICO Science Day I Brest I France



Development of new imaging tools for the monitoring of plankton
Conclusions and perspectives
Development during JERICO showed that whole plankton digitalisation and image analysis provides good quality data for deriving indicators (taxa, size distribution, biomass and function) on plankton community.
These indicators can be used to monitor whole plankton successions at relatively high frequency and are relevant in the framework of the MSFD (D4: food web and D1: diversity) or for any plankton survey.
Collaborative online solutions is likely to sustain long term monitoring programs and platforms, and enhance community building and large collaborative projects (ECOTAXA).
Perspectives (JERICOnext) is to test in situ systems (with the UVP5) and continue the dissemination of methods through the scientific community and coastal surveys (for example french MPA).
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15- Image analysis developments within JERICO: The AviExplore software

Alicia Romero-Ramirez (MNHN), Jean-Claude Duchêne (EPOC, CNRS), Guillaume Bernard (University of Helsinki), Ludovic Pascal (EPOC, U. Bordeaux), Olivier Maire (EPOC, U. Bordeaux), Antoine Grémare (EPOC, U. Bordeaux)

- 4 key words: Video analysis, long-term, large-scale, benthos survey, benthic behavior.
- 2 Regional key words:

One of the aims of Jerico is to strengthen the use of image analysis techniques to monitor biological compartments and processes that are recorded either at high frequency and/or over large spatial scales using automated or semi-automated procedures.

Epibenthos video and image analysis provides a complementary and yet more holistic description of the habitat than benthic sampling (Roberts et al., 2004). Depending on the objectives of the study, imaging devices for epibenthos surveys can be carried on different platforms types (Smith and Ruhmohr, 2005): static platforms like benthic landers or mobile platforms like Remote Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV). Each type of platforms provides imaging recordings that may deal with different difficulties. Static platforms produce long-series of images acquired under different light conditions, different water turbidity produced by sediment suspension and different degrees of biofilm development. Those parameters reduce directly the visibility and affect the quality of images. Apart from the visibility reduced issues, image analysis of mobile platforms need also to take into consideration the position and speed of the platform so that the exact position of observed organism is located.

AviExplore has been developed to overcome those difficulties. Thus, AviExplore provides a unique environment for video analysis. Its main original features include: 1) image(s) selection tools for extraction on videos, (2) automatic extraction of targeted information, (3) solutions for long-term series, (4) real time acquisition and in some cases analysis and (5) wide range of video analysis possibilities allowing for your own script edit. We will briefly describe AviExplore and focus on its use with different case studies.

Potential applications of AviExplore are numerous. AviExplore intend to become a standard tool for the analysis of benthos video surveys.

Roberts, D., Davies, D., Mitchell, A., Moore, H., Picton, B., Portig, A., Preston, J., Service, M., Smyth, D., Strong, D., Vize, S., 2004. Towed video analysis and Macrobenthic Infauna: 1993-2002, In: University, Q.s. (Ed.), Strangford Lough Ecological Change Investigation (SLECI). Environmental and Heritage Service Belfast

Smith, C.J., Ruhmohr, H., 2005. Imaging Techniques, In: A., E.A.a.M. (Ed.), Methods for the Study of Marine Benthos. Blackwell Science LtD: Oxford, p. 418

Slides are presented in the next pages

Towards an automatic video analysis software for marine benthic ecology. An overview of several case studies

Alicia Romero-Ramirez, Jean-Claude Duchêne, Guillaume Bernard, Ludovic Pascal, Olivier Maire and Antoine Grémare

WP10: IMPROVED EXISTING AND EMERGING TECHNOLOGIES

- Strengthen the use of image analysis techniques to monitor biological compartments.
- Develop new image analysis software for the treatment of :
  a) *in-situ* **sediment profile images (SPI)** to infer the ecological quality status of benthic habitats → Press Briefing
  b) *in-situ* **video** imaging of the water sediment interface using ROV or other **mobile** carriers to infer the abundance of suprabenthos
  c) **videos recorded by fixed cameras** to assess activity and growth in benthic organisms

2

Software Description: AviExplore

3

Case studies

Moving tool: Epibenthos Search
1. Coral in Mediterranean
2. *Axinella polypoides* detection

Fixed tool

Sediment Column

3. *Upogebia*
4. *Abra alba*

Sediment Surface

5. *Ditrupa arietina*
6. *Abra ovata*

4

Case study 1:

- Film from ROV during MEDECO cruise (South Italy)
- Geolocation file available
- Goals:
  – Coral detection : presence/absence
  – Coral sizing
  – Differentiation between probably dead and apparently living corals (*Lophelia pertusa* and *Madrepora occulata*)

5

Case study 1: Corals

Non treated Film — Treated for dead and living corals — Treated for living corals

Shown film size: 100 images — Analysed film size: 1300 images

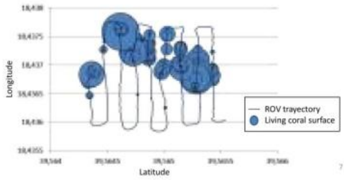
6

Case study 1: AviExplore Results

Image Detection Rates
Images can be classified as: img with coral or img without coral.
- Total Accuracy (*) : 91.2%

(*) Agreement between images classified by the software and visually

Error analysis
- False positive error: 5.4 %
- False negative error: 4.3%



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Case study 2: *Axinella*

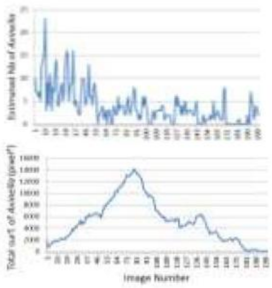
- Film from ROV at Palamos Canyon in Spain
- Geolocation file not available
- Goals:
  - *Axinella Polypoides* counting as estimation of abundance
  - *Axinella Polypoides* sizing

8

Case study 2: *Axinella*

9

Case study 2: AviExplore Results



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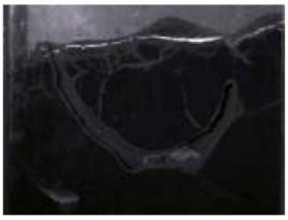
Case study 3: *Upogebia* behaviour

- Goal: Identify the types of behaviour.
  - Resting
  - Burrowing
  - Walking
  - Ventilating
  - Hidden



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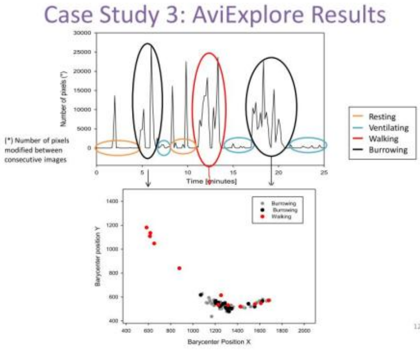
Case Study 3: AviExplore Results



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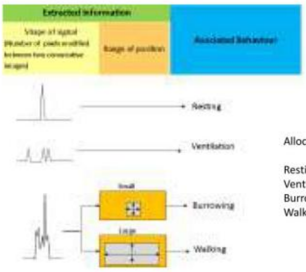
Case Study 3: Behaviour summary



Allocated time in our example:

Resting:	32.7 %
Ventilation:	44 %
Burrowing:	16.7 %
Walking:	6.6 %

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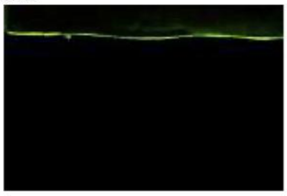
Case Study 4: *Abra alba*

- Goal: assess the intensity and the modality of sediment reworking by tracking luminophore movements



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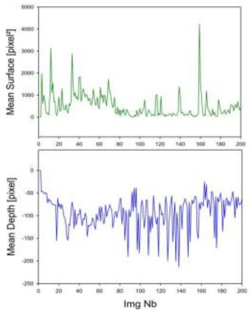
Case Study 4: AviExplore Results

Movement Intensity as a difference between two consecutive images

Mean epth within the sediment column where movements are taking place



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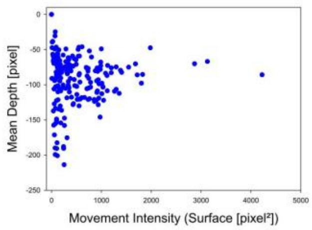
Case Study 4: AviExplore Results



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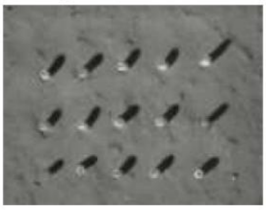
Case study 5: *Ditrupa arietina*

- Goal: Describe filtering activity by tracking the opening of the gill fan



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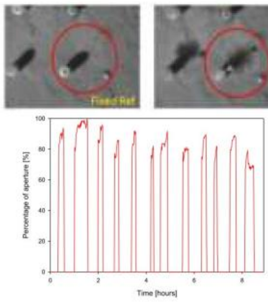
Case study 5: AviExplore Results



T_m= 42,58 min

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Case study 6: *Abra ovata*

- Goal: describe feeding activity by tracking siphon movements

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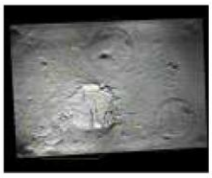
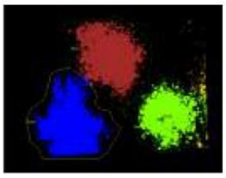
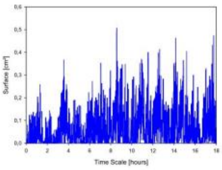
Case study 6: AviExplore Results







Conclusions

- AviExplore allows for the automatation of videanalysis tasks. The main advantages from its use are:
  - Gain of time
  - Gain of Objectivity
- AviExplore:
  - Proposes solutions for long-term as well as large scale studies
  - Allows for rapid selection of images of particular interest
  - Allows for automated extraction of targeted information
  - Provides a large range of video analysis possibilities through a comprehensive script editor.
  - Allows for automated acquisition and in some cases automated real time analysis
- AviExplore is currently available on request: alicia.romero-ramirez@u-bordeaux.fr

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4

16- Dissolved oxygen variability of the LIW in the Ligurian Sea (OXY-COR TNA results)

Laurent Coppola (UPMC-CNRS), Katrin Schroeder (CNR), Stefania Sparnocchia (CNR), Mireno Borghini (CNR), Dominique Lefevre (CNRS)

- 4 key words: dissolved oxygen, Levantine Intermediate Water, ocean mixing
- 2 Regional key words: Mediterranean Sea, Ligurian Sea

The Levantine Intermediate Water (LIW) is the warmest and saltiest water resulting from the dense water formation processes that occur in several zones of the Mediterranean Sea. This water mass is formed in the Levantine basin and circulates from the Eastern basin to the Western basin through the Sicilian Strait. In the Northwestern basin, the Corsica Channel is a strategic site where a branch of the LIW is passing through before reaching the DYFAMED site. From previous time series data, a time lag has been observed in term of T-S change in the LIW level. To solve this issue, regular and long term oxygen measurements might provide a good opportunity to understand and to estimate accurately this time lag. This also gives us the possibility to quantify the variability versus anomalies of the LIW property due to the climate change already observed in the Mediterranean Sea. In addition to monthly oxygen monitoring at the DYFAMED site, DO sensors have been installed on mooring in summer 2014 (SBE63) but only the DO monthly profiles will be presented here. The objective of the access is to complete the oxygen observation in the Ligurian Sea by implementing a DO sensor on the CC mooring at the core of the LIW water mass. The collected data will provide information to track the water mass variability, the impact of the water mass change on the oxygen content and to estimate the time lag between the eastern (Corsica Channel) and the western (Dyfamed) part of the Ligurian Sea.

Slides are presented in the next pages

Dissolved oxygen variability of the LIW in the Ligurian Sea (OXY-COR)

L.Coppola (CNRS), K.Schroeder (CNR), S.Sparnocchia (CNR), M.Borghini (CNR), D.Lefevre (CNRS)

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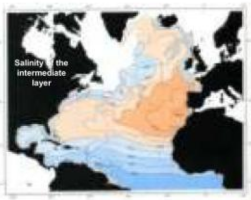
Tracking long-term hydrological changes in a changing sea



Mediterranean Sea is a source of warm and salty water

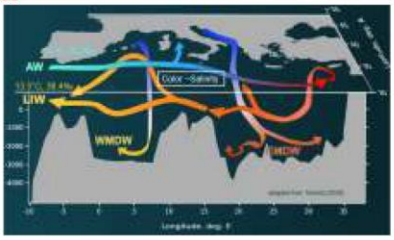
→ role in the heat and salt contents and water formation processes in the North Atlantic

→ understanding the interannual variability of the Mediterranean Sea has a more global importance than previously thought

Objectives of **HYDROCHANGES** program (CIESM), national projects (eg. **MOOSE**, **HYMEX**)

- **EMT in 90's:** shift of the DWF zone → eastern deep waters warmer and saltier
- **WMT in 2004/2005:** new WMDW warmer and saltier, larger volume of WMDW

Reasons: huge convection in GoL, EMT propagation and warmer/saltier LIW in WMED



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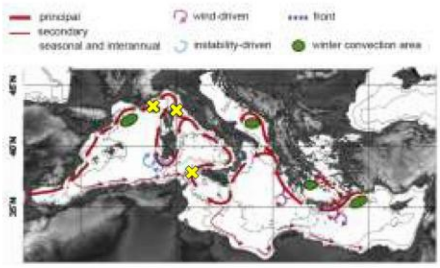
LIW circulation in WMED



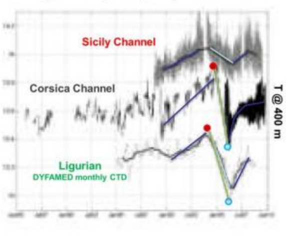
LIW circulation knowledge thanks to HYDROCHANGES program (CIESM)

Sicily - Corsica - Ligurian

Schroeder et al. OceanSciences 2013

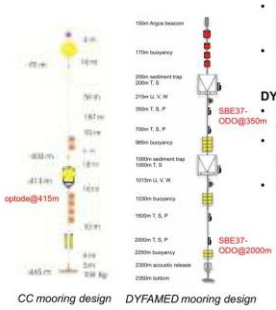
- Similar long-term oscillation : T increase until 2004 followed by a sharp decrease until spring 2006
- Corsica and DYFAMED both reached their absolute maximum and minimum in less than 24 months, suggesting dramatic changes occurring in recent years **(WMT)**

Finally, the return of a warming period started in May 2006 in the Corsica Channel and one month later at the DYFAMED station (June 2006)



→ **T-S time lag observed**
→ **Need O2 proxy more sensitive**
→ **TNA OXY-COR**

Field experiment: track oxygen in the core of the LIW depth (350m-400m)

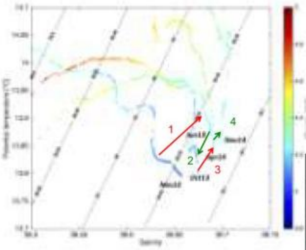


CC mooring:
- Installation of optode 3975 on SBE16 since Oct 2012 @415m (time acq. 30min)
- Installation of new optode 4330 since May 2013 @415m

DYF mooring:
- Installation of optode 4330 in 2012 did not work
- Installation of new SBE37-ODO since July 2014 (LIW = 350m and WMDW = 2000m)
- Collect in July 2015

1

Corsica Channel cruises results

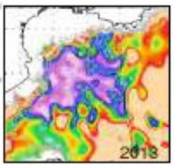


1- Nov12-Jun13: strong mixing = O2 supply

2- Jun13-Oct13: resp./diffusion = O2 lost

3- Oct13-Apr14: low mixing = few O2 supply

4- Apr14-Nov14 O2 stable = low resp?



Winkler reference allow to adjust the DO concentrations of SBE43 profiles (cruises) and optode (mooring). Ratio W/SBE = 0.95

surface of the mixed patch at the LIW level

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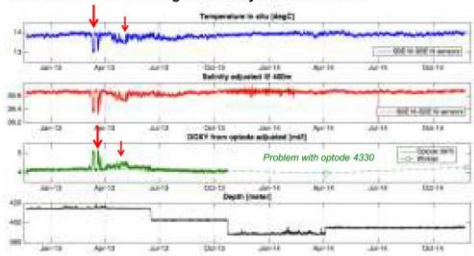
Corsica Channel mooring results: 2 years observation



Few T-S-O2 variability except the **mixing** in March 2013 with rapid O2 increase (+1ml/l or 46 µmol/kg): mixing of colder and less dense water recently ventilated with oxygen

Propagation of **WIW lense** formed in winter 2012/2013 and **travelled undisturbed** into the Tyrrhenian Sea

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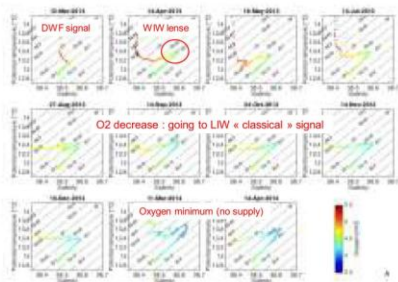
DYFAMED monthly CTDO2 profiles in 2013-2014 (0-2350m)



Apparition of **warmer and saltier** water, **richer in O2 (+1ml/l)** in the LIW core (400m)
Signature of the **WIW lense** observed at the Corsica Channel site one month ago ?

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SUMMARY AND CHALLENGES

- CORSICA Channel and DYFAMED sites are connected through LIW circulation. **Time lag** of LIW travel is around **1 month**
- Perturbation in CORSICA Channel seems to **influence** the LIW property at the DYFAMED (center of Ligurian Sea)
- Ventilated water mass travelling through the Tyrrhenian Sea seems to be undisturbed by **advection/diffusion process** (reducing the oxygen content)

- Replace the DO sensor on CC mooring and look DO data on DYFAMED mooring
- Finally, need to **connect SICILY STRAIT – LIGURIAN - GULF of LION O2 data** to understand the variabilty/history of the LIW during its pathway in the WMED

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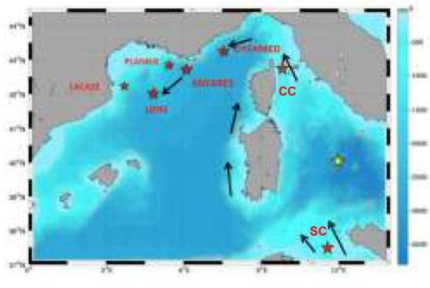


- Larger needs: monitoring the **Tyrrhenian Sea** («black box») and the **Levantine Basin** (LIW formation) ➔ H2020 BG12 plans ?

2

17- Field test of µLFR modules for on-line measurement of ammonia and orthophosphate in Ferrybox water quality monitoring systems

Luca Sanfilippo, (SYSTEA SpA), Enrico Savino, Pompeo Moscetta (SYSTEA SpA)

- 4 key words: µLFR technology, nutrients measurement in sea water, on-line monitoring in Ferrybox systems, ammonia and orthophosphate fluorimetric methods
- 2 Regional key words:

The proposed TNA project was aimed to test in operative conditions a new line of products specifically developed by SYSTEA S.p.A. to be extensively used in Ferrybox water quality monitoring systems for unattended nutrients on-line monitoring in sea and surface water.
The proposed field tests were performed in the facilities of Institute of Coastal Research / KOI of Helmholz Zentrum Geesthacht (HZG), partner of Jerico project.
Two kind of field tests were performed:
- a first field test was performed in the Cuxhaven fixed monitoring station at the Elbe river mouth
- a second field test was performed in the Ferrybox Lysbris, in operation on a regular route along North Sea.
Two independent analytical modules based on µLFR technology based on fluorimetric methods to on-line measure ammonia and orthophosphate were provided and integrated in the existing system layout and local control unit; a data comparison between existing Micromac-1000 on-line analyzers manufactured by SYSTEA and in use from several years by HZG were performed too.
SYSTEA provided the µLFR modules already prepared to be installed and to be operated unattended.
HZG allowed SYSTEA to install those units and provided the technical support during the field experiments.
Several weeks of unattended on-line measurements on both ammonia and orthophosphate chemical parameters were collected in both sites; the data results were elaborated by HZG and technically commented.

Slides are presented in the next pages

Field test of microLFA modules for on-line measurement of NH_3 and PO_4 in Ferrybox (FITO MicroLFA)

Luca Sanfilippo I SYSTEA S.p.A. I luca.sanfilippo@systea.it

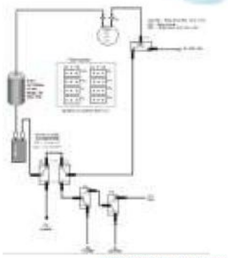
MicroLFA Smart on-line analyzer: technical characteristics

- Automatic sample blank correction
- Automatic washing and calibration
- Automatic sample dilution allows double scale measurements
- Plug-in multi-hydraulic connector available for easy reagents changeover
- Compactness and modularity allow easy integration in Ferrybox
- RS-232 protocol compatibility with Micromac-1000 and sondes
- Compact dimensions: 270 (H) x 150 (L)x 175 (W) mm hydraulics / electronics

The micro Loop Flow Reactor NH_3 Fluorimetric Measurement range: 0-30 µMol/L

Analytical sequence description:

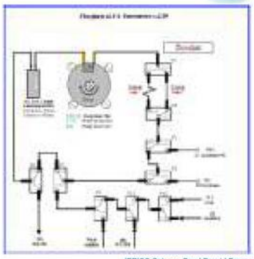
1. Water sampling
2. Fluorescence start reading
3. OPA reagent dosing and mixing
4. 55 ºC heating to speed-up the reaction
5. Final fluorescence reading and correlation with NH_3 concentration
6. Hydraulic circuit final cleaning



The micro Loop Flow Reactor PO_4 Fluorimetric Measurement range: 0-6 µMol/L

Analytical sequence description:

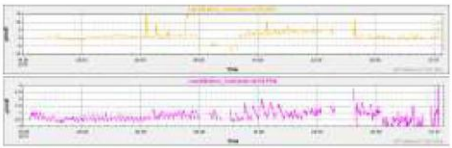
1. Water sampling and trapping: the amount is related to the measurement range
2. Residual water sample washing from the circuit
3. Reagents dosing and mixing in DI water
4. Fluorescence start reading
5. The trapped sample is mixed with the fluorescent solution, producing a decrease in fluorescence
6. Final fluorescence reading and correlation with PO_4 concentration
7. Hydraulic circuit final cleaning.



Field test in Cuxhaven fixed station on Elbe river mouth

- NH_3 and PO_4 measurement data were automatically collected from May 19th to July 7th, 2014
- a further set of PO4 monitoring data were also collected from August 9th to September 22nd, 2014
- PO_4 data comparison with Micromac C MP3 on-line analyzer

Field test in Cuxhaven fixed station on Elbe river mouth



NH_3 and PO_4 graphic trends (µMol/L) in Cuxhaven fixed station collected between May 19th and July 7th, 2014

Measurement frequency: one hour.

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Field test on Lysbris Ferrybox system

- Location on Lysbris, under the Ferrybox
- N.32 unattended cruises performed between July 16th and September 25th, 2014; measurement frequency: one hour
- PO_4 and NH_3 data comparison with on-board Micromac-1000 units

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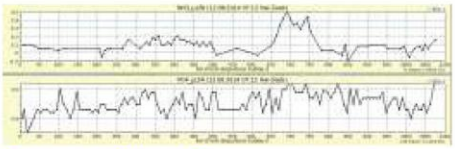
Field test on Lysbris Ferrybox system



Data trends of NH_3 and PO_4 concentrations collected during a Ferrybox cruise operating between Halden and Zeebrugge on August 12th, 2014.

x axis - km from departure harbour; y axis - µMol/L

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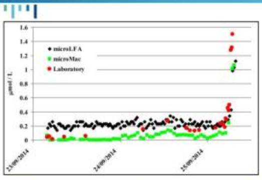
Field test on Lysbris Ferrybox system



Ferrybox PO_4 measurements performed during the last cruise on 23/25-09-14 with:

µLFA module (black diamonds)

Micromac-1000 (green squares)

CFA instrument in laboratory (red dots)

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µLFA Smart module: conclusions

- Valid alternative to Micromac-1000 analyzers, due to lower reagents consumption
- Special design allows reliable field use for long term unattended monitoring
- PO_4 fluorimetric method allows trace level detection in open sea
- Module compactness allows easier integration in Ferrybox systems.

MANY THANKS TO: Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung; Consiglio Nazionale delle Ricerche

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V] Topic 4: Monitoring of Chemicals and contaminants, pH & carbonate systems

18- Marine Aerosols Properties in the northern Adriatic

Jacques Piazzola, (Mediterranean Institute of Oceanography), Nikos Mihalopoulos (University of Crete), Elisa Canepa (CNR-ISMAR), Luigi Cavaleri (CNR-ISMAR)

- 4 key words: coastal aerosols; anthropogenic compounds; atmospheric transport
- 2 Regional key words: Mediterranean

Aerosol particles in coastal areas result from a complex mixing between sea spray aerosols locally generated at the sea surface by the wind-waves interaction processes and a continental component issued from natural and/or anthropogenic sources. This paper presents a physical and chemical analysis of the aerosol data acquired from May to September 2014 in the Adriatic Sea in the northern Italian coast. The aerosol distributions in the 0.1-240 µm size range were measured on the Acqua Alta platform using PMS probes and a chemical characterization was made using an Ion Chromatography analysis (IC) and a thermo-optical technique. This presentation focuses on two particular meteorological episodes, the Bora and Sirocco winds and characteristics of different aerosol conditions. The aerosols size distributions measured during Bora conditions show a stronger sea-surface production of aerosols through wave-breaking processes than in the Northern Mediterranean. From the chemical point of view, the results recorded during Sirocco conditions show atmospheric reaction of aged sea-spray aerosols with some species present the atmosphere.

This presentation was canceled.

19- Unmanned tools for monitoring chemical pollution in coastal water study

Luca Nizzetto (NIVA, Norway), Kai Sørensen (NIVA), Malcolm Reid (NIVA), Jan Thomas Rundberget (NIVA), Christopher Hartman (NIVA), Ian Allan (NIVA)

- 4 key words: Marine pollution, Ferrybox, contaminant of emerging concern
- 2 Regional key words: North sea, Norwegian Sea

The development of analytical chemistry methods and sensors has fostered awareness on the complexity of the environmental burden of chemical substances of anthropic origins that reach water environment from agricultural, industrial and household sources. Coastal waters are receptors of these contaminants. Still there is a very limited capability for their cost-effective monitoring in marine waters, hence very little is known on their significance and possible impacts on the coastal ecosystem. We explored the viability of the automatic samplers on the Ferrybox fleet for detecting a range of anthropogenic contaminants of emerging concern in marine waters. We run two campaigns in the North sea and Norwegian sea remotely collecting bulk water

samples. These were analyzed using novel non-target screening methods which allow screening for the presence of an arbitrary number of substances at trace levels. High dilution and interference of sea salt with extraction media can represent a challenge for the analysis of sea water samples. Nevertheless we could detect a range of human pharmaceuticals at ng L^{-1} levels. These included: some anti-allergic drugs, anti-pyretics (paracetamol), anti-depressants, caffeine and one antibiotic. We also tested a new unmanned sampler for the deployment of passive water samplers on board of the ships to target hydrophobic contaminants at ultra-trace levels. In this presentation we discuss performance and limitations of the existing technology.

Due to confidentiality matters, slides for this presentation aren't available.

20- Legacy and Emerging Chemical Contaminants in European Coastal waters (ECCECs)

Miroslav Brumovsky (RECETOX), Luca Nizzetto (RECETOX), NIVA

4 key words: emerging contaminants, legacy contaminants, spatial distribution, seasonal occurrence

- 2 Regional key words: Mediterranean Sea, North Sea

Monitoring of chemical contaminants in the environment is essential for providing the baseline data necessary for defining priorities for the establishment of Environmental Quality Standard concerning chemical pollution. Occurrence of several classes of emerging contaminants, i. e. pharmaceuticals and personal care products, artificial sweeteners, currently used pesticides and perfluorinated compounds, was studied in the Western Mediterranean and North Sea. To obtain more representative data, several water samples from each area were pooled and processed together. Along with spatial distribution, the seasonal variations were also investigated on the basis of occurrence of contaminants in spring and autumn period.
The vertical distribution of legacy contaminants in the Mediterranean Sea was studied using passive sampling. Passive samplers were deployed in the Gibraltar and Sicily channel for a period of 6 and 3 months. The data obtained from this activity could assess the budget of selected contaminants in marine water column and reveal the mechanisms controlling their vertical transport.
Access to MPLS-CNR and Cosyna 1_FB infrastructure as well as professional support is highly acknowledged.

Due to confidentiality matters, slides for this presentation aren't available.

21- Sensor developments for continuous measurements of pH and alkalinity on FerryBox systems

Wilhelm Petersen (HZG), Steffen Aßmann, Carsten Frank, (Contros GmbH)

- 4 key words: pH, Alkalinity, Spectrophotometry, FerryBox
- 2 Regional key words: coastal ocean, North Sea

Coastal oceans are a critical interface in the earth system between the land and open-ocean. Processes in the shelf seas play a crucial role in global biogeochemical cycles and the high productivity systems have a significant influence on ocean CO2 storage. To fully quantify the complete carbon system in seawater it is necessary to determine at least two of the following five variables (all can be measured directly); pH, total alkalinity (AT), inorganic carbon (CT), carbonate ion (CO3) and the partial pressure of CO2 (pCO2). Depending on the specific situation a combination of either pCO2 and CT (or AT), or pH and AT (or CT) can be used. Highly reliable measurements are required to resolve the carbonate system with adequate accuracy. As pH and pCO2 are inversely correlated this combination leads to rather high uncertainties for the calculated parameters. Spectrophotometry is currently the technique used to detect pH (directly) and total alkalinity and carbonate ion providing high precision measurements. Spectrophotometry can characterize the abundance of two forms of a suitable indicator mixed in a small volume of seawater. The equilibrium of these forms is directly connected to either pH or after acidification of the sample to total alkalinity (AT). An additional pCO2 sensor is

strongly recommended at higher pCO2 levels (>500µatm) and provides inherent quality assurance since more than two parameters are measured. First tests and applications of new sensors for pH and AT designed for flow-through systems (e.g. FerryBoxes) will be demonstrated.

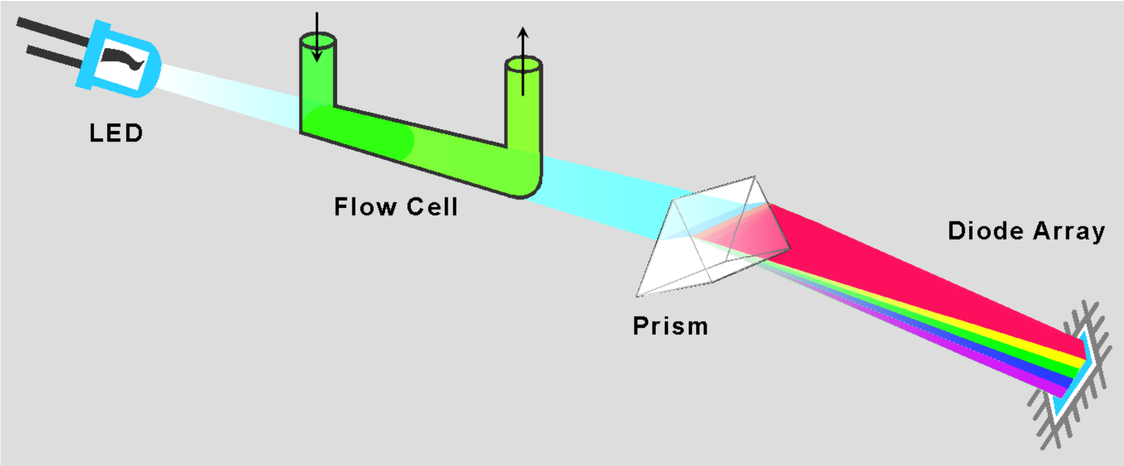


Figure: Schematic overview of the measurement principle.

Slides are presented in the next pages

JERICO Science Days

Sensor Development for Continuous Measurements of pH and Alkalinity with FerryBox Systems

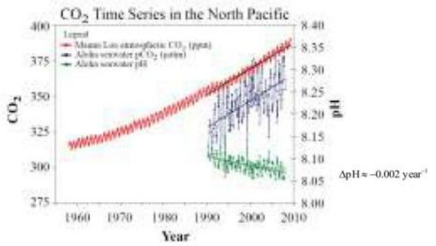
Steffen Aßmann**, **Wilhelm Petersen***, Carsten Frank**

*Helmholtz-Zentrum Geesthacht (HZG); ** Contros Systems&Solution GmbH

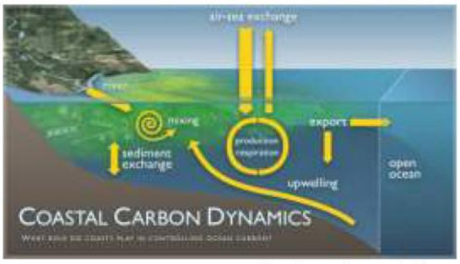
April 2015, Brest

CONTROS Systems & Solutions GmbH | Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung

Motivation



Coastal Carbon Dynamics:



(http://www.pmel.noaa.gov/co2/)

Status of Monitoring the Carbonate system

- The ocean is facing a rapid change due to the **increased uptake of CO_2** from the atmosphere → **Ocean acidification**
- The oceans are **under-sampled** for a comprehensive analysis of the impacts
- **Small** anthropogenic signal **vs. large** natural variability (seasonal, short-term, diurnal)
  - → **High quality measurements** for identification of small signals
  - → **Long-term monitoring** for identification of long-term trends
- **Coastal areas** (e.g. North Sea) have **large uncertainties** in their **contribution to the global CO_2 budget**
- **SOOs** (e.g. FerryBox etc.) are adequate platforms for continuous **monitoring of the surface ocean**

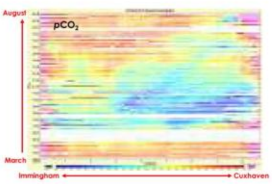
Topics of interest

– Primary production	**O_2, pCO_2, Chl-a**
– Ocean acidification	**pH**
→ Alkalinity transport	**Total alkalinity (TA)**
→ Sinks / sources for CO_2	**pCO_2, pH**
→ Feedbacks to the rising atmospheric CO_2 concentration	**pCO_2, pH, TA**

→ From physical parameters to chemical and biological processes

FerryBoxes as Platforms

- cost effective and good to handle on SOO
- less high demands on autonomy for new sensors developments (inline sensors, protected environment, power requirement...)
- high spatial and temporal resolution
- long-term records and seasonally resolution
- tracking of short-term biological processes



Carbonate System

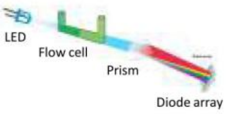
- **Two out of four** (five) measureable parameters are needed for a full characterization of the carbonate system
  → **pH, pCO_2, C_T, A_T** (CO3)
- pH and pCO_2 are available as autonomous sensors
  → Combination is not recommended
  (strongly anti-correlated, propagation or errors)

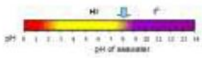
Input	pH	A_T (µmol kg^{-1})	C_T (µmol kg^{-1})	pCO_2 (µatm)
pH – A_T			± 3.8	± 2.1
pH – C_T		± 2.7		± 1.8
pH – pCO_2		± 21	± 18	
pCO_2 – C_T	± 0.0025	± 3.4		
pCO_2 – A_T	± 0.0026		± 3.2	
A_T – C_T	± 0.0062			± 5.7

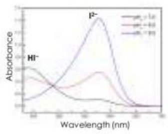
(Millero, 2007)

High precision
pH - Sensor

pH – Principle





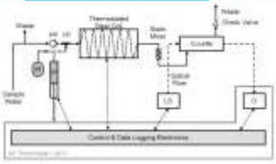


- FIA* system using an indicator dye *m*-Cresol purple
- Determination of the concentration of the indicator acid (HI^-) / base (I^{2-}) due to different absorption spectra
- Calculation of the pH value using Henderson–Hasselbach equation

$$pH = pK_a + \log_{10}\frac{[I^{2-}]}{[HI^-]}$$

*FIA = Flow injection analysis

Setup of the Autonomous pH System



Precision ± 0.0007
Accuracy ± 0.003

Aßmann et al., 2011 Ocean Science.

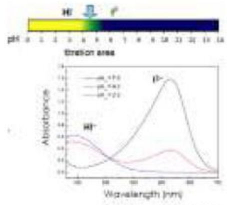
TA - Sensor

Motivation of TA (A_T) Measurements

- TA is a conservative parameter
  → independent of T- and p-changes
- Less susceptible to biological interferences than DIC
- only weakly correlated to pH, DIC and pCO2
- A good water mass tracer that can be used to parametrise important TA/S relationships
- In comparison to DIC an accurate, technically ready measuring principle is available for autonomous measurements

Measuring Total alkalinity (TA) – open cell titration

- FIA system
- Acidification (HCl) of a seawater sample
- Addition of the indicator dye Bromocresol green
- Degassing (full removal of CO_2 = open cell titration)
- Determination of the ratio of the indicator acid (HI^-) / base (I^{2-}) from absorption spectra (CCD spectrometer)
- Calculation of the pH value using Henderson-Hasselbach equation



$$pH = pK_a + \log_{10}\frac{[I^{2-}]}{[HI^-]}$$

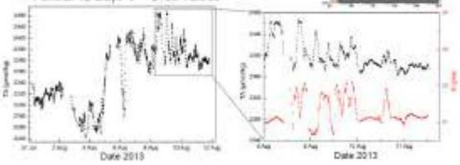
W. Petersen : pH and Alkalinity Sensors — JERICO GA, Brest 2014

First field test of pH and Alkalinity Sensor

W. Petersen : pH and Alkalinity Sensors — JERICO GA, Brest 2014

Field Application in the North Sea pH and pCO2 Data (1st attempt: closed cell titration)

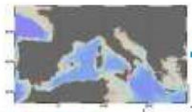
- Measurements in the North Sea (Waddensea)
- Measured range: 2240 µmol/kg to 2470 µmol/kg
- Measurement Cycle: 7 minutes
- Period: 12 days → ~ 2100 values



W. Petersen : pH and Alkalinity Sensors — JERICO GA, Brest 2014

From lab prototype to a commercial product

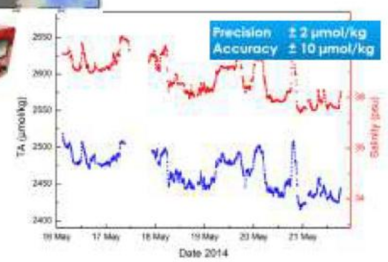
W. Petersen : pH and Alkalinity Sensors — JERICO GA, Brest 2014



Commercial TA-Analyser (Contros)

Open Cell Titration

Preliminary Test (Mediterranean Sea)



W. Petersen : pH or

Conclusions

- There is a **need for autonomous, continuously measuring sensors** providing parameters for biogeochemical processes, especially for the **carbonate system:**
  - understanding and monitoring **Ocean Acidification**
  - better understanding of the **carbonate system in coastal oceans**
- **New systems** developed **for pH and TA** can provide reliable data for characterizing the entire carbonate system
- test and demonstration on research cruises are **promising** concerning **accuracy and robustness**
- Optimization of the systems are ongoing activities (NEXOS, JERICO-NEXT)

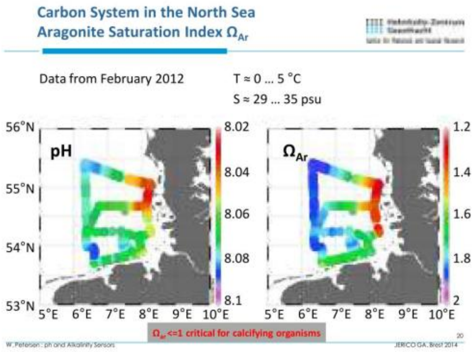
	pH	Open-Cell TA
Accuracy	± 0.003	<± 10 µmol/kg
Precision	± 0.0007	± 2 µmol/kg

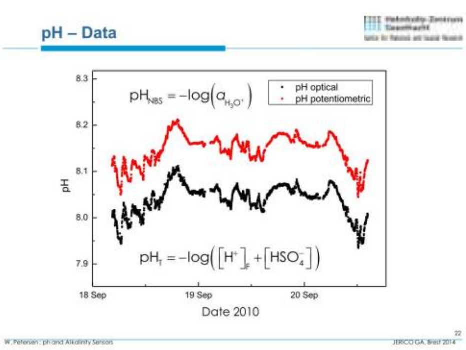
W. Petersen : pH and Alkalinity Sensors — JERICO GA, Brest 2014

3


JERICO


Thank You
W. Petersen : pH and Alkalinity Sensors
JERICO GA, Brest 2014
19


Carbon System in the North Sea
Aragonite Saturation Index Ω_{Ar}
Data from February 2012
T ≈ 0 … 5 °C
S ≈ 29 … 35 psu
pH
Ω_{Ar}
56°N
55°N
54°N
53°N
5°E 6°E 7°E 8°E 9°E 10°E
8.02
8.04
8.06
8.08
8.1
1.2
1.4
1.6
1.8
2
Ω_{Ar}<=1 critical for calcifying organisms
20


pH – Data
$pH_{NBS} = -\log(a_{H_3O^+})$
pH optical
pH potentiometric
$pH_T = -\log([H^+]_F + [HSO_4^-])$
pH
8.3
8.2
8.1
8.0
7.9
18 Sep
19 Sep
20 Sep
Date 2010
22


Recent Chlorophyll-a Data (April 2015)
Cruise Liner "Mein Schiff 3" :
Platforms:

22- Combined pCO2-pH in situ metrology: assessing acidification in Norwegian coastal waters by ferrybox operation

Emanuele R. Reggiani (NIVA), Richard G. J. Bellerby, Andrew King, Kai Sørensen, Marit Norli (all NIVA), Michel Masson (Franatech GmBH)

- 4 key words: pCO2, pH, acidification, ferrybox
- 2 Regional key words: CO2, coast

With over 20000 km of coastal line, Norway is extremely exposed to effects on climate driven by the North Atlantic current. A better understanding of the variability of the carbonate system fluxes around different ecosystems is fundamental for modeling ocean acidification and for developing scenarios of how rising CO2 may influence ecosystem structure and function. In addition to increasing CO2, inputs of total alkalinity, organic carbon and nutrients to coastal and shelf waters from rivers and ice can have important impacts on the buffering capacity of receiving waters, and thus the future CO2 uptake capacity. Informed ocean acidification scenarios, at both basin and local level are required to develop optimal management policies of securing and utilizing marine resources.
Among the currently available methods for measuring marine carbonate system variables, underway spectrophotometric pH and membrane-solid state pCO2 detection, provide a reliable pairing to implement unattended continuous monitoring systems in situ.
Systems developed with joint efforts by NIVA and Franatech, have demonstrated robustness and reliability under deployment on volunteer observing ships (VOS) along ferrybox systems, , delivering a significant, first level - quality checked data stream under challenging operating condition. We have implemented metrological routines to perform a (proxy) over-determination and crosscheck in underway mode in order to enable data retrieval and delivery in a post first-QC form.
We show here recent measurements following the advances made and how the combined monitoring of pH and pCO2 will deliver the level of accuracy of carbonate system classification required.

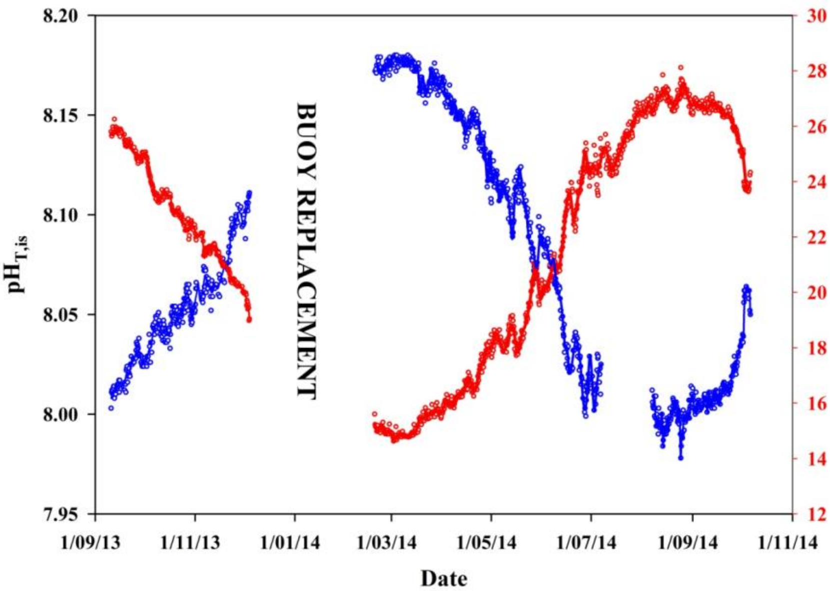
Due to confidentiality matters, slides for this presentation aren't available.

23- Seasonal pH variability in the Saronikos Gulf: a year study (MEDACID)

Melchor González-Dávila, (Universidad de Las Palmas de Gran Canaria), J. Magdalena Santana Casiano, Universidad de Las Palmas de Gran Canaria; George Petihakis, (HCMR), Manolis Ntoumas, (HCMR), Eva Krasakopoulou, Univ. Of Aegean, Presenting autor: Aridane González González

- 4 key words: pH, seasonal variability, sea surface variability, pH sensor
- 2 Regional key words: Saronikos Gulf, Mediterranean Sea

One year of pH values determined by a photometric pH sensor together with physical variables were recorded at 3 m depth in the Saronikos Gulf at 37.61° N 23.56° E, in the Eastern basin. It is the first time that such high frequency measurements are performed in a coastal oligotrophic system in Eastern Mediterranean. The surface station is a SEAWATCH buoy equipped with sub-surface sensors at 3.5 meters below sea level for currents, temperature and conductivity as well as wave and meteorological sensors. A full year cycle from September 2013 to October 2014 in sea surface temperature and pH showed the temperature ranged from 14.8ºC at the beginning of march 2014 to over 27ºC from mid-august to mid-September, where temperatures of 27.5 were also reached by the end of August. Temperature and pH at in situ conditions followed a reverse behaviour. Maximum pH values in total scale were determined in March 2014, where a value of 8.14 was measured. After that month, the temperature increased and the pH decreased until reach by the end of August values of 7.98. During the period of maximum temperatures, pH values were in the 8.00- 7.98 range. After the last week of September the temperature of the seawater left the 26ºC range and started to decrease, while the pH increased from 8.01 that was determined by the end of September. At the Saronikos Gulf, pH changed seasonally over 0.16 pH units. After normalizing the pH values to a constant temperature of 25ºC, in order to remove the thermodynamic effects, a pH of 8.02 ± 0.01 was determined, clearly indicating that most of the seasonal pH variability was associated to the seasonal solar heating cycle that produced a change of almost 13ºC in the sea surface seawater temperature. Partial pressure of carbon dioxide has been computed from salinity-alkalinity relationship providing data for the seasonal variability and CO_2 fluxes. The photometric pH sensor has been shown to be an excellent tool for long-term acidity determination.



Due to confidentiality matters, slides for this presentation aren’t available.

LIST OF POSTERS

Authors list	Title	Corresponding author's Email address
Jaccard, P., Zibordi, G., Sorensen, K..	Radiometry for ocean colour validation from fixed and moving platforms (RAD)	pierre.jaccard@niva.no
Faimali, M., Pavanello, G., Greco, G., Trentin, I.	Overview of biofouling prevention methods currently used for oceanographic sensors: results of a survey from JERICO EU FP7 Project	giovanni.pavanello@ge.ismar.cnr.it
Joseph, E., Cano, E., Letardi, P., Albini, M.	Standardised Electrochemical in Situ Assessment of Metal Coatings (SESAM)	edith.joseph@unine.ch
Riminucci, F., Ravaioli, M., Bortoluzzi, G., Bergami, C.	E1 and S1 coastal observatories in the JERICO Project (Northern Adriatic sea, Italy)	francesco.riminucci@bo.ismar.cnr.it
Antonio Olita, Alberto Ribotti, Simon Ruiz, and Ananda Pascual	Deep Chlorophyll Maximum distribution in the Alboran sea and its relationship with mesoscale and frontal features through synchronous glider observations.	antonio.olita@cnr.it
Sparnocchia, S., Bastianini, M., Borghini, M., Letardi, P., Traverso, P., Schroeder, K.	The contribution of CNR fixed platforms to the JERICO TNA program	stefania.sparnocchia@ts.ismar.cnr.it
Brix, H., Baschek, B., Breitbach, G., Eschenbach, C., Horstmann, J., Petersen, W., Riethmüller, R., Schroeder, F., Stanev, E., Schulz-Stellenfleth, J.	The Coastal Observing System for Northern and Arctic Seas (COSYNA): Challenges and Solutions for an Integrated Measurement and Modelling Approach	wilhelm.petersen@hzg.de
Bachelier, C., Benabdelmoumène H., Bernardet, K., Duformentelle, P., Fuda, J.-L.,, Godinho, E.	The French National Glider Facility	jean-luc.fuda@cnrs.fr
A. Lavin, D. Cano, C González-Pola, E. Tel, C. Rodriguez, M. Ruiz and R. Somavilla	Enhance of knowledge and products provided by a time series hydrographic stations using a fixed-point water column observatory. The Biscay AGL Buoy.	alicia.lavin@st.ieo.es