STRUCTURE AND VARIABILITY OF THE ABYSSAL WATER MASSES OF THE EASTERN MEDITERRANEAN IN THE RECENT YEARS: THEIR LINKS WITH ADRIATIC AND AEGEAN SEA

Proposal paper

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Outline

1. Introduction about the study area
2. Observations and datasets used
3. Thermohaline variability in the Ionian sea
   - Connection with Adriatic and Aegean Sea
   - Iso-surface plots of T, S, Oxygen
4. General circulation of the Ionian sea from ADCP vessel mounted and Absolute Dynamic Topography
5. Discussion in between each point
6. Conclusions
Introduction

• The Ionian Sea: a basin located in the middle of the Mediterranean Sea influenced by the exchanges between waters from eastern and western basins, so as from the Adriatic Sea that “in normally conditions” represents the source of dense waters for the whole eastern Mediterranean.

• AdDWs spread and sink into the Ionian Sea through the Otranto Strait after winter seasons. It takes 2-3 years for the new water to reach the southern Ionian, 10-15 years to reach the Levantine basin and 15-20 years to reach the far east of the Levantine (Wu and Haines, 1996).

• The entire overturning of the eastern Mediterranean basin would take around 100 years (Roether and Schlitzer, 1991).

• The EMT: represent a change of the typical steady state picture (AdDW source of EMDW) occured between 1989 and 1994/1995.

• A continuously increase of salt was observed in the layer 200-1000m after 2003 till 2007 and this fact contributed to generate new AdDW and than new EMDW saltier and warmer than before.

• A bimodal decadal oscillation system (BIOS) has been recently described by Gacic et al. (GRL, 2010) to explain the salt content changes into the Adriatic Sea and of course this can be related to the Eastern Mediterranean thermohaline variability observed in the last two decades.

Cardin V. Bensi M. Pacciaroni M. Variability of water mass properties in the last two decades in the Southern Adriatic Sea with emphasis on the period 2006-2008. Submitted on CSR in 2010.
Objectives

The main goal of this work is to investigate data collected into sub-areas A, B, C, D (Ionian and Adriatic Sea) and in particular the distribution of dense waters of Adriatic origins into the Ionian Sea.

1. Variability of the EMDW in the last years

2. Contribution from Adriatic Sea and Aegean Sea

3. Possible Future scenarios?
Datasets

MSM13-2 : October 2009

MSM 15-4: July 2010

Ionian sea: (Zone A) (between 2003 – 2008)

**Potential density (kg/m³)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tpot (°C)</th>
<th>Salinity (p.s.u.)</th>
<th>Sigma-t (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>13.34</td>
<td>38.70</td>
<td>29.19</td>
</tr>
<tr>
<td>2008</td>
<td>13.41</td>
<td>38.73</td>
<td>29.20</td>
</tr>
</tbody>
</table>

**Results and discussion**
In the abyssal plan we distinguish 2 different water masses:

1. Old EMDW (colder and fresher)
2. New EMDW (saltier and warmer)

Oxygen is an important tracer
## Ionian sea: (Zone A)

### Table 1 – Mean thermohaline properties in the abyssal stations of the Ionian Sea (Zone A)

<table>
<thead>
<tr>
<th>Year/month</th>
<th>Cruise</th>
<th>Stations</th>
<th>$\theta$ ($^\circ$C)</th>
<th>Salinity</th>
<th>Salinometer</th>
<th>$\sigma$ (kg/m³)</th>
<th>$O_2$ (ml/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/January</td>
<td>M73-1</td>
<td>106</td>
<td>13.415</td>
<td>38.738</td>
<td>n/a</td>
<td>29.2058</td>
<td>n/a</td>
</tr>
<tr>
<td>2008/March</td>
<td>S-IT2</td>
<td>008-009</td>
<td>13.418</td>
<td>38.738</td>
<td>38.7459</td>
<td>29.2047</td>
<td>4.7</td>
</tr>
<tr>
<td>2008/September</td>
<td>S-IT6</td>
<td>008</td>
<td>13.419</td>
<td>38.738</td>
<td>38.7433</td>
<td>29.2049</td>
<td>4.6</td>
</tr>
</tbody>
</table>
### Otranto Strait and Adriatic Sea: (Zone B)

<table>
<thead>
<tr>
<th>Year/Month--cruise</th>
<th>Θ (°C)</th>
<th>S</th>
<th>σ₀</th>
<th>DO (ml/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006/Nov -- VECTOR</td>
<td>13.36</td>
<td>38.75</td>
<td>29.22</td>
<td>4.92</td>
</tr>
<tr>
<td>2008/Oct -- SESAME</td>
<td>13.25/13.30</td>
<td>38.71/38.72</td>
<td>29.22</td>
<td>4.88</td>
</tr>
<tr>
<td>2009/Oct -- MSM13</td>
<td>13.26/13.30</td>
<td>38.72</td>
<td>29.22</td>
<td>4.82</td>
</tr>
</tbody>
</table>

All data indicate a tendency to a fresher and slightly colder Adriatic outflow.

Mooring data in the northern part of **Otranto Strait** (Oct 09 and July 2010)

Results and discussion
Ionian sea: (Zone B)

October 2009

Why the signal of LIW is still strong on the Otranto Strait but not in the South Adriatic?
Results and discussion

Aegean sill : (Zone D)

CDW (13.55, 38.73) at ~1800 m

Old EMDW at ~ 3000 m

New EMDW (saltier and warmer) at ~ 4000 m

In few months is noticeable a slighty increase in salt in the deeper layer and also a slighty decrease in temperature.
General surface circulation

October 2009

Results and discussion

Dyn. Ht. -250 [dyn m] @ PRES=Top

CTD data

Satellite data
Results and discussion
Results and discussion

Bensi et al. – Venice, 2010
Results and discussion
Dense water pathway

Results and discussion
Conclusions and suggestions?

1. The Adriatic outflow is changing, so we are observing changes in EMDW of the zone A in agreement with these changes.

2. The outflow of AdDW is split in 2 parts (east and west) probably as consequence of the topography.

3. There are evidences of changes of the EMDW of the zone D but not in agreement with the ones observed in the zone A. It depends on time lag between each zone?

4. Possible future scenarios for the EMDW?
   a) Which is the role of the Aegean outflow in the recent changes of the dense water in the ionian abyssal plan? i.e. the mixing of CDW with AdDW in the northern ionian.