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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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

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<tr>
<th>Time slot</th>
<th>Topic</th>
<th>Speaker</th>
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<tbody>
<tr>
<td><strong>Tuesday, 28th of April – Science Day</strong></td>
<td><strong>Topic 1: Harmonisation, Technology, sensors &amp; platforms</strong></td>
<td><strong>Chairpersons: Wilhelm Petersen (HZG) &amp; Georges Petihakis (HCMR)</strong></td>
</tr>
<tr>
<td>16:00-16:20</td>
<td>1. Comparison of 3 ferrybox ferry observations in the Baltic Sea</td>
<td>S. Kaitala (SYKE)</td>
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<tr>
<td>16:20-16:40</td>
<td>2. Unmanned Surface Vehicles and Voluntary Observing Ship for oceanographic in situ measurements</td>
<td>L. Delauney (Ifremer)</td>
</tr>
<tr>
<td>16:40-17:00</td>
<td>3. Evaluation of different typology of commercial sensors to be used on fishing gears</td>
<td>S. Sparnocchia (CNR)</td>
</tr>
<tr>
<td>17:00-17:20</td>
<td>4. JERICO - Biofouling Monitoring Program (BMP): biofouling diversity on different materials, exposure conditions and locations.</td>
<td>G. Pavanello (CNR)</td>
</tr>
<tr>
<td>17:20-17:45</td>
<td>5. Results from 3 TNA calibration experiments (CIEBIO, RTC and TOFU) and Toward a networking approach for metrology in oceanography</td>
<td>M. Ntoumas (HCMR) and F. Salvetat (Ifremer)</td>
</tr>
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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)**

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<tr>
<th>Time</th>
<th>Activity</th>
<th>Chairpersons</th>
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<tbody>
<tr>
<td>08:00-08:45</td>
<td>Bus to Ifremer (Stop at Ibis Styles &amp; Railway station)</td>
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| 08:45-10:45| **Topic 2: Integrated monitoring, Modelling & in situ observation, network assessment**  
*Chairpersons: Stefania Sparnocchia (CNR) & Julien Mader (AZTI)* |                    |
<p>| 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| <strong>Topic 3: Monitoring of biological compartment</strong>                          |                    |
| 11:15-12:15| <em>Chairpersons: Antoine Grémare (CNRS) &amp; Jukka Seppälä (SYKE)</em>             |                    |
| 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)                                                           |                    |</p>
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<th>Time</th>
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<tr>
<td>14:00-15:00</td>
<td><strong>Topic 3: Monitoring of biological compartment</strong></td>
<td><strong>Chairpersons: Antoine Grémare (CNRS) &amp; Jukka Seppälä (SYKE)</strong></td>
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<tr>
<td>14:00-14:20</td>
<td>15. <em>Image analysis developments within JERICO</em></td>
<td>A. Gremare (CNRS)</td>
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<tr>
<td>14:20-14:40</td>
<td>16. <em>Dissolved oxygen variability of the LIW in the Ligurian Sea</em></td>
<td>L. Coppola (CNRS)</td>
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<tr>
<td>14:40-15:00</td>
<td>17. <em>Field test of microLFA modules for on-line measurement of NH3 and PO4 in Ferrybox (FITO MicroLFA)</em></td>
<td>L. Sanfilippo (Systea)</td>
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<tr>
<td>15:00-18:00</td>
<td><strong>Topic 4: Monitoring of Chemicals and contaminants, pH &amp; carbonate systems</strong></td>
<td><strong>Chairpersons: Kai Sorensen (NIVA) &amp; Laurent Delauney (Ifremer)</strong></td>
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<tr>
<td>15:00-15:20</td>
<td>18. <em>Physicochemical characterization of aerosols in the Adriatic Sea (MAPOM)</em></td>
<td>C. Quentin (CNRS)</td>
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<tr>
<td>15:40-16:10</td>
<td><strong>Coffee break and poster session</strong></td>
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<tr>
<td>16:10-16:30</td>
<td>20. <em>Legacy and Emerging Chemical Contaminants in European Coastal waters (ECCECs)</em></td>
<td>M. Brumovsky (RECETOX)</td>
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<td>16:30-16:50</td>
<td>21. <em>Sensor developments for continuous measurements of pH and alkalinity on FerryBox systems</em></td>
<td>W. Petersen (HZG)</td>
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<tr>
<td>17:10-17:30</td>
<td>23. <em>Seasonal pH variability in the Saronikos Gulf: a year study (MEDACID)</em></td>
<td>A. González (ULPG)</td>
</tr>
<tr>
<td>17:30-18:00</td>
<td><strong>Poster session</strong></td>
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*End of the Science Day [18:00: Bus to Railway station & Ibis Styles]*
## Participant List

<table>
<thead>
<tr>
<th>Family name</th>
<th>Surname</th>
<th>Institution</th>
<th>Email @</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almeida</td>
<td>Sara</td>
<td>IH</td>
<td><a href="mailto:sara.almeida@hidrografico.pt">sara.almeida@hidrografico.pt</a></td>
</tr>
<tr>
<td>Bastianini</td>
<td>Mauro</td>
<td>CNR</td>
<td><a href="mailto:mauro.bastianini@ismar.cnr.it">mauro.bastianini@ismar.cnr.it</a></td>
</tr>
<tr>
<td>Beaume</td>
<td>Nolwenn</td>
<td>IFREMER</td>
<td><a href="mailto:nolwenn.beaume@ifremer.fr">nolwenn.beaume@ifremer.fr</a></td>
</tr>
<tr>
<td>Blauw</td>
<td>Anouk</td>
<td>Deltares</td>
<td><a href="mailto:anouk.blauw@deltares.nl">anouk.blauw@deltares.nl</a></td>
</tr>
<tr>
<td>Boukerma</td>
<td>Kada</td>
<td>IFREMER</td>
<td><a href="mailto:kada.boukerma@ifremer.fr">kada.boukerma@ifremer.fr</a></td>
</tr>
<tr>
<td>Brumovsky</td>
<td>Miroslav</td>
<td>RECETOX</td>
<td><a href="mailto:brumovsky@recetox.muni.cz">brumovsky@recetox.muni.cz</a></td>
</tr>
<tr>
<td>Buch</td>
<td>Erik</td>
<td>EuroGOOS</td>
<td><a href="mailto:erik.buch@eurogoos.eu">erik.buch@eurogoos.eu</a></td>
</tr>
<tr>
<td>Chapalain</td>
<td>Georges</td>
<td>Cerema/LGCE</td>
<td><a href="mailto:Georges.Chapalain@cerema.fr">Georges.Chapalain@cerema.fr</a></td>
</tr>
<tr>
<td>Charria</td>
<td>Guillaume</td>
<td>IFREMER</td>
<td><a href="mailto:guillaume.charria@ifremer.fr">guillaume.charria@ifremer.fr</a></td>
</tr>
<tr>
<td>Colijn</td>
<td>Franciscus</td>
<td>HZG</td>
<td><a href="mailto:franciscus.colijn@hzg.de">franciscus.colijn@hzg.de</a></td>
</tr>
<tr>
<td>Coppola</td>
<td>Laurent</td>
<td>CNRS</td>
<td><a href="mailto:coppola@obs-vlfr.fr">coppola@obs-vlfr.fr</a></td>
</tr>
<tr>
<td>Delauney</td>
<td>Laurent</td>
<td>IFREMER</td>
<td><a href="mailto:Laurent.delauney@ifremer.fr">Laurent.delauney@ifremer.fr</a></td>
</tr>
<tr>
<td>Delory</td>
<td>Eric</td>
<td>PLOCAN</td>
<td><a href="mailto:eric.delory@plocan.eu">eric.delory@plocan.eu</a></td>
</tr>
<tr>
<td>Durand</td>
<td>Dominique</td>
<td>NIVA/IRIS</td>
<td><a href="mailto:dodu@iris.no">dodu@iris.no</a></td>
</tr>
<tr>
<td>Farcy</td>
<td>Patrick</td>
<td>IFREMER</td>
<td><a href="mailto:patrick.farcy@ifremer.fr">patrick.farcy@ifremer.fr</a></td>
</tr>
<tr>
<td>Galea</td>
<td>Anthony</td>
<td>UoM</td>
<td><a href="mailto:anthony.j.galea@um.edu.mt">anthony.j.galea@um.edu.mt</a></td>
</tr>
<tr>
<td>Gaughan</td>
<td>Paul</td>
<td>MI</td>
<td><a href="mailto:paul.gaughan@marine.ie">paul.gaughan@marine.ie</a></td>
</tr>
<tr>
<td>Gonzalez</td>
<td>Aridane</td>
<td>ULPGC</td>
<td><a href="mailto:aridaneglez@gmail.com">aridaneglez@gmail.com</a></td>
</tr>
<tr>
<td>Gorringe</td>
<td>Patrick</td>
<td>EuroGOOS</td>
<td><a href="mailto:patrick.gorringe@eurogoos.eu">patrick.gorringe@eurogoos.eu</a></td>
</tr>
<tr>
<td>Grémare</td>
<td>Antoine</td>
<td>CNRS/UB</td>
<td>antoine.gremare@u-bordeaux</td>
</tr>
<tr>
<td>Haller</td>
<td>Michael</td>
<td>HZG</td>
<td><a href="mailto:michael.haller@hzg.de">michael.haller@hzg.de</a></td>
</tr>
<tr>
<td>Kaitala</td>
<td>Seppo</td>
<td>SYKE</td>
<td><a href="mailto:seppo.kaitala@ymparisto.fi">seppo.kaitala@ymparisto.fi</a></td>
</tr>
<tr>
<td>Keeble</td>
<td>Simon</td>
<td>BLIT</td>
<td><a href="mailto:simon@bluelobster.co.uk">simon@bluelobster.co.uk</a></td>
</tr>
<tr>
<td>Krieger</td>
<td>Magali</td>
<td>IFREMER</td>
<td><a href="mailto:magali.krieger@ifremer.fr">magali.krieger@ifremer.fr</a></td>
</tr>
<tr>
<td>Laakso</td>
<td>Lauri</td>
<td>FMI</td>
<td><a href="mailto:Lauri.Laakso@fmi.fi">Lauri.Laakso@fmi.fi</a></td>
</tr>
<tr>
<td>Lamouroux</td>
<td>Julien</td>
<td>Noveltis</td>
<td><a href="mailto:julien.lamouroux@noveltis.fr">julien.lamouroux@noveltis.fr</a></td>
</tr>
<tr>
<td>Lefebvre</td>
<td>Alain</td>
<td>IFREMER</td>
<td><a href="mailto:alain.lefebvre@ifremer.fr">alain.lefebvre@ifremer.fr</a></td>
</tr>
<tr>
<td>Loubrieu</td>
<td>Thomas</td>
<td>IFREMER</td>
<td><a href="mailto:Thomas.Loubrieu@ifremer.fr">Thomas.Loubrieu@ifremer.fr</a></td>
</tr>
<tr>
<td>Name</td>
<td>First Name</td>
<td>Institution</td>
<td>Email</td>
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</tr>
<tr>
<td>Mader</td>
<td>Julien</td>
<td>AZTI</td>
<td><a href="mailto:jmader@azti.es">jmader@azti.es</a></td>
</tr>
<tr>
<td>Mills</td>
<td>David</td>
<td>CEFAS</td>
<td><a href="mailto:david.mills@cefas.co.uk">david.mills@cefas.co.uk</a></td>
</tr>
<tr>
<td>Mohlin</td>
<td>Malin</td>
<td>SMHI</td>
<td><a href="mailto:Malin.Mohlin@smhi.se">Malin.Mohlin@smhi.se</a></td>
</tr>
<tr>
<td>Morin</td>
<td>Pascal</td>
<td>CNRS</td>
<td><a href="mailto:pmorin@ipev.fr">pmorin@ipev.fr</a></td>
</tr>
<tr>
<td>Nair</td>
<td>Rajesh</td>
<td>OGS</td>
<td><a href="mailto:rnair@ogs.ogs.trieste.it">rnair@ogs.ogs.trieste.it</a></td>
</tr>
<tr>
<td>Newton</td>
<td>Janet</td>
<td>Univ WA</td>
<td><a href="mailto:newton@apl.washington.edu">newton@apl.washington.edu</a></td>
</tr>
<tr>
<td>Nizzetto</td>
<td>Luca</td>
<td>NIVA</td>
<td><a href="mailto:luca.nizzetto@niva.no">luca.nizzetto@niva.no</a></td>
</tr>
<tr>
<td>Nolan</td>
<td>Glenn</td>
<td>MI</td>
<td><a href="mailto:glenn.nolan@marine.ie">glenn.nolan@marine.ie</a></td>
</tr>
<tr>
<td>Norli</td>
<td>Marit</td>
<td>NIVA</td>
<td><a href="mailto:marit.norli@niva.no">marit.norli@niva.no</a></td>
</tr>
<tr>
<td>Ntoumas</td>
<td>Manolis</td>
<td>HCMR</td>
<td><a href="mailto:mntou@hcmr.gr">mntou@hcmr.gr</a></td>
</tr>
<tr>
<td>Pavanello</td>
<td>Giovanni</td>
<td>CNR</td>
<td><a href="mailto:giovanni.pavanello@ge.ismar.cnr.it">giovanni.pavanello@ge.ismar.cnr.it</a></td>
</tr>
<tr>
<td>Perivoliotis</td>
<td>Leonidas</td>
<td>HCMR</td>
<td><a href="mailto:lperiv@hcmr.gr">lperiv@hcmr.gr</a></td>
</tr>
<tr>
<td>Petersen</td>
<td>Wilhelm</td>
<td>HZG</td>
<td><a href="mailto:wilhelm.petersen@hzg.de">wilhelm.petersen@hzg.de</a></td>
</tr>
<tr>
<td>Petihakis</td>
<td>George</td>
<td>HCMR</td>
<td><a href="mailto:gpetihakis@hcmr.gr">gpetihakis@hcmr.gr</a></td>
</tr>
<tr>
<td>Petit de la Villéon</td>
<td>Loic</td>
<td>IFREMER</td>
<td><a href="mailto:Loic.Pett.De.La.Villeon@ifremer.fr">Loic.Pett.De.La.Villeon@ifremer.fr</a></td>
</tr>
<tr>
<td>Pichereau</td>
<td>Sylvie</td>
<td>IFREMER</td>
<td><a href="mailto:sylvie.pichereau@ifremer.fr">sylvie.pichereau@ifremer.fr</a></td>
</tr>
<tr>
<td>Puillat</td>
<td>Ingrid</td>
<td>IFREMER</td>
<td><a href="mailto:ingrid.puillat@ifremer.fr">ingrid.puillat@ifremer.fr</a></td>
</tr>
<tr>
<td>Quentin</td>
<td>Céline</td>
<td>CNRS</td>
<td><a href="mailto:celine.quentin@mio.osupytheas.fr">celine.quentin@mio.osupytheas.fr</a></td>
</tr>
<tr>
<td>Reggiani</td>
<td>Emanuele</td>
<td>NIVA</td>
<td><a href="mailto:ere@niva.no">ere@niva.no</a></td>
</tr>
<tr>
<td>Ribotti</td>
<td>Alberto</td>
<td>CNR</td>
<td><a href="mailto:alberto.ribotti@cnr.it">alberto.ribotti@cnr.it</a></td>
</tr>
<tr>
<td>Rimanucci</td>
<td>Francesco</td>
<td>CNR</td>
<td><a href="mailto:francesco.rimanucci@bo.ismar.cnr.it">francesco.rimanucci@bo.ismar.cnr.it</a></td>
</tr>
<tr>
<td>Riou</td>
<td>Philippe</td>
<td>IFREMER</td>
<td><a href="mailto:philippe.riou@ifremer.fr">philippe.riou@ifremer.fr</a></td>
</tr>
<tr>
<td>Robakiewicz</td>
<td>Malgorzata</td>
<td>IBW PAN</td>
<td><a href="mailto:marob@ibwpan.gda.pl">marob@ibwpan.gda.pl</a></td>
</tr>
<tr>
<td>Robin</td>
<td>Agnès</td>
<td>EC</td>
<td><a href="mailto:agnes.robin@ec.europa.eu">agnes.robin@ec.europa.eu</a></td>
</tr>
<tr>
<td>Romagnan</td>
<td>Jean-Baptiste</td>
<td>UPMC</td>
<td><a href="mailto:romagnan@obs-vlfr.fr">romagnan@obs-vlfr.fr</a></td>
</tr>
<tr>
<td>Salvetat</td>
<td>Florence</td>
<td>IFREMER</td>
<td><a href="mailto:florence.salvetat@ifremer.fr">florence.salvetat@ifremer.fr</a></td>
</tr>
<tr>
<td>Sanfilippo</td>
<td>Luca</td>
<td>SYSTEA SpA</td>
<td><a href="mailto:luca.sanfilippo@systea.it">luca.sanfilippo@systea.it</a></td>
</tr>
<tr>
<td>Seppälä</td>
<td>Jukka</td>
<td>SYKE</td>
<td><a href="mailto:jukka.seppala@ymparisto.fi">jukka.seppala@ymparisto.fi</a></td>
</tr>
<tr>
<td>Slabakova</td>
<td>Violeta</td>
<td>IO-BAS</td>
<td><a href="mailto:v.slabakova@io-bas.bg">v.slabakova@io-bas.bg</a></td>
</tr>
<tr>
<td>Sørensen</td>
<td>Kai</td>
<td>NIVA</td>
<td><a href="mailto:kai.sorensen@niva.no">kai.sorensen@niva.no</a></td>
</tr>
<tr>
<td>Sbrnccchia</td>
<td>Stefania</td>
<td>CNR</td>
<td><a href="mailto:stefania.sbrnccchia@ts.ismar.cnr.it">stefania.sbrnccchia@ts.ismar.cnr.it</a></td>
</tr>
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</table>
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
Comparison of 3 ferrybox ferry observations in the Baltic Sea

Three Ag@line ferrybox ferries comparison
27-20.6.2014 by Swedish coast

Three Ag@line ferrybox ferries comparison
27-15.7.2014 by Swedish coast

Weekly validation of chlorophyll fluorometer
Spring bloom case

Weekly validation of chlorophyll fluorometer
Summer with cyanobacteria blooming

Annual calibration of fluorometers (in February)

Chlorophyll

<table>
<thead>
<tr>
<th>CHL</th>
<th>CHL</th>
<th>Counts</th>
<th>95% CI</th>
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<td>1</td>
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<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
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</tbody>
</table>

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

Validation of same records with phycocyanin as auxiliary parameter
Why weekly validation is needed?

Measuring both Phycocyanin and Chla fluorescence will improve Chla concentration estimates:

\[ \text{Chla} = b_0 + b_1 \times \text{Fl} \]

Corrected Fluorescence

Records from of Pyhtäälä Smart Buoy

Date in 2012

www.luode data.fi/ruotta

Fluorometer calibration, validation and frequent checking, example CDOM

Field validation

Relationship between CDOM measured in lab and CDOM absorption and DOC concentration measured from discrete water samples. The variation in the relationship for specific locations indicate spatial differences in the quality of CDOM.

Dependency of CDOM fluorescence on temperature, instrument specific correction factors are needed before data can be fully exploited.

Fluorometer calibration, validation and frequent checking, example CDOM

Calibration with quinine sulphate solutions, to yield equivalent results with all instruments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Calibration Drugs per Year</th>
<th>Valuation set(1)</th>
<th>Auditing Method</th>
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<td>Chl a Inv.1</td>
<td>Solid secondary standard, Chemicals in solution</td>
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<tr>
<td>Phycocyanin</td>
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<td>Phycocyanin Inv.1</td>
<td>Solid secondary standard, Chemicals in solution</td>
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<tr>
<td>CDOM</td>
<td>Quinine sulphate, Contecene, Peorlere</td>
<td>CDOM Fluorescence A, doxocine, DOC Inv.1</td>
<td>Solid secondary standard, Chemicals in solution</td>
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</table>
Fluorometer calibration, validation and frequent checking.

Calibration needed to get consistent measurements between platforms, instruments, years, operations etc.

Validation needed to convert optical signal to meaningful numbers

Frequent checking needed to maintain high quality measurements during operational work.

Thank you
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
USV 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...

- USV for Shallow water
  - Eva logs, sonobuoy
  - 10 hours operation, auto or radio controlled, 30 kg
  - Echo sounders, GPS, camera

- Coastal USV
  - Deployed with continuous human supervision

Novel platforms

- USV for Shallow water
  - Z-Boat 1000 – Oceanocon group – Swater service
  - Remotely operated (10hrs, 3 miles, max speed: 10 km)
  - Echo sounders, GPS, real-time telemetry up to 60km

Novel platforms

- ASMV (Autonomous Self-Moving Vehicle)
  - ASV Limited (UK) – C Enduro platform

Applications and Sensors
- Marine & Oceanographic data collection
- Environmental sensors e.g. CO2 monitoring
- Seismic support e.g. PTO Acoustic Monitoring
- Data gateway e.g. ACV/RVS/Glider to satellite

Operation characteristics
- 3 months endurance, 4-tons speed for over 4000 miles range
- 2 breakfree meters, 550 x 600 kg, METOP operability (Indoors)

Novel platforms

- Coastal USV - VAIMOS
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

Novel platforms

✦ Coastal USV - VAIMOS

VAIMOS in automated operation

Novel platforms

✦ Coastal USV - VAIMOS

VAIMOS on STRASSE Oceanographic campaign for salinity surface measurement

Novel platforms

✦ Coastal USV - Mubesens

VAIMOS on STRASSE Oceanographic campaign

Novel platforms

✦ Coastal USV - Mubesens

Mubesens:
- 6 m x 2.50 m
- Autonomous up to 80 km
- Autonomous up to 70 km/h
- Autonomous up to a depth of 20 m
- Data processing and transmission to a laptop
- Multi-parameter probes
- 150 or 600 m cord

Novel platforms

✦ Coastal USV - Mubesens

Mubesens:
- 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 (oceanographic vessel)
Novel platforms

**Coastal USV - Mobesens**
Prod and water winching sampling in operation

**UOV (Unmanned Ocean Vessel)**

Objectives:
- Autonomy for long term deployment
- Open ocean navigability
- Rough conditions
- Real time data transfer
- Autonomous waypoints routing

- obstacle avoidance?
- Regulation for UOV?

**The Wave-Glider from Liquid robotic**

**The wave glider from Liquid robotic**

**What's next?**
- A ship for AUV launching and docking…
- Part of a Dreamwork/Disney animated cartoon?

**The Sail-Boat from CMR Instrumentation**

**What's next?**
- Surely not ;)

Marine Advanced Research introduces the WAM-V™
Novel platforms

What’s next?

- Obstacles avoidance?
  - Radar, lidar, camera and navigation algorithm...
- Regulation for UUV?
  - Regulation for UUV - a very fuzzy situation
- Men resources for deployment
  - Man problem - personnel operational issue
- Large bandwidth data transport medium

Spin-offs

- Few net URLs...
  - Unmanned Marine System - www.veryglobal.com
  - OceanScience - www.oceantheservices.com
  - Evo Logic - www.evologic.com
  - SeaRobotic - www.searobotic.com
  - Nymphia - www.nymphia.fr
  - CMR Instrumentation - www.cmrsensing.com
  - Liquid Robotix - www.liquidrobotix.com
  - Harbor Wing Technologies - www.harborwingtech.com
  - SolarSailor - www.solarsailor.com
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
Tables of content

- Introduction
  - Fishing vessels as Voluntary Vessels of Opportunity
  - The Fishery & Oceanography Observing System in the Atlantic Site
- Evaluation of the commercial probes used in monitoring systems participating in JERICO
  - Calculation of sensors offsets
  - Example of data correction
- Conclusions

Introduction
Fishing vessels as Voluntary Vessels of Opportunity

The use of fishing vessels as Voluntary Vessels of Opportunity (VVOs), 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.

Evaluation of the commercial probes used in FOS/FOOS and RECOPHICA

The reliability of the data collected by the fishing vessels is intrinsically bound to the sensors accuracy, and to exploit the accuracy of these data is a cornerstone experience for application in oceanography.

Experimental set-up
Demonstration surveys
(1) Trials with sensors mounted on fishing gears
(2) Simultaneous profiling with the sensor
Trials with sensors mounted on fishing gears

- Sensors and CTD are fixed to a sledge
- The sledges are deployed at the sea bottom
- The sledges are left at the sea bottom for about 15 min (sledges are not deployed)
- When the sledges are deployed, water regularly flows through the sensors.

Simultaneous profiling

Simulations of data collection during fishing activity:
Two types of profiling vs. depth

CTD reference
Stairs profile

Data and Methods

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

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

Results: Depth offsets

Star-Oddi sensors
NKE sensors

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

Results: Star-Oddi Temperature offsets

- 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.

Temperature Data collected by Star-Oddi sensors should be considered reliable only when the dwell time at a fixed permanence is longer than 30s (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 set of fishing rod) can be corrected in any reliable way and thus confidence used.
**Results: NKE Temperature and Salinity offsets**

- Median temperature offset is inside the normal accuracy range of the sensor ($\pm 0.5°C$) in most cases.
- Median salinity offset is outside the normal 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**

Temperature and depth values collected by the NKE probes can be made quite accurate by correcting the raw data with the calculated offsets.

**CONCLUSION**

- Relying on their ability to continuously and automatically record oceanographic parameters (typical for VDOs), it became very easy to reduce the work of fishing vessels as well as save 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 operation.
- 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.

**DATA DISTRIBUTION**

Data from $n$ vessels operating in the Atlantic (NekAndFOOS) are routinely distributed through MyOcean - Mediterranean Sea in Situ Therapeutic Assembly Centre.

**EXAMPLE OF Data correction**

Temperature maps from January 2014 to March 2014 are published on the JERICO website:

http://www.jerico-project.eu/
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 BIOFOULING MONITORING PROGRAM (BMP):
BIOFOULING DIVERSITY ON DIFFERENT MATERIALS,
EXPOSURE CONDITIONS AND LOCATIONS

BIOFOULING MONITORING BOX (BMB)

- Selection of partners and monitoring sites along a geographical gradient
- For each selected site, two sampling stations (open water and coastal water), where possible

BIOFOULING MONITORING PROGRAM (BMP):
SELECTION OF PARTNERS
AND IMMERSION SITES

7 partners
12 BMBs

BIOFOULING MONITORING PROGRAM (BMP)

Available data
- ISMERI Coastal water: every month
- ISMERI Open water: months 0-3, 6, 9
- FREMER Coastal water: months 0-4, 7, 10
- FREMER Open water: months 0-4, 7, 10
- HCMR Coastal water: months 0-4, 10
ISMAR – OPEN WATER
AFTER 3 MONTHS

HCMR – COASTAL WATER
AFTER 3 MONTHS

FREMER – COASTAL WATER
AFTER 3 MONTHS

BMP CONCLUSIONS
- When deploying an oceanographic instrument, in particular but not only for long-term studies, it is essential to keep into account biofouling-related issues.
- High variability in biofouling dynamics, linked to:
  - Materials
  - Light/mesh exposure
  - Sensor structure (geometry)
  - Deployment site
  - Season
  - Deployment duration
- Many factors other factor
- It is only possible to forecast a general trend, but only field tests/monitoring will tell us the truth!
- There is no universal anti-biofouling approach

BMB NEXT: FUTURE IMPROVEMENTS

ACKNOWLEDGEMENTS
MANY THANKS TO ALL THE PEOPLE WHO SUPPORTED JERICO BMP
CMR-BMIP: Stelios Sparmorio, Francesco Zorzi, Elia Cunin
HCMR: Dario Paulmuller
IFREMER: Michel Plateau, Michel Reperez
AZTI: Carla Hernandez
CEFAS: Dave Stott
SMHI: Bengt Karlson
SYKE: Janne Sarsvik
...AND THANK YOU FOR YOUR ATTENTION!

ANY QUESTION?

giovanni.pavanelli@pa.SEMB cường
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 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

Marek Hronenkov / HCMM / mroto@fzj.de

RTC objectives

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

Sensors:
- Two SBE 35 Deep Ocean Standard Thermometers (serial numbers 58 and 59) manufactured by SeaBird Electronics, Inc., that were purchased by HCMM in 2007.
- The serial number serial number 39 had never been used in the field while the other (serial number 58) has been employed in HCMM's evaluations/calibration experiments.

RTC: OGS - Oceanographic Calibration Centre equipment

- Precision Digital Thermometer FlukeHart 1900 with metal-enclosed SIMRT Rearmount: SS0S, with reference sensors LAM 4030B and Guadine 930.
- Gallium Cell Maintenance Apparatus FlukeHart 5230, with Gallium melting point (MgCd) cell FlukeHart 5403.

RTC: Linearization at seven calibration sets - points

Seven calibration sets points (28 °C to 3 °C) were chosen, and at each setpoint, the bath temperature was logged for 10 minutes.

The averaged data of the sensors at the different setpoints and the corresponding temperature readings with respect to the relevant reference temperatures.

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

SBE thermometers logging at the Triple Point of Water (0.0018 °C), after the hydrostatic head effect correction.

SBE sn:59 was never used
SBE sn:59 was used only at the lab (>120 hours)
RTC: Results

Both SBE 35 are used as the reference temperature sensors for HCPR:
• 4 Fixed stations + 1 FerryBox System
  • SBE 37 Micronal CTDs
  • 20 SBE 19 plus CTDs
  • 5 Ifremer CTDs

The bath set point resistances of the SBE 35 on 54 before and after the Scope and Offset adjustments.

CIEBIO and TOFU

CIEBIO calibration workshops

<table>
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<tr>
<th>Date</th>
<th>Title</th>
<th>Coordinator</th>
</tr>
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<tr>
<td>5th February 2012</td>
<td>1st Calibration and validation prevention of optical sensors &amp; sharing of calibration facilities</td>
<td>JYVE, Helsinki</td>
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<tr>
<td>5th October 2012</td>
<td>2nd Calibration exercise (7,5,02), sharing of calibration facilities</td>
<td>IFREMER, Ghent</td>
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</tbody>
</table>

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

Laboratory dissolved oxygen calibration:
1. Static water circulation by an Haake N2 recirculation system and two aerators
2. SBE43 sensor together and Winler chemical titration served as the reference
3. 5 calibration points
4. Samples for each point used for Winler

Laboratory chlorophyll calibration:
2. Reference of chlorophyll cultures
3. Concentration points of uramine solution

Field test:
1. Dive onboard the RV Philia
2. Water samples acquired for the determination of dissolved oxygen and chlorophyll content.

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 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 results: Dissolved Oxygen sensors.

Laboratory dissolved oxygen calibration: overestimation of Winler titration method with respect to laboratory tests and in-situ samples.
CIEBIO results: Fluorescence sensors.

Laboratory slide calibration: new calibration curve and new scale factor 3 or 5 times lower than data sheet. New curves were validated by direct comparison with flow-in-air data.

CIEBIO results: Sea-truth?????

Performing fluorimetric calibration in the field only can be problematic.

Files: ECO PL620, species:
- Range: 0-99 µg l Chl
- Sensitivity: 1.2-35 µg l Chl
- Calibration point: 25 µg l of a Thalassiosira weissflogii phytoplankton culture.

CIEBIO results: Turbidity sensors.

- Laboratory turbidity calibration: The turbidity experiments were performed only in laboratory for blank and three points of reference solution based on Turbidity 52 NTU Calibration Standard by Thales. The dilution of the reference solutions was produced with 1 L of deionized water and the concentrations of 2.5, 1.25, and 0.62 NTU.
- For the latter measurements the method suggested by WetLab was used covering both the LED and detector whereas the lower dark values were recorded with black tape only on the sensor's face, deionized water.
- The results were in agreement with the calibration sheet of the sensor manufacturer.

TOFU equipment: Sensors, software and hardware used

Software (LabVIEW based):
- Stabilization analogue voltage provided by 0-5 V sensors were collected by a datalogger
- Processed and displayed in real-time through the software program developed by CINE.
- The selected voltage was converted into the oxygen concentration by using a modified version of the algorithm by Owe and Mohn (1983).

Hardware:
- The dissolved oxygen sensor of National Instruments based (NI 4097)
- Multi-canal data acquisition capability
- 0-5 V voltage range and an accuracy of 0.01 mV for the range 0-5 V.

TOFU experimental set-up: Dissolved oxygen sensors.

- Two pairs of KELL 41 and submersible pumps connected to the SBE37
- Two Aanderaa DO optodes

TOFU experimental set-up: Dissolved oxygen sensors.

- During the whole experimental phase, temperature ranged from 15 °C to 30 °C and the salinity from 36.8 PSU to 38.3 PSU.
- At each point the DO saturation was 100% Reference value: Winkler (triplicates)
**TOFU results:** Dissolved oxygen sensors.

Dissolved oxygen concentration measured by four SBE43 sensors (red dot 2931, square dot 2933, star dot 3941, plus dot 3953) vs.室内 3875 (dot 5987) concentration in the three configurations (red, green, blue). Grey data correspond to the concentrations obtained through WAVE station.

**TOFU experimental set-up:** Fluorometers Eco FLNTU

A chamber developed by CNRS 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/hour.

Sensors: 3 Wetlab 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 Chlorella experiment

**TOFU results:** Eco FL-NTU Uranine experiment

Instrument noise (coefficient 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

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<th>Turbidity (NTU)</th>
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</tbody>
</table>

Snippet of the user interface of the software measuring the acquisition of analogue and serial data from a ECO FL/TU system. This plot shows the increase of the voltage signal of the a 1.7% sensor corresponding to the addition of 80 ml of Fertimarine at 50 NTU into the blank.

**JERICO Calibration TNA experiments**

RTU, OOS and HCMR shared and developed procedures for Temperature, salinity, and calibration.

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

**JERICO Calibration TNA experiments**

Thank you
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
Why this proposal?

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

The reasons:
- The changing view on Data – from single use to multi-use, local to global (science) need to ability to (price) commodity – this transition means assigning value, therefore, methodology (whether you like it or not).
- The European policy climate – Integrated Maritime Policy, Blue Growth, MF13, regulatory measures for environmental sensors and instrumentation.

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

Thanks for your attention.
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 (RECOPECA 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

Table of contents

- Context: Coastal Observing Systems in Bay of Biscay / English Channel
- Approach & Methodology
- Study framework
- From Local ... Limited Atlas & Western English Channel
- To regional ... First results - JECOSPECS programme
- Conclusions & Perspectives

How to proceed?

- Efficient observation network
- Network able to detect (and constraint) model errors

Principle: form and study the properties of the Ensemble-based
Representative Matrix (model ECM) in data space
Method: study the eigenspectrum of the ECM to identify which error modes
the network can detect

*DMM: Error Covariance Matrix
La Mead et al., 2009; De Mey, 2010; 2014; Kourkoulis et al., 2014

Diagnostics: eigenvalues of the scaled representor matrix

- $R$: Representor Matrix
  - $R$ is a projection of model ECM in observation space

$P_{ECM}$

- $R$: Observation ECM
- If $R > P_{ECM}$ (or $R$ efficient)
- If $R > P_{ECM}$ (or $R$) entered efficiency

- Number of eigenvalues larger than 1
  - of the scaled representor matrix $g = R \cdot \text{vec} \cdot R^T$
Study framework

- Model: MARIMO, MANGA configuration
  (English Channel + Bay of Biscay)

- Ensembles of 70 model simulations: Modified parameters or forcings:
  - Atmospheric forcings: $U_{10}, V_{10}, T_{dn}, P_{ms}, f_{10}$
  - Bottom friction coefficient $C_u$
  - Diffusion coefficient (river plume influence) $C_s$
  - Parameterization coefficient of the turbulent closure scheme $C_c$

- 4 seasonal periods, year 2006:
  - 15/01 → 02/02
  - 02/05 → 31/05
  - 02/07 → 15/07
  - 22/10 → 11/11
A tandem monitoring between FerryBox and glider

- Identifying the added value of a glider line sampling the water column under a FerryBox line in a macrotidal regime.
- Study configuration:
  - FerryBox + glider section
  - Roscoff-Plymouth
- Network features:
  - FerryBox:
    - 2 FerryBox per day
    - 36 h intervals
    - Sampling + 1 km
  - Glider:
    - 1 FerryBox + 4 days
    - Sampling + 1 km
    - 3D
- Temperature and salinity profiles considered
  - Observation error:
    - \( e\Delta T = 0.5{}^\circ C \)
    - \( e\Delta S = 0.25 \) psu

In the eastern English Channel surface high-frequency snapshot of the hydrography shows following level of hydrological patterns.

RecopescA – in situ profiles from fishing vessels

End of 2014:
- 15,279 profiles collected

Network scenarii

Spring 2015:
- Temperature profiles only considered
- Observation error: 0.5\(^\circ\ C\), sensor accuracy 0.05\(^\circ\ C\) [MS-EP07 profiel]
- 0.3\(^\circ\ C\), sensor accuracy & representativity error
Model uncertainty in spring (of Ensemble Variance)

Representant Matrix Spectra

Representant Matrix Spectra

Based on Representant Matrix Spectra (PMS):
- SCY > ESC > SF

But:
- Limits due to ensemble size (50 members):
  - Too high for the ensemble (not straightforward)
  - Too poor to consider other indicators (following step)
  - To consider more local systems (1st part)

Modal profiles for spring

Modal profiles for spring

Quantitative indicators

Quantitative indicators

\[ \text{efficiency} = \frac{\text{number of MP}}{\text{number of available profiles}} \]

\[ \text{efficiency} = \frac{\text{number of MP}}{\text{number of available profiles}} \]

Following this diagnostic:

SCY > ESC > SF

Network models (model error modes) detected by the network, projected on observation space

\[ \pi \text{ network models (model error modes) detected by the network, projected on observation space} \]
Conclusions & Perspectives

In the Bay of Biscay and English Channel:
- Volunteer observer opportunity (LOsS) has been successful
- Based on efficient early warning system (project IFREMER)

Conclusions & Perspectives

RMS method - a promising approach:
- To improve navigation safety
- To enhance route selection
- To reduce fuel consumption

Thanks for your attention...
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.
Why Evaluation of hydrodynamical model parameters stability 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))
- Field data from different regions

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

Michael Keller, Frank Janssen, John Salsen, Wilfried Petersen and Regina Danckwerts
1 Institute of Coastal Research, Heligoland-Ostseeforschung (IFM)
2 Department of Remote Sensing and Oceanography (IFM), Hering}

H2O FerryBox routes

- Operation of currently four operational FerryBox:
  - "Minerva" on Heligoland-Düne / Heligoland-Ostseeforschung (IFM) since 2009
  - "Challenger" on England-Norway-Belgium (since 2007)
  - "Rondeau" on England-Norway-Belgium (since 2013)
  - "Ferrybox Ferret" on Heligoland-Düne / Heligoland-Ostseeforschung (IFM) since 2009

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  - "Ferrybox Ferret" on Heligoland-Düne / Heligoland-Ostseeforschung (IFM) since 2009

Observation data sets

Ferrybox Normal

- Name: "Minerva" on Heligoland-Düne / Heligoland-Ostseeforschung (IFM) since 2009
- Operating hours: 7 days, 24 h per day
- Temperature: Surface, Bottom: 7:45 PM, 56.4°F

Model descriptions

- Model name: GRIMM (NEMO)
- Model type: Operational 3D hydrodynamical ocean circulation model
- Grid resolution: 1/15° (500 m in German Bight), 0.25° in the German Bight
- Boundary conditions: Meteorological and wave forcings from German Weather Service (DWD)
- Freshwater input: Daily average from German river, climatological runoff from other rivers
- Time period: 01/2000 - 01/2012

FOAM NEMO

- Model type: Coupled 3D hydrodynamical-ecosystem model, nested in Met Office global ocean model
- Grid resolution: 1/15° (500 m in German Bight), 0.25° in the German Bight
- Boundary conditions: Meteorological and wave forcings from German Weather Service (DWD)
- Freshwater input: Climatological inputs from 360 rivers, updated river scheme
- Time period: 01/2011 - 06/2012
Evaluation Water temperature

- Positive difference = model overestimation
- Negative difference = model underestimation

**Differences: BSH-FerryBox**

**BSH-FerryBox**

**FerryBox**

FerryBox 2 outlier = 6.3 K

**Model evaluation at English coast:** Water temperature

- Generally good agreement between FerryBox and models
- Underestimation in winter, overestimation in summer

**Differences: BSH-FerryBox**

**BSH-FerryBox**

**FerryBox**

Hiller et al. (in review)

**Model evaluation at „Deutsche Bucht“:** Water temperature

- Good agreement between FerryBox and SARINEI results
- Overestimation in winter, underestimation in summer (SARINEI)

**Differences: BSH-FerryBox**

**BSH-FerryBox**

**FerryBox**

Hiller et al. (in review)

**Evaluation Salinity**

- Positive difference = model overestimation
- Negative difference = model underestimation

**Differences: BSH-FerryBox**

**BSH-FerryBox**

**FerryBox**

FerryBox 2 outlier = 5.0

**Model evaluation at English coast:** Salinity

- Low agreement between FerryBox and models
- Too low variability in BSH, mostly too low salinity in AMBIT

**Differences: BSH-FerryBox**

**BSH-FerryBox**

**FerryBox**

Hiller et al. (in review)
Model evaluation at „Deutsche Bucht“:
Salinity

- Good agreement between Fanny3x and MARINE6 stations.
- Salinity fronts not adequately represented in both models.

Model evaluation at „Deutsche Bucht“:
Salinity

- Negative bias: 0.03 (RMS), 3.33 (MAE).
- MAPE: 11.1 (RMS), 11.3 (MAE).

Conclusions

- Comparing evaluation of two hydrodynamic models, SDS_custom_v1 and AMM.
- Generally, good agreement for off-coast regions of water temperature and salinity.
- Limitations:
  - Temperature offset (AMM), failed to simulate peaks and too low in late summer near English coast (SDS_custom_v1).
  - Low performance near the coasts (both), especially for salinity.
  - Simulation of freshwater input by rivers (not runoff data of all rivers).
  - Vertical mixing representation in the models (e.g. Scottish coastal water current).
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
Baltic OSE and OSSE

Zhenwen Wan | Danish Meteorological Institute | zew@dmi.dk

Tables of content

- Circulation Model, Data Assimilation Scheme and Data Sources
- Observation System Experiment in the Baltic Sea
- Observation System Simulation Experiment in the Baltic Sea

Baltic monitoring systems and their assessments

- Real-time monitoring systems run 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.dmri.dk/models/hbm.uk.php

Data Sources

- SST — Satellite remote sensing L3 data
  Detailed in
  http://catalogue.myocean.eu.org/static/resources/myocean/pum/MYC2-OSI-PUM-010-018-V1.0.pdf

- TS profiles — from In Situ Thematic Assembly Centre
  Detailed in

Model domain and sampling locations. 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 TS profiles from moorings
Exp. 3: identical to reference run, but assimilating both data SST and TS 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).
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 & b), 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

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<td>+6.9%</td>
<td>+73%</td>
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OSE -- 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

OSE -- 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.
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.

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.

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.
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.

The end
Thank you!
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 isopycnals, 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

Objectives of the GESEBB campaign

- To analyze the 3D characteristics of the PW 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 eddy 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-III (7th Framework Programme).

First mission design

A floating submersible over the center of the PW SWODDY

Final mission

Cloud coverage... Not possible to locate the center of the eddy
**INTRODUCTION**

**DATA & METHODS**

**RESULTS**

**DISCUSSION**

**CONCLUSIONS**

**VERTICAL CURRENTS INSIDE X13**

(As a function of two different depth layers)

- Deep layer: 50-100m in depth
- Shelf seawater layer: Surface-lower depth (Shelf layer)

**CONCLUSIONS**

- DIFFERENT EVENTS WERE OBSERVED DURING THE OBSERVATION PERIOD:
  - A SHEDDY (MODE-WATER EDGE) AND TWO CYCLONES (CYCLONIC THICKNESS) WERE OBSERVED IN THE AREA.
  - HIGHEST FLUORESCENCES OBSERVED BELOW THE SEASONAL THERMOCLINE (STORM)
  - HIGHEST FLUORESCENCES INSIDE MODE-WATER EDGE, IN COMPARISON TO THE CYCLONIC THICKNESS
  - THESE STRUCTURES SIGNIFICANTLY CHANGE THE HYDROGRAPHIC OF THE AREA.

**THANKS FOR YOUR ATTENTION!**

Acknowledgements:
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Laurent Deshayes (NIOZ), Francesco Faraci (MISCOLO), Ana Ritce (Oceanlab),... And all the people that made possible this campaign!

Complementary information: Marie Calafate: mail@calafate.com
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, FRIIPP, GABS, MUSICS)

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 assess insights on the dynamics of the area, encompassing physical, biological, and chemical processes, at scales ranging from the sub-regional to the sub-mesoscale.

GABS – Deep Glider Acquisitions between Balares and Sardinia, Oct 12 – Nov 13
FRIIPP – Frontal dynamics influencing Phytoplankton Production and distribution during CIR period, May 14
MUSICS – Multi Sensor Investigations in the Channel of Sardegna, Aug – Sept 14
ABACUS – Algerian Basin Circulation Unmanned Survey, Sept – Oct 14

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

Deep Glider Acquisitions between Balares and Sardinia

GABS

OBJECTIVES
a) to assess the frontal properties of the physical processes of intermediate waters
b) to assess the spatial and temporal patterns of the western Mediterranean
c) to validate the operational hydrodynamic numerical model of the western Mediterranean (http://www.sedreocat.cnrs.fr)
d) to investigate mechanisms of spring bloom triggering over a frontal area

GABS 1st mission: 31/03/2013 – 16/03/2013
The glider measured water temperature, conductivity and incentives up to 3000 m, then maneuvered, and traveled at depths ranging between 300 m in the western Western – Atlantic and up to 4000 m in the western Western – Atlantic. Conductivity inside anticyclonic eddies, at about 300 m in about 40 kph.

Supported by " nf and Red is outboard. 31/01 – 02/02
2B/02-09/03

A series of phytoplankton blooms were triggered at the interface between the cold Antarctic Intermediate Water and the warm Atlantic Water in the North Atlantic. The blooms were detected by satellite imagery, and their timing was correlated with the occurrence of high sea surface temperatures. The blooms were observed in the North Atlantic and the Mediterranean Sea, and were associated with the intrusion of warm water from the subtropical region.
FRIPP

FRIPP OBJECTIVE

The project aimed to study the frontal dynamics influencing phytoplankton production and distribution during the DCM period.

FRIPP PRELIMINARY RESULTS

The two gliders deployed in the Mediterranean Sea to study the impact of frontal dynamics on phytoplankton production and distribution.

Multiproxy Multi-frequency data from the gliders, including CTD, ADCP, and nutrient sensors, were collected to study the impact of frontal dynamics on phytoplankton production and distribution.

Multi-Sensor Investigations in the Channel of Sardinia

MuSICS

S. Della Santa

SAROS Marine Engineering and Geosciences Division, Tusco

P. Tedd L. Mortar

LOGONGH Pino,

F. D. J. Enric

L. C. Pino, Pisa

Other contributors:

D. C. Donato, L. C. D. B. B., Tedd J.

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.

- Access water quality data at various sensors using the glider.

- Determine and quantify exchanges through the buoyant and the complex interactions through eddies.

Algerian BASin Circulation Unmanned Survey

ABACUS

Giuseppe Aulicko, Giorgio Bottia, Yuri Cotroneo, Giannetta Fusco

DIST, Lirun, “Fondazione” Naples, Italy

Nadia Ah-Ammor, Hendere Yache

ENSMA/B, Bôa des Cares, Dely Slihat, Algeria

J. Tintoré, M.C. Torres

CSCS-MICEDAS/CISB (Spain)

Objective:

- To identify the physical and biological properties of surface and intermediate water masses between Sicily and the Algerian coast.

- To understand sub-basin dynamics and the complex interactions due to eddies.

- To collect high-resolution data on various planktonic variables when monitoring the Algerian coast.

- To establish a monitoring site between Sicilian and Algerian Coasts.
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).
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
K. Sanchez-Vidal, A. Ruano-Rodriguez, H. Bengtson, H. Hellemans, E. Zacharias
JERICO Science Day: Berlin, Germany

Why monitoring particle (and carbon) fluxes?

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

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

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

Objectives of the JERICO TNA METRO (Mediterranean sediment Trap Observatory) experiment

3. Monitoring 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).
Methods of the JERICO TNA METRO (Mediterranean sediment Trap Observatory) experiment
Field work – Sicily Channel

First results obtained
Total mass fluxes in the Sicily Channel

- Total mass fluxes show minimum values (170 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?

First results obtained
Environmental drivers: CH\(_4\) concentration

- High CH\(_4\) values in January and February 2014, higher primary production and nitrogen deficiency in the Agostino-Bernini core, as seen by MBARI imagery.

January 2014, April 2014

First results obtained
Environmental drivers: circulation

- Atlantic water flows at the surface West to East.
- LIF and DABVR flow at intermediates depth East to West.
- Long time series of currents in C01 and C02 since 1999, regular six months oceanographic cruises.
- Currents 130 m in C01 site.
- Energetic currents (maximum values > 90 cm/sec).

CE01-C01
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 particulate.

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

<table>
<thead>
<tr>
<th>Area</th>
<th>Depth (m)</th>
<th>Annual mean flux (mg m⁻²)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Mediterranean</td>
<td>220-450</td>
<td>100-1000</td>
<td>Wapstra et al.</td>
</tr>
<tr>
<td>Mediterranean Sea</td>
<td>300-900</td>
<td>200-3000</td>
<td>Louvet et al.</td>
</tr>
<tr>
<td>Adriatic Sea</td>
<td>400-800</td>
<td>400-1000</td>
<td>Zupanci et al.</td>
</tr>
<tr>
<td>Black Sea</td>
<td>400-800</td>
<td>500-1500</td>
<td>Pitter et al.</td>
</tr>
</tbody>
</table>

To be done / future work

- Complete chemical analyses of content of major components of particle fluxes (organic carbon and its stable isotope, opal, calcium carbonate, lithogenic) as well as grain size of settling particles
- Analyse pollutants (trace metals as well as 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
**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
**Phytoplankton fluorescence**

- a proxy of biomass, taxonomy, production

To study phytoplankton dynamics at relevant biological scales, fluorescence-based techniques are essential part of automated platforms and sensor systems.

To increase the coherence, we need to take further steps, besides technical developments, in harmonizing methods, calibration and validation.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chl fluorescence</td>
<td>Phytoplankon abundance</td>
</tr>
<tr>
<td>Chl fluorescence</td>
<td>Cyanobacteria abundance</td>
</tr>
<tr>
<td>Spectral fluorescence</td>
<td>Phytoplankon taxonomy</td>
</tr>
<tr>
<td>Variable fluorescence</td>
<td>Phytoplankon productivity</td>
</tr>
</tbody>
</table>

---

**Phytoplankon fluorescence**

- Single channel fluorometers for Chlorophyll a

- Advantages of the technology:
  - Semiquantitative estimation of Chl concentration
  - Fraction of Chl a in non-fluorescing photosystem II (bacteriochlorophyll)
  - Photobacterial effects on magnitude of fluorescence (physiology)
  - Challenges in calibration & validation
  - Challenges in instrument comparison (due to spectra & primary calibration)

---

**Single channel fluorometers for phycooblastoids**

- Wavelength selection
- Photoacclimation and pH
- Origin of fluorescence signal
- Presence of different chlorophylls in other organisms
- Primary calibration
- Secondary calibration
- Field validation
- Pseudo-specific fluorescence of phycoobilin

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**Spectral fluorescence as taxonomic tool**

- Fluorescence spectra is a sum of a series of well
  - Composed from absorption and fluorescence of each component linearly
  - Related to concentration

---

**Measuring fluorescence**

- Single channel fluorometers for Chlorophyll a

- Advantages of the technology:
  - Semiquantitative estimation of Chl concentration
  - Fraction of Chl a in non-fluorescing photosystem II (bacteriochlorophyll)
  - Photobacterial effects on magnitude of fluorescence (physiology)
  - Challenges in calibration & validation
  - Challenges in instrument comparison (due to spectra & primary calibration)
Measuring spectral fluorescence
- Multichannel fluorometers

Challenging spectral fluorescence
- Spectral groups

Four major spectral groups:
- Cyanobacteria
- Chrysophytes
- Chlorophytes
- Green algae
- CO2

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

Measuring spectral fluorescence
- Field demonstration

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 Chl 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
- Analysis of added value of new wavebands
- Development of a suite of analytical tools for spectral analysis
  - To analyze spatial-temporal patterns (hysteresis) and trends
  - To locate gradients and assesses automated water sampling

Measuring variable fluorescence
- Quick overview of techniques

Minimum fluorescence $F_{0}$: reaction centers open
- sample in dark (0-30min) to relax all fluorescence quenching processes

Maximum fluorescence $F_{m}$: reaction centers closed
- adapting a strong light pulse (FLP) or rapid chain of flashes (FRP) to saturate the electron transport chain
- $F$ and $F_{m}$ steady state and maximum fluorescence under similar light
- measurements under growth light

PSII photochemical efficiency $= F_{v} / F_{m}$
- $F_{v} / F_{m}$ value for healthy cells is ~0.85
Measuring variable fluorescence
- Towards primary production estimates

$ETR = E \cdot \phi_{\text{max}} \cdot \phi_{\text{Fv}} \cdot \phi_{\text{F0}}$

- $E$ = light intensity
- $\phi_{\text{max}}$ = functional absorption cross section
- $\phi_{\text{Fv}} = \text{ratio of functional PSII reaction centers to CHL a}$
- $\phi_{\text{F0}} = \text{PSII efficiency factor} = \phi_{\text{Fv}} F_{\text{v}} / (F_{\text{v}} - F_{\text{0}})$
- $\phi_{\text{F0}}$ = electron yield from each reaction center charge separation

$\phi_{\text{F0}}$ = conversion factor between ETR and CO₂ uptake
- Assumptions in the ETR above
- Light source of incubations
- Different water samples
- Different incubation times
- Photosynthetic quotient

Measuring variable fluorescence
- Towards operationality

- Next generation FRRI
- Two wavebands
- Fitted in flow-through systems
- Rapid light curves

Measuring variable fluorescence
- Ongoing issues

- Variability of conversion factor (modeling, proxies)
- Spectral scaling methods; instrument vs. nature (includes spectral mismatch & PSII absorption)
- Added value of new spectral bands
- Harmonization of protocols and equations (e.g., rapid light curves)
- Testing new, improved instrument calibration proposed recently
- Instrument intercomparison
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
Algal bloom observations using the JERICO infrastructure

Ragnar Kallrin, Niko Matti, *Ny u* and Andrei Andreevsky
Swedish Meteorological and Hydrological Institute, Gothenburg, Sweden
NCHI/Vägby Institute of Technology, Stockholm, Sweden

*Corresponding author
jarge.kallrin@smhi.se

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

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

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. CTD, Acoustic Doppler Current Profiler)
- Ships of opportunity, i.e. research vessels
- Fluorescence of chlorophyll – proxy for phytoplankton biomass
- Fluorescence of phycocyanin – proxy for biomass of certain cyanobacteria
- Oxygen – related to primary production
- Automated water sampling
- Research vessels
- Benthic flux
- CTD with sensors for fluorescence of chlorophyll and phycocyanin – Oxygen – related to primary production
- Shoe sampling

Some problems to solve
- What is the spatial and temporal distribution of phytoplankton?
- How do blooms develop?
- Are the blooms harmful?
High frequency sampling using two FerryBox systems reveals bloom of harmful algae in the Kотtugott - eastern part of the North Sea

Key methods
Chlorophyll a fluorescence
Automated water sampling
Microscope analysis

Harmful algal bloom detected
Pile herring, Trachurus/Pennellaichthys observed directly after bloom

Biomass of phytoplankton at the class level at station Anholt E

Kartel et al. in prep

Combining data from multiple platforms 22-23 August 2012

Study of cyanobacteria bloom

Underway measurements:
- Salinity
- Temperature
- Oxygen
- Chlorophyll fluorescence
- Turbidity
- Phycoerythrin fluorescence
- CDOM fluorescence
- Photographs every minute

Water samples:
- Phytoplankton composition and biomass
- HPLC pigments (also not shown)
- Molecular biological description of biodiversity

Karenia mikimotoi
- Found in August in the Kотtugott- Skagerak front near Skagen
- Thin layer at 20 and 45 m depth
- Abundances 300 000 cells L⁻¹

Cyanobacteria bloom in the Baltic Sea 2013
Satellite remote sensing of surface accumulations of cyanobacteria

17 July 2013. MODIS, Baltic Argus Watch System

Conditions during study in July 2013
Phycocyanin fluorescence - proxy for cyanobacteria

Conditions during study in July 2013
Chlorophyll fluorescence – proxy for phytoplankton biomass

Overview of conditions in 2013

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

Microscopy
- Sample preserved using Lugol’s solution on the ship
- Analyzed using inverted microscope
- Sediment volume ~ 20 ml
- Magnification 40-400 x

rDNA
- U0-50 ml filtered on the ship
- Frozen using liquid nitrogen
- Sequenced using Illumina MiSeq
- Approximately 100-300 sequencing reactions
- Euukaryotic organisms:
  - 15S rDNA (OTUs)
  - Clustered at 97% sequence similarity
- Prokaryotic organisms
  - 16S rDNA (OTUs)
  - OTU = Operational Taxonomic Unit
Overview of data from microscopy

Total biovolume

Number of taxa

Comparison of DNA relative counts and microscope counts

Comparison Utternhöhl vs rDNA

Microscopy — Utternhöhl
- organisms with morphological features detected
- cell numbers
- cell volumes — biomass
- Low sample throughput
- Small organisms (< 0.5 μm) not well identified
- Autotrophic plankton not included

rDNA 16S and 18S
- high sample throughput
- skilled taxononist not needed
- also the very small organisms are included
- Sequence must be available in database
- Limited information related to cell abundance or biomass

Summary and conclusions

- Microscopy analysis and DNA 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 analyzed
  - Variable DNA content in organisms
  - Cell counts and molecular results are not directly comparable
- A more extensive study is underway

The JERICO NEXT STEPS

Algal bloom studies in several European seas

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

Novel methods
- Imaging Flow Cytometry
- Molecular methods
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 Mediterranea

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 ISiS 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
Development of new imaging tools for the monitoring of plankton

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

Virtually Imaging Platform for Plankton and Particles – VIP3

- In situ plankton > 500 µm and particles > 60 µm
- Benchtop plankton > 3 µm

1 software for analysing images

ZooScan 1.4

http://www.cbs-tlf.fr/duke/RadkZoo/RadZooZoo.html
www.zooscan.com

VIP3 Achievements 2010-2015

~ 25 papers
7 PhD

VIP3 Ongoing projects

- Tenerife & the Canary Island: plankton analysis (ZOOLab & F/K4Lab). 1996 net samples
- RadkZoo program: decadal multi-net program. Over 2800 net samples since 2009
Zooprocess - Running new instruments

Tuned to handle images and image sequences from 5 types of instruments - Pito Zeecon and UFPS for image acquisition.

Zooprocess - Workflow

- get vignettes & features for automatic identification
- Log of settings and metadata for further processing
- Numerical separation / sample-specific learning set
- Validation / Quality Control - Cross-validation on a subset

Zooprocess - Metadata management tools

- Scanned metadata filling forms and editor
- Quality tags

Zooprocess - Numerical separation of Touching Objects (TO)

- 4 elements TO → Separated TO → 4 new objects
- Increased data quality and accuracy of counts and biomassa estimations

Zooprocess - Vignette management for Quality Check (QC)

- Automatic Identification
- Visual validation
- Identification QC by mass validation on a randomly selected representative subset of each identified category
Development of new imaging tools for the monitoring of plankton.

**EcoTAKA - Automatic Identification & validation**

- Improve the efficiency of automatic identification and manual validation by enhancing collaborative work, improving GUI and data management.

**Whole Plankton - time series and Ecological Succession**

- A pilot study to demonstrate feasibility of end to end plankton monitoring - collection - digitisation - image analysis - plankton computer assisted recognition - relevant indicators of plankton change.

**Whole Plankton - time series and Ecological Succession**

- Weekly data from microbes to jellyfish - physical background.

**Physical structure sequence**

- Remarkable events.
- Physical forcing on whole-plankton succession.

**Whole Plankton - time series and Ecological Succession**

- Development during JERICO showed that whole plankton digitisation 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** succession at relatively **high frequency**, and are relevant in the framework of the MSFD (D4: food webs and D1: diversity) or for any plankton survey.

**Collaborative online solution** is likely to sustain long term monitoring programs and platforms, and enhance community building and large collaborative projects (EcoTAKA).

Perspectives (JERICO2023) is to test **in situ systems** (with the UVIS) and continue the **dissemination of methods** through the scientific community and **coastal surveys** (for example French MPAs).
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.


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 Bernaud, Ludovic Pascal, Olivier Maire and Antoine Gremare

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 profiling images (SPI) to infer the ecological quality status of benthic habitats
  b) in situ video imaging of the water-sediment interface using ROVs or other mobile carriers to infer the abundance of suprabenthos
  c) videos recorded by fixed cameras to assess activity and growth in benthic organisms

Software Description: AviExplore

Case studies

Moving tool: Epibenthos Search
1. Coral in Mediterranean
2. Axinella polyopoides detection
Fixed tool
- Sediment Column
- Upogebia
- Abra abla
- Abra alba
- Diuraphana anedina
- Abra orata

Case study 1:
- Film from ROV during MEDECO cruise (South Italy)
- Geolocation file available
- Goals:
  - Coral detection: presence/absence
  - Coral sitting
  - Differentiation between probably dead and apparently living corals (Lophelia pertusa and Madrepora occulata)

Case study 1: Corals

Non treated film
Treated for dead and living corals
Treated for living corals

Shallow film size: 100 images
Analysed film size: 1000 images

Case study 1: AviExplore Results

Image detection rules:
Images can be classified as: type with coral or type without coral.
- Total Accuracy: 99.4%
- Agreement between images classified by the software and visually
- Error analysis:
  - False positive error: 5.4%
  - False negative error: 4.3%

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* stringing

Case study 3: Upogebia behaviour

- Goal: Identify the types of behaviour.
  - Resting
  - Burrowing
  - Walking
  - Ventilating
  - Hidden
Case Study 3: Behaviour summary

Case Study 4: Abra alba
- Goal: assess the intensity and the modality of sediment reworking by tracking luminophore movements.

Case Study 4: AviExplore Results

Case Study 5: Ditrupa arietina
- Goal: Describe filtering activity by tracking the opening of the gill fan.

Case study 5: AviExplore Results
Case study 6: *Abra ovata*

- **Goal**: describe feeding activity by tracking siphon movements

Conclusions

- AviExplore allow for the automation 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.
  - Provides automated acquisition and in some cases automated real-time analysis.

- AviExplore is currently available on request:
  - skiu.romero-ramirez@u-bordeaux.fr
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)

Track long-term hydrological changes in a changing sea

- EMT in 90's: shift of the DWIF zone → eastern deep waters warmer and saltier
- WNT in 2004/2005: new WIMDW warmer and saltier; larger volume of WIMSW

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

Sicily - Corsica - Ligurian

- Similar long-term oscillation: 1 increase until 2004 followed by a sharp decrease until spring 2006
- Corsica and DITFED both reached their absolute maximum and minimum less than 24 month, suggesting dramatic changes occurring in recent years (WNT)

Field experiment: track oxygen in the core of the LIW depth (350m-490m)

OL mooring:
- Installation of moorings 3875 on SBE15 since Oct 2012 @41.5m (time: 31mns)
- Installation of moorings 4330 since May 2013 @41.5m

DYF mooring:
- Installation of moorings 4330 in 2012 did not work
- Installation of new SBE37-000 since July 2014 (LIW = 350m and WIMSW = 2200m)
- Gales in July 2015

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

→ T-S time lag observed
→ Need CTD proxy more sensitive
→ Talk GEF-COR
Summary and Challenges

- CORSICA Channel and DYFAMED sites are connected through LW circulation. Time lag of LW travel is around 1 month.
- Perturbation in CORSICA Channel seems to influence the LW properly 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 CG mooring and take DO data on DYFAMED mooring.
- Finally, need to connect SICILY STRAIT – LIGURIAN - GULF of LION.

DyFamed monthly CTDO2 profiles in 2013-2014 (9-2350m)

Summary and Challenges

- Larger needs: monitoring the Tyrrhenian Sea (black box) and the Levantine Basin (LW formation) ➔ K2020 BG12 plans?
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 Helmholtz 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 NH₃ and PO₄ in Ferrybox (FITO MicroLFA)

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-CMP3 and others
- Compact dimensions: 279 (W) x 190 (D) x 175 (H) mm
- Hydraulics / electronics

The micro Loop Flow Reactor NH₃ Fluorimetric Measurement range: 0-30 μMol/L

- Analytical sequence description:
  1. Water sampling
  2. Fluorescence start reading
  3. EPA reagent dosing and mixing
  4. 55°C heating to speed-up the reaction
  5. Final fluorescence reading and correlation with NH₃ concentration
  6. Hydraulic circuit final cleaning

The micro Loop Flow Reactor PO₄ 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 PO₄ concentration
  7. Hydraulic circuit final cleaning

Field test in Cuxhaven fixed station on Elbe river mouth

- NH₃ and PO₄ measurement data were automatically collected from May 19th to July 7th, 2014
- A further set of PO4 monitoring data were also collected from August 3rd to September 22nd, 2014
- PO4 data comparison with Micromac C MP3 on-line analyzer
Field test in Cuxhaven fixed station on Elbe river mouth

NH₃ and PO₄ graphic trends (µMol/L) in Cuxhaven fixed station collected between May 19th and July 7th, 2014
Measurement frequency: one hour.

Field test on Lysbris Ferrybox system

- Location on Lysbris, under the Ferrybox
- 12 unattended cruises performed between July 16th and September 25th, 2014; measurement frequency: one hour
- PO₄ and NH₃ data comparison with on-board Micromac-1000 units

Field test on Lysbris Ferrybox system

Data trends of NH₃ and PO₄ 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

Field test on Lysbris Ferrybox system

Ferrybox PO₄ 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)

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
- PO₄ fluorimetric method allows trace level detection in open sea
- Module compactness allows easier integration in Ferrybox systems.

MANY THANKS TO:
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 aerosol 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, antipyretics (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 (>500 μatm) 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
**Motivation**

- The ocean is facing a rapid change due to the increased uptake of CO₂ 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 CO₂ budget
- SOOs (e.g. FerryBox etc.) are adequate platforms for continuous monitoring of the surface ocean

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**Coastal Carbon Dynamics:**

- Primary production
- Ocean acidification
- Alkalinity transport
- Sinks/sources for CO₂
- Feedbacks to the fling atmospheric CO₂ concentration
- From physical parameters to chemical and biological processes

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**FerryBoxes as Platforms**

- Cost-effective and good to handle on SOO
- Less high demands on autonomy for new sensors developments (time sensor, unlinked environment power requirement...)
- High spatial and temporal resolution
- Long-term records and seasonality resolution
- Tracking of short-term biological processes
Carbonate System

- **Two out of four** (five) measurable parameters are needed for a full characterization of the carbonate system
  - pH, pCO₂, C₅, A_i(CO₃)
- pH and pCO₂ are available as autonomous sensors
- Combination is not recommended

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<tr>
<td>pCO₂</td>
<td>± 1.8</td>
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<td>± 1.9</td>
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<tr>
<td>A_i(CO₃)</td>
<td>± 1.9</td>
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**High precision pH - Sensor**

**pH – Principle**

- RIA: using an indicator dye (Cresot purple)
- Determination of the concentration of the indicator acid (H⁻) / base (B⁻) due to different absorption spectra
- Calculation of the pH-value using transcendence-linear equation

**TA - Sensor**

- 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 parameterise important T/A/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 (H$^+$) / base (OH$^-$) from absorption spectra (CCD spectrometer)
- Calculation of the pH value using Henderson-Hasselbach equation

Field Application in the North Sea
pH and pO2 Data (1st attempt: closed cell titration)

- Measurements in the North Sea (Waddensea)
- Measured range: 3240 µmol/kg to 3470 µmol/kg
- Measurement Cycle: 7 minutes
- Period: 12 days → 3100 values

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
- Field demonstration on research cruises are promising concerning accuracy and robustness
- Optimization of the systems are ongoing activities (MEXOS, JERICO-NEXT)
Thank You
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 CO₂ 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

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