Glider Observations and modelling of an abrupt mixing process in the upper ocean

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Acknowledgements:
Teledyne Webb Research support services
• Introduction: IMEDEA glider activities at Western Med

• Objectives

• Data set:
  • Dec09 glider mission
  • Buoys network
  • Model outputs

• Results

• Summary
IMEDEA glider activities at Western Med.

Complex dynamics
- At North: NC
- At south BC, its associated front and AW inflow
- In-between, mesoscale (eddies, meandering...) due to heterogeneous water masses mixing

Path planning / adaptive sampling
Alvarez et al., 2004, IEEE
Garau et al., 2006, IEEE
Glider and altimetry
Ruiz et al., 2009a, J. Mar. Sys.
Ruiz et al., 2009b, Geophy. Res. Lett.
Bouffard et al., 2010, J. Geophy. Res.
Multi-platform approach
Pascual et al., 2010, Sea Tech.
Pascual et al., 2011, JGR (in preparation)
Thermal lag
Garau et al., 2011, JAOTech (accepted)

Summary of 5 years of glider activities
Ruiz et al., 2011, Sci. Mar. (submitted)
Study area and scientific objective

Atmosphere-Ocean interactions

- To investigate the impact of an atmospheric front on the ocean mixed layer
- Atmospheric forcing.
- Mixed layer (high resolution from glider data).
- Heat content.
### Summary glider mission

#### Jason 1 Dec09 mission – Western Med

<table>
<thead>
<tr>
<th>Area</th>
<th>Balearic Sea – Western Mediterranean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>ECOOP</td>
</tr>
<tr>
<td>Start Date</td>
<td>09/12/2009</td>
</tr>
<tr>
<td>End Date</td>
<td>20/12/2009</td>
</tr>
<tr>
<td>Total Days</td>
<td>12 Days</td>
</tr>
<tr>
<td>Total Navigation Miles</td>
<td>255 Km</td>
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<tr>
<td>Number of Profiles</td>
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<tr>
<td>Number of Iridium Connections</td>
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<td>Data transmitted through Iridium</td>
<td>4.231KB</td>
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<td>Data Stored and Downloaded:</td>
<td>10.5MB (289,459 records)</td>
</tr>
<tr>
<td>Initial Batteries</td>
<td>13.97 Volts</td>
</tr>
<tr>
<td>Final Batteries</td>
<td>12.63 Volts</td>
</tr>
</tbody>
</table>

0-200m Coastal glider

 eventos
Deep buoys network in the WMED - Puertos del Estado

- Meteorologic, oceanographic and waves data
- Hourly data
- Northwestern Mediterranean Sub-basin
• 6 km resolution
• hourly
• 47 levels
• (NCEP as boundary conditions)
Glider Results: Hydrography
Results: hydrography and estimated mixed layer (criteria $\Delta 0.2^\circ C$)

(Ruiz et al, 2011, in preparation)
Results: Observations from Buoys PdE network

Atmospheric forcing over the sub-basin
• Very good agreement with the observations
• Dragonera: 1020hPa → 990 hPa
• Very good agreement with the observations
• Wind >20m/s during the storm
Kind of cyclogenesis → only 1-2 days
Low pressure traveled NE from Marroco to Ibiza and next to SE until the African coast and dissipated
The heat content (Hc) is computed as:

\[ Hc = \rho_0 c_p \int_{z_2}^{z_1} \Delta T \, dz \]

\( \rho_0 \): mean density; \( c_p \): heat capacity; \( T \): temperature; \( z \): depth

WRF model

The total heat budget \( Q_T \) consists of two radiation components and two turbulent components.

The first are the solar net radiation flux \( Q_S \) absorbed by the sea (shortwave) and the net terrestrial flux radiation \( Q_B \) emitted by the sea (longwave).

The turbulent components are the latent heat flux \( Q_E \) and the sensible heat \( Q_H \), which are related to energy losses of the sea by evaporation and convection, respectively. Hence, the budget can be represented by:

\[ Q_T = Q_S + Q_B + Q_E + Q_H \]
Summary

• High resolution glider data from a mission performed in the Northwestern Mediterranean allow to characterize the upper ocean response to the pass of an atmospheric front.

• Potential temperature change observed by CTD glider data in the upper layer: 16°C to 14.5°C.

• Abrupt change (~30 m) of the mixed-layer-depth after the pass of the Atmospheric front

• WRF model reproduces an atmospheric cyclogenesis event (validated with buoys observations) that could be responsible of the mixing process observed in the upper ocean.

• Preliminary analysis of heat content from glider data and modelled heat fluxes (WRF and NCEP) demonstrate that latent and sensible heat loss dominate the net surface heat balance.

Next step: Using WRF as atmospheric forcing

High resolution ocean numerical mode (ROMS) to reproduce the mixed process
Garau et al., 2011, J. Atmos. Oce. Tech. (accepted)
Thermal Lag Correction on Slocum CTD Glider Data

Index for gliderToolbox/ctdTools/thermalLagTools

Matlab files in this directory:
- adjustThermalLagParams - ADJUSTTHERMALLAGPARAMS - CTDs Thermal lag parameters adjustment.
- buildMinimizationOptions - BUILDMINIMIZATIONOPTIONS - Builds a set of options for minimization
- buildPolygon - BUILDPOLYGON - Builds a polygon based on two lines and computes its area
- computeAvailablePotentialEnergy - COMPUTEAVAILABLEPOTENTIALENERGY - Potential energy wrt no density inversion
- computeTCLag - COMPUTETCLAG - Compute time lag between Temperature and conductivity signals
- correctThermalLag - CORRECTTHERMALLAG - CTDs Thermal lag correction.
- fitThermalLagParams - FITTHERMALLAGPARAMS - CTDs Thermal lag parameters fitting.

Dependency Graph
- View the Graph.